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Joint statement
September 2023

# The Inflation Reduction Act: How should the EU react?

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The Inflation Reduction Act (IRA), enacted in 2022, aims at promoting the production and adoption of clean energy in the United States, fostering job creation, and effectively addressing competitive pressures from China. This ambitious response of the US to the issue of climate change is welcome. Yet, the IRA's local content requirements have drawn criticism because they conflict with principles outlined by the World Trade Organization (WTO). Moreover, the IRA creates economic distortions in foreign direct investment and might prompt European companies to relocate their operations to the United States. The IRA has stirred a strong debate about the future of European industrial policy because it poses new and fundamental challenges and demands careful rethinking of European industrial strategy. The conundrum is the following: how can Europe manage its Green Transition while strengthening its economic and strategic resilience, preserving jobs and productivity growth, and maintaining European solidarity and international coordination?

## The IRA in itself is small, and so will be its aggregate macroeconomic effects

Assessing the precise financial implications of the IRA poses a considerable challenge. Estimates range from $390 to $900 billion for the period from 2023 and 2031. At the same time, it is clear that

(i) the overall funding level of the various programs the EU has already initiated to meet climate targets and facilitate the green transition is comparable to the IRA, and

(ii) the subsidies under the IRA are expected to exert minimal overall macroeconomic impact on both the US and the EU.

While specific industries may have greater incentives to invest in the US rather than the EU under this new framework, a closer examination at the sectoral level fails to yield evidence linking the IRA to significant risks for the EU. In this context, a subsidy race should be avoided with the US as well as within the EU.

## But the IRA should nevertheless force a rethink of European industrial policy doctrine

The IRA revolves primarily around providing production and investment subsidies, many of which are uncapped. We highlight that this strategy will be inefficient to address the challenges of decarbonization. The European policy mix, which involves both carbon pricing and dedicated industrial intervention, is clearly a superior approach. At the same time, Europe should learn from the simplicity and expediency of the IRA approach. It should be a priority to simplify and expedite European procedures. Aid should be concentrated on sectors for which EU countries either currently possess or can be anticipated to develop comparative advantages, resulting in substantial environmental and technological externalities.

## Expand energy supply to reduce energy price differentials

Rather than the IRA itself, it is the existing and sizeable energy price differentials that are likely to substantially impact Europe's attractiveness and the competitiveness of its industries. Therefore, concerted endeavors to reduce energy prices within Europe are of paramount importance. It is key to accelerate the deployment of renewable energy sources in order to strengthen energy supply.

In the realm of conventional power generation, Germany and France have adopted different strategies. We advocate for mutual support, particularly by designating both nuclear power plants and hydrogen-capable gas power facilities as transitional technologies on the path to climate neutrality within the EU taxonomy. Moreover, both countries stand to gain from intensified collaboration in expanding Europe's electricity and hydrogen infrastructure. The reform of European electricity markets should also be a central tenet of any European Green Industrial policy, with the wholesale market as the main instrument for coordinating power generation dispatch.

## Secure raw material supplies, strengthen trade agreements and international cooperation

Finally, we recommend securing raw material suppliers and strengthening international cooperation through trade agreements and incentives to build domestic capacities. Rather than a complaint to the WTO with little chance of success,  we believe that it would be more efficient to cooperate with the U.S. on rules about subsidies linked to environmental protection, in a framework that might be shared with a number of partners, such as border adjustment agreements linked to environmental protection, on methane emissions for instance.*

* The authors would like to thank Niklas Garnadt, Thilo Kroeger and Christian Ochsner of the German Council of Economic Experts, Ghassane Benmir of the LSE and the team of the Council of Economic Analysis for monitoring this report, in particular Maxime Fajeau, scientific adviser, Pierre-Léo Rouat, research fellow, Jeanne Astier and Yanis Boussaïd. They would also like to thank the members of the CAE for their comments.

## Introduction

On August 16, 2022, the Inflation Reduction Act (IRA) was successfully passed by the US Congress. While the package's title suggests a focus on tackling inflation, its primary objectives revolve around promoting the production and adoption of clean energy in the United States, stimulating job growth, and addressing competitive pressures from China. According to the Congressional Budget Office's (CBO) projections, implementing the IRA should generate $738 billion in additional government revenues and incur $499 billion in government spending from 2023 to 2032. As a result, this initiative is expected to significantly reduce the deficit by an estimated $238 billion. The green technology incentive part of the IRA is estimated to be worth $369 billion over the period 2023 to 2032

The IRA approach to decarbonisation is entered on the energy and transportation sectors, and primarily focuses on production and investment subsidies, rather than regulation or emission targets. 43.6% of the planned funding volume is earmarked for tax credits on green energy production. The IRA imposes strict domestic requirements for many of these tax credits. In particular, subsidies increase when raw materials and intermediate inputs come from the US.

These local content requirements have sparked considerable controversy in Europe, as they directly contradict the principles outlined by the World Trade Organisation (WTO), particularly the national treatment clause that necessitates equitable treatment for imported and domestically produced goods after clearing customs.

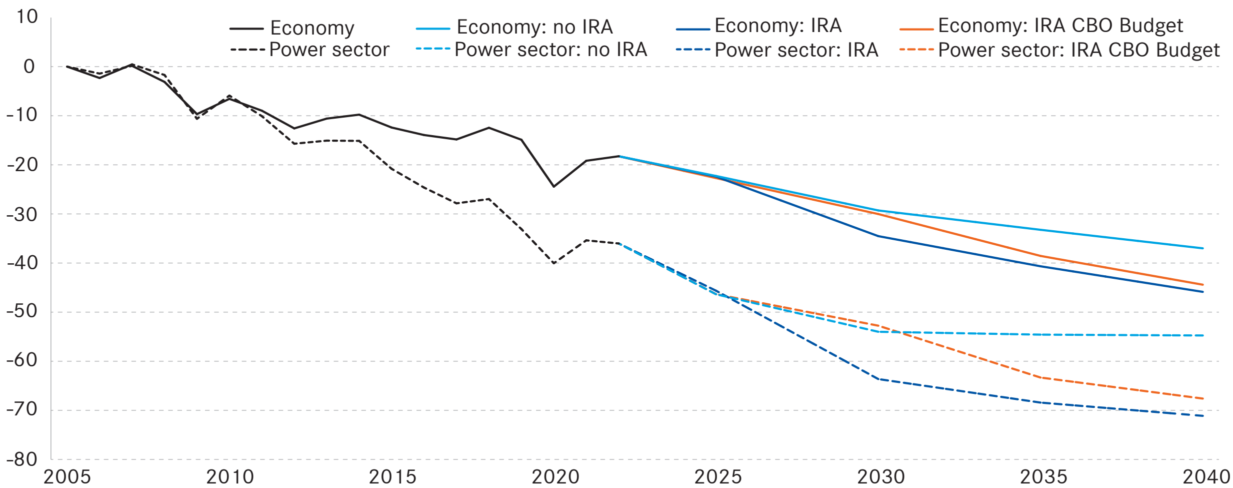
European policymakers also worry that the IRA could generate economic distortions in foreign direct investment (FDI) and trigger the relocation of European companies to the US. Finally, the IRA could trigger a detrimental and inefficient subsidy race, significantly increasing the cost of the Green Transition.

Are these fears warranted? How will the IRA affect the Green Transition? Is the IRA a threat or an opportunity for Europe? And, how should the European Union respond?

## What is the IRA and why should we care?

The IRA stands as the most ambitious federal response to the pressing issue of climate change in the United States, and as such, it should be viewed as a global public good (Figure 1). In the absence of the IRA, US economy-wide $CO_2$ emissions in 2040 are projected to be only 37% lower than in 2005. The IRA is estimated to achieve an additional reduction of economy-wide $CO_2$ emissions of about 10 pts in 2040 (Brookings, 2023).[1] The impact is particularly pronounced when considering $CO_2$ emissions from electricity production. Under the IRA, a substantial decline of 70% is anticipated by 2040, compared to a counterfactual reduction of 55%.

Figure 1: Economy-wide and electric sector CO2 emissions over time*




*Values are based on US-REGEN modeled scenarios with IRA incentives (blue), a counterfactual reference without IRA (gray), and an IRA scenario with a constraint that fiscal costs match CBO values through 2030 (orange).

**Source**: Bistline J. et al.(2023): *op. cit*.

[1] Bistline J., Mehrotra N., Wolfram C. (2023): "Economic Implications of the Climate Provisions of the Inflation Reduction Act", *Brookings Papers on Economic Activity*. Projections from the US Energy Information Administration. *Annual Energy Outlook 2023* get to very similar estimates of the reduction in emissions induced by the IRA.

## A Breakdown of IRA Provisions

The Inflation Reduction Act incorporates several key provisions that primarily focus on the electricity and transportation sectors, amounting respectively to $131 bn for clean electricity generation and storage, and $33 bn for both clean vehicles and fuel (all estimated budget expenditures cited in this subsection are based upon CBO's initial projections published in September 2022).[2] Nevertheless, substantial efforts have also been dedicated to initiatives involving hydrogen technology, carbon capture, and promoting green manufacturing practices.

In terms of projected fundings, investment and production tax credits represent a very large share of projected total fiscal outlay (217 bn according to Brookings, 2023). These are, in many cases, not cumulative: qualifying electricity facilities are allowed to choose whether to take the investment or production subsidy, and the relative value of each credit could vary by location, technology, bonus credit eligibility, and assumed capital costs. While tax credits are largely channeled to electricity generation, the IRA extends and expands credits for clean fuels like low carbon hydrogen ($19 bn), nuclear power production ($30 bn) and carbon capture and sequestration ($3 bn).

Two types of tax credits are directed towards individuals. First, $40 bn are destined to individuals through the *Clean Energy and Efficiency Incentives*, which aims to support energy efficiency investments as well as clean energy production (small wind energy, solar, etc.). The other provision concerns purchases of electric or hydrogen vehicles, with a subsidy up to $7,500 (tied to local-content production requirements).

Additionally, the Act includes provisions for direct expenditures in selected sectors, totaling $121 bn. These include subsidies for establishing a Green Bank ($ 66 bn), and for the agriculture and forestry sectors ($21 bn).

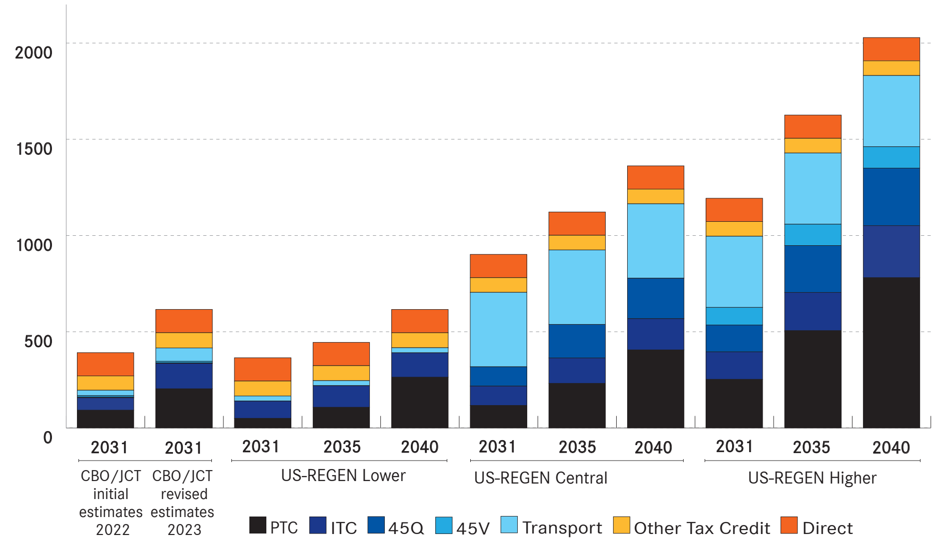
## Fiscal implications in the US

The range of estimates for the total cost of the IRA is very large, from $390 bn to $900 bn between 2023 and 2031.

The precise fiscal implications of the IRA are hard to predict because several provisions make total IRA expenditures particularly sensitive to projections regarding the evolution of the power sector and of Electric Vehicles (EV) usage in the counterfactual scenario without the IRA.

Many subsidies are not capped and are allocated as a percentage of investment. This is the case for supply-side greenfield subsidies in sub-sectors such as energy storage, batteries, solar, geothermal, and small wind electricity production (the base subsidy amounts to 6% of investment and is increased if certain conditions are met, e.g. to 30% if wage and employment conditions are met). The total amount thus depends on how much investment will be made in those technologies.

Figure 2: Estimates of cumulative (undiscounted) fiscal costs from IRA tax credits by provision across low, central, and high fiscal cost sensitivities in US-REGEN[a]

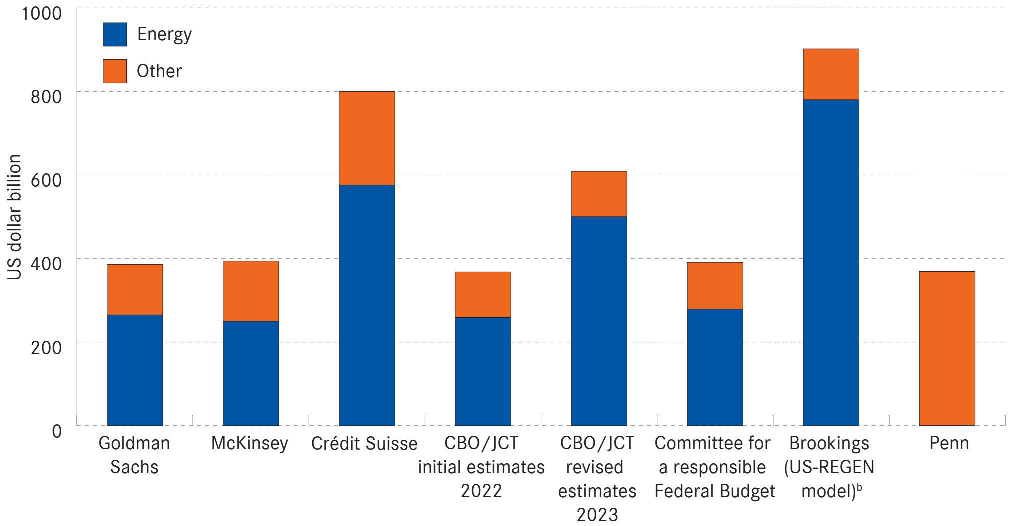



**Source**: Bistline J. et al.(2023): *op. cit.* Calculations by the Franco-German Council of Economic Experts.

[a] CBO/JCT scores are based on September 7, 2022 estimates. Values are shown in nominal terms. The Other category includes additional end-use incentives (e.g., credits for heat pumps) and manufacturing. 45Q credits are for captured CO2, and 45V credits are for clean hydrogen

[2] As we note below, significant uncertainty remains regarding the precise cost of IRA provisions. Revised estimates of the Joint Committee on Taxation (JCT) published in June 2023, and presented in Figures 2 and 3, suggest that the fiscal cost of various provisions could be much larger than indicated in these initial estimates

Figure 3: Estimates of IRA's "Energy & Climate" section costs[a]




**Source**: Brookings, Committee for a responsible Federal Budget, Congressional Budget Office (CBO), Crédit suisse, Goldman Sachs, MacKinsey & Compagny, Tax Fondation (2023), University of Pennsylvania (Penn). Calculations by the Franco-German Council of Economic Experts.

[a] These estimates relate to the provisions of the "Energy and Climate" section of the IRA. There are some minor variations in the total duration covered by these estimates (till 2029 to 2031).

[b] These is the central scenario.

Other subsidies are allocated per output and are similarly uncapped. For instance, subsidies for the generation of solar, geothermal, wind, and biomass power are expressed in cents per kilowatt-hour (kWh) and for clean hydrogen production in US-Dollars per kilogram. The total amount of expenditures on these subsidies will depend on the evolution of the energy mix between 2023 and 2031. If the proportion of renewable energy in total production significantly increases, the size of the fiscal outlays will be greater.

Medium-term estimates of trends in renewable energy production prices also influence the tax wedges associated with these subsidies. Provisions outlined in the Residential Clean Energy Credit and New Energy Efficient Homes Credit are additionally dependent on real estate prices, although they are admittedly less volatile. Furthermore, production subsidies in the transportation sector may prove of varying importance depending on electric vehicles' price trends and market share over the current decade.

Behavioural responses (e.g. price elasticities of investment, of production, or of consumption of EV vehicles) also play a role in determining the overall scope of the IRA. These responses involve assessing the extent to which the implementation of the IRA will impact investments, production, and consumption patterns in specific sectors, particularly the consumption of electric vehicles. It is worth noting that certain subsidy eligibility conditions must be met, including compliance with local-content requirements and labor laws. How these conditions will affect potential investments is still unclear, particularly in the automobile sector.

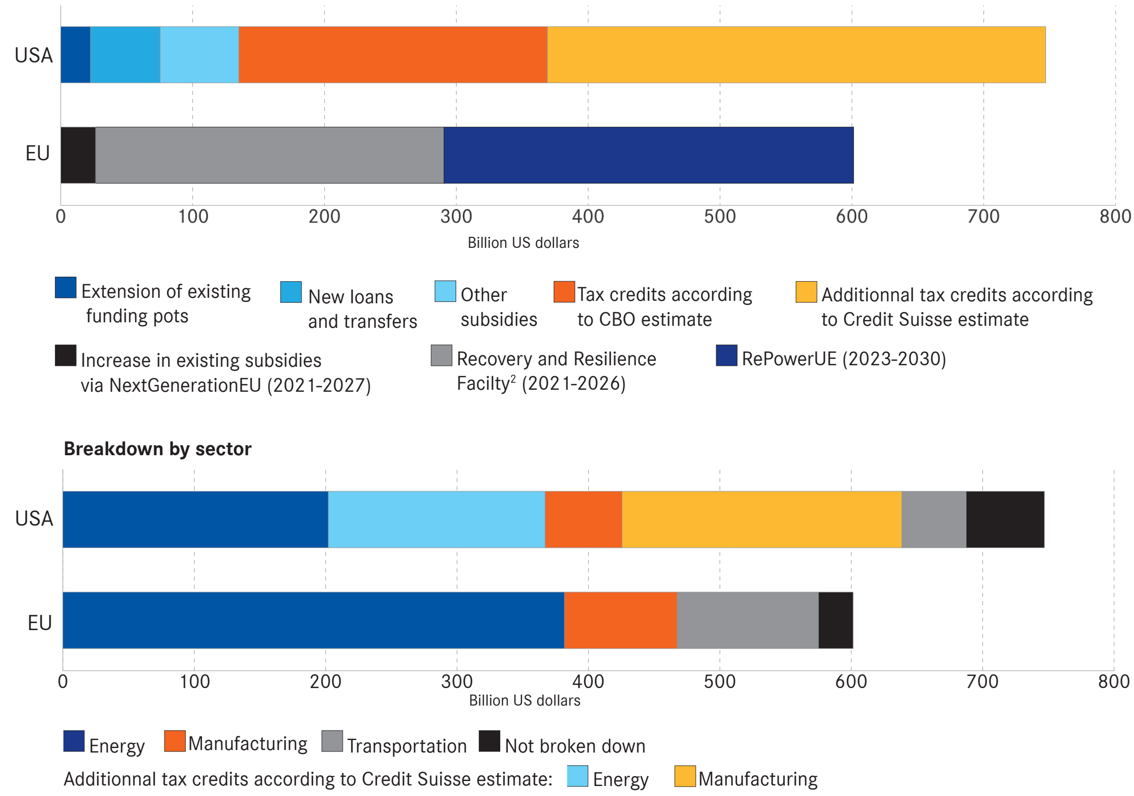
## Comparison with EU programs

The EU has already put in place a large number of programmes – aimed at climate targets and the green transition – that could offset the distortions introduced by the IRA. Importantly, the overall funding level of EU programs is comparable to the IRA (Figure 4).

The EU does not rely on a single flagship scheme but instead implements a variety of initiatives at both the EU and national levels (GCEE, 2023). In direct response to the IRA, the EU presented its Green Deal Industrial Plan which totals around €510 billion (roughly $560 billion) and includes funding both from the NextGenerationEU programme and the RePowerEU fund. NextGenerationEU was established in 2020 in response to the coronavirus crisis. As part of this programme, the Recovery and Resilience Fund (RRF) allocates roughly €720 billion in grants and loans to the member states, with 37% explicitly designated to facilitate the green transition (European Commission, 2023a).[3] Measures worth around €500 billion have been earmarked of which roughly €200 billion contribute to the green transition. In response to the energy crisis an amount of €220 billion from the RRF, which was not yet earmarked for any projects, was reallocated to the RePowerEU programme,

[3] European Commission (2023): *The Recovery and Resilience Facility.*

Figure 4: Comparison of production and environmental subsidies in the US and the EU




**Source**: German Council of Economic Experts (2023): The Inflation Reduction Act: Is the new U.S. industrial policy a threat for Europe?", *Policy Brief* 1/2023.

which totals €310 billion and focuses entirely on energy security and the green transition. In addition to the programmes under the Green Deal Industrial Plan, €35 billion ($40 billion) worth of funds from the RRF have already been used for measures supporting the green transition.

As a result, EU programmes already outpace the IRA in their financial support for renewable energy. According to the International Renewable Energy Agency (IREA), the EU subsidies for renewable energy exceed those of the IRA. With 0.5% percentage of GDP, they are twice higher than the IRA's.[4]

While EU and national programmes are broadly comparable to the IRA in terms of overall funding commitments, they differ structurally. EU subsidies are typically much more upstream than IRA's investment and production subsidies, meaning they are focused on supporting early-stage development and are less predictable, often tied to specific projects.

On March 9, 2023, the European Commission adopted the Temporary Crisis and Transition Framework (TCTF), extending and amending the framework enacted in March 2022. It aims to boost and retain clean tech investments in Europe. The framework allows public support for production in strategic sectors (clean technologies, digital, etc.) alongside tax credits. The TCTF complements various sectoral initiatives, such as RepowerEU for renewables, and the European CHIPS Act which allows state aids to support investments along the semiconductor value chain.

As a result, subsidy announcements soared in the EU. In April, Spain announced a subsidy of €450 million to ArcelorMittal for producing steel with hydrogen and 650 million in support for 5G equipment and infrastructure. Between March and June 2023, the European Commission approved €3.5 billion in State aid to Spain, of which 837 million to subsidise battery manufacturing.[5]

In the Netherlands, the state is negotiating with Tata and Nobian, the European leader in chemical products for the industry. The country allocated €1.4 billion of grants to support energy-intensive SMEs.

Germany committed to providing several hundred million euros to the Swedish battery manufacturer Northvolt to compensate for high energy prices. Germany's approved

[4] IEA (2022d), *World Energy Outlook 2022*, IEA, Paris, Annex A.

[5] European Commission (2023): *Competition Policy, Search on Competition*.

aid totalled €6,3 bn between March and June 2023, including €4.35 billion to compensate coal producers for the cessation of their activities and between 0 to 1.5 bn USD as part of the Wind Energy Act.

France allocated a total of €8,6 billion in state aid between March and June 2023 (European Commission, 2023). This includes €2.9 billion in state aid for a new semiconductor manufacturing plant by STMicroelectronics and GlobalFoundries. In Addition, it will offer €2.1 billion in subsidies for a floating offshore wind farm and promised €850 million in support to the ACC gigafactory (producing batteries for automobiles), inaugurated in late May.

## What are the expected effects of the IRA on the EU's economy?

The overall projected fiscal cost is not necessarily a good indicator of the expected effect of the IRA on the economy. Ultimately, this effect will depend on the subsidy wedges introduced by the IRA provisions, on behavioral responses to these wedges in terms of investment, production and consumption, on the amplification effects through input-output linkages and on the technological externalities induced by the IRA. What can we expect from these various diffusion channels?

### Main diffusion channels

#### Anticipated reallocation effects of investment and production subsidies

The IRA could affect capital allocation both between countries and between sectors, boosting production and investment in the US in key sectors targeted by IRA subsidies. One of the concerns is that this may trigger relocation of investments and production from Europe to the US And that this could potentially restrict the availability of capital in Europe for promoting green transformation.

Moreover, the accelerated expansion of renewable energies and electromobility in the US may lead to a rapid surge in demand for critical raw materials. Consequently, there could be a shortage of these essential resources, accompanied by price increases, with the potential to impede the progress of the green transformation in Europe.

Although the IRA improves the investment attractiveness of the US, production capacities in the United States along the value chain of sustainable technologies are also unlikely to be sufficient in the short term to displace European manufacturing on a large scale. At the same time, the Inflation Reduction Act will provide a demand stimulus for European high technology in green power generation. For example, German manufacturers are technological leaders in the production of efficient electrolyzers. This itechnology will be essential in the US for green hydrogen production. As in the US, the IRA is likely to lead to learning effects and efficiency gains in the EU once global value chains have been adjusted.

The United States and the European Union have intense trade relations and are mutually dependent on each other for the purchase and sale of manufactured products. Intra-industry trade between the US and Europe is high in many sectors, including machinery and vehicles.[6] Despite domestic content requirements, the IRA is likely to strengthen these commercial links. European manufacturers could benefit from the IRA, as long as the components needed to qualify for subsidies are not all made in the US This increase in demand can stimulate innovation even in industrial sectors with high domestic production requirements.

#### The role of energy prices

A potential concern is that the IRA will increase the differential in energy prices between the EU and the US Such energy price differentials have potential impacts on trade flows, and the location of economic activity. Sato and Dechezleprêtre (2015)[7] estimate, for instance, that a 10% increase in the energy price differential between two countries leads to a 0.2% increase in imports of the country whose energy becomes relatively more expensive. Saussay and Sato (2023)[8] show that a 10% decrease in relative energy prices between two countries increases the amount of foreign direct investments by 3%, with the effect concentrated on energy-intensive sectors.

Nevertheless, the effects of the IRA on electricity prices in the United States are projected to be quite moderate. According to the US Energy Information Administration, in the year 2030, under the Reference and High Uptake scenarios, electricity prices are expected to be approximately 10 cents per kilowatt-hour in 2022 dollars, which is nearly 10% lower compared to the No IRA and Low Uptake scenarios, where electricity prices are estimated to be around 11 cents per kilowatt-hour.

[6] Eurostat (2023): International trade in goods - a statistical picture - Statistics Explained (europa.eu)

[7] Sato M. and Dechezleprêtre A. (2015): "Asymmetric Industrial Energy Prices and International Trade", *Grantham Research Institute on Climate Change Working Paper*, n° 178.

[8] Saussay A. and Sato M. (2023): "The impacts of energy prices on industrial foreign investment location: evidence from global firm level data", *Working Paper.*

The shale gas revolution, which significantly reduced energy prices in the US a decade ago, provides a natural point of comparison for gauging the likely magnitude of the IRA impacts on the economy. The shale boom saw an increase of nominal investment (e.g. in mining, oiled machinery) of more than $65 billion in less than 4 years, but the macroeconomic impacts from this investment boom appeared comparatively modest. Accordingly, the shale boom gas significantly decreased energy prices in the US relative to Europe. But the effects of this large change in energy prices were also modest on aggregate: Melick (2014)[9] shows that US manufacturing output and employment increased by only 2 to 3% compared to Europe despite the price advantages created by the shale gas boom. However, this effect varies across industries, increasing with average sectoral energy intensity to as much as 30% in the chemical industry. At about $369 billion over ten years, the IRA is only slightly larger than a quarter of the accumulated cost savings from the shale gas boom, which was about $1,400 billion over the period from 2008 to 2017. Given the empirically validated economic effects of the shale gas boom, the IRA is likely to have relatively small effects on US production and production shifts to the United States. Since there are currently already high energy price differentials between the US and Europe (IEA, 2022b),[10] the additional effect arising from the IRA subsidies could even be smaller than suggested by the studies on the shale gas boom.

### Innovation externalities

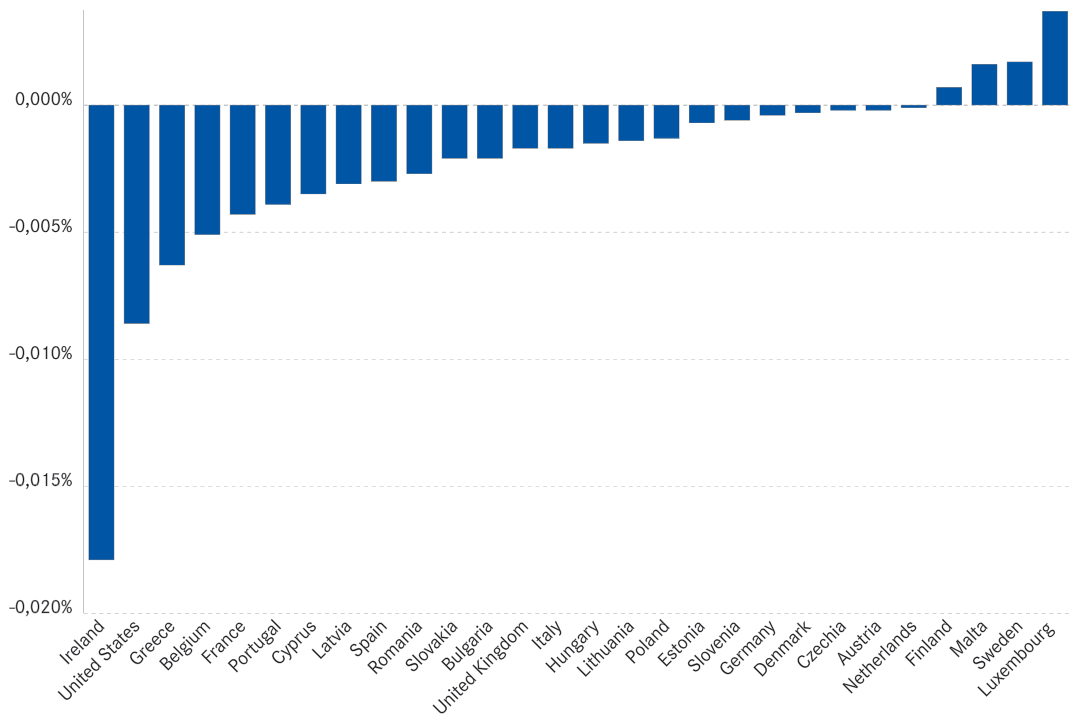
The relocation of production facilities for green transformation products to the US could have a medium-term effect on the transfer of research and development activities, with potential consequences regarding the competitiveness of European companies in the long term. These effects are difficult to predict as they will depend on the nature of the innovation externalities generated by the IRA.

## Calibrating the macroeconomic effects of the IRA

### Estimated macroeconomic impact in the US

Integrated energy-economy models like the EPRI US-REGEN model can offer useful estimates of the IRA's economic impact, encompassing the various diffusion channels mentioned above. US-REGEN comprises a rich description of the electric and energy sectors, with endogenous investment and technological adoption margins. The model can also accommodate learning-by-doing externalities. Calibrations of the impact of the IRA in Bistline et al. (2023) using US-REGEN show a significant effect on investment in the sectors targeted by IRA provisions: results suggest a boost (relative to 2022 levels) of approximately $21 billion per year over 10 years in electric power generation and

Figure 5: Estimated effect of the IRA on real national income by country in a multi-country multi-sector model




**Source**: French and German Council of Economic Experts.

[9] Melick W. R. (2014): "The Energy Boom and Manufacturing in the United States", *FRB International Finance Discussion Paper*, N. 1108.

[10] IEA (2022b): *Energy Prices* [database].

approximately $7 billion per year in transmission and distribution. These magnitudes are sizable relative to the current level of investment. But they are comparatively small as both a share of overall investment and overall economic activity. In other words, IRA investments in the baseline case are therefore not likely large enough to meaningfully affect macroeconomic aggregates in the US. Bistine et al. (2023) forecast a boost in investment, particularly in clean electricity generation, but reports that "even substantially larger investments in power generation, transmission, and distribution would carry relatively modest macroeconomic impacts given the low share of power and electricity investment relative to overall investment".

### Estimating the macroeconomic Impact in Europe

The negligible effects on aggregate US output found in US-REGEN (and corroborated by simulations from various other models)[11] suggest *prima facie* that the macroeconomic consequences of the IRA for European countries should be extremely limited. We can further validate this prediction by exploring the economic implications of the IRA in a multi-country, multi-sector model with detailed input-output linkages (Baqaee and Farhi, 2019).[12] The model allows for rich substitution patterns (across sectors, across countries and across factors), which can capture a wide set of reallocation effects along the supply chain in response to policy shocks such as tariffs or subsidies. We note however that the model does not encompass any investment margin, and therefore essentially considers technology as fixed. The effects we estimate can therefore be understood as the projected steady-state medium run impact of the IRA, happening only through substitution and reallocation, but taking underlying technology as given. The IRA is modeled as a subsidy (i.e. a wedge between prices and marginal costs) in sectors affected by IRA provisions, financed by lump sum taxation on national income in the US. Details on the computation of the wedges, on the structure of the model and on the assumptions underlying these calibrations are available in Appendix A2. Results from calibrations confirm that the anticipated macroeconomic effects of the IRA for European countries are minuscule, at a 5 to 10 years horizon: real national income would be unaffected in Germany, and would decline by .004% in France, and by .001% for the European Union as a whole.

In a recent column, Attinasi et al. (2023), using the same model, get estimates of the effect of IRA that are significantly larger.[13] Various reasons explain the larger estimated effects in their simulations. First, they assume that IRA subsidies work as a pure trade shock, akin to a net productivity gain. Instead, we account for the fact that these subsidies need to be paid for. Second, they add positive TFP shocks to the US, and negative shocks in the rest of the world, to capture technology-investment driven productivity growth, while we refrain from making any assumption on productivity gains induced by the IRA. We explain in Appendix A2.

## Sectoral insights

While the macroeconomic effects of the IRA are likely to be small for the US, and for European countries in return, this does not preclude that the effects for specific sub-sectors could be significant and require dedicated responses from European policy makers (Hertie School, 2023).[14]

Among the sectors that are expected to be specifically impacted by the IRA, the production of electric vehicles is one that has attracted considerable attention, due to the large subsidies for buying EVs coupled with the local content requirement included in the IRA. Modeling the exact impact of these subsidies on the automobile market remains complicated. But some insights already emerge.

First, Europe is ahead of the US in the EV sector. While its exports are comparable ($12.3 bn[15] vs. $11 bn[16]), Europe produces more for its own consumption. Overall EV production was 1.12 million in 2020 against 455,000 in the United States. In 2022, production in Europe was still roughly three times higher than in the US.[17] Accordingly, the adoption of electric vehicles is also higher in Europe: over 20% of vehicles sold have been electric in 2022 (IEA, 2023),[18] compared with 8% in the US.

This greater adoption of vehicles can be explained by the fact that European countries have already adopted large consumer subsidies for EV adoption, which average €6,000 (Kleimann et al., 2023),[19] as well as by differences in preferences (vehicle size and range). In addition, the cost of

[11] Calibrations from the Penn Wharton Budget Model for example also suggest zero effect of the IRA on US GDP by 2031 (Penn Wharton (2022): *Inflation Reduction Act: Preliminary estimates of budgetary and macroeconomic effects*, University of Pennsylvania)

[12] Baqaee D.R. and Farhi E. (2019): "The Macroeconomic Impact of Microeconomic Shocks: Beyond Hulten's Theorem", *Econometrica*, vol. 87 (4), pp. 1155–1203.

[13] Their estimates are one to two orders of magnitude larger. They suggest the IRA could lead to a 0.7% increase in US output and a -0.2% in EU output.

[14] Jansen J., Jäger P. and N. Rederker (2023): "For climate, profits, or resilience? Why, where and how the EU should respond to the Inflation Reduction Act", *Policy Brief*, Hertie School Jacques Delors Centre.

[15] Eurostat (2023): "International trade in hybrid and electric cars", Statistics explained.

[16] International Council on Clean Transportation (2022): "Power play: Unlocking the potential for US automotive trade with electric vehicles", *Briefing*, ICCT.

[17] International Council on Clean Transportation (2023): "Annual update on the global transition to electric vehicles: 2022", Briefing, ICCT.

[18] IEA (2023): *Global EV Outlook 2023*, IEA.

[19] Kleimann, D., N. Poitiers, A. Sapir, S. Tagliapietra, N. Véron, R. Veugelers and J. Zettelmeyer (2023): "How Europe should answer the US Inflation Reduction Act", *Policy Contribution*, n°04/2023, Bruegel.

electric vehicles relative to internal combustion engine vehicles has been higher in the US than in the EU. The IRA is expected to substantially increase the adoption of electric vehicles in the US: Bistline et al. (2023)[20] estimate that the IRA's consumer subsidies for electric vehicles will amount to $390 billion by 2031, which equates to just under 5.8 million subsidized e-cars per year. Based on this estimate, the share of e-cars in all new cars would increase from about 7% in 2022 to 44% in 2030. Without IRA, the authors estimate an increase to 32%. Taking into account currently implemented policies, including the IRA, the IEA (2023) estimates a similarly high share of just under 50% in 2030. In contrast, the last estimate before the promulgation of the IRA expected e-cars to account for only 20% of all new cars in the US in 2030 (IEA, 2022d).[21]

However, we don't expect the expansion of the US market for electric vehicles to lure substantial demand or production away from Europe. For example, for 2030, both the expected share of electric vehicles in all new cars in Europe was revised upward from 40% to nearly 60% and the projected global sales of electric vehicles were also revised upward from 30 million to 40 million (IEA, 2022d, 2023). Europe would continue to be a larger sales market than the US in 2030 with 10.5 million electric vehicles sold in Europe vs. 8.2 million in the US (IEA, 2023).

Moreover, the effective impact of local content requirement will be substantially lessened by the exception granted to vehicles leased: indeed, according to the IRS interpretation issued in December 2022, these vehicles will fall in the "commercial" category, and as such will not be subject to any requirement as to location of assembly or battery origin (nor as to income level, as a matter of fact). Given the ease of shifting from purchase to leasing, this exception might well become the rule for imported cars, meaning that local content requirement would have limited practical effects.

Europe also imposes tariffs on electric vehicles that are much higher than in the US (10% vs. 2.5%), which would correspond to a subsidy for European vehicles of around $3,750 for an average price of around $50,000 (PIIE, 2023).[22] Electric vehicles being costly to transport, this mitigates the competitive advantage granted by the IRA. In the EU, the vast majority of vehicles sold come from the European continent (82% in Germany, 81% in France according to Mayer T., 2023).[23] The automotive market's characteristic feature as a continental market underscores the influence of transportation costs and customs duties on the industry. High customs duties not only on assembled vehicles but also on key components play a role in encouraging foreign direct investment (FDI) to cater to regional demand from local factories (ibid).

A central piece of the IRA's subsidies for clean transport are subsidies for battery manufacturing with the aim of becoming less dependent on China. With 30% to 40% of the value added, batteries are a central component of the e-car value chain (IEA, 2022b). So far, battery production is dominated by China, with about 75% of lithium-ion battery production and similarly high shares in the production of chemical components for batteries. The e-car purchase incentives included in the IRA exclude e-cars with batteries that contain Chinese-made components. The requirements for the share of critical materials and produced batteries that must come from domestic production or from states with a free trade agreement with the US also pursue the goal of becoming less dependent on China.

Battery cell production is expected to expand rapidly in the US and be sufficient to meet demand locally (Mehdi and Moerenhout, 2023).[24] However, it is likely to be difficult to meet the sourcing requirements for critical materials. For example, the US is expected to rely on imports of anode and cathode materials, which currently account for about 60% to 70% of battery value added, for the foreseeable future (Mehdi and Moerenhout, 2023). Dunn and Trost (2023)[25] estimate that if raw material imports from countries with free trade agreements were expanded to the maximum, about 2.5 million batteries per year would meet IRA requirements in 2027. This is likely to be less than half of the e-cars sold in the US. In A scenario with less expansion of imports, the authors project just over 1 million batteries per year. Since the vast majority of battery production is not likely to be subsidized, the IRA is unlikely to result in large-scale shifts of production to the US. Because e-car purchase subsidies are also subject to these requirements, batteries produced with critical materials that come from countries with which the US has a free trade agreement are likely to be installed in e-cars sold in the United States. The subsidized batteries are therefore unlikely to be in direct competition with European batteries. However, for the battery value chain in Europe, the increase in US manufacturers' demand for critical materials from countries with which the US has a free trade agreement could complicate diversification efforts by European manufacturers.

[20] Bistline, J., N. Mehrotra and C. Wolfram (2023): "Economic implications of the climate provisions of the Inflation Reduction Act", *NBER Working Paper*, n°31267, National Bureau of Economic Research, Cambridge, MA.

[21] IEA (2022d): Global EV Outlook 2022: Securing supplies for an electric future, IEA.

[22] Chad B. (2023): "Industrial policy for electric vehicle supply chains and the US-EU fight over the Inflation Reduction Act", *Working Paper,* n°23-1, PIIE.

[23] Mayer T. (2023): "L'Inflation reduction act américain : un danger pour la production automobile hexagonale ?", *Billet*, CEPII.

[24] Mehdi A. and T. Moerenhout (2023): "The IRA and the US Battery Supply Chain: Background and Key Drivers", Commentary June 8, 2023, Center on Global Energy Policy at Columbia University, New York.

[25] Trost J.N. und J.B. Dunn (2023): "Assessing the feasibility of the Inflation Reduction Act's EV critical mineral targets", *Nature Sustainability*, pp. 1–5.

Another industry that receives substantial subsidies is production of green hydrogen. Tax credits for green hydrogen production in the US are up to $3 per kg of hydrogen produced over a ten-year period or, alternatively, up to 30% of investment costs on a one-time basis (The White House, 2023). The Production subsidies are estimated to immediately reduce the cost of producing green hydrogen in the US from over $4 to between $0.9 and $1.2 per kg compared to roughly €4 in Europe (NWR, 2022).[26] This cost advantage puts the price of green hydrogen on par with the price of conventional fossil hydrogen. It is also higher than the estimated transport of $2.1 to $2.7 per kg from the US to Europe.[27] Nonetheless, currently high transport costs and demand for green hydrogen in the US make it relatively unlikely that large amounts of subsidized green hydrogen from the US will be imported to Europe in the next years.

Low costs for green hydrogen are likely to accelerate the deployment of low carbon manufacturing technologies, e.g. in steel or ammonia production in the United States. Low carbon production in these industries will be more cost-effective than in Europe, which could lead to import substitution. This effect will be more relevant in industries where green hydrogen accounts for a larger share of total costs, as e.g. ammonia production (Egerer et al., 2023).[28] In steel production, where capital costs for the plants required to produce iron via direct reduction and steel via electric arc furnaces account for a large share of total costs and pure hydrogen is required for production (Egerer et al., 2023), import substitution could be less relevant.

The substantial cost reduction for green hydrogen is likely to provide an incentive to build large-scale capacity for its production in the United States. Accordingly, US electrolyzer demand to produce green hydrogen is expected to increase. In December 2022, the German National Hydrogen Council expected an electrolysis capacity required in 2030 of about 78 GW to produce green hydrogen, assuming a two-thirds share of green hydrogen in US hydrogen demand (NWR, 2022). This compares to only a bit more than 10 GW capacity estimated to be set up by 2030 without the IRA (IEA, 2022c).[29] According to IEA calculations from the third quarter of 2022, the global supply capacity of electrolyzers in 2023 is about 21.5 GW. However, it is expected to grow strongly in the coming years. Total production capacity until 2030 is expected to be 374.1 GW (IEA, 2022a).[30] Accordingly, about one-fifth of the electrolyzer production expected between 2023 and 2030 would be needed to serve estimated demand in the US

We don't expect the increased demand for electrolyzers to lead to supply bottlenecks in Europe. First, there has been a substantial gap between the planned capacity of electrolyzer production and the announced green hydrogen projects of more than 100 GW until 2030 prior to the IRA (IEA, 2022a). The gap between production and targets for green hydrogen has been a bit lower at 70 GW. The additional demand from the US is lower than this gap. In addition the increased demand from IRA subsidies is expected to drive up the price of electrolyzers and thereby, in turn, increase the supply of electrolyzers. Through these market mechanisms, the above estimates of electrolyzer supply are likely to represent a lower bound on the amount produced over this period.

## How should the EU respond? What should an EU green industrial policy look like?

The subsidies under the IRA itself are expected to have little macroeconomic impact on the EU. In certain industries relevant to achieving climate targets, however, the IRA's production and investment subsidies could increase the incentives to invest in the United States rather than in the EU. There is no strong evidence that would associate the IRA with significant security risks for the EU. The IRA is not expected to increase the EU's dependence on single (e.g. Chinese) suppliers, neither for wind power plants components, nor hydrogen, and not even for solar panels where China is the world leader in production (Hertie School, 2023). Rather than the IRA, the existing and sizable energy price differences are expected to have a greater impact on the competitiveness of industries in the EU, in particular in energy intensive industries.

### Avoid a subsidy race - revise subsidy system

To strengthen the competitiveness of European companies, additional subsidies have been demanded in the EU as a response to the IRA. However, the limited impact emphasized above does not warrant the EU entering a subsidy race with the US, at the risk of relying upon irrelevant decision criteria and of feeding non-cooperative approaches. The EU aims to achieve a similar steering effect as intended by the IRA subsidies in the direction

[26] NWR (2022): Einschätzung zum Inflation Reduction Act, Stellungnahme, Nationaler Wasserstoffrat, Berlin.

[27] This calculation assumes transport cost as reported by IEA (2022a) and a distance of 7,500 km (roughly the geodesic distance from Texas to Portugal). IEA (2022a), *Global Hydrogen Review 2022*, IEA, Paris.

[28] Egerer, J., Farhang-Damghani, N, Grimm, V. and P. Runge (2023): "The Industry Transformation from Fossil Fuels to Hydrogen will reorganize Value Chains: Big Picture and Case Studies for Germany".

[29] IEA (2022c), Global Hydrogen Review 2022, IEA, Paris.

[30] IEA (2022a), Electrolysers – Analysis, Report.

of low-emission technologies with the emissions trading system (EU-ETS). Beyond this, the EU should use the IRA as an opportunity and an example for how to achieve certain objectives efficiently and expediently. These objectives include (i) addressing externalities, in particular environmental and technological externalities; (ii) ensuring sovereignty and economic resilience through secure supply-chains, and (iii) enabling the efficient reallocation of capital and labor in the context of structural change and of the green transition.

## Learning from the IRA's simplicity, predictability and expediency

The direct investments and production subsidies deployed in the IRA exhibit key advantages, including simplicity, predictability, and expediency. The IRA tax credits and the conditions under which a firm qualifies to obtain them are easy to understand and predict. EU subsidies, in contrast, are typically awarded through an application process the outcome of which is by design uncertain. Thus, the IRA tax breaks are more predictable for companies than EU subsidies and hence more readily accounted for in their long-term production plans. Moreover, the IRA tax incentives are immediately available to households and businesses, and they ensure a stable regulatory framework for the next ten years.

The EU should review existing programs to identify where bureaucratic hurdles can be reduced. Current schemes often suffer from lengthy and fragmented processes, recent efforts by the EU under the European Green Deal notwithstanding. Thus, the EU should strive to simplify and expedite procedures for project development and accessing subsidies. Further steps should be taken to simplify administrative requirements and provide clearer guidelines to facilitate smoother project development.

At the same time, the effectiveness of EU can make policies more effective by aligning them as much as possible with market dynamics. For this, regular information exchanges with the industries concerned are advisable, as well as formal market analyses and regular evaluations of policy outcomes to make necessary policy adjustments.

More generally, appropriate tools can help balance economic development with environmental considerations. One example is the trading of construction permits for subsidized industrial projects, which involves establishing a market-based mechanism for trading such permits, whose amount is ex ante fixed, among interested parties. This strengthens the efficient allocation of permits, encourages the adoption of cleaner technologies, and provides financial incentives for environmental protection, but would require monitoring systems and stringent emission standards.

## Effective climate policy combines carbon pricing with incentives

Investment and production subsidies alone are less effective in addressing environmental externalities than the European approach, which combines carbon pricing with support for production and investment. Carbon pricing efficiently leverages many more margins of emission reduction, e.g. energy conservation. Whithout carbon pricing, the amount of subsidies required to achieve a decarbonisation goal becomes higher (Bureau et al., 2023).[31] Moreover, while the incentives from production subsidies through tax credits expire after ten years (or the respective period for which they are awarded), firms expect long lasting and even increasing incentives for climate friendly production under the EU's emission trading scheme.

Simulations from the US-REGEN model illustrate this point (Figure 6). First, results show that even at the higher end of fiscal costs, the IRA is socially cost-effective in reducing GHG emissions. In this case, tax credits would reduce $CO_2$ emissions at an average abatement cost of \$83 per metric ton in the power sector. This is significantly below the most recent estimates of the social cost of $CO_2$ (e.g. \$200/t-$CO_2$ in 2020 according to Rennert et al., 2022).[32] But, according to the US-REGEN model estimates, it would only take a carbon tax of \$15 per t-$CO_2$ to reach a similar level of reduction in $CO_2$ emission. In other words, the implicit abatement cost is 5 to 6 times higher with the IRA than with a carbon tax.

Figure 6: Comparing the $CO_2$ emission effects and implied abatement of IRA to Carbon Tax alternative

| | IRA | Carbon TAx |
|---|---|---|
| **Generation share (Change in pp from 2021 to 2035)** | | |
| Coal | -14 | -18 |
| Natural Gas | -21 | -5 |
| Coal CCS | +3 | +0 |
| Wind & Solar | +28 | +19 |
| Other | +7 | +4 |
| $CO_2$ (% drop from 2005) | -68 | -68 |
| Abatement Cost (\$/t-$CO_2$) | 83 | 15 |

**Source**: Brookings, 2023 (op. cit.)

[31] Bureau D., Glachant J-M et Schubert K. (2023): “Le triple défi de la réforme du marché européen de l'électricité”, Note du CAE, n°76, March.
[32] Rennert K., Errickso F., Prest B.C. et al. (2022): “Comprehensive evidence implies a higher social cost of CO2”, *Nature* 610, pp. 687–692.

Furthermore, while clean energy subsidies, as opposed to carbon pricing, have positive supply-side effects, these effects are too small to justify relying entirely on subsidies to address the Green Transition. The US-REGEN model estimates suggest that the abatement cost is typically lower under carbon pricing than under specific subsidies.

The case for clean energy subsidies is strengthened in case of strong learning-by-doing externalities. The EU has not fully integrated such externalities into its Green Transition Strategy and can learn from the expediency of the US approach. Due to EU regulations on the internal market, the European approach tends to focus more on upstream measures such as research and development subsidies.

It may also be useful to align subsidies more closely with the emission reductions achieved by the subsidized activities, for example by establishing certification - as is done in the United States in the case of hydrogen subsidies - based on the carbon footprint of activities and products. This is most compatible with the European emission trading system and reduces regulatory uncertainty and complexity.

As many of the technologies needed for the green transformation will have to be new or further developed, policy should promote innovation in this area.

### Avoid fragmentation of the single market

Member States should coordinate their responses to the IRA and agree on a common approach at the European level as much as possible. National subsidy programs in response to the IRA should not lead to a subsidy race among Member States. EU state aid rules should continue to ensure this. By adding a level-playing-field argument to justifications ensuing from environmental and technological externalities, the IRA may reinforce the rationale for subsidizing green technologies. A key concern for the EU should be to avoid a situation where Member States engage in a subsidy race that would distort competition within the single market, and potentially fragment it. This is of paramount importance because of the intense level of competition within the internal market, and because of the large amount of State aid recently authorized under temporary frameworks.[33] Any response through additional subsidies should thus be carefully coordinated at the EU-wide level. In terms of financing, relying on EU-wide funds would thus be advisable. In terms of governance, it means that participation in collective endeavors, like those supported through IPCEIs, should be encouraged.

### Aim for targeted support of strategic sectors

Aid should be concentrated on sectors for which EU countries have comparative advantages and that generate significant externalities, both environmental and technological.

Determining which sectors to focus on is challenging. The EU approach to list specific subsectors discretionarily has its drawbacks; it can lead to cherry-picking and political capture. That does not mean that the EU should abstain from providing targeted aid aimed at addressing the externalities. But it should implement procedures that are less subject to political capture and, most importantly, that implement regular evaluations of the programs' success and ensure that unsuccessful projects are terminated. To reduce discretionary selection of projects, state aid regulations and industrial policies should use metrics such as technological readiness levels (already developed by the EU) and $CO_2$ equivalent emissions (measuring the carbon content of technologies).

## Expand energy supply to reduce energy price differentials

Energy price differentials are likely to be much more relevant for Europe's attractiveness as a business location than the IRA. Joint efforts to reduce energy prices in Europe are thus of first-order importance. Energy supply needs to expand rapidly by accelerating the expansion of renewable energy supply (GCEE, 2022 para. 336).

When it comes to conventional power plants, Germany and France are pursuing different strategies. While France continues to rely on nuclear power, Germany has to build up hydrogen-capable gas-fired power plants with a capacity of up to 25 GW in order to replace coal-fired power plants that are to be phased out by 2030 (Federal Government of Germany, 2023; EWK, 2023). Germany and France should support each other in these efforts, especially by supporting an EU taxonomy that considers both nuclear power plants and hydrogen-capable gas power plants as transitional technologies on the path to climate neutrality. The lower the hurdles for the construction of new plants, the faster capacities will become available that contribute to reducing the high prices on wholesale electricity markets.

Hydrogen is needed not only for the operation of German gas-fired power plants, but also in large quantities for the transformation of industry to climate neutrality in both countries. Germany plans to import about two thirds of the clean hydrogen needed until 2030 (95-130 TWh according to the German National Hydrogen Strategy, 2023). Both countries would benefit from jointly procuring part of the large quantities needed from suppliers worldwide,

[33] See for instance European Commission (2023): "The use of crisis State aid measures in response to the Russian invasion of Ukraine", *Competition State Aid Brief*, Issue 1/2023, July 2023.

in countries with favorable conditions for green hydrogen production. Together, they should be better able to diversify imports of hydrogen and derivatives and thus reduce Europe's dependencies. Joint European procurement of (renewable) energy imports can also help reduce costs by using the EU's greater bargaining power and economies of scale (GCEE, 2022 paras. 288 and 518; Bauer et al., 2023). The import of hydrogen could also ease the situation on the electricity wholesale market, since imports lower electricity demand for hydrogen or derivatives production at home, which has a dampening effect on the electricity price.

Likewise, both countries should cooperate closely in epxanding Europe's electricity and hydrogen infrastructure. This concerns both the interconnectors of the electricity grids and the pipeline infrastructure for hydrogen. It is important to quickly expand the European hydrogen network and establish pipeline and port infrastructures for imports into Europe. At the European level, the measures envisioned in the EU Green Industrial Deal to simplify and accelerate planning procedures should help accelerate the expansion of generation and transmission infrastructure (European Commission, 2023).

Ensuring stable and low electricity prices from clean electricity sources is paramount for the success of the European Green Transition. Reforming European electricity markets should therefore be a priority and the centerpiece of any European Green Industrial policy. The European strategy of using auctions to set the level of support for renewable electricity is likely more cost-effective to achieve renewable electricity expansion targets than production subsidies as implemented by the IRA. The competitive allocation of subsidies through auctions should therefore be maintained.

To refinance investments in renewable energy, different financial models have emerged in recent years in addition to the sliding market premium, such as direct supply contracts (power purchase agreements, PPAs) and self-consumption models. It is desirable to maintain different refinancing models, in particular PPAs. In addition to various smaller improvements of existing models, a more invasive transition to two-sided market premiums (Contracts for Difference - CfDs) or corridor models for the promotion of renewable energies is also being discussed. In these models, repayments are also due from the subsidized plants in times of high revenues in the electricity market. All of these models should be evaluated with respect to aspects of de-risking investments, cost effects for investors, consumers and the state budgets, incentives for system-serving locational and operation incentives of plants, regulatory requirements, European harmonization, interactions with other sectors, etc. To reduce regulatory uncertainty and thus facilitate investment planning for firms, the contours of the reform need to be clarified soon (Bureau et al., 2023).[34] In the broader context, it is important to strengthen the wholesale electricity market as the main instrument for coordinating generation dispatch.

## Secure raw material supplies, strengthen trade agreements and international cooperation

The accelerated expansion of renewable energies and e-car production in the wake of the IRA are likely to further tighten the availability of critical raw materials in the short term. At the same time, the strict domestic content regulations for critical raw materials set incentives to expand North American raw material production. This could create new opportunities for the diversification of European raw material supplies. Vice versa, if US-based companies sharply increase their demand for raw materials from other sourcing countries due to the IRA, it will be important to avoid increasing the dependency on China for critical raw materials. To this end, it could be helpful to deepen the cooperation under the Minerals Security Partnership, an initiative that includes the US, the European Commission, and other developed economies (GCEE, 2022 Box 23). At the same time, incentives to build domestic capacities for raw material extraction and recycling should be strengthened, for instance in the framework of the EU Critical Raw Material Act (GCEE, 2022 paras. 524 et seq.). Finally, the supply of raw materials should be improved through new agreements with raw material producing countries (GCEE, 2022 para. 514 et seq.).

Strengthening international cooperation is of paramount importance for these efforts to be carried out in an orderly and efficient way. Trade agreements can be useful, in particular provisions eliminating export restrictions (and lowering export taxes) for energy and raw material goods, as is the case in recent EU negotiations and agreements, for instance with Mercosur and New Zealand.

Finally, while a complaint to the WTO could be a clear signal that the European Union supports multilateralism, it would likely trigger retaliatory measures, with little chance of success. It would be more efficient to cooperate with the US on rules about subsidies linked to environmental protection, ideally with the goal of deepening trade cooperation and establishing a framework that might be shared with a number of partners.

Such a reaffirmation of international cooperation could take the form of developing a common tool to curb methane emissions globally. The IRA contains a levy on methane emissions to support new methane regulations in the oil and gas sectors whilst the EU aims to reduce methane

[34] *op. cit.*

emissions by 30% under the Methane Action Plan. There is, therefore, scope for cooperation between the two groups, with the goal of harmonizing existing policies.

One strategy put forward by the Peterson Institute for International Economics (2023)[35] is to establish a Methane Border Adjustment Agreement on the oil and gas sectors (amounting to $1,500 per metric ton). The proposed border adjustment charge would be applied to countries that fail to meet the updated methane standards set by the US and the EU in their oil and gas industries. This measure aims to incentivise countries to implement adequate oil and gas regulations to reduce methane emissions, leaving aside the agricultural sector. According to the PIIE, this border adjustment could lead to a substantial reduction in methane emissions from countries exhibiting high methane emissions intensity, and the impact on energy prices in the EU and the US would be negligible.

[35] Kimberly A. C., Garicano L., and Wolfram C. (2023): "How an international agreement on methane emissions can pave the way for enhanced global cooperation on climate change", *Policy brief*, Peterson Institute for International Economics.

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# Appendices

## A.1. Literature review

The literature broadly reaches a consensus regarding the impact of the IRA on both the US and the EU: they would be positive but limited in the case of the USand moderately negative for the EU (while some studies find a slightly positive effect).

### A.1.1 Regarding its effect on the American economy:

Technical-economic or macroeconomic models compare the impact of the IRA to a reference scenario that aggregates various laws and measures implemented up to a specific date, usually early 2021. Assessments of decarbonisation measures alone indicate a predominantly positive, albeit modest, impact on economic activity and employment by 2030. Technical-economic models project an increase in economic activity by 0.6 to 0.9 ppts of GDP. However, studies by Diamond (2022)[36] and Arnon et al. (2022),[37] which take into account all IRA measures (macroeconomic models), including tax increases, estimate a negative impact of approximately -0.1 ppt of GDP. Such macroeconomic models provide a representation of economic interactions between various agents (households, businesses, public administrations) and the rest of the world. These allow to integrate second-order effects.

Technical-economic models project employment to increase by 1 to 1.7 million by 2030 (Foster et al., 2023[38]; Ashmoore et al., 2022[39]; Farbes et al., 2022[40]), accompanied by significant sectoral reallocations (job losses in fossil fuel sectors largely offset by gains in construction and manufacturing industries), excluding the impact of financing measures.

Input-output models such as those by Chakraborty et al. (2022)[41] and Maye and Mazewski (2023)[41] find a positive effect on US employment, with the addition of one million new jobs. Maye and Mazewski find an impact on GDP of +0.7 percentage points.

### A.1.2 Concerning its impact on the EU economy:

According to EU institutions, the effect of the US law will be marginal. The EU parliament indicates that "the effects of IRA are of limited size [;] the EU economy is not expected to go into recession because of the IRA"[43] while the European Investment Bank describes the current investment gap between the EU and the US as lying "far beyond the scope of the IRA".[44] A study from Hertie Schools (2023) similarly finds a limited impact on the European economy, including in the EV manufacturing sector. This can be explained by the fact that European firms had already planned to establish factories in the US before the law and would therefore benefit from these taxes. Regarding cars produced in the EU, exports to the US are already very limited and concentrated in the upper segment of the market, which is ineligible to the IRA. Therefore, most provisions would have a small impact. Additional evidence indicates that the IRA will affect European competitiveness in certain key sectors, especially as subsidies are currently falling in Europe (Copenhagen Economics, 2023).[45] This will be the case in the hydrogen and refined electrofuels sectors, with a possible redirection of investment from Europe to the United States. As a result of the IRA, the costs of producing electricity from renewable energies would be close to or below zero. As a result of the subsidies, the particularly high costs of exporting hydrogen would be covered, and hydrogen produced in the United States could be profitably exported to Europe. This would be even truer for refined electrofuels.

[36] Diamond J. (2022), « Macroeconomic Effects of the Inflation Reduction Act », *Working Paper*, Baker Institute for public policy, Rice University.

[37] Arnon et al. (2022).

[38] Foster D., Maranville A. and Savitz S. F. (2023), « Jobs, Emissions, and Economic Growth. What the Inflation Reduction Act Means for Working Families », Energy Futures Initiative, Policy Paper.

[39] Ashmoore O., Gopal A., Mahajan M., Orvis R. and Rissman J. (2022), « Update inflation reduction act modeling using the energy policy simulator », Energy Innovation Policy and Technology LLC.

[40] Farbes J., Jenkins J., Jones R., Mayfield E., Patankar N., Schivley G. and Xu Q. (2022), « Preliminary Report: The Climate and Energy Impacts of the Inflation Reduction Act of 2022 », Zero Lab, Princeton University.

[41] Chakraborty S., Lala C. and Pollin R. (2022): *Job Creation Estimates Through Proposed Inflation Reduction Act. Modeling Impacts of Climate, Energy, and Environmental Provisions of Bill*, Political Economy Research Institute, University of Massachusetts Amherst.

[42] Maye A. et Mazewski M. (2023), « Economic Impacts of the Inflation Reduction Act's Climate and Energy Provisions », Data for Progress.

[43] European Parliament (2023): "EU's response to the US Inflation Reduction Act (IRA)", In-depth analysis.

[44] Hoyer W. (2023): How to make the IRA work–for the European economy, European Investment Bank.

[45] Copenhagen Economics and Confederation of Swedish Enterprise (2023): The effects of the US Inflation Reduction Act (IRA) on EU competitiveness. Figure 3: Electric vehicle share of new passenger vehicle sales (from Bistline et al., 2023)

## A.2. Construction of tax wedges

The Baqaee-Fahri model is a comprehensive widely used in the field of international trade. To ensure accuracy, the model employs calibration techniques based on data from the World Input-Output Database (WIOD). One notable feature of the model is its incorporation of tax wedges, which introduce a discrepancy between the marginal cost and sales price. These wedges can be externally adjusted through fiscal policies or subsidies.

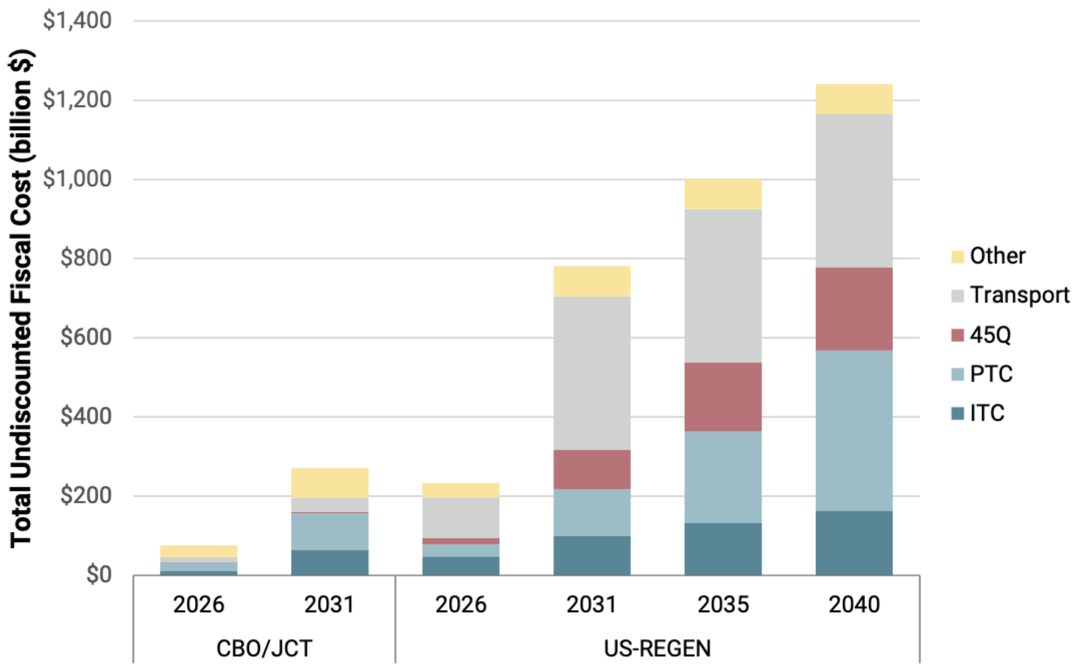
The Baqaee-Fahri model encompasses a total of 41 countries, each comprising 30 sectors and 4 factors. In its baseline calibration, the model assumes the mobility of factors across sectors in the long run. However, for medium-run projections, the model adopts a scenario where each sector and country consists of one non-mobile factor, with a representative firm representing each sector. This setup allows for a more focused analysis of steady-states and is particularly suited for medium-term predictions.

The Baqaee-Fahri model presents researchers and policymakers with a valuable tool for analyzing and exploring different counterfactual scenarios. By manipulating tax wedges within the model, one can examine the potential effects on trade patterns and overall economic outcomes. This model plays a crucial role in shedding light on the complexities of international trade dynamics and enables the generation of informed projections for the medium term.

### A.2.1. Most of the distortive tax credits focus on renewables and electric vehicles

Assessments of the fiscal cost of the US IRA tax credits by 2031 span a large range of estimates, from $271 billion according to the CBO to $780 billion according to Bistline et al. (2023). Yet by 2031, the lion's share of this fiscal expenditure will concentrate on Production and Investment Tax Credits (PTC and ITC) supporting renewable electricity production, and subsidies for electric vehicles through the Passenger clean vehicle tax credit (30D) – corresponding to the 'Transport' wedge in Figure 1 below. Most of the `Other' category relates to the subsidies to electric battery manufacturing provided by the Advanced manufacturing production tax credit (45X).

Figure 1: Estimates of cumulative (undiscounted) fiscal costs from IRA tax credits (from Bistline et al., 2023, fig. 2)




Thus the distortive impacts of the US IRA on trade with the EU can be mostly summarized by estimating the distortion in the production costs of i) renewable electricity ii) electric vehicles and electric battery.

In the Baqaee-Farhi (2022) framework that we use in the assessment, these distortions can be represented as 'wedges' applied to the production costs of each of these items. We examine how to calibrate each of them in the following.

### A.2.2 Calibrating the reduction in renewable electricity production costs

PTC and ITC available to electricity producers aims at lowering the cost of producing carbon-free electricity. To calibrate the resulting impact, we consider their modeled impact on the Lazard's Levelized Cost of Energy (LCOE) of the main renewable electricity generation technologies encompassed in the IRA for the following technologies:

- Lazard's Levelized Cost of Energy+ (April 2023)
    - Solar Photovoltaic
    - Onshore Wind
    - Offshore Wind
    - Geothermal

For the remaining minor renewable electric technologies, we calibrate the wedge by applying the maximum $0.03/kWh subsidy to the baseline production cost calibrated from the following sources:

- Levelized Costs of New Generation Resources from Annual Energy Outlook 2022 (EIA)
    - Conventional Hydroelectric Power
- Renewable Power Generation Costs in 2021 (IRENA, 2022)
    - Wood and Other Biomass
- Landfill Gas Energy Cost Model (US EPA, 2016)
    - Biogenic Municipal Waste

### A.2.3 Energy and electricity mix evolution

The US IRA is implemented at a time when the share of renewables in the US electricity mix is already growing rapidly. Simultaneously, the electrification of several end uses (e.g. residential and commercial heating through heat pumps or electric vehicles) is increasing the share of electricity in the overall energy mix. Further, the provisions of the IRA itself are expected to speed up the penetration of renewable energy sources in the US electricity generation mix.

Electricity production in the sectoral disaggregation of the WIOD database used in Baqaee & Farhi (2022) is embedded in NACE sector D, which combines it with natural gas sales and distribution. To compute the relevant wedge, it is therefore necessary to consider:

- The evolution of the relative shares of electricity and natural gas within sector D
- The evolution of the power generation mix within the electricity sector

To this end, we use the latest US Energy Information Agency's Annual Energy Outlook (AEO 2023). Released in April 2023, the AEO provides a suite of scenarios projection the future evolution of the US energy system. The most relevant for us are:

- The "No IRA" counterfactual scenario that allows us to isolate the sole impact of the reduction in cost of renewable electricity production, without any concomitant change in the energy mix attributable to the IRA

The "High uptake of the IRA" scenario, which provides us with an upper bound on the reduction in electricity costs stemming from the IRA (considering the highest possible penetration of renewables and electrification that could result from its implementation).

To build the wedge on WIOD sector Electricity, Gas and Water Supply, we combine the technology specific wedges above using the following tables from each of the two AEO 2023 scenarios listed above:

- Evolution of the renewable electricity mix
  Generation for each renewable technology from 2022 to 2031 in billion kWh, from Table 16. Renewable Energy Generating Capacity and Generation
- Evolution of the overall electricity mix
  Total Net Electricity Generation by Fuel from 2022 to 2031 in billion kWh, from Table 8. Electricity Supply, Disposition, Prices, and Emissions
- Evolution of the electricity / natural gas split
  Delivered Energy Consumption, All Sectors from 2022 to 2031, from Table 2. Energy Consumption by Sector and Source and Prices per energy carrier (2022 dollars per unit) from 2022 to 2031, from Table 1. Total Energy Supply, Disposition, and Price Summary

We then combine the resulting wedge over time from 2022 to 2031 into a single 10-year wedge by computing an average over the period weighted by the annual value of delivered electricity and natural gas:

Table 1: Wedge on WIOD sector Electricity, Gas and Water Supply

| No IRA energy mix | High uptake of IRA energy mix |
|---|---|
| 0.902 | 0.878 |

### A.2.4 Calibrating the reduction in electric vehicles and battery production costs

Similarly, computing the wedge on electric vehicle and battery manufacturing requires both a technology-specific wedge and a projection of the evolution of the electric vehicle share in new vehicles sales.

The cost of an electric vehicle purchased in the US is reduced by $3,750 to $7,500 depending on whether the vehicle itself and some of its components have been assembled in Northern America (Canada, US, Mexico). In keeping with our strategy to assess the maximum potential distortive impact of the IRA, we focus on the upper end of that band. Further, we choose to model the impact of battery-production related tax breaks through their impact on the cost of electric vehicles.

To that end, we adopt the estimates provided by the International Council on Clean Transportation's January 2023 white paper, Analyzing the impact of the Inflation Reduction Act on electric vehicle uptake in the United States (ICCT, 2023).

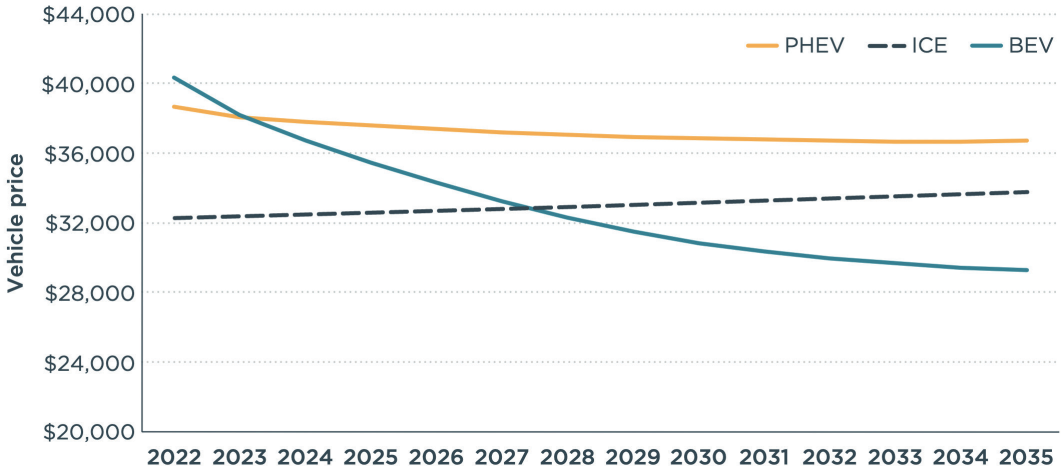
Table 2: Summary of Low, Moderate, and High IRA scenarios and how the incentives are applied to battery electric vehicle prices (from ICCT, 2023)

| IRA provision | | IRA scenario: Low | IRA scenario: Moderate | IRA scenario: High |
|---|---|---|---|---|
| **Passenger clean vehicle tax credit (30D)** | Domestic battery assembly | 100% of new BEVs are eligible for the full $3,750 value | | |
| | Critical minerals sourcing | In 2023, it is assumed that 100% of new BEVs meet the critical minerals sourcing requirements and thus are eligible for the full $3,750.<br>For future years, the share of new vehicles that meet the requirements are as follows: | | |
| | | 76% in 2025<br>56% in 2030<br>55% in 2032 | 79% in 2025<br>72% in 2030<br>78% in 2032 | 82% in 2025<br>89% in 2030<br>100% in 2032 |
| | MSRP eligibility | 87% of new BEVs qualify | | |
| | AGI eligibility | 68% of new BEVs qualify in 2023 and 77% qualify in 2030 | | |
| | Final vehicle assembly | Sufficient North American assembly capacity to meet demand | | |
| | Average 30D incentive value 2023–2032: | **$3,400** | **$5,000** | **$6,150** |
| **Advanced manufacturing production tax credit (45X)** | Value of $45/kWh battery credit passed to consumer, with phase out by 2033 | 0% for all years | 25% in 2023<br>50% in 2024–2029<br>37.5% in 2030<br>25% in 2031<br>12.5% in 2032<br>0% in 2033 | 50% in 2023<br>100% in 2024–2029<br>75% in 2030<br>50% in 2031<br>25% in 2032<br>0% in 2033 |
| | Average 45X incentive value 2023–2032: | **$0** | **$1,450** | **$2,900** |
| **Average incentive value of 30D and 45X combined, 2023-2032:** | | **$3,400** | **$6,450** | **$9,050** |

To calibrate the total tax credit per vehicle, we adopt the high end of their estimated combined impact of the Passenger clean vehicle tax credit (30D) and Advanced manufacturing production tax credit (45X).

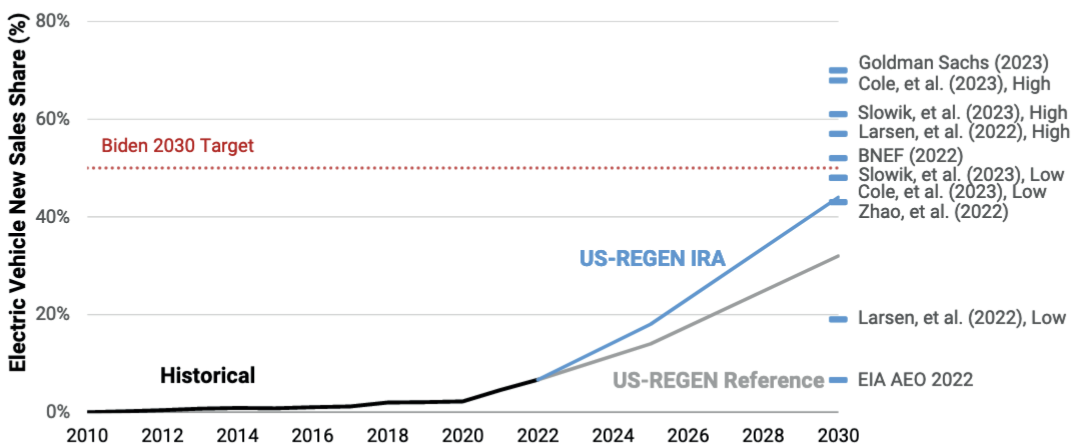
We then need a trajectory for the average purchase price of an electric vehicle over the period 2022-2031. Once more, we adopt the assumptions of ICCT (2023), illustrated in Figure 2.

Figure 2: Sales-weighted average conventional and electric vehicle prices projection (ICCT, 2023)




We finally need a projection for the evolution of the share of electric vehicles in new vehicle sales in the US until 2031. There is considerable disagreement in the literature on that final point. The EIA's AEO 2023 projects a share of 19% under a high IRA uptake, Bistline et al. (2023) project it at 44%, while Goldman Sachs (2023) sees it as high as 70%.

Figure 3: Electric vehicle share of new passenger vehicle sales (from Bistline et al., 2023)




To compute our wedge in the IRA high uptake scenario, we adopt the middle road assumption among the reported estimates in the literature, and assume a share of electric vehicles in new sales growing from 6% in 2022 to 44% in 2031.

Conversely, when considering a share of electric vehicles unaffected by the IRA, we consider the EIA AEO 2023's No IRA scenario value of 17% in 2031.

Taking a weighted average of the annual wedges obtained above, the share of electric vehicles and number of annual vehicle sales (also obtained by the EIA AEO 2023), we obtain the following wedges:

Table 3: Wedge on WIOD sector Transport Equipment

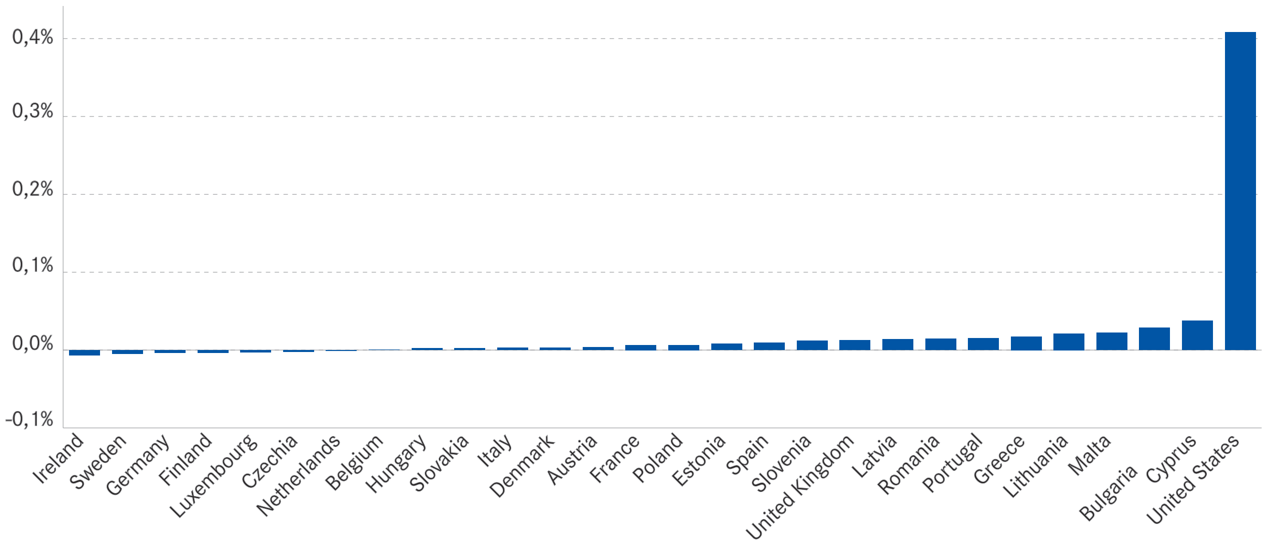
| No IRA electric vehicle share | High uptake of IRA electric vehicle share |
|---|---|
| 0.969 | 0.930 |

## A.3. Sensitivity and robustness

Our calibrations rely on modeling the impact of the IRA as subsidy wedges. This means that the reduction in unit production costs in sectors impacted by the IRA stems from a subsidy, the cost of which is being paid for by a lump sum tax on US taxpayers. In a recent column, Attinasi et al. (2023), using the same model, get estimates of the effect of IRA that are significantly larger. The main point of departure in their simulations is that they assume that IRA subsidies work as a pure trade shock, akin to a net productivity gain. Instead, we account for the fact that these subsidies need to be paid for.

The figure below shows calibration results where instead of modeling IRA provisions as subsidies, we model them as iceberg trade shocks, as in Attinasi et al. (2023). The effects are significantly larger (one order of magnitude larger) than in our baseline calibration, and in line with their estimates. We note however that modeling the IRA as a pure productivity shock obviously magnifies the estimated gains to the US, and is conceptually problematic, as IRA subsidies are not a free lunch, and will have to be paid for one way or another.

Figure 4: Effect of the IRA on real income[a]. Iceberg Costs



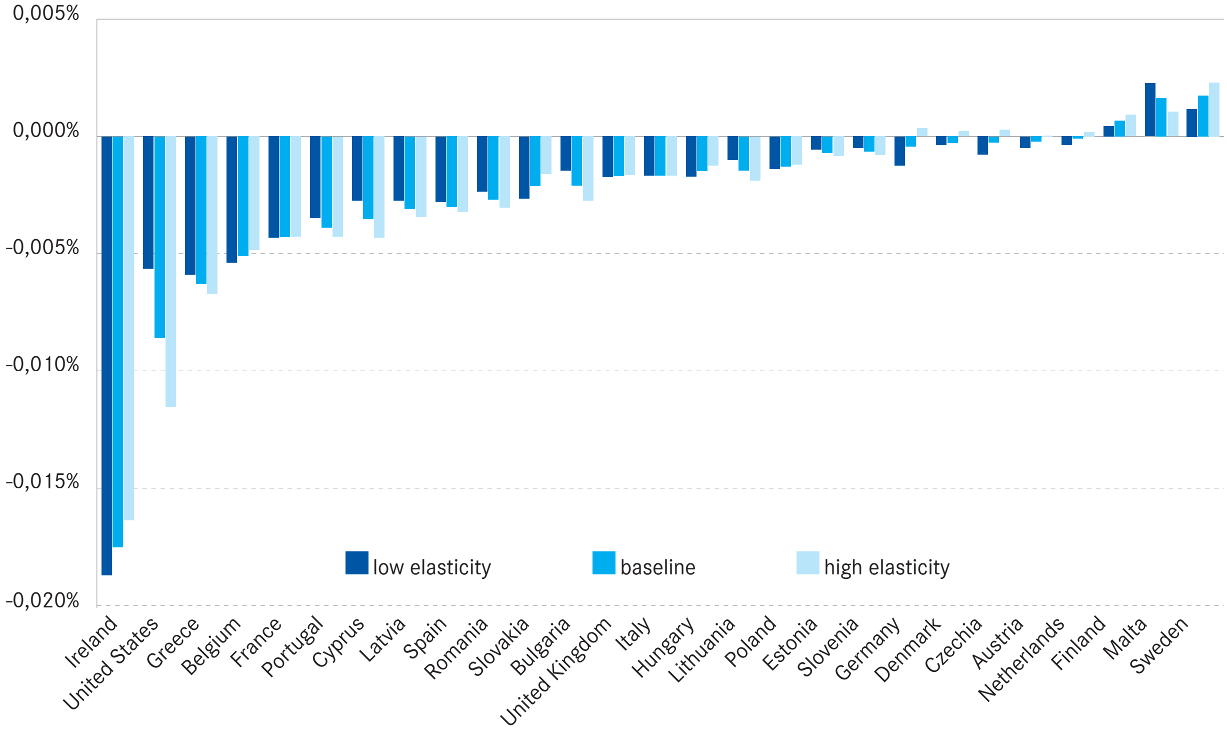

**Source**: CAE and GCEE calculations

[a] Estimated effect of the IRA on real national incomeby country and multi-sector model (Baqaee anf Farhi, 2019)

We also investigated the sensitivity of our estimates to various parameter values, and in particular to the choice of substitution elasticities. In our baseline calibration, we follow Baqaee-Farhi and use the following values: sigma (Consumption) = 0.9, theta (Composite Value-added and Intermediates) = 0.5, epsilon (Intermediate Inputs) = 0.2.

In the figure 5, we show the sensitivity of our estimates to using elasticity parameters that are (i) 20% larger, and (ii) 20% smaller. Results show that estimates are not very sensitive to these assumptions, and that the estimated impact of the IRA remains very small even with significantly larger substitution elasticities.

Figure 5: Effect of the IRA on real income[a]. Tax wedge

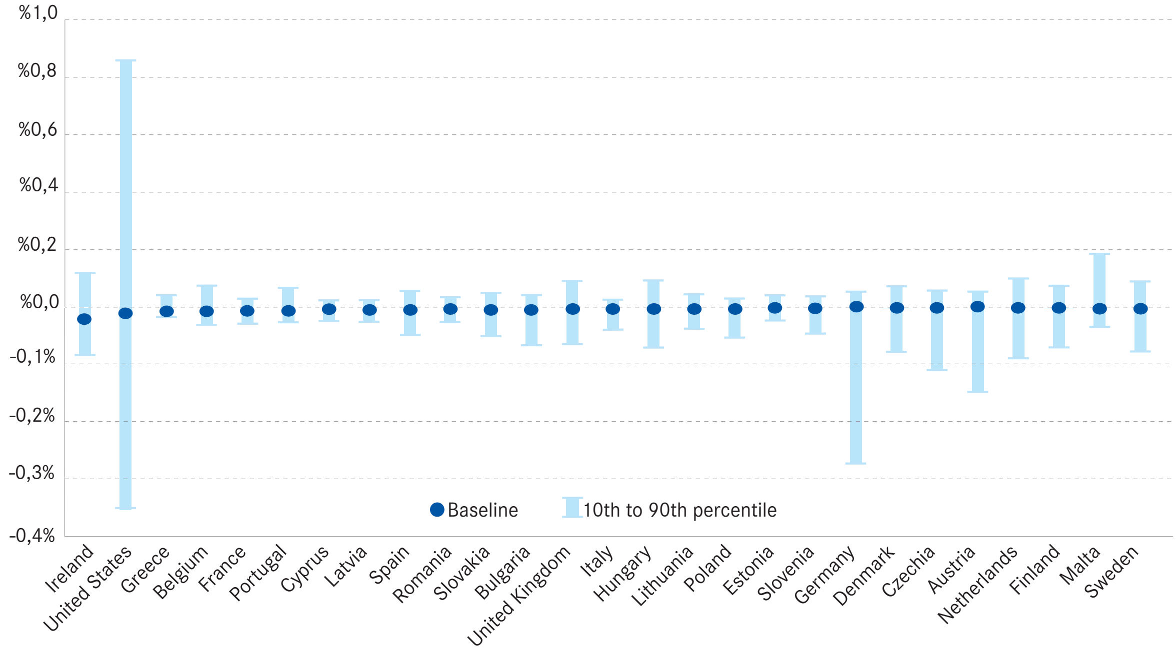



**Source**: CAE and GCEE calculations.

[1] Estimated effect of the IRA on real national incomeby country and multi-sector model (Baqaee anf Farhi, 2019).

We finally explore how heterogeneous the estimated effects are across sectors within country. In the figure 6 we rank, for each country, sectors based on the effect of the IRA on their total output, and report for each country the first and last decile of sectoral effects (where sectors are weighted by their share in total national income). Results show the presence of heterogeneous effects in some countries, like the US, but heterogeneity remains somewhat limited for European countries, with limited effects across almost all sectors.

Figure 6: Effect of the IRA on real income[a]. Taxe wedge-sector heterogenity[b]




**Source**: CAE and GCEE calculations.

[a] Estimated effect of the IRA on real national incomeby country and multi-sector model (Baqaee anf Farhi, 2019).

[b] 10th-90th percentile band of sectoral effects. Sector weighted by their share in total national income.

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