45Q: A Comparison of Storage Methodologies

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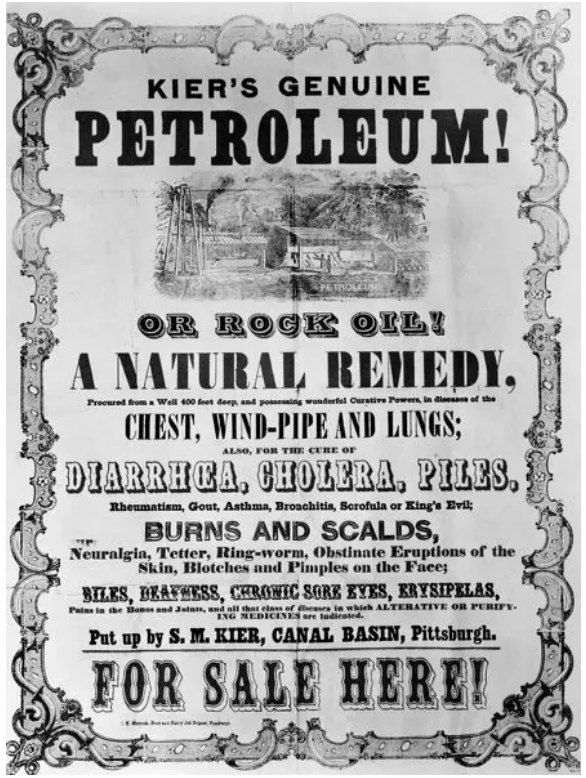
University of Wyoming

September 4, 2019

Thirty-Sixth Annual
INTERNATIONAL PITTSBURGH
COAL CONFERENCE
University of Pittsburgh · Swanson School of Engineering

Happy Belated 160th Birthday Oil Industry



8/50/1859 336/10,400

https://thefederalist.com/2019/08/28/1859-project-birth-oil-industry-saved-whales-propelled-todays-prosperity/

And now there are four (4)…CO_2 Storage Methodologies

1. EPA GHGRT Subpart RR
2. ISO:27916 CO_2-EOR
3. California LCFS & CCS Protocol
4. SPE CO_2 SRMS

SESSION 19: CARBON MANAGEMENT –II: 14:10 - 14:30 A Comparison of CO_2 Storage Quantification Methodologies

And now there are four (4)…CO_2 Storage Methodologies

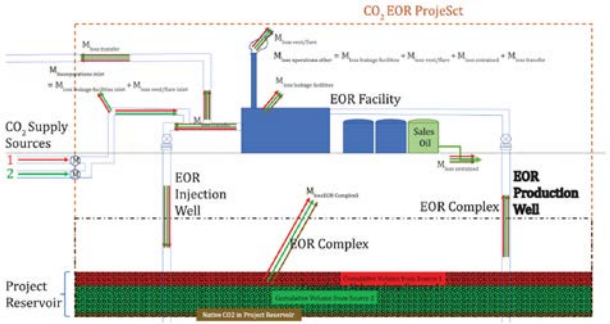
Phase of project	GHGRP Subpart RR	ISO 27916	CARB CCS PROTOCOL
Authority	EPA	Voluntary	CARB
Reporting	Report the annual mass (Accounting)	Quantify & document the annual mass	Quantify & document the annual mass
Well construction & corrective action	Class II	Class II	Class II
Monitoring, reporting, and verification (MRV) plan	5 components	5 components	Several components + 100 years of Post Injection Monitoring
Records retention	3 years after closure	duration of the project & shared with regulator	10 years after closure
Monitoring technologies	Detailed requirements of measurement devices, may use standards	Best available technology & standard industry practices	Long list of MUST includes
Verification	EPA	Self-certification, regulatory authority certifcation, or 3rd party certification	CARB specifies verification team
P & A	Class II	Class II	Pursuant to Executive Officer & Sequestration Site Certification
Post-injection site care and site closure (PISC)	No PISC	No PISC	<2 years P&A all wells, <15 years prove plume is stable, ≤100 years monitor for leaks

COMPARATIVE ANALYSIS OF ALTERNATIVE APPROACHES FOR DETERMINING SECURE GEOLOGIC STORAGE. Godec, Koperna, Carpenter. 2019. Pittsburgh Coal Conference

In order to get the credit with 45Q…

1. Must "**begin construction**" by December 31, 2023
   - *What is the definition of "beginning"?*
   - *This provides **uncertainty** for investors to move forward with financing*
2. The credit must be **transferable**
   - *From the CAPCO to STORCO*
   - *Must have a tax liability for there to be any value*
3. Must certify "**safe and secure storage**"
   - *What is safe and what is secure?*

NRECA
America's Electric Cooperatives



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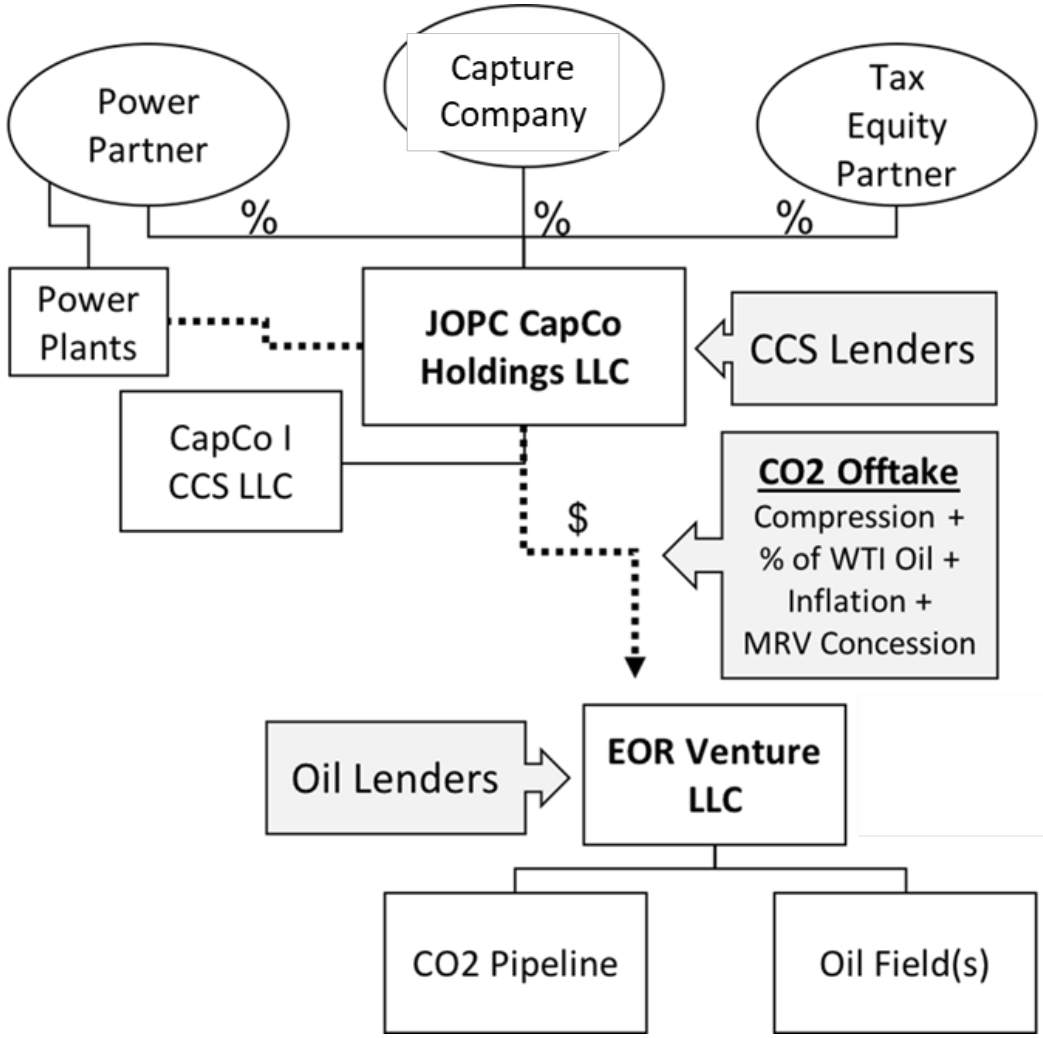
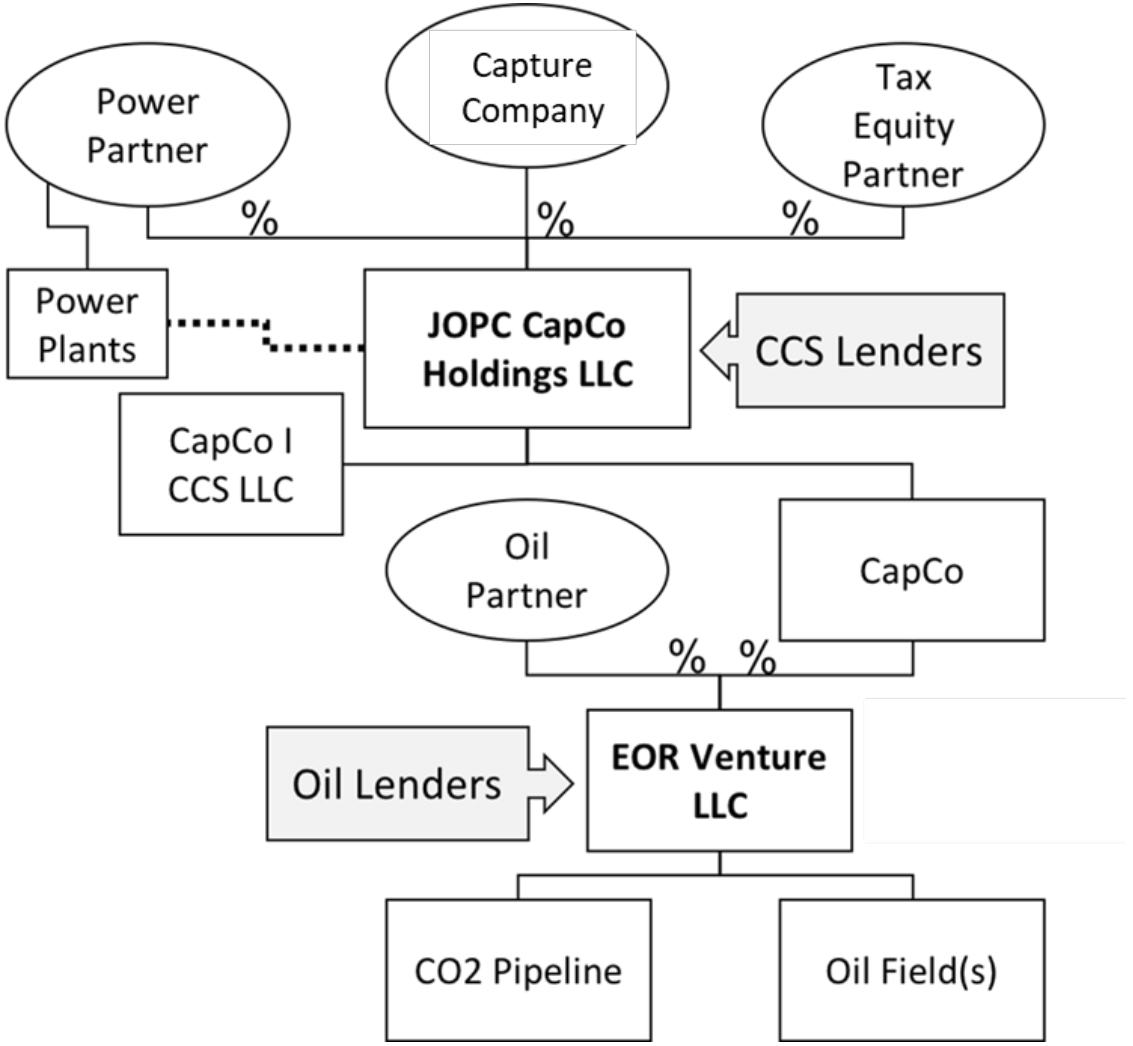
Transferable Credits





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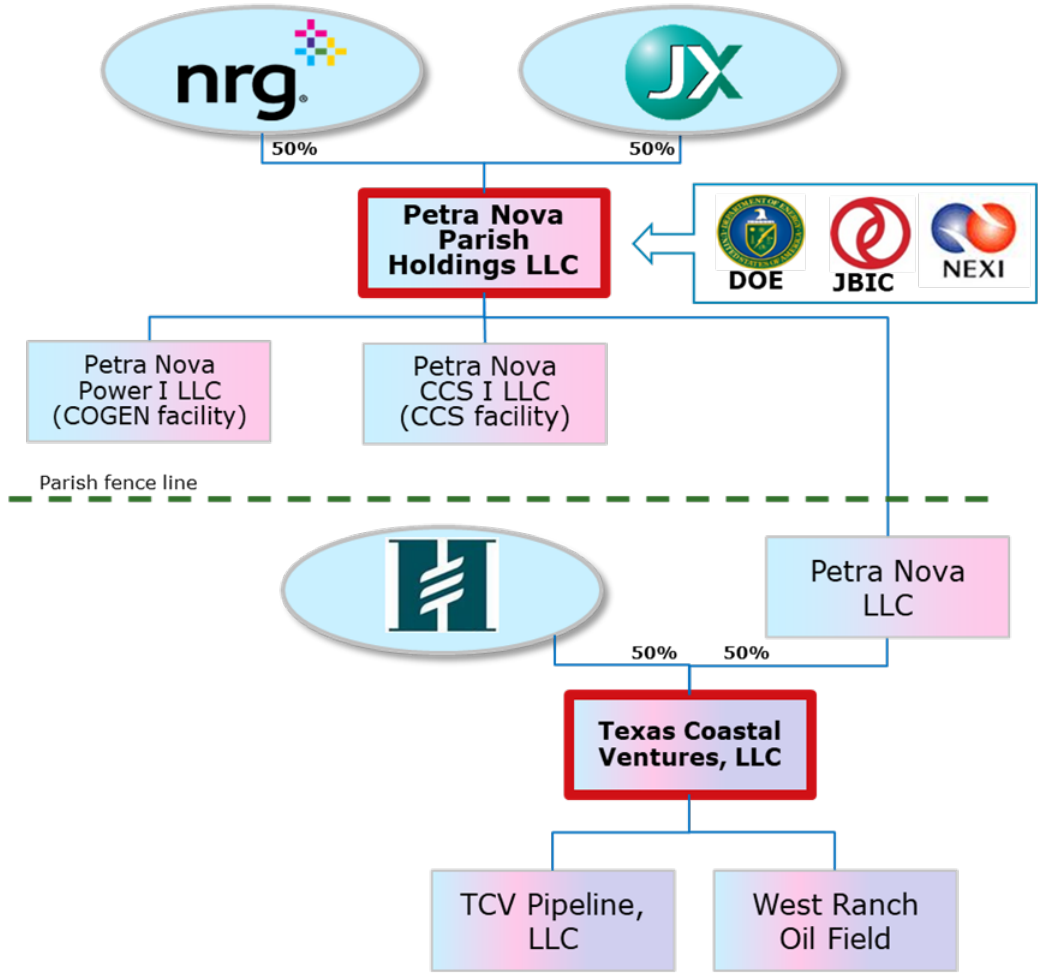
Transferable Credits

PETRA NOVA Carbon Capture

Commercial Structure



Our Partners

JX Holdings is a leading integrated energy, resources, and materials company

NRG Energy, Inc. is the largest independent power company in the US

Hilcorp Energy is one of the largest privately-held oil and natural gas E&P companies in the US

JBIC and NEXI combined on a $250 million project loan.

US DOE awarded $190 MM grant funded through Clean Coal Power Initiative

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Safe & Secure Storage

Form **8933** — Department of the Treasury, Internal Revenue Service

Carbon Oxide Sequestration Credit

► Attach to your tax return.
► Go to *www.irs.gov/Form8933* for the latest information.

OMB No. 1545-0123
2018
Attachment Sequence No. 165

Name(s) shown on return — Identifying number

Saline tonnes this year

Qualified carbon oxide captured using carbon capture equipment originally placed in service at a qualified facility before February 9, 2018, disposed of in secure geological storage and not used as a tertiary injectant in a qualified enhanced oil or natural gas recovery project, nor utilized in a way described in section 45Q(f)(5).

1a Metric tons captured and disposed of
b Inflation-adjusted credit rate
c Multiply line 1a by line 1b . . . 1c

Qualified carbon oxide captured using carbon capture equipment originally placed in service at a qualified facility before February 9, 2018, disposed of in secure geological storage and used as a tertiary injectant in a qualified enhanced oil or natural gas recovery project, or utilized in a way described in section 45Q(f)(5).

2a Metric tons captured and used
b Inflation-adjusted credit rate
c Multiply line 2a by line 2b . . . 2c

EOR tonnes this year

Saline tonnes <12 yrs

Qualified carbon oxide captured using carbon capture equipment originally placed in service at a qualified facility on or after February 9, 2018, during the 12-year period beginning on the date the equipment was originally placed in service, disposed of in secure geological storage, and not used as a tertiary injectant in a qualified enhanced oil or natural gas recovery project, nor utilized as described in section 45Q(f)(5).

3a Metric tons captured and disposed of
b Section 45Q(a)(3) applicable dollar amount (see instructions)
c Multiply line 3a by line 3b . . . 3c

Qualified carbon oxide captured using carbon capture equipment originally placed in service at a qualified facility on or after February 9, 2018, during the 12-year period beginning on the date the equipment was originally placed in service, disposed of in secure geological storage, and used as a tertiary injectant in a qualified enhanced oil or natural gas recovery project, or used as described in section 45Q(f)(5).

4a Metric tons captured and disposed of
b Section 45Q(a)(4) applicable dollar amount (see instructions)
c Multiply line 4a by line 4b . . . 4c

EOR tonnes < 12 yrs

Secure Geological Storage

This includes storage at deep saline formations, oil and gas reservoirs, and unminable coal seams under such conditions as the IRS may determine under regulations.

After 2010, the following apply.

- Secure geological storage requires approval by the U.S. Environmental Protection Agency (EPA) of a Monitor, Report and Verify Plan (MRV Plan) submitted by the operator of the storage facility or tertiary injection project.
- The annual amount of carbon oxide claimed for the credit must be reconciled with amounts reported to the EPA under its Greenhouse Gas Reporting Program, subpart RR.

https://www.hewbordenave.com/2012/01/draw-the-law

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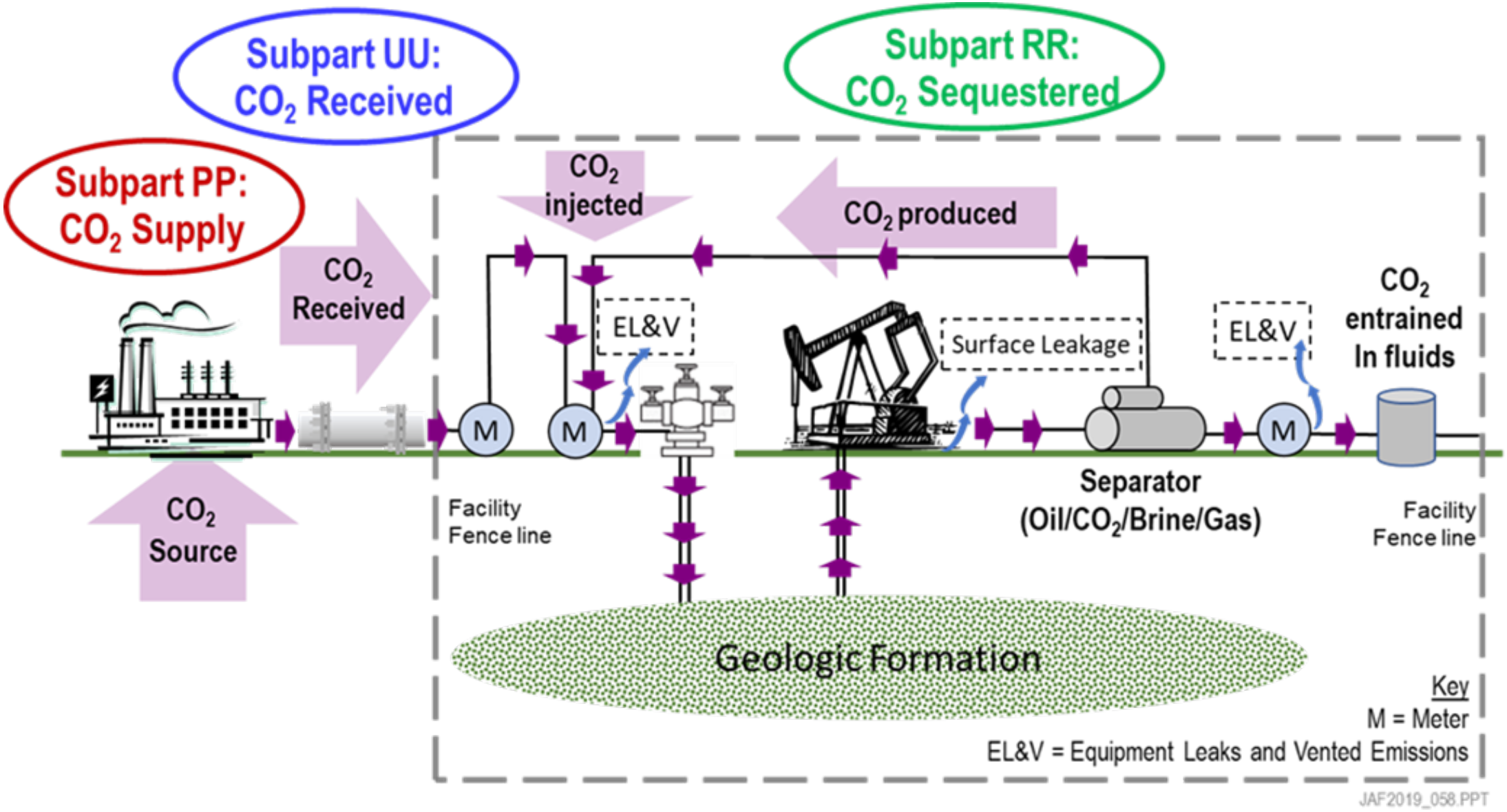
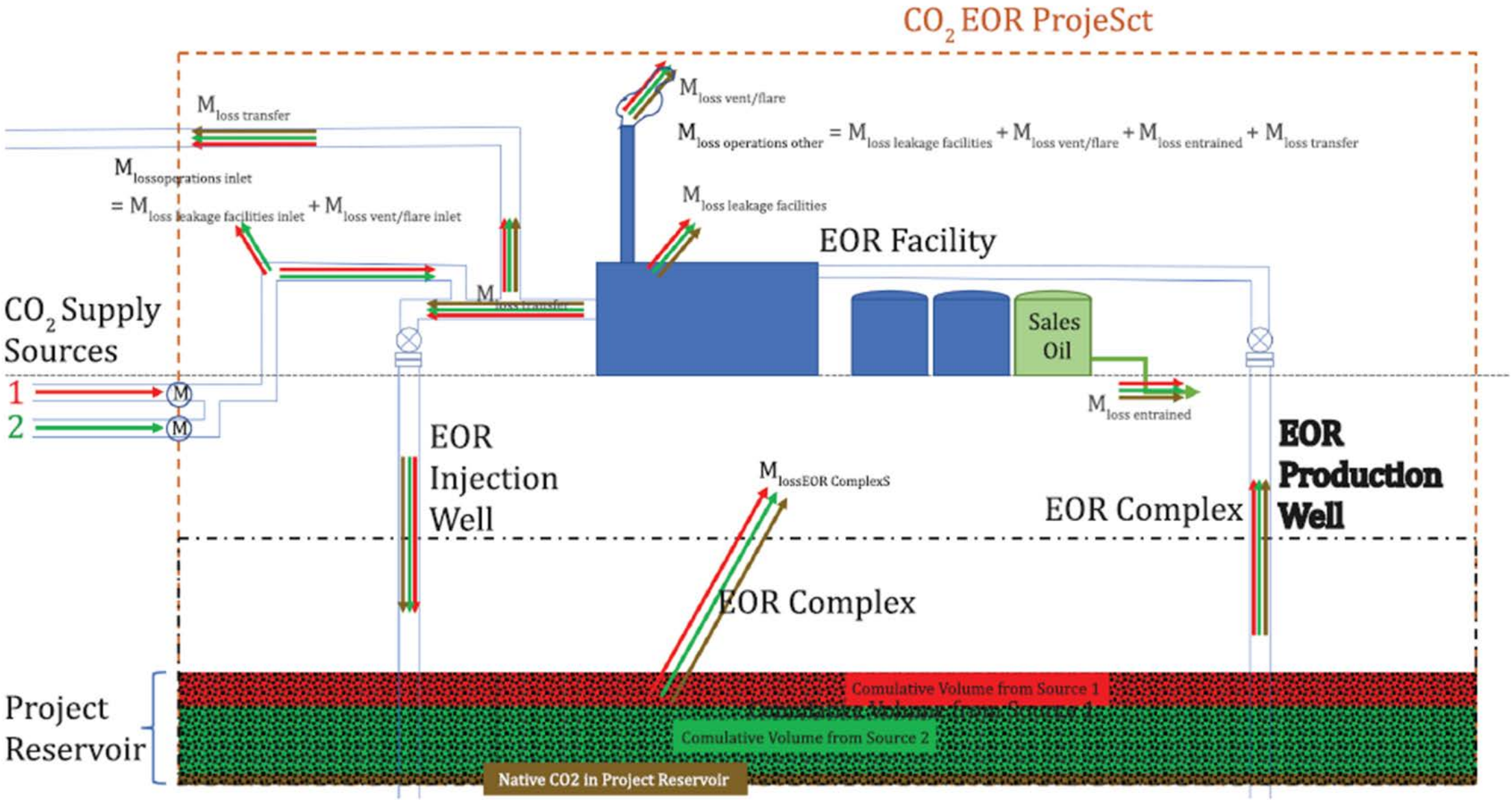
EPA GHG Reporting Tool Mass Balance



COMPARATIVE ANALYSIS OF ALTERNATIVE APPROACHES FOR DETERMINING SECURE GEOLOGIC STORAGE.
Godec, Koperna, Carpenter. 2019. Pittsburgh Coal Conference

ISO 27916-2019 Mass Balance



ISO:27916-2019

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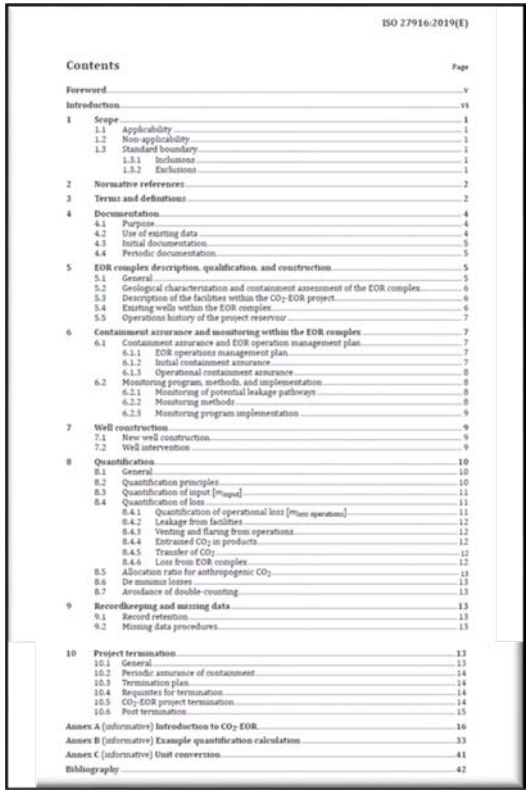
ISO:27916 Table of Contents

1. Scope
2. Normative references
3. Terms and definitions

ISO Required Boilerplate

4. Documentation
5. EOR complex description, qualification, & construction
6. Containment assurance & monitoring within the EOR complex
7. Well construction
8. Quantification
9. Recordkeeping
10. Project termination



ISO 27916:2019(E)

Contents

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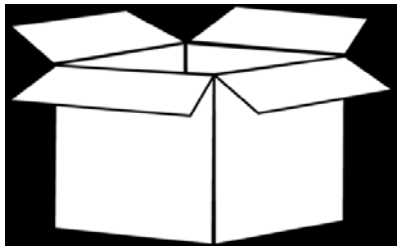
Section 4: Documentation

- Intended to facilitate documentation of the ***safe, long-term containment***, and the ***quantification of associated storage of CO_2*** in EOR operations
- **Initial documentation** to include:
  - storage complex & site description
  - containment assurance
  - monitoring plan
  - quantification method
  - assessment of CO_2 injection history
- **Periodic documentation** to include:
  - quantity of CO_2 stored
  - back up data
  - quantification notes
  - verification statement

Section 5: EOR complex description

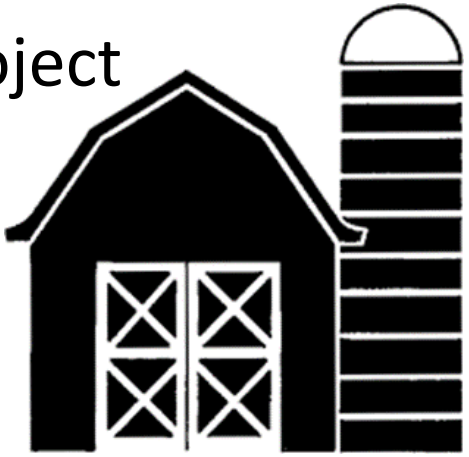
Designed to ***demonstrate*** that the EOR complex ***is adequate*** to provide ***safe, long-term containment of CO_2*** and shall include site-specific and other information pertaining to:



a) **geologic characterization** of the EOR complex

b) a **description of the facilities** within the CO_2-EOR project

c) a **description of all wells** & engineered features of the project



d) the **operations history** of the project reservoir

Section 6: Containment Assurance

- An ***initial assessment*** of potential leakage pathways to provide ***assurance*** that operations consistent with containment of CO_2 that may include:
    a) **unexpected changes** in project performance that have potential to influence storage
    b) addition or abandonment of **injection zones**
    c) change to the **areal extent** of the project reservoir
    d) addition or abandonment of **wells**
    e) anomalous change of **injection-withdrawal ratio**
    f) development of reservoirs which are located **above or below the project reservoir**
    g) discovery of **CO_2 beyond the boundary** of the CO_2-EOR complex
- A ***monitoring plan*** including plans to monitor for leakage and methods

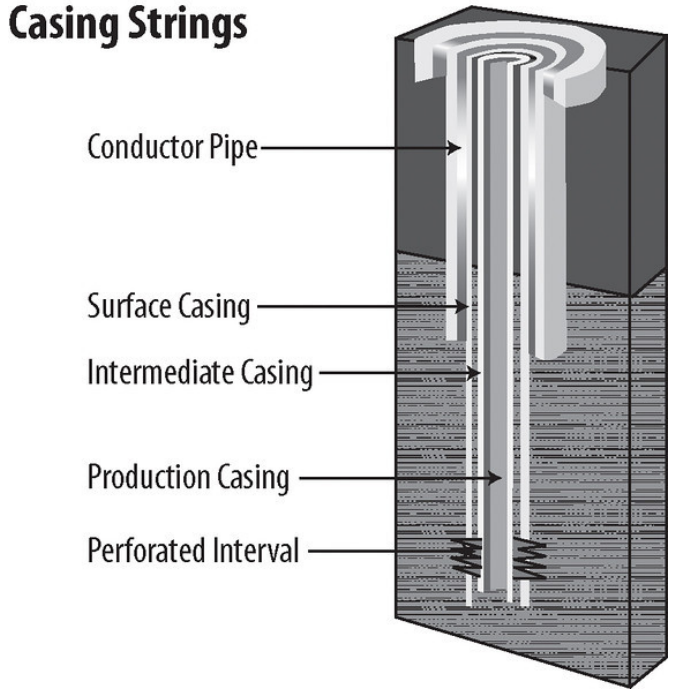
Section 7: Well Construction

Sufficient information to demonstrate that ***new*** & ***existing*** wells & ***well interventions***, are:

- ✓ Designed…
- ✓ Constructed…
- ✓ Tested…

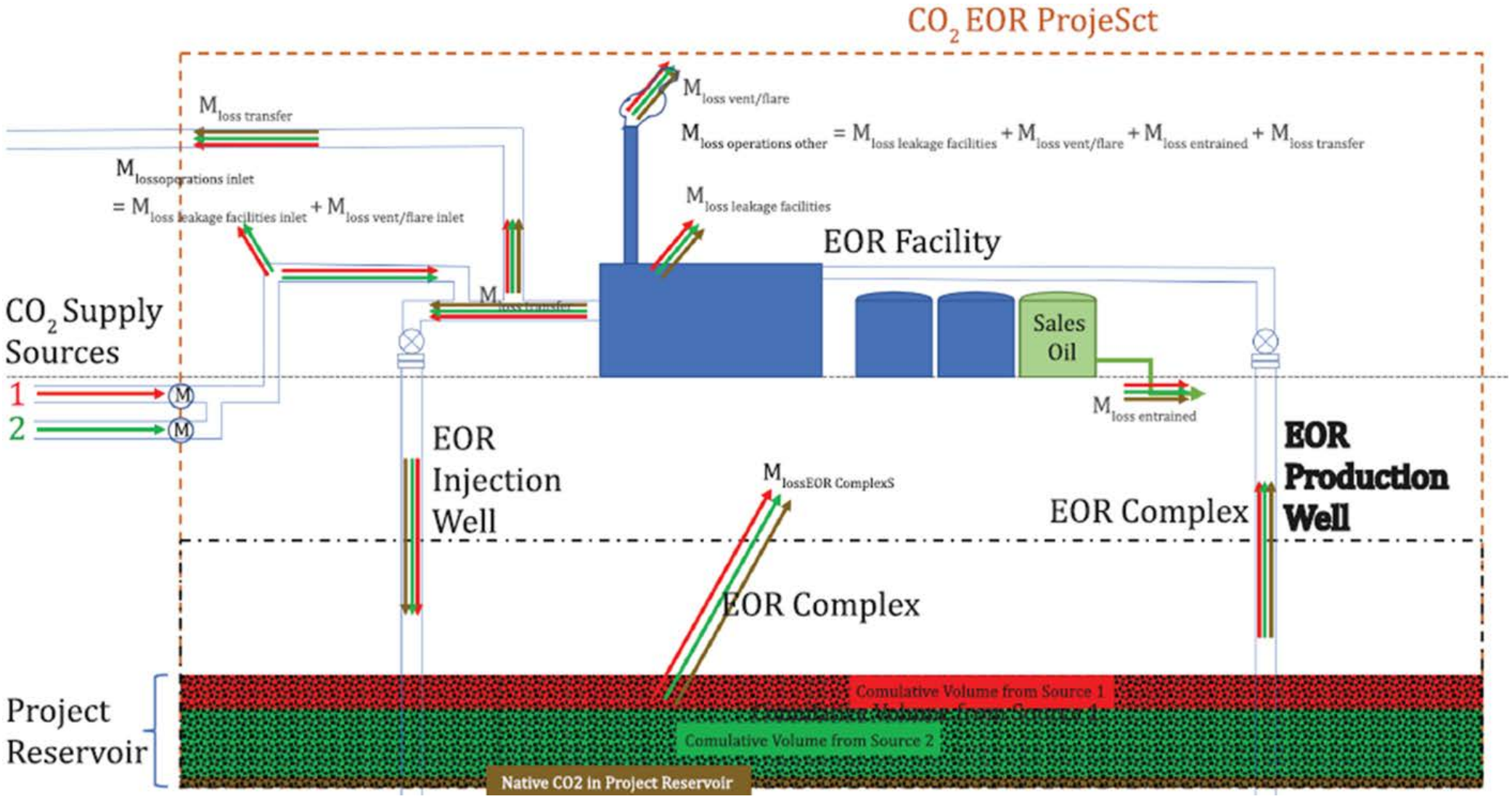
…to provide safe,

…long-term containment of CO_2



Section 8: Quantification

Mass balance approach: CO_2 stored = CO_2 input less CO_2 lost from operations & subsurface & entrained



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Section 10: Project Termination

- Allows for ***operation beyond period of reporting storage***
- Requires a ***termination plan***
- 5 ***criteria for termination*** including:
  1. **Absence of leakage**
  2. **Compliance** with decommissioning rules
  3. **Demonstration of containment** of CO_2 in the EOR complex
  4. Risks managed **throughout the project life**
  5. Facilities removed/retained **as necessary** by lease or contract

Regulations vs. Standards: LANGUAGE

- ***Normative (Required) = Shall / Must***
- ***Informative (Suggested) = Should / May / Can***

"shall" or "must" **–** only option given
"should" **–** preferred option over several
"may" **–** an option given
"can" **–** no option given

EPA Subpart RR vs. ISO 27916

Gray box = ISO exceeds Subpart RR

	EPA GHGRT Subpart RR	ISO 27916 (CO_2-EOR)
Mass Balance (CO_2)	(a) Mass of CO_2 received	Mass received
	(b) Mass of CO_2 injected into the subsurface	Mass input (received + native)
	(c) Mass of CO_2 produced (i.e., mixed with produced oil, gas, or other fluids)	Mass loss entrained
	(d) Mass of CO_2 emitted by surface leakage	Mass loss operations (may be called fugitive)
		Mass loss **vent/flare**
	(e) Mass of CO_2 equipment leakage and vented CO_2 emissions from surface equipment located between the injection flow meter and the injection wellhead	Mass loss leakage facilities (may be called fugitive)
	(f) Mass of CO_2 equipment leakage and vented CO_2 emissions from surface equipment located between the production flow meter and the production wellhead	Mass loss leakage facilities (may be called fugitive)
		Mass loss **transfer**
	(g) Mass of CO_2 sequestered in subsurface geologic formations	Mass stored (annual)
		Mass loss **EOR complex**
	(h) Cumulative mass of CO_2 reported as sequestered in subsurface geologic formations in all years since the facility became subject to reporting requirements under this subpart	Mass stored (cumulative)
		Mass **native (non-anthropogenic)**

EPA Subpart RR vs. ISO 27916

Gray box = ISO exceeds Subpart RR

	EPA GHGRT Subpart RR	ISO 27916 (CO_2-EOR)
Project Termination	**May request** to discontinue reporting at any time	In addition to any existing permitting, regulatory, and contractual framework by the authority
	Approved by the Administtrator	Only when:
	a demonstration that current monitoring and model(s) show that the injected CO2 stream is **not expected to migrate** in the future in a manner likely to result in surface leakage.	a) the **absence of detectable leakage** (see 6.2) or open conduits to the surface out of the EOR complex, and that the injected CO2 is, at the time of project termination, **safely contained**;
		b) compliance with all well **decommissioning and plugging** requirements for all CO_2-EOR project wells [see 7.2 g)], that wells do not allow fluid movement out of the EOR complex, and that the CO_2-EOR project wells do not pose a leakage risk
		c) the injected CO2 is safely contained with sufficient documentation of the characteristics of the EOR complex and operational history of the CO2-EOR project to **demonstrate long-term stability and predictability** of the associated storage;
		d) risks and uncertainties relating to the associated storage of CO_2 **were managed throughout the EOR project life**; and
		e) **facilities and ancillary equipment** associated with the CO2-EOR project **have been removed**, except those required to be retained by lease or contractual obligations, integral to other operations, or intended for different uses which may be left in place with approval of the authority.

Next Steps for Adoption/Use of ISO:27916 in US

International Organization for Standardization

Administers

- International Experts
- Liaisons (NGOs)
- Technical Advisory Group (TAG)
- National Mirror Committee (NMC)

Authorizes

- **Technical Committees (TC)**
- **Secretariats**
- **Technical Advisory Groups (TAG)**
- **National Mirror Committees (NMC)**

- TC82 Mining
- *TC265 CCUS*
- TC298 Rare Earth Elements

Next Steps for Adoption/Use of ISO:27916 in US

1) *ANSI creates National Mirror Committee (NMC) to* ***"Americanize"*** *the standard for use in US via the National Technology Transfer and Advancement Act 1995, expected in October 2019*

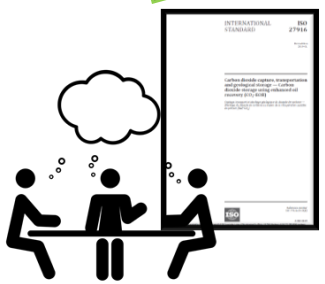
2) IRS issues guidance *that clarifies the definition of* ***"safe and secure storage"*** *via application of ISO:27916 (or Subpart RR) for 45Q, expected late 2019/early 2020*

ISO

Creates TC

Authorizes

ANSI
American National Standards Institute



- National Mirror Committees (NMC)

- Technical Committee (TC)

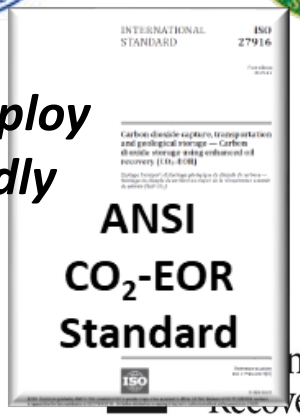
Publishes

Administers

CSA Group

- *TC265 CCUS*

3) Use 45Q to deploy CCUS more broadly before 2024



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Questions, Comments, Concerns

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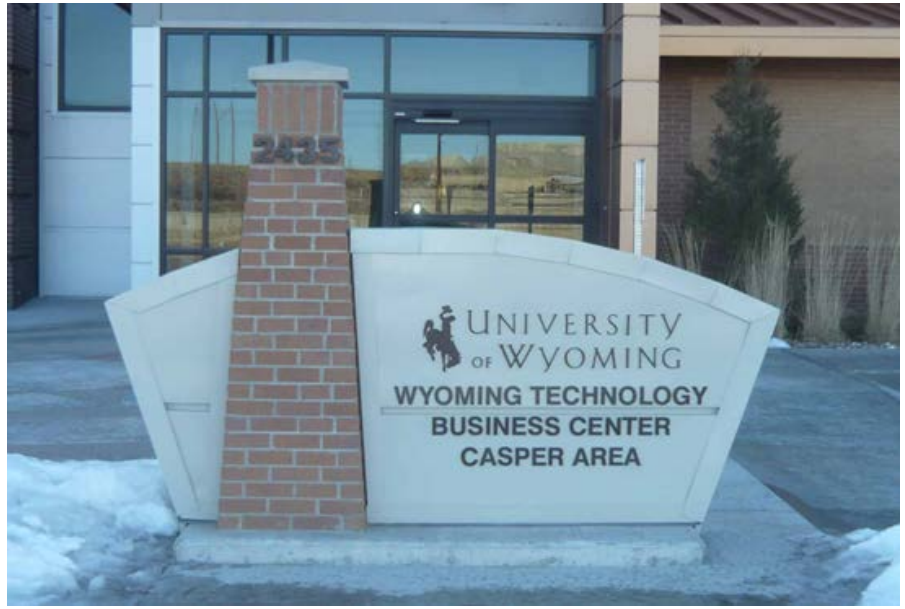

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