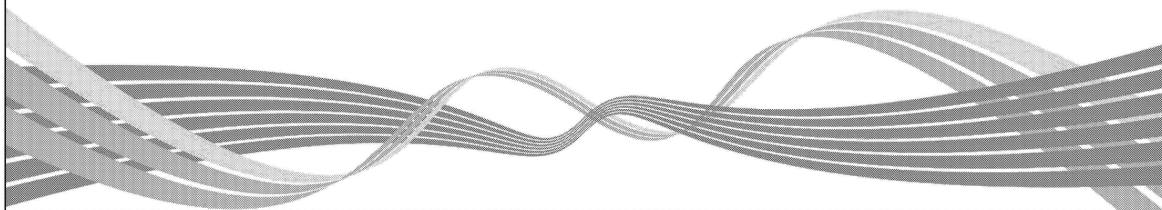




US Clean Energy Parks

Improving our products and creating low carbon businesses through carbon storage

Executive briefing 21st August 2019





- **Overview**

- CO2 emissions from our U.S. operations are mostly associated with distributed sources of flue gas. Current US policies and incentives make the application of CCUS to these commercially unattractive.
- Where we have higher CO2 concentration emissions sources, capture opportunities are proposed.
- CCUS can be deployed commercially to reduce the lifecycle carbon intensity of our products and becomes material when opportunities are aggregated in clusters or Clean Energy Parks.
- We identify three key areas in United States where CCUS deployment will enable business value creation from low-carbon products in the near-, medium-, and long-term.

- **Context**

- 45Q tax credit (\$50/t for storage, \$35/t for EOR) and the California LCFS (~currently \$190/t, but long-term market projections ~ \$100/t) provide incentives for CCUS deployment.
- The National Petroleum Council study on CCUS deployment recommends the clarification and extension of current regulatory and legal frameworks and greater financial incentives (~\$100/t) to unlock greater deployment potential.

- **Recommendation**

- BP can progress CCUS opportunities linked to the fuels production now, starting with Cherry Point and closely followed by Whiting, while we continue to shape the Gulf Coast opportunity.
- A clear remit and cross-segment governance process is required to resource project definition and progress at pace.

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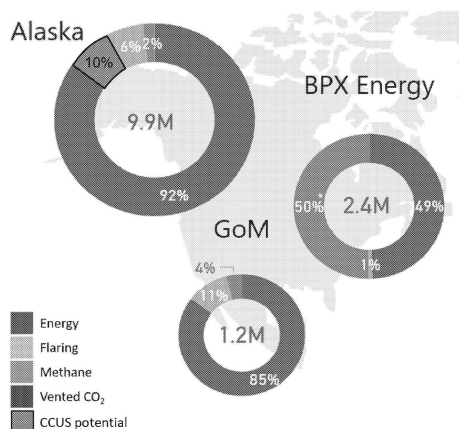
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US Upstream CCUS options

Limited economic opportunities to apply CCUS in the US Upstream portfolio

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- BP Upstream emits ~13.5 mtpa CO₂e in the US
- The majority of the emissions are from the combustion of our natural gas to power our own operations at multiple, small, distributed sites in remote locations. CCUS application to these sites is logistically challenged, and the cost of carbon capture from dilute sources (~\$100/t) exceeds current incentives.
- Electrification and efficiency are more feasible abatement options
- Businesses are currently focused on reduction of methane leaks and flaring as part of our methane intensity goal
- Alaska low carbon workshop identified opportunity to strip CO₂ from fuel gas for ~1mtpa abatement, with storage through EOR, at a cost >\$150/t. LNG production may enable further options.
- Recent BPX portfolio expansion into Permian may provide opportunities to deploy CO₂ EOR+ if anthropogenic sources can be accessed

*Likely based on EPA reporting factor guidelines

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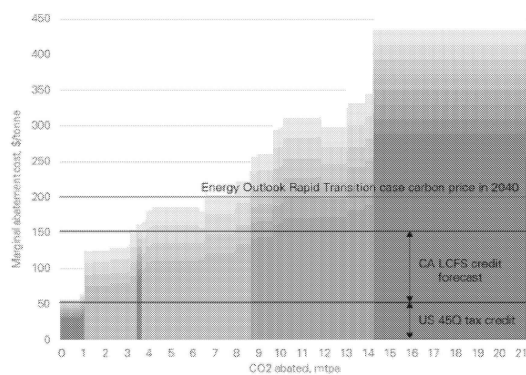
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US Downstream CCUS options

Selective deployment in existing operations with new investment options

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Marginal abatement cost curve for applying CCUS at BP refineries globally. Some emission reduction opportunities (green) are economic with current incentives in the US

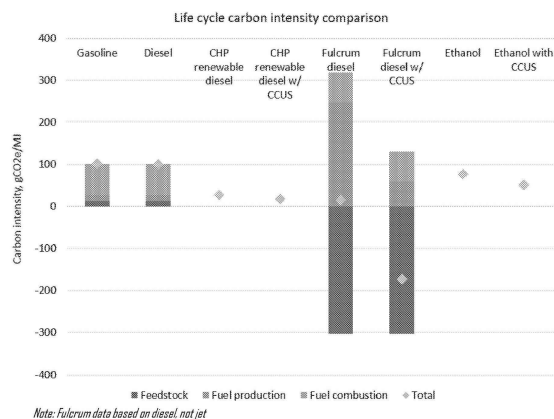
- BP Downstream emits ~21 mtpa CO₂ globally (including imported H₂, steam and power)
- Of these, around 14 mtpa could be abated using CCUS, but with high average CCUS cost of ~\$200/t (including total capture capex of \$8-10 bn)
- Current incentives sufficient for economic deployment in conjunction with Downstream-led low-carbon fuels efforts
- CCUS team engaged in Downstream strategy to identify where CCUS can provide additional value in near- and long-term

Application of CCUS within product lifecycle

Renewable feedstocks and customer applications benefit the most from CCUS

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- Commercial opportunities to reduce emissions associated with our oil & gas production and refining in the US using CCUS are limited.
- Our operations produce ~25% of the lifecycle emissions of fuels derived from oil, and only 5% of emissions when piped gas is combusted to generate power.
- Deep reduction of lifecycle emissions can be achieved through the production of low carbon fuels.
- Integration of CCUS into low-carbon fuels production enables deeper decarbonization and can enable the establishment of infrastructure to decarbonize hard to abate sectors such as heavy industry.

Feedstocks for the low-carbon fuels opportunities

Carbon intensity can be further reduced through application of CCUS

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Municipal solid waste (MSW)

- Large sources of waste are usually close to markets for fuels. Supply of waste is likely to be the main constraint on plant size.
- Attractive alternative to landfill
- Technology less mature – no large scale plants yet in operation.
- Opportunity to significantly reduce fuel production carbon footprint using CCUS
- High capex per unit of fuel



Crops (e.g., corn ethanol, agricultural by-products)

- Requires significant land space
- Corn ethanol produced widely at scale
- Cellulosic ethanol technology promising but not yet mature
- Relatively small CO₂ quantities produced by individual facilities (e.g., ~0.1mtpa) which are distributed over wide geographical regions. This limits economies of scale for CCUS.
- Currently low margin business. Hard for producers to invest capital in capture facilities.



Plant and animal by-products (e.g. vegetable oil, tallow)

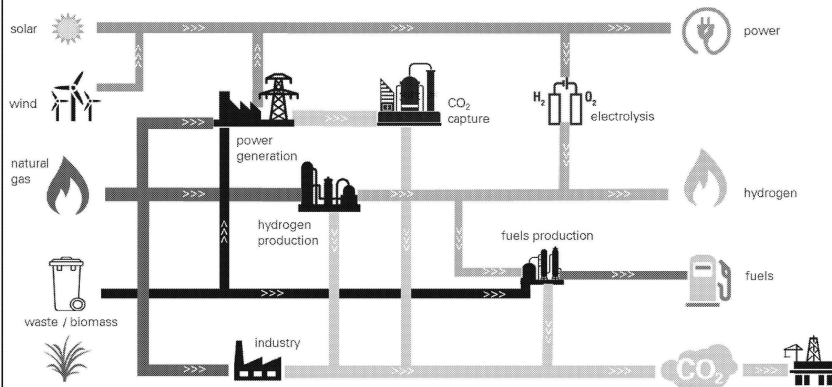
- Able to incorporate into existing refining assets to produce Green Diesel
- Hydrogen production required for fuel upgrading
- Opportunity to capture CO₂ associated with hydrogen production

Creating a low-carbon energy company

will require the delivery of decarbonized gas and fuels, as well as renewables

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BP has existing businesses in wind, solar and trading. Combining power from gas with CCUS we can offer a reliable and flexible low-carbon power system

We have an opportunity to participate in power and hydrogen production as part of a low-carbon energy value chain

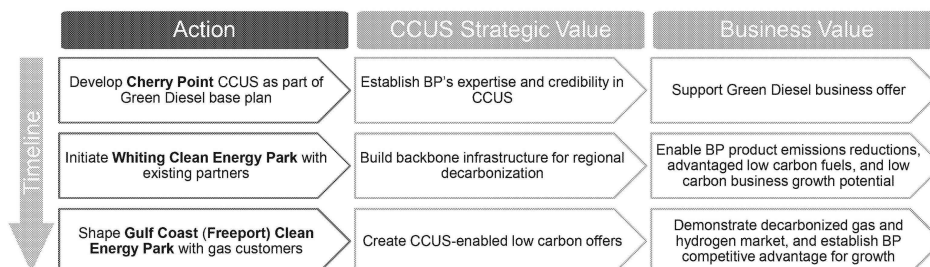
We can produce and market low-carbon liquid fuels

CCUS is the enabling backbone of our low-carbon offers.



Role of CCUS in BP's low-carbon strategy in the U.S.

- **Existing operations** should apply CCUS where incentivized or to support license to operate
- **New strategic investments** should include CCUS to enable Clean Energy Parks and further decarbonize low carbon fuels
- **Low-carbon customer offers** and internal emissions **offset opportunities** should be tied in where aligned with BP's carbon ambitions



Cherry Point Clean Fuels

Downstream plan to make diesel from renewable feedstocks, decarbonizing our products

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- The planned Green Diesel project will make 20kbbd of renewable diesel for the California market from renewable feedstocks (fats, oils and greases), for an investment of \$1.1bn
- This fuel will have substantially lower carbon intensity than diesel created from oil, generating credits under the California Low Carbon Fuel Standards
- The project will increase hydrogen demand at the refinery, necessitating the construction of a new hydrogen plant
- Hydrogen generation produces 0.3 Mtpa of high purity stream of CO₂ with a low cost-of-capture
- Applying CCUS to this CO₂ further lowers the carbon intensity, generating more LCFS credits. This will require an additional \$50m capex.

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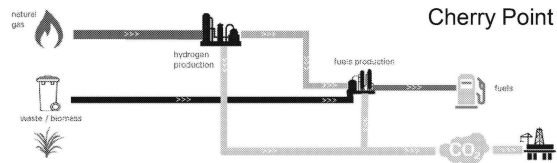
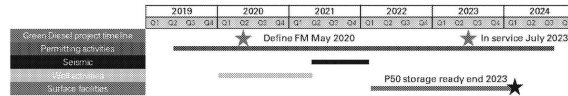
Cherry Point Clean Fuels

CCUS can further reduce carbon intensity, decarbonizing our operations

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- The local geology around the refinery is not suitable for carbon storage
- The CO₂ can be liquified, loaded on a rail car and transported east to a suitable storage destination
- Currently North Dakota is being screened as a location where the geology, regulations and stakeholder attitudes are all favorable for carbon storage
- The CO₂ will qualify for both federal 45Q and California LCFS incentives, covering the cost of the transport and providing an economic return on investment
- The project represents the fastest-to-deploy opportunity for CCUS within the Downstream portfolio
- Once established, storage complex could offer a storage service for other sources by rail



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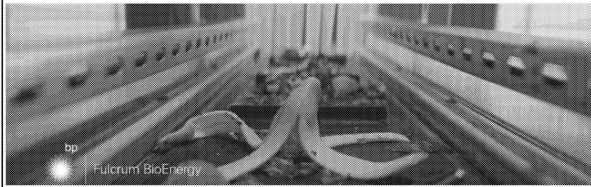
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Whiting Clean Energy Park

Existing partnerships with Fulcrum and Linde provide advantaged CCUS deployment...

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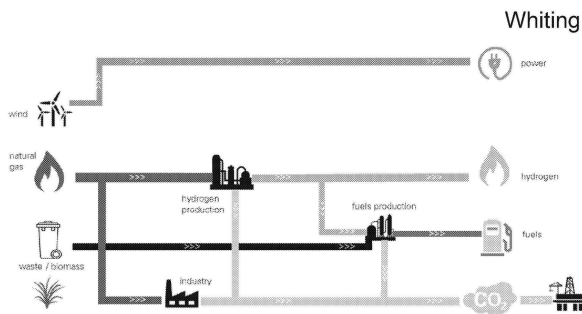


- Fulcrum Bioenergy, a BP Ventures investment, plans to build an MSW to 2kbpd biojet plant near Whiting (\$600-700m capex). Storing the CO₂ generated creates additional credit value through the California LCFS and 45Q incentives.

- To capture that value, Fulcrum would need a partner with Upstream skills. Due to existing partnership and local advantages, BP is well-positioned to provide transport and storage.

- The Whiting refinery's hydrogen supply is from a Linde facility which presents a low capture cost. Reducing carbon from the hydrogen feedstock would mitigate Whiting's exposure to carbon price risk. Linde is currently assessing cost and timeline.

- Establishing storage infrastructure would enable future opportunities in renewable diesel, blue H₂ supply, ethanol, etc.



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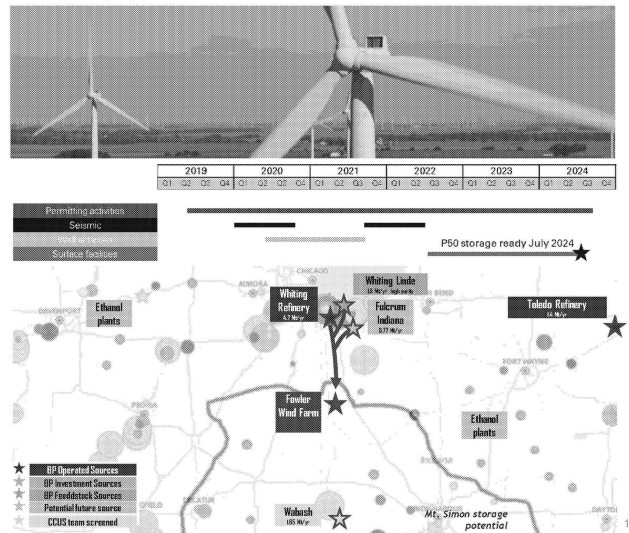
Whiting Clean Energy Park

...while establishing infrastructure for potential storage at BP's wind farm

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- The storage potential of the Mt Simon sandstone in the Illinois basin has been extensively studied, and hosts a current CO₂ storage operation at Decatur, IL.
- We operate the Fowler Ridge wind farm ~75 miles due south of Whiting (pipeline capex ~\$75m). This represents the closest location to the Chicago area where the Mt Simon is at a suitable depth for CO₂ storage. BP has good relationships with landowners in this region.
- Appraisal and development of the storage resource may take 4-5 years before injection operations can commence.
- Following a Downstream conditional commitment to CCUS, Upstream work should commence in data collection, stakeholder engagement, and land contracts.



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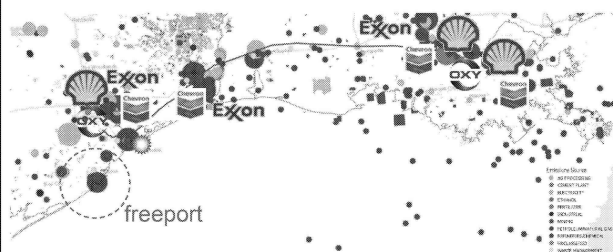
in educating stakeholders, obtaining conditional contracts on pore space rights, collecting 2D scoping seismic data and developing technology options to use the vibrations of the wind farm for 4D seismic monitoring

Freeport Clean Energy Park

Opportunity to offer decarbonized gas to our customers...

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Freeport present day emissions



- Over the next 5-15 years, we expect ExxonMobil and Shell to apply CCUS to their own operations to the east of Houston. This infrastructure could allow them to offer decarbonization services to their customers.
- Unlike our major competitors, BP does not have a large emissions footprint along the Gulf Coast. Texas City Petchem emissions are currently uneconomic to capture (~\$100/t) and Fulcrum's proposed locations do not present storage synergies.
- The Freeport area has existing BP gas customers, interested parties, and additional planned industrial developments. BP could develop a decarbonized gas offer for our customers, securing market share through the energy transition and maintaining competitive advantage.
- Longer term the Gulf Coast presents an opportunity for blue hydrogen production to further decarbonize industry and enable low-carbon energy export such as ammonia as a shipping fuel.

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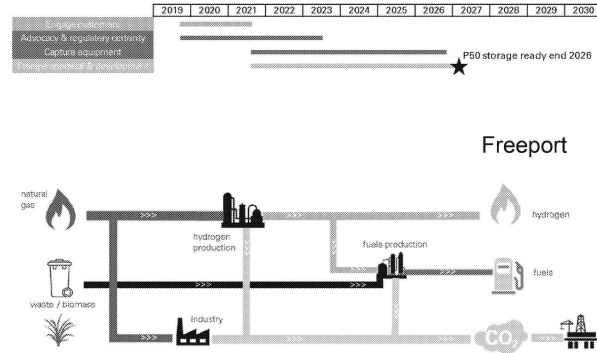
Freeport Clean Energy Park

...and enable us to maintain market share through the energy transition

- This market for customer decarbonization needs time to mature but work can be done now to secure long term gas markets
- Customer relationships - work with customers to develop what a decarbonized gas offer is worth to them and what development timelines are possible

Redacted - First Amendment

- Storage destinations - evaluate potential partnerships for onshore CO₂EOR+ opportunities and support offshore storage evaluations through the UT GOMCarb partnership



CCUS Forward Plan for the US Deployment to support our current operations and future strategy						DRAFT Confidential bp
Delivery Focus	Project	Status	Vision	Enablers	BP CapEX	Next Steps
Near-term (1-3 years) 0.3 mtpa CO ₂ 20 kbd Renewable Diesel	Cherry Point Clean Fuels	Target FID 2020	Enabling Green Diesel with blue hydrogen	Move CCUS for Green Diesel from a sensitivity into the base plan	\$50M	- Detailed Engineering quotes for facilities - Identification of storage locations in North Dakota - Work with Downstream stakeholders to get CCUS into base plan for GD - Engage RTE to offer technical and advocacy support
Medium term (3-5 years) 0.6 to 3+ mtpa	Whiting Clean Energy Park	Target appraisal 2020	Creating low carbon fuels in a core BP location	- Downstream commitment for storage appraisal - Fulcrum to commit to CCUS at Gary, IN plant - Linde to incorporate CCUS on Whiting H2 plant	\$100M to >\$250M	- Identify technical case and timeline for Fowler seismic acquisition and appraisal - Secure Downstream commitment to enable storage appraisal to commence
Longer term (5-10 years) 1 to 5+ mtpa	Gulf Coast (Freeport) Clean Energy Park	Assessing market and framing advocacy	Developing a decarbonized gas and carbon storage offer for our Gulf Coast customers. Enabling hydrogen.	- Legislation modification enabling offshore storage, and/or - Identification of onshore storage/EOR location	\$20M to >\$250M	- Assess market for decarbonized gas premium - Develop advocacy strategy through OGCI & Rice University-led initiatives - Work with customers to shape decarbonized gas offer - Appraise storage and EOR+ potential near Freeport

ANR/CDW/MT/MS/DR