# *CCUS, Wyoming, & Non-OECD Economies: ISO Standards as the common denominator*

*Carbon Management Technology Conference*

*July 20, 2017*




1. ISO Standards & CCUS
2. Wyoming & $CO_2$ Demand
3. Non-OECD Economies




# 1: ISO Standards & CCUS

# What are Standards?

- Consensus based
- Designed as a rule, guideline or definition
- Revisable & updateable
- Voluntary
- Standards must fit to purpose:
  - *Prescriptive based*
  - *Objectives based*
  - *Performance based*
  - *Principles based*
  - *Hybrids*

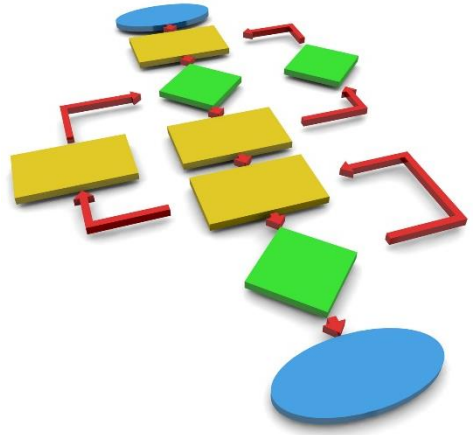
# Why Standards?

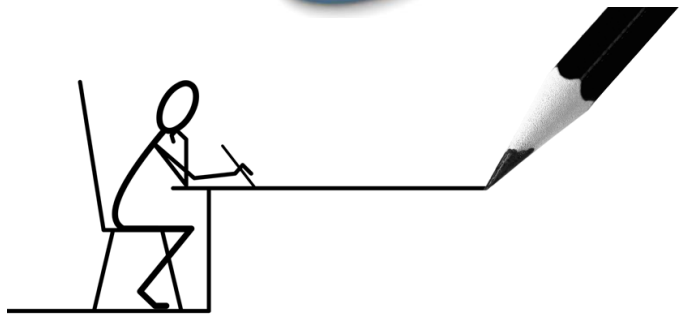
- Because they are not laws…
  - *Standards & regulations can work together*

- Not Mandated ∴ typically initiated by industry…
  - *And ∴ better received & used by industry as part of the process*
- Demonstrate regulatory compliance
- Streamline the regulatory process
- Harmonize across jurisdictions

# ISO Standards Development

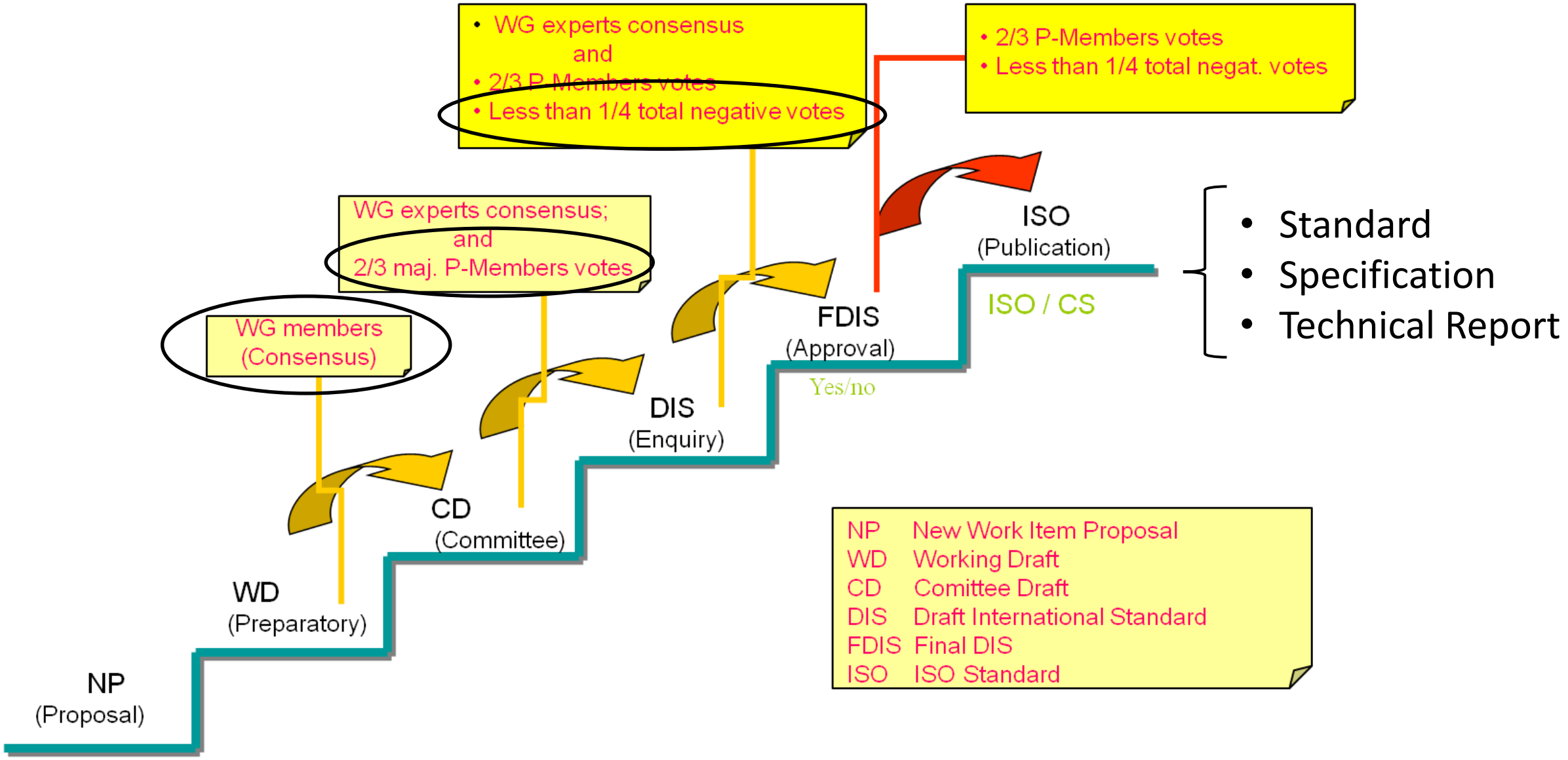
- ISO does not write standards or influence technical content – manage the process
- Technical Committees (TC) of International Experts write standards
- P-Member countries approve standards
- Nations adopt ISO standards





ANSI
American National Standards Institute

# ISO Standards Development



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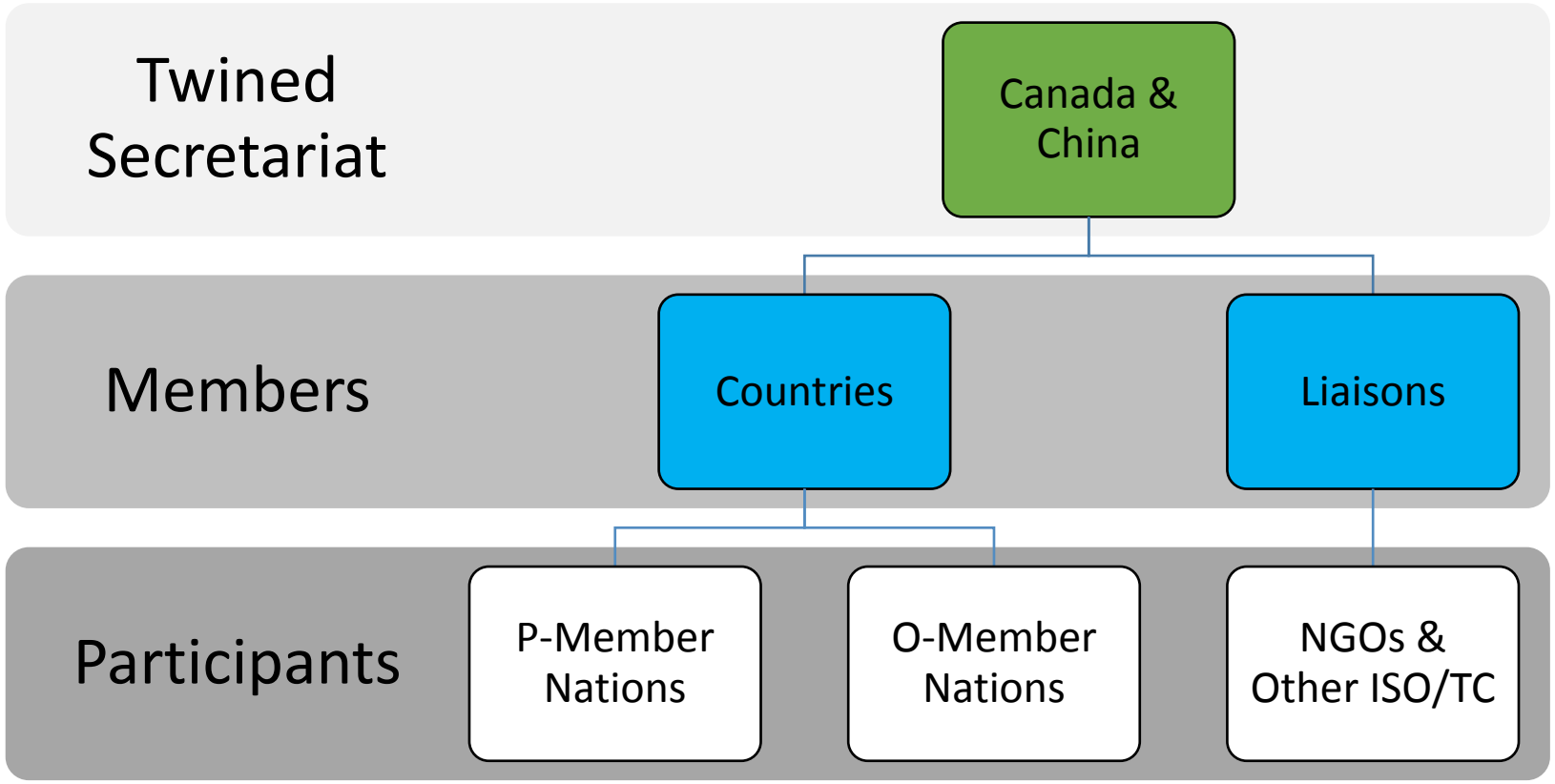
# ISO/TC 265 Carbon dioxide capture, transportation, and geological storage

Standardization of design, construction, operation, environmental planning and management, risk management, quantification, monitoring and verification, and related activities in the field of carbon dioxide capture, transportation, and geological storage



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# ISO TC 265 – P-Members

Participating Countries (18):

| | |
|---|---|
| Australia | Norway |
| Canada | Saudi Arabia |
| China | South Africa |
| France | Spain |
| Germany | Sweden |
| India | Switzerland |
| Japan | United Kingdom |
| Malaysia | Republic of Korea |
| Netherlands | United States (ANSI) |

- ✓ *Voting Members*
- ✓ *Guaranteed International Expert Participation on all WGs*

# ISO TC 265 – O-Members

## Observing Countries (10):

| | |
|---|---|
| Argentina | Italy |
| Czech Rep. | New Zealand |
| Egypt | Qatar |
| Finland | Serbia |
| Iran | Sri Lanka |

- ✓ Non-voting Members
- ✓ *May request* International Expert Participation on all WGs
- ✓ May upgrade to P-Member at any time

# ISO TC 265 – Liaisons

- ISO TC207 Environmental Management
- ISO TC67 Petroleum and Natural Gas
- CEN/TC 234 Gas Infrastructure
- Carbon Sequestration Leadership Forum (CSLF)
- European Industrial Gases Association (EIGA)
- International Energy Association (IEA)
- IEAGHG
- CO2 GeoNet
- World Resources Institute (WRI)

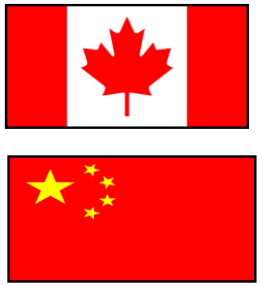


- ✓ Non-voting Members
- ✓ *Guaranteed* International Expert Participation on all WGs

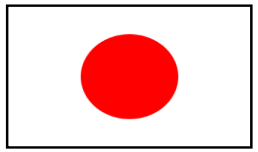
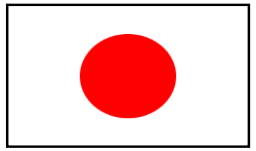
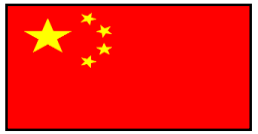
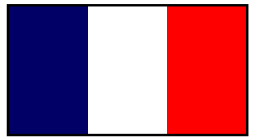
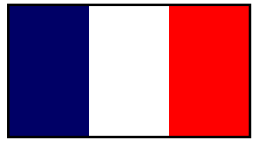
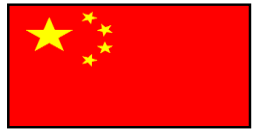
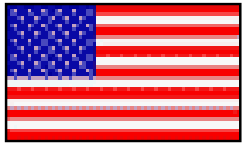
# ISO TC 265 – Working Group Structure

**Cat Herding**

The challenges and rewards of managing online scientific communities

**TC-265**

| WG1 Capture | WG2 Transportation | WG3 Storage | WG4 Q&V (MVA) | WG5 Cross-Cutting | WG6 CO2-EOR |
|---|---|---|---|---|---|
|  |  |   |   |   |   |



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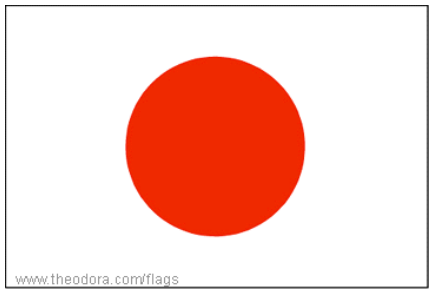
# WG1: Capture




## Scope:

- Pre-, post-, & oxyfuel combustion capture
- Dehydration, compression & pumping
- Liquefaction, installation, operation, maintenance
- Quality of $CO_2$ streams
- Industrial processes
- Separation, purification
- Monitoring, management systems
- Plant retrofitting

## Technical Report:

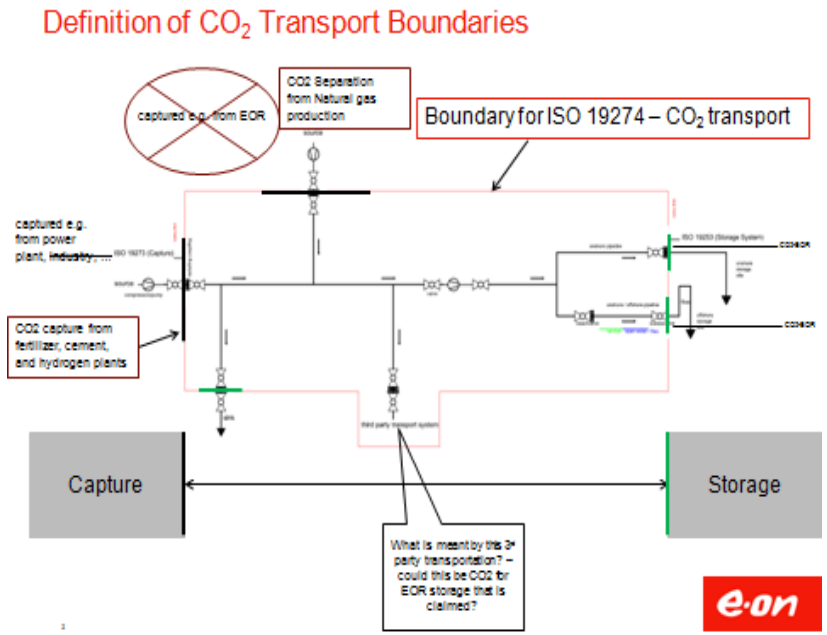
ISO TR 27912 Carbon dioxide capture systems, technologies, equipment and processes for power and industry

## Drafting a Standard:

ISO CD 27919 Performance Evaluation Methods PCC Power Plant

# WG2: Transportation

## Pipeline transportation systems boundaries:




- Pipelines not currently covered by existing ISO/TC-67 standards
- Health, safety and environment (HSE) aspects specific to transport
- Materials of Construction


INTERNATIONAL STANDARD ISO 27913

Carbon dioxide capture, transportation and geological storage — Pipeline transportation systems

ISO


### International Standard:

ISO 27913 Carbon dioxide capture, transportation and geologic storage – Pipeline transportations systems



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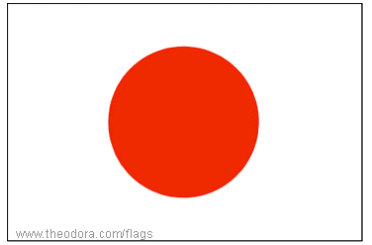
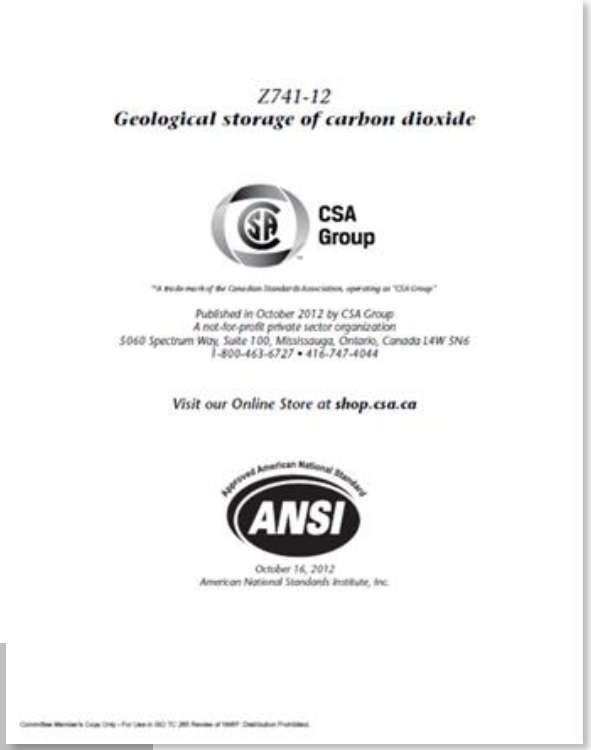
# WG3: Storage

## Geological storage of carbon dioxide Canada (Onshore) & Japan (Offshore):


- Z-741-12 as seed document
- Site selection
- Site characterization
- Risk assessment & management
- Well construction
- Closure
- Post-closure


Z741-12
Geological storage of carbon dioxide

CSA Group

Published in October 2012 by CSA Group
A not-for-profit private sector organization
5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada L4W 5N6
1-800-463-6727 • 416-747-4044

Visit our Online Store at shop.csa.ca

ANSI

October 16, 2012
American National Standards Institute, Inc.

Draft International Standard:

ISO DIS 27914 Geological Storage



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# WG4: Quantification & Verification

Quantification & Verification Methodology; Led by China, with support from France:

- Project boundary & leakage
- $CO_2$ quantification
- Monitoring and reporting
- Third party verification
- Life Cycle Analysis

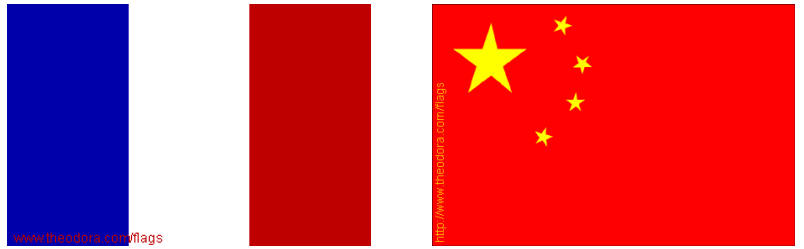
Draft Technical Report:

ISO DTR 27915 Quantification & Verification

Drafting a Standard:

ISO Ballot 27920 Quantification & Verification

# WG5: Crosscutting Issues



Crosscutting Issues; Led by France, with support from China:

- Terminology
- Definitions
- System Integration
- Public Participation & Engagement
- Mixing of gas streams from different sources

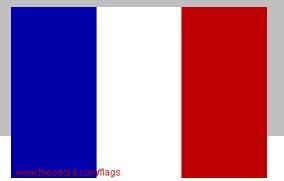
Drafting a Standard:

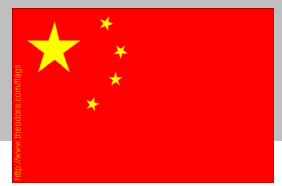
ISO Ballot 27920 $CO_2$ Stream Composition

Draft International Standard:

ISO DIS 27917 Vocabulary

# WG5: Crosscutting Issues





## Example of harmonizing cross-cutting terms among WGs: $CO_2$ stream:

"*a stream consisting overwhelmingly of carbon dioxide*"

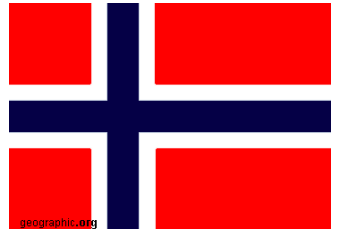

**WG5**: a stream consisting overwhelmingly of carbon dioxide

**WG2:** stream consisting overwhelmingly of carbon dioxide ***with a limited fraction of other chemical substances***

**WG3:** a stream of carbon dioxide ***that has been captured from an emission source (e.g., a fossil fuel power plant) and meets applicable regulatory requirements for $CO_2$ storage***

***Note: It may include any incidental associated substances derived from the source materials or the capture process, added as a result of commingling for transportation, added to the stream to enable or improve the injection process and/or trace substances added to assist in $CO_2$ migration detection.***

# WG6: $CO_2$-EOR


## Carbon Dioxide Storage using EOR; led by USA, with support from Norway:

- Operating oil field environments
- Known reservoir & pore space management
- Manage known lateral stratigraphic traps in the target formation
- Coordination with WGs1-5

**Drafting a Standard (2nd):**

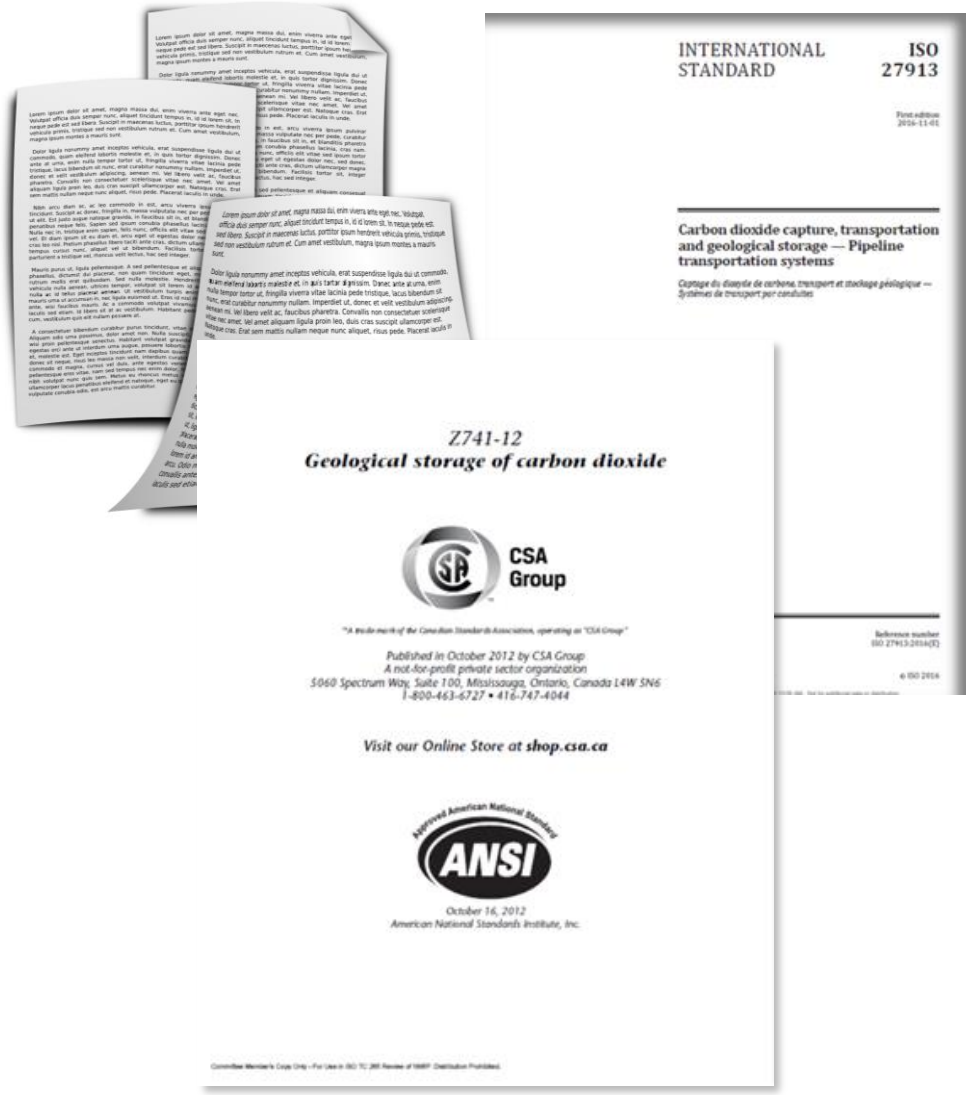
ISO CD 27916 Carbon dioxide storage using Enhanced Oil Recovery (EOR)

- *Lack of international experience in EOR*
- *No closure*

# ISO/TC 265 – Set of Standards & Technical Reports

<u>Used individually or as an integrated full Life Cycle set:</u>

- Capture
- Transport
- Storage (onshore & off)
- Quantification & Verification
- Crosscutting Issues
- $CO_2$-EOR



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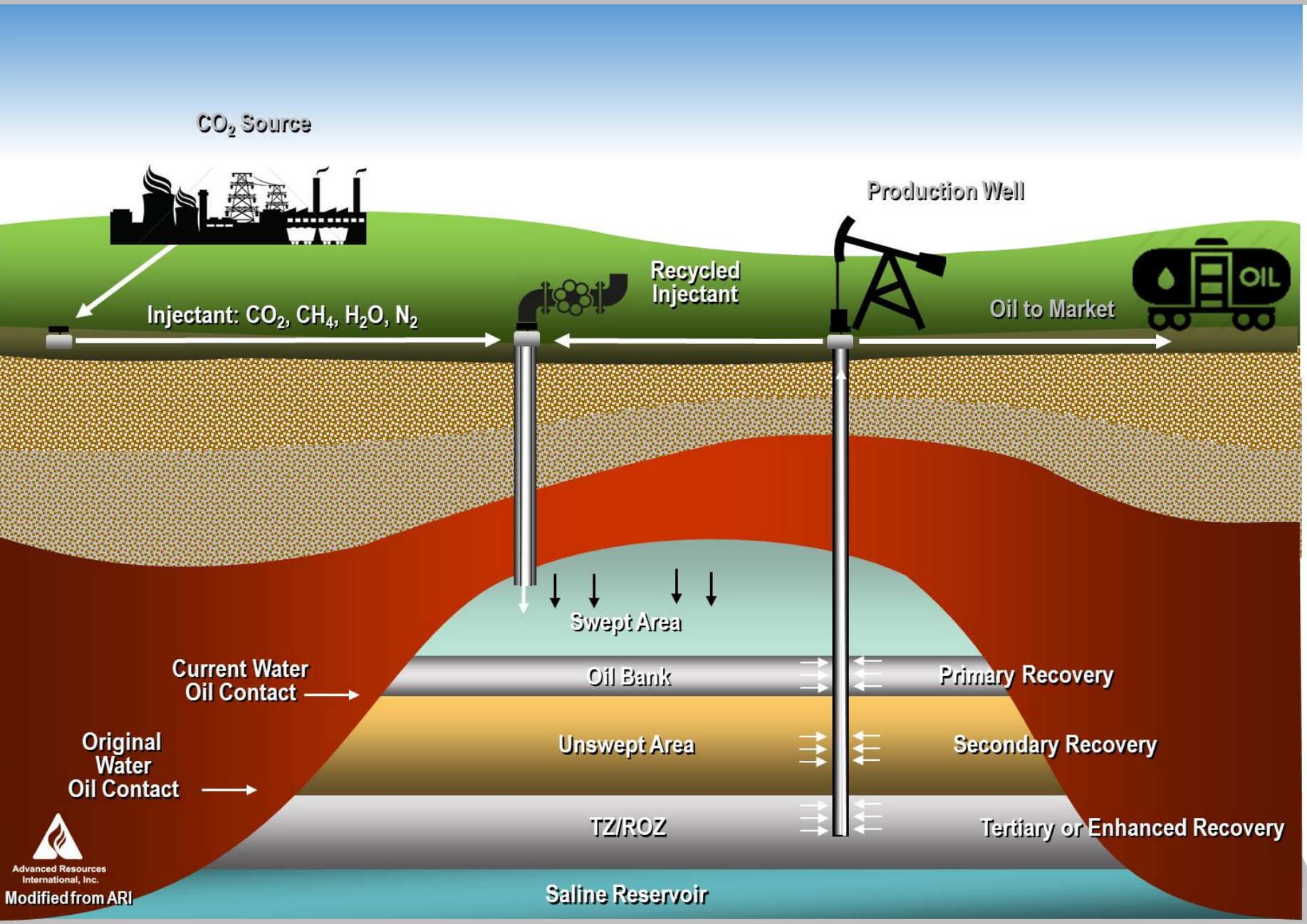
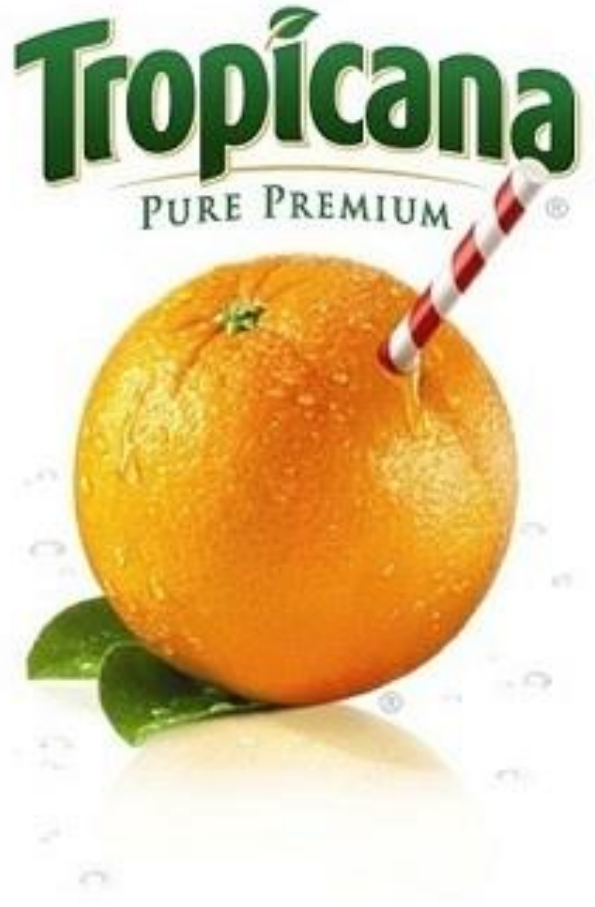
# 2: Wyoming & $CO_2$ Demand

# What is Enhanced or Improved Oil Recovery?

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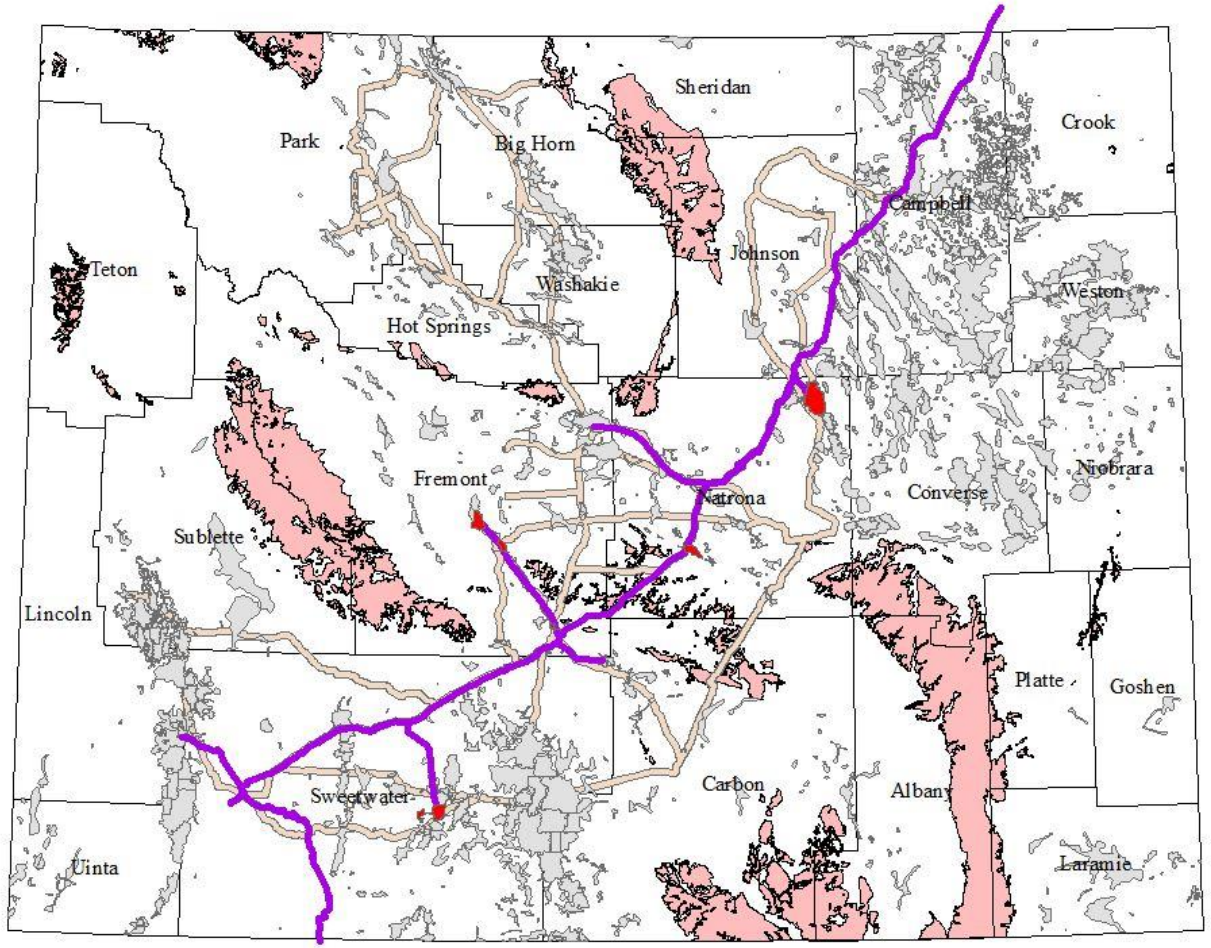
# $CO_2$ & WY – Potential




Based on $85/bbl. oil price, Onshore, L-48 per ARI, 2013

## WY Potential $CO_2$-EOR

- Potential 1.8 Billion bbls
- Technically recoverable 1.1b bbls
- Economically recoverable 644MM bbls

## Wyoming $CO_2$ Injection (1991 – 2016)

| Year | Project | Incremental bo | Cumulative CO2 (mcf) | Cumulative CO2 (tons) |
|---|---|---|---|---|
| 1986 | Wertz | 24,150,949 | 203,167,188 | 11,620,842 |
| 1989 | Lost Soldier | 45,834,473 | 675,416,216 | 38,632,741 |
| 2008 | Beaver Creek | 8,825,908 | 168,613,153 | 9,644,406 |
| 2013 | Big Sand Draw | 916,792 | 39,838,773 | 2,278,715 |
| 2012 | Grieve | -2,059 | 36,258,949 | 2,073,955 |
| 2003 | Patrick Draw | 17,079,074 | 334,713,367 | 19,145,076 |
| 2003 | Salt Creek | 25,762,143 | 2,838,584,423 | 162,362,548 |
| | | **122,567,280** | | **245,758,283** |
| | | | | *2.1 tons of CO2 per bo* |

½ = 3x



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# $CO_2$ & WY – Demand

Bighorn Basin – Potential of 1 Billion barrels in $CO_2$ EOR[1,3]

- **Potential $CO_2$ demand ~3 to 4.5 Tcf**
  - Phosphoria
  - Tensleep
  - Madison

Powder River Basin – Potential of 885 Million barrels in $CO_2$ EOR[2,3]

- **Potential $CO_2$ demand ~4.7 to 7.1 Tcf**
  - Frontier
  - Muddy
  - Minnelusa

Green River Basin

- **Potential $CO_2$ demand ~0.8 to 1.3 Tcf**
  - Almond

Sand Wash Basin

- **Potential $CO_2$ demand ~0.08 to 0.1 Tcf**
  - Tensleep
  - Madison

Wind River Basin

- **Potential $CO_2$ demand ~1.1 to 1.7 Tcf**
  - Tensleep
  - Madison

## Big Horn & PRB

- Potential $CO_2$ demand ~ 7.7 to 11.6 Tcf

## Realization of this production requires:

- ***$CO_2$ availability***
- $CO_2$ Pipeline & Infrastructure
- Operator progression from Secondary Recovery to $CO_2$-EOR



1: Yin et al, 2014, 2: Branting & Whitman, 1992, 3: Wo, Whitman, & Steidtman, 2009

# $CO_2$-EOR + CCUS = SYNERGY: Examples of Success

## Sask's Powers Boundary Dam

- First of it's kind – first fully operational CCUS at commercial scale
- Retrofit of Production unit 3 at the Boundary Dam coal-fired power station near Estevan
- Provides 1 Mtpa $CO_2$ supply to the Weyburn–Midale CO2-EOR projects
- $CO_2$ capture on line in 2014

Source: http://saskpowerccs.com

## Petra Nova Carbon Capture

- 90% capture from a 240 MW flue gas slipstream of the 610 MW (net) pulverized coal-fired generating unit
- 50/50 joint venture between NRG Energy and JX Nippon Oil & Gas Exploration
- Operational in 2016 generating 1.4 Mtpa of $CO_2$ to EOR market


Source: /http://www.nrg.com/generation/projects/petra-nova/



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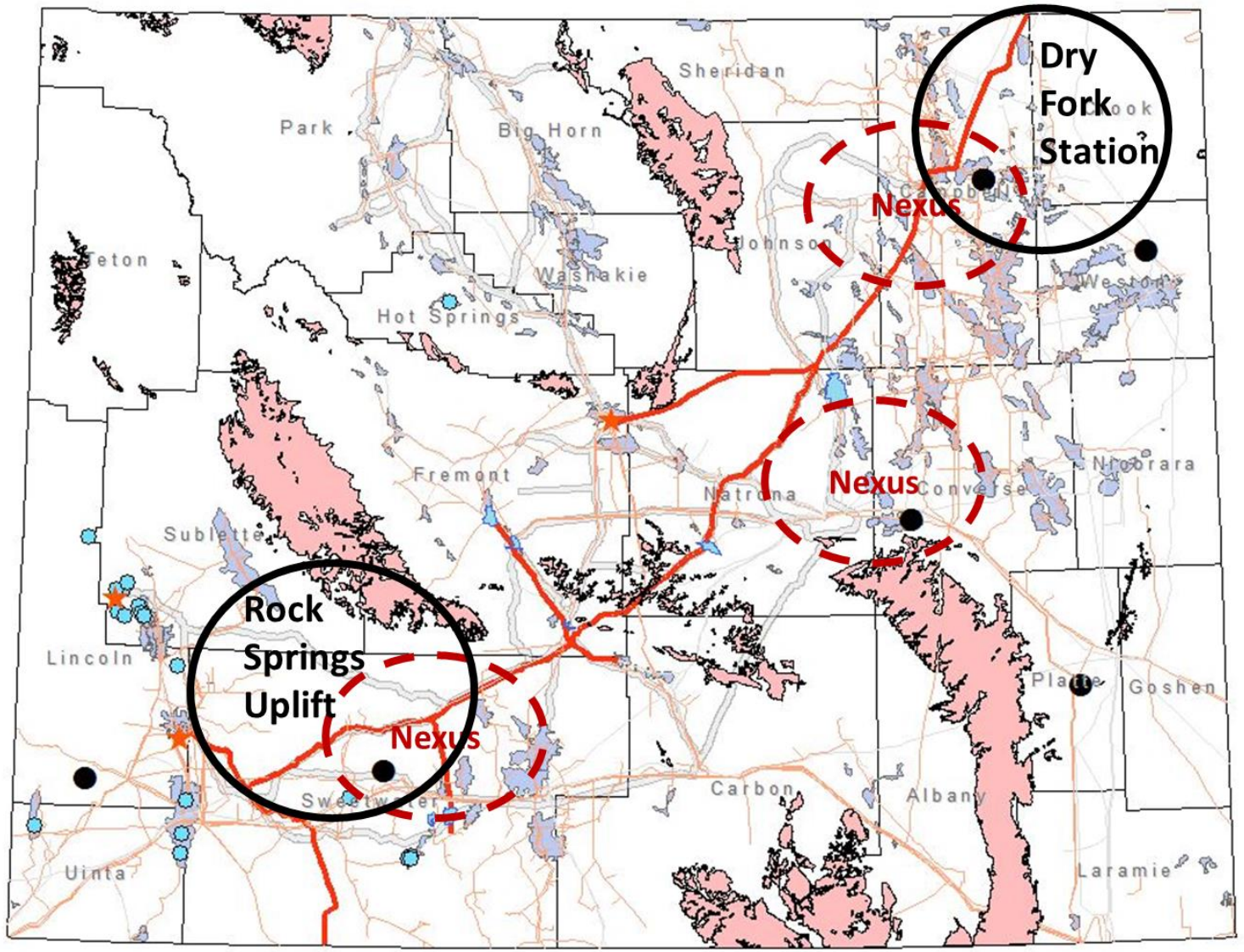
# WYOMING's NextGen CCUS Facility




## Perfect Synergy:

Overlay/Heat Map:

- CFPP
- $CO_2$ – EOR Infrastructure & Projects
- UW CarbonSAFE Awards



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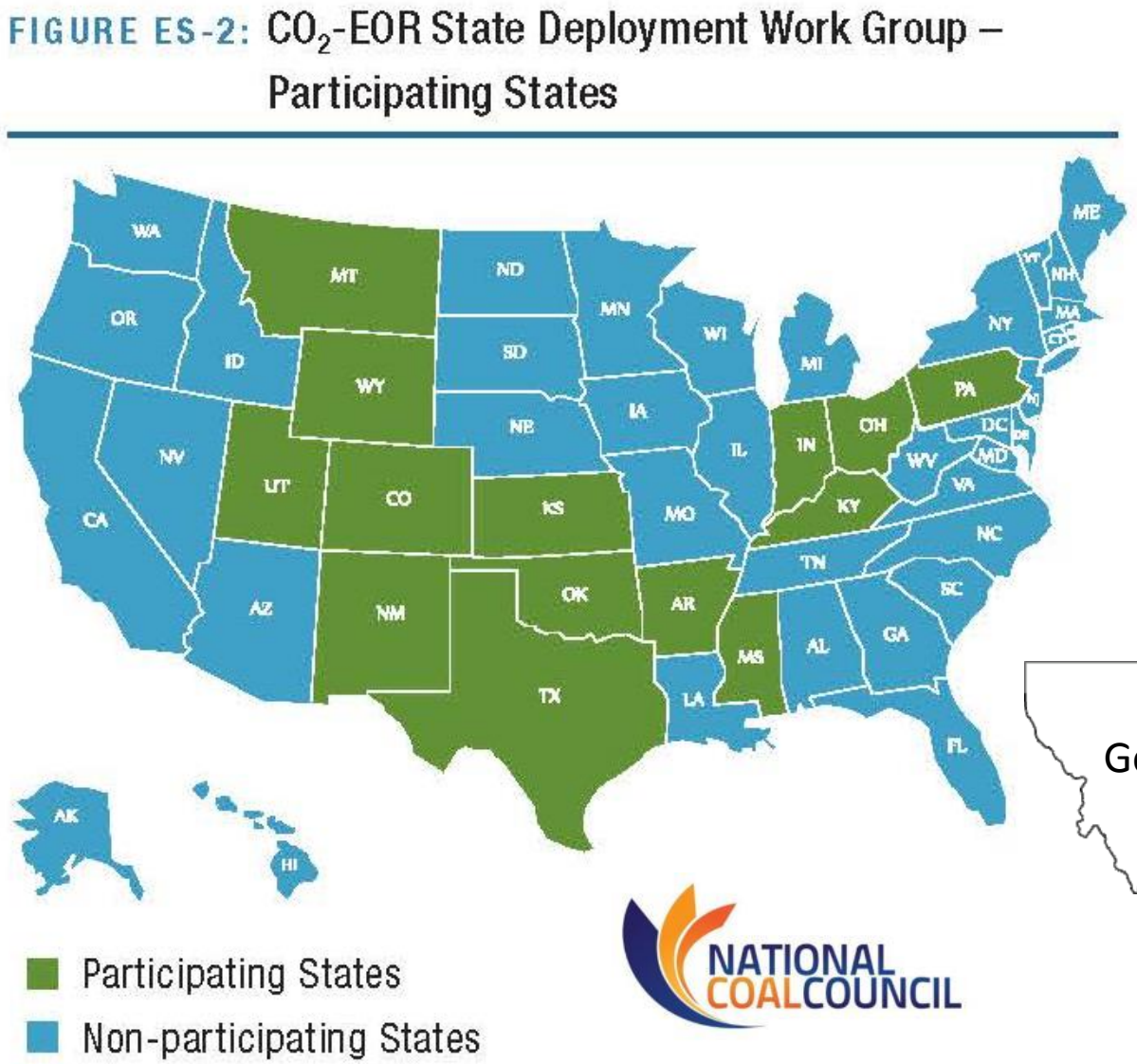
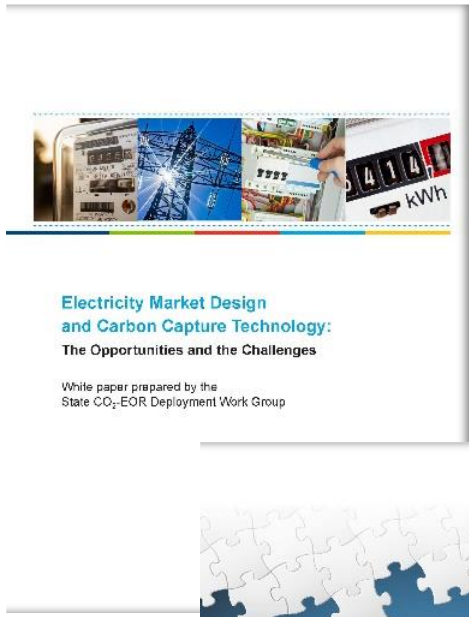
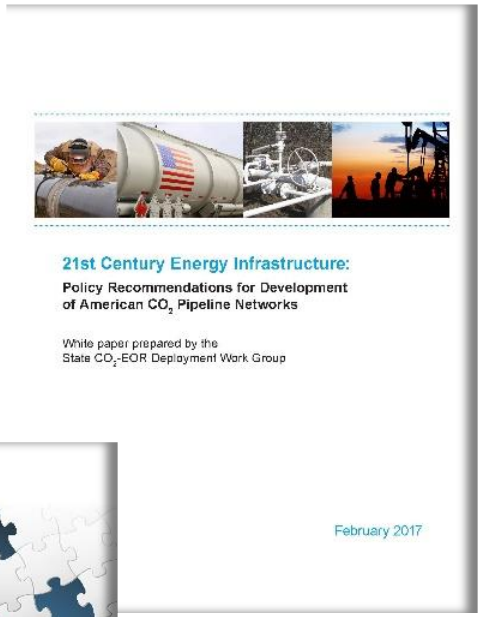
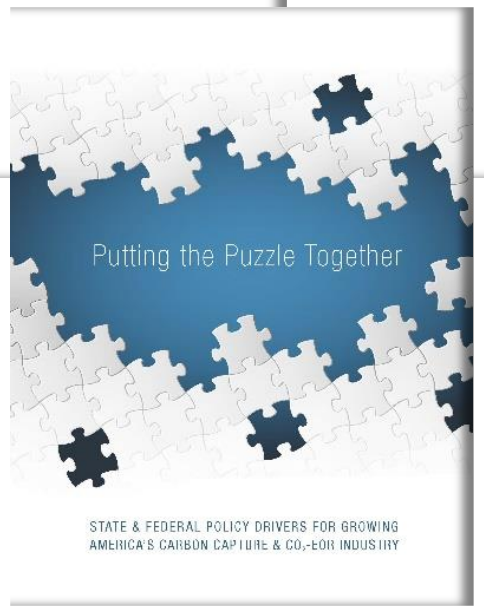
# Western Governors Association $CO_2$-EOR Initiative




NATIONAL COAL COUNCIL




Gov. Bullock (D)

Gov. Mead (R)



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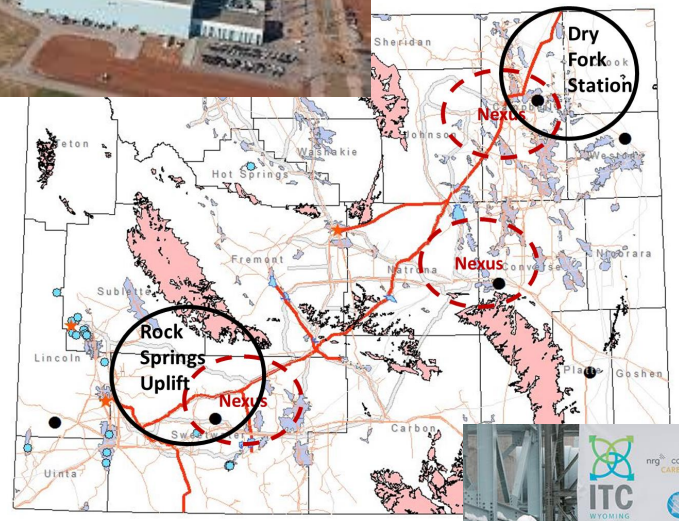
# Wyoming's CCUS Team





School of Energy Resources
University of Wyoming

Carbon Management Institute
University of Wyoming

Enhanced Oil Recovery Institute
University of Wyoming

PAW

ITC Wyoming Integrated Test Center

Wyoming Mining Association

Wyoming Infrastructure Authority

Wyoming Business Council

Western Research Institute



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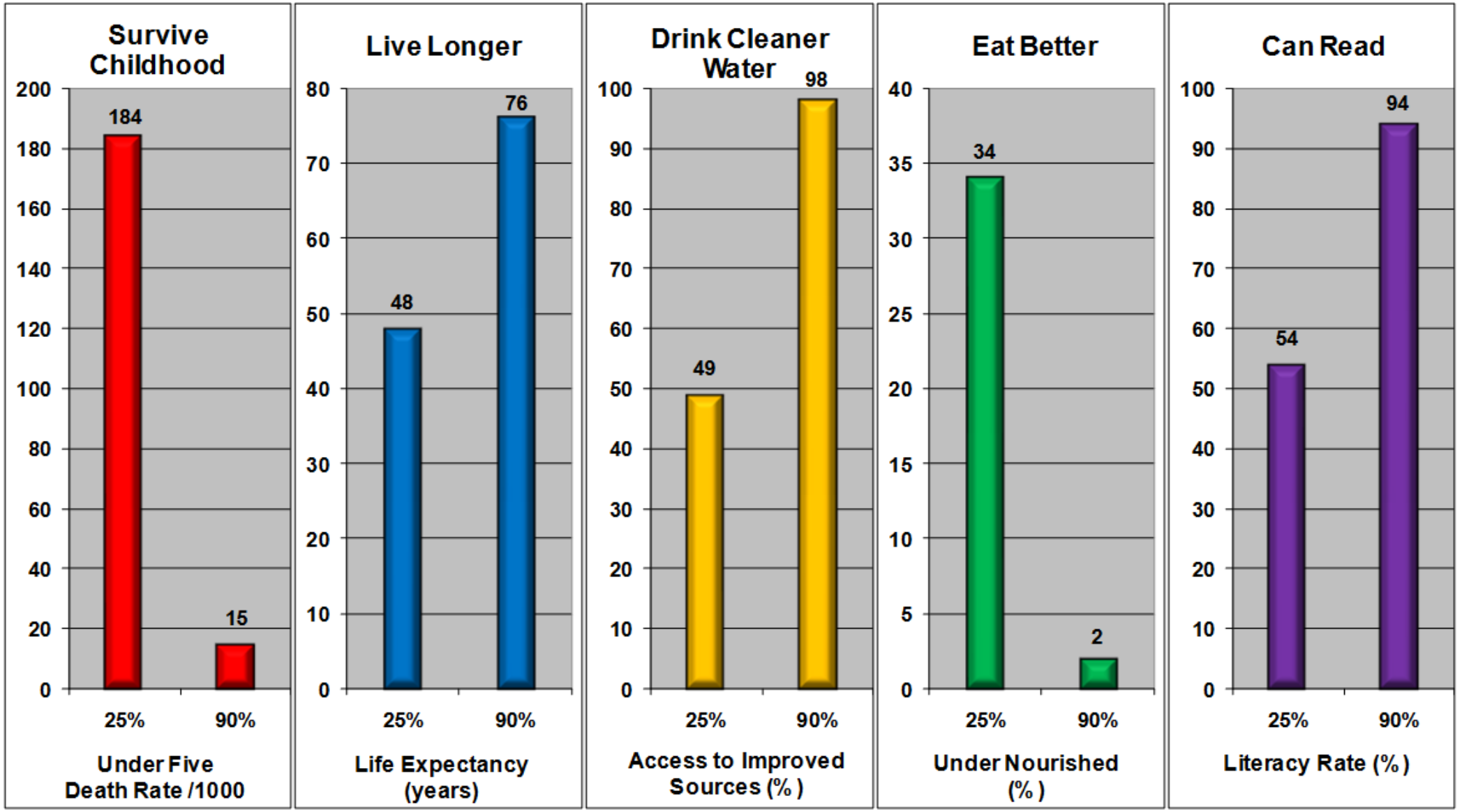
# 3: Non-OECD Economies

# Coal/Energy & Poverty: Energy is Good




Source: Dr. Frank Clemente, Penn State University



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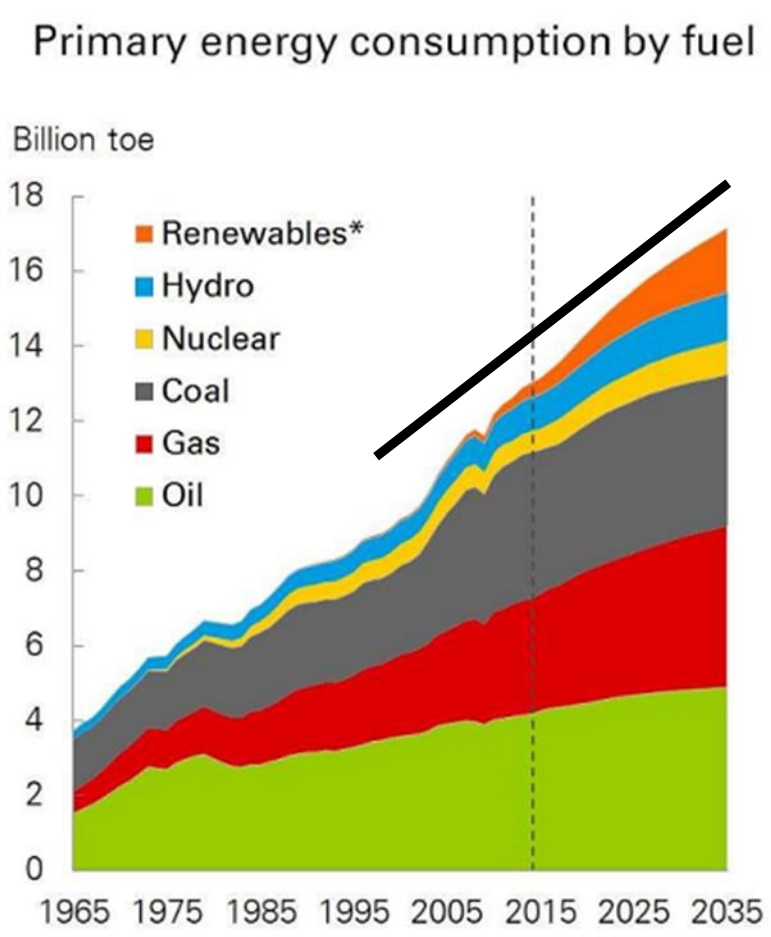
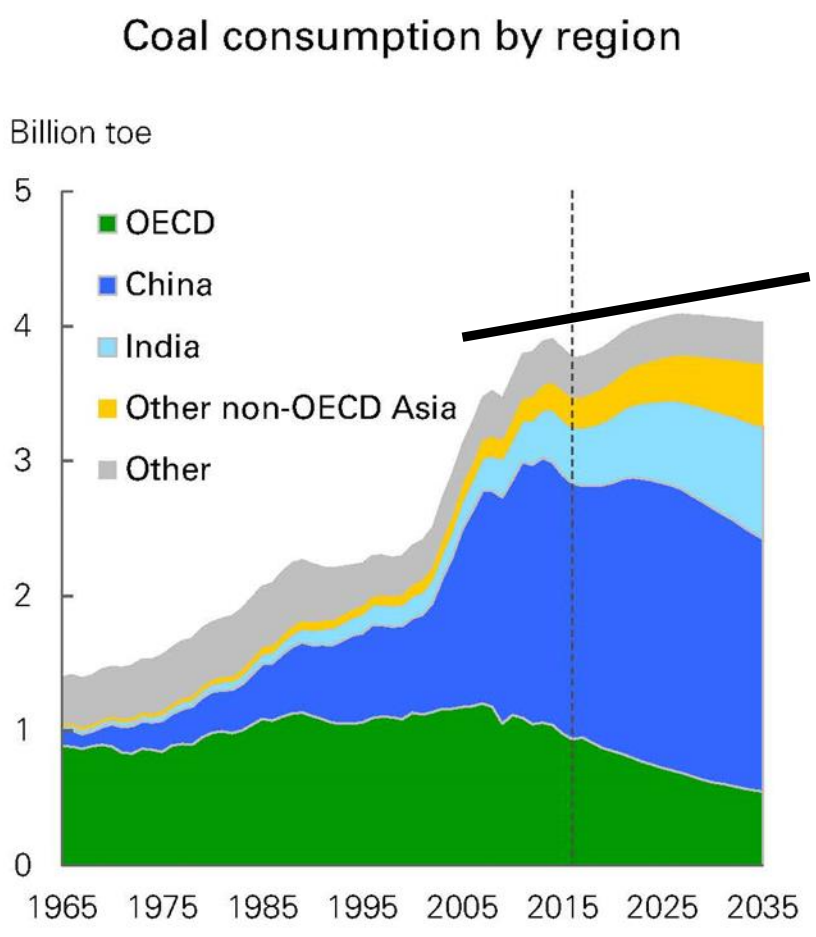
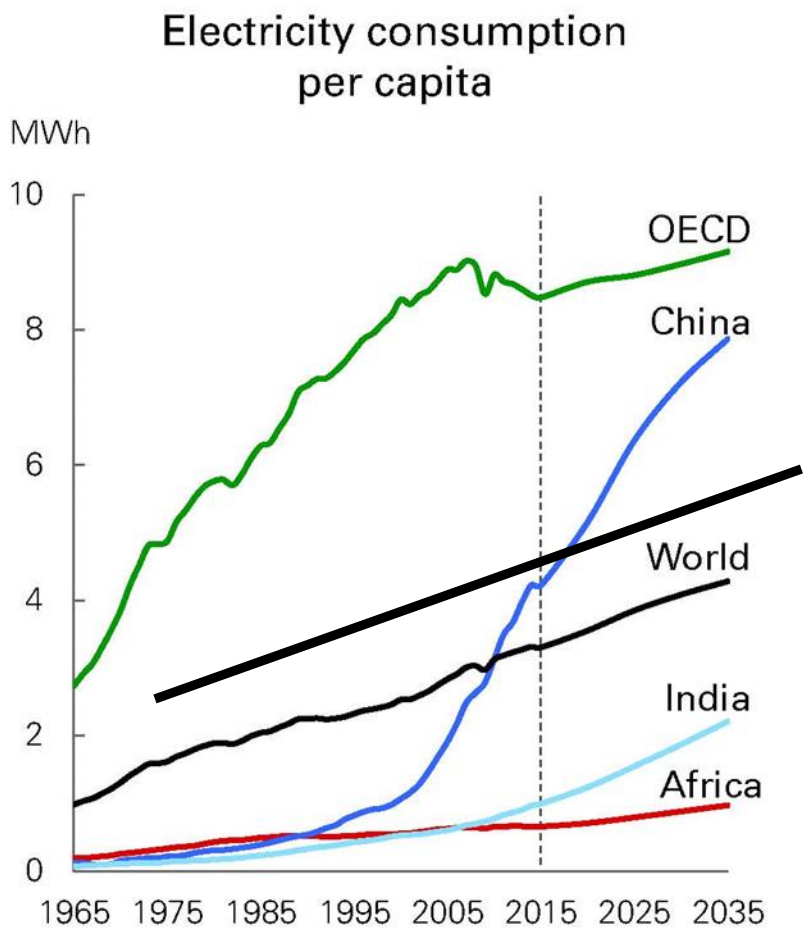
# Non-OECD Energy Demand – Pick your trend line…




Source: BP Global Energy Outlook, 2017

# Why CCUS & Why ISO?

- How does this help advance CCUS?
- David Greeson relative to a 0.5% efficiency increase in capture process, "*who cares?*"
- Chuck McConnell described the "*let's get serious*" perspective derived from many who asked "*so what*?"
- CODE FOR: WHY DO CCUS & WHY ISO?

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# Real-world applications – It Does Matter

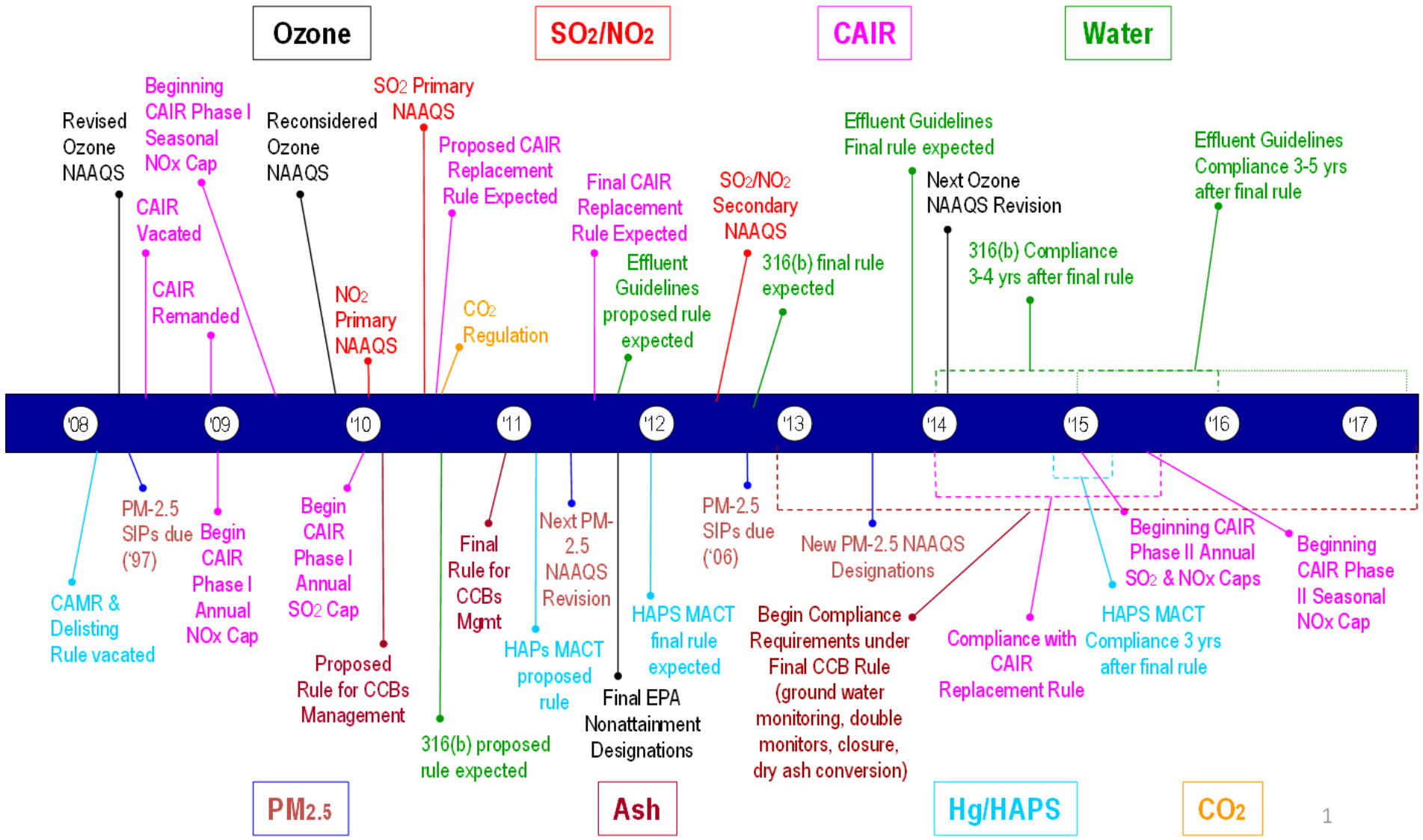
**Mike Monea, President & CEO**
*International CCS Knowledge Center*

"Standards, smart local and ***global standards, are essential*** to the timely advancement of the technologies and equipment that will be necessary to make safe reliable power with the capture of emissions from hydrocarbon fueled power plants."

**Chuck McConnell, Executive Director**
*Rice University E & E Initiative*

"Get technology in ***places in the world*** where it can improve their lives and increase their energy security."

# Regulatory Confusion = Regulations




## $CO_2$ Issues:

- GHG Subpart RR & UU
- UIC Class II
- UIC Class VI
- EPA MRV Plan
- 45Q



Source: Edison Electric Institute and Dick Winschel, CONSOL Energy

# Lack of…

OECD
BETTER POLICIES FOR BETTER LIVES

APEC
Asia-Pacific Economic Cooperation

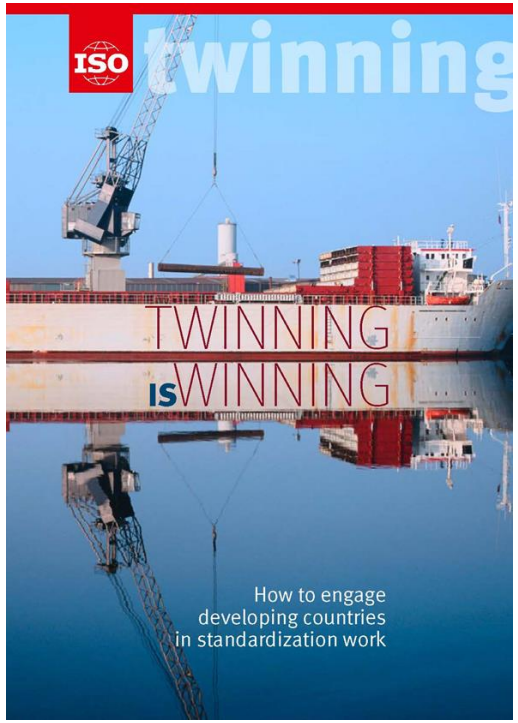
United Nations Framework Convention on Climate Change

## …Regulatory Framework:

- Malaysia
- Argentina
- Iran
- Brazil
- Egypt


## …Industry Experience:

- Saudi Arabia
- Mexico



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# It matters…US ISO Technical Advisory Group Members









# CCUS, Wyoming, and Non-OECD Economies

# Thank You – Question & Comments


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