Heidelberg Materials
Deep Decarbonization with Carbon Capture and Storage

NRMCA Concrete Innovations #26 | Webinar | CCUS | L. Rowland

11/20/2024

Concrete Accounts for More Than 50% of Everything We Make[1]

Most widely produced solid material on earth

- Concrete delivers…
  - Economy
  - Strength & Durability
  - Versatility
  - Resilience
- Because concrete is practically synonymous the term construction it….
  - Is responsible for 7% – 8% of global manmade CO_2 emissions
  - It can be argued this is a relatively small CO_2 investment for more than 50% of the stuff we make but, we are working to lower these #s

[1]Rencontre du Conseil d'Etat avec la Présidence de l'EFL EPFL Fribourg, https://www.concrete.org/portals/0/files/pdf/webinars/ws_S23_KarenScrivener.pdf

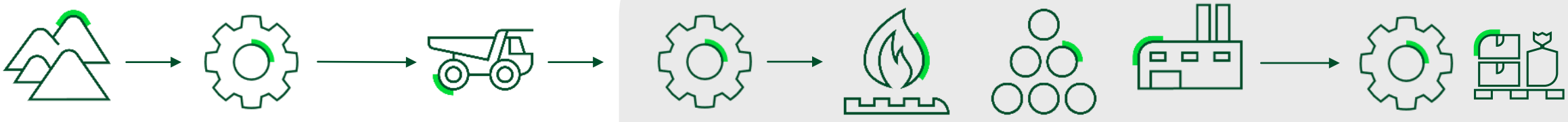
Understanding the role of calcination in cement's CO_2 emissions

Embodied carbon in cement A1 – A3, "Cradle to Gate"

A1 Extraction and Upstream Production

A2 Transport

A3 Cement Manufacture

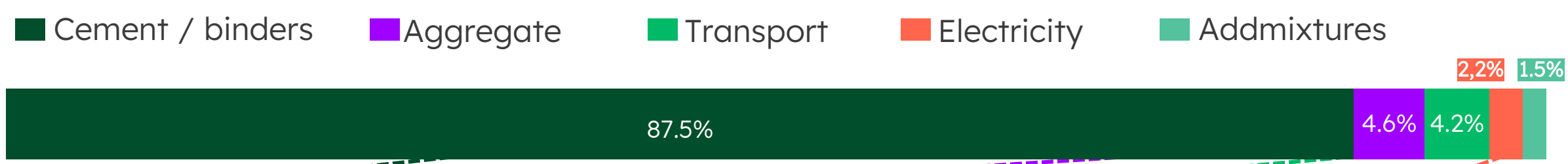


Quarry	Primary Crusher	Transport	Raw mill	Burning Fuel + Calcinating Limestone ($CaCO3 \rightarrow CaO + CO_2$)		Clinker Cooler & Finish mill
< 1%	< 1%	< 1%	2%	25%	**63%**	7%

Approx. % of CO_2 emissions based on Edmonton's 816 GWP for Type GU (CEM 1)

Calcination is largest %

Ready Mixed Concrete – Embodied CO_2 by Component & Activity



- Process technology in cement
- Alternative binding agents
- Implementation in concrete by utilising flexible concrete technology mean

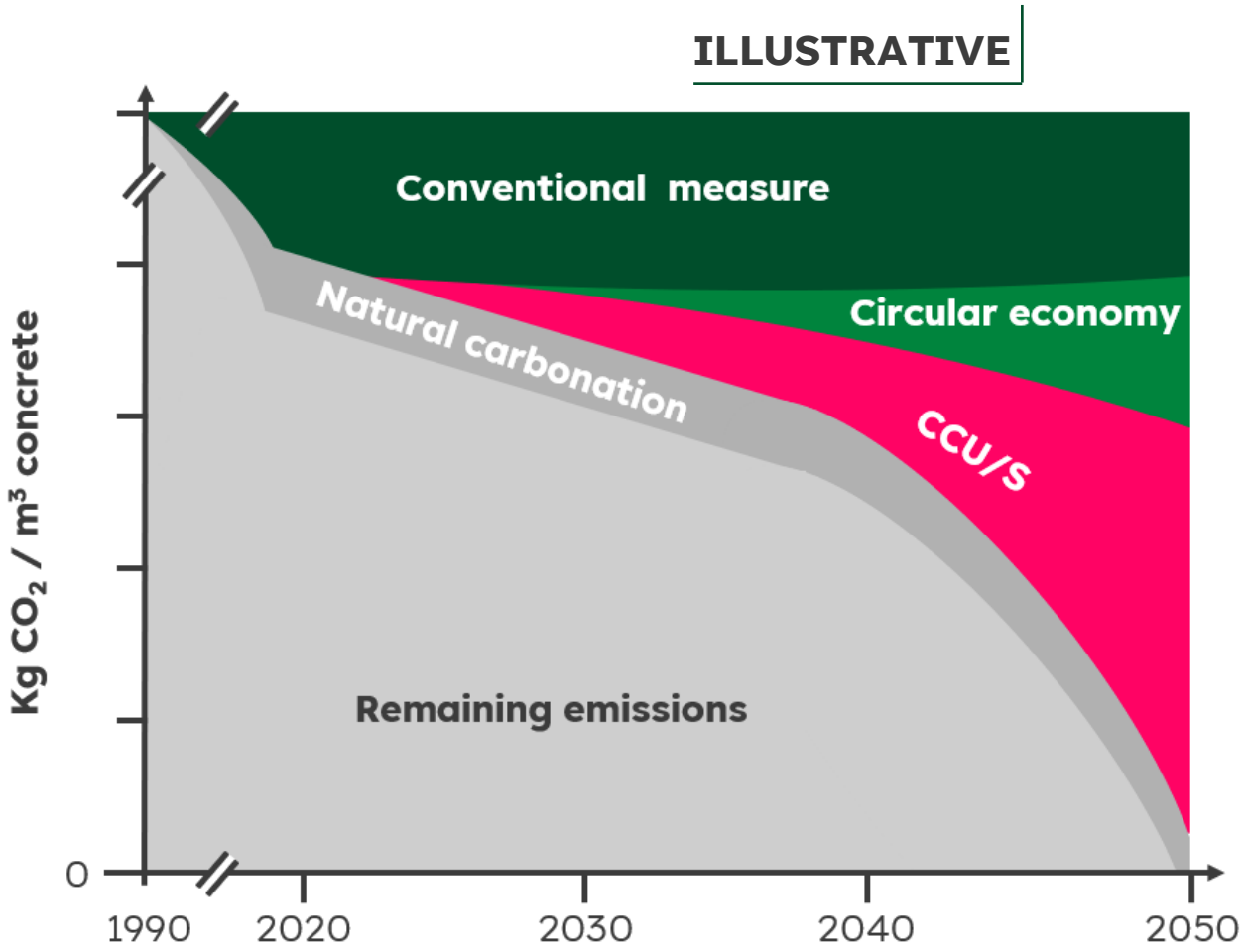
- Local, low energy and low GWP building materials are a central. An uncounted CO_2 success factor

- Efficient logistics
- Utilising state-of-the-art drive units
- Openness for new technologies

- Renewable energy is a usable benefit today

CO_2 in concrete is more than just cement

4 levers are required to reach Net Zero



- We target **net zero 2050**
- **4 main levers** to get there
- CCUS projects planned in **several waves**

Net Zero only realistic with CCUS as key lever

Our Industry-leading Concrete Promises

10mt

cumulative CO_2 reduction through CCUS by 2030

400kg CO_2/t cementitious material as average across the whole portfolio in 2030[1]

47% emission reduction[2] across the cementitious materials portfolio by 2030

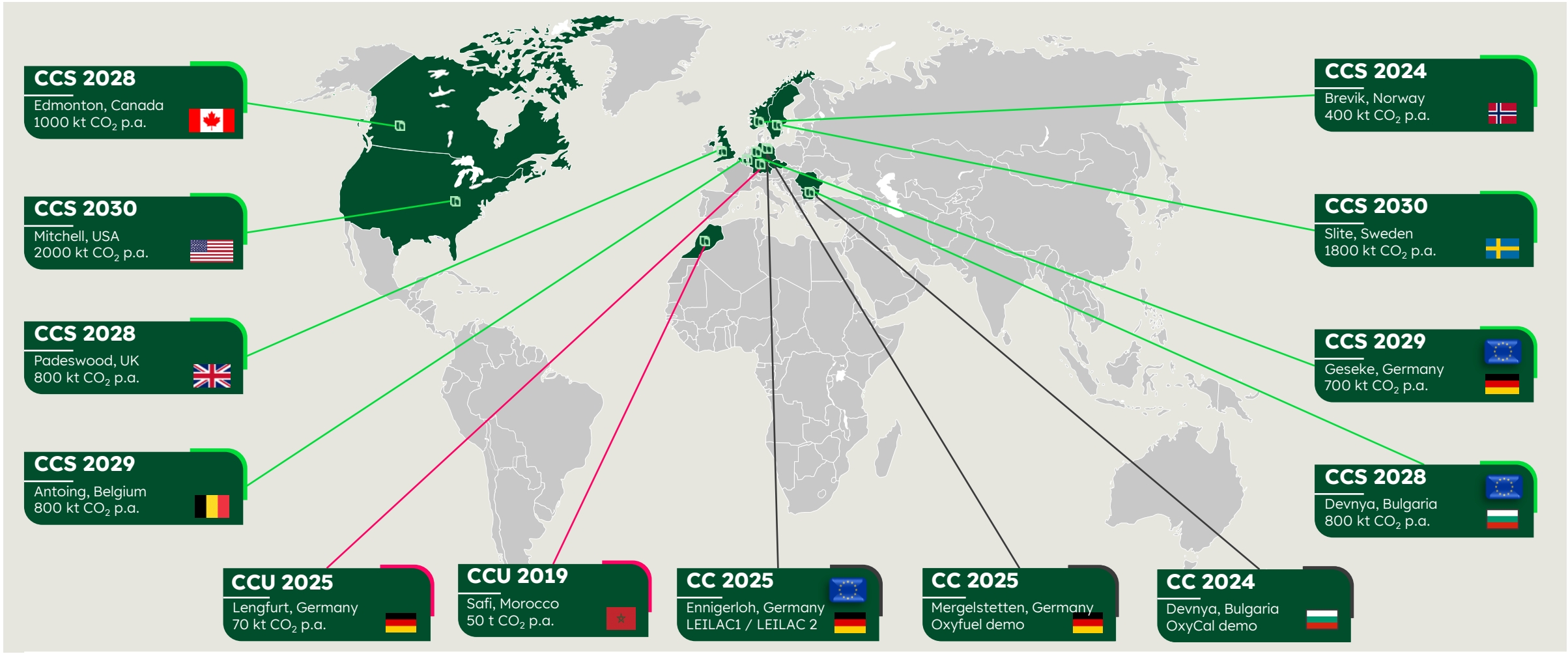
50% of our revenue will be generated from sustainable products by 2030

Corporate carbon footprint reduction in line with SBTi 1.5°C path by 2030

[1] Scope 1, 2 acc. to GCCA

[2] Reference year 1990 with an average of 750 kg CO2/t of cementitious material

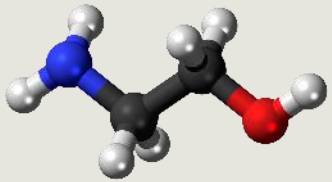
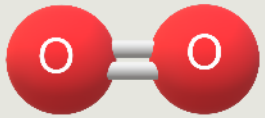
We have extensive and most advanced project portfolio in the sector



We will capture 10 Mt CO_2 cumulatively and invest 1.5b€ by 2030

EU funded projects

We continuously explore and invest in capture technologies

	Amine technology	Oxyfuel based technology[1]	Cryogenic technology	Other new capture technologies
				▪ **LEILAC** ▪ Membrane ▪ MOF[2] ▪ Potassium
Maturity				
Energy use				
Cost efficiency				

- **Diversified portfolio approach, to mature different technologies**
- **Intelligent combination of different technologies**

1 - Combination with other technology necessary
2 - Metal-organic framework

Carbon Capture and Storage

- **Brevik, Norway**
  - Worlds 1st Industrial Scale CCS plant
  - Operational in 2024
  - 400,000 tons/year ~ 50% of total
- **evoZero Cement**
  - For the European market

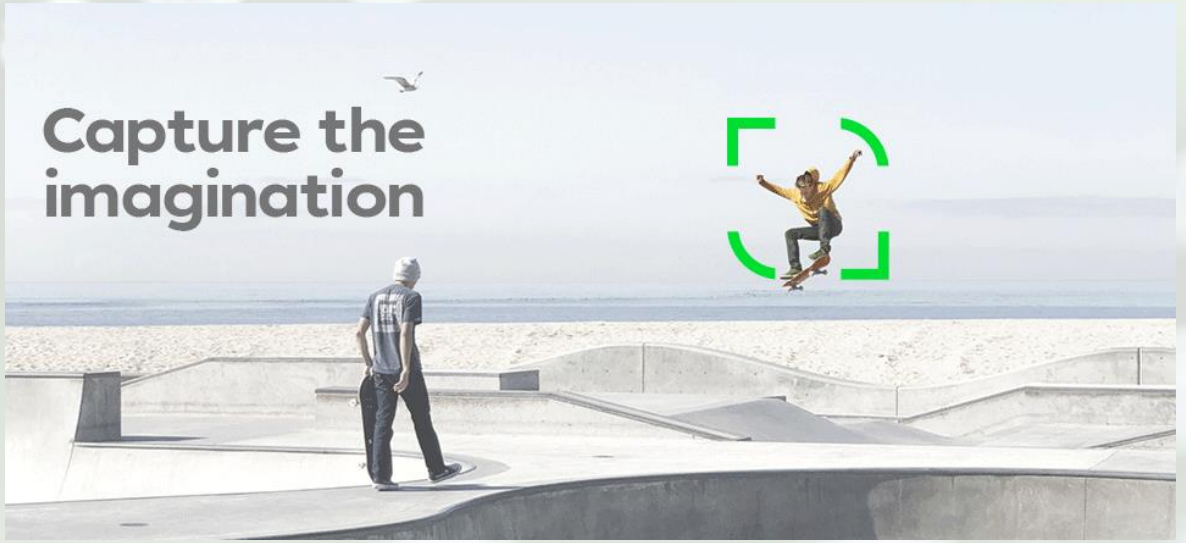
The world's 1st Net Zero cement without offsets

1st industrial scale CCUS in Brevik, Norway

Will capture ~ 400,000 tons of CO2 annually

3 things you should know about evoZero:

- **evoZero** is the world's first carbon captured net-zero cement offered at scale and without compromising on quality.
- **CCUS** is key to achieve our sustainability goals, a safe, reliable means to decarbonize our industry.
- **Available** in Europe in 2025.



After CCUS what CO_2 for Ready-mixed Concrete Production Might Look Like with CCS

Cement / binders | Aggregate | Transport | Production | Admix

evozero

- Process technology in cement
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CO_2 in concrete is more than just cement

Edmonton’s Net Zero Future

1 million

mt CO_2 p.a.

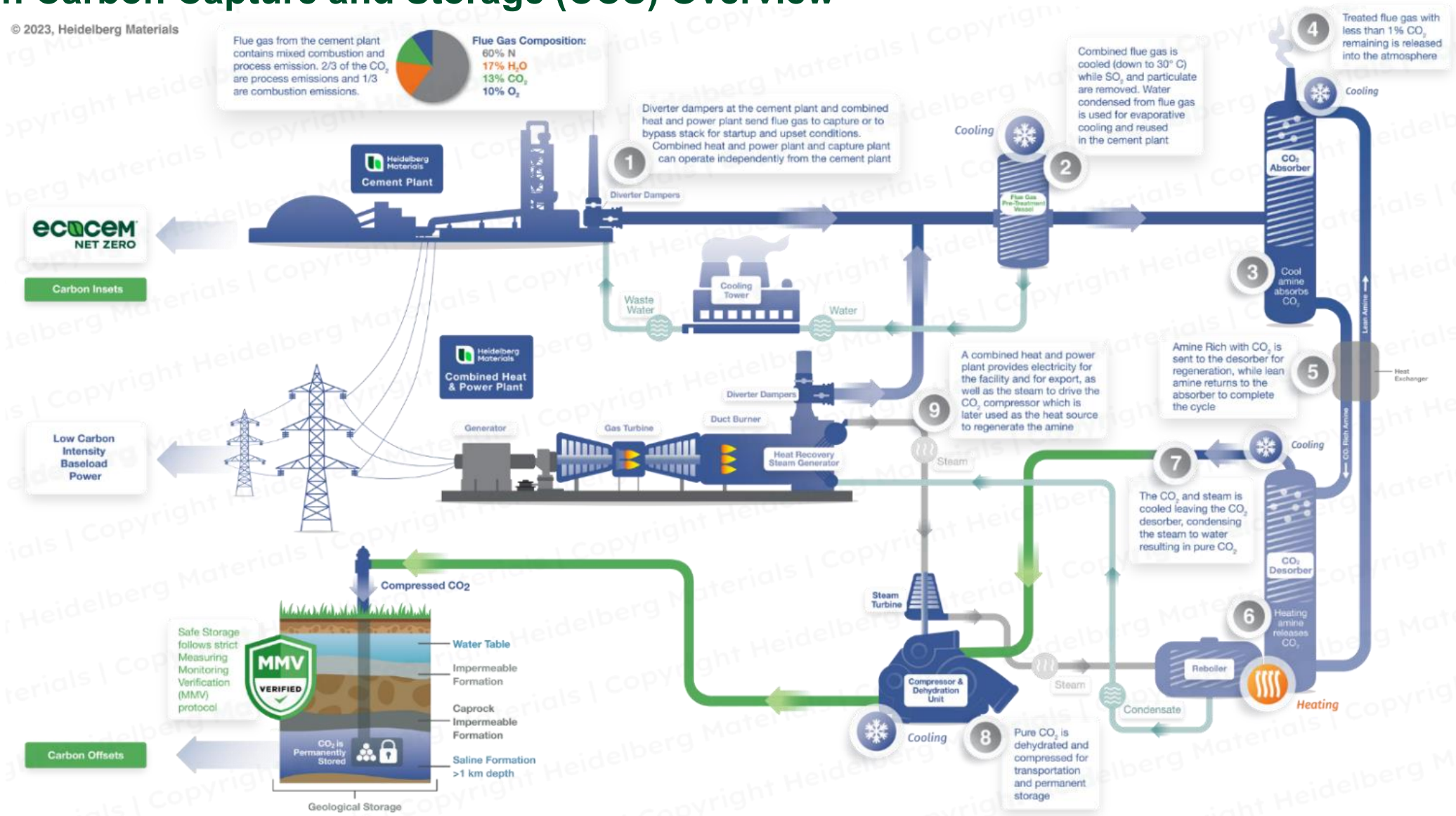
Scope: Amine-based CO_2 removal system & combined heat & Power plant

Status: Feasibility study complete and project preparation well on track (Commissioning: 2028)

Objective: The world’s first full-scale carbon neutral cement plant

Rendering Edmonton, Alberta

Edmonton Carbon Capture and Storage (CCS) Overview



Mitchell, IN – Carbon Capture Utilization and Storage (CCUS) - by 2030

2 million

mt CO_2 p.a.

Scope: Amine-based CO2 removal system, targeting 2mt CO_2 annually at 95% rate

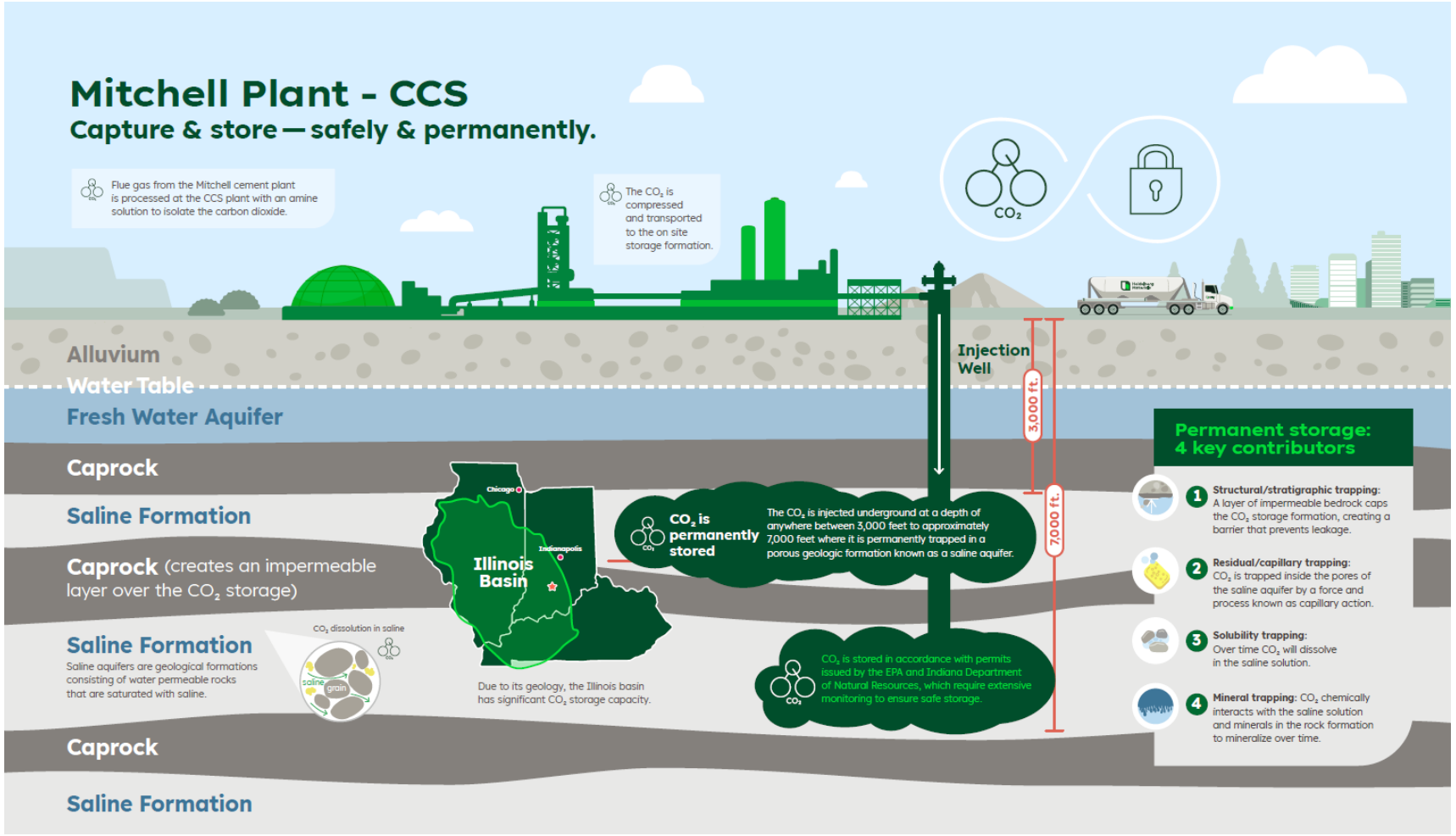
Status: Feasibility study for capture and onsite storage onsite; three (3) DOE grant awards

Objective: The first full-scale carbon neutral cement plant in the United States

Carbon Capture & *Permanent* Storage

Storage

- CO2 to be stored in deep saline reservoirs
- Permanent storage 1,500-3,000 meters below ground in porous brine filled rock under multiple layers of impermeable cap-rock
- Far below potable water and oil and gas reservoirs
- Current known global storage capacity 40 million tons/yr.
- Storage capacity and efficacy subject to MMV (Measurement, Monitoring, and Verification)



Edmonton Carbon Capture and Storage Overview

Storage

- CO_2 to be stored in deep saline reservoirs
  - Permanent storage 1,500-3,000 meters below ground in porous rock filled with brine with multiple overlying layers of impermeable cap-rock
  - Far below potable water and oil and gas reservoirs
  - Current global storage capacity 40 million tons/yr.
- Examples of CO_2 Storage
  - Alberta – Shell's Quest project has permanently stored over 6 million tons of CO2 since 2015
  - Saskatchewan – Aquistore project permanently stored 500,000+ tons of CO_2 annually since 2015
  - Illinois – Decatur project permanently stored over 1 million tons from 2011 to 2014

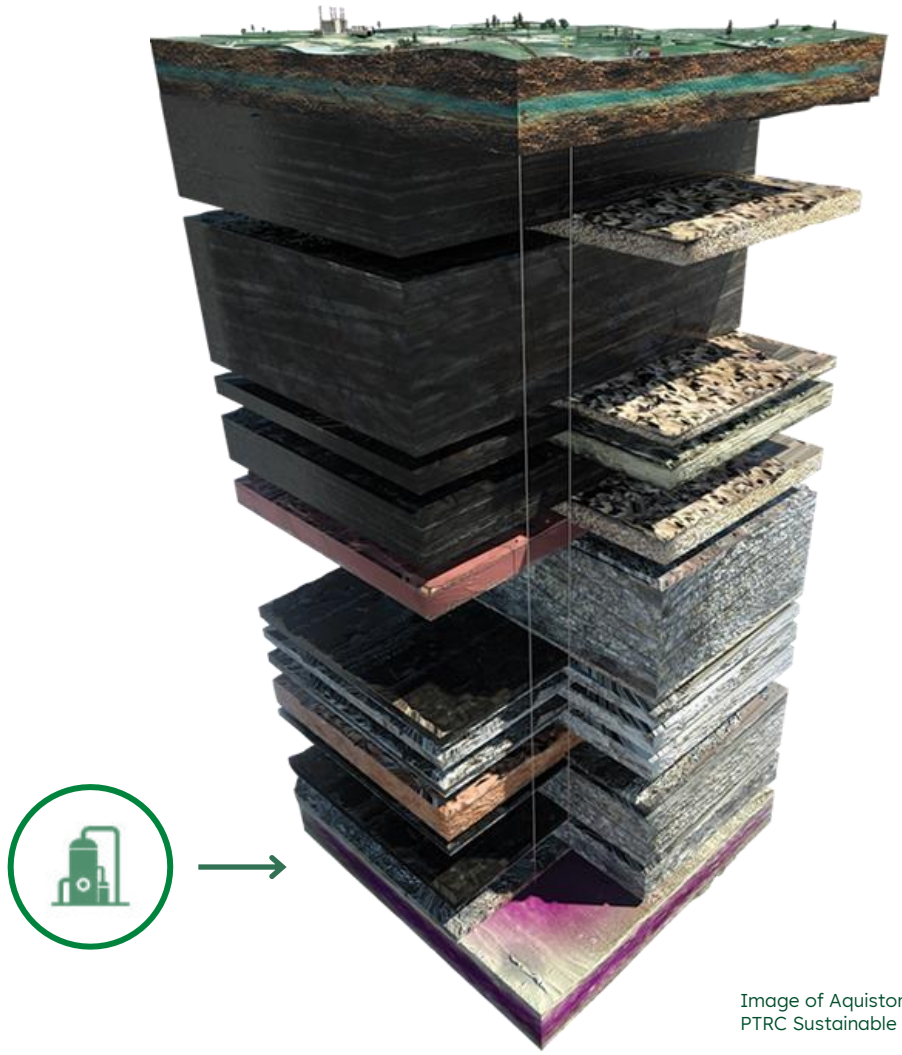
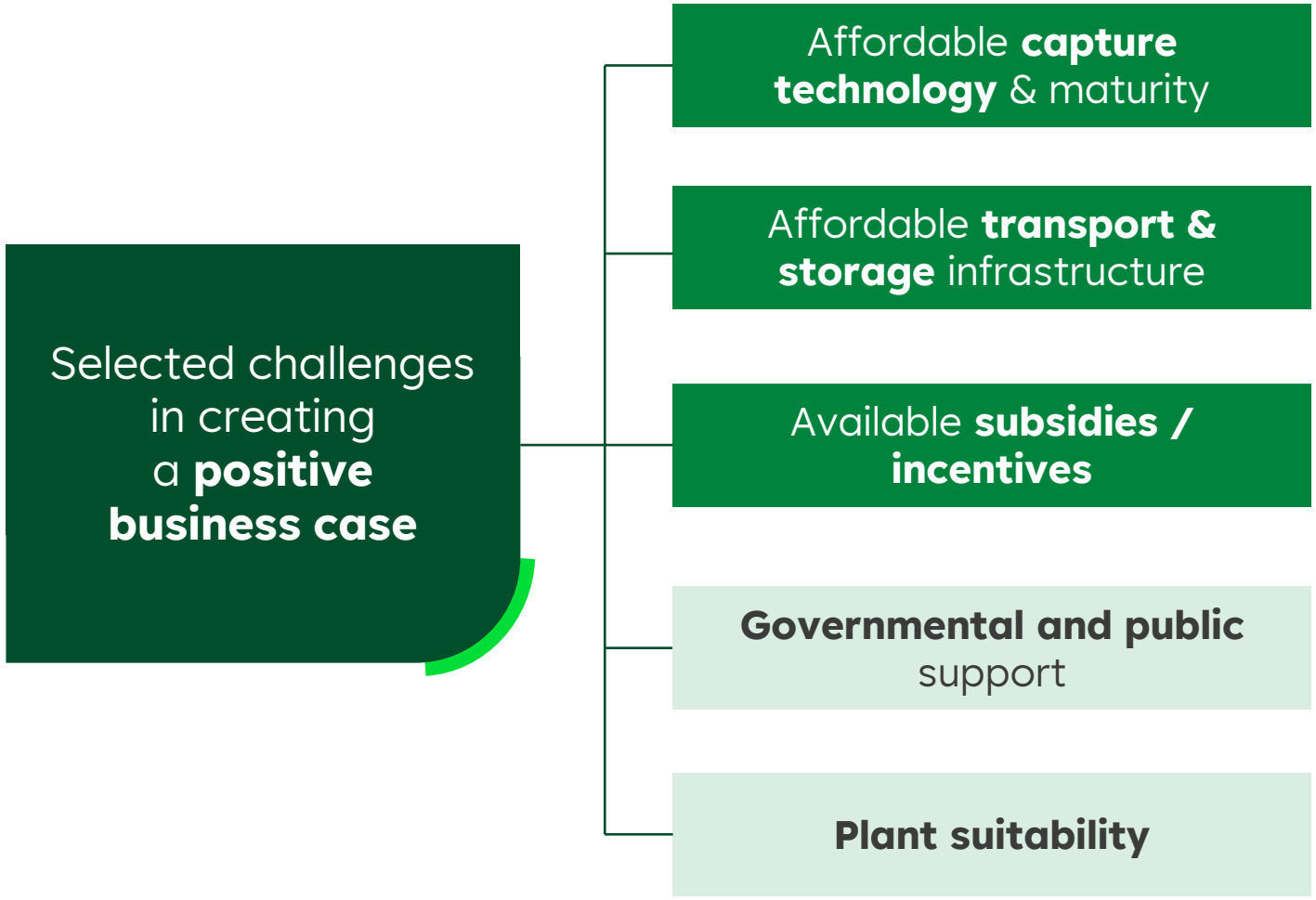


Image of Aquistore site courtesy PTRC Sustainable Energy

How to make the CCUS business case work?



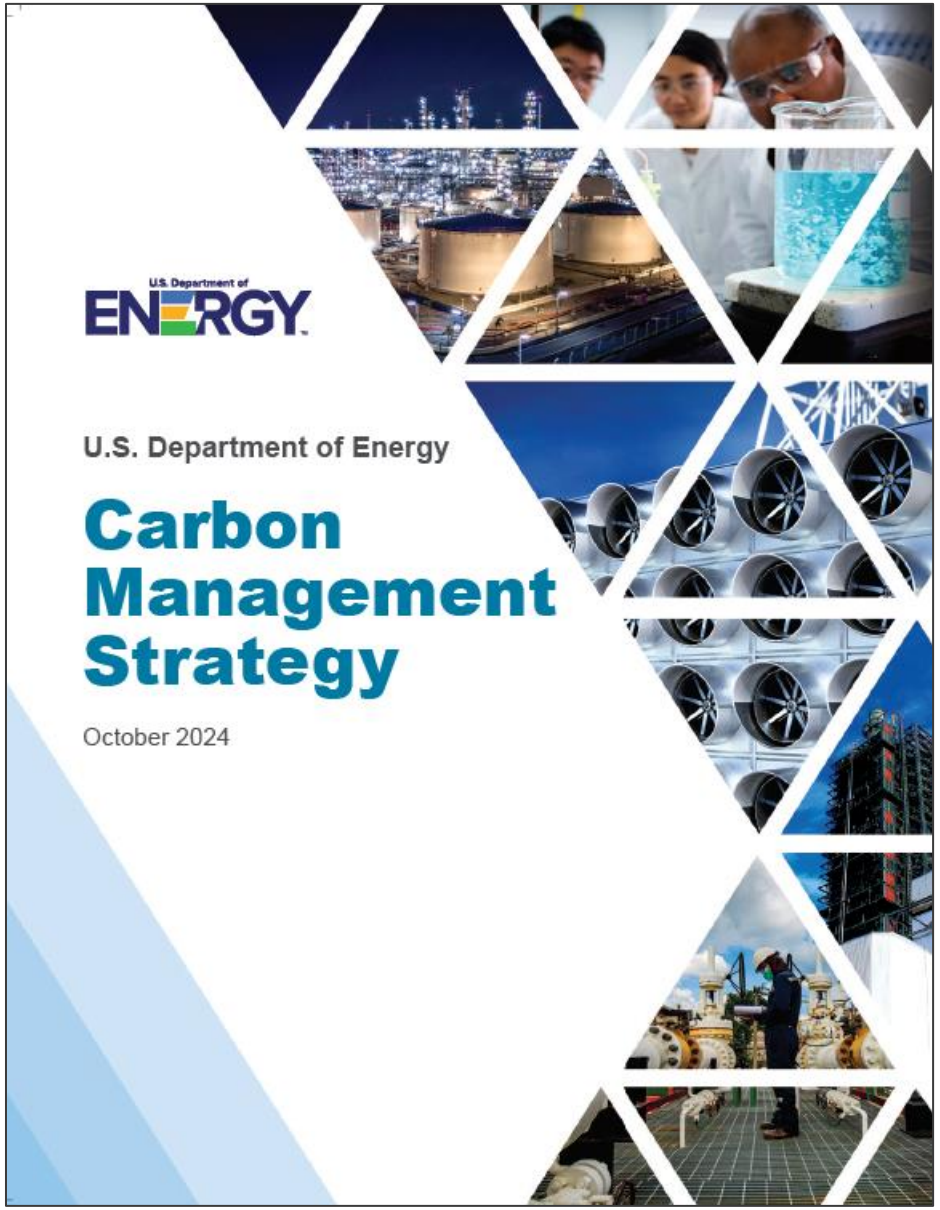
SELECTED HIGHLIGHTS, NOT EXHAUSTIVE

- Existing capturing technology comes at high CAPEX/OPEX
- Transport networks need to be created
- Storage areas need to be established
- Current market does not allow for positive business cases without subsidies
- Permitting barriers / timelines and public education must be improved
- Carbon storage and physical space requirements must match needs

Market Forces and CCS Infrastructure

Primary Drivers

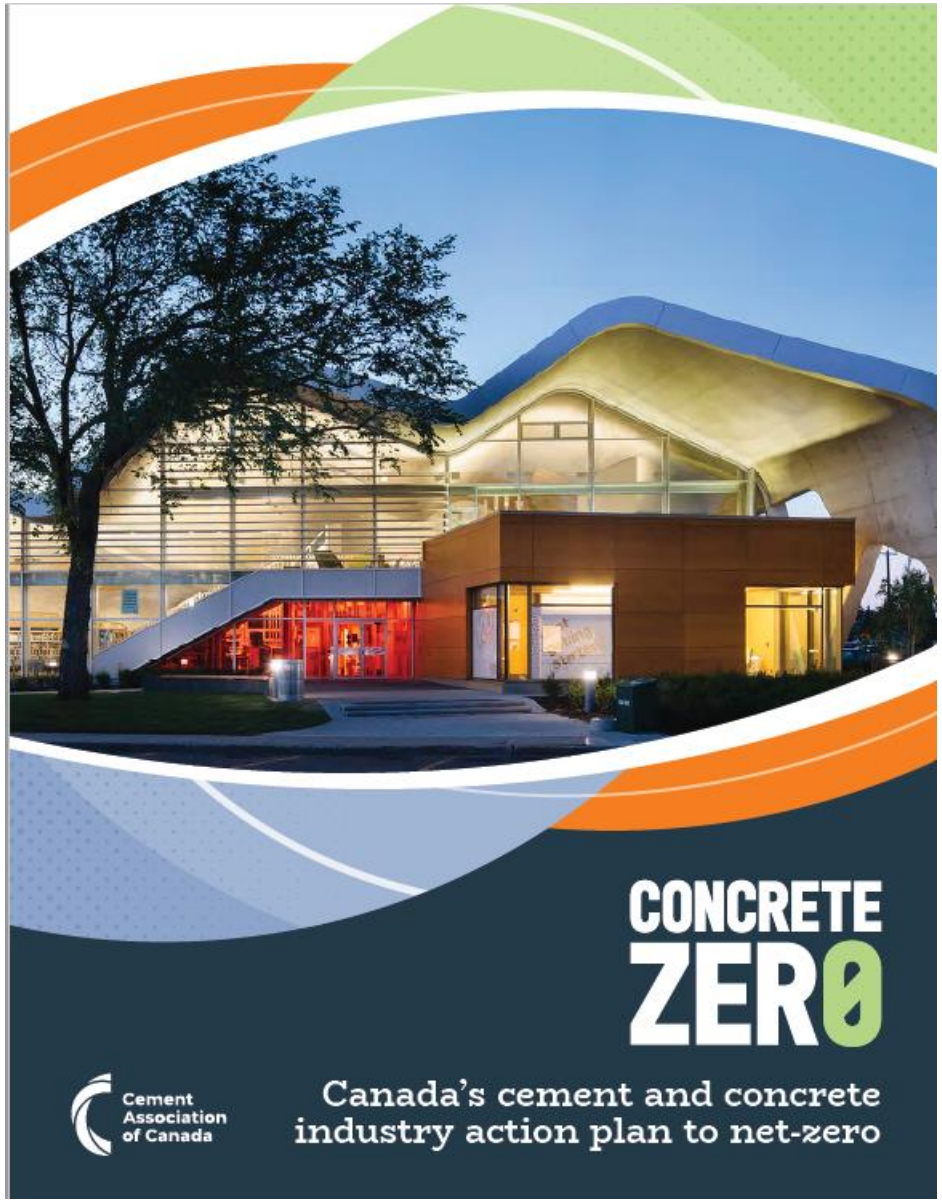
- Private Industry Business Cases / ESG Commitments
  - I.e. Heidelberg Materials Sustainability Commitments 2030
  - PCA Roadmap to Carbon Neutrality
  - CAC – Concrete Zero Action Plan
  - GCCA Concrete Future, The GCCA 2050 Cement and Concrete Industry Roadmap for Net Zero Concrete
- Governmental Spending - US
  - Buy Clean Initiatives from GSA / FHWA / DOD
  - 45Q Tax Credit for Carbon Sequestration
  - Department of Energy grants and programs



Market Forces and CCS Infrastructure

Primary Drivers

- Governmental Spending - Canada
  - SIF – Strategic Innovation Fund
  - ITCs - Carbon Capture, Utilization and Storage (CCUS) ITC, Clean Economy Investment Tax Credits
  - CIB - The Canada Infrastructure Bank
  - Canada Growth Fund - CGF
  - ACCIP - Alberta Carbon Capture Incentive Program



Market Forces and CCS Infrastructure

US Department of Energy Grants and Programs

- The Carbon Storage Assurance Facility Enterprise (CarbonSAFE)
- The Carbon Dioxide Transportation Infrastructure Finance and Innovation (CIFIA) Program
- The Regional Direct Air Capture Hubs Program
- The Regional Initiatives Program
- The Communities Local Energy Action Program (LEAP) Program

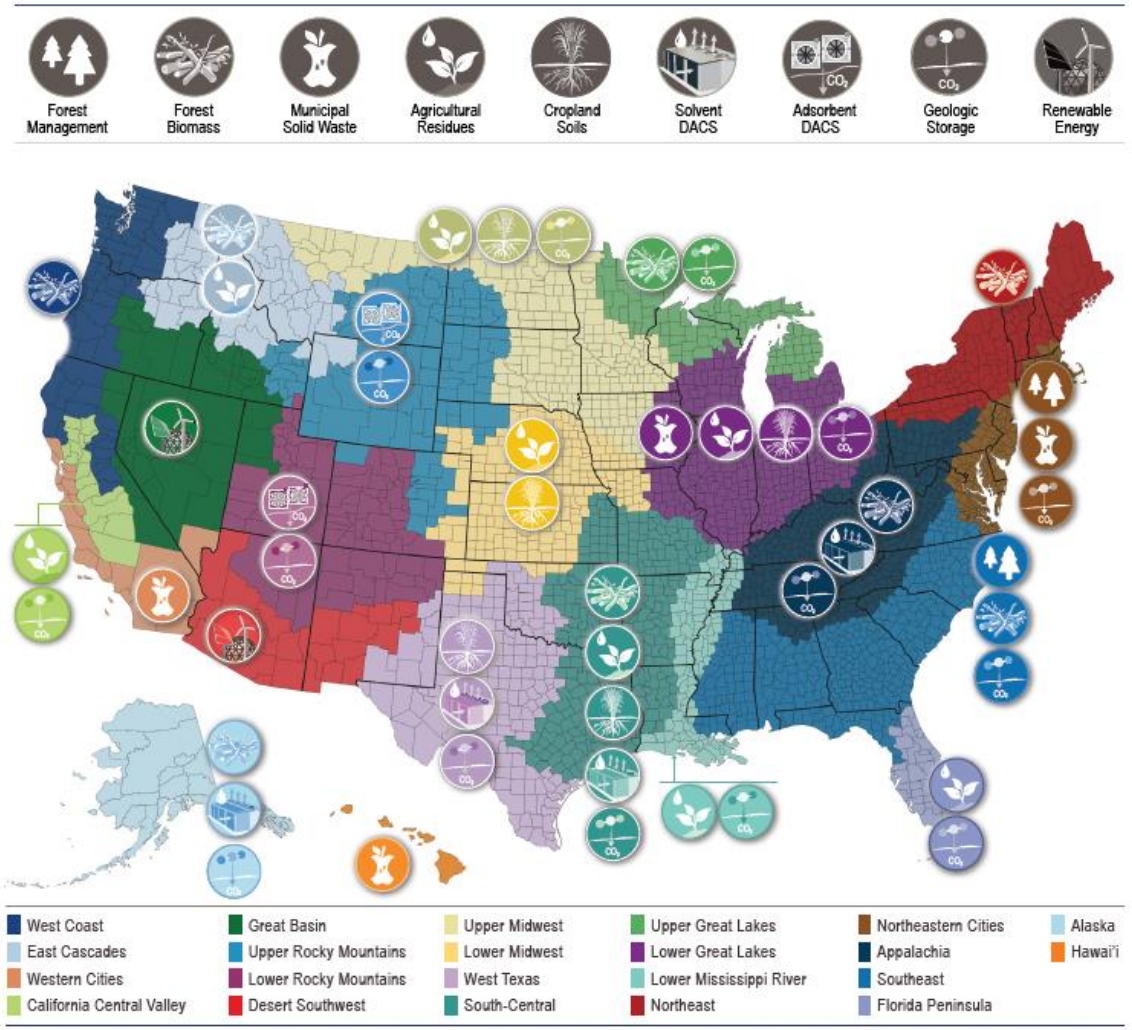


Figure 10-1. *Regions map with county delineation and primary carbon-removal resources. Regional boundaries are delineated based on quantitative assessments of carbon-removal resources with boundary conditions such as requiring each region to be contiguous, including bodies of water. The icons qualitatively highlight key regional resource contributions to CO_2 removal.*

Market Forces and The Bottom Line

Cost Effective (Not Cheap) Decarbonization – Source DOE Carbon Management Strategy 10/2024

- DOE cost estimates $ / tonne – Top 4
  1. Refining **244 MMT** @ $90 - $170
  2. Iron/Steel **100 MMT** @ $90-$160
  3. Pulp and Paper **80 MMT** @ $160 - $290
  4. Cement **66 MMT** @ $90 – 140
- Direct Air Capture & Storage @ $600 - $1,180

Project Costs Estimates @ 100% Premium

- **= 2% - 5% of Building Construction Cost**

Use-case	Sector/Source	Current U.S. Emissions (MMT CO2)	Estimated Cost Range ($/tonne)
Industrial Decarbonization	Refining	244	90-170
	Iron/Steel	100	90-160
	Pulp and Paper	80	160-290
	Cement	66	90-140
	Natural Gas Processing	59	60-90
	Petrochemicals	55	90-170
	Fertilizer	36	100-180
	Liquefied Natural Gas	17	No data
Carbon Dioxide Removal	Direct Air Capture with Storage	N/A	600-1,180

Takeaways & Key Points

- **CCS / CCUS necessary to reach decarbonization goals**
- **Public support and permit reform will enable implementation**
- **Amine technology is “current best practice”**
  - Is proven technology already in use by different sectors
  - Is economically viable despite increased cost
  - Meets scale needs and is “mature” technology
- **Carbon hubs and clusters can use common pipelines**
- **Safe and effective with MMV**
- **Are economically viable despite increased cost**
  - Even at + $140 / tonne cost to typical projects is 2% - 5%
  - Lowest industrial decarbonization cost

Thank you

Questions?

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