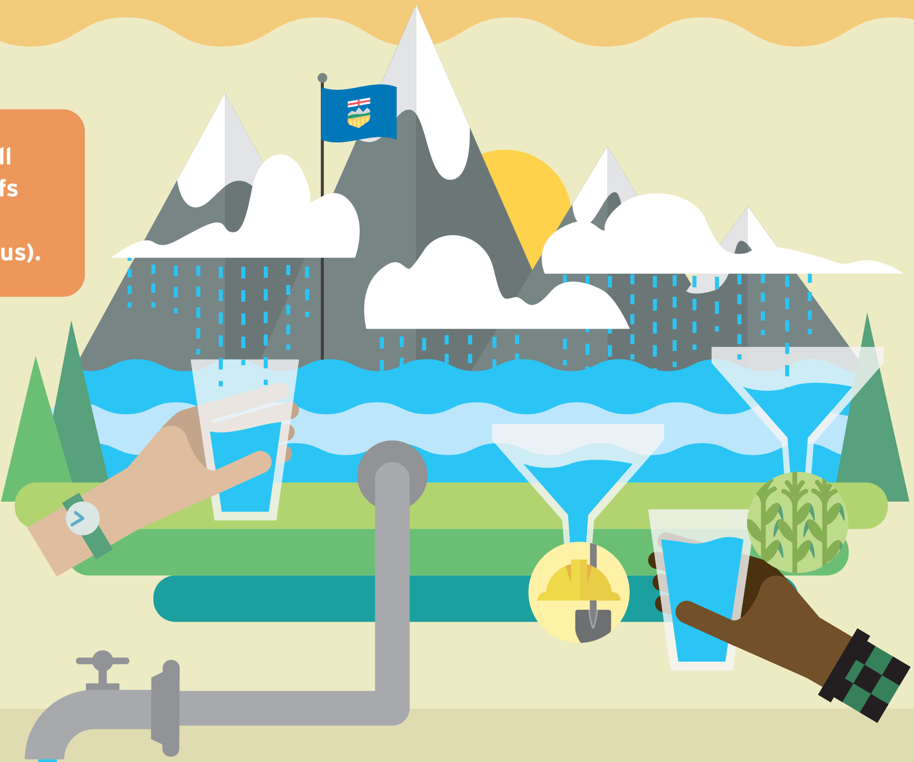
WATER & CARBON CAPTURE

SUPPORTING ALBERTA'S ENERGY FUTURE

Carbon capture, utilization, and storage (CCUS) is integral to Alberta's transition to a low carbon economy.

CCUS development in Alberta will lead to interactions and trade-offs in water management for people, food, and energy (The Water Nexus).



CCUS developers should assess their unique water needs and their water context, including availability and risks, from the outset.

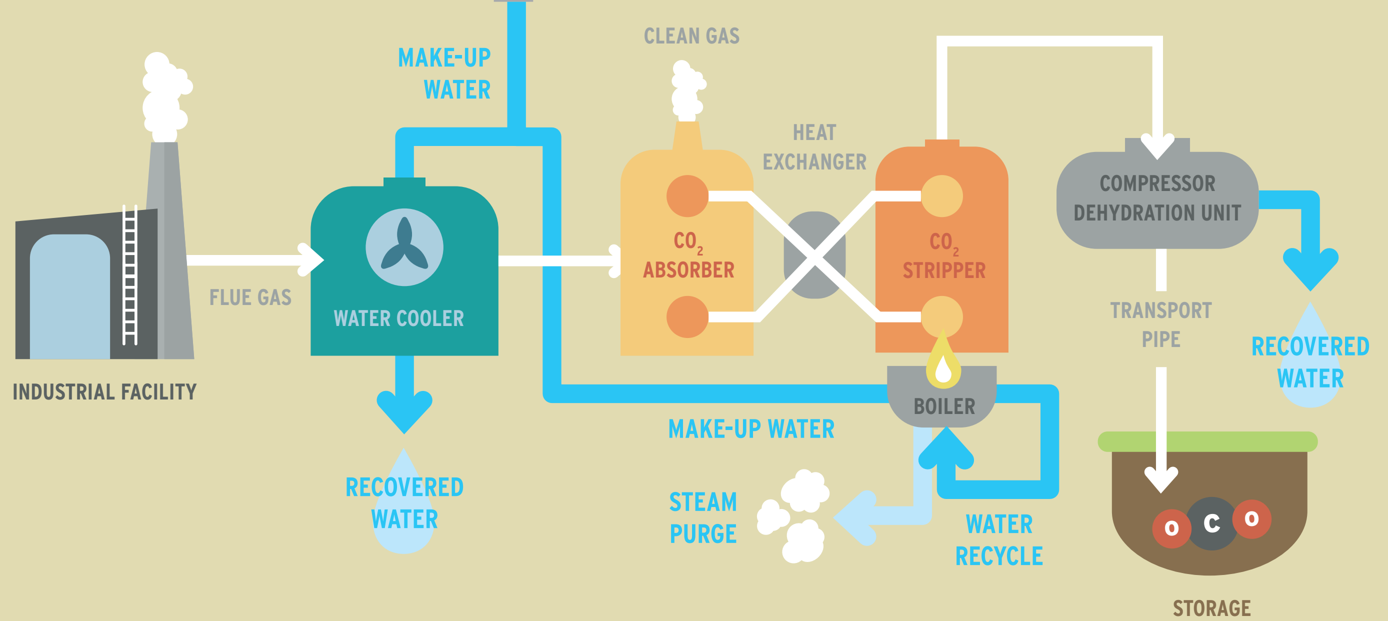


Figure 1: Amine-based carbon capture.

Many CCUS projects are expected to recover more water than they consume. With the appropriate management, the recovered water could potentially be used to offset other water demands.

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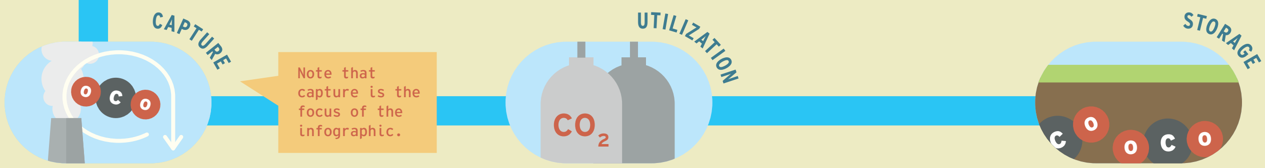
WATER DEMAND FOR CCUS

Policy makers and industry are sending strong signals that CCUS will play an important role in Alberta's energy future. Broadly, CCUS refers to a process involving:



Capture: Capturing carbon dioxide (CO_2) from large point sources like power generation or industrial facilities. Non-point sources can also be used, such as direct air capture.

Utilization: Using the captured CO_2 for some other process, which could be nearby to the point of capture or offsite. Compression and conveyance are typically required prior to utilization.

Storage: Storing the CO_2 which is not being utilized in a deep geological formation for permanent sequestration.

All Albertans will benefit from further dialogue on the environmental trade-offs associated with CCUS, particularly the potential impacts on the province's water resources, and its role in the water-energy-food nexus. Numerous CCUS projects have been proposed in Alberta with a 2050 time horizon, with a total capture capacity of over 200 million tonnes of CO_2/yr. Amine-based absorption technologies are currently commercially available and will see broad deployment by 2050. Meanwhile, research and development work will continue on the next generation of capture technologies, which will have their own water considerations.

Amine-based carbon capture has varying water consumption rates based on factors such as flue gas composition, cooling demands, solvent absorption efficiency, and power generation requirements. This variability is expressed in the form of Low, Medium, and High scenarios **(Figure 2)**.

In some carbon capture applications, such as biomass, natural gas power plants, and the oilsands, it may be possible to generate more water than is consumed. If this water can be treated and reused within the same industrial process or for some other beneficial purpose, CCUS can provide a net benefit to water supplies. However, any generated water which cannot be used must be appropriately managed, for example through disposal.

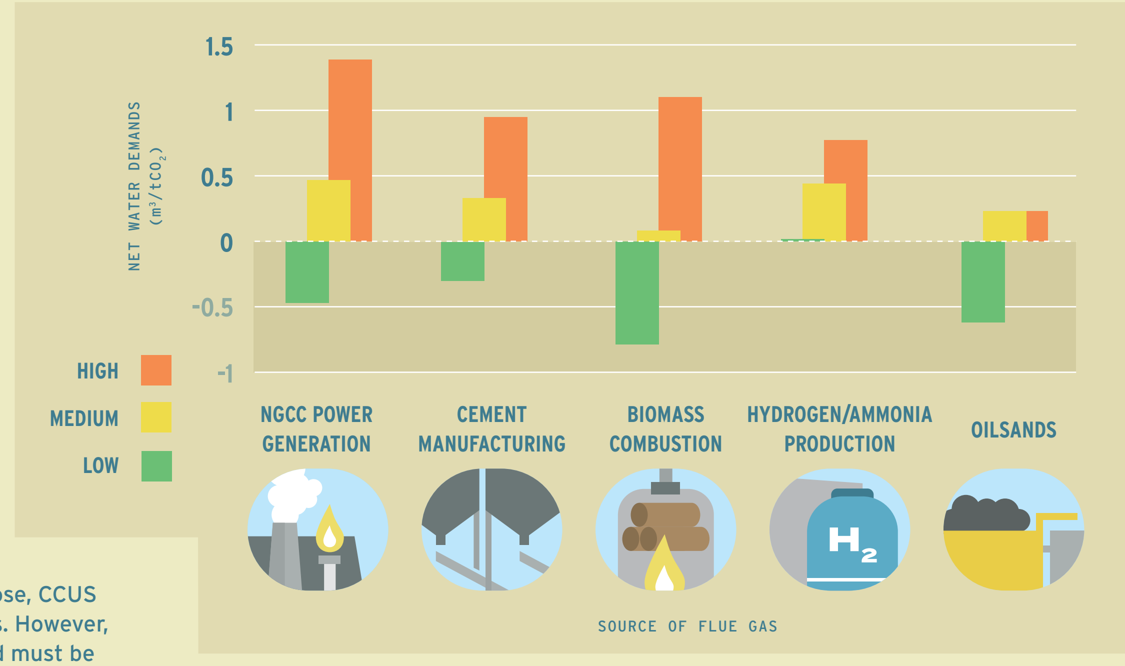
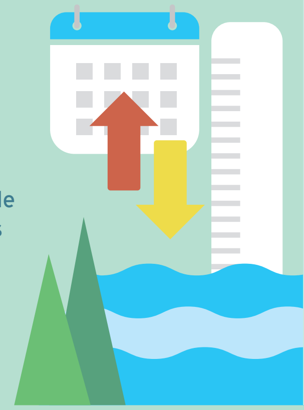


Figure 2: Summary of the potential water demands for amine-based carbon capture.

WATER SUPPLY FOR CCUS

In Alberta, the amount of water available for use varies greatly by location, time of year, and year over year. This variability is managed by regulators and users to meet ecological and human needs while making water available for economic development. Rivers in southern Alberta, which flow through more populated areas, face higher competition for water resources compared to other regions **(Figure 3)**.



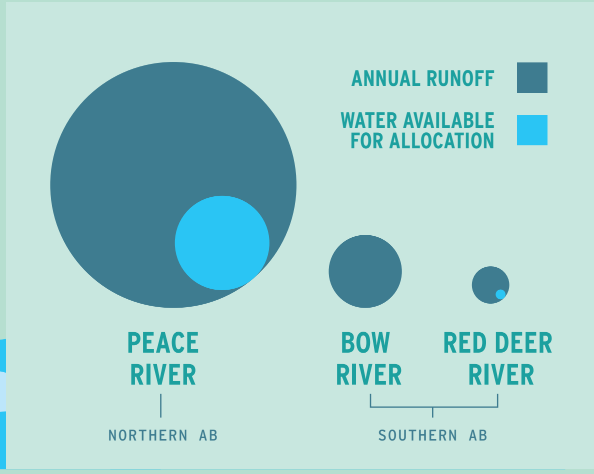


Figure 3: Visualization of annual median runoff and availability for the Peace, Bow, and Red Deer Rivers, which vary seasonally and annually.

COMPARING WATER SUPPLY TO DEMAND

Many CCUS production facilities are proposed across Alberta. Using a 2050 time horizon, **Figure 4** compares water that is available for new uses to the anticipated consumptive water demands of proposed CCUS development for the Red Deer River Basin, which are expected to require new water licences. The Red Deer River serves as an illustrative example of a basin nearing its maximum allocation capacity. Other rivers exhibit unique patterns of water availability and demand.

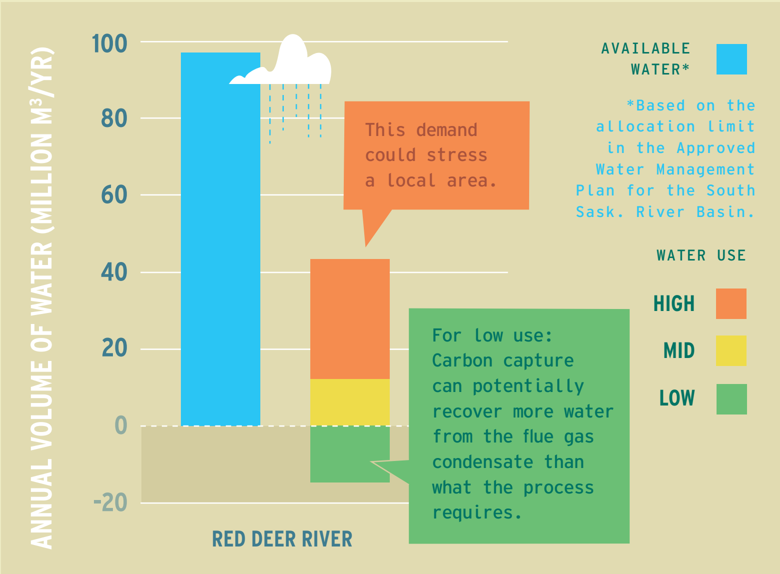


Figure 4: Comparison of water available on an annual basis to water required for new CCUS projects in the Red Deer River Basin.

Figure 5 compares the approximate locations of proposed carbon capture facilities to water availability across Alberta. In some locations, limited water availability introduces project risks for carbon capture, and carbon capture development may lead to trade-offs in the context of the Water Nexus. On the other hand, existing facilities which are retrofitted with carbon capture may already have sufficient water licenses to accommodate a demand increase, potentially leading to a net-neutral impact on water availability. Alternatively, carbon capture projects which generate more water than they consume could lead to net-positive impacts on water availability. For each project, a good understanding is required of its basin-specific water context as well as its potential water impacts.

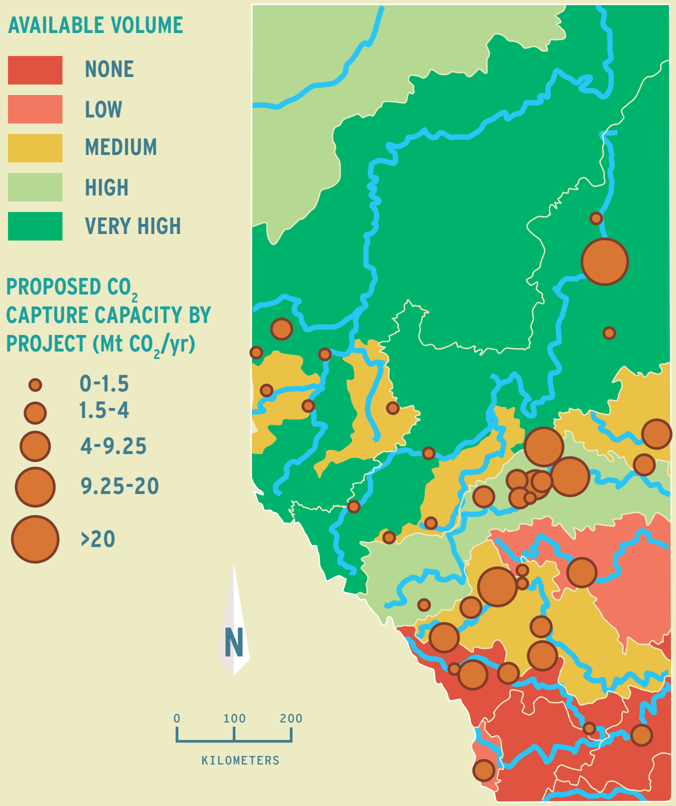


Figure 5: Comparison of proposed CCUS facilities to water availability in a median flow year across Alberta.

THE LINK BETWEEN HYDROGEN AND CCUS

CCUS has been recognized as one of the four pillars of the global energy transition, alongside renewable power generation, bioenergy, and hydrogen.[1] In Alberta, the province's Hydrogen Roadmap explicitly links hydrogen development and CCUS,[2] a position which has been echoed by industry.

WaterSMART's 2023 study on the water impacts of hydrogen development in Alberta estimated that it could potentially consume between 121,100 and 503,360 dam³/yr.[3] When the announced carbon capture projects are layered onto this potential hydrogen development, the combined water use across the province ranges between 20,513 and 705,504 dam³/year. **Figure 6** illustrates how carbon capture projects have the potential to reduce the net water consumption of hydrogen development, assuming that water recovered from the capture processes can be used to offset the demands for hydrogen production. For both hydrogen and CCUS development, water impacts, risks, and opportunities should be analyzed on a location-specific basis.

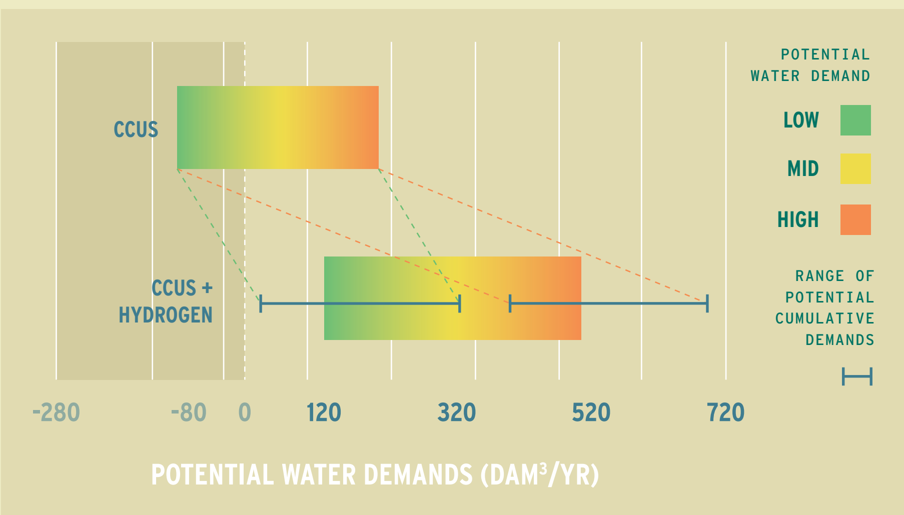


Figure 6: Potential water demands for CCUS and hydrogen development.

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1. www.iea.org/reports/energy-technology-perspectives-2020
2. www.open.alberta.ca/publications/alberta-hydrogen-roadmap
3. www.watersmartsolutions.ca/knowledge-base/study-of-water-impacts-of-hydrogen-development in-alberta-2023/

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WaterSMART CCUS Study Report.