BRIEFING - November 2025

E-fuels' sustainable carbon challenge

How CO_2 transport can satisfy Europe's needs for carbon utilisation in e-fuels

Summary

CO_2 infrastructure planning encompasses the development of a pipeline network, storage facilities, and transport systems needed to capture, move, and permanently store or use CO_2 emissions. The EU must ensure that **CO_2 infrastructure planning is aligned with emission reduction as the first priority**. Carbon capture storage (CCS) and carbon capture utilisation (CCU) must not deter from emission avoidance. However, both CCS and CCU can play an important role in reducing the climate impact of hard-to-abate sectors and generating negative emissions in the future.

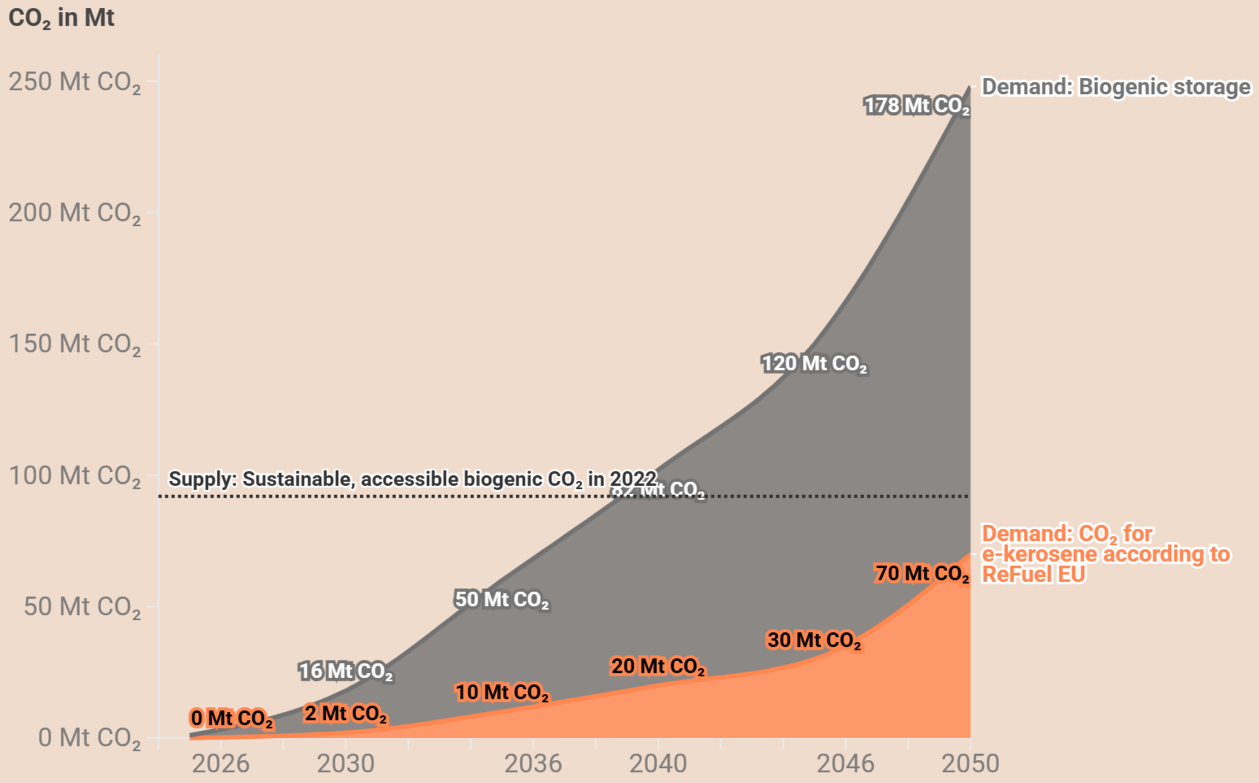
EU-level debates often frame CO_2 transport infrastructure primarily in relation to fossil CCS. This narrow focus **risks overlooking the valuable contribution that CCU can make**. This briefing therefore highlights the need for CO_2 transport planning to also take into account the availability and use of biogenic CO_2.

On the CCU side, aviation and shipping e-fuels will represent a key demand driver for biogenic carbon, i.e. CO_2 captured from biomass sources instead of fossil fuels. CO_2 transport infrastructure should take into account the future CO_2 demand for e-SAF which T&E estimates to be around 70 Mt per year in 2050 for e-SAF mandated by ReFuelEU. This does not imply that all CO_2 demand is biogenic. Direct Air Capture (DAC)-based CO_2 will also be part of the carbon supply. This briefing focuses on sustainable biogenic CO_2 because it is available in the near term and aligns with current sustainability rules, whereas DAC is not yet at scale and will need to ramp up over the longer term.

On the CCS side, permanent geological storage of both fossil and biogenic emissions is vital for achieving the net-zero objective. The EU aims to achieve a CO_2 storage capacity of at least 50 million tonnes per year by 2030, as outlined in the Net-Zero Industry Act. According to the EU's impact assessment on the 2040 climate target, the EU would need to increase CO_2 storage capacity to 240 Mt per year by 2040 to meet the 90% emissions reduction target.

When prioritised for e-fuels, sustainable biogenic carbon can meet aviation's carbon needs through 2050

Projected biogenic CO_2 supply and demand from biogenic storage and e-fuels in Mt CO_2



Source: T&E (2025), based on ERM (2025) and Ricardo (2022) • Biogenic CO_2 sent to permanent geological storage according to 1.5TECH scenario, e-kerosene demand according to ReFuel EU in a low-growth scenario.

Carbon capture, utilisation and storage (CCUS) CO_2 demands need to be met sustainably: Fossil emissions should only be captured where unavoidable process emissions occur to avoid a lock-in of abatable fossil emissions from fossil power generation, for instance. For e-fuels plants, both pulp and paper installations that generate energy from biogenic waste and biogas upgrading constitute attractive sources of biogenic CO_2. Pulp and paper in particular has strong prospects and should be considered in CO_2 infrastructure planning, given the large volumes available, moderate CO_2 concentrations and no seasonality in its supply. While CO_2 from biomass power plants and from bioethanol production is eligible under the delegated acts on RFNBO and low-carbon fuels, T&E does not consider these to be sustainable sources of carbon. Overall, **we find 92 Mt of sustainable, accessible, biogenic CO_2 per year in Europe in 2022.**

CO_2 transport infrastructure can play an important role in connecting sustainable CO_2 with CCUS applications. In the case of e-fuels plants, transporting CO_2 over long distances is cheaper than the long-distance transport of the required quantity of electricity or hydrogen. In Europe, there are around 20 (30) Mt of biogenic CO_2 within 50 (100) km of planned pipelines. Factoring e-fuels demand into the planning of CO_2 transport infrastructure can connect this biogenic carbon with e-fuels plants. This will require allowing third-party access to CO_2 transport infrastructure for suppliers of biogenic carbon to enable CCU by e-fuel producers. Including a focus on CCU at the planning stage will allow significant untapped biogenic CO_2 volumes to be connected, thereby enabling additional e-fuels production. Guaranteeing such third-party access is also key to enable DAC installations in the longer term to not only contribute to carbon dioxide removals, but also to supply carbon to various CCU applications, such as e-fuels production.

CO_2 transport via rail could be a cost-effective option, especially at medium flow rates (~50-500 kt CO_2/year) and at longer distances of > 100 km. Such medium flow rates are highly relevant for e-fuel plants. Public support for both pipelines and rail could give e-fuel producers flexibility and help them overcome CO_2 sourcing bottlenecks. Supporting multimodal transport can provide resilience, especially during the early ramp-up phase.

Recommendations:

- Measures to **secure an open and competitive framework for CO_2 transport** (e.g. 3rd party access for suppliers and off takers of biogenic carbon) will be key to make CO_2 infrastructure an enabling factor for the e-fuels industry.
- **No review of the list of eligible carbon sources** in the RFNBO and low-carbon fuels delegated acts is needed in the near term. Weakening the rules on carbon sourcing (e.g. delaying the phase-out date of 2041 for fossil carbon) will not substantially lower e-fuel production costs. The dominant cost driver for e-fuels is the price of green hydrogen, not the source of carbon. Softening these rules would therefore do little to improve affordability while undermining regulatory certainty.
- The EU should **stop supporting CCS projects relying on unsustainable carbon sources** like biomass energy plants burning wood pellets.
- **Prioritise sustainable, biogenic carbon towards CCU** applications like e-fuels production, for instance from pulp and paper.
- As biogenic CO_2 becomes constrained, DAC will be essential to meeting long-term CCU and storage needs. The **EU should support early DAC deployment** through dedicated funding and robust CDR accounting rules, while ensuring that any integration within the ETS preserves the environmental integrity of the cap.
- **Completion of the EU TEN-T rail network** to support CO_2 transport via rail.

1. Is CO_2 availability an issue for e-fuels?

Aviation and shipping e-fuels like e-methanol and e-kerosene require carbon as an input. The **EU Delegated Act (DA) on Renewable Fuel of Non-Biological Origin (RFNBO)** **GHG methodology** **determines eligible carbon sources** for e-fuels contributing towards a range of EU policy targets, including the Renewable Energy Directive III, Refuel EU Aviation, and FuelEU Maritime. Eligible sources include atmospheric CO_2 captured from the air (also referred to as Direct Air Capture (DAC)), biogenic CO_2 stemming from the production or the combustion of biofuels, bioliquids or biomass fuels complying with the RED criteria and fossil CO_2 from point sources. The latter will be phased out by 2036 for CO_2 from the combustion of fuels for electricity generation and 2041 for other activities listed under the EU ETS (e.g. cement or iron production). These time limits ensure that e-fuels use circular sources of carbon in the long run and deliver the emissions savings they promise. Extending these time limits calls into question the qualification of e-fuels as low-carbon or carbon-neutral, as they rely on fossil carbon sources. Unlike other CCU applications, which temporarily embed carbon in products, e-fuels produced with fossil carbon do not provide any form of storage benefit and should be considered merely as a slightly delayed release of fossil carbon with limited net climate benefits.

To achieve genuine decarbonisation, this leaves **sustainable biogenic CO_2 and DAC as carbon sourcing options for e-fuels production**. This briefing focuses on the availability and transport of biogenic CO_2 for storage, e-fuels and other CCU applications. It assesses short- and long-term CO_2 availability and demand, and discusses the role CO_2 transport infrastructure can play in mobilising biogenic CO_2 for storage and e-fuels. In the longer term, however, developing DAC will be needed.

This briefing excludes bioethanol and biomass energy plants from the total availability as both bioethanol made from crops as well as biomass energy plants powered with wood pellets are not sustainable.

Contrasting T&E study with eFuel Alliance study on CO_2 point-source potential In Europe

Frontier Economics conducted a study on behalf of the eFuels Alliance to assess the availability and potential of large CO_2 point sources across EU-27 that could supply CO_2 feedstock for the production of synthetic fuels. The study finds that current total CO_2 emissions (fossil and biogenic) amounted to 828 Mt CO_2/year in 2022, of which 240 Mt CO_2/year of biogenic carbon across EU-27. The study does not exclude any biomass feedstocks as potential CO_2 sources. In 2050, their analysis suggests there should still be a total amount of 661 Mt CO_2/year in 2050, including significant growth of biogenic carbon emissions, reaching 368 Mt CO_2/year in 2050. In contrast, the study commissioned by T&E finds a total *accessible* biogenic CO_2 volume of 112 Mt out of around 200 Mt of biogenic CO_2 *emitted* in 2022 in Europe.

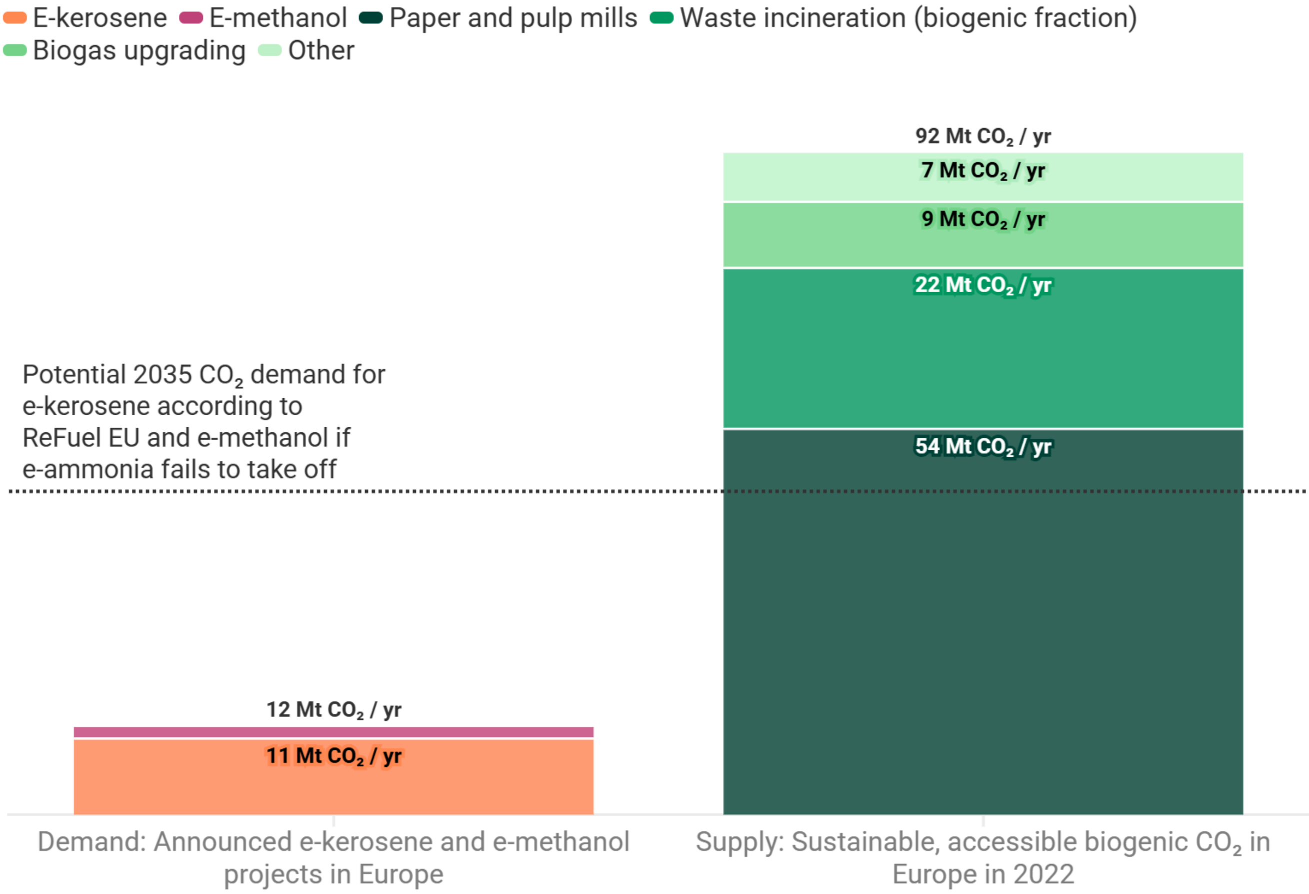
The differences between the two studies can be explained as follows:

- The study commissioned by the eFuel Alliance highlights the volumes of biogenic carbon that are *eligible*, but does not address where and how this carbon could be captured and transported to an e-fuels plant and at what cost. Even though the study acknowledges the challenges of capturing biogenic carbon (due to “transport constraints or more generally economic viability depending on the locally emitted CO_2 volumes”), the question of how the eligible “368 Mt CO_2/year of biogenic emissions, which would be eligible to produce synthetic fuels” could be unlocked remains unanswered. The study foresees 117 Mt CO_2/year in 2050 of biogenic carbon from biomass combustion, coming from power and heat generation facilities switching from fossil to biogenic fuels. In doing so, it fails to differentiate between sources in terms of sustainability and does not consider the legally binding cascading principle for biomass (article 3.3 RED). This article ranks bioenergy as one of the lowest priorities for biomass use, just above disposal. Biogenic carbon from a pulp and paper mill is the result of on-site combustion of pulp and paper co-products of the process of producing paper and cardboard and should be considered more sustainable than a biomass power plant using imported wood pellets (e.g. the Drax power plants in the UK).
- The report does not refer to storage or CCS at all. Yet, e-fuels plants are not the only destination for emissions from unavoidable process-related industries like cement and biogenic emissions. CCS is a more attractive option for these industries, as permanent storage could help position their products as commercially interesting products in potential lead markets for low-carbon steel or cement. Treating CCU entirely separately from ongoing EU-level discussions on CO_2 transport infrastructure and CCS is problematic.
- The study calculates what additional volume could be produced, if the eligibility of fossil carbon would be widened. The conclusion is that 130 Mt CO_2/year of process-related fossil emissions “would potentially allow for generating approximately an additional 36 billion litres of (diesel-equivalent) synthetic fuels in 2050”. While this sounds like an impressive volume, it is important to highlight that it would only represent around ~15% of current European road transport energy consumption.

T&E

1.1 In the short to medium term, CO_2 availability is not an issue for e-fuels

Biogenic CO_2 availability far exceeds CO_2 demand from first-of-a-kind e-kerosene and e-methanol projects in Europe



Source: T&E (2025), based on ERM (2025) • ERM identifies 112 Mt of accessible, biogenic CO_2 in 2022. Here, we exclude CO_2 from bioethanol and biomass power sources for sustainability reasons.

Based on ERM's study, T&E finds a total of 92 Mt per year of accessible and sustainable biogenic CO_2 emissions in Europe in 2022. Accessible biogenic CO_2 here refers to all major point sources from pulp and paper, waste management, biogas upgrading and cement & lime and other industries that rely on biomass to meet their energy demand. This is **largely sufficient to meet the CO_2 demand of the current first-of-a-kind e-kerosene and e-methanol projects T&E identified in Europe.** A single e-kerosene plant with a capacity of 80 kt/year requires around 280 kt/year of CO_2. Equivalently, a single e-methanol plant with a capacity of 200 kt/year also requires around 280 kt/year of CO_2. Hence, first-of-a-kind e-fuels plants require at least one biogenic CO_2 emitter with >300 kt/year. This meets the description of pulp and paper mills with average biogenic emissions of 400 kt/year but it limits the upper size of e-fuels plants that rely on a single emitter.

What is “sustainable” biogenic CO_2?

In this report, “sustainable, accessible biogenic CO_2” refers to biogenic CO_2 streams that are available at scale today in Europe and do not directly create additional demand for biomass. **These sources are not sustainable in an absolute sense** and can entail significant environmental risks. They are **considered here on a strictly relative and transitional basis**, as they rely on existing industrial or waste processes rather than dedicated biomass-to-energy pathways, which pose greater sustainability concerns. For more information, please refer to T&E’s briefing on the sustainability of different biomass types for the production of advanced and waste biofuels.

Pulp and paper mills account for ~60% of the accessible biogenic CO_2 identified as sustainable in the context of this briefing. Most biogenic CO_2 emissions in pulp and paper mills come from burning black/brown liquor and other residues generated during pulp processing. These by-products are typically used on-site for process energy.

Risks:

- Carbon capture at pulp and paper sites is only credible if it does not drive additional wood extraction. Energy for the capture process must be supplied through existing waste heat, not additional biomass. Reduced electricity generation by pulp and paper mills must be compensated by additional decarbonised renewable electricity. Within this report, we assume no additional biomass is burnt to compensate for energy used in the capture process.
- Carbon capture at pulp and paper sites risks locking in an environmentally unsustainable production model. Wood extraction in Europe is already too high, threatening forest ecosystems and depleting carbon sinks. CCUS infrastructure creates a long-term dependence on pulp and paper output and thus ongoing wood harvesting.
- Forestry biomass combustion is not carbon-neutral in the short term: the CO_2 released is only rebalanced once forests regrow - a process that can take decades, creating a carbon debt that lowers the 2050 emissions reduction potential from CCUS.

Waste management accounts for ~25% of the accessible biogenic CO_2 identified as sustainable in the context of this briefing. The biogenic fraction of mixed municipal solid waste is often too contaminated for composting or material recovery. If biogenic waste is landfilled, it can generate methane emissions if not treated properly. In line with the waste hierarchy, biogenic waste should therefore be separately collected and prioritised for prevention, reuse and material recovery (or, where appropriate, conversion into biofuels), rather than being mixed into residual waste streams and incinerated. Where residual waste cannot be avoided, incineration can be preferable to landfill.

Risks:

- Reliance on CO_2 from waste treatment can lock-in continued waste production, conflicting with EU objectives to prioritise waste prevention, reuse and recycling.

This is especially important since a large share of biogenic CO_2 emissions from waste treatment comes from food waste.

- Mixed waste streams contain fossil carbon (e.g. plastics), meaning that overall climate performance depends on the biogenic share and the ability to also permanently store fossil emissions.
- CO_2 from residual waste should only be considered after applying the waste hierarchy, and it should not compete with separate collection, recycling, and waste reduction targets.

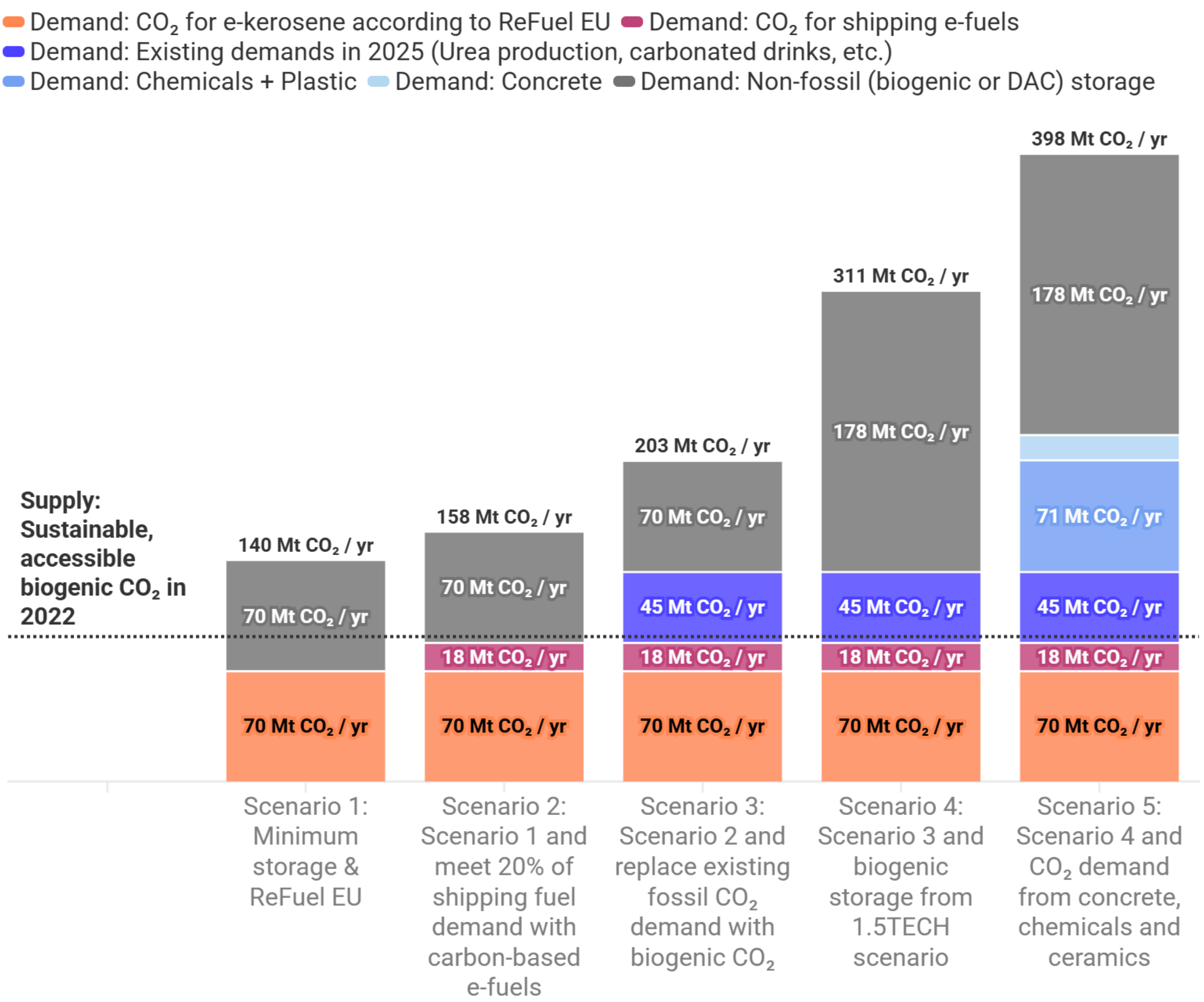
Biogas upgrading accounts for ~10% of the accessible biogenic CO_2 identified as sustainable in the context of this briefing. During upgrading, raw biogas is upgraded into methane by separating CO_2. This CO_2 can be sustainable when it comes from genuine waste and residue feedstocks such as agricultural residues, animal manure, wastewater sludge.

Risks:

- Agricultural residues have important existing and competing uses, especially for soil health (e.g. straw retention for soil organic carbon, animal bedding, erosion prevention and water retention). Removing too much crop residue can degrade soils and undermine long-term productivity.
- Animal manure is mostly returned to soils as a fertiliser, and should generally remain prioritised for that purpose within ecologically sound limits.
- Biogas pathways can create lock-in risks and sometimes even drive unsustainable practices, for instance if they incentivise industrial livestock production.
- Methane leakage across the biomethane value chain can significantly reduce or erase climate benefits.

1.2 In the long run, e-fuels will need to turn towards DAC to be scalable

2050 CCUS demand for biogenic CO_2 exceeds current availability



Source: T&E (2025), based on ERM (2025), CO_2 Value Europe (2024), ESABCC (2023), and Ricardo (2022)

While the exact split between fossil and biogenic CCUS and the scale of the future demand for CCUS is uncertain, only a share of Europe's biogenic CO_2 will ultimately be available for e-fuels in aviation and shipping. Other CCU and CCS applications compete for the same CO_2 source streams. The chart above shows that by 2050, the total CCUS demand for biogenic CO_2 ranges from 140 Mt CO_2 in the minimum demand scenario to ~400 Mt CO_2 per year in a high demand scenario. With the 92 Mt of sustainable, accessible biogenic CO_2 in Europe, even the minimum demand case already exceeds supply. Therefore, DAC will need to be scaled up to meet the demand for carbon for both utilisation and storage purposes.

Moreover, projections of biogenic CO_2 availability in 2050 remain highly uncertain as they often rely on speculations about future biomass use, new biogenic feedstock and industrial fuel switching/electrification. T&E previously commissioned a study on the future availability of biogenic CO_2, which found that most of the growth in accessible biogenic CO_2 would be linked to increased unsustainable combustion of forestry biomass. Still, estimates of today's accessible biogenic CO_2 are more reliable than long-term forecasts. Given these uncertainties, the focus needs to be on sustainable, biogenic carbon that is readily available today. Continuing to use fossil CO_2 in synthetic fuels or other CCU applications would undermine climate neutrality goals. Therefore, it is crucial that the EU supports scaling up DAC and does not reopen the door to fossil CO_2 in e-fuels beyond 2041 to meet CO_2 demand for both utilisation and storage.

2. What role does CO_2 transport play?

Rail is a cost-effective CO_2 transport option for medium-sized emitters over medium to long distances

Transport cost per tonne of CO_2 as a function of transport distance and annual CO_2 flow rate. Cells show the cost for the cheapest transport option, which is indicated by the colour.

Cheapest transport option: Truck (liquid) | Pipeline (gas) | Pipeline (liquid) | Rail (liquid) | Ship (liquid)

Distance - Flow rate	30 kt CO_2/yr	100 kt CO_2/yr	300 kt CO_2/yr	1000 kt CO_2/yr
10 km	60 €/t (Truck, liquid)	38 €/t (Pipeline, gas)	28 €/t (Pipeline, gas)	23 €/t (Pipeline, gas)
30 km	61 €/t (Truck, liquid)	48 €/t (Pipeline, gas)	34 €/t (Pipeline, gas)	25 €/t (Pipeline, gas)
100 km	69 €/t (Truck, liquid)	58 €/t (Truck, liquid)	48 €/t (Pipeline, liquid)	35 €/t (Pipeline, liquid)
300 km	91 €/t (Truck, liquid)	76 €/t (Rail, liquid)	67 €/t (Rail, liquid)	49 €/t (Pipeline, liquid)
1000 km	147 €/t (Truck, liquid)	135 €/t (Rail, liquid)	94 €/t (Ship, liquid)	70 €/t (Ship, liquid)

Source: T&E (2025), based on ERM (2025) • Includes conditioning and assumes CO_2 is available in gas state after capture.

ERM modelling commissioned by T&E considers the transport cost of CO_2 via trucks, ships, pipelines (gas & liquid phase) and rail. It shows that the most cost-effective CO_2 transport option depends on CO_2 volumes and distances. While gas-phase pipelines are cost-effective for large volumes of CO_2 transported over short distances, liquid-phase pipelines or tankers become more cost-effective across longer distances. Transport costs could be below €50/t

CO_2 for short distances and go up to €70/t CO_2 for larger distances up to 1000 km at a scale of at least 1 Mt CO_2/year.

At the same time, the CO_2 volumes required for e-fuels projects (300 kt CO_2/year) could be transported cost-effectively (~€67/t CO_2) with **rail over a medium distance of around 300 km**, for instance. Trucking may offer a particular advantage over a wide range of distances and has lower infrastructure needs. However, given the average annual demand of e-fuels plants (hundreds of thousands of tonnes of CO_2), rail is well positioned to be the most cost-effective option for e-fuels plants when co-location with a large biogenic carbon source is not feasible - especially during the scale-up phase of the e-fuels industry. Nevertheless, enabling CO_2 rail transport will require addressing practical barriers such as rail network access, congestion risks, and others. Completion of the EU TEN-T rail network will help in this sense.

These considerations also apply to DAC projects. Currently announced large-scale DAC plants aim to capture CO_2 volumes ranging from tens of thousands of tonnes per year to hundreds of thousands of tonnes per year. As a result, the most cost-effective transport option will again depend on the captured volumes and distances to utilisation or sequestration sites.

2.1 CO_2 transport infrastructure for CCU can mobilise additional biogenic carbon

Pipelines could be the backbone for large-scale, long-distance transport, which can serve both CCS and CCU projects. Rail and barges can provide important transitional and flexible options for CCU applications like e-fuels projects, but pipeline infrastructure will be key for transporting large volumes of CO_2. In the map below, it can be seen that at the moment some lack access to transport networks but host sizable sustainable biogenic CO_2 feedstock that could be used for e-fuels production. Indeed, out of the annual 92 Mt of accessible, sustainable biogenic CO_2, more than 50 Mt are more than 100 km away from planned pipelines corridors, with around 10 Mt located in inland Sweden and Finland. When planning CO_2 transport infrastructure and pipelines in particular, it is important to consider how these CO_2 volumes could be mobilised if pipeline infrastructure would be extended into these regions.

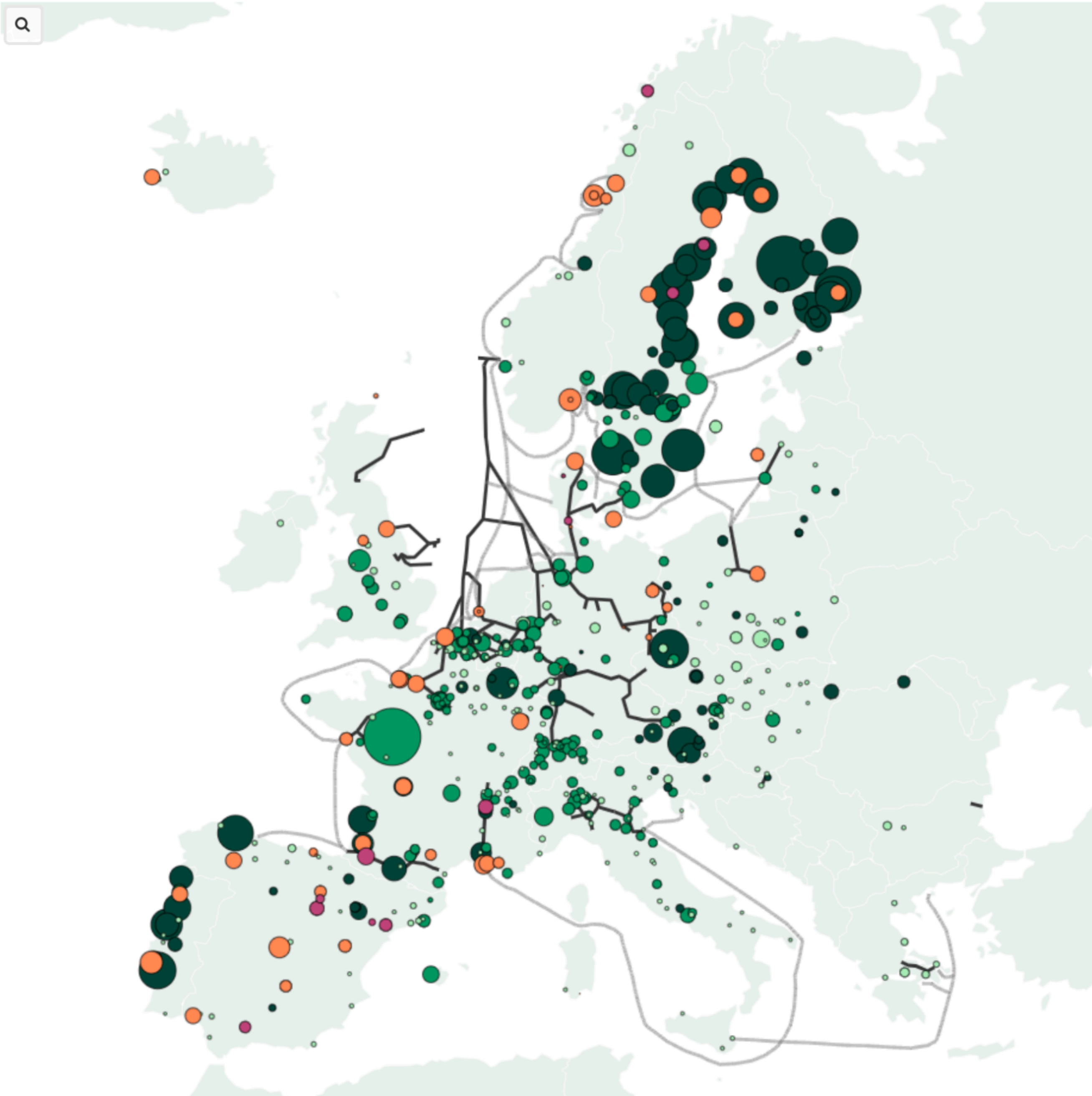
ERM modelling shows that about 60% of planned e-fuels have as of today sufficient biogenic CO_2 within 100 km perimeter to meet their CO_2 feedstock needs. However, as the map on the following page shows, northern Europe has higher concentrations of biogenic CO_2 sources but fewer e-fuel production projects, whereas southern Europe, with stronger renewable electricity potential, faces limited CO_2 availability. The roll-out of CO_2 transport infrastructure will require cross-border connections and multimodal transport solutions to ensure that all e-fuels projects have access to CO_2 supply. Strategic planning is required regarding the best CO_2 transport option for the volumes and location. As already touched upon in the above section, trucking may support smaller CO_2 volumes over short distances, while barges and ships can support more significant volumes.

More than 60% of announced e-methanol and e-kerosene projects have sufficient biogenic CO_2 from large emitters in a 100 km radius

Planned CO_2 pipeline — Planned CO_2 shipping route

Biogenic CO_2 in Mt/yr 0.5 2

Paper, pulp and primary wood products · Waste management · Other · e-kerosene · e-methanol



Source: T&E (2025), based on ERM (2025) • For sustainability reasons, we exclude CO_2 from bioethanol and biomass power sources. Circle sizes for e-kerosene and e-methanol plants represent the projects' CO_2 needs.

2.2 CO_2 transport infrastructure is equally relevant for CCU as for CCS

As is already the case for gas transmission and for a future hydrogen pipeline network, CO_2 transport infrastructure in the EU will be owned and operated by neutral CO_2 pipeline operators, which will need to be coordinated at European level. CO_2 pipelines have all the characteristics of a **natural monopoly**: high upfront costs, long lifetimes, and no realistic scope for parallel competing networks. Geological storage sites face similar dynamics, with a handful of operators controlling critical access points. In the absence of **robust EU-level safeguards**, emitters and users risk facing discriminatory access, inflated transport tariffs, or simply being left unconnected. The result would be a fragmented and inefficient CO_2 market, with smaller projects and new entrants crowded out.

The ERM report confirms that existing and planned CCS transport infrastructure, particularly in central Europe linking to North Sea storage sites, could also serve e-fuels CCU projects. The ERM report finds that around 30 Mt of accessible biogenic CO_2 per year lie within 100 km of planned pipelines, exceeding the demand of currently announced e-fuels projects. This CO_2 availability overlap creates a strong case for shared infrastructure between CCS and CCU. Especially since standards on CO_2 purity should not be a barrier for e-fuels, as conversion processes typically require additional purification to eliminate impurities (e.g., sulphur, halides, ammonia, metals) that may deactivate catalysts.

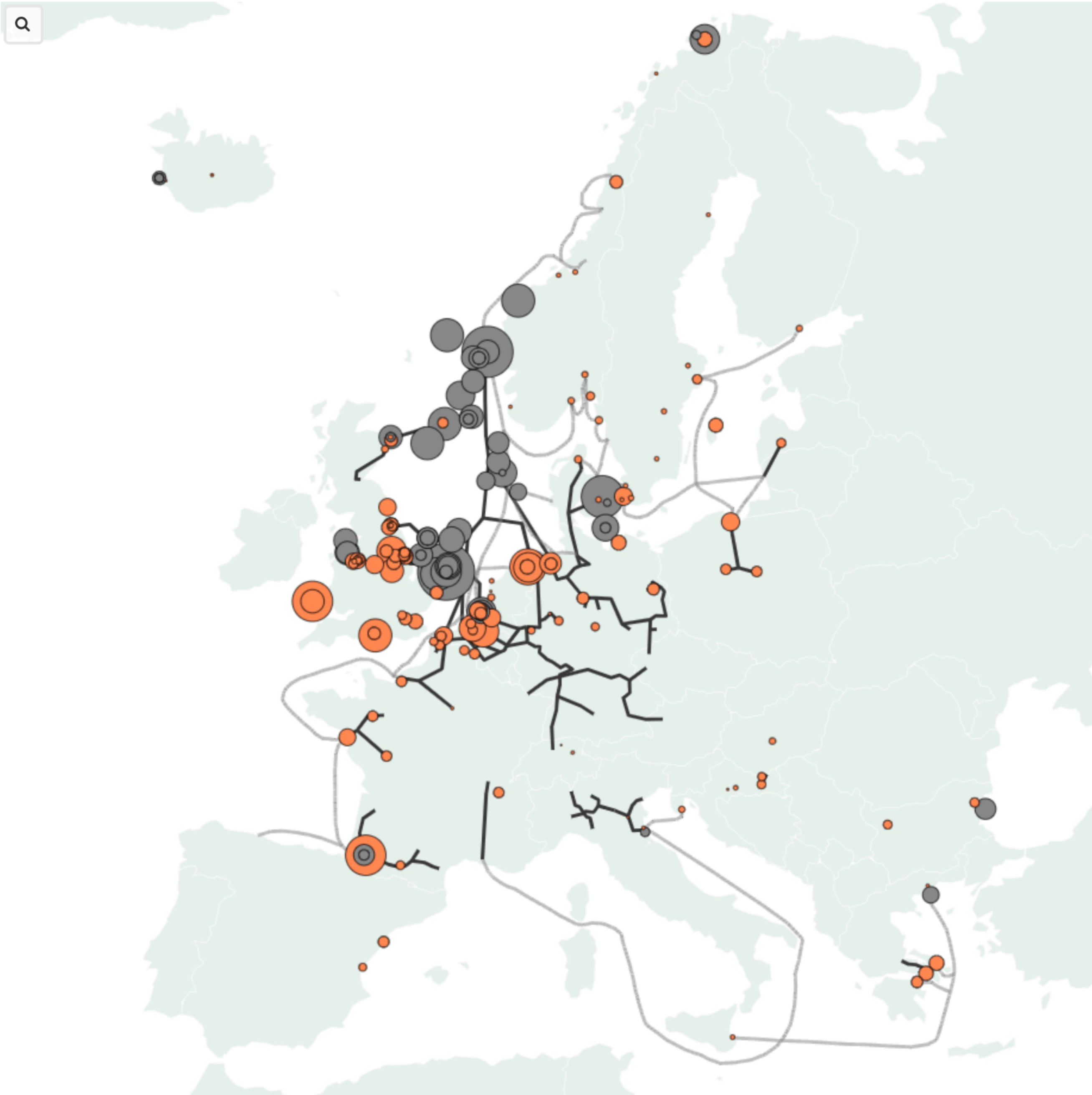
As can be seen in the visual on the next page, existing and planned CO_2 pipeline projects are almost exclusively designed to deliver captured CO_2 to geological storage sites, creating and reinforcing natural monopoly dynamics. It is crucial to allow CCU projects to access these existing and planned networks. This would enable cost reductions through economies of scale. In this context, it is crucial that the EU ensures fair and open access to transport infrastructure in its future policy frameworks, such as the CO_2 markets and infrastructure legislation.

Most of Europe's planned carbon capture and storage projects are concentrated around the North Sea

Planned CO_2 pipeline   Planned CO_2 shipping route

CO_2 in Mt/yr 1 ○ ◯ 10

Storage   Capture

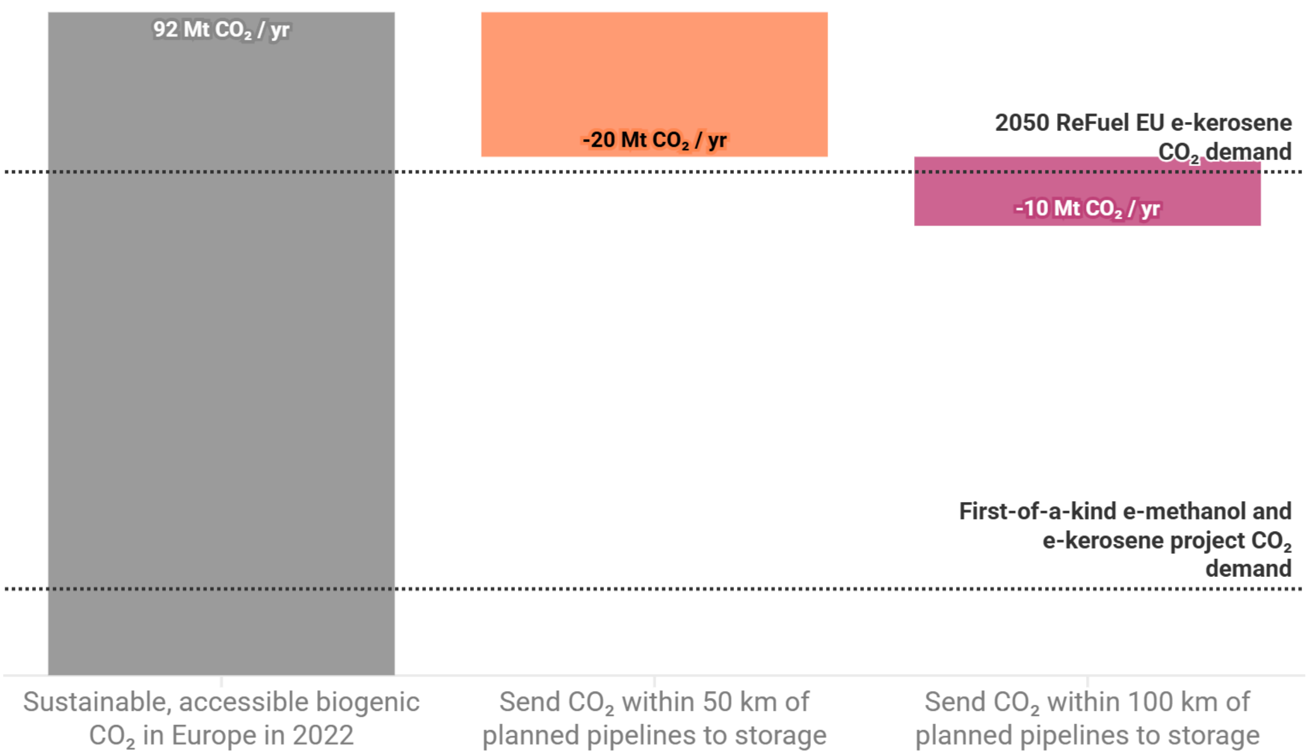


Source: T&E (2025), based on IEA carbon storage project tracker and CATF carbon capture project tracker

Open access would allow e-fuels projects to offtake CO_2 downstream, provided that robust monitoring, metering and verification systems are in place to accurately track biogenic CO_2 flows entering and leaving the network. In the upcoming policy framework, such as in the CO_2 transportation infrastructure and market legislation, it is crucial that the EU ensures fair, transparent and open access to CO_2 transport infrastructure.

At the same time, it is important to recognise the natural competition for biogenic CO_2 between CCS and CCU projects. Sequestering CO_2 close to CO_2 transport infrastructure reduces its availability for CCU projects like e-fuels. EU policy needs to strike a careful balance between prioritising carbon for one sector over the other.

Storing biogenic CO_2 close to planned pipelines instead of utilising it reduces availability by up to 30 Mt CO_2/yr

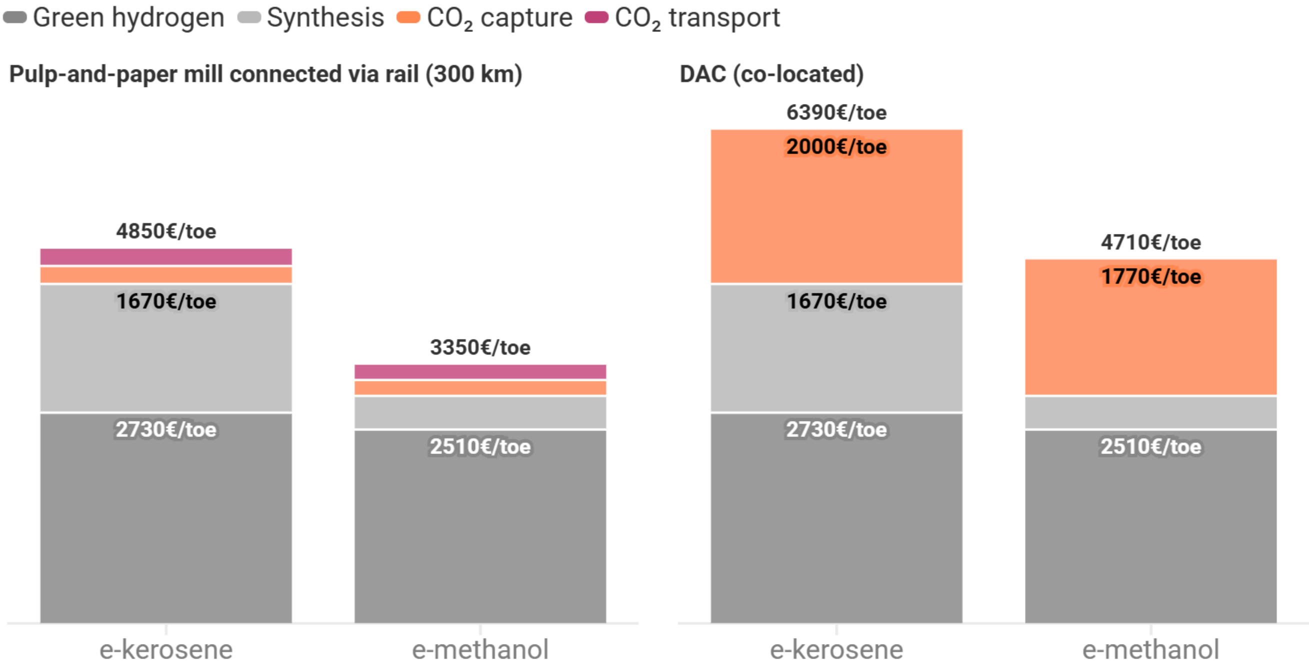


Source: T&E (2025), based on ERM (2025)

2.3 CO_2 transport comes at a small cost for e-fuels production

Weakening the rules on the eligible sources of carbon for the production of e-fuels will not meaningfully bring down the cost of e-fuels production. Transporting (biogenic) CO_2, even over larger distances, adds less than 10% to the production cost of the e-fuel.[1] The **main cost of sourcing carbon to produce e-fuels is related to the capture cost** which mainly depends on the CO_2 concentration, the input energy required to enable the capture process, and not on whether the source is fossil or biogenic. Currently, green hydrogen is the largest cost component of e-fuels and not carbon sourcing. Switching to fossil CO_2 sources nearby would therefore usually not make e-fuels substantially cheaper. The economic feasibility of e-fuels depends far more on securing low-cost renewable electricity and bringing down the costs of synthesis processes. Moreover, the ERM report shows that most planned e-fuels projects in Europe already have sufficient biogenic CO_2 sources nearby, around 60% of sites are within 100 km of suitable CO_2 sources.

Long-distance CO_2 transport represents less than 10% of the cost of e-kerosene and e-methanol



Source: T&E (2025), based on ERM (2025) and Project SkyPower (2024) • Assume 600 €/t CO_2 for DAC, 70 €/t for biogenic CO_2 capture cost and 67 €/t CO_2 for rail transport cost including conditioning. E-kerosene cost for methanol-to-jet pathway in Norway.

[1] 5% for e-kerosene, 6% for e-methanol assuming EUR 67/tonne for 300 km of rail transport

3. Recommendations

This briefing has demonstrated that planning CO_2 infrastructure needs to also consider biogenic CO_2 availability, especially for one of the main CCU applications: e-fuels production. The strong link in EU-level discussions between CO_2 transport infrastructure and the permanent storage of fossil CO_2 risks neglecting the helpful role of CCU. Why? CCU can support the economic viability of CO_2 transport infrastructure through increased demand. However, the governance of CO_2 transport infrastructure, in particular third-party access for suppliers of biogenic carbon (as well as offtakers), will be key to make CO_2 infrastructure an enabling factor for the e-fuels industry. Securing such governance will also help DAC projects, by facilitating the transport of captured atmospheric carbon to offtakers, be it for the purpose of CCU or CCS.

Measures to secure an open and competitive framework for CO_2 transport include:

- Enshrine **fair and open third-party access** to all CO_2 transport and storage infrastructure, backed by **transparent tariff-setting** and **independent regulatory oversight**.
- **Streamline permitting** and **rights of way** for cross-border pipelines and multimodal connections, ensuring access is not blocked by national bottlenecks.
- Prioritise **repurposing of existing infrastructure** such as gas pipelines, storage caverns, and port assets, to accelerate deployment while lowering costs.
- Guarantee **transparency on available storage capacity, planned connections, and tariffs**, so that emitters can plan with certainty and investors can assess risks fairly.
- Completion of the **EU TEN-T rail network** for CO_2 transport by rail

Our analysis also showed that the cost of capturing CO_2 from cheap biogenic sources such as pulp and paper plants and transporting it is not the largest component of the overall production cost of e-fuels. Hence, **weakening the rules on carbon sourcing in the RFNBO and low-carbon fuels delegated acts will not significantly bring down the cost of e-fuels**. For a pulp and paper mill connected via rail, for instance, carbon capture and storage only account for ~ 10% of the total e-fuel production cost.

Reviewing or extending the deadline for fossil carbon is not necessary, as there is sufficient biogenic carbon available to allow e-fuels to scale up in line with existing mandates for synthetic aviation fuels and plans of shipping companies to fuel ships with e-methanol in the next decade. In the context of the forthcoming review of the RFNBO rules by 2028, hydrogen and e-fuels producers have called for regulatory certainty. Instead, the focus should be on enabling Final Investment Decision (FID) for e-fuels projects (e.g. by supporting double-sided auctions to support offtakers to commit to long-term contracts).

However, the e-fuels industry is not the only industry interested in using biogenic carbon. Estimates for the future demand for the permanent underground storage of biogenic carbon (e.g. by means of Bioenergy with Carbon Capture and Storage or BECCS projects) significantly outstrip the demand coming from utilisation (see info graph in Executive Summary). There is also the existing demand for carbon that still needs to be met in the future. Given these competing uses for sustainable carbon and the limited availability, **T&E advocates that the EU**

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stops supporting BECCS. We refer specifically to projects whereby biomass is combusted for electricity generation and the emitted biogenic carbon would be permanently stored. **Sustainable sources of biogenic carbon, such as pulp and paper mills, waste incinerators with carbon capture should be prioritised for CCU applications like e-fuels**. Support for CCS projects should rather be focused on the permanent storage of fossil carbon, especially from hard-to-abate sectors. The benefits of such a prioritisation was already recognized in the Commission's Industrial Carbon Management Strategy, which recognizes captured CO_2 as "a valuable commodity, especially if it is captured from bio-sources or the atmosphere", which "should be used more widely in manufacturing processes, in particular [...] the production of sustainable fuels to tackle hard-to-abate transport".

Even in an optimistic scenario whereby biogenic carbon were to be prioritised and CO_2 transport infrastructure unlocks most of the sustainable biogenic carbon potential in Europe, it remains a fact that the carbon demand of the e-fuels industry will outstrip the biogenic CO_2 supply. In the longer-term, **developing DAC will be needed**. Whether DAC will scale up will depend on the ability of DAC plants to improve the efficiency of their operations, by reducing the energy input required to capture CO_2. This will be key to bring down the cost of DAC. Supporting first-of-a-kind DAC projects that are sufficiently mature through the EU Innovation Fund can be a first step.

Further information

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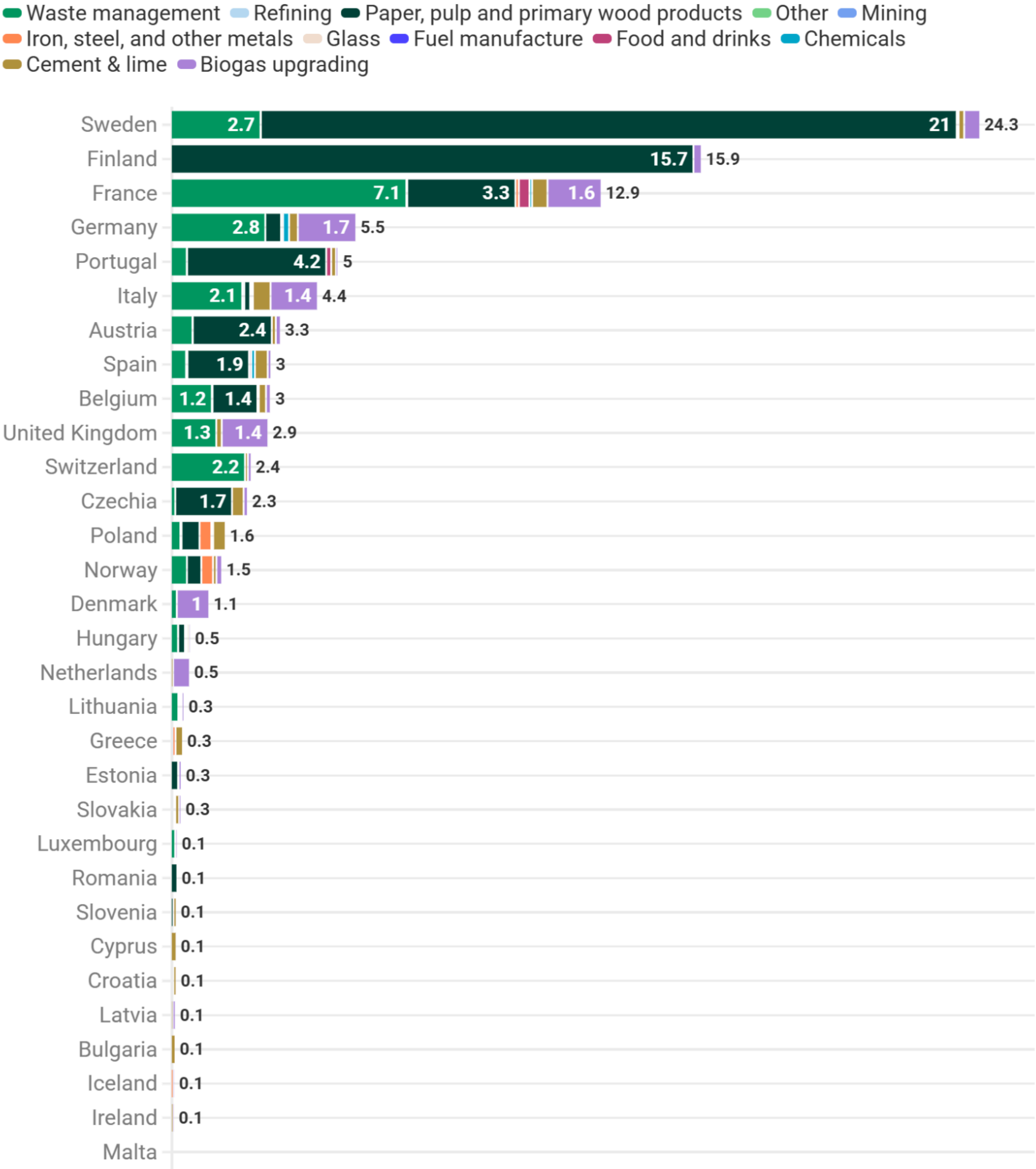
Annex: Two thirds of sustainable, accessible biogenic CO_2 concentrated in Sweden, Finland, France and Germany

Sustainable, accessible biogenic CO_2 availability by country in million tonnes (Mt)



Source: T&E (2025), based on ERM (2025)