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Energy in US and EU Industrial Policies: A Comparative Analysis

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Introduction

The International Monetary Fund defines industrial policy as "*government efforts to shape the economy by targeting specific industries, firms, or economic activities*". This places industrial policy as an opposite approach to the purest reliance on the market to achieve the best economic outcome. For its implementation, industrial policy needs a specific toolbox concerning subsidies, protectionist measures, and investments in research and development of the targeted sectors. Usually, industrial policy is designed with a specific goal, or sector to be supported by governments. Several examples can be found identifying national champions across different national economies. In this, self-sufficiency has initially been considered a priority, then varying according to the historical context. Literature[1] shows how major economies started to push for liberalization only after reaching some level of supremacy over the relevant industries. Several cases can be traced in European countries' policymaking during the Industrial Revolution, with Germany and France on top of the list. This shows that industrial policy was key to the early development of Europe, as much as it was in more recent times for Asian countries, enabling governments to protect national markets where operators were granted the space to grow before entering in competition with foreign actors. The clearest results of this practice are the automotive sector in Germany, as well as the semiconductor industry in Taiwan. Notably, Berlin had led an innovation wave in the last decades of the nineteenth century, well represented by the patent registration of the first rational-heat engine in 1893 by Rudolf Diesel. After the First World War and the Weimar Crisis, the German industry had lost its edge. The rise to power of the National Socialist German Workers' Party in the 1930s, and the leader's personal initiative[2] played a role in reassigning centrality to the sector as the preferred recipient of the country's natural and financial resources. The automotive sector is key to the country's economy still today. With the whole of Europe depending on external aid for reconstruction during the second postwar period, industrial policy became a key pillar of government interventions. A wider role for the State started to be accepted with the implementation of the first welfare policies, leading to an increasing favor for governments' deeper role in the economy. This changed again with the rise of the New Right, a political trend championed by Margaret Thatcher and Ronald Reagan, respectively in Europe and in the United States. The new leaders advocated strongly for a reduced role of the government, often represented as "*the problem, not the solution*"[3]. This new angle was followed and empowered by a

[1] Polanyi, K. (2001). *The Great Transformation: The Political and Economic Origins of Our Time*. Boston: Beacon Press.
[2] Tolliday, S. (1995). *Enterprise and State in the West German Wirtschaftswunder: Volkswagen and the Automobile Industry, 1939-1962.* The Business History Review.
[3] Ronald Reagan Presidential Library (1981). Inaugural Address.

broadly accepted approach in international trade, which excluded geopolitics from the equation[4] and considered economic factors as the sole responsible for defining trade flows and supply chains. The new framework envisioned a scenario where the intertwinement of national economies was deep enough to equal the growth of one with the growth of all. In an attempt to achieve the most economically efficient set available, while integrating all countries in a single system, industrial policy was left behind by favoring a massive de-industrialization trend in the developed countries, to exploit lower costs in low-income States. This favored a reduction in prices and indeed more efficient supply chains, while slashing developed countries employment rate in manufacturing, with a one-third reduction in less than 25 years[5]. In a time where experts were starting to believe to the end of history[6], countries political like-mindedness were not considered as a valuable factor to shape international policies. In recent years, this trend was abruptly reversed. The transition from a positive sum game to a zero-sum exercise[7] was summoned by John Sullivan, the National Security Advisor to US President Biden, who called for new rules of the game to inform the international scene[8]. This marked the comeback of geopolitics, and therefore industrial policy in the political discourse of the West. The deindustrialization trend was discarded, and reshoring of manufacturing operations took the lead. Clear evidence of the interconnection between geopolitics and industrial policy was the introduction of the new concept of friend-shoring. This demands the restructuring of supply chains according to geopolitical factors, including in those chains only countries that can be considered politically reliable allies, more than economic convenient partners.

The two legislations on which our analysis will be focused are enshrined in this context, with both responding to geopolitical risks rather than any other factor. The Inflation Reduction Act was the result of a growing concern the United States experienced toward China's role in international economy, and specifically in the strategic sectors of clean energy. Similarly, the European Union produced the Net Zero Industry Act as a tool to maintain its industrial position in those same sectors against the competition of third parties, and notably the United States and China. From a theoretical standpoint, both Acts' scope is focused on protecting the internal industrial fabric against competition perceived as unfair, more than anything else. As a matter of fact, reindustrialization moves along a threshold where economic efficiency is traded for security.

The following work aims at presenting two very different approaches in achieving the aforementioned result. The Inflation Reduction Act represented the first ever structured climate policy Washington

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[4] Mead, W.R. (2014). *The Return of Geopolitics: The Revenge of the Revisionist Powers*. Foreign Affairs.
[5] Rwothorn, R., Ramaswamy, R. (1997). *Deindustrialization – Its Causes and Implications.* International Monetary Fund.
[6] Fukuyama, F. (1992). *The End of History and the Last Man*. Free Press.
[7] Luce, E. (2023). The new Washington consensus. Financial Times, 19.04.23. Retrieved here, 13.09.23.
[8] White House (2023). *Remarks by National Security Advisor Jake Sullivan on Renewing American Economic Leadership at the Brookings Institution*.

managed to adopt, and it is equipped with instruments belonging to the tradition of the United States policymaking, subsidies first of all. The Net Zero Industry Act was widely perceived as the European Union's response to the IRA, therefore being the most obvious candidate to play its counterpart for the sake of the analysis. The following chapters will outline the specifics of the two legislations, from a political and financial standpoint. Whereas the Inflation Reduction Act is primarily compared with the Net Zero Industry Act, more European legislations will be called into question, in order to provide a clearer and more comprehensive discussion. Indeed, the two Acts are not perfectly comparable because of the different roles they play in the respective regulatory framework. The European Union has developed the most evolved climate policy globally, with dozens of regulations and directives tackling clean and low-carbon energy deployment, and related greenhouse gas emission reduction. The United States did not play a central role in climate policies prior to the approval of the IRA. As a result, the Act needed to encompass a broader scope in an effort to bridge the substantial gap between US jurisdiction and those of other global actors.

Finally, a necessary disclaimer needs to be stated. At the moment of writing, the Net Zero Industry Act has not yet been passed into law, as it is currently being discussed and modified by the European Parliament and Council. The present analysis has no intention to predict the outcome of the ordinary legislative procedure, but to assess the differences in the approach used to tackle the clean energy challenge in the relative geographies. This is more than relevant for two reasons. The central role of both Brussels and Washington in international politics empowers them to set an example for others to follow on the energy transition. In this sense, studying American and European climate policies means exploring possible future global standards in the area. Second, the international debate intensively focused on the antagonism between the two Acts. Thus, it is worth exploring further if there is steak beyond the sizzle.

Technologies for the energy transition: two approaches, a common goal

The EU and the technologies' cherry-picking

Severely hit by the Covid pandemic, the European Union started an economic recovery process in 2021 that was set to have a short lifespan. Already at the beginning of the following year, the Russian invasion of Ukraine forced an energy revolution for the European Union as a whole, dependent on Russian fossil fuel supplies for 40 percent of its total gas consumption, or 155 billion cubic meters of annual imports[9]. Thanks to a set of measures adopted in a rush, Brussels managed to get through the first winter of war with no major crisis. This was achieved through a legislative tool known as "emergency regulation", allowing for an accelerated process of adoption if "severe difficulties arise in the supply of certain products, notably in the area of energy" as stated by Art. 122 of the Treaty of Functioning of the European Union. Precisely, five bills aimed at reducing gas consumption and energy prices while streamlining renewable energy projects permitting. At the end of 2022, the EU managed to reduce the share of Russian gas in the continent's gas demand to less than 10 percent, down from 40 percent at the beginning of the year. This data might be worth reading if combined with the increase in solar and wind additions by 41 percent and a slightly lower increment for heat pumps[10]. Whereas this data was questioned by many for their statistical meaningfulness[11], it nevertheless depicts a successful transition by which Europe managed to find its way out of the "first global energy crisis", as the Executive Director of the International Energy Agency defined it[12].
Unfortunately, Russia was not the only adversary the European Union would have found in its path to economic recovery. In August 2022, in the midst of the worst energy price crisis the Union ever faced – with gas prices breaking through the roof of 300 EUR/MWh from a 10-year average of just above 20 EUR/MWh[13] – the United States Congress adopted the Inflation Reduction Act (IRA). The legislation was meant to boost the American industry for clean energy via a massive subsidy scheme against the pervasive Chinese presence in the sector, perceived as a threat to the US national economic security. Abruptly, the Act raised serious concerns from many sides, with the European Union being one of the strongest voices against the distortive and anti-competitive effects such incentives would cause to global markets. In a rush, the European Commission was demanded by the Union's industry

[9] IEA (2022). *A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas*.
[10] IEA (2023). *Renewable Energy Market Update – June 2023*.
[11] A similar framing of the data concerning the increase in the addition of solar and wind energy neglects the very low baseline the EU was starting from in 2021.
[12] Chow, E., Xu, M. (2022). *World is in its 'first truly global energy crisis' - IEA's Birol*. Reuters, 25.10.22.
[13] Tradingeconomics.com. Retrieved here.

to properly respond to the IRA in a fast manner, to prevent necessary investments in strategic sectors from being diverted to the United States. With the publication of a Green Deal Industrial Plan in February 2023[14], aiming at introducing a new industrial policy for the region, the two regulations implementing the key points of the Industrial Plan were revealed, and presented the following month. In March, the Net Zero Industry Act (NZIA) and the Critical Raw Materials Act (CRMA) were published, the former being the focus of our analysis throughout this next chapter.

The eight net zero strategic technologies

The Net Zero Industry Act (NZIA) is a proposal for a regulation put forward by the European Commission, whose main goal is to strengthen the resilience of the European manufacturing sector for clean energy technologies. The NZIA operates on two different levels, horizontally through the identification of key technologies and vertically throughout the overall supply chain of these technologies. The focus of this following section will be the first of the two dimensions.

Via the NZIA, the European Commission attempts to create an environment able to retain the best industrial players in the European market, and their investments in the European clean energy sector. The tools proposed are streamlined permitting, coordination of private funding, public procurement procedures, and general incentives for specific relevant projects referred to as Net-Zero Strategic Projects. Their scope is then defined by a much debated and divisive annex, where the Commission proposal lists the so-called strategic net-zero technologies, namely those technologies eligible for the main support provisions included in the Net-Zero Industry Act.

The strategic net-zero technologies represent a sub-group of a much larger set of technologies that were not considered 'strategic', according to three criteria informing the Commission's selection. These are: (i) technology readiness level, (ii) contribution to decarbonization and competitiveness, and (iii) security of supply risks from import dependencies.

Indicators

First developed by NASA during the space exploration age in the 1970s, it was later adapted to the energy sector by the International Energy Agency. The technology readiness level (TRL) represents an instrument to measure the maturity of technologies, on a scale from 1 – initial idea – to 11 – proof of stability. The strategic technologies referred to in the Net Zero Industry Act are those classifiable as TRL 8 (first-of-a-kind commercial) or more.

[14] European Commission (2023). *Communication: A Green Deal Industrial Plan for the Net-Zero Age.*

The second requirement listed is the contribution to decarbonization and competitiveness of a technology, which refers to the contribution that the European Union laws recognize to each solution for the achievement of its 2030 climate target. These are framed under the 2020 Fit-for-55 package, aiming at curbing emissions by 55 percent by the end of the decade from 1990 levels, and then propelled by the REPowerEU plan. Published in 2022, it identifies technology-specific targets to reach the emissions reduction objective, therefore weighting each clean energy's role in the future European Union's energy mix.

The last benchmark evaluates the risk of disruptions in the network due to excessive reliance on imports for each technology's supply chain. A particular case is made for third countries importing a relevant share of a specific component or technology. Extreme reliance on a single importer is indeed considered highly dangerous for the economic resilience of the Union. Threats are generally located in Asia, with China playing a prominent role in almost every strategic sector. Chinese companies are currently the ones manufacturing the solar panels the Member States deploy today, since Europe's solar industry is almost completely reliant on imports[15], with 89 percent of these coming from China[16]. An opposite situation can be found in the wind sector, where the European Union acts as a net exporter of turbines[17]. Nevertheless, the European Union depends on Chinese companies for 80 percent of the extraction and 100 percent for the processing[18].

The strategic technologies accordingly listed in the European Commission's proposal are eight:

- *Solar photovoltaic and solar thermal technologies*
- *Onshore wind and offshore renewable technologies*
- *Battery/storage technologies*
- *Heat pumps and geothermal energy technologies*
- *Electrolysers and fuel cells*
- *Sustainable biogas/biomethane technologies*
- *Carbon Capture and Storage (CCS) technologies*
- *Grid technologies*

In short, the technologies here listed represent what the Von der Leyen Commission foresees as the main tools to reach the Union's ambitious multitarget: reducing emissions while increasing economic resilience and fostering growth.

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[15] Bettoli, A., Nauclér, T., Nyheim, T., Schlosser, A., & Staudt, C. (2022). *Building a competitive solar-PV supply chain in Europe*. McKinsey.

[16] Eurostat (2023). Retrieved here.

[17] Ibid.

[18] European Commission (2023). *Study on the Critical Raw Materials for the EU.*

Analysis by technology

The European Union's vision for the future strongly relies on electrification based on renewables, as six out of eight technologies show. European countries played a major role in accelerating the cost decline for solar and wind energy technologies. This came as a result of massive incentives from countries like Germany, Italy and Spain[19], which managed to provide investment returns high enough for firms to start allocating more and more capital to the deployment of solar panels and wind turbines, with positive effects on the overall global cost of manufacturing. In the last ten years, the average levelized cost of electricity (LCOE) for new utility-scale solar PV projects decreased by 88 percent decrease, while onshore wind LCOE dropped by 68 percent[20].

The subsequent push for electrification came with strings attached, namely an urgent need for infrastructure deployment. The increasing necessity for flexibility will require more and better options as far as storage solutions and grids are concerned. Global demand for batteries is set to increase by 600 percent by 2030[21]. The European Union will experience more than a three-fold growth in terms of deployment needs, from roughly 60 GW capacity today available to more than 200 GW in 2030, and 600 GW in 2050[22]. Hence, batteries represent a strategic sector requiring focused investments for the European Union, which currently imports almost all materials and components for manufacturing[23]. A similar urgency has recently grown in Brussels about grid infrastructure. Indeed, the freshly adopted third revision of the Renewable Energy Directive will require the European member countries to satisfy 42.5 percent of their energy consumption through renewable sources by 2030. Moreover, the deeply divisive new light-duty vehicles emissions standards, banning the internal combustion engine cars sale after 2035, will put even stronger pressure on transmission and distribution networks to deliver an increasing quantity of electricity. Beijing has been lately very active in this sector as well, with Chinese companies acquiring shares in Portugal's Energias de Portugal (21.35 percent)[24], Italy's CDP Reti (35 percent)[25] – indirectly investing in Terna, since CDP has a 30 percent share in the Italian transmission operator. This trend needs to be read jointly with the underinvestment in infrastructures recalled by the Economist[26], possibly explaining the pressing need

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[19] Brown, P. (2013). *European Union Wind and Solar Electricity Policies: Overview and Considerations*. Congressional Research Center

[20] IRENA (2021). *Renewable Power Generation Costs in 2021.*

[21] European Commission SWD (2023). *Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity.*

[22] European Commission SWD (2023). *Energy Storage - Underpinning a decarbonised and secure EU energy system*

[23] Bielewski, M., Pfrang, … and Grabowska, M., (2022). Clean Energy Technology Observatory: Batteries for Energy Storage in the European Union – 2022 Status Report on Technology Development, Trends, Value Chains and Markets

[24] Reuters (2011). *China Three Gorges wins Portugal EDP stake sale.* Published, 22.12.11. Retrieved here, 18.08.2023.

[25] CDP (2014). *CDP: 40.9 percent stake in CDP Reti transferred to State Grid and Italian institutional investors.*

[26] Economist (2023). *The case for an environmentalism that builds.* Published, 5.04.23. Retrieved here, 29.08.23.

the Union is facing to address such a sector, which holds significant key implications for regional energy security and for delivering the transition.

The case for renewable hydrogen is slightly different than solar and wind. With official rules for renewable hydrogen production being adopted in late June 2023[27], the European industry is still at an introductory stage. Nonetheless, hydrogen as a carrier of clean energy is currently one of the most debated sources, whose relevance in the public discourse is mirrored by the increasing quantity of legislative and non-legislative acts on the subject. In order, the Von der Leyen Commission published the first "European Strategy for Hydrogen" in 2020, and the "Hydrogen and Decarbonized Gas Market Directive and Regulation" in 2021 as part of the Fit-for-55 package. The following year hydrogen projects were granted facilitated access to funding thanks to the inclusion of the category in the IPCEI[28] framework. Hydrogen also plays a relevant role in the targets set by the new revision of the Renewable Energy Directive, and its development as a reliable source of energy is the main aim of the European Hydrogen Bank, a financing instrument aimed at unlocking private investments across the whole value chain, both domestically and abroad.

Overall, the only two technologies in the Act not related to the European Union's electrification strategy are Carbon Capture and Storage and biogas. The latter, for which the REPowerEU plan sets a non-binding annual production target of 35 billion cubic meters by 2030, is not a novelty. Biogas and biomethane were already part of the European Commission's strategy for decarbonizing the European aviation and maritime transport sector, with the latest adoption of the Fuel EU Maritime regulation and the proposal for a ReFuel EU Aviation regulation. On the other hand, the inclusion of Carbon Capture and Storage represents a new development in European legislation. Whereas providing some financial support to carbon capture, utilization and storage projects under the Innovation Fund, CCS was never previously identified as a trustable addition to the European decarbonization toolbox. The lack of a specific regulatory framework and the perception of institutional distrust in the technology caused a drop in related investments in 2016-2021 compared to the five years before[29]. Perhaps, a definitive input for the inclusion of the technology in the NZIA scope was given by the presence of significant incentives for CCS projects in the US Inflation Reduction Act. The United States is currently the main player in both early-stage venture capital and later-stage private investments[30]. In an effort to boost the development of the CCS sector, the NZIA

[27] The relevant delegated acts related to REDII were initially published by the Commission at the beginning of February 2023, and after a period of four months without objections from the European Parliament and Council they were formally adopted in the European legislation.

[28] Important Projects of Common Interest. As of today, two calls were approved, Hy2Tech and Hy2Use, involving more than 76 projects across the continent.

[29] Kapetaki, Z., (2022). Carbon Capture Utilisation and Storage in the European Union – 2022. Clean Energy Observatory Status Report on Technology Development Trends, Value Chains and Markets. European Commission

[30] Ibid.

sets a mandatory target of 50 million tons for annual CO2 injection capacity by 2030 (Art. 16). If approved, this provision would make the European legislation the first to include such an ambitious goal, also considering that the Act requires oil and gas producers to implement such capacity (Art. 18).

One benchmark for all

The labeling of these net-zero technologies as "*strategic*" makes them eligible for a variety of financial and permitting instruments that will be deeply discussed in the second chapter of this work. Other than the facilitations provided by the Act, the net-zero regulation proposal sets a target for manufacturing capacity to reach at least 40 percent of all strategic net-zero technologies deployment needs of the Union by 2030 (Art. 1), comprised of certain elements of the supply chain (Rec. 18).
The Act demonstrates the intention to merge high resilience across strategic sectors for a more secure energy system with the appropriate flexibility for such diverse industry needs. Thus, in the Commission's proposal the 40 percent benchmark, a mandatory target applying indistinctly to all technologies listed in the strategic annex, is paired with references to pre-existing industry-set goals for five of the eight technologies, these being solar, wind, heat pumps, electrolyzers, and batteries (Rec. 17). The formers are set by industrial alliances, platforms instituted by a joint effort of the European executive and the private sector to implement relevant European policy goals. The first industry alliance was launched in 2017 aiming at strengthening European battery manufacturing, and today the Commission plays a role in nine alliances[31], all related to strengthening the European decarbonization path. Members are institutional actors (Member states representatives or European institutions officers), industry (firms, trade unions), financing players (financial institutions, private investors), and civil society (academia, research institutes).

The solar technologies manufacturing sector is by far the weakest in terms of European market share coverage, since only 3 percent of current European deployment needs for solar cells is managed through European production. For solar manufacturers, the predetermined industrial target is set by the European Solar PV Alliance, aiming at achieving 30 GW of photovoltaic panel capacity by 2030[32] (whereas the target officially considers 2025 as the final timeframe, it considers the final investment decisions, with the implementing phase likely to happen in later years). The 30GW goal can be translated into 45 percent of European needs, making the industry alliance target slightly higher than the one set by the Commission.

[31] The sectors today covered by an industrial alliance are aviation, raw materials, solar energy, clean hydrogen, plastic recycling, semi-conductor, low carbon fuels, and industrial data management.
[32] ESIA statement published the 9.12.2022. Retrieved here on 19.08.2023.

A similar scenario can be identified for the energy storage sector. Whereas the battery industry is still in an emerging phase, the European industry has the potential to transform its technological leadership into a commercial advantage, despite currently lagging behind in terms of competitivity (prices of European-manufactured batteries are on average 30 percent more expensive than Chinese ones[33]). European consumption accounts today for 25 percent of global demand, and it is set to increase. The relevant industrial group in the sector, the European Battery Alliance, has defined a target of 90 percent of European deployment needs covered by continental manufacturing capacity by the end of the decade[34].

Since renewable hydrogen became a relatively hot topic in the European energy policy, and with the EU striving to become a front-runner in the sector, the 10 Mt of hydrogen production capacity set by the European Clean Hydrogen Alliance represents 100 percent of the European deployment needs by 2030[35].

A different story relates to wind and heat pumps manufacturing sectors, where European companies are global leaders. In this case, the aim outlined by the Net Zero Industry Act (as made explicit in recital 17) is to maintain and possibly increase this market share. Today, Europe manufacturers produce approximately 85 percent of the continent's needs for wind turbines' deployment[36] and 60 percent for heat pumps[37]. The Act's goal is then to retain the current market shares throughout the decade considering the foreseen increase in consumption.

Weaponization of key clean technologies

Overall, the 40 percent manufacturing capacity target applied across all sectors appears to consider the solar industry as the general benchmark, being the most vulnerable to external disruptions among those considered. Russia's invasion of Ukraine played a major role when designing the proposal under scrutiny, stimulating a more attentive approach to economic security and supply chains. Throughout the escalation of the conflict, gas supplies were strategically curtailed by Moscow, which had been the primary supplier to European countries up until that point. As a first step, Gazprom redirected gas flows to Europe through Nord Stream and Turkish Stream, in an attempt to bypass Ukraine. In 2021, European Member States experienced a steep reduction in gas imports from Russia, culminating in the Nord Stream sabotage at the end of September. Today Russia's share of European gas consumption

[33] Dungs, J. J. (2023). *China Has Perfectly Tangled the Battery Value Chain with Electric Vehicles.* Forbes, 17.08.2023.
[34] EBA statement published the 23.03.2022. Retrieved here on 19.08.2023.
[35] ECHA – EC "Electrolysers joint declaration" published the 4.05.2022. Retrieved here on 19.08.2023.
[36] WindEurope (2020). *Wind energy and economic recovery in Europe: How wind energy will put communities at the heart of the green recovery*.
[37] European Commission SWD (2023) for the Net Zero Industry Act Regulation.

equals 12.9 percent, deeply reduced from 53.8 percent at the beginning of 2021[38]. The war shed new light on the strategy of energy "*weaponization*", producing two effects. The immediate reaction was to design a political response to increase the resilience of the Union's energy systems through the REPowerEU plan, relying on renewables as a source of diversification and risk mitigation. Furthermore, Brussels realized that an increased renewable penetration might cause weaponization risks for commodities other than gas, and notably strategic raw materials, components, and final products needed to power the transition. Along with other related policies, the Net-Zero Industry Act serves as a means to deter China from employing the same strategy Russia tried to implement on a different table. In this regard, Beijing has already shown a tendency to exploit its commercial leadership in specific sectors to influence political issues. The most recent example happened in early July 2023, when the Chinese Ministry of Commerce announced an export-control regime for two critical minerals, Germanium, key for solar cells production, and Gallium, a key element for the semiconductors industry. Both are labeled as strategic by EU legislation, since 90 percent of EU consumption of Germanium is covered by Chinese companies, the latter being the only ones in the world producing Gallium[39]. The move sparked from a restriction on exports to China of advanced microchip machines imposed by the government of the Netherlands a few days earlier, while being also perceived as a swift response to European attempts to limit the role of Chinese companies in the clean energy sector.

What's missing: left-behind technologies

The choice to structure the future industrial policy of the Union through a detailed list strictly defining the technologies to be considered strategic to the 2030 climate targets achievement necessarily leaves some technologies behind. Some of the technologies excluded by the A-list are classified as net zero technologies. These compose a wider group, containing all the necessary tools to achieve the European Union's net-zero target by 2050. While the strategic technologies are specific to the manufacturing sector, this broader list spans a wide spectrum, including energy supply, demand management, grid enhancement, storage, and carbon capture, utilization, and storage (CCUS) options, all characterized by a technology readiness level (TRL) equal or higher than 8. Among these, nuclear and hydropower caught the eye of many specialists across Europe for their B-classification. Therefore, both are worth a deeper analysis because of their historical role in energy generation and/or their intertwinement with the very foundations of the European Union.

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[38] Enerdata (2023). Behind the scenes of Russia's gas strategy – Executive brief.

[39] Aarup, S. A., Lau, S., Haeck, P., & Gijs, C. (2023). *China's threat on mineral exports knocks EU off balance*. Politico.eu, 6.07.23.

Nuclear

Nuclear has not always played a divisive role among European countries such as the one dominating today's debate over fission as an energy source. Quite the opposite, the first intergovernmental conference from which the Treaty of Rome would have stemmed one year later mentioned nuclear energy in its title, since nuclear was perceived at that time as one of the cornerstones of the future for Europe. During the 1956 Intergovernmental Conference on the Common Market and Euratom in Belgium, heads of State made the decision to institute a Common Assembly among the members of the previously pre-existing European Coal and Steel Community, European Political Community, European Defence Community, and the European Court of Justice[40]. But more than that, following the input of one of the Pioneers of the EU[41] Jean Monnet, the leaders of Europe decided for the institution of an international organization to manage the development of nuclear energy on the continent. As stated in the preamble of the treaty establishing the European Atomic Energy Community, by "*recognising that nuclear energy represents an essential resource for the development and invigoration of industry*" the leaders of Europe embodied the zeitgeist of the second postwar period. After the signing of the Treaty of Rome in 1957, simultaneously establishing the European Economic Community and Euratom, a thriving period for the European nuclear industry started. The nuclear fleet of European countries was mainly built during the two decades after the institution of Euratom. With France and Germany as main investors, the European power system started to rely more and more on nuclear generation between 1980 and 1990, considering an average buffer period of 10 years from the construction to the operational phase. Indeed, the momentum for nuclear energy started right after the signing of the Treaty, with a steep increase of commissioned projects (red line) until the middle of the 1980s, with the rising oil prices making a strong business case for nuclear[42]. With the 1986 catastrophe of Černobyl, the trajectory of nuclear power generation in Europe underwent a significant deterioration. Italy abandoned nuclear as an energy source in 1987 with a public referendum, and Germany saw its newly born anti-nuclear Green Party propelled to a government coalition in the 1987 election, 10 months after the event. No remarkable effects were observed in France, the most reliant European country on nuclear. As decommissioning and phase-out programs were implemented all across Europe, aging generators were not replaced, and their

[40] Roy, J. (2012). *All roads lead to Rome: Background, content and legacy of the Treaties on the European Economic and European Atomic Energy Communities*. *Designing the European Union: From Paris to Lisbon*. Springer.
[41] European Union website (2023). EU Pioneers. Retrieved here on 20.08.23.
[42] Toth, F. L., & Rogner, H. H. (2006). *Oil and nuclear power: Past, present, and future.* Energy Economics, *28*(1).

lifespan was not expanded. For more than a decade, the European Union rejected the idea of a comeback for nuclear energy, at times explicitly. In 2000, the European Commission mentioned nuclear energy as a "*source of energy in doubt*", and "*undesirable*"[43].

With the coming of the new millennium, the concept of the nuclear renaissance was developed, referring to a new key role for nuclear technologies in tackling the energy trilemma – sustainability, security, and affordability. This debate found increasingly stronger attention in later years, with two opposing sides confronting themselves in Brussels. Many recent pieces of legislation related to energy policy saw a fierce contraposition between pro- and against-nuclear member countries.

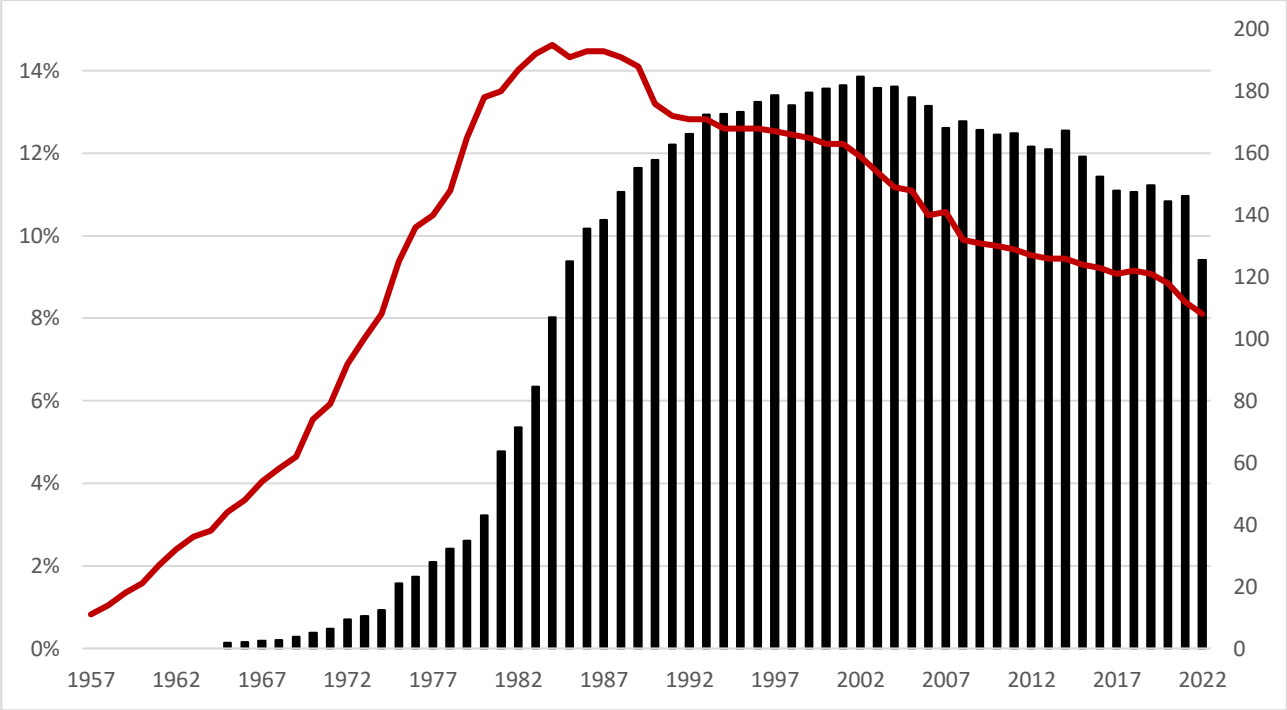

Figure 1: Share of primary energy by nuclear confronted with the reactors' fleet in the EU (from first stone to decommissioning). Source: Author's elaboration of data from Energy Institute Statistical Review of World Energy (2023) and IAEA's Power Reactor Information System.

This new and intense lobbying effort propelled the institution of a formal Nuclear Alliance, a French-led group of 14 European member states, with the main aim of facilitating a stronger role for nuclear energy in the European decarbonization strategy[44]. On the other side of the fence, seven countries headed by Berlin strongly opposed the inclusion of nuclear in the European climate toolbox[45]. A first

[43] European Commission (2000). *Green Paper - Towards a European strategy for the security of energy supply.*

[44] The Alliance first met in Paris on the 16th of May, 2023, including Belgium, Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Hungary, Netherlands, Poland, Romania, Slovenia, Slovakia, Sweden, United Kingdom as invitee and Italy as observer.

[45] Abnett, K. (2023). *Germany, Spain push to keep nuclear out of EU renewable energy goals.* Reuters, 16.03.23. Retrieved here on 21.08.23.

win for the nuclear side was scored after the adoption of a climate delegated act complementary to the European taxonomy for sustainable activities in 2022, which listed nuclear among the green investment areas in the Union. Furthermore, nuclear advocates were not immune to the hydrogen fever. Many of the most recent and crucial bills for the implementation of the European Green Deal, notably the Hydrogen and Decarbonized Gas Market Package and the third revision of the Renewable Energy Directive, were characterized by heated discussions about the low-carbon classification of the so-called pink hydrogen, produced through electrolysis powered by nuclear electricity. Described by some as a 'dialogue of the deaf', this debate rolled out its effects on the Net Zero regulation, with tensions mounting in the College of Commissioners days before the act was released. In a leak published a week before the official date, nuclear fission was indeed included in the annex as the ninth net-zero strategic technology[46], just to disappear a few days later. The issue divided the Commission, with President Ursula von Der Leyen and Thierry Breton, French Commissioner for the Internal Market, wrestled Vice-presidents Margrethe Vestager and Frans Timmermans, respectively Commissioner for Competition and Commissioner for the Green Deal[47]. In the end, nuclear energy was mentioned in the Net Zero Industry Act among the net-zero technologies, as "*advanced technologies to produce energy from nuclear processes with minimal waste from the fuel cycle, small modular reactors, and related best-in-class fuels*" (Art. 3). This means that the main supporting measures for funding and permitting streamlining will not be available for nuclear operators, while not contributing to the 40 percent target by 2030 of manufacturing capacity. The reasons for the exclusion of nuclear technologies from the strategic labeling can be retraced starting from the previously described criteria for selection used by the European Commission. Whereas characterized by a technology readiness level (TRL) ranging from 8 to 11 according to the specific fission technique, the second and third requirements were critical to the exclusion. Indeed, the Commission considered the long lead times in the industry as obstacles for the provisions of the Net Zero regulation to display any relevant effects before 2030, thus not advancing the decarbonization effort. Lastly, the nuclear sector is recognized to present only moderate security of supply risks, while according to official estimates[48], the uranium consumption of European utilities is virtually 100 percent dependent on foreign imports, with domestic production able to cover just 0.15 percent of the European yearly consumption. Moreover, the European nuclear fleet is aging, with 86 percent of the European Union's active nuclear reactors functioning for 31 years or longer. Among these, 30 reactors have been

[46] Taylor, K. (2023). *LEAK: Brussels targets 40 percent of clean tech manufacturing in Europe by 2030*. Euractiv, 6.03.23. Retrieved here on 21.08.23.
[47] Hancock, A., Espinoza, J, Bounds, A. (2023). *Brussels at odds over funding rules for nuclear power.* Financial Times, 14.03.23. Retrieved here on 21.08.23.
[48] Euratom Supply Agency (2023). *Origins of uranium delivered to EU utilities in 2022 (tU).*

connected to the grid for 41 years or more[49]. The lobbying association nucleareurope[50], ex FORATOM, the continent's nuclear industry is grappling with a deficit in skilled professionals, because of the downturn that impacted the sector, threatening the industry's future development and security. Overall, nuclear energy accounts today for over 25 percent of the Union's electricity generation, first after combustible fuels[51]. At the time of writing, the European Parliament and the Council have not yet concluded their first reading position on the Act, but many discussions took place between parties about the role nuclear should play in the act, with increasing support for the re-inclusion of nuclear technologies among the strategic ones[52].

Hydropower

Hydropower technologies certainly represent the second notable exclusion. Nevertheless, the absence of hydropower was not as much debated as nuclear, for several reasons. Today, hydro represents the second largest renewable source in European power generation, with 32 percent of the EU's renewables production and 12 percent of the total EU's electricity generation[53]. Hydropower has great potential in the European energy system mainly for flexibility purposes, as it represents an option for counterbalancing the intermittence of solar and wind. Indeed, it represents one of the few renewable dispatchable and programmable generators currently available, with a faster startup time than any other option, in the order of a few minutes[54]. On a broader scale, some challenges threaten hydropower's role in the European decarbonization path as an electricity generator. First, the European fleet exhibits a notable age factor, wherein over 80 percent of the plants surpasses the 30-year mark, and nearly 25 percent of these was built over six decades ago.[55] A renewed role for hydropower in generation would thus require major refurbishment investments. Moreover, since hydropower represents one of the first energy sources exploited in the continent, there is not much space for untapped potential[56], which is almost irrelevant in Northern and Western Europe, with a slightly more favorable outlook in Eastern and Southern Member States. Nevertheless, the more and more frequent droughts in Mediterranean countries, with peaks in Spain and Italy, caused a 19 percent year-on-year fall for hydropower generation in 2022, highlighting a serious risk for future scenarios[57].

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[49] Schneider, M. (2022). *The World Nuclear Industry Status Report 2022*.
[50] FORATOM (2020). Nuclear: investing in a competent workforce for the benefit of society.
[51] Eurostat (2021). *Electricity production, consumption and market overview.*
[52] Messad, P. (2023). *Lawmakers reintroduce nuclear in EU's net-zero industry list.* Euractiv, 20.08.2023. Retrieved here on 21.08.23.
[53] Eurostat (2021). *Renewable energy statistics*.
[54] Huggins, R. A. (2016). *Energy storage: fundamentals, materials and applications*. Springer.
[55] IRENA (2023). The changing role of hydropower: Challenges and opportunities.
[56] Ibid.
[57] Ember (2023). *European Electricity Review 2023*.

A second reason for the exclusion of hydropower, is that today the European industry plays occupies a leadership position in manufacturing of related technologies because of its deep experience. Indeed, European manufacturers of hydropower equipment hold sway over two-thirds of the global market today, with major players holding much of their business operations outside Europe[58]. This translates into limited security of supply risk, whereas Chinese companies are expanding their role as manufacturers of hydropower-related technologies domestically and with export strategies in areas with strong untapped potential, such as Africa.

A brighter note for the industry is represented by pumped hydro storage (PHS), which accounts for over 90 percent of the Union's power storage capacity[59]. Whereas not explicitly listed in the Net Zero Regulation, PHS technologies might fall under the classification of storage technologies as it was designed by the Commission, being labeled as strategic.

[58] Hydropower Europe (2021). *Strategic Industry Roadmap*
[59] European Commission (2020). *Study on energy storage*.

Technological neutrality in the United States

The United States is the biggest polluter historically. Today, whereas China accounts for a higher total CO2 output, Washington is well above Beijing as one of the global top CO2 emitters annually from a per capita perspective[60]. Indeed, a Chinese citizen's annual carbon footprint average equals 9.7 tons of GHG, whereas a United States citizen accounts for 19.3 tons of GHG. For this reason, the Inflation Reduction Act represents a much-awaited piece of legislation, with potential groundbreaking effects on the international climate change debate. Indeed, the United States climate policy was on a colliding course with internationally set decarbonization targets during the Trump Presidency. According to an analysis conducted by the New York Times[61], during the four years of his administration, the United States reversed more than 100 environmental laws. The dismantling process affected several sectors, such as air pollution and emissions, drilling, extraction, and infrastructure. More than that, Donald Trump formally expressed the intention to exit the Paris Agreement, undermining Washington's long-term political credibility in matters of climate change. Filling the political void created, climate change and strategies to address it played a big role in Biden's 2019 presidential campaign. Hours after taking the oath of office as the new President of the United States, Joe Biden adopted a series of executive orders to reverse Trump's exit from the Paris Agreement. The flagship climate legislation proposed by the Biden Presidency was unveiled in 2020 as the Build Back Better Act, part of a broader eponymous Plan, to reduce the United States' contribution to global emissions. The proposal was adopted by the House of Representatives, while failed to succeed in the Senate because of a lack of internal support. After political turmoil within Biden's Democratic Party, excruciating rounds of negotiations managed to build a strong consensus around a rewritten Build Back Better Act, called the Inflation Reduction Act (IRA), officially adopted on the 16th of August 2022.

The IRA's relevance is directly linked to the magnitude of the federal funding provided for climate efforts. Even if an official estimate of the final costs is challenging for the uncapped nature of many support measures, from a total capacity of $500 billion, it directs as much as $369 billion in federal funding to clean energy[62], with the explicit aim to curb 40 percent of emissions compared to 2005 levels[63]. According to an analysis carried out by the Rhodium Group[64], a nonpartisan research organization, the legislation is considered able to provide the necessary tools to drive down United

[60] UNEP (2021). State of the Climate – Data action note: data you need to know. Retrieved here on 20.08.23.
[61] Popovich, N., Albeck-Ripka, L., Pierre-Louis, K. (2021). *The Trump Administration Rolled Back More Than 100 Environmental Rules. Here's the Full List.* New York Times, 20.01.20. Retrieved here on 21.08.23
[62] The White House (2022). Remarks by President Biden At Signing of H.R. 5376, The Inflation Reduction Act of 2022.
[63] European Parliament (2023). EU's response to the US Inflation Reduction Act (IRA).
[64] Larsen, J., King, B., Kolus, H., Dasari, N., Hiltbrand, G., & Herndon, W. (2022). *A turning point for US climate progress: assessing the climate and clean energy provisions in the Inflation Reduction Act*. Rhodium Group.

States' emissions by 32-42 percent by 2030 from 2005 levels, in line with the stated target. In a parallel scenario where the act is not adopted, the United States would have been expected to achieve a significantly lower emissions reduction (24-35 percent), thus showing the potential of the IRA to close the gap between a business-as-usual scenario and US climate-related pledges dating back to the 2015 Paris Agreement. Overall, the Inflation Reduction Act is structured on three pillars, notably the tax system, healthcare, and energy and climate. Our analysis will cover the latter.

Scope: not only generation technologies

The Inflation Reduction Act represents Biden's arsenal to achieve the stated 40% of annual emissions reductions by 2030 compared to 2005 levels. During the presentation of the law, the IRA was described by the President as "*the most aggressive action ever, ever, ever to confront the climate crisis*"[65]. Through the IRA's implementation, the United States aims at re-orienting how it produces and consumes energy, with possible positive spillovers for other international players in terms of technology cost reduction. Despite an unprecedented goal, the Act builds on some already existing provisions in the national law already targeting traditional clean energy generators. The Inflation Reduction Act enhances these measures in terms of capital available and scope. Many support measures provided by the Act target several sectors related to clean energy. While not the focus of this section, it is fundamental to briefly introduce the concept of tax credits, being the main instrument used by the Inflation Reduction Act to foster clean energy technology adoption. Tax credits for renewable energy sources have played a role in American climate policies since the 2009 Recovery Act, approved under Obama's Presidency[66]. The Inflation Reduction Act takes the tested mechanism as a basis, improving the volume of funds available and the lifespan of the credit. Under the IRA, tax breaks will be available for a period of ten years, strengthening the investing environment to make it more certain for investors.

As far as clean energies are concerned, the following sectors are considered by the Tax credits for electricity from renewables:

- Multiple solar and wind technologies
- Municipal solid waste
- Geothermal (electric, heat pump, and direct use)
- Hydroelectric, marine, hydrokinetic, and tidal
- Energy storage technologies

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[65] White House (2022). *Remarks by President Biden on the Passage of H.R. 5376, the Inflation Reduction Act of 2022*. Retrieved here the 21.08.23.

[66] For more insights on President Obama's bill: The White House (2016). *The Recovery Act made the largest single investment in clean energy in history.* Retrieved here the 21.08.23.

- Microgrid controllers
- Fuel cells
- Microturbines and combined heat & power
- Biomass and landfill gas

As far as the electricity sector is concerned, specific tax credits are designed to support nuclear power production (section 45U), and Carbon Capture, Utilization, and Sequestration (section 45Q). Moreover, the clean fuels falling under the scope of the act are biodiesel, renewable diesel, and alternative fuels. Finally, clean vehicles are an integral part of the Inflation Reduction Act, with a specific tax break designed to support Electric and Hydrogen-fueled light-duty, and commercial vehicles (section 30D). The targeted vehicles can be new or previously owned, with a difference in the maximum incentive amount recognized to the consumer.

With the exception of clean vehicles, the other clean energy tax incentives will be phased out after the 31st of December 2024, transitioning into a period of complete technology neutrality. This will be implemented through the introduction of a new family of subsidies with no boundary to the scope of application other than the zero GHG emissions requirement, the Clean electricity tax credits. Those technologies eligible for the Tax credits for electricity from renewables, will be targeted by the technology-neutral tax credit if projects enter in the construction phase before the start of 2025, while clean fuels will be targeted by a similarly designed incentive starting in 2025 and ending in 2027.

Section 45V: focus on hydrogen

According to official estimates[67], clean hydrogen will represent the major source of public spending in the clean fuels area, with a new specific measure (45V) for its production. The incentive will support hydrogen production process to make it available for use in transportation, industry, and power generation. The size of the credit is related to the amount of emissions produced by the process, with a maximum incentive possible of 3$ per kg of hydrogen as long as emissions account for less than 0.45 kg CO2e/kg H2. As with other provisions in the same Act, the Treasury Department was asked by Congress to produce guidelines on the methodology to use for emissions accounting. Analysis shows[68] that the design of this process will be crucial to direct government funds to real green producers. Indeed, it appears that unless hydrogen generation relies on clean energy on an hourly basis and originates from newly established renewable plants according to the additionality principle, the procedure might result in emissions rates surpassing those of hydrogen derived from

[67] Congressional Budget Office (2022). *Estimated Budgetary Effects of H.R. 5376, the Inflation Reduction Act of 2022*. Retrieved here the 21.08.23.

[68] Ricks, W., Xu, Q., & Jenkins, J. D. (2023). *Minimizing emissions from grid-based hydrogen production in the United States*. Environmental Research Letters, *18*.

fossil fuels. This is because excessively weak rules might include in the incentive's scope hydrogen from electrolysis powered with the current US electricity mix. Statistically, this would imply powering electrolyzers using a blend consisting of 58 percent fossil fuels[69]. Considering a minimum of 42 kWh to produce 1kg of hydrogen (currently the power consumption to produce 1 kg of hydrogen varies from 42.2 to 65.6 kWh[70]), and an average of 0.38 kg of CO2e/kWh emitted by the US electricity net generation[71], it would realistically result in 15.96 kg of CO2e/kg of hydrogen produced. This confirms the scenario describing potentially mislabeled clean hydrogen as more carbon intensive than today's natural gas-fired hydrogen, whose emissions per kg of hydrogen produced are in the range of 10-14 kg CO2e[72]. The debate is still open on the matter.

Emissions accounting: the life-cycle assessment

As demanded by the Inflation Reduction Act, the methodology for the already discussed technology-neutral incentives will be based on a life-cycle analysis. This corresponds to an emissions accounting system that considers all greenhouse gas emissions caused by every process related to a product in its lifespan. Generally, this means taking into account production, transportation, and in some cases final use. Two main frameworks for life-cycle analysis exist: cradle-to-grave and well-to-gate. While the first one considers the entirety of the process, from the material extraction, manufacturing, and transport all the way to final use, the well-to-gate approach focuses on the extraction and manufacturing steps in the value chain. The Inflation Reduction Act embraces the latter, stating that the emissions analysis "*shall only include emissions through the point of production*" (45Vc). Whereas providing a more complete picture than other options, the life-cycle analysis presents several challenges for implementation.

A crucial issue stays in the difference between a grid's average carbon intensity and its marginal intensity. The first considers an average value for the carbon intensity of the electricity system, with no dynamism based on consumers, location, and time of measurement, while providing an intuitive value. Still, this metric cannot take into account the specific emissions resulting from an additional amount of electricity consumption, usually provided by the marginal generator of an electricity system. For instance, if an increase in consumption for hydrogen production is met by a natural gas

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[69] Statista (2023). *Distribution of electricity generation in the United States from 2007 to 2022, by fuel type*.

[70] Aghakhani, A., Haque, N., Saccani, C., Pellegrini, M., & Guzzini, A. (2023). *Direct carbon footprint of hydrogen generation via PEM and alkaline electrolysers using various electrical energy sources and considering cell characteristics.* International Journal of Hydrogen Energy.

[71] U.S. Energy Information Administration (2022). *How much carbon dioxide is produced per kilowatthour of U.S. electricity generation?*

[72] IEA (2023). *Towards hydrogen definitions based on their emissions intensity.*

generator raising its output, as is generally the case in the United States, an average carbon intensity metric would not be able to adequately spot the carbon intensity increase, leaving a marginal carbon intensity metric fitter for the job. Conversely, if electricity from renewable sources that might otherwise go unused (such as curtailed electricity) is utilized for hydrogen production, the marginal emissions rate attached to the electrolysis process would be zero, and the resulting molecule would be labeled as properly carbon-free. The exposed methodologies provide different pros and cons[73]. While an average carbon intensity approach would facilitate more investments because of a simpler accounting system, it would not perform as efficiently in defining the real-world emissions caused by the additional electricity consumption. On the other hand, a marginal carbon intensity framework would be more realistic in accounting for the real impact of a good's production, whereas possibly putting a spanner in the works of sectors in their infant stage.

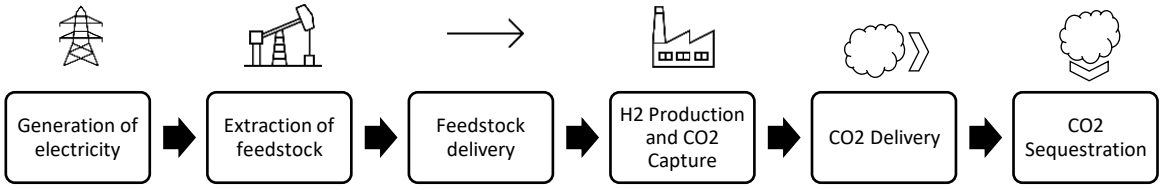

Figure 2: Well-to-gate system as intended by the US Department of Energy for hydrogen production. Source: Adapted from US Department of Energy (2023). Clean Hydrogen Production Standard (CHPS) Guidance.

Local content requirements: what makes tax credit an industrial policy

As this section's title implies, the Inflation Reduction Act is mainly regarded as an impressive subsidy scheme. If the act were to be limited to this, there would be no room to take industrial policy into the discourse, and the IRA would have been presented merely as a climate policy. However, that was not the case. One year after the adoption of the law, President Biden referred to the Act as "*delivering on promises that have long been made to the American people to lower costs for families,[…] increase America's energy security, create good-paying jobs here in America, and to address the existential threat of climate crisis*"[74]. Interestingly, the climate issue is not part of the podium for the reasons why the Act was needed. The very name of the legislation does not mention the environment or energy, while addressing an economic risk. Even though some commentators played on the

[73] Siler-Evans, K., Azevedo, I. L., & Morgan, M. G. (2012). Marginal emissions factors for the US electricity system. *Environmental science & technology*, *46*(9), 4742-4748.
[74] White House (2023). *Remarks by President Biden on the Anniversary of the Inflation Reduction Act*. Retrieved here the 22.08.23.

difficulties of gathering American public opinion around a climate change law[75], there is valuable information to derive from this. The Inflation Reduction Act is an important legislation for its climate potential, but that represents a positive externality of its first intended aim: providing the American industry with the edge over international competitors in clean technologies manufacturing. Given the crucial role that tax credits play in the implementation of the act's targets, those very incentives are composed of a base, and various bonuses that can be added. Indeed, a clean electricity generator can aim at a combination of incentives to best exploit the advantages offered by the Act. According to the provisions outlined by the legislation, a solar farm project promoter would need half of the initial foreseen investment to be operating, if able to respect the requirements necessary to obtain the incentives. Two out of three bonuses generally available are closely related to the industrial policy approach of the Act, namely the domestic content and the wages and apprenticeship requirement. The latter refers to the minimum wage for the relevant labor classification to be paid to workers, and a minimum percentage of apprentices out of the overall workforce. The former relates to the sourcing of raw materials and components for the manufacturing of a specific technology and can be applied to clean energy and electric vehicles tax credits. For clean energy projects to be eligible, iron and steel used for manufacturing must be entirely sourced from a North American facility. Moreover, components built in North America must reach 40 percent of the total costs of manufactured parts incorporated in a final product The share increases to 55 percent in 2027 (offshore wind benefits of looser requirements, with 20 percent of the total costs of components sourced in North America until 2028).

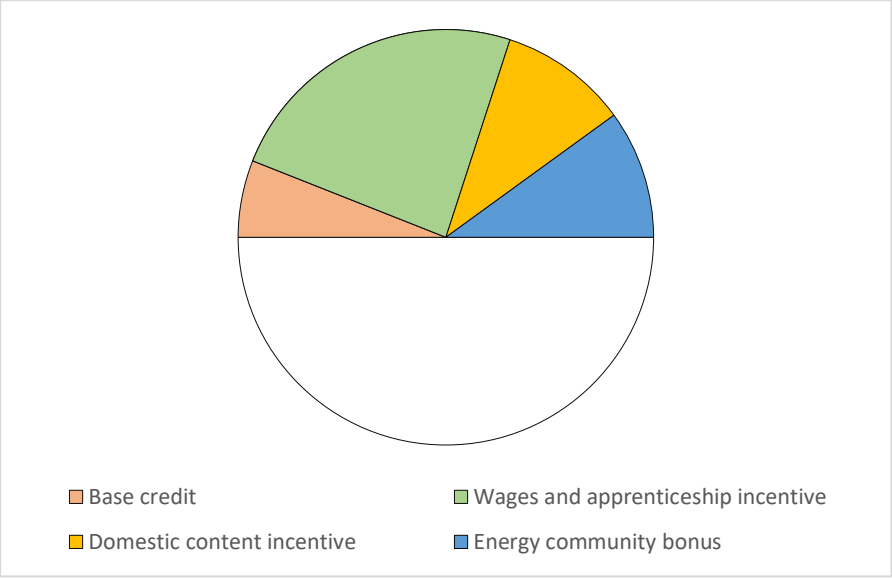

Figure 3: Investment tax credit for renewable projects, percentage of the total project cost as outlined by the IRA (section 48).

[75] Roston, E., Eckhouse, B. (2022). *The Inflation Reduction Act Is a Climate Bill. Just Don't Call It One.* Bloomberg, 15.08.2022. Retrieved here the 22.08.23.

A different framework is designed for the Clean Vehicle Credit (30D). In this case, the domestic sourcing criterion is applied to both critical minerals and the battery components used for manufacturing. In essence, the tax credit consists of two distinct bonuses: one involving a progressive percentage of domestically processed or extracted minerals, and a second linked to battery components that are either locally manufactured or assembled. The eligibility requirement envisages a 40 percent mandatory benchmark for minerals to be sourced domestically from 2023, with a linear progression of +10 percent every year, reaching a definitive share of 80 percent for vehicles sold in 2027. Similarly, 50 percent of clean vehicles' battery components will need to be manufactured or assembled locally in 2023, escalating linearly up to 100% for vehicles placed in service in 2029[76].

In a preliminary version of the act, the local content requirement for clean vehicles was meant for United States-only minerals and components. The scope of the incentive was later widened to include all countries with free trade agreements with Washington. This includes Mexico and Canada while disqualifying other key trade partners, remarkably the European Union. Moreover, eligible vehicle producers will be forced to exclude from their supply chains any component sourced from foreign entities of concern (FEOC) from 2024 and any relevant mineral the following year. The FEOC formula used in the Inflation Reduction Act relies on a general definition provided by the 2021 Bipartisan Infrastructure Investment and Jobs Act, describing foreign entities of concern as subjects "*owned by, controlled by, or subject to the jurisdiction of North Korea, China, Russia, and Iran*"[77]. A more detailed text to identify a FEOC under the Inflation Reduction Act is currently expected to be provided by the US Treasury Department. Indeed, whereas the first two clauses are easier to grasp, namely "*owned by*" and "*controlled by*", more room for interpretation exists for the third one, "*subject to the jurisdiction of*". According to legal experts[78], a strict implementation of the principle could involve all United States companies with subsidiaries or business activities in one of the four countries.

Different from other provisions in the Act, the Clean Vehicle Credit is designed to be a consumption subsidy. Indeed, it does not support the production of the targeted good, but facilitates its purchase by the final consumer. The introduction of a local content requirement turns what looks like a conventional consumption subsidy into a production incentive, as the credit is applied when production criteria are fulfilled[79]. From the latest analyses[80], the models eligible for the credit are 37,

[76] Internal Revenue Service (2023). *Notice of proposed rulemaking on Section 30D New Clean Vehicle Credit*. Retrieved here the 22.08.23.
[77] Infrastructure Investment and Jobs Act, section 40207(5).
[78] Hogan Lovells (2023). Administration defines "Foreign Entity of Concern" with implications for EV batteries under the IRA. Retrieved here the 22.08.23.
[79] Conditions to be fulfilled by the consumer are included, but not key to the act's scope (i.e., buyer's income).
[80] IEA (2023). *Global EVs outlook 2023*.

4 Plug-in Hybrid Electric Vehicles (PHEVs), and 33 Batteries Electric Vehicles (BEVs). The United States represents currently the third market globally for EVs, behind China and the European Union, but the Inflation Reduction Act provisions are supporting record growth in the sector. In 2021, the North American region was home to 10% of the global electric cars production, far behind China (54%) and Europe (27%). A similar framework characterized battery manufacturing, with China leading the way with 66% of the global market, Europe accounting for 21%, and North America being a distant third at 11%[81].

Whereas total cars sales have dropped by 8% year-on-year in the US (much more than the 3% global average), clean vehicles sales increased by 55%, with BEVs accounting for 70%. While the IRA is providing a solid framework for investments in the sector, the industry was already on a steady growing course. Indeed, January 2023 sales grew by 112% year-on-year, while January 2022 already displayed a 97% growth from the first month of 2021[82]. More than that, the Act managed to attract major private capitals flows from foreign companies, with $52 billion post-IRA foreign investments in the North American (including Mexico and Canada) EVs supply chain[83].

International perspective: a general dissatisfaction from traditional partners

The previously discussed local content requirements for clean vehicles represent the so-called apple of discord with Washington's international partners. Indeed, the signing of a Free Trade Agreement with the United States requirement made European, Japanese, and South Korean car companies ineligible for the Clean Vehicle Tax Credit. In the discussions concerning the Act, the automotive sector gained the spotlight because it represents a unique case where no base incentive is considered, being the support fully conditional to the local content requirements, while in other IRA provisions it accounts for as much as 20% of the overall credit (and 10% of the total cost). As shown in Figure 4, the FTA clause initially declared ineligible almost 1/4 of the market. Following the protests, Washington was engaged in several negotiations with partners in order to discuss the eligibility to the credit for their national companies. The first success was reached in March 2023, when the United States and Japan signed a trade deal on raw materials[84] that would have eased the inclusion of major brands like Toyota in credit's scope. In August 2023 at Camp David, a trilateral meeting was hosted by the United States with Japan and South Korea. Whereas the meeting's agenda focused on security issues, economic security was discussed as well. Cooperation among the three partners on matters

[81] IEA (2023). Energy technology perspective 2023.
[82] Ibid.
[83] Natter, A., Coppola, G., Laing, K. (2023). *Biden Makes Electric Vehicle Credits Elusive in Bid for US Auto Renaissance.* Bloomberg, 31.03.23. Retrieved here, 23.08.23
[84] Lawder, D. (2023). *US, Japan sign trade deal on electric vehicle battery minerals*. Reuters, 28.03.23. Retrieved here, 23.08.23.

such as "*supply chain resilience, energy security, [and] critical minerals*"[85] was mentioned by the final declaration, but no trade deal was signed with South Korea, whose vehicles are still currently excluded from the support measures. A brighter note for all parties involved was represented by the implementing regulations the US Treasury Department unveiled last year on December 29th.

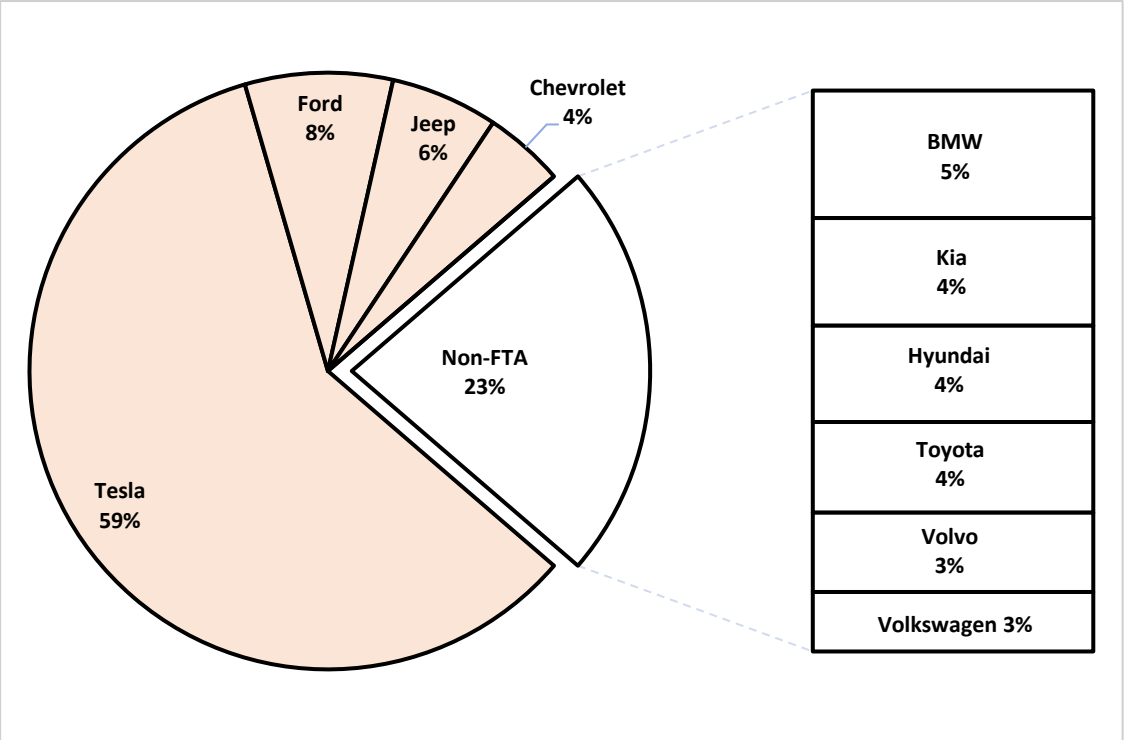

Figure 4: Electric Vehicles sold in the United States by brand in 2022. Source: Author's elaboration from Statista (2023).

The document admitted the possibility of including lease vehicles under the scope of the Act, while relying on a separate track of legislation referring to commercial vehicles not based on the local content requirements. Analysis[86] shows that South Korean vehicles available for leasing boosted to 40% of all South Korean electric vehicles entering the US market, from 2% in 2022. While the Treasury regulation proved as an effective solution, or a useful loophole, to temporarily address the issue, in the long term more solid strategies will be demanded by allies.

European Union and the United States: unfriendly friends

Among the unhappy partners about the IRA, Brussels stands unexpectedly. Since its institution, the European Union traditionally played by the same side as the United States, both in terms of security and trade. Moreover, Washington and the European member countries are deeply economically

[85] White House (2023). *The Spirit of Camp David: Joint Statement of Japan, the Republic of Korea, and the United States.*

[86] Bown, C. P. (2023). *How the United States solved South Korea's problems with electric vehicle subsidies under the Inflation Reduction Act*. Peterson Institute for International Economics.

intertwined, with the United States representing the first trade partner for the EU [87]. In this trade relationship, vehicles and related components are the third most exported European good to the United States[88], turning the exclusion from the Clean Vehicle Tax Credit into a low blow for a key sector. Margrethe Vestager, European Commissioner for Competition, stated that the IRA "*discriminates against EU producers and exports*" because of "*local content, assembly, manufacturing requirements*"[89]. Other voices joined Vestager's call, such as Thierry Breton, European Commissioner for Internal Market, alerting that the approval of the act would have led to retaliation measures by the European Union[90]. The political shock of many European representatives can be partially explained because of the scarce information-sharing the US displayed in the several already established frameworks for cooperation. In 2021, a diplomatic effort by both sides brought to the institution of the *EU – US Trade and Technology Council*. However, the TTC is not the first forum to foster bilateral trade relations among the two administrations. Two years after the formal creation of the European Union with the Treaty of Maastricht, the 1995 New Transatlantic Agenda had already attempted to facilitate the creation of a substantial open market across the Atlantic Ocean. Other initiatives followed, until the 2013 Transatlantic Trade and Investment Partnership (TTIP), a plan to effectively reach a wide Free Trade Agreement between Washington and Brussels. The failure of the negotiations in 2016, paired with the beginning of the Trump Presidency and the Snowden scandal[91], represented the last attempt to build a formal framework for bilateral trade cooperation. The TTC came as a joint effort by Biden's and Von der Leyen's Presidencies to build on the failed TTIP talks and re-focusing the scope of talks on strictly strategic issues, such as security of supply chains, green and digital technologies, and export control cooperation. Whereas included in its area of expertise, export incentives related to the upcoming Inflation Reduction Act were never discussed during the sessions of the second TTC meeting happening in mid-May 2022[92]. This might have happened for two reasons. First, by not including any of the main players from the US legislative procedure (Congress and the Department of Treasury), the drafting process of the Inflation Reduction Act was never discussed in detail by the TTC because of a lack of direct expertise by the American delegation. Second, the fairly negative repercussions that the signing of the legislation meant for many US partners were unexpected, or better neglected, by the American legislators. On this, Democratic

[87] European Commission (2023). *EU trade relations with the United States. Facts, figures and latest developments.*
[88] Eurostat (2023). *USA-EU - international trade in goods statistics*.
[89] Vestager intervention at the "EU response to the US Inflation Reduction Act" debate. EU Parliament, 14.12.22.
[90] *Europe needs 'coordinated, united and strong response' to massive US subsidies - Le Maire.* Euronews, 07.11.22
[91] More on this to be found here: Tourkochoriti, I. (2014). *The Snowden revelations, the Transatlantic Trade and Investment Partnership and the divide between US-EU in data privacy protection*. University of Arkansas at Little Rock Law Review.
[92] European Commission (2022). *EU-US Trade and Technology Council: strengthening our renewed partnership in turbulent times.* Retrieved here, 23.08.23.

Senator Joe Manchin – a key player in the negotiations that brought to the Inflation Reduction Act approval – said "*I gotta be honest with you. I should have paused and said 'OK, I'm going to make sure our NATO allies are involved in this*" referring to the drafting of the strict requirements needed for car producers to be eligible for the tax credit. Allegedly, Senator Manchin "*did not realize the European Union is not a free trade agreement [partner]*"[93]. For the record, the two allies launched the US-EU Task Force on the Inflation Reduction Act in October 2022, in order to address issues raised by Brussels over the implementation of the IRA's provisions[94]. A major problem the Act represents for the European Union is in the different climate policy approaches used if compared to the American one. Indeed, carbon pricing is considered weak in resisting a subsidy regime applied abroad. Indeed, Brussels currently uses a cap-and-trade framework, the EU Emission Trading System, to curb emissions and is in the process of implementing a Carbon Border Adjustment Mechanism in late 2023. The success of both acts is endangered by the IRA subsidy scheme available to US companies, since European governments might fear unfair competition from Washington in terms of costs. Where European producers would be required to pay an extra price for carbon, their American counterparts would rather benefit from a tax credit, driving down their costs of production, and consequently their goods' prices. Not only the European Union is in this situation though, since Canada has currently in place a system requiring all provinces to implement a minimum carbon price of CA$65[95] (€44), half of the current EU ETS carbon price of €89[96]. For this reason, the Inflation Reduction Act might pressure its partners to reduce costs in a rush to protect their industrial fabric against US competition. This would obviously undermine the climate benefits of IRA, nullifying the positive potential domestic results through a reduced efficiency in climate action from international actors[97]. Overall, the issues caused by the IRA's provisions for the European Union can be centered around the well-functioning of its own industrial policy and the potential distress that the European internal market would suffer if not able to match the US financial firepower in subsidizing its own producers. Negotiations have been ongoing between Brussels and Washington to reach a raw materials agreement since March 2023. Nevertheless, the very phrasing used in the Inflation Reduction Act explicitly mentions a Free Trade Agreement, adding fuel to the fire. For Europe to be considered as an FTA partner the US legislation requires a legally binding agreement, particularly difficult to achieve for reasons internal to the EU institutions functioning. Indeed, whereas the US

[93] Natter, A. (2023). *Manchin Says He Didn't Know US, EU Lacked Free Trade Agreement*. Bloomberg, 19.01.23. Retrieved here, 23.08.23.
[94] European Commission (2022). *Launch of the US-EU Task Force on the Inflation Reduction Act*.
[95] Government of Canada (2018). *Greenhouse Gas Pollution Pricing Act*.
[96] Ember (2023). Carbon Price Tracker. Accessed here, 24.08.23.
[97] Clausing, K. A. & Wolfram, C. (2023). *Carbon border adjustments, climate clubs, and subsidy races when climate policies vary*. National Bureau of Economic Research.

President can decide to adopt such a pact as an executive order without involving Congress, the European Commission has not such an option. The European procedure for FTAs requires the Commission to adopt a negotiating directive outlining the nature, scope, and content of the pursued agreement, asking for authorization from the European Council. The Commission then negotiates on behalf of the co-legislators (namely, the Parliament and Council of the European Union). When a deal is reached, it needs approval by both Parliament and Council to enter into force[98]. The European executive adopted the relevant negotiating directives in June 2023, and the Council authorized the Commission to start the talks with the US government in July[99].

Friendshoring: a new Washington Consensus for China containment

As previously discussed, Washington's approach does not fall within the characteristics of a traditional protectionist stance. Whereas strict local content requirements are included in many of the tax credit provisions, the ongoing negotiations with partners to better shape the current legislation to allies' requests show a different picture, best outlined by a recent formula, the New Washington consensus. The original expression dates to the end of the Cold War, when it was used by the economist John Williamson to describe a 10-point reform plan applicable to all developing countries in financial crisis which was broadly agreed by the US government, the International Monetary Fund, and the World Bank, whose headquarters are all located in Washington. The formula became later widely used as a synonym for the neoliberalism approach in political economy[100]. Inclusion in West-led international trade schemes was seen as a promising strategy to widely integrate non-allied governments in the future unipolar West-led order[101]. As ex-President Clinton put it when referring to the 2000 agreement that brought China to join the World Trade Organization, "*I believe it will move China faster and further in the right direction*"[102]. Today, the approach was reversed in a Copernican revolution, with geopolitics surpassing economics as the top concern for global leaders. The statement delivered at the end of April 2023 by Jake Sullivan, President Biden's National Security Advisor, confirms just this. The necessity to institute a new Washington consensus because of changing conditions was widely understood by analysts as a preference for resilience over efficiency[103], specifically with regard to supply chains of strategic technologies. Nevertheless, as Sullivan recalled,

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[98] European Council (2018). *Draft council conclusions on the negotiation and conclusion of EU trade agreements*.
[99] European Council (2023). *Trade with the United States: Council authorises negotiations on EU-US Critical Minerals Agreement*.
[100] Williamson, J. (1997). The Washington consensus revisited. *Economic and social development into the XXI century*.
[101] Council on Foreign Relations (2023). *What Happened When China Joined the WTO? – World 101*.
[102] New York Times Archive (2000). *Full Text of Clinton's Speech on China Trade Bill.* Retrieved here, 24.08.23.
[103] Luce, E. (2023). *The new Washington consensus*. Financial Times, 19.04.23. Retrieved here, 24.08.23.

"*Our objective is not autarky […], we need [our friends] to join us*"[104]. This strongly resonates with the newly designed concept of friend-shoring, where a country keeps on accessing international markets while reducing geopolitical risks by sourcing a strategic good from politically like-minded countries[105]. The weaponization of commodities has traditionally involved the energy industry, as the oil crisis and the gas crisis showed respectively in 1973 and 2022. Renewable sources, whereas being a diffused energy generation source, are dependent on raw materials, whose geographical concentration is extremely high. For instance, the five largest mining companies control over 60 percent of the lithium global supply and 56 percent of cobalt output, with the processing industry being highly spatially clustered as well[106]. An understanding of China's role as the major global player in the sector is crucial for a better comprehension of Washington's willingness to de-risk its supply chains. Indeed, China stands as the predominant leader in both extraction and refinement of strategic minerals, with 68 percent of nickel's global reserves, 40 percent of copper, 59 percent of lithium, and 73 percent of cobalt[107]. Moreover, China holds an impressive 78 percent of the global manufacturing capacity for electric vehicle battery cells, and ¾ of the world's lithium-ion battery mega factories. Interestingly enough, Washington signed free trade agreements in January 2023 with the Democratic Republic of Congo and Zambia to strengthen the batteries value chain, with the DRC producing more than 70% of the global cobalt supply and Zambia being the sixth-larger copper producer[108]. A missing piece of the puzzle is China's role in both countries, considered two of the five strategic pillars of Beijing's mining presence in Africa[109].

The solution proposed by the Biden Administration is then perfectly represented by the Inflation Reduction Act: boosting the domestic industry output, while re-shaping supply chains to include countries whose political stance is closer to Washington. Securing these allies is crucial in a bid to progressively reduce supply chain disruption risks, and the United States showed its willingness to open the doors of its incentives in a wider manner, stretching to those identified by Sullivan as "*non-traditional FTAs partners*".

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[104] White House (2023). *Remarks by Advisor Sullivan on Renewing American Economic Leadership*.
[105] Kessler, S. (2023). *What Is 'Friendshoring'?.* New York Times, 3.01.23. Retrieved here, 24.08.23.
[106] IRENA (2023). *Geopolitics of the energy transition: Critical materials*.
[107] Castillo, R., Purdy, C. (2022). *China's Role in Supplying Critical Minerals for the Global Energy Transition*. Brookings.
[108] U.S. Department of State (2023). *Signed MoU with the DRC and Zambia to Strengthen EVs Battery Value Chain*.
[109] Herzer Risi, L., Doyle, C. (2023). *Examining China's Impact on Mining in Africa*. Wilson Center.

Scale up and scale fast: funding the energy transition

The transition to a different energy system needs to rely on a clear and firm political will to be effective. Politics and policies can both help to provide a vision and the regulatory instruments to facilitate the path in between. In the energy sector, this means facilitating the key technologies that can help society reach the goals that were set. As was discussed in the previous chapter, this can be achieved through the most different strategies, without necessarily affecting the final success. However, this is not enough. When it comes to implementing the drivers of a transition, the adage "*follow the money*" says it all. For decades, renewable energy technologies produced electricity entirely because of public spending programs from a limited group of countries. According to literature[110], correcting externalities is among the main functions of a State. This means that public money is channeled to support a technology that provides a benefit to society not recognized by traditional market transactions, and notably a lower carbon intensity than other generators. Feed-in tariffs were the first tool adopted by many jurisdictions, particularly in Europe[111], to help renewables development, achieving increased efficiency while reducing costs. Today, renewables are often cost-competitive with fossil fuels, if not cheaper[112]. Nonetheless, governments still provide administrative and financial support to clean generators, with a different goal. In such cases, public funding programs act as risk mitigators, providing a safer environment to encourage private investors. These represent the main resources to fuel the transition at the right pace.

In recent years, the combination of the economic recovery from the pandemic and the energy crisis following the war in Ukraine caused an increase in clean energy investments. The conflict had a two-way impact on renewable, fueling the volatility of fossil fuels while making energy diversification a top priority of governments around the world. The market quickly absorbed this perception, where fossil fuels investments increased slower than renewables, 15 percent against 24 percent[113] from 2021 to 2023. Due to geographic and political reasons, Europe's economies were more affected than any others by the Russian invasion of Ukraine. The impact on renewables has been massive: capacity additions in the EU are expected to increase by 40 percent more than the pre-war forecasts[114].

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[110] Stiglitz, J. E. (1997). *The role of government in economic development*. Annual World Bank Conference on Development Economics (Vol. 1996, pp. 11-23).

[111] García-Alvarez, M. T., & Mariz-Pérez, R. M. (2012). *Analysis of the success of feed-in tariff for renewable energy promotion mechanism in the EU: lessons from Germany and Spain*. Procedia-Social and Behavioral Sciences (65).

[112] IRENA (2022). *Renewable Power Generation Costs*.

[113] IEA (2023). *World Energy Investment 2023*.

[114] IEA (2023). *Renewable Energy Market Update – June 2023.*

Whereas the Union represents a top performer in this area, the rest of the world follows the trend. Overall, energy investments will account for $2.8 trillion in 2023, where more than 60 percent will be directed to clean energy sectors. Solar energy provides clear evidence of this. In 2013, investments in oil production were five times greater than funds allocated to solar technologies. In 2023, investments in solar are expected to surpass those in the oil sector globally for the first time[115]. This boost, greater in the last two years than ever before, was mostly driven by internal policies of the three largest operators in the sector: China, the European Union, and the United States. The two targets of our analysis account for 52 percent of global clean energy spending, while China follows the Western block with 1/3 of the total[116].

For both Brussels and Washington, funding programs for renewable and low-carbon energy technologies are being implemented in order to support the ambitious policies afore described. The way in which this will be implemented and the underlying economic vision are the focus of the following chapter.

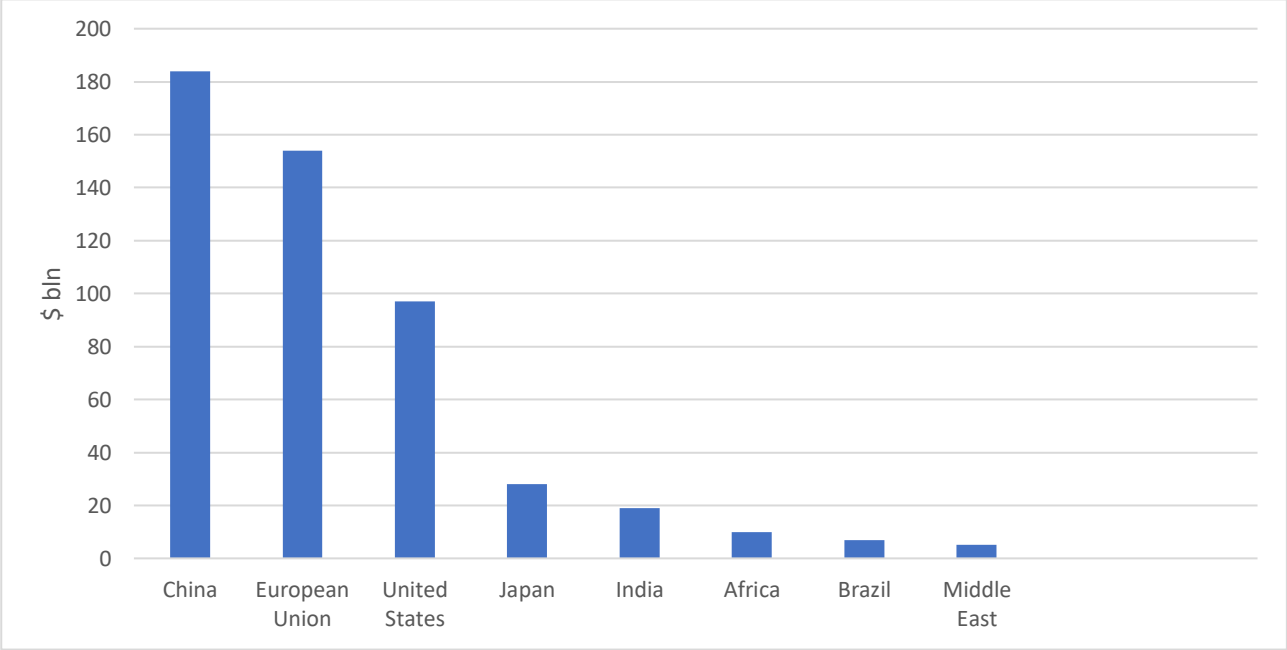

Figure 5: Variation in annual clean energy investment, 2019-2023. Source: IEA (2023). World Energy Investment 2023.

[115] IEA (2023). *World Energy Investment 2023.*

[116] In the EU-US figure, OECD countries' data serves as a proxy. Ibid.

The internal market overall: the European way to funding

The European Union is among the first institutional actors to integrate renewables into its spending programs. Overall, Brussels has an integrated toolbox of twelve funding options targeting the energy transition. Other than this, the REPowerEU can provide additional funding to the net zero industry, despite it was initially designed to support the diversification from Russian fossil fuels.

In order to achieve the energy-related targets set in the Fit-for-55 package, the Commission estimated a total annual investment of €487 billion in energy-related fields for the 2021-2030 period. This would translate into a €272 billion annual increase from the previous 2011-2020 span, or a +127 percent variation. This can be partially explained by the enhanced volatility of commodities prices, including raw materials key to clean technologies. For instance, unstable raw materials' prices provoked the interruption of up to 25 percent of planned EU solar panel projects[117]. In the current long-term financial budget of the Union, the relevant programs provide a maximum of:

- €36 billion for R&D development of clean technologies (Technology Readiness Level 1-7).
- €124 billion for the deployment of such technologies.
- €8 billion to support experimental installations and manufacturing plants for net-zero technologies (Technology Readiness Level 8-9).

Overall, the present EU budget clearly depicts the strengths and weaknesses of the European clean energy industry. Indeed, the Union had, and still has, a prominent role in supporting the development of key clean technologies at early stages of development and is today the second region globally for renewable capacity additions annually[118]. However, the manufacturing process is the one where dependency issues arise, whether they are related to minerals, components, or products.

The Net Zero Industry Act comes as an answer to the multiple sources of instability and threats to the European net-zero manufacturing industry, arising from deep exposure to third parties. According to official estimates[119], an additional €92 billion investment would be required in order to implement the regulation until 2030.

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[117] European Commission (2022). *EU strategic dependencies and capacities: second stage of in-depth reviews*. SWD (2022) 41.

[118] IEA (2023). *Renewable power on course to shatter more records as countries around the world speed up deployment.*

[119] European Commission (2023). *Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity.* SWD(2023) 68.

The Strategic Technologies Platform for Europe: where is the European money?

The Net Zero Industry Act was first mentioned in the European Green Deal Industrial Plan communication, issued in February by the European Commission as the first answer to multiple pressures to step up its game on clean energy technologies manufacturing. The document outlined a possible strategy for the Union's industrial development, where both the strategic raw materials and the manufacturing of key technologies were addressed, together with a new fund to support the provisions of the new continental industrial policy. That funding program was the same previously invoked by President Von der Leyen during the 2022 State of the Union speech, where the Commission President referred to it as a requirement for an "*industry made in Europe*"[120]. Mentioned for the first time less than a month after the adoption of the Inflation Reduction Act, many believed that the scale of the fund would have been comparable to the IRA firepower. This sparked doubts among commentators[121] about the political feasibility of the plan. Indeed, the European Union adopted a joint issuing debt strategy for the first time in history to facilitate the post-pandemic economic recovery, causing political tensions among Member States. Next Generation EU represented a unicum in European economic policy, since before the Covid-era joint debt as a strategy to finance public spending was generally understood as not allowed by the European treaties[122]. In 2020, European common outstanding debt amounted to €50 billion, on a steadily increasing course since the 2011 financial crisis. This was mainly related to the back-to-back funding mechanism, wherein the Commission acted as an intermediary for Member Countries in the global financial markets. It issued bonds whose earnings were transferred directly to the respective country under the same conditions as the initial capital reception. After the NextGenEU was agreed and adopted, the total joint debt reached over €300 billion at the end of 2022, representing 85 percent of the increase in the overall European outstanding debt as of May 2023[123]. This set a precedent to follow a similar route in the decarbonization challenge. Discussions developed on the matter, with the College of Commissioners divided on the subject matter, along the same lines of Member States. Countries, and their respective Commissioners, played their respective traditional roles when it comes to fiscal and economic policy: north vs. south. Indeed, the frugal countries resisted the possibility of more joint EU debt issuance, afraid of the moral hazard risk of countries free-riding on their financial credibility. On the other hand, countries like Italy and France came out in favor of an EU-level funding instrument to sustain the proposed industrial policy, in order to ensure a level playing field among countries with

[120] European Commission (2022). *State of the Union Address by President Von der Leyen*.
[121] Lynch (2023). The EU wants to build tomorrow's technologies. Will countries pay for it?. Politico, 22.05.23. Retrieved here, 3.09.23.
[122] Bonfanti, G., Garicano, L. (2022). *Do financial markets consider European common debt a safe asset?*. Bruegel.
[123] Claeys, G., McCaffrey, C., & Welslau, L. (2023). *The rising cost of European Union borrowing and what to do about it*. Bruegel.

different fiscal capacities. Without European funds, national measures would have been the primary means of supporting the initiatives outlined in the European Green Deal Industrial Plan, potentially impacting competition among countries with varying debt-to-GDP ratios.

According to the plan set out by the European Commission in the mentioned communication, the European Sovereignty Fund would have stemmed from the 2023 review of the Multiannual Financial Framework 2021-2027. Initially designed as an interinstitutional agreement, the MFF is today enshrined in the European Union Treaty of Functioning (Art. 312). Today the MFF is takes the shape of a Council regulation and follows a specific legislative procedure requiring unanimous approval in the European Council and adoption from the European Parliament. According to the TFEU, the framework determines the "*amounts of the annual ceilings on commitment appropriations by category of expenditure and of the annual ceiling on payment appropriations*" and contains the tools necessary for its operation. The present MFF was presented in 2018 and adopted in 2021, with the inclusion of the already mentioned NextGenEU. In May 2022[124], the European Parliament asked for a revision of the budget 'as soon as possible' to cope with the new scenario involving the effects of the war in Ukraine on energy prices. In September 2022 and then in February of the following year, the Commission President embraced the idea, linking the revision to the creation of a Sovereignty Fund. However, this did not happen.

From a European Sovereignty Fund to a reshuffling of existing resources

The European Commission proposed a revision of the Multiannual Financial Framework translating into a €100 billion increase. The bulk of the new cash is directed towards Ukraine support measures and migration policies, leaving the net-zero industry behind. In fact, only 10 percent of the new funds available will target strategic technologies, with a very wide scope ranging from quantum computing to biotechnologies[125]. Practically, the additional €10 billion available will be sourced from Member States' contribution, under the framework of external assigned revenues as described in the EU Financial Regulation (Art. 20).

Briefly, what was presented as a brand-new Fund was substituted by a different tool, the Strategic Technologies for Europe Platform[126]. This comes in the shape of a Regulation, therefore subject to negotiations among the co-legislators that might affect the current structure of the proposal. As conceived by the European Commission, the STEP covers three main areas: deep and digital

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[124] European Parliament (2022). *European Parliament resolution of 19 May 2022 on the social and economic consequences for the EU of the Russian war in Ukraine — reinforcing the EU's capacity to act.*

[125] European Commission (2023). *EU budget: Commission proposes to reinforce long-term EU budget to face most urgent challenges.* EU Commission press release.

[126] Bourgery-Gonse, T. (2023). *EU Commission wants new technology fund, but no fresh cash in sight.* Euractiv, 20.06.23. Retrieved here, 4.09.23.

technologies, clean technologies, and biotechnologies. The second pillar is expected to provide support to the Net Zero Industry Act provisions, including in its scope the following technologies: renewable energy, electricity and heat storage, heat pumps, electricity grid, renewable fuels of non-biological origin, sustainable alternative fuels, electrolyzers and fuel cells, carbon capture, utilization and storage, energy efficiency, hydrogen, water purification and desalination. Unsurprisingly, the list includes all the strategic technologies of the Net-Zero Industry Act, without being limited to it. Overall, the Platform aims to create synergies among the already existing European funds, facilitating the monitoring and application process for project promoters. Moreover, the STEP will provide a new opportunity for facilitating combined or cumulative funding from multiple European instruments. Finally, projects contributing to the STEP goals will be awarded with a Sovereignty Seal. This is designed as a quality label, thus serving as a multiplier of market opportunities for relevant projects, guiding private investors accordingly.

Public-Private Investment Ratio

As already discussed, the role of the State in the clean energy sector must be that of de-risking investments in strategic projects and technologies that can contribute to the goal of decarbonization. Public money alone cannot succeed in delivering the transition needed, but can act as a facilitator for private investments to integrate and multiply the financial firepower provided by governments[127]. Indeed, small amounts of capital from public entities can mitigate the risks that private actors are not able yet to undertake, or for which the financing conditions would be prohibitive for innovators. Public funding can thus serve as a catalyst for progress in key sectors.

While in the period 2011-2020 public funds covered 15 percent of the overall investments in Europe, analyses[128] show that, for climate and energy the need for investments from public players might amount to some 20-25 percent. This data is found to be consistent with global estimates as well[129]. Moreover, the public-private ratio is certainly a dynamic measure, with variations across sectors, time, and geography. The latter plays a particular role in the European policymaking, with member States displaying various sensitivities on how much the availability of finance represents a constraint for investments. This can be explained by the different internal economic conditions, and political and regulatory landscape[130].

Overall, more than €110 billion is expected to stem from the initial injection of funds under the STEP, taking into account the single multiplier of the relevant financial instruments involved. Moreover, the

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[127] IRENA (2023). *Low-cost finance for the energy transition*.
[128] Zarvas, Z. and G. Wolff (2021). *A green fiscal pact: climate investment in times of budget consolidation*. Bruegel.
[129] IEA (2020). *Tracking clean energy innovation*.
[130] European Investment Bank (2021). *Investment Survey 2021: European Union overview*.

Commission proposes fiscal incentives for Member States rebalancing their priorities in the cohesion policy funds towards STEP objectives. Coupled with the increased flexibility for European countries to use the RRF resources to complement the InvestEU products, the total firepower the Platform might unlock would equal €160 billion[131]. As far as the Net Zero act is concerned, in order to reach the estimated necessary investment of €92 billion for the legislation implementation, a 20:80 ratio is officially forecasted between public and private investments, which would translate into €15-18 billion of public funding to be provided. As seen, the amount currently provided is lower than 10 billion, since the resources are not directly assigned to clean technologies but shared with other technological areas.

Management mode of European funds

Under the scope of the platform fall all the relevant funds already established in the European landscape, whose management and competencies can differ widely. In the direct management framework, the European Commission is considered the only responsible party for all phases in the implementation process of funds. This means that a centralized administration takes place for the evaluation, monitoring, assessment, and payment of a funding program. Overall, directly managed programs account for 20 percent of the European budget under the Multiannual Financial Framework 2021-2027. A second possibility is indirect management: support entities like international organizations and national authorities partially or fully take the lead. This is usually the case in development or humanitarian aid issues, and it covers some 10 percent of the EU budget. The most important and used typology of administrating funds is shared management, where the European Commission and member States have joint authority to run funding programs. These account for the most part of the MFF 2021-2027 budget, for as much as 70 percent of the total. In this management configuration, Member States are charged with the responsibility of selecting projects and following them on a day-to-day basis while the Commission assures big-picture monitoring of how the funds are used. With reference to the Strategic Technologies for Europe Platform, the funds involved in the mechanisms correspond to both the first and last typology.

[131] European Commission (2023). *EU budget: Commission proposes to reinforce long-term EU budget to face most urgent challenges.* EU Commission press release.

Centralized Programs

Following Horizon 2020, Horizon Europe represents the main funding instrument at a European level for research and innovation. It is included in the MFF 2021-2027, accounting for over €95 billion. The program relies on three pillars: scientific, industrial, and innovation applications. The second one provides a basis for considering Horizon Europe as a contributor to the Net Zero act scope, with a particular reference to two of the six clusters, with these being Digital, Industry, and Space (cluser 4), and Climate, Energy, and Mobility (cluster 5). As outlined by the 2023/2024 Work Programme of the fund, cluster 5 might include the promotion of storage technologies, clean hydrogen projects, and carbon capture, use and storage. Overall, this contribution amounts to €20.2 billion to support clean energy technologies research and development, potentially lowering costs for future deployment with positive cost externalities all across the value chain. Horizon Europe will obtain €0.5 billion from the MFF revision, to be managed under the STEP framework.

The Innovation Fund represents one of the largest funding programs for clean technologies globally. Linked to the European Union Emission Trading System, its resources are linked to the sale of the system's allowances (EUA). With 450 million EUA sold every year for the period 2020-2030 at an average price of 75 €/tCO2, the overall contribution should amount to €43 billion[132]. The scope of the Innovation Fund includes technologies related to renewable energy generation, energy storage, clean hydrogen production, and CCS. In 2022, the Innovation Fund supported 17 projects concerning batteries, hydrogen, solar, and wind technologies for slightly less than €2 billion. However, the next round's budget will be increased to €3 billion[133]. President Von der Leyen suggested that the Fund's resources might be partially used to provide the net-zero industry operators with production tax credits. The Fund will receive an additional €5 billion from the MFF revision, resulting in a total generated investment of up to €20 billion.

The InvestEU Fund is the European main tool to tap private investment potential through public support by backing said investments with an EU budget guarantee equal to €26 billion. Replacing the Investment Plan for Europe, popularly known as Junker Plan[134], InvestEU is considered able to mobilize as much as €372 billion in investments, with a mandatory 30 percent contributing to the climate targets of the European Union. This would amount to more than €111 billion focused on climate goals. Because of its demand-driven nature, it is not possible to forecast the total spending that could be directed toward net-zero industry projects. Official estimates[135] consider the possibility

[132] IEA (2023). *World Energy Investment 2023.*

[133] Ibid.

[134] Launched in 2015, the plan has mobilized over €340 billion of investments in three years in sectors related to strategic technologies.

[135] European Commission (2023). *Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity.* SWD(2023) 68.

that up to 11.5 percent of the EU budget guarantee could be used for net-zero industry-related purposes, translating into more than €40 billion in relevant investments catalyzed. InvestEU will be a major recipient of the additional €10 billion introduced with the STEP proposal, with €3 billion. This will contribute to increasing the guarantee by €7.5 billion, with a 40 percent provisioning rate. Currently, 85 percent of the guarantees provided by the Fund have been deployed to the market, which is considered a proxy of the large absorption potential that projects financed by InvestEU have[136]. Overall, official estimates[137] account for a multiplier potential of 10, meaning that the additional guarantee will be able to deliver some €75 billion more in private investments.

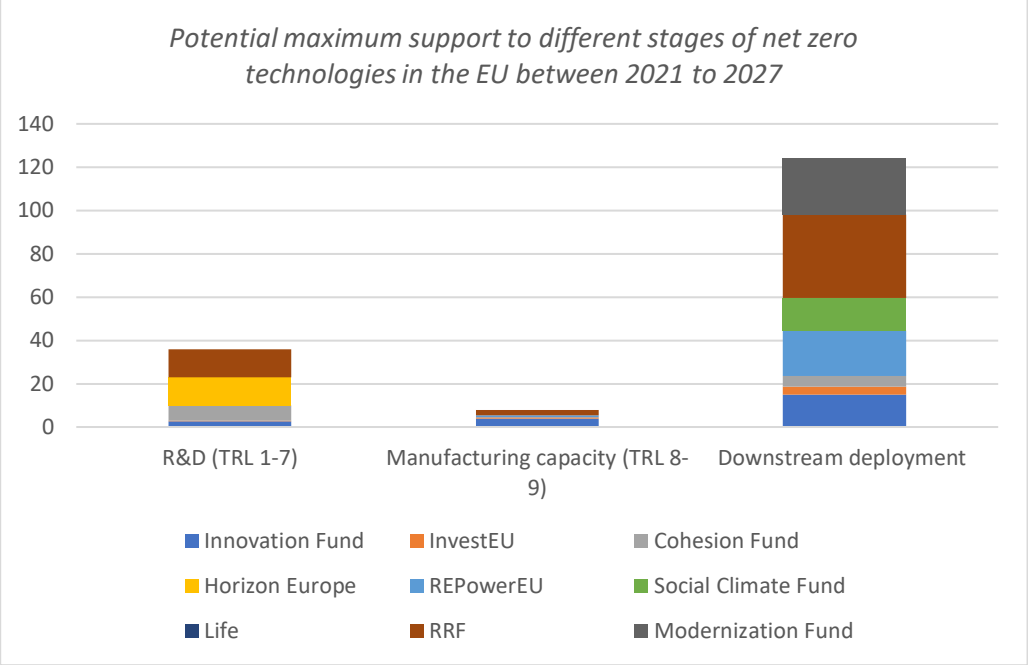

Figure 6: Potential maximum support to different stages of net zero technologies in the EU between 2021-2027. Source: European Commission (2023).

Decentralized Programs

The already mentioned Next Generation EU, the financial backup of the economic recovery strategy the European Union adopted to respond to the pandemic, relies for the largest part on the Recovery and Resilience Facility. This is composed of the 27 Member Countries' National Recovery and Resiliency Plans. Of the total €723 billion available, climate measures need to cover at least 37 percent of it, accounting for slightly less than €270 billion. Moreover, in February 2023 the adoption of the Guidance on Recovery and Resilience Plans in the context of REPowerEU allowed Member States to include an additional chapter in their NRRPs supported by the REPowerEU initiative. This will translate into €20 billion more for matters related to energy security and sustainability of the

[136] European Commission (2023). Regulation for a Strategic Technology for Europe Platform.
[137] Ibid.

European energy systems. According to the adopted NRRPs available, investments for almost €40 billion are expected to be directed to renewable energy sources, hydrogen, storage options, and grids[138] [139]. Additionally, more than €5 billion are committed to the decarbonization of heating systems in buildings, such as heat pumps[140]. Finally, investments for €13 billion are expected in R&I, including hydrogen and low-carbon industries[141].

A second valuable set of instruments is composed of the European Regional Development Fund (ERDF), the Cohesion Fund, and the Just Transition Fund, all strictly intertwined with the Cohesion Policy 2021-2027. This provides five targets, whose achievement can be implemented via the funds related to its operations. Particularly, the ERDF is designed to support competitiveness in Member States' SMEs in specific sectors, including low-carbon and resilient energy systems. Furthermore, the Cohesion Fund focuses on renewable energy promotion in fifteen countries with a Gross National Income lower than 90 percent of the EU-27 average[142]. Furthermore, the Just Transition Fund contributes to the goal of sustaining countries most affected by the transition in order to prevent the increase of disparities in the European Union. This allows for investments in the decarbonization process of industrial facilities in accordance with the EU ETS, thus including Carbon Capture and Storage. Overall, the three instruments support the Net Zero Industry Act's strategic technologies with almost €85 billion, with direct financing accounting for €24.5 billion (40 percent assigned to renewable energy technologies and the remaining to clean technologies)[143].

Finally, the Modernisation Fund is designed to facilitate carbon-dependent regions, 10 Member States today and 13 from 2024, in the achievement of the 2030 Union targets by channeling investments in the upgrading energy system while improving energy efficiency. Renewable generation, storage technologies, grids, and heat pumps all fall under the scope of the program. The Modernisation Fund relies on revenues from the sale of 2% of the Emission Trading System's EUAs. Total revenues from EUAs' sales in support of the Fund's scope may amount to €48 billion, at an average carbon price of €75/tCO2[144].

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[138] European Commission (2023). *Recovery and resilience scoreboard: Clean power.*
[139] European Commission (2023). *Recovery and resilience scoreboard: Digital public services.*
[140] European Commission (2023). *Recovery and resilience scoreboard: Energy efficiency in buildings*.
[141] European Commission (2023). *Recovery and resilience scoreboard: Research & innovation.*
[142] Today, this includes fifteen countries: BG, CZ, EE, GR, HR, CY, LV, LT, HU, MT, PL, PT, RO, SK, SI.
[143] European Commission (2023). *Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity.* SWD(2023) 68.
[144] European Commission (2023). Modernisation Fund.

Funding at a national level: State aid in the European Union

From the very beginning of European common history, the internal market has been a crucial regulatory matter, as well as a precious asset. The very first form of a common continental approach to regulation was adopted in 1957, with the establishment of the European Economic Community. Among the main pillars of the Treaty of Rome, the second article mandates the institution of a Common Market. A complete single market was reached only in 1993 with the adoption of the Single European Act. The main goal of the founding members of the European Community was to ensure increased political and social integration through economic relations. This was possible only by allowing the free movement of goods across the continental area, while building the foundations for fair competition among market participants. The European competition law relies on the seventh title of the Treaty of Functioning of the European Union, namely from Art. 101 to Art. 109. The pillars of the European competition policy are related to the management of private (cartels, market dominance issues, mergers) and public (state aid) anti-competitive behavior. While the first is common to any other competition Law globally, the State aid legislation represents a unicum. Indeed, the European Single Market involves private actors from a multitude of different countries. Therefore, the way in which the single national authorities relate to their national private sector needs to be regulated evenly in order to avoid detrimental effects from annihilating the level playing field of the European market. The 27 Member countries are characterized by very different fiscal capacities, with varying levels of financial support they can provide to their private fabric. In an attempt to provide a safe space against anti-competitive behavior, the Treaty of Functioning categorizes State aid as generally incompatible with the internal market (Art. 107). Following the definition presented by the Article, four cumulative criteria need to be fulfilled in order to classify state aids as such. First, "*use of state resources*", where the TFEU recognizes a difference between "*aid granted by a Member State*" and "*through State resources*". This phrasing helps widen the scope of the legislation not only to those funds mobilized directly by the State, but also by third bodies that can direct funds or capital on behalf of the State[145]. Second, distortion of competition needs to arise from the measure applied, meaning that the market position of the recipient of the aid is improved through the recognition of State resources at the expense of its competitors. To fall under the scope of Art. 107, the aid must provoke distortions in the trade among Member States, therefore it needs an inter-national qualification. Third, the Article outlines that prohibited state aids are those "*favoring*" subjects. According to the European Court of Justice (ECJ)[146], the term is used with reference to any kind of beneficial economic edge that the recipient would have not received in normal market conditions, thus without the State intervention.

[145] European Court of Justice (1993). *Sloman Neptune v Bodo Ziesemer*. Judgment of 17.03.1993 – C-72/91.
[146] European Court of Justice (1994). *Banco Exterior de España SA*. Judgment of 15.03.1994 – C-387/92, BeckRS 2004.

To assess this, the Market Economy Investor Principle (MEIP)[147] is often used by the ECJ to simulate if a potential state aid was to be considered appropriate for a market player. Fourth, the aid is recognized as such if it facilitates certain actors or the production of specific goods. The rationale of this specification is needed to exclude the big-picture economic policy of the Member State, where no specific recipient is envisioned but a general improvement is sought. Last comes the concept of undertaking, referring to any subject engaged in economic activities according to case law[148]. The definition of it is then related to no specific legal form of institution but to the quality of activities and operations that any subject can engage in.

The State aid Temporary Framework

With the pandemic and the attached effects on the economy, governments expressed the need of more funds in order to support their industrial fabric. Differences in the national economic situation of Member States were mirrored in the differences for the preferred approaches to funding. During the Covid outbreak, countries like Austria and Germany proposed the possibility of completely suspending the state aid legislation[149]. Whereas this proposal was discarded, the Commission did approve a relaxation of state aid rules, through the approval of the State Aid Temporary Framework in March 2020, building on a similar tool adopted during the 2008 financial crisis[150]. The 2020 framework did not introduce new legislation. Indeed, the needed relaxation was reached within the limits of Art. 107, which states that aid shall or may comply with the internal market if aimed at targeting "*exceptional occurrences*" or to alleviate "a *serious disturbance in the economy of a Member State*". Therefore, the framework can be considered as guidelines to countries on those areas of intervention with a high probability of being accepted by the Commission as compliant with the European Law. The normal procedure of state aid evaluation requires an individual detailed analysis of each case by the European executive in order for the aid to be cleared. Instead, the State Aid Temporary Framework completely revolutionized the mechanism, providing minimum requirements for support measures to be considered compatible with the internal market, thus facilitating and accelerating the process. In a time of crisis, massive billion-euro support schemes were cleared in a

[147] For a further exploration: Miguez, J. A. R. (2018). *Clarifying the Applicability of the Private Investor Test*. European State Aid Law Quarterly, 17.
[148] European Court of Justice (2006). *Enirisorse Spa v Sotacarbo* Spa. Judgment of 23.03.2006, C-237/04, BeckRS.
[149] Grüll, P. (2020). *Austria demands 'greater flexibility' of EU state aid law in letter to Vestager.* Euractiv, 23.04.20. Retrieved here, 7.09.23.
[150] European Commission (2008). *Temporary framework for State aid measures to support access to finance in the current financial and economic crisis*.

few days[151], while the average pre-crisis analysis period was estimated as some five months[152]. The effort allowed the European Commission to review and accept over 650 pandemic-related relief measures, amounting to over €3 trillion in one year and a half[153]. The Commission's endeavor represented a balancing effort more than anything else, aiming to support businesses forced by law to cease their operations while also preserving the internal market for the post-pandemic period from uneven competition.

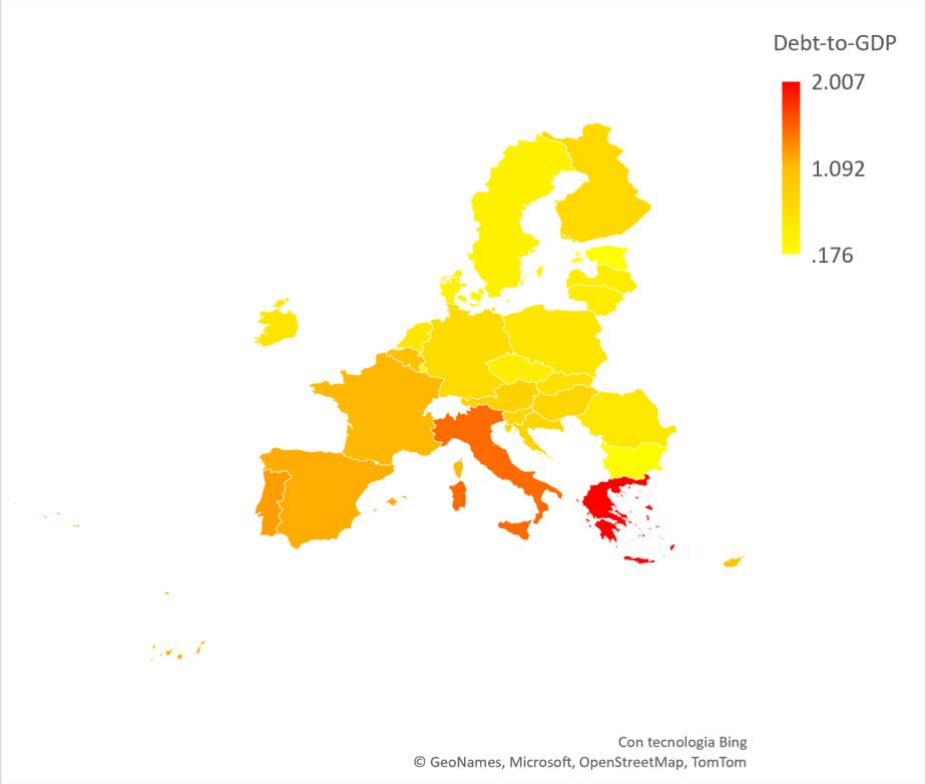

Figure 7: The different debt-to-GDP ratios of European countries in 2021. Source: IMF (2023). World Economic Outlook.

According to official estimates[154], this was a success. Indeed, whereas countries spent a record amount on support measures, no evidence was found of disproportionate aid, meaning that the funds were necessary to counterbalance the negative effects of the pandemic on the Union. Other than COVID-related measures, environmental aid ranked first, with energy savings being a key focus of many support schemes.

[151] The French *Plan de sécurisation du financement des entreprises* was notified to the Commission on March 17th, and received clearance on March 21st, with a five-day procedure.
[152] European Commission (2019). State Aid Scoreboard 2019.
[153] European Commission (2021). *Commission Statement on consulting Member States on proposal on the future of the State aid Temporary Framework.*
[154] European Commission (2022). State Aid Scoreboard 2022.

Temporary Crisis (and Transition) Framework

Building from the success of the State Aid Temporary Framework, the Commission adopted a similar measure to address the detrimental economic effect due to the energy crisis caused by the Russian invasion of Ukraine. The Temporary Crisis Framework was adopted in March 2022. Undergoing two amendments throughout the year, the Commission envisioned the opportunity to include the decarbonization challenge in the framework's third version.

The European Green Deal Industrial Plan calls for "*access to funding for net-zero industry to be extended and accelerated*". Starting from a common perspective of the previous efforts' success, the European Commission consulted with Member States to advance the possibility of extending the TCF scope to investment in strategic net-zero technologies as part of the European diversification strategy from Russian fossil fuels. Unveiled in March 2023, the Temporary Crisis and Transition Framework (TCTF) served as an assist to the upcoming Net Zero Industry Act. The Regulation comes as the European response to the Inflation Reduction Act, and its massive financial firepower in the shape of tax credits. The European Commission, in accordance with national governments, considered state aid as the most efficient and effective tool to tackle the issue. All net-zero technologies were included among those recognized by the TCTF as areas where support is compatible with the internal market. The addition to the TCF corresponds to section 2.5 to section 2.8. The former states the need to "*accelerate the roll-out of renewable energy and energy storage*". The related two subsections mirror the functioning of the Inflation Reduction Act, with the possibility to implement both investment and operating aid[155]. The first can be designed as direct grants, loans, or tax advantages including tax credits, while the second requires a two-way contract for difference (CfD) mechanism. CfDs are the main framework chosen by the Commission for public entities to support clean generators. These are financial derivative contracts where the price of an underlying asset triggers the remuneration. By signing a CfD, one party declares its willingness to exchange its floating and potentially volatile rate for a stable one with a contractor, usually a public entity. The fixed remuneration amount, or strike price, is usually identified through an auction process. After the contract is finalized, the generator sells its energy on the market, and it receives compensation from the public entity equal to the strike. The State receives, or covers, the difference between the strike and the market price. This difference is referred to as clawback when positive or payout when negative. The last section of the Temporary Crisis and Transition Framework is the most supportive and targeted to the Net Zero Industry Act provisions. Indeed, section 2.8 deals with "*aid for accelerated investments in sectors strategic for the transition towards a net-zero economy*". In the following paragraph, the Commission explicitly outlines the possibility for Member States to "*address the productive investment gap*" in net-zero

[155] Section 2.5.1 and 2.5.2 of the Temporary Crisis and Transition Framework

technologies. This section's scope includes six out of eight strategic net-zero technologies, with the missing ones being grids and sustainable gases, both mentioned previously in the act under Section 2.5. Moreover, a clause was inserted allowing Member States to provide undertakings with higher support in cases of investments being diverted from Europe. This paragraph allows governments to match the incentive a company can receive from a third country, with the rationale of protecting climate-related state-of-the-art manufacturing technology. Countries in southern and eastern Europe were particularly vocal in expressing their discontent with the possibility that countries like France and Germany could have seized the new loose guidelines with detrimental effects on the internal market[156]. For this reason, a requirement was included to impede the wealthiest countries from exploiting unevenly the relaxation of the State aid legislation, by prescribing that to match foreign subsidies, undertakings should be in less developed areas[157].

Moreover, State aid in European Law is subject to another key legislation, the General Block Exemption Regulation (GBER). First introduced in 1998, it allows the Commission to declare specific sectors or categories of State aid compatible with TFEU Art. 107. Aids in sectors regulated by the GBER are exempted from prior notification to and clearance by the Commission, thus reducing the total administrative burden related to State aid. Throughout the years, the GBER proved its effectiveness, exempting over 91% of State aid procedures from Commission notification[158]. Notably, in June 2023 the European executive adopted an amendment to the regulation to facilitate support measures targeting both green and digital transition.

Overall, contrary to the historical tradition of the EU, state aid was chosen as a pillar of the EU industrial strategy in recent crises. This comes with pros and cons. Indeed, allowing Member States to directly intervene to support their businesses unlocks a much larger financial capacity than any possible centralized tool. The overall amount of funds directed from Member States under the Temporary Crisis Framework amounted to €672 billion across nine months[159]. Moreover, State aid has proved to be particularly efficient in the short term during the Covid crisis, allowing for both scale and agility. However, this rapidity comes at the expense of deeper scrutiny by the European Commission.

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[156] When presenting the communication containing the Temporary Crisis and Transition Framework, Commissioner Vestager declared that historically state aids by Germany and France accounted for 77% of the overall amount cleared.

[157] European Commission (2023). Section 2.8 (86).*Temporary Crisis and Transition Framework for State Aid measures to support the economy following the aggression against Ukraine by Russia*.

[158] Letter of Margrethe Vestager to Economic and Financial Affairs Ministers, 13.01.23.

[159] Ibid.

According to the TCTF, the Commission has a maximum of 19 days from the notification reception to approve a state aid measure. This might not leave space for a careful evaluation, leading to the possibility that the audit process is transformed into a mere box-ticking exercise. As Margrethe Vestager stated when presenting the new guidelines in March 2023, the necessary relaxation "*comes with significant risk for the integrity of the single market and […] also for our unity. At the end of the day, state aid is the transfer of money from taxpayers to shareholders*[160]".

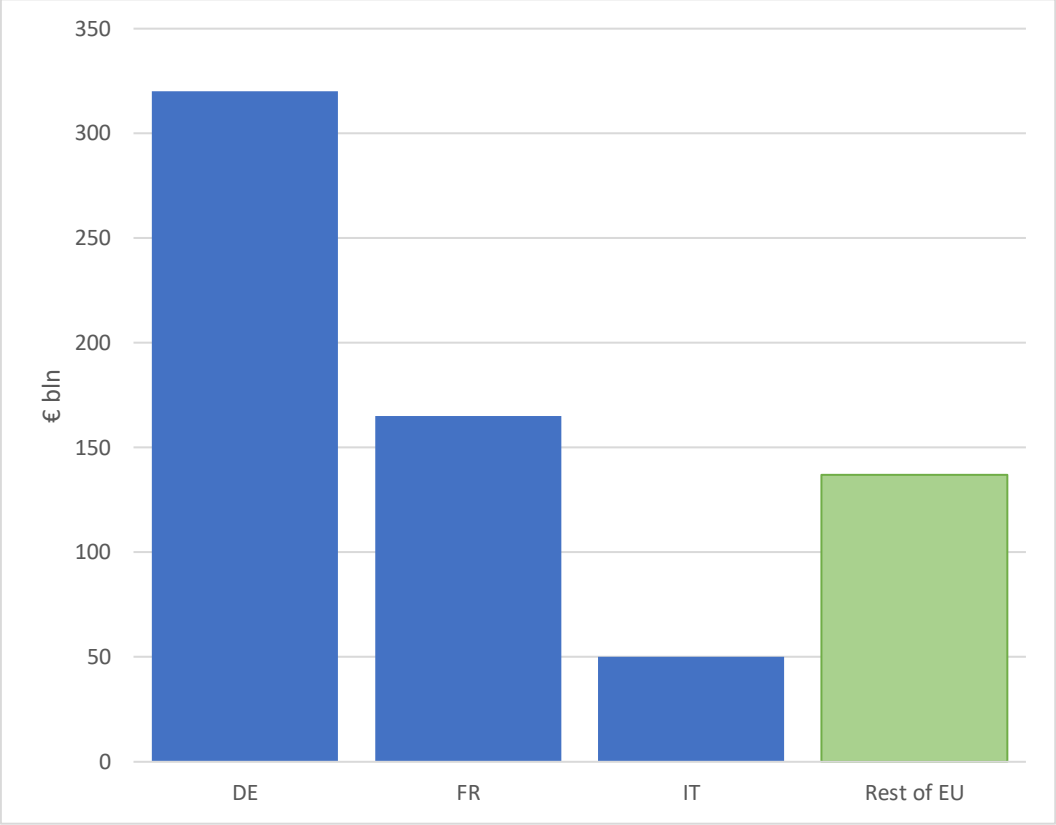

Figure 8: State aid under the TCTF, by country. Source: Letter of Margrethe Vestager to Economic Affairs Ministers (2023).

[160] European Commission (2023). *Remarks by Executive Vice-President Vestager on the proposal for a State aid Temporary Crisis and Transition Framework*.

Let the market decide: how Washington boosts the transition

With the adoption of the Inflation Reduction Act, the United States frightened the European Union with a two-way weapon. The legislation scared the European bureaucrats because of its massive capacity of public spending, matched with a rather easy administrative process. Whereas the billion dollars caught the eye of the media, in many cases companies planning to invest in the European Union decided to redirect their operations to the United States because of simpler access to funding, and therefore a more reliable environment for investments to be implemented[161]. Out of the overall $394 billion in federal funds, energy is the largest recipient with over 60 percent of the total. Manufacturing and environment both follow at 12 percent, and electric vehicle investments account for 5 percent. Overall, 9 out of 10 dollars provided by the American government will be likely directed towards sectors relevant to the analysis.

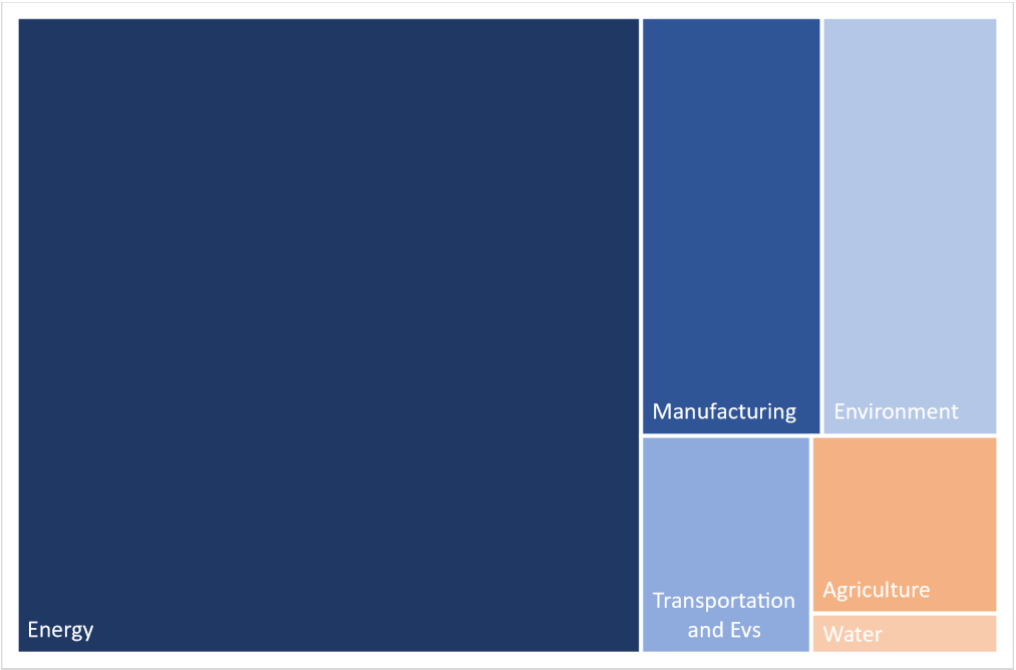

Figure 9: Inflation Reduction Act funds. Source: Inflation Reduction Act of 2022, H.R. 5376, 117th Cong. (2021–22); McKinsey analysis (2022).

The financial tools through which these funds will be provided are various: tax incentives, federal grants, and loans. Among these, the largest share is channeled through tax credits, both for consumers and for corporate players. By choosing this tool over others, the United States government shows a firm preference for a market-oriented approach over other possibilities. This means that over 66 percent of the overall funds available will be directed toward those producers and companies able to

[161] Chu, A., Irwin-Hunt, A., Roeder, O. (2023). *Inside the $220bn American cleantech project boom*. Financial Times, 16.08.23. Retrieved here, 10.09.23.

commercialize in a fast and efficient manner eligible technologies. Tax credits can vary in terms of the final recipient and the scope of their action. Incentives are available for both corporate players and single consumers, with the former being granted the largest resources, over 55 percent of the Inflation Reduction Act funds. As previously discussed, corporate tax credits will be available for production operations as well as investments. Interestingly, whereas corporations will be the first target of government spending under the IRA framework, they will be the ones paying for it in the first place. Indeed, a subsection of the legislation introduced a new corporate minimum tax, applicable to players marking over $1 billion of profits to shareholders. This should help the government collect over $200 billion in a decade[162].

Follow the money: Corporate Average Minimum Tax

The unprecedented amount of capital provided by the United States government with the Inflation Reduction Act relies partially on a tax reform targeting large corporations. As President Biden stated during the 2023 State of the Union "*we pay for these investments in our future by finally making the wealthiest and the biggest corporations begin to pay their fair share*"[163]. The Corporate Alternative Minimum Tax (CAMT) aims to implement this goal. Overall, the CAMT is designed to make sure that large companies contribute to the public federal expense since in the United States big corporations are known to use accounting tools to lower the final rate of their taxes. Literature[164] shows that in 2020 more than 50 US companies among the S&P 500 and Fortune 500 were subject to a 0 percent tax rate on their federal corporate income taxes. Among these figured Nike, Zoom, and FedEx, which accounted for $0 in contribution to the federal system. Overall, 55 companies reported gross revenues of over $40 billion, which would translate into slightly more than $8 billion in taxes on the current federal corporate tax rate of 21 percent. This was not the case. In the American tax system, companies have various opportunities to lower their taxable income, for instance through stock-based options. These are complementary instruments to remunerate employees by giving them the right to buy shares of the company at a fixed price in the future. With financial markets assumingly tending to increase their value, this mechanism translates into a benefit for the recipient. However, stock-based options are treated differently when analyzed for accounting or tax purposes. Indeed, accounting requires a company to report on its book estimated values while the tax system allows companies to wait until the option is exercised. The gap between the two values is what creates the

[162] Rappeport, A. (2023). *New Corporate Minimum Tax Ushers In Confusion and a Lobbying Blitz.* New York Times, 7.09.23. Retrieved here, 11.09.23.
[163] White House (2023). *Remarks of President Joe Biden – State of the Union Address*.
[164] Gardner, M., Wamhoff, S. (2021). *55 Corporations Paid $0 in Federal Taxes on 2020 Profits*. Institute of Taxation and Economic Policy.

opportunity for corporations to reduce their taxable income. This is because companies often report in their books minimized expected costs for stock-based options assigned to employees[165]. When these exceed the initial estimate when exercised by the recipient, companies are entitled to report the final real value for tax matters. This allows corporations to then reduce their tax expense because of a reduction in their taxable income due to higher costs, that in real life were not corresponding to any transaction. Other than stock-based options, different instruments can be used by firms to lower their tax burden. Under the United States tax system, companies are entitled to use an accelerated depreciation model[166]. Under this framework, assets are not accounted for their depreciation rate over time of service in equal installments but budgeted far before their end of service. This allows companies to report the full cost of an asset in order to reduce their taxable income with no or little relation to the real economic depreciation of the good. Whereas the accelerated depreciation model does not affect the taxable income, tax, and after-tax profits, larger liquidity in the short term can greatly benefit corporations. With an increasingly diminishing value of money as time passes by, a dollar today values more than the same dollar tomorrow, because in the meantime capital can be invested in order to produce additional value. These are just examples of the several possible loopholes large corporations can exploit to reduce the overall tax amount they are required to pay to the government. In an attempt to solve this issue, the Biden Administration proposed a deep reform of the tax system in the Build Back Better Act. Many of the provisions were designed to target the said workarounds. Out of almost 40 related provisions, few lasted the fierce opposition of the corporate sector[167]. After being discarded in the Senate, the Build Back Better Act was submitted again as the IRA, resulting from long negotiations internal to the Democratic Party. Indeed, the IRA was adopted with no support from the other side of the Congress. While losing some key measures for the sake of gathering the widest possible consensus[168], the final legislation maintained the flagship proposal of the Administration. The provision, coming into effect in 2023, states that large companies will be required to pay the maximum tax rate between the regular rate of 21%, and the minimum set at 15%. In the scope of the CAMT are all those companies that registered at least $1 billion in profits as average of a three-year period. Foreign companies are included in this mechanism, with the legislation considering all those "*foreign-parented US firms*" profiting over $100 million yearly as long as the overall corporate group's profits accounts for more than $1 billion. According to

[165] Gardner, M. (2021). *Zoom Pays $0 in Federal Income Taxes on Pandemic Profits.* Institute of Taxation and Economic Policy.
[166] Gardner, M., Wamhoff, S. (2019). How Congress Can Stop Corporations from Using Stock Options to Dodge Taxes. Institute of Taxation and Economic Policy.
[167] PwC (2021). *Revised Build Back Better bill as passed by the House - key business and individual tax provisions*.
[168] Rappeport, A. (2022). *How a Last-Minute Lobbying Blitz Watered Down a Climate Bill Tax*. New York Times, 8.08.23. Retrieved here, 13.09.23.

estimates[169], the CAMT could contribute to collecting more than $200 billion in a ten-year time, equal to a 5.8 percent increase in the overall private sector tax revenues. The way in which the measure is designed is likely to impact a limited number of companies, with a study[170] considering less than 80 corporations to be included in the Act's scope, and the first six of these[171] accounting for as much as half of the overall contribution. As with many other provisions in the Inflation Reduction Act, the Corporate Average Minimum Tax's specifics were not included in the legislation, with the task to define them assigned by Congress to the United States Treasury Department. Whereas the Treasury, supported by the Internal Revenue Service, published temporary guidelines, the official text has not been issued yet.

Opponents of the new measure highlighted some negative fallouts. First, critics argued that the Act would impose an unnecessary administrative burden on companies, as they would be obligated to calculate both the 15 percent minimum tax rate and the 21 percent standard rate with the included discounting options[172]. Second, in the long-term, the effect of the measure's cost has a high potential to be spread over to workers. According to official estimates[173], while the CAMT would affect shareholders in the first place, it would slowly reach all capital income. Labor income would be burdened with as much as 25 percent of the corporate tax being transferred to workers in ten years.

Finally, it is interesting to note that the Biden Administration proposed at the international level, notably through the Organization for Economic Cooperation and Development (OECD), a taxation reform to fight against multinational corporations' practice of exploiting tax havens to reduce their tax expense. Under the OECD-brokered agreement, the global base erosion tax mandates that every signatory country establishes a minimum tax rate at a national level of at least 15 percent on the profits generated by corporations exceeding $750 million in annual revenues within its jurisdiction.

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[169] Joint Committee on Taxation (JCT). *Estimated Budget Effects Of The Revenue Provisions Of Title I*.

[170] Hoopes, J.L., Kindt, C. (2022). *Estimating the Minimum Tax on Book Income Liability Using Public Data*. University of North Carolina Tax Center.

[171] The study was finalized in 2021, with data from previous years. The conclusions of the analysis reported that Berkshire Hathaway, Amazon, Ford, AT&T, eBay, and Moderna would have been the companies most affected by the CATM, would have it been into effect.

[172] Ma, E., Myers, T.R. (2023). *Inflation Reduction Act includes 15% corporate minimum tax on book income.* The Tax Adviser.

[173] Joint Committee on Taxation (2013). *Modeling the Distribution of Taxes on Business Income*.

Tax Credits: an American tradition

The Inflation Reduction Act was widely appreciated, at home and abroad, for the simplicity of its support mechanisms. Part of this success was due to tax credits. The proposal entails also other financial tools, namely loans, and grants, but tax credits stole the show because of the scale at which they are used, and for the approach to the transition they suggest. The legislation relies strongly on such instruments to support the goals it proposes, with some 66 percent of the overall estimated funds of the IRA to be delivered in the shape of tax credits. Through this, specific operators providing the system with a valuable service or behavior are compensated by the government by lowering their taxes accordingly. While the official data by the Congressional Budget Office and the Joint Taxation Committee for the total energy and climate funding amounts to $369 billion, the uncapped nature of the tax breaks is likely to drive the final costs of the Inflation Reduction Act up to more than its double, as high as $870 billion by 2030[174]. Tax credits in the Inflation Reduction Act are divided according to the recipient: corporations or consumers. Corporations will collect more than the majority of the overall funds provided, for this reason playing a central role in the Act's implementation. Particularly, the Act's extreme reliance on such a measure to interact with the private sector shows a firm market-oriented approach followed by the Biden Administration in designing the legislation. By choosing to rely on tax credits, the government renounces to impose major top-down decisions on what tools to use to reach the goals rightfully defined by politics. This is precisely the case in the IRA. As previously discussed, whereas at first tax credits are assigned by technology, from 2025 all technology-specific tax credits will migrate to one unique clean energy tax credit, with the only requirement of emitting "*not more than zero*" once operating. This translates into a dependence on whatever technology the market will consider promising in the next years. Indeed, tax credits operate as an ex-post support measure. Therefore, the incentive will not constitute the only business model of the clean generator, but it will integrate or add up to the already existing economic viability of a project. Several differences can be found with the European way of transition, where the financial firepower is traditionally targeted at the research and innovation stage[175]. Conversely, Washington suggests a different model, where only those innovations able to reach the are compensated by the taxpayers.

In the Inflation Reduction Act, three typologies of tax credits will be available for market players, two for corporations and one for consumers. Precisely, companies will be recognized with a chance to pursue investment tax credits or production tax credits, or both at the same time depending on the

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[174] Bistline, J., Blanford, G., Brown, M., Burtraw, D., Domeshek, M., Farbes, J., ... & Zhao, A. (2023). *Emissions and energy impacts of the Inflation Reduction Act*. Science, 380(6652).

[175] Jansen, J., Jäger, P., Redeker, N. (2023). *For climate, profits, or resilience? Why, where and how the EU should respond to the Inflation Reduction Act.* Hertie School – Jacques Delors Center.

sector. While the two instruments have existed before in the US legislation, the Inflation Reduction Act expands their scope and capacity. The investment tax credit (ITC) consists of a bonus equal to a percentage of the overall investment cost made by the plant operator to establish a manufacturing facility to produce clean energy equipment or directly generate energy. The Production Tax Credits (PTC) assigns an incentive to facilities per output generated. This means that generators producing electricity will be remunerated according to their MWh output, with a use-it-or-lose-it mechanism. Tax credits for consumers will be available as well to facilitate the uptake of electric transport, with the already discussed Clean Vehicle Tax Credit. While the latter has been already eviscerated in the previous section, the next one will discuss the potential economic effects that both kinds of corporate tax incentives could produce on the energy system in the country where they are implemented.

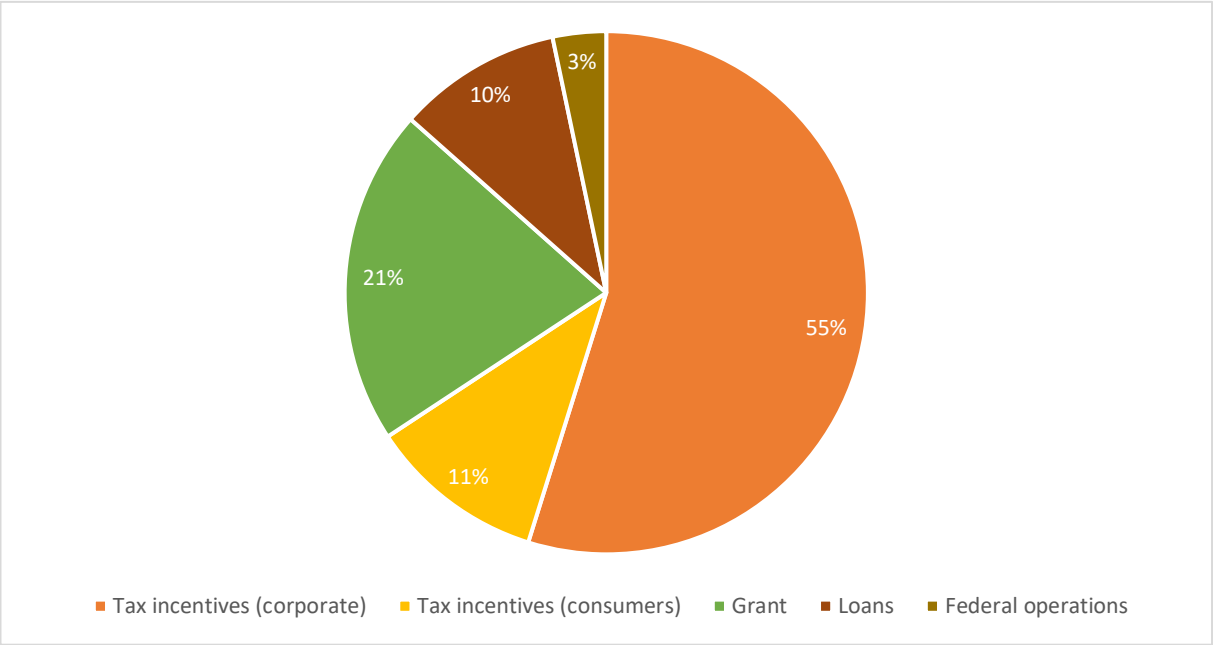

Figure 10: The IRA's energy and climate funding. Source: Author's elaboration from data by McKinsey (2022).

The new frontiers of tax crediting: *direct pay and transferability*

The United States has a long history of tax credit usage and design, and a successful one for the most part. However, some issues were noted, particularly in terms of what social class the incentive has targeted and supported the most. Before the Inflation Reduction Act, clean energy tax credits were traditionally non-refundable. Non-refundability means that investors or producers cannot subtract from their taxes a greater amount than that they owe to the State. This has a massive impact on how the public resources on which the credit relies are redistributed once the tax break is operating. High-income subjects are advantaged from the non-refundability clause since their taxable income is higher, thus their taxes are higher. Being able to exploit more the incentive, they will receive a higher amount of funds. On the other hand, lower-income players will be disadvantaged because the

maximum amount of credit they will be able to collect will be lower. To solve this issue, the investors unable to adequately benefit from the credit partnered with large bank groups, in a practice defined as tax equity financing. The transaction would see the clean energy developer recognizing a financial institution the right to use the credit in exchange for the bank's participation in the clean energy project's equity. However, this presents a range of unresolved issues. The primary concerns include the high bureaucratic costs associated with implementing the transaction, and the frequent scenario where developers lack project ownership and, as a result, have no equity stake to share. Other climate policies operate in the opposite direction, with a carbon tax naturally targeting higher-income producers more than others. In order to rebalance the design of tax credits, the Biden Administration introduced monetization tools to create a level playing field for all contributors. These empower recipients to convert the assigned credits into cash or financial assets. The two instruments included in the Inflation Reduction Act are *direct pay* and *transferability*. The two have different focuses, with the first covering subjects exempted from income tax and the second focusing on the rest of the contributors. *Direct pay* allows those entities not subject to taxes to obtain the credit as a direct payment issued by the Internal Revenue Service. In fact, with previous versions of tax credits, all non-profit organizations, as well as State actors and State-owned utilities were automatically excluded because of how the crediting system was conceived. *Transferability* allows taxpayers who would not be able to fully capture the value of their assigned tax credit to sell it to a second market player in exchange for cash. The latter creates a new set of opportunities for clean energy project developers, with related effects on the overall energy market. First, partnerships with financial institutions, and all the related costs, becomes economically inefficient. Second, developers will be empowered to directly own the clean energy project thanks to the possibility of completely seizing the scale of the tax credit, regardless of their taxable income. A simpler process will not only benefit developers, but will attract a larger number of investors. The competition in financing clean energy projects will allow developers to sell their tax credits at a higher price. Whereas needed to balance the distributional effects of tax credits, the described functioning outlines a particular system inefficiency. In selling their tax credit, clean energy developers obtain a slightly lower amount of money from the investor than the initial incentive value, with the gap corresponding to the reason the investor has in choosing to buy the tax credit rather than paying its taxes. With analyses[176] considering this delta equal on average to 6-15 percent of the credit value, the inefficiency of this support is obvious. In a scenario where the government recognizes a $100 tax credit, bearing an equal cost, to support a clean energy provider, the latter will only receive $85-94.

[176] Antonache, I., O'Neill, R. (2023). *Inflation Reduction Act provides transferable energy tax credit options*. Portland Business Journal.

Production tax credit: impact on the electricity markets

Production tax credits are one of the two main typologies of tax incentive in the IRA designed to support the private sector in contributing to the energy transition envisioned by the legislation. The PTC aims to promote the uptake of clean energy providers by lowering the price of the electricity produced. Estimates for the final cost of the measure differ widely: whereas the Congressional Budget Office accounted for $62 billion over ten years, other analyses signal a potential expense almost three times larger[177]. This can have double beneficial effects on the market. Often, the marginal generator is represented by a fossil fuel plant, expensive to run but fully dispatchable and programmable. In this scenario, clean generators benefit from the gap between their operational costs and the marginal price the market remunerates them with. A production tax credit helps additionally widen this delta, with positive repercussions to the clean generator. On the other hand, when clean energy facilities are the marginal generator, the price is set equal to their bid to the market, the tax credit lowers not only the plant's cost but also the price they can bid to the market, thus reducing the overall price of electricity at that specific moment. However, production tax credits can negatively affect markets depending on specific conditions. As previously implied, short-term electricity markets organize supply according to the bid each generator submits. The higher the bid submitted, the further in line the facility will be placed to satisfy demand. In this context, prices are key to maintaining balance in the market. When prices soar, they indicate a lack of supply, attracting additional generators to join, while low prices can indicate a period of oversupply, encouraging providers to decrease their output. In extreme conditions, negative prices can occur. In all industries, prices can drop below the production costs, signaling to facilities to cease production. If the so-called price signal fails to convey the message of interrupting operations, storage can help absorb the overproduction, and when storage is not an option, that excess can be discarded. However, both strategies involve additional expenses. A third way for producers would then be to identify subjects able to boost their consumption for a price lower than the cost of storage or discard. The third scenario constitutes the economic fundamental for negative pricing. In the energy sector, negative pricing is intertwined with renewable energy uptake[178]. Indeed, most renewable energy sources are non-dispatchable, therefore their generation cannot be controlled. For instance, Texas, being the State in the US with the deepest wind energy penetration, displays the country's highest recurrence of negative pricing, with 19 percent during a year[179]. Particularly, oversupply is likely to occur if the intermittence of renewable generators is combined with the scarce flexibility of conventional baseload generators, usually coal or nuclear

[177] Gros, D., Mengel, P.L., Presidente, G. (2023). *The EU and the US Inflation Reduction Act: no rose without thorns.* Bocconi University's Institute for European Policymaking.
[178] Ambec, S., Crampes, C. (2017). *Negative prices for electricity*. Florence School of Regulation.
[179] Boettiger, C (2021). *ERCOT Wind Energy Leading To Lower, More Volatile Pricing*?. BTU Analytics.

power plants. These generators work best when operated continuously and are not well fit for matching a volatile demand, since they require long lead times to reach their full production capacity[180]. Baseload generators plan their production in order to be available at full capacity when demand is higher, but because of their long lead times, they need to start processes hours before when demand is still low. The lower the demand, the lower the economic value of the MWh produced, and consequently, the bid they present to the market. Indeed, generators' bids during low-demand periods could be lower than their marginal cost, because accounting for the future surplus. In some cases, this can be significant enough to justify a negative bid.

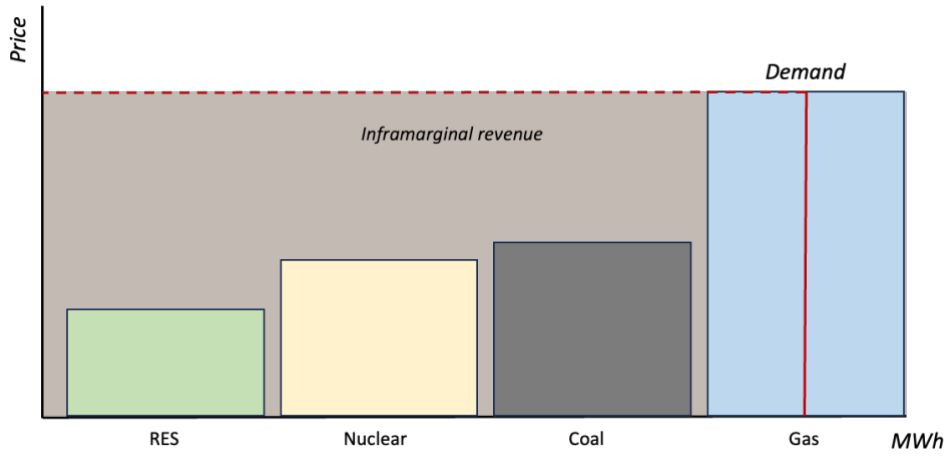

Figure 11: The Merit-Order Model in electricity markets.

In this picture, clean energy production tax credits can play a major role. Indeed, if poorly designed, they can constitute an incentive for generators to keep producing even in a negative pricing scenario. For instance, if an operator is eligible for subsidies amounting to x dollars per MWh, and in a situation where prices turn negative and settle at -x +1 requiring the operator to pay a price marginally lower than the subsidy received, it would still be profitable to keep the plant running. This has severe consequences on the overall system. Because renewable energy generation is generally flexible, it is theoretically extremely price-responsive in a no-PTC scenario. With the tax credit standing, generators choose to produce non-needed energy in order to be remunerated by the government. The detrimental effects provoked by PTCs are three. First, the tax credit is a form of State aid, using public resources. Therefore, the energy oversupplied is not remunerated by the market, but by the public resources. Second, since system operators rely mainly on price as a metric to manage the demand-supply balance, the reliability of the system is endangered by non-economically motivated negative prices. Third, negative prices harm conventional generators, still crucial to the stability of the system,

[180] US Energy Information Administration (2020). *About 25% of U.S. power plants can start up within an hour.*

because they rely on a different cost structure than renewables. Indeed, whereas a wind farm requires high upfront capital expense to build it, operational costs are strictly limited to maintenance. With these premises, every price higher than 0 is convenient to bid. On the other hand, fossil fuel generators suffer from lower CAPEX but significant operational costs, mainly because of the fuel price. Normally, conventional generators advance positive bids equal to their fuel costs. This means that when prices are decreasing excessively, or even going negative, the loss suffered is massive, considering that conventional generators cannot benefit from a production tax credit[181]. Whereas no analysis has been conducted yet on the Inflation Reduction Act's effects on American electricity markets, it is possible to build on previous works on past versions of the Clean Energy PTC in the United States Law. Literature shows[182] that such detrimental effects were caused at the beginning of the 2010s by the PTC first introduced by the 1992 Energy Policy Act and extended by the 2009 American Recovery and Reconstruction Act[183]. The analysis suggests that $22/MWh tax credit for production is excessive, with serious risks for the overall system. The Inflation Reduction Act provides production tax credits for clean energy providers as high as $33/MWh if all available bonuses are achieved. Whereas the United States energy infrastructure system changed in the last ten years with a much larger flexibility capacity, the comparison can still be useful to explore the possible consequences of one of the Act's main provisions on the market.

Investment tax credit: incentivizing renewables uptake

As with the PTC, the Investment Tax Credit does not represent a novelty in the United States Law. First introduced in 1992 with the already mentioned Energy Policy Act, its lifetime has been extended several times, the last happening in August 2023 with the Inflation Reduction Act. Different from the production tax credit, the ITC can be exploited by both consumers and corporations when installing clean energy production systems. According to the US solar industry's data[184], the positive effects of the credit have been massive. From 2006 to 2022, solar industry value in the United States increased by more than 200 times, fueled by continuous innovation breakthroughs and encouraging policies. Moreover, the constant support of tax incentives for supporting solar technologies investment has helped slash the levelized cost of electricity characterizing utility-scale applications, catalyzing as a result additional capital. With reference to solar energy, the United States market experienced a

[181] As seen in Chapter 1, the Inflation Reduction Act provides a tax credit for nuclear power plants, but no support measure is available for coal or gas facilities. Whereas this is in line with the climate nature of the policy, the potential economic damages should be considered.
[182] Huntowski, F., Patterson, A., Schnitzer, M. (2012). *Negative Electricity Prices and the Production Tax Credit*. The NorthBridge Group.
[183] Internal Revenue Service (2009). *Energy Provisions of the American Recovery and Reinvestment Act of 2009 (ARRA).*
[184] Solar Energy Industry Associations (2023). Solar Investment Tax Credit.

reduction of almost 85 percent in LCOE over seven years[185], translating into a lower cost suffered per MWh produced. The levelized cost of electricity is a summary metric used to compare the cost of building a power plant with the output it is able to generate. The general formula to compute the LCOE includes financing costs, overnight capital costs, fixed and variable operations and maintenance (O&M) costs, fuel costs if applicable, and an estimate for the utilization rate of each plant type. The steep decrease observed in the solar sector is related to a fall in costs related to the construction phase, where investment tax credit might have helped in two ways. First, by directly reducing the cost of investment, the marginal price of the generator will be lowered accordingly. Second, the reduction of the initial cost burden of the project attracts for more investors, therefore leading to a general increase in projects started. This creates positive cost externalities because of two economic models, economies of scale and learning curve. Economies of scale suggests that an increase in the quantity of production translates into a decrease in the marginal cost for the producer, while the second concept assumes that the production process of a good improves over time in terms of efficiency and quality. Both are considered to have played a role in the uptake of solar technology applications[186]. Furthermore, tax incentives targeting investments have been observed[187] to affect recipient firms' behavior in terms of labor. Particularly, when companies are offered a capital expense reduction, this often causes a subsequent increase in labor demand. Interestingly, this trend has a deeper effect on college-educated workers when it comes to industries with large capital shares of innovation, energy included.

30 years later: same credit, different scope

Throughout the years, the investment tax credit for clean energy in the United States radically changed its goal, while maintaining a similar design. Indeed, the Energy Policy Act aimed at creating a sector that was still in its infancy stage globally. In the late 1990s and early 2000s, the main challenge policymakers were called to tackle in order to foster clean energy technology deployment was represented by cost. Until recent years, renewable energy generators relied on subsidies and public support to access the market, not able to compete against conventional sources. Today, clean energy is often competitive with and cheaper than conventional sources, even without subsidies[188]. Investment tax credits, together with other support measures, have proven their effectiveness in tackling the cost issue. On the other hand, countries that first had the edge in the sector did not manage

[185] Dwivedi, C. (2018). *Influence of Production and Investment Tax Credit on Renewable Energy Growth and Power Grid*. IEEE Green Technologies Conference.
[186] Bolinger, M., Wiser, R., & O'Shaughnessy, E. (2022). *Levelized cost-based learning analysis of utility-scale wind and solar in the United States.* Iscience.
[187] Lerche, A. (2022). *Investment Tax Credits and the Response of Firms*. IZA Institute of Labor Economics.
[188] IRENA (2023). *Renewable Power Generation Costs in 2022*.

to retain their leadership role. Indeed, while reducing prices and driving consumption up, the manufacturing capacity was increasingly lost in favor of Asian suppliers, with China as the global champion.

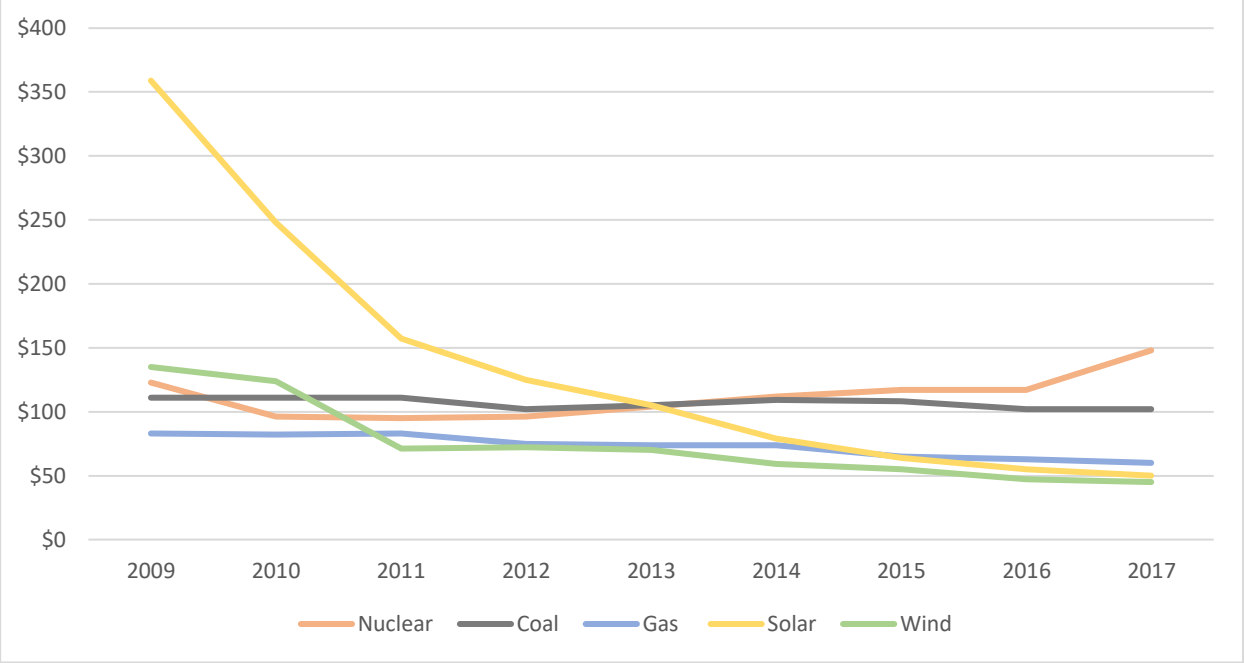

Figure 12: Average LCOE for selected energy sources by year in the US. Source: Energy Innovation, 2018.

Data[189] shows that until 2006 the photovoltaic panels manufacturing capacity was almost entirely located in Europe, Japan, and the United States. Already in 2010, Chinese companies accounted for a majority stake over almost all solar PVs' key production stages[190]. On one hand, the concentration of production capacity helped lower costs even more. On the other, the security of supply was severely endangered. The most recent version of the investment tax credit aims at solving this issue, by reducing the significant cost gap separating Chinese and American-manufactured clean energy technologies. Still today, solar panels produced in China are 20 percent less expensive than those made in the United States[191]. In a context where costs are not the only metric anymore, and security appears to be valued more than competitiveness by Western governments, retaining the industrial capacity to manufacture renewable energy technologies is a political priority for all powers. Overall, the IRA's investment tax credits aimed at lowering the cost of construction for specific technologies in order to challenge China's competition, while the Energy Policy Act was focused on enhancing the sector's competitiveness.

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[189] Jäger-Waldau, A. (2011). *PV status report 2011 : research, solar cell production and market implementation of photovoltaics*. Joint Research Centre, Institute for Energy and Transport.
[190] IEA (2022). Solar PV Global Supply Chains.
[191] Ibid.

Analyzing key factors: an examination of two approaches' differences and effects

Carrot or stick: a theoretical framework for clean energy policymaking

This next section aims to better explain the broader context around the two policies analyzed. Indeed, both the Net Zero Industry Act and the Inflation Reduction Act represent a tailored approach to their sponsor institutions, both integrated into a pre-existing policy environment that is worth deepening. As far as the European Union is concerned, the Net Zero regulation represents the tip of the iceberg in terms of climate and energy policies, standing on the shoulders of giants. The United States climate policies history tells a different, and more limited tale. In the currently examined pieces of legislation, as well as shown traditionally in the previous efforts to limit climate change, the two actors adopted very different – and almost opposite – approaches.

When designing industrial policies, politics' main issue is to guarantee that investments in green technologies are executed at an adequate scale[192]. The methodology for doing so varies greatly, depending on the need and the characteristics of the context where the policy must demonstrate efficiency. The European Union and the United States represent two different approaches in this sense, because of different structures and contexts.

The EU is a one-of-a-kind political entity, in between an international organization and a national state[193], whose structure is often defined as multi-level governance with strongly decentralized power, although in recent times the European Commission has seen its role becoming more and more key to the political and legislative scenario[194]. Nonetheless, the EU has a restrained capacity in the design of industrial policies. Indeed, the Treaty of Functioning of the European Union defines industry as a supporting competence of the EU (Art. 6), thus limiting its action scope if related to that of member countries. On the other hand, the US is a federal republic. The federalist nature assigns a superior power to the central government over the federate states, allowing therefore for stronger central policymaking, despite some level of decentralization being present in the US as well.

Notwithstanding the form of state, political analysis allows for a greater understanding of how the two executive institutions behave. The United States came into existence in opposition to what was perceived as a suffocating imperialist superpower. This is still today a key feature of the American political landscape. Throughout its history, despite the significant increase in state involvement in the

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[192] Rodrik, D. (2014). *Green industrial policy*. Oxford review of economic policy, 30(3).
[193] Hlavac, M. (2010). *Less than a state, more than an international organization: The Sui generis nature of the European Union*. Georgetown University.
[194] Lehne, S. (2023). *The Comeback of the European Commission*. Carnegie Europe.

economy during the New Deal era in the 1930s, the state never aimed nor developed the capacities to attract more legislative competencies within its sphere[195]. In 1981, President Ronald Reagan famously stated that in crisis "*government is not the solution to our problem, the government is the problem*". In Europe, the role of the State developed differently, also because of the general achievement of a comprehensive welfare State, that empowered governments to be more present in the economic scene[196].

As it has been said, the climate legislation framework in the two countries is fairly different. For a more complete discussion, the analysis will compare the different sections of the Inflation Reduction Act, the main flagship legislation of the United States climate policy, with more than one crucial piece of legislation the European Union has in place. This will empower the discussion to provide a more accurate depiction of the two systems in their support for clean energy. The following pages will be organized around three areas of focus. First, a review of the climate policy path that brought the two countries to the present moment, which will be followed by a discussion of the two approaches displayed to achieve decarbonization, carbon pricing for the European Union and subsidy schemes for the United States. Lastly, the analysis will turn the spotlight on how the two entities relate to the international system through their climate and clean energy legislation, with particular attention to the World Trade Organization.

Background: energy policies across the Atlantic

The EU as a global trendsetter: climate policymaking before it was cool

The European Union is still today perceived as the standard setter globally when it comes to climate change policies. Indeed, Brussels' endeavor is truly unmatched by the other top players in the international scene. The 1997 Kyoto Protocol, the first step in the global process of decarbonization, saw the European Union as the sole major emitter to ratify and implement the pact in 2002. The Protocol provoked some major changes in the way the climate challenge was addressed in Europe, with the definition of the first-ever binding greenhouse gas emission reduction targets, and the development of a mechanism to trade emissions. This was officially adopted in 2003 and launched in 2005 as the EU Emission Trading System. The EU ETS follows the cap-and-trade mechanism, where the public player sets an optimal volume of emissions that can be generated by producers in the region, while accordingly issuing allowances to emit. Periodically, the cap is reduced, in an effort to consequently reduce emissions. The EU ETS is constantly updated to increase its scope, and today

[195] Hay, C., Lister, M., & Marsh, D. (Eds.). (2022). *The state: theories and issues*. Bloomsbury Publishing.
[196] Gonthier, F., & Matthews, T. (2015). The rise of interventionism in the European Union and its social foundations. *Revue française de sociologie*, *56*(1), 7-46.

covers more than 40% of the Union's total annual GHG emissions[197]. The European cap-and-trade can be considered a structural part of the Union's energy policy, since it also addresses energy-intensive industries, indirectly nudging the most polluting producers to migrate towards efficiency and low-carbon or carbon-neutral solutions. Moreover, the European Union has had policies in place directly targeting renewable energy sources for more than two decades, starting with the legislation popularly known RES Directive[198], adopted in 2001. The act aimed at facilitating the use of renewable energy sources in the internal electricity market, by setting individual national targets in order to achieve 22 percent penetration of renewable energy in the electricity mix by 2010. This represented a first step towards the main European renewable energy law, adopted in 2009, and then updated twice in 2018 and 2023. The first version, known as RED I[199], set an EU-wide 20% target by 2020, which was then articulated in single national targets. While not all Member States fulfilled their contribution, the general target was achieved. As part of the Clean Energy Package for all Europeans, a revision of the directive entered into force in 2018. RED II[200] presented a significant difference from the previously adopted approach, involving the elimination of national targets and the establishment of an overarching EU-wide binding objective. RED II was considered key to delivering on the EU's determined contribution to the 2015 Paris Agreement, setting a 32% by 2030 binding target for renewable energy penetration in the European energy mix. The transition from the Junker Commission (2014-2019) to the one headed by Ursula Von der Leyen (2019-2024) was characterized by an increased climate ambition, that was mirrored by the legislative activity carried out in the following years. In 2020, the Fit-for-55 package was unveiled, proposing a third revision of the Renewable Energy Directive[201]. The bill aimed at increasing the Union's target for 2030 to a 45% renewable energy penetration in the EU energy mix. A final agreement was achieved in 2023, setting a 42.5% binding target by 2030 for the share of renewable energy in the EU's total energy consumption, along with an extra 2.5% as an indicative increase, potentially leading to the proposed total of 45%. Other key energy bills presented in the Fit-for-55 package framework were the Hydrogen and Gas Markets Decarbonization Directive and Regulation, with the specific aim to lower the climate impact of gas consumption, while transitioning to hydrogen.

Thanks to the several legislations brought forward in recent years, such as European Green Deal and Fit for 55 Package related laws, the European Union aims at reducing its emissions by 55% by 2030

[197] European Commission (2008). *Questions and Answers on the Commission's proposal to revise the EU Emissions Trading System.*

[198] Directive 2001/77/EC

[199] Directive 2009/28/EC

[200] Directive 2018/2001/EU

[201] Directive 2021/0218 (COD)

from 1990 levels and reaching climate neutrality by 2050. Both objectives, currently enshrined in the EU Law, might be at hand[202] [203].

US climate policies: past struggles and a surprising debut

During Bush Administration, the President's speeches never mentioned global warming[204]. Climate change was instead the preferred phrasing because it helped to convey less dramatic and "*more controllable*" effects than its alternative[205]. While this may seem more like an anecdote than a political analysis factor, it sheds light on the intricate relationship that Americans hold with climate change. This is exemplified by the fact that US citizens rank third globally for climate deniers, following Saudi Arabia and Indonesia[206]. It was again President Bush who did not accept to ratify the Kyoto Protocol in 2001, building on a non-binding resolution[207] unanimously approved in 1997 by the US Senate stating Washington should not even be a signatory of the Treaty.

The first ten years of the new millennium saw many clean energy- and climate-related proposals being discarded by the US Congress. A first attempt to institute a cap-and-trade system for greenhouse gas emissions, in the form of three acts known as the Climate Stewardship Acts, failed to pass in 2004, 2005, and 2007 in three different configurations of the Congress. A proposal for enhancing research and development on clean energy technologies, the Global Warming Pollution Reduction Act, died in committee in 2007, and the same fate befell a similarly designed Sustainable Energy Act proposed in 2013.

Whereas failing to gather political support around a new cap-and-trade system with the American Clean Energy and Security Act in 2009, that very year the Obama Administration managed to get the American Recovery and Reinvestment Act approved in the aftermath of the financial crisis. Official estimates[208] mention $80 billion in clean energy investments, mainly issued through tax breaks and direct spending. Major investments in electricity infrastructure were programmed, from renewal of transmission and distribution grids to smart grid implementation[209]. However, during Obama's Presidency, some major advancements were achieved mainly through Presidential executive orders, to overcome Congress opposition. With President Trump in office, US climate policy did not advance

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[202] Bozso, B., de Castro Dias, E., Röhrig, K. (2023). *Assessing Climate Action under the 'Fit For 55' Package*. CAN Europe.
[203] d'Aprile, P., Engel, H., et al. (2020). *How the European Union could achieve net-zero emissions at net-zero cost*. McKinsey & Company.
[204] Samenow, J. (2018). *Debunking the claim 'they' changed 'global warming' to 'climate change' because warming stopped*. Washington Post, 29.01.18. Retrieved here, 26.08.23.
[205] Ibid.
[206] Smith, M. (2019). *Most people expect to feel the effects of climate change, and many think it will make us extinct*. YouGov.
[207] The Byrd-Hagel Resolution was adopted 95-0.
[208] White House (2009). *Progress Report: The Transformation to a Clean Energy Economy*.
[209] Department of Energy (2009). *A Glimpse of the Future Grid through Recovery Act Funding.*

and was instead characterized by a deregulation trend[210]. This proved to be particularly easy because of the executive, thus not legal, nature of many provisions. A major example is provided by the Clean Power Plan, issued by the Obama Administration in 2015 and aimed at reducing the carbon footprint of the US electricity system, and substantially deleted two months after the President's appointment. In 2020, President Biden set a different tone and agenda on climate issues, rejoining the Paris Agreement hours after his appointment. With all this in mind, the Inflation Reduction Act represents landmark legislation, accounting for the entirety of the United States' climate Law.

Poles apart: Decarbonization strategies

Carbon pricing and subsidies represent the ultimate example of carrot and stick in climate policy. However, these are two sides of the same coin when it comes to strategies to reduce emissions. The European Union preferred the stick of carbon pricing to achieve its ambitious climate goals, playing the role of trailblazer for others to follow. Indeed, the European Union Emissions Trading System entered into force in 2005, making it the world's first international emissions trading system. In fact, whereas the World Bank certifies over seventy jurisdictions with an established carbon pricing mechanism[211], the EU ETS is the only framework whose scope extends beyond national borders. The cap-and-trade system relies on the issuance of allowances to pollute by a central authority, which are then traded by producers according to their needs. The total of allowances refers to the optimal level of emissions, and it is reduced periodically, consequently driving down emissions. This has a positive externality on green producers, because their less carbon-intensive processes empower them to trade and profit from the sale of allowances to less efficient producers, which will be eventually forced to comply or driven out of the market. Constantly updated, the current ETS covers more than 40% of the total European emissions, including those from carbon dioxide (CO2), nitrous oxide (N2O) and perfluorocarbon (PFC). The cap-and-trade system relies on a strong market-oriented approach, since the price of carbon is not set by the central institution but is autonomously defined by the balance between supply and demand. The very first phase of the European carbon pricing experience showed how deep the system's dependency on the market forces is. In 2005, an excessive number of allowances was allocated, causing a stagnation in the European carbon price in the following years. Today, the EU Emission Trading System carbon price is over €80/ton CO2, with the post-pandemic economic recovery and the energy crisis following the invasion of Ukraine as the main price increase drivers. According to official data[212], the EU ETS managed to deliver a 35% emission reduction since

[210] Baker, C. (2020). *The Trump administration's major environmental deregulations*. Brookings.
[211] World Bank (2023). *Carbon Pricing Dashboard*. Available here.
[212] European Commission (2023). *EU Emission Trading System (EU ETS).*

2005 for the sectors concerned. Nonetheless, the European approach was not followed by major emitters for almost two decades, until China instituted its national ETS in 2021, after closely cooperating with the European Union in the designing of the mechanism[213].

The United States has implemented since 1990 a cap-and-trade system for nitrogen oxides (NOX) and sulfur dioxide (SO2) as a Program of the Clean Air Act, mainly to reduce the acid rain phenomenon. The scope of the system is anyway much more limited, being comprehensive of slightly more than 6% of total emissions[214]. As previously discussed, the United States Congress failed to adopt a cap-and-trade system including CO2 emissions in 2009 with the proposed American Clean Energy and Security Act (ACESA). Instead of the proverbial stick of climate policies, the United States strategy turned to subsidies, or carrots. Remarkably, the successful second version of the ACESA relied mainly on tax credits, in a moment when President Biden served as President Obama's deputy. His Inflation Reduction Act aims at reducing emissions with the same tool.

Whereas both are potentially effective, the two methods follow very different, and almost opposite approaches to the decarbonization challenge. Carbon pricing is often defined as a stick because it nudges the consumer far from the carbon-intensive good by increasing its price. On the other hand, subsidies aim at reducing a product's price when this is strategic to the transition in order to convince the buyer to choose it. In the end, they both focus on facilitating the substitution of polluting goods with clean ones.

Whereas counterintuitive when considered in the context of evaluations by prominent analysts in Brussels on European industrial policy[215], the Net Zero Industry Act will operate in a framework underpinned by a fundamentally market-based carbon pricing system. Indeed, the EU ETS cannot force the market in any precise direction, having nudged consumers and producers to react to the increasing price for carbon-intensive goods, empowering them to autonomously identify alternatives. On a more theoretical note, the main issue with carbon pricing systems when compared to subsidies - and ETS is no exemption - is their inability to lower energy prices, and therefore to gather political support[216]. A cap-and-trade system operates on the relative price of green and brown goods, while it has no impact on the absolute price of low-carbon or renewable energy in the short term. Still, emission trading systems can successfully lead to decarbonization in the power sector as well, by changing the order in which power plants are activated. Generally, electricity markets' price definition

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[213] European External Action Service (2016). *EU-China Cooperation on Emission Trading in China*.

[214] US Environmental Protection Agency (2023). *Greenhouse Gas Inventory Data Explorer.* Available here.

[215] The think tank Bruegel defined NZIA as "*crude protectionism and dirigisme*", stating that with its approval "*market-based outcomes […] could be thrown overboard*". Poitiers, N., Sapir, A., Tagliapietra, S., Veugelers, R., & Zettelmeyer, J. (2023). *The EU Net Zero Industry Act and the risk of reviving past failures*. Bruegel.

[216] In 2018, a fuel tax sparked the *gilets jaunes* massive protests in France. More here: Driscoll, D. (2023). Populism and carbon tax justice: The yellow vest movement in France. *Social Problems*, *70*(1).

follows the merit order model, organized as follows: generators with high CAPEX and low OPEX are used as baseload to serve the bulk of the demand, while generators with the opposite cost structure are activated only when needed. The price is set by the operating cost of the most expensive generator needed to satisfy the demand. Non-dispatchable sources such as solar and wind are not part of the game, being usually recognized access every time they are able to generate electricity. By applying a price on carbon, the most intensive sources will be moved to the last place of the order because of higher operating costs, thus lowering their hours per year of generation, and consequently reducing emissions. The main effect of an efficient carbon pricing system is that of substituting gas, the traditional marginal plant in the European Union, with coal, a common base-load generator, benefiting from the resulting lower carbon intensity of the electricity mix[217].

Generally, subsidies are considered more popular since they can lead to lower energy prices in the short term due to public support for generators. This is true today because of the great price reductions marking solar and wind technologies, enabling renewable plants to be normally competitive with traditional fossil fuel generators. As analysis shows[218], the Inflation Reduction Act is considered able to deliver on the 40% emissions reduction by 2030 target the Biden administration has stated to pursue. However, a mandatory condition for this is high prices for fossil fuels, thus increasing the price reduction effect that subsidies have on renewables and low-carbon sources. In this scenario, the proliferation of new clean technologies, coupled with the learning curve effect, could potentially drive down prices to a level where the substitution of sources, along with the emissions saved as a result, enables a reduction of 40% in emissions.

[217] Gugler, K., Haxhimusa, A., & Liebensteiner, M. (2021). *Effectiveness of climate policies: Carbon pricing vs. subsidizing renewables.* Journal of Environmental Economics and Management, 106.

[218] Larsen, J., King, B., Kolus, H., Dasari, N., Hiltbrand, G., & Herndon, W. (2022). *A turning point for US climate progress: assessing the climate and clean energy provisions in the Inflation Reduction Act*. Rhodium Group, 12.

World Trade Organization (non)compliance

The European way: playing by the rules with a compliant CBAM

As a pillar of the Fit-for-55 package, the European Commission proposed the Carbon Border Adjustment Mechanism Regulation in 2021 and passed it into law in 2023. The CBAM was a key necessity for the European Union to ensure a level playing field for its internal market. Indeed, European producers must comply with a regional emission trading system adding a cost on carbon that competitors abroad do not experience. In a balancing effort, the European executive designed a tool to properly account for the carbon intensity of goods produced outside the scope of the EU ETS. At the same time, this initiative seeks to encourage more environmentally friendly industrial practices among the Union's trade partners, while preventing carbon leakage risks in strategic sectors, such as electricity, hydrogen, and steel. Until today, this risk was managed through the issuance of free allowances for those sectors most endangered by foreign carbon-intensive players. As mentioned, the new mechanism operates in strict relation with the EU ETS: in fact, CBAM's implementation will be progressive and aligned to the gradual phase-out of the free allowances in the ETS, trading at the same price as the European Union Allowances. As foreign producers represent a major recipient of the act's provisions, international trade standards and measures must be considered. When mentioning for the first time in 2020 the project for a mechanism to prevent carbon leakage, European Commission President Ursula Von der Leyen herself stated that the CBAM design would have been done in a WTO-compatible fashion[219]. In the World Trade Organization framework, the relevant principles for our analysis are gathered in the General Agreement on Tariffs and Trade (GATT), ratified during the 1994 Uruguay Round of negotiations. The two key principles of most-favored-nation and nondiscrimination inform the overall WTO structure, with the goal of lowering trade barriers between countries while facilitating the liberalization of global commerce. The reasons the European Commission used to support its WTO compliance claim for CBAM are mainly two. First, the goal of the regulation is not to protect the European industry but to promote a global interest, decarbonization, by expanding the European carbon pricing on foreign exporters. This would comply with the general exemptions outlined by Art. 20 General Agreement, where "*the conservation of natural resources*" can allow the application of measures traditionally considered restrictive to trade and in violation of the general principles[220]. Second, the need for a CBAM arose from the adverse impacts experienced by European producers following the enforcement of an internal carbon pricing

[219] European Commission (2020). *State of the Union Address by President von der Leyen at the European Parliament Plenary.*

[220] Krenek, A., Sommer, M., & Schratzenstaller, M. (2020). *A WTO-compatible Border Tax Adjustment for the ETS to Finance the EU Budget* (No. 596). WIFO Working Papers.

system (EU ETS), to which their international competitors were not adhering. This would make CBAM eligible under Art. 2(2a) of the GATT, stating that "*a charge equivalent to an internal tax*" cannot be prohibited by WTO rules[221]. Moreover, CBAM is set to apply to all non-EU countries in the same manner, not providing any legal ground for differential treatment allegations. Sole exceptions are Iceland, Liechtenstein, and Norway – contracting parties of the European Economic Area – where the EU ETS is directly applied, and Switzerland, whose cap-and-trade system has been linked to the European one since 2020. These countries will not be considered foreign, since their producers are already targeted by a carbon price under the ETS[222].

American subsidies highlight a multilateralism failure

With the adoption of the Inflation Reduction Act, the United States embraced protectionism as the safest way to fuel the decarbonization path. Whereas this surprised many, according to some this does not represent a novelty[223]. Whether new or not, the Act is set to deeply affect the international markets. According to research[224], the legislation is not going to cause any major general trade destruction, making trade flow relocation a more probable outcome. However, specific sectors will be hit more severely, with electrical and optical equipment for batteries and renewable energy technologies being the most deeply affected. China's wide presence in the market is the main issue the Act aims to solve by rebalancing the clean energy industrial power. Chinese businesses' clean technologies exports to North America – the Buy American clauses include the whole region, with Canada and Mexico – will be limited by 10% to 52%. A similar span describes possible losses for European exports to the region, ranging between 10% and 44%. A related analysis of the effects on the manufacturing side provides a complete picture of the alleged protectionist nature of the Act: indeed, while China and Europe will experience up to 5% and 3% reduction respectively, the US manufacturing sector will see its volume rise by up to 30%, with positive spillovers for Mexico and Canada as well[225]. This data depicts a situation that many perceived as noncompliant with the international trade rules, thus the World Trade Organization. In this case, the analysis needs a different legal reference than the GATT 1994, as the scrutiny will center around subsidies. In the W.T.O. framework, subsidies are evaluated through the principles set by the 1994 Agreement on Subsidies and Countervailing Measures. The agreement builds on a two-way traffic light definition for subsidies: these are classified as prohibited or actionable, going from red to orange in terms of acceptability and compliance with international law.

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[221] Lowe, S. (2019). *Should the EU tax imported CO2?.* Centre for European Reform.
[222] Sapir, A. (2021). *The European Union's carbon border mechanism and the WTO*. Bruegel.
[223] Lamy, P. (2023). *The slow American protectionist turn*. Centre for Economic Policy Research.
[224] Attinasi, M., Boeckelmann, L., Meunier, B. (2023). *Unfriendly friends: Trade and relocation effects of the US Inflation Reduction Act*. Centre for European Reform.
[225] Baqaee, D.R., Farhi, E. (2023). *Networks, Barriers, and Trade*. Econometrica.

If a subsidy is ruled as prohibited, the measure needs to be promptly phased out after the WTO decision. Prohibited subsidies generally originate from two main groups: export subsidies and local content subsidies. Indeed, the WTO framework regards both kinds as particularly hazardous, since they are intentionally crafted to manipulate trade. The second category of incentives relevant to the scope of the Agreement defines the so-called actionable subsidies. Typically, WTO complaints are filed by member countries in case a second member country has in place a provision hurting its commercial interests, generally recognized as actionable subsidies. The difference between the two is that whereas prohibited subsidies must be phased out because they hurt international trade at large, actionable subsidies may remain in effect provided that their negative impact on other WTO members is balanced by countervailing measures approved by the WTO itself.

As far as the Inflation Reduction Act is concerned, the "*Buy American*" requirement proves problematic, as it might fall under the definition of prohibited local content subsidies. Another issue stems from the free-trade agreement requirement necessary for producers to be eligible for the tax incentives, with particular regard to the Clean Vehicle Tax Credit. In fact, this might be considered as preferential treatment for imported goods from specific countries. In a scenario where the IRA's provisions are ruled as red-light prohibited subsidies, the legal conflict should stand with the principle – domestic over imported goods – embedded in the Agreement (Art. 3, 1b), therefore being ruled as "*prohibited subsidies*" in violation of WTO standards. A second scenario can be analyzed, where the Act is regarded as an "*actionable subsidy*" scheme. This would occur if direct adverse effects of the IRA on other WTO member countries' domestic industries were demonstrated[226], thus qualifying for countervailing action. This means that after the WTO approval, a challenging country would be empowered to implement retaliatory measures to mitigate the impact of the initial subsidy (Art. 5). After the adoption of the Inflation Reduction Act, many countries called foul because of the explicit undermining of WTO crucial principles: a study published by the European Parliament[227] highlights particularly how the IRA undermines the most-favored-nation principle, stated in the first Article of the WTO founding agreement, the already discussed GATT. Despite the threats, no action was taken, and the main US partners started seeking for bilateral solutions, engaging in negotiations with Washington to secure access to the IRA benefits.

This is because today the W.T.O. is largely considered an ineffective organization, whose agency has been reduced by Washington itself [228]. Briefly, the organization can implement its rules through the Dispute Settlement Body (DSB) and the attached Appellate Body, whose main task is to confirm or reverse the DSB's ruling. Whereas the DSB is composed of all member governments, the Appellate

[226] As the previously presented analysis shows. (Attinasi, Boeckelmann, Meunier, 2023).
[227] Scheinert, S. (2023). *EU's response to the US Inflation Reduction Act (IRA).* European Parliament.
[228] Porter, E. (2023). *Death of the WTO Is No 'Glass Onion' Mystery*. Bloomberg, 7.02.23. Retrieved here, 27.08.23.

Body consists of seven judges representing seven member countries. These are appointed by the organization's General Council, hosting all member countries, through a consensus principle. In 2019, the Trump Administration implemented a blocking strategy to prevent the Appellate Body's renewal[229]. That year, the mandate of two out of the three remaining judges ended, and no consensus was reached to appoint their replacements because of the United States' opposition to the candidates presented. According to WTO rules[230], a case requires a minimum of three judges to be convened. This implies that with only one judge available, the Appellate Body was essentially unable to function. According to some[231] Washington's strategy, unchanged with Biden's Presidency, could be partially explained by the historical high rate of disputes that targeted the United States trade remedies under the WTO framework, forcing American policymakers to adjust accordingly. During the US-China trade war started in 2018, with Beijing being the main focus of those trade remedies challenged by third countries, the fear of a WTO hindering the US economic security strategy against China convinced the Trump administration to pull the plug on the WTO's key body.

[229] Nebehay, S. (2019). *U.S. seals demise of WTO appeals bench - trade officials*. Reuters, 9.12.19. Retrieved here, 27.08.23.
[230] As stated in Art. 17 of the WTO's *Understanding on rules and procedures governing the settlement of disputes*.
[231] Bown, C. P., Keynes, S. (2020). *Why Trump Shot the Sheriffs: The End of WTO Dispute Settlement 1.0*. Peterson Institute for International Economics.

The business side: how the Inflation Reduction Act endangers European competitiveness

Until now, this work focused mainly on public actors and policy specifics. Those are fundamental to building a reliable analysis of what the legislation aims at and why some structural decisions were taken. However, the Inflation Reduction Act and the Net Zero Industry Act both are champions of relative geographies in terms of industrial policy. Arguably, a proper industrial policy is expected to produce effects on the relevant industries. The business side is then as a primary concern for lawmakers when designing industrial policy. Many times, during the previous chapters the definition of the European Net Zero regulation as a response to the Inflation Reduction Act has been repeated. This is because once the IRA was adopted by the US Congress, European institutions and Member States were surprised to see a threat arising from a traditionally close partner. The crisis context brought in the big guns, with the energy crisis severely affecting Europe's competitiveness compared with other markets, particularly the United States, where electricity prices never reached the volatility the EU suffered. In September 2022, just a month after the prices peaked on the Amsterdam Title Transfer Facility, the European average was $0.28/kWh[232] while in the United States power prices averaged at $0.18/kWh[233], lower than one-third. The adoption of the massive subsidy scheme added fuel to the fire, with European leaders pressured to react fast and effectively to protect the European industrial fabric. In the next pages, different angles will be considered to understand how the Inflation Reduction Act could impact European competitiveness, with particular reference to clean energy sectors.

Economic theory of competition: how investments are driven

The theory of the firm describes companies as active agents, ready to absorb new information and respond consequently. This poses the issue of understanding what are the factors nudging a firm to respond in a particular way to an input received from the external environment. Neoclassical economy provides an explanation based on two fundamental drivers of a firm's action: maximizing profits and minimizing costs. A deeper focus on costs, and particularly those arising from transactions, was operated by Oliver Williamson[234]. His work on transaction costs can provide a valuable theoretical framework to analyze the behavioral effects on companies of regulatory actions by the State. According to his theory, the main metric companies are affected by when making business decisions is transaction cost. It is defined as frictions in the economic system, that firms naturally seek to

[232] Eurostat (2023). *Electricity & gas hit record prices in 2022.*
[233] Statista (2023). *Household electricity prices worldwide in September 2022, by select country.*
[234] Williamson, O. E. (1981). *The economics of organization: The transaction cost approach*. American journal of sociology, 87.

minimize. Among these costs, the administrative one plays a major role. This means that a firm would be willing to undertake such a burden only if an adequate incentive is made available on the market. For a European company willing to enter the American market following the Inflation Reduction Act adoption, the administrative costs are related to the overall bureaucracy needed to comply with a different national jurisdiction. Therefore, the dilemma would be related to what strategy to choose. From the perspective of European institutions, a negative scenario would consist of companies choosing to manufacture goods directly in the United States, relocating their facilities with detrimental effects on European employment and economic productivity. However, other than a threat the Inflation Reduction Act might create opportunities for European companies without requiring the shift of industrial capacity. Indeed, businesses might seize the benefit of the IRA by investing in American facilities, with these investments not necessarily being diverted from the European market, but adding value to it. The trade-offs worth analyzing to better understand the context businesses are currently facing are mainly two: proximity vs. concentration and tariffs jumping.

In an increasingly globalized world, where transport costs decrease steadily, relocating the manufacturing facility where labor cost is lower provides a clear advantage to the producer. Moreover, if one facility serves multiple markets, the advantage will grow higher, the higher the demand supplied thanks to economies of scale. On the other hand, there are positive factors stemming from keeping production facilities closer to where customers are. When supply chains are exposed to potential disruptions and transport costs are significant, proximity can be an advantage.

Tariff jumping describes the behavior of businesses that, seeking to avoid trade barriers to access a specific market, directly operate in the relevant geography. Depending on the purpose of the protectionist measure, this can be positive or negative for the destination market of the firm. Indeed, governments generally tend to protectionism policy whenever they need to ensure a safe space for their national industry to develop, or for employment reasons. Only in the latter scenario, tariff jumping does not constitute an issue for the host government.

This framework suggests that companies would find an incentive to relocate their manufacturing capacity in the event of an increase in trade costs. In fact, horizontal foreign direct investments are more convenient, the more expensive exporting is[235]. Trade costs here represent a wider concept than mere transportation expenses, including local content requirements tariffs as in the case of the IRA. On the other hand, the same theory explains that goods whose production is characterized by higher capital costs are likely to prefer export over other possibilities. This is because high CAPEX can be spread over a larger number of units produced, and better and more efficient use of the machinery

[235] Helpman, E., Melitz, M. J., Yeaple, S. R. (2004). *Export versus FDI with heterogeneous firms*. American economic review, 94.

capacity. This is relevant because clean energy plants are characterized by a peculiar cost structure that revolutionized the electricity sector, where operative expenses, mainly related to fuel purchase, traditionally accounted for the largest shares of final costs. The levelized capital costs of electricity of a solar power plant is on average almost four times that of a combined cycle gas turbine[236]. While additional layers of complexity could be added to the picture, the goal of the present work is not to predict the modalities of the relocation trend. Instead, the aim is to analyze the underlying factors driving this phenomenon.

Notwithstanding the theoretical framework, its application varies according to the sectors. Indeed, the specifics of each market and the characteristics of supply deeply affect how an industry reacts to inputs from the external environment (i.e., new opportunities in different geographies). Supply has two main areas of interest, who produces and what is produced. Suppliers are mainly defined by their cost structure, varying over two metrics previously introduced, capital and operating expenses. The analysis of products can take into account a number of variables in order to better understand whether the said good is inclined to be traded internationally or not.

The automotive sector

The Inflation Reduction Act sparked the most vocal reactions from the automotive industry of the United States' international partners, and particularly Brussels. The reasons why the European Union targeted the Clean Vehicle Tax Credit as the most problematic measure contained in the Act are several. First, the automotive sector represents one of the pillars of the European economy. In fact, the European Union traditionally retained the global leadership in vehicle production, losing the primacy to China in the mid-2010s. In terms of international trade, the European Union is the first exporter of cars globally, with the sector being the third most valuable in the Union's exports[237]. Moreover, while the general European exports/imports ratio is severely negative, meaning that Member countries purchase more goods than they sell on the international markets, the story is different for the automotive industry. The net surplus equaled €96 billion in 2022, while the continent's international trade deficit amounted to €430 billion in the same year[238]. Finally, in the trade relation between the European Union and the United States, cars play a paramount role. The American market accounts for more than 18 percent of the total sector's European export by value, while only receiving 10 percent of the units exported[239].

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[236] Statista (2022). *Estimated levelized capital costs of electricity for new power plants in the United States with operation start in 2027, by energy source.*

[237] Eurostat (2023). *International trade in goods by type of good*.

[238] Ibid.

[239] ACEA (2023). *The Automobile Industry: Pocket guide 2022/2023*.

All this makes the automotive industry one of the most valuable assets the European economy can rely on. Just after the approval of the Inflation Reduction Act in the United States, companies started to consider the possibility of developing new projects in the country, potentially diverting investments from the European market. This has been the case for Mercedes-Benz, which invested over $500 million in an electric recharging network project, BMW, investing almost $2 billion to scale up its production in the United States, and Audi, which is planning on building its first manufacturing facility across the Atlantic[240]. Tesla represent one of the first companies explicitly putting to rest a planned European project, while prioritizing an American one explicitly because of the new context created by the Inflation Reduction Act[241]. Excluding Tesla's, all the previous examples illustrate tariff-jumping practices, where companies are willing to invest in a market because local content incentives reduce the trade costs they would otherwise incur when exporting. The trend can produce effects on two time-horizons. Indeed, in the short term the European automotive sector could incur in a decrease or lack of growth, with consequences on economic productivity and employment. In the medium term, a major displacement of facilities for electric vehicles manufacturing might pose serious threats to the future development of the industry in Europe in terms of innovation skills and capabilities.

However, there are at least three reasons why a catastrophic scenario could be avoided. Almost 20 percent of the United States market is already served by plants owned by European companies[242]. This leaves little space for additional penetration in a market where European manufacturers are already largely present, even though some opportunities might arise in the transition phase from ICE to EVs. A second reason relies upon the fact that a manufacturing plant for EV components or assembly takes on average of 3.5 years[243]. With the Clean Vehicle Tax Credit currently planned to phase out in the next decade, there is a limited time horizon for the investment to recoup its costs, considering that EVs per se are often sold at a loss by producers[244]. Lastly, with the current regulatory framework, exporting electric vehicles from the United States to Europe is far more expensive than the other way around, due to the 10 percent tariff imposed on EV imports versus the 2.5 percent applied by Washington[245]. This would encourage producers to serve the European market from within its boundaries, rather than from abroad.

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[240] Reuters (2023). *How companies are reacting to the U.S. Inflation Reduction Act*. Published, 24.02.23. Retrieved here, 16.02.23.

[241] Waldersee, V. (2023). *Tesla scales back German battery plans, won over by U.S. incentives*. Reuters, 22.02.23. Retrieved here, 16.09.23.

[242] Statista (2023). *Estimated U.S. market share held by selected automotive manufacturers in 2022.*

[243] Gros, D., Mengel, P.L., Presidente, G. (2023). *The EU and the US Inflation Reduction Act: no rose without thorns.* Bocconi University's Institute for European Policymaking.

[244] Baik, Y., Hensley, R., Hertzke, P., & Knupfer, S. (2019). *Making electric vehicles profitable.* McKinsey & Co.

[245] Bown, C. (2023). *Industrial policy for electric vehicle supply chains and the US-EU fight over the Inflation Reduction Act*. Peterson Institute for International Economics.

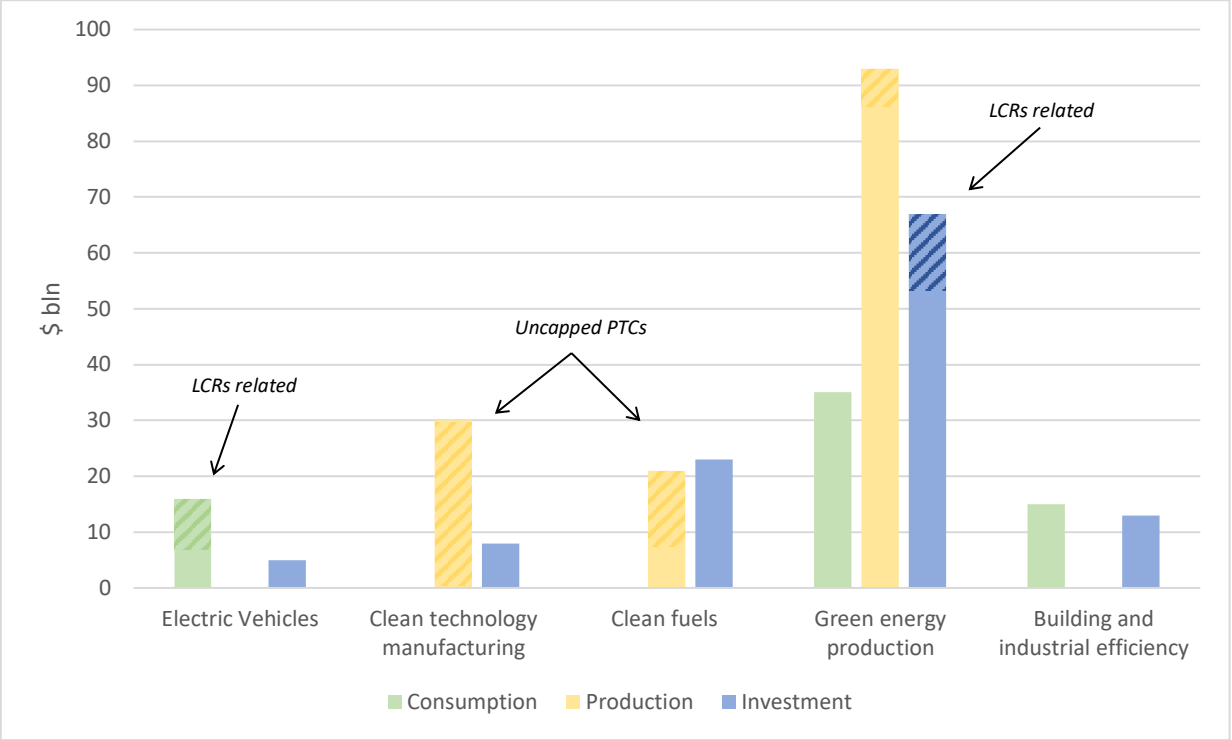

Figure 13: IRA tax credits and their likelihood to distort trade. Source: Bruegel (2023).

The clean energy sector

Whereas likely to have deep effects on the US electricity market, the international one is not going to be impacted by the Inflation Reduction Act, simply because it does not exist. Electricity cannot be stored efficiently enough for trade where transmission infrastructure is not in place. Still, the IRA could impact the European market indirectly. This means that although electricity itself cannot be traded, the goods produced using it can be. As long as IRA's incentives continue to reduce the cost of electricity, the prices of those products will indirectly become more competitive. The better-off sectors will likely be the most energy-intensive ones. Aluminum production is highly electricity-intensive and estimates[246] suggest that aluminum producers in the United States may achieve a cost reduction thanks to the IRA measures for the power sector of up to $600 per tonne, which is equivalent to 25 percent of the average global prices. Moreover, the green hydrogen industry in the United States is expected to gain an edge over the European one. The levelized cost for hydrogen depends on electricity prices for 40 to 70 percent[247], therefore tax credits lowering the cost of electricity will have a clear impact on the green hydrogen industry. Currently hydrogen markets are purely regional because of high transport costs, but a large enough gap between US and EU hydrogen could cover

[246] Copenhagen Economics (2023). *The effects of the US Inflation Reduction Act (IRA) on EU competitiveness*.
[247] Lazard (2021). *Lazard's Levelized Cost Of Hydrogen Analysis*.

the transportation costs, making the export economically feasible. This same scenario could include export to Europe of electrofuels, whose transport is cheaper and easier than hydrogen. Ammonia, which can be produced using green hydrogen, has a higher liquefaction temperature and almost twice its energy density, with lower transport costs that could make it even more prone to export[248]. Estimates for ammonia transportation costs accounts for 56 to 83 percent of hydrogen's[249].

[248] McDonald, J. (2021). *Blue ammonia to comprise bulk of hydrogen transportation due to lower costs.* S&P Global.
[249] IRENA (2022). *Global Hydrogen Trade To Meet The 1.5°C Climate Goal (Part II): Technology Review Of Hydrogen Carriers.*

Concluding remarks: NZIA vs. IRA, an unfair comparison?

Permacrisis is a neologism created to describe the new state of the international scene, with social and natural crises increasing in quantity and severity in recent years. This new condition has had a reflection on both politics and policies. The short-term disruption, the Ukraine war-related energy price shock, and the long-term one, climate change, are unprecedently closing the gap between social and political priorities. Whereas still a source of division, the energy transition has been embraced by the most important actors on the international scene, as it has become a matter of competitiveness and economic resilience. The European Union played on the climate stage alone for a long time. The leading role in the first climate conferences, and the implementing efforts displayed in the Kyoto Protocol framework, where it was the only major emitter subject to binding targets, made Brussels the climate champion of international politics for decades. Then China stepped in. Initially, Beijing's role was appreciated for the steep cost reductions it managed to achieve in manufacturing clean technologies, thanks to economies of scale deriving from serving multiple markets. Increasing fears of the weaponization of supply chains and China's ambiguous stance on the international order brought the energy transition to the heart of the Western political discourse, United States included. Washington had previously failed several times to develop a structured climate policy, until the issue became a matter of national security. President Biden made climate change one of his top priorities, and managed to force the adoption of disruptive legislation with scarce political support. The Inflation Reduction Act, adopted in August 2022, is the result of tense negotiations, focused on empowering the clean energy industry in the United States, and North America at large, to face Chinese dominance in the sector. It pursues this goal by subsidizing American producers and investors, provided that they create job opportunities for American workers and use locally sourced materials. After a first round of applause from the international community due to the approval of crucial legislation in the fight against climate change, fears of trade distortion arose. Interestingly, the more vocal the criticisms were, the easier it was for them to come from close partners. Particularly, the European Union was surprised by the adoption of the Act, whose specifics and underlying risks had not been discussed with European officials before. Indeed, whereas a EU-US cooperation on trade framework exists, namely the Trade and Technology Council, its composition failed to adequately represent key actors in the US legislative procedure. This glitch brought to the approval of measures with high trade distortion potential, with the top negotiators in Congress allegedly unaware of the matter. The most problematic feature of the Act for US partners stays in the local content requirements that many funding provisions recognize as a binding clause, thus excluding third countries' businesses from joining. The massive $369 billion subsidy framework for clean energy generation and electric vehicle

manufacturing made the European Union feel the pressure to respond to protect its competitiveness in strategic sectors.

For this, the European Commission laid out a two-pillar integrated strategy, focusing on facilitating administrative and financing processes for strategic technologies. The proposed tools in support of the European clean-tech industry were two: the Net Zero Industry Act and the Temporary Crisis and Transition Framework. While the first aims at reducing administrative burden and permitting procedures for 8 groups of clean energy technologies, the second encompasses a relaxation of the rules defining how EU States can support their companies, with particular reference to the same eight technologies listed in the Net Zero regulation. While both aimed at shielding the domestic clean energy industry from what they perceived as unfair external competition, the two Acts differ in their approaches to achieving the same objective. This constituted the primary focus of the current analysis, whose main findings were:

Neutrality vs. Partiality: The Inflation Reduction Act provides a technology-neutral clean energy production and investment tax credit, whose benefits can target all technologies delivering zero-emission energy. On the other hand, the European Act defines a specific list of technologies, in what was defined by critics as a cherry-picking exercise to choose who and what will have a role in the energy transition challenge.

***Ex-post* vs. *ex-ante* support**: Market orientation is key to a second difference, related to the adopted financing strategy. The main funding instrument on which the IRA relies on is tax credit. Companies and consumers are provided with a decrease in their taxes for producing, purchasing, or investing in clean energy-related goods. Tax credits are considered to be deeply market-oriented because they remunerate only those projects or generators able to deliver on the market. Moreover, tax credits can direct massive financing in a simple and linear manner for recipients. The European funding landscape is more fragmented since it relies on ten different instruments, including State aid. This means that, while the quantity of funds available for clean energy manufacturing and electric vehicles is similar between the two jurisdictions[250], access to public support in the United States is easier, with positive repercussions in terms of avoided transaction costs for companies and consumers.

WTO (non)compliance: The Inflation Reduction Act has been widely considered a deliberate violation of international trade principles. Specifically, the domestic content requirements attached to tax credits infringe the WTO Agreement on Subsidies and Countervailing Measures. However, the United States is likely to avoid retaliation because of the blocking strategy it is currently applying on

[250] Kleimann, D., Poitiers, N., Tagliapietra, S. (2023). *Green tech race? The US Inflation Reduction Act and the EU Net Zero Industry Act*. Bruegel.

the WTO Appellate Body, *de facto* paralyzing the whole organization. The European Union has shown an opposite approach when dealing with a potential trade distortive measure, with the Carbon Border Adjustment Mechanism approved in 2023 explicitly designed to comply with WTO standards.

However, the main difference between the two systems is a contextual one. As previously stated, the Net Zero Industry Act will operate in a crowded regulatory area, while the Inflation Reduction Act is currently virtually alone in fighting its battles. This outlines a counter-intuitive but necessary question: can the two acts be evaluated one against the other? After the approval of the IRA, many in the European Union applauded its simplicity and scale, while the Net zero regulation was met with a cold reception. It is possible, and necessary, to compare the climate policy approaches Brussels and Washington decided to implement. This can provide valuable insights into the current trends of clean energy policymaking and an opportunity for further exploration of differences between the two institutional actors behind the policies. Nevertheless, when comparing the Inflation Reduction Act with the Net Zero Industry Act, it is essential to bear in mind that bias is lurking around the corner. In conclusion, the current discourse highlights a rather fortunate situation: two of the world's three largest economies are engaged in a competition centered on clean technologies, resulting in potential positive externalities for all.

Bibliography

Aarup, S. A., Lau, S., Haeck, P., & Gijs, C. (2023). *China's threat on mineral exports knocks EU off balance*. Politico.eu, 6.07.23.

Abnett, K. (2023). *Germany, Spain push to keep nuclear out of EU renewable energy goals.* Reuters, 16.03.23.

ACEA (2023). *The Automobile Industry: Pocket guide 2022/2023*.

Aghakhani, A., Haque, N., Saccani, C., Pellegrini, M., & Guzzini, A. (2023). *Direct carbon footprint of hydrogen generation via PEM and alkaline electrolysers using various electrical energy sources and considering cell characteristics.* International Journal of Hydrogen Energy.

Ambec, S., Crampes, C. (2017). *Negative prices for electricity*. Florence School of Regulation.

Antonache, I., O'Neill, R. (2023). *Inflation Reduction Act provides transferable energy tax credit options*. Portland Business Journal.

Attinasi, M., Boeckelmann, L., Meunier, B. (2023). *Unfriendly friends: Trade and relocation effects of the US Inflation Reduction Act*. Centre for European Reform.

Baik, Y., Hensley, R., Hertzke, P., & Knupfer, S. (2019). *Making electric vehicles profitable.* McKinsey & Co.

Baker, C. (2020). *The Trump administration's major environmental deregulations.* Brookings.

Baqaee, D.R., Farhi, E. (2023). *Networks, Barriers, and Trade*. Econometrica.

Bettoli, A., Nauclér, T., Nyheim, T., Schlosser, A., & Staudt, C. (2022). *Building a competitive solar-PV supply chain in Europe*. McKinsey.

Bielewski, M., Pfrang, et al. (2022). *Clean Energy Technology Observatory: Batteries for Energy Storage in the European Union – 2022 Status Report on Technology Development, Trends, Value Chains and Markets*. Joint Research Center.

Bistline, J., Blanford, G., et al. (2023). *Emissions and energy impacts of the Inflation Reduction Act*. Science, 380.

Boettiger, C (2021). *ERCOT Wind Energy Leading To Lower, More Volatile Pricing*?. BTU Analytics.

Bolinger, M., Wiser, R., & O'Shaughnessy, E. (2022). *Levelized cost-based learning analysis of utility-scale wind and solar in the United States.* Iscience.

Bonfanti, G., Garicano, L. (2022). *Do financial markets consider European common debt a safe asset?*. Bruegel.

Bourgery-Gonse, T. (2023). *EU Commission wants new technology fund, but no fresh cash in sight.* Euractiv, 20.06.23.

Bown, C. (2023). *Industrial policy for electric vehicle supply chains and the US-EU fight over the Inflation Reduction Act*. Peterson Institute for International Economics.

Bown, C. P. (2023). *How the United States solved South Korea's problems with electric vehicle subsidies under the Inflation Reduction Act*. Peterson Institute for International Economics.

Bown, C. P., Keynes, S. (2020). *Why Trump Shot the Sheriffs: The End of WTO Dispute Settlement 1.0*. Peterson Institute for International Economics.

Bozso, B., de Castro Dias, E., Röhrig, K. (2023). *Assessing Climate Action under the 'Fit For 55' Package.* CAN Europe.

Brown, P. (2013). *European Union Wind and Solar Electricity Policies: Overview and Considerations*. Congressional Research Center

Castillo, R., Purdy, C. (2022). *China's Role in Supplying Critical Minerals for the Global Energy Transition*. Brookings.

CDP (2014). *CDP: 40.9 percent stake in CDP Reti transferred to State Grid and Italian institutional investors.*

Chow, E., Xu, M. (2022). *World is in its 'first truly global energy crisis' - IEA's Birol*. Reuters, 25.10.22.

Chu, A., Irwin-Hunt, A., Roeder, O. (2023). *Inside the $220bn American cleantech project boom*. Financial Times, 16.08.23. Ret

Claeys, G., McCaffrey, C., & Welslau, L. (2023). *The rising cost of European Union borrowing and what to do about it*. Bruegel.

Clausing, K. A. & Wolfram, C. (2023). *Carbon border adjustments, climate clubs, and subsidy races when climate policies vary*. National Bureau of Economic Research.

Congressional Budget Office (2022). *Estimated Budgetary Effects of H.R. 5376, the Inflation Reduction Act of 2022*.

Copenhagen Economics (2023). *The effects of the US Inflation Reduction Act (IRA) on EU competitiveness*.

Council on Foreign Relations (2023). *What Happened When China Joined the WTO? – World 101*.

D'Aprile, P., Engel, H., et al. (2020). *How the European Union could achieve net-zero emissions at net-zero cost*. McKinsey & Company.

Department of Energy (2009). *A Glimpse of the Future Grid through Recovery Act Funding.*

Dungs, J. J. (2023). *China Has Perfectly Tangled the Battery Value Chain with Electric Vehicles.* Forbes, 17.08.2023.

Dwivedi, C. (2018). *Influence of Production and Investment Tax Credit on Renewable Energy Growth and Power Grid*. IEEE Green Technologies Conference.

Economist (2023). *The case for an environmentalism that builds.* Published, 5.04.23.

Ember (2023). *Carbon Price Tracker.*

Ember (2023). *European Electricity Review 2023*.

Enerdata (2023). *Behind the scenes of Russia's gas strategy – Executive brief.*

Euratom Supply Agency (2023). *Origins of uranium delivered to EU utilities in 2022 (tU).*

Europe needs 'coordinated, united and strong response' to massive US subsidies - Le Maire. Euronews, 07.11.22

European Commission (2000). *Green Paper - Towards a European strategy for the security of energy supply.*

European Commission (2008). *Questions and Answers on the Commission's proposal to revise the EU Emissions Trading System.*

European Commission (2008). *Temporary framework for State aid measures to support access to finance in the current financial and economic crisis*.

European Commission (2019). *State Aid Scoreboard 2019*.

European Commission (2020). *State of the Union Address by President von der Leyen at the European Parliament Plenary.*

European Commission (2020). *Study on energy storage*.

European Commission (2021). *Commission Statement on consulting Member States on proposal on the future of the State aid Temporary Framework.*

European Commission (2022). *EU strategic dependencies and capacities: second stage of in-depth reviews*. SWD (2022) 41.

European Commission (2022). *EU-US Trade and Technology Council: strengthening our renewed partnership in turbulent times.*

European Commission (2022). *Launch of the US-EU Task Force on the Inflation Reduction Act*.

European Commission (2022). *State Aid Scoreboard 2022.*

European Commission (2022). *State of the Union Address by President Von der Leyen*.

European Commission (2023). *Communication: A Green Deal Industrial Plan for the Net-Zero Age.*

European Commission (2023). *EU budget: Commission proposes to reinforce long-term EU budget to face most urgent challenges.* EU Commission press release.
European Commission (2023). *EU Emission Trading System (EU ETS).*
European Commission (2023). *EU trade relations with the United States. Facts, figures and latest developments.*
European Commission (2023). *Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity.* SWD(2023) 68.
European Commission (2023). *Modernisation Fund.*
European Commission (2023). *Recovery and resilience scoreboard: Clean power.*
European Commission (2023). *Recovery and resilience scoreboard: Digital public services.*
European Commission (2023). *Recovery and resilience scoreboard: Energy efficiency in buildings*.
European Commission (2023). *Recovery and resilience scoreboard: Research & innovation.*
European Commission (2023). *Regulation for a Strategic Technology for Europe Platform.*
European Commission (2023). *Remarks by Executive Vice-President Vestager on the proposal for a State aid Temporary Crisis and Transition Framework*.
European Commission (2023). Section 2.8 (86).*Temporary Crisis and Transition Framework for State Aid measures to support the economy following the aggression against Ukraine by Russia.*
European Commission (2023). *Study on the Critical Raw Materials for the EU.*
European Commission SWD (2023) for the Net Zero Industry Act Regulation.
European Commission SWD (2023). *Energy Storage - Underpinning a decarbonised and secure EU energy system*
European Commission SWD (2023). *Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity.*
European Council (2018). *Draft council conclusions on the negotiation and conclusion of EU trade agreements*.
European Council (2023). *Trade with the United States: Council authorises negotiations on EU-US Critical Minerals Agreement*.
European Court of Justice (1993). *Sloman Neptune v Bodo Ziesemer*. Judgment of 17.03.1993 – C-72/91.
European Court of Justice (1994). *Banco Exterior de España SA*. Judgment of 15.03.1994 – C-387/92, BeckRS 2004.
European Court of Justice (2006). *Enirisorse Spa v Sotacarbo* Spa. Judgment of 23.03.2006, C-237/04, BeckRS.
European External Action Service (2016). *EU-China Cooperation on Emission Trading in China.*
European Investment Bank (2021). *Investment Survey 2021: European Union overview*.
European Parliament (2022). *European Parliament resolution of 19 May 2022 on the social and economic consequences for the EU of the Russian war in Ukraine — reinforcing the EU's capacity to act.*
European Parliament (2023). *EU's response to the US Inflation Reduction Act (IRA).*
European Union. Directive 2001/77/EC
European Union. Directive 2009/28/EC
European Union. Directive 2018/2001/EU
European Union. Directive 2021/0218 (COD)
For more insights on President Obama's bill: The White House (2016). *The Recovery Act made the largest single investment in clean energy in history.*
FORATOM (2020). *Nuclear: investing in a competent workforce for the benefit of society.*
Fukuyama, F. (1992). *The End of History and the Last Man*. Free Press.

García-Alvarez, M. T., & Mariz-Pérez, R. M. (2012). *Analysis of the success of feed-in tariff for renewable energy promotion mechanism in the EU: lessons from Germany and Spain*. Procedia-Social and Behavioral Sciences (65).
Gardner, M. (2021). *Zoom Pays $0 in Federal Income Taxes on Pandemic Profits.* Institute of Taxation and Economic Policy.
Gardner, M., Wamhoff, S. (2019). *How Congress Can Stop Corporations from Using Stock Options to Dodge Taxes*. Institute of Taxation and Economic Policy.
Gardner, M., Wamhoff, S. (2021). *55 Corporations Paid $0 in Federal Taxes on 2020 Profits*. Institute of Taxation and Economic Policy.
Gonthier, F., & Matthews, T. (2015). *The rise of interventionism in the European Union and its social foundations*. Revue française de sociologie, 56.
Gros, D., Mengel, P.L., Presidente, G. (2023). *The EU and the US Inflation Reduction Act: no rose without thorns.* Bocconi University's Institute for European Policymaking.
Grüll, P. (2020). *Austria demands 'greater flexibility' of EU state aid law in letter to Vestager.* Euractiv, 23.04.20.
Gugler, K., Haxhimusa, A., & Liebensteiner, M. (2021). *Effectiveness of climate policies: Carbon pricing vs. subsidizing renewables.* Journal of Environmental Economics and Management, 106.
Hancock, A., Espinoza, J, Bounds, A. (2023). *Brussels at odds over funding rules for nuclear power.* Financial Times, 14.03.23.
Hay, C., Lister, M., & Marsh, D. (Eds.). (2022). *The state: theories and issues*. Bloomsbury Publishing.
Helpman, E., Melitz, M. J., Yeaple, S. R. (2004). *Export versus FDI with heterogeneous firms*. American Economic Review, 94.
Herzer Risi, L., Doyle, C. (2023). *Examining China's Impact on Mining in Africa*. Wilson Center.
Hlavac, M. (2010). *Less than a state, more than an international organization: The Sui generis nature of the European Union*. Georgetown University.
Hogan Lovells (2023). *Administration defines "Foreign Entity of Concern" with implications for EV batteries under the IRA.*
Hoopes, J.L., Kindt, C. (2022). *Estimating the Minimum Tax on Book Income Liability Using Public Data*. University of North Carolina Tax Center.
Huggins, R. A. (2016). *Energy storage: fundamentals, materials and applications*. Springer.
Huntowski, F., Patterson, A., Schnitzer, M. (2012). *Negative Electricity Prices and the Production Tax Credit*. The NorthBridge Group.
Hydropower Europe (2021). *Strategic Industry Roadmap*
IEA (2020). *Tracking clean energy innovation*.
IEA (2022). *A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas*.
IEA (2022). Solar PV Global Supply Chains.
IEA (2023). Energy technology perspective 2023.
IEA (2023). *Global EVs outlook 2023*.
IEA (2023). *Renewable Energy Market Update – June 2023*.
IEA (2023). *Renewable power on course to shatter more records as countries around the world speed up deployment.*
IEA (2023). *Towards hydrogen definitions based on their emissions intensity.*
IEA (2023). *World Energy Investment 2023*.
Internal Revenue Service (2009). *Energy Provisions of the American Recovery and Reinvestment Act of 2009 (ARRA).*

Internal Revenue Service (2023). *Notice of proposed rulemaking on Section 30D New Clean Vehicle Credit.*

IRENA (2021). *Renewable Power Generation Costs in 2021.*

IRENA (2022). *Global Hydrogen Trade To Meet The 1.5°C Climate Goal (Part II): Technology Review Of Hydrogen Carriers.*

IRENA (2023). *Geopolitics of the energy transition: Critical materials*.

IRENA (2023). *Low-cost finance for the energy transition*.

IRENA (2023). *Renewable Power Generation Costs in 2022*.

IRENA (2023). The changing role of hydropower: Challenges and opportunities.

Jäger-Waldau, A. (2011). *PV status report 2011 : research, solar cell production and market implementation of photovoltaics*. Joint Research Centre, Institute for Energy and Transport.

Jansen, J., Jäger, P., Redeker, N. (2023). *For climate, profits, or resilience? Why, where and how the EU should respond to the Inflation Reduction Act.* Hertie School – Jacques Delors Center.

Joint Committee on Taxation (2013). *Modeling the Distribution of Taxes on Business Income*.

Kapetaki, Z., (2022). *Carbon Capture Utilisation and Storage in the European Union – 2022. Clean Energy Observatory Status Report on Technology Development Trends, Value Chains and Markets*. Joint Research Center.

Kessler, S. (2023). *What Is 'Friendshoring'?.* New York Times, 3.01.23.

Kleimann, D., Poitiers, N., Tagliapietra, S. (2023). *Green tech race? The US Inflation Reduction Act and the EU Net Zero Industry Act*. Bruegel.

Krenek, A., Sommer, M., & Schratzenstaller, M. (2020). *A WTO-compatible Border Tax Adjustment for the ETS to Finance the EU Budget* (No. 596). WIFO Working Papers.

Lamy, P. (2023). *The slow American protectionist turn*. Centre for Economic Policy Research.

Larsen, J., King, B., et alt. (2022). *A turning point for US climate progress: assessing the climate and clean energy provisions in the Inflation Reduction Act*. Rhodium Group.

Lawder, D. (2023). *US, Japan sign trade deal on electric vehicle battery minerals*. Reuters, 28.03.23.

Lazard (2021). *Lazard's Levelized Cost Of Hydrogen Analysis*.

Lehne, S. (2023). *The Comeback of the European Commission*. Carnegie Europe.

Lerche, A. (2022). *Investment Tax Credits and the Response of Firms*. IZA Institute of Labor Economics.

Lowe, S. (2019). *Should the EU tax imported CO2?.* Centre for European Reform.

Luce, E. (2023). The new Washington consensus. Financial Times, 19.04.23.

Lynch, S. (2023). The EU wants to build tomorrow's technologies. Will countries pay for it?. Politico, 22.05.23.

McDonald, J. (2021). *Blue ammonia to comprise bulk of hydrogen transportation due to lower costs.* S&P Global.

Mead, W.R. (2014). *The Return of Geopolitics: The Revenge of the Revisionist Powers*. Foreign Affairs.

Messad, P. (2023). *Lawmakers reintroduce nuclear in EU's net-zero industry list.* Euractiv, 20.08.2023.

Natter, A. (2023). *Manchin Says He Didn't Know US, EU Lacked Free Trade Agreement.* Bloomberg, 19.01.23.

Natter, A., Coppola, G., Laing, K. (2023). *Biden Makes Electric Vehicle Credits Elusive in Bid for US Auto Renaissance.* Bloomberg, 31.03.23.

Nebehay, S. (2019). *U.S. seals demise of WTO appeals bench - trade officials*. Reuters, 9.12.19.

New York Times Archive (2000). *Full Text of Clinton's Speech on China Trade Bill.*

Polanyi, K. (2001). *The Great Transformation: The Political and Economic Origins of Our Time*. Boston: Beacon Press.

Popovich, N., Albeck-Ripka, L., Pierre-Louis, K. (2021). *The Trump Administration Rolled Back More Than 100 Environmental Rules. Here's the Full List.* New York Times, 20.01.20.

Porter, E. (2023). *Death of the WTO Is No 'Glass Onion' Mystery*. Bloomberg, 7.02.23.
PwC (2021). *Revised Build Back Better bill as passed by the House - key business and individual tax provisions*.
Rappeport, A. (2022). *How a Last-Minute Lobbying Blitz Watered Down a Climate Bill Tax*. New York Times, 8.08.23.
Rappeport, A. (2023). *New Corporate Minimum Tax Ushers In Confusion and a Lobbying Blitz.* New York Times, 7.09.23.
Reuters (2011). *China Three Gorges wins Portugal EDP stake sale.* Published, 22.12.11.
Reuters (2023). *How companies are reacting to the U.S. Inflation Reduction Act*. Published, 24.02.23.
Ricks, W., Xu, Q., & Jenkins, J. D. (2023). *Minimizing emissions from grid-based hydrogen production in the United States*. Environmental Research Letters, *18*.
Rodrik, D. (2014). *Green industrial policy*. Oxford review of economic policy, 30(3).
Ronald Reagan Presidential Library (1981). Inaugural Address.
Roston, E., Eckhouse, B. (2022). *The Inflation Reduction Act Is a Climate Bill. Just Don't Call It One.* Bloomberg, 15.08.2022.
Rowthorn, R., Ramaswamy, R. (1997). *Deindustrialization – Its Causes and Implications.* International Monetary Fund.
Roy, J. (2012). *All roads lead to Rome: Background, content and legacy of the Treaties on the European Economic and European Atomic Energy Communities*. *Designing the European Union: From Paris to Lisbon*. Springer.
Samenow, J. (2018). *Debunking the claim 'they' changed 'global warming' to 'climate change' because warming stopped*. Washington Post, 29.01.18.
Sapir, A. (2021). *The European Union's carbon border mechanism and the WTO*. Bruegel.
Scheinert, S. (2023). *EU's response to the US Inflation Reduction Act (IRA).* European Parliament.
Schneider, M. (2022). *The World Nuclear Industry Status Report 2022*.
Siler-Evans, K., Azevedo, I. L., & Morgan, M. G. (2012). *Marginal emissions factors for the US electricity system*. Environmental science & technology, 46.
Smith, M. (2019). *Most people expect to feel the effects of climate change, and many think it will make us extinct*. YouGov.
Stiglitz, J. E. (1997). *The role of government in economic development*. Annual World Bank Conference on Development Economics (Vol. 1996, pp. 11-23).
Taylor, K. (2023). *LEAK: Brussels targets 40 percent of clean tech manufacturing in Europe by 2030*. Euractiv, 6.03.23.
The Byrd-Hagel Resolution was adopted 95-0.
Tolliday, S. (1995). *Enterprise and State in the West German Wirtschaftswunder: Volkswagen and the Automobile Industry, 1939-1962.* The Business History Review.
Toth, F. L., Rogner, H. H. (2006). *Oil and nuclear power: Past, present, and future.* Energy Economics, *28*(1).
UNEP (2021). State of the Climate – Data action note: data you need to know.
US Department of State (2023). *Signed MoU with the DRC and Zambia to Strengthen EVs Battery Value Chain*.
US Energy Information Administration (2020). *About 25% of U.S. power plants can start up within an hour.*
US Energy Information Administration (2022). *How much carbon dioxide is produced per kilowatthour of U.S. electricity generation?*
US Environmental Protection Agency (2023). *Greenhouse Gas Inventory Data Explorer.*
Vestager intervention at the "EU response to the US Inflation Reduction Act" debate. EU Parliament, 14.12.22.
Waldersee, V. (2023). *Tesla scales back German battery plans, won over by U.S. incentives*. Reuters, 22.02.23.
White House (2009). *Progress Report: The Transformation to a Clean Energy Economy*.

White House (2022). *Remarks by President Biden At Signing of H.R. 5376, The Inflation Reduction Act of 2022.*
White House (2022). *Remarks by President Biden on the Passage of H.R. 5376, the Inflation Reduction Act of 2022*.
White House (2023). *Remarks by National Security Advisor Jake Sullivan on Renewing American Economic Leadership at the Brookings Institution*.
White House (2023). *Remarks by President Biden on the Anniversary of the Inflation Reduction Act*.
White House (2023). *Remarks of President Joe Biden – State of the Union Address*.
White House (2023). *The Spirit of Camp David: Joint Statement of Japan, the Republic of Korea, and the United States.*
Williamson, J. (1997). The Washington consensus revisited. *Economic and social development into the XXI century*.
Williamson, O. E. (1981). *The economics of organization: The transaction cost approach*. American journal of sociology, 87.
WindEurope (2020). *Wind energy and economic recovery in Europe: How wind energy will put communities at the heart of the green recovery*.
World Bank (2023). *Carbon Pricing Dashboard*.
Zarvas, Z. and G. Wolff (2021). *A green fiscal pact: climate investment in times of budget consolidation*. Bruegel.