THE STATUS OF CCS IN THE UK PT II

UNPACKING CCS BUSINESS MODELS IN THE UK: POWER, POWER BECCS AND GREENHOUSE GAS REMOVALS

29TH FEBRUARY 2024

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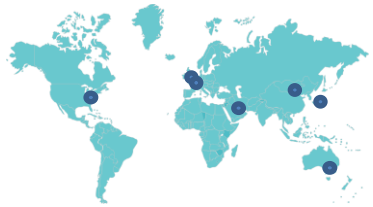

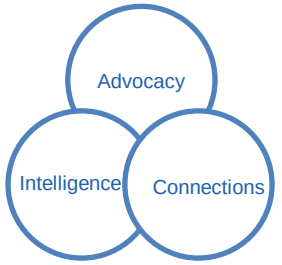

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GGR Business Model

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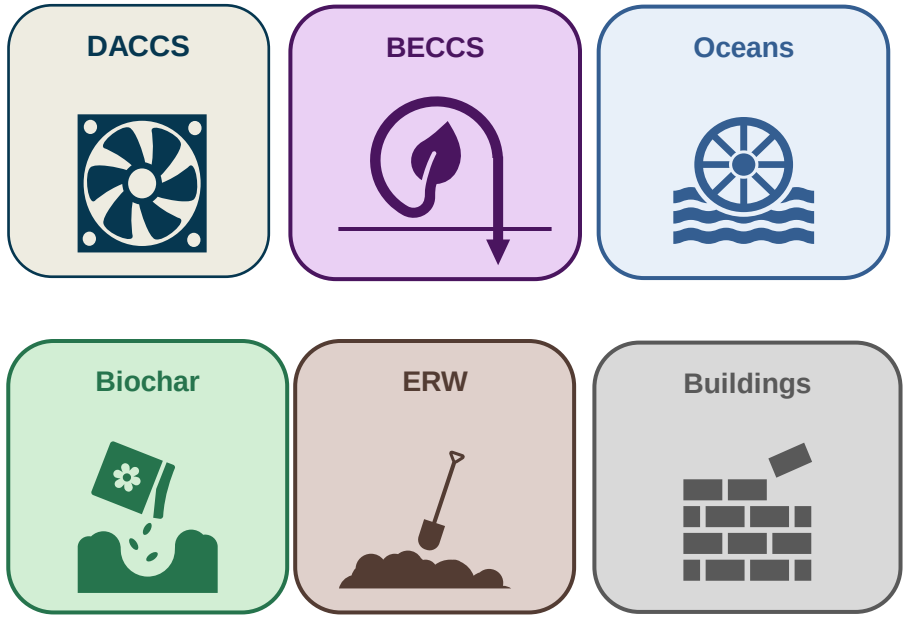
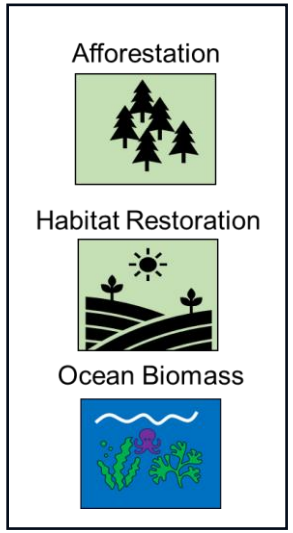
Greenhouse Gas Removal (GGR) technologies provide highly-durable removal of CO_2 from the atmosphere

- GGR technologies essential to reach net zero and **“unavoidable”** to limit global warming to 1.5˚C (IPCC).
- **UK may require 75-81 MtCO2/yr** of engineered removals by 2050 to balance residual emissions from aviation, agriculture and industry.
- **Economic benefits** including new export opportunities, IP for UK companies, high-quality green jobs.
- By 2050 the global market could be worth up to $6.5 trillion (BeZero Carbon)

The engineered GGR sector is nascent but already diverse



Nature-based GGRs also have important role to play



GGRs are a nascent sector that require rapid scale up over CB6

To meet Carbon Budgets 5 and 6 GGRs will need to grow to become a majority sector user of CCS. To minimise risk, our policy is to maintain a portfolio approach of DACCS and BECCS.

Portfolio Approach

Both **biomass** (e.g. BECCS) and **non-biomass** GGRs (e.g. DACCS) will be essential to meet carbon budgets sustainably.

None are yet deployed at scale.

GGRs could be the largest scale user of the CCS network by the mid 2030s.

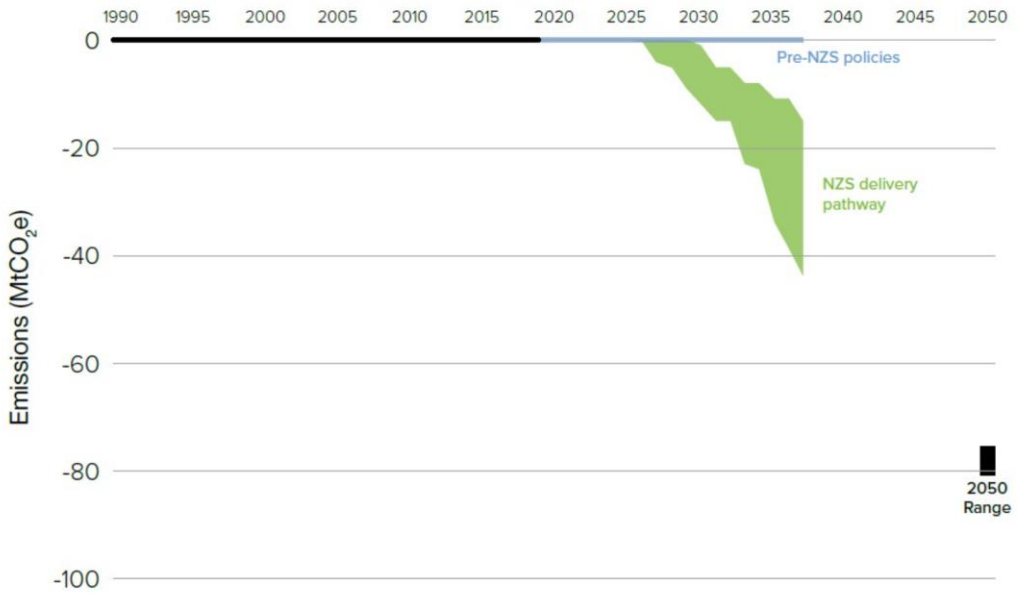
We want to establish a portfolio approach to mitigate the risks associated with scale up of new technologies:

- CCS: DACCS and BECCS
- Non-CCS GGRs (likely to be smaller in scale) e.g.:
  - Storage in products (e.g. concrete)
  - Storage in biochar applied to soils or buried

Interim ambition = **5Mt/year by 2030**, rising to ~23Mt/year by 2035 to meet CB6.

Current UK deployment = 0 tonnes

Figure 26: Indicative greenhouse gas removal (negative) emissions pathway to 2037

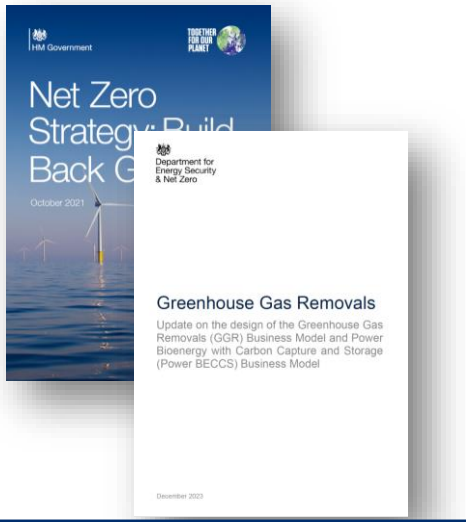


Department for Energy Security & Net Zero

HMG intervention is required to address a range of market barriers

There are significant barriers to investing on a merchant basis, including:

- **Costs and access to finance** – high capex and opex for first-of-a-kind technologies
- **Market risks** – nascent markets and uncertain future demand/prices
- **Standards and verification** – absence of trusted standards or certification for GGRs
- **Coordination/cross-chain risks** – dependence on CO2 T&S infrastructure



We are taking steps to overcome these barriers and develop a thriving UK GGR industry:

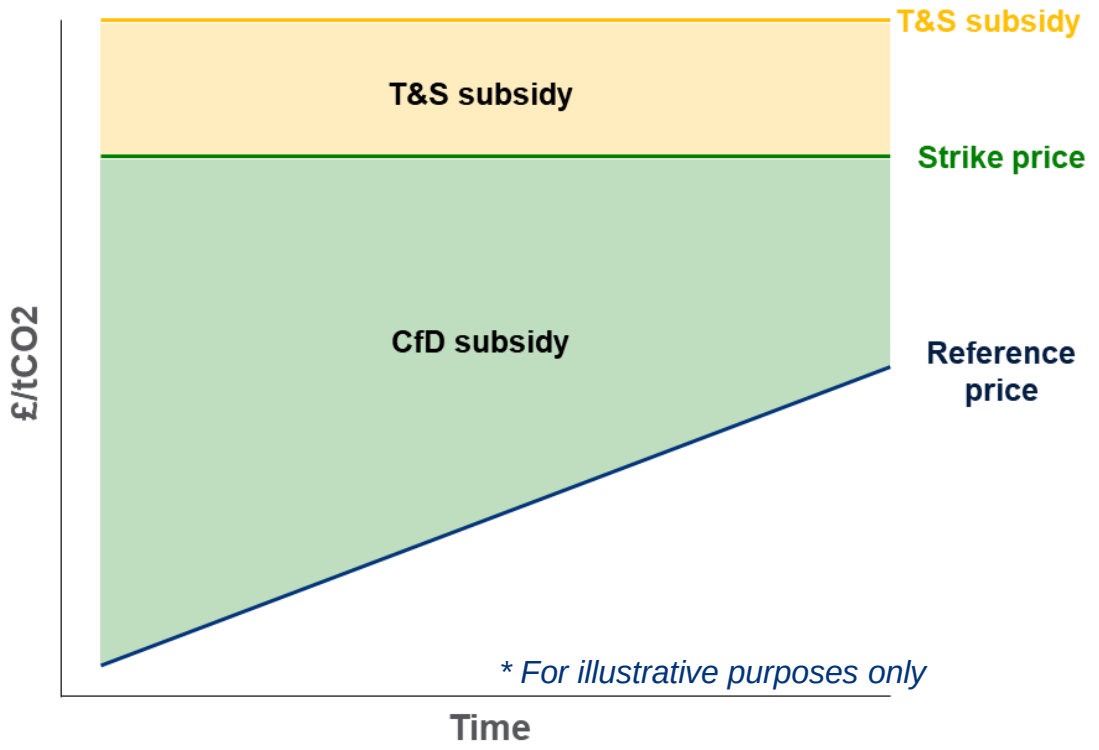
- **Innovation funding:** supporting R&D including funding for demonstrators and pilot plants
- **GGR markets:** developing the UK ETS as a long-term GGR market while scaling high-integrity voluntary carbon markets
- **GGR Business Model:** developing a contract mechanism designed to provide revenue support for negative emissions
- **GGR Standard:** establishing government standards and methodologies for GGR projects as a requirement for access to the business model and the UK ETS

The GGR Business Model will provide revenue support for negative emissions

- The GGR Business Model will provide **revenue support for 15 years** based on a **contract for difference** model
- Designed to harness the potential benefits of both the **voluntary carbon market** and the **UK Emissions Trading Scheme** (UK ETS).
- **Reference price** will initially be based on the **'achieved sales price'** for GGR credits in the absence of a liquid market or reliable benchmark price.
- Initial deployment will be through the CCUS Clusters Sequencing Programme, starting with **HyNet Track-1 expansion**.
- Further work is needed to assess the approach to supporting non-CCUS enabled technologies.

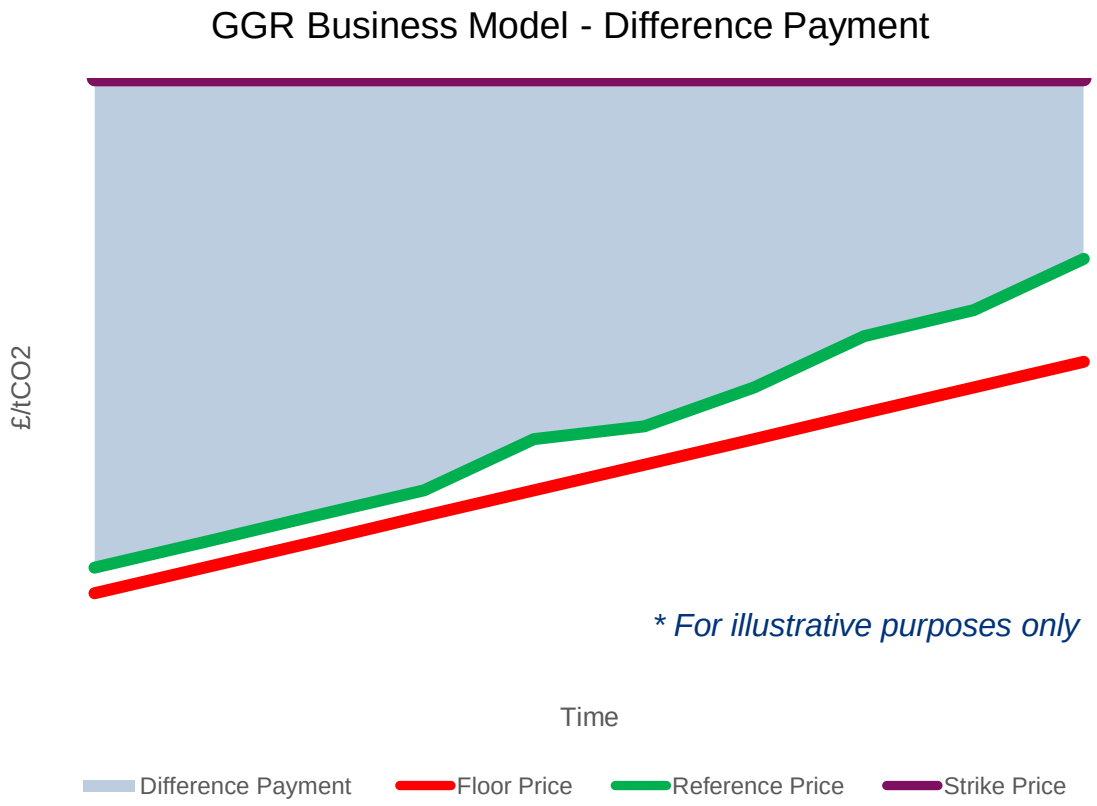
GGR Business Model Strike Price

- The Contract for Difference model will pay projects the difference between the Strike Price and the Reference Price.
- The Strike Price represents the costs of delivering negative emissions including a reasonable rate of return, and will be agreed bilaterally for initial projects.
- The primary aim of the GGR Business Model is to support the production of negative emissions. We are considering which of these costs will be eligible to report under the Strike Price.
- Following existing precedent in other business models, CO2 transport and storage (T&S) will also be supported via the GGR Business Model.



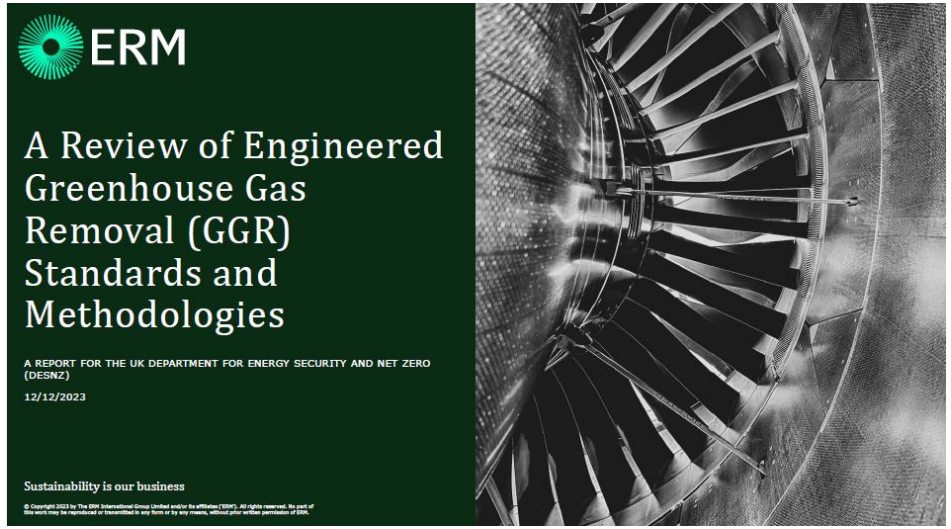
Reference Price and value-for-money mechanisms

- In a CfD, the subsidy from government is determined by the difference between the Strike Price and Reference Price.
- We are minded to set the Reference Price based on the developer's **Achieved Sales Price.**
- The difference payment will be combined with a **Price Discovery Incentive (PDI),** which will be a proportion of the Achieved Sales Price.
- DESNZ is considering whether to implement a **Floor Price** and is considering what level of support, if any, would be provided to **mitigate volume risk.**



GGR standards and methodologies (including monitoring, reporting and verification)

- ERM conducted an **independent review of existing GGR standards** and methodologies for engineered GGRs.
  - At the point of the review, **no single existing standard** would be appropriate to cover all the engineered GGR technologies in scope.
- Government announced the intention to **develop methodologies** supporting the business model rather than endorse one, or multiple, third-party methodologies.
- The Government will only support GGR credits delivered using the Government-defined methodological approach.



- **As a first step, the Government is likely to define methodology quality thresholds** for early projects, before detailed GGR methodologies are finalised.

Deployment through the CCUS Programme

GGR projects eligible to apply to the Track 1 expansion phase of the CCUS Programme.

GGR Business Model Track-1 Expansion Hynet Eligibility Criteria
Location: BECCS projects that produce electricity must be located onshore in Great Britain. All other GGR projects are subject to the central location criteria.
Must provide net negative emissions (applies to all GGR technologies, including DACCS)
Must have a minimum net negative contribution of 0.05 Mtpa CO_2 to storage (applies to all GGR technologies, including DACCS)
The Project must not have applied for and cannot receive support under another carbon capture Business Model in this application window (applies to all GGR technologies, including DACCS)
Bioenergy Carbon Capture and Storage (BECCS) projects must have a **minimum projected capture rate of 90%**
For BECCS Projects, must use eligible feedstock (minimum 90% biogenic CO_2 generation)
BECCS Projects must have an efficiently produced**, valuable co-product**

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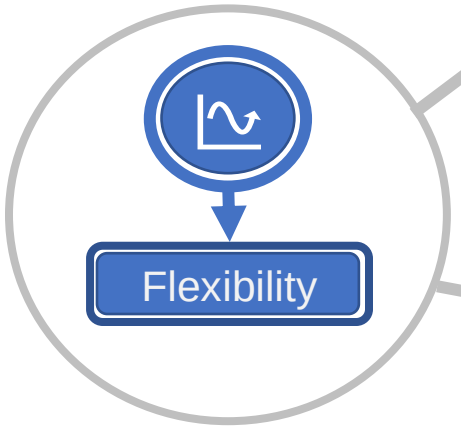
DPA Business Model

Business Model – Objectives

To help deliver emissions reductions and achieve the Carbon Budget 6 targets. To do this we will implement the Dispatchable Power Agreement (DPA), **a private law contract of up to 15-years** funded by the Supplier Obligation. Objective: to bring forward at least one power CCUS plant in the mid 2020s through the CCUS Cluster Sequencing Process. In order to do this there are key policy positions to consider:

Flexibility



A plant operating in a flexible dispatch mode will face uncertainties regarding the load factor of the plant. This presents a problem if investors are reliant upon wholesale market revenues for the entirety of the return on investment in the plant (capex required for a power CCUS plant is higher than that for an unabated equivalent plant).

An **availability payment** paid to the generator on a regular basis, based on the plant's **availability of low carbon generation capacity** (regardless of whether the plant is dispatching or not) significantly helps mitigate this uncertainty. The generator is still exposed to all other market signals and will also need revenue from the wholesale market and/or ancillary services market.

Payment will be directly linked to:

- Availability of the plant's generating capacity;
- Carbon capture rate achieved.

Size of payment to be set through a competitive or bilateral negotiation award process.

Affordability

At average 2021 UK carbon prices, a power CCUS plant would have been out of merit compared to an unabated equivalent due to the increased opex costs of the CCUS plant vs an unabated thermal plant. Going forward, we expect that higher carbon prices will provide the price signal to dispatch (depending also on fuel and other variable costs). However, given current carbon price levels and potential price volatility, the DPA needs to provide the correct signal when the carbon price is insufficient.

A variable "top-up" payment on the wholesale market price paid on generation output:

- Covering the costs of running CCUS (i.e. the cost of making generation low carbon);
- Calculated on a regular (daily) basis benchmarked against a reference unabated plant

The level of the top-up will be calculated relative to:

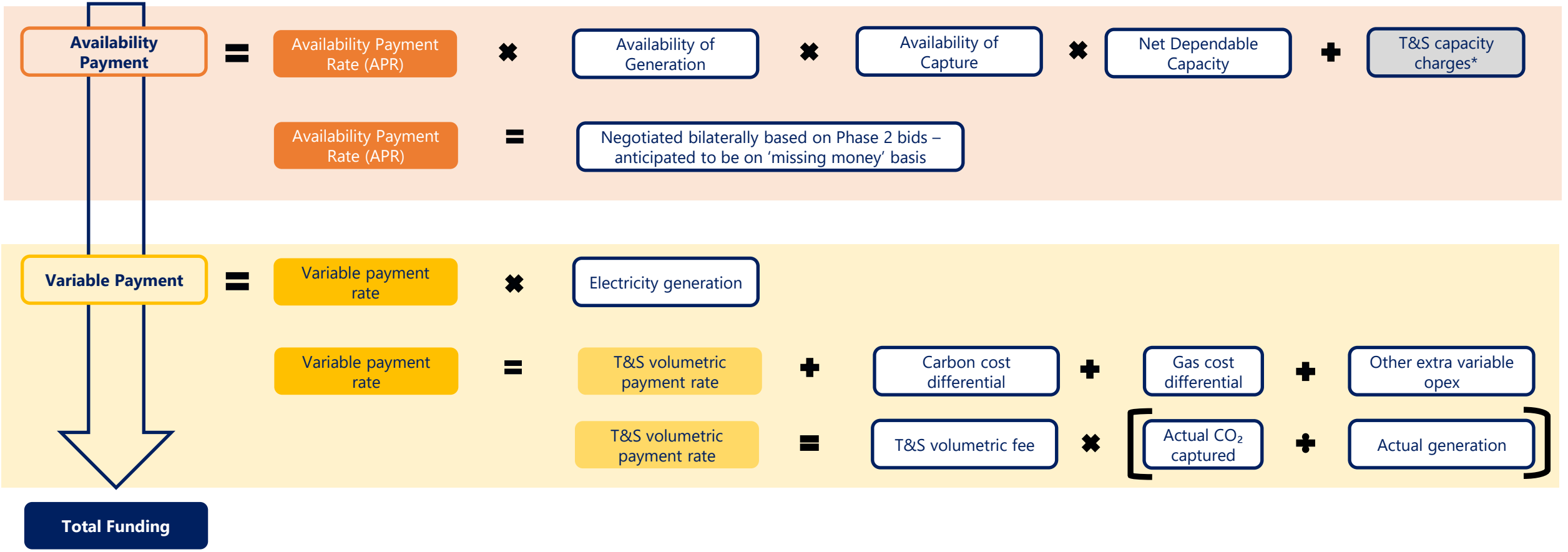
- Fuel price;
- Carbon price.

If the variable cost of a CCUS plant is lower than the unabated reference plant (i.e. when carbon prices are high), no payment will be made to the Generator.

How the DPA funding is calculated

The Dispatchable Power Agreement is comprised of two components:

- an availability payment: paid to provide the 'missing money' and enable the plant to be built
- a variable payment: paid to ensure that the abated generator dispatches ahead of unabated alternative



* T&S capacity charges are pass through costs to consumers

Risk Apportionment, Guarantees and Caps

No guarantee under the DPA…

- …of minimum revenue – both the Availability Payment and the Variable Payment can fall to zero.
- …of profit – if projects do not perform in the market they will not achieve their anticipated returns.
- …of usage – while the Variable Payment would reduce a Generator's short run marginal cost, this will only bring the Generator's SRMC to the level of the Reference Plant (and will not always be paid i.e. if the carbon price is high enough). If the Reference Plant is not required to dispatch by the market then nor will the Generator be positioned in the merit order to dispatch by the Variable Payment.

No cap under the DPA…

- …on profit – although a Gainshare mechanism is likely to be applied, this will only entitle the DPA Counterparty to a 30% share of gains above a certain threshold.
- …on losses – there will be no painshare mechanism. It is possible (though unlikely) under the DPA design that a Generator receives no subsidy payments nor any market revenue.

Risk under the DPA:

- …majority held by the Generator
- …with some cross-chain risks (e.g. to do with the T&S Network's performance/other events outside the Generator's control) held by the DPA Counterparty

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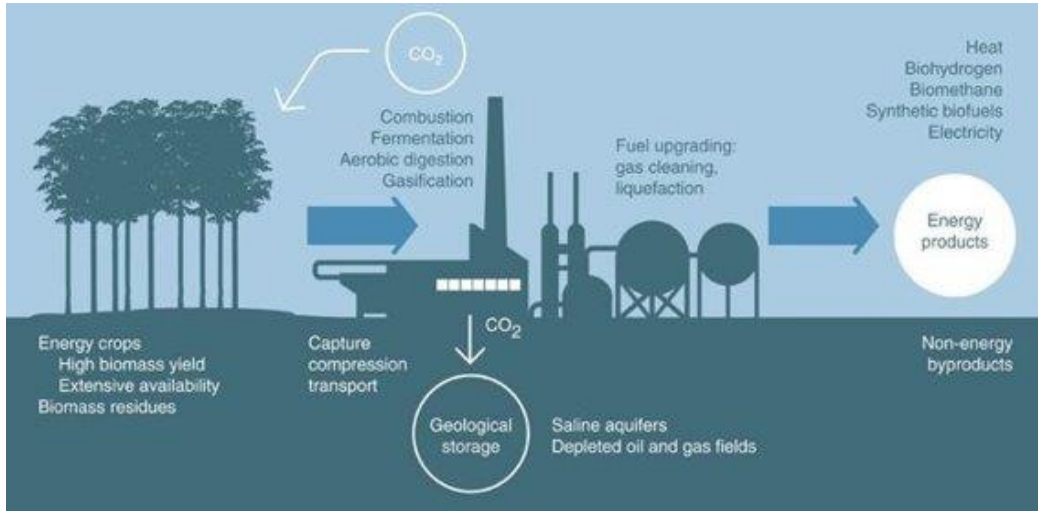
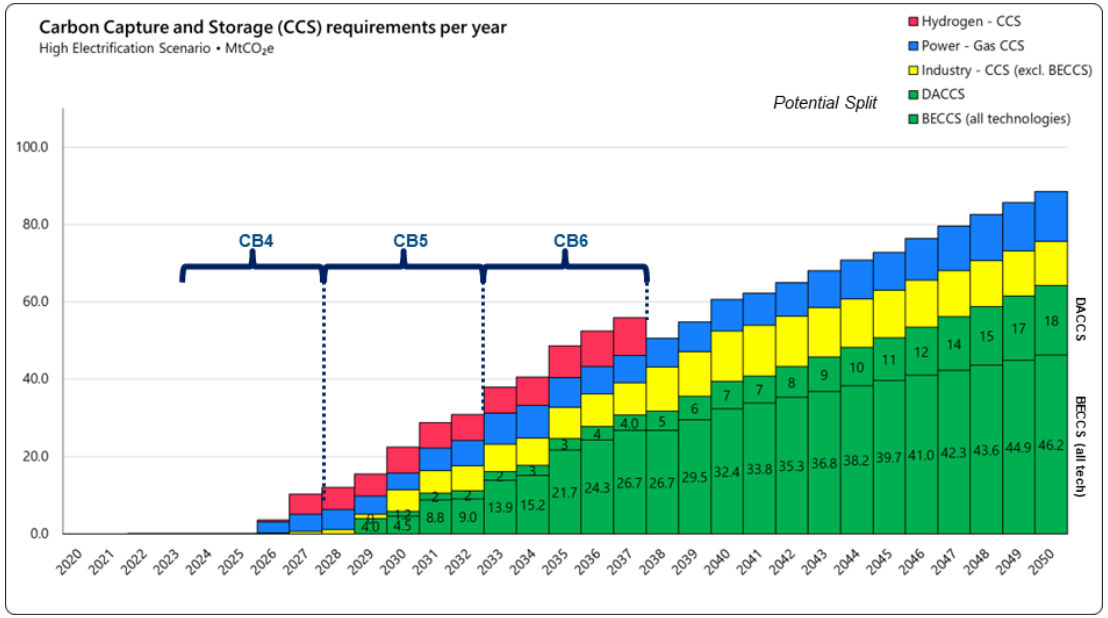
Power BECCS Business Model

Power BECCS will provide both negative emissions and electricity generation



Power BECCS provides **low carbon electricity generation** and delivers economy-wide negative emissions. Negative emissions are key to the **government's decarbonisation strategy**

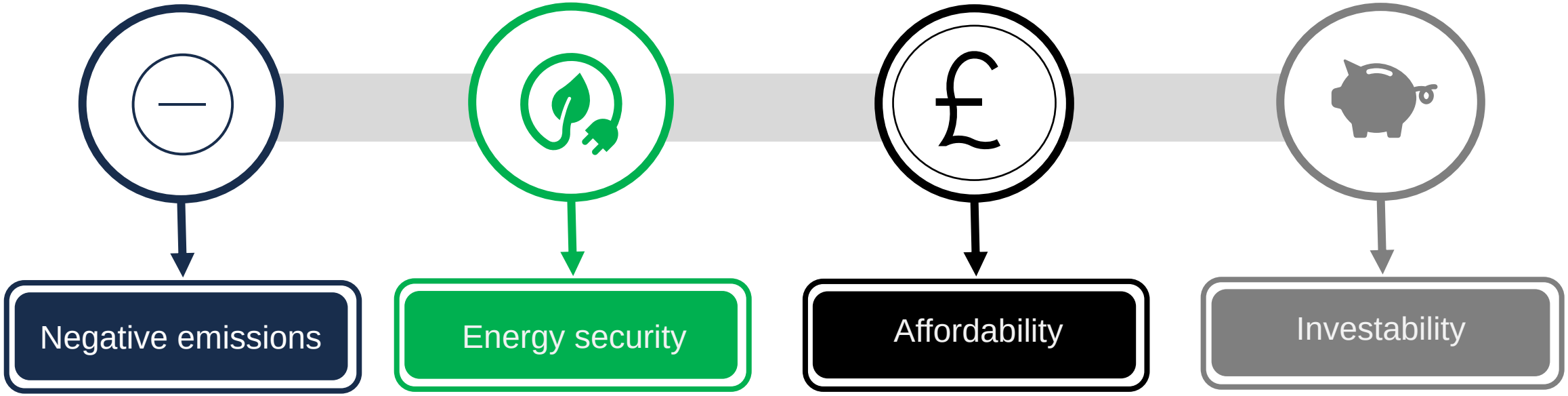
Power bioenergy with carbon capture and storage (BECCS) is the process of using sustainable biomass feedstock to fuel a **combustion process** to **generate electricity** in combination **with carbon capture and permanent storage**.



Power BECCS in context

- Reach net zero emissions by 2050
- Store 20 – 30 million tonnes of CO_2 a year by 2030 including at least 10Mtpa of CO_2 by 2030 in Track-2
- Support CCUS in at least two industrial clusters by the mid-2020s and a further two by 2030 while supporting 50,000 jobs in 2030.
- Deploy at least one power CCUS plant in the 2020s and look to bring forwards multiple additional power CCUS projects by 2030 to support the decarbonisation of our power sector by 2035, subject to security of supply
- Up to 1GW of CCUS-enabled hydrogen in operation or under construction by 2025 and 10GW of low carbon hydrogen production capacity by 2030
- Capture up to 6 MtCO2 per year of industrial emissions by 2030 and 9 MtCO2 per year by 2035.
- **Deploy at least 5 Mtpa of engineered CO_2 removals by 2030, rising by up to 23 Mtpa by 2035**

The Power BECCS Business Model will support projects to deploy early and at scale to meet the UK's carbon budgets



Incentivise large-scale negative emissions to meet UK carbon budgets

Ensure power production to contribute to security of supply

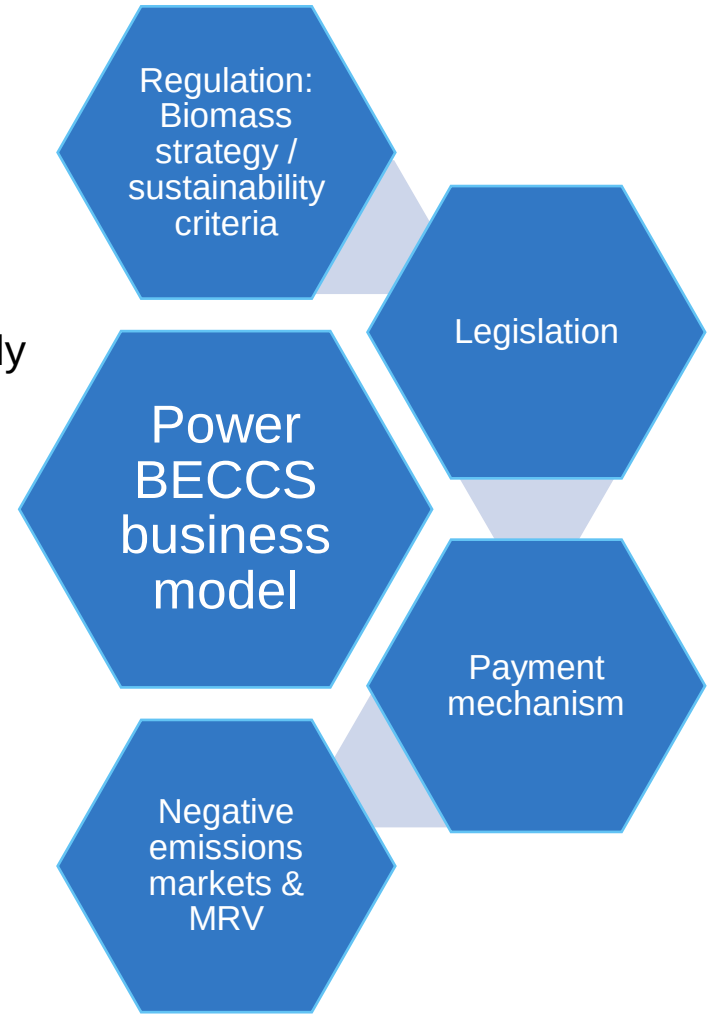
Minimise costs to electricity consumers and ensure value for money

Provide revenue support for both power generation and negative emissions

The Power BECCS Business Model is designed to support projects which have a minimum abated **power generation capacity of 100MW**, to ensure net zero policy objectives are met. The Greenhouse Gas Removals (GGR) Business Model is designed to support smaller scale Power BECCS projects, in addition to other GGR technologies.

Power BECCS business model key elements

Biomass strategy / sustainability criteria sets the supply chain emissions target and specific sustainability requirements on the feedstock used, to ensure biomass genuinely contributes to decarbonisation.



Legislation allows the business model to be signed and operated.

Clarifying the role of both **voluntary carbon markets** (VCMs) and **compliance markets** such as the UK ETS to support the production of negative emissions.

Payment mechanism provides developers and investors the clarity of how and where their revenues will be generated.

The Power BECCS Business Model will be based on a ‘dual CfD’ model

Dual CfD mechanism = CfDe + CfDc

A difference payment for the low – carbon electricity generated (CfDe)

A difference payment for the carbon stored (CfDc)

Transport and Storage (T&S) payment

Each difference payment will be based on a Strike Price and a Reference Price

- CfDe incentivises low carbon electricity generation, contributing to energy security.
- Payment is calculated based on the difference between a ‘Strike Price’ reflecting cost of investment and a ‘Reference Price’ reflecting the average market price for electricity.

- CfDc incentivises production of negative emissions, contributing to net zero ambitions.
- Payment is calculated based on the difference between a ‘Strike Price’ reflecting the cost of producing negative emissions and a ‘Reference Price’ reflecting the market value.

Dual CfD will also have a third, separate, payment stream for the T&S fees associated with the project.

Expectation is that carbon credits may be sold into an appropriate compliance (UK ETS) or voluntary carbon market.

Recent updates have set out minded-to positions on Power BECCS term length and reference prices

In our December 2023 update we set out our minded-to positions on term-length and reference prices:

- 15-year **term-length** ensures balance between subsidy costs and achieving negative emissions, with potential scope for extension.
- Baseload market reference price (BMRP) will likely be the **reference price for the CfDe**, in order to maximise the level of negative emissions.
- **Reference price for CfDc** is likely to be based on the 'achieved sales price' (i.e. the actual price achieved by the developer for negative emissions credits sold in approved markets)

CfDe Reference Price	Season ahead reference price	x Discounted primarily on the grounds of liquidity as it could affect the investability of the business model
	Quarter ahead reference price	
	Intermittent Market Reference Price (IMRP)	x Ruled out due to a lack of long-term hedging arrangements which can expose the project to volatility that can also disincentivise a project to sell into a market. Power BECCS will run at baseload, the start-stop nature that IMRP would incentivise would have technical impacts of the life expectancy of the assets.
	BMRP	✓ Promote baseload generation; required for the maximum level of negative emissions ✓ Currently used by current baseload generation CfDs ✓ Incentivises generators to make season-ahead sales of power, promote stability of forward power sales ✓ Power BECCS projects aren't suited to dispatchable profile due to start up and shut down capabilities ✓ BMRP under stable market conditions is the most investable option and provides best value for money

Power BECCS business model development in the UK so far

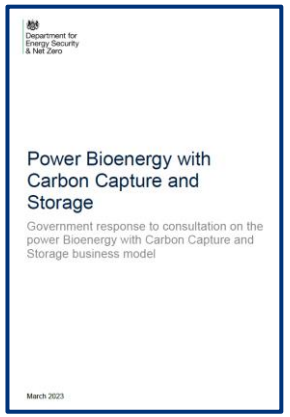
October 2021
Power BECCS report investigating the difference business model options for power BECCS

March 2023
Government response confirming the ‘dual CfD’ as the intended power BECCS business model

December 2023
GGR and power BECCS business models update

August 2022
Consultation seeking views on potential business models for power bioenergy carbon capture and storage

August 2023
Task and finish report outlining how BECCS is able to generate negative emissions



Immediate priorities for policy development include:

- design of the Price Discovery Incentive and options for setting a Price Floor
- options for volume support to mitigate the risks of a shortfall in market demand for GGR credits
- detailed consideration of the interaction of the CfDe and CfDc reference prices

Further update on the design of the business models in due course, following further policy analysis and engagement with stakeholders.

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