



July 17, 2019



Enhanced Oil
Recovery Institute

Is CCUS Feasible in WY? Wyoming's Triple Threat – The Cowboy Unicorn

Disclaimer

Acknowledgment: Some portions of the presentation is based upon work supported by the Department of Energy under Award Number DE-FE0031624.

Disclaimer: This portion of the presentation was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

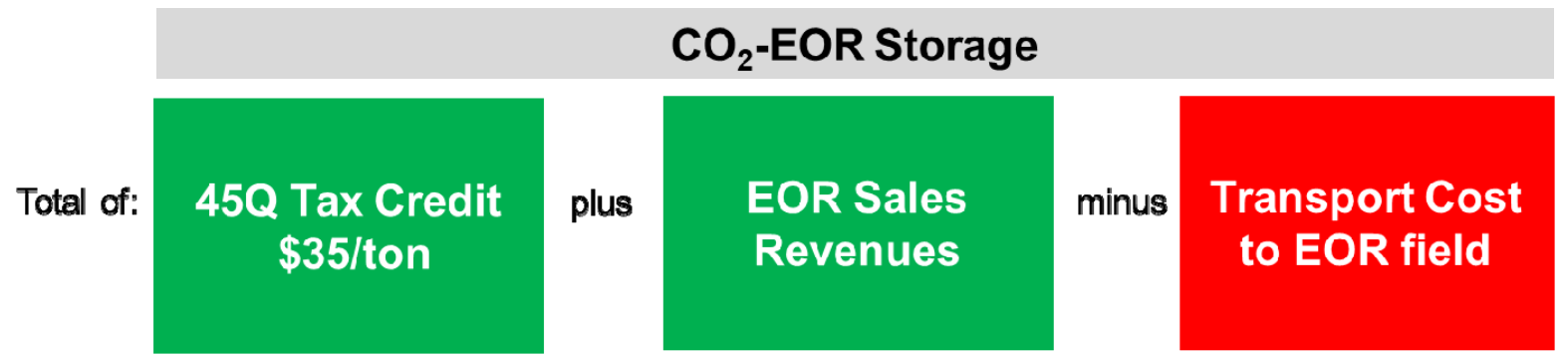


Economics 101 - CCUS

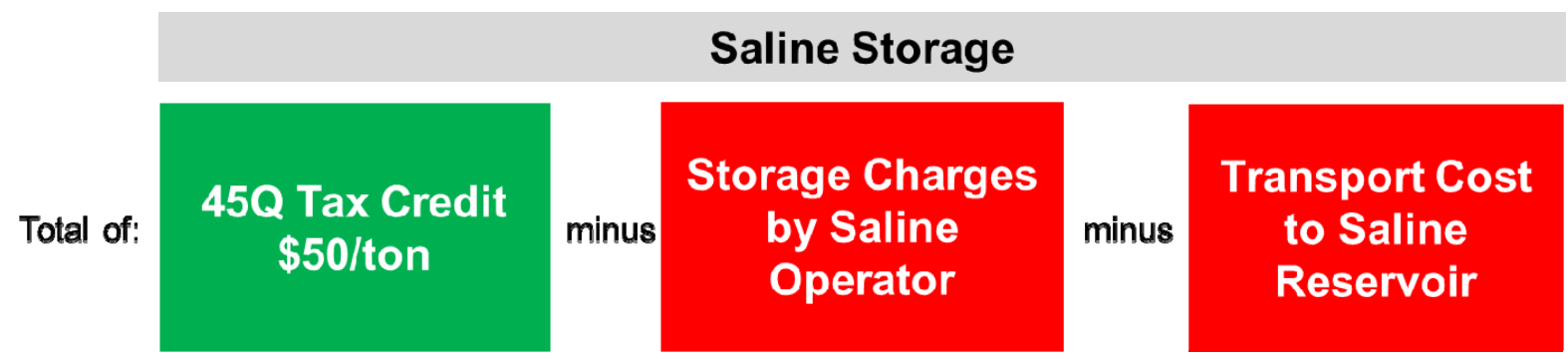
Cost of Capture

- Equipment x Financing % Rate
- O&M
- Energy penalties

→ **Less than:**



OR



CO₂-EOR – SaskPower's Boundary Dam



CO₂-EOR – NRG Petro Nova



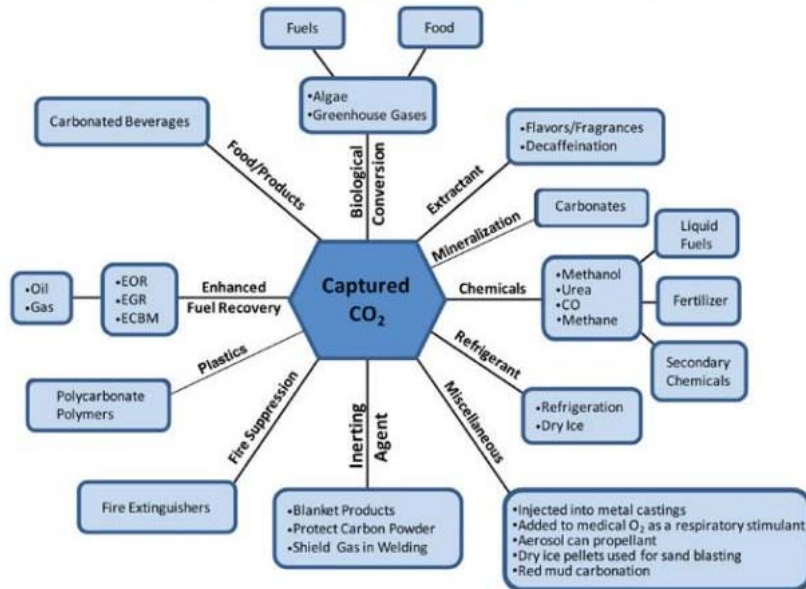
CO₂-EOR – ADM Saline Project



Economics 101 - Utilization



Figure 10 - Potential CO₂ Utilization Pathways and Markets⁴⁰



Economics 101 - Utilization

Cost of Capture

- Equipment x Financing % Rate
- O&M
- Energy penalties



Beneficiation or Manufacture

Less than

Total of:

Incentives

plus

Sale of
Materials

minus

Cost to
Manufacture



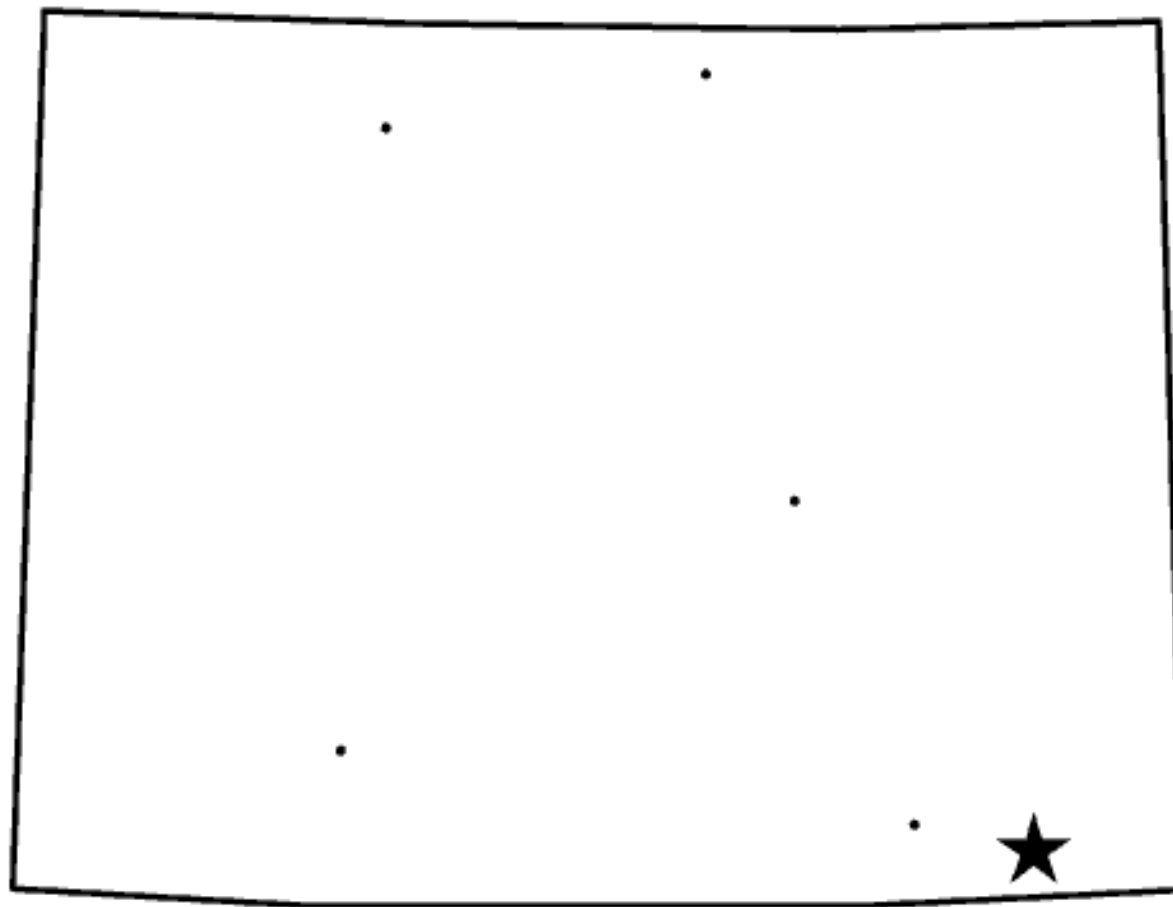
What “Other” things does CCUS need...

SPE CCUS FORUM – San Antonio - 2018

- Places to put the CO₂
- Good set of rules with Regulatory Support
- Forward looking understanding of market
- Sources of and easily move the CO₂
- A set of incentives
- Citizenry Support
- Industry Support



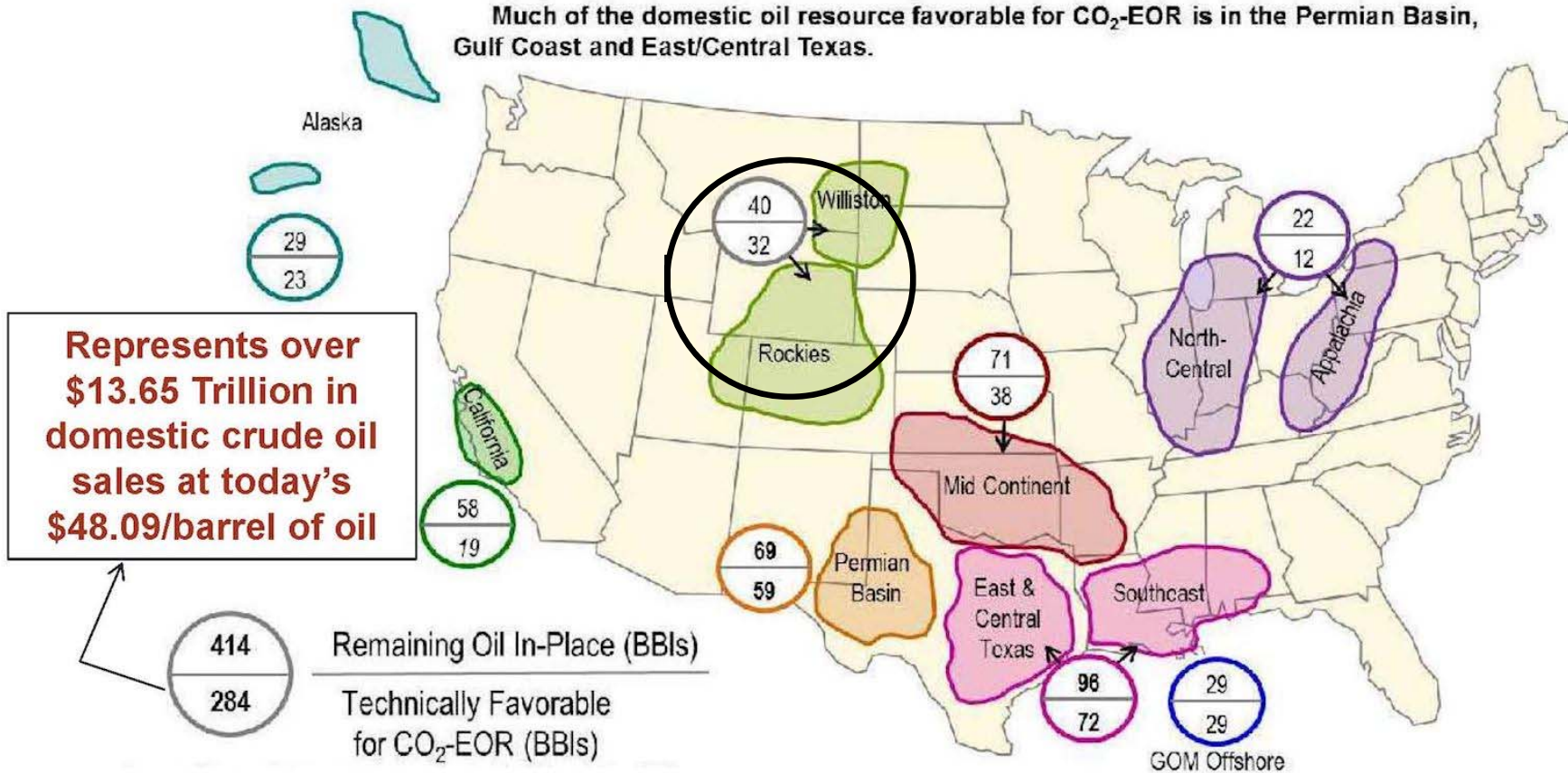
What if...



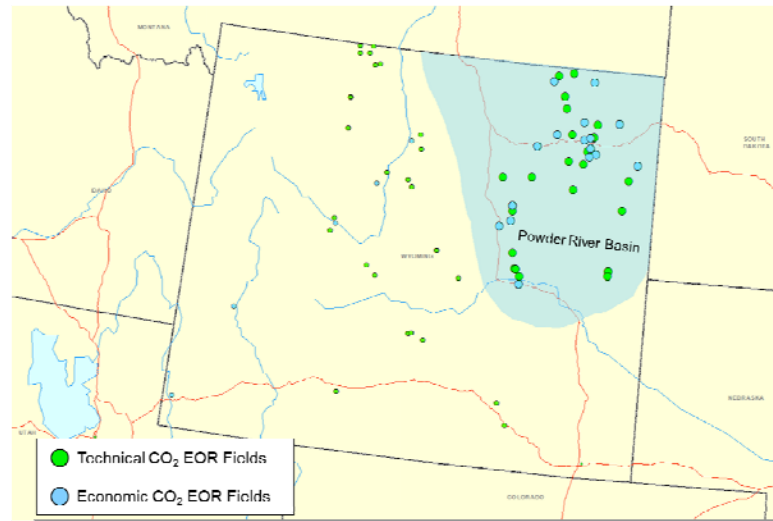
What if...a great place to put the CO₂

Regional Distribution of CO₂-EOR Potential

Much of the domestic oil resource favorable for CO₂-EOR is in the Permian Basin, Gulf Coast and East/Central Texas.

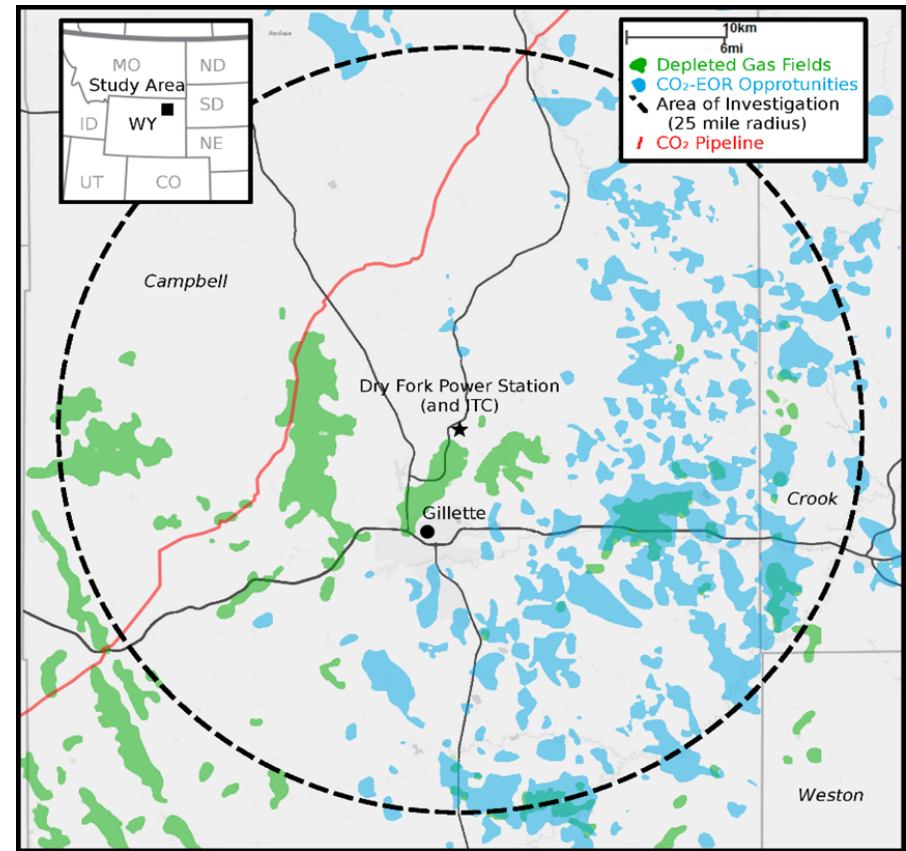
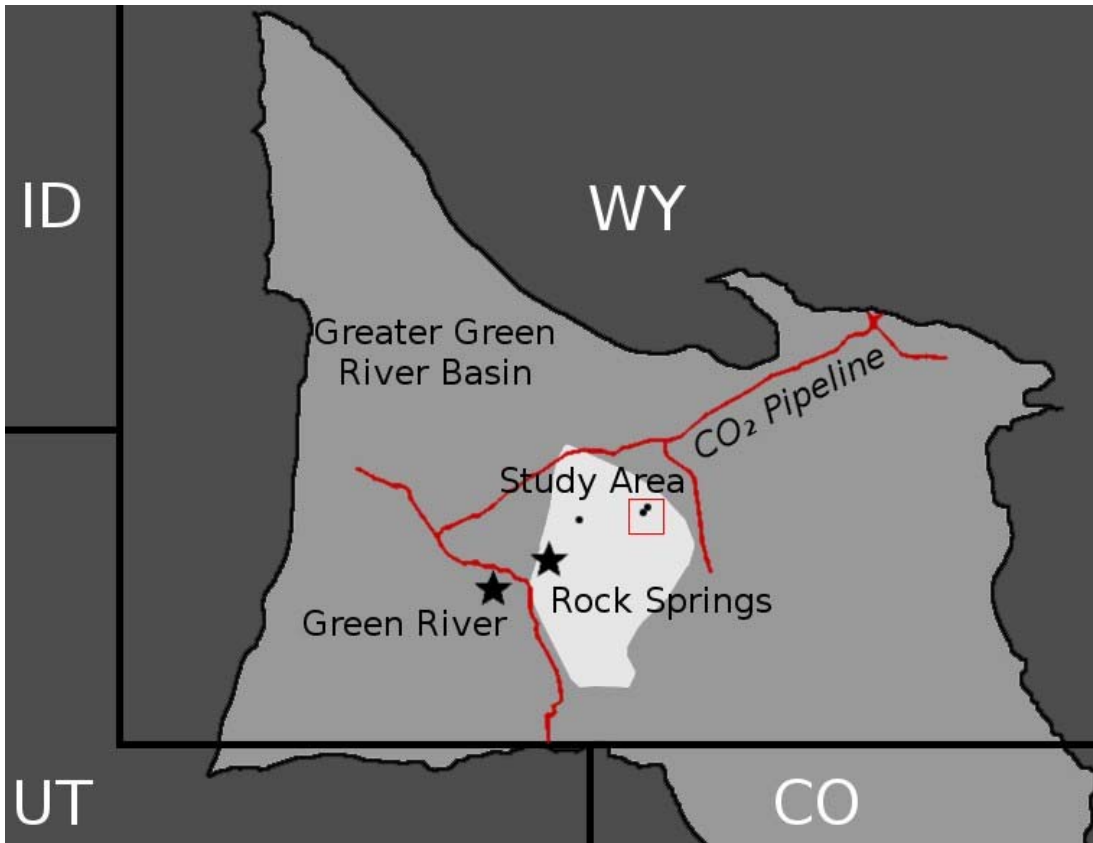


What if...a great place to put the CO₂ (EOR)



WY CO ₂ EOR Resources	Oil Fields	CO ₂ EOR Oil	Purchased CO ₂		CO ₂ Utilization	
		(MMBbl)	(Bcf)	(MMmt)	(Mcf/Bbl)	(mt/Bbl)
WY Technically Recoverable	89	2,101	18,434	975	8.8	0.46
<i>PRB Technically Recoverable</i>	46	815	6,691	354	8.2	0.43
WY Economically Recoverable	50	1,602	14,197	751	8.9	0.47
<i>PRB Economically Recoverable</i>	17	411	3,510	188	8.5	0.45

What if...a great place to put the CO₂ (2 saline sites)



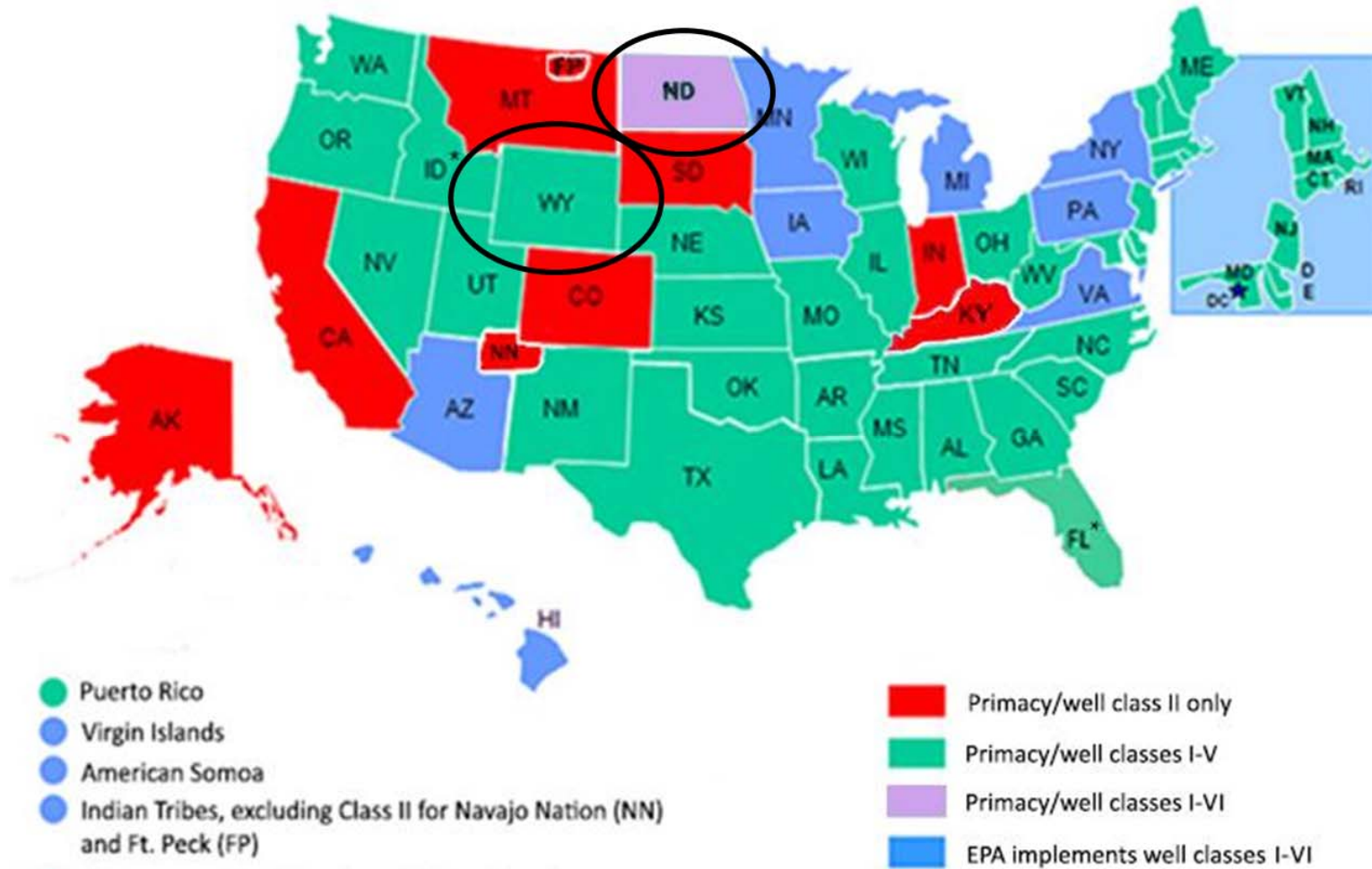
2 CarbonSAFE Saline Storage Sites

What if...good set of rules with regulatory support

- Specifies who **owns the pore space** (Wyo. Stat. § 34-1-152)
- Establishes permitting procedures & requirements for **CCS/CCUS sites** (Wyo. Stat. § 35-11-313)
- Provides a mechanism for **post-closure MRV** via a trust fund approach (Wyo. Stat. § 35-11-318)
- Provides a mechanism for **unitization of storage interests** (Wyo. Stat. § 35-11-315)
- Specifies that the injector, not the owner of pore space, **is generally liable** (Wyo. Stat. § 34-1-513)
- Clarifies that vis-à-vis storage rights, **production rights are dominant** but cannot interfere with storage (Wyo. Stat. § 30-5-501)
- Provides a certification procedure for **CO2 incidentally stored during EOR** (Wyo. Stat. § 30-5-502)



What if...good set of rules with regulatory support



What if...forward looking understanding of market

Wyoming State Government
Revenue Forecast
Fiscal Year 2019 – Fiscal Year 2024



Mineral Price and Production Estimates
General Fund Revenues
Severance Taxes
Federal Mineral Royalties
Common School Land Income Account and State Royalties
Total State Assessed Valuation

Consensus Revenue Estimating Group
CREG

January 2019

Consensus Revenue Estimating Group

- 5-year rolling evaluation
- Updated every quarter
- Mineral prices
- Mineral production
- Severance taxes
- Federal Mineral Royalties



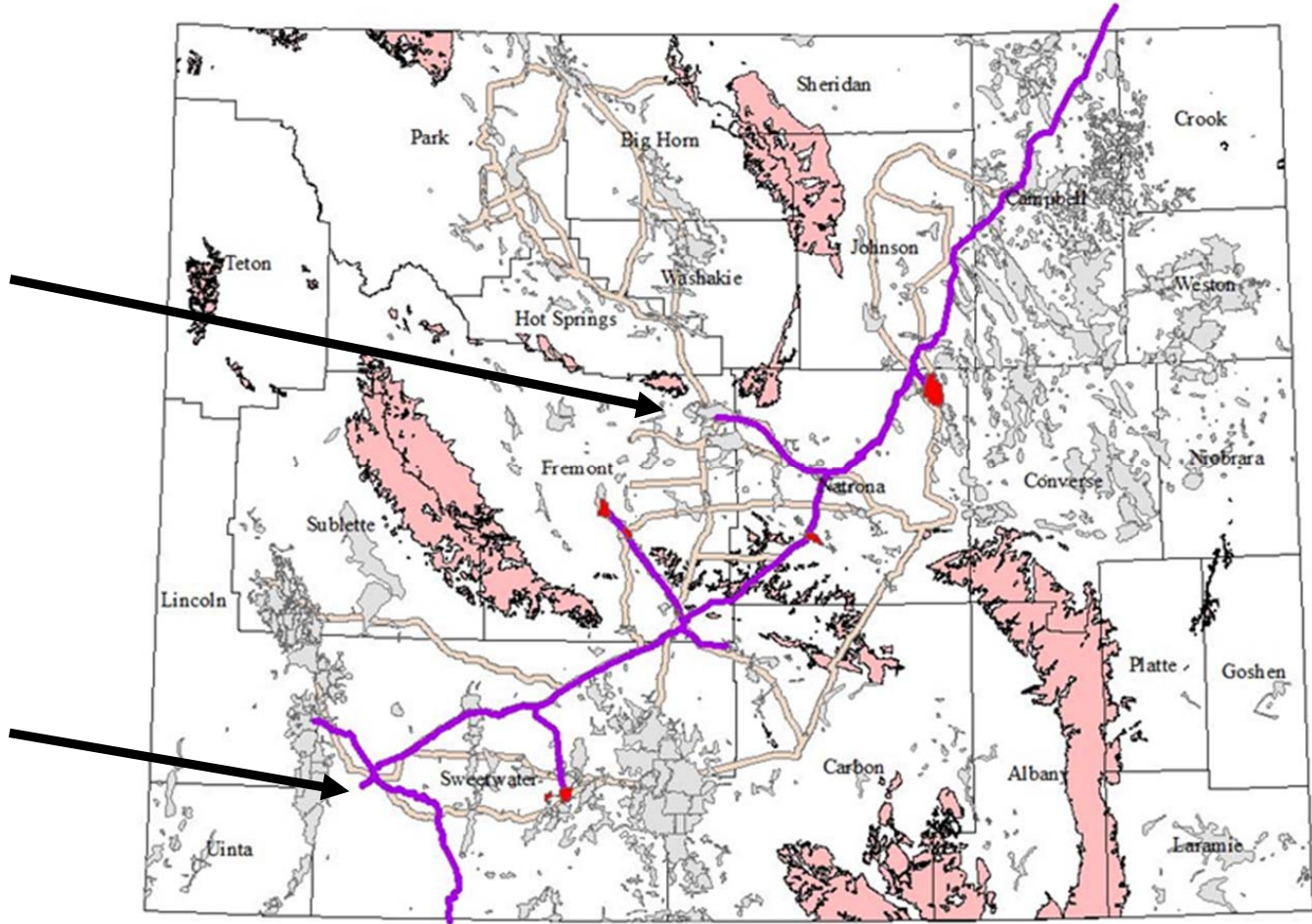
What if...places to get and easily move the CO₂



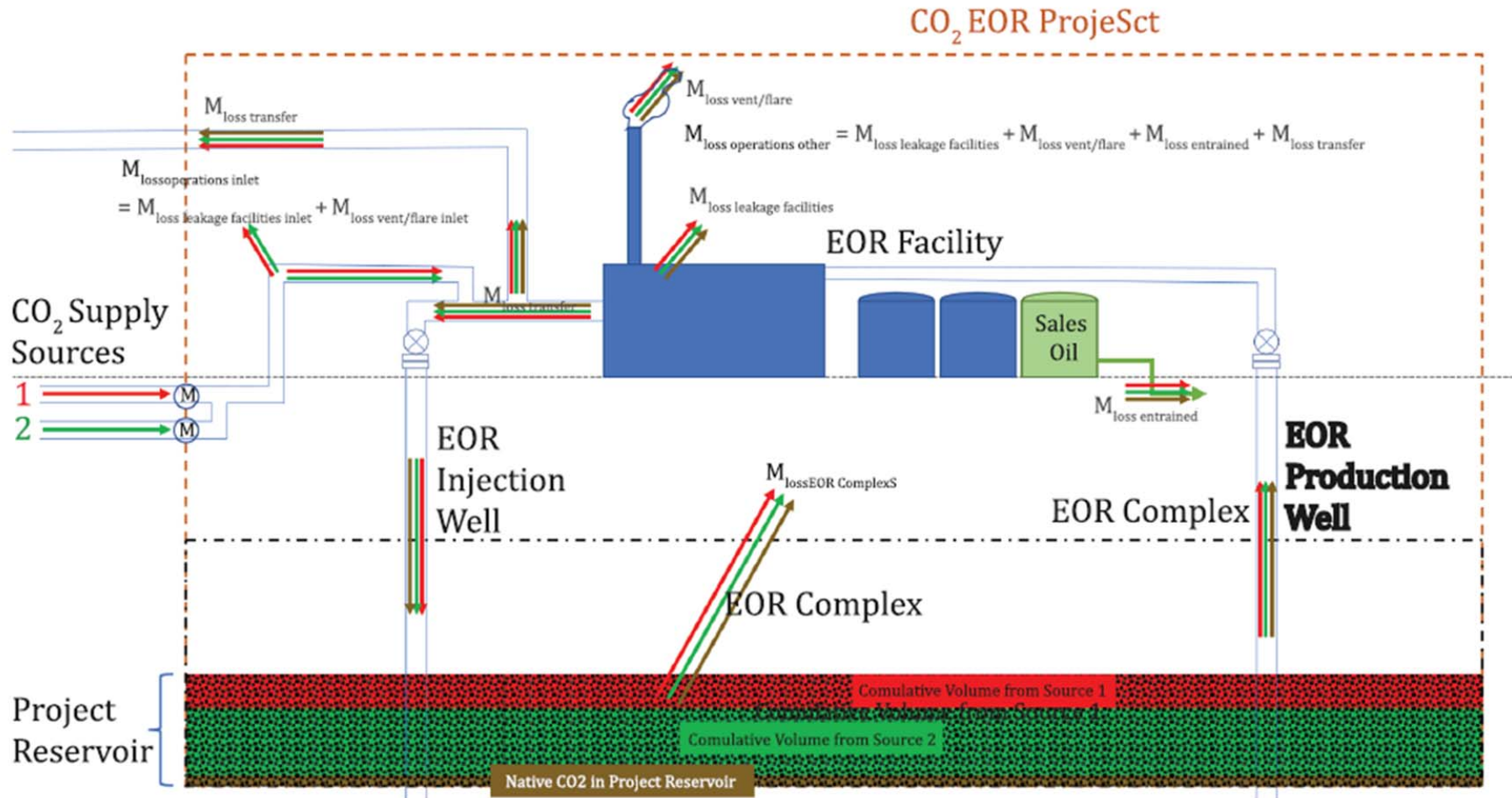
ConocoPhillips



ExxonMobil



What if...a set of incentives (45Q: \$35/ton & \$50/ton)



What if...citizenry support

SF159: Exemption for purchase of coal fired generation facilities that would otherwise have been retired; public utility purchase requirements; conditions for exemption.



What if...industry support – Commercial CCUS EOI



JUPITER OXYGEN
CORPORATION



What if...industry support – Statewide Interoperability



What if...industry support – Carbon Utilization



Dry Fork Station

- ✓ Built in 2007
- ✓ 385 MW Power Plant
- ✓ 3.3 Million tons of CO₂/year
- ✓ ZERO H₂O discharge



What if...industry support – Carbon Utilization



XPRIZE competition



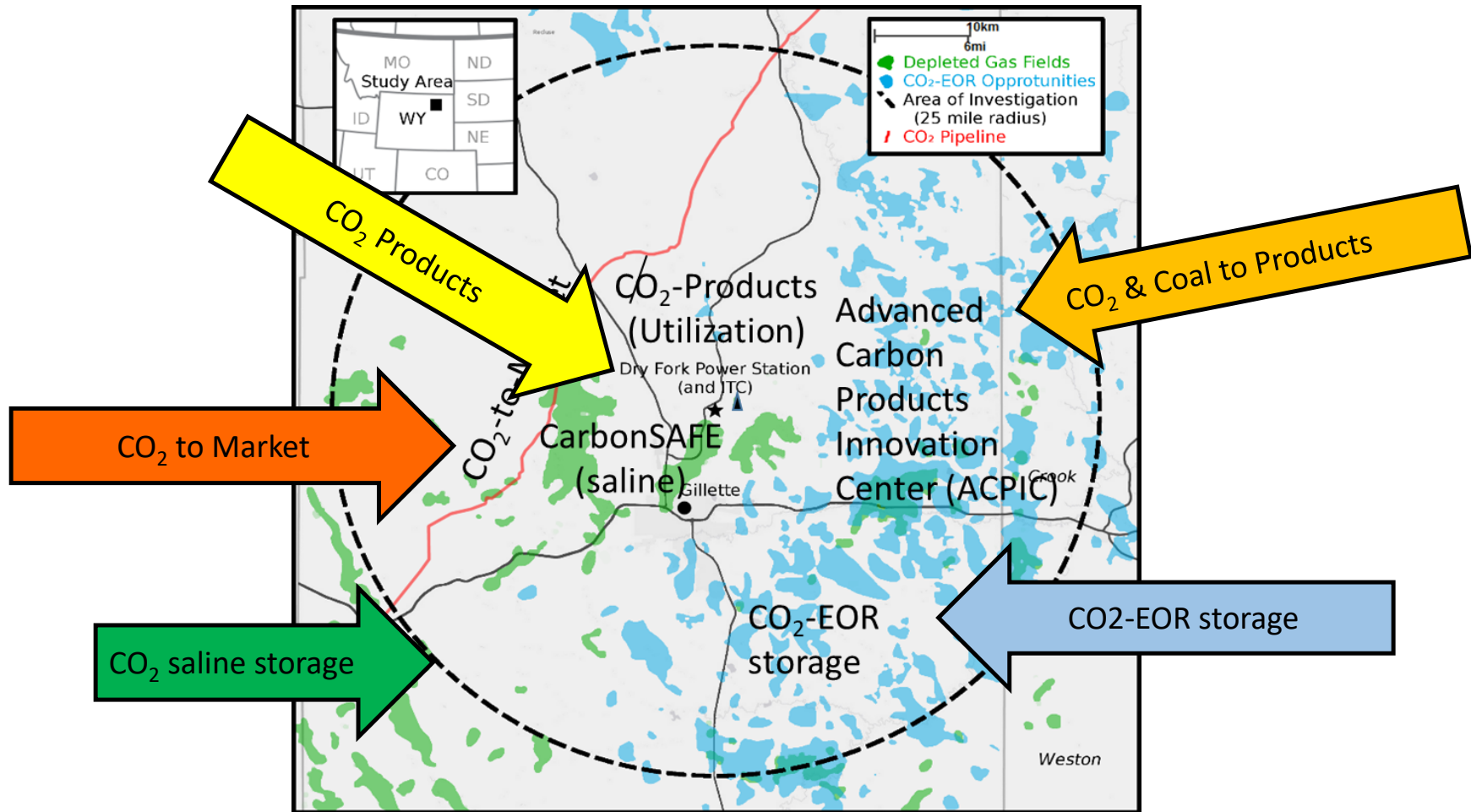
What if all these existed...in WYOMING



The Carbon Ecology in the Wyoming Carbon Valley

- CO₂ to Market (WIA & Pipeline Corridors)
- CO₂ Products (Utilization @ ITC)
- CO₂ & Coal to Products @ ACPIC
- CO₂ saline storage @ CarbonSAFE
- CO₂-EOR storage – State of Wyoming

The Carbon Ecology in the Wyoming Carbon Valley

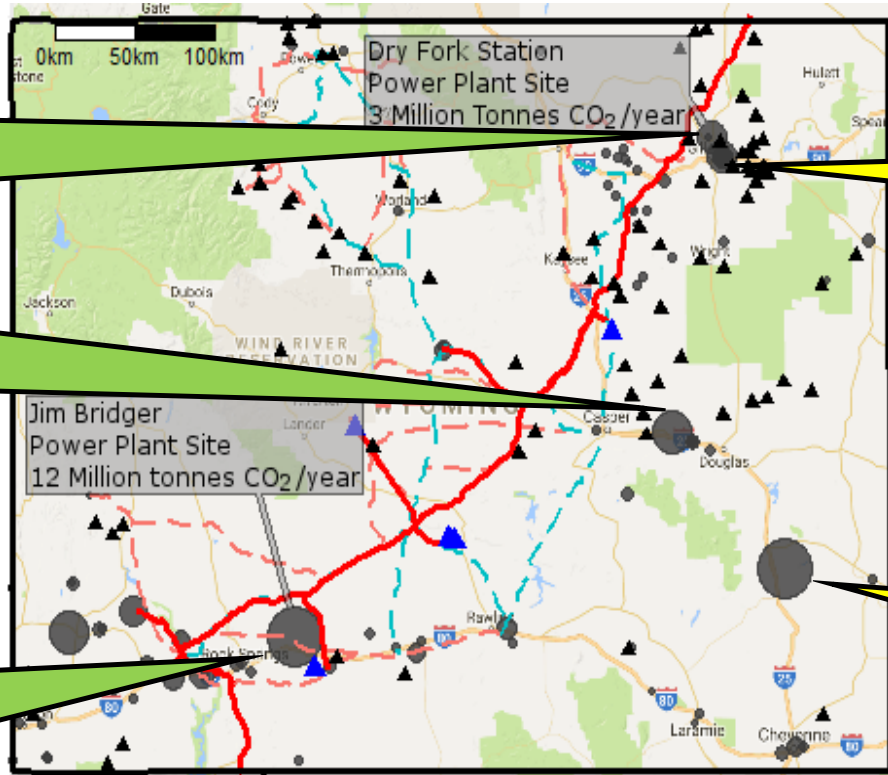


Wyoming's Utilities engaged in CCUS

#1 BE's Dry Fork Station & ITC

#3 RMP (PacifiCorp) Dave Johnston

#2 RMP (PacifiCorp) Jim Bridger



WY CO2 Pipeline Network

- CO2 Pipeline
- - Lateral Corridor
- - Trunk Corridor
- ▲ EOR Target
- ▲ CO2-EOR Field

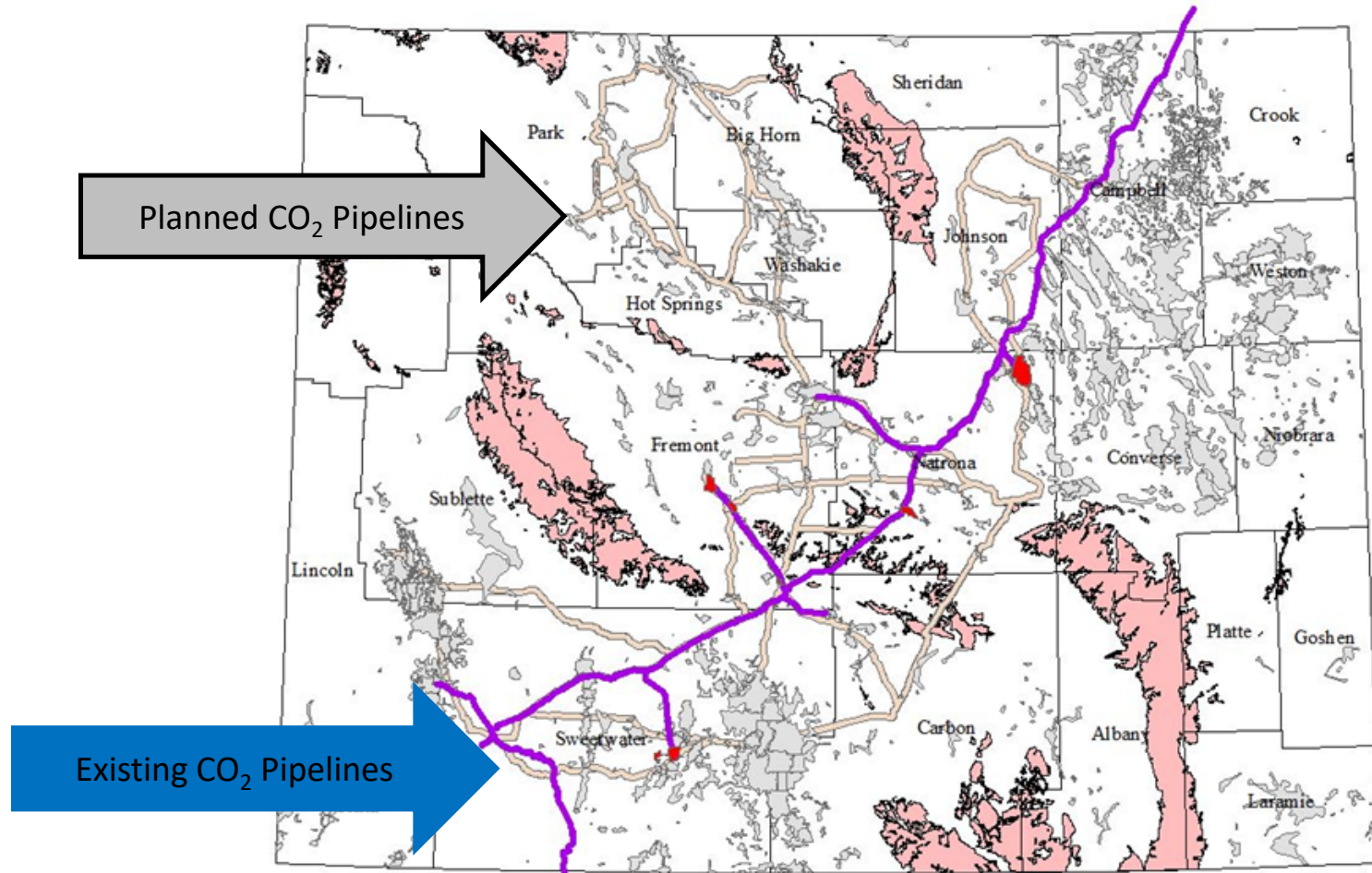
#5 RMP's Wyodak Power Plant

CO2 Emissions (Million tonnes)



#4 BE's Laramie River Power Station

The Carbon Ecology in the Wyoming Carbon Valley



Base o



Questions, Comments, Concerns

Dr. Steven Carpenter, Director

steven.carpenter@uwyo.edu

O: 307-315-6442

C: 513-460-0360

