CCUS: 5 things to look for in 2024

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Executive summary

These are the themes we expect to guide the CCUS sector in 2024

Projects

2024 will see an **unprecedented number of FIDs.** Over 110 projects are seeking FID, with 40-60 likely progressing

CO_2 storage

Licensing will continue to gain momentum in the US, UK and Australia. **CO_2 storage drilling** activity will pick up

Regulation

Major countries including Brazil and Germany will take important strides in **CCUS regulatory framework development**

DAC and new capture tech

2024 will see strong **momentum in direct air capture and next-generation capture technologies**

Key elections and policy updates

Key elections in 2024, particularly the US, will have a lasting impact on the global CCUS environment.

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1. 2024 will see an unprecedented number of project FIDs

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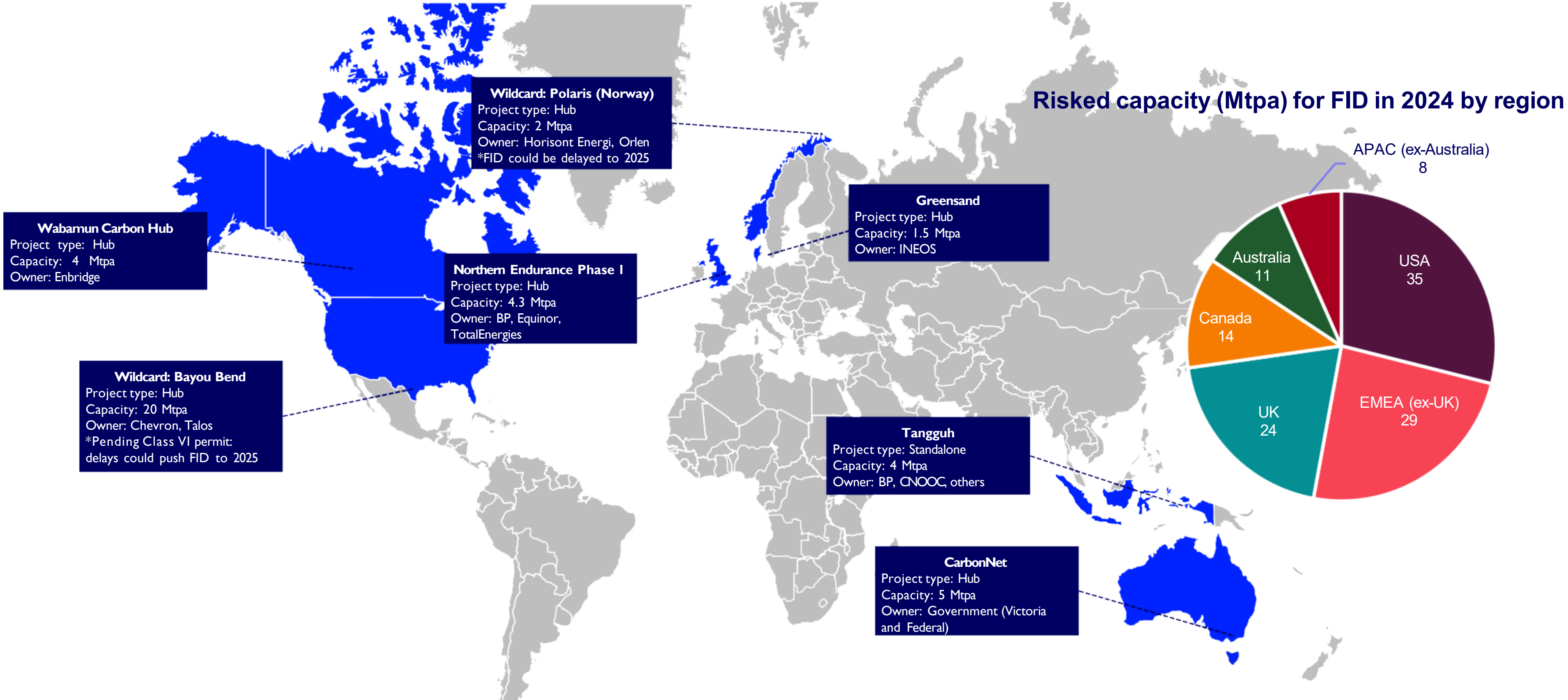
Globally,119 projects are aiming for FID in 2024 – the largest number yet

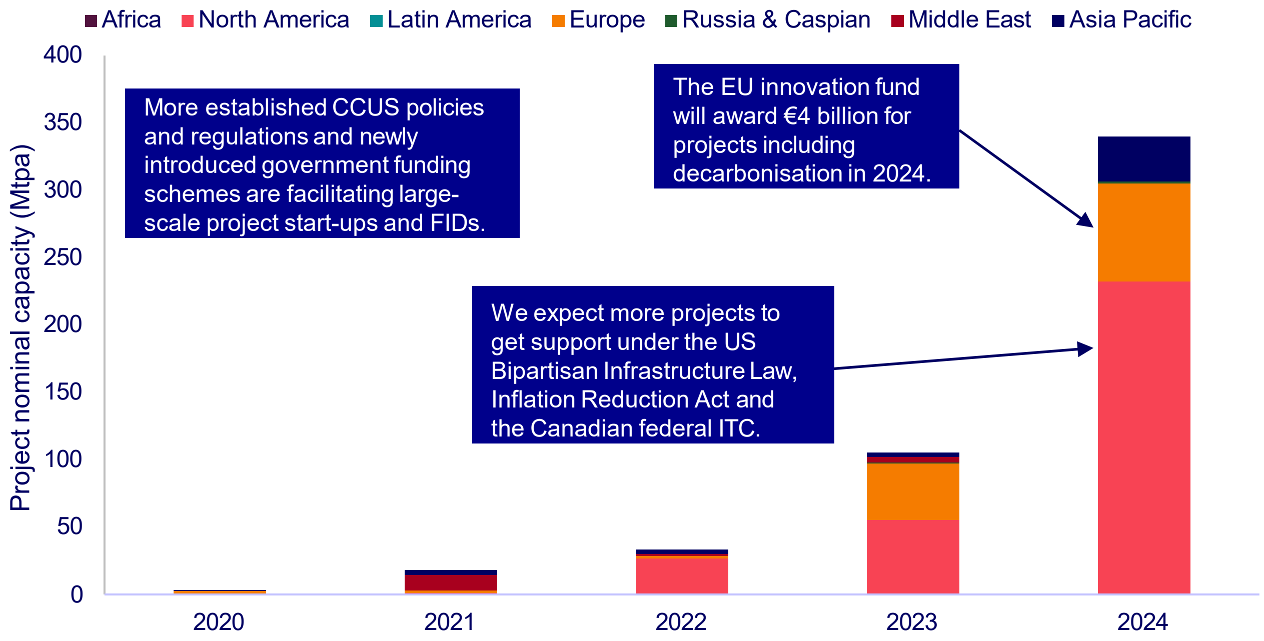


Source: Wood Mackenzie Lens Carbon

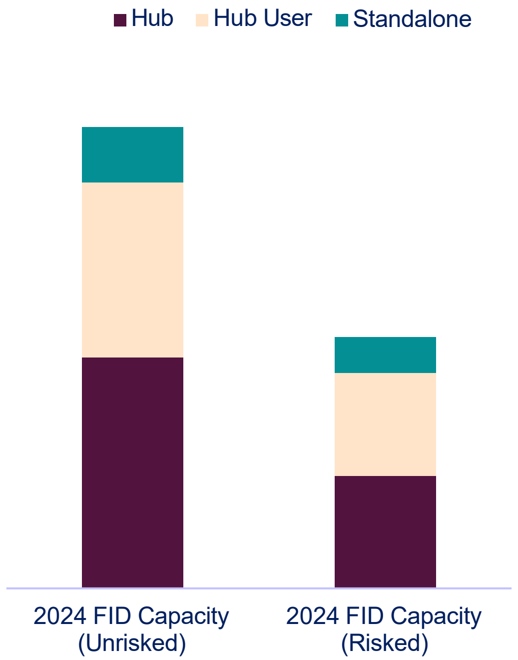
Projects reaching FID in 2024 are primarily hubs in North America and Europe

119 projects with 115 Mtpa capture capacity and 240 Mtpa storage capacity are aiming for FID in 2024

Project nominal capacity by FID year and region



2024 FIDs by project type



Source: Wood Mackenzie Lens Carbon. These charts are based on current project announced timelines.

2. Licensing will continue to gain momentum and CO_2 storage drilling activity will pick up

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Licensing activity will continue, in support of an increasing project capacity

New licensing rounds are expected in the US and the UK. Southeast Asia is the wild card

United States	Denmark	United Kingdom	Australia	Norway

• Third Texas GLO **CO_2 storage licence round**, request for proposals will be in February/March for the **Texas State Waters** in Brownsville, Matagorda and Freeport Areas
  • We expect majors such as Chevron, Equinor and TotalEnergies to bid
• Louisiana is expected to continue awarding licences on an ad-hoc basis
• We expect BOEM to announce plans for future CO_2 storage lease sales for federal waters
	• In December 2023, Denmark opened applications for CCS licences in **five onshore areas**
	• Application deadline is January 24th
	• Results are expected to be announced in 2024
		• NSTA is setting a rapid trajectory for subsequent licence rounds, estimating up to **100 licences will be required to reach net zero targets**. Details of the scale and regularity of future rounds will be announced.
		• The 2nd UK carbon storage licensing round is expected to be launched in 2024
			• Australia opened **ten new blocks for the 2023 GHG acreage release**: four in **Victoria** (Otway, Bass and Gippsland basins) and six in **Western Australia** (Perth, Carnarvon, Bonaparte and Browse basins). Bidding closed in November 2023.
			• Winning bids will be announced
			  • We expect Santos, Woodside and INPEX to increase current acreage
				• Seven active licences awarded between 2019–2023 to 12 companies
				• Expect the trend of targeting **storage in saline aquifers** to continue, licence awards to remain on an ad-hoc basis, out of regular licence rounds

Wildcard: CO_2 storage license areas could formally open in **Malaysia and Indonesia** to support the CCUS industry. Petros is the only company which has been awarded two CO_2 storage licenses in Malaysia. We expect the MEMR/2/2023 policy in Indonesia to lead towards regulation of licensing activity.

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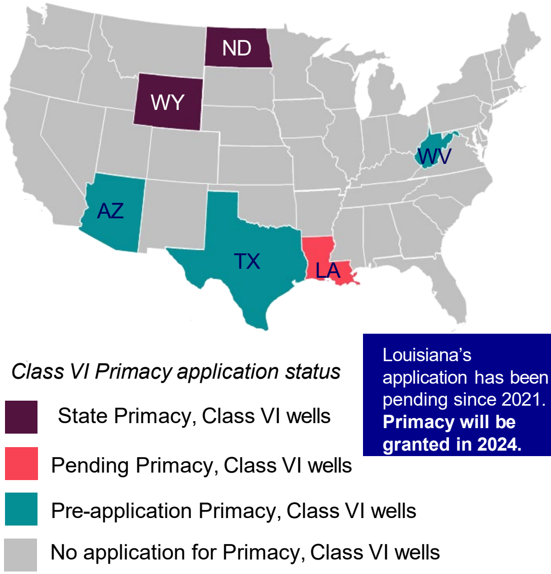
More regulatory changes are expected to shorten project timelines

Applications for CO_2 storage wells and drilling expected to increase

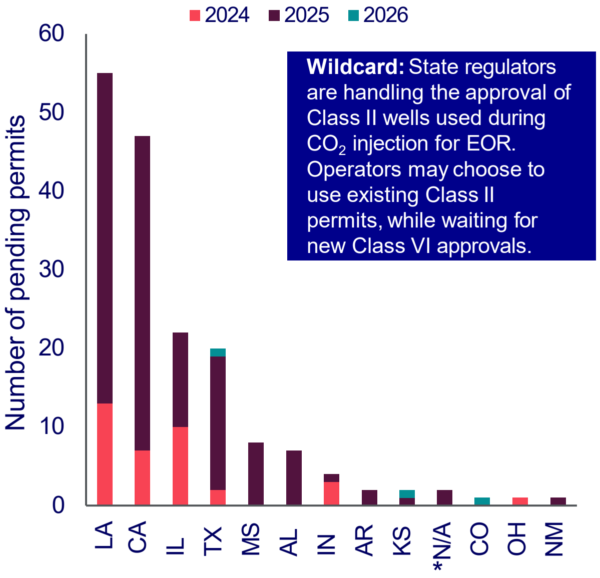
State Primacy status for class VI wells



Louisiana's application has been pending since 2021. **Primacy will be granted in 2024.**

Source: Wood Mackenzie, US EPA

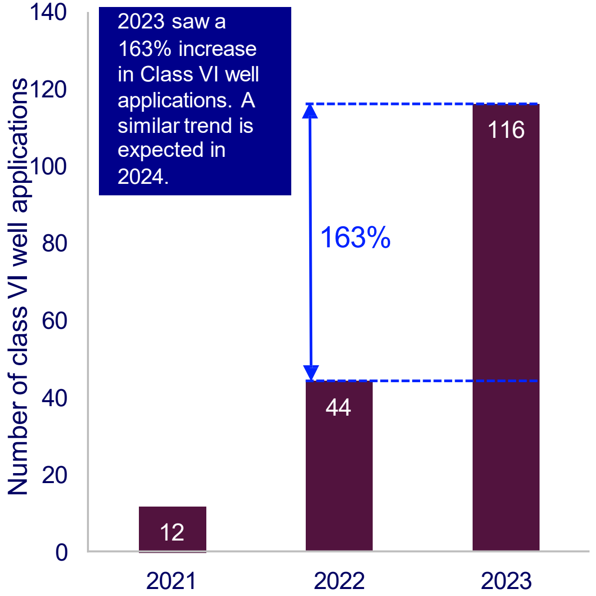
EPA Class VI well approval year by state



Wildcard: State regulators are handling the approval of Class II wells used during CO_2 injection for EOR. Operators may choose to use existing Class II permits, while waiting for new Class VI approvals.

Source: Wood Mackenzie, US EPA *N/A – Native American land

EPA Class VI well applications by year



2023 saw a 163% increase in Class VI well applications. A similar trend is expected in 2024.

Source: Wood Mackenzie, US EPA

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Note: Class VI well permits are required for underground storage of CO_2 in the US

3. Major countries will take important strides in regulatory framework development

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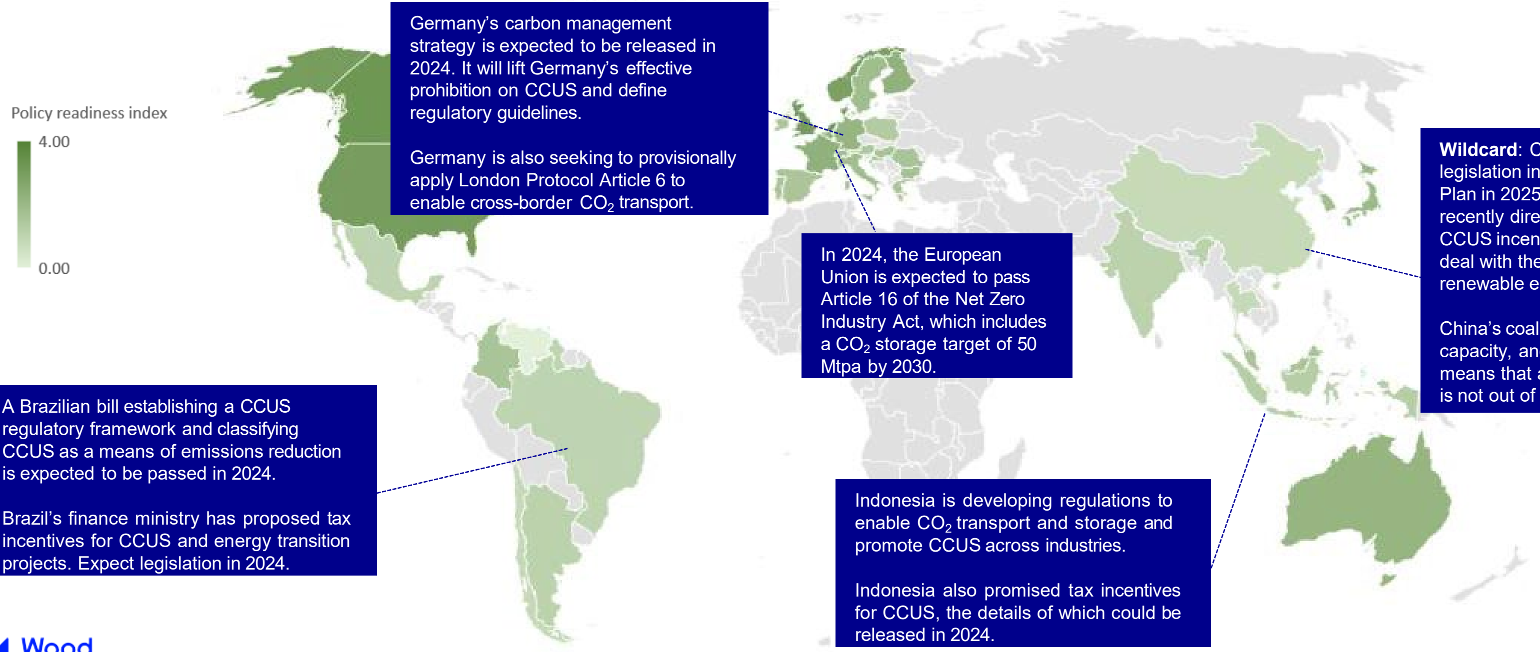
Globally, there is a high degree of divergence within CCUS policy and regulatory frameworks

In 2024, expect major jurisdictions to make key strides in developing regulatory frameworks for CCUS

Wood Mackenzie's CCUS policy readiness for North and South America, Europe and APAC



Germany's carbon management strategy is expected to be released in 2024. It will lift Germany's effective prohibition on CCUS and define regulatory guidelines.

Germany is also seeking to provisionally apply London Protocol Article 6 to enable cross-border CO_2 transport.

In 2024, the European Union is expected to pass Article 16 of the Net Zero Industry Act, which includes a CO_2 storage target of 50 Mtpa by 2030.

Wildcard: China is unlikely to release legislation in advance of its 15th 5 Year Plan in 2025, however, the country recently directed banks to implement CCUS incentives and signed a climate deal with the US focusing on CCUS and renewable energy.

China's coal reliance, investment capacity, and recent deal with the US means that a surge in CCUS incentives is not out of the question.

A Brazilian bill establishing a CCUS regulatory framework and classifying CCUS as a means of emissions reduction is expected to be passed in 2024.

Brazil's finance ministry has proposed tax incentives for CCUS and energy transition projects. Expect legislation in 2024.

Indonesia is developing regulations to enable CO_2 transport and storage and promote CCUS across industries.

Indonesia also promised tax incentives for CCUS, the details of which could be released in 2024.

Source: Wood Mackenzie CCUS Policy Readiness Index

4. Expect strong momentum in direct air capture (DAC) and new capture technologies

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At-scale DAC readiness will be a focus in 2024 and beyond, though cost and execution risks loom

Expected developments in 2024

- **Phase 1 of Stratos**, the world's first global-scale DAC plant (0.5 Mtpa), will reach or near the end of construction in advance of the project's 2025 target start-up date.
- **Climeworks' Mammoth DAC project,** the company's second and largest DAC project (0.036 Mtpa), is expected to begin operation in the latter half of 2024.
- The **US Department of Energy is expected to announce further DAC hubs** and finalize funding quantities
- Startups are likely to develop **pilots with newer technologies**, reaching technology readiness level 6

Wildcards: Cost and execution

- We will have a watchful eye on how next-of-a-kind (NOAK) DAC projects are able to improve operational efficiency and lower costs. **A lack of significant cost and operational improvements for NOAK projects would be a headwind** for DAC project announcements and FIDs.
- **Momentum of large DAC financing deals** could falter if projects fail or fall behind (or increase as more projects are announced).
- Several startups have promised **DAC at costs significantly under current commercial levels** (typically under US$100 per tonne). This could have a radically disruptive impact on the industry if it comes to fruition — though all developers are still years away from proving out their claims.

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Expect to see project announcements, FIDs, and start-ups involving new capture technologies and industries

Notable projects to be commissioned in 2024

Norcem Brevik Cement Plant
Owner: Heidelberg Materials
Location: Norway
Volumes: 0.4 Mtpa
Significance: World's first cement plant integrated with CCS technology
Technology Vendor: Aker Carbon Capture

Swayana Mpumalanga
Owner: Swayana and Lanzatech
Location: South Africa
Volumes: 0.7 Mtpa
Significance: World's first large scale bio-capture project for renewable fuel production
Technology Vendor: LanzaTech

Wabash Hydrogen
Owner: Wabash Valley Power Assn Inc.
Location: USA
Volumes: 1.75 Mtpa
Significance: Large-scale project using adsorptive capture
Technology Vendor: Honeywell UOP

Notable projects aiming to reach FID in 2024

Sutter Decarbonization Project
Owner: Calpine
Location: USA
Volumes: 1.75 Mtpa
Significance: Retrofit post-combustion capture on 550 MW NGCC plant
Technology Vendor: ION Clean Energy ICE-21 Solvent

Drax BECCS Phase 1
Owner: Drax
Location: UK
Volumes: 4 Mtpa
Significance: New business model, and largest technology application to date
Technology Vendor: Mitsubishi Heavy Industries

Arthit
Owner: PTTEP
Location: Thailand
Volumes: 1 Mtpa
Significance: Substantial project using membrane capture technology
Technology Vendor: Honeywell UOP

Potential Gamechanger

Svante's Veloxotherm Technology

The final investment decision for the Lehigh Hanson CO2MENT project will be made next year. If the project goes forward, it would be the first use of Svante's rotary contact machines which aid the CO_2 adsorption process.

The reconfiguration should allow for continuous CO_2 adsorption with lower energy requirements (when compared to amine solvents). This technology could revolutionize CO_2 capture, substantially reducing cost and allowing for higher capture volumes.

5. Key elections in 2024 will have a lasting impact on the CCUS policy environment

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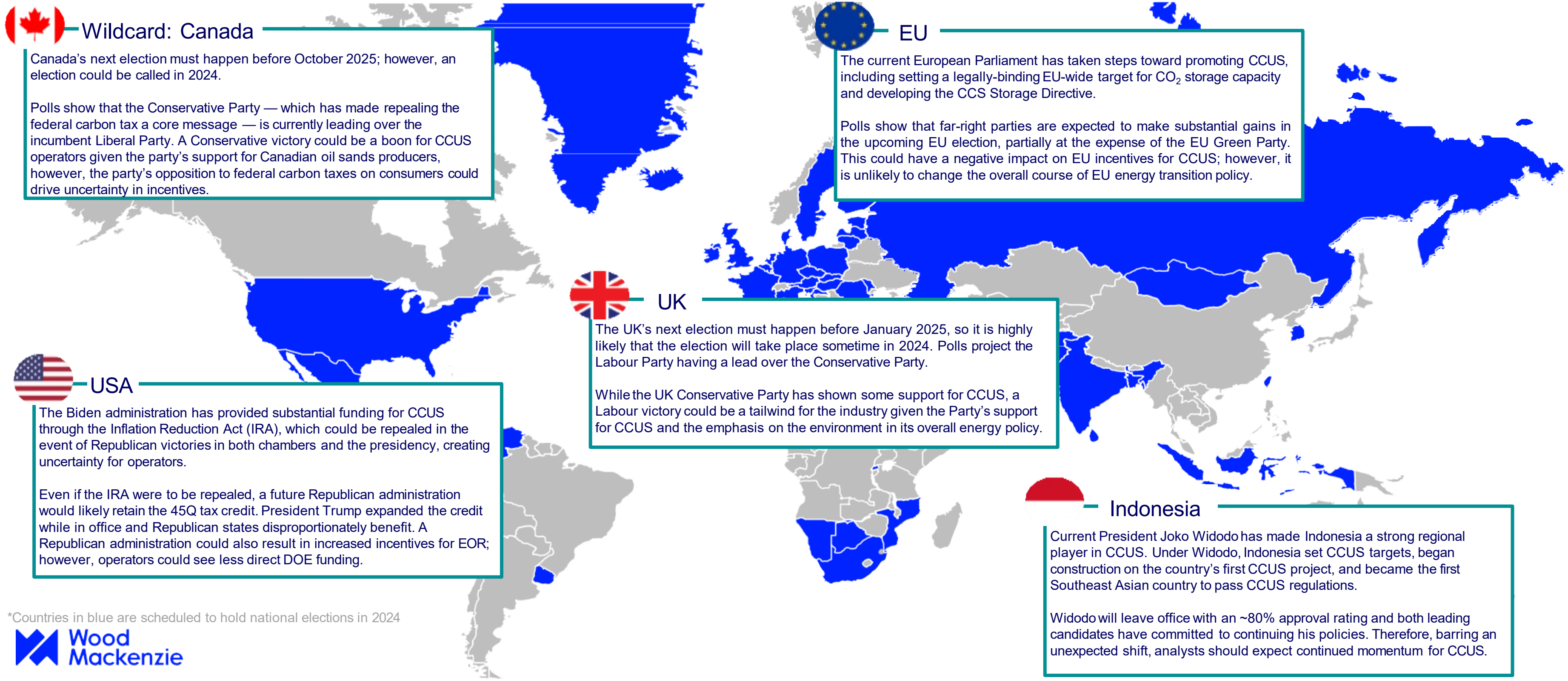
Elections in countries with significant announced project capacity will have lasting implications for CCUS policy

The Economist called 2024 'the biggest election year in history,' with 4 billion people being sent to the polls globally



Wildcard: Canada

Canada's next election must happen before October 2025; however, an election could be called in 2024.

Polls show that the Conservative Party — which has made repealing the federal carbon tax a core message — is currently leading over the incumbent Liberal Party. A Conservative victory could be a boon for CCUS operators given the party's support for Canadian oil sands producers, however, the party's opposition to federal carbon taxes on consumers could drive uncertainty in incentives.

EU

The current European Parliament has taken steps toward promoting CCUS, including setting a legally-binding EU-wide target for CO_2 storage capacity and developing the CCS Storage Directive.

Polls show that far-right parties are expected to make substantial gains in the upcoming EU election, partially at the expense of the EU Green Party. This could have a negative impact on EU incentives for CCUS; however, it is unlikely to change the overall course of EU energy transition policy.

UK

The UK's next election must happen before January 2025, so it is highly likely that the election will take place sometime in 2024. Polls project the Labour Party having a lead over the Conservative Party.

While the UK Conservative Party has shown some support for CCUS, a Labour victory could be a tailwind for the industry given the Party's support for CCUS and the emphasis on the environment in its overall energy policy.

USA

The Biden administration has provided substantial funding for CCUS through the Inflation Reduction Act (IRA), which could be repealed in the event of Republican victories in both chambers and the presidency, creating uncertainty for operators.

Even if the IRA were to be repealed, a future Republican administration would likely retain the 45Q tax credit. President Trump expanded the credit while in office and Republican states disproportionately benefit. A Republican administration could also result in increased incentives for EOR; however, operators could see less direct DOE funding.

Indonesia

Current President Joko Widodo has made Indonesia a strong regional player in CCUS. Under Widodo, Indonesia set CCUS targets, began construction on the country's first CCUS project, and became the first Southeast Asian country to pass CCUS regulations.

Widodo will leave office with an ~80% approval rating and both leading candidates have committed to continuing his policies. Therefore, barring an unexpected shift, analysts should expect continued momentum for CCUS.

*Countries in blue are scheduled to hold national elections in 2024

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