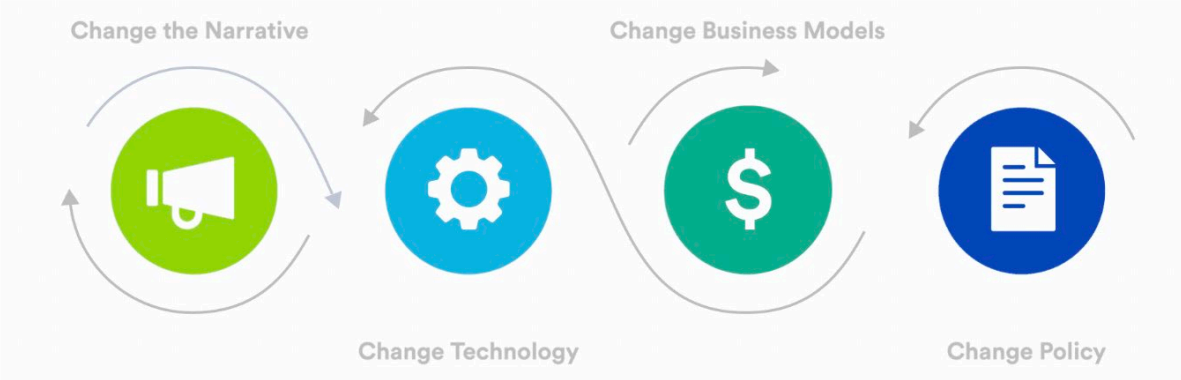
Bringing Broader Benefits with CCS Deployment

CARB Public Workshop on Carbon Capture, Removal, Utilization, and Storage Program (SB 905)

February 27th, 2025

CLEAN AIR TASK FORCE

CATF: Who We Are

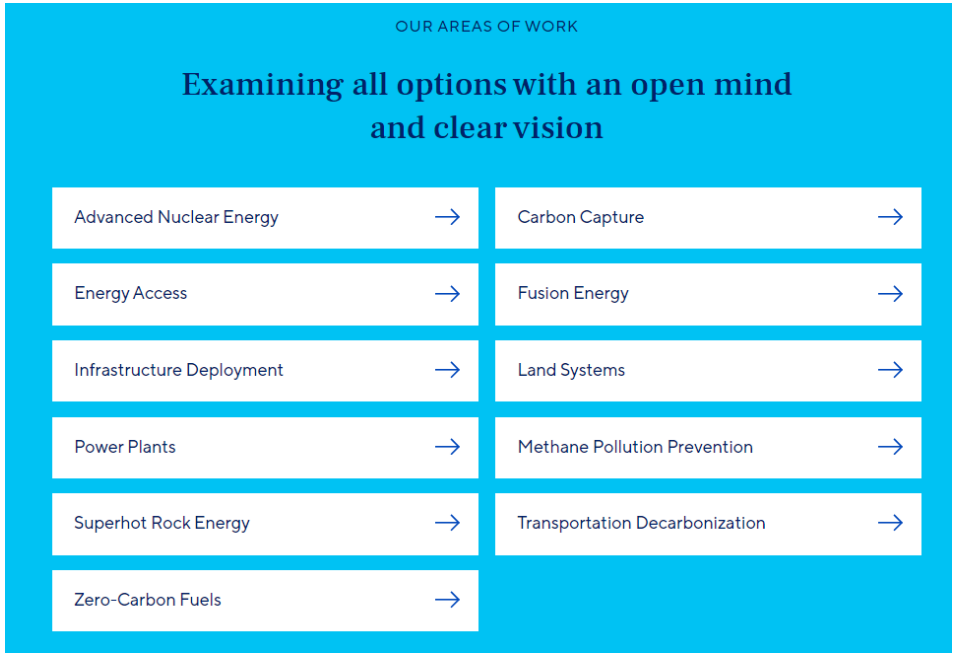


Our Mission: Push technology and policy changes needed to achieve a zero-emissions, high-energy planet at an affordable cost

Our Vision: Meet the world's rising energy demand in a way that is financially, socially, and environmentally sustainable

Our Approach: Change Policies | Change Technologies | Change Business Models | Change Narratives

Focus: Industrial | Power | Transportation | Land Systems



CCS Economics – Cost Primer

CCS projects have 3 main pieces to their value chains, each with distinct costs and drivers:

Capture

- Costliest piece, highly variable – can range from ~$15/tCO$_2$ to over $100/tCO$_2$
- Costs dependent on source type, generally higher for dilute streams of CO$_2$ (e.g., NGCCs), lower for highly concentrated streams (e.g., ethanol)

Transport

- Pipeline by far the most economically favorable mode of transportation (usually <$15/tCO$_2$)
- Marine transport costlier than pipeline, but still economically favorable
- Truck and rail very costly on a per-ton basis (usually >$100/tCO$_2$)

Storage

- Storage costs depend on geologic characteristics (i.e., depth, porosity, permeability)
- DOE estimates that most onshore storage costs will range between ~$7-13/tCO$_2$

Sharing the Benefits Report

Key Findings:

- Incentives (e.g., Federal 45Q Tax Credit, Low Carbon Fuel Standard) are essential for project viability
- Economically viable projects can deliver benefits to local landowners and host communities
- Projects not eligible for LCFS, such as at cement plants, may face challenging economics
- Project viability and benefit potential depend heavily on:
    - CO_2 flue gas stream concentration
    - Ability to use pipeline or marine transport
    - Proximity to good geologic storage
- Trucking and railing CO_2 are pipeline alternatives, at a sizeable cost that impact project viability

Sharing the Benefits Report

Key Findings:

- For CCS and CDR projects to succeed in California, they must concurrently serve three needs and interests:
    - The need to reduce emissions and atmospheric CO_2
    - The need for projects to make economic sense for developers, and
    - The economic, social and environmental needs of local landowners and host communities.

CATF Co-Benefits Study

Goal: Understand the impacts of adding carbon capture on the releases of criteria air pollutants from industrial sources

Chose specific stacks from cement and refining operations at individual facilities

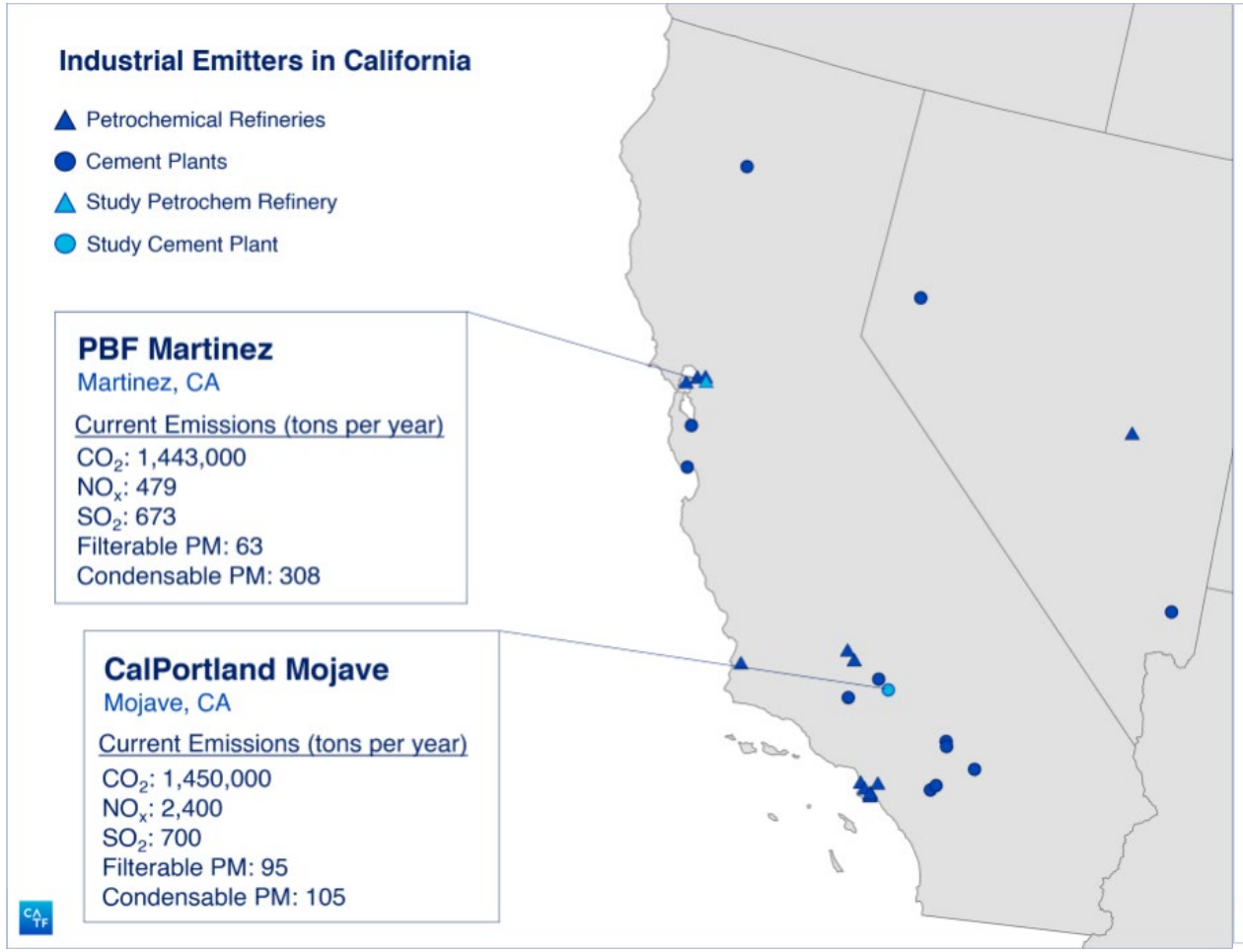
- Two cement plants
- Two fluidized catalytic cracking units at refineries
- Four plants total, located in Texas and California

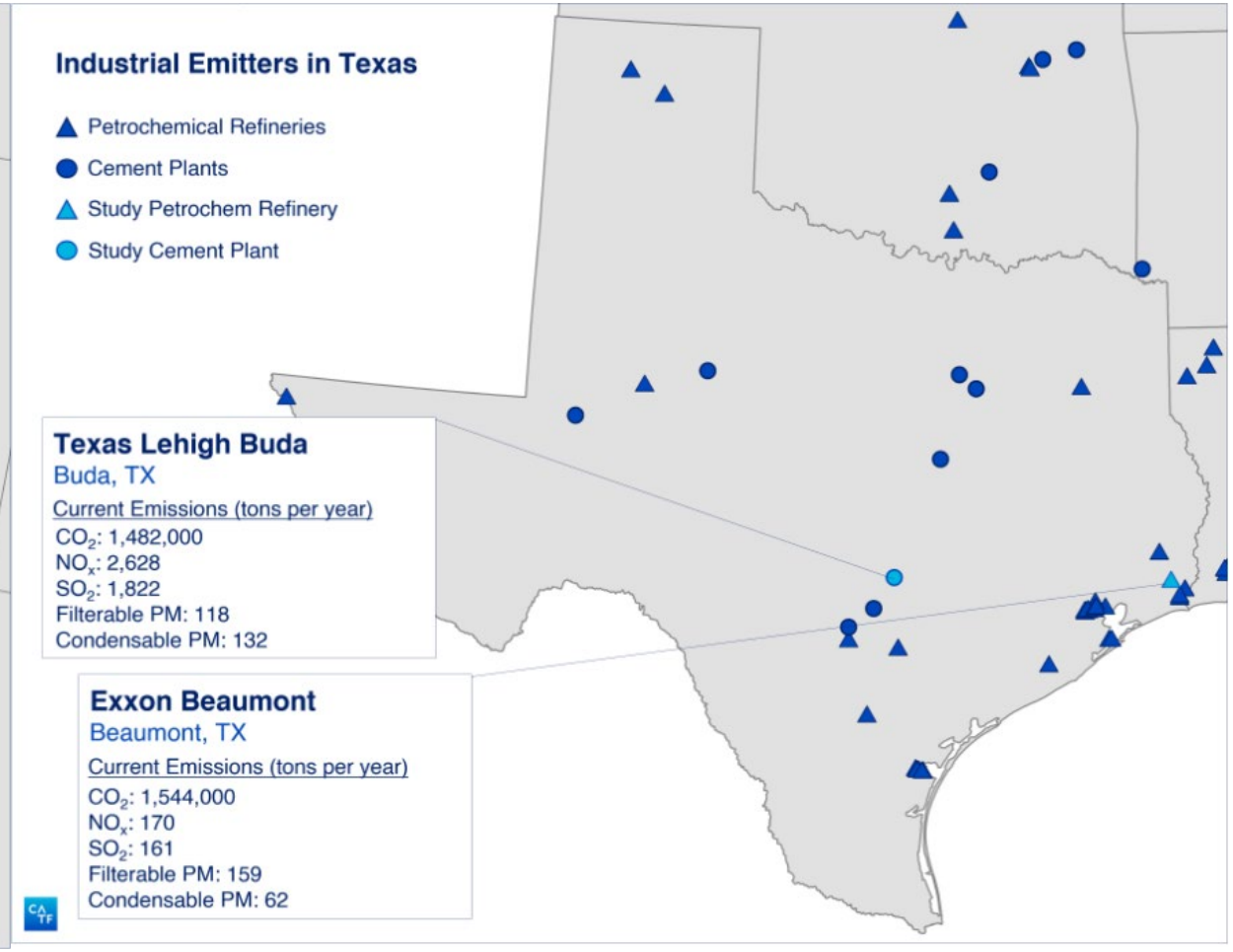
Plants selected represent high emitters to determine upper bound of pollution reduction potential

This study is based on a modeling exercise, not data from an actual retrofit

Amine capture system assumed with a 90% capture rate, voluntary criteria pollutant controls for capture system operating requirements

CATF Co-Benefits Study





Modeled Emission Changes

DECREASES

	CO_2 Reduction (% reduced) (tons captured /yr)	Reduction in Various Pollutants Studied (% reduced) (tons captured per year)			
	CO_2	NOX	SO_2	FILTERABLE PM	CONDENSABLE PM
CEMENT					
Mojave	**87%** 1,263,000 TPY	**2%** 54 TPY	**99+%** 699 TPY	**97.5%** 92 TPY	**93%** 97 TPY
Buda	**87%** 1,290,000 TPY	**2%** 59 TPY	**99+%** 1,821 TPY	**97.5%** 115 TPY	**93%** 121.8 TPY
REFINERY FCCU					
Martinez	**87%** 1,250,000 TPY	**73%** 351 TPY	**99+%** 673 TPY	**97.5%** 61 TPY	**96%** 296 TPY
Beaumont	**87%** 1,344,000 TPY	**33%** 55 TPY	**99+%** 160 TPY	**95%** 151 TPY	**95%** 59 TPY

INCREASES

Facility	VOC (tons per year)
CEMENT	
Mojave	2.81 TPY
Buda	2.87 TPY
REFINERY FCCU	
Martinez	2.78 TPY
Beaumont	2.99 TPY

Monitoring and Data Sharing

CCS Monitoring, Measurement, and Verification (MMV) plans are highly sophisticated and robust, but lack accessibility to non-experts

Community Involvement in MMV

- Public participation in developing MMV plans may bolster public acceptance of CCS
- Operators should understand individual community concerns and needs
- Operators should work with communities to address specific concerns in MMV plans

MMV Data Transparency & Accessibility

- MMV data is complex and relatively inaccessible to the public
- A centralized hub for monitoring and project data would help make MMV more accessible
- Monitoring data needs to be contextualized to be more accessible to the public (leverage AI?)

CLEAN AIR TASK FORCE

Ben Grove
Senior Manager, Carbon Storage
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Realizing Broader Benefits of Carbon Management

Brett Zeuner, Senior Program Manager, Environmental Equity

Foundation for California Community Colleges

FOUNDATION *for* CALIFORNIA COMMUNITY COLLEGES

Overview

- Who We Are – Foundation for California Community Colleges
  - The Unique Role of California Community Colleges
- Project on Community Benefit Plans
  - Goals
  - Overview
  - Stakeholder Feedback
  - Key Findings
- Recommendations for Community Benefits
- Impact of Federal Policy Changes
- Key Takeaways

Foundation for California Community Colleges

- Established in 1998 as the official auxiliary nonprofit supporting the California Community Colleges
- Over $167 million in annual support across six areas of impact
- 70+ programs and services designed to support students, colleges, and communities
- Trusted partner to the state and system, working to facilitate collaboration, accelerate innovation, increase statewide resources, and expand our collective capacity

Unique Strengths of Community Colleges in Climate

- Huge physical and operational footprints
- Deep community ties
- Essential roles in workforce development

➔ Opportunity to support community benefits work


California Tahoe Conservancy

Climate Practice at Community Colleges

Support to Communities for Climate Resilience

Work that leverages colleges as anchor institutions in diverse communities, linking them to resources for climate resilience.

Workforce Development for Climate-Ready Careers

Initiatives that build the climate workforce to drive adaptation and transition to a low-carbon economy.

Sustainable Facilities and Operations

Projects that reduce carbon emissions from campus' physical plants and operations, modeling best practices for communities.

Project on Community Benefit Plans

Goals of the Project

- Allow stakeholders to share feedback on Carbon Management (CM) Community Benefit Plans (CBPs) with California Air Resources Board (CARB)
- Document stakeholder feedback from existing comments, interviews, and in-person listening sessions
- Provide guidance on developing effective CBPs for entities pursuing CM projects

Project Overview

Literature Review

Stakeholder Interviews

Listening Sessions

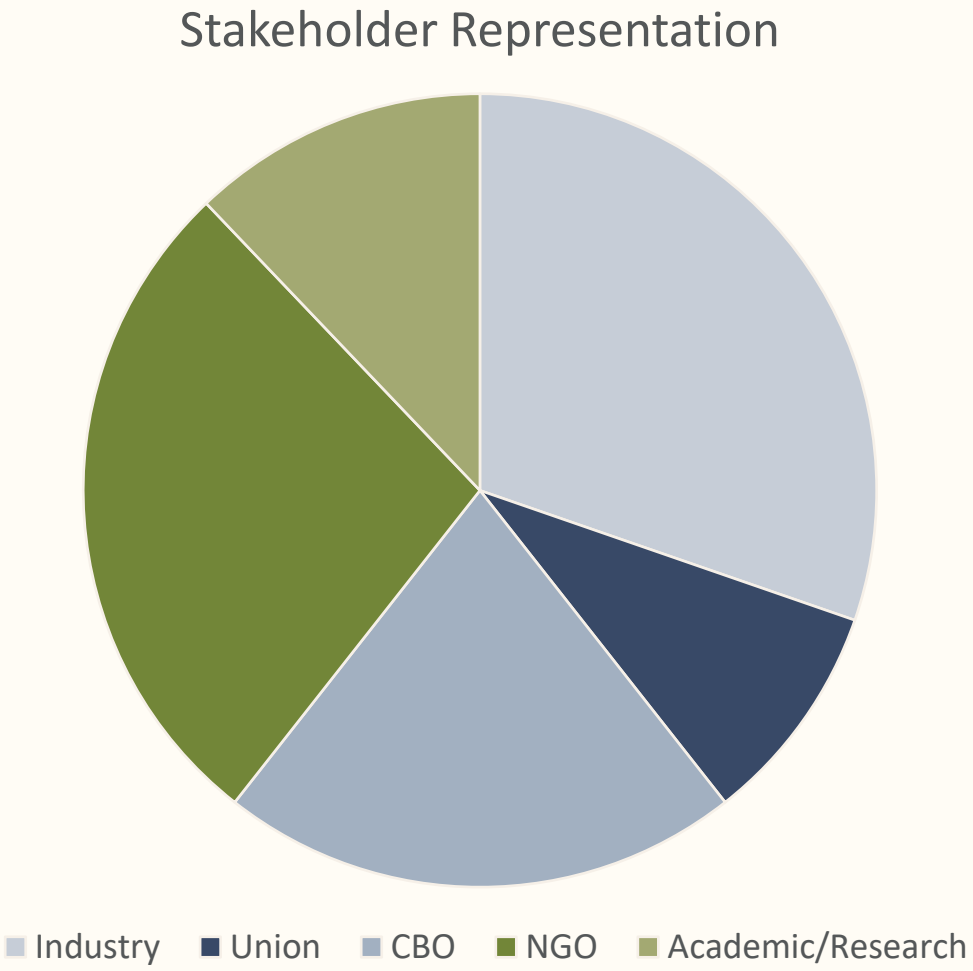
Recommendations for Community Benefits Plans

Template for Community Benefits Plans

Stakeholder Feedback

Stakeholder Interviews

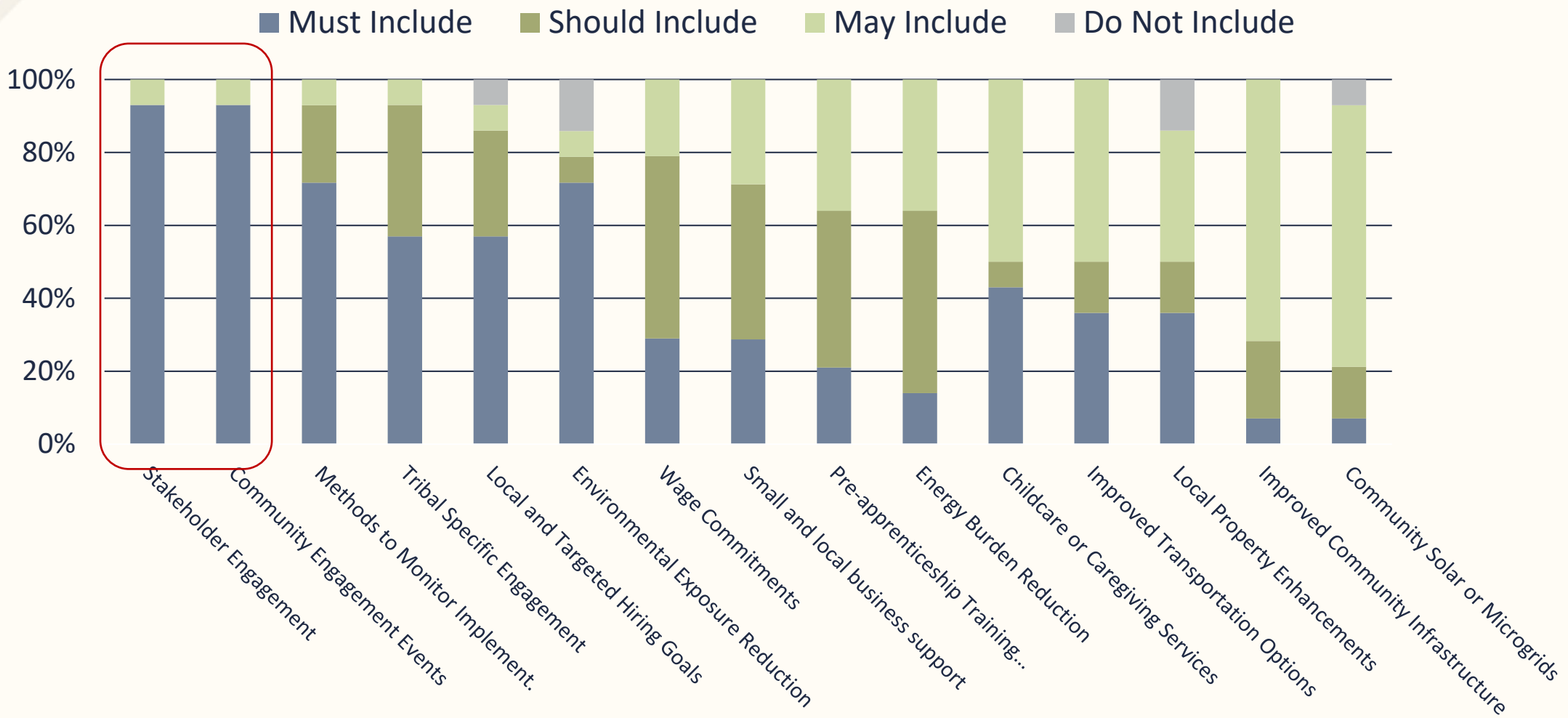
- 14 interviews
- 5 distinct stakeholder types
- Questions focused on...
  - Degree of prescriptiveness
  - Inclusion of specific benefits
  - Consensus building
  - Monitoring and evaluation



Stakeholder Listening Sessions

- Two in-person listening sessions:
  - Stockton, CA
  - Bakersfield, CA
- Engagement approaches:
  - Open-ended discussion
  - Activity/task-based questions

Feedback: Community Benefits



Feedback: Consensus and Resolution

Most stakeholders:

- Emphasized transparency and open communication
- Recommended that the method for building consensus be established with the community
- Stressed that a method for dispute resolution be agreed upon in advance

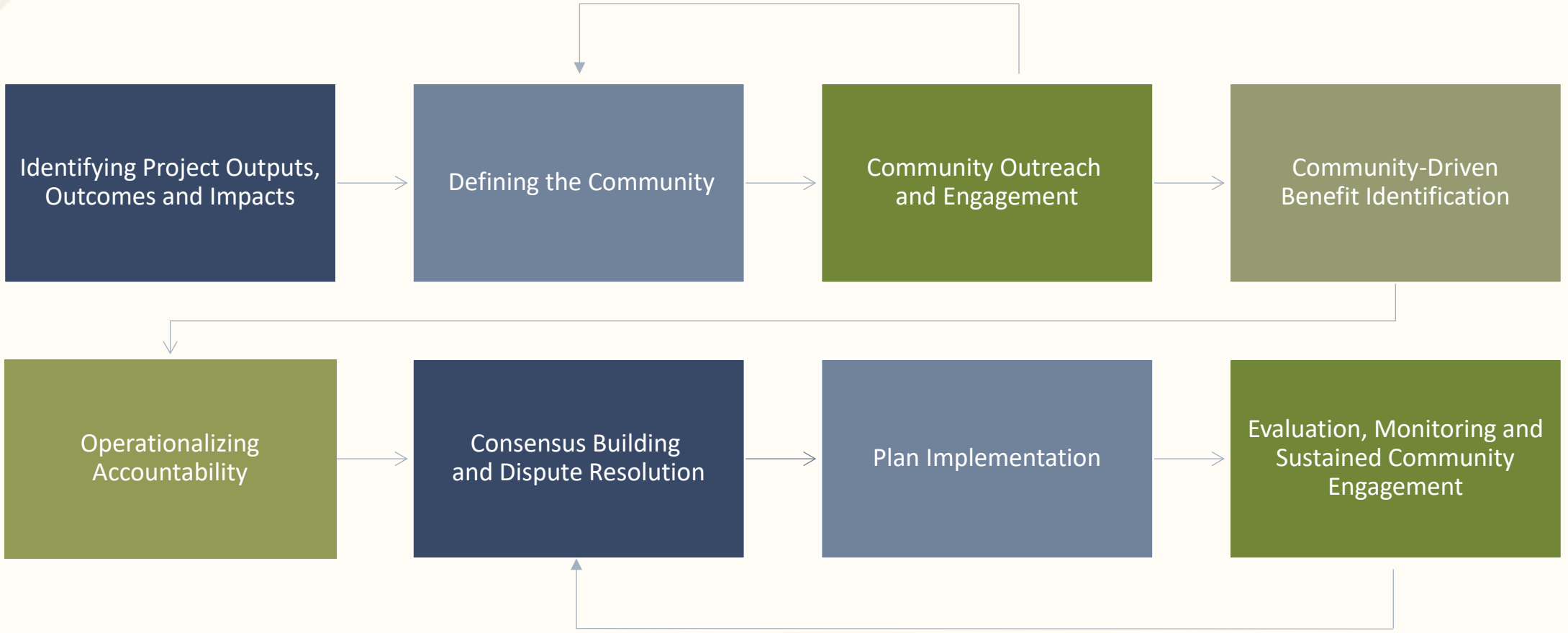
Feedback: Community Impact

- **Safety and health concerns**
- **Economic benefits**
- **Industrial development**
- **Local vs. global impact**
- **Environmental benefits***

**point source capture concerns*

Recommendations for Community Benefits

Process Overview of a CBP



Key Elements of a Successful CBP

- Transparency
- Accountability
- Flexibility
- Valuing the Process
- Sustaining Relationships

Broader Benefits Findings

- Flexibility is preferred and seen as most effective
  - Notably true for all stakeholder categories
- Recognition that with CBP work for their CM projects, POs gain in the long run
  - Win-win to develop community trust and relationships/partnerships
- Senate Bill 905 recommendation for online tracking system for CM projects

Specific Recommendations for Implementation

Access to Data

- Outline plans to support platforms that allow community members to access or share data on project impacts.

Participatory Monitoring

- Describe plans for participatory monitoring and third-party monitoring, including post-closure if relevant.

Technical Capabilities

- Discuss any plans to add technical or monitoring capabilities requested by the community to increase benefits or reduce risks.

Impact of Federal Policy Changes

The Reality of CBPs at the Federal Level

- California can be a leader for the preservation of this work.
- Federal requirements and guidelines for CBPs may weaken or disappear altogether.
- Lack of competing (state vs. federal) CBP guidelines may benefit all parties.
- Whether they are required or not, CBPs provide mutual benefit to both project operators and the community.

Thank You!

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FOUNDATION *for* CALIFORNIA COMMUNITY COLLEGES

Two opportunities for broader benefits from CCUS / CDR deployment in California:

1. Wildfire prevention, air pollution reduction, and rural and tribal economic benefits from a state biomass strategy
2. Affordability and community benefits from alternative carbon infrastructure development models

NET-ZERO CALIFORNIA

www.netzerocalifornia.org

Confronting California's wildfire crisis

- **Goal:** Rapid expansion in pace and scale of fuels reduction treatments (thinning, prescribed fire) – up to 2.3 million acres/year
- **Barrier:** Cost estimate of ~$4 billion per year. How to pay for it?
- **Solution:** Collect and convert biomass from fuels reduction into high-value end-uses, e.g. biomass-hydrogen with CCS, innovative wood products

Important: *Biomass resource is a waste stream*

Broader benefits of a biomass-carbon strategy

- Wildfire risk reduction
- Rural and tribal economic development
  - 2.3m acres/yr = ~20-30 million tons of forest waste
  - 50+ new mfg facilities supporting forest health and rural and tribal autonomy
  - Case study: Redding Rancheria Economic Development Corporation
- Air pollution reduction
  - Avoided wildfire, pile burning, PM 2.5 from diesel

Policy needs

- Key needs relate to (i) long-term feedstock supply certainty; and (ii) revenue incentives for carbon-negative biomass outcomes/products
- For more information:
  - *How can California pay for wildfire prevention at scale? (Feb 2025)*
  - *Addressing California's wood waste crisis (Nov 2024)*
  - *Reflections on the inaugural California Biomass Workshop (Feb 2024)*

World Resources Institute · Sierra Business Council · The Nature Conservancy · Lawrence Livermore National Laboratory · Environmental Defense Fund · California Department of Conservation · Berkeley Forests · Sierra Institute for Community and Environment · Inter-Tribal Council of California, Inc. · The Watershed Center Hayfork, California · North Coast Resource Partnership · IBank California Infrastructure and Economic Development Bank · Project 2030 · UC Davis Policy Institute for Energy, Environment, and the Economy · Net-Zero California

Alternative infrastructure development models

- **What we mean:** Direct government support to enable the development of carbon transport and storage infrastructure
- **Potential model options:** could include public ownership, “P3”, private ownership with regulated asset base, others.
- **Model applicability:** Could be a handful of key projects or a broader statewide model
- **Why might we need this?** Next slide...

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Defining a business case

Barriers to Entry

Significant capital expenditure for infrastructure assets, development and construction costs.

First of a kind (FOAK) technologies and services create significant risk and uncertainty for debt and equity investment providers

Natural monopolistic nature of development, creating anti-competitive behaviours

New permitting for CO2 storage change of use of existing offshore assets

Market Failures

Lack of supplementary support such as commercial insurances for demand side risk and stranded asset risk

Investment co-ordination failure within CCUS – deployment of industrial/power CCUS technology alignment with CCS transport and storage systems.

Low carbon pricing creating limited incentivisation

Limited demand for CCUS due to infancy of sector, creating significant demand starvation risks (unlike the gas transmission network prior to development)

Cluster Sequencing

Market failures and the significant barriers to entry meant that the private market alone would not deliver CCUS.

A cluster sequencing process was proposed to connect CCUS enabled emitters with an active CCS network whilst providing economical support through respective government backed business models.

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Defining a business case

NZC summary: UK government saw significant hurdles to CCUS/CDR deployment at the pace and scale necessary to achieve goals of 20-30 Mt/yr by 2030 and 75-180 Mt/yr by 2050

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Why use a Regulated Asset Base (RAB) model

1

Attracting Investment in T&S Networks

Establishing a commercial framework that enables and supports stable investment in CO_2 T&S projects over these long-life assets

Providing investors with a clear sight of the long-term revenue model to ensure they can earn a reasonable regulated return on their investment

To provide affordable and fair pricing structures for consumers whilst incentivising efficient and effective operation of services.

2

Enabling Low-Cost Decarbonisation

ERR Objective:

Deliver an Economic Regulatory Regime (ERR) that promotes efficiency, stability and flexibility to allow for future CO_2 market expansion (including non-pipeline transported CO_2) whilst ensuring affordability and VfM for the users.

3

Developing CO2 Capture Markets

Balancing the need for anticipatory investment to address future demand against the economic attractiveness of the T&S network to near term users.

Ensuring T&S networks can accommodate multiple and different types of users with varying demand profiles

Accommodating to different potential network designs and growth profiles.

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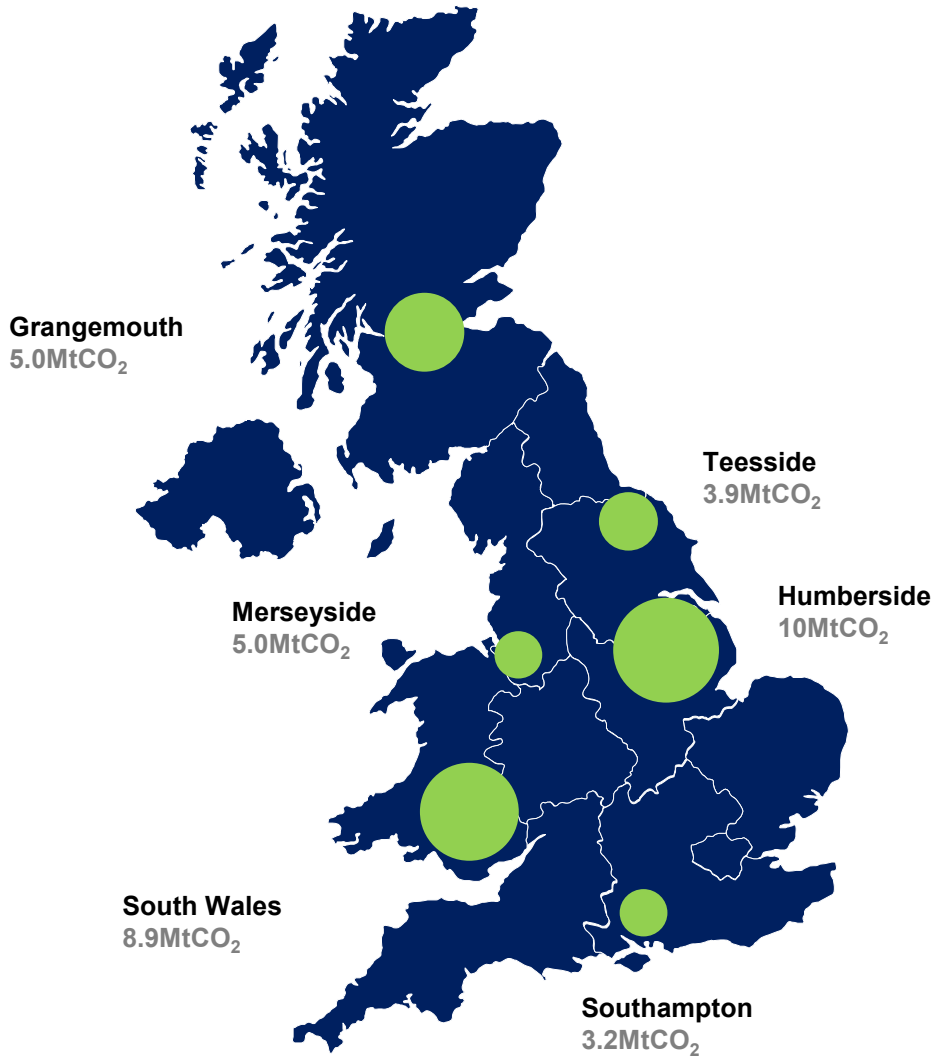
Broader benefits of alternative models

In addition to achieving deployment goals at low-cost…

- **Siting/community:** May increase opportunities for community participation, e.g. Citizens Morongo
- **Long-term liability:** More robust state regulation/capacity could address issues related to long-term liability
- **New job generation:** May support a faster/more robust O&G -> carbon job transfers while workers remain in similar region

UK roll-out strategy

- Identify clusters (Fig. 1)
- Establish one “T&SCo” per cluster
- T&SCo develops proposed network plan and business strategy
- “Initial settlement” with UKDESNZ
  - Committed £21.7B over 25-years to two Track 1 clusters (Teesside, Merseyside) (Dec 2024)
- Evolution overtime into model where CO2 capture entities become the “ratepayer”



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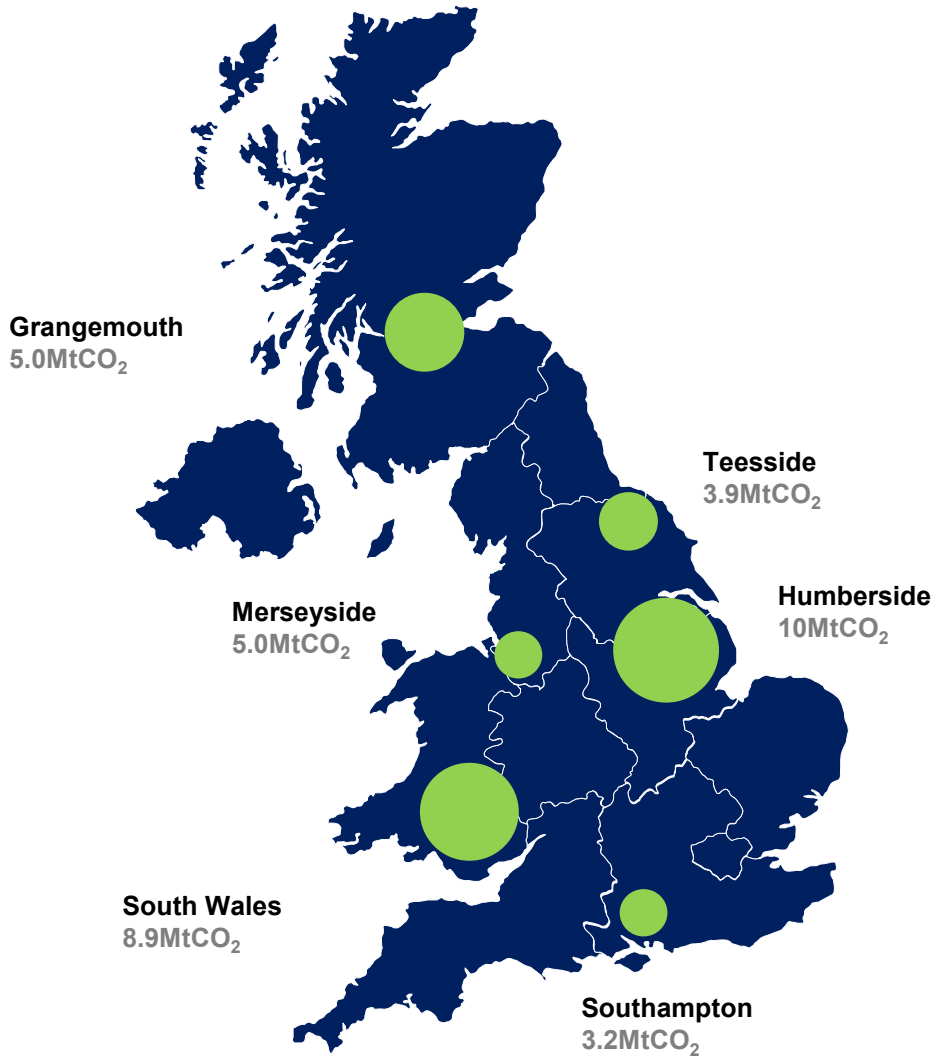

Forthcoming report

andlinger center for energy+the environment

Stanford | Doerr School of Sustainability

NET-ZERO CALIFORNIA

- To help establish a path to large-scale CCUS/CDR in California, Net-Zero California, Princeton and Stanford have initiated a research project to establish a roadmap to 100 Mt/yr by 2045.
- Key features:
  - Multiple scenarios (more industrial, more biomass, more DAC)
  - Geospatial mapping of notional T&S networks overtime
  - ‘Reverse-engineering’ the sequence of actions for deployment
  - Consideration of pros/cons/potential of alternative models
- We are just starting – please reach out for more info/questions!!

Appendix

- *The following slides are from a briefing Net-Zero California staff received from UK Department of Energy Security and Net-Zero ("DESNZ") on their transport and storage infrastructure model.*
- *For more information:*
  - *Investment frameworks for the development of CCUS in the UK (June 2019)*
  - *CCUS: An update on the business model for Transport and Storage (Jan 2022)*
  - *Bridging capital discipline and energy scenarios (July 2022)*
  - *The challenges of carbon capture and storage in California: Commercial frameworks (June 2023)*

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DESNZ – Net-Zero California

27th Feb 2024

Department for Energy Security & Net Zero

The UK Government CCUS Programme

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The UK has the potential to be a leader in CCUS

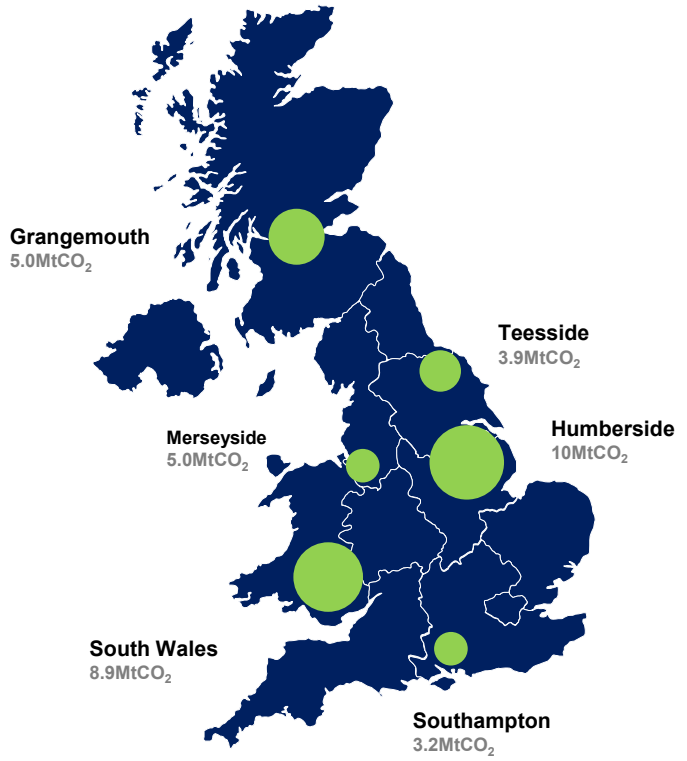
Our **2050 Net Zero Strategy** emphasised the importance of decarbonising industry and energy, generating hydrogen and negative emissions

All industrial clusters need to be decarbonised to achieve net zero

Industrial CCUS clusters can be the starting point for a new **carbon capture industry** with a **sizeable export potential**

CCUS 'Clusters' take advantage of the fact that many **emissions-intensive facilities are located in tight geographical clusters** and would be able to connect to a large-scale CO_2 storage site using shared infrastructure

~78 billion tonnes of theoretical CO_2 storage, one of the largest potential capacities in Europe



Location of clusters and 2018 emissions

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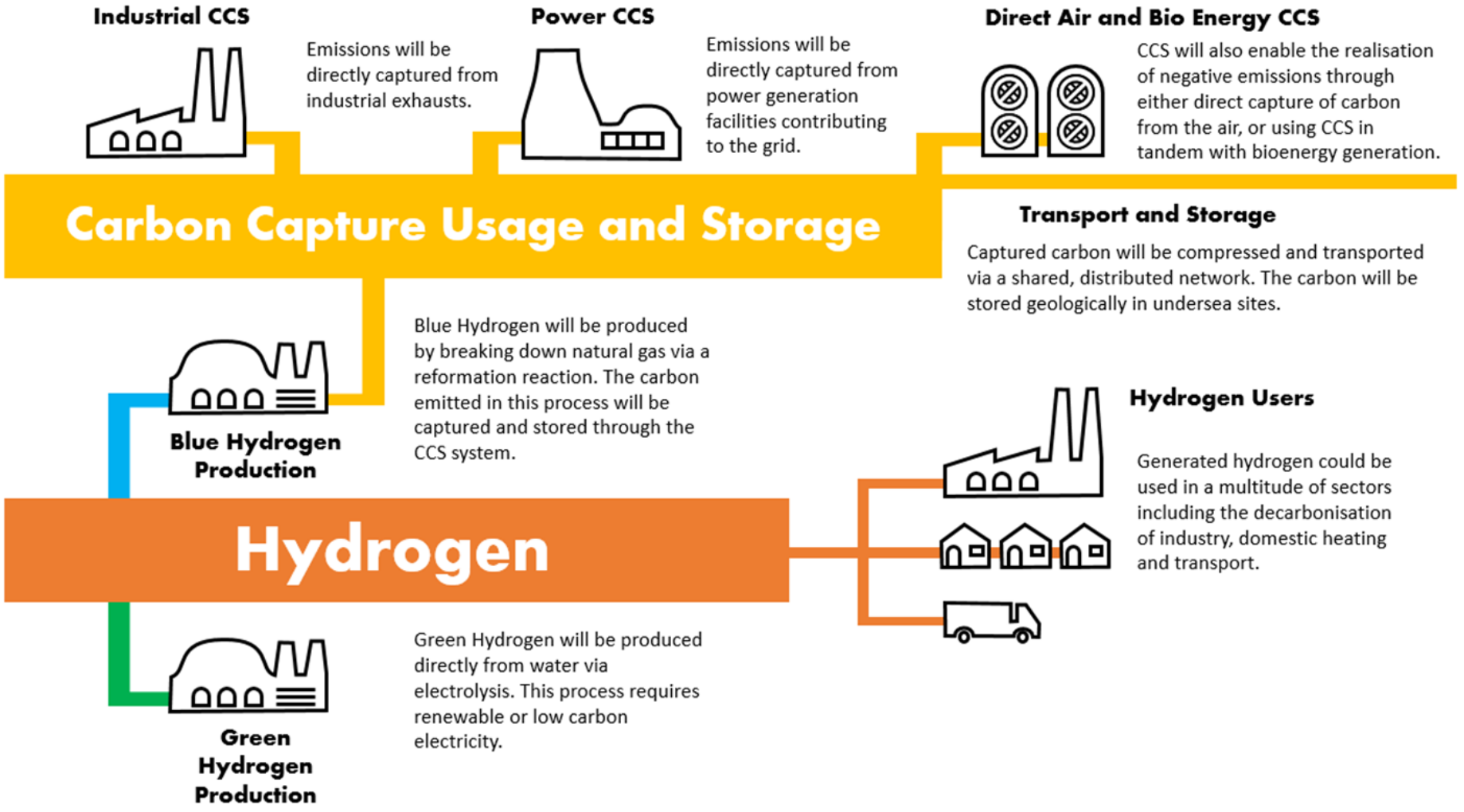
CCUS Landscape



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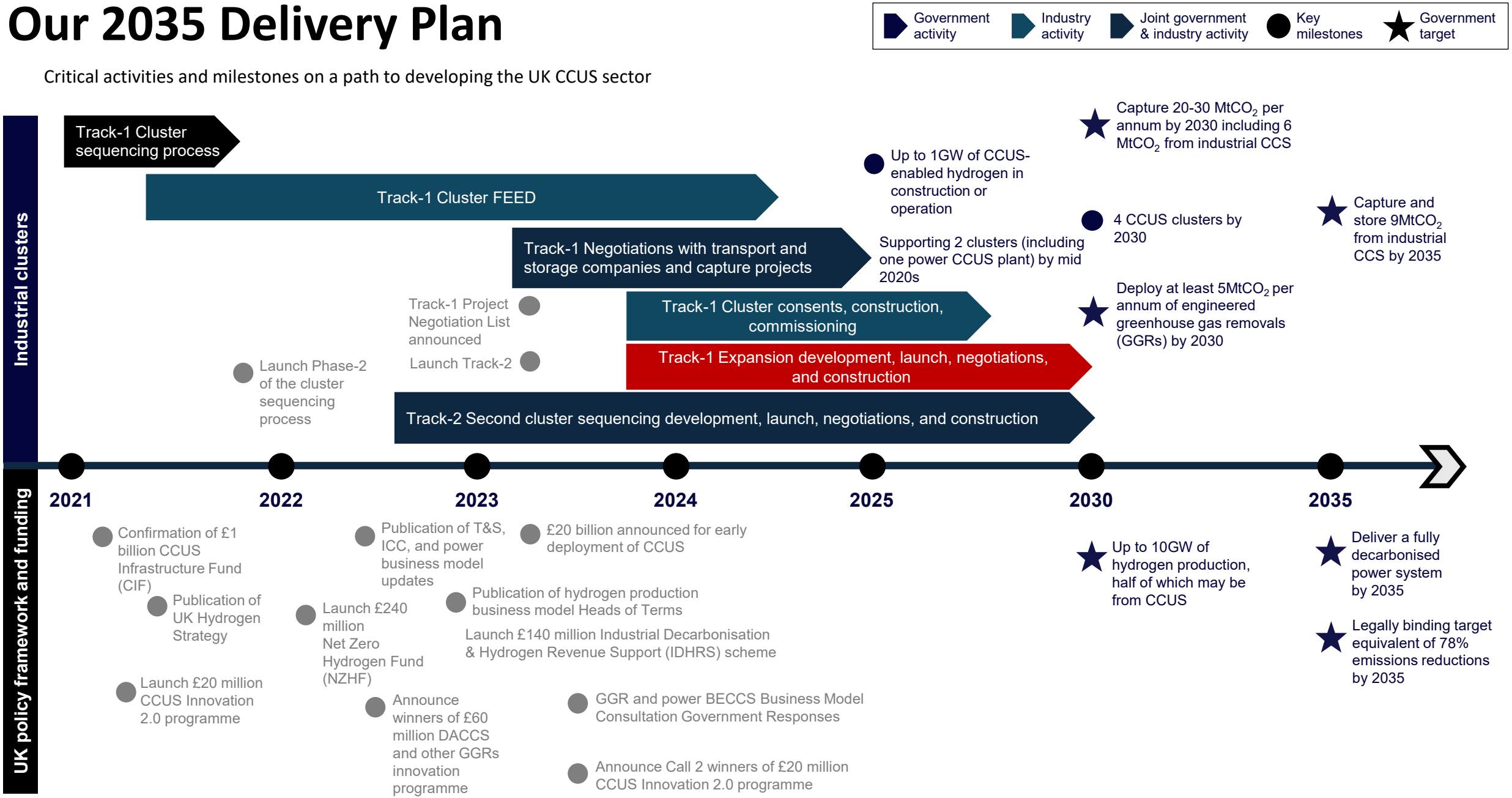
Our ambition

- Reach net zero emissions by 2050
- Store 20 – 30 million tonnes of CO_2 a year by 2030 with 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
- Bring forward at least one power CCUS plant in the 2020s
- Up to 1GW of CCUS-enabled hydrogen in the 2020s and 10GW of low carbon hydrogen production capacity by 2030
- Capture up to 3 $MtCO_2$/yr of industrial carbon capture by 6 MtCO2 per year by 2030 and 9 $MtCO_2$ per year by 2035
- 5MtCO2 engineered Greenhouse Gas removal by 2030

Our 2035 Delivery Plan

Critical activities and milestones on a path to developing the UK CCUS sector



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UK business models for CCUS deployment

Bespoke business models have been developed across the CCUS chain:

- Industrial Carbon Capture (ICC) Business Models (including the Waste ICC Business Model)
- Dispatchable Power Agreement (DPA)
- Power Bioenergy CCS (BECCS) Business Model
- Greenhouse Gas Removals (GGRs) Business Model
- Transport and Storage (T&S) Regulatory Investment (TRI) Model
- Hydrogen Production Business Model

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Power CCUS business model overview

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Business Model – Objectives

To help deliver emissions reduction 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:

Provide minimum necessary support compatible with fiscal rules

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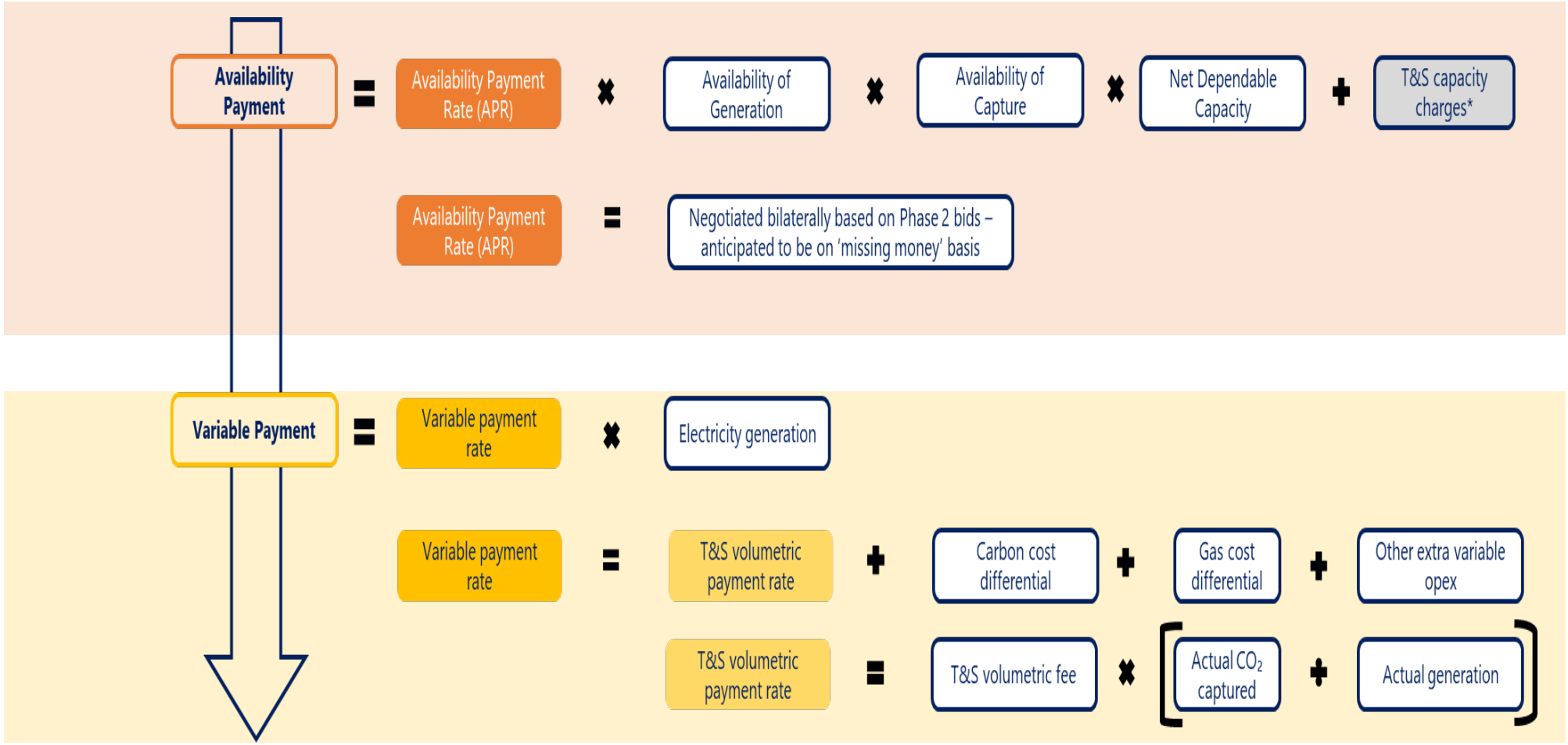
How the DPA funding is calculated

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 unbated alternative



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

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Gainshare

To ensure value for money for consumers, and to mitigate potential overcompensation of a Generator under the DPA (due to significant uncertainties around future market revenues for these kinds of power plants), we have applied two Gainshare mechanisms to the DPA – Project Gainshare and a Sale Gainshare. Established principle of bilaterally negotiated public subsidies.

Sale Gainshare

- Sales of economic interests in the Generator where returns are greater than the agreed equity IRR threshold result in payment of 30% of amounts from that sale above the threshold being paid to the DPA Counterparty provided that:
- The sale takes place before the later of the date on which the aggregate economic interests of an investor group fall below 60% of its original level, or 5 years from the Start Date.
- The economic interest being sold derives at least 60% of its value from the Generator

Project Gainshare

- Equity IRR of projects would be assessed every 5 years (for a 15-year DPA).
- At assessment point, the equity IRR is above an agreed threshold, the Generator would pay 30% of amounts above the agreed threshold

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ICC business model overview

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ICC: Objectives and Structure

Our objective for developing a business model is to incentivise:

1. **Existing industrial facilities** who have a viable future in the UK to invest in carbon capture to decarbonise, whilst ensuring emissions are not offshored and delivering value for money for the taxpayer.
2. Investment in **new industrial facilities** in the UK, supporting our ambition to level up the economy.

There are two types of ICC business model: the ICC business model (for the industrial sector) and the Waste ICC business model (for the waste management sector). The Industrial Carbon Capture (ICC) business models incorporate:

i. **A private law contract of up to 15-years (the 'ICC Contract')** between emitter and counterparty:
   - Pays emitter per tonne of captured CO_2, to cover the additional costs of deploying carbon capture.
   - Offers risk protections in specific circumstances (e.g., T&S outages, legal changes) if obligations are met.

ii. **Capital grant co-funding** for a portion of the capital cost of capture projects:
   - Available for initial projects only.
   - Helps mitigate against certain risks associated with these projects.

Contracts will be funded from the exchequer via the IDHRS scheme*, with capex co-funding from the CCS Infrastructure Fund.

IDHRS = the Industrial Decarbonisation and Hydrogen Revenue Support scheme

Department for Energy Security & Net Zero

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Commercial Design - ICC

The ICC Contract pays the emitter a **payment per tonne of captured and permanently stored CO_2 (covering operational expenses, T&S fees, and rate of return on capital investment).** It will have an overall duration of up to **15 years** (a 10-year initial period with possible extension for a further 5 years).

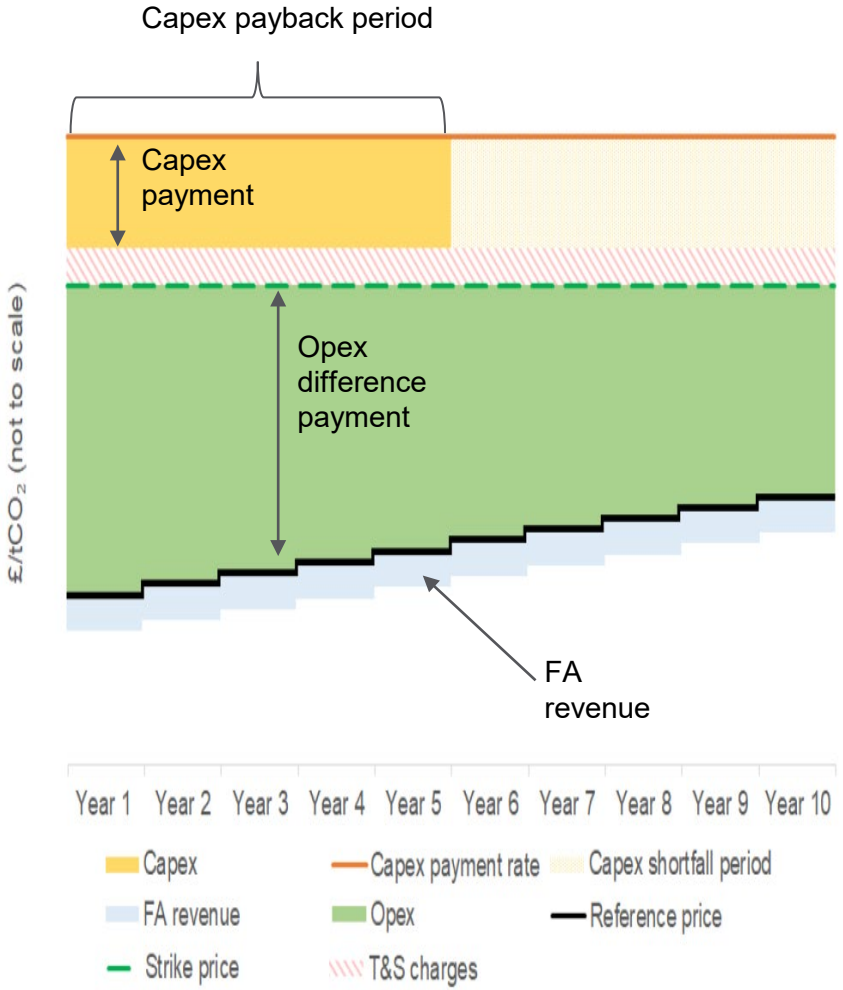
The contract payment will be determined by the gap between the negotiated 'strike price' and the 'reference price'. The strike price will be negotiated bilaterally for initial projects and will have a *capex component* and an *opex component*.

Free allowances are forfeited in proportion to the volume of captured and stored CO_2 and compensated at the reference price.

For the first 10 years, ***opex payments*** will follow an asymmetric structure**:

- If the opex component in the strike price exceeds the reference price, the Counterparty pays the Emitter the difference;
- If the opex component in the strike price is lower than the base reference price, no opex-related payments occur between the Counterparty and the Emitter. (Capex payments, FA revenue, and T&S charges remain unaffected and are still paid.)

Capex payments (including capex repayment and return on investment) will be paid in a minimum of 5 years* (longer if capture volumes are lower than expected) and is a fixed payment per tonne of CO_2 captured and stored.



The Fixed Trajectory Reference Price will follow an equally-stepped upward trajectory of £2.50/year

- *Opex costs will be adjusted as part of the opex reopener after 12 valid billing periods and in line with inflation (CPI) throughout the contract term*
- *In the extension period, a carbon market reference price and two-way payments will apply, and there will be no free allowance forfeiture or protection. Projects must qualify annually by satisfying performance, market and T&S conditions*

Department for Energy Security & Net Zero

Commercial Design – Waste ICC

The Waste ICC Contract pays the emitter a **payment per tonne of captured and permanently stored CO_2.** It will have an overall duration of up to **15 years** (a 10-year initial period with possible extension for a further 5 years).

The contract payment will be determined by the gap between the negotiated 'strike price' and the **'applicable carbon reference price'** – which is the UK ETS price multiplied by the applicable percentage (the percentage of captured emissions subject to the UK ETS).

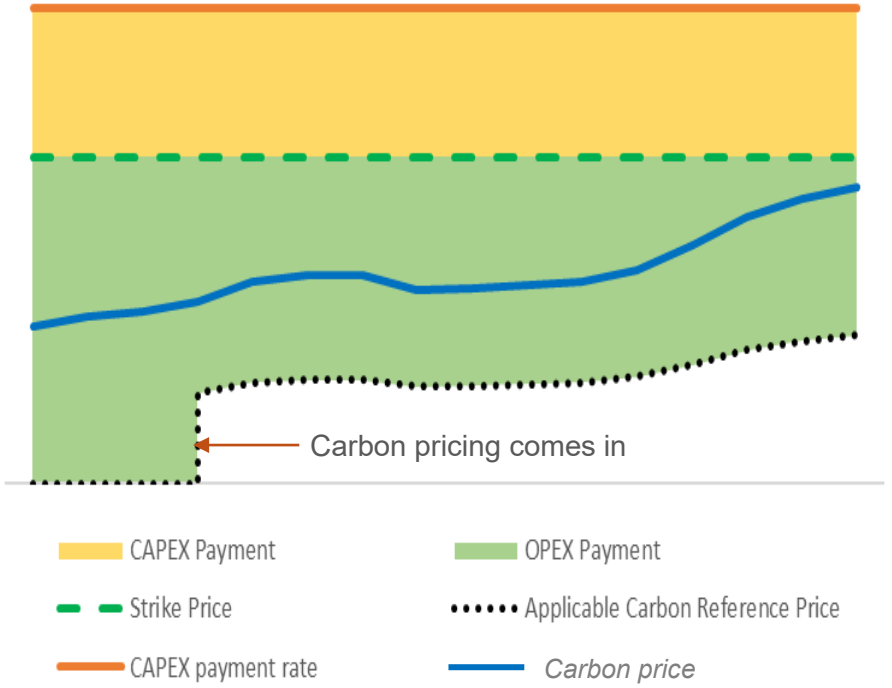
The strike price will be negotiated bilaterally for initial projects and will have a *capex component* and an *opex component*.

Capex payments (including capex repayment and return on investment) will be paid over 10 years (if capture volumes are as expected).

Opex payments = Strike Price – Applicable Carbon Reference Price

- If the opex component in the strike price exceeds the reference price, the payments are positive (paid to the Emitter);
- If the opex component in the strike price is lower than the reference price, the payments are negative (paid from the Emitter).

Opex, capex and T&S fees are combined to calculate an overall payment (which can be negative).



Waste ICC projects can capture biogenic emissions, which may result in 'negative emissions'. These may have a value and reduce the need for subsidy, but the markets are currently under development.

The Waste ICC Contract includes a 'Restrict and Review' approach. If permitted, projects may generate negative emissions revenues, but their subsidy will be reduced.

- *Opex costs will be adjusted as part of the opex reopener after 12 valid billing periods and in line with inflation (CPI) throughout the contract term*
- *Projects must qualify annually by satisfying performance, market and T&S conditions*

ICC key stages of development

Date	Policy development
Sept 2019	• **Consultation seeking views on potential business models for CCUS**
August 2020	• **Government Response to 2019 consultation on potential business models for CCUS**
March 2021	• Consultation seeking views on a potential approach to allocating CCUS Programme support
Oct 2021	• Published an update covering eligibility criteria, capital grant support, and the commercial and contractual framework, including further elements of the payment structure, risk allocation and 'Capture as a Service' (a delivery model in which companies could provide carbon capture as a 'service' to industrial facilities)
	• Published the provisional Heads of Terms and Front-End Agreement for the ICC contract
Nov 2021	• **Published an update covering the eligibility of waste management CCUS projects to apply for the ICC business model**
April 2022	• Published a summary of the ICC business model, including updates on the commercial framework, (payment mechanism, interaction with Transport and Storage charges, free allowances payments, opex reopener, contract extension provision), risk allocation, adaptations for CHP projects, updates on the legal contractual framework (termination provisions, Operational Conditions Precedent, Milestone Requirements, Qualifying Changes in Law, metering, reporting requirements), and considerations for waste management CCS projects.
	• Additionally, it provided information on the proposed Cluster Sequencing Process Track-1 negotiation approach and next steps.
	• Published the draft ICC contract for initial projects consisting of draft Terms and Conditions and Front-End Agreement
	• **Consultation seeking views on proposed business model for ICC and Waste ICC**
July 2022	• Update on crucial adjustments to the industrial carbon capture (ICC) business model, specifically for CCUS projects in the waste management sector
	• Published the draft Waste ICC contractual riders
Dec 2022	• **Government Response to April 2022 consultation**
	• Published an update outlining the key design aspects of the ICC (including Waste) business models.
	• Published the ICC Contract (comprising front end agreement and standard terms and conditions), the Greenhouse Gas Removal Credits Annex, ICC Supply Chain Report Spreadsheet, the Waste ICC Contract's Biogenic CEMS rider, and the CCS Infrastructure Fund (CIF) Grant Funding Agreement offer letter and terms and conditions
Oct 2023	• **Published an updated ICC business model summary, ICC standard terms and conditions, ICC Front End Agreement, ICC standard terms and conditions comparison, ICC Front End Agreement, Waste ICC standard terms and conditions, Waste ICC Front End Agreement**

Department for Energy Security & Net Zero

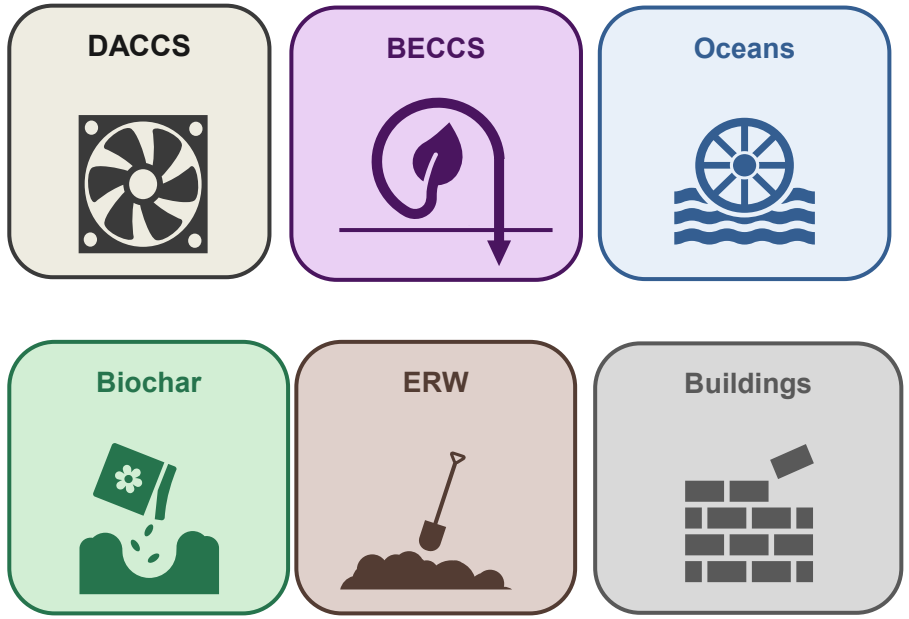
GGR business model overview

Department for Energy Security & Net Zero

Greenhouse Gas Removal (GGR) technologies provide highly-durable removal of CO2 and will be important to the UK's net zero ambitions

- 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.
- To minimize risk, our policy is to **commercialise and scale a portfolio** of technologies including DACCS and BECCS.
- **Economic benefits** including new export opportunities, IP for UK companies, high-quality green jobs.

The engineered GGR sector is nascent but already diverse



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

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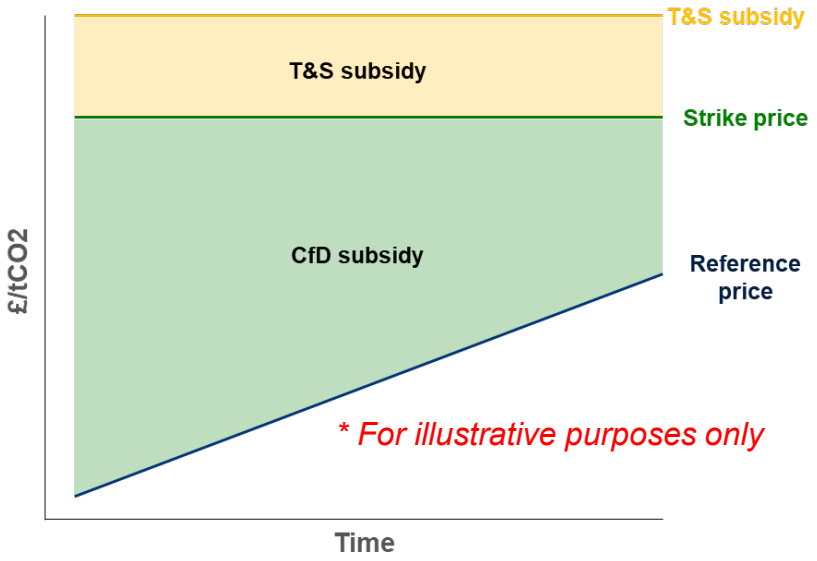
The GGR Business Model provides revenue support for negative emissions – our latest policy update was published in December 2023



- Revenue **support for 15 years** based on a **contract for difference** model – applicable to a range of technologies
- **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.
- Designed to harness the potential benefits of both the **voluntary carbon market** and the **UK Emissions Trading Scheme** (UK ETS).
- **CO2 transport and storage (T&S) fees** will be supported as a separate payment.
- The GGR Business Model will require compliance with the UK GGR Standard.

Policy objectives

- Provide **revenue certainty** for GGR projects
- **Stimulate the market** for GGRs
- Ensure **value-for-money** for government

Key design challenges

- Allocation of **demand risk** in GGR markets
- Incentivising **price discovery**
- Support for **co-product costs** (e.g. electricity/fuels)

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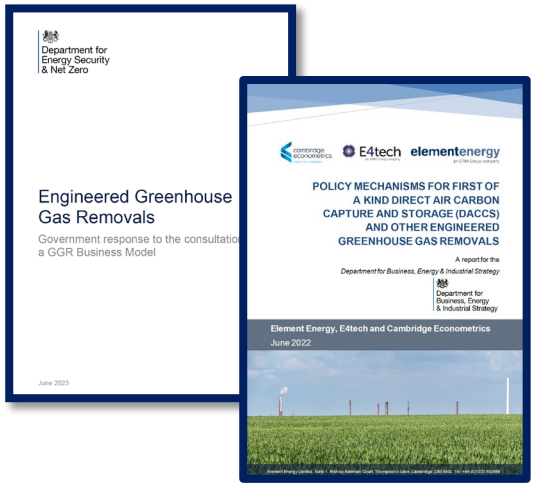
Policy development has been informed by extensive stakeholder engagement and independent advice

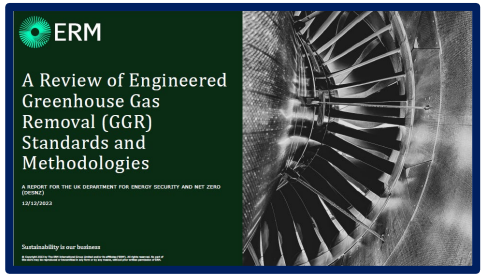
Call for Evidence (Dec 2020)
HMG response (Oct 2021)

UK ETS Consultation (Mar 2022)
HMG response (Jul 2023)

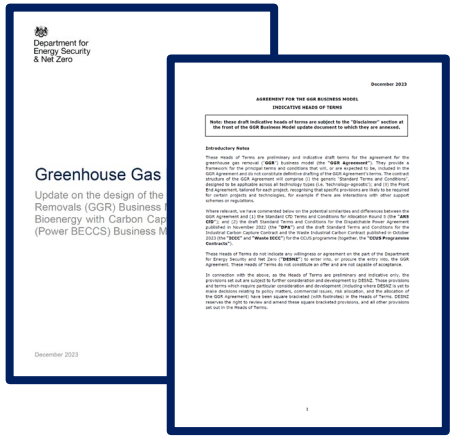


GGR Business Model Consultation and external study on policy incentives (Jul 2022)
HMG response (June 2023)

GGR Expert Group est. 2023



Independent review of GGR standards (Jul 23)



Business Model design update and indicative Heads of Terms (Dec 2023)

Department for Energy Security & Net Zero

Transport and Storage Regulatory Investment Model

Department for Energy Security & Net Zero

Why use a Regulated Asset Base (RAB) model and what is the objective of the Economic Regulatory Regime (ERR)

1 Attracting Investment in T&S Networks

Establishing a commercial framework that enables and supports stable investment in CO_2 T&S projects over these long-life assets

Providing investors with a clear sight of the long-term revenue model to ensure they can earn a reasonable regulated return on their investment

To provide affordable and fair pricing structures for consumers whilst incentivising efficient and effective operation of services.

2 Enabling Low-Cost Decarbonisation

ERR Objective:

Deliver an Economic Regulatory Regime (ERR) that promotes efficiency, stability and flexibility to allow for future CO_2 market expansion (including non-pipeline transported CO_2) whilst ensuring affordability and VfM for the users.

3 Developing CO2 Capture Markets

Balancing the need for anticipatory investment to address future demand against the economic attractiveness of the T&S network to near term users.

Ensuring T&S networks can accommodate multiple and different types of users with varying demand profiles

Accommodating to different potential network designs and growth profiles.

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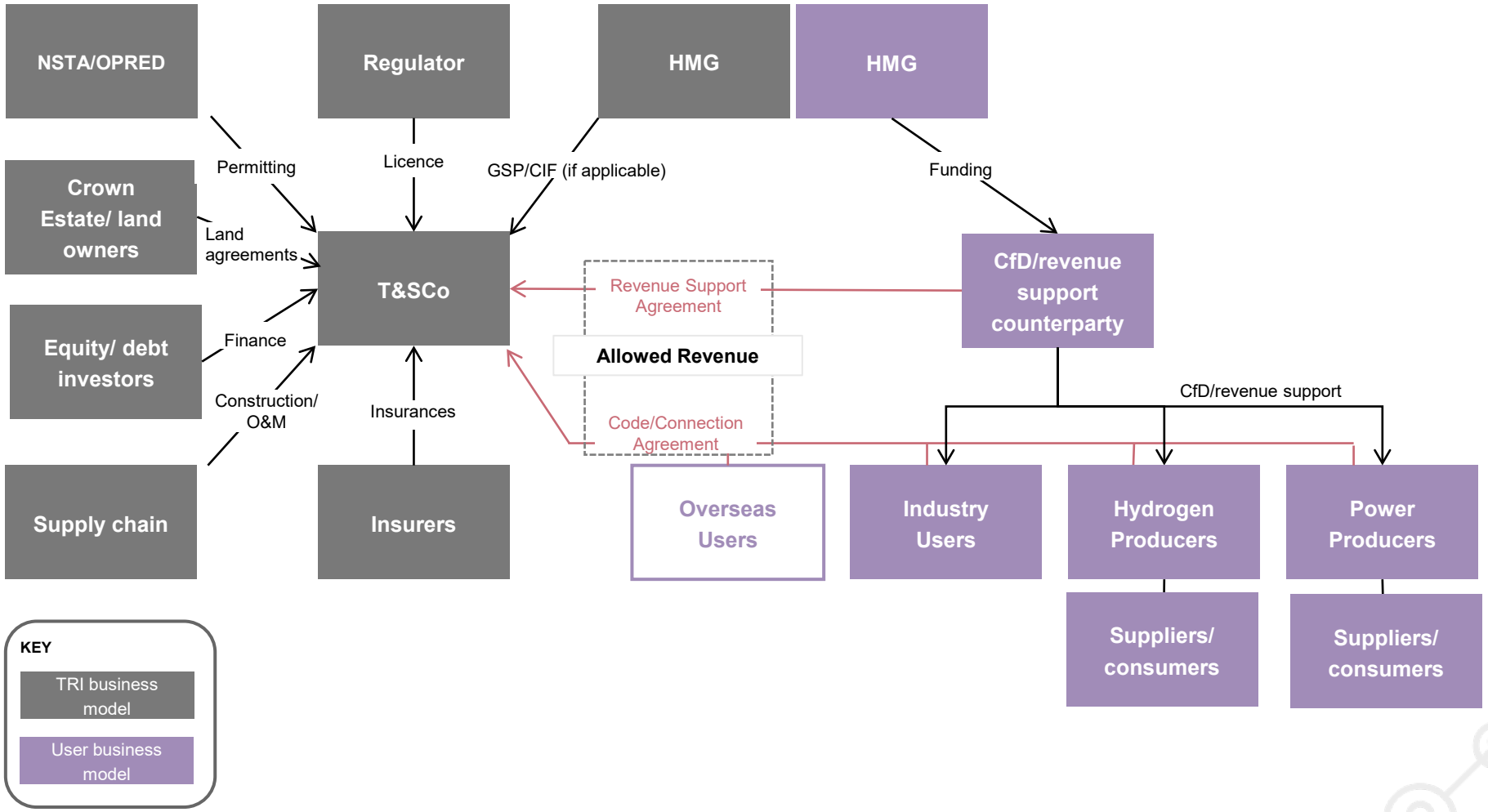
Why use a Regulated Asset Base (RAB) model and what is the objective of the Economic Regulatory Regime (ERR)

Key elements

- Allowed Revenue
- Regulated Rate of Return
- Tariff Structure
- Performance Incentives and Penalties
- Regulatory Adjustment Mechanisms
- Demand Side Risk support through a Revenue Support Agreement (RSA)
- Stranded Asset and Leakage support through the Government Support Package (GSP)
- Supplementary Agreements



Department for Energy Security & Net Zero

Defining a business case

Barriers to Entry

Significant capital expenditure for infrastructure assets, development and construction costs.

First of a kind (FOAK) technologies and services create significant risk and uncertainty for debt and equity investment providers

Natural monopolistic nature of development, creating anti-competitive behaviours

New permitting for CO2 storage change of use of existing offshore assets

Market Failures

Lack of supplementary support such as commercial insurances for demand side risk and stranded asset risk

Investment co-ordination failure within CCUS – deployment of industrial/power CCUS technology alignment with CCS transport and storage systems.

Low carbon pricing creating limited incentivisation

Limited demand for CCUS due to infancy of sector, creating significant demand starvation risks (unlike the gas transmission network prior to development)

Cluster Sequencing

Market failures and the significant barriers to entry meant that the private market alone would not deliver CCUS.

A cluster sequencing process was proposed to connect CCUS enabled emitters with an active CCS network whilst providing economical support through respective government backed business models.

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What are the key areas of challenge (and support) from stakeholders

Network right sizing – building out the network capacity to account for future utilisation, increasing short term cost but reducing total lifetime costs

Affordability – can it be done affordably ensuring Value for Money and creating a positive Net Present Value

Network longevity and sector evolution – does it enable a future CCUS sector and facilitate private investment

Achieving our Net Zero, CB6 and Ten Point Plan targets – how do we achieve VfM and reach the ambitious targets set

Supplier capacity and capability – can it be done, is the technology there and do the stakeholders have the required expertise

Significant public interest and expectation to achieve national carbon budget and net zero targets – can we achieve what we have stated we would

Government published the **'Evaluation of the Track-1 Cluster Sequencing Processes**[1]**'** in 2023 which provides an evaluation of the initial approach and further lessons learned.

[1] Evaluation of the Track-1 Cluster Sequencing Processes

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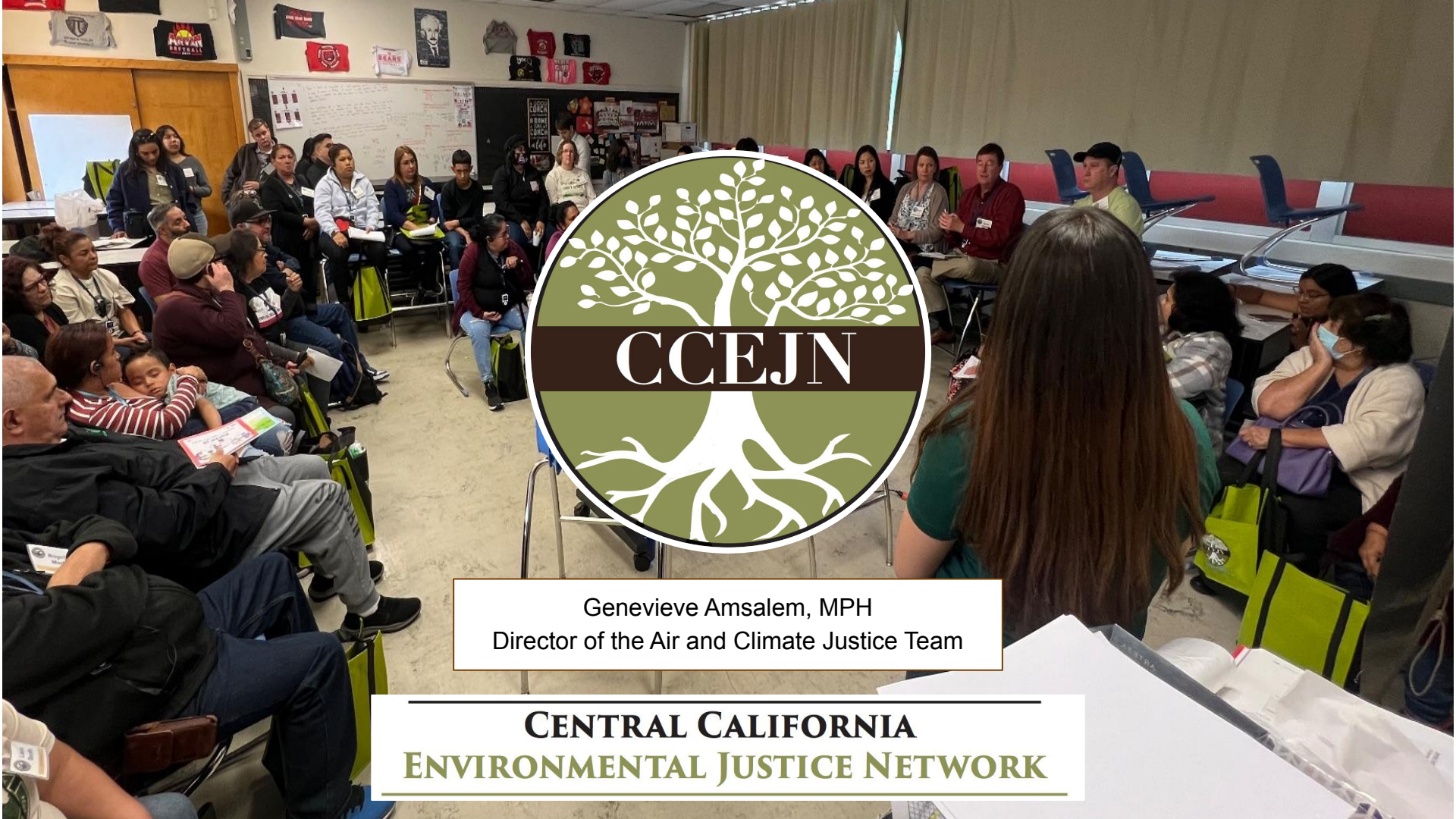
Thank you, any questions?



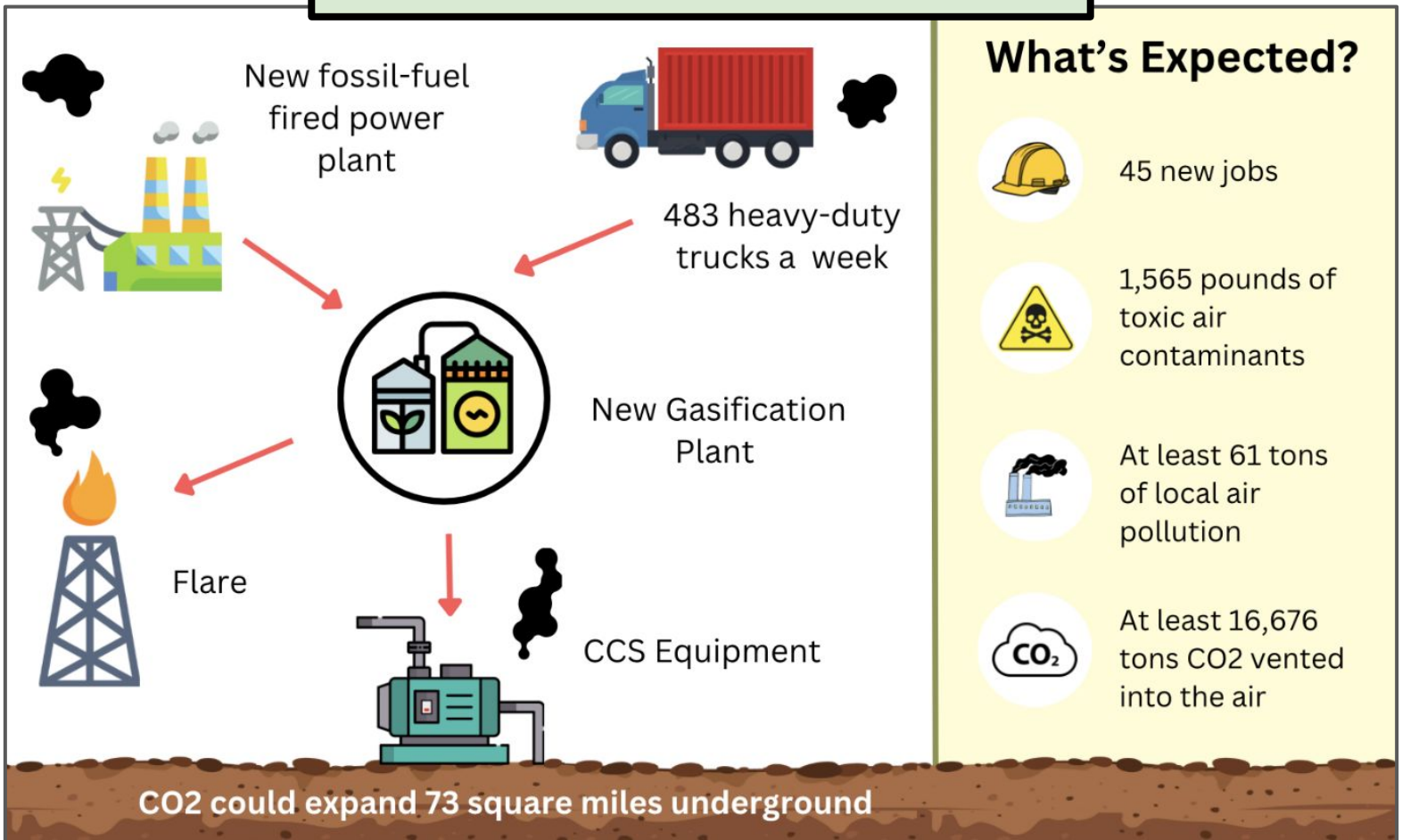
Genevieve Amsalem, MPH
Director of the Air and Climate Justice Team

CENTRAL CALIFORNIA
ENVIRONMENTAL JUSTICE NETWORK


PROTECT FRONTLINE
COMMUNITIES!


Pioneer

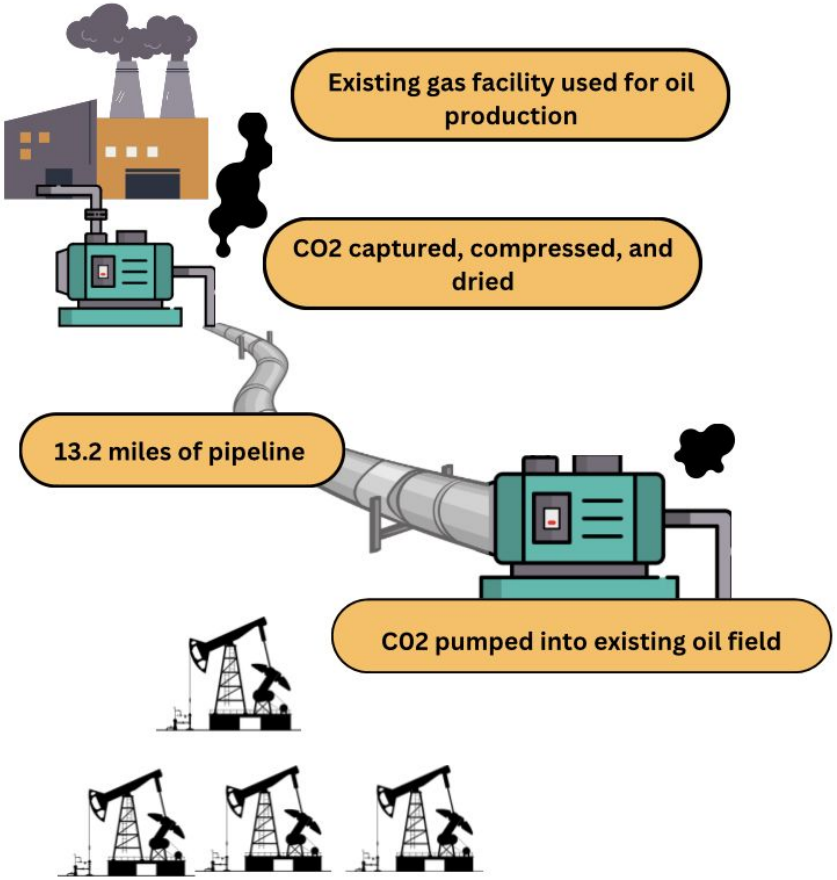
PROJECT A



What's Expected?

- 45 new jobs
- 1,565 pounds of toxic air contaminants
- At least 61 tons of local air pollution
- At least 16,676 tons CO2 vented into the air

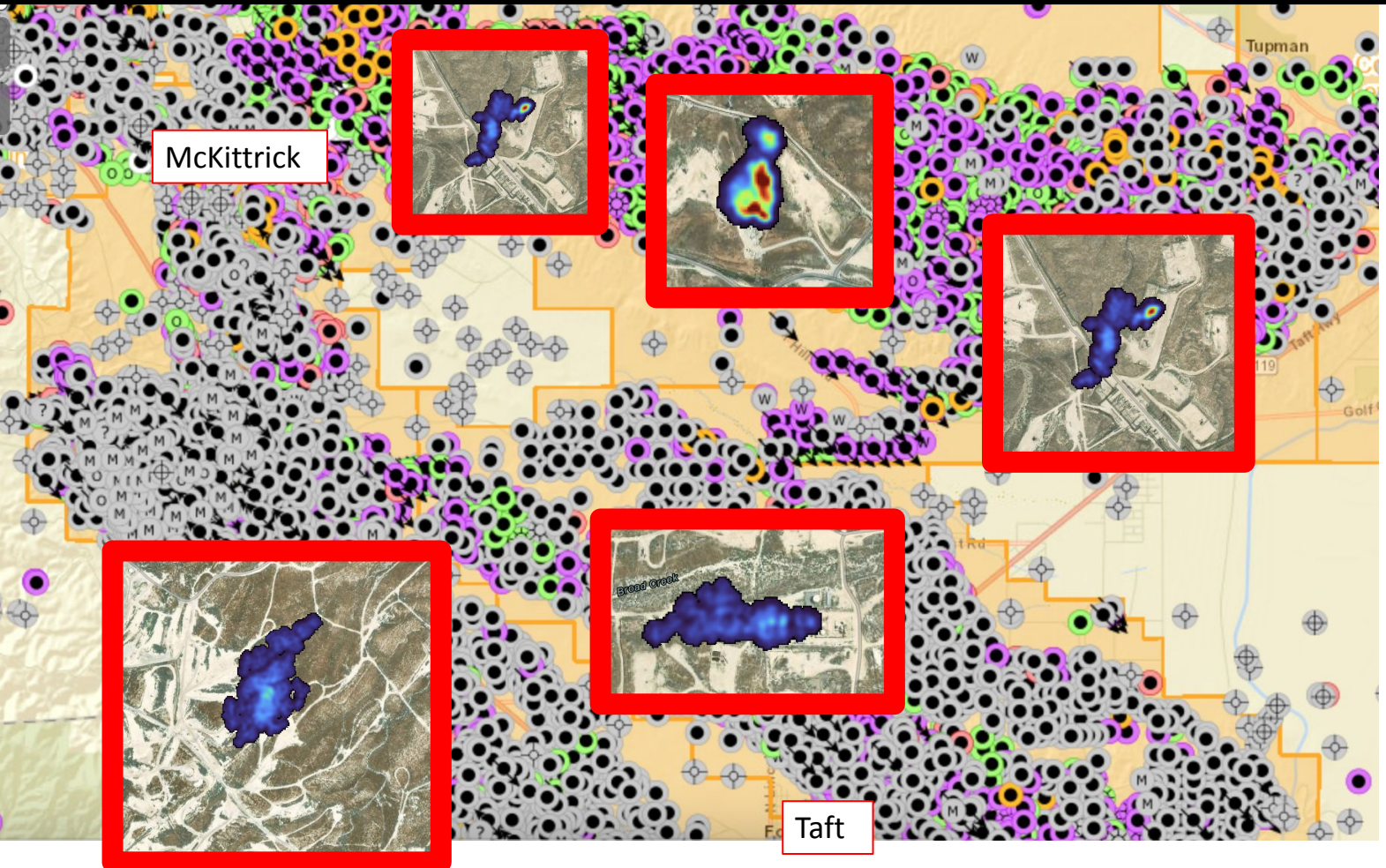
PROJECT B



Proposed Project Details

- 157 oil wells would be plugged to try to keep the CO2 from rising up to the surface
- “Personnel working in the area may be exposed to a concentration of CO2 greater than 4 percent, which may result in fatalities” (Draft EIR)
- Elementary school 2.5 miles from pipeline
- 5-10 full-time jobs
- May require up to 250,000 gallons/ day

Methane Super Emitter Events: 1/9/25 & 1/20/25



Underlying map: CALGEM WellFinder: https://www.conservation.ca.gov/calgem/Pages/wellfinder.aspx

Gas plumes: EPA's Methane Super Emitter Data Explorer: https://echo.epa.gov/trends/methane-super-emitter-program/data-explorer

- New O&G Well
- Canceled O&G Well
- Active O&G Well
- Idle O&G Well
- Plugged O&G Well

Oil Field Inspections by State Methane Task Force and CalGEM

2022- 2024

Field Name	Inspected	Leaking	Percent Leaking	Inspecting Agency
Shafter, North	73	18	25%	CARB Methane Task Force
Rio Bravo				
Greely				
Fruitvale	48	33	69%	CalGEM
Kern Bluff	46	25	54%	
Mountain View	68	27	40%	
	Total Inspected	Total Leaking	Total Percent Leaking	
	235	103	44%	

Sources: [CARB Methane Task Force Fifth Public Meeting October 17, 2023]
[CalGEM Well Inspections & Repair Updates]

PROJECT C

- Just over **6,000 oil wells** in the Area of Review and 15 extend into the CO2 injection zone
- **8 schools within 2 miles** (5,260 students in grade school, nearly 27,000 students in college)
- **Hospital** within 2.5 miles
- XYZ **Park** 3,750 feet from project site & 7,830 feet from the injection well
- Nearest **residential** development 300 feet from project site; 0.6 miles from injection well
- Estimated use of **1.3 million gallons/day** of produced and groundwater

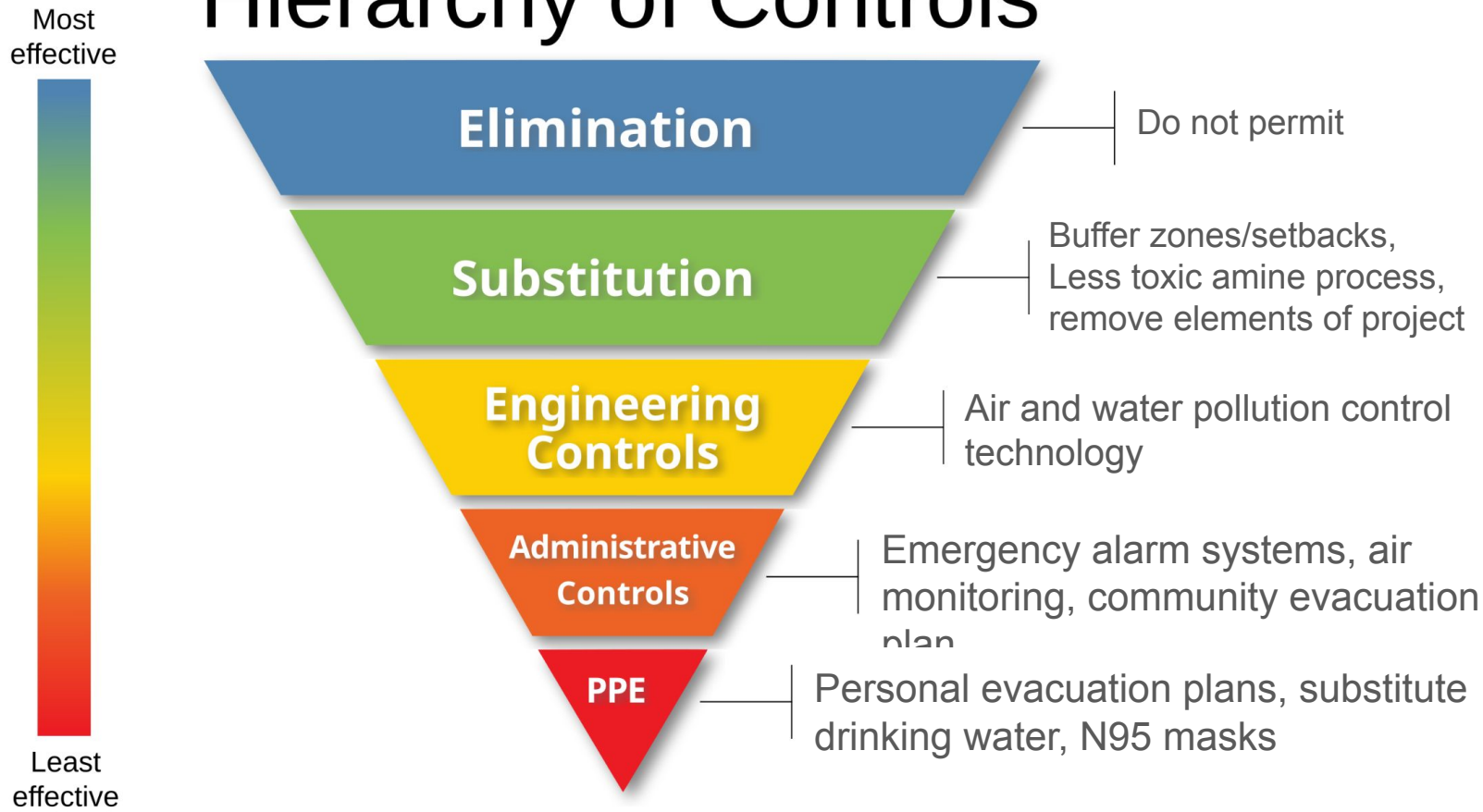
Guadalupe Martinez
Delano Resident

"This Community Benefit Agreement – that's how they're going to get us to accept. Because that's the question you're asking me. What would it take for us to give in? I won't. Because that's not the issue. When there's a catastrophe, when there's a disaster and you end up with people injured or dead. How are you going to pay with... What? With that community benefit agreement?

That should not be our goal. That's not my goal. My goal is for you, engineer, agency, whoever you are, prove to me we're not going to have these catastrophes. Prove to me it's safe.

https://vimeo.com/883463988/f7cd06efbb?share=copy

Hierarchy of Controls



Harm reduction

- Can’t increase local air and water pollution
- At least 10 miles between homes and capture, storage, or pipelines
- Add odorant (or colorant)
- Prove stable geology where projects are to be sited
- CO2 regulatory definition must apply to all phases
- Do not convert old pipelines to CO2
- Require pure CO2 streams
- Financial assurances that do not count on a company maintaining strong fiscal health for over a century (bonds, 3rd party ins)
- Required participation in CCS permit portal
- Robust community engagement to develop strong community protections
- Require worst-case scenario modeling
- Full EIR on all projects
- Community benefits required

Consent

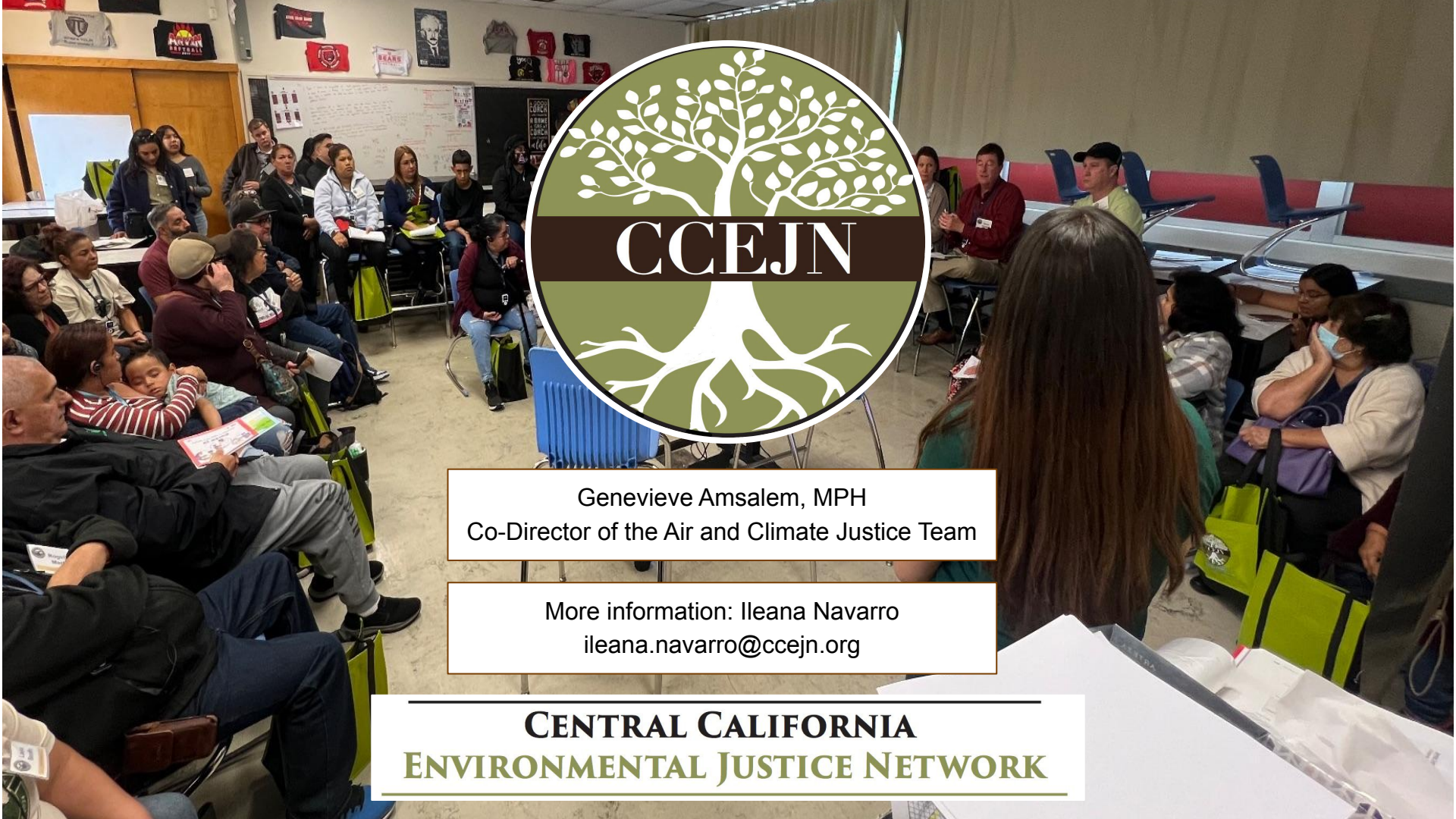
- Informed consent and good process
- Notify community members at least 6 months before permit application
- At least 3 public workshops before gov decisions made

Community Voices

https://ccejn.org/2025/02/26/residents-and-regulators-discuss-carbon-capture-and-storage/

EJAC Recommendations

https://ww2.arb.ca.gov/sites/default/files/2024-09/EJAC%20CCUS%20and%20DAC%20Resolution%20Language.pdf



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