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Strategic Supply Chain Issues & Ireland's Energy Transition

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Abbreviations

CAP Climate Action Plan
CO_2 Carbon dioxide
CBAM Carbon Border Adjustment Mechanism
CRMA Critical Raw Materials Act
DECC Dept. of Climate, Energy & Environment
DETE Department of Enterprise, Trade and Employment
DG Directorate-General
DMAPs Designated Maritime Area Plans
DOE Department of Energy (US)
EC European Commission
ECA European Court of Auditors
EERE Office of Energy Efficiency & Renewable Energy (US)
ETS Emissions Trading System
EU European Union
EU27 27 Member States of the European Union
EV Electric Vehicle
FSR Foreign Subsidies Regulation
GB Great Britain
GPP Green Public Procurement
GTAP Global Trade Analysis Project
GW Gigawatt
GWEC Global Wind Energy Council
Ibec Irish Business & Employers' Confederation
IEA International Energy Agency
ILUC Indirect Land Use Change
IPCC Intergovernmental Panel on Climate Change
ISCC International Sustainability & Carbon Certification
Kg Kilogram
$kgCO_2eq/\$$ Kilograms of CO_2 emitted per dollar of economic output
MAP Maritime Area Planning
MARA Maritime Area Regulatory Authority
MOUs Memorandums of Understanding
MRIO Multi-Regional Input-Output
$MtCO_2eq$ Million Tonnes of CO_2 Equivalent
MW Megawatt
NECPs National Energy & Climate Plans
NESC National Economic & Social Council
NORA National Oil Reserve Agency
NGOs Non-Governmental Organisations
NRDC Natural Resources Defence Council
NREL National Renewable Energy Laboratory (Denmark)
OECD Organisation for Economic Cooperation & Development
POME Palm Oil Mill Effluent
PV Photovoltaic
RED Renewable Energy Directive
RFNBOs Renewable Fuels of Non-Biological Origin
RoI Republic of Ireland
RTFO Renewable Transport Fuel Obligation
SAF Sustainable Aviation Fuel
TAXUD TAXation et Union Douanière (Taxation and Customs Union)
UCO Used Cooking Oil
UK United Kingdom
USA United States of America
USD United States Dollar
WFW Watson, Farley & Williams
WTO World Trade Organisation

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Executive Summary

Ireland's energy transition is advancing at a time of profound change in global trade, technology, and environmental governance. As action progresses to reduce greenhouse gas emissions and accelerate the deployment of renewable energy systems, the underlying supply chains for key energy technologies and commodities have come into sharper focus. These supply chains, spanning components, materials, services and infrastructure, are recognised as critical enablers of national decarbonisation strategies, economic resilience and energy security.

This paper explores strategic supply chain issues that are central to the successful delivery of Ireland's climate and energy objectives. While Ireland possesses abundant natural resources for renewable energy, particularly in the form of wind, our capacity to develop and deploy these resources at scale is increasingly shaped by global supply chain dynamics, geopolitical developments, and international trade relations. The cost, availability and sustainability of key technologies and resources such as wind turbines, solar panels and biofuels are not solely determined by national policies, but by cross-border supply chains, trade policy developments at EU-level and evolving international regulatory frameworks.

Three thematic areas structure the analysis in this paper. First, it examines the international supply chain for wind energy technologies, highlighting Ireland's exposure to emerging bottlenecks in turbine components, critical raw materials, and specialised infrastructure. The concentration of global manufacturing capacity, especially in China, raises complex challenges around dependency, competitiveness, and trade policy alignment at the European level. Ireland's ambition to become a leader in offshore wind demands both strategic planning and active investment to secure access to international supply chains while building key enabling infrastructure at home.

Second, the paper explores carbon emissions embedded in international trade. As Ireland and its partners reduce territorial emissions, attention must also turn to consumption-based emissions that are imported through global supply chains. This section examines the implications of carbon leakage, the role of the EU's Carbon Border Adjustment Mechanism (CBAM), and policy action required to align trade practices with climate ambition. The analysis underscores the need to integrate imported emissions into national policy frameworks to fully reflect Ireland's climate footprint.

Third, the paper addresses sustainability issues in the international biofuel supply chain. With biofuels playing a growing role in the decarbonisation of transport, particularly in light-duty road transport, it is essential to ensure that imported biofuels and associated feedstocks meet stringent environmental and social standards. The report examines the regulatory landscape for renewable transport fuels, the challenges associated with tracing feedstock origins, and the risks of indirect land use change (ILUC). Ensuring integrity in biofuel sourcing is essential not only for emissions accounting, but also for maintaining public trust and meeting Ireland's climate commitments.

Across all three domains, the paper identifies a core strategic insight: Ireland's success in the energy transition increasingly depends on its ability to integrate and adapt effectively to developments in global supply chains. This includes targeted and timely investment in infrastructure, alignment of planning and permitting frameworks, robust enforcement of environmental regulations, and active participation in the development of EU external trade policy.

This Secretariat paper accompanies NESC Council report no.169, *Ireland's International Trade Dependencies and the Energy Transition* (NESC, 2025a). Council report no.169 examines Ireland's energy trade dependencies with a focus on fossil fuel import-dependency, trade in electricity, and trade in green hydrogen and its derivates.

Both Council report no.169 and this Secretariat paper frame Ireland's energy transition, not as a domestic policy challenge, but as one shaped by global trade interdependencies. This paper aims to inform national decision-making by offering a cross-cutting perspective on how strategic supply chain issues, trade policy, and environmental governance intersect with Ireland's climate and energy goals.

Chapter 1 The International Wind Technology Supply Chain

1.1 Introduction

Renewable energy technologies involve complex global supply chains. The international supply chain for renewable energy components and finished goods such as wind turbines, solar panels, batteries, electrical interconnectors and electrolysers faces several strategic risks that can potentially impact their deployment, availability and cost. In areas where demand for technological components is high, supply can fall short of demand, potentially impacting upon project delivery timelines, efficient deployment and project costs.

The EU lacks sufficient domestic manufacturing capacity for many renewable energy technologies, relying to an increasing degree on imports from locations such as China, India and Southeast Asia. These intra-regional supply chain interdependencies create risks for the European supply chain in the event of trade disputes and supply disruptions relating to renewable energy technologies. Trade policy measures such as trade restrictions, tariffs and export controls risk impacting upon project costs and the successful achievement of Europe’s renewable energy deployment targets and associated timelines.

Ireland is a global leader in the deployment of onshore wind technology. Ireland’s domestic wind technology sector primarily encompasses project development, installation and maintenance services, rather than the manufacturing of large components such as turbines, blades and towers. As a result, Ireland's onshore wind sector continues to rely on international suppliers to a significant degree, with limited domestic manufacturing of wind turbine components.

While Ireland already has a well-established domestic onshore wind industry in specific service areas, our offshore wind sector is still in the early stages of development (DECC, 2023a). We are likely to remain reliant on imports for many offshore wind goods and services such as large blades, towers, nacelles, offshore substations and installation vessel services (Carbon Trust, 2020: 55-68). Exposure to supply chain bottlenecks risks leading to project delays and increased project costs, emphasising the need to prioritise rapid delivery in areas such as port development, as well as planning and permitting procedures.

Ireland has especially strong wind energy natural endowments, and the sector is expected to make the largest contribution towards our energy transition. This chapter focusses on both the European and global wind technology supply chains, examining issues such as emerging supply chain bottlenecks, concentration risks, sourcing of critical raw materials, changes in EU external trade policy and the potential effects of trade disputes.

1.2 Emerging bottlenecks in wind technology components and services

Certain wind turbine components and services are at risk of becoming bottlenecks over the coming years as demand ramps-up in the European market. Wind turbine blades are giant composite structures, and their production is highly specialised.

A recent WindEurope study identified rotor blade production as a current supply chain bottleneck of concern in Europe (WindEurope, 2023a:6). Blade factories are running near maximum capacity and must expand further to meet demand for longer blades, especially in the offshore sector. For offshore turbine models reaching 15 MW, blade lengths can reach 115 metres (NREL, 2020). Additional expansion of existing facilities and new plants will be needed in the coming years to satisfy both planned European projects and demand in export markets. If sufficient new blade capacity isn't added, it could delay projects and cap the rate of turbine installations.

Tower fabrication has been able to scale within the European supply chain more smoothly but will need to expand further as orders increase. Demand for towers, particularly large offshore towers, will pick up in the second half of the decade, requiring additional expansion. Analysis by WindEurope suggests the region will reach ~2.5X more tower production capacity in 2025 as compared to output in the early 2020s (WindEurope, 2023a:6). A constraint in tower manufacturing is steel plate supply, particularly as European steel mills face higher costs and competition from cheaper Chinese suppliers (Basquill, 2025).

A wind turbine nacelle sits at the top of the tower and contains the gearbox, low- and high-speed shafts, generator, and brake. Some nacelles are larger than a house and for a 1.5 MW geared turbine, can weigh more than 4.5 tonnes (U.S. DoE, 2025). There are currently 30 turbine assembly facilities globally producing nacelles for offshore wind, with a further 55 under construction or in planning (see Table 2.1).

Table 2.1: Overview of global offshore wind turbine nacelle facilities

	China	Europe	USA	Asia Pacific	Global
Total number of offshore nacelle assembly facilities	21	5	0	4	30
Number of announced offshore nacelle assembly facilities	47	1	3	4	55

Source: GWEC (2023).

Offshore wind turbine nacelles differ from onshore nacelles in several respects due to the distinct environmental conditions they operate in. Offshore wind turbines are generally larger as there is more space for larger turbines in the marine environment. The higher generation capacities of offshore turbines justify the higher installation and maintenance costs at sea as compared to land (U.S. EERE, 2024). According to the Global Wind Energy Council (GWEC), global demand is likely to outstrip supply for offshore wind nacelle capacity from the mid-2020s onward in regions other than China (GWEC, 2023: 29).

Table 2.2: Offshore nacelle capacity - Demand vs supply analysis 2023-2030 (GW)

	2023	2024	2025	2026	2027	2028	2029	2030
Europe	5.1	2.9	6.5	9.6	10.8	16.2	20.4	26.4
China	8	12	14	15	15	15	15	15
Asia-Pacific excl. China	1.8	1.5	2.9	2.7	3.3	5	5.5	6.9
North America	0.5	0.9	2.3	3.5	4.5	4.5	4.5	4.5

Sufficient (green): Europe 2023–2025; China 2023–2030; Asia-Pacific excl. China 2023–2026; North America 2023–2024. Potential bottleneck (amber): Europe 2026–2030; Asia-Pacific excl. China 2027–2030; North America 2025–2030.

Source: GWEC (2023).

Offshore wind farms also require complex cabling systems to efficiently transmit power from the turbines to the onshore grid. Inter-array cables connect individual wind turbines within a wind farm, collecting power from each turbine and transmitting it to an offshore substation (Ørsted, 2024). Offshore wind farm export cables connect the offshore and onshore substations to transmit power from the wind farm to shore (Offshore Wind Scotland, 2024; Skillnet Ireland, 2024). A key supply chain concern is the gap in vessel installation capacity for cable laying (see further below), which could slow down the speed of offshore wind farm installations across Europe (Janipour, 2023).

Foundations for offshore turbines are another bottleneck. The preferred foundation type - monopiles - are growing to extreme sizes for 15+ MW turbines. The required scale-up in monopile tonnage is substantial over the 2022-2030 period to meet regional offshore wind development plans in Europe (WindEurope, 2023a:24). According to analysis by the Global Wind Energy Council (2024), bottlenecks are projected to emerge in the European supply chain for fixed-bottom foundations from 2026 onwards, and from 2029 onwards for floating offshore foundations. The vast majority of projected demand in Europe until the end of the decade will be for fixed-bottom foundations, with far lower projected production volumes for floating foundations (see Tables 2.3-2.4). Floating offshore foundations are still largely in the pilot-project phase. Floating foundation manufacturing in Europe must grow five-fold by 2030 to meet projected demand (WindEurope, 2023a:38).

Even if all the technological components needed are available to deliver a wind energy project, the sector can only deliver if the enabling infrastructure is in place. Infrastructural requirements differ between onshore and offshore wind. For onshore wind projects, this includes cranes, trucks and project sites that are accessible via road transport. For offshore wind projects, these depend on specialised port infrastructure and a limited fleet of heavy-lift installation vessels. Purpose-built wind turbine installation vessels can operate in rough waters with heavy-lifting capabilities and dynamic positioning systems (Desalegn et al, 2023: 3). These vessels transport and install turbines, foundations and substations. Other specialised vessels include cable-laying vessels used to lay secure undersea cables that connect turbines to onshore grids. Importantly, wind turbine installation vessels can move between regions, meaning developers in Europe and Asia can be in competition for available vessels. Projects that experience delays can see installation vessels being redirected to projects in other countries or regions, highlighting the need to avoid prolonged delays in project delivery.

Table 2.3: Fixed-bottom foundations production capacity - Demand vs supply analysis 2023-2030 (units)

	2023	2024	2025	2026	2027	2028	2029	2030
Europe	509	252	551	734	732	1097	1306	1639
China	887	1263	1411	1324	1210	1154	1071	1000
Asia-Pacific excl. China	241	223	263	229	253	277	288	345
North America	42	73	193	294	339	308	294	270

Sufficient   Potential bottleneck

Source: GWEC (2023).

Table 2.4: Floating offshore foundations production capacity - Demand vs supply analysis 2023-2030 (units)

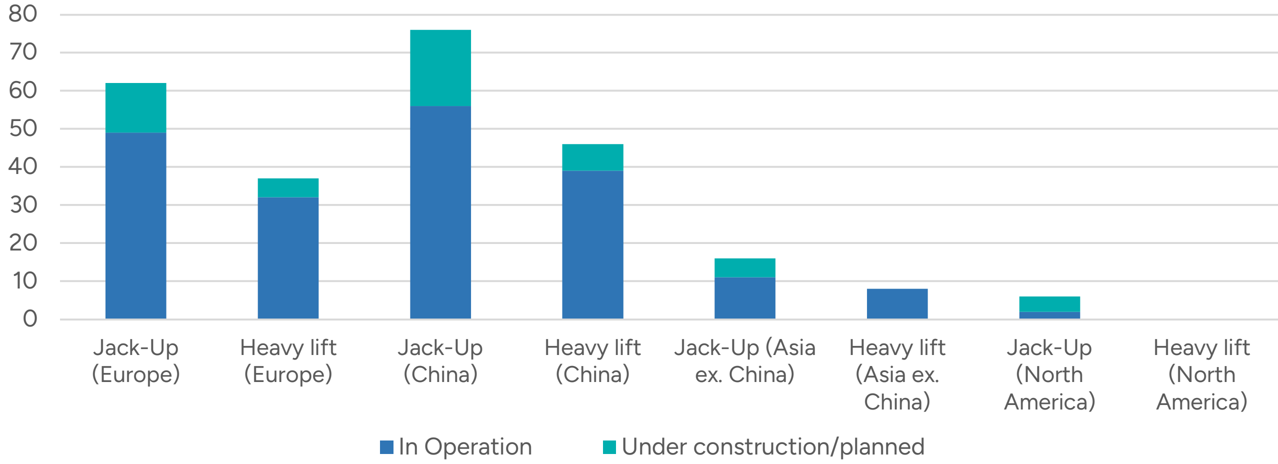
	2023	2024	2025	2026	2027	2028	2029	2030
Europe	11	7	8	29	29	50	130	182
China	2	0	25	40	40	0	0	0
Asia-Pacific excl. China	0	8	0	11	32	57	75	77
North America	0	1	1	0	0	0	12	32

Sufficient   Potential bottleneck

Source: GWEC (2023).

Global demand for wind turbine installation vessels is projected to grow five-fold by 2030. European projects will face competition from developers in markets such as Vietnam, Taiwan, South Korea and Japan, where demand is expected to grow at rates similar to Europe (WindEurope, 2023a: 39). Lower demand for vessels in the US market may result in some vessels becoming available for use in other regions, following a pull-back in government support in the US market from 2025 onwards. However, the US market only constitutes a small share of the global fleet (see Figure 2.1) and some US vessels are designed specifically for the US market (ibid).

Figure 2.1: Number of wind turbine installation vessels 2023



Source Data: Global Wind Energy Council (2024).

Specialised port facilities are crucial to the development of offshore wind projects in areas such as logistics, assembly and storage. Ports are where the operation and maintenance of offshore wind farms are run from, where turbines and other equipment are transported to, and where floating turbines are assembled (WindEurope, 2024a). Timely delivery of specialised offshore wind port infrastructure is essential to ensure vessels and grid connections are ready when turbines arrive for deployment. A study commissioned by Wind Energy Ireland identified Belfast Harbour's D1 facility as the only existing facility which can accommodate staging and marshalling of fixed-bottom projects (Wind Energy Ireland, 2022). Port of Cork Ringaskiddy is identified as also having the potential to serve as a staging port for either foundations or turbines, but not both. Ringaskiddy also has notable restrictions in terms of loading capacities. Several ports have indicated development plans suitable to accommodate the deployment of fixed-bottom installations. Locations which have plans suitable for fixed-bottom installation are Bremore, Cork Dockyard, Moneypoint, Rosslare and Shannon Foynes Port Company. The same study also noted that there are no existing facilities suitable to allow for manufacture and staging of floating wind projects in Ireland and that several new facilities will be required to meet demand on staging ports.

The regional and global wind energy supply chain is also affected by constraints in logistics. Shipping price spikes due to disruptive events and port congestions can cause delays in the delivery of key components to projects.

Delays in project delivery due to factors such as port infrastructure bottlenecks or permitting delays can result in turbine components being held in order backlogs, delaying timely installation, project completion and revenue realisation (Windward, 2024). Such delays complicate planning and negatively impact on project financing, while slowing progress towards decarbonisation.

1.3 Critical raw materials

Modern wind turbines rely on critical raw materials that are in high demand and face multiple supply risks. These include steel, copper, rare earths, nickel, manganese, aluminium, ferrous scrap and glass-fibre fabrics (WindEurope, 2023b). Wind turbines and their foundations are extremely steel-intensive, making up 90% of the materials used in offshore wind turbines. Europe's steel producers have experienced cost pressures due to high energy costs. European steel prices were ~69% higher in Dec 2022 than in Jan 2019, whereas Chinese steel prices remained largely unchanged over the same period (Janipour, 2023). In April 2024 the European Commission opened an investigation into Chinese suppliers of wind turbines under the Foreign Subsidies Regulation (FSR), suspecting unfair competition (WindEurope, 2025a).

Epoxide resins are another important material in the production of rotor blades and in the coating of wind turbine structures. Epoxide resin prices stood at $3.99 in Europe in February 2025, $3.64 in the US and $1.84 in China (Janipour, 2023). In 2024, the European Commission initiated anti-dumping proceedings concerning imports of epoxide resins from China (EUR-Lex, 2024).

Rare earth elements such as neodymium and dysprosium are used for the manufacturing of permanent magnets used in generators for wind turbines (UK tech Metals Observatory, 2025; Alves Dias et al, 2020). The European wind technology manufacturing base is heavily reliant on China as a supplier of these rare earth elements.[1] China controls the vast majority of the global rare earth supply, including 80% of the global supply of neodymium (Ashcroft, 2024). Neodymium prices have been extremely volatile in recent years, rising from $70/kg in 2018 to reach $222/kg in 2022, before eventually falling to $96/kg in 2025 (Strategic Metal Invest, 2025). If supply of rare earth elements from China was to be disrupted, severe shortages and price spikes could occur, given limited availability for alternative sources.

In 2010, China imposed unofficial restrictions on exports of rare earth elements to Japan, following a diplomatic dispute between the two countries (Morrison & Tang, 2012). The incident began in September 2010, after the detention of a Chinese fishing trawler captain by Japanese authorities in disputed territory. In response to the escalating tensions, Chinese customs officials began halting shipments of rare earth materials bound for Japan. Japanese manufacturers faced immediate supply shortages and price spikes, disrupting production in key sectors such as electronics and automotives (Bradsher & Tabuchi, 2010). Prices of rare earths increased on global markets, and concerns over supply security prompted other countries to seek alternative sources and reduce dependence on China. In 2012, the United States, the EU, Japan and other countries jointly filed a complaint at the WTO against China's broader export restrictions on rare earths, tungsten, and molybdenum (WTO, 2012). In 2014, the WTO ruled against China, stating that its export quotas and duties violated WTO rules. China subsequently removed the disputed restrictions (EC, 2014).

In March 2023, the European Commission proposed the Critical Raw Materials Act (CRMA) to bolster the EU's autonomy in sourcing critical minerals (EC, 2023a). The Act establishes benchmarks along the strategic raw materials value chain and for the diversification of the EU supplies. These are:

- At least 10% of the EU's annual consumption for extraction
- At least 40% of the EU's annual consumption for processing
- At least 25% of the EU's annual consumption for recycling
- No more than 65% of the EU's annual consumption from a single third country

These measures aim to reduce reliance on external suppliers, particularly China, which dominates the supply of several critical minerals to Europe.

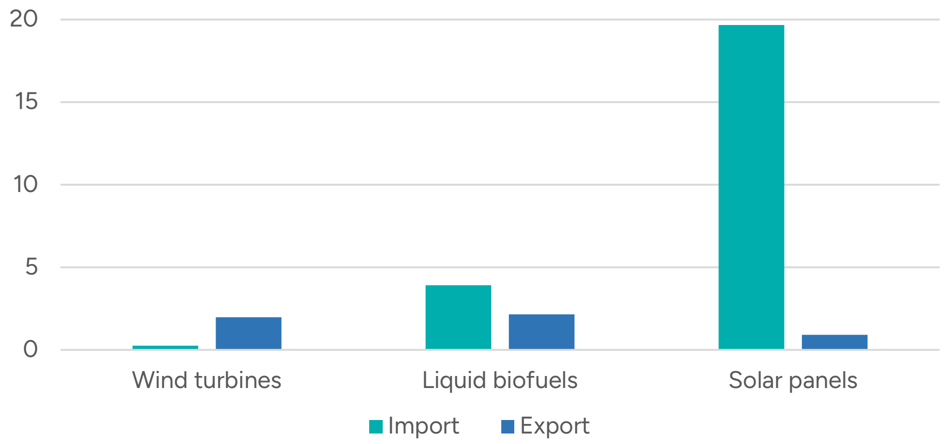
[1] The EU gets 98% of its rare earth supply from China (EC, 2024a).

1.4 EU external trade in wind energy technology

As distinct from other technologies such as solar PV, the international supply chain for wind equipment production is "less geographically concentrated, as suppliers prefer to locate production plants close to demand centres due to the high costs and risks associated with transporting large and fragile components over long distances" (IEA, 2023a: 68-69). As a result, the European wind tech supply chain exhibits a significant degree of localisation, encompassing various stages from manufacturing to deployment.

Figure 2.2 displays the value of EU imports of selected renewable energy technologies. The EU is broadly export-oriented for trade in wind turbines but is heavily reliant on imports of solar panels. Almost all (98%) of the EU's solar panel imports come from China, while 29% of the wind turbines imported into the EU come from China (Eurostat, 2024a). Chinese suppliers have also recently begun to win contracts for offshore wind projects in Europe (Luxcara, 2024).

Figure 2.2: EU external trade (€bn) in selected renewable energy products 2023

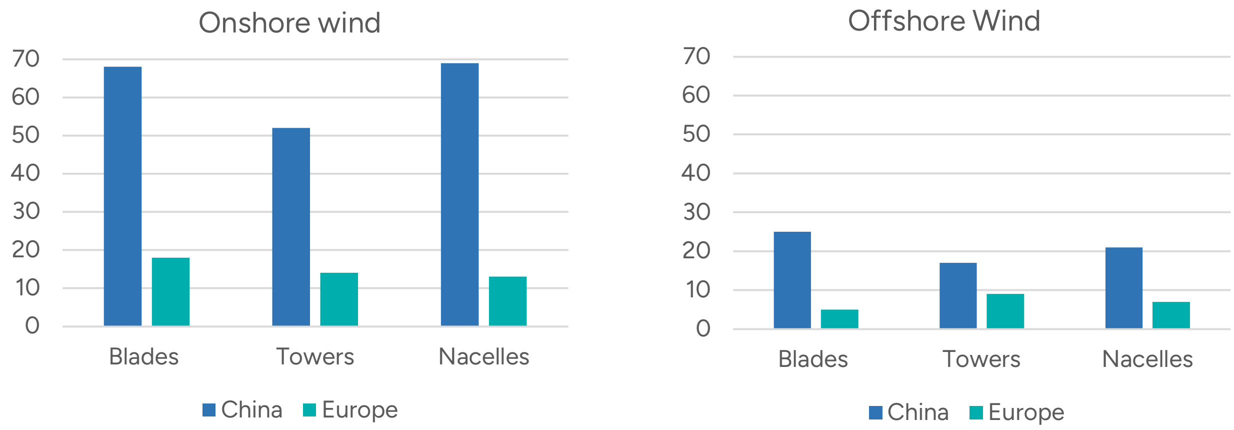


Source Data: Eurostat (2024a).

Europe's REPowerEU strategy seeks to install 420 GW of wind energy by 2030, implying the addition of at least 30 GW of new generation capacity each year (WindEurope, 2023c). As a result, European wind turbine manufacturers and service providers now face unprecedented demand growth, with a particular need to invest in new manufacturing capacity to service the offshore wind sector. With much of current expansion geared toward offshore wind, manufacturers are investing in new specialised facilities and scaling up existing lines to handle the latest generation of large-scale offshore turbines (WindEurope, 2025b). In 2025, European factories are expected to reach production of about 32 GW of turbines per year, comprised of 22.5 GW of onshore and 9.5 GW of offshore (WindEurope, 2024b). WindEurope has forecast that the EU will install 29 GW per annum on average over the 2024-2030 period. This would bring the EU's total (onshore and offshore) installed wind capacity to 393 GW by 2030, close to the 425 GW needed to deliver on climate and energy targets (WindEurope, 2024c).

While Europe has historically been the most important region in terms of both production capacity and demand, China has come to hold an increasingly dominant position. In 2023, China accounted for approx. 65% of global wind capacity additions, placing four Chinese wind turbine original equipment manufacturers into the top five global rankings for the first time. The top five original equipment manufacturers collectively hold 54% of the global wind equipment manufacturing market, showing the extent of market consolidation (Review Energy, 2024).

Figure 2.3: Projected 2025 onshore and offshore wind energy equipment manufacturing capacity (GW) by region and component

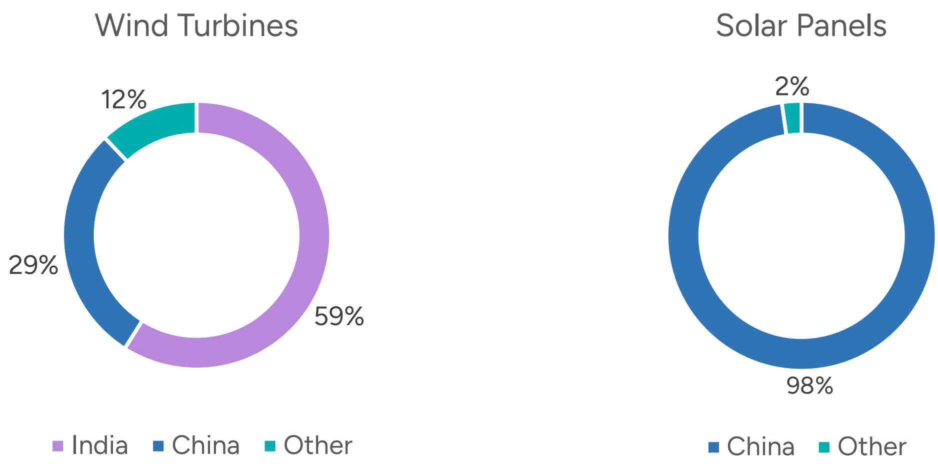


Source Data: IEA 2023b; IEA 2023c.

European suppliers have historically held a dominant position both within the European market and as suppliers to global markets other than China. Chinese production heretofore has largely focussed on meeting domestic demand, with market share of just 4.2% in markets outside of China (Janipour, 2024). However, China's domestic capacity now far exceeds ongoing domestic demand, and Chinese manufacturers are positioned to re-orient towards exporting wind technology to meet growing demand on global markets, including in Europe (EU Today, 2024).

Chinese producers already supply onshore wind farm projects in Europe, with approx. 2.6 GW of capacity installed or under development (WFW, 2024). Due to a focus on serving the domestic market, China makes up 29% of EU wind turbine imports in value terms, with India being by far the largest exporter to the EU market (see Figure 2.4). However, as China pivots towards exporting wind technology, this presents both risks and opportunities for the European wind tech sector. China's excess capacity has the potential to serve rising demand for wind technology in Europe. Chinese produced wind tech is also highly cost competitive, presenting the opportunity to reduce costs and enhance viability for major wind projects in Europe. However, the sheer extent of China's excess capacity and cost competitiveness, as well as concerns about unfair trading practices, highlight the risk that the European industry will be undercut by Chinese competition over time.

Figure 2.4: EU partners for imports of selected energy products (% total value) 2023



Source Data: Eurostat (2024a).

The offshore wind sector has unique industrial processes, components and infrastructure requirements to ensure efficient installation, maintenance and energy generation in harsh marine environments (Hong et al, 2024). The DECC *Policy Statement on the Framework for Phase Two Offshore Wind* states the aim of supporting "the long-term potential for a floating offshore wind industry, including all elements of the necessary supply chain required for an industry of this type, in Ireland" (DECC, 2023b: 18). While it is the ambition to substantially develop domestic offshore wind industrial capacity, Ireland is likely to be reliant on imported goods and services to a substantial degree in key offshore wind components and services if national targets for the offshore renewable energy sector are to be met.

Table 2.5: Offshore wind sector targets in Europe (GW)

	2027	2030	2035	2040	2045	2050
EU Wind Power Package		**111**				**317**
UK		50				
Germany		30	40		≥70	
Netherlands		22.2		50		70
Denmark		12.9				
Belgium		5.7		8		
France			18			45
Poland	10.9					
Norway				30		
Ireland		7		20		37
Spain		3				
Greece		2				
Portugal		10		.		

Source: GWEC (2024).

As Ireland will need to source many components and services from international suppliers, the development of the offshore wind sector here will be subject to supply chain capacity constraints at the regional level. Other European countries have ambitious offshore wind development targets. In line with EU countries' regional offshore targets, approx. 111 GW of the planned expansion in renewable capacity is expected to be derived from offshore wind, rising to 317 GW by 2050 (EC, 2023b).

1.5 Trade disputes and trade protectionism

Europe's wind industry supply chain is increasingly exposed to the risk of emerging trade disputes, trade protectionism and broader geopolitical risks. A key risk for the European wind energy sector is competition from Chinese manufacturers and increased dependency on Chinese component suppliers. If Sino-EU trade in wind technology is disrupted by trade disputes, as has happened in the Solar PV and electric vehicle (EV) sectors, this risks significantly impacting upon the development of the sector in Europe, the cost of components sourced from China, and regional supply chain stability.

The experience of the solar PV sector is particularly noteworthy as a cautionary tale, highlighting the risk of unfair competition for the European wind tech sector, as well as the critical importance of the Sino-EU trading relationship. From the early 2000s through much of the 2010s, Europe was a global leader in solar PV manufacturing, with countries like Germany and Italy at the forefront of global module production (OECD, 2019). At the end of the 2000s, EU countries held about 20% of global production capacity for modules and polysilicon, as well as over 10% for cells (IEA, 2024b:215). Starting in 2007, the Chinese government implemented policies to support its solar panel manufacturing sector. This included internal electrification projects and export-oriented industrial policy measures, resulting in Chinese manufacturers capturing over 80% of the European market within six years (Datenna, 2020).

In September 2012, following complaints from EU solar manufacturers, the European Commission launched an anti-dumping investigation into Chinese solar panels, wafers and cells (EC, 2012). The investigation focused on whether Chinese firms were receiving unfair subsidies and selling below production costs, undermining European manufacturers.[2] To avoid a broader trade war, the EU and China eventually reached a compromise in July 2013 on the basis of a minimum import price for Chinese solar panels entering the EU market.[3] In September 2018, the EU allowed the minimum import price agreement to expire, effectively removing all significant restrictions on Chinese solar imports (Banks, 2018). As of 2022, China's global share in all manufacturing stages of solar panels, including polysilicon, ingots, wafers, cells and modules, has exceeded 80% (IEA, 2023d:7). The EU's current share of global solar PV manufacturing capacity has fallen to less than 1% (IEA, 2024b: 215). In 2023, the EU sourced 98% of its solar PV imports from China (Eurostat, 2024a).

China's dominance in solar PV manufacturing has led to reduced costs globally, making solar energy more accessible and affordable. However, the Sino-EU dispute highlights the difficulty of balancing trade protections and cost-effective renewable energy expansion. The EU's diminished manufacturing capacity has stunted the sector's development in Europe, led to near total reliance on Chinese suppliers, and highlighted broader long-term regional supply chain dependencies and associated energy security risks.

Additional trade tensions have recently emerged in the Sino-EU trading relationship in relation to trade in battery Electric Vehicles (EVs). In September 2023, the European Commission launched an anti-subsidy investigation into Chinese EV manufacturers. The Commission expressed concerns that substantial state subsidies allowed Chinese producers to sell EVs in the EU at artificially low prices,

2 In June 2013, the EU imposed provisional anti-dumping duties on Chinese solar products with an initial tariff of 11.8%, set to rise to 47.6% if no resolution was reached. China's Ministry of Commerce retaliated by launching an anti-dumping investigation into European wine exports (Traynor, 2013).

3 The agreement was initially scheduled to last until 2015 but was later extended due to continued concerns. Although a broader trade war was averted, many European solar firms had already become insolvent due to Chinese competition.

potentially harming the European automotive industry. Following the conclusion of an investigation in October 2024, the EU imposed countervailing duties on Chinese EV imports.[4] The Chinese Ministry of Commerce responded by placing retaliatory tariffs ranging from 34.8%-39% on imports of European brandy, as well as announcing details of an ongoing anti-dumping investigation into EU pork products and the possibility of imposing duties on imported petrol-powered vehicles from Europe, indicating a broader scope of retaliation (Reuters, 2024).

The consistent pattern of trade tensions in the Sino-EU renewable energy technology trading relationship highlights strategic risks for the European wind technology sector. In particular, the experience of the European solar PV sector illustrates the significant risks associated with Chinese excess capacity and the potential for European manufacturers to be undercut by low-cost Chinese competitors assisted by state subsidies. The EU's wind technology sector is wary of repeating past mistakes observed in the solar industry, where limited action against low-cost Chinese imports and unfair trading practices led to the collapse of many European solar PV manufacturers (WindEurope, 2024d).

The European Commission's 2023 *European Wind Power Action Plan* sets the goal of creating a fair and competitive international trading environment for trade in wind energy technology (EC, 2023c). This is to be achieved by facilitating EU manufacturers' access to foreign markets and by protecting the internal market against trade distortions. Announcing the Wind Power Package in her 2023 annual State of the EU speech, European Commission President Ursula von der Leyen emphasised that "the future of our clean tech industry has to be made in Europe" (WindEurope, 2023d).

From the perspective of European manufacturers in the wind sector, China is generally regarded as a closed market (WFW, 2024). At the same time, Chinese wind turbines are being offered on the European market at 30-50% less than European-made turbines on deferred payment terms of up to 3 years. Such deferred payment terms cannot be offered by European manufacturers under OECD rules (Roy, 2024). Additional concerns from a European perspective include the lack of available market data on the operation, quality and performance of Chinese-produced installed wind technology, as well as tendering processes and financing arrangements (WFW, 2024). Further concerns exist in terms of adherence to environmental, social and governance principles in China.

In April 2024, the European Commission launched an investigation into Chinese suppliers of wind turbines in Spain, Greece, France, Romania and Bulgaria, citing suspicions of state subsidies. The investigation was motivated by concerns that the domestic European wind industry may be undercut by low-cost imports from China which could threaten the long-term viability of the European manufacturing base (European Parliament, 2025). Launching the investigation, Margrethe Vestager, the Executive Vice President of the European Commission, said "we can't afford to see what happened on solar panels, happening again on electric vehicles, wind or essential chips" (Bellini, 2024).

In July 2024, the EU requested dispute settlement consultations at the WTO regarding Taiwan's local content requirements for offshore wind projects, arguing that these measures discriminated against imported goods and services (EC, 2024c). The dispute with Taiwan was subsequently resolved through a Taiwanese commitment to no longer include localisation requirements in future allocation rounds, either as eligibility conditions or as award criteria (EC, 2024d). However, as distinct from Taiwan, EU disputes with the People's Republic of China are complicated by the EU's increased dependency on China as a supplier of wind technology components, as well as the fact that the EU is wholly reliant on China as a supplier of rare earth elements needed within the EU's own domestic wind tech supply chain. This gives China considerable leverage in any potential trade disputes relating to wind technology.

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4 These duties varied by manufacturer, with rates ranging from 8% to 35% (EC, 2024b; O'Carroll, 2024).

From an Irish perspective, the emergence of Sino-EU disputes in relation to trade in wind technology is of critical strategic importance for the development of the sector here. In the event that the EU expands trade defence measures to protect the European wind tech industrial base, this will risk leading to trade disputes that could disrupt the supply of Chinese components and rare earth elements to the European supply chain, exacerbating regional bottlenecks and capacity constraints. This could negatively impact upon costs and timelines for wind energy deployment in Europe. In the event that the EU pursues a less defensive position on Sino-EU trade in wind technology, this would risk repeating the experience of the European solar PV sector, where Chinese competition ultimately undercut the commercial viability of the European manufacturing base.

According to Libke et al (2024), European strategy on trade with China in green technology faces a dilemma, as economic growth, climate and security goals cannot all be maximally achieved (p.2). European policymakers and EU Member States need to focus on de-risking the relationship by defining where the risks are greatest and what constitutes a tolerable degree of dependency on China, actively seeking partners in the world to preserve competition, and communicating clearly about the necessary trade-offs (ibid).

Ireland's relatively limited domestic manufacturing capacity in the wind tech sector places us in the position of being comparatively less exposed to the risks associated with Chinese competition as compared to several other EU Member States. Member States such as Germany, Spain, Italy, France and Denmark already have large-scale manufacturing capacity for wind technology, making them more directly exposed to Chinese competition in terms of risks to established companies and jobs. Ireland, by contrast, currently has very little direct exposure to competition from Chinese exporters of wind technology.

External trade and investment policy is an EU competency[5], meaning trade policy in relation to China will ultimately be agreed at EU-level to reflect the common interests of the bloc as a whole. While Ireland could argue in favour of a more liberal EU trade policy towards China in order to utilise Chinese excess capacity and access low-cost wind tech components, a liberal EU trade strategy towards China risks fundamentally undermining the EU's wind tech industrial base over the longer-term. Ireland should argue in favour of a balanced EU strategy towards China which provides appropriate trade protections to address market distortions and ensure a level playing field.

1.6 Efficiency in infrastructure investment and planning

While Ireland may be unable to produce advanced large scale wind technology components domestically, steps can be taken to de-risk project delivery and the international sourcing of such components. This can be achieved in the main by timely investment in the critical infrastructure necessary to facilitate efficient project delivery. The assembly and deployment of large offshore wind components necessitate specialised port facilities. Without timely delivery of this specialised port infrastructure, Ireland could face delays in project delivery timelines, exacerbating supply chain disruption and increasing project delivery costs due to logistical inefficiencies.

A particular risk in terms of efficient project delivery is complex and lengthy permitting processes. The 2024 Draghi report (2024) highlighted the fact that onshore wind projects in Ireland have the lengthiest permitting procedures in the EU (p.16). Wind projects require substantial levels of capital investment, and delays in the permitting process can significantly increase project development costs. When approval timelines are excessively long, developers face uncertainty and potential cost overruns. By contrast, a well-coordinated permitting process can provide investor certainty. Countries with faster

[5] The European Commission formulates and negotiates on EU external trade policy to benefit the entire EU. Member states vote on trade policy at the Council of the EU and the European Parliament provides democratic oversight to align trade policy with social and environmental goals.

permitting systems stand to benefit from greater investment appetite and increased competition in offshore wind auctions.

The Maritime Area Planning (MAP) Act 2021 established a streamlined consenting process for offshore developments by introducing a single State consent process (Maritime Area Consent) for the maritime area, and a single development consent process for planning permissions with a unified environmental assessment. The Maritime Area Regulatory Authority (MARA) was established as an independent body responsible for granting Maritime Area Consents and ensuring a coordinated approach to maritime planning and to address potential bottlenecks in the permitting process. These reforms aim to simplify the regulatory framework and reduce delays associated with multiple overlapping consents (MARA, 2024). Additionally, the government has adopted a strategic plan-led approach by identifying specific maritime areas suitable for offshore wind development through the introduction of Designated Maritime Area Plans (DMAPs).

In addition to these reforms, measures should be introduced to benchmark and align Irish wind project delivery timelines vis-à-vis prevailing norms in peer European countries. According to Kershaw (2022), "monitoring at each stage of offshore wind development, including planning and siting, during development activities, and throughout the lifetime of offshore wind energy project operations, can help support smarter siting, best management practices, and the selection of risk-reduction technologies". Implementing a formalised process to benchmark Irish wind project delivery against international peers could provide valuable insights to ensure Ireland's competitiveness as an investment location. This could be achieved by:

- Establishing a collaborative forum involving industry leaders, regulatory authorities, academic experts and policymakers to establish monitoring priorities and develop solutions to address emerging impediments to efficient delivery of wind energy projects.
- Introducing a formalised system to monitor and benchmark Irish wind project delivery timelines against prevailing norms in international markets.
- Working collaboratively with international industry stakeholders to share information and develop solutions to address emerging blockages in the system.

1.7 International Strategic Partnerships

A key means of supporting supply chain resilience is by fostering collaboration with international partners in government, industry and academia (Hong et al, 2024: 6,18). Such collaboration should aim to identify potential gaps between industry strategies and current advancements in technology, with a view to sharing expertise, overcoming technical hurdles and bridging emergent skills gaps through research, education and training programmes (ibid).

In March 2025 the UK and Irish governments issued a Joint Statement announcing increased cooperation in a number of areas, including ensuring a strategic and efficient approach to shared maritime space to mobilise investment, support a healthy marine environment and provide clean energy (UK Prime Minister's Office, 2025). The Joint Statement commits to:

- Working together to harness the potential of the Celtic and Irish Seas by deepening co-operation on offshore energy and interconnection.
- Closer collaboration, including through our two bilateral Memorandums of Understanding (MoUs), and the opportunity for more formal co-operation between British and Irish system operators.
- Mobilising investment into strategic infrastructure in the Irish and Celtic Seas by establishing frameworks to guide private investment and removing barriers to trade and investment.
- Licensing and regulatory bodies will work together to establish co-operation in relation to data collection and usage, to continue to improve the management of the maritime area.

- Undertaking new joint initiatives on mapping the sea basin to improve interoperability and resilience, and to deepen existing co-operation on maritime decarbonisation, including on joint efforts to establish green maritime corridors.
- Co-operation between the two governments on infrastructure development in Northern Ireland.

Ireland's renewable energy ambitions depend upon integrating into the wider European supply chain. Strategic government-to-government partnerships can secure access to expertise, technology, materials and infrastructure. Ireland should seek to build strategic partnerships with countries that have cutting-edge renewable energy industries, developed supply chains, and high levels of demand for renewable energy goods and services produced in Ireland.

Strengthening international strategic partnerships can be supported by using diplomatic channels to form MoUs and Intergovernmental Energy Agreements (DG Energy, 2025). Ireland should pro-actively pursue such bilateral agreements with international partners with cutting-edge renewable energy sectors to facilitate joint ventures, collaborative research and cooperation on supply chain development. Such international agreements can cover cooperation in areas such as technological research and development, port infrastructure, developing supply chain corridors and investment in manufacturing facilities.

Strengthening international strategic partnerships will be critical to building supply chain resilience and to achieving our ambitious goals for renewable energy deployment. This can be facilitated by:

- Providing financial and institutional support to expand Irish academic and industry collaborative research endeavours.
- Funding and supporting international strategic partnerships to drive innovation and development in areas such as supply chain development and critical infrastructure.
- Coordinating institutional and commercial actors to pursue EU funding in support of innovative demonstration projects, such as those available through the Horizon Europe programme (EC, 2024e).

1.8 Conclusion

European and global wind energy supply chains are increasingly characterised by strategic dependencies and emerging bottlenecks. China is an increasingly important actor in terms of global wind turbine manufacturing, and the EU faces critical choices regarding how to manage its growing reliance on Chinese imports while protecting the viability of its domestic manufacturing base. These decisions carry significant implications for the stability, competitiveness, and long-term resilience of the European wind energy sector.

Ireland, with its world-class wind resources and strategic ambition to become a leader in offshore wind energy development, is highly exposed to the risks of emerging regional supply chain bottlenecks and wind technology trade disputes. Limited domestic capacity for manufacturing wind technology components necessitates a high level of reliance on international suppliers, making the country especially sensitive to trade policy developments and logistical constraints. Ireland must respond to these risks through timely investment in port infrastructure, ensuring efficiency in permitting processes, supporting a balanced EU external trade policy and by developing international strategic partnerships. Such action will be crucial to securing the components and services necessary for large-scale wind project delivery.

Chapter 2 Carbon Emissions Embedded in Trade

2.1 Introduction

According to the OECD (2024), greenhouse gas emissions embodied in international trade are those that are "generated during the production, transportation, and delivery of internationally traded goods and services (i.e. the full lifecycle of products)". These emissions occur in the countries of origin where production occurs, while the consuming country imports the goods and services without directly emitting the relevant greenhouse gases.

Emissions embedded in international trade are important in the context of the energy transition for several reasons. Countries generally report their emissions using a territorial carbon accounting approach, counting only those emissions that occur within their borders. This impacts upon assessment of the true level of progress in addressing climate change on a country-by-country basis, particularly for wealthier service-based economies such as Ireland which import significant levels of embodied emissions while achieving declines in domestic emissions.

Analysis of emissions embodied in international trade can provide useful insights for effective climate policy and environmental regulations. If national or regional policies and strategies to reduce emissions are focussed solely on domestic emissions, they risk encouraging offshoring of emissions to countries with weaker climate regulations, which fails to reduce global emissions.

This chapter examines key issues in relation to emissions embedded in trade, examines long-term trends in territorial and consumption-based emissions, and examines the potential impacts of the EU's Carbon Border Adjustment Mechanism (CBAM) in terms of Ireland's external trade in goods.

2.2 International trade and consumption-based carbon accounting

Monitoring of trends in sectoral carbon emissions and resource extraction is traditionally done based on production of goods and services at a national level. Production-based carbon accounting allocates responsibility for emissions to producers on the basis of the national territory where the emissions occur. According to Tukker (2020) "the simple rationale for this is that National Statistical Institutes or environment agencies only have a legal mandate to inventory data on economic transactions, emissions and resource use within the country in which they have been established … Given the large amounts of products that may enter and leave countries through trade compared to domestic production, this traditional territorial environmental accounting has become insufficient for various reasons" (p.1).

The distinction between consumption and production-based accounting hinges on "whether the producer or the consumer is responsible for the CO_2 emitted" (Munksgaard & Pederson, 2001). Consumption-based accounting suggests that greenhouse gas emissions generated in the production of internationally traded goods and services should be attributed to the final consumers (Jakob et al, 2021).

Developed economies import large volumes of goods for consumption that have been produced in jurisdictions with higher carbon intensities and lower environmental standards. The carbon emissions associated with the consumption of these goods is not accounted for in the importing country's territorial emissions. However, calculating consumption-based emissions allows for the measurement of a country's "CO_2 trade balance" (Munksgaard & Pederson, 2001). As distinct from territorial emissions, consumption-based emissions have been adjusted for trade. Consumption-based emissions are "territorial emissions minus emissions embedded in exports, plus emissions embedded in imports" (Ritchie, 2019).

2.3 Carbon leakage

A key issue of concern in relation to international trade and the goal of reducing greenhouse gas emissions is carbon leakage, whereby countries reduce their territorial emissions without reducing consumption-based emissions either by importing more of the goods they consume or by offshoring production to other jurisdictions which can then be imported for local consumption. While offshoring of production may coincide with reductions in territorial emissions where the goods are imported and consumed, it may also result in no decrease in global emissions and may even result in a higher level of global emissions if production processes are more carbon intensive and environmental standards are lower in the offshore jurisdiction. Such an outcome runs counter to the aims of environmental policy, as "the mere transfer of emissions from one country to another does not help the global environment" (Wu et al. 2022: 391).

Carbon leakage occurs when policies and practices to reduce greenhouse gas emissions in one jurisdiction result in an increase in emissions in another jurisdiction. This typically happens when companies relocate carbon-intensive production overseas to jurisdictions with less stringent carbon mitigation policies in order to avoid paying the costs associated with carbon pricing or to avoid emissions caps (DG TAXUD, 2025).

The higher cost of compliance in jurisdictions with higher standards means that "a carbon producer competing against producers located in countries with little or no climate policy tool – all other things equal – are at a competitive disadvantage" (Droege et al, 2017: 240). This has the effect of incentivising the offshoring of carbon-intensive manufacturing to countries with less stringent environmental regulations, resulting in the displacement of production and employment away from countries that adopt higher standards.

An analysis by Xu & Dietzenbacher (2014) examined CO_2 emissions embodied in trade over the 1995-2007 period. This study found that "in many developed countries, the growth of emissions embodied in imports is much higher than the growth of emissions embodied in exports. A key reason for this finding is the change in the structure of trade, both in intermediate and in final products … Producers and consumers in developed countries have shifted towards importing a larger share of products from emerging countries. This is the distinguishing feature that led to an increase of emissions embodied in imports for developed countries and an increase of emissions embodied in exports for emerging countries" (p.10).

This highlights a critical dynamic in global carbon accounting and the distribution of emissions responsibility in the context of global trade and the energy transition. It draws attention to how the structure of trade, particularly between developed and emerging economies, has shifted emissions geographically without necessarily reducing them globally (Fuhr, 2021; Pan et al, 2017). As a result, emerging economies, particularly China, India and Southeast Asia, have seen rising emissions, a substantial share of which arises from the production of goods for export. Conversely, wealthier countries can appear to reduce emissions by offshoring production, even if their true carbon footprint in consumption terms increases. This raises issues of climate justice, as less developed countries are producing carbon-intensive goods for higher-income nations' consumption. At the same time, higher-income economies' territorial emissions generally understate the true carbon footprint of their consumption.

Carbon leakage has the effect of undermining carbon mitigation policies. While stricter environmental standards may reduce local emissions, global emissions may in fact be unchanged or potentially even higher when economic activity is relocated to countries with lower environmental standards.

While carbon leakage does highlight a particular set of risks, whereby higher carbon mitigation standards may be undercut by offshoring, it is also true that higher environmental standards can serve to attract investment from environmentally conscientious firms seeking to locate activity in countries with more sustainable business practices.

2.4 Global trends in emissions embedded in trade

From the 1990s onwards, developed countries saw a faster increase in carbon emissions embodied in imported goods than in their exported goods. This was driven by the fact that the goods consumed in higher-income economies increasingly originated elsewhere, particularly from emerging economies such as China. China's accession to the WTO in 2001 and increased integration in global supply chains was a key driver of the outsourcing of production of both intermediate goods (e.g. components and raw materials) and final goods (e.g. electronics, textiles) from the early 2000s (Pan et al, 2017).

The dramatic increase in the net import balance of emission embedded in trade for high-income countries closely corresponds to the large increase in net exports of emissions in upper-middle income countries, which includes China (see Figure 3.1). Figure 3.2 displays the balance of emissions for a selection of regions. Notably, the positive net balance of emissions embedded in trade is higher for the EU27 than for the USA, with both increasing substantially following China's accession to the WTO, following which production of intermediate and finished goods was increasingly outsourced to China.

Figure 3.1: Net import-export balance (billion tonnes of CO_2 per annum) by income group

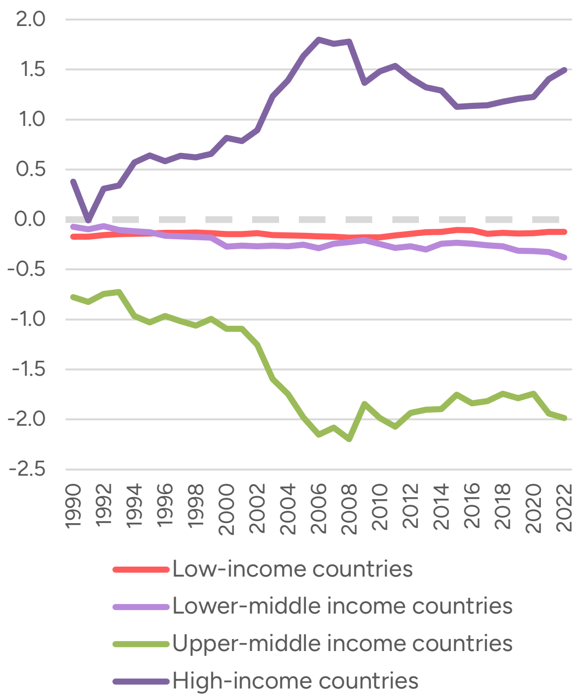
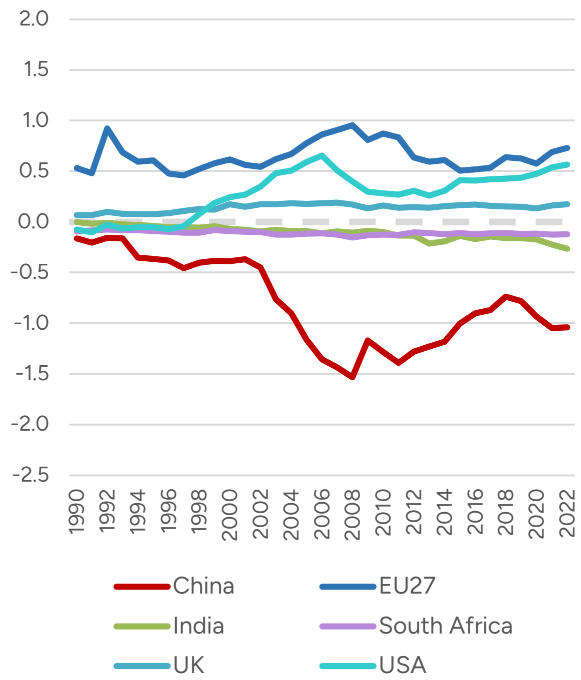


Figure 3.2: Net import-export balance (billion tonnes of CO_2 per annum) for selected regions

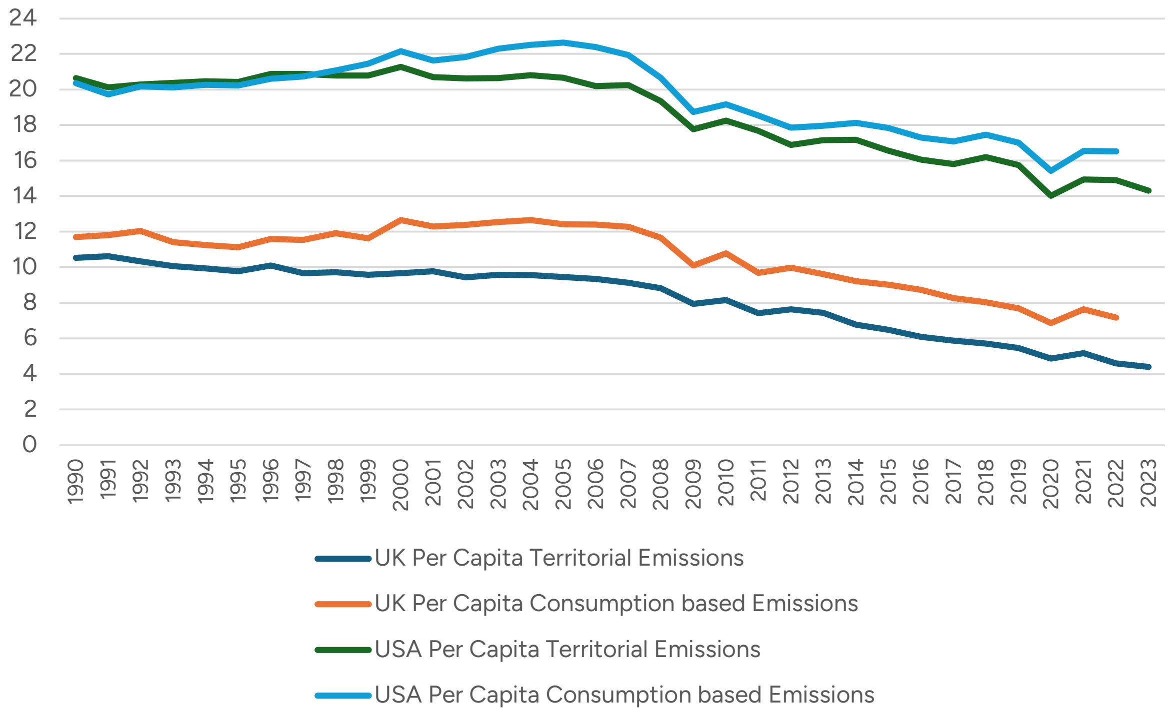


Source Data: Global Carbon Budget (2024a).

Figure 3.2 reveal trends in the total emissions for these major economies. Comparison of per capita emissions embedded in trade reveals a distinct set of trends in terms of the relative contributions of individual consumers to global emissions in these jurisdictions.

Figure 3.3 displays the per capita territorial and consumption-based emission for the UK and the USA. In per capita terms, both territorial and consumption-based emissions are higher in the USA than in the UK. In both the UK and the USA, reductions in territorial emissions were largely offset by increases in consumption-based emissions up until the onset of the Global Financial Crisis, following which both territorial and consumption-based emissions fell and tracked more closely.

Figure 3.3: UK and USA territorial vs. consumption-based CO_2 emissions (tonnes per capita)

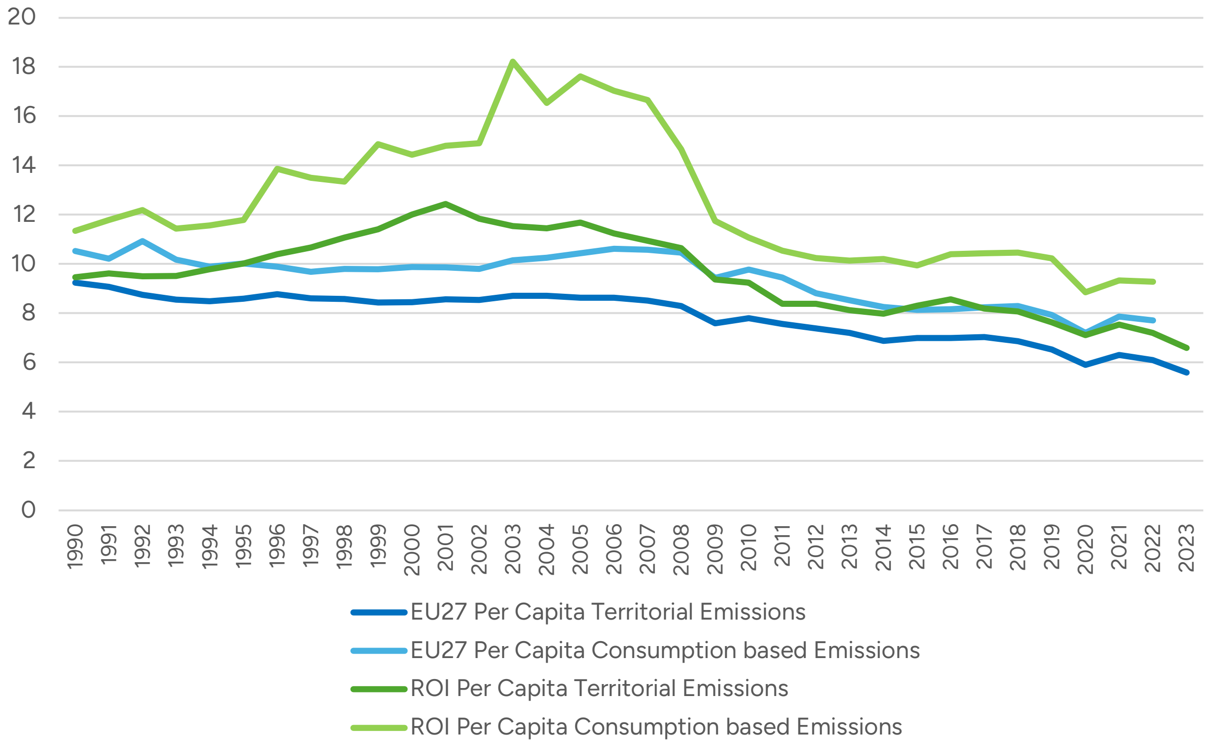


Source Data: Global Carbon Budget (2024b).[6]

These trends are broadly mirrored for the EU27 (see Figure 3.4). Using the FIGARO Multi-Regional Input-Output (MRIO) model, Eurostat has found that emissions embodied in imported goods and services are consistently higher than the emissions embodied in the EU's exports, making the EU a net importer of embodied CO_2 emissions (Eurostat, 2024b). As with the USA and the UK, the EU27's reductions in territorial emissions coincided with increases in consumption-based emissions up until the onset of the global financial crisis, following which consumption levels fell, and both territorial and consumption-based emissions tracked more closely.

6 2023 data for consumption-based emissions not available at time of writing.

Figure 3.4: Territorial & consumption-based CO_2 emissions (tonnes per capita) in Ireland and the EU27

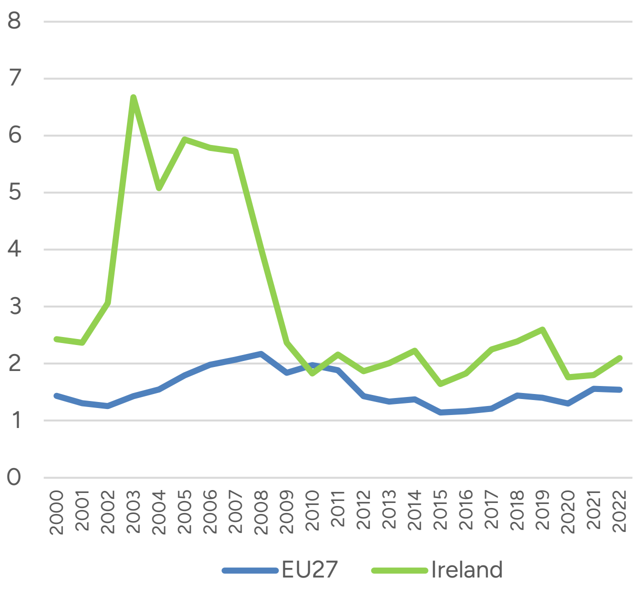


Source Data: Global Carbon Budget (2024b).

Like the EU as a whole, the Republic of Ireland (RoI) is a net importer of emissions – we import more CO_2 embedded in goods and services than we export. Notably, Ireland has had both higher per capita territorial emissions and higher per capita consumption-based emissions than the EU27 average. From 2000 up to the onset of the onset of recession in Ireland in 2008, reductions in Ireland's per capita territorial emissions coincided with increases in the net balance of CO_2 emissions embedded in trade - consumption-based emissions were increasing even as territorial emissions were falling. Ireland's net balance of CO_2 emissions embedded in trade was substantially higher than the EU average throughout the Celtic Tiger period but subsequently fell over the course of the economic downturn (see Figure 3.5 below).

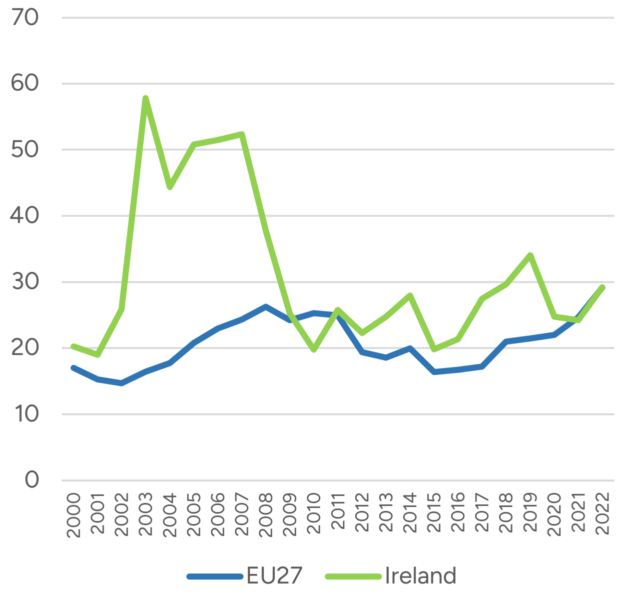
In 2022, 30% of Ireland's carbon footprint was due to the net balance of emissions embedded in trade, a level that is broadly comparable to that for the EU27 (see Figure 3.6). While Ireland was a significant outlier within Europe in terms of the net trade balance of CO_2 emissions embedded in trade during the Celtic Tiger period, Ireland has converged vis-à-vis EU peers in recent years.

Figure 3.5: Net trade balance of CO_2 emissions embedded in trade (tonnes per capita)



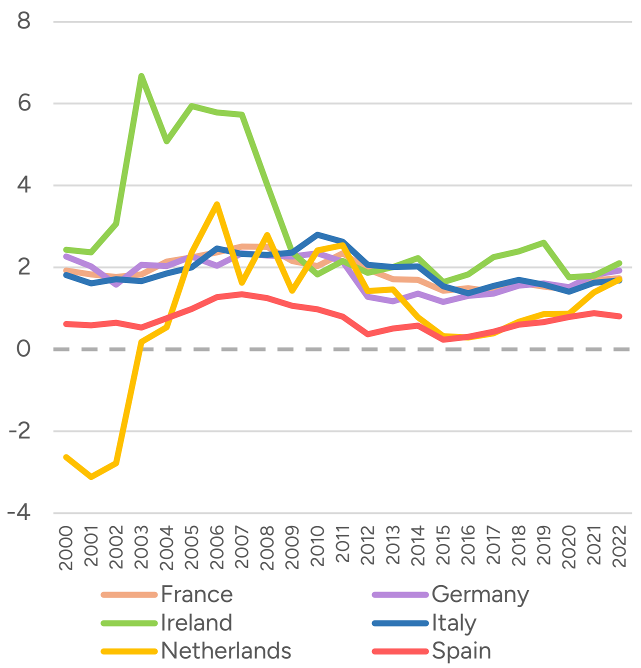
Source Data: Global Carbon Budget (2024c).

Figure 3.6: Share (%) of CO_2 emissions embedded in trade



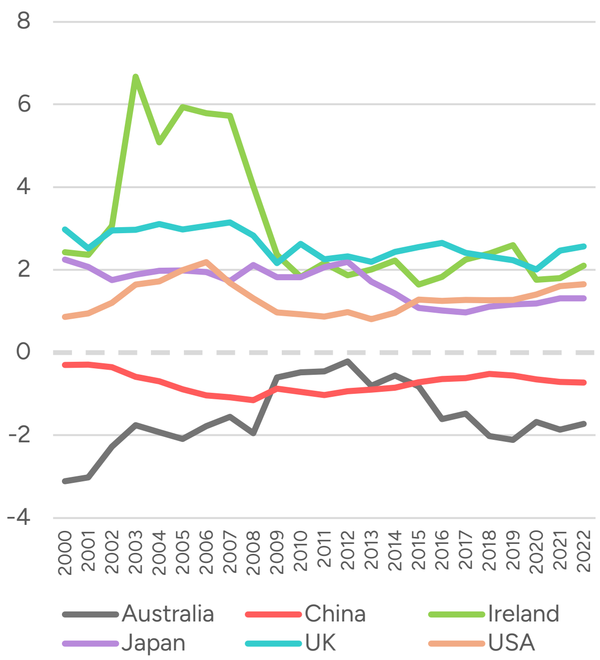
Source Data: Global Carbon Budget (2024d)

Figure 3.7: Net balance of CO_2 emissions embedded in trade (tonnes per capita) - Ireland & selected EU countries



Source Data: Global Carbon Budget (2024c).

Figure 3.8: Net balance of CO_2 emissions embedded in trade (tonnes per capita) - Ireland & selected non-EU countries



Source Data: Global Carbon Budget (2024d).

According to an analysis by De Bruin et al (2024) based on 2017 data[7], by far the largest contributor to Ireland's imports of emissions embedded in trade is fuels, with imports of 7.49 million tonnes of CO_2 equivalent ($MtCO_2eq$) per annum, mainly in the form of petroleum and coal. The next largest contributions are from chemical products (3.48 $MtCO_2eq$), followed by animal agriculture (2.05 $MtCO_2eq$), metal and mineral products (1.88 $MtCO_2eq$), air transport (1.67 $MtCO_2eq$) and plant agriculture (1.23 $MtCO_2eq$) (p.21). In terms of Ireland's exported emissions, the main contributing sectors are air transport (15.3 $MtCO_2eq$), animal agriculture (3.64 $MtCO_2eq$), chemical products (1.59 $MtCO_2eq$) and other transport (1.08 $MtCO_2eq$). The most significant sectors in terms of the net balance of imported emissions embedded in trade are fuels (6.83 $MtCO_2eq$), chemical products (1.89 $MtCO_2eq$) and metal and mineral products (0.95 $MtCO_2eq$).

De Bruin et al note the particularly large contribution of air travel services in Ireland's balance of emissions embedded in trade. Ireland is a substantial net exporter of air travel services due to the large indigenous air travel sector in Ireland and the country's position as an air travel hub. When air travel is omitted, Ireland's net balance of imported emissions rises considerably (ibid).

2.5 The EU's Carbon Border Adjustment Mechanism

The EU's Carbon Border Adjustment Mechanism (CBAM) is the EU's climate policy instrument designed to address carbon leakage by levelling the playing field between EU industries subject to the EU Emissions Trading System (ETS) and foreign producers that are not subject to equivalent carbon pricing regimes. CBAM aims to put a fair price on the carbon emitted during the production of carbon intensive goods imported into the EU while encouraging cleaner industrial production and global supply chains. By confirming that a price has been paid for the embedded carbon emissions generated in the production of certain goods imported into the EU, CBAM aims to ensure that the carbon price of imports is equivalent to the carbon price of domestic production in the EU, and that the EU's climate objectives are not undermined (DG TAXUD, 2025).

CBAM has been partially implemented since October 2023. During the transitional phase businesses are obliged to submit reports on greenhouse gases embedded in their imports on a quarterly basis (EC, 2023d). A definitive CBAM regime is expected to be in place from January 2026 but will initially only apply to a certain number of products with a high risk of carbon leakage. These are:

- Iron & steel
- Cement
- Fertilisers
- Aluminium
- Hydrogen
- Electricity

In February 2025, the European Commission announced a set of changes to simplify CBAM implementation and reduce the administrative burden of compliance for businesses. This package introduced a new CBAM de minimis threshold exemption of 50 tonnes mass.[8] This allows around 99% of emissions to remain within the scope of CBAM, while exempting around 90% of importers.

[7] This analysis uses the Global Trade Analysis Project (GTAP) 11 database using data for 2017, which was the most recent year available in that dataset at the time of publication.

[8] If an EU importer brings in less than 50 tonnes (by mass) of CBAM-covered goods per year, they will be exempt from CBAM obligations for that year.

2.6 The impact of CBAM on goods trade in Ireland

The implementation of CBAM will have several noteworthy implications in Ireland. These include potentially significant impacts in terms of cross-border trade in electricity between the island of Ireland and Great Britain (GB). These electricity trade related issues are dealt with in NESC Council Report no. 169, *International Trade Dependencies and the Energy Transition* (NESC, 2025).

In terms of trade in goods, Irish businesses importing carbon-intensive goods such as cement, steel, aluminium and fertiliser from outside the EU are already obliged to report the embedded carbon emissions associated with these products. From 2026, financial obligations will be introduced, necessitating the purchase of CBAM certificates based on the carbon content of the imported goods. These charges will influence the cost structure and business decisions of Irish importers, particularly those relying on carbon-intensive imports sourced from outside the EU. The introduction of CBAM necessitates that Irish businesses adapt to new reporting requirements and ensure compliance with the mechanism's regulations (Ibec, 2024).

In May 2025, the UK and the EU announced plans to link their respective ETSs as part of a broader initiative to strengthen post-Brexit cooperation (UK Cabinet Office, 2025a). The linking of the EU and UK ETSs will effectively exempt goods trade between the EU and the UK from potential CBAM charges. This agreement is of critical importance from an Irish perspective, given the large share of goods such as iron & steel, fertiliser and cement sourced from the UK.

In order to mitigate the potential impacts of CBAM, Irish importers will ultimately need to evaluate the carbon intensity of goods provided by non-EU suppliers, whether regional carbon pricing regimes are in place in the exporting country, and any potential gaps in carbon prices relative to the EU. Importers may need to consider sourcing alternatives where existing suppliers are deemed to have significantly higher carbon-intensities and low or no carbon pricing regimes as compared to potential alternative suppliers. Such considerations have the potential to result in trade diversionary effects, as importers may seek to reduce their CBAM related costs through alternative sourcing.

In terms of the carbon intensity of RoI iron and steel imports, this can vary considerably across source countries. Figure 3.9 displays the carbon intensity of iron and steel exports in a selection of non-EU countries, as well as the share of Irish imports sourced from these countries. India is a clear outlier in terms of the carbon intensity of its iron and steel exports and does not yet have a cap-and-trade ETS. China's iron and steel production is relatively carbon-intensive and has recently been included in China's ETS (Transition Asia, 2025). However, China's steel sector currently faces a much lower carbon cost, typically under $10–12 per tonne, due to the free allocation of allowances, as compared to more than €100 per tonne in the EU ETS (*ibid*).

In terms of RoI imports of fertiliser, the carbon intensity of fertiliser imported to Ireland is relatively high for Egypt, Russia and Turkey, each of which are significant exporters of fertiliser to Ireland (see Figure 3.10). Egypt is particularly notable as a significant exporter of fertiliser to Ireland that does not have a national carbon tax or ETS in force, while also having high carbon intensity of production.

In terms of RoI imports of cement, these are dominated by the UK, which makes up 91.2% of total RoI imports in value terms (World Bank, 2024b). Almost all other RoI imports of cement are sourced from within the EU, with approx. 2% being sourced from Turkey. As the EU and UK ETSs will ultimately be linked, CBAM will have effectively no impact on the cost of imported cement in Ireland.

Similarly, most RoI imports of aluminium products are sourced from either the UK, Norway or from EU Member States.[9] As a result, the implementation of CBAM will have limited impact on the cost of imported aluminium products.

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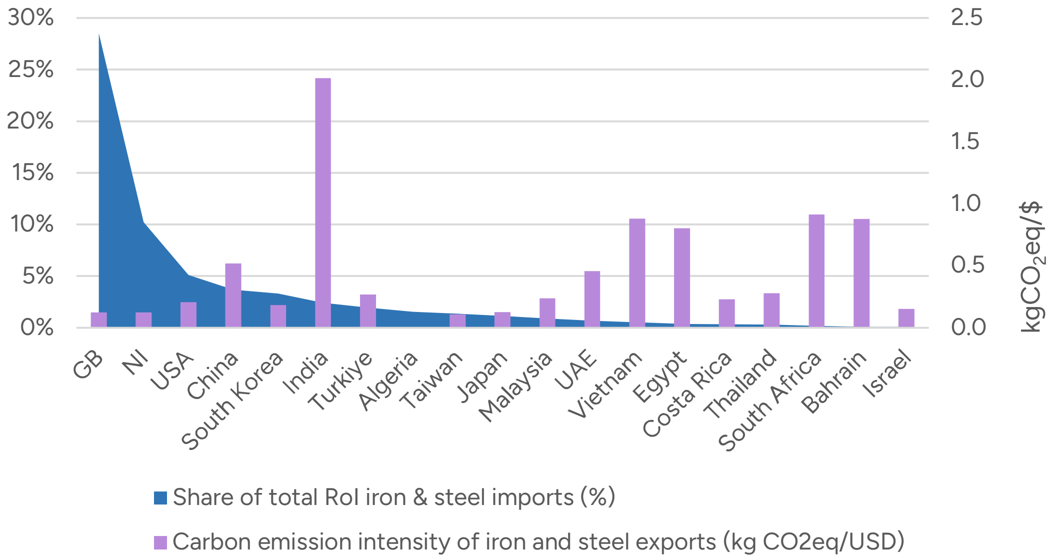
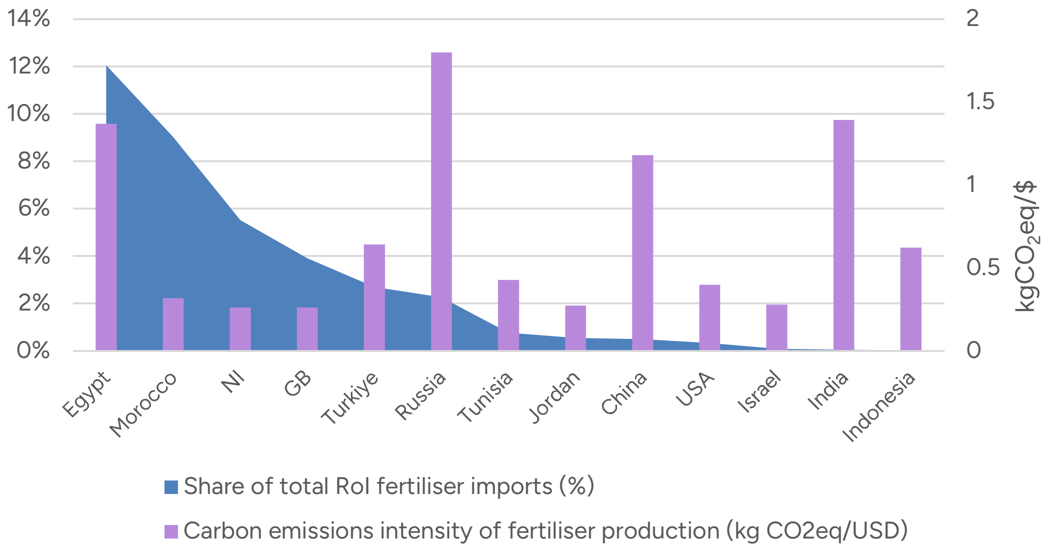
9 In terms of imports of unwrought aluminium, alloyed (HS Code 760120), Ireland sources 65.7% in value terms from the UK, and a further 29.9% from Norway (World Bank, 2025c). Ireland imports 27.7% of its articles of

Figure 3.9: Share (%) of total RoI iron & steel imports and carbon intensity of iron & steel exports (kg CO_2eq/$) for non-EU partner countries



Source Data: CSO (2025) & World Bank (2023).[10]

Figure 3.10: Share (%) of total RoI manufactured fertiliser imports and carbon intensity of manufactured fertiliser exports (kg CO_2eq/$) for non-EU partner countries



Source Data: World Bank (2023); World Bank (2024a).[11]

aluminium such as casting (HS Code 761690) from China, with a value of $16.7m in 2023 (World Bank, 2024d).

10 CBAM charges will not apply to imports of iron and steel from GB or NI when the UK and EU ETSs are eventually linked. UK carbon intensity data displayed for GB and NI. No carbon intensity data available for Algeria at time of writing. Excludes non-EU countries that already participate in the EU ETS. 2023 goods import data and 2023 carbon intensity data.

11 CBAM charges will not apply to imports of fertiliser from GB or NI when the UK and EU ETSs are eventually linked. UK carbon intensity data for GB and NI. No carbon intensity data available for Algeria at time of writing. Excludes non-EU countries that already participate in the EU ETS. 2024 goods import data and 2023 carbon intensity data.

2.7 Advancing policy for global climate mitigation

To address the issue of emissions embedded in trade, the Irish Government should adopt a comprehensive approach that integrates both production-based and consumption-based emissions into climate policy. As this chapter has demonstrated, Ireland's carbon footprint is substantially influenced by imported emissions, particularly in high-emission sectors such as fuels, chemical products, and metal and mineral goods. Territorial emissions alone no longer offer a sufficient basis for assessing the country's contribution to global climate change. In light of this, a shift toward incorporating consumption-based emissions accounting into national policy frameworks is necessary to achieve a more accurate and equitable understanding of Ireland's global climate impact. According to De Bruin & Yakut (2022), "climate policies in Ireland focus on reducing production-based emissions and would need to include measures to address consumption-based emissions to ensure Ireland's global carbon footprint is limited" (p.1).

Munksgaard and Pederson (2001) observe that "the consumer CO_2 accounting principle gives additional information to decision makers about the CO_2 impact of consumer habits" (p.328). This allows for more attention and policy intervention to be directed towards the consumer, through measures such as information campaigns and product labelling related to the carbon intensity and environmental sustainability of imported goods and services.

Ireland should consider the development of additional domestic policy instruments that influence the international sourcing of goods by importing businesses and sustainable consumption practices. One option is to encourage product labelling for goods and services that provide consumers with information on their environmental footprint, including the level of emissions generated in their production and transport (Carbon Trust, 2025).

Investment in carbon literacy and consumer awareness campaigns can also help reduce the demand-side drivers of embedded emissions. Educational initiatives focussed on the environmental impact of consumption can help to drive behavioural change (Charria, 2023). This would align with broader sustainability goals and reinforce the importance of lifestyle choices in contributing to national and global emissions reduction targets.

Several private sector initiatives from companies and coalitions have emerged in response to growing net zero supply chain commitments and increasingly stringent climate disclosure regimes (Aslam & Aisbett, 2023). Such practices can increase demand for lower-carbon products and encourage businesses to give greater consideration to environmental criteria in their international sourcing decisions. Research by Meinrenken et al (2020) has shown that companies with a better understanding of their product's carbon emissions along its life cycle achieve larger reported carbon reductions.

National policy should also advance measures to assist the transition to a circular economy as a means to reduce both territorial and consumption-based emissions. A circular economy focusses on designing out waste, keeping products and materials in use for as long as possible, and regenerating natural systems (Ellen MacArthur Foundation, 2022; 2025). By reducing the demand for raw material extraction and lowering the production of new goods, circular economy initiatives directly address the emissions associated with the full lifecycle of products, including those embodied in imports. Circular economy initiatives can contribute to reducing embedded emissions by substituting imports of carbon-intensive goods with recycled or reused materials already present within the domestic economy (WEF, 2023).

The Circular Economy and Miscellaneous Provisions Act 2022 formally defines the circular economy in Irish law and integrates circular economy principles and targets into waste and resource management systems (Statute Book, 2022). The *Whole of Government Circular Economy Strategy* (DECC, 2021a) outlines the State's overarching vision for transitioning to a circular economy. It establishes a framework for government departments, public bodies, and local authorities to integrate circular principles across all sectors, covering green public procurement, reuse, repair, eco-design, and citizen engagement. The strategy identifies key priority sectors including construction, food, transport and manufacturing, and calls for the development of sectoral roadmaps to guide implementation (ibid).

To further align domestic consumption with global climate goals, public procurement policies should be continually revised to favour low-carbon goods and services. Procurement rules should favour suppliers with verifiable sustainability credentials. Green public procurement (GPP) helps to reduce Ireland's imported emissions and supports the growth of global low-carbon production practices (DECC, 2021b).

Ireland can also play a proactive role at EU and international levels in advocating for broader adoption of carbon pricing mechanisms in external trade and investment policies and for measures that recognise both producer and consumer responsibility in global emissions. By promoting climate cooperation with key trading partners and supporting capacity building in lower-income countries, Ireland can contribute to the global effort to reduce carbon leakage while supporting a fair and just transition. Jakob et al. (2021) propose a responsibility-sharing approach based on the economic benefits derived from emissions, which could serve as a guiding principle in international trade and investment negotiations.

2.8 Conclusion

This chapter has examined the issue of emissions embedded in international trade. Since the early 2000s, global supply chains have become increasingly more integrated, and production processes have become more geographically dispersed. As a result, traditional territorial emissions accounting is largely insufficient to capture the full environmental impact of national consumption patterns.

Evidence presented in this chapter highlights that many high-income economies are significant net importers of carbon emissions. This points to the structural challenge posed by carbon leakage, as historical reductions in domestic emissions can be offset by increased reliance on carbon-intensive imports from jurisdictions with weaker environmental policies or lower carbon pricing. The existence of such leakage risks undermines the integrity and effectiveness of national and regional climate policies and can overstate the extent of progress in reducing emissions in high-income economies where a production-based emissions accounting approach is used.

The introduction of the EU's CBAM marks a significant policy innovation aimed at addressing these concerns. By aligning the carbon cost of imports with those incurred by domestic producers under the EU ETS, CBAM seeks to level the competitive playing field, incentivise cleaner production practices globally, and ensure that emissions reductions within the EU are not negated by offshoring.

For Ireland, the implications of CBAM vary across sectors. While some sectors such as cement and aluminium are largely shielded from the effects of CBAM due to existing trade patterns and ETS linkages, others such as fertiliser and iron and steel, may face more exposure due to sourcing from higher carbon-intensity producers outside the EU.

As CBAM moves from transitional reporting requirements to a definitive financial mechanism from 2026, some Irish businesses may choose to adapt their international sourcing and supply chain strategies to mitigate CBAM's effects. The full implementation of CBAM underscore the importance of transparent emissions data and accessible carbon benchmarking across jurisdictions.

More broadly, the findings of this chapter underscore the need for Irish climate policy to continue to evolve beyond the production-based carbon accounting framework. Incorporating a fuller understanding of consumption-based emissions, supported by targeted policy instruments, consumer awareness initiatives, and transparent emissions data, will be essential in aligning national climate goals with global emissions responsibility. The integration of both producer and consumer accountability in climate policy design represents a step forward in addressing the shared but differentiated responsibilities of a globally interconnected economy.

Ultimately, addressing emissions embedded in trade will require an integrated policy approach that encompasses regulatory reform, international cooperation and engagement, and societal participation. While Ireland's territorial emissions may continue to fall under existing climate policies, true leadership in climate action will require that these gains are not offset by rising consumption-based emissions. National policy that recognises and acts upon the transboundary nature of carbon emissions will be essential in aligning Ireland's economic development with its commitment to global climate mitigation.

Chapter 3 The international biofuel supply chain

3.1 Introduction

The use of biofuels is promoted as reducing reliance on foreign suppliers of fossil fuels and as enhancing security of energy supply (ECA, 2023: 4, 52). While biofuels can be sustainably produced under the right set of conditions, there are land availability and other environmental sustainability constraints associated with expansion of biofuel production both in Ireland and internationally. Potential risk factors associated with greater adoption and use of biofuels include "the negative direct impact that the production of biofuels may have due to indirect land use change (ILUC)" (EC, 2024f).

The European Court of Auditors (ECA) has highlighted sustainability concerns related to food-based biofuels and ILUC "when agricultural land previously destined for food and feed markets is diverted to biofuel production" (ECA, 2023:21). A review by Jeswani et al (2020) has found that reductions in greenhouse gas emissions from biofuels are achieved "at the expense of other impacts, such as acidification, eutrophication, water footprint and biodiversity loss" (p.2).

According to the ECA (2023) "despite their potential to reduce greenhouse gas emissions, biofuels may sometimes have a negative impact on the environment and climate. For example, biofuels … may adversely affect biodiversity, soil and water, and may fail to deliver reductions in greenhouse gas emissions compared to fossil fuel use if these crops require additional land. Extending agricultural land into areas like forests or peatlands may result in additional greenhouse gas emissions rather than reductions" (p.7).

As Ireland increases its use of biofuels to meet renewable energy targets in the transport sector, ensuring the sustainability of biofuel supply chains has become both a strategic and regulatory priority. While biofuels contribute to decarbonising road transport, especially in the short to medium term, they also raise complex environmental, ethical, and economic challenges, particularly in relation to the sourcing of feedstocks that are imported from third countries. The European Commission and Irish authorities have raised concerns over potential fraud in biofuel imports, especially where waste-based fuels are concerned.

This chapter examines the regulatory policy framework for biofuel use in Ireland and the EU, recent trends in Ireland's imports of biofuels, and key environmental issues of concern in relation to the sustainability of imported biofuels in Ireland.

3.2 EU policy context

The European Union's policy on biofuels is centred on promoting the use of sustainable renewable energy in the transport sector while safeguarding environmental integrity and minimising negative impacts such as deforestation and food insecurity.

The EU's policy on biofuels is governed primarily by the Renewable Energy Directive (RED), which was most recently revised in 2023 under Directive (EU) 2023/2413, otherwise known as RED III (EUR-Lex, 2023). This Directive sets out legally binding targets for the share of renewable energy in the EU's final energy consumption, with a specific focus on decarbonising the transport sector. The Directive aims to support the EU's climate and energy goals, particularly those outlined in the European Green Deal and the "Fit for 55" package.

Within the transport sector, Member States are required to ensure a reduction of at least 14.5% in the greenhouse gas intensity of the fuels supplied by 2030. This may be achieved through the incorporation of sustainable biofuels, advanced biofuels, and renewable fuels of non-biological origin (RFNBOs), such as hydrogen-derived synthetic fuels. These targets aim to stimulate the development and integration of cleaner alternatives in a sector that is among the most difficult to decarbonise.

The sustainability of biofuels is tightly regulated under RED III. Only those biofuels that meet rigorous sustainability and greenhouse gas emission savings criteria may count towards national renewable energy targets. Feedstocks must not be sourced from land with high biodiversity value or land with high carbon stock, such as primary forests, peatlands, or wetlands (EC, 2024f). These conditions are intended to prevent deforestation and habitat degradation while promoting climate integrity.

To address concerns around indirect land-use change (ILUC), the EU has implemented a cap on the contribution of crop-based biofuels, limiting their share to no more than 7% of the final energy consumption in transport per Member State (European Parliament, 2015). Furthermore, biofuels considered to be at high risk of ILUC, notably those derived from palm oil, are being phased out.

In parallel, the EU's policy has shifted from supporting crop-based biofuels to promoting advanced and non-food-based biofuels (ECA, 2023: 6). These include residues and waste materials such as used cooking oil, animal fats, and agricultural residues. Advanced biofuels benefit from additional incentives, including double counting towards renewable targets, to encourage investment in innovative production technologies. By 2030, Member States are required to ensure that advanced biofuels represent at least 3.5% of energy supplied to the transport sector.

The EU's policy also includes sector-specific regulations to further integrate sustainable fuels. The ReFuelEU Aviation Regulation mandates minimum shares of sustainable aviation fuels (SAFs), starting at 2% in 2025 and scaling up to 70% by 2050. For the maritime sector, the FuelEU Maritime Regulation imposes progressive reductions in the greenhouse gas intensity of energy used on board ships, beginning with a 2% cut in 2025 and reaching 80% by mid-century. These initiatives are designed to support the use of biofuels and RFNBOs in sectors where electrification is currently limited.

Implementation and compliance with EU biofuels sustainability criteria are monitored through mandatory reporting obligations for Member States, alongside verification via EU-recognised voluntary certification schemes such as the International Sustainability and Carbon Certification (ISCC). These schemes ensure traceability and compliance with sustainability and greenhouse gas emission savings criteria across the entire supply chain. The European Commission oversees implementation and retains the authority to take corrective action, including suspension of schemes or infringement procedures, where Member States fail to meet their obligations.

3.3 The renewable transport fuel obligation

The Climate Action Plan (CAP) aims to achieve a 50% reduction in carbon emissions in the transport sector by 2030. In addition to measures to increase sustainable mobility, public and active travel, and electrification of road transport, the CAP aims to increase biofuel use in transport as a transitional measure, with the sector contributing 13.7% of transport sector decarbonisation by 2030.

Ireland has set targets for biofuel use as part of the CAP in order to reduce greenhouse gas emissions. These targets include a minimum of 20% biodiesel (B20) in diesel and 10% bioethanol (E10) in petrol by 2030.

Ireland's policy and targets on biofuel use are centred on the Renewable Transport Fuel Obligation (RTFO). The RTFO places an obligation on suppliers of mineral oil to ensure that 25% (by energy content) of the motor fuel (gasoline and motor diesel) they place on the market in Ireland is renewable, e.g. bioethanol or biodiesel (NORA, 2025). The RTFO aims to increase the use of biofuels, reduce reliance on fossil fuels, and contribute to meeting Ireland's renewable energy targets and climate goals.

The RTFO includes an additional obligation for 'advanced biofuels'[12] and a cap on fuels produced from food and feed crops. In 2024, the advanced obligation was 1% (by energy content). For 2025, the advanced obligation is 1.5% (by energy content).

3.4 Ireland's imports of biofuels

There are limited domestic resources available to expand production of biofuels in Ireland (ESB, 2024). Ireland currently has one of the lowest levels of domestic productive capacity in biodiesel and bioethanol in Europe and remains broadly reliant upon imports from other European countries (Byrne Ó Cléirigh, 2022).

Biofuel import volumes have grown consistently in recent years, with biodiesel making up an increasing share of liquid biofuels imported to Ireland (see Figures 4.1 & 4.2).

Figure 4.1: Irish indigenous production and international trade (ktoe) in liquid biofuels

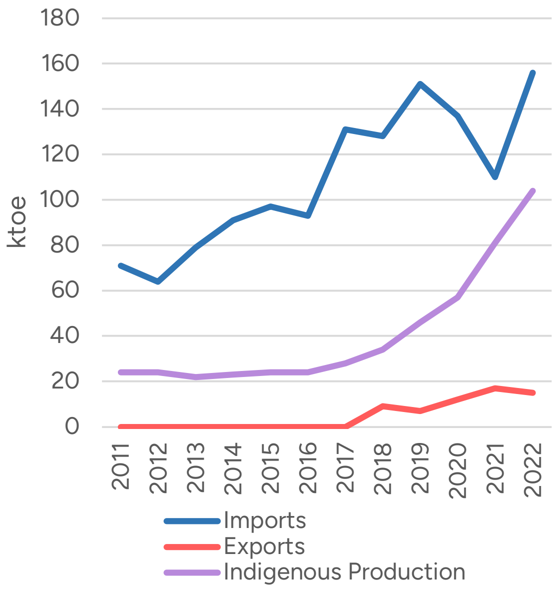
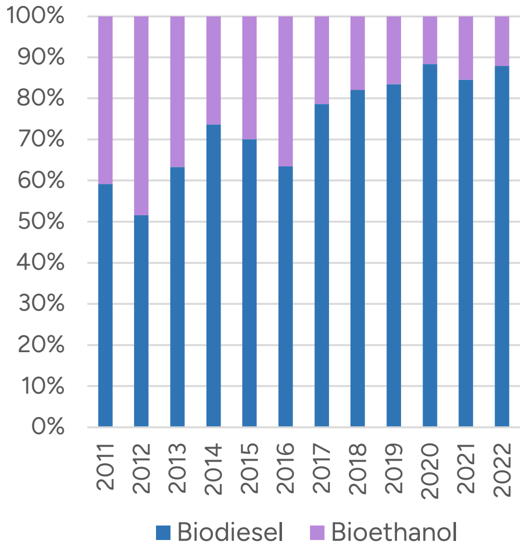


Figure 4.2: Share (%) of Irish biofuel imports by fuel type



Source Data: CSO (2023).

Over the past decade, Ireland has sourced all of its imported biodiesel from the Netherlands, Belgium, the UK and Spain, and sourced all its imported bioethanol from the Netherlands, France, the UK and Spain (see Figures 4.3 & 4.4).

12 Advanced biofuels are liquid fuels produced from non-food feedstocks like waste and residues, and they offer a higher reduction in greenhouse gas emissions compared to traditional biofuels.

Figure 4.3: RoI imports (ktoe) of pure biodiesel by source country

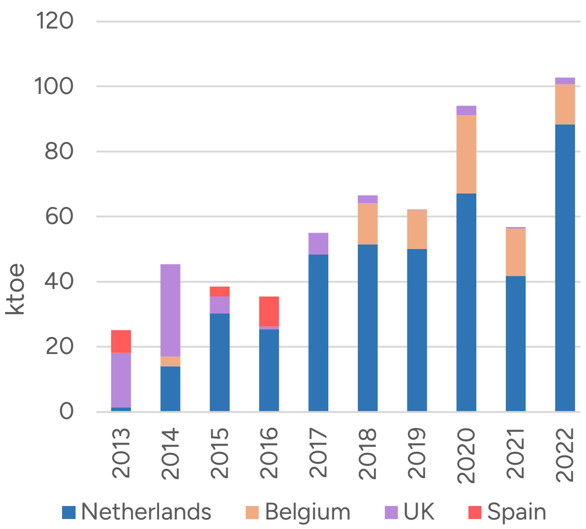
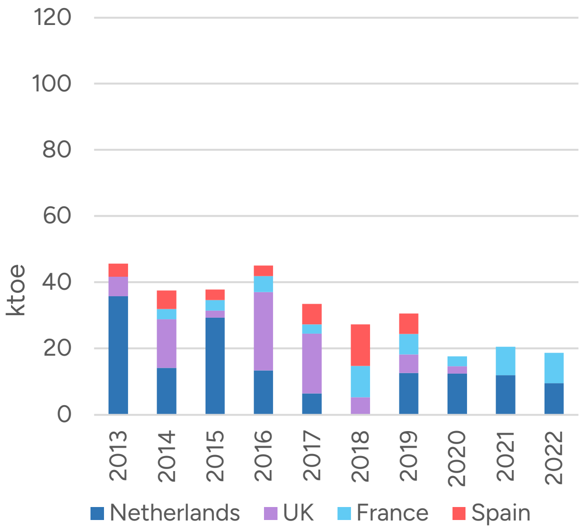


Figure 4.4: RoI imports (ktoe) of bioethanol by course country



Source Data: Eurostat (2024c).

Key considerations when assessing the environmental sustainability of Ireland's biofuels imports is the type of feedstocks used by biofuel suppliers, how these feedstocks are produced, and where they are sourced from.

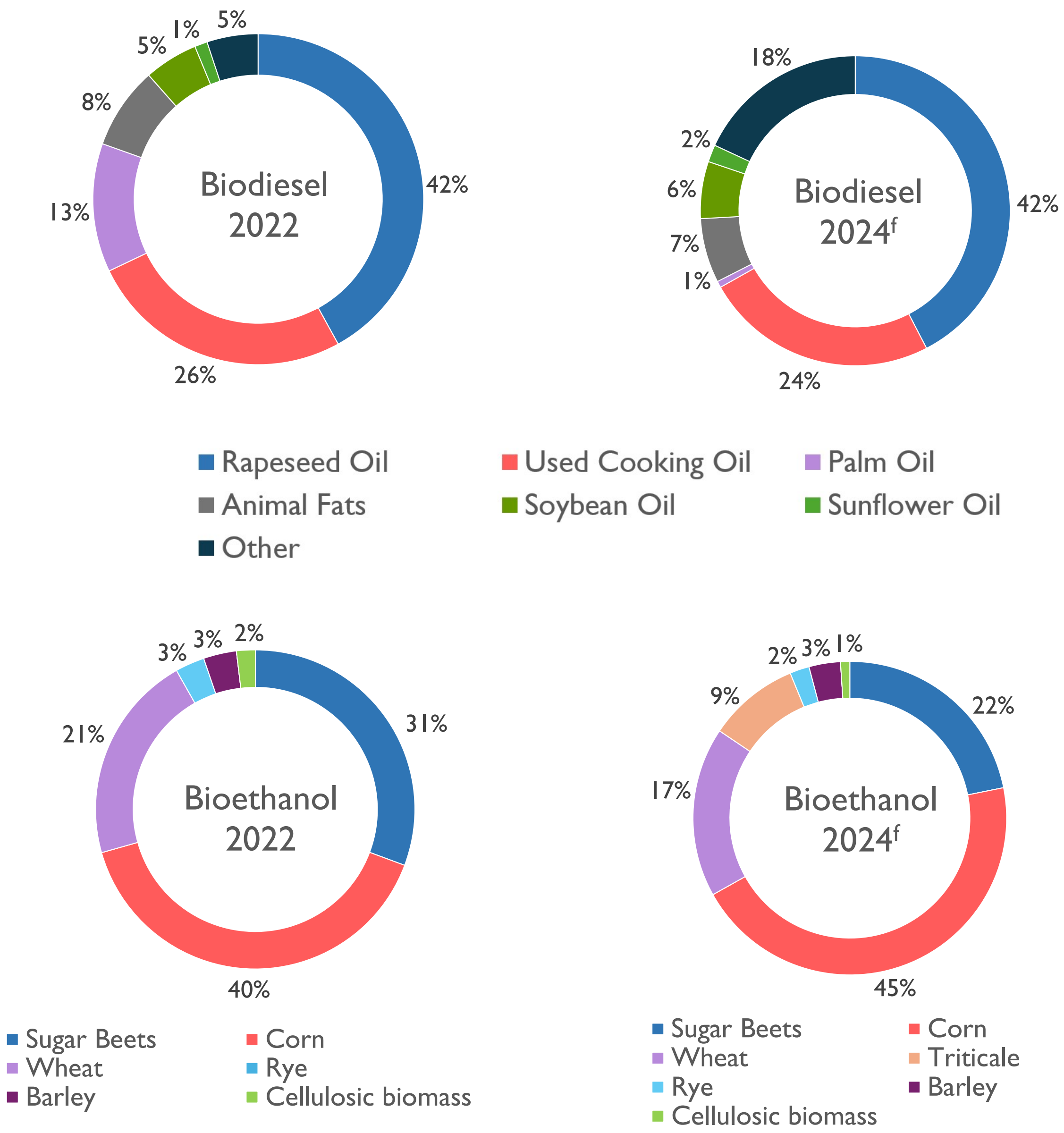
Figure 4.5 displays the share of feedstocks used in the production of biofuels in the EU in 2022 and 2024. The share of palm oil in EU biofuel feedstock fell from 13% in 2022 to 1% in 2024. In terms of bioethanol feedstocks, triticale made up 9% of feedstocks used in the EU in 2024, up from 0% in 2022.

The EU's growing reliance on imported feedstocks for biofuel production has raised several environmental, regulatory, and market integrity concerns. While the RED imposes strict sustainability and greenhouse gas emissions criteria on biofuels used within the EU, challenges persist in verifying that imported feedstocks meet these standards. The primary concerns relate to fraudulent declarations, indirect land-use change (ILUC), traceability gaps, and the classification of waste-based inputs.

A particular area of concern is the continued use of high ILUC-risk feedstocks such as palm oil. Although RED II and its associated Delegated Regulation (EU) 2019/807 establish a pathway to phase out these fuels by 2030, including a cap on crop-based biofuels, enforcement remains uneven across EU Member States (EUR-Lex, 2019). The risk that biofuels indirectly drive deforestation and biodiversity loss, especially in tropical producer countries, persists when sustainability standards are not robustly audited.

The traceability of waste-based feedstocks, such as used cooking oil (UCO) and animal fats, is a key concern. The EU has seen a sharp rise in the import of UCO from countries in Southeast Asia, where regulatory controls relating to waste collection systems are often limited. Reports from independent watchdogs and NGOs indicate that this imported UCO can originate from virgin oils that have not undergone actual end-use, thereby undermining the sustainability claims attached to these fuels (Transport & Environment, 2024). Investigative findings suggest that some suppliers blend virgin palm oil with genuine waste oil or mislabel the feedstocks to exploit the EU's double-counting provisions under the RED (Van Grinsven et al, 2020).

Figure 4.5: Share (%) of feedstocks used in biofuels production in the EU



Source Data: U.S. Dept. of Agriculture (2022; 2024).

3.5 Misclassification of palm oil imports

In March 2025, the Irish government announced plans to implement stricter controls on biofuel imports following reports of potential fraud involving mislabelled feedstocks. Investigations by the National Oil Reserve Agency (NORA) discovered that biofuels imported into Ireland, purportedly derived from sustainable waste products like palm oil mill effluent (POME), may actually consist of virgin palm oil - a feedstock not classified as sustainable under EU regulations (Murray, 2025).

The NORA investigation identified discrepancies in import data, noting that Ireland had imported millions of litres of POME-based biofuel from China, despite the fact that China does not produce palm oil (O'Halloran, 2024). The Pome imported to Ireland is believed to have actually been sourced from Indonesia and Malaysia (Murray, 2025). Such anomalies suggest that some overseas suppliers were reclassifying virgin palm oil to exploit EU incentives for sustainable fuels.

Practical enforcement challenges, especially concerning the traceability of imports and fraud in waste-based fuel streams, continue to undermine comprehensive enforcement of EU regulation on biofuels. The European Commission has acknowledged these gaps and is undertaking reforms to tighten supply chain controls, improve certification processes, and support better data collection across Member States (European Parliament, 2024).

3.6 Conclusion

Maintaining the environmental credibility of biofuel imports is essential to achieving Ireland's 2030 climate targets in the transport sector. However, international sourcing of biofuels and associated feedstocks raises concerns in relation to Indirect Land Use Change (ILUC), deforestation and biodiversity loss. This is particularly true in tropical regions and where large-scale plantations are concerned.

Ireland must meet its obligations under the EU RED, which mandates strict sustainability criteria across the entire biofuel supply chain. However, implementation and oversight remain challenging given the global scale of biofuel and feedstock supply chains.

Reliance on third-party certification schemes, voluntary declarations by suppliers and external regulators in third countries outside the EU highlights the need to enhance monitoring and reporting efforts to ensure the environmental and social sustainability of global biofuel and biofuel feedstock production at national and EU levels.

To address these challenges, Ireland needs to enhance import screening protocols, strengthen traceability systems, and advocate for stronger EU-level enforcement and certification harmonisation.

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