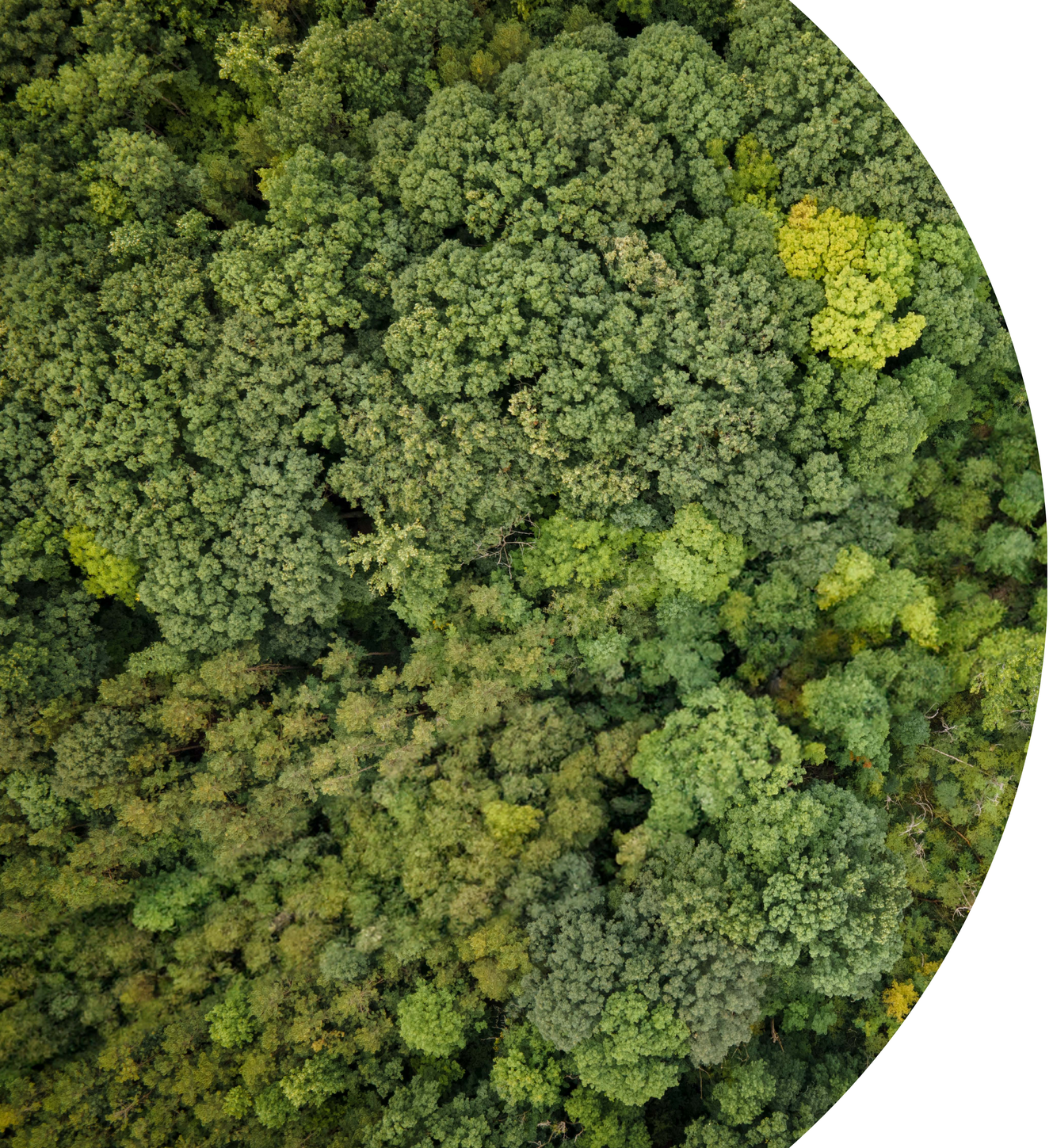


ARUP

Arup guide to EU decarbonisation legislation

2025

ARUP

Evolving EU legislation will affect your planning, design and investment decisions. Arup can guide you.

Contents

Foreword

2024 reflections and 2025 look-ahead

EU carbon legislation overview

1. Legislation Spotlight

RED III & H&GDP

- Introduction
- Impact of RED III on other legislative items
- What's new with the H&GDP
- Methodology Delegated Act and its significance
- Additionality Delegated Act and possible exemptions

Sustainable alternative fuels

- Sustainable alternative fuel types
- Sustainable aviation uels
- Share of RFNBO in coproduced fuels

Imported sustainable alternative fuels

- Global production centers
- EU SAF production capacity
- Requirements for non-EU producers
- Fuel certification requirements

2. Sector Timelines

- Compliance carbon market
- Aviation
- Maritime
- Carbon-intensive industries
- E-Fuel Sector in the EU and UK
- Sustainable industries

Appendix

- A. Acronyms and Terminology
- B. Categories of EU legislation
- C. Description of legislative items
- D. RED III – Additional resources

Foreword

Understanding the evolving EU decarbonisation legislation and its impact and requirements, will be key to development and investment in transport and energy infrastructure in Europe. Project planners, designers, developers, and investors will all need to be aware of the legislative items to progress projects in this space.

2024 saw significant advances in European Union (EU) decarbonisation legislation, continuing the momentum from the year prior. The new and adopted legislation is expected to spur significant investment in hydrogen and its derivatives, maritime and aviation fuels, alternative power for road transportation, green steel, zero-carbon chemicals and advanced manufacturing.

In addition to new legislation, 2024 also allowed the market to observe the initial implications and limitations of the legislation adopted in 2023 (the bulk of the Fit-for-55 legislation package), with all sectors facing challenges.

– The **transport** sector is juggling growing decarbonisation mandates (via RED III, ReFuelEU, FuelEU, HDV Emission Standards) with the challenge of the associated costs that they must bear, for example for purchase of sustainable alternative fuels; construction of new infrastructure to facilitate the transition (mandated via the Alternative Fuels Infrastructure Regulation (AFIR)); and greater obligations under the EU ETS. In maritime, FuelEU, as a regional regulation, does not have enough reach to effectively influence the global market.

– In the **energy** sector, while the regulatory support for uptake of sustainable alternative fuels is strong (particularly in aviation), many developers are struggling to progress projects to a bankable state and investors have a limited risk appetite, considering, primarily:

  i. Strict requirements under the delegated acts of RED III for sourcing of renewable electricity and sources of carbon;

  ii. Difficulty in securing long-term offtake contracts, due to current and projected price-gap to conventional fuels, particularly in the maritime sector; and

  iii. Lower Technology Readiness Levels (TRL); and

  iv. EPC contracting structure, risk-sharing approach, and project interfaces.

– **Carbon-intensive industries**, including manufacturing, face the challenge of accelerating decarbonisation to avoid being penalised by costs from EU ETS (following phase-out of free allowances) while having to remain cost-competitive with non-EU competitors. Carbon captured from industrial sources may also become invalid for sustainable alternative fuel production from 2041, restricting the deployment of carbon capture and utilisation (CCU) in the sector.

Navigating the legislative landscape in developing and investing in projects in these sectors is challenging, particularly while the legislation is continuing to evolve and develop. This guide aims to highlight some of the significant changes and takeaways.

Brigitte Danks
Consultant
Europe Advisory Services

Clara Jessop
Senior Consultant
Europe Advisory Services

2024 reflections and 2025 look-ahead

Important EU decarbonisation legislation was adopted during 2024

– All Fit-for-55 legislation has now been adopted, except for the Energy Taxation Directive (ETD) revision for which agreement has not yet been reached.

– The Hydrogen and Gas Decarbonisation Package (H&GDP), adopted in May 2024, filled the missing piece of the puzzle regarding hydrogen and derivates production requirements, providing investors with greater clarity.

– Further clarity was gained on legislative support and requirements for carbon capture, utilisation and storage (CCUS), integral for understanding its role to play.

– Net Zero Industry Act was adopted in June 2024, supporting production of net-zero technologies within the EU, job creation, and foreign investments, as was the Critical Raw Materials Act (April 2024), designed to address the supply chain vulnerabilities of critical raw materials of strategic importance for the EU economy.

– Revised regulation on CO_2 emission standards for heavy-duty vehicles (HDVs) puts pressure on the road transport sector to accelerate the uptake of zero- and low-emission HDVs.

2024 also saw significant milestones in existing legislation

– 2024 was the maritime sector's first year being included in the EU Emission Trading System (ETS).

– Beginning of mandated annual reporting for the Carbon Border Adjustment Mechanism (CBAM) as well as for the Corporate Sustainability Reporting Directive (CSRD).

– The aviation sector's first year having reduced free allowances (25% reduction) under the EU ETS.

– Deadline for Member States (end of 2024) to transfer ReFuelEU into national law, including specifying the penalty scheme for non-compliance.

– Under the Alternative Fuel Infrastructure Regulation (AFIR), numerous infrastructure requirements for Member States were due by 2025, such as for electric (light-duty) vehicle recharging stations, liquefied methane refuelling stations and electricity supply at terminal-side aircraft stands.

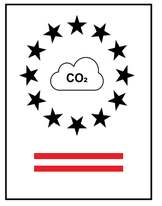
Additional adoptions and milestones are expected during 2025

– The Delegated Act for the Hydrogen & Gas Decarbonisation package expected to be adopted during the first half of 2025, following the draft published in September 2024.

– 2025 will be the first year that the mandates under ReFuelEU and FuelEU apply, for SAF uptake and greenhouse gas (GHG) emission intensity reduction respectively.

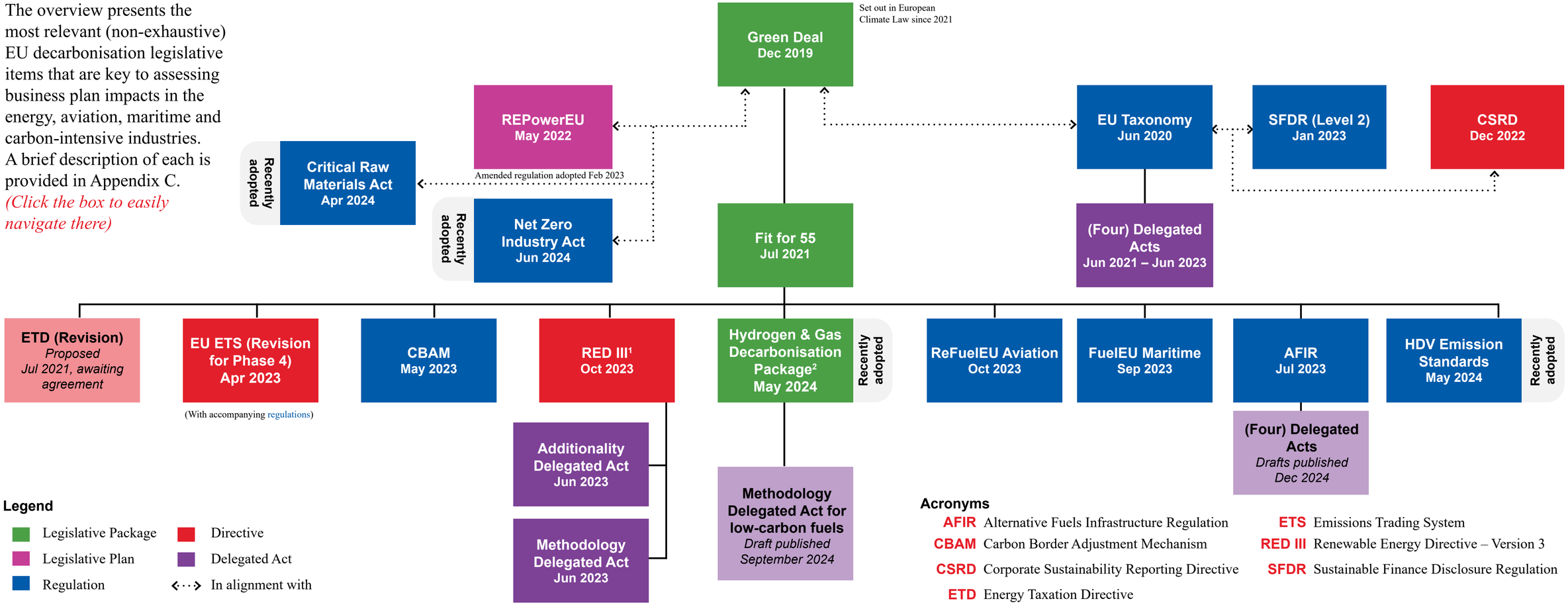
– With the inclusion of maritime in the EU ETS ramping up to covering 70% of emissions in 2025 and 100% in 2026, the industry expects 2025 and 2026 to demonstrate the extent to which EU port evasion will likely occur.

– The planned adoption of the International Maritime Organisation's mid-term measures will provide much awaited answers on a global regulatory framework for maritime.



EU carbon legislation relevant to the energy, transport and carbon-intensive industries

The overview presents the most relevant (non-exhaustive) EU decarbonisation legislative items that are key to assessing business plan impacts in the energy, aviation, maritime and carbon-intensive industries. A brief description of each is provided in Appendix C. *(Click the box to easily navigate there)*



Policies and regulations within the EU, with date of adoption indicated
Source: European Commission

Acronyms

AFIR	Alternative Fuels Infrastructure Regulation	**ETS**	Emissions Trading System
CBAM	Carbon Border Adjustment Mechanism	**RED III**	Renewable Energy Directive – Version 3
CSRD	Corporate Sustainability Reporting Directive	**SFDR**	Sustainable Finance Disclosure Regulation
ETD	Energy Taxation Directive		

[1] "RED III" is what the industry commonly uses to refer to the 2023 revisions to the 2018 Renewable Energy Directive (RED II)
[2] Includes Directive (EU) 2024/1788 and Regulation (EU) 2024/1789

ARUP

Legislation Spotlight

RED III and Hydrogen & Gas Decarbonisation package

RED III and Hydrogen and Gas Decarbonisation package: latest changes

The Hydrogen and Gas Decarbonisation Package (H&GDP) adopted in 2024 builds on and complements the Renewable Energy Directive (RED III) by defining the requirements for low-carbon fuels.

Recent legislation for alternative sustainable fuels

– RED III (2023) refers to the latest revision of the Renewable Energy Directive, revising the 2018 version (RED II). RED III increased targets and support for renewable fuels of non-biological origin (RFNBOs) (including green hydrogen) and recycled carbon fuels (RCFs), including sector-specific targets (refer to Appendix D).

– Importantly, 2023 also saw the adoption of the associated Additionality and Methodology Delegated Acts, which define requirements for renewable energy, RFNBOs and RCFs.

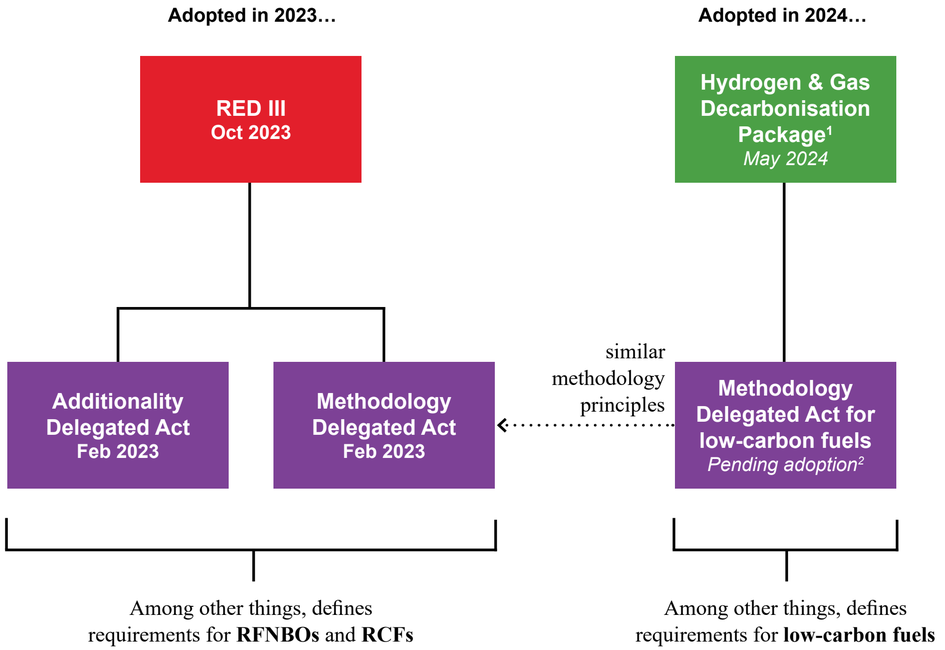
– The EU recognised low-carbon fuels (that do not qualify as RFNBOs or RCFs) as able to play a role in accelerating the adoption of low-carbon technologies and supporting the overall goal of reducing GHG emissions, however requirements for this fuel category were not defined under RED III.

Hydrogen & Gas Decarbonisation package

– The H&GDP, adopted in May 2024, defines (among other things) the requirements for low-carbon fuels. These fuels are non-fossil based and have a 70% emission reduction compared to the fossil fuel comparator but do not qualify as RFNBOs or RCFs under RED III and the associated delegated acts.

– In September 2024 a draft Methodology Delegated Act for low-carbon fuels was published by the European Commission (EC). Adoption is expected in the first half of 2025.

– The majority of the principles for the draft H&GDP Methodology Delegated Act are the same as for RED III, simplifying application for developers. Some key additions are explained in this publication.



1– Includes Directive (EU) 2024/1788 and Regulation (EU) 2024/1789
2- Draft published September 2024, with adoption expected in the first half of 2025

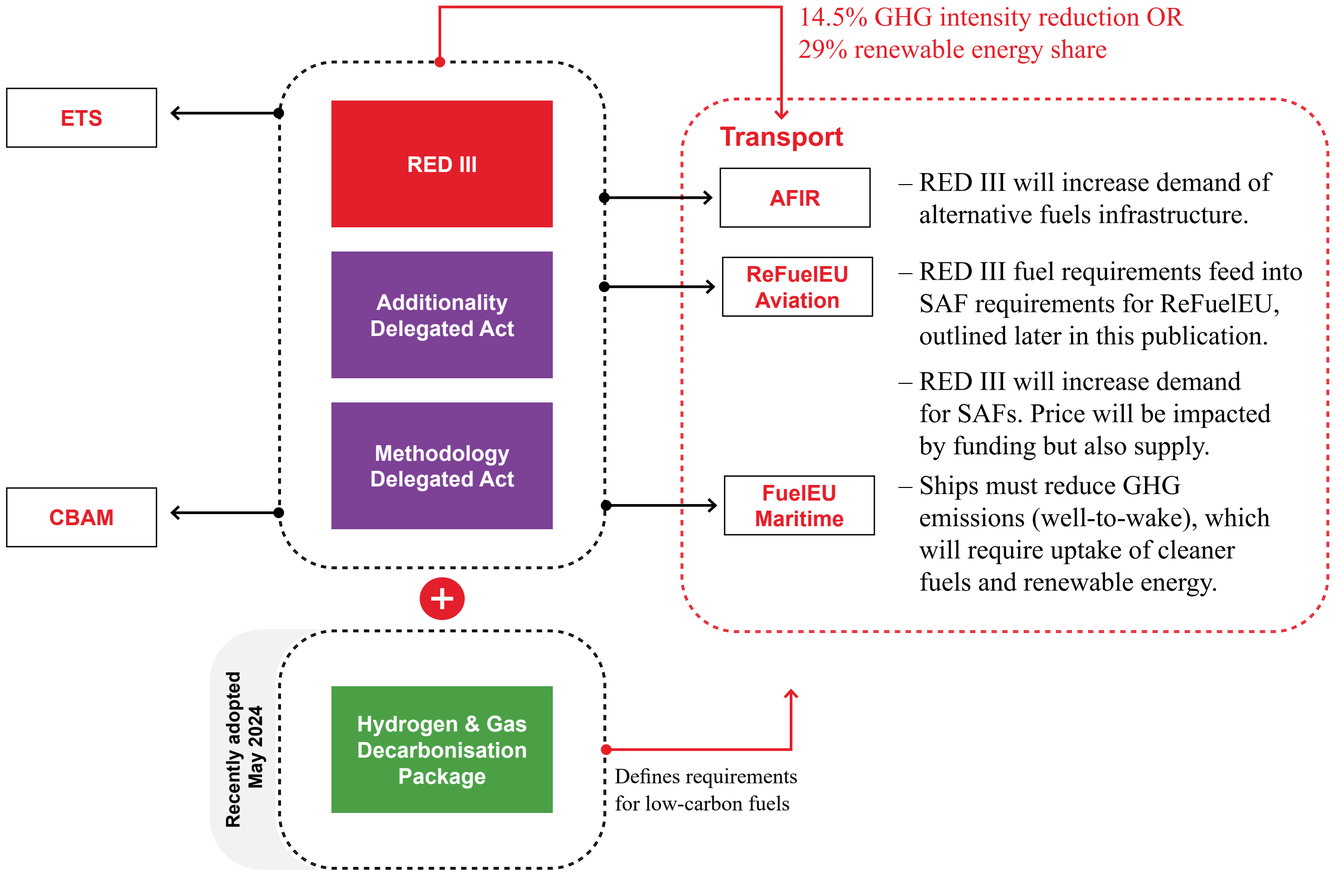
RED III is central to several other legislative items

RED III and H&GDP are central to a lot of the EU decarbonisation legislation, as they set targets for various sectors and define what can be considered as RCFs, RFNBOs and low-carbon fuels, relevant for certification.

– As industries transition to cleaner energy sources and fuels in response to RED III, reduced emissions will mean companies will be able to sell unused ETS credits from their free allowances on the secondary market, until free allowances are phased out (in 2034).

– The market price of ETS credits may be impacted by the accelerated transition prompted by RED III.

– RED III and the associated funding to support innovation and transition may impact prices of products produced in the EU while CBAM may impact prices of imported products.



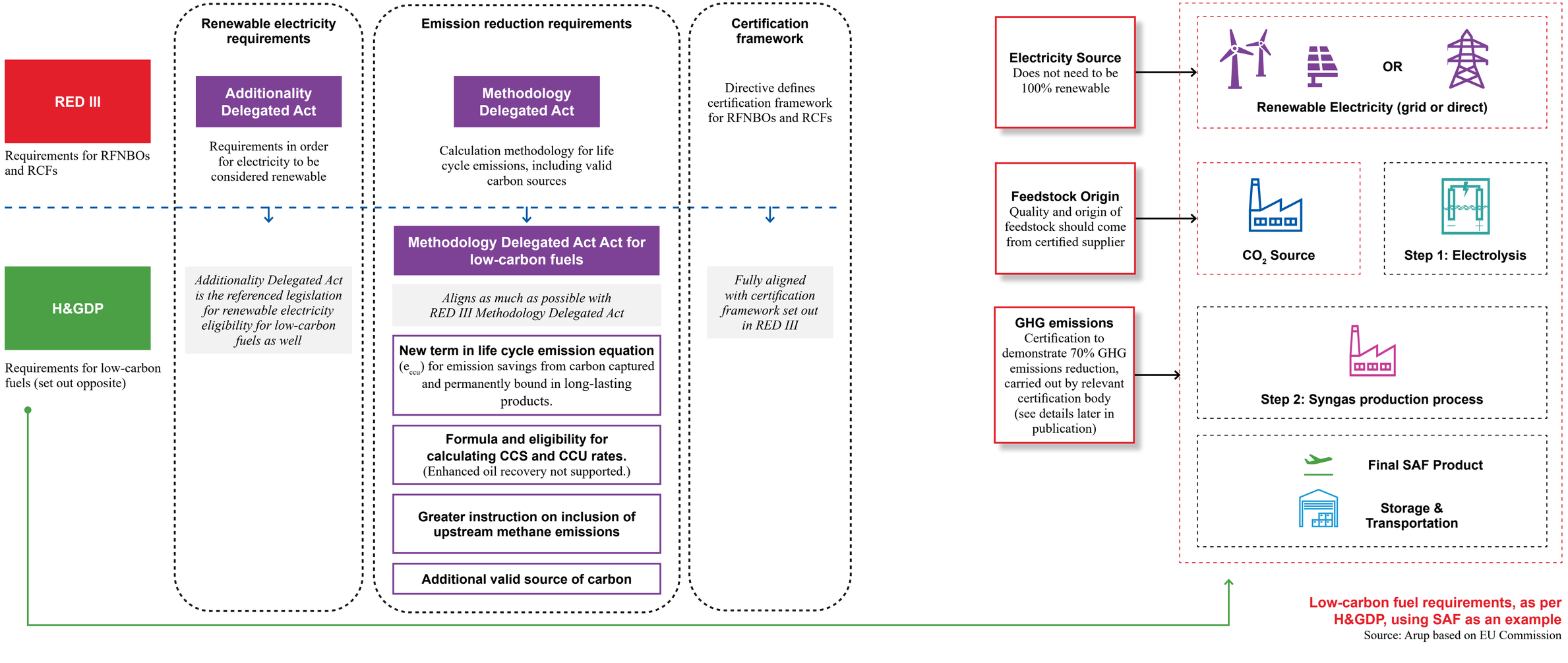
– To meet RED III GHG emission reduction targets, emission savings from transport must be calculated according to the process set out in the Methodology Delegated Act.

– RED III will prompt better financial support for the regulations listed adjacent.

– Fuels used to meet various targets set out in RED III must have at least 70% reduction of GHG emissions compared to fossil fuels.

Hydrogen & Gas Decarbonisation package

Hydrogen & Gas Decarbonisation package (H&GDP) (May 2024) complements RED III and addresses the gap in the legislation for low-carbon fuels. The Delegated Act for GHG methodology is pending adoption, however a draft was published September 2024.



Low-carbon fuel requirements, as per H&GDP, using SAF as an example

Source: Arup based on EU Commission

Methodology Delegated Act(s) | Calculation of emissions

The Methodology Delegated Act of RED III defines the calculation methodology for the life cycle emissions of RFNBOs and RCFs. The draft Methodology Delegated Act for low-carbon fuels (of the H&GDP) sets a similar calculation method, with an additional defined term (e_{ccu}).

Key objectives of the Methodology Delegated Act(s)

– The Methodology Delegated Act(s) of RED III (and the H&GDP in draft form) specify the following:

1. **Minimum threshold of GHG emission savings**:
   – The total life-cycle emissions from the production and use of RFNBOs, RCFs (and low-carbon fuels) must deliver a 70% or more reduction of emission to that of the fossil fuel comparator of 94 gCO2e/MJ. This equates to life-cycle emissions of less than 28.2 gCO2e/MJ.
2. **Valid sources of carbon** for the consideration of avoided emissions, summarised on the following page.
3. **Standard methodology** for calculating the emission reductions of RFNBOs and RCFs (RED III) and low-carbon fuels (H&GDP), with key contributors summarised opposite.

– Items (1) and (3) from the list above create stricter requirements and accountability for sustainable alternative fuels, and these requirements carry on to other regulations such as ReFuelEU.

– Item (2) ensures that the carbon used in the production of RFNBOs and RCFs is sustainably sourced and does not detract from the overall ambition to lower GHG emissions; and prevents double-counting of avoided emissions.

Emissions from processing including leakages and waste treatment

Emissions from all transportation and distribution of the fuel up to the end customer

Emissions from combusting the fuel in its end-use

(net) emission savings from carbon capture and geological storage

$$E = e_i + e_p + e_{td} + e_u - e_{ccs} - e_{ccu}$$

Elastic + Rigid – Existing use input emissions

e_i *elastic*
Elastic inputs
Inputs for which the supply expands with increasing demand.
e.g. electricity, hydrogen, petroleum products

e_i *rigid*
Rigid inputs
Inputs where supply cannot be expanded to meet extra demand, i.e. the input is diverted from an existing use.
e.g. blast furnace gas that was previously used for power generation; all inputs qualifying as a carbon source for the production of RCFs

$e_{ex\text{-}use}$
Existing use input emissions
The avoided emissions when an input is utilised in fuel production instead of its existing use or fate which would have resulted in emissions into the atmosphere.
i.e. the carbon utilised in the fuel production was taken from an existing process that is defined as a valid source of CO2 (refer to following page).

To consider avoided emissions, the carbon must be a valid carbon source, as discussed overleaf

Net emission savings from carbon captured and permanently chemically bound in long-lasting products.
For low-carbon fuels only (as per draft Delegated Act for the Hydrogen & Gas Decarbonisation package).

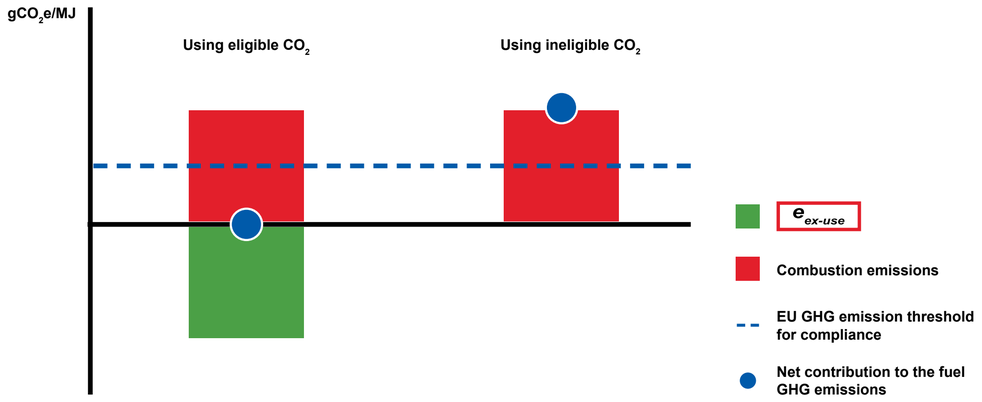
Methodology Delegated Act(s) | Valid sources of carbon

In most cases, RFNBOs, RCFs and low-carbon fuels must use a valid source of carbon to meet the 70% emission reduction requirement.

– When the carbon used in the fuel production process is considered a valid source of carbon, the carbon dioxide can be considered as avoided emissions temporarily stored in the fuel, compensating the end-use combustion emissions.

– Without the subtraction of these avoided emissions, the life cycle emissions of the sustainable alternative fuel are unlikely to be under the 28.2 gCO2e/MJ emission threshold, as depicted graphically below.

– From 2041, carbon dioxide captured from industrial activities will no longer be a valid source of carbon. Due to limited availability of valid biogenic sources worldwide, this impending limitation on valid carbon sources is currently blocking the development of numerous new projects. The exclusions are not imminent, being in 2036 and 2041, and the legislation may change before these deadlines arise (noting the EU have committed to reviewing these deadlines).



Illustrative depiction of how consideration of e_{ex-use} for eligible CO_2 can cancel out combustion emissions under the Methodology Delegated Act(s)
Source: Arup

Valid Carbon Sources	Currently/Eventually Invalid Carbon Sources
Captured CO_2 from an ETS-obligated facility[1] that already paid for the ETS allowance (not indefinitely, see to the right)	From 2036 onwards, CO_2 captured from industrial activities for electricity production specifically From 2041 onwards, CO_2 captured from any industrial activities in Dir. 2003/87/EC such as cement, oil or steel production
Captured CO_2 from combustion of RED-compliant biofuels, RCFs or RFNBOs (that did not receive credits for carbon capture and replacement)	CO_2 captured that has received emission credits under other provisions of the law (to avoid double counting)
Direct air capture of CO_2	CO_2 captured from a fuel that is deliberately burned for producing the CO_2
Captured CO_2 from geological sources (where CO_2 was released naturally)	
Biogenic CO_2 captured from the production or the combustion of biofuels, bioliquids or biomass fuels complying with the sustainability and greenhouse gas saving criteria; or treatment of biogenic waste.	
Low-carbon fuels only - Carbon that stems from inputs qualifying as a carbon source for the production of RCFs	

1 – Eligible activities listed under Annex I of Directive 2003/87/EC

Carbon sources valid for RFNBO and RCF production as indicated by the RED III Methodology Delegated Act. Applicable also to low-carbon fuels, including purple addition, as per draft Methodology Delegated Act for H&GDP.
Source: European Commission

The Additionality Delegated Act | Requirements

The additionality, temporal correlation and geographical correlation requirements are described in the Additionality Delegated Act (of RED III), to avoid sustainable alternative fuel production monopolising renewable energy from the grid.

Three requirements of the Additionality Delegated Act

The Additionality Delegated Act of RED III describes three requirements for electricity used for sustainable alternative fuel production to qualify as renewable, outlined below. Exemptions to one or more of these requirements exist in certain scenarios, described on the following slide.

Additionality fulfilled if producer has concluded PPA(s) with renewable energy source (RES) plant that:

– Was commissioned or repowered max. 36 months before the electrolyser, and

– Does/has not received Capex or Opex support (or support has been fully repaid).

– *Applicable as of 1 Jan 2028 (First mover reward: exemption from additionality criterion if electrolyser started operating before 2028, see Art. 11).*

Temporal Correlation

RFNBO production takes place within the same calendar month* as contracted renewable energy generation. (*Will change to during the same hour-period, either from 2030 or from 2027 if the Member State directs.)

– Temporal correlation also applies to storage with a new storage asset behind the same network point.

Guaranteed compliance routes:

– Day-ahead electricity market prices in the bidding zone ≤ 20 € / MWh OR

– Day-ahead market prices < 0.36 times the price of an allowance to emit 1 tCO_2e.

Geographical Correlation

– Same bidding zone as RES plant at time of commissioning or

– Neighboring bidding zone where day-ahead electricity prices for the same hour ≥ bidding zone where electrolyser is located (market coupling) or

– Offshore bidding zone adjacent to bidding zone of electrolyser.

The Additionality Delegated Act | Scenarios

Renewable electricity obtained via direct connection (Scenario 1) or via the grid (Scenario 2) must comply with none, some or all of the requirements set out in the Additionality Delegated Act, as depicted below.

	Scenario	Requirements	Additionality	Temporal	Geographical	Arup Insights
SCENARIO 1 Direct Connection	**1.1**	No temporal or geographical requirements	✓	✗	✗	Uncommon in many countries. Requires a very large RE production plant.
SCENARIO 2 Grid Connection (renewable offtake via PPAs (UNO))	**2.1** General	Additionality, temporal correlation and geographical correlation requirements apply	✓	✓	✓	
	2.2 Where renewable energy share in the grid exceeds 90%. *PPA not necessarily required*	Exempt from additionality, temporal and geographical correlation rules provided the relevant conditions are met (refer to Appendix D)	–	–	–	Limited number of countries/ bidding zones qualify for this case.
	2.3 Power grid is sufficiently decarbonised	Exempt from additionality rule provided the relevant conditions are met (refer to Appendix D). Temporal and geographical correlation rules still apply	–	✓	✓	Limited number of countries/ bidding zones qualify for this case.
	2.4 RFNBO production facility improves grid stability	Exempt from additionality, temporal and geographical correlation rules if conditions are met (refer to Appendix D)	–	–	–	Reliability and ease of obtaining required evidence uncertain.

Source: European Commission

See detailed additionality table in Appendix D

The Additionality Delegated Act | Where can be exempt?

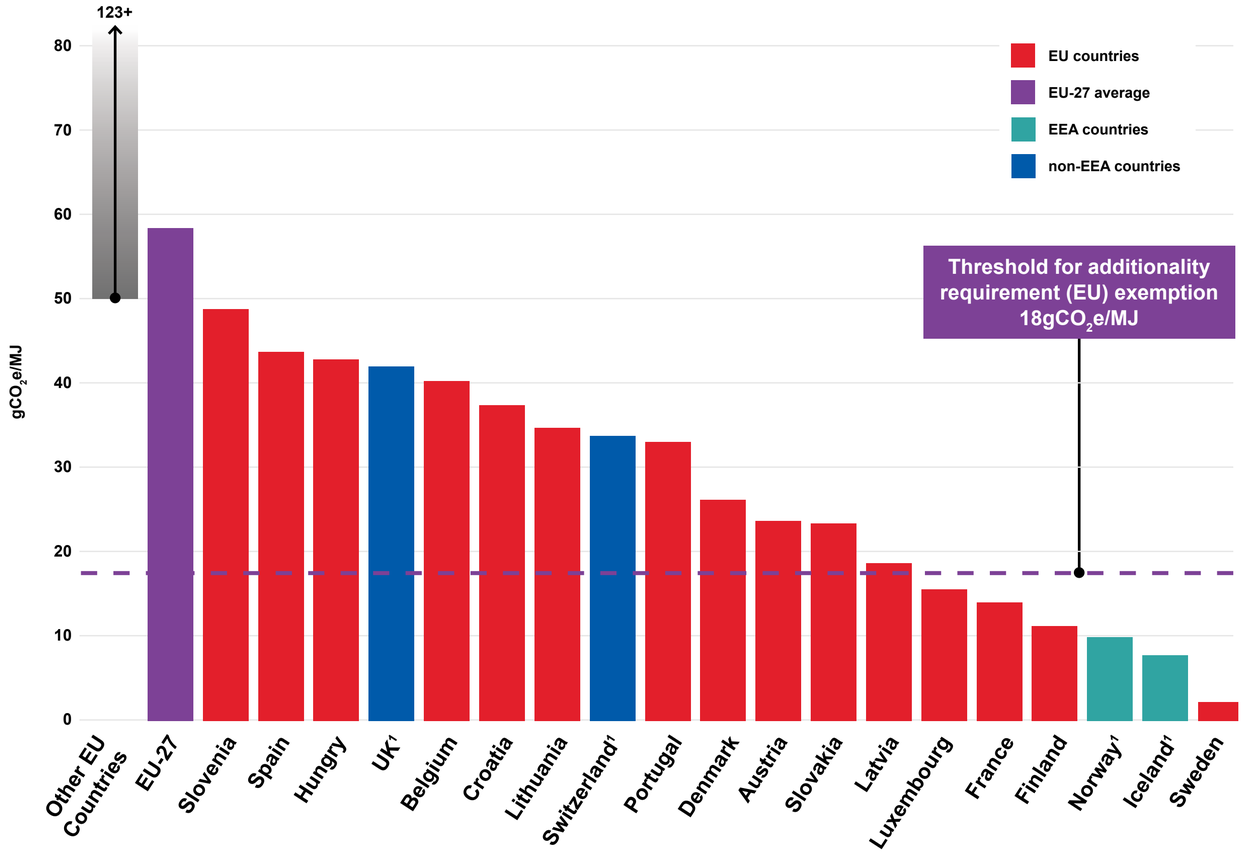
Several European countries are eligible for exemption from the additionality requirement (and some also to the temporal/ geographical correlation requirement) due to low grid emission intensity and/or high renewable energy (RE) share in the grid.

National Electricity Generation Emission Intensities in the EU

– Fuel producers located in bidding zones with grid emission intensity under the 18gCO2e/MJ threshold (scenario 2.3) are exempt from the additionality requirement for 5 years. Temporal and geographical correlation requirements still apply, which means a PPA with time matching must be signed with a renewable energy producer.

– Under Scenario 2.2, several bidding zones in Europe are eligible for exemption from all three requirements due to the RE share in the grid exceeding 90%. Countries such as Norway, Iceland and Albania have achieved or are close to achieving this percentage. Under this exemption, electricity can be used directly from the grid and considered renewable, without a PPA.

– Exemption from the additionality requirement gives sustainable fuel production projects a significant advantage from a scale-of-investment perspective. Other factors, such as local support, grid connection availability, access to carbon sources, and speed of local permitting processes, also have a large impact production location attractiveness.



GHG emission intensity of electricity generation in 2023[1]

UK (ESO, 2023); Switzerland (IEA, 2022); Norway (Entsoe, 2023); Iceland (Electricity Maps, 2023)

A note on bidding zones

– Bidding zones in Europe often, but don't always, correspond to a country.

– A bidding zone encompasses the broadest geographical area where electricity generators and consumers can freely submit their offers to buy or sell power without facing any technical limitations.

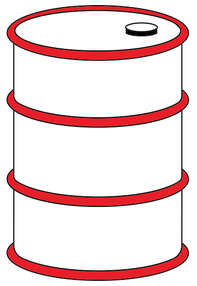
– In Europe, the boundary definitions of these bidding zones vary. Some zones transcend national boundaries, like the combined Austrian, German, and Luxembourg market, or the Single Electricity Market for the island of Ireland. Conversely, some countries, including Italy, Sweden, (and Norway) have multiple smaller bidding zones within their own borders.

[1] Different sources used for non-EU countries. Calculation for non-EU countries may not follow the methodology required in Part C of Annex of Methodology Delegated Act, for calculating GHG emission intensity of electricity, and should thus be considered indicatively only.

ARUP

Spotlight on Sustainable Alternative Fuels

EU legislated definitions and requirements



What fuels are recognised by EU carbon legislation?

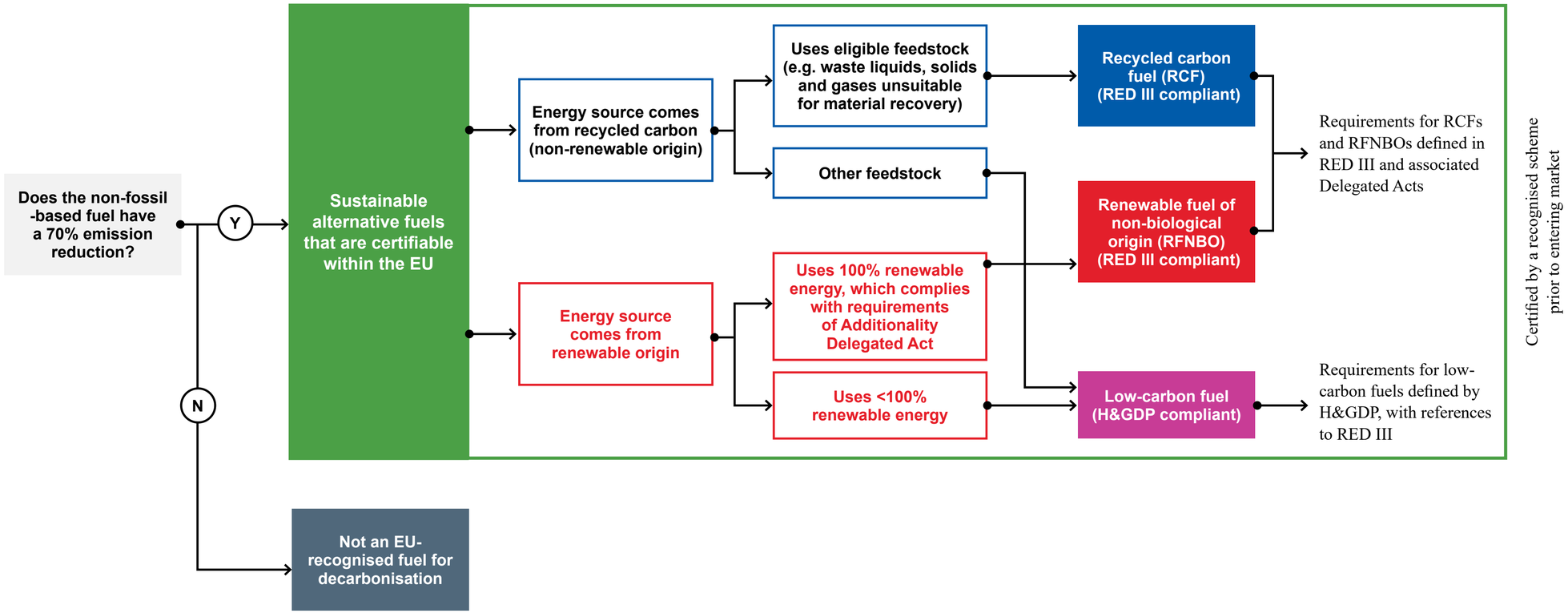
RED III and the H&GDP classify sustainable alternative fuels into RFNBOs, RCFs and low-carbon fuels, and define the criteria for each.

Sustainable Fuel Types under EU Legislation

– Three fuel types defined by EU legislation are recycled carbon fuels (RCFs); renewable fuels of non-biological origin (RFNBOs); and low-carbon fuels.

– RFNBOs and RCFs are differentiated by whether their energy content is derived from renewable or non-renewable origin. Requirements are defined by RED III and the associated Delegated Acts.

– Non-fossil derived fuels with a 70% emission reduction compared to the fossil fuel comparator (considering full life cycle emissions) that don't qualify as RFNBOs or RCFs can qualify as a low-carbon fuel. H&GDP defines requirements for low-carbon fuels.



What fuels are recognised by EU carbon legislation?

ReFuelEU defines which fuels are eligible as sustainable aviation fuels (SAFs) to be counted towards ReFuelEU annual SAF targets. The eligibility criteria refer to requirements set out in RED III for RFNBOs and RCFs, and H&GDP for low-carbon fuels.

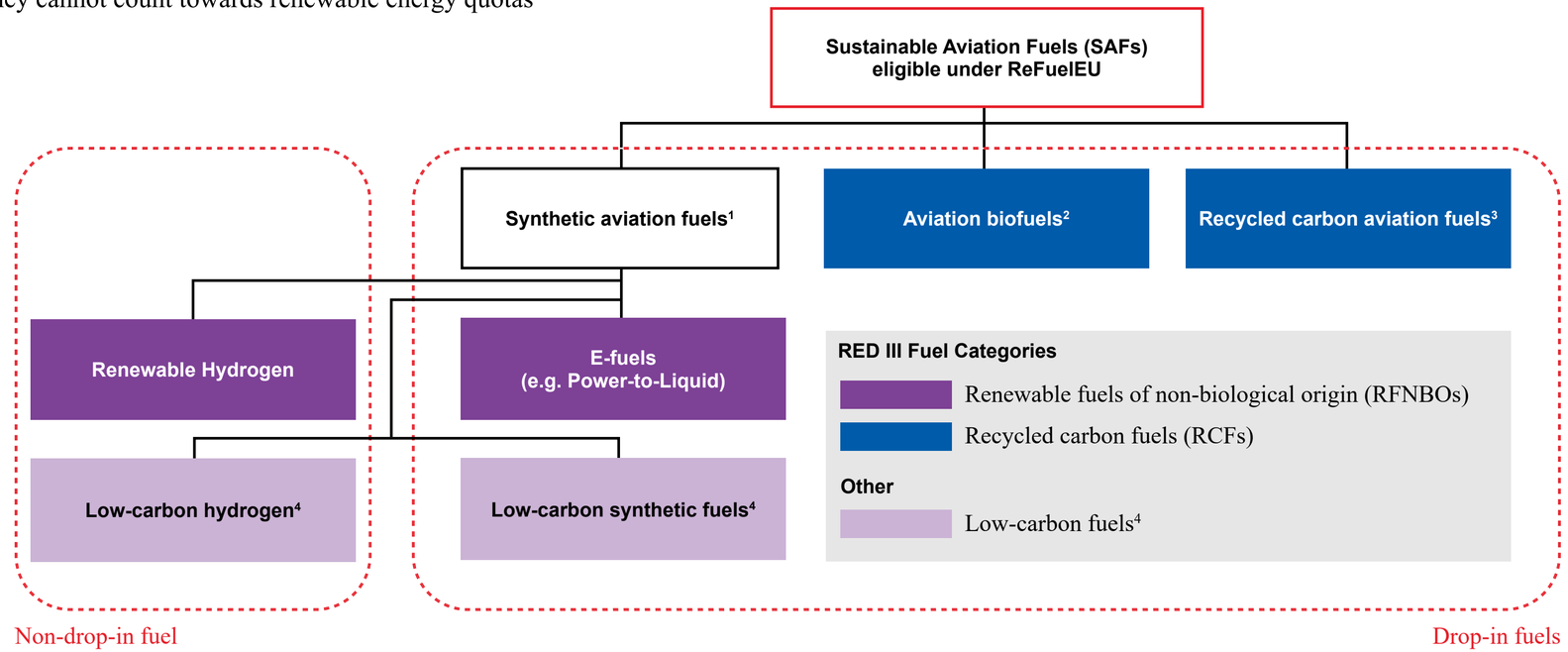
Eligible SAF under ReFuelEU

– Eligible SAF presented opposite are divided into RFNBOs, RCFs and low-carbon fuels.

– Synthetic fuels that do not fully qualify as RFNBOs (i.e. use less than 100% renewable energy) may still qualify as eligible SAF as a low-carbon synthetic fuel, so long as requirements set out in the H&GDP are met. Note that while low-carbon fuels are eligible SAFs under ReFuelEU, they cannot count towards renewable energy quotas defined under RED III.

E-fuels versus low-carbon synthetic fuels

A product can be considered as a low-carbon synthetic aviation fuel if it is derived using energy from non-fossil sources. A 70% GHG emission reduction is required. A portion of the product could be considered an e-fuel (RFNBO) if the energy for that portion is 100% renewable.



[1] Synthetic fuels have sub-targets under ReFuelEU SAF blend percentage mandates.
[2] Certified biofuels complying with RED III. Excluding biofuels from food and feed crops. Eligible feedstocks: agricultural or forestry residues, algae, bio-waste, used cooking oil or certain animal fats.
[3] Must be RED III compliant, e.g. from waste gases and waste plastic
[4] Differentiated from RFNBOs as does not use 100% renewable electricity but instead "non-fossil" energy sources, however, must still achieve 70% GHG emission reduction compared to fossil fuels.

Fuels included in the ReFuelEU Regulation and their classification with respect to RED III

Source: Arup, EU Commission

What fuels are recognised by EU carbon legislation?

The percentage of the final product that can be considered RFNBO compliant correlates to the percentage of energy used that can be considered renewable, according to the Additionality Delegated Act.

Share of RFNBO in coproduced fuels

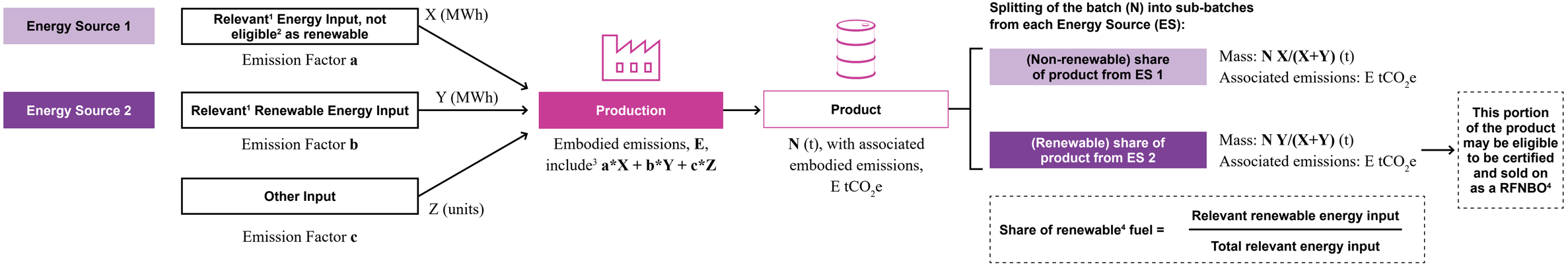
– According to RED III, RFNBOs are defined as liquid or gaseous fuels for which the carbon content is derived from renewable sources rather than biomass, and the energy used in the fuel production is 100% renewable energy (RE). If the energy is <100% RE, a portion of the end-product may qualify as RFNBO and the remaining portion may qualify as a low-carbon fuel (defined by the H&GDP).

– The diagram below illustrates how EU legislation defines which portion of your end-product is an RFNBO if only part of your energy source for your relevant energy inputs is 100% renewable.

– In the example below, if "Energy Source 2" (ES 2) was 100% RE and "Energy Source 1" was <100% RE, then a portion of the end product (related to share from ES 2) may be RFNBO compliant, so long the life cycle emission calculation, for the total end-product (N) has at least a 70% emission reduction compared to the fossil fuel comparator. (To achieve this, a high RE proportion overall is required, and generally use of valid carbon sources.)

– If the share of product from ES 2 is eligible to be considered an RFNBO, then the share of product from ES 1 (which would have the same emission reduction value) would be considered a low-carbon fuel, according to the H&GDP, since it also has a 70% emission reduction.

– "Other inputs" are not considered for determining the portion of the end-product that is RFNBO but are taken into account when calculating the GHG emissions.



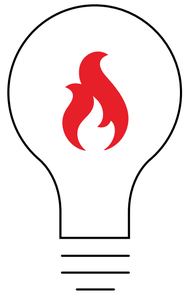
Delineation of RFNBO and low-carbon fuel according to RED III and the H&GD package
Source: Arup

[1] Relevant energy input: energy input contributing to the energy content of the product
[2] According to requirements set out in the Additionality Delegated Act (of RED III)
[3] For full and detailed emission calculation requirements refer to the Methodology Delegated Act (of RED III)
[4] Note that full life cycle emissions, including embodied emissions, E, must have a 70% emission reduction compared to fossil fuel comparator, and that E is common to both the non-renewable and renewable portion of the product

ARUP

Spotlight on Imported Sustainable Alternative Fuels

The impact of EU legislation on non-EU fuel producers

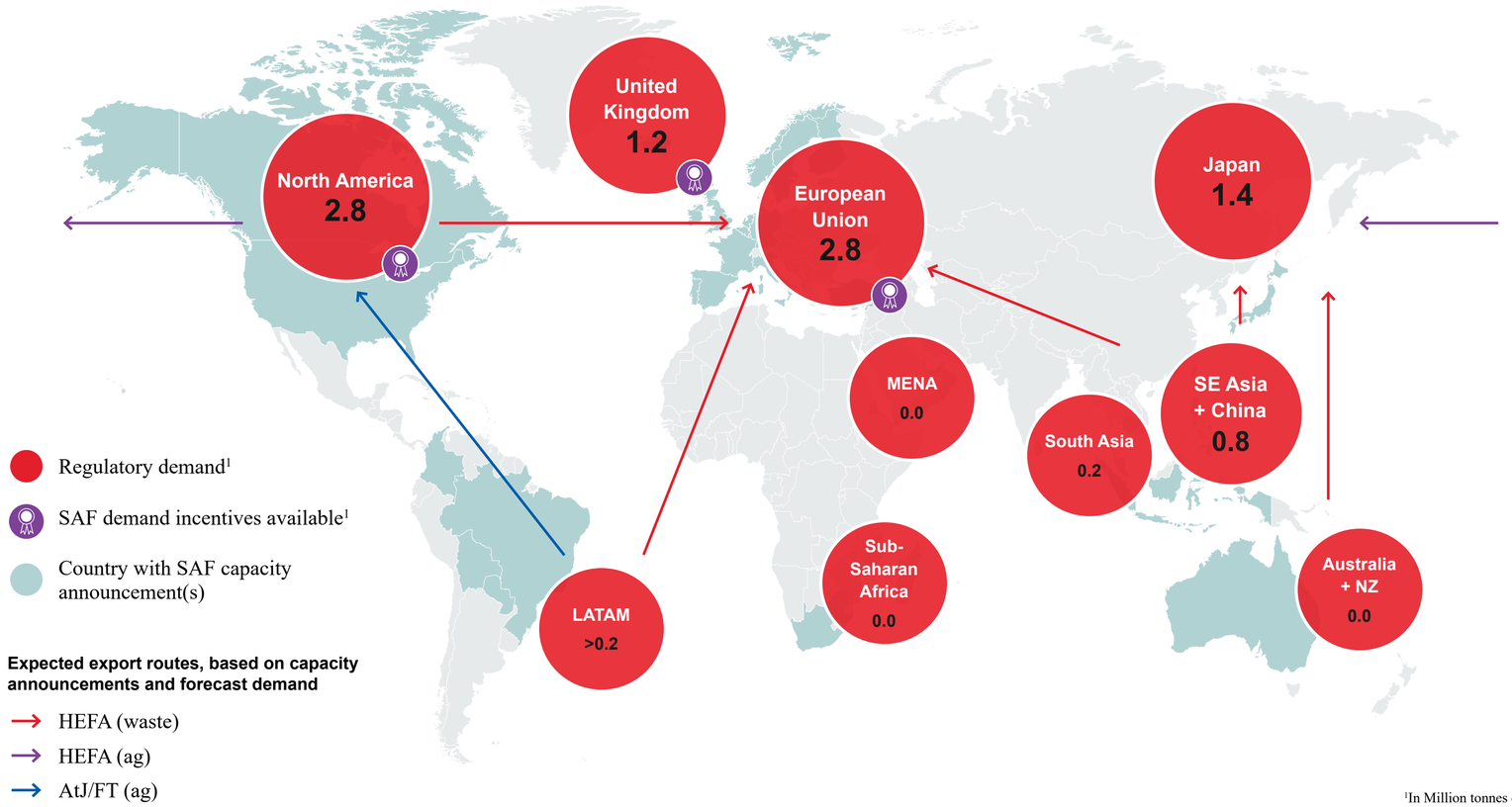


Global production centers

Legislative instruments for encouraging and/or mandating the production of sustainable fuels vary across the world, as do quantities of forecast production for sustainable fuels. Due to the EU's SAF mandate via ReFuelEU, Europe is expected to rely on imported SAF from other regions.

Global SAF demand and production

- Globally, the regulatory landscape regarding sustainable alternative fuels varies considerably. Some countries have adopted similar policies to the EU, while others rely more heavily on voluntary agreements and market-based incentives.
- Legislation such as RED III and ReFuelEU is driving demand of sustainable alternative fuels in Europe. The SAF mandates from ReFuelEU, increasing gradually until 2050, is driving significant investment in SAF production facilities across the EU as well as outside of it.
- Currently announced SAF projects in Europe are not reliably sufficient to meet the forecasted demand, particularly for synthetic SAF and more generally post 2030, and thus Europe may end up importing SAF from China and Southeast Asia, the United States, and Latin America. Note the outlook is subject to change depending on:
  - Protectionist policies in the EU to foster local production
  - Increased SAF demand in the countries that currently have higher predicted capacity compared to demand
  - Potential diversion of SAF production process to focus also on maritime and on-road applications
- Demand forecasts for RFNBOs, RCFs and low-carbon fuels more generally aren't as certain but may also see need for imports.



[1]In Million tonnes of SAF

Overview of expected global SAF dynamics by 2030 based on SAF demand, SAF announcements and SAF policies implemented and announced.
Source: SkyNRG (2024)

Expected EU SAF production capacity

Based on announced projects, EU production of SAF could possibly meet the 2030 demand for the overall SAF mandate, however EU supply of synthetic SAF (e-SAF) is currently forecast to fall short. Beyond 2030, demand is expected to increase substantially.

SAF Production Estimates versus Demand in the EU

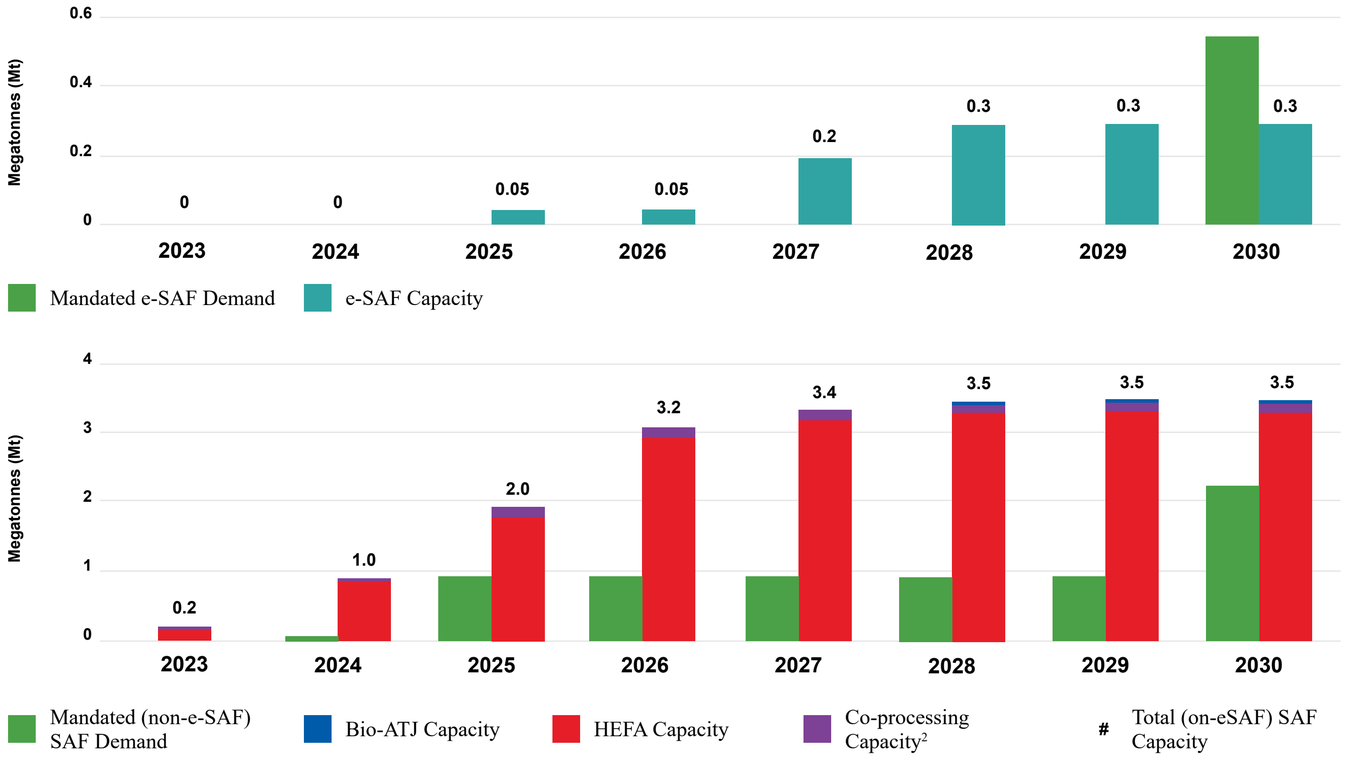
– Based on announced EU projects, SkyNRG (2024) forecasts suggest that the supply of SAF could possibly meet 2030 demand for the overall SAF mandate, while supply of e-SAF is looking likely to fall short.

– Announced e-SAF projects are expected to deliver 0.3Mt by 2030, which falls far below the 0.6Mt required for the e-SAF sub-mandate. However, e-SAF projects in the feasibility stage pipeline add up to approximately 1.2Mt by 2030, meaning that only 25% of the projects at feasibility need to progress to Final Investment Decision (FID) (and develop on schedule) in order for the 2030 target to be met.

– Forecasts are highly sensitive to the realisation of announced projects that still face the challenge of raising capital, construction and commissioning. Some projects will likely be delayed or not eventuate.

– Beyond 2030, the growth in production capacity will need to ramp up substantially to meet demand. Competition for available feedstock (e.g. HEFA, green hydrogen, renewable energy) with other sectors and the degree of required capital expenditure will make this ramp-up very challenging in the EU.

SkyNRG (2024) estimated that between 500-800 SAF facilities will be needed globally by 2050, which, assuming €1.8 billion per facility, would result in around €36 billion capital expenditure annually between 2025 and 2050.
European Aviation Environmental Report (EASA, 2025)



1 – "Expected" SAF capacity is based on announced projects (excluding those at feasibility stage that are not yet announced, as well as those that have not provided progress updates in over two years or are identified as being high risk). Note that most announced facilities still need to raise capital, build, and commission and that not all announced projects can be expected to eventuate (on time). SAF output is also adjusted if deemed needed by SkyNRG based on market intelligence.
2 - For co-processing SkyNRG used an actual production volume instead of a total production capacity.

Expected SAF capacity[1] in the EU27 and UK by 2030, based on 2024 announcements
Source: SkyNRG (2024)

What requirements apply to non-EU e-fuel producers?

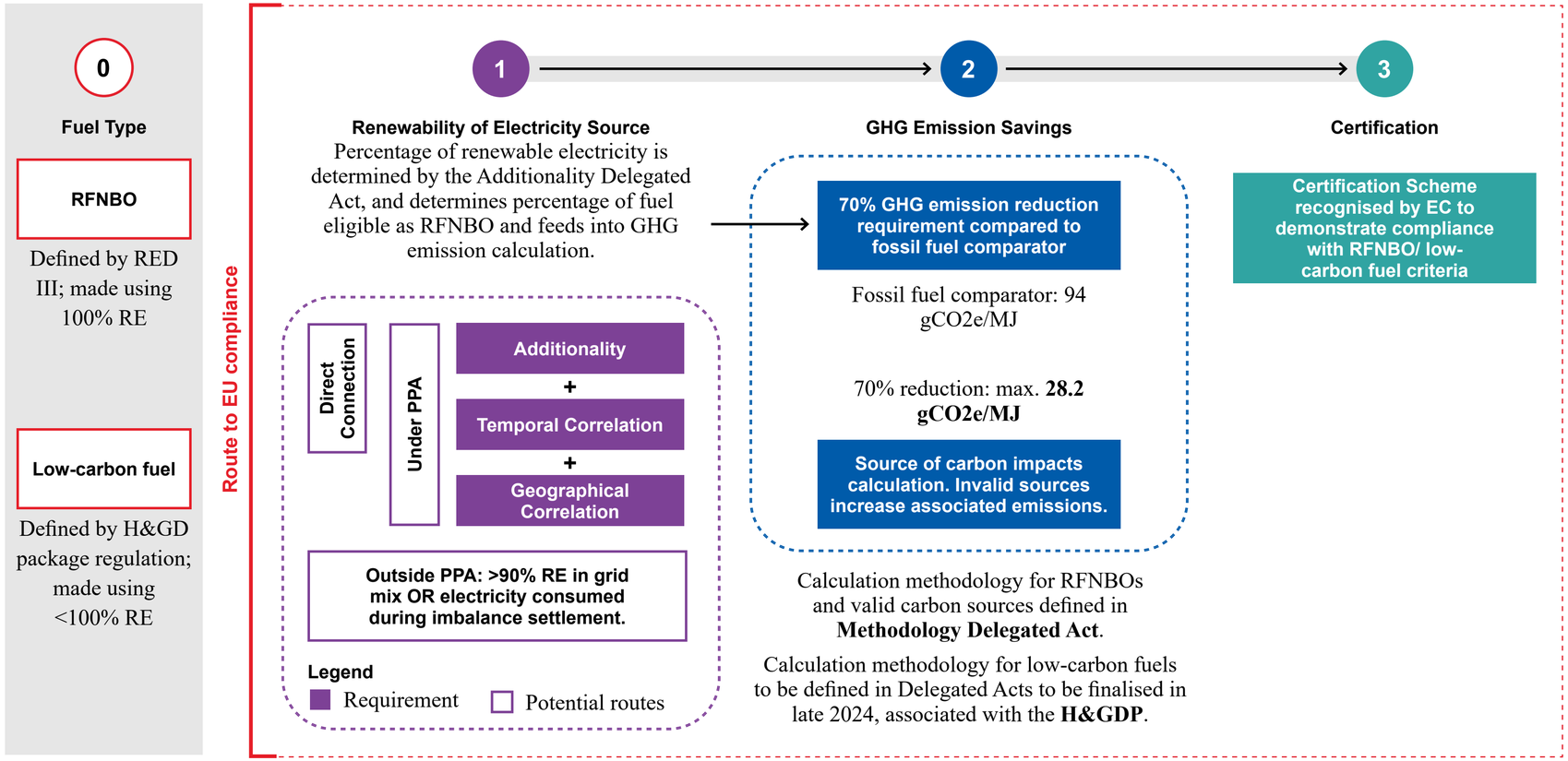
EU legislated requirements for RFNBOs and low-carbon fuels must be met by both locally made and imported fuels into the EU.

EU E-Fuel Requirements

– Non-EU fuel producers are likely to find the requirements for sustainable alternative fuels in Europe as more strict than in their country of production.

– Some requirements can be similar, for example the UK has a similar (but not identical) rule for additionality of renewable electricity.

– Other aspects have more significant differences, for example the EU's exclusion of industrially capture carbon as a valid source of carbon from 2041, and the requirement for eligible fuels to have a minimum of a 70% emission reduction compared to the fossil fuel comparator (as per calculation according to the Methodology Delegated Act).



Simplistic (non-detailed) overview of requirements for imported synthetic fuels into the EU

Source: Arup

Fuel certification for local and non-EU producers

Certification of fuels is required for RFNBOs, RCFs and low-carbon fuels to count towards legislated targets (e.g. RED III, ReFuelEU, FuelEU) and be recognised in reporting (e.g. CSRD).

Certification of Compliance

– Fuel producers may use either a national certification scheme or a recognised international voluntary scheme (by the European Commission (EC)).

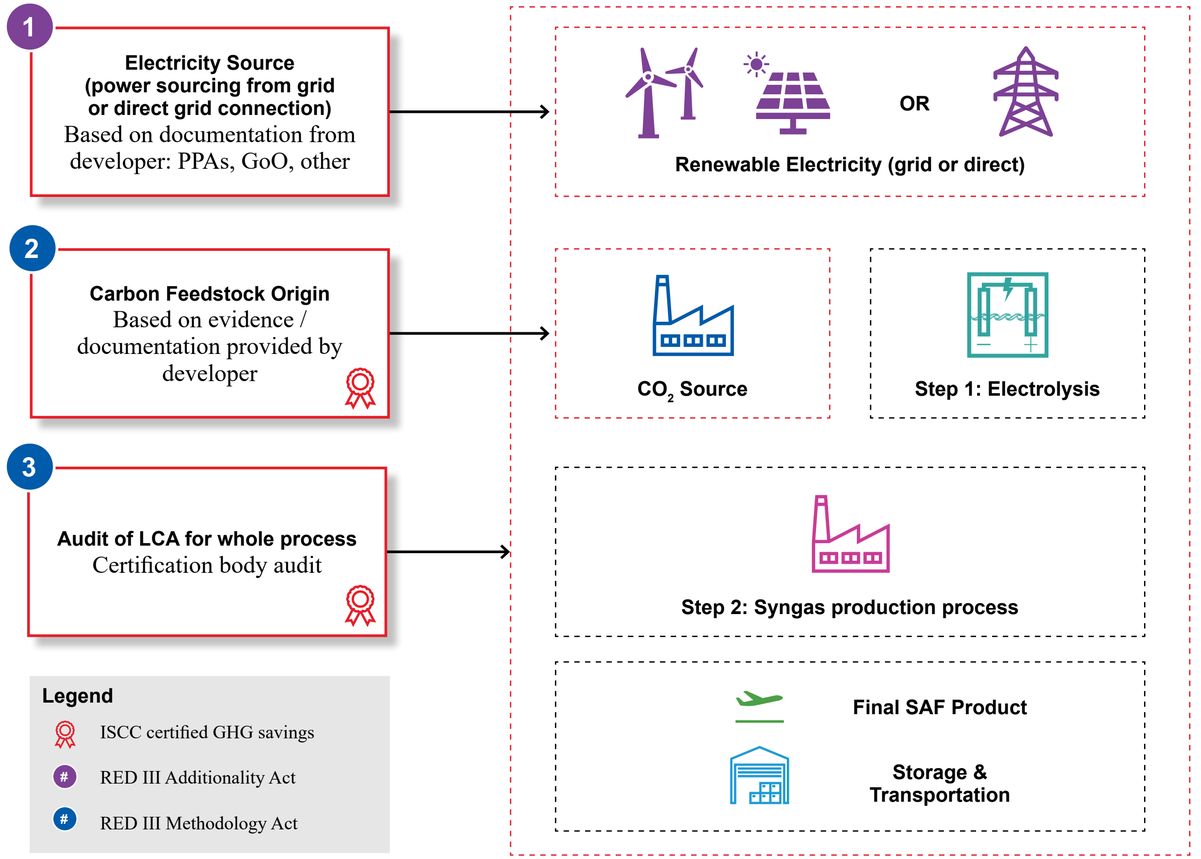
– In December 2024, the European Commission published the implemention decisions that recognise the following voluntary schemes for demonstrating compliance with the RFNBO requirements:

  – ISCC: extension of scope to cover RFNBOs, specialising in aviation fuels (shown to the right).

  – CertifHy: covers RFNBOs produced for transportation.

  – REDcert-EU: currently expanding its certification of biofuels to include RFNBOs and RCFs.

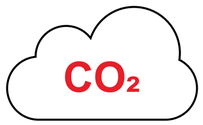
– This is an important step forward in the compliance process, by providing developers with more clarity around recognised certification bodies.

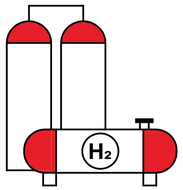


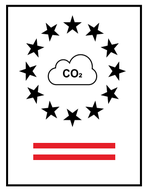
ISCC RED III certification for full lifecycle process (using SAF as example)
Source: Arup based on ISCC

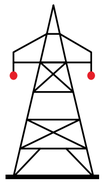
Sector timelines

Presented on the following slides are timelines of policy implementation for the EU compliance carbon market and in some key sectors.



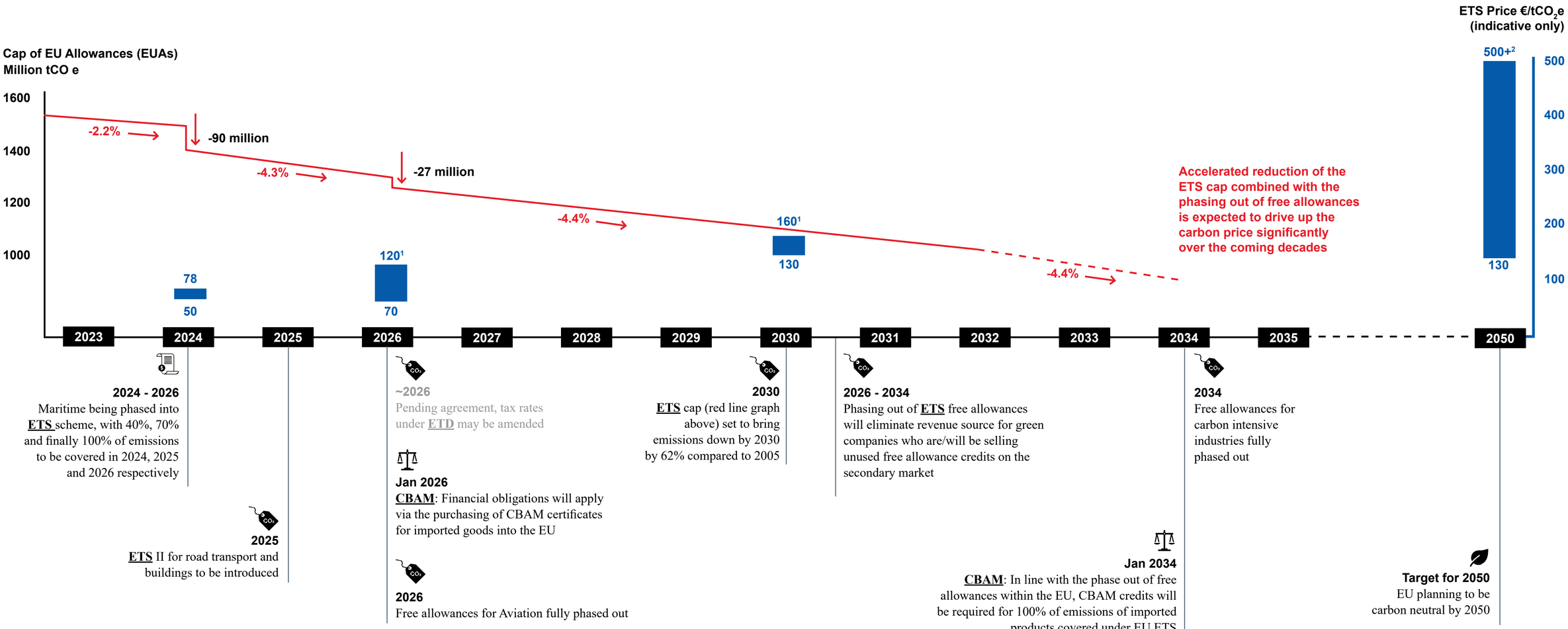







Sector focus

Legislation timeline | Compliance carbon market



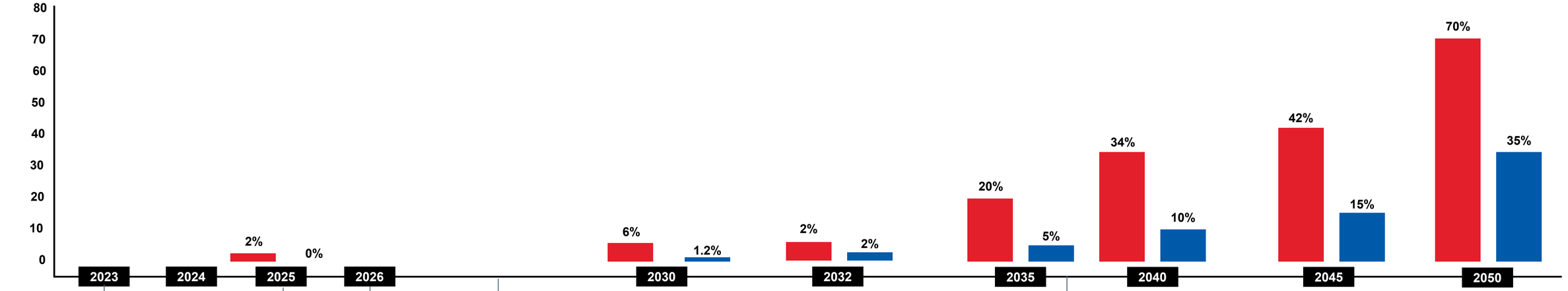
1 Source: Kopernikus-Projekt Ariadne (2022)

2 CE Delft (2021) and Tol (2020). Note 2050 Estimates vary greatly due to great uncertainty, and should only be considered as an indication of possible trajectory

Sector focus

Legislation timeline | Aviation

% of SAF and Synthetic Aviation Fuels required in jet fuel in the EU



2023
RED III and Delegated Acts define requirements for RFNBOs and RCFs that can be eligible SAF (under ReFuelEU)

2025-2050
ReFuelEU Aviation commands SAF mixing increase every 5 years (see % shown)

~2026
Pending agreement, tax rates under **ETD** may be amended

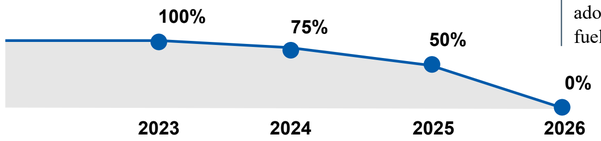
2026
Deadline for the EU Commission to assess possibility of extending **CBAM** to cover aviation

2026
Hydrogen & Gas Decarbonisation Package adopted, defining requirements for low-carbon fuels, eligible as SAF (under ReFuelEU)

2027
First regulatory review of **ReFuelEU**, to potentially add or amend elements. Review will be repeated every 5 years

~2036
10 years after adoption, proposed tax changes under **ETD** revision plan to be fully enacted, which may include min. tax rate of ~€10.75/GJ for kerosene

Phasing out of Aviation Free ETS Allowances



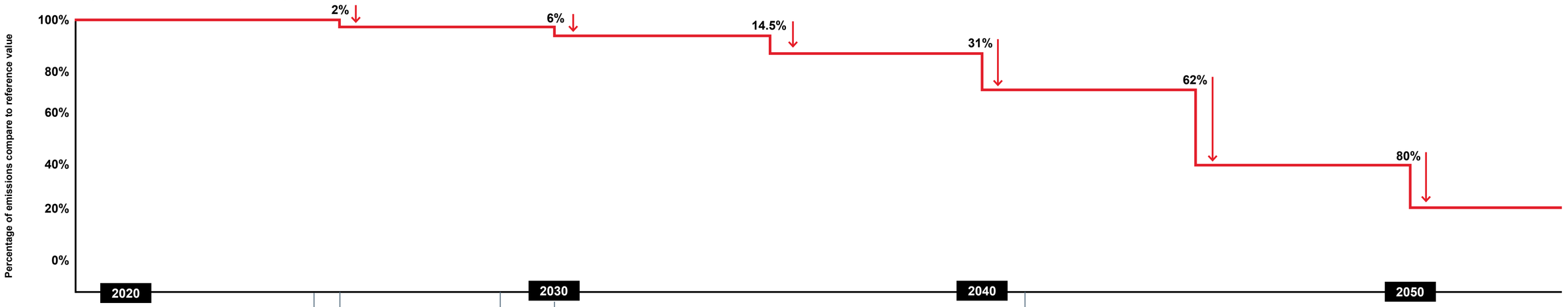
(Total) Mandate for Sustainable Aviation Fuel

Sub-mandate for Synthetic (e-fuel) Aviation Fuel

Sector focus

Legislation timeline | Maritime

GHG emission intensity reduction – Percentage reduction mandates compared to reference value (FuelEU)



2024 – 2026
Maritime phased into **EU ETS**; shipping companies must purchase EUAs for a portion of relevant emissions: 40% in 2024, 70% in 2025, and 100% from 2026 onwards. (Surrendering of EUAs takes place in following year, i.e. first in 2025 for 2024 emissions.)

2025 - 2050
FuelEU Maritime obliges vessels >5000 tonnes to reduce GHG intensity of their energy use every 5 years from 2025, as indicated in graph above

Jan 2025
AFIR: Designated ports should provide a # of refuelling points for liquified methane

September 2025
First compliance deadline for maritime inclusion in **EU ETS**, for surrendering of allowances (EUAs) for emissions reported in 2024

Jan 2030
FuelEU Maritime obliges vessels to use electric shorepower or zero emission generators

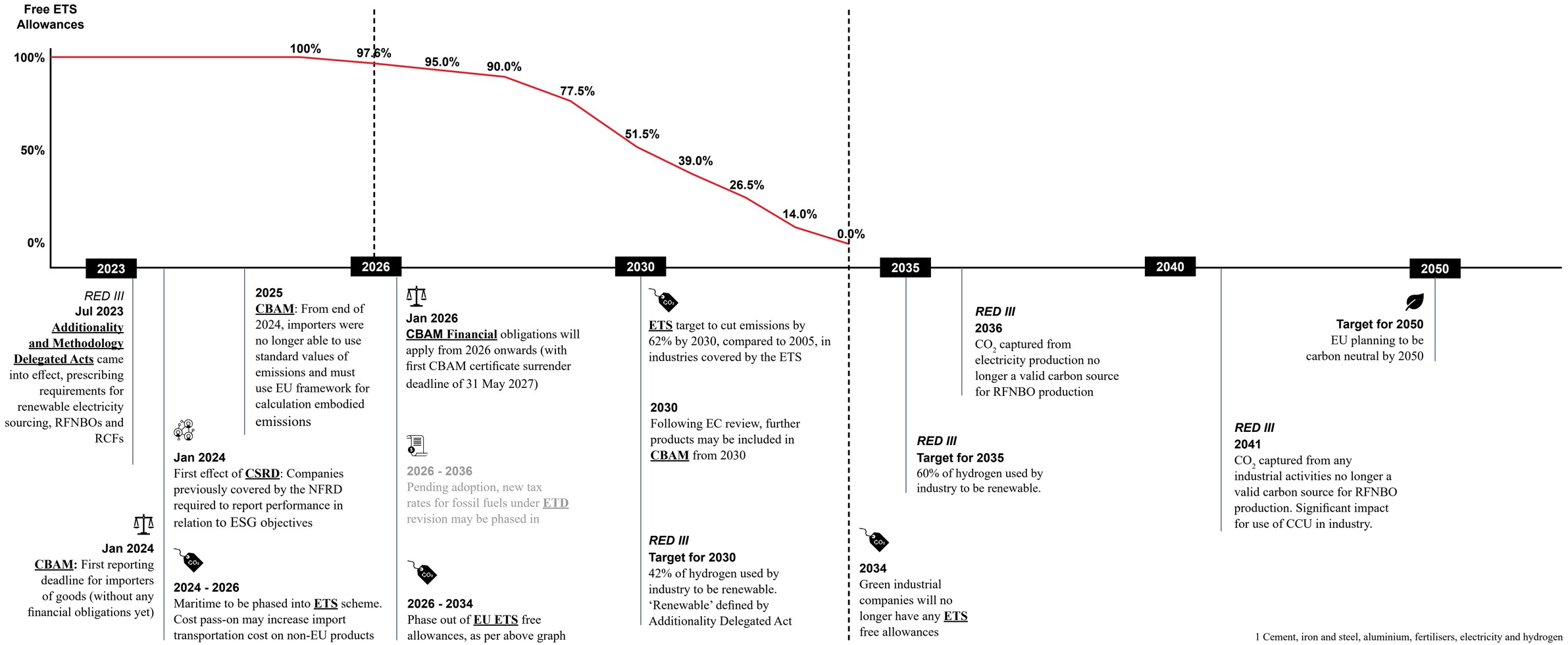
Jan 2030
AFIR obliges ports of a certain size to provide shore-side electricity for at least 90% of the total number of port calls by end of 2029

2027
International Marine Organisation's (IMO's) global regulatory framework expected to be implemented (pending potential adoption in 2025).

RED III
Jan 2041
Valid carbon sources for avoided emissions for sustainable alternative fuels to only include biogenic sources and CC. Cost implications for sustainable alternative fuels possible as a result, depending on how the market adjusts and future regulation/technology.

Sector focus

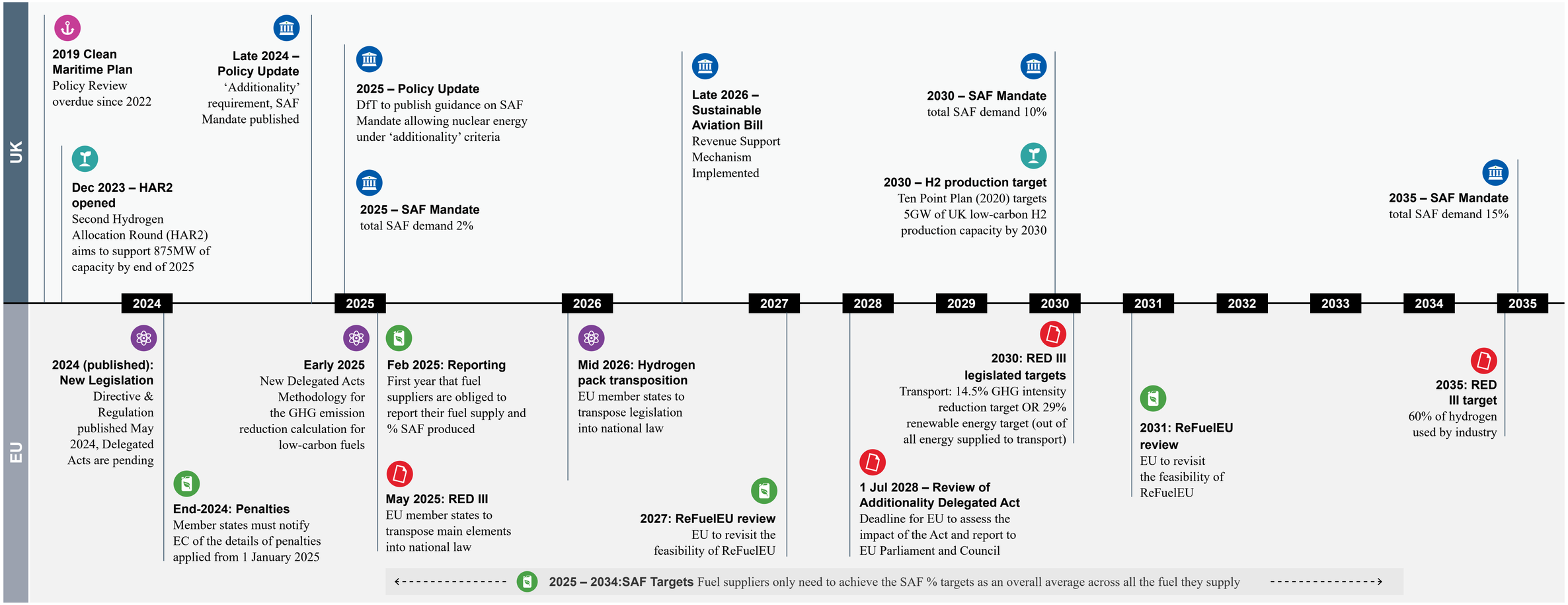
Legislation timeline | Carbon-intensive industries[1]



1 Cement, iron and steel, aluminium, fertilisers, electricity and hydrogen

Sector focus

Legislation timeline | E-Fuel Sector in the EU and UK



Sector focus

Sustainable Industries | Impact of Incoming Legislation

How are companies affected by recently adopted legislation?

We provide several cases:

⊕ Benefit ⊖ Potential cost implications

	EU ETS Phase 4 (2021 – 2030)	RED III (October 2023)	Critical Raw Materials Act (CRMA) (May 2024)	Net-Zero Industry Act (NZIA) (May 2024
An Urban Mining Factory	The emissions cap and allowance reduction for carbon intensive industries increase the need for alternatives. Where electrification is viable, CRM will be required to manufacture renewable tech. ⊕	The Renewable Energy (RE) targets from RED III increase demand for critical raw materials through their use in RE technology, some of which may be obtained through Urban Mining ⊕	Introduction of the CRMA greatly stimulates the case for Urban Mining, as it sets the aim to obtain 25% of critical raw material consumed in the EU by 2030 from recycling (up from 8.3% in 2023) ⊕	Application of non-price criteria in public procurement improves the competitiveness of urban mining, given its circularity and being less prone to ESG issues ⊕
A Renewables Developer	The emissions cap and allowance reduction for carbon intensive industries increase the need for alternatives. Where electrification is viable, demand for renewables will increase ⊕	The >42.5% renewable energy consumption target from RED III will increase demand for renewable installed capacity ⊕	If compliance to CRMA provisions prove costly to manufacturers, prices of renewable technology coming from within the EU could rise. ⊖	RE developers will benefit from streamlined permitting procedures and training programmes to improve skills relevant to NZTs ⊕
An Electrolyser Manufacturer	The emissions cap and allowance reduction for carbon intensive industries increase demand for alternatives. Hydrogen is one of few viable alternatives for energy intensive industries. ⊕	The >42% renewable hydrogen target from RED III will likely increase demand for electrolysers ⊕	Manufacturers will need to adapt their supply chains to match CRMA goals which may lead to additional costs (although likely also receive rewards for domestic sourcing) ⊖	Company could benefit from support to EU NZT manufacturing and regulatory sandboxes to support R&D for developing new technology ⊕
Key aspects of legislation	– *Yearly reduction factor of allowances increased from 1.74% to 2.2%.* – *Annual emission cap in the energy intensive and aviation industries.* – *Concurrently, phasing out of free allowances for the maritime, aviation and energy-intensive industries by respectively 2024-2026, 2026 and 2034.*	– *EU total energy consumption to 42.5% renewable.* – *1.6% annual increase in renewable energy used in industry.* – *>42% of hydrogen used in industry from renewable sources.* – *Either 29% share of renewables in the transport sector or a 14.5% reduction in greenhouse gas intensity.* – *49% share of renewable energy in buildings.*	– *Streamlined permitting* – *Targets for consumption of CRM:* – *>10% from EU extraction* – *>40% from EU processing* – *>25% from recycling* – *<65% of each strategic raw material at any point should come from a single third country*	– *Streamlined permitting* – *CO_2 injection capacity* – *Application of non-price criteria in public procurement, auctions and public incentives for consumption of NZTs* – *Dedicated training programmes to improve skills relevant to NZTs* – *Regulatory sandboxes to support innovative NZTs*

Appendix A:

Acronyms and Terminology

Appendix A

Glossary of Acronyms

Abbreviation	Term
AFIR	Alternative Fuels Infrastructure Regulation
CBAM	Carbon Border Adjustment Mechanism
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CRMA	Critical Raw Materials Act
CSRD	Corporate Sustainability Reporting Directive
EC	European Commission
ETD	Energy Taxation Directive
ETS	(EU) Emissions Trading System
EU	The European Union
g	Gram
GHG	Greenhouse gas
GW	Gigawatt
H_2	Hydrogen

Abbreviation	Term
H&GDP	Hydrogen & Gas Decarbonisation Package
ISCC	International Sustainability & Carbon Certification
kg	Kilogram
kW / kWh	Kilowatt
MSR	Market Stability Reserve
MJ	Megajoule
MW / MWh	Megawatt hour
PPA	Power purchase agreement
PtL	Power-to-liquid
RCF	Recycled carbon fuel
RED III	Renewable Energy Directive III
RE	Renewable energy
RES	Renewable energy source
RFNBO	Renewable fuel of non-biological origin

Abbreviation	Term
SAF	Sustainable aviation fuel
SFD_R	Sustainable Finance Disclosure Regulation
SNG	Synthetic natural gas
t	Tonne (1000kg)
TEN-T	Trans-European Transport Network
TNAC	Total Number of Allowances in Circulation
UNO	Unless noted otherwise
WtE	Waste-to-Energy

Appendix A

Carbon Terminology

Term	Explanation
Carbon credits	Carbon credits are tradeable certificates on the voluntary carbon market that constitute an offset of 1 tonne of CO2e (carbon dioxide equivalent) from the atmosphere
Carbon emissions	The release of carbon dioxide into the atmosphere. In practice it tends to be a catchall term related to other GHG emissions when quantified and converted to CO_2e.
Carbon offset	A project or an activity that reduces or removes carbon emissions from the atmosphere to compensate unavoidable emissions produced by others.
Carbon tax	An environmental tax or penalty regulated by governments that organisations have to pay for their excessive emissions of carbon dioxide and other GHG. The EU has the ETS for this purpose.
Carbon sink	A natural or engineered resource that has the ability to store and remove carbon dioxide from the atmosphere (e.g. forests, peats).
Carbon neutral	Anthropogenic carbon dioxide emissions emitted into the atmosphere are balanced with carbon dioxide offsets from reduction and removal projects.
Carbon dioxide equivalent (CO_2e)	A metric used to calculate GHG emissions. It combines all greenhouse gases (e.g. methane, nitrous oxide) in one, by representing their global warming potential in terms of equivalent quantity of CO_2.
Carbon market	There are two types: compliance market and voluntary market. Both of these markets conduct the trade of carbon credits or equivalent.
Carbon registry	An organisation that verifies and validates the reduction/protection/removal of carbon emissions, and issues carbon credit certificates in the voluntary carbon market, based on its developed methodologies.
Carbon accounting	The quantification of carbon emissions and reductions, it complements greenhouse gas (GHG) accounting.
Carbon leakage	The event that carbon emissions reduced in one geographical area would be replaced with carbon emissions in another geographical area (e.g. by companies moving operations overseas to fall under different legislation).
Decarbonisation	The act of reducing carbon intensity through any measure taken (e.g. process optimisation or using alternative fuels).
Conventional fuels	Refers to fossil-based fuels which are inherently depleting and have a high carbon intensity (e.g. oils, natural gases, coals).
Sustainable alternative fuels	A collective term often used to refer to RFNBOs, RCFs and low-carbon fuels (both gaseous and liquid), as opposed to conventional fuels.

Appendix B:

Categories of EU legislation

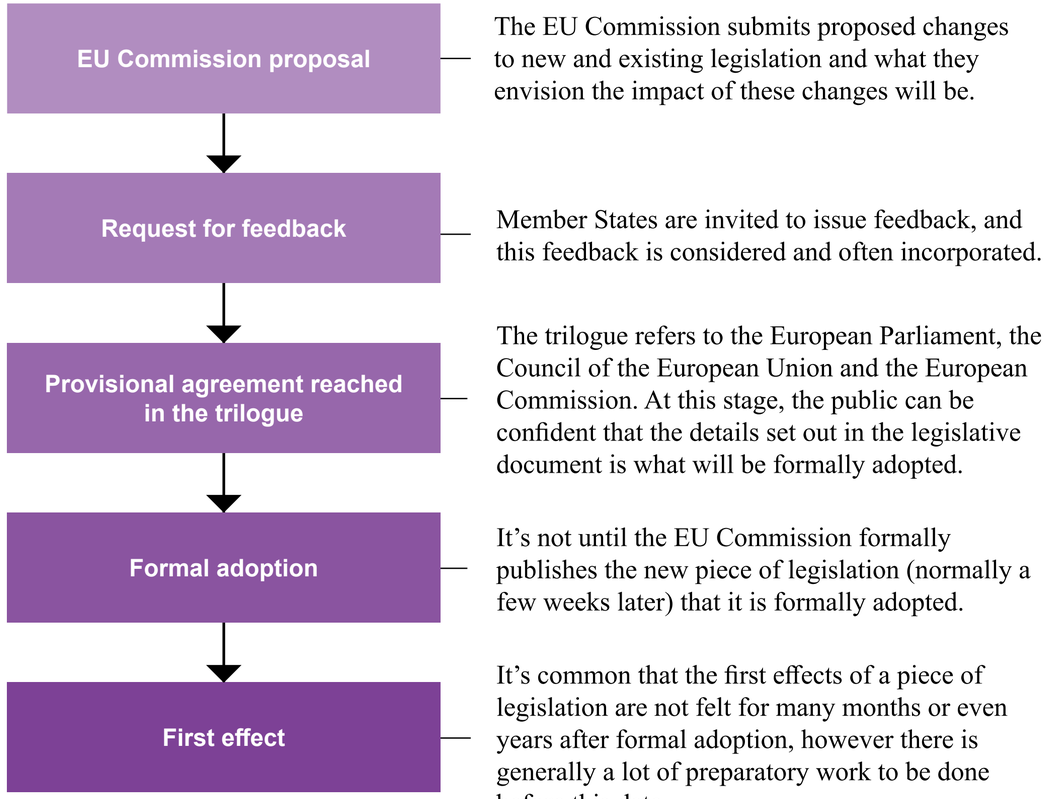
Categories of EU legislation

There are several types of legislation issued by the European Union, each with different reaches of regulatory power. Three of the primary forms are described below, along with the key steps in the proposal and implementation process.

Types of legislation and the approval process

Type of legislation	Description	Comments	Implementation
Directive	Sets out a goal that all EU countries must achieve. However, it is up to the individual countries to devise their own laws on how to reach these goals	Softer form of legislation	Member States have a deadline (normally 2 years) to transpose the directive into national law
Regulation	EU drafted law that must be applied immediately in their entirety across the EU Member States (and Norway to some extent)	Binding legislative act, does not require transposition into national laws	Immediately binding in their entirety to all EU countries
Delegated Act	A binding legislative act used as a supplement or to amend non-essential elements of other EU legislative acts, normally to provide rules or specifications for consistent application	Used for more science-based topics	The EU Commission adopts the delegated act and if Parliament and Council have no objections, it enters into force

Types of EU Legislation
Source: Arup



Non-exhaustive list of key steps in the development and approval process
Source: Arup

Appendix C:

Brief description of legislative items

EU carbon legislation

Brief descriptions of legislative items related to or falling under the Green Deal | Strategy and policy drivers

Name	Type	Explanation	Expected Impact
Green Deal	Legislative Package	• Presented in Dec 2019, the Green Deal outlines goals to ensure the EU reaches carbon neutrality by 2050 • This target is legally binding as it is enshrined in European Climate Law (since June 2021), as is the commitment to reduce net GHG emissions by at least 55% by 2030 (compared to 1990 levels) • All of the EU carbon legislation either comes under this policy initiative via the Fit for 55 programme or is aligned with this policy initiative	• Long term commitment from EU to support the transition and decarbonisation • Provides some long-term certainty to companies to inform investment decisions

REPowerEU	Legislative Plan	• Adopted 14 Feb 2023, RePowerEU is the EU Commission's plan to (i) end EU's dependence on Russian fossil fuels and (ii) tackle the climate crisis by proposing to:
		  • Increase Energy Efficiency Target from 9% to 13% and encouraging energy saving practices
		  • Diversify/increase supply of LNH and hydrogen
		  • Accelerate the rollout of renewables (with specific initiatives suggested for solar, heat pumps, permitting, hydrogen, biomethane)
		  • Issue carbon contracts for difference (CCfDs) which, in effect, promise a future minimum price for carbon that clean fuel producers can rely on, pressing the cost of capital and stimulating investment decisions in these industries
			• Leads to public investments in gas pipelines / LNG infrastructure which can be used for (liquid) hydrogen as well
			• Decreases risk for private investments in green energy production

Net Zero Industry Act	Regulation	• The NZIA regulation was formally adopted in June 2024. It distinguishes 10 strategic net-zero technologies that might benefit from becoming net-zero strategic projects, receiving priority status (e.g. in administrative processes and auctions), with the aim of accelerating industrial deployment . • The NZIA has quantitative goals to produce 40 percent of the EU's clean technology requirements, e.g. photovoltaic panels, wind turbines, batteries and heat pumps, domestically by 2030; as well as a specific target for CO2 carbon capture and storage (CCS), with an annual injection capacity of at least 50mt of CO2 by 2030	• Greater support for production within the EU of net-zero technologies as well as more jobs and foreign investments • Hydrogen could represent 20% of the EU's energy mix by 2050 • Wind energy could make up 42.5% of EU's renewable energy by 2030 • Max permitting time of 12 months for projects <1GW annually
Critical Raw Materials Act (CRMA)	Regulation	• Adopted May 2024, the CRMA is a regulation designed to address the strategic importance and supply chain vulnerabilities of critical raw materials for the EU's economy, by promoting their responsible sourcing, recycling, and substitution to ensure the resilience and competitiveness of the economy. • Benchmarks (by 2030) are defined for the amount of EU's annual consumption of raw materials that should come from EU extraction, EU processing and recycling, as well as a limit on how much can be sourced from any one third country.	• Arup explores what the CRMA entails and its implications in further detail in Arup's publication 'Critical Raw Materials EU Guide'
Fit for 55	Legislative Package	• Overarching legislative program (realisation of the Green Deal), adopted July 2021 • Short term goals for 2030 (55% reduction of carbon emissions w.r.t 1990)	See items on following pages

Return to page 2

EU carbon legislation

Brief descriptions of legislative items related to or falling under the Green Deal | Carbon levies

Name	Type	Explanation	Expected Impact
EU Emissions Trading System (ETS)	Regulation	• Reform formally adopted in April 2023 • Puts a price on carbon dioxide equivalent emissions and sets an annual cap for emissions in the sectors covered (predominantly energy, energy-intensive industries (e.g. oil, steel, cement) and aviation within the EU). • Free allowances are currently given to certain emitting sectors each year, and for emissions above this threshold additional allowances must be purchased either from the secondary market (other companies selling their unused free allowances) or from auctions from the Member States. • With the latest reform, free allowances for the aviation sector – previously 85 per cent – will by fully phased out by 2026; free allowances for energy-intensive industries will be phased out by 2034; a separate ETS (ETS II) will be created for buildings and road transport; and the maritime sector is being phased into the ETS between 2024 and 2026.	• GHG emissions will become more expensive for included sectors • In comb. with CBAM, will drive up prices of fuels and products outside of EU. • ETS extension to maritime (2024-2026) may improve competitiveness of low-carbon fuels for maritime sector, so long as port evasion doesn't become common. • Free allowance phase out of the aviation sector will stimulate uptake of low-carbon fuels for SAF production. • A separate ETS for road transport will improve competitiveness of RFNBOs and RCFs for transport.
Carbon Border Adjustment Mechanism (CBAM)	Regulation	• Adopted in May 2023. A tool to combat carbon leakage and encourage decarbonisation outside of EU's borders, by forcing importing EU companies to buy certificates that mark the cost difference between the carbon price in the country of production and in the EU under ETS. • In first instance CBAM only applies to (bulk, above certain threshold) (i) Steel, (ii) Aluminium, (iii) Cement, (iv) Fertiliser, (v) Energy and (vi) Hydrogen and their precursors. After 2030 more downstream products can be included. • Financial obligations will begin in 2026 and be phased in in alignment with the phasing out of ETS free allowances. (I.e., until the free allowances within the EU are completely phased out by 2034, products from outside of the EU will only have to buy certificates for emissions above the level of the free allowances.)	• Will increase carbon penalties of carbon intensive products produced outside of the EU to put these on a level playing field with EU carbon penalties • Increases costs and administrative burden of imported carbon intensive products such as steel, aluminium, cement, fertiliser, energy and hydrogen. In later stages more upstream products and chemicals may be added • Slight form of protectionism for EU production, especially when considered in line with Net Zero Industry Act
Energy Taxation Directive (ETD)	Directive	• The potential revision of the ETD forms an integral part of the Green Deal legislative package. The revision aims to ensure that the taxation of energy products and electricity better reflects the impact they have on the environment and on health, by removing disadvantages for clean technologies and introducing higher levels of taxation for inefficient and polluting fuels. The proposal from July 2021 proposed: • Minimum tax rates adjusted to ensure conventional fossil fuels are taxed the highest, on a per energy content basis. • A tax for conventional fossil fuel (e.g. kerosene) use in the maritime/aviation sectors will be introduced, being phased in over 10 years from a minimum rate of €0/GJ from the year of adoption to €10.75/GJ ten years later. • Sustainable and alternative fuels in both the aviation and maritime sectors will enjoy a zero minimum tax rate until 2033 • Fuels have separate tax rates for use as motor fuels versus use for heating. (Heating use tax rates much lower, e.g. €0.9/GJ for conventional fossil fuels) • No distinction in tax rates for types of use of fuels/electricity (in commercial vs non-commercial, for example) • Agreement has not yet been reached in the trilogue on the revision, and its unclear if and when the revision will be adopted.	• If revision is adopted, would lead to change in cost price of both fossil fuels and sustainable fuels • Big impact on shipping and aviation sectors: they've enjoyed zero taxes on fossil fuel usage up until now. The taxes being introduced for kerosene use combined with the temporary zero tax rate for sustainable/alternative fuels until 2033 will create a lot of incentive for these sectors to transition quickly to more sustainable fuels.

Return to page 2

EU carbon legislation

Brief descriptions of legislative items related to or falling under the Green Deal | Energy

Name	Type	Explanation	Expected Impact
RED III	Directive	• RED III, revised from RED II in October 2023, increases the requirement for share of renewables in EU energy mix to 42.5% in 2030, with a goal of 45%. It defines decarbonisation sub-targets for Member States regarding the share of renewable energy or fuels to be used and/or GHG reduction requirements by 2030, to meet across the transport, industrial, buildings, heating and cooling sectors. • Sets minimum threshold of GHG emission savings for RFNBOs and distinct set of RCFs (at 70% compared to fossil fuels) • Aims to shorten permitting processes, requiring national authorities to take no longer than 12 months to approve new renewable energy installations, if located in so-called "renewables go-to areas“, and within 24 months in other areas.	• Opens up significant investment opportunities in renewable energy and sustainable fuels • Promotes the use of RFNBOs and RCFs to reach the new targets • Phasing out of grey hydrogen to be replaced with green hydrogen • Along with the Additionality and Methodology Delegated Acts, this directive provides some certainty to the fuel and energy industries on potential demands for RFNBOs and RCFs in the future and provides clarity on requirements for these, helping to de-risk investment opportunities in these emerging sectors.
> Additionality Delegated Act	Delegated Act	• The Additionality Act specifies requirements for electricity to be considered renewable in RFNBO and low-carbon fuel production. RFNBOs require 100% of the electricity to be renewable, while for low-carbon fuels, the amount of renewable electricity is still relevant for achieving the 70% emission reduction threshold. • Connection between an electricity plant and a fuel production plant can be done via a direct connection or via the grid. • For grid connections, additionality, temporal and geographical correlation requirements are detailed in this act.	• Relevant for renewable energy developers and RFNBO (including hydrogen) and low-carbon fuel plants as the conditions impact the timing, location and business cases of such projects.
> Methodology Delegated Act	Delegated Act	• The Methodology Act sets the standard methodology for calculating GHG emission savings of RFNBOs and RCFs (which is necessary to determine whether they comply with the EU's GHG emission thresholds). This methodology must be followed for certification. • Defines valid carbon sources in order to consider the carbon’s ‘avoided emissions’, which is often necessary to meet the 70% emission reduction threshold. Captured CO2 from industrial processes will not be allowed from 2041 • Sets minimum threshold of GHG emission savings for RCFs (at 70% compared to fossil fuels)	• Provides a standard method for calculating emission savings to ensure consistency across markets and the basis for certification • Restricts valid sources of carbon from 2041 to primarily biogenic carbon, increasing the value of biogenic carbon already significantly
Hydrogen and Decarbonised Gas Market Package	Regulation (1) and Directive (1) and Delegated Act (1)	• The H&GDP (consisting of a Regulation and Directive, both formally adopted in May 2024) complements RED III and addresses the gap in the legislation for low-carbon fuels. The Delegated Act for GHG methodology is pending adoption, however a draft was published September 2024 which aims to be consistent with the Methodology Delegated Act of RED III. • The package aims to decarbonise the production and consumption of hydrogen and methane. It provides an update for existing gas market regulations and establishes a framework for hydrogen infrastructure, and renewable and low-carbon gases (including both hydrogen and fuels). • A third separate (new) independent entity for the development of a hydrogen network, namely the EU entity for Hydrogen Network Operators (ENNOH), will be established.	• Increased structural support for the production of the hydrogen network in the EU • Indicated intention for the EU to further support biomethane production • The package aims to increase the share of renewable and low-carbon gases in the EU from the previous portion of 5% (in 2023) to 66% in 2030.

Return to page 2

EU carbon legislation

Brief descriptions of legislative items related to or falling under the Green Deal | Transport

<table>
<tr><th>Name</th><th>Type</th><th>Explanation</th><th>Expected Impact</th></tr>
<tr>
<td>ReFuelEU Aviation</td>
<td>Regulation</td>
<td>

Adopted in October 2023, this regulation obliges all fuel suppliers to provide the following minimum share of SAFs to operators at EU airports

<table>
<tr><td></td><td>2025</td><td>2030</td><td>2035</td><td>2040</td><td>2045</td><td>2050</td></tr>
<tr><td>Percentage of SAF required</td><td>2%</td><td>6%</td><td>20%</td><td>34%</td><td>42%</td><td>70%</td></tr>
<tr><td>(Sub-mandate for synthetic fuels)</td><td>-</td><td>(1.2% by 2030, 2% by 2032)</td><td>(5%)</td><td>(10%)</td><td>(15%)</td><td>(35%)</td></tr>
</table>

Flights departing from airports with ≥ 800,000 passengers or more than 100,000 tonnes of freight traffic per year (including those from non-EU airlines) and from aircraft operators that have >500 passengers or >52 cargo flights per year must uplift with SAF-blended fuels and adhere to measures to avoid tankering and over-fuelling, and airports must provide appropriate infrastructure to support storage and blending of SAFs
The proposal would require reporting of compliance (by 31 March each year) and would introduce penalties for fuel suppliers, operators and airports who fail to comply with the obligations. The collected funds would go towards research/innovation into improving affordability of SAFs

</td>
<td>

Puts onus on fuel producers to develop SAF and airlines to buy SAF, creating supply and demand for investment
Directly incentivises airports and aircraft fuel distributors to improve SAF infrastructure, which will press its integrated cost price for end-users
The labelling system will promote greener flights by better informing consumers, also reinforcing the above
Growing SAF market will create around 200,000 additional jobs in the EU
ReFuelEU SAF targets demand between 200-400 SAF production plants to be realised by 2050

</td>
</tr>
<tr>
<td>FuelEU Maritime</td>
<td>Regulation</td>
<td>

Adopted in September 2023, vessels above 5000 tonnes calling at European ports are obliged through this initiative to reduce GHG intensity of energy used as follows compared to 2020. Additionally, requirements for connecting to electric onshore power while in the harbour will apply from 2030

<table>
<tr><td>2025</td><td>2030</td><td>2035</td><td>2040</td><td>2045</td><td>2050</td></tr>
<tr><td>-2%</td><td>-6%</td><td>-14.5%</td><td>-31%</td><td>-62%</td><td>-80%</td></tr>
</table>

The requirements apply to the shipping company, who needs to monitor and report data on annual energy used on board vessels to an accredited verifier. Monitoring plans were due to be submitted to the verifiers by end of August 2024. Non-compliance will result in financial penalties and ultimately being banned from the EU.

</td>
<td>

Was intended to increase production and uptake of RFNBOs and RCFs for maritime use at competitive costs. However, as of 2024, Arup has observed the regional regulation has limited impact on the global industry (due to possibility of EU port evasion), and alternative fuel costs remain prohibitively high. Industry awaiting IMO mid term measures, expected 2025.
Likely to lead to more investments and innovation in sustainable development of the maritime sector

</td>
</tr>
</table>

Return to page 2

EU carbon legislation

Brief descriptions of legislative items related to or falling under the Green Deal | Transport

Name	Type	Explanation	Expected Impact

Alternative Fuels Infrastructure Regulation (AFIR)	Regulation (1) and Delegated Acts (4)	• Adopted in September 2023 and applicable since April 2024, the AFIR sets targets for EU Member States to provide alternative fuel infrastructure including:
		  • EV charging: Member States responsible for meeting targets set in AFIR to ensure adequate accessibility and power output capacity of recharging stations for light-duty vehicles (from 2024 onwards) and heavy-duty vehicles (from end of 2025 onwards).
		  • Hydrogen refuelling: At least one publicly accessible hydrogen refuelling station at every urban node and every 200km along the core TEN-T by 2031, with a minimum cumulative capacity of 1 tonne per day for TEN-T refuelling stations.
		  • Maritime ports: Ports with a large number of passenger or container vessels must provide shore-side electricity for at least 90% of the total number of port calls by end of 2029. Additionally,
		  • Airports: Electricity supply required for all aircraft stands next to the terminal by 2025 and all remote stands by 2030
		  • Other: Liquefied methane refuelling stations to be provided at core TEN-T maritime ports and regularly along the TEN-T core network by 2025.
		• In December 2024, the EU Commission published four (4) draft Delegated Acts to supplement the AFIR and refine the regulatory framework. At time of publication, these acts are pending formal adoption.
			• Road and maritime transport can rely on refuelling stations in the future when using of alternative fuels
			  • Positive impact for business plans of alternative fuel producers/providers
			• Fair amount of infrastructure for Member States to provide by 2024, 2025 and 2030

CO2 emission standards for heavy-duty vehicles (HDVs)	Regulation	• A revision to the emission standards for HDVs was adopted in May 2024 as part of the Fit-for-55 package. • Under the regulation, manufacturers will have to comply with targets for fleet-wide average CO2 emissions starting from 2025. These targets will apply to new HDVs registered in the reporting period of a given year, namely from 1 July of that year to 30 June of the following year. • The obligation and fees for non-compliance lies with the vehicle manufacturers, not with or partially with those ordering/purchasing the vehicles. • In addition, the amended regulation has a wider scope for emission standards for HDVs, covering nearly all emissions from HDVs as it applies not only to heavy lorries but also to medium lorries, city buses, coaches, and trailers. The revised targets are more ambitious than the previous regulation, aiming for accelerating CO2 emission reductions in the coming decades: 15% by 2025, 45% by 2030, 65% by 2035 and 90% by 2040.	• Manufacturers expected to sharply increase percentage of EVs in their fleet production by 2030. • Manufacturers' ability to meet targets relies on customers ordering more zero- or low-emission vehicles, which is not guaranteed.

Return to page 2

EU carbon legislation

Brief descriptions of legislative items related to or falling under the Green Deal | Green Finance

Name	Type	Explanation	Expected Impact

EU Taxonomy	Regulation	• The EU Taxonomy is a key part of the EU's Sustainable Finance Action Plan and was adopted 12 July 2020
		• Provides regulatory technical standards to determine which economic activities are environmentally sustainable
		  • Sets out four overarching conditions that an economic activity must meet in order to qualify as environmentally sustainable
		  • Implementing and delegated acts have been issued.
		• SFDR and CSRD (see below) measure alignment with the EU Taxonomy
			• Both financial and non-financial companies need to meet requirements of the EU Taxonomy and report this via the SFDR and CSRD respectively
			• Also, products such as RFNBOs, RCFs and other carbon intensive products and processes will have to align with the EU Taxonomy

Sustainable Finance Disclosure Regulation (SFDR)	Regulation	• Applicable since 10 March 2021 (Level 1) to all financial market participants and advisors operating in the EU (including those based outside the EU who market their products to EU-based clients). Level 2 of the SFDR entered into force on 1 Jan 2023 • European regulation to help improve the transparency of financial decisions by standardising ESG disclosures (at both product and entity levels) in the financial realm (i.e. a powerful tool against greenwashing) • Product-level disclosures measure alignment with requirements set out in the EU Taxonomy. Financial products are classified as either 'Article 6' products (note green), 'Article 8' products (light green), or 'Article 9' products • Level 1 arguably was too vague with the criteria for each classification, allowing financial actors to exaggerate the sustainable dimensions of their products and/or include assets linked to polluting activities as Article 9 products. Level 2 aims to rectify this by strengthening criteria	• It will increase transparency amongst financial market participants and might persuade them to more actively invest in sustainable assets • With the introduction of Level 2 SFDR, financial actors will have to reevaluate the classification of their products to clearer distinctions. This will lead to more comparable asset portfolios in terms of their sustainability
Corporate Sustainability Reporting Directive (CSRD)	Directive	• Entered into force on 5 Jan 2023. Replacing the Non-Financial Reporting Directive (NFRD). Contains disclosure requirements for many ESG aspects. • Purpose is to improve transparency so investors and other stakeholders can understand a company's sustainability objectives and performance • Applicable to all large non-financial companies operating in the EU. (NFRD only applied to large public-interest companies, mainly listed companies.) Companies can choose to report non-alignment, rather than complete an assessment • Companies are considered large if they meet two of the following criteria: (i) turnover exceeds €40 million p.a., (ii) balance sheet totals more than €20 million, (iii) more than 250 employees (average over a year) • Will come into effect as of fiscal year 2024 for companies already covered by the NFRD, and from fiscal year 2025 for other large companies. Listed small and medium-sized enterprises (SMEs) will also be required to report from fiscal year 2026 • From fiscal year 2028, non-EU companies with a (consolidated) turnover of more than €150 million in the EU will be subject to a special disclosure regime	• CSRD will motivate companies to align with EU taxonomy standards as they may receive less interest from investors otherwise • New systems, processes and a governance structure will have to be set up because of the huge amounts of data that companies will be required to collect, process and publish

Return to page 2

Appendix D:

RED III | Additional resources

RED III | Sector-specific obligatory targets

RED III added and revised sector-specific obligatory targets from RED II. Notably, targets now apply to the buildings and industrial sectors, and promote greater production and use of renewable fuels of non-biological origin (RFNBOs) and recycled carbon fuels (RCF).

Industry	Category	2018 RED II – Sector-Specific Targets	2023 RED III - Sector-Specific Targets
Buildings	Buildings' energy source	N/A	49% share of renewable energy
Industry	Industries' energy source	N/A	Renewable energy use to increase by 1.6% annually
	Hydrogen in industry	N/A	42% of hydrogen should come from renewable fuels of non-biological origin (RFNBOs) by 2030, 60% by 2035, essentially to replace grey hydrogen
Transport	Renewable energy in transport	14% energy target (out of road and rail fuels)	14.5% GHG intensity reduction target or 29% renewable energy target (out of all energy supplied to transport)
	Advanced biofuels (Annex IX, part A)	3.5% (out of road and rail fuels, with multiplier)	5.5% of a combination of both fuel types, with a 1% RFNBO minimum (out of all energy supplied to transport)
	Renewable fuels of non-biological origin (RFNBOs)	No target	
	Waste oils (Annex IX, part B)	1.7% cap (out of all energy supplied to road and rail)	1.7% cap (out of all energy supplied to transport)
	Food- and feed-based biofuels	Cap at whichever is lower: 7% or 2020 consumption in each member state + 1% (out of road and rail fuels)	Cap at whichever is lower: 7% or 2020 consumption in each member state + 1% (out of all transport energy consumption)
	Multipliers	2x for advanced biofuels and waste oils • 4x for renewable electricity used in vehicles • 1.5x for renewable electricity in rail • 1.2x for aviation and maritime fuels, except food- and feedbased biofuels	Towards the overall 29% renewable energy target and all applicable sub-targets for either an energy target or GHG target: • 2x for advanced biofuels, RFNBOs, and waste oils • 4x for renewable electricity in vehicles • 1.5x for renewable electricity in rail • 1.2x for advanced biofuels and 1.5x for RFNBOs in aviation and maritime sectors
	Fossil comparator	94 gCO2e/MJ for all transport energy	• 183 g CO_2e/MJ for electricity used in vehicles • 94 g CO_2e/MJ for all other energy used in transport
Heating & cooling	Heating and cooling energy source	1.1% annual increase (indicative target that is not binding)	• Binding targets: Renewable energy usage should increase 0.8% annually until 2026 and 1.1% annually from then until 2030

Source: European Commission (2023) and International Council on Clean Transportation (2023)

The Additionality Delegated Act | Scenarios

Electricity used for fuel production must meet the requirements for the relevant case of electricity sourcing in order for it to be considered fully renewable. This can be achieved by either a direct connection (Scenario 1), or via the grid (Scenario 2) if relevant requirements are met

	Scenario	Requirements
SCENARIO 1 Direct Connection	**1.1**	• The renewable electricity plant is new, i.e. starts operating no earlier than 36 months before the electrolyser • Production and consumption take place within the same installation or are directly connected • The RFNBO production facility does not utilise grid power even if grid connected (if connected, must have smart metering)
SCENARIO 2 Grid Connection (renewable offtake via PPAs), UNO	**2.1** General	When sourcing renewable electricity from the grid, the electricity may only be considered as fully renewable if the additionality, temporal correlation and geographical correlation requirements described on the previous page are met. There are exemptions to these criteria in certain situations, outlined in scenarios 2.2 – 2.4
	2.2 Where renewable energy share in the grid exceeds 90%	Exempt from additionality, temporal and geographical correlation rules provided the following conditions are met: • The electrolyser needs to be located in a bidding zone where the average share of renewable grid electricity exceeds 90% in the previous calendar year and • Production must not exceed a set maximum number of hours, defined by the number of hours in a calendar year multiplied by the renewable energy share of the bidding zone • Production exceeding this share is considered non-renewable Applies to the bidding zone where RFNBO production takes place for the next five calendar years. PPA may not be required in this case, however legislation is unclear.
	2.3 Power grid is sufficiently decarbonised	Exempt from additionality rule provided the following condition is met. Temporal and geographical correlation rules still apply: • Emission intensity of the bidding zone grid is below the value of 18 gCO2e/MJ. (See overleaf for illustration of countries under or close to this threshold.) Applies for the next five years if the threshold is reached
	2.4 RFNBO production facility improves grid stability	Exempt from additionality, temporal and geographical correlation rules if the RFNBO producer can prove with the help of the national TSO that during an imbalance settlement period (nation dependent): • Power-generating installations using renewable energy sources were redispatched downwards • The electricity consumed for RFNBO production reduced the need for redispatching by a corresponding amount

Source: European Commission

Appendix E:

Sources

Sources

SkyNRG. (2024, June). Sustainable Aviation Fuel Market Outlook. https://skynrg.com/skynrg-releases-sustainable-aviation-fuel-market-outlook-2024/

European Union Aviation Safety Agency (EASA). (2025). European Aviation Environmental Report. https://www.easa.europa.eu/sites/default/files/eaer-downloads/EASA_EAER_2025_Book_v5.pdf

ARUP

To learn more on how Arup's Strategy and Business Investor Advisory team can support you, contact us at energy@arup.com

Duncan White
Director
Europe Advisory Services Leader

Michael Daly
Director
Europe Energy Business Leader

Clara Jessop
Senior Consultant
Europe Advisory Services

Brigitte Danks
Consultant
Europe Advisory Services

Lukas Bertels
Consultant
Europe Advisory Services

ARUP