

IEA CCS Regulatory Review: Recent US Actions

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U.S. DEPARTMENT OF ENERGY | Fossil Energy

Agenda:

- EPA Regulations:
  - Greenhouse Gas, New Plants
  - Greenhouse Gas, Existing Plants
  - Regulatory Compliance Timeline
  - Class II and Class VI Updates and Considerations
- US Project Status
- R&D Status
- Moving Forward

New Fossil Baseload: [111(b)]

Coal-Fired Units: less than 1,100 lbs CO_2/MWh [~500 gCO_2 / kWh]

Reference: New Super Critical: 1,800-2,000 lbs CO_2/MWh [800-900 gCO_2 / kWh]

Coal may comply with ~ 40% capture

NGCC: 1,000 lbs CO_2/MWh [453 gCO_2 / kWh]
Gas CT: 1,100 lbs CO_2/MWh [500 gCO_2 / kWh]

- Compliance is on a 12 month rolling basis
- Captured CO_2 may be sent for geologic storage
- EOR may be used with appropriate reporting (Subpart RR)

Timeline:
Proposed Regulation: November, 2013
Final Regulation expected Summer, 2015

Note: 111(b) must be final before 111(d) is final!

Clean Power Plan: The Building Blocks

Building Block	Strategy EPA Used to Calculate the State Goal	Maximum Flexibility: Examples of State Compliance Measures
1. Make fossil fuel-fired power plants more efficient	Efficiency Improvements	Efficiency improvements Co-firing or switching to natural gas Coal retirements Retrofit CCS (e.g.,WA Parish in Texas)
2. Use lower-emitting power sources more	Dispatch changes to existing natural gas combined cycle (CC)	Dispatch changes to existing natural gas CC
3. Build more zero/low-emitting energy sources	Renewable Energy Certain Nuclear	New NGCC Renewables Nuclear (new and up-rates) New coal with CCS
4. Use electricity more efficiently	Demand-side energy efficiency programs	Demand-side energy efficiency programs Transmission efficiency improvements Energy storage

Existing Fossil Baseload [111(d)]

- Building blocks define emission rate for each states
- Can be translated into mass-based standard
- States can tailor their approach
- CCS Retrofits can be used as compliance
  - No plants are required to retrofit with CCS

111(d), Timing

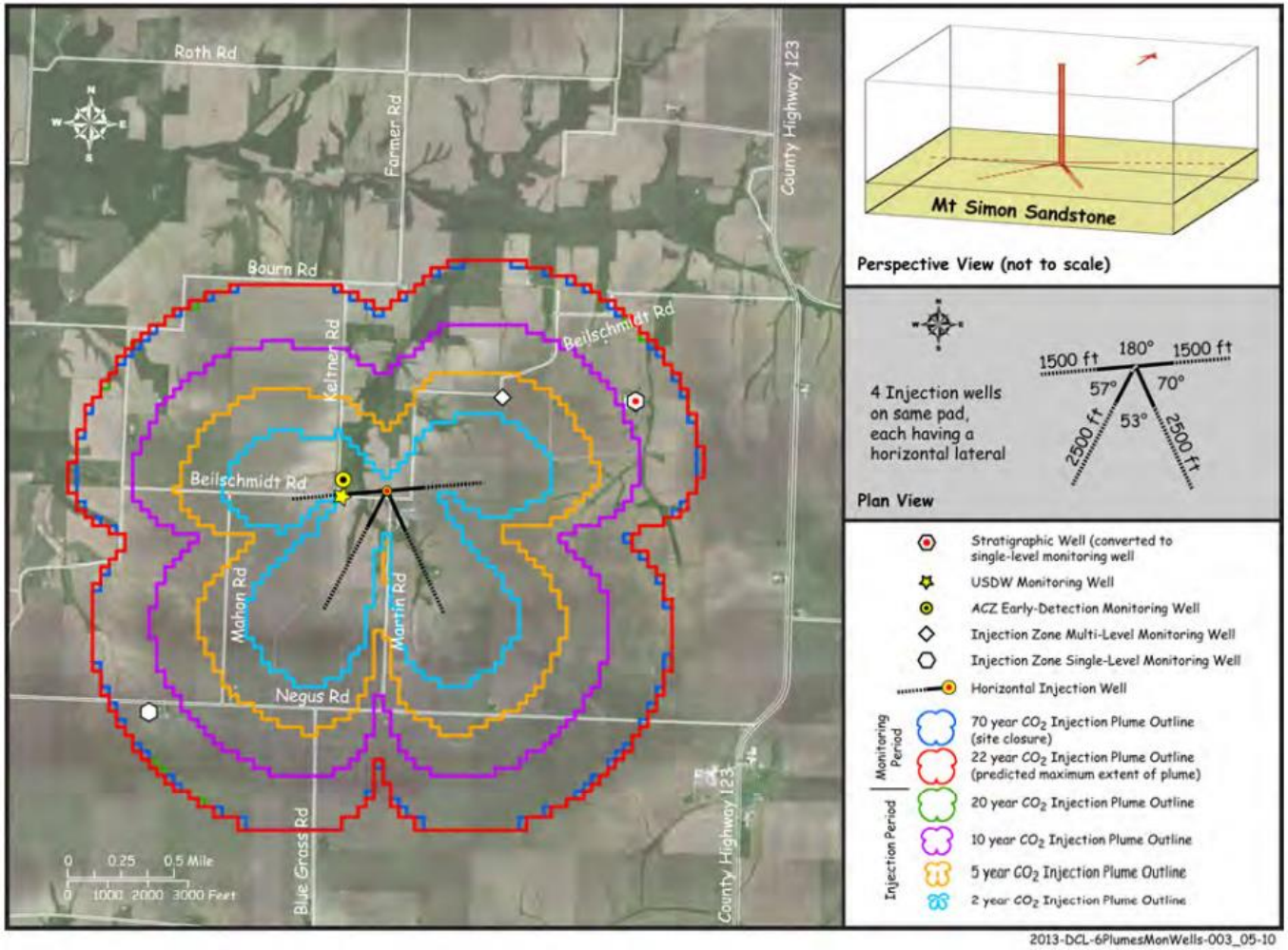
- "Mid-Summer", 2015: Final Rule Published
- Summer 2016: State Plans due
- Summer 2017: 1-Year Extension (If granted)
- Summer 2018: Multi-State Plans due

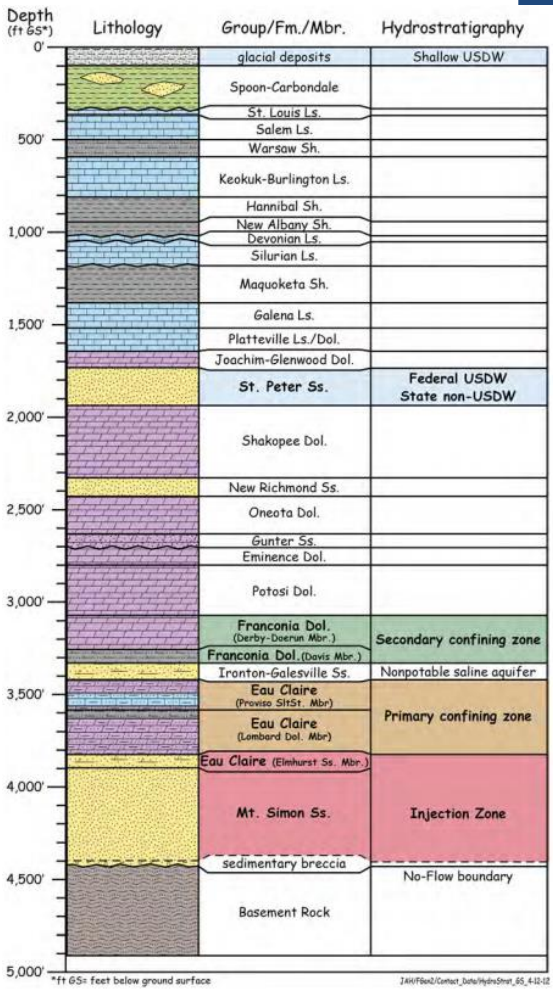
- 2020: Compliance begins
- 2025: Interim Target ("Glide path")
- 2030: Full Compliance

Class VI Update

- "5" Permits Granted
- ADM: Drilling Injection well
- FutureGen Project Cancelled (4 wells)
  - Continuing through permit appeals process
  - May use injection site in the future
- EPA Developing Guidance: II-VI Transition
  - Focus: Protection of Underground Sources of Drinking Water (USDWs)
  - Summer 2015 Publication

FutureGen: Area of Review





Tax Credits

- Proposed: $2 Billion Investment Tax Credit (ITC)
- > 75% Capture of CO_2
- Up to 30% of capital investments

- Sequestration Tax Credit:
  - $50 / metric ton, Saline Storage
  - $10 / metric ton, Enhanced Oil Recovery
  - Guaranteed for 20 years of operation
    - Replaces 45Q: $20 / $10, 75 Million Metric Tons available

Loan Program Office Project Development Financing

LPO Advanced Fossil Energy Solicitation

CARBON CAPTURE
- From traditional coal or NG generation
- Saline formations or EOR

ADVANCED RESOURCE DEVELOPMENT
- ECBM, UCG, novel oil and gas drilling
- Use of co-produced waste gases vs. flaring

LOW CARBON POWER SYSTEMS
- Oxycombustion, chemical looping
- Syngas-, H2, or NG-based fuel cells

EFFICIENCY IMPROVEMENTS
- CHP and waste-heat recovery
- High-T or high-efficiency cycles

W.A. Parrish, TX
NRG/PetraNova project

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Broke Ground January 2015!

Brief history and roadmap for CCS

	Then CCS Program Initiated (1997)	Now Progress to Date	Future (2030) Broad Commercial Deployment
CCS R&D	• Niche commercial efforts • 1930's and 1970's tech for capture • Little known for storage	• Much knowledge gained • Major tech development • Tools being developed and tested	• "Commercial toolbox" developed • Dramatic cost reductions • 1000's of sites worldwide
Storage Infrastructure/ Field Tests	• Little known outside of oilfield services • Sleipner project initiated	• Increased visibility; • Knowledge gained and lessons learned • 12 large projects world-wide	• Market frameworks in place • Novel regulatory mechanisms • Turnkey operation

CCS: A Critical Crossroads

Success of the demos

- Serial # 1 in operation 2013-2018
- A deep and rich set of public learning

Regulatory Certainty

- CCS Required for New Plants
- Drivers in place for Existing Plants
- UIC Program, Existing Permits providing certainty

Financial Support

- Strong Tax incentives
- EOR is common; New approaches providing value