PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

POLICY BRIEF

23-13 Russia's invasion of Ukraine has cemented the European Union's commitment to carbon pricing

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INTRODUCTION

As climate change has risen in urgency in Europe, climate activists determined to dramatically reduce the region's carbon emissions have had to contend with energy security activists who are more worried about access to low-cost energy derived from fossil fuels. Yet in the wake of Russia's invasion of Ukraine in 2022, environmentalists across the region aiming to abandon all fossil fuels as soon as possible have forged a new political alliance with national security hawks seeking to free Europe from dependence on oil and natural gas imported from Russia. This new confluence of objectives has produced a remarkable result: Europe is increasingly on course to meet its ambitious climate goals by 2030 and beyond.

The European Union's decarbonization strategy for the 2020s—based on the entire "kitchen sink" of climate-related policies, regulations, bans, tax breaks, and subsidies being offered for renewable energy, as well as carbon pricing mechanisms—was already being implemented before Vladimir Putin's aggression in Ukraine. But national security priorities are now accelerating Europe's climate agenda, not least through a planned dramatic expansion of market-driven carbon pricing in the EU economy. Despite the energy shock of 2022, the price of EU carbon emissions permits was maintained in the €85 per ton range once Russia's energy blackmail became apparent in late 2021. Perhaps even more striking, the European public has come to accept higher carbon prices in order to address climate change and reduce Europe's dependence on Russia.

As part of its 2023 reforms regarding emissions trading, Europe has committed itself to reducing carbon emissions from power plants and heavy industry by 62 percent by 2030 and also to reducing emissions from road transportation and buildings by 43 percent by 2030. The European Union has diverged from US policies, shifting the onus of decarbonization away from earlier green subsidies and toward carbon pricing. Whereas the United States seeks to meet climate goals

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by regulations,[1] subsidies, and tax breaks embodied in the Inflation Reduction Act (IRA) of 2022, the European Union has emphasized its carbon pricing mechanism under the Emissions Trading System (ETS and soon ETS-2).

These two approaches have deepened trade tensions. Europe is protesting the US IRA subsidies, and since the first implementation of the ETS, Brussels has been threatening to impose carbon border adjustments (similar to tariffs) to protect local producers of certain goods against imports made with unpriced carbon emissions. But because Europe is now within sight of meeting its 2030 climate goals, a period of "competitive transatlantic decarbonization" may be in the offing.

To be sure, the differing climate change policies in the European Union and the United States will require active management from policymakers to avoid trade frictions that threaten cooperation. But if the policies are implemented with sensitivity and care, progress on decarbonization on both sides of the Atlantic can be the foundation for establishing open climate clubs, which would increase economic incentives for the rest of the world to join in reducing their emissions.

This Policy Brief describes how the European Union managed to overcome Russian energy blackmail in 2022 and used the political motivation from this national security crisis to accelerate its decarbonization process. The planned dramatic increase in the scope of carbon pricing in the European Union can herald the total decarbonization of ETS sectors and expand into important new ones. The interplay between the EU carbon border adjustment mechanism (CBAM) and the US IRA may cause transatlantic trade friction, of course. But these two approaches could also offer a path to greater cooperation. Because both the European Union and the United States must implement additional policies to secure their comprehensive decarbonization,[2] a set of forward-looking policy proposals are outlined here.

First, given the scope and economic impact of recently agreed carbon pricing expansion, the European Union should shift toward ensuring timely implementation of emissions trading reforms. The pursuit of additional far-reaching policy measures to reduce EU carbon emissions should only focus on the remaining economic sectors uncovered by carbon pricing. Second, EU governments must reform their electricity market regulation and aggressively invest in a regional electricity grid to facilitate the rapid growth of renewable electricity, while refraining from deploying new taxpayer-funded IRA-like subsidies for renewable energy production.

In addition to these steps, the European Union should actively pursue the formation of "open carbon clubs" with the United States and any other adequately decarbonized producer in relevant traded goods categories. The European Union should also refrain from actively subsidizing or regulating an expeditious reduction of China's role in renewable energy supply chains, as this would jeopardize the European Union's ability to meet its climate goals. The European Union should promote the spread of well-designed cap-and-

1 An important historic hindrance for far-reaching US climate regulation has been the Byrd Amendment, stipulating that only (some) laws with budgetary implications can be passed with a simple Senate majority, whereas other legislation requires support of 60 senators.

2 See Fries (2023) for proposals for a balanced and aligned set of decarbonization policies in the United States and the European Union.

trade systems, as these provide a politically superior mechanism to direct taxation for implementing rapid increases in carbon prices. Finally, the European Union should immediately begin planning for the introduction of "negative carbon emissions permits" issued to entities that actively remove CO_2 from the atmosphere. Negative emissions permits would incentivize development of direct air capture (DAC) technologies and help secure liquid and reliable pricing of CO_2 in the European Union in the coming decades.

OVERCOMING RUSSIAN ENERGY BLACKMAIL

Concerns over reliance on Russian natural gas imports helped EU leaders implement a series of adaptation policies and rapidly expand alternative sources of supply. Consequently, the European Union has now overcome the natural gas price shock started by Russia's intentional failure to refill the natural gas storage facilities it owned across the European Union during the early summer of 2021. EU natural gas prices began to rise from pandemic era lows from August 2021 onwards.[3] When Russia launched its invasion in February 2022, prices rose again to over €100 per megawatt-hour, but it was only Putin's cutting of Nord Stream1 supplies in early June 2022 that sent European gas prices stratospheric, peaking at over €250 per megawatt-hour in late August 2022. This development is illustrated in figure 1 with historical TTF prices in both nominal and real terms.

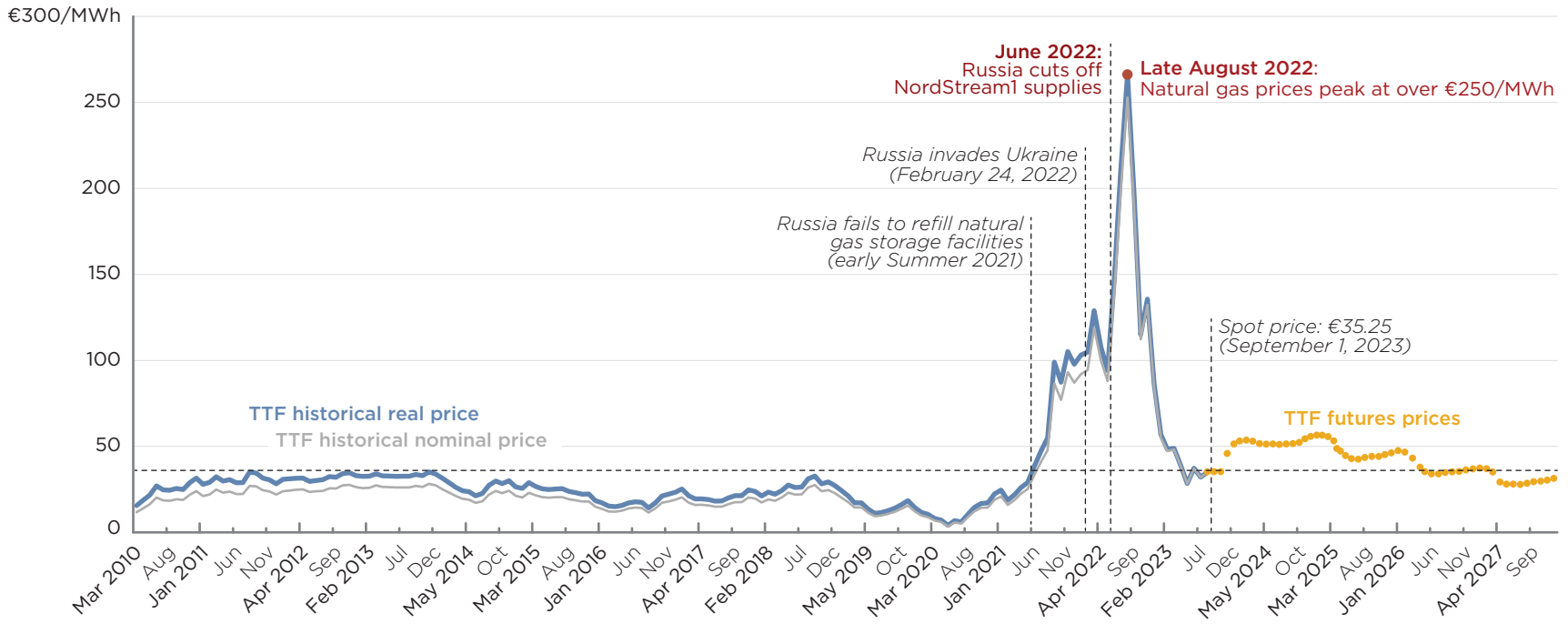
Figure 1 further shows how European natural gas prices dropped precipitously in the fall of 2022 and in early fall of 2023 were around €30 per megawatt-hour. This is in line with real EU LNG prices in most of the prepandemic era of the 2010s. Equally important, figure 1 illustrates how natural gas prices in Europe are not expected by futures market participants to return to levels near those witnessed in 2022. A rise is expected from current lows during the coming winter, but LNG supply in Europe is expected to be adequate to ensure a price in the coming years not dramatically above the (real) historical prepandemic LNG price. Moreover, if recent price declines are sustained in the coming months, it is probable that EU winter 2023-24 gas prices will also decline toward current low spot price levels. This is a remarkable achievement by the European Union, with both obvious energy security and geopolitical implications. Putin can no longer blackmail Europe with energy supplies, as Europe has exchanged most Russian pipeline gas with supplies from other neighboring countries and global LNG supplies, especially from the United States.[4]

3 Prices are taken from the Dutch Title Transfer Facility (TTF) Virtual Trading Point, operated by Gasunie Transport Services (GTS), the natural gas transmission net operator in the Netherlands. The traded liquefied natural gas (LNG) futures prices are available from the Intercontinental Exchange. LNG spot (open next month) contract prices will differ from long-term pipeline gas prices, but do so with a likely relatively stable divergence, and prices in the latter are often regularly reset to reflect movements in the spot price. As such, LNG price changes will also affect long-term pipeline gas contracts. Obviously, since the Russian supply disruption severed many of Europe's largest long-term pipeline contracts, necessitating instead purchases of LNG on a short-term basis after mid-2022, TTF prices at that point became the more valid capture of the marginal price of natural gas in Europe.

4 Europe continues to import pipeline gas from Russia at levels of about 450 million cubic meters per week through the Ukraine Transit and Turkstream pipelines, or levels at approximately 20 percent of the prewar period. Russia has similarly been the origin of about 20 percent of the European Union's LNG imports since late 2022. Data from Bruegel are available at https://www.bruegel.org/dataset/european-natural-gas-imports.

Figure 1

Dutch TTF next month historical prices, March 2010–July 2023, and futures contracts, October 2023–December 2027



Notes: Real Title Transfer Facility (TTF) prices deflated by the Harmonized Index of Consumer Prices of the euro area (August 2023 = 100). September 1, 2023 = latest available price data.

Sources: Eurostat; Intercontinental Exchange, Data for TTF Natural Gas; and Intercontinental Exchange via www.barchart.com.

An important aggravating factor in the 2022 EU energy price shock came from the power sector, as reactor maintenance problems affected the French nuclear power sector and drought triggered declines, especially in Southern European hydropower production. This caused natural gas-based power production to play a more prominent role as a marginal power price setter,[5] dragging European power prices dramatically upwards, with natural gas prices spiking over the summer of 2022.[6] European wholesale power prices have also since declined to below February 24, 2022 levels, and futures pricing does not indicate an elevated risk of future price spikes. This likely reflects the gradually improving nuclear power supply from France, and expectations of normalizing (i.e., less severe drought conditions) weather in Southern Europe. Early 2023 weather indicators, however, suggest that European rain patterns may not be normalizing in 2023.[7] Today climate change itself, rather than Russian aggression, poses a long-term threat to the European Union's power supply.

The year following Russia's invasion witnessed significant changes to the European Union's power supply, as commonly agreed measures to conserve electric energy have had a positive effect. Figure 2 highlights the shift in sourcing of EU power from March 2021 to February 2023.[8]

The European Union managed to reduce its overall power demand by 4.2 percent, or 113 terawatt hours (TWh), during the 12 months following Russia's invasion, more or less making up for the 17.4 percent decline in EU nuclear production from the temporary disruptions in France and Germany's counterproductive decision to proceed with a complete permanent phaseout of nuclear power. Supply of solar, wind, and other renewables increased by 5.6 percent, or just below 40 TWh, countering the similarly sized decline in EU hydropower production. Finally, an additional 5.3 percent coal-fired power production more than matched the roughly 15 TWh drop in power production from gas and other fossil fuel sources in the European Union.

The transformation of the European Union's power supply is therefore still a work in progress and has since the Russian invasion been mostly characterized as "running to stand still." In the 12 months after the invasion, the European

5 Electricity grids must balance at all times and EU power prices are set at the margin, meaning that the cheapest sources of power are accessed first and the price for all is set by the cost of the last required unit of electricity to balance the grid. This system enables cheaper producers of power to reap large profits, if the marginal source of power—in 2022-23, generally gas-fired power plants in the European Union—rise dramatically in cost.

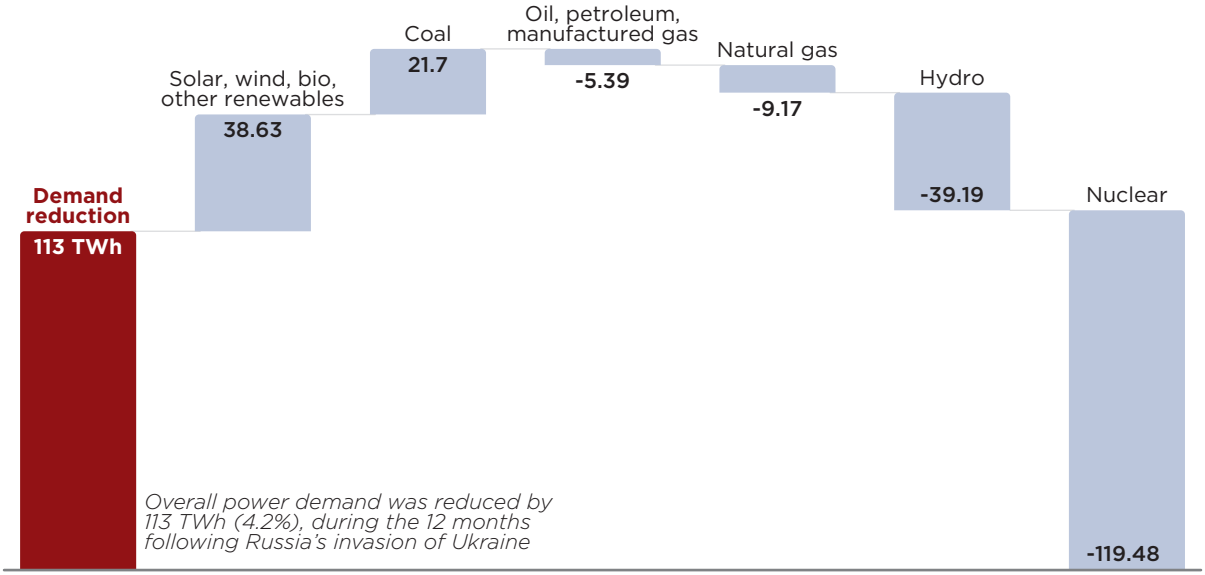
6 Daily average wholesale prices, sourced from ENTSO-e, show how prices in the three largest EU power markets—Germany, France, and Italy—peaked at over €700 per megawatt-hour in late August 2022, before falling back to near prewar levels in Germany and France below €100 per megawatt-hour by the spring of 2023. Prices in Italy remain elevated, at over €100 per megawatt-hour. All data reproduced from Ember, available at https://ember-climate.org/data-catalogue/european-wholesale-electricity-price-data/.

7 In 2022 France became a net energy importer for the first time in decades due to the shortfall in nuclear and hydropower production and the need to import power from the rest of Europe. Hydro stocks in France are high in 2023, but risks for the second half of the year remain. See Réseau de Transport d'Électricité, https://www.services-rte.com/en/view-data-published-by-rte/hydraulic-stock.html.

8 Monthly power production data summed for the annual comparison from Ember's Electricity Data Explorer, available at https://ember-climate.org/data/data-tools/data-explorer/. Data extracted on September 1, 2023. No monthly data are available for EU electricity exports, so estimating the change in demand assumes fixed EU net electricity exports over the two time periods.

Union replaced approximately 160 TWh of non-CO_2 emitting nuclear and hydropower production with new renewables production and reduction in power demand. Coal did add a little to EU electricity supply, though its rise was largely accounted for by declines in other fossil fuel-based sources of power.

Figure 2
EU power supply by source, March 2021–February 2022 vs. March 2022–February 2023



Source: Ember Electricity Data Explorer, https://ember-climate.org/data/data-tools/data-explorer/.

ACCELERATING CARBON PRICING IN THE EUROPEAN UNION

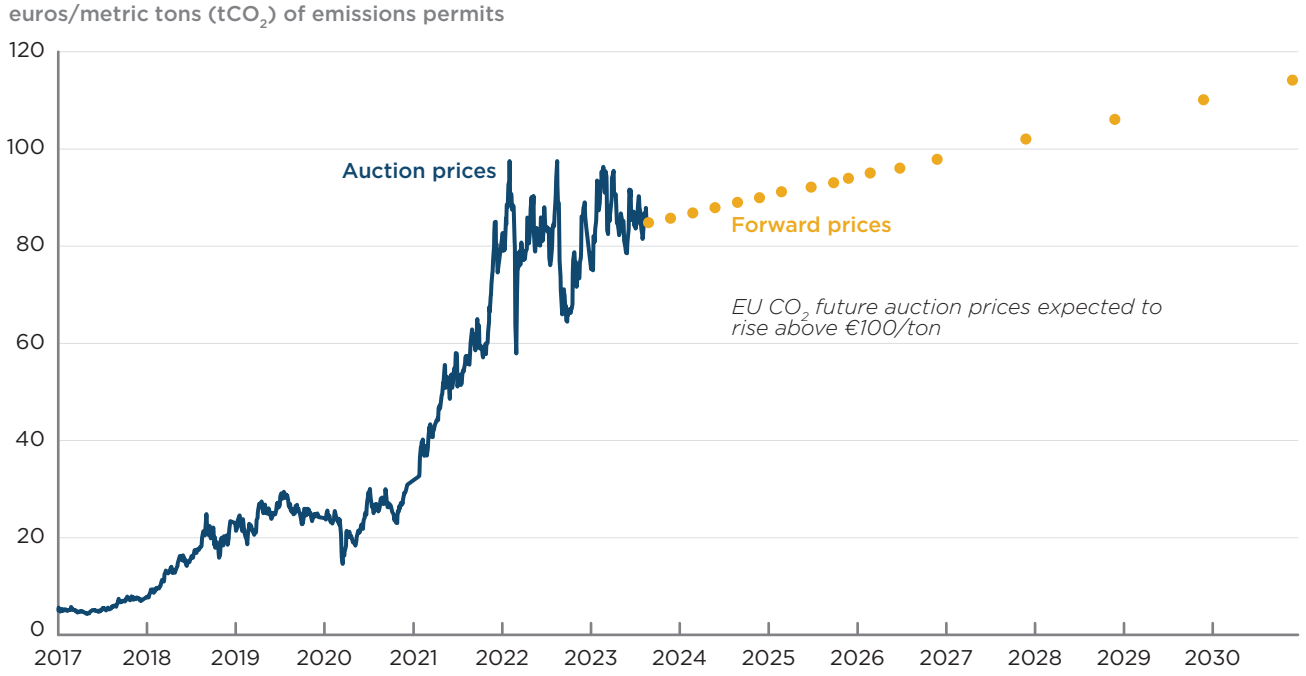
Of far more importance, however, is the crucial political push the national security risks revealed by relying on Russian fossil fuels have given the implementation of carbon pricing across the EU economy. EU CO_2 emission auction prices (EU T3PA contract) have since early 2022 been hovering between €80 and €100, and are, according to futures markets, expected to rise above €100 per ton during the next three to four years (figure 3).

ETS reforms[9] proposed by the European Commission in 2021 and the firm European political commitment[10] to decarbonization affirmed during the stressful pandemic period underlined the EU commitment to carbon pricing. Now further strengthened by the urgent political need to exit Russian fossil fuels, carbon market participants have become increasingly convinced about the future

9 Here in particular, the suggested higher annual decline in available emissions allowances (falling at 4.3 percent per year after 2023 and at 4.4 percent from 2028) and the strengthening of the ETS Market Stability Reserve (MSR) with 24 percent of allowances in circulation transferred, has seemingly had an important effect on prices.

10 It is noteworthy and perhaps indicative of a degree of global carbon market interconnectedness and/or shared political concerns of climate change that the price of California's carbon permits roughly doubled from around $15 per ton in early 2021 to over $30 per ton (and well above the minimum auction reserve price) by mid-2022. See data from the California Air Resources Board, available at https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/program-data/cap-and-trade-program-data-dashboard#Figure7.

Figure 3
Historical auction prices (T3PA contract) and futures prices for EU ETS CO_2 emissions permits, January 2017–December 2030



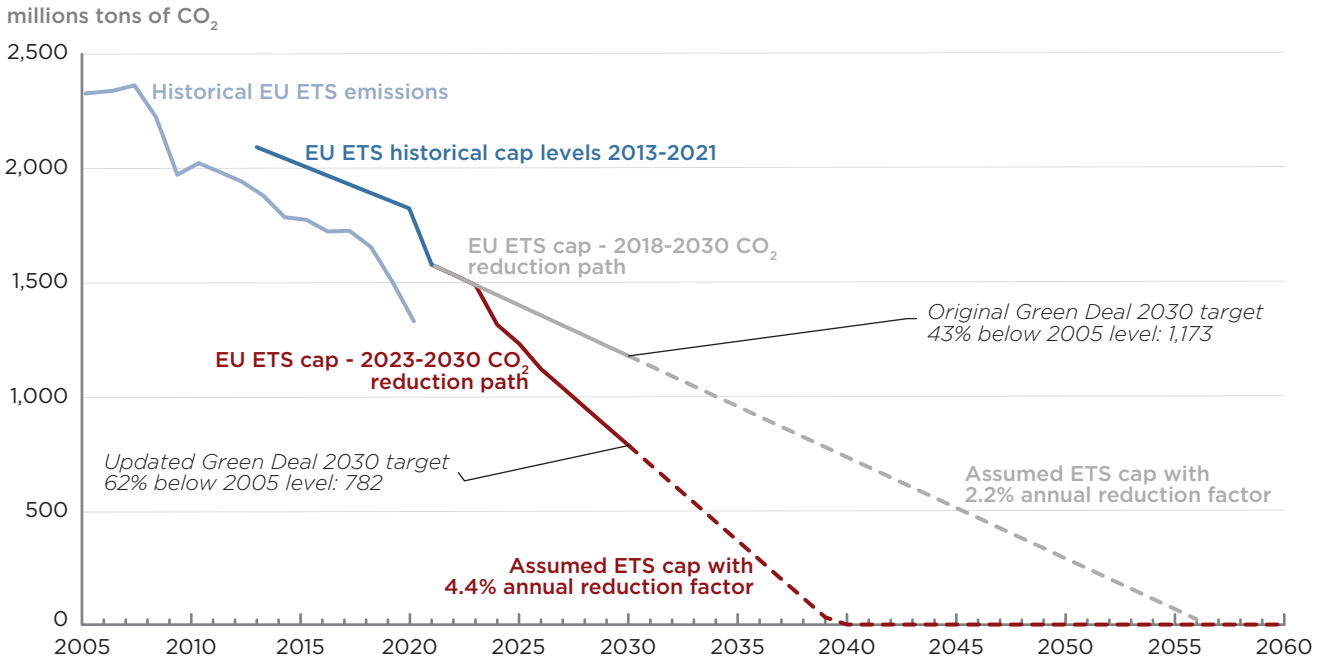
Note: Last auction price data from August 31, 2023. Futures settlement prices from August 31, 2023.
Source: European Energy Exchange, https://www.eex.com/en/market-data/environmentals/eu-ets-auctions.

relative scarcity of CO_2 emissions allowances in the European Union.[11] Increased certainty regarding future emissions scarcity incentivizes physical CO_2 emitters (as well as financial market participants in EU carbon markets seeking to exploit market movements) to purchase more emission credits today and "bank them" for use in future periods. Carbon market pricing therefore brings the economic effects of expected future emissions shortage into the present via higher CO_2 prices today. Current and future market pricing makes it clear that carbon prices in Europe are, absent entirely new developments, unlikely to fall for the foreseeable future. Recent German government proposals to, under certain circumstances, subsidize the cost of electricity for energy-intensive industries underlines the same point.[12] Figure 4 highlights the significant reduction in ETS emissions permits during the 2020s, finally agreed by EU leaders in early 2023 (Council of the European Union 2023).

11 The dramatic increase in natural gas prices starting in late 2021 would also have led to expectations of fuel switching to more coal-fired electricity production from ETS-included stationary facilities, with a corresponding need to purchase more CO_2 emissions permits than similar capacity gas-fired facilities.

12 The German Ministry of Economics proposed subsidizing up to 80 percent of the electricity costs for energy-intensive industries until 2030 to help them overcome the energy cost shock of temporarily higher electricity prices from higher natural gas prices and accelerated decarbonization in Germany after Russia's invasion. This proposal is controversial in Germany and may run afoul of EU state aid rules. See Laura Pitel, Guy Chazan, and Patricia Nilsson, "Germany Plans to Subsidise Power-Hungry Industries," *Financial Times*, May 5, 2023.

Figure 4
EU ETS emissions and ETS caps, 2005–60



ETS = Emissions Trading System

Sources: European Environmental Agency; Eurostat.

EU leaders agreed to increase the targeted ETS emissions reduction in 2030 from 43 percent to 62 percent below 2005 emissions and to do so principally via a roughly doubling of the annual linear reduction factor from 2.2 percent to, by 2024, 4.3 to 4.4 percent per year.[13] Figure 4 illustrates the steepening of the EU emissions reduction path in the 2023 ETS reforms. The updated emissions reduction path implies a decline in EU emissions during the 2020s comparable to the drop witnessed during the first and second wave COVID-19 lockdowns in 2020.[14] Figure 4[15] further shows that if one assumes—as this must be the political base case—that the linear reduction in emissions permits is also continued after

13 In order to reach the 62 percent target by 2030, EU legislators also agreed to one-off emission cap reductions of 90 million tons of CO_2 in 2024 and 27 million in 2026. The linear reduction factor will be 4.3 percent from 2024-27 and 4.4 percent from 2028-30. See revised Article 9 in European Parliament and European Council (2023).

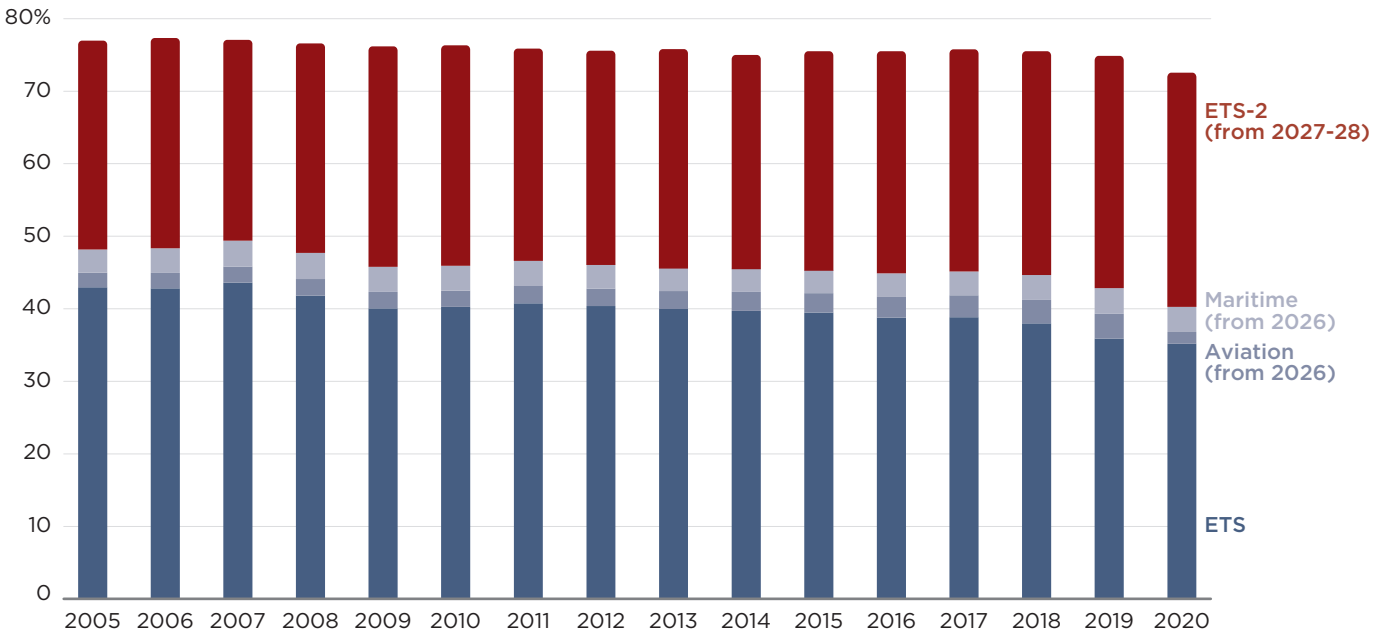
14 The steep decline in the emissions cap (gray line) from 2020-21 is the adjustment made to reflect Brexit and the departure of the United Kingdom (excluding Northern Ireland) from the ETS.

15 Figure 4 is constructed with the legislated emissions reductions—43 percent and 62 percent, respectively, from 2005 verified emissions from stationary installations from the EU27 of 2,059 million tons (note that future EU27 targets can only be estimated using EU27 historical emissions)—in 2030 as the anchor point. A linear reduction factor (LRF) estimated from the 2021 annual cap of 1,572 million tons (European Commission 2022) to the target reduction of 43 percent of 2005 levels comes out at 2.149 percent, or 44.2 million tons annually of CO_2. However, if the same methodology is used for the 2023 reformed emissions path, the implied LRF from 2023 levels to a 62 percent reduction by 2030 is only 4.05 percent, or 83.4 million tons annually. This is at odds with the legislated targets of 4.3 and 4.4 percent annually. There is no obvious way to reconcile this discrepancy, so figure 4 is estimated using the implied 4.05 percent LFR.

2030, then EU ETS permits drop to zero by 2040 (rather than previously by 2057), or, in other words, well within the lifetime of most stationary facilities in electricity production and manufacturing covered by the ETS. The incentive to hoard ETS emissions permits today is clear, as is the need for ETS-included facilities to quickly initiate their decarbonization processes.[16]

International focus has often been on the European Union's move to also include international aviation (2 percent of 2021 EU emissions) and maritime sectors (3.5 percent of 2021 emissions) in the ETS, due to the extraterritoriality of carbon pricing in these sectors. Of far more political and climate importance, however, is the European Union's decision to establish a new "ETS-2" system to put a price on carbon emissions from also fossil fuel combustion in road transportation, and commercial, institutional and residential buildings by the late 2020s.[17] In other words, European cars, homes, and workplaces will soon be covered by EU carbon pricing too. Figure 5 shows the share of EU historical emissions since 2005 that will from the late 2020s be covered by an EU emissions cap as part of the ETS and ETS-2 schemes.

Figure 5
Share of total EU emissions covered by future EU carbon pricing, 2005–20



ETS = Emissions Trading System

Note: Excluding land use, land-use change, and forestry/memo items; including international transport.

Sources: European Environment Agency; Eurostat data series ENV_AIR_GGE.

16 Ember (2023) shows how the most recent EU government clean (renewables + nuclear) electricity production targets for 2030 have risen from 74 percent in 2019 to 83 percent today, including 100 percent in four member states. These targets may well be exceeded by events.

17 In addition to these three main sectoral categories, ETS-2 will also cover some emissions from manufacturing sectors not included in the original ETS. The precise scope of the "SME inclusion" in ETS-2 is not yet finalized, so is not included here. See European Parliament and European Council (2023).

While the share of EU emissions covered by carbon pricing is likely to fall by the late 2020s as emissions under the existing ETS program fall fast (and emissions in, say, agriculture, which is not covered by carbon pricing, fall much less), figure 5 illustrates that especially with ETS-2, the vast majority of total EU emissions will soon be priced. ETS-2 will be levied at the distributors that supply fuel to EU buildings and road transport (and additionally included sectors) from 2027 to 2028 (delayed if energy prices remain high), meaning individual households or small and medium-sized enterprises (SMEs) will not be directly affected. Crucially, as households, commercial buildings, and road transportation are not subject to international competition, no free emissions permits will be allocated in ETS-2. Instead, a "Social Climate Fund" of up to €65 billion (financed largely by auctioning carbon emissions permits) will be implemented to help affected vulnerable households, microenterprises, and commuting transportation users manage the price impacts of ETS-2. Unlike in the ETS, where emergency measures to limit excessive price increases are (presumably deliberately) weak,[18] prices in the more politically sensitive ETS-2 system will initially de facto be capped at €45 per ton through the release of additional emissions certificates, should prices exceed this level for a period of two consecutive months.[19] While the ETS-2 system is hence designed to somewhat cushion the price impact on EU populations, €45 per ton is a significant relative price effect, large enough to affect consumer behavior, and a level only reached in the regular ETS by April 2021.[20]

EU legislators set a target for a 43 percent reduction (from 2005 levels) by 2030 in ETS-2 sectors, and while the specific starting time and precise linear reduction factor remains to be determined, a range of 5.10-5.38 percent per year (amounting to an annual reduction of roughly 46 million tons of CO_2) is prescribed in the legal text (see Council of the European Union 2023, 42).[21] Given the political sensitivity of these sectors and their limited emissions reductions witnessed from 2005 to 2021, this is an ambitious target. Figure 6 illustrates how a material break in EU emissions in the covered sectors—characterized by relatively stable emissions from 2005 to 2021—will be needed to reach this goal.

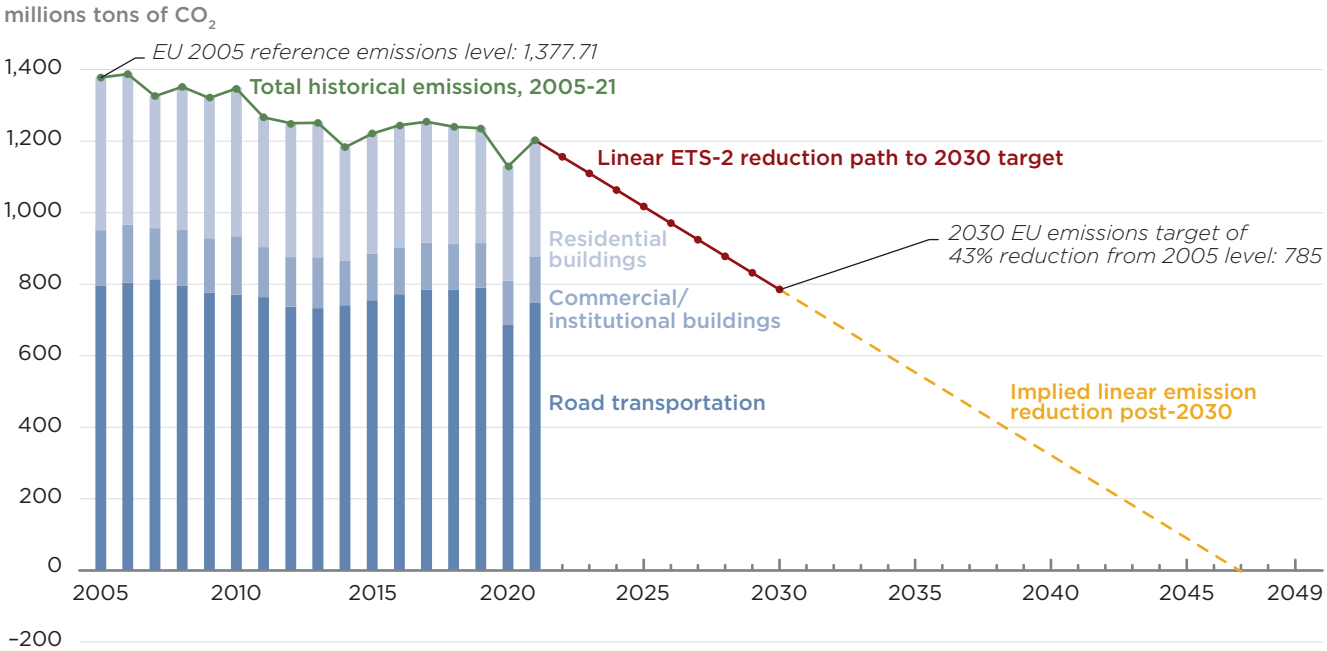
18 No explicit provisions for a price cap or binding price movement limitation exists in the ETS, which instead relies on a Market Stability Reserve (MSR) to which excess emissions certificates are transferred to maintain a degree of price stability. However, with the newly decided increase in the transfer of excess certificates to 24 percent of the amount above a certain threshold, the MSR will increase in size. This will in turn see more of the permits transferred to the MSR canceled, as the MSR cannot exceed 400 million certificates, and the number of available emission certificates will ultimately be reduced in the longer term (increasing the incentive to bank emissions permits today).

19 European Parliament and European Council (2023a) amended article 30h.2. The operation of the automatic release of new permits to maintain prices below €45 per ton will be assessed by the European Commission in 2029.

20 Conceptually, an ETS-2 price capped at €45 per ton begins to share some similarities with a carbon tax, as the permissible financial burden is determined by the legislative process rather than market forces.

21 Figure 6 is an estimate, like figure 4, anchored in the prescribed 2030 target emissions reductions over 2005 levels. This implies an ETS-2 target of 785 million tons, implying an LRF of only 4.8 percent, or roughly 46 million tons, necessary to reach the target. The same estimated LRF is used to project the ETS-2 levels beyond 2030.

Figure 6
Historical emissions in road transportation and buildings in ETS-2 and future legislated emissions reduction path



ETS = Emissions Trading System
Source: European Environment Agency; Eurostat.

The principal means through which road transportation emissions will be reduced is the switch to electric vehicles (EV) across Europe—a trend already heavily incentivized by numerous national and EU support schemes, the automotive industry, and the European Union's legal commitment to ending the production of internal combustion engine (ICE) vehicles by 2035, as well as the approaching decline of total ownership costs for EVs to (at current road fuel levels) below that of ICE-powered vehicles. On top of these powerful forces, ETS-2 is a further incentive to accelerate the switch to EVs, estimated to reach over 70 percent of new sales by 2030 (ACEA 2022). This is also the case in buildings, where ETS-2 will financially incentivize the already quickening pace—3 million in 2022 alone[22]—of heat pump installations across the European Union. ETS-2 will thereby complement the regulatory bans on fossil fuel heating systems in new and existing buildings currently being adopted by many EU member states.[23]

THE EU CBAM, THE US IRA, AND TRANSATLANTIC TRADE

Given the rapidly increasing reliance on carbon pricing in the European Union and the increase in CO_2 prices, protection against carbon leakage has become politically imperative. The roll-out of the EU CBAM scheme has been an integral part of the 2023 ETS reforms. European legislators wanted on the one hand to

22 EHPA (2023a) shows record sales of 3 million heat pumps in the European Union in 2022.
23 EHPA (2023b) shows details for most EU members.

"level the carbon playing field" facing ETS, including European producers, while at the same time end the erstwhile practice of simply granting free emissions permits to shield local producers to incentivize them to reduce emissions. The first CBAM phase starting in October 2023 (on a reporting basis) consists of the cement, aluminum, fertilizer, electric energy production, hydrogen, and iron and steel sectors; it now also covers indirect emissions[24] and is envisioned to expand to other sectors in the future. Initially, EU producers in these six sectors will continue to benefit from free emissions allowances, but these will be phased out at an accelerated pace from 2026 to 2034.[25] Only importers of goods with a CO_2 content above the de minimis ETS inclusion threshold will be included.[26]

Given how CBAM is intended to levy a carbon-based tariff on imported goods simplistically determined by their carbon content and the ETS price, high ETS prices will mean a high tariff on imported goods. To maintain a level playing field (and presumably World Trade Organization compliance) during the transition period, imported goods will only be subject to CBAM for the proportion of emissions not subject to free allocation to EU-based producers. Foreign exporters to the European Union already subject to a carbon price at home will also be able to subtract such domestic carbon costs from the EU CBAM levy.

The legal and political resilience of the EU CBAM remains to be tested after October 2023, but given the emphasis on carbon pricing in the European Union's overall decarbonization strategy, it will be politically impossible for the European Union to materially reduce the CBAM's expanding economic and trade effects. This will raise the European Union's risk of carbon-based trade wars with its economic partners, not least the United States, which at the federal level appears unlikely to implement a carbon price.[27] For relevant US exports to not be affected by the EU CBAM, Brussels will have to find a reason to declare US products subject to "climate regulations of comparable ambition" (i.e., paying a similar shadow carbon price) as the EU carbon price. Given the European Union's current dependence on US LNG exports and military support to Ukraine, it is evident that EU officials will strive to avoid risking Congressional wrath by levying CBAM tariffs on US exports. Bown (2023) highlights the relatively high degree of policy innovation present to attempt to defuse the politically charged confrontation over access to IRA subsidies for European-made EVs.

Hence, transatlantic optimists would conclude that it should be feasible for the European Union to find a way to declare that US decarbonization efforts are of "similar ambition" in terms of fighting climate change as its own. However, the challenges associated with finding collaborative outcomes from diverging decarbonization policies should not be underestimated. Clausing

24 Indirect emissions refer to those related to transportation of the goods in question and other activities carried out in relation to their export to the European Union by entities other than the exporter itself. See Commission (2023d) for details of how indirect (embedded) emissions are estimated.

25 Free permits equal 97.5 percent in 2026, 95 percent in 2027, 90 percent in 2028, 77.5 percent in 2029, 51.5 percent in 2030, 39 percent in 2031, 26.5 percent in 2032, and 14 percent in 2033. From 2034, no CBAM-free permits will be granted.

26 Imports that fall outside the usual EU thresholds for inclusion in customs duty treatment are also not subject to CBAM.

27 US state-level initiatives are led by California, whose carbon price has since 2021 hovered between $25 and $30 per ton.

and Wolfram (2023) illustrate the challenges in an international trading system with countries implementing climate policies with high and low ambitions and utilizing cost-imposing (EU carbon pricing) and cost-abating (US IRA subsidies) policy strategies. Free-riding opportunities in low climate ambition jurisdictions are self-evident, but across the Atlantic, it is rather the competitive risks facing firms in cost-imposing rather than cost-abating high climate ambition economies. Clausing and Wolfram (2023) discuss how this can generate "subsidy wars," which, due to the positive externalities of clean energy, may be globally advantageous. Ultimately, a combination of carbon clubs and the CBAM may plausibly overcome transatlantic carbon-based trade friction. Such an outcome may, however, require that the US federal government, perhaps due to future rising fiscal constraints, voluntarily chooses to reduce the availability of cost-abating IRA subsidies for US-based green production. At a minimum, transatlantic carbon trade friction will require constant top-level political management to avoid causing potentially wider damage to economic and political relations.

Congressional passage in August 2022 of the IRA marked the first major federal government climate change bill enacted. The IRA contains a host of dramatic shifts in American climate and tax policies, and will, apart from lowering US CO_2 emissions by 29 percent to 42 percent of 2005 levels,[28] have a large impact on especially US power production, industrial processes, advanced "green manufacturing," and transportation sectors.

The IRA is often described as having a price tag of $391 billion over the decade to 2032. However, this number is an estimate from the Congressional Budget Office (CBO) following a series of specific "budget scoring rules" included in the Congressional legislative process in CBO (2022). Importantly, Congressional budget scores are often carried out under extreme time pressure, leading to potentially large uncertainties about the ultimate fiscal effects of particularly the type of tax credits the IRA bestows upon the US "green economy." The IRA legislates uncapped tax credits for investing in or producing specified green goods and services, and as such, the cost of the IRA depends on the private sector's uptake of these incentives.[29] Similarly, IRA production tax credits in the renewable energy sector are facility-specific, so that, for instance, a wind farm built in 2032 under the IRA will continue to receive IRA production tax credits for the lifetime of the facility well beyond 2032. At the same time, the US Congress has been reluctant to allow sunsetting tax credits to expire, due to the political risk of being accused of "raising taxes." Other research reports, such as Della Vigna et al. (2023), consequently estimate that the true fiscal costs of the IRA could reach $1.2 trillion, or more than three times the CBO's estimate,

28 See Larsen et al. (2022) and King et al. (2023) for in-depth assessments of the emissions impact of the IRA.

29 An important technical discussion concerning the accounting treatment of transferable IRA tax credits under the OECD/G20 Base Erosion and Profit Shifting Global Corporate Tax Reform remains unsettled. At stake is whether multinational firms can use IRA tax credits to potentially reduce their tax liabilities below the OECD/G20 reform's dictated minimum of 15 percent. Granting the tax accounting treatment option to get below 15 percent would self-evidently positively affect the private sector's interest in investing in IRA-compatible projects and boost relevant green investments in the United States.

once realistic private sector investment plans are incorporated into the analysis.[30] The IRA is hence likely to be far more transformative for the US economy and decarbonization than the CBO cost would suggest.

The IRA will ensure that US power production will be rapidly decarbonized through several channels. Transferable (i.e., companies can sell them on to other businesses, once their tax bill reaches zero) clean production and investment tax credits will spur new renewable power production capacity, production tax credits will keep existing nuclear power profitable well beyond 2030, and they will help lower the development costs of new carbon capture technologies to potentially retrofit existing fossil-fuel based power production capacity. Up to 80 percent of US power production may now be clean generation by 2030, putting the United States in line to reach President Joseph R. Biden, Jr.'s goal of 100 percent clean US power production by 2035 (Larsen et al. 2022, 4-5). Completely decarbonized US power production within a decade would be in line with the most aggressive EU renewables power production targets, and greatly facilitate continued transatlantic trade unimpeded by the effects of even a wide-ranging EU CBAM.

The IRA provides transferable carbon capture tax credits for US green industrial production across a range of industries, including ethanol, ammonia, hydrogen, cement, and iron and steel production, as well as oil and gas refining. Combined with funding for domestic industrial conversion (i.e., electrification) grants and subsidies for the development of industrial-scale direct air capture of CO_2, the IRA is expected to promote the decarbonization and electrification of sizable parts of US-based heavy industry, as well as help promote transferable innovations toward these goals. Like with the acceleration of clean US power production, decarbonizing US industry in many of the same sectors that are part of the early CBAM design through the IRA will increase the chances that the European Union and United States can avoid a carbon-based trade war in the future. Allowing for the full private sector IRA incentives to successfully decarbonize US electricity supply and manufacturing to take effect, it becomes politically realistic that the European Union within relatively few years will be able to politically declare relevant US exports "sufficiently decarbonized" to match the price effects of the EU ETS and avoid CBAM tariffs. Given that the EU CBAM begins to take effect in 2026, speed of US decarbonization will be imperative for the European Union to take this decision.

In addition to the IRA, the US Senate is currently debating a proposal for a foreign pollution fee (FPF).[31] If adopted, this bill would levy a fee on foreign energy and heavy manufacturing imports to the United States if the embodied pollution (noticeably CO_2 emissions) in the product exceeds 110 percent of the comparable US-made product. No fee would apply to domestically produced energy, goods, or US exports, or imports from US partner countries. As the FPF relies on national averages for production pollution intensity, it would invariably and by explicit political intent target Chinese imports, as individual best practice facilities will not be eligible.[32] At the same time, however, given the rapid

30 See also Jiang et al. (2022).

31 Office of Senator Bill Cassidy, Draft of Foreign Pollution Fee Act of 2023 (FPFA).

32 The FPFA allows for facility-specific exemptions in nonpartner countries only in market economies and if US government officials can perform spot inspections on the facility. Neither applies to China.

decarbonization required of ETS-participating EU-based manufacturing facilities, very few if any EU exports to the United States would be affected. As at least the early version of the EU CBAM and the FPF cover several of the same traded goods categories, it seems not entirely implausible that these two carbon-based trade tools form the basis of a future "transatlantic carbon club" in relevant industrial goods between the European Union and the United States. Even a "carbon club" with common external penalties for low climate ambition third countries will not, however, overcome the competitiveness problem associated with EU members of the club relying on cost-increasing carbon prices, while US producers remain subsidized. As noted above and in Clausing and Wolfram (2023), it may take a future Congressional fiscal rethink of the full extent of the IRA's subsidies and replacement with other federal government climate policies to launch a successful transatlantic carbon club.

Overall, the IRA's "carrot-based" subsidies-driven decarbonization strategy and the proposed FPF are explicitly aimed at promoting domestic production, and rapidly decrease US dependency on China in the green economy. This political economy choice is perhaps not too surprising for an economy which in 2022 had a $1.2 trillion goods trade deficit with the rest of the world, in which the historic post-World War II general consensus for free trade has frayed in the last decades, and which currently sees itself in direct global competition with China. The European Union—in addition to its own extensive green public subsidies—with carbon pricing has a very powerful "stick-based" incentive to drive its own decarbonization process. Fears that the IRA will lead to actual relocation of EU green industries to the United States are hence exaggerated, as are concerns that aggregate future private investments in the European Union's green transition will materially drop from being reoriented to the United States to benefit from IRA subsidies. Individual EU firms—typically large firms with significant political heft—may threaten to shift specific future green investments to the United States, but in doing so they would be abandoning profitable (due to the price of carbon emissions) investment opportunities in the European Union certain to be picked up by other European firms, and the impact on aggregate private EU green investments is likely to be negligible. The European Union should consequently not attempt to match the financial subsidies entailed in the IRA, and no reason exists to materially lower general restrictions on EU state aid to green industries to try to achieve this purpose.

CONCLUSION

The European Union has, at the costs of sizable but manageable energy price subsidies and lasting cost disadvantages to the most energy-intensive industries, overcome the immediate effects of Vladimir Putin's energy blackmail from mid-2022. In early 2023, it doubled down on its market and carbon pricing-based decarbonization strategy with far more ambitious early targets for 2030. A very different European path from the subsidy- and regulation-driven decarbonization strategy pursued by the United States is now legislated on both sides of the Atlantic.

The dramatic increase in the scope of EU carbon pricing and the equally noteworthy increase in emission prices recently brought about by ETS reforms, as well as the firm political commitment shown to the system during sickness

and war, suggests the European Union is now well on its way to reaching many of its climate goals. The relative price effects exerted by carbon cost at current and higher levels in the future will present the private sector with the necessary incentives to invest heavily in Europe's green transition. Some independent estimates suggest that the recent increase in the European Union's 2030 overall legally binding renewables target to 42.5 to 45 percent is already too low, given updated private investment trends (Cremona, Rosslowe, and Candlin 2023). Carbon pricing will aggressively push the European Union toward reaching its 2030 and 2050 climate goals. Contrasted with the costs of the US green industrial tax subsidies in the IRA—estimated in Della Vigna et al. (2023) to reach $1.2 trillion—the European Union's market-based approach appears at least as effective, but also increasingly fiscally and redistributionally prudent. The GOP House majority in the spring of 2023 passed a bill[33] to increase the federal government's debt ceiling that included in Title 3 of the bill removing the vast majority of the IRA's green subsidies. This makes it plausible that the political resiliency of the European Union's carbon pricing strategy might exceed that of the IRA's federal government tax subsidies. Ultimately, the US debt ceiling was raised leaving the IRA intact, but this outcome appears to rest on at least partial Democratic control of Washington continuing. This may cause some businesses investing in decades-long infrastructure to hesitate.

With this in mind, EU policymakers should now focus on the full and timely implementation of what has recently been agreed. It is not obvious that additional new ambitious carbon reduction initiatives are required, or are politically and economically desirable as European economies absorb the effects of important decisions to date in 2023. The European Union now has the advantage that it must merely do what it has already written into law, rather than politically have to forge new consensus on what more needs to be done. Implementation will be key to reaching its climate goals by 2030 and beyond.

European governments will have to invest a lot in regional electricity grids to accommodate new renewable supply (regulatorily set network charges will not incentivize such investments and publicly provided grids best ensure equal access), but already legislated carbon pricing will provide the necessary financial incentives to propel private sector investments in European renewable energy supply and related downstream sectors. The European Union has no reason to fear the IRA may undermine aggregate green investment levels at home, nor has reason to provide additional taxpayer-financed subsidies toward this purpose. Given the IRA's greening effect on the US economy, it represents at least an opportunity to potentially reduce the risks of future carbon-based transatlantic trade wars, as it increases the chances that the European Union may accept US-produced goods and services as adequately "carbon free" to be exempt from the future effects of the EU CBAM. CBAM-exempt US goods and services could then provide the obvious building blocks for potential future "transatlantic carbon clubs." This collaborative outcome, however, will most likely require that the current US decarbonization cost subsidy strategy is complemented by at least some elements of the EU carbon cost imposition, as competitiveness

33 House Speaker Bill to Provide for a Responsible Increase to the Debt Ceiling, and for Other Purposes, 118th Congress, April 19, 2023, https://www.speaker.gov/wp-content/uploads/2023/04/LSGA_xml.pdf.

concerns will otherwise politically fester. It is a high political threshold to create a successful transatlantic carbon club aimed at more carbon-intensive third countries.

Rapid decarbonization at the speed dictated by current carbon pricing will require that the European Union continues to participate in existing international supply chains. These will invariably involve China, and in the solar photovoltaic (PV) sector, for instance, Chinese imports are proving crucial for Europe's ability to rapidly scale up the expansion of renewable energy supply.[34] In other words, clear tradeoffs exist between the European Union's ability to forcefully pursue its decarbonization goals in a timely manner, and concerns over the potential for new economic dependencies developing with China. Following the likely permanent imposition of US trade tariffs and extensive technology restrictions on China, the European Union remains China's most important international market. It would be far from costless for a China facing increasingly deficient domestic demand in its economy to initiate a trade war with Europe, including key components in the green transition. A deepening of economic relations with China remains undesirable, absent significant policy shifts from Beijing. But the European Union would, given its economic and political importance to a China locked in rivalry with the United States, be ill-served by pursuing very expensive IRA and FPF-like public subsidy and trade restrictions schemes in attempts to quickly import substitutes and reduce Europe's current dependency on Chinese supply for the green transition. The proposal (European Commission 2023) to set fixed domestic EU production capacity goals in "strategic net-zero industries" should remain aspirational and only be pursued gradually, and mostly through market-based processes. The European Union's decarbonization goals are best pursued by continued but responsible reliance on global supply chains.

The European Union's successful pursuit of cap-and-trade systems in recent years further highlights the political advantages of its market-based carbon pricing compared to an outright politically determined carbon tax. The early ETS design from 2005 to roughly 2018 clearly illustrated the dangers of having systems with excessive carbon emissions permits available, and suffered declines in prices to economically irrelevant levels (visible at the far left of figure 4 until mid-2017). Yet following the successful reforms initiated in 2018 and subsequent EU political commitment, the ETS has delivered carbon prices all but impossible to implement through the political legislative process. No matter public concern over climate change among European voters, it is inconceivable that European politicians in the midst of the COVID-19 pandemic and the Russian energy emergency could have in recent years legislated a carbon tax yielding a price above €80 per ton, which is what the ETS has delivered. In advanced democracies, well-designed cap-and-trade systems can steer the "market price" of carbon toward economically deterministic levels via the superficially apolitical fog of the market mechanism far faster and more reliably than any carbon tax. Adjusted for politics, the EU ETS shows that cap-and-trade systems are the superior carbon pricing mechanism for effective climate policy.

34 Chen (2023) shows how the European Union imported 12.5 GW of solar PV modules in March 2023 alone, up 76 percent from a year earlier. The first quarter of 2023 saw imports of 29.5 GW, an increase of 77 percent over the first quarter of 2022.

Lastly, given the likely fast decline in available ETS emissions permits highlighted in figure 4, ending as soon as the late 2030s suggests that EU policymakers should already begin discussing further ETS reforms and contemplate the creation of negative CO_2 emissions permits, or CO_2 removal permits and integrate them into the ETS.[35] This will prevent erratic carbon price setting, even as regular emissions permit availability drops towards zero and carbon market liquidity dries up during the 2030s. Furthermore, after deflating the number of tradable CO_2 removal permits to ensure more CO_2 was removed from the atmosphere than the amount of new emissions certificates created, it would provide a powerful financial incentive to develop direct air capture CO_2 capabilities in the European Union.

To conclude, Europe's successful cap-and-trade system could continue, even as the point of net-zero emissions approaches.

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