Sustainable
Markets Initiative

Net Zero explainer for companies

A review of current thinking and practice and an exploration of a new framework for companies to reach net zero

Prepared for the Sustainable Markets Initiative by Work Group 1 of the SMI CCUS Taskforce

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This document is presented to stimulate thought leadership on pathways to accelerate global delivery of net zero.

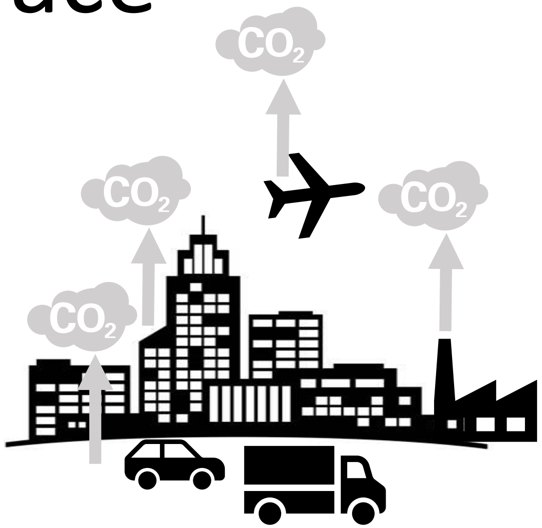
The ideas contained here build on previous work* and set out a simple, science-based and useful frame for helping deliver net zero.

All views expressed in this document are those of its authors. They do not necessarily represent the views of any organisation to which they may be affiliated.

Feedback and questions are welcome! Please direct them to martin.towns@bp.com.

*including reports and papers by Myles Allen, Stuart Haszeldine, Wolfgang Heidug, Margriet Kuijper, Eli Mitchell-Larson, Paul Zakkour, Ron Oxburgh and others.

Preface



Everyday activities such as driving a petrol car or heating a home with a gas fired boiler create emissions of CO2.

These and all other greenhouse gas emissions need to be rapidly reduced, and residual emissions balanced by removals if the world is to reach *net zero* and deliver the goals of Paris Agreement.

This explainer describes a **new framework for carbon reporting** and **policy instruments that can be used to reach net zero**. It is provided to stimulate thought leadership.

The document starts by describing the limitations of current frameworks. It goes on to describe a new framework in which **companies can reach net zero**.

It then introduces the **Carbon Storage Unit (CSU)**. This new asset class allows the benefits of storing CO_2 to be attributed appropriately and uniquely to those activities which drive delivery of net zero.

Finally, the document introduces a **Carbon Storage Obligation (CSO)** and describes how it could be implemented, using the UK as an example.

Executive Summary

Requirements for net zero

Meeting net zero requires rethinking transport, heating, industry and power generation, and the deployment of new technologies at scale – especially renewables. Solutions are being developed and delivered, and costs continue to fall.

But meeting net zero also requires a **substantial and cost effective industry** for:-

- **capturing CO_2 from large, stationary sources**
- **capturing CO_2 directly from the atmosphere**
- **permanently storing CO_2 in deep geological formations**

Scale up of these activities continues to lag the pace necessary to deliver net zero by 2050*.

Net zero will also require:-

- new **carbon accounting frameworks** that ensure consistent, accurate and fair reporting.

* Net Zero by 2050 – Analysis - IEA

The carbon balance and net zero accounting framework

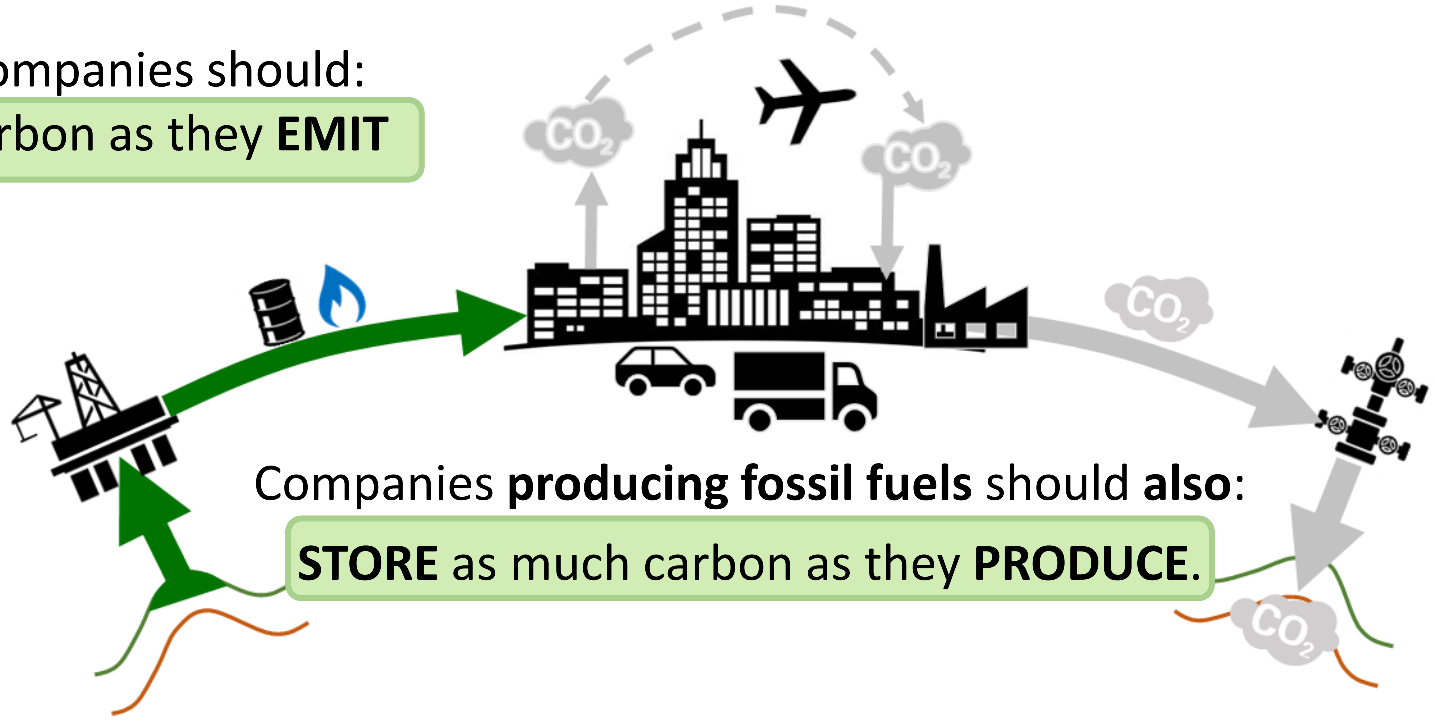
In a net zero world the use of fossil fuels will be very much less than today. But it is very likely that some fossil fuel production will continue and there will be **residual emissions** from its use in some *hard-to-abate* sectors (see [Net Zero by 2050 Scenario - Data product – IEA]).

These emissions will have to be neutralised by **removing carbon dioxide** from the atmosphere and **permanently storing it**. Net zero companies may do this themselves or pay others to do it on their behalf.

To be net zero, all companies should:

REMOVE as much carbon as they **EMIT**

RECOMMENDATION:
An accounting framework should be adopted that would enable companies producing fossil fuels to use this **definition of net zero**.



Companies **producing fossil fuels** should **also**:

STORE as much carbon as they **PRODUCE.**

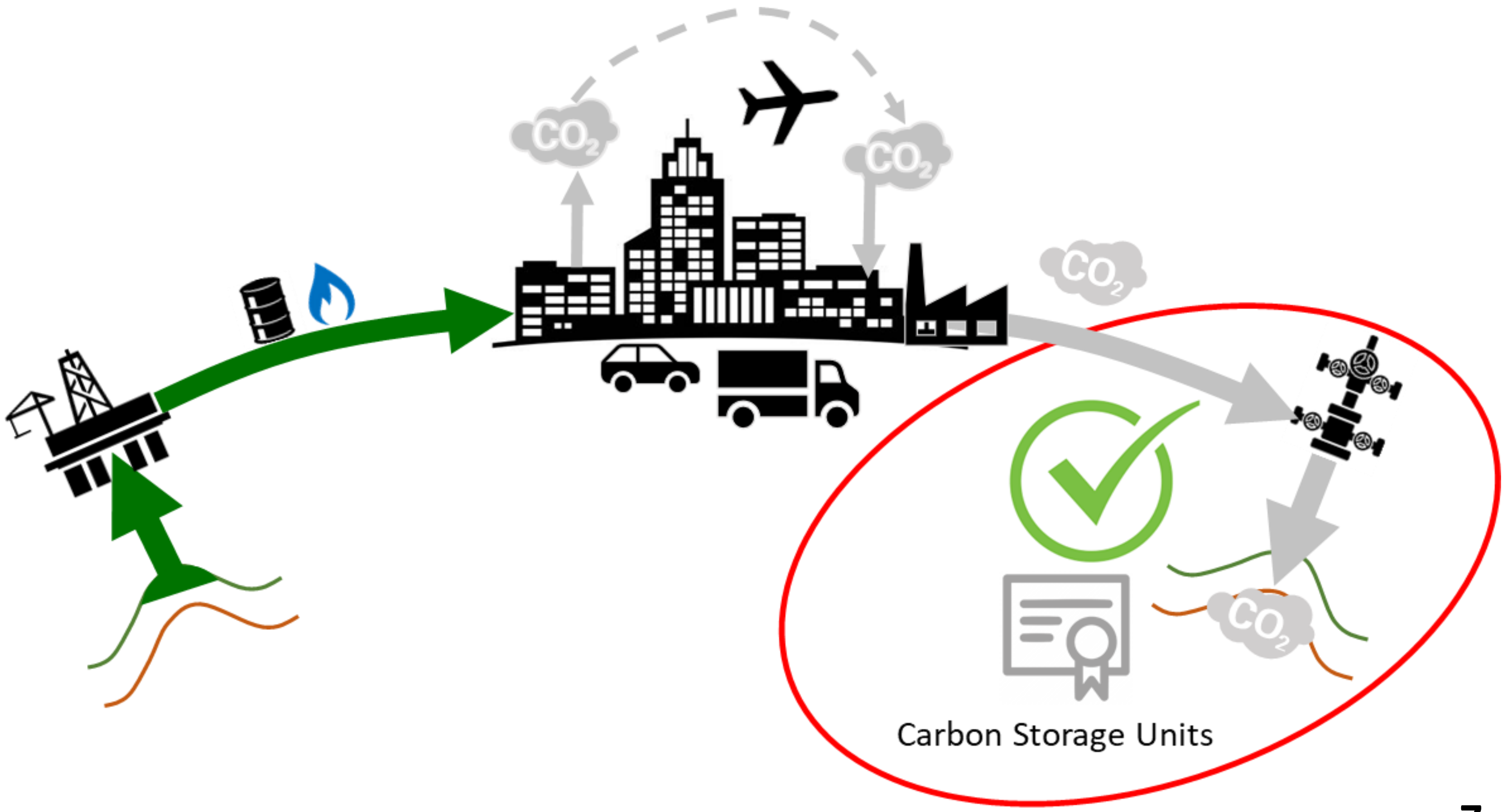
Carbon Storage Units (CSUs)

To make this work, the world will need an active carbon storage industry, and an active market in carbon storage services.

These require a **trusted and tradeable unit** that can be used to account for permanent carbon storage.

RECOMMENDATION:

Systems of tradeable **Carbon Storage Units (CSUs)** should be developed and introduced now to account for the permanent storage of carbon.

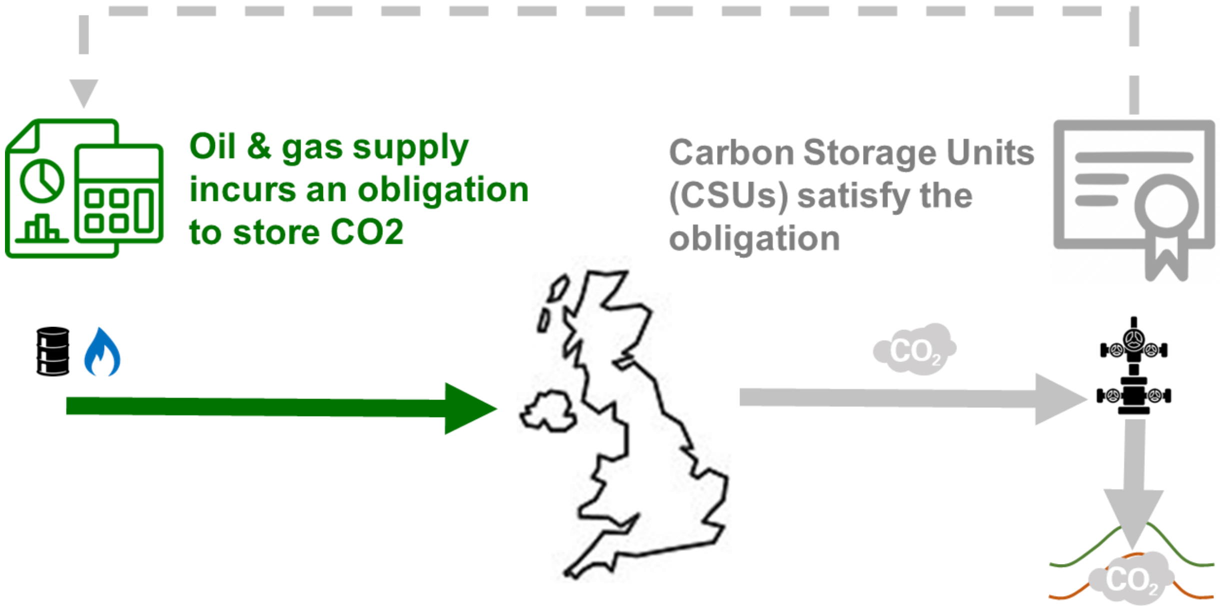


(Carbon can also be stored in shorter-lived nature-based solutions, such as standing vegetation. This type of storage should not be considered permanent and would not result in the issue of CSUs. However, nature-based solutions will play a vital role in tackling climate change and could balance, for example, emissions from land use change for agriculture).

Carbon Storage Obligations (CSOs)

Carbon pricing and **government support** for abatement projects are important policy tools for activating investment in low carbon energy and products.

However, it is **unlikely that these will be sufficient to drive deep decarbonisation** and the delivery of net zero in the timeframe necessary. Some form of **obligation** will be required.



RECOMMENDATION:

Systems of **Carbon Storage Obligations** should be introduced.

These would require fossil fuel suppliers to **store an increasing fraction of the carbon contained in the fossil fuels they supply.**

The obligation would be **small to start with** and **rise to 100% to deliver net zero**.

CSUs can be designed to balance both production and supply with no double-counting.

A UK Carbon Storage Obligation system as an example.

Countries with storage resources may mandate domestic storage initially, but ultimately expand to include storage in other countries.

Key messages, recommendations & next steps

Key Messages – 1

1. Along with huge expansion of renewable energy sources and other low carbon technologies, achieving **net zero** will also **require carbon removals from the atmosphere and permanent carbon storage.**

2. Permanent storage can be achieved by **sequestering CO_2 in deep geological formations**, and through some types of usage such as conversion into in building materials.

3. New **carbon accounting frameworks** and **complementary policies** are needed to enable the rapid scale up of a **carbon capture, use and storage (CCUS)** industry.

4. In this framework, **all companies** wishing to become net zero should **remove as much carbon as they emit**.

5. In addition, companies that produce fossil fuels should also **store as much carbon as they produce**.

6. A new asset class of **Carbon Storage Units (CSUs)** should be introduced as a standard global currency for permanent carbon storage.

Key Messages – 2

6. A system of **Carbon Storage Obligations (CSOs)** should be introduced to drive the rapid scale up of a carbon capture, use and storage industry.

7. CSOs offer an efficient way to **embed the cost of decarbonisation** in the price of **products and services** that use fossil fuels.

8. CSOs **mandate progressive decarbonisation** while using the power of markets for **competitive price discovery**.

9. Companies that store carbon earn **revenues from the sale of CSUs** to those companies under an obligation to surrender them.

10. Companies that capture carbon from their operations will benefit from **avoided carbon costs** and **low carbon premiums** for their products. Their capture, transport and storage costs may be met in part through CO_2 supply contracts with carbon storers who want to grow their operations to meet a rising demand for CSUs.

11. A CSO **drives decarbonization** at a **predictable and rapid pace** and enables **private investment**. This enables **innovation** and **cost reduction**.

Recommendations

1. Define new net zero pathways for fossil carbon producers that recognise net zero is achieved when a company **stores as much carbon as it produces** and **removes as much carbon as it emits**. Set up a new **production & storage accounting frame** to govern this.

2. Create a new internationally recognised asset class for permanent geological storage – a **Carbon Storage Unit (CSU)**. One CSU is created when one tonne of CO2 is permanently stored under a recognised protocol.

3. Implement a **Carbon Storage Obligation (CSO)** that mandates geological carbon storage in proportion to fossil carbon supplied. A CSU can be used to satisfy the obligation placed on a supplier and enable a fossil carbon producer to balance its carbon produced with no double counting.

Next Steps

1. For companies that produce fossil carbon - commit to **report carbon produced and carbon stored**.

2. For think tanks, companies and NGOs - increase **awareness of the Carbon Storage Unit (CSU) concept** in stakeholder communities, and establish a voluntary market for CSUs.

3. For governments - explore how a **Carbon Storage Obligation (CSO)** can **complement other policy mechanisms** to accelerate decarbonisation. Include CSUs as Internationally Transferable Mitigation Outcomes in Nationally Determined Contributions.

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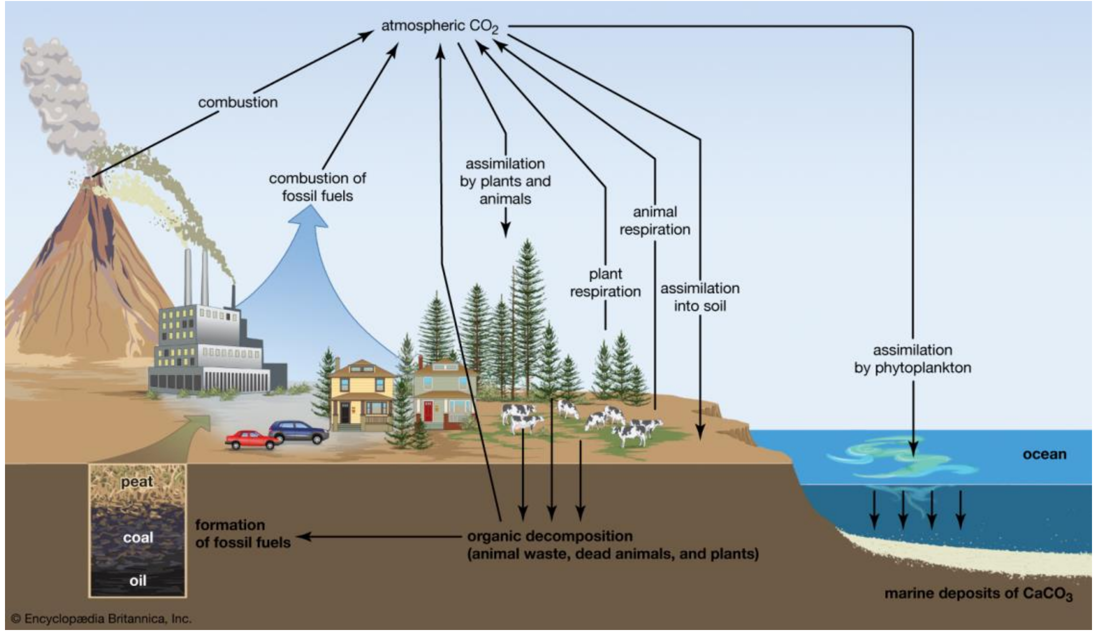
The carbon journey – Part 1

Where can it go?

In the natural world, carbon is stored in vegetation, in soil and rocks, in the oceans and in the atmosphere. For at least the last 800,000 years the carbon cycle has been largely in balance, which has kept atmospheric CO_2 concentrations broadly steady. The pre-industrial world was *net zero*.



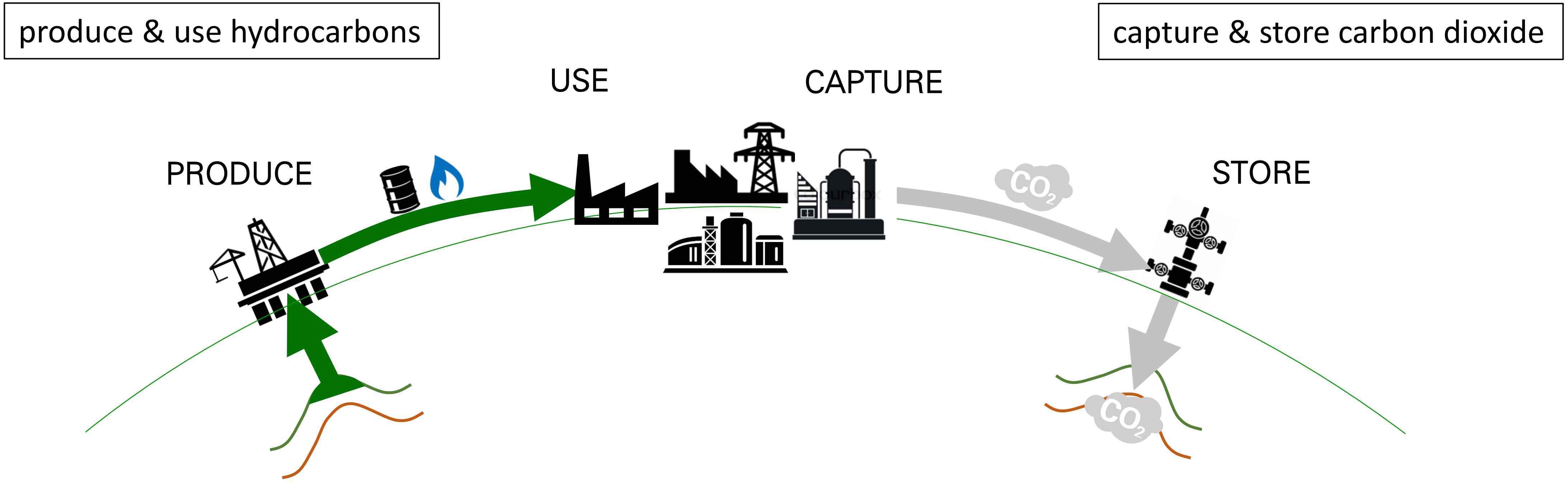
carbon sequestration | Definition, Methods, & Climate Change | Britannica

However, the large scale industrial extraction and use of hydrocarbons (coal, oil and gas) now means that emissions far exceed the earth's natural capacity to remove atmospheric CO_2. The resultant accumulation of CO_2 in the atmosphere is the major driver of global climate change.

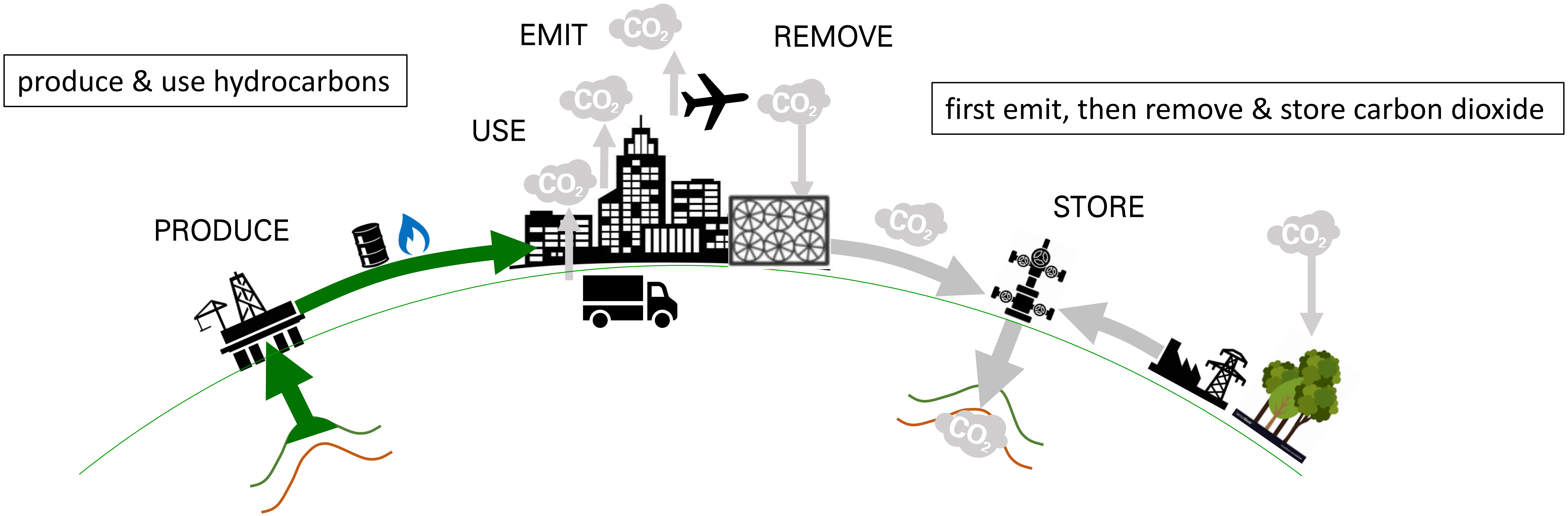
In 2015, the Paris Agreement set a goal to keep the rise in mean global temperature to well below 2 °C above pre-industrial levels, and preferably limit the increase to 1.5 °C. To do this, emissions will need to fall to net zero around mid-century.

Two of the most effective ways to reduce CO_2 emissions are to **improve energy efficiency** and to **replace hydrocarbon use with low carbon energy sources** such as renewables and nuclear.

In some processes and systems, switching energy sources or feedstocks is challenging or impossible. In these cases it may be more practicable and cost effective to **capture CO_2 directly from the process before it is emitted**. It can then be stored permanently by injecting it into rocks deep underground.



For some uses of hydrocarbons, capturing emissions at source is infeasible or prohibitively expensive. In a net zero world these emissions can be neutralised by **removing CO2 directly from the atmosphere and storing it permanently underground**. This can be done using **Direct Air Capture with Storage** (DACS) technology, or **bioenergy with carbon capture & storage** (BECCS).



Natural climate solutions such as reforestation can also play an important role in neutralising emissions, for example those arising from land use change for agriculture. However, the focus of this pack is permanent geological storage.

The GHG Protocol:

The problem of Scope 3 emissions

The Greenhouse Gas protocol

In 2001, the **Greenhouse Gas (GHG) Protocol** was developed and launched by the World Resources Institute (WRI)* and the World Business Council for Sustainable Development (WBCSD)**.

The GHG Protocol Corporate Standard provided a framework for a company to classify and report its emissions.

WORLD RESOURCES INSTITUTE

wbcsd

* World Resources Institute
** World Business Council for Sustainable Development

Scopes of emissions

The GHG Protocol Corporate Standard* classifies a company's GHG emissions into three 'scopes'.

Scope 1 emissions are direct emissions from owned or controlled sources.

Scope 2 emissions are indirect emissions from the generation of purchased energy.

Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions. These include, for example, emissions from an employee's business travel, and a motorist's tail pipe emissions from the use of an oil and gas company's fuel products.

It is important to recognise that an **indirect value chain Scope 3 emission** for one company, organisation or individual is **always** a **direct Scope 1 emission** for another company, organisation or individual.

* Greenhouse Gas Protocol

Pathways to Paris

The GHG Protocol doesn't define how a company can be Net Zero, it only provides a framework for reporting emissions and removals.

However, other organisations, including the Science Based Targets Initiative (SBTi)*, are using GHG Protocol definitions to create a suite of methodologies via which they offer to validate a company's plans and targets to reduce emissions as being **'aligned to the Paris Agreement'**.

To award *Paris aligned* verification, a typical verification body's methodology requires a company to **make all reasonable efforts to minimise emissions** and then **neutralise any residual emissions** with **carbon removals**.

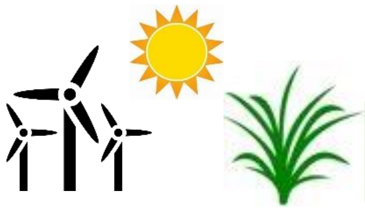
But, for which scopes?

*Science Based Targets initiative

How can a company be net zero for Scope 1 and Scope 2 emissions ?

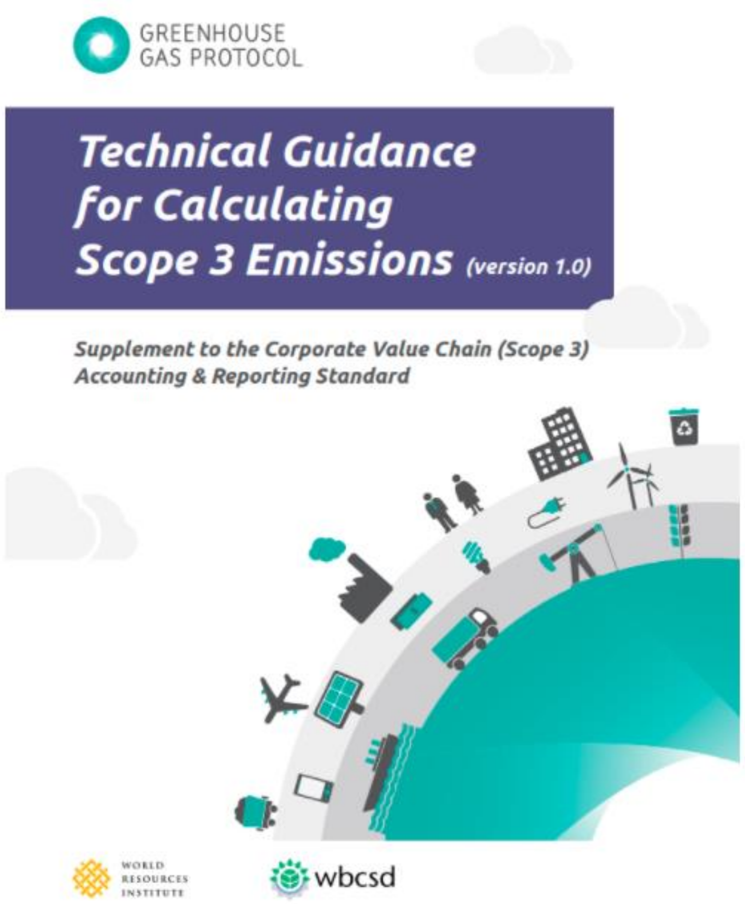
SBTi methodologies currently validate pathways ‘aligned to the Paris Agreement’ and are one way in which companies can demonstrate consistency or alignment with the Paris goals. But some companies want to go further and are setting **‘net zero by 2050’ targets**. Verifiers are developing new methodologies to validate these.

The actions required for **Scope 1** are reasonably clear. A company can **modify its processes, improve efficiency**, and, having done this, **remove carbon** to neutralise residual emissions.



And for **Scope 2** a company can **source zero-carbon energy from suppliers**.

The Scope 3 challenge



However, Scope 3 is particularly challenging - since its definition is *full value chain*, and value chains have **multiple stakeholders**.

The same single emission source could be reportable for many different companies.

So who should pay for its abatement or neutralisation, and who can take credit for doing so?

Here are two examples.

Example 1 - Making steel for cars

Let’s take as an example a steel maker who uses natural gas in its production process and provides steel to an electric car maker……..

The emissions from the steel plant are **Scope 1** for the steel company

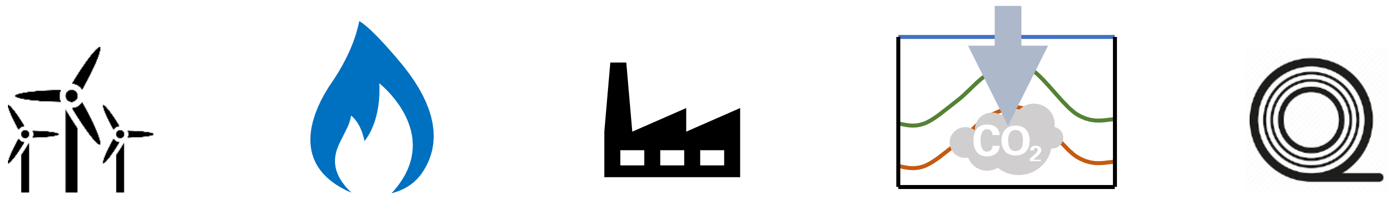
They are **Scope 3** for natural gas producer.

They are **Scope 3** for the natural gas supplier.

They are **Scope 3** for the car manufacturer who uses the steel to make electric cars.

etc., etc…..

Let’s imagine the steel maker decides to fit carbon capture equipment to its plant, and contracts an oil and gas company to store the captured CO2. Let’s also imagine that the same oil and gas company both produces and supplies the gas to the steel maker. (And for simplicity let’s assume that 100% of the emissions are captured and stored and the additional processing plant runs on clean power.)



In this situation the steel maker’s **Scope 1** emissions fall to zero, as do the **Scope 3** emissions of all the other stakeholders this value chain.*

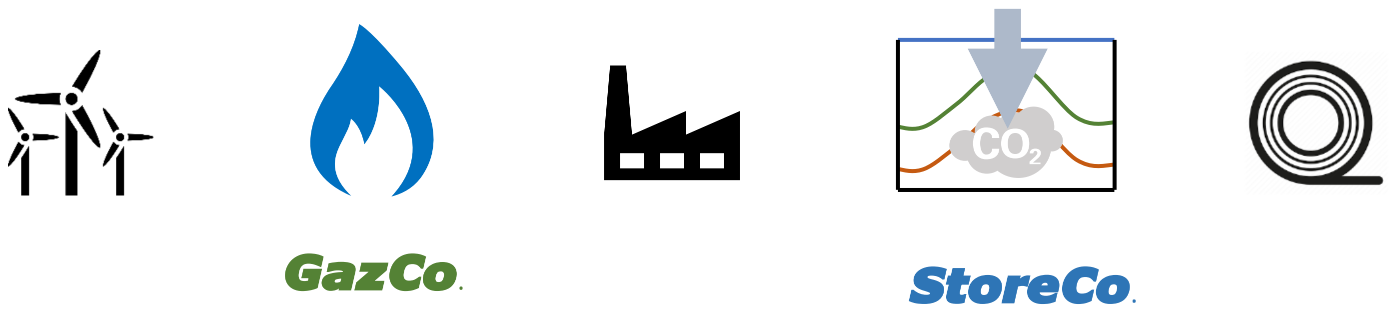
Because the company storing CO2 is the same oil and gas company that produces and supplies gas to the steel plant, then this outcome seems fair and reasonable.

*This is actually not explicitly defined in documentation but it is logically consistent with currently defined frameworks.

But what if the gas producer, gas supplier and CO2 storer are all different companies?

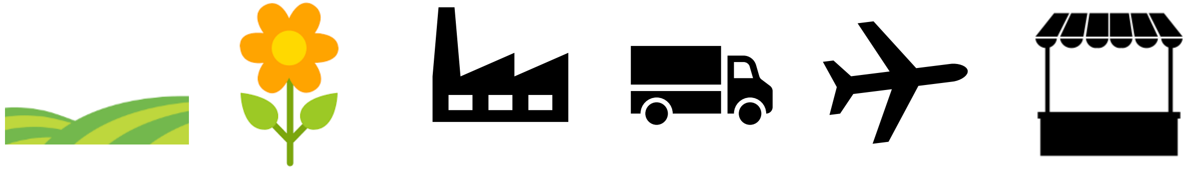
The gas producer and supplier each benefit from action taken by the steel maker and a third party CO2 storer which reduce their scope 3 emissions, although they have not actually done anything to reduce emissions.

But the carbon dioxide storage service provider cannot claim any **Scope 3** benefit, as the storage service it provides does not sit in the value chain of its hydrocarbon production or supply.



Example 2 - Selling flowers

As another example, consider an aircraft transporting flowers from growers to sellers overseas…..



The emissions created by the aircraft as it burns fuel in flight are **Scope 1** for the airline.

They are **Scope 3** for the freight company who arranged the transport of the flowers.

They are **Scope 3** for the flower grower. They are **Scope 3** for the flower seller.

They are **Scope 3** for oil and gas company that produced the oil for refining to fuel.

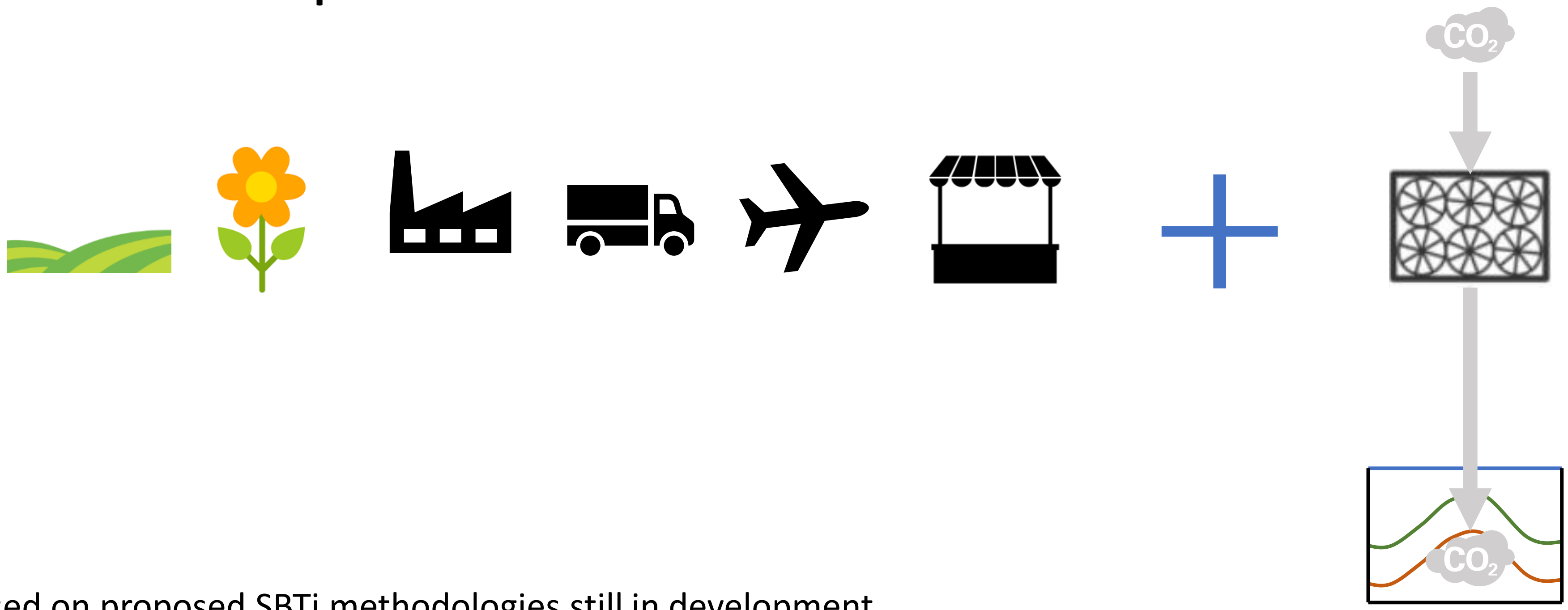
They are **Scope 3** for the refiner who produced the kerosene.

They are **Scope 3** for the fuel distributer who supplied the kerosene to the airline.

etc., etc…..

Now let’s imagine the airline transporting flowers decides to contract a third party to perform Direct Air Capture with Storage (DACS) to remove and permanently store the carbon associated with the fuel used to power its aircraft.

In this situation the airline’s reported *gross* **Scope 1** emissions remain unchanged as the emission still occurs. But it can **report a removal** that **neutralises the carbon emitted***.



*based on proposed SBTi methodologies still in development

The company performing the DACS is able to report a **Scope 1** removal and report that this was sold to the airline.

Can other value chain stakeholders, who played no part in the CO2 capture and storage activity record a reduction in their **Scope 3**? Since offsetting activity sits outside their direct value chain they cannot.

This provides little incentive to others to work with and support the airline to remove its emissions.

If the company performing the CO2 removal and storage also produced oil and gas, it would still be unable to count the carbon removed against its **Scope 3,** having transferred its offsetting function to the airline under a contractual instrument.

Scope 3 stakeholders have little or no incentive to manage their Scope 3 emissions.

From these examples we see that for companies that produce fossil carbon, limiting **Scope 3** abatement activity to their direct hydrocarbon value chain does not ensure outcomes that fairly attribute abatement activity to those who deliver it. It also limits the potential for technical and commercial optimisation that could enable increased ambition and accelerated action.

Furthermore, methodologies that require companies to remove and permanently store CO_2 to neutralise all their **Scope 3** emissions are problematic.

As we have seen, every **Scope 3** emission is another party's **Scope 1** emission, and **the same emission may be reportable as Scope 3 for multiple companies**. If each were required to neutralise the same emission, it could be neutralised several times over! While this may appear initially to be an environmental good, in practice it is likely to deter companies from making ambitious commitments.

To sum up:

Before moving on, let's review the **key issues** we've addressed:

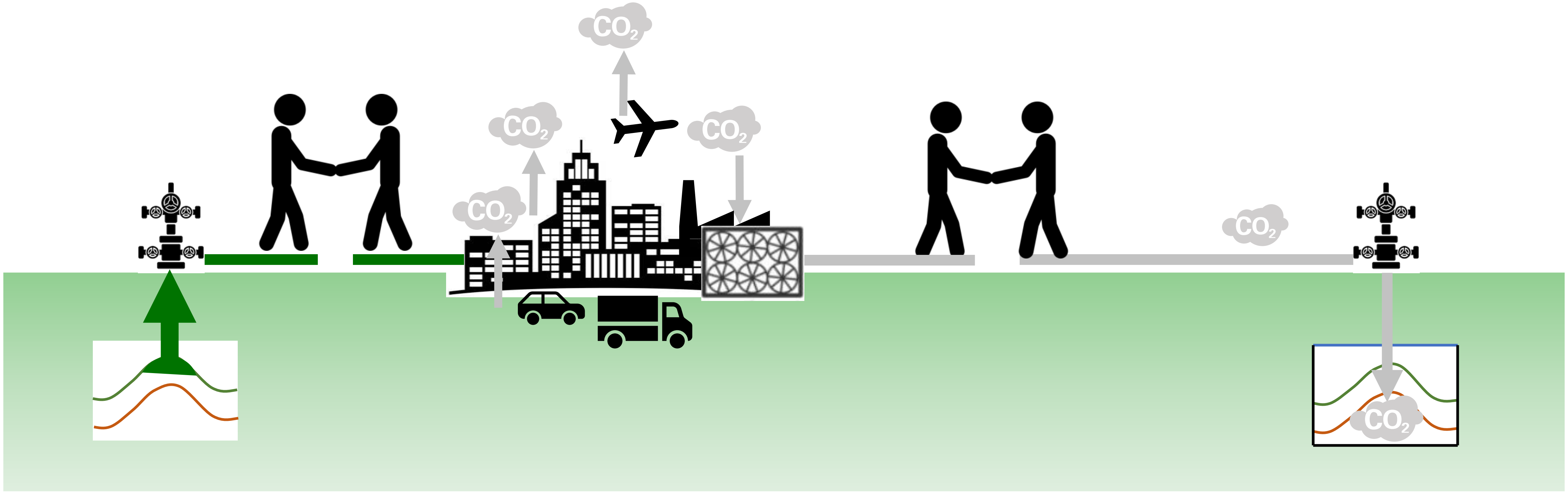
1. Reducing **direct emissions** and **neutralising any remaining emissions with removals** are key net zero targets.

2. However, there is also societal and corporate recognition that **value chain emissions** are important and there is a willingness to act to reduce or neutralise them.

3. **Current frameworks** enable value chain emissions to be defined and reported as Scope 3. However, the breadth of the definition makes the same emission reportable by multiple stakeholders. **This non-uniqueness makes galvanising action to abate the emission challenging.**

A framework is therefore needed to incentivise Scope 3 reductions.

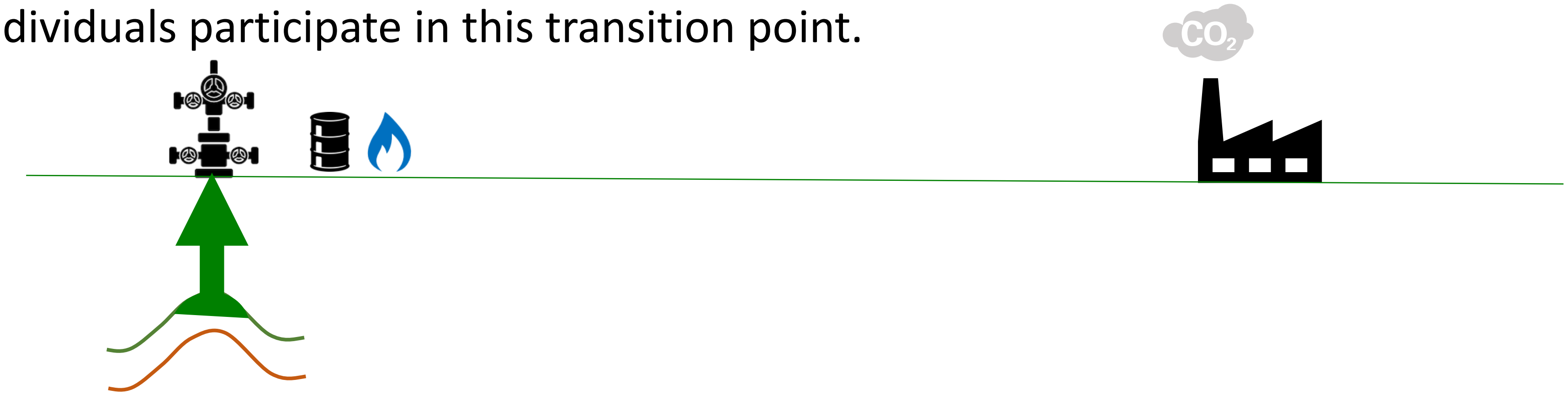
A methodology is needed that encourages fossil carbon producers, suppliers and CO_2 storage service providers to work with **Scope 1** emitters to *either* **capture CO_2 before it is emitted** *or* **remove it from the atmosphere if emission is unavoidable.** In so doing, hydrocarbon producers and suppliers would have the opportunity to acquire from a storage service provider a unique attribution of the **carbon stored** that **balances** their **production and supply activity** to deliver net zero.



What does it mean for hydrocarbon production companies be net zero?

As the world explores what it means to be net zero, many see a special role for energy companies that produce fossil fuels. Some companies have set net zero targets that relate to the carbon contained in the hydrocarbons they produce. Others focus principally on the carbon in the products they sell. Carbon value chains are complex, but **two key transition points** merit special focus:

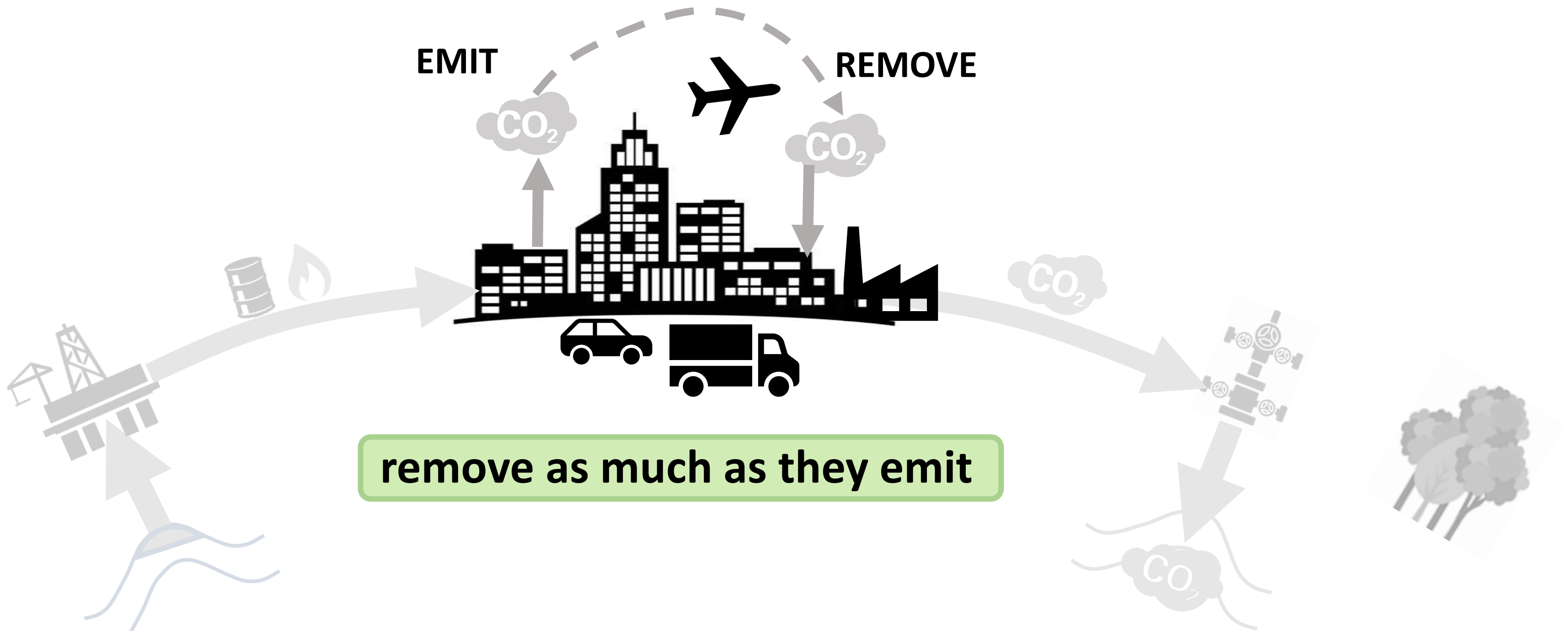
1. The point at which fossil **carbon transitions from the subsurface to the active economy** through hydrocarbon production. This transition point is managed by hydrocarbon production companies.
2. The point at which **carbon enters the atmosphere** (i.e. direct emission). Many companies and individuals participate in this transition point.



Each of these transition points occurs only once. A framework that enables carbon **storage to balance production** and carbon **removal to balance emission** can underpin a new model for co-operation to deliver net zero.

To be net zero all companies must remove as much carbon as they emit.

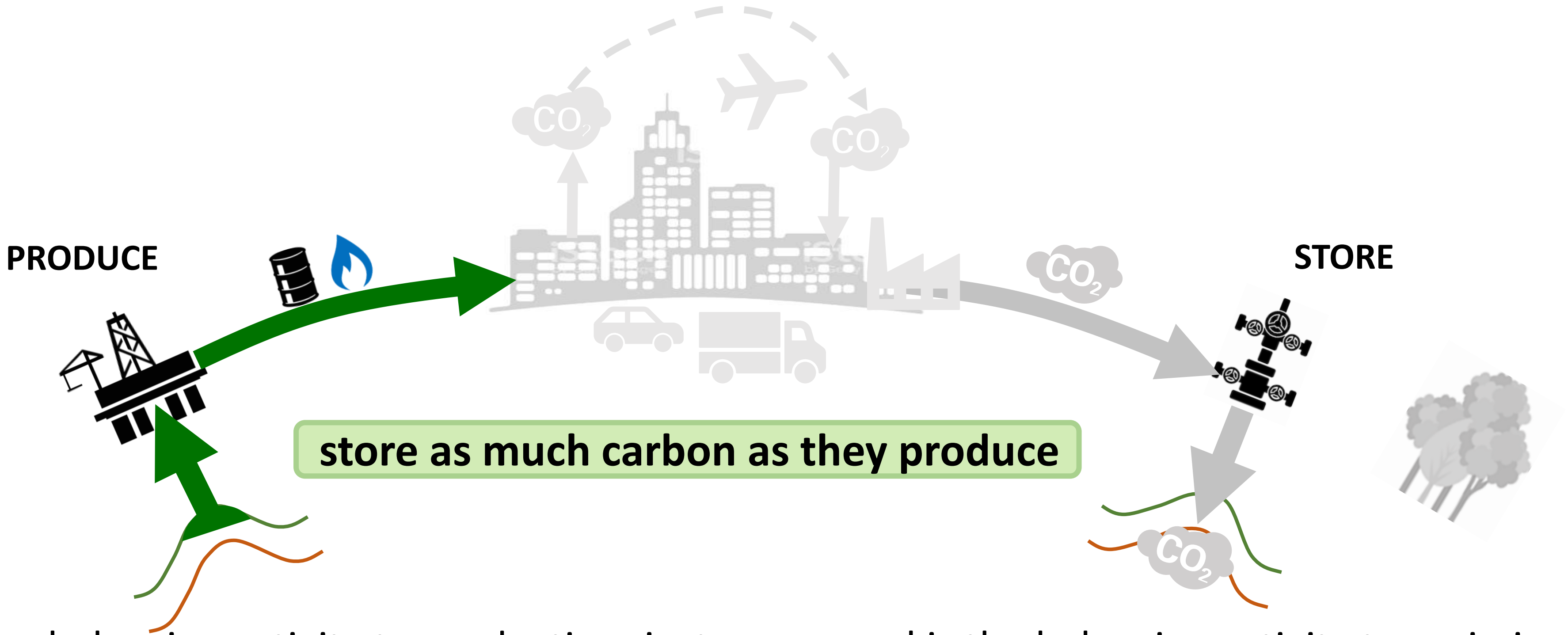
Focusing on the second transition point, emission to atmosphere - in a **net zero** economy, **all companies,** organisations and individuals should be **net zero** in their **direct (scope 1) emissions**.



This means that having minimised their emissions, they should balance any residual direct emissions with carbon removals, or simply, they should **remove as much as they emit**. Companies will benefit from beginning their transition to net zero now, in order to meet customer and investor expectations, to avoid carbon costs and to take advantage of new low carbon business opportunities.

Hydrocarbon production companies should also store as much carbon as they produce.

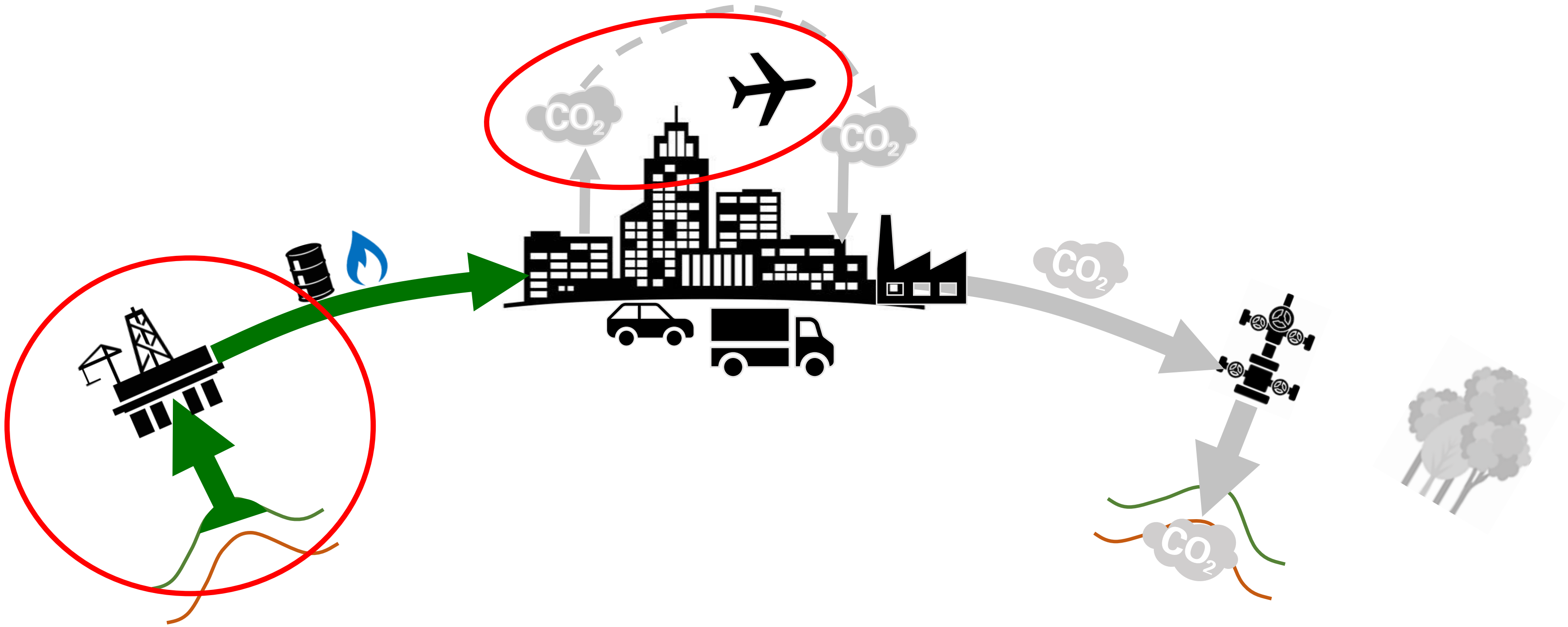
Now focusing on the first transition point, production from the subsurface – to be net zero, hydrocarbon production companies should balance the carbon in the materials they extract from the subsurface with the carbon they return for permanent storage. Put simply, they should **store as much carbon as they produce.**



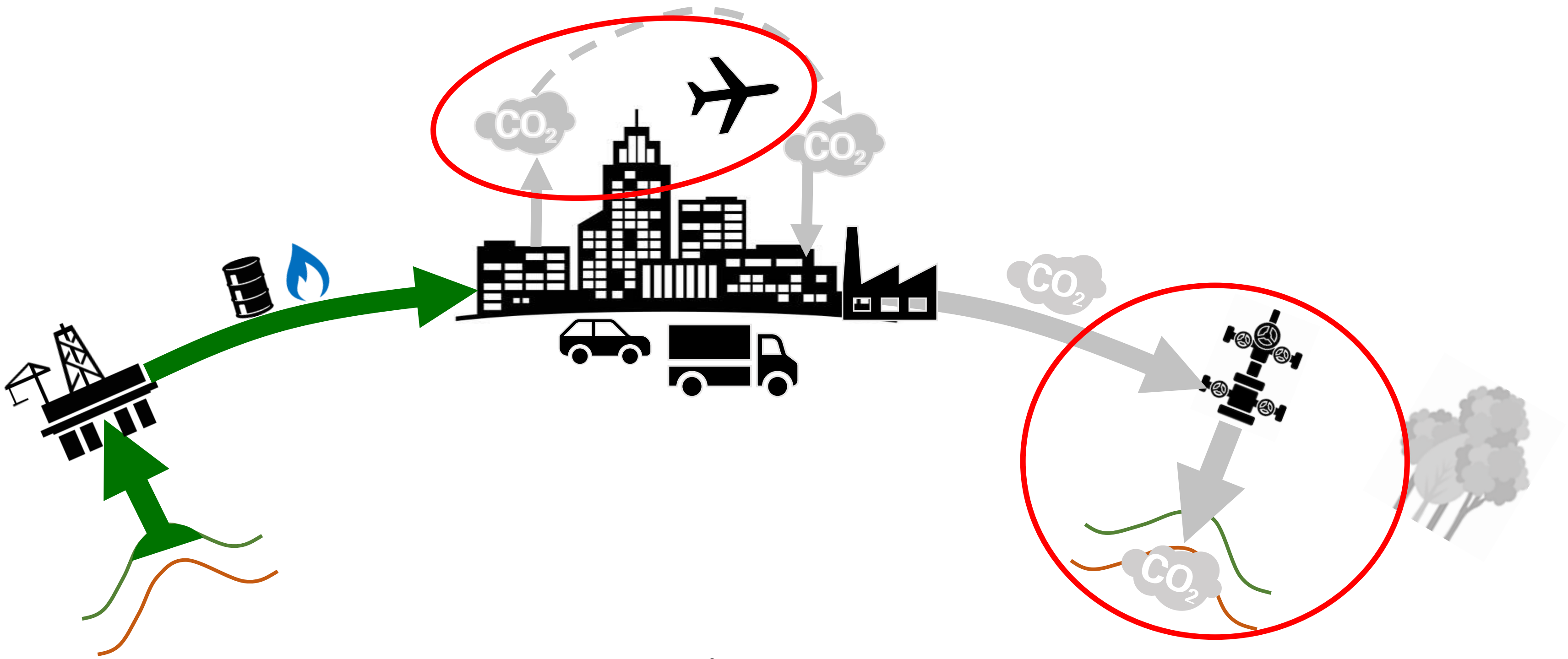
Storage is the balancing activity to production, just as removal is the balancing activity to emission.

And again, **all companies that produce fossil fuels will benefit from beginning their transition to net zero now**, in order to meet customer and investor expectations, to avoid carbon costs and to take advantage of new low carbon business opportunities.

These goals are complementary or "*two sides of the same coin*". For example, the CO_2 **emitted** by an airline from an aircraft burning jet fuel contains carbon that was **produced** by an oil and gas company.



Likewise, if this emission is balanced by a removal, the carbon **removed** from the atmosphere must be permanently **stored** for the airline to be net zero.



Each company has a different stake in this capture / removal and storage activity. The airline contracts for the removal and permanent storage of CO_2 from the atmosphere to neutralise its direct emission (for example by buying a carbon removal credit based on geological storage); while the oil and gas company could **purchase an <u>attribution</u> of this permanent storage** to balance the carbon it produced and supplied to the market from which the jet fuel was derived. Both aspects could help fund CO_2 capture and storage activity.

Net Zero Oil and Gas companies – a definition

To sum up, **oil and gas companies would become net zero when they**:

1. **Remove as much carbon dioxide* as they emit**

2. **Store as much carbon as they produce**

This definition is immediately useful for reporting progress against **voluntary targets**.

It can also be a profound enabler for **public policy development**, for example policies based on a **Carbon Storage Obligation (CSO)**. This is described later.

*$CO_{2\ equivalent}$ recognising non-CO_2 greenhouse gas emissions must also be neutralised

Accounting Frames

Could a simple, robust and science-based system of reporting be developed to cover the requirement of fossil fuel producers?

The following sections propose how this might be done.

Key concepts for accounting frames

To start with, the following concepts are important to frame appropriately systems of accounting that enable carbon abatement and neutralisation activity to be recognised and uniquely attributed:

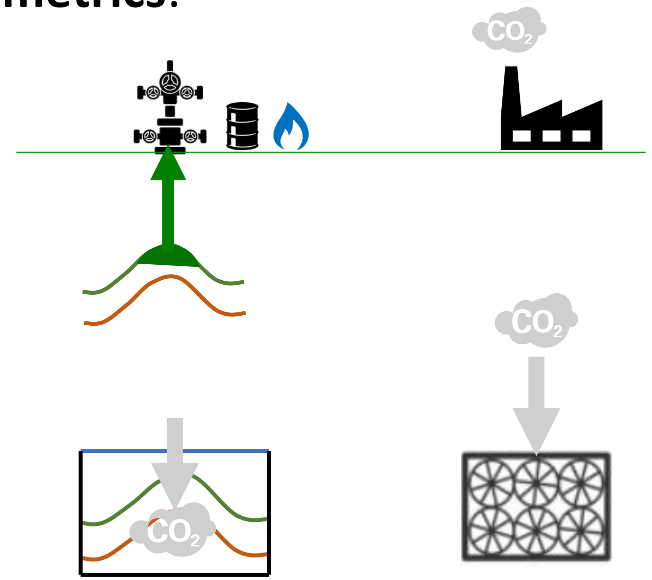
1. Atmospheric CO_2 is entirely fungible as the atmosphere is well mixed.
2. All CO_2 emissions are fungible as they are at the threshold of becoming atmospheric CO_2.
3. Stored carbon is fungible within a permanency class **but not between classes**
   - **i. Geologically sequestered CO_2** can be considered to be **stored permanently**.
   - **ii. Carbon storage in standing biomass and soils is more temporary** and should be **reported separately**.

Accounting systems should recognise these equivalencies and distinctions.

The fungibility of atmospheric CO_2 and the fungibility of geologically stored CO_2 make it possible both practically and commercially to optimise pathways to net zero.

What are we measuring and where? Metrics for net zero.

As we have seen, there are two key **transition points** associated with fossil carbon use - **production** and **emission**. And there are two key transition points for the balancing activities of **removal** and **storage**. An accounting frame for net zero can therefore be described with just **four metrics**:



Metrics relevant to **all companies** (equivalent to Scope 1):

1. **Direct emissions** (tonnes of CO_2 equivalent)
2. **Direct removals** (tonnes of CO_2)

Metrics relevant to **producers of fossil carbon**:

3. **Carbon produced** (tonnes of CO_2 equivalent on complete combustion)
4. **Carbon stored** (tonnes of CO_2)

Metrics such as carbon intensity are also very useful as they enable informed consumer choice and the assignment of differentiated value. They should be used to complement the four essential metrics of a net zero accounting frame as listed above.

How do we do the accounting? Two frames for net zero.

<u>Two complementary accounting frames</u> are needed to ensure each aspect of this activity is uniquely attributed. They are:

i) **emissions and removals reporting**
ii) **carbon production and storage reporting**

Returning to our example, and using both frames, **the activity of removing and storing CO_2 allows both the airline and the oil & gas company to achieve net zero**. Because **the two accounting frames operate in parallel** and complement each other, the same activity can feature in both frames **without any double-counting**.

A note on temporary biological storage.

As we have noted, **carbon can also be stored more temporarily** in standing biomass (such as forests) and in soils.

This type of storage is **<u>necessary and valuable</u>**. Companies may choose to use it as a contribution to their decarbonisation goals if appropriate additionality criteria can be met. However, it is not equivalent to permanent geological storage* and **it should be reported separately**.

*e.g. Mitchard, E.T.A. The tropical forest carbon cycle and climate change. *Nature* **559,** 527–534 (2018). https://doi.org/10.1038/s41586-018-0300-2

The Carbon Storage Unit (CSU)

Defining a standard accounting unit for geological storage

Defining a Carbon Storage Unit (CSU)

Just as there are currently both **voluntary** and **compliance** markets for **carbon removals**, similar markets could be developed for **geological carbon storage** using a **tradeable Carbon Storage Unit**.

One CSU would be created when one tonne of CO_2 is stored permanently in the subsurface under a recognised protocol (such as UK, US or EU regulation).

Creating and selling CSUs

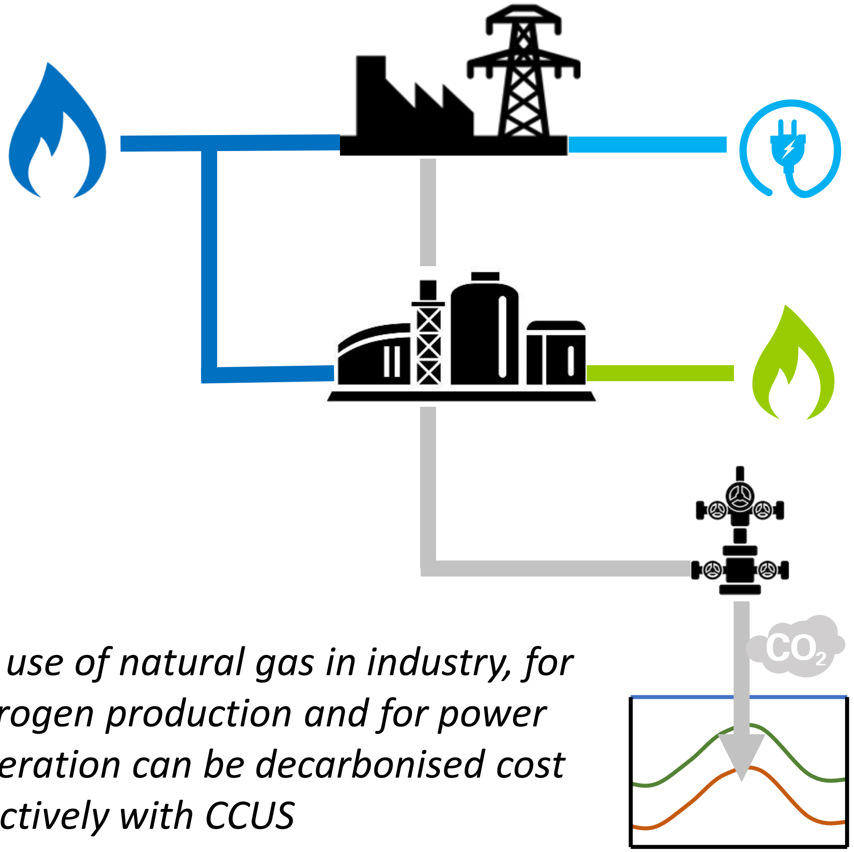
To illustrate the use of the CSU let's return to the example of a steel maker who uses natural gas in its production process and supplies steel to an electric car maker.

By deploying CCUS, most emissions from the steel plant can be eliminated, helping the steel maker progress to net zero. The steel maker may sell its steel at a premium to a car manufacturer seeking materials with a low carbon footprint for its product line. In turn, the car manufacturer can realise a premium from its customers who want to minimise their own carbon footprint.

The company contracted by the steel maker to store its CO_2 would create CSUs by storing CO_2 permanently under a recognised protocol.

Any oil and gas company could then buy CSUs from the storer to balance its carbon production and also progress toward its net zero target. This creates an additional revenue stream for the storer, reducing the amount it needs to charge the steel maker. It is envisaged that many oil and gas producers may wish to offer CCUS services themselves, directly creating CSUs.

Trading CSUs



The use of natural gas in industry, for hydrogen production and for power generation can be decarbonised cost effectively with CCUS

CCUS can be used to decarbonise both industrial processes and power generation cost effectively where there are large stationary sources of CO_2.

Industrial hubs can use shared CO_2 transport and storage infrastructure to minimise costs and optimise capacity usage.

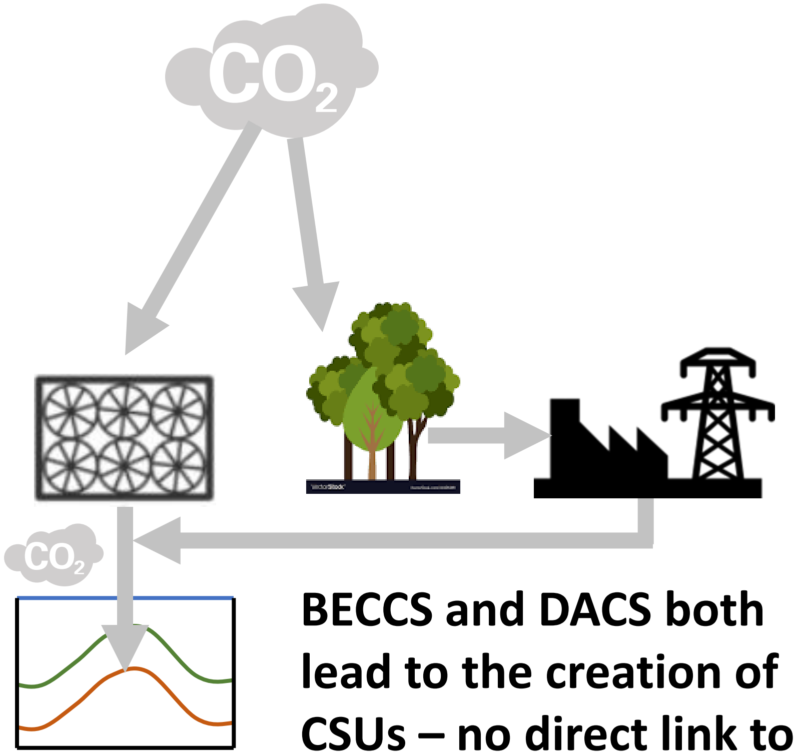
In addition to eliminating Scope 1 emissions from industry, **permanently storing CO_2 creates tradeable CSUs.** These can be used by oil and gas producers to balance the carbon they produce, whether or not they supply hydrocarbons to the decarbonised industrial hub.

Carbon Storage Units (CSUs) and Carbon Removal Credits (CRCs)

When biomass is combusted, the resulting CO_2 can be captured and permanently stored in the subsurface, such as in the process of **bioenergy with carbon capture and storage** (BECCS). This leads to permanent carbon storage and the creation of **CSUs**.

Carbon can also be captured directly from the air and stored geologically. This process, know as **direct air capture and storage** (DACS), also leads to permanent carbon storage and the creation of **CSUs**.

Both DACS and BECCS play an important role in the carbon accounting framework, by creating both CSUs to balance carbon production, **and** *carbon removal credits* or *negative emissions* to neutralise emissions. More on this later.



BECCS and DACS both lead to the creation of CSUs – no direct link to fossil carbon is required as CO_2 from the atmosphere is entirely fungible.

Using Carbon Storage Units

CSUs as:
1) trustworthy records of permanent storage,
2) evidence of voluntary balancing of production with storage,
3) evidence of meeting supply-linked obligations to permanently store carbon.

Using Carbon Storage Units - 1

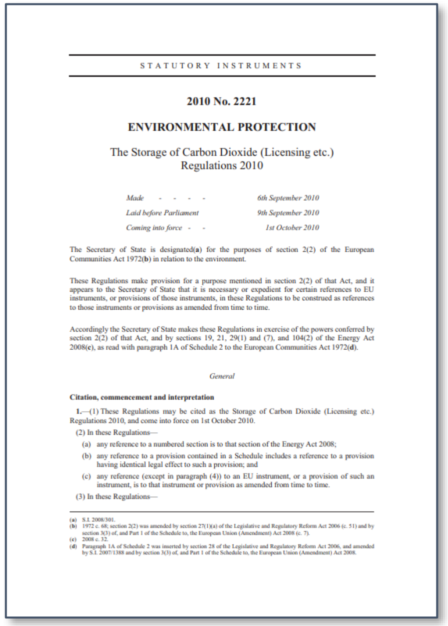
CSUs as trustworthy records of permanent storage

CSUs as a trustworthy record of permanent storage

Firstly, CSUs would provide stakeholders with a trustworthy record of permanent storage.

It is envisaged that CSUs would be issued under clearly defined protocols, either by independent inspectors, or by accredited storers who would be audited regularly.

Many countries already have well developed legislation to ensure carbon storage is safe and permanent. Examples include the UK's Storage of Carbon Dioxide Regulations 2010 and Class VI well permitting regulations for CO_2 injection in the USA.



STATUTORY INSTRUMENTS

2010 No. 2221

ENVIRONMENTAL PROTECTION

The Storage of Carbon Dioxide (Licensing etc.) Regulations 2010

Made - - - -	*6th September 2010*
Laid before Parliament	*9th September 2010*
Coming into force - -	*1st October 2010*

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Citation, commencement and interpretation

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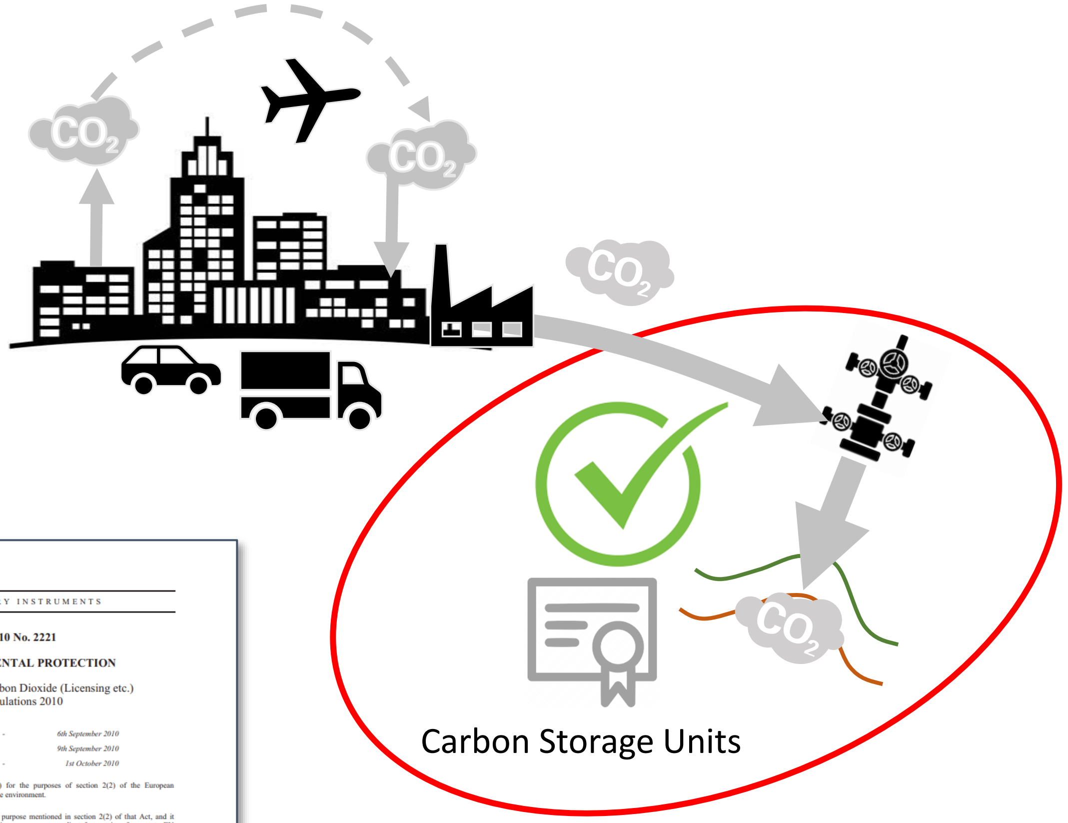


CSUs as certificates of permanent CO_2 storage are **traceable and verifiable** records that can underpin claims of low carbon intensity for a variety of products from electricity to steel.

CSUs will allow auditors to verify carbon intensity calculations, **giving consumers confidence** that the low carbon products they are buying are indeed low carbon, and that carbon captured from their production value chain has been stored according to the strict standards determined by the appropriate national or regional protocol.

Low carbon?

VS

Low carbon

Using Carbon Storage Units - 2

CSUs as evidence of voluntary balancing of production with storage

2) Evidence of voluntary balancing of carbon production with carbon storage

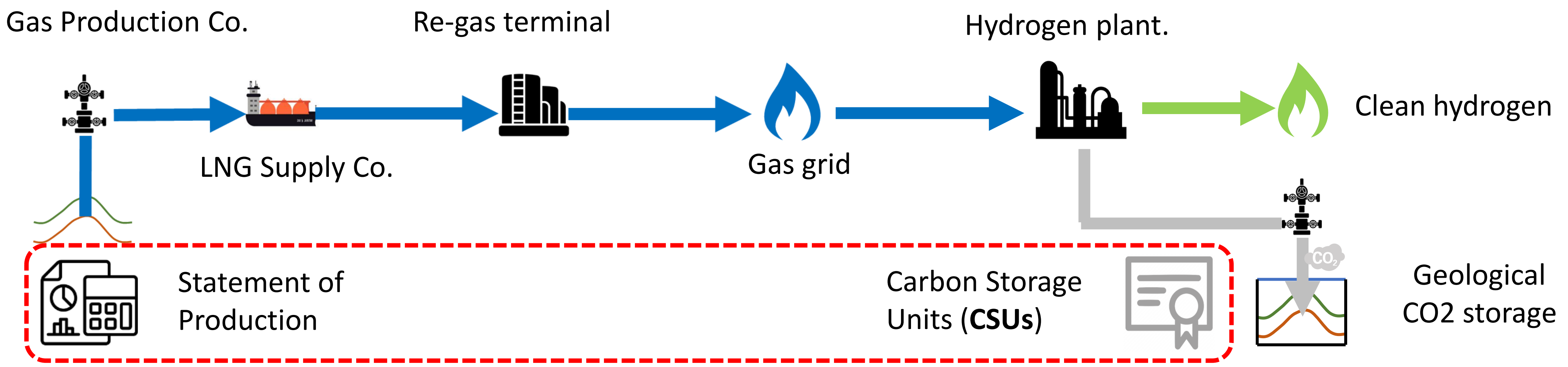
Secondly, CSUs would enable fossil carbon producers to report, on a voluntary basis, a balancing amount of carbon storage. Ultimately this would enable them to become **net zero across their production** by **storing as much carbon as they produce**.

It is not feasible, nor would it be economically efficient, for every fossil fuel producer to act individually to capture and store all the carbon from their own downstream value chain. But because CSUs will be tradeable, **fossil fuel production companies will be able to create or buy CSUs** from those who do store carbon and **set them against their statements of production -** showing how much of the carbon they have produced has been balanced with carbon stored.

The CSU needs a feature which enables carbon producers to buy this production balancing attribute of permanent carbon storage.

Hydrocarbon value chains can be complex. But it would be helpful here to explore a relatively simple chain to illustrate how the CSU can be used. Let's take the example of gas produced in one country and exported as LNG to another country. Let's imagine the gas is then used to produce clean hydrogen and all the resulting CO_2 is captured and stored; and appropriate CSUs are generated.

For the Gas Production Co. to claim that the carbon in the gas it produced has been balanced by an equivalent quantity of carbon stored, it needs to uniquely link the carbon stored to its production.



To enable this voluntary matching of production and storage, part of the CSU needs to be **"detachable"** from the permanent record of storage, and **tradeable**, so that Gas Production Co can buy it.

Using Carbon Storage Units – 3

Introduction to the Carbon Storage Obligation (CSO)

CSUs as evidence of meeting supply-linked obligations to permanently store carbon.

CSUs as evidence of meeting supply-linked obligations to permanently store CO_2

Thirdly, governments of countries, regions or blocs of countries wishing to become net zero can introduce a **Carbon Storage Obligation (CSO).** This is a policy instrument which helps ensure the timely development of a CCUS industry at the scale necessary to meet the country's or regions' decarbonisation goals.

The CSO would mandate **suppliers** of fossil carbon into the jurisdiction's markets to store geologically a defined fraction of the carbon they **supply**, with this fraction increasing over time.

Once the fraction reaches 100% (by 2050 for example), all carbon supplied would be balanced by carbon stored. As a result, the net emissions to atmosphere from fossil carbon use within the jurisdiction would be zero. Furthermore, provided fossil carbon use did not grow faster than mandated storage over the same period, emissions would fall progressively from the point at which the CSO is introduced until net zero is reached.

Interaction with emissions standards

CSOs would operate within the frame of carbon **production and storage.**

It can therefore be introduced alongside and complement existing policies that operate within the frame of **emissions and removals** such as emissions trading schemes, and complement **carbon intensity standards** such as fuel quality directives.

UK ETS

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Benefits of Carbon Storage Obligations (CSOs)

A Carbon Storage Obligation provides the following benefits:

- **Provides a framework through which net zero can be delivered.**
- **Replaces subsidies** currently required to drive CCUS investment.
- **Fully embeds the cost of decarbonisation in the hydrocarbon value chain,** ensuring cost is fairly distributed across consumers of all goods and services that use hydrocarbons.
- Mandates **timely CCUS deployment** and drives **predictable growth**, enabling learning and improvement cycles and supply chain development, and avoiding supply shocks.
- Imposes **low initial consumer cost exposure** as costs of early plants are spread across a wide customer base, with decarbonisation cost exposure increasing slowly and predictably over time.
- Enables decarbonised hydrocarbons to compete on a **technology neutral basis** with other forms of low carbon energy.
- Uses markets to drive **competitive price discovery** and **innovation**
- Supports the development and deployment of **carbon removal technologies** and could ultimately become their principle funding mechanism.

Where in the value chain should the obligation fall?

A Carbon Storage Obligation (CSO) places the point of obligation downstream of production, at the **point of supply**.

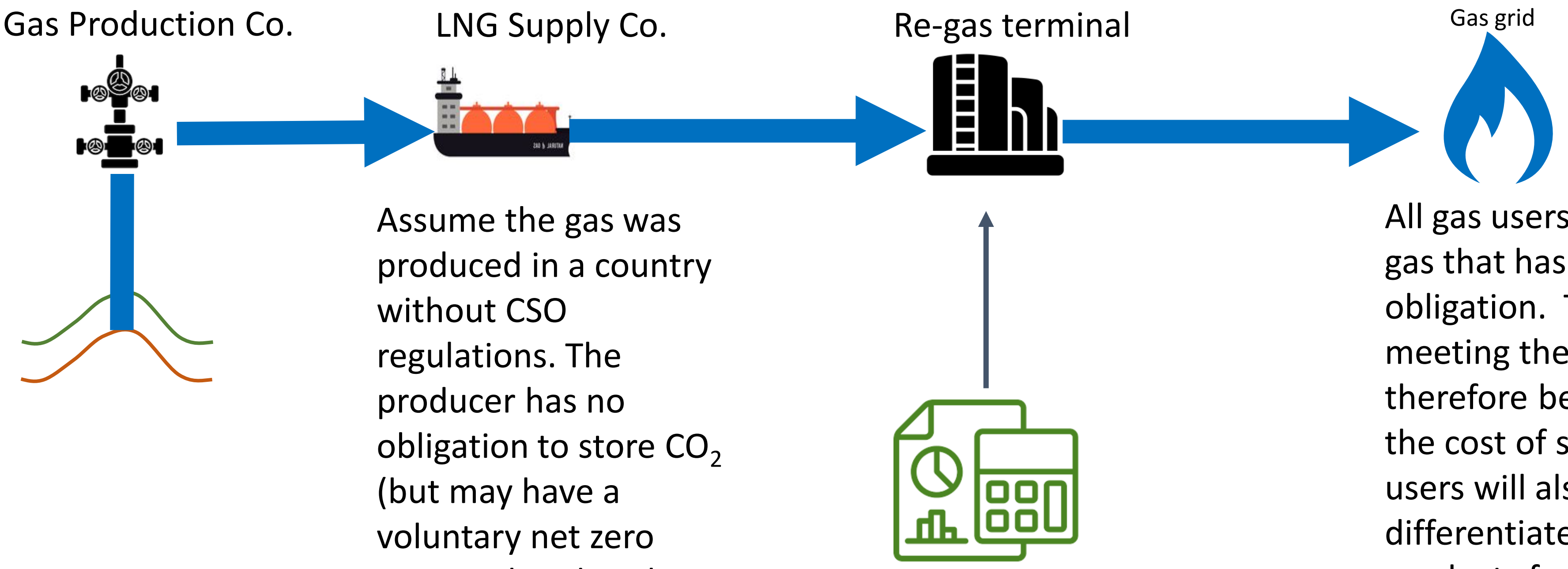
Placing the obligation at the point of supply is necessary because policy and regulation is not usually implemented globally, but rather on a regional basis, and placing it further upstream would have unintended consequences.

If the obligation were placed at the point of production, domestic hydrocarbon production within the regulated jurisdiction would be disadvantaged relative to hydrocarbons imported from jurisdictions not subject to a CSO. It would mean that only that fraction of supply delivered from domestic production would fall under the obligation, not all supply, making cost pass through challenging. Also, exported hydrocarbons would also be forced to compete at a cost disadvantage relative to other sources in the global market not subject to an obligation.

Placing the obligation at the **point of supply** solves all of these issues.

Example of CSO in operation – importing gas

Let's look again at our previous example – but assume this time that the gas is imported as LNG to a country with a Carbon Storage Obligations (CSO).



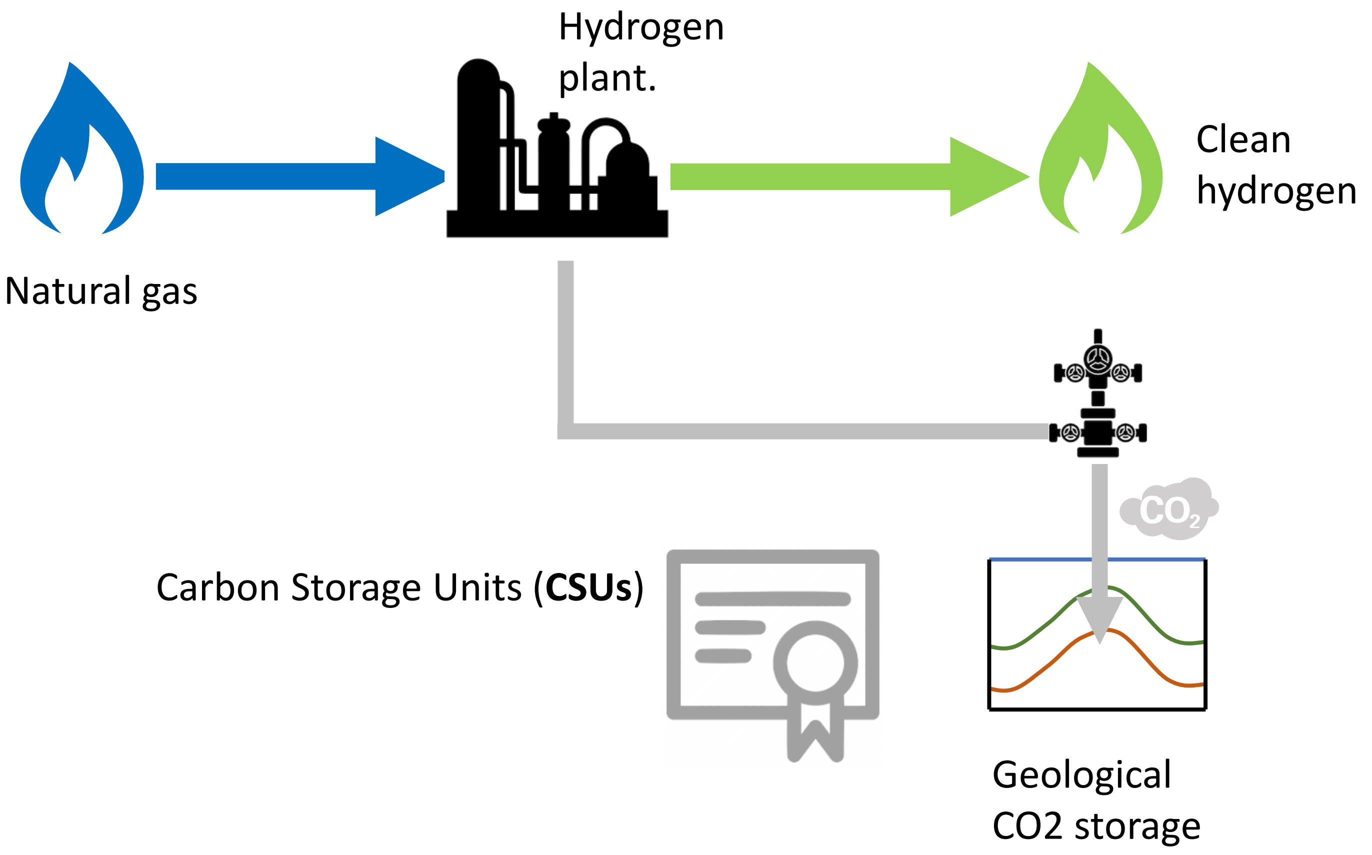
Assume the gas was produced in a country without CSO regulations. The producer has no obligation to store CO_2 (but may have a voluntary net zero target related to the oil and gas it produces, as described in the previous section).

The carbon storage obligation is incurred by the supplier here as gas enters the regulated market.

All gas users can only buy gas that has incurred an obligation. The cost of meeting the obligation can therefore be embedded in the cost of supply. Some users will also chose to buy differentiated low carbon products for a price premium.

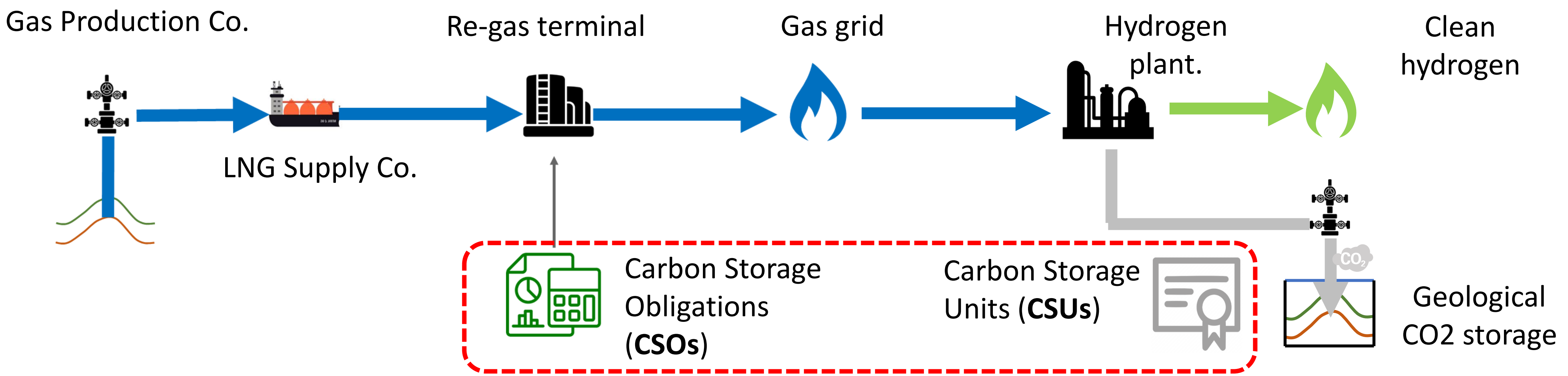
Example of CSO in operation – producing low carbon hydrogen

Again, let's imagine the gas is then used to produce low carbon hydrogen and all the resulting CO_2 is captured and stored; and appropriate CSUs are generated.



Matching the Carbon Storage Units (CSUs) with the Carbon Storage Obligations (CSOs)

Putting both parts together we can see that by storing all the carbon produced the full chain has been decarbonised*.



But this time **the gas supplier** needs to use the CSU to satisfy its Carbon Storage Obligation (CSO). The **obligation is fulfilled** when the Carbon Storage Certificate is matched to the Carbon Storage Obligation.

To allow for this yet another, separate part of the CSU needs to be **"detachable"** from the CSU and **tradeable** so that the gas supplier can buy it.

*Assuming for simplicity that any energy used in the process is supplied from zero carbon sources such as renewables or clean hydrogen.

Design of the CSU

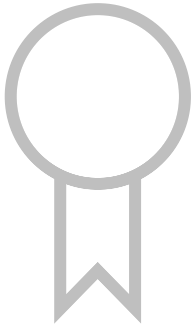
To meet all these needs, a CSU needs three parts – the certificate of CO_2 permanently stored, and two detachable, tradeable "tabs".

Each part serves a different purpose, and acts at a different point in the value chain.

A single CSU meets the needs of both hydrocarbon producers and suppliers, since production and supply are simply successive points in the hydrocarbon value chain. **When the chain ends in storage, the whole chain is decarbonised**.

One Carbon Storage Unit

This section is retained by the custodian of stored CO_2. It certifies that a tonne of CO_2 has been permanently geologically stored under an approved protocol.



(The custodian is likely to be the CO_2 storage operator until such as time as the storage complex is closed and transferred to the care of a state agency subject to regional regulation).

Tab S*

This tab can be detached and traded in a **compliance market** created by imposing a Carbon Storage Obligation.

Fossil carbon **suppliers** can purchase and surrender **Tab Ss** to satisfy obligations incurred as a result of supplying hydrocarbons into a market under a Carbon Storage Obligation.

Tab P**

This tab can be detached and traded on a **voluntary market** created to match **storage with production**.

Fossil carbon **producers** can report and retire **Tab Ps** as balancing units to the carbon contained in the commodities they produce.

*Supply balancing

**Production balancing

(It might be helpful to compare the CSU to an *airline boarding pass* - only one passenger can travel, but the tabs are used to track progress through different check points.)

Transitioning to net zero

So far, this paper has focused on the role of carbon capture and storage in a net zero world. Let’s now look at the journey to that point.

Transitioning to net zero – a role for *activation* and *enduring* policies

The Carbon Storage Obligation is an *enduring* policy option for deep decarbonisation. It can be used to get all the way to net zero. As we've seen, by embedding decarbonisation costs in the hydrocarbon value chain, a CSO places no draw on national treasuries. However, its successful implementation relies upon there being a functioning CCUS industry in place, albeit a small one, ready to grow.

Having an operational CCUS industry means that cost base has been demonstrated, all necessary regulation is in place and a country's first storage sites have been developed. This condition allows obligations under a CSO to be met initially by expanding current developments, and at a later stage, fund the development of entirely new ones. It enables the market in CSUs to be liquid.

It is beyond the scope of this document to outline comprehensively which *activation* policies can be used to initiate a CCUS. Suffice it to say, the 45Q tax credit approach used in the USA, the UK's Transport & Storage Revenue Investment, Dispatchable Power Agreement and Industrial Carbon Contracts, and the SDE++ approach used in the Netherlands are all valid routes.

The CSO can be introduced alongside activation policies, and **allow governments to phase out the subsidies required to support early CCUS activation policies**. This will be illustrated in the next section.

Reporting on the transition to net zero for companies and countries

To describe progress toward net zero, we propose annually reporting:

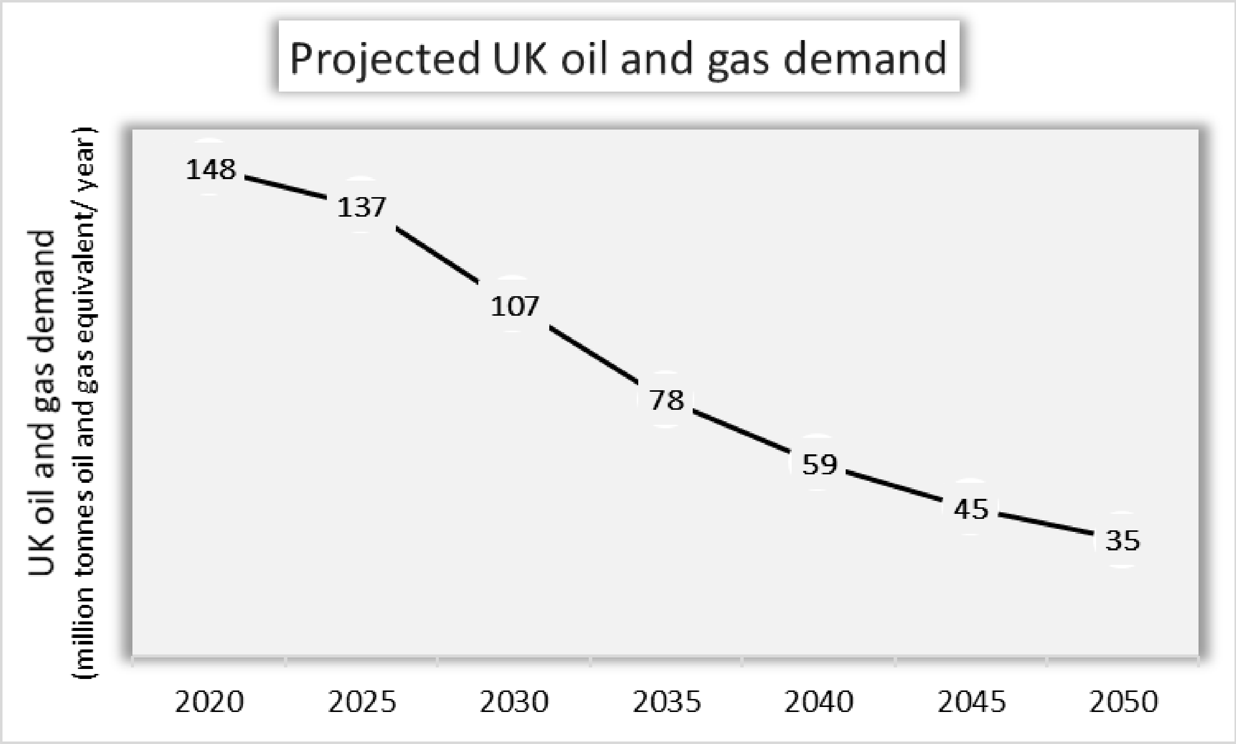
- **Carbon storage as a fraction of production or received supply**, and
- **Carbon removals as a fraction of emissions**.

This can apply to both **companies** and **countries,** and is consistent with the concept of an **increasing stored fraction** in the Carbon Storage Obligation, i.e. the obligation initially requires only a small fraction of carbon supplied to be stored, but rises to 100% to achieve net zero.

How would this work in practice?
The UK as an example

A Carbon Storage Obligation in the UK – an example

This section looks at how a **Carbon Storage Obligations (CSO)** would work in practice. To illustrate this let's take the United Kingdom as an example*:



Today the UK both produces and imports oil and gas. For this illustration we will assume negligible production or import of coal.

One recent projection by the UK's Department for Business, Energy & Industrial Strategy (BEIS) of future oil and gas demand is shown here#.

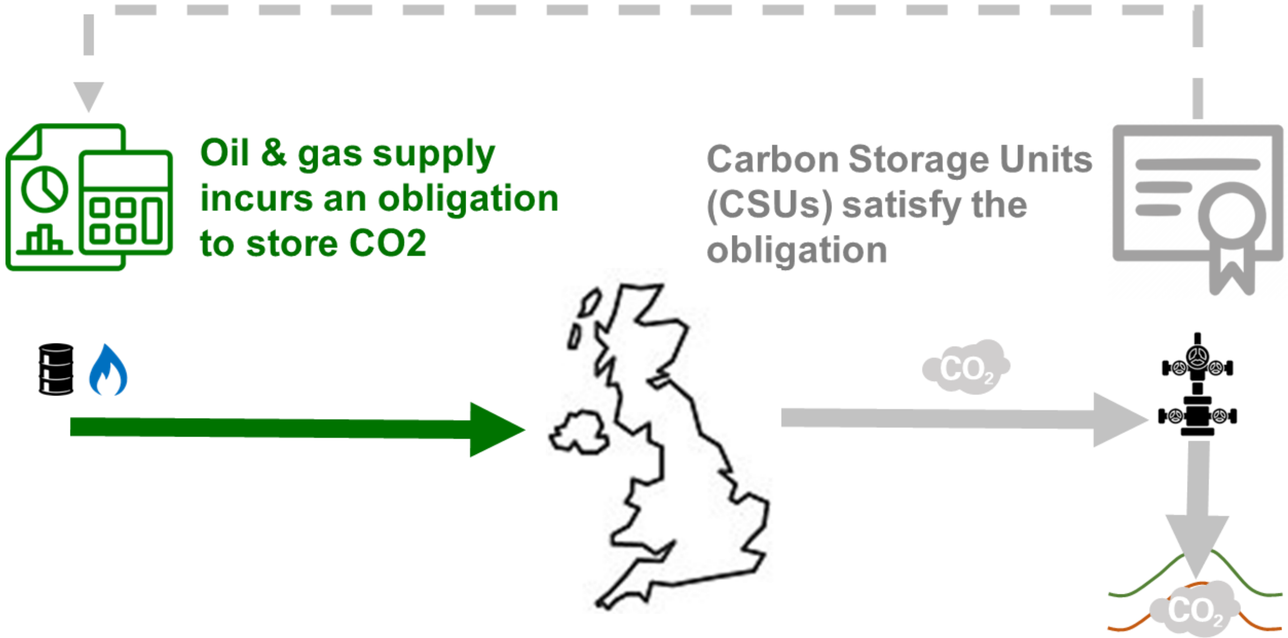
This projection considers the recommendations of the Climate Change Committee (CCC) for reaching the government's legislated target of net zero by 2050.

*Lord Oxburgh recommended the implementation of a carbon storage obligation for the UK in his 2016 report. The full report is here.

#Oil and Gas Authority: Production and expenditure projections - September 2021

The CSO requires suppliers of hydrocarbons into the UK market to store CO2*

The UK CSO system would mandate **suppliers** of fossil carbon into the UK's markets to store geologically a defined **fraction of the carbon they supply**, with this fraction **increasing over time**, reaching **100% to achieve net zero**.



CSUs Tab Ss would be submitted to the UK Government to discharge the carbon storage obligation.

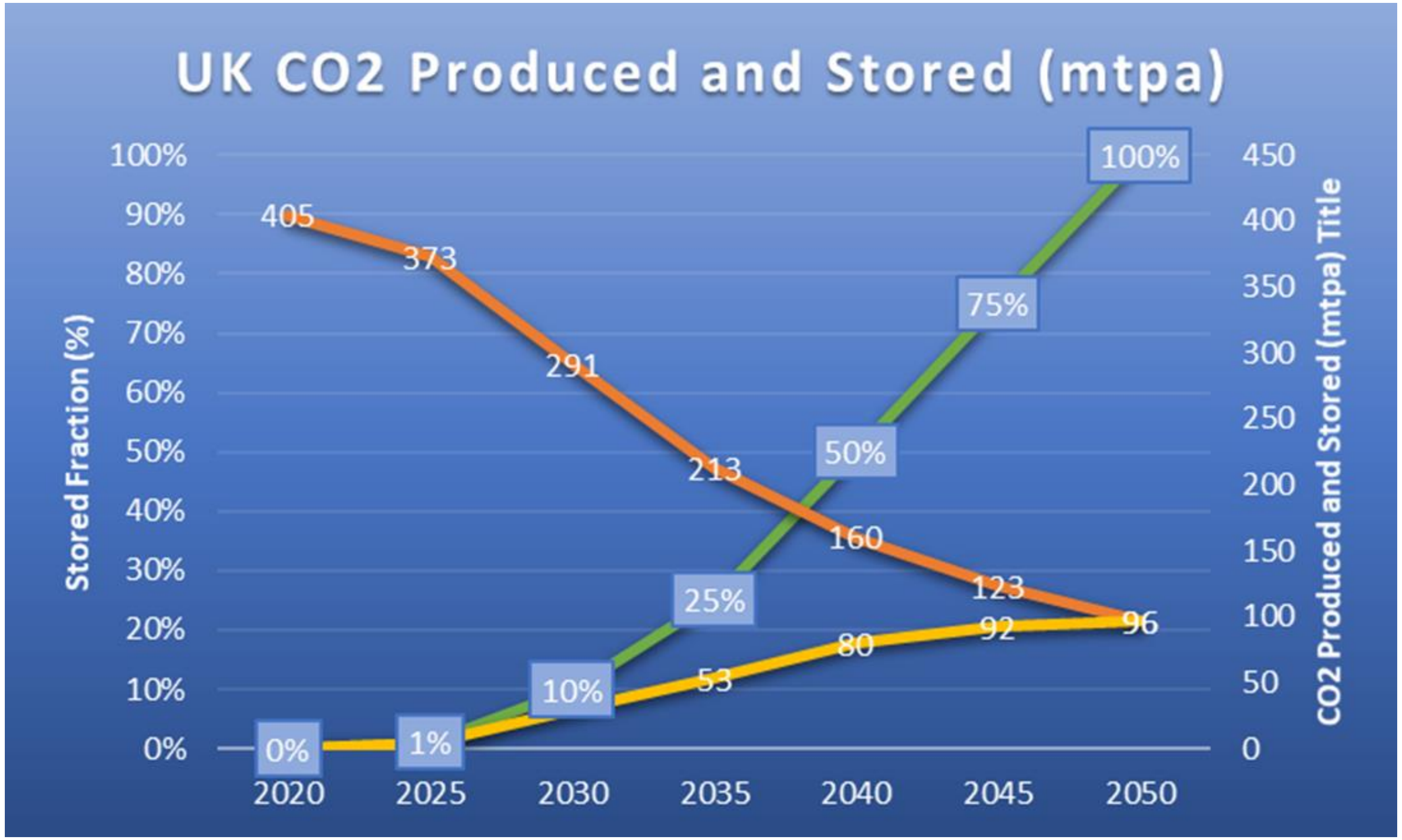
This creates demand for CSUs and a market to determine their price.
To ensure full market price discovery, **CSU** certificates will be **tradeable**.

Some oil and gas suppliers will want to participate in CO_2 storage in the UK, but others may not.
The CO_2 storage business will be open to participation by a range of companies, many of which may not supply oil and gas in the UK and therefore would not incur storage obligations.

*Countries with storage resources may mandate domestic storage initially, but ultimately expand to include storage in other countries.

At net zero, the UK's CO_2 production is balanced with storage

In this projection, CO_2 production drops dramatically from around 400 mtpa now to 100 mtpa in 2050.



For our illustration, let's assume the CSO policy requires an **increasing mandated storage fraction**, which rises from 10% in 2030 to 25% in 2035, and to 100% in 2050.

Using the BEIS forecast for oil and gas demand this would result in a storage obligation of about 30mtpa of CO_2 storage by 2030, rising to some 50 mtpa by 2035 and around 100 mtpa by 2050.

Decarbonisation costs are embedded in the oil and gas value chain

As all suppliers are subject to the same obligation, the cost of meeting the obligation is a cost of doing business and contributes to price determination of the oil and gas supplied. **Decarbonisation costs are embedded directly in the oil and gas value chain**.

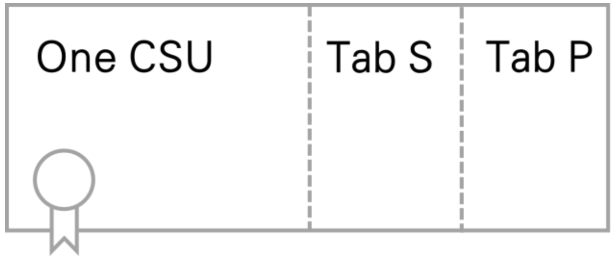
The value achieved when selling the CSU Tab Ss will **reduce** and eventually **remove the need for government to subsidise CCUS**.

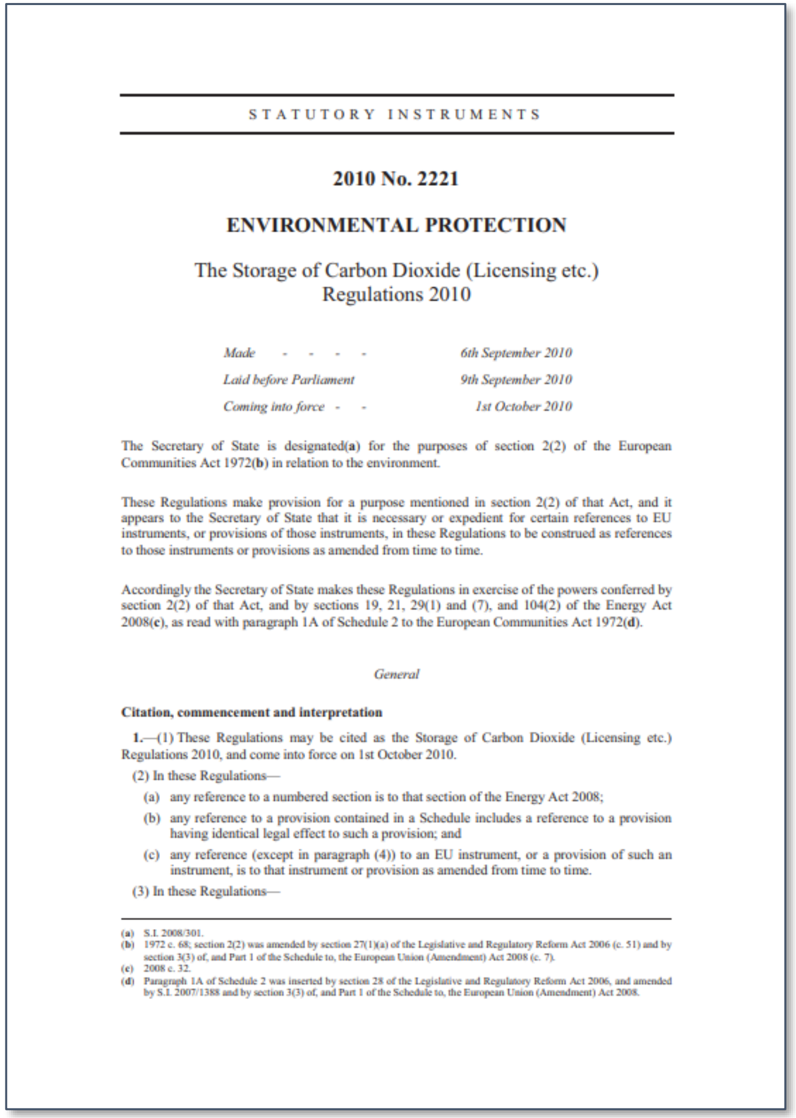
Competition to keep supply costs low will ensure the most cost effective solutions for capturing and storing CO2 are found, subject to regulatory requirements.

So, how is a CSU created?

One **CSU** is created when a tonne of CO_2 is permanently stored in the subsurface according to UK regulations.

In the future the UK may also recognise **CSUs** created in other jurisdictions. More on this later.





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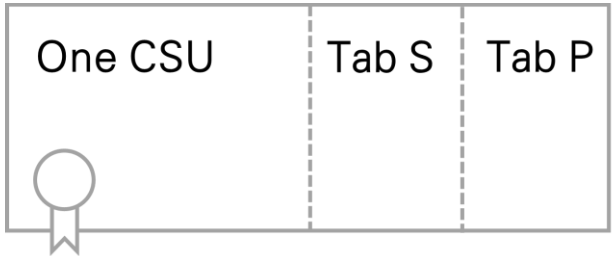
Who owns the CSU initially?

Initially all three parts of the **CSU** belong to **the storage company** operating in the UK with a storage license from the Oil & Gas Authority and a pore space lease from the Crown Estate (or Crown Estate Scotland).

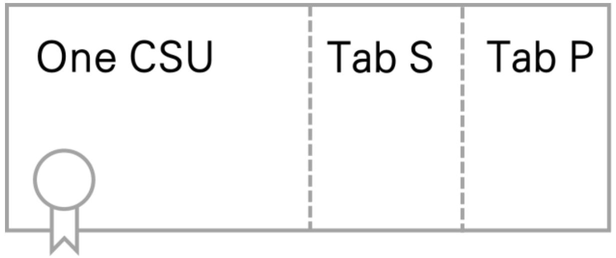


The storage company will be able to sell **Tab Ss** to **oil and gas suppliers** who need **CSUs** to satisfy their **Carbon Storage Obligations;** or they could retain it for its own needs if they also supply oil and gas and so have their own storage obligations to satisfy.

Similarly the storage company will be able to sell **Tab Ps** through a voluntary market **to oil and gas companies wishing to reach Net Zero**, or again they could retain it for their own needs if they also produces oil and gas and have **a voluntary carbon storage or Net Zero target to deliver**.

How are CSUs used?

Tab Ss are counted by Governments. **Tab Ps are counted by Companies.**



CSU Tab Ps can be retired and reported as balancing units to the carbon contained in the oil and gas a company **produces anywhere in the world** – not just in the UK. In so doing, oil and gas companies can demonstrate delivery of their decarbonisation or Net Zero voluntary targets. **Tab Ps can be traded globally in voluntary markets.**

CSU Tab Ss are surrendered to the UK government as evidence of having satisfied an obligation incurred **in the UK** through hydrocarbon **supply**. The UK government then retires them. **Tab Ss are traded in compliance markets that may be specific to a particular country or bloc.**

The **CSU Certificate** remains the property of the storage company as long as they retain custodianship of the storage site. In the UK, regulations allow storage sites to ultimately be returned to the care of the state with the Oil & Gas Authority (OGA) as duty holder. **CSUs** would be transferred to the OGA along with custody of the storage site.

Lets talk about money!

Sources of revenue to pay for decarbonisation

Decarbonising oil and gas requires huge capital investment and significant ongoing operating costs. In a sustainable market, these costs must ultimately be borne by consumers. A CSO enables this.

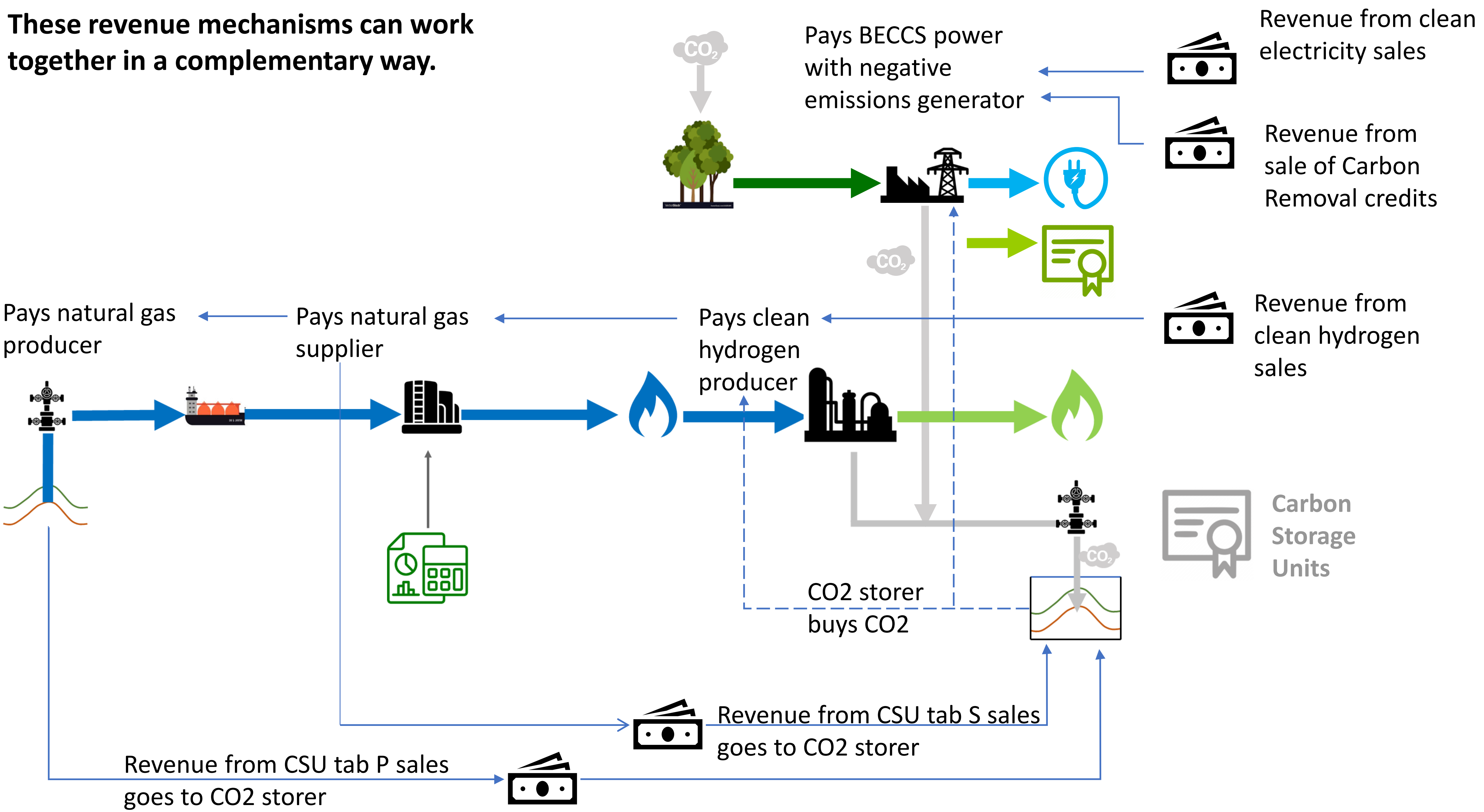
Since the CSO covers all targeted hydrocarbons supplied to the UK, the cost of satisfying it by **purchasing CSU Tab Ss** can be embedded in the cost of supply and thereby socialised over all consumers. This is likely to be the largest source of revenue as it is a compliance market.

However, this does not exclude an important role for **voluntary markets**. Additional revenues can be raised by the CO_2 storer through the **sale of CSU Tab Ps** to oil and gas producers in a voluntary market.

Where a **decarbonised product** enabled through CCUS can command a **price premium**, this premium will contribute to decarbonisation cost. Verifiable carbon tracking along the product value chain enables consumers to have confidence that they are buying a low carbon product.

In addition to reducing emissions (and **avoiding exposure to an explicit carbon price**), CCUS will play an essential role in enabling **CO_2 removals or *negative emissions***. The **sale of resulting carbon removal credits** will be a significant revenue stream.

These revenue mechanisms can work together in a complementary way.



Sources of value from decarbonisation (i)

Let's look at revenue flows in the previous diagram more closely.

The principle source of funding here is the supply of clean energy. In our example, one product is clean hydrogen, but hydrogen itself can go on to become clean heat, clean electricity, clean steel production etc.

Let's now imagine a market in which clean hydrogen is competing with unabated natural gas as a source of energy. In our example, clean hydrogen is produced from natural gas, and the additional process steps add cost. However, since hydrogen is a clean fuel, a hydrogen end-user will **not need to buy emissions allowances** within the UK ETS. This narrows the cost gap but may not close it.

The hydrogen producer may also be able to sell its product at a **price premium** to natural gas on a calorific value basis as **consumers seek to reduce their direct emissions**. Again this narrows the cost gap. But what if these revenue streams cannot close the gap completely?

Sources of value from decarbonisation (ii)

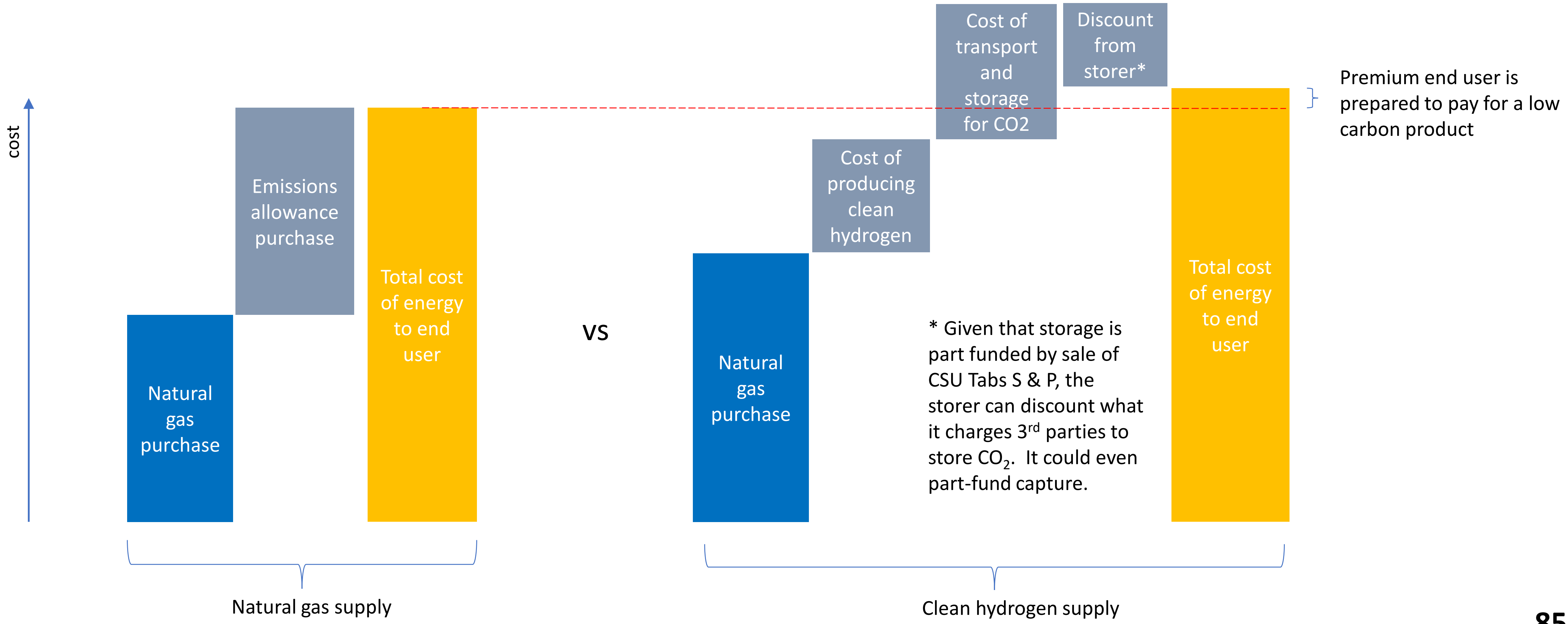
Suppliers of gas into the UK will fall under the storage obligation, and will therefore need to buy CSU Tab Ss. They buy these from CO_2 storers. To ensure an adequate supply to meet demand CO_2 storers will work with emitters of CO_2 to secure the best sources of supply – reliable flows of CO_2 with low capture and transport costs.

CO_2 from a hydrogen production facility located next to CO_2 transport & storage infrastructure may indeed be an advantaged source. In this case, **a CO_2 storer could offer discounted or even free storage services to the hydrogen producer in order that it can store sufficient CO_2 to meet CSU demand from hydrocarbon suppliers**. Depending on the market price of a CSU Tab S, the CO_2 storer may even be prepared to **buy CO_2, defraying the cost of clean production** from natural gas.

The value achieved when selling CSU Tab Ss and Tab Ps will allow CCUS deployment to expand with **no further need for government subsidy**.

How energy from low carbon blue hydrogen could compete with unabated energy production

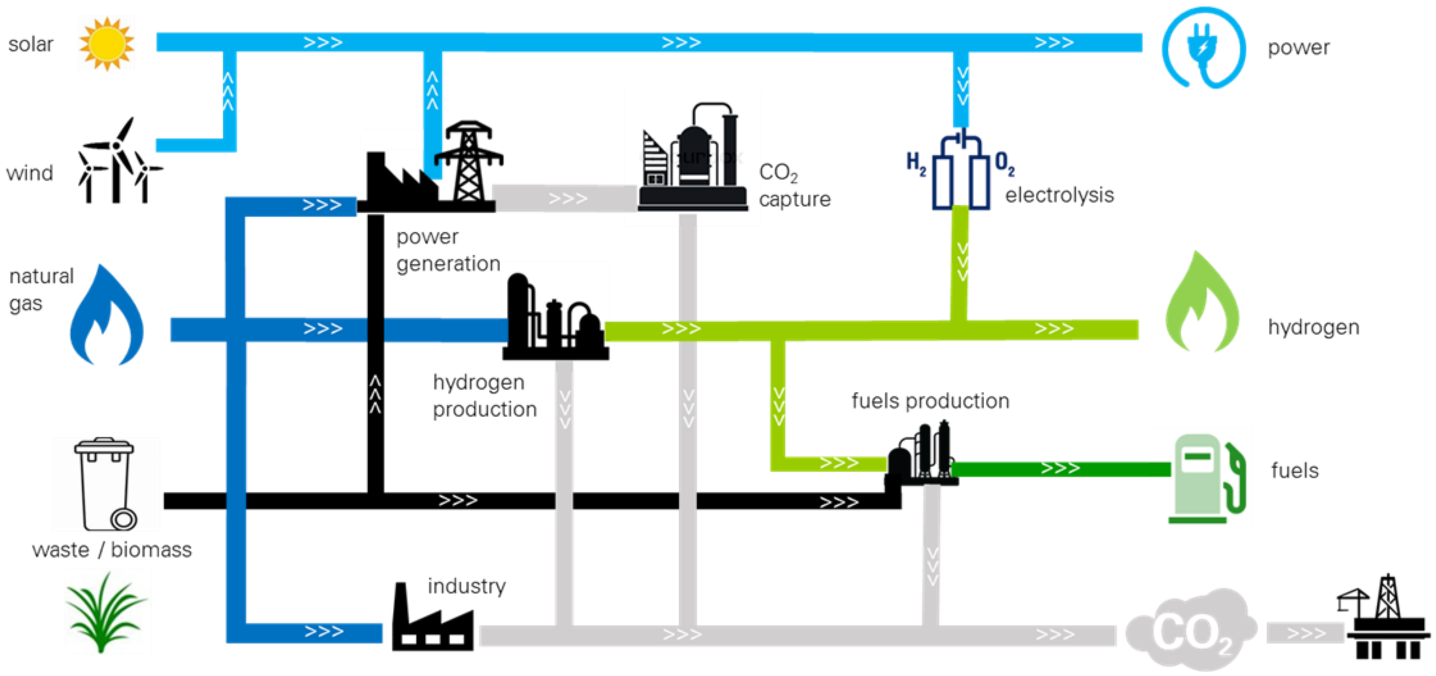
As in any sustainable market, market forces themselves will determine the distribution of rents throughout a value chain. But to illustrate what we've covered so far, this bridge diagram illustrates how in the right policy environment, clean hydrogen could compete with CO_2 emitting alternatives.



The market for CSUs

The benefits of a market in CSUs

A **Carbon Storage Obligation (CSO)** creates a compliance market for CSUs. This incentivises CO_2 storers to work with CO_2 producers to secure competitive supply costs. It places storers in an ideal position to co-ordinate CO_2 capture activity around CO_2 transport and storage hubs.



It is in the interest of storers to co-ordinate the decarbonisation of existing processes and the build out of new CCUS-enabled low carbon enterprise. This ensures they have sufficient CO_2 to store and competitively supply demand for CSUs.

It facilitates the creation of **Clean Energy Parks**

Growing demand for CSUs in a traded market will help rebalance the energy system

As the mandated storage fraction rises under the CSO, three things are likely to happen:

1. CO_2 will need to be captured from more sources. Some of these will be more expensive, putting upward pressure on costs and therefore the price of CSUs.
2. Economies of scale will drive down costs, and technologies will improve as deployment at scale drives innovation. The effect will be to help check the rising cost of CSUs as the CO_2 capture, transport and storage industry grows.
3. Hydrocarbons are likely to be priced out of some markets in favour of electrification (supplied by renewables) or bio-feedstocks, checking demand for hydrocarbons.

Using the BEIS forecast, UK domestic demand for mandated storage services might plateau at c.100 mtpa.

However, demand for CCUS services from overseas and for negative emissions could sustain growth significantly beyond this.

Activation policies are needed to create a CCUS industry

Now that we've seen what a sustainable market for CCUS services might look like, let's explore how to create it.

To create a well functioning market for CSUs there must first be a credible supply at a predictable price. In other words, there must be a fledgling CCUS industry.

In the UK, the government has proposed a range of policies to initiate the formation of CCUS-enabled decarbonised industrial hubs. These include dispatchable power agreements for electricity from gas-fired power with CCUS and industrial carbon capture contracts, supported by a CO_2 transport and storage regulatory investment model.

These industry *activation policies* and the business models they support are necessary. They can also transition readily to a sustainable market model driven by a **CSO** complemented by the UK **ETS** and specific process and product **performance standards**.

Create a CSU scheme in the UK now – from the first project onwards

It is proposed that **the UK government establishes a system now for creating and issuing CSUs** for all carbon stored by the UK CCUS industry, **from the first project onwards**.

As in the enduring system:

- The CSU Certificates would be retained by the storage company, as custodian of the stored CO_2.
- Tab Ps would also belong to the storer for retention or sale.

But to start with:

- Tab Ss would be transferred to the UK government. This will allow the government to build up a market buffering stockpile of CSU Tab Ss.

Since these Tab Ss would not be surrendered to start with to satisfy an obligation, they need not be immediately retired. Instead they should be retained until a Carbon Storage Obligation CSO system is implemented. The UK government could then sell them to obligated parties at a pre-determined backstop price.

This would help create a liquid market in CSUs; and would allow the UK government to **re-coup some of its initial costs of establishing a CCUS industry**.

Policy flexibility: Option to stage CSO implementation

There is considerable flexibility in how a CSO is introduced. For example, it does not necessarily have to cover all types of hydrocarbon supply immediately.

In the UK, given coal usage is already curtailed by performance standards, its inclusion in a CSO may not be needed.

For liquid fuels, UK and EU policies have already created a high effective carbon price that could be sufficient to deploy CCUS to decarbonise the liquid fuel value chain if CCUS protocols were added to existing regulation.

By comparison, gas is lightly regulated, but the best opportunities for CCUS often sit in the gas value chain.

It may be relatively easy to introduce **a CSO on gas supply first**.

Policy integration: CSO and regulated revenue models

In the UK, it is envisaged that CCUS will be deployed in regional hubs, where multiple emitters share common CO_2 transport & storage infrastructure. Although owned and operated by private companies, transport & storage companies will have an effective regional monopoly on the services they provide and their service charges will therefore be regulated.

In the UK, companies that own and operate regulated assets may also engage in business activities outside the regulated scope. To maintain a distinction between regulated and non-regulated activity, a **dual till mechanism** can be adopted.

The **first till** would be used for revenues and costs associated with transporting and storing CO_2 as a regional service provider. This activity is **regulated**.

The **second till** would be used for **non-regulated** activity. This could include importing CO_2 from outside the licenced area for subsequent storage. It could also include the sale of CSU Tab Ss to obligated parties. Neither of these businesses are monopolies; each regional operator competes directly with others.

Transitioning from government contracted carbon capture and storage to a sustainable market

The UK government will use direct contracts with a range of industries to *activate* CCUS deployment at scale. As we have discussed, where government effectively capture, transport and storage, it will also acquire the CSU Tab Ss.

The introduction of a CSO as an *enduring* policy creates a demand for CSU Tab Ss. Where a T&S service provider stores CO_2 for a company not in receipt of government funding, there will be no requirement hand the ensuing CSU Tab Ss to the government. Rather the T&S company can sell them to companies who need them to meet the requirements of the CSO. The T&S company must charge the new CO_2 source the regulated price for its **T&S service (till one)** but revenues received from the **sale of Tab Ss** are not regulated and therefore pass through **till two**.

Till two revenues can be used to fund supply contracts with CO_2 sources. These supply contracts may cover all or part of the cost incurred by the CO_2 source for using the regulated T&S service. They may even part-fund the costs of CO_2 capture incurred by the CO_2 source company. In this way they replace the need for government contracts. Hybrid models are also possible, with decarbonisation costs shared between the private sector and government.

Through this mechanism, a T&S company can expand its customer pool and is incentivised to co-ordinate cost effective decarbonisation of a region. Ultimately, networks will become interconnected, allowing even more opportunities for optimising and accelerating decarbonisation.

CSO and Emissions Trading Schemes

Through this discussion, we have seen how revenues raised from CSU (Tab P & S) sales under a Carbon Storage Obligation fund the expansion of a CCUS industry, drive a predictable pathway to net zero and complement other mechanisms including Emissions Trading Schemes.

Given the recent large increases in the price of an emission allowance in the EU and UK, it might reasonably be asked whether a cap-and-trade market alone can underpin the CCUS industry's sustained growth and funding transition from government contracts to sustainable market mechanisms. The following table describes some of the reasons why this is unlikely to be the case and outlines how the combination of an ETS and a CSO is likely to drive a better outcome.

CSO and Emissions Trading Schemes

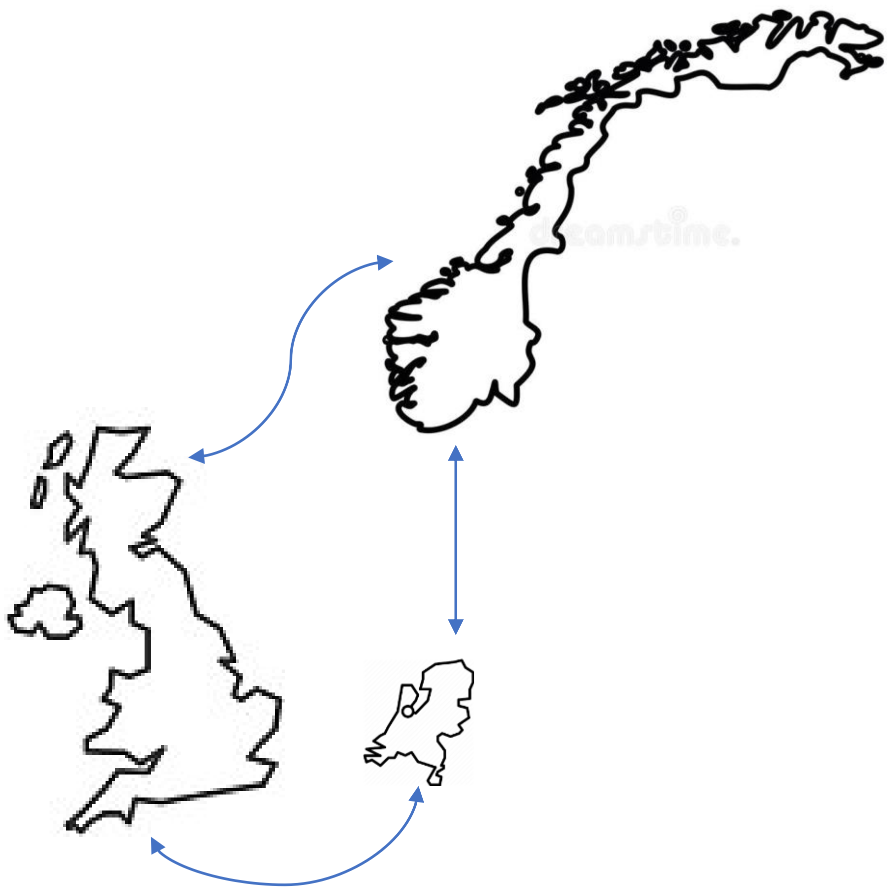
Issue	ETS alone	ETS and CSO
Pace of carbon price increase vs required activity	Capturing, transporting and storing CO2 is a high cost activity. Until an ETS price reliably and predictably exceeds the cost of CCUS implementation, emitters would have little incentive to deploy it.	CSO mandates capture and storage of CO2, and can therefore commence at once, before a general carbon price reaches the level that would otherwise be required. As it is initially applied to a limited number of facilities and cost is socialised over all hydrocarbon consumers, cost increases to consumers would be small and increase gradually.
Exposure to carbon price step changes	An ETS incentivizes emissions abatement activity in price order, the lowest cost options first. By the time price is sufficiently high to incentivize CCUS, few other options may be available and industry would face a rapid rise in cost to decarbonise further.	While achieving the *cheapest first* benefits of an ETS, the ETS+CSO combination avoids delaying commencement of higher cost abatement activity such as CCUS and therefore reduces the potential for a subsequent rapid price step up.
Opportunity for innovation and supply chain development	Delayed deployment of CCUS followed by rapid roll out provides little opportunity for innovation through successive deployments and learning cycles or the build out of a strong, local supply chain.	Predictable pace of deployment provides ideal conditions for innovation and the development of strong supply chains that maximise local content.

Crossing Borders

Working with other countries

Now that we've explored what a CSO would look like in the UK and how it could be introduced, let's consider **expansion to other countries**.

Countries with geological storage capacity within their national boundaries or territorial waters could introduce a CSO in the same way as the UK. It would then be possible to build out a larger (and therefore more efficient) market by recognising CSUs created in other jurisdictions. This would, for example allow a CSU Tab S created from storage activity in the UK to be bought and surrendered by a hydrocarbon supplier to The Netherlands under a Dutch Carbon Storage Obligation, and vice versa.



Expanding the market

With storage capacity established in some countries, a CSO could readily be introduced in countries not endowed with or able to use their own geological storage capacity.

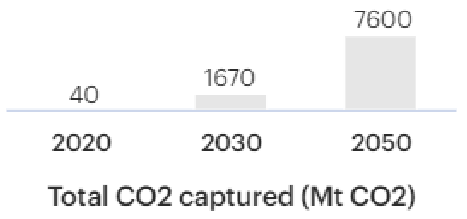
Instead, hydrocarbon suppliers would satisfy their obligations with CSU Tab Ss from storage activity occurring in other countries. This could naturally incentivise international movement of CO2 by pipeline or ship from source to store.

As with all policy mechanisms that effectively price carbon, **a CSO would need to work in conjunction with a carbon border adjustment mechanism**.

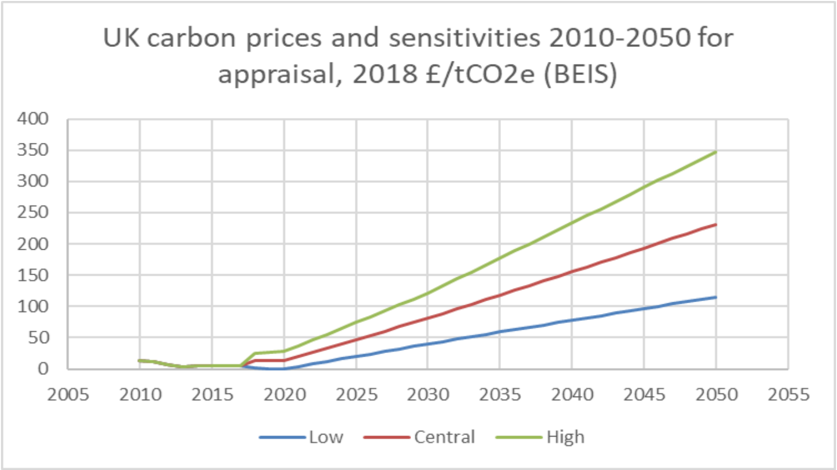
In Closing

CSO meets an unfulfilled imperative

Net zero by 2050 requires extraordinary growth in CCUS. According to the IEA's May 2021 report, CCUS activity will need to grow from 40 mtpa CO_2 today to 7,600 mtpa by 2050.



However, in the absence of a carbon price, it is almost always cheaper to emit than to store CO_2. In 2021 only **21.5%** of global GHG emissions are covered by carbon pricing initiatives* and even in those countries with carbon prices such as the UK, forecasts suggest prices will be insufficient to drive widescale CCUS deployment until 2035.



That is why a targeted policy mechanism to drive CCUS industry growth at a predictable pace is needed. This will enable **private investment, innovation and competitive price discovery** so that CCUS can deliver its full potential in a net zero world.

CSO complements other policies options to drive delivery of net zero

Within the frame of **emissions and removals** a **cap and trade** mechanism such as the UK or EU Emissions Trading Scheme provides an incentive to reduce emissions.

Within the frame of **production and storage**, a **Carbon Storage Obligation** would provide a complementary mandate for geological sequestration.

Product and process **performance standards** drive out the most polluting processes.

Carbon intensity tracking and labelling would allow consumers to make informed choices about what they buy.

In addition to all of these and very importantly, **voluntary corporate commitments** can accelerate action to reduce or eliminate both direct and indirect emissions.

Key Messages – 1

1. Along with huge expansion of renewable energy sources and other low carbon technologies, achieving **net zero** will also **require carbon removals from the atmosphere and permanent carbon storage.**

2. Permanent storage can be achieved by **sequestering CO_2 in deep geological formations**, and through some types of usage such as conversion into in building materials.

3. New **carbon accounting frameworks** and **complementary policies** are needed to enable the rapid scale up of a **carbon capture, use and storage (CCUS)** industry.

4. In this framework, **all companies** wishing to become net zero should **remove as much carbon as they emit**.

5. In addition, companies that produce fossil fuels should also **store as much carbon as they produce**.

6. A new asset class of **Carbon Storage Units (CSUs)** should be introduced as a standard currency for permanent carbon storage.

Key Messages – 2

6. A system of **Carbon Storage Obligations (CSOs)** should be introduced to drive the rapid scale up of a carbon capture, use and storage industry.

7. CSOs offer an efficient way to **embed the cost of decarbonisation** in the price of **products and services** that use fossil fuels.

8. CSOs **mandate progressive decarbonisation** while using the power of markets for **competitive price discovery**.

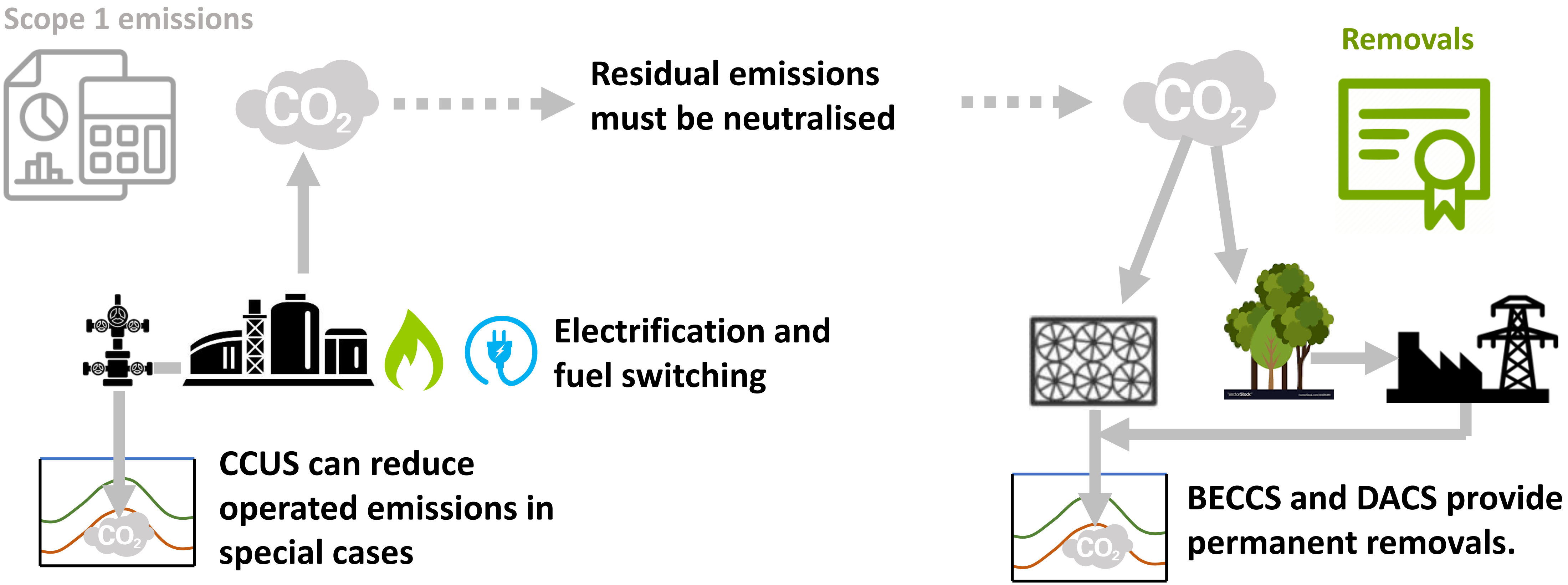
9. Companies that store carbon earn **revenues from the sale of CSUs** to those companies under an obligation to surrender them.

10. Companies that capture carbon from their operations will benefit from **avoided carbon costs** and **low carbon premiums** for their products. Their capture, transport and storage costs may be met in part through CO_2 supply contracts with carbon storers who want to grow their operations to meet a rising demand for CSUs.

11. A CSO **drives decarbonization** at a **predictable and rapid pace** and enables **private investment**. This enables **innovation** and **cost reduction**.

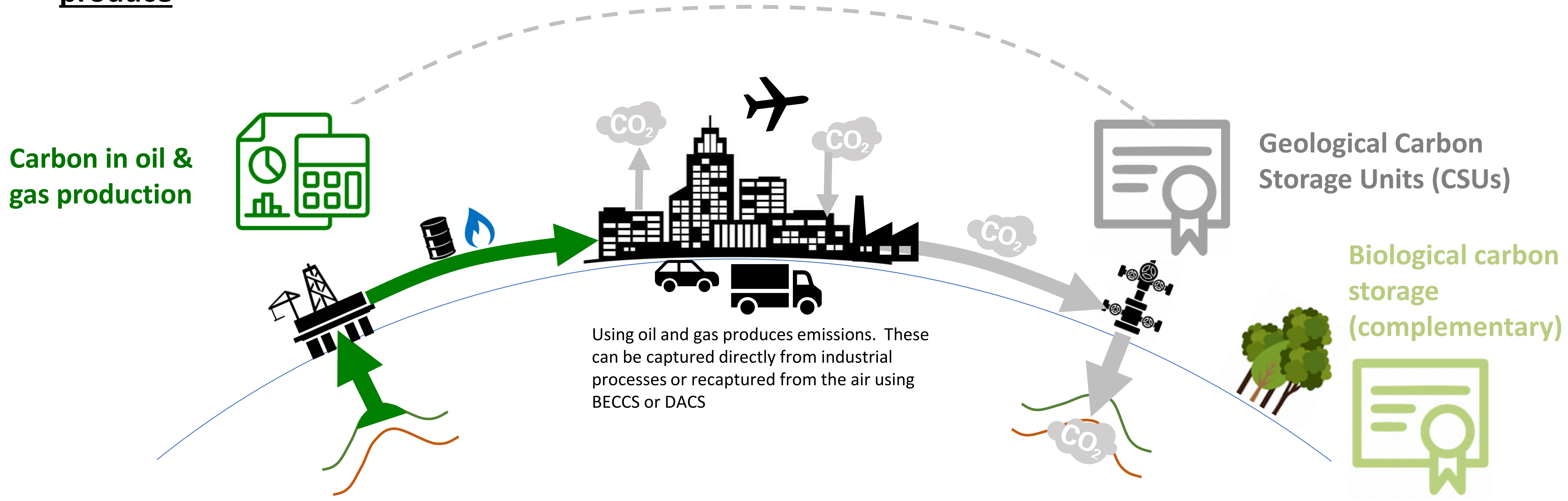
Appendix 1: How can an oil and gas producer be net zero?

To be Net Zero across operations for Scopes 1 and 2 emissions companies must reduce emissions as far as possible and neutralise remaining emissions by removing as much carbon dioxide as they emit



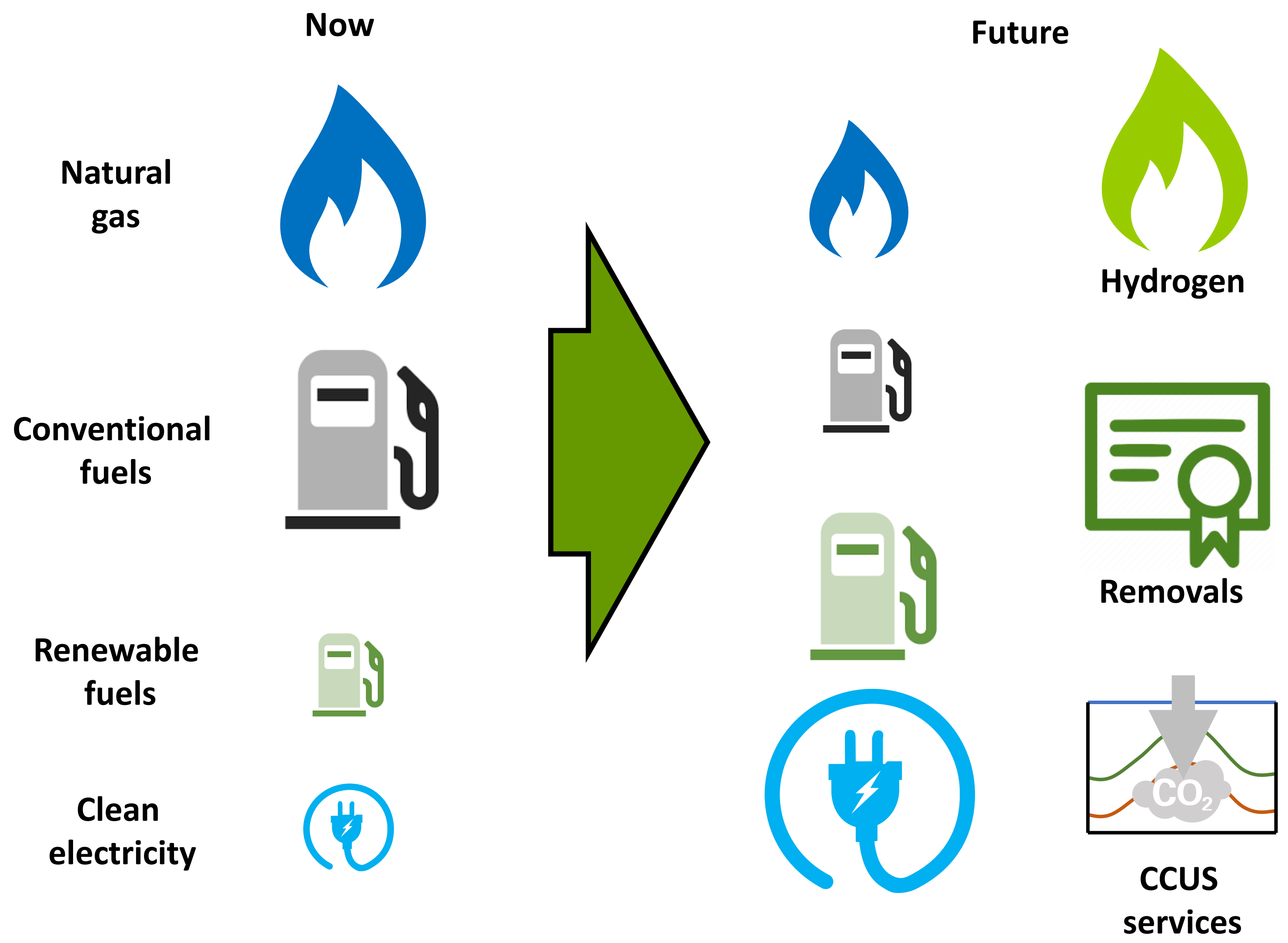
To achieve net zero operations for Scopes 1 and 2 emissions , companies can manage their portfolios, improve energy efficiency, electrify processes, switch from natural gas to hydrogen, and where viable capture and store CO_2. Any remaining emissions must be neutralised with removals.

To be net zero across upstream oil and gas production companies must store as much carbon as they produce



To achieve net zero upstream oil and gas production companies must store as much carbon as they produce. Policy frameworks are essential to make storage commercially viable. Biological carbon storage has a complementary role and may contribute to a company's goals, but is not equivalent to permanent geological storage.

Reporting product carbon intensity allows customers to chose (or governments to mandate) low or zero carbon options.



To cut the carbon intensity of products sold to customers, companies can sell more clean power, clean hydrogen and biofuels and reduce sales of conventional fuels.

By reducing operating emissions, companies will also reduce the lifecycle emissions of their products.

Additionally, companies can also offer CCUS and carbon dioxide removal to customers.