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WORLDWIDE PETROLEUM CONSULTANTS

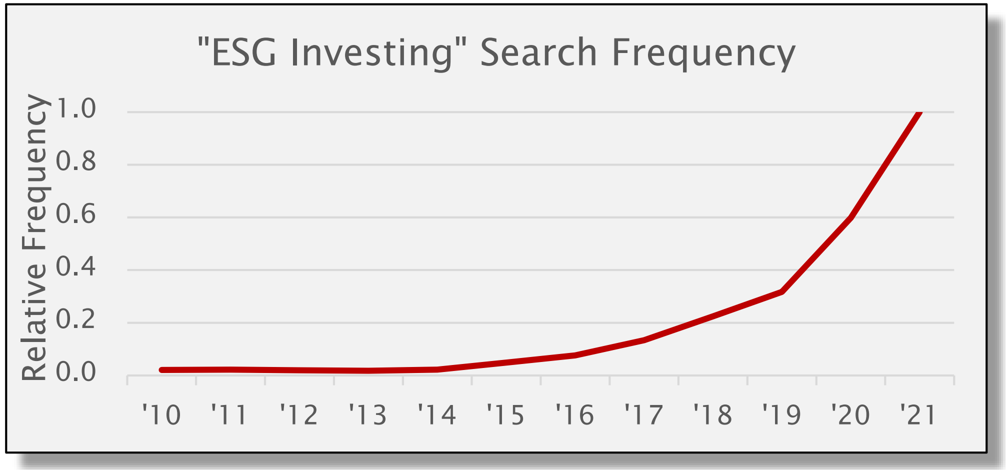
Carbon Capture, Use, and Storage

An Opportunity for the Oil & Gas Industry

The Oil & Gas Conference
August 18, 2021

Joe Mello

Interest in ESG Investing is Growing



wsj.com

Carbon Capture is Key to Companies' Net Zero Pledges

Another widespread technique is carbon capture and storage, or CCS, where CO2 is removed from factory chimneys and pumped underground or stored in a solid form. The method has been around for decades, but until recently wasn't widespread. The economics didn't add up, partly because the carbon prices charged in Europe and the carbon-capture tax credit paid in the U.S. were too low.

Bloomberg.com

Occidental to Strip Carbon From the Air and Use It to Pump Crude

- A new technology could help reduce pollution at the same time it increases the supply of fossil fuels

jpt.spe.org

ExxonMobil Doubles Down on Carbon Capture in $3-Billion Plan To Lower Emissions

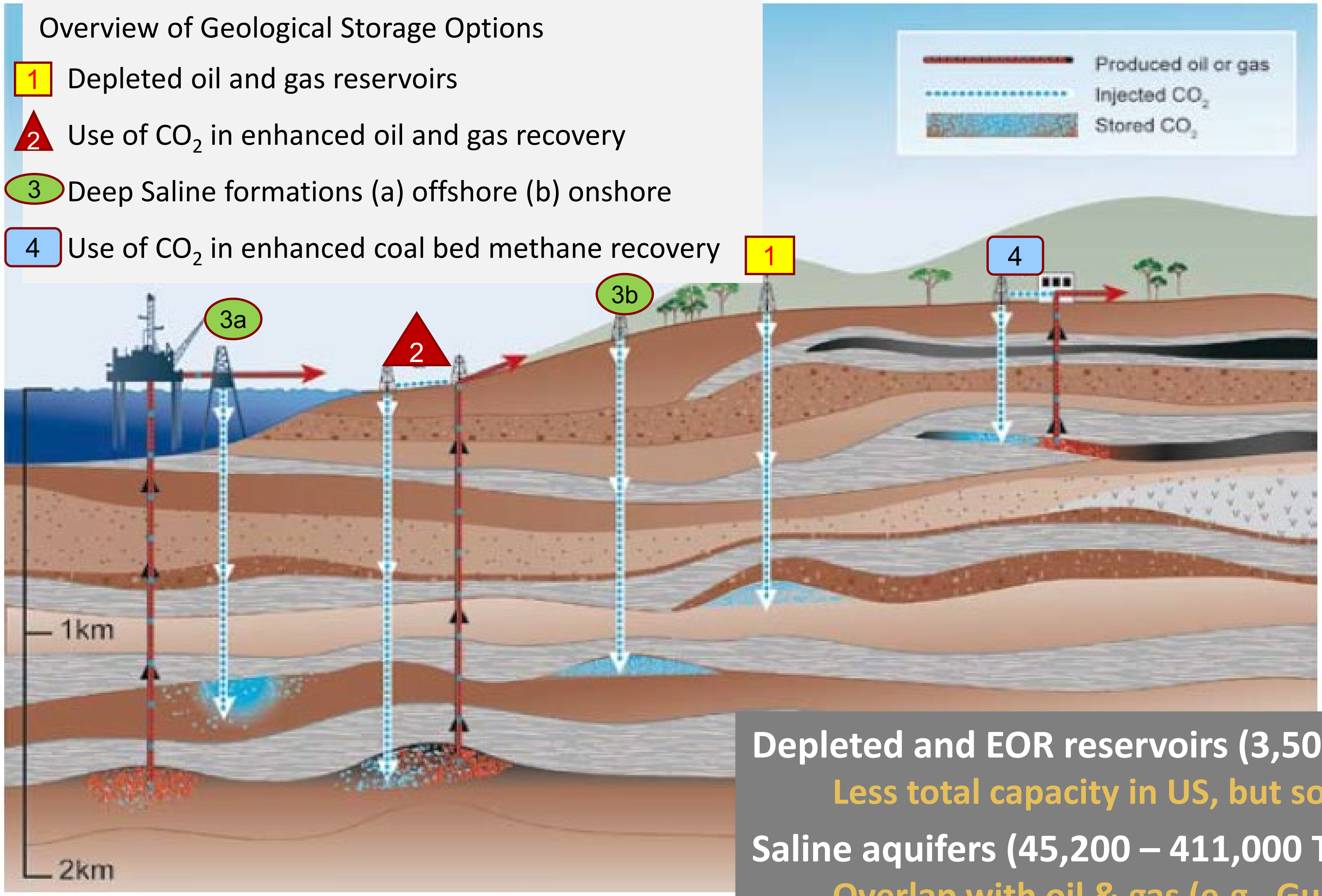
The US oil giant is launching a new business unit that will boost its ability to reduce its own greenhouse gas emissions along with those of other industries.

theguradian.com

BP leads energy companies preparing two major UK carbon capture projects

17m tonnes of carbon dioxide to be stored beneath the North Sea every year

Types of Carbon Storage



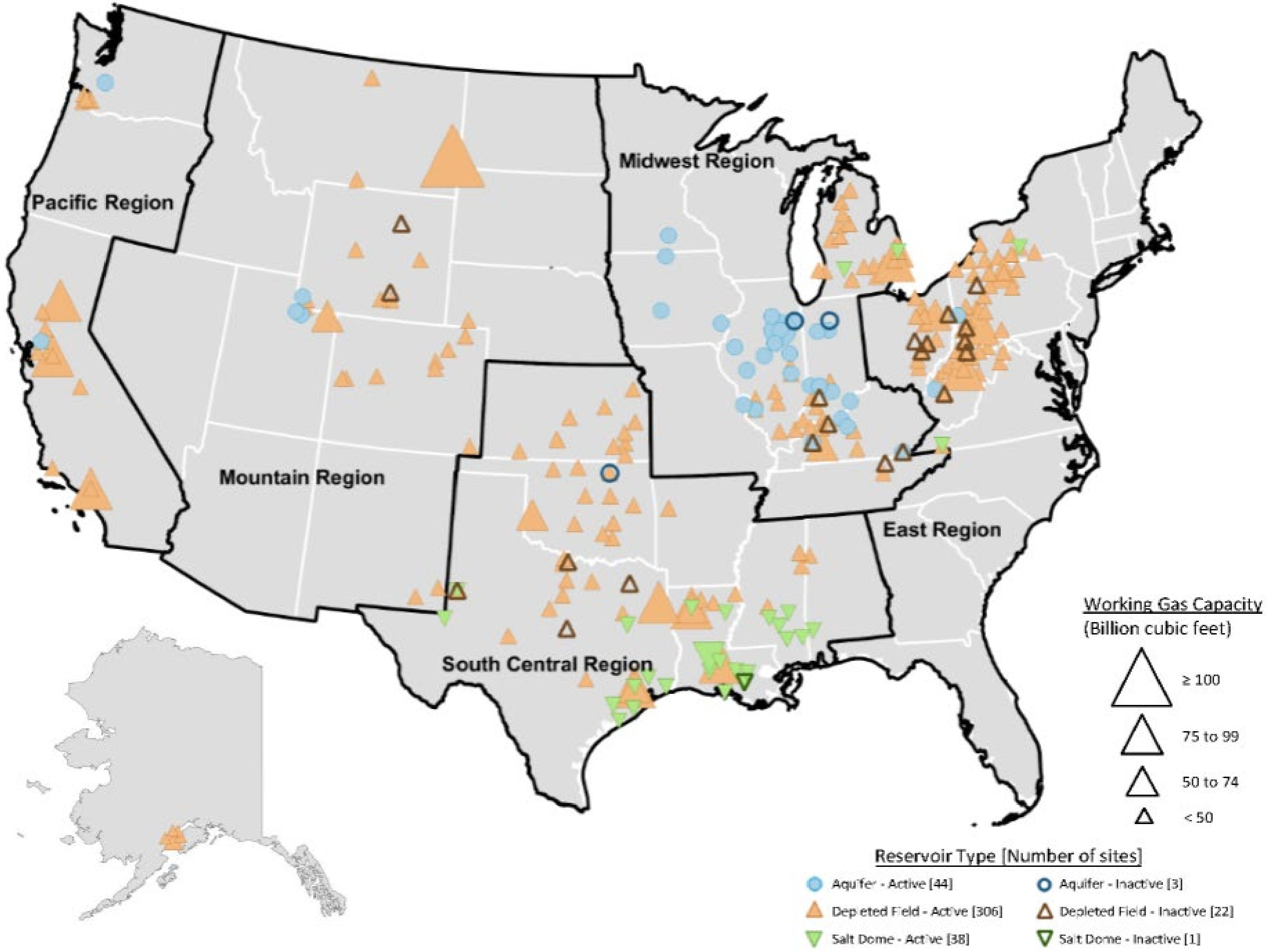
Source: IPCC "Carbon Capture Special Report"

Depleted and EOR reservoirs (3,500 – 4,400 TSCF)
- Less total capacity in US, but some advantages

Saline aquifers (45,200 – 411,000 TSCF)
- Overlap with oil & gas (e.g., Gulf Coast)
- New frontiers (IL, Atlantic shelf)

Underground Storage in the US

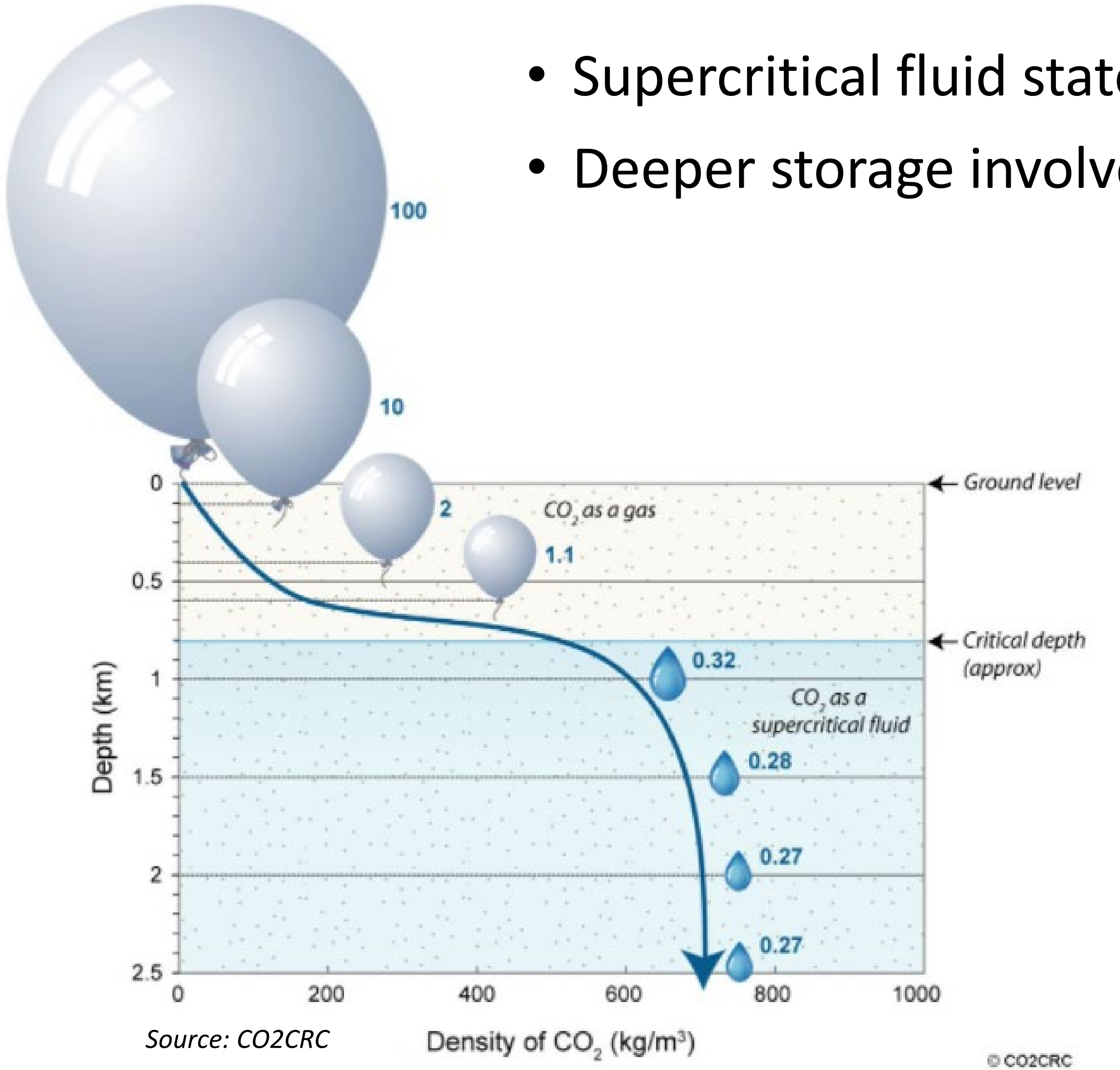
U.S. Underground Natural Gas Storage Facility, by Type (December 2017)



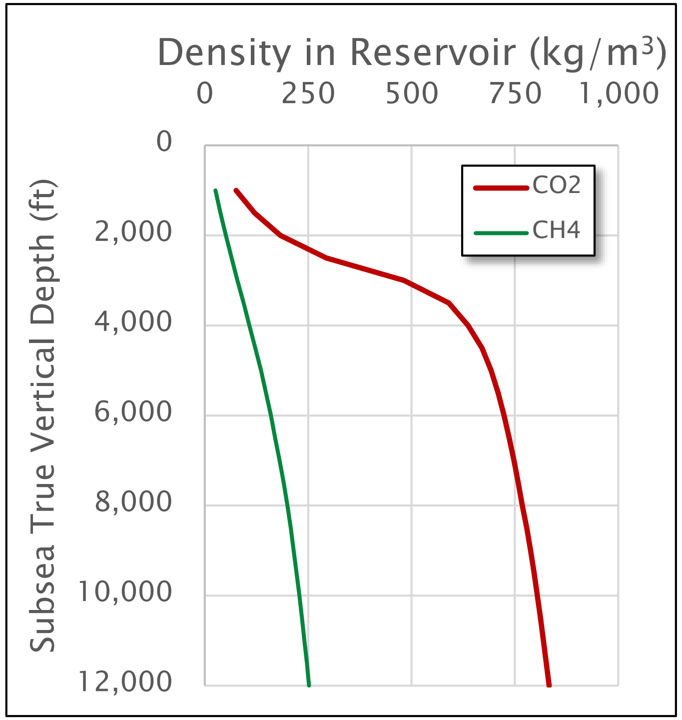
Source: EIA

CO_2 Has Unique Properties For Geologic Storage

- Supercritical fluid state enables very dense storage below ~3,000'
- Deeper storage involves higher costs



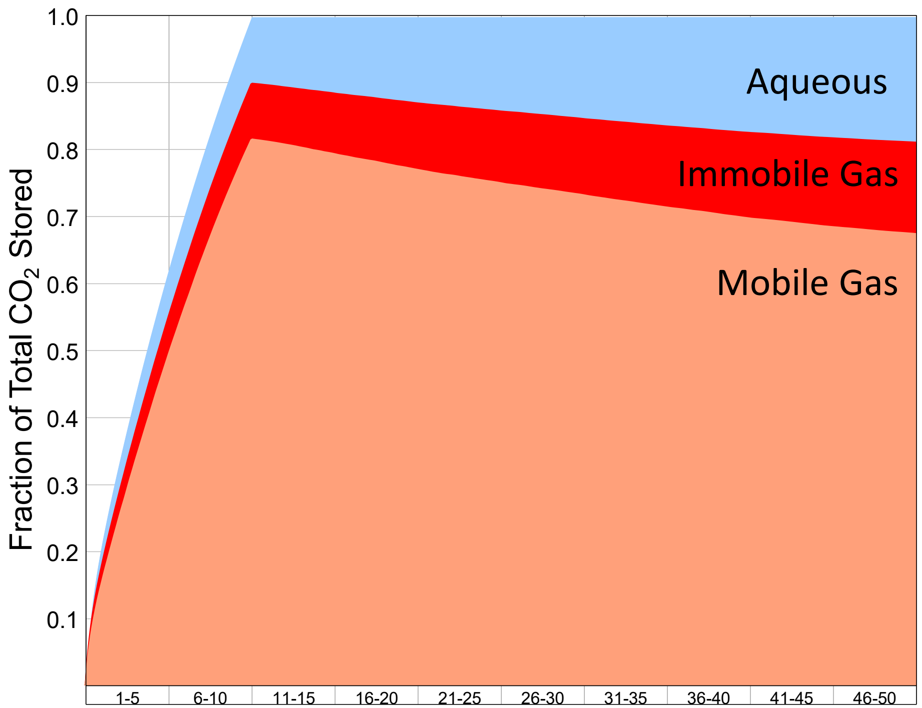
Source: CO2CRC



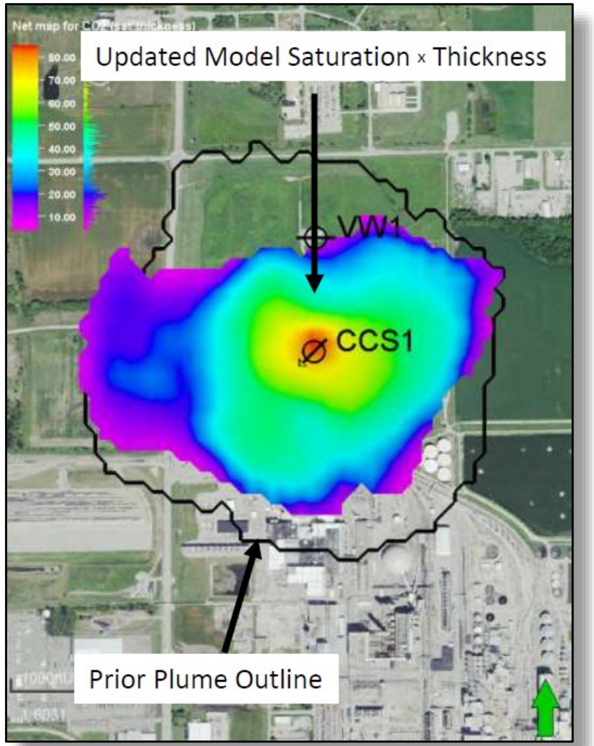
This example is based on coastal Louisiana P and T trends; shows diminishing density benefits below ~6,000'

CCS Technical Evaluations

- Subsurface assessments of these projects rely heavily on simulation modeling
  - Relatively few carbon sequestration projects are online as analogs
  - Contrast to E&P projects where analogy and volumetrics are reliable pre-production
  - Modeling also plays a key role in monitoring requirements (Area of Review)

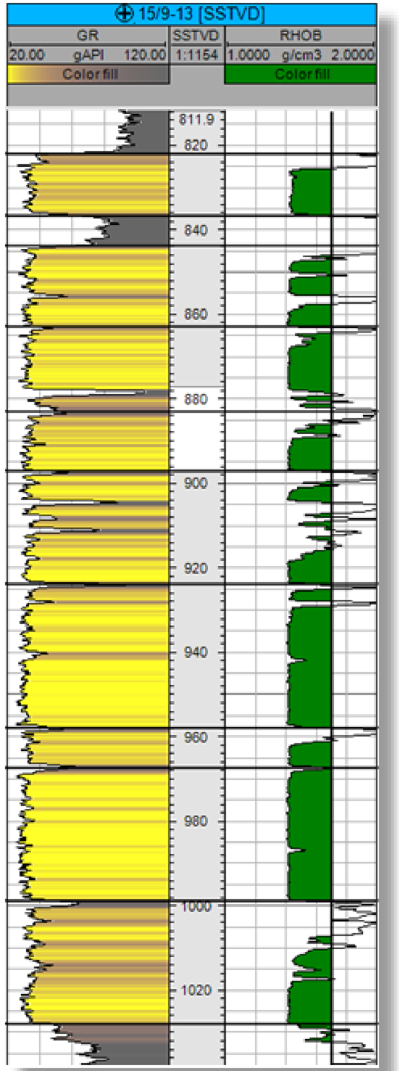


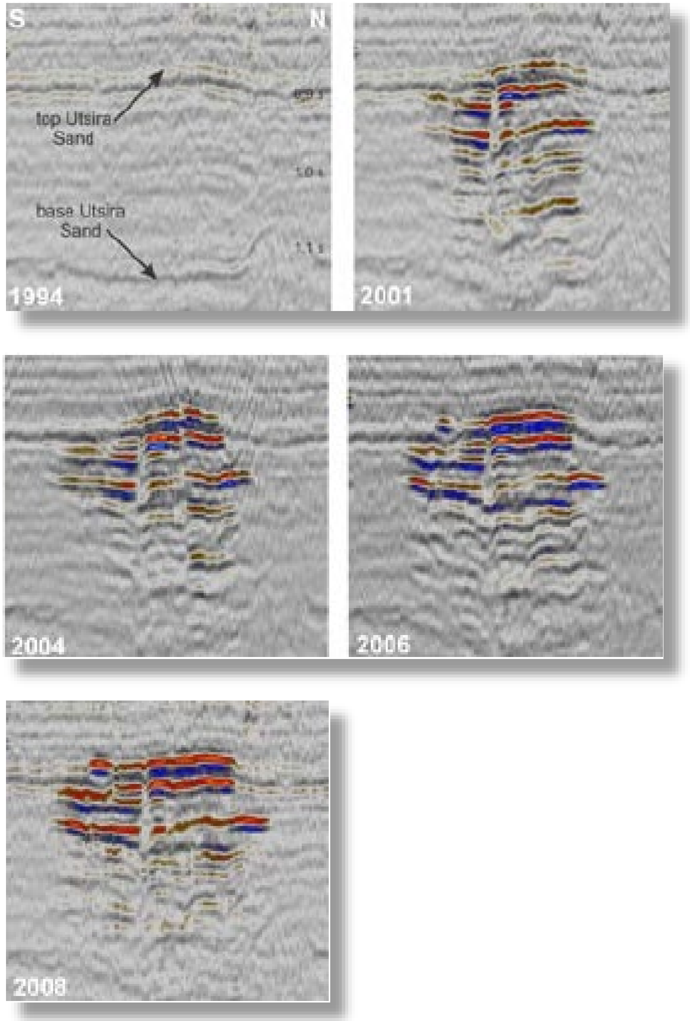
Simulated storage mechanisms over time in one saline aquifer



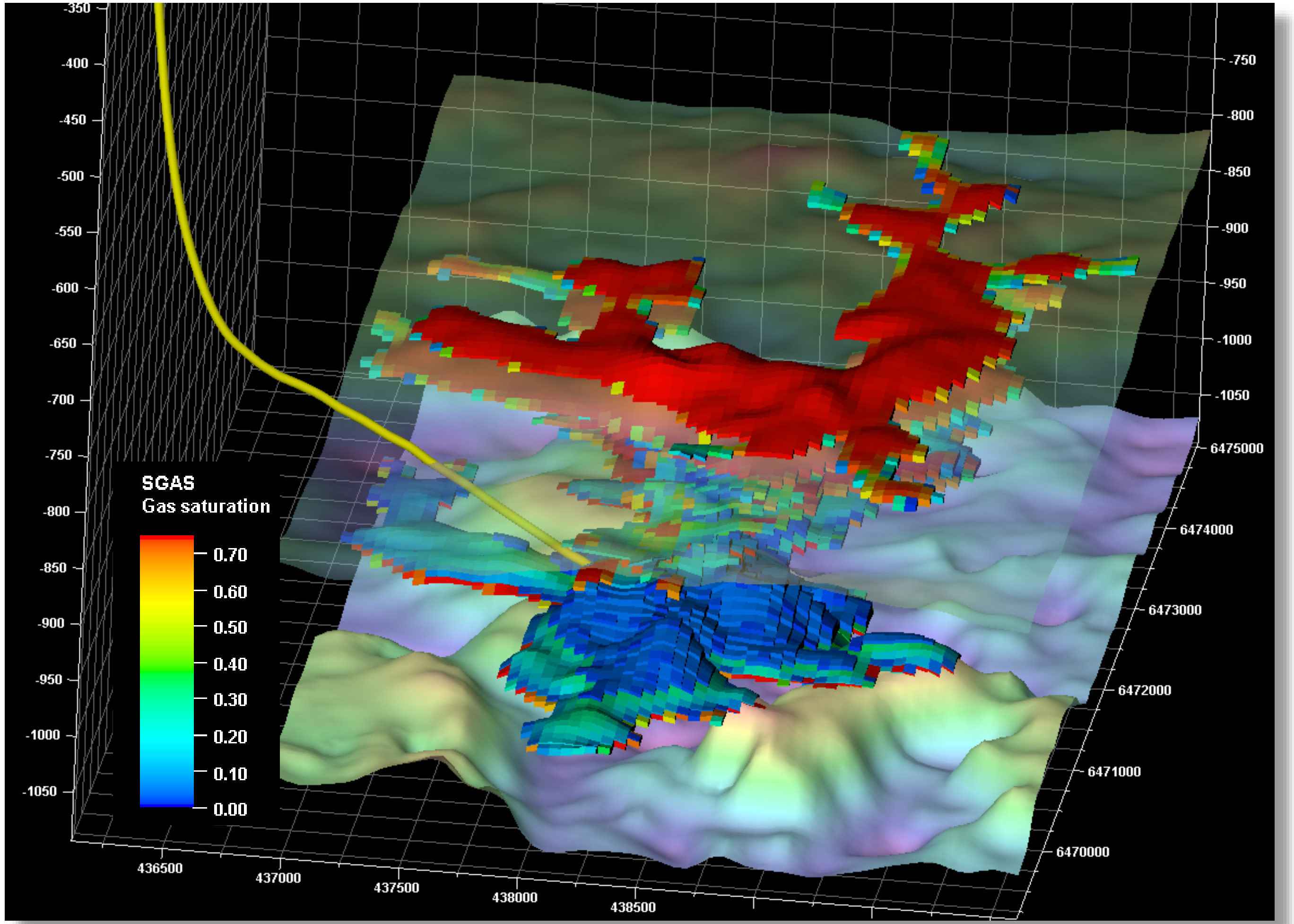
Source: Illinois State Geological Survey

Sleipner Field Case Study





Source: Chadwick, R.A. (2013), Offshore CO2 storage



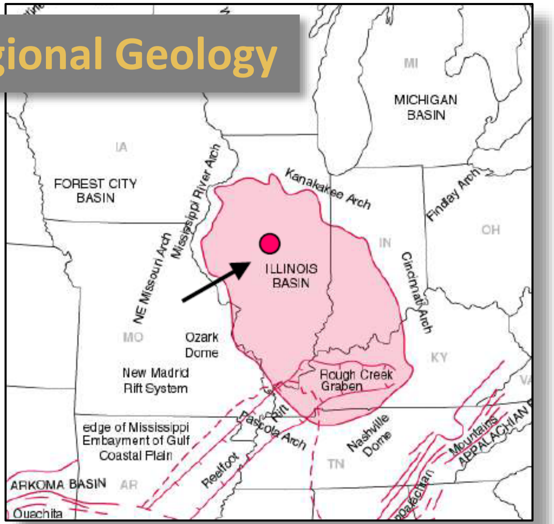
Flowstream to Cash Flow: 45Q Tax Credits

Credit per metric ton **captured** and **stored ($50)** or **utilized ($35)** from a **qualified facility**, lasting **12 years** from the in-service date, which must be under construction **before 2026**

- Storage wells require a new EPA Class VI permit
  - Only a handful of permitted wells to date
  - Monitoring, post-injection site care requirements
- "Capture Equipment" drives the credit generation
  - Separation, dehydration, compression from processes or direct air capture
  - 1 metric tonne ≈ 19 mcf
  - CO_2 worth $1.85 to $2.63/mcf – almost on par with natural gas when stored!
- Potential enhancements under new administration
  - "Infrastructure Bill" contains lots of CCUS support – permitting support, loans, grants
  - Change from tax credit to direct payments (American Jobs Plan)
  - Increase credits to $50/$85 per tonne with a 20-year term (H.R. 2633)

Characteristics of an Ideal Project

Regional Geology

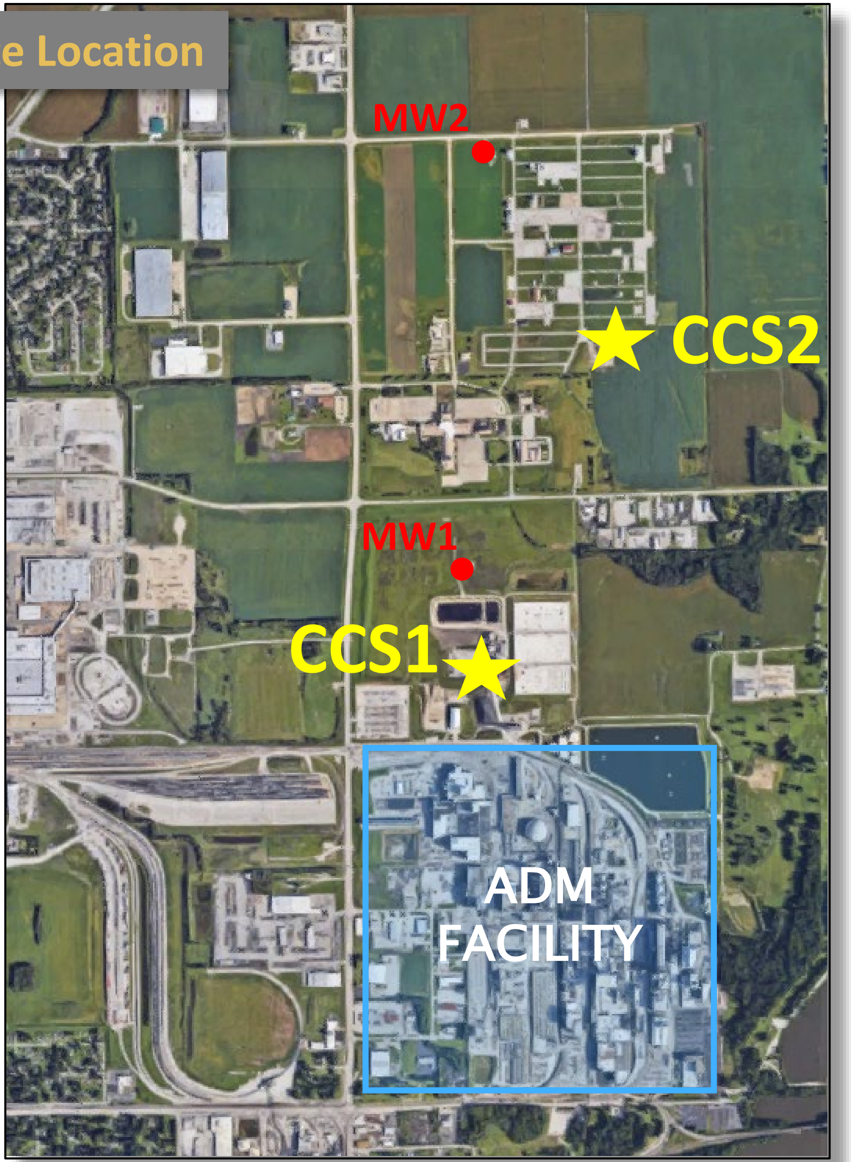


Source: Illinois Industrial Carbon Capture & Storage

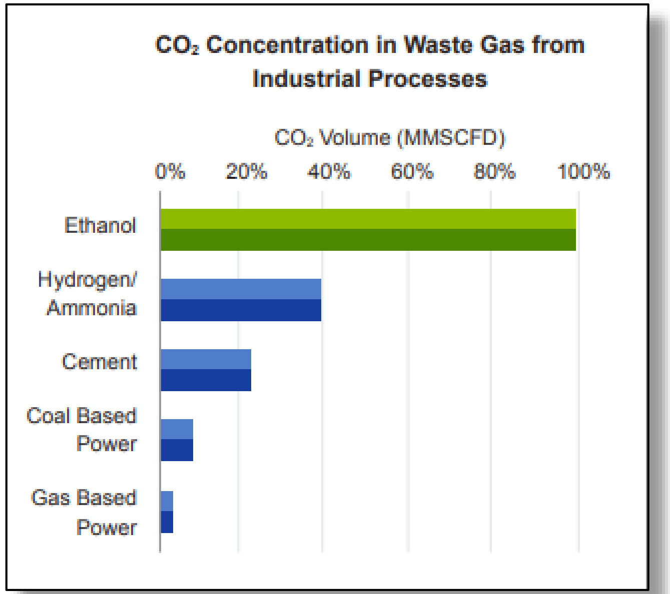
SYSTEM	GROUP	FORMATION	Storage Elements
Ordovician	Maquoketa	Brainard	Secondary Seal
		Ft. Atkinson	
		Scales	
	Galena	Kimmswick	
		Decorah	
	Platteville		
	Ancell	Joachim	
		St. Peter	Potential target
	Knox	Shakoppee	Secondary Seal/ Reservoir
		New Richmond	
		Oneota	
		Gunter	
Cambrian		Eminence	
		Potosi	Potential target
		Franconia	
		Ironton-Galesville	
		Eau Claire	Primary Seal
		Mt. Simon	Target reservoir
Precambrian			

Source: Illinois State Geological Survey

Site Location

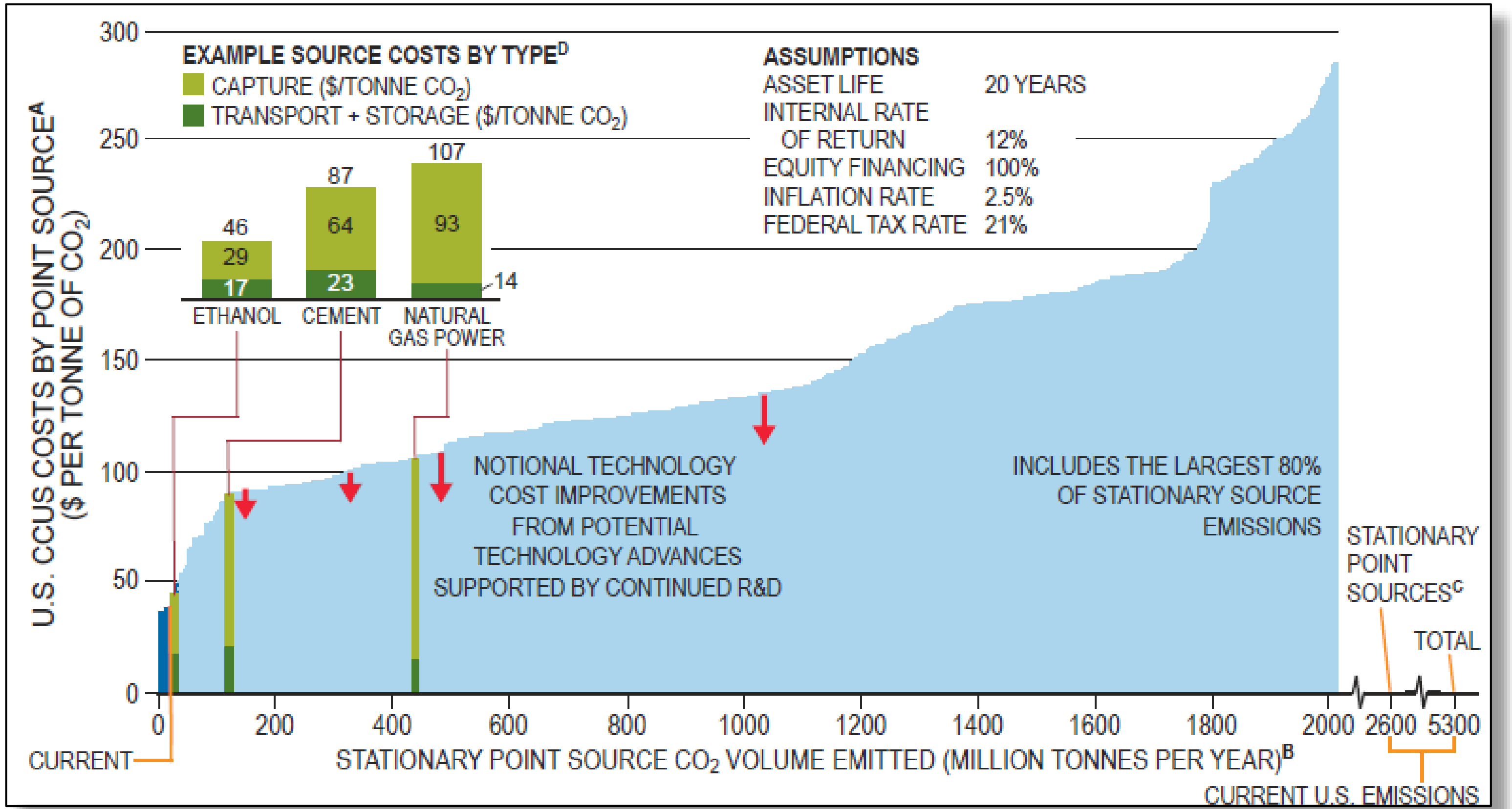


CO_2 Source

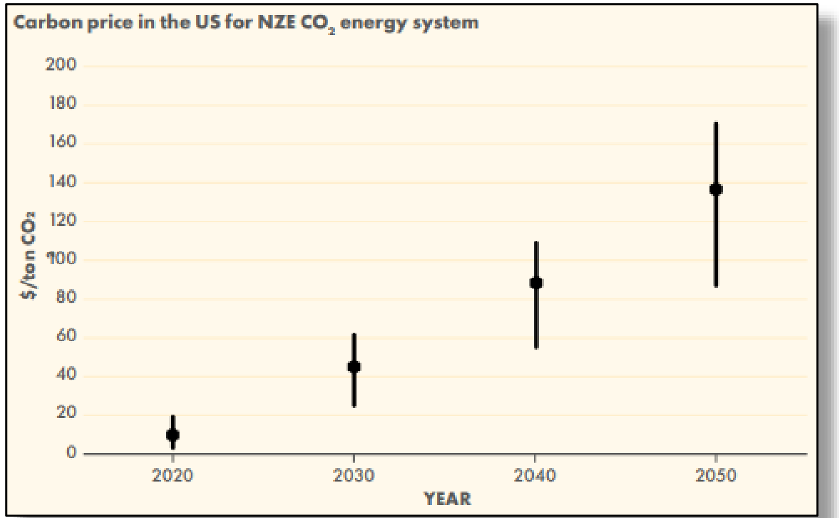


Source: DOE, "Capturing and Utilizing CO_2 from Ethanol"

Capture and Storage Costs



Source: "Meeting the Dual Challenge", Ch. 2



Source: Shell

- With current federal incentives and existing technology/costs, only best projects likely to provide good ROI
- Technology breakthroughs can make current policy work for more projects
- Policy breakthroughs can make current technology work for more projects

SPE Storage Resources Management System

- Most language, logic, and methods follow PRMS
- "Capacity" replaces reserves
- Must be commercial
  - Storage fees
  - Tax credits
  - Government subsidies
  - **Coupled with revenue- and CO_2-generating project**
- Independent project evaluations with standard definitions protect capital

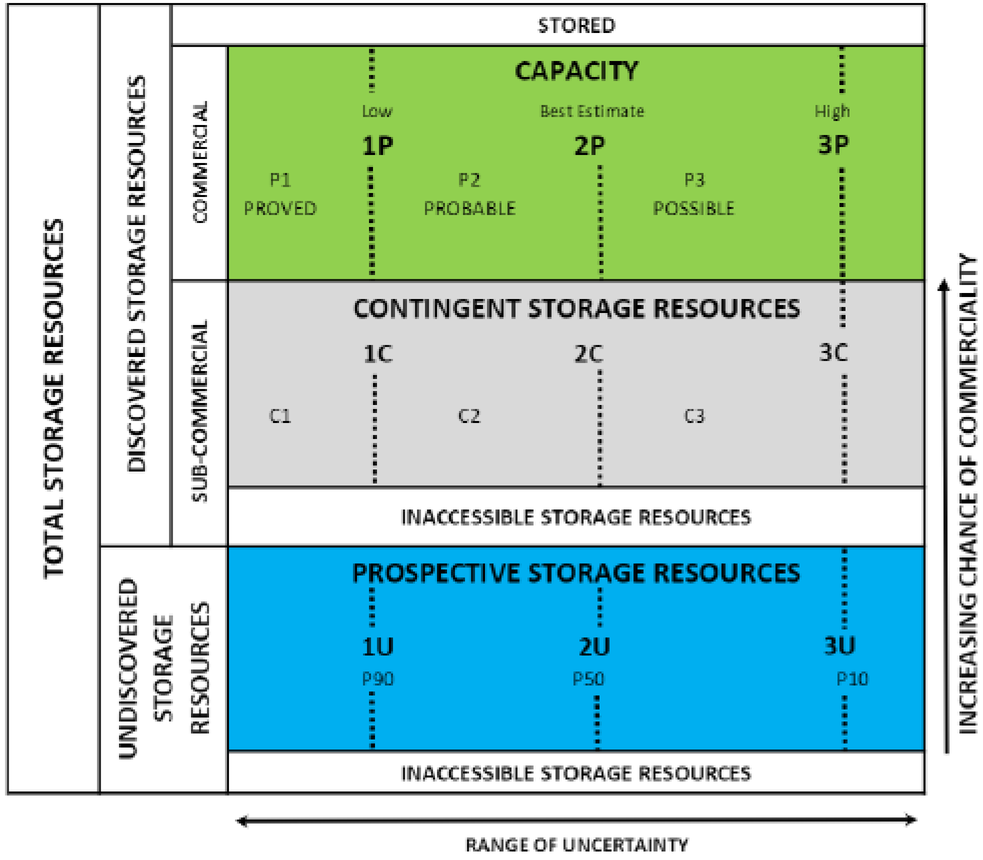
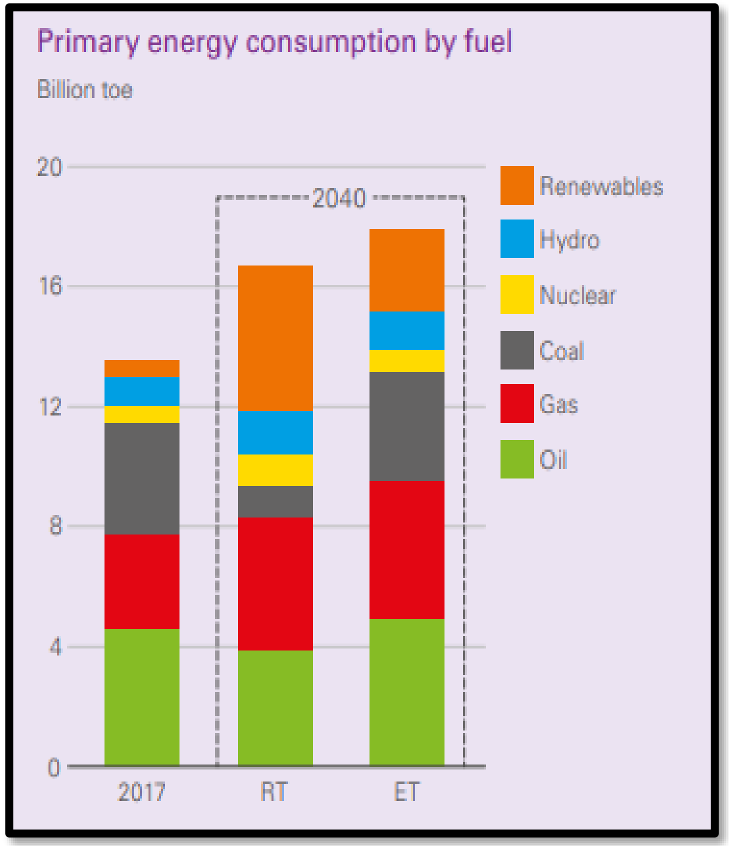


Fig. 1.1 – Resources Classification Framework

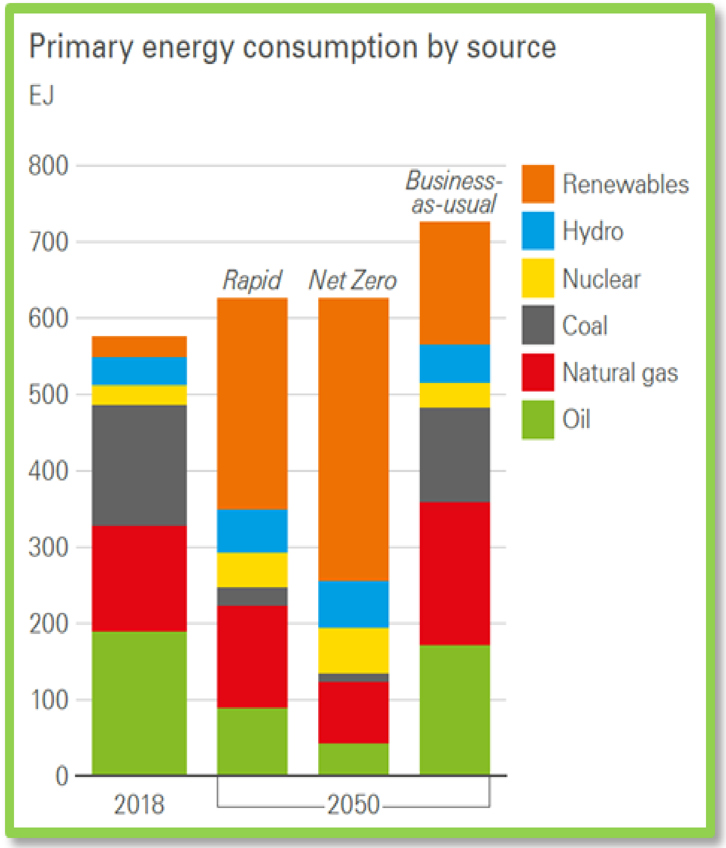
Global Energy Needs vs. "Net-Zero" IPCC Pathway

BP 2020 Outlook

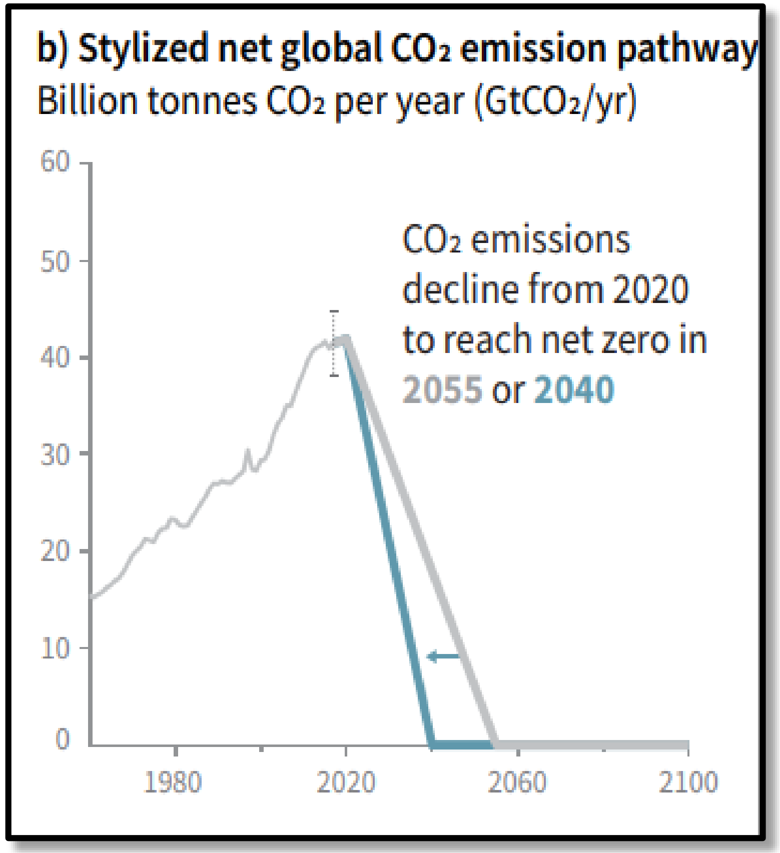
2019



2020



IPCC 2018 Pathway



Source: IPCC, 2018: Summary for Policymakers

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