

Integrating Carbon Dioxide Removal (CDR) into the UK Emissions Trading System (UK ETS): A Policy and Economic Analysis

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Introduction

The urgency to meet net-zero targets has intensified the focus on CDR. While UK ETS targets industrial decarbonisation, it lacks a mechanism for CDR, presenting significant policy challenges and inefficiency in achieving net-zero.

Research Objective

Identify appropriate policy for CDR integration in UK ETS ensuring market efficiency, price stability, and alignment with global efforts on net zero and CDR investments, without deterring mitigation.

Methodology

A mixed-methods approach combining **economic** modelling, **policy** analysis, and **stakeholder** consultation synthesis to assess the integration of CDR into the UK ETS, with a focus on impacts to carbon pricing, market design, and socioeconomic outcomes.

Reduction Vs Removal

6 GtCO₂e

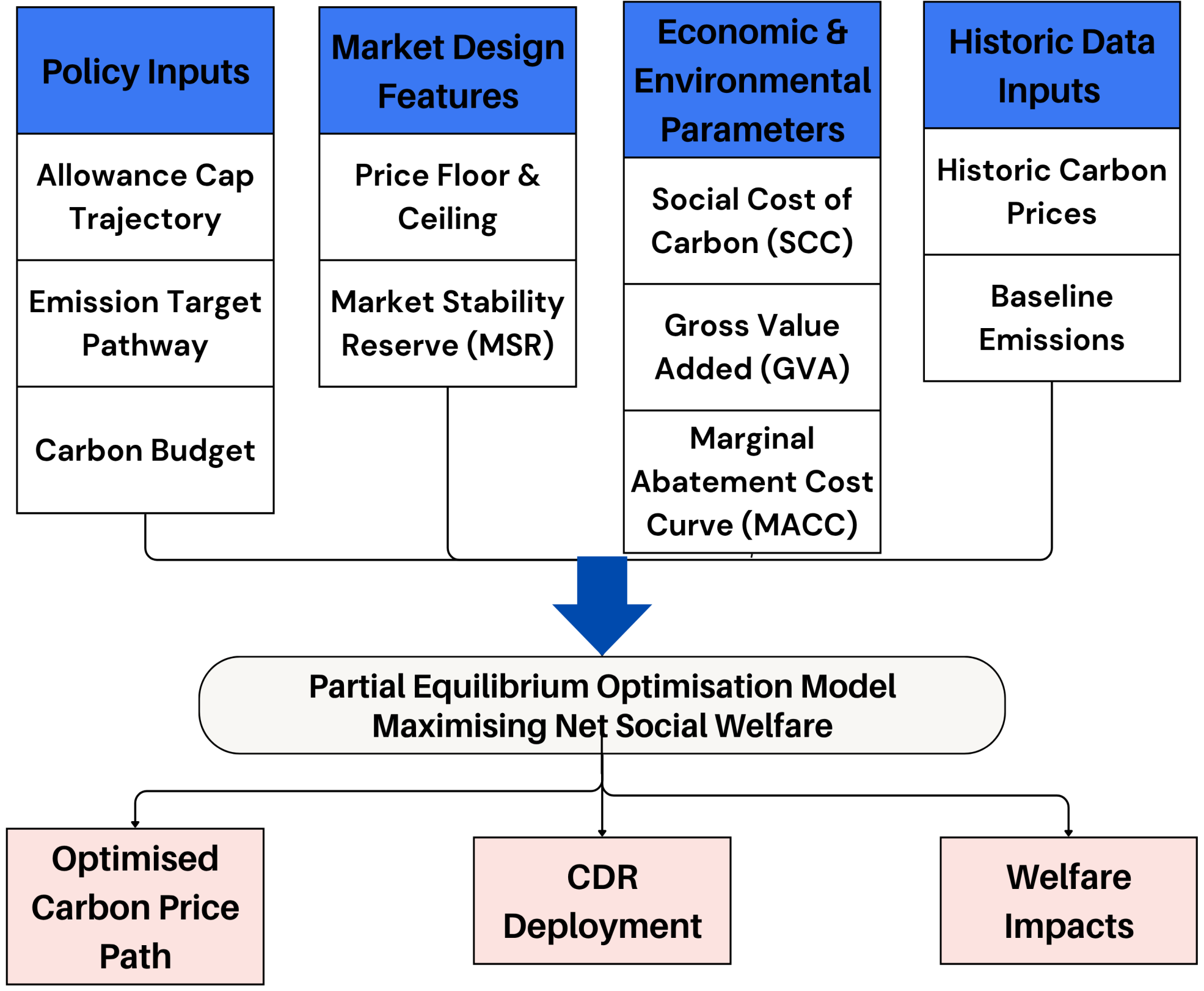
of global CDR deployment per year is required to limit warming to 1.5C according to IPCC. This is compared to reduction of global emissions to about 25-30 GtCO₂ per year by 2030 and to reach net zero by 2050 (UNEP, 2023).

Considerations:

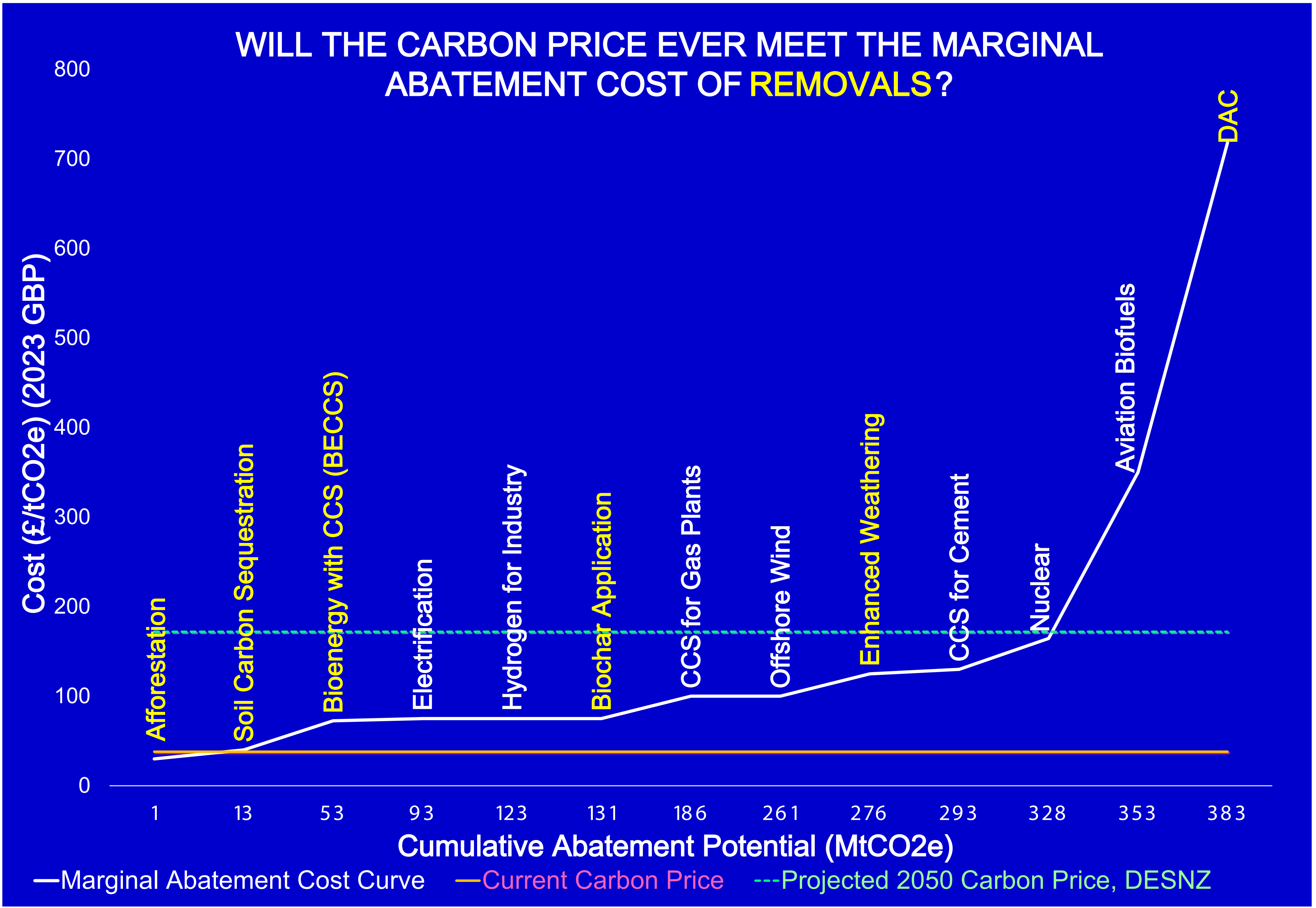
- Environmental:** Modelling UK decarbonisation pathway (MACC)
- Financial:** Installation Cost Analysis
- Socioeconomic** : Stakeholder Sentiment Analysis

Model Framework

Policy-driven optimisation model of the UK



The model is written using Pyomo as a partial equilibrium optimisation problem. The data used are collected from DESNZ, NERA report, SCC Meta-Analysis, and Carbon Budget 7.



The Marginal Abatement Cost Curve covers the Power, Industry, and Transport sectors and CDR methods. The decarbonisation methods included in the MACC are Offshore Wind, BECCS, Electrification, Hydrogen for Industry, Nuclear, CCS for Gas Plants, Electric Vehicles, Heat Pumps, Insulation Upgrades, CCS for Cement, Biochar, Enhanced Weathering, Aviation Biofuels, and Direct Air Capture. The abatement costs and mitigation potential for many technologies were identified in the IPCC AR6, UK Government Contracts for Difference, UK Transport Decarbonisation Plan, Industrial Decarbonisation Strategy, and CDR.fyi.

Modelling

Objective Function:

$$\max \sum_{s,t} [\alpha \cdot GVA_{s,t} - \beta \cdot (C_{s,t}^{AB} \cdot AB_{s,t} + C_{s,t}^{AA} \cdot AA_{s,t} + C_{s,t}^{CDR} \cdot CDR_{s,t}) - \gamma \cdot SCC_t \cdot E_{s,t} + \delta \cdot CDR_{s,t} \cdot CRV_{s,t}]$$

Maximise social welfare by balancing economic output (GVA), abatement (AB) and removal (CDR) costs, and the climate impact of emissions (SCC) and removals (CRV).

1. Sectoral Emissions Balance

$$E_{s,y} = BAU_{s,y} - \sum_{a \in A_s} AB_{a,s,y}, \forall_{s,y}$$

2. Abatement Potential Limits

$$AB_{a,s,y} \leq \max AB_{a,s,y}, \forall_{a,s,y}$$

3. CDR Supply Limits

$$CDR_{a,s,y} \leq \max CDR_{a,s,y}, \forall_{s,y}$$

4. Allowance Cover Requirement

$$E_{s,y} \leq FA_{s,y} + AA_{s,y}, \forall_{s,y}$$

5. ETS Cap Constraint

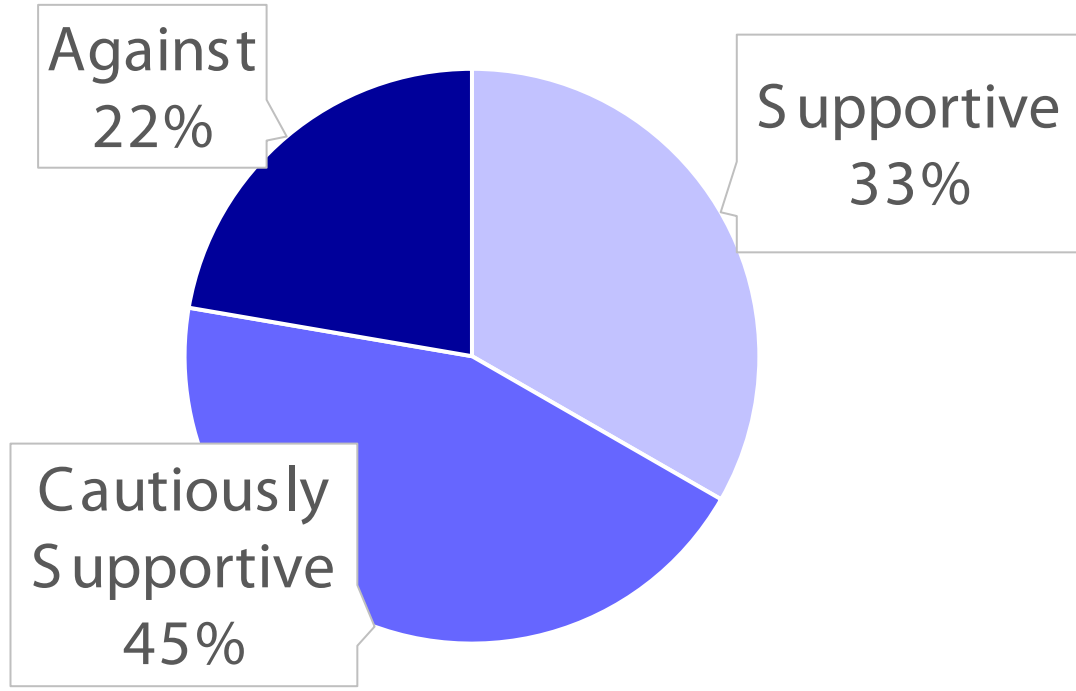
$$\sum_s E_{s,y} \leq CAP_y, \forall_y$$

6. Non-negativity Constraints

$$E_{s,y}, CDR_{s,y}, ABA_{a,s,y}, AA_{s,y}, P_y \geq 0, \forall_{s,a,y}$$

Stakeholder Analysis

Stakeholder Support Levels



Key insights from UK ETS public consultation:

- Support for Maintaining the **Gross Cap**
- Concerns Over **Permanence** and **Integrity** of GGRs
- Opposition to **Full Integration** to avoid mitigation deterrence
- Call for **Robust Measurement and Verification** of GGRs, post-verification
- Market **Stability** and **International Competition** to maintain investor confidence

Main Findings

CDR can support net zero pathway with careful design to prevent price volatility. Fossil fuel-dependent industries are most exposed to carbon pricing. Strong support for integrating CDR in UK ETS, however with concerns over market stability, and permanence.

Policy Recommendations

- Implement Progressive Carbon Pricing**
- Provide Economic Incentives for Early Adoption**
- Promote International Cooperation**
- Set Clear Long-term Targets**

For a deeper dive into this research or collaboration inquiries, reach out via email at antigoni.theocharidou21@imperial.ac.uk or connect on LinkedIn [Antigoni Theocharidou] by scanning the QR Code.

