U.S.DOE/NETL's Carbon Storage Program

The 22nd Annual CO_2/ROZ Conference
EOR Carbon Management Workshop, Midland Texas

NATIONAL ENERGY TECHNOLOGY LABORATORY

CO_2 ROZ 2016 Conference

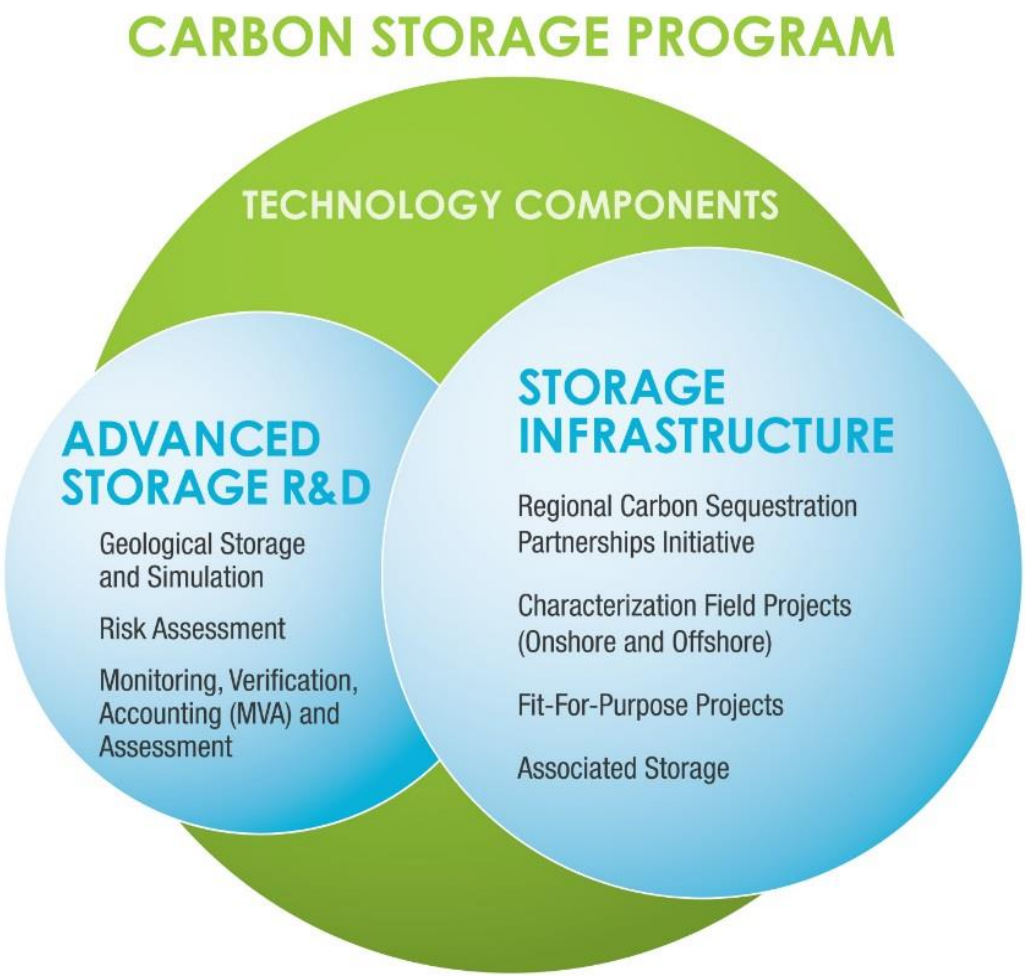
December 6, 2016

Solutions for Today | Options for Tomorrow

U.S. DEPARTMENT OF ENERGY

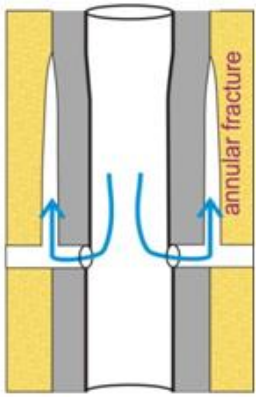
Carbon Storage Programmatic Structure and Technical Priorities

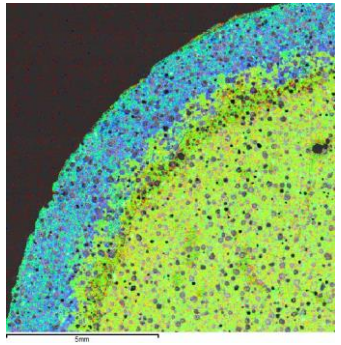
- Predicting and monitoring CO_2 plume and brine pressure front movement, stabilization, and impacts
- Optimization of reservoirs for CO_2 storage capacity
- Developing and validating risk-assessment strategies
- Mitigating risks, such as leakage from old wells and induced seismicity
- Carrying out (large-volume and Fit-for-Purpose) field tests for different storage types and depositional environments



Carbon Storage Program
Addressing Subsurface Challenges and Risk

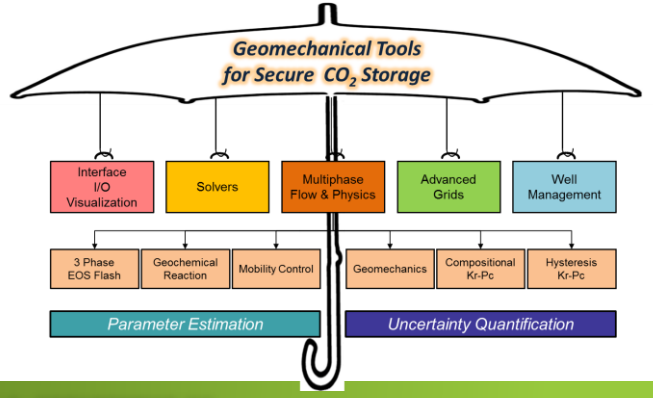
Well Integrity and Mitigation

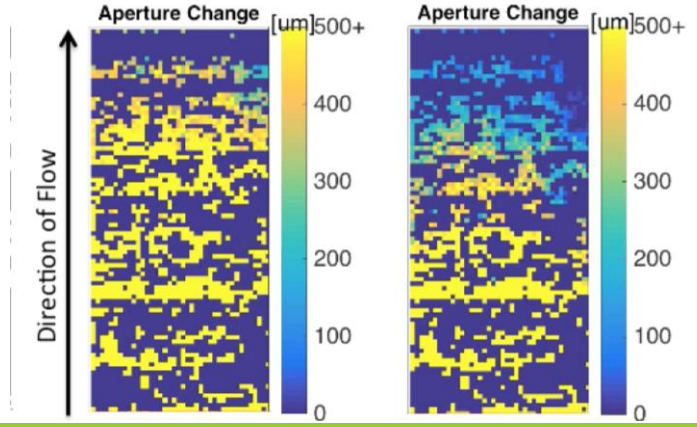




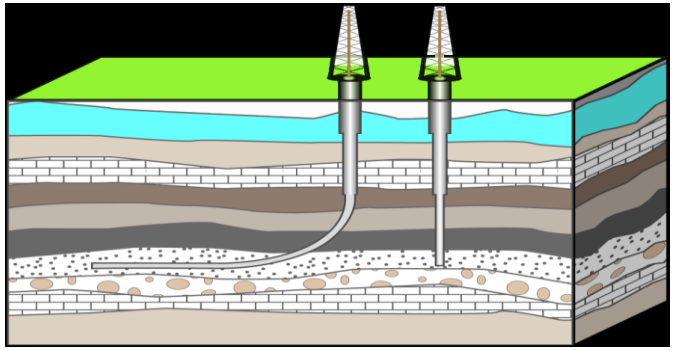
Monitoring, Verification and Accounting (MVA)

Storage Complex Efficiency and Security



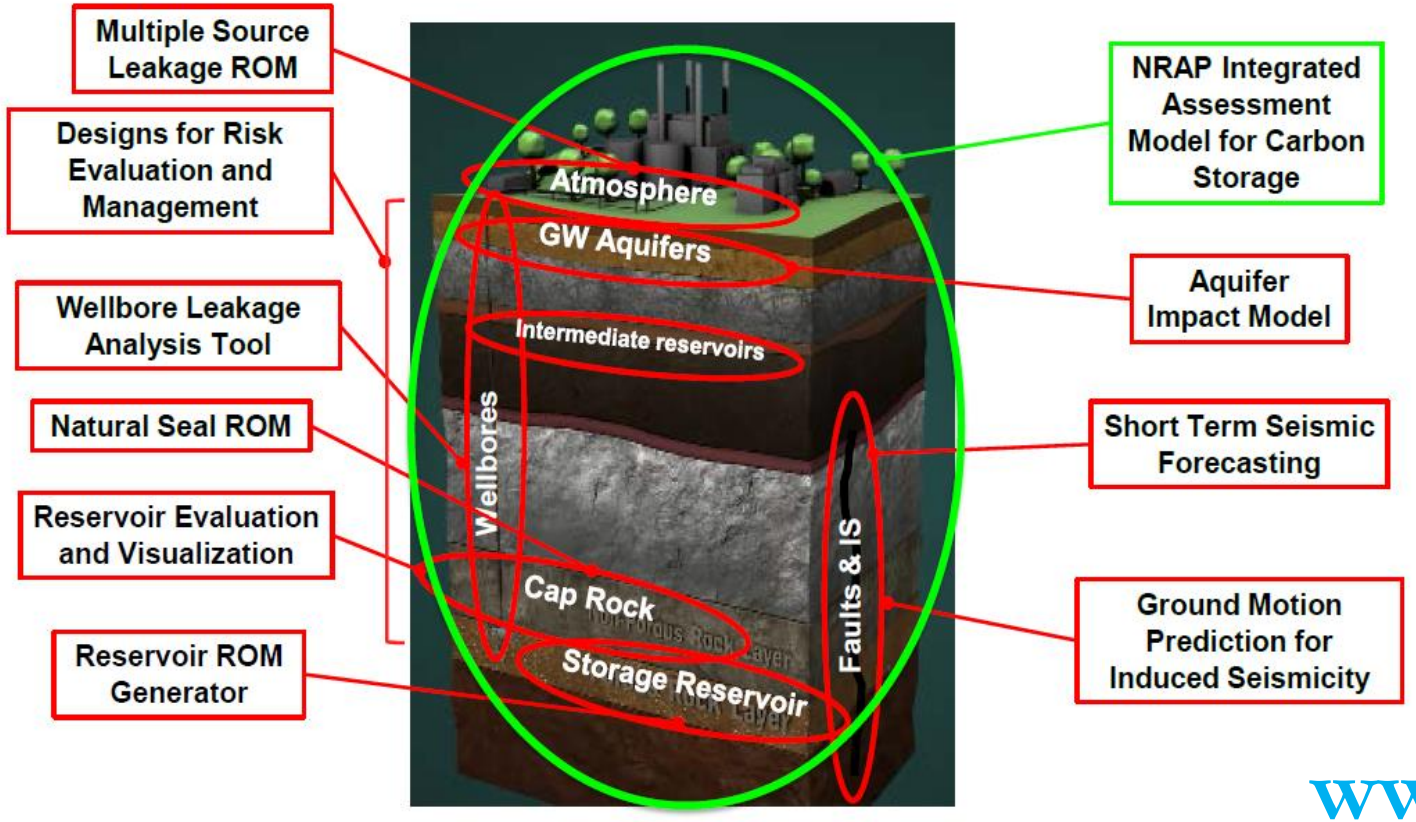


Risk Assessment



Carbon Storage Program
National Risk Assessment Partnership (NRAP)

NRAP is developing toolsets to reduce uncertainty and quantify potential impacts related to release of CO_2 and induced seismicity



Technical Team

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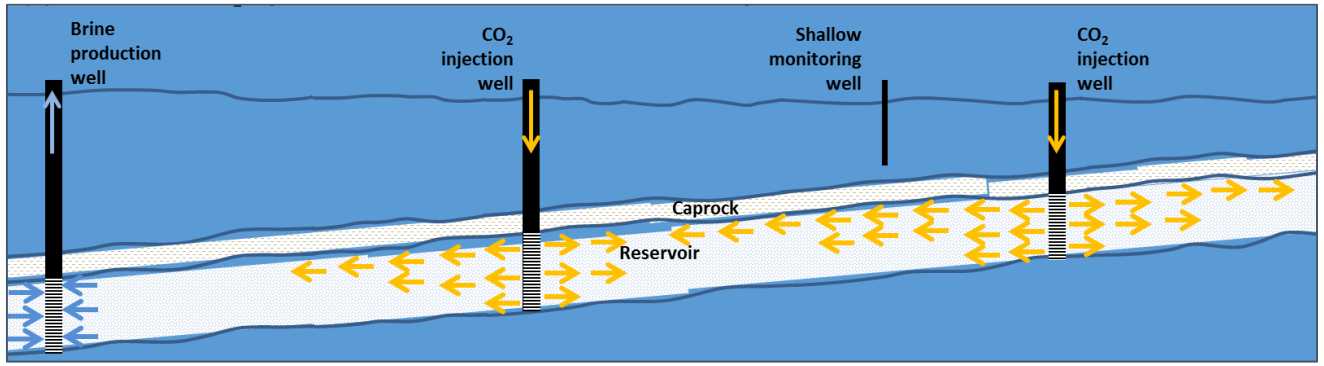
EDX Energy Data eXchange

www.edx.netl.doe.gov/nrap

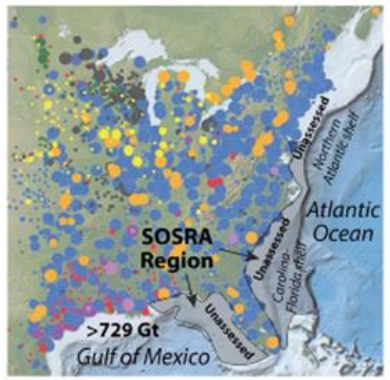
Carbon Storage Program
Addressing Larger-scale Challenges

Regional Carbon Sequestration Partnerships

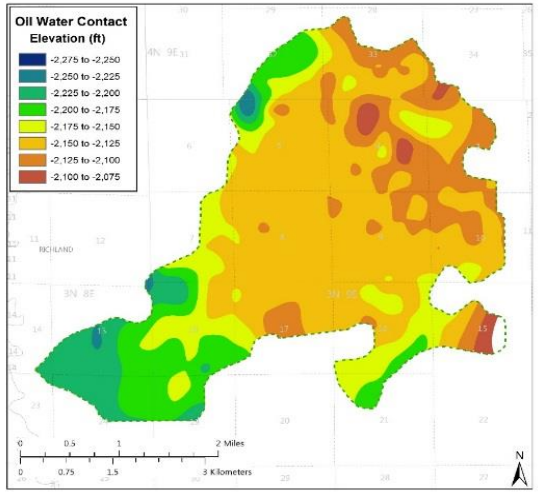
Brine Extraction Storage Tests (BEST)

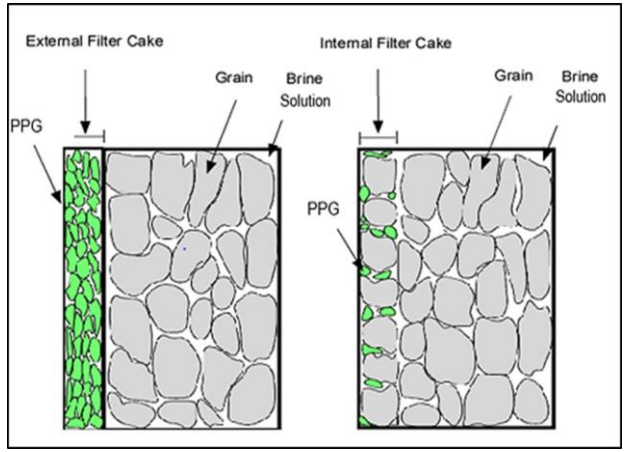


Offshore Storage

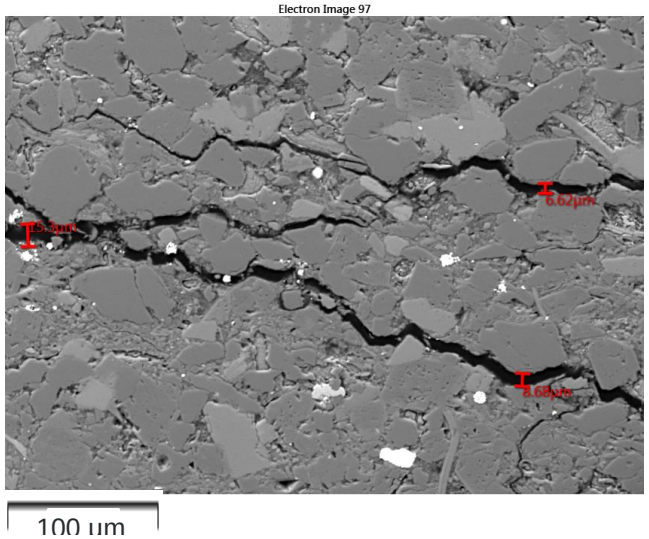


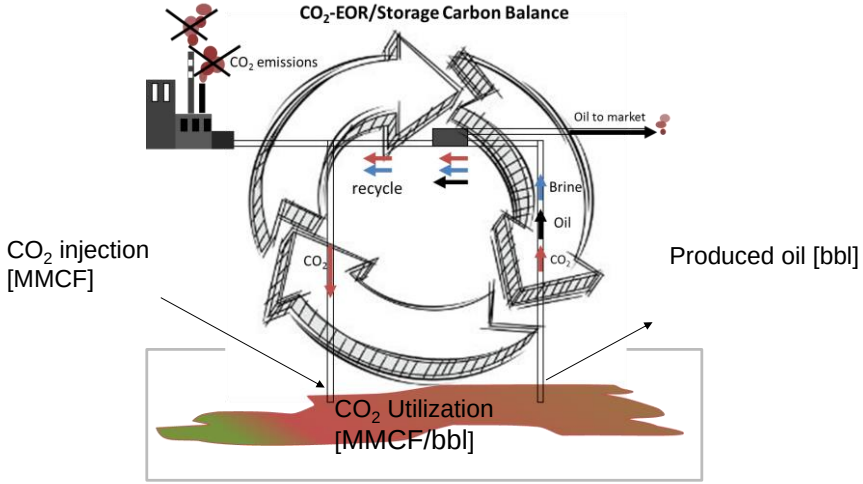
Associated Storage
Enhanced Oil Recovery and Residual Oil Zones (ROZ)





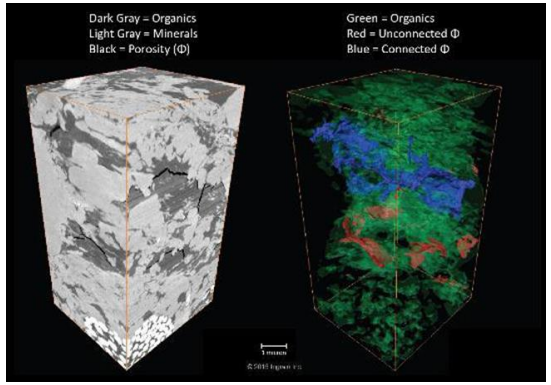
- **Searching for new ROZs:**
  - Basin modeling indicates potential ROZ near Elkhorn Ranch Field in North Dakota.
  - Tilted oil/water contact a key indicator of possible ROZ in Noble Field in Illinois.
- **Geochemical and reservoir modeling to improve understanding of CO_2 storage in known ROZ in Seminole Unit in Texas.**
- **Framework for a methodology to determine if a CO_2-EOR operation can be classified as Net Carbon Negative Oil (NCNO).**
- **Data gathered on nano- to macro-scale properties of fracture networks key to associated storage in the Bakken formation in North Dakota.**
- **Synthesized swelling delayed CO_2 resistant preformed particle gel (PPG) (10 um- mm) for conformance control**



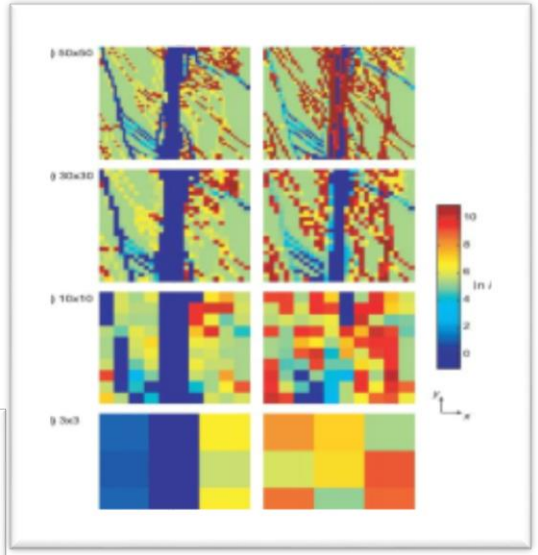


Associated Storage
Project Findings

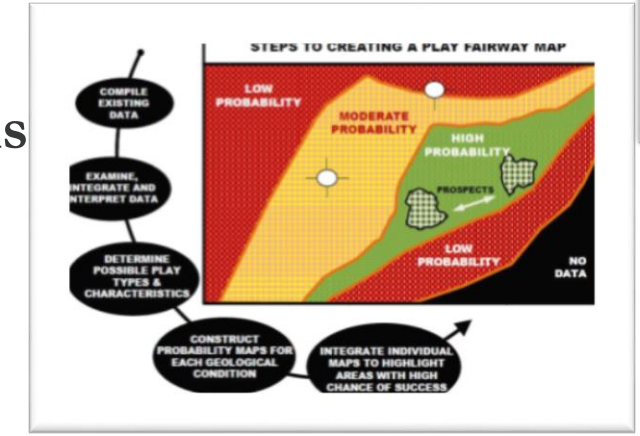
- Advanced SEM results show that although porosity values are low in the tight Bakken shale, it appears that much of the microscale porosity is connected



- Upscaling is difficult but important for accurate reservoir modeling

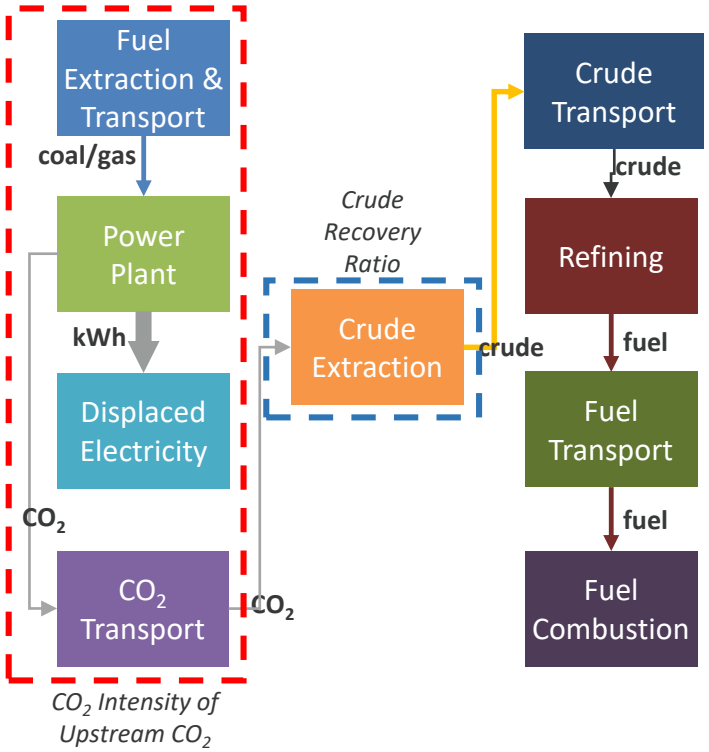


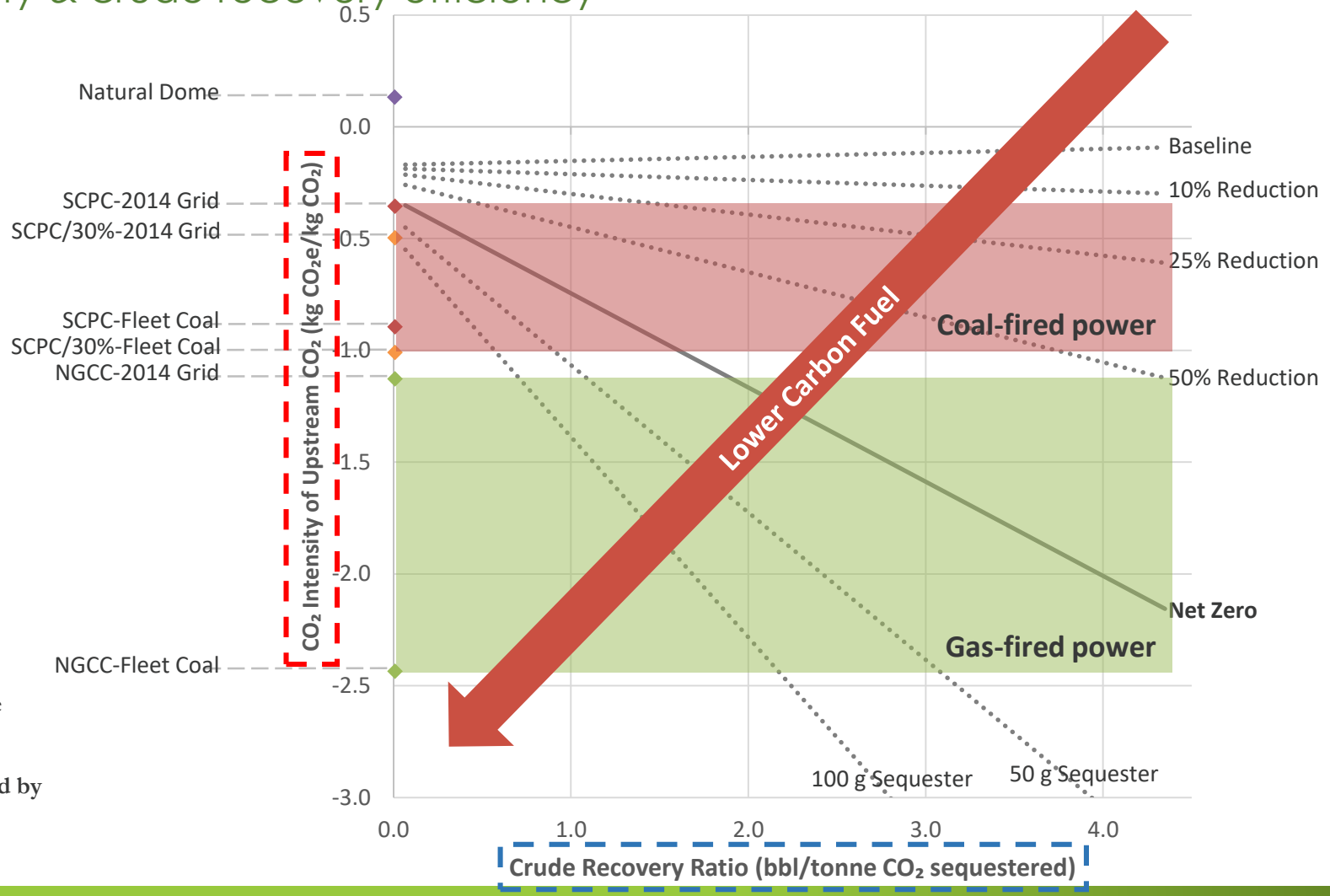
- Basin modeling can provide useful indications on locations of ROZs.



NETL LCA Net Carbon Negative Oil Study (2016)

EOR for GHG Reduction: Achievable low-carbon fuel targets are dependent on the intersection of CO_2 source GHG intensity & crude recovery efficiency



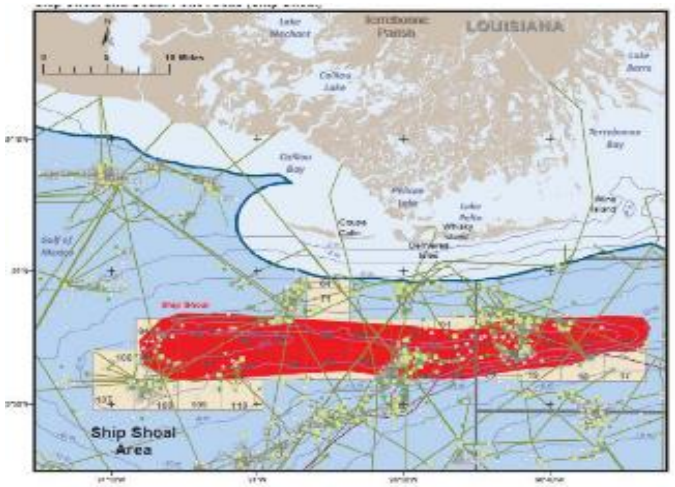


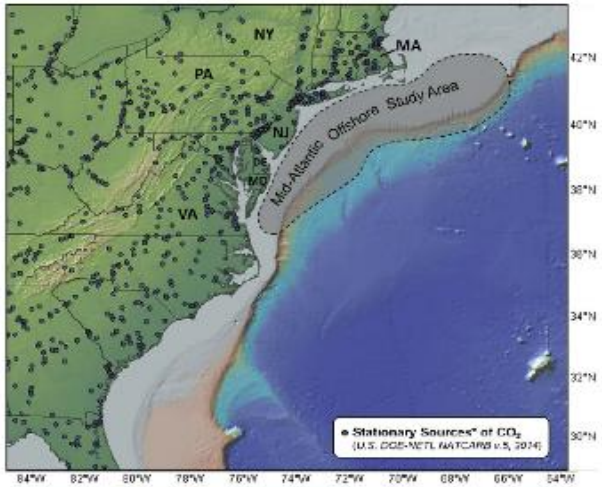
- An LCA framework allows for in-depth examination of the system where captured CO_2 from fossil power is paired with EOR/ROZ
- Key considerations are the carbon intensity of the power that is displaced by the new plant equipped with carbon capture and the willingness of the crude producer to behave like a sequestration site

NETL LCA Net Carbon Negative Oil Study (2016)

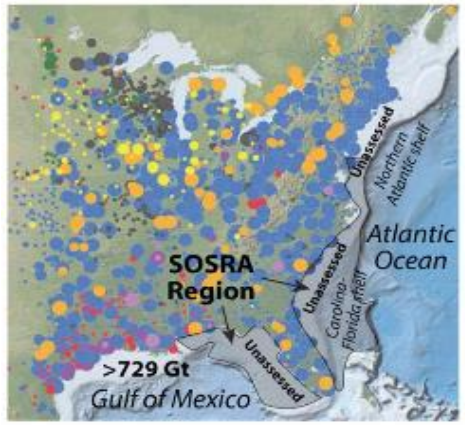
- EOR is a means to drive carbon capture, in turn driving learning and cost reduction
- Infrastructure developed for EOR will be compatible with development of CO_2 storage in saline formations
- Results of LCAs can address a range of different perspectives, but results are very sensitive to the scope of the question and are only "correct" in context
- Consequential LCAs show that EOR can deliver emissions reduction benefits today when coupled with anthropogenic CO_2; changes in markets and climate policy may change this conclusion
- We don't know how EOR fits into future, carbon constrained markets under or with large-scale availability of anthropogenic CO_2

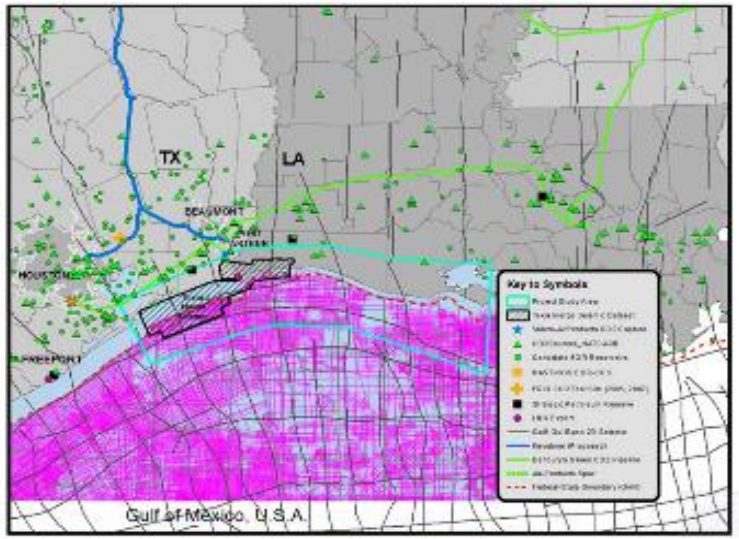
Offshore Storage (Sub-seabed)
Assessing and Addressing Challenges





- First broad assessment of offshore U.S. prospective storage potential underway
- Projects utilize existing geologic and geophysical data to conduct a prospective storage resource assessment
- Projects also involve 3D flow and geomechanical modelling
- Goal is identification of formations with the potential to store at least 30 million metric tons of CO_2

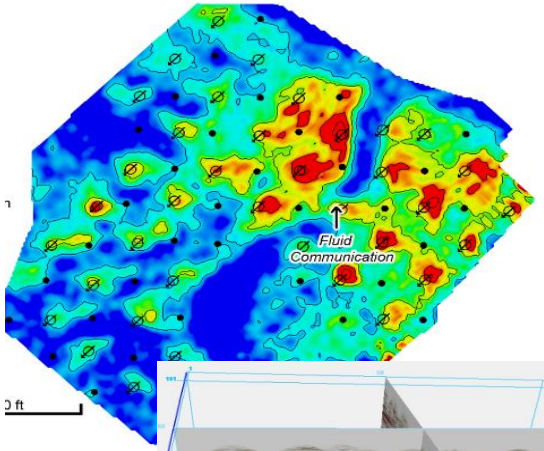


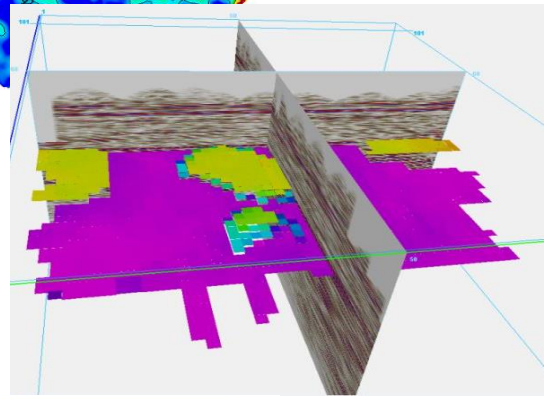


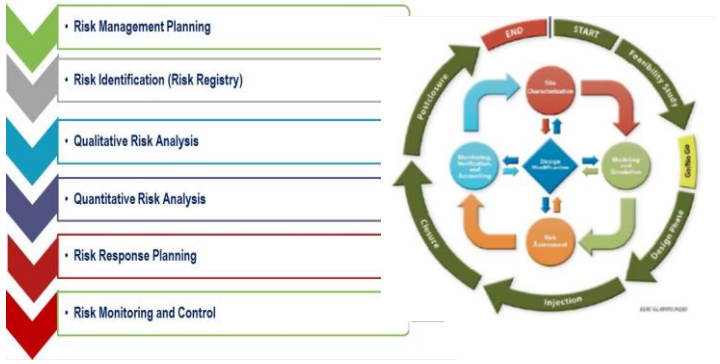
Regional Carbon Sequestration Partnerships (RCSP): Large Scale CO_2 Projects

Number on Map	Project Name	Project Type	CO_2 Source	Geologic Basin	Metric Tons of CO_2 Stored
1	Big Sky Carbon Sequestration Partnership–Kevin Dome Project	Saline Storage	Kevin Dome (natural)	Kevin Dome	N/A (no injection date)
2	Midwest Geological Sequestration Consortium–Illinois Basin Decatur Project	Saline Storage	ADM Ethanol Production Facility	Illinois Basin	999,215 (final stored and project in post-injection monitoring phase)
3	Midwest Regional Carbon Sequestration Partnership–Michigan Basin Project	Enhanced Oil Recovery	Core CO_2 Services, LLC Natural Gas Processing Facility	Michigan Basin	596,282 (as of Sept. 30, 2016)
4	The Plains CO_2 Reduction Partnership–Bell Creek Field Project	Enhanced Oil Recovery	Conoco Philips Lost Cabin/Madden Natural Gas Processing Plant	Powder River Basin	2,982,000 (final stored and project in post-injection monitoring phase)
5	Southeast Regional Carbon Sequestration Partnership–Citronelle Project	Saline Storage	Southern Company's Plant Barry Coal-Fired Power Plant	Interior Salt Basin, Gulf Coast Region	114,104 (final stored and project in post-injection monitoring phase)
6	Southeast Regional Carbon Sequestration Partnership–Cranfield Project	Enhanced Oil Recovery/ Saline Storage	Jackson Dome (natural)	Interior Salt Basin, Gulf Coast Region	4,743,898 (final stored and project in post-injection monitoring phase)
7	Southwest Carbon Sequestration Partnership–Farnsworth Unit Project	Enhanced Oil Recovery	Arkalon Ethanol Plant (Liberal, KS) Agrium Fertilizer	Anadarko Basin	490,720 (as of Sept. 30, 2016)

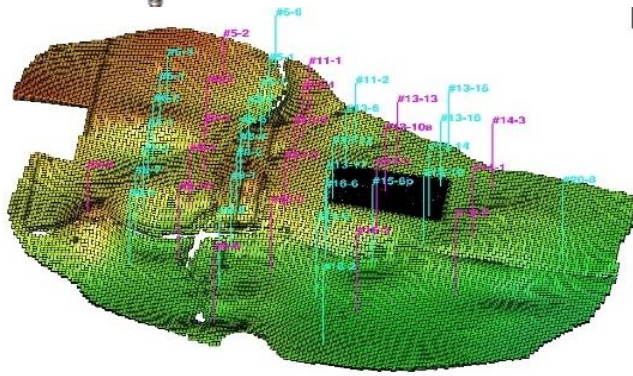
RCSP Key Accomplishments



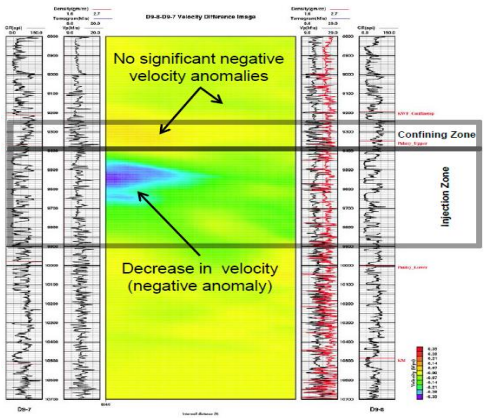


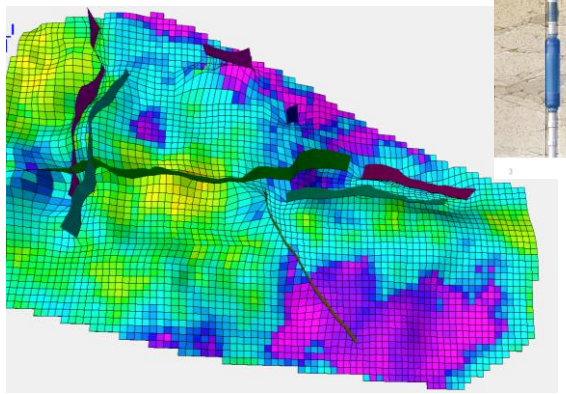


- Established the first U.S. national network of companies and professionals – carbon storage
- Proved adequate large scale injectivity and available capacity in regionally important storage formations
- Provided examples of simulation models and MVA technologies that predict CO_2 movement and confirm confining system integrity
- Contributed toward developing/evaluating innovative storage technologies for a cost-effective commercial toolbox
- Developed and implemented expert panel-based risk assessment strategies
- Contributed to a series of BPMs on major topics associated with geologic storage implementation
- Demonstrated the benefits of early engagement with local communities and stakeholders

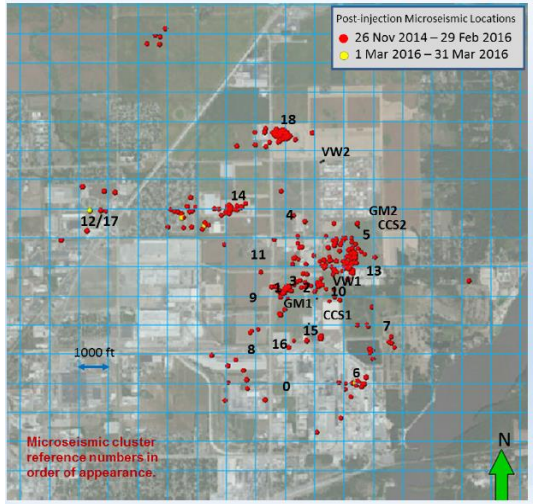


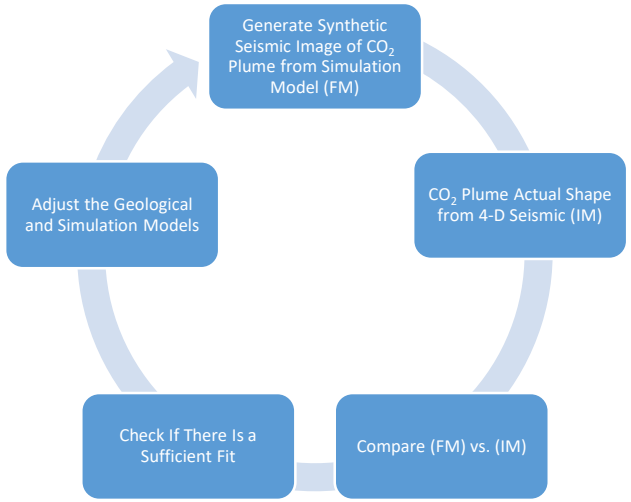
Lessons Learned Help Identify Issues Still Requiring Further Research



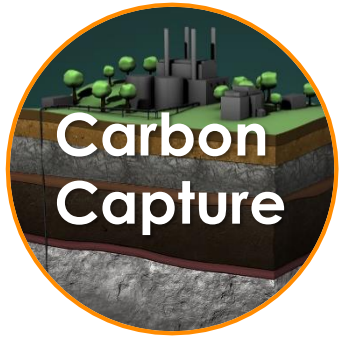


- Need to improve the fidelity of technologies to characterize small scale heterogeneity which causes fingering of CO_2 in reservoirs.
- Improved MVA technologies are needed to better quantify CO_2 saturation in the far field, away from wellbores.
- Technologies can detect fluid injection-related microseismic (non-felt) events but it is very hard to quantitatively model or predict these events.
- Intelligent monitoring systems are needed to develop and implement real-time operating solutions.
- Need to incorporate improved assessment of MVA technology failure rates (inherent in R&D) into risk management strategies





Integrated R&D Approach for Future Commercial-Scale Deployment



2017
Large Capture
Pilots Initiated

2020
R&D Completed for Carbon Capture
2nd Generation Technologies

2025
Integrated CCS
Projects initiated

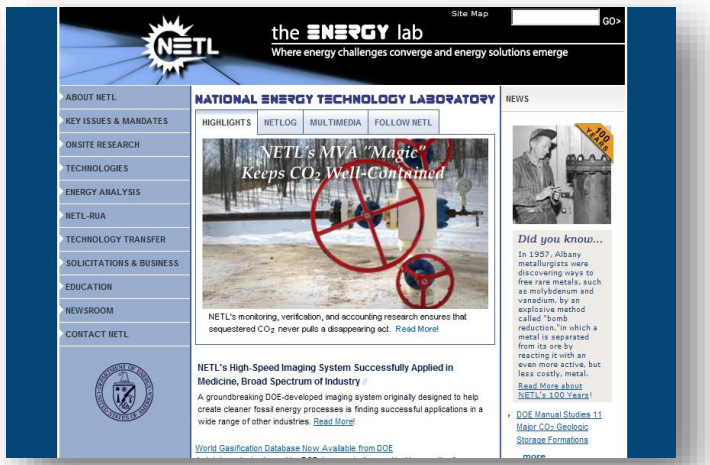
2035
Advanced technologies available for broad commercial-scale deployment

2017
Initiate Storage Feasibility for Integrated CCS

2022
Commercial-scale storage complexes characterized

For More Information

NETL
www.netl.doe.gov



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Delivering Yesterday and Preparing for Tomorrow