CCS program and geological assessment for CO_2 storage in the US

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Outline

- Geological assessment
- Review of Australian work
- Introduction to US carbon capture and storage program
- Overview of Regional Carbon Sequestration Partnerships program (US)
- Some thoughts on the progress of, and issues related to, geological assessment in the US

Geological assessment - what do we want to know?

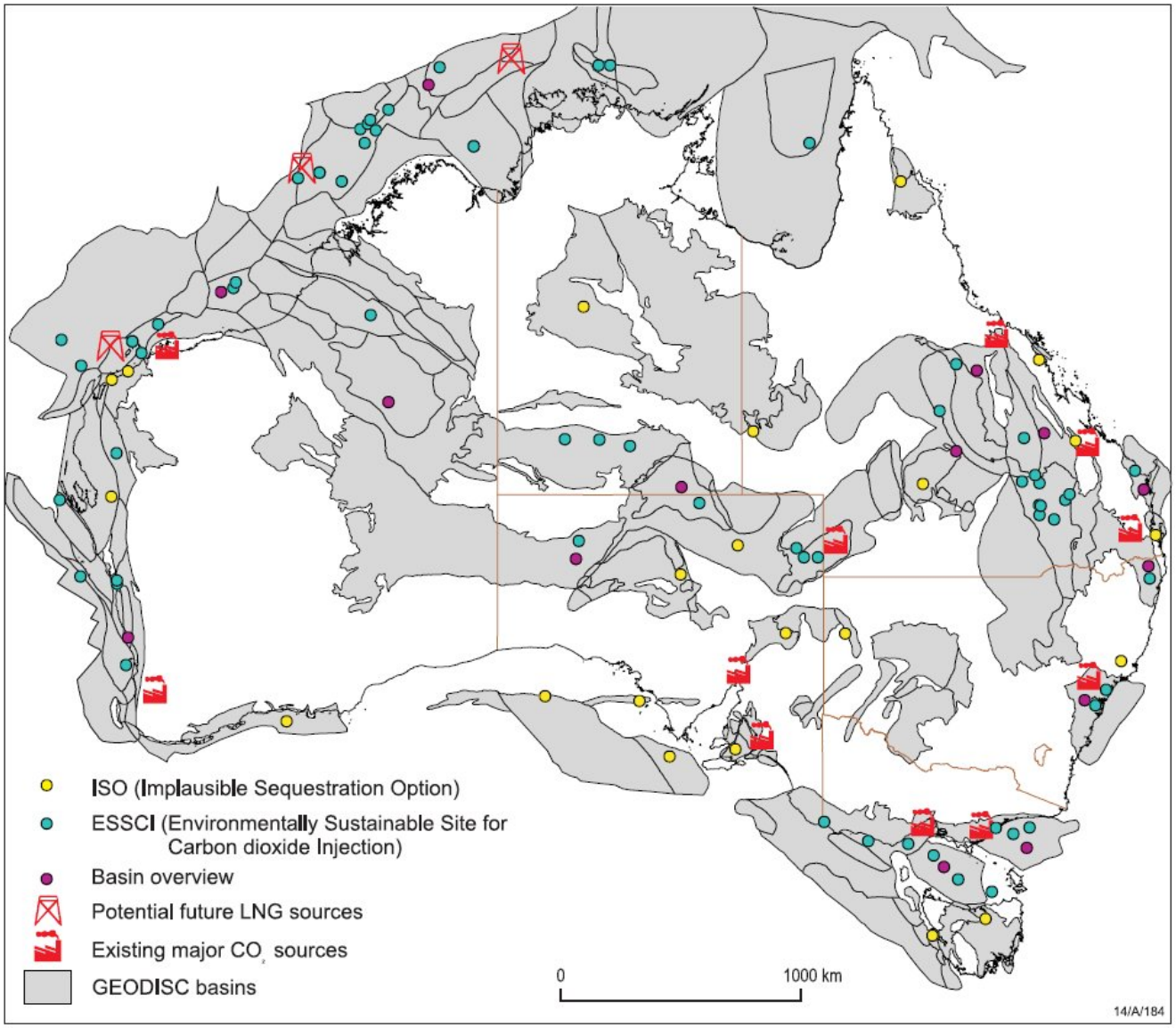
Geological storage of CO_2 has been recognised as key technology for CO_2 mitigation.

- Where can CO_2 be geologically be stored – technically; safely; permanently; economically; environmentally; etc.?
- How much CO_2 can we store (and can we store enough)? Is there sufficient viable storage capacity (and injectivity) near emission sources?
- "Decision support system"
  - Enable matching of CO_2 sources to sinks
  - Enable planning for future facilities (power stations, etc.)
- National resource, especially under predicted future GHG/CO_2 regulations
- Better understanding of other national resources – oil, gas, coal, water…

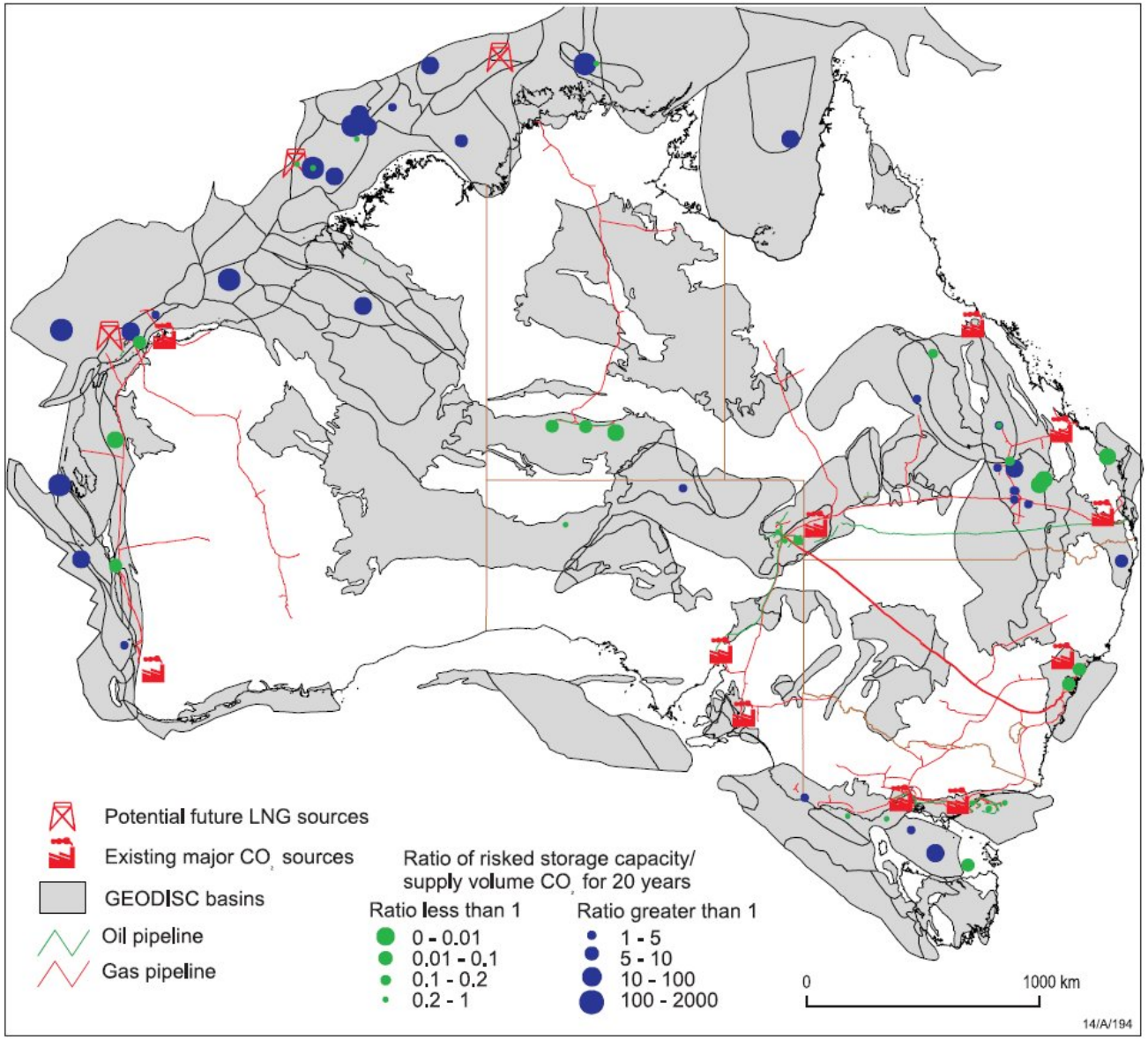
Geological assessment for CO_2 storage takes time, resources, focus

Geological assessment in Australia

- GEODISC - “Geological Disposal of Carbon Dioxide”, 1999 – 2003
- Aim: “To examine the potential of geological sequestration in Australia, and produce a portfolio of sequestration options around Australia.”
- Government & natural gas industry
- “The primary output from GEODISC was a regional analysis of the geological storage potential of CO_2 for all sedimentary basins in Australia.”
- Sound methodology for assessing sequestration options was developed
- Basis for future assessment work and planning



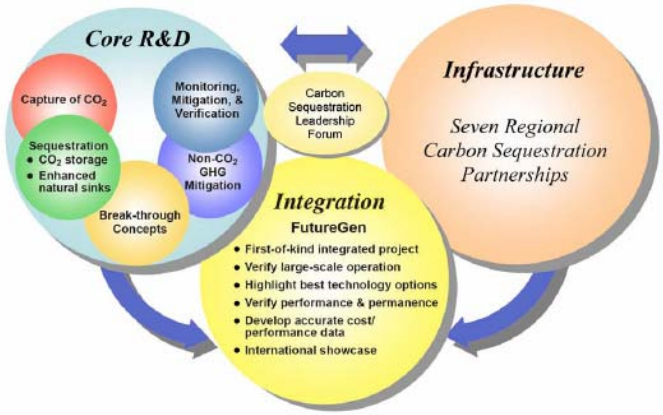
Source: Bradshaw et al, 2002



Source: Bradshaw et al, 2002

CCS program in the USA

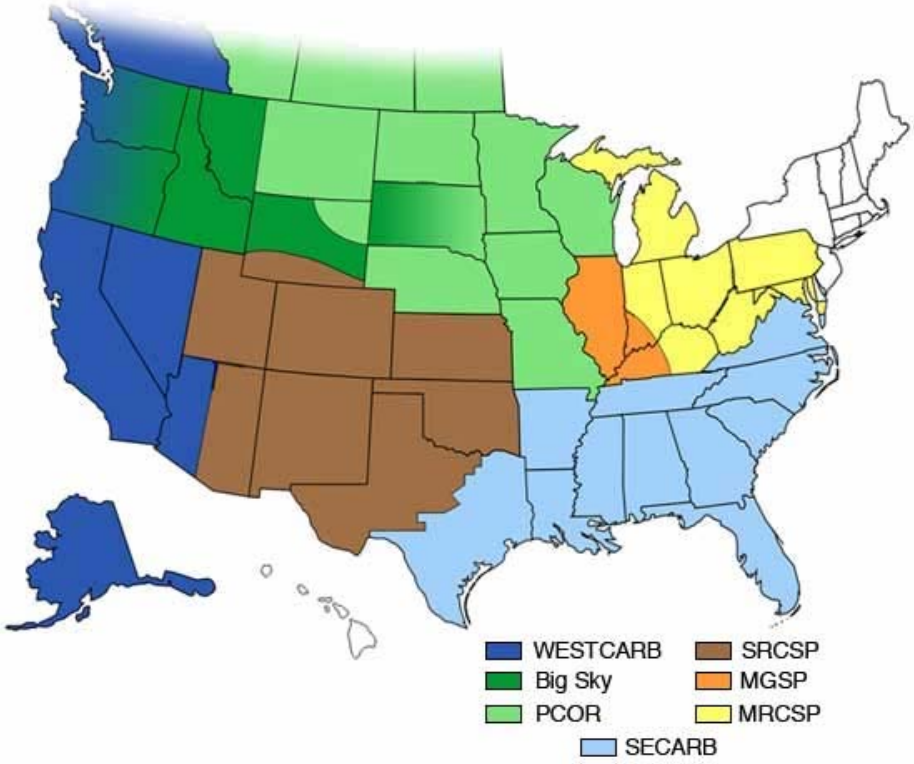
- Federal CCS program - Department of Energy, managed within Office of Fossil Energy, and implemented through National Energy Technology Laboratory (NETL).
- Initiated 1997
- "To develop by 2012 fossil fuel conversion systems that offer 90% CO2 capture with 99% storage permanence at less than 10% increase in cost of energy services."
- Core R&D: Laboratory and pilot scale research
  - New technologies for GHG mitigation
- Infrastructure (demonstration and deployment): Promote development, ability to accept and deploy CCS technologies
- Integration: FutureGen
- $100M budget in 2007



Source: DOE Technology Roadmap 2006

Regional Carbon Sequestration Partnerships program

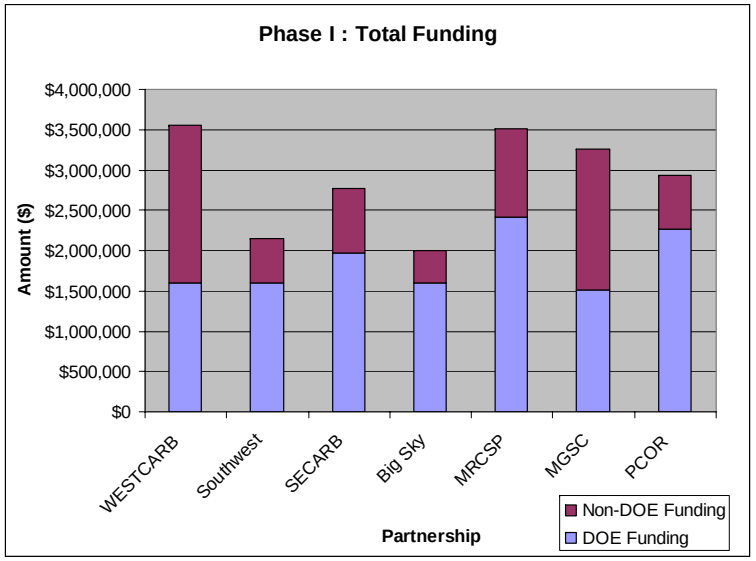
- Geographic differences in sources and sinks led to regional approach
- 7 partnerships – technology, infrastructure, regulations to implement CO_2 sequestration.
- "Developing the Infrastructure for Wide Scale Deployment"
- Geologic sequestration
- Terrestrial sequestration
- 2003 – 2017
- 41 states, 3 Indian nations, 4 Canadian provinces; 350 organisations – public, industry, educational institutions etc.

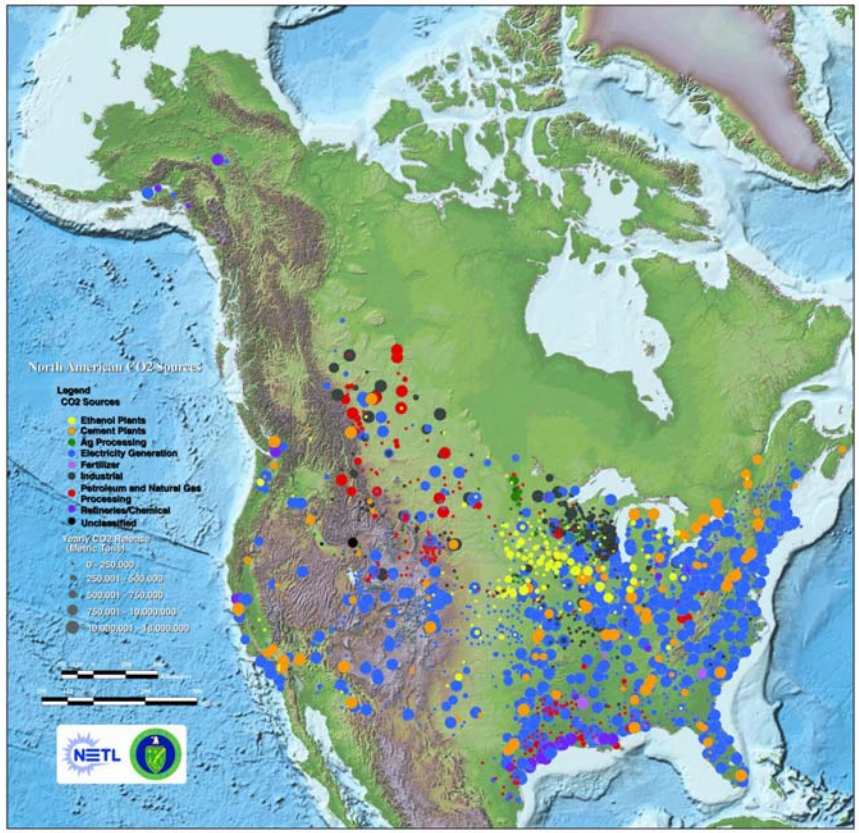


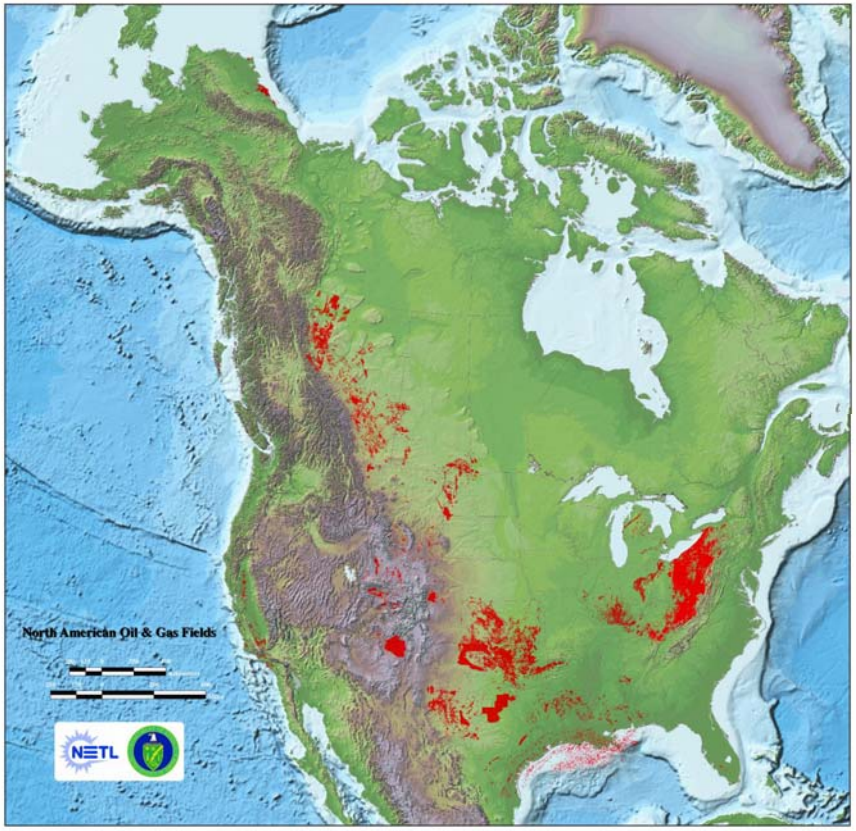
Source: Natcarb

Regional Carbon Sequestration Partnerships: Phase 1

- "Characterisation" phase
- 2003 – 2005
- Funding - $15M DOE (+$7M non-DOE)
- Framework for validation and deployment:
  - Characterise regional opportunities for CCS & characterise sources
  - Identify opportunities for pilot tests
  - Establish national network to support deployment (capability)
  - Raise awareness of CCS (outreach)
  - Understand permitting / regulatory issues etc.
- NATCARB





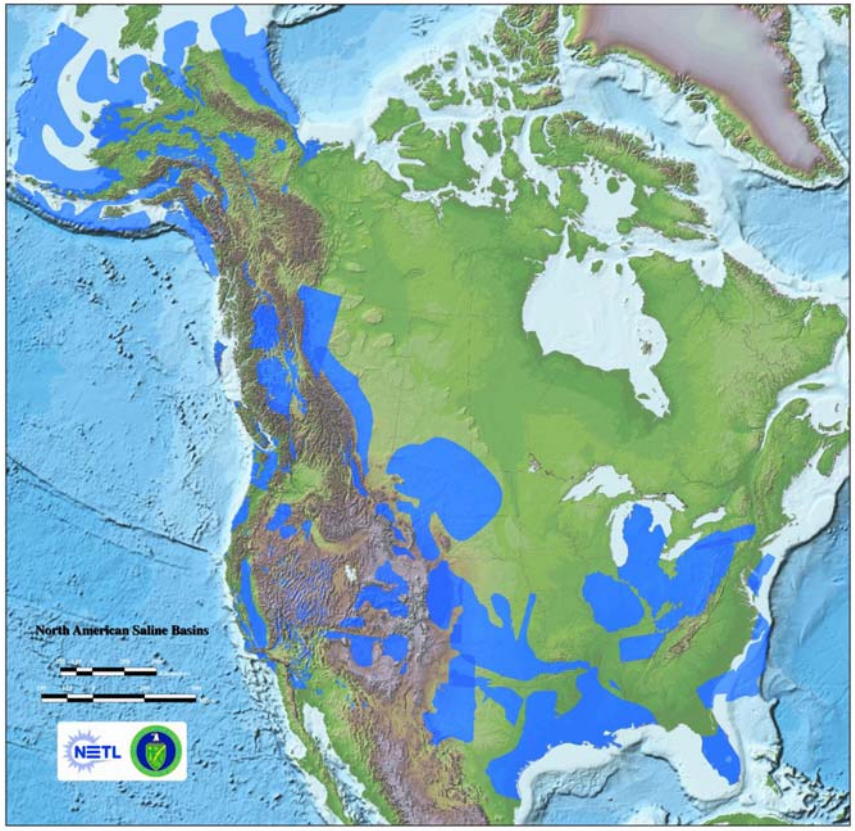


Sources

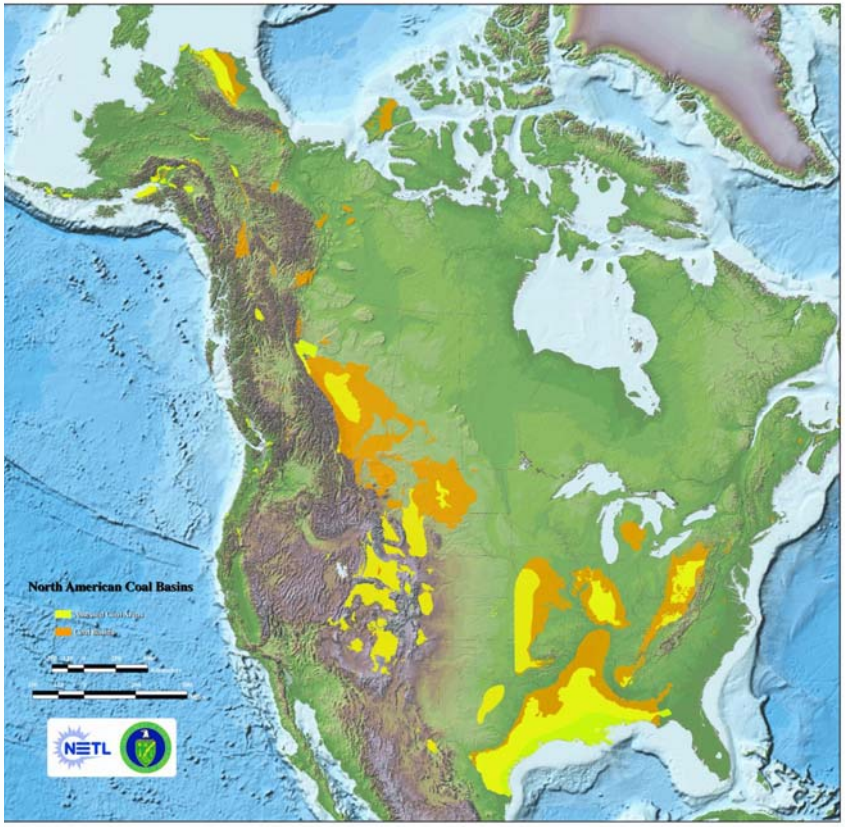
Oil and gas fields

4,365 stationary sources = 3.8Gt/yr of CO_2

Source: Natcarb, DOE CCS Roadmap 2007,
Carbon sequestration atlas of US and Canada (2007)



Saline formations



Unmineable coal

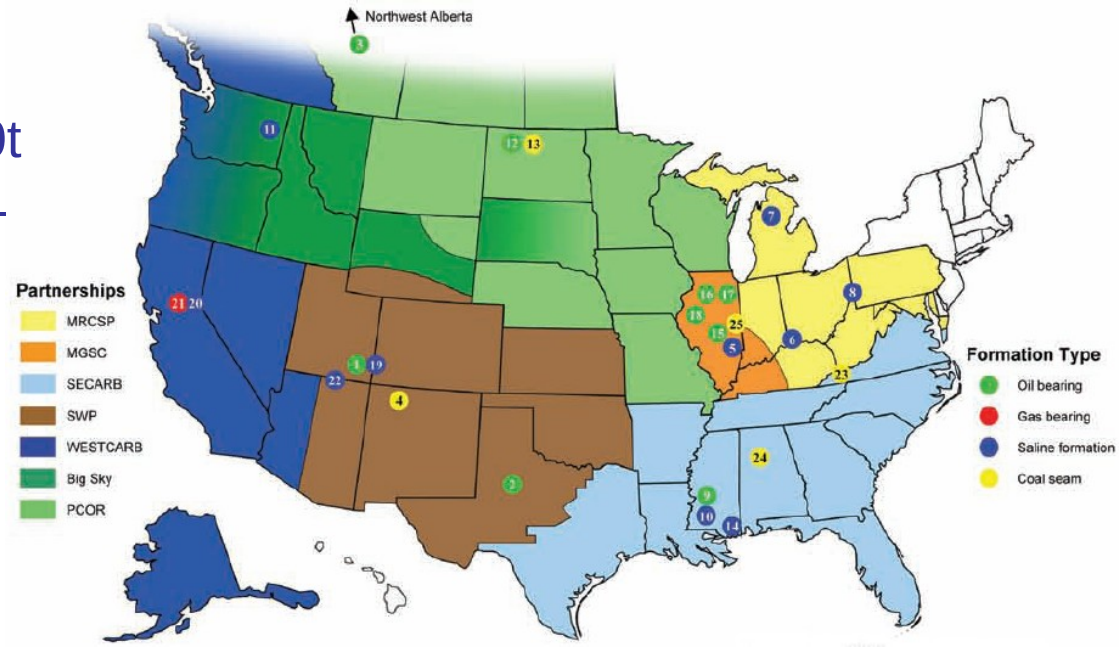
Source: Natcarb

Regional Carbon Sequestration Partnerships: Phase 2

- “Validation” phase
- Total funding $112M DOE (+~45M)
- Timeframe: 2005 - 2009
- Primary focus is on small scale field tests in most promising sequestration options to validate CCS in a variety of formations (geological and terrestrial)
- Validate models; verify capacity estimates; collect data on capacity and injectivity; demonstrate MMV; practical guidelines for operation
- Continued outreach, permitting/regulatory activities, characterisation work

Phase 2 Geologic Field Tests

- 25 field tests
- 18 projects <10,000t
- 3 projects 20,000t – 75,000t
- 3 larger projects, 250kt, 450-750kt, and 900kt
- 1 large-scale, 800kt/year, into oil-bearing formation



Overall: 10 × saline formation; 9 × oil-bearing formation; 5 × coal seam; 1 × gas-bearing formation

Source: DOE CCS Atlas of the US and Canada, 2007

Regional Carbon Sequestration Partnerships: Phase 3

- “Deployment” phase
- 2008-2017
- 3-4 large scale demonstration projects?
  - up to 1Mt/yr
- $470 million in DOE funding over 10 years (+20% cost share with partnerships)

Policy focus on geological assessment

US –

- Focus is on “infrastructure”
- It is not seen as the responsibility of DOE to provide national geological assessment (more in domain of USGS and state geological surveys)
- Therefore different project direction and resources allocated accordingly
- As a result a national assessment does not exist yet, (although needed now)

S.280 Climate Stewardship and Innovation Act of 2007 (introduced in Senate)

SEC. 354. GEOLOGICAL STORAGE.

(a) IN GENERAL- The Secretary of Energy, in consultation with the Secretary of Agriculture and the Administrator of the Environmental Protection Agency, shall establish guidelines for setting individual project baselines for reductions of greenhouse gas emissions and greenhouse gas storage in various types of geological formations to serve as the basis for determining the amount of greenhouse gas reductions produced by the project.

(b) SPECIFIC ACTIVITIES- The Secretary of Energy, in consultation with the Director of the U.S. Geological Survey, shall--

(1) develop local and regional databases on existing practices and technologies for greenhouse gas injection in underground aquifers;

(2) develop methods for computation of additionality discounts for prospective greenhouse gas reductions or offsets due to carbon dioxide injection and storage in underground aquifers;

(3) develop accepted standards for monitoring of carbon dioxide stored in geological subsurface reservoirs by--

(A) developing minimum suitability standards for identifying and monitoring of geological storage sites including oil, gas, and coal bed methane reservoir and deep saline aquifers; and

(B) testing monitoring standards using sites with long term (multi-decade) large injections of carbon dioxide into oil field enhanced recovery projects; and

(4) address non-permanence and risk of release of sequestered greenhouse gas by--

(A) establishing guidelines for risk assessment of inadvertent greenhouse gas release, both long-term and short-term, associated with geological sequestration sites; and

(B) developing insurance instruments to address greenhouse gas release liability in geological sequestration.

(c) National Geological Carbon Sequestration Assessment-

(1) FINDINGS- The Congress finds the following:

(A) One of the most promising options for avoiding emissions of carbon dioxide is through long-term storage by geological sequestration in stable geological formations, which involves--

(i) capturing carbon dioxide from industrial sources; and

(ii) injecting the captured carbon dioxide into geological storage sites, such as deep saline formations, unmineable coal seams, and depleted gas and oil fields.

(B) As of the date of introduction of this Act, there are only very broad estimates of national geological storage capacity.

(C) The potential to recover additional oil and gas resources through enhanced oil and gas recovery using captured carbon dioxide emissions is an option that could add the equivalent of tens-of-billions of barrels of oil to the national resource base.

(D) An initial geological survey of storage capacity in the subsurface of sedimentary basins in the United States would--

(i) provide estimates of storage capacity based on clearly defined geological parameters with stated ranges of uncertainty;

(ii) allow for an initial determination of whether a basin or 1 or more portions of the basin may be developed into a storage site; and

(iii) provide information on--

(I) a baseline for monitoring injections and post injection phases of storage; and

(II) early opportunities for matching carbon dioxide sources and sinks for early deployment of zero-emissions fossil fuel plants using capture and storage technologies.

(2) National geological carbon sequestration assessment-

(A) Development and testing of assessment methodology-

*(i) IN GENERAL- Not later than 1 year after the date of enactment of this Act, the **Director of the United States Geological Survey** shall develop and test methods for the conduct of a national assessment of geological storage capacity for carbon dioxide.*

(ii) OPPORTUNITY FOR REVIEW AND COMMENT- During the period beginning on the date that is 180 days after the date of enactment of this Act and ending on the date of completion of the development and testing of the methodologies under clause (i), the Director shall provide the Under Secretary for Oceans and Atmosphere of the Department of Commerce, the Secretary of Energy, the Administrator of the Environmental Protection Agency, the Director of the Minerals Management Service, the Director of the Bureau of Land Management, the heads of other Federal land management agencies, the heads of State land management agencies, industry stakeholders, and other interested parties with an opportunity to review and comment on the proposed methodologies.

(B) Assessment-

(i) IN GENERAL- The Director shall conduct the assessment during the period beginning on the date on which the development and testing of the methodologies is completed under subparagraph (A) and ending 4 years after the date of enactment of this Act.

(ii) AVAILABILITY OF INFORMATION- The Director shall establish an Internet database accessible to the public that provides the results of the assessment, including a detailed description of the data collected under the assessment.

(iii) REPORT- Not later than 1 year after the date on which the assessment is completed under clause (i), the Director shall submit to the appropriate committees of Congress and the President a report that describes the findings of the assessment.

(3) AUTHORIZATION OF APPROPRIATIONS- There are authorized to be appropriated $15,000,000 to carry out this section for fiscal years 2008 through 2011.

Resources

- Adequate support for assessment effort
  - Understanding of what is needed to complete the assessment
- RCSPs - $20 million over 2 years, then ~$140 million over 4 years
  - But how much goes to assessment work?
  - Phase 2: Most resources go towards the field tests
- Estimate $15-20 million (over 3-5 years) for national assessment similar to Australia's

Geographic and stratigraphic gaps

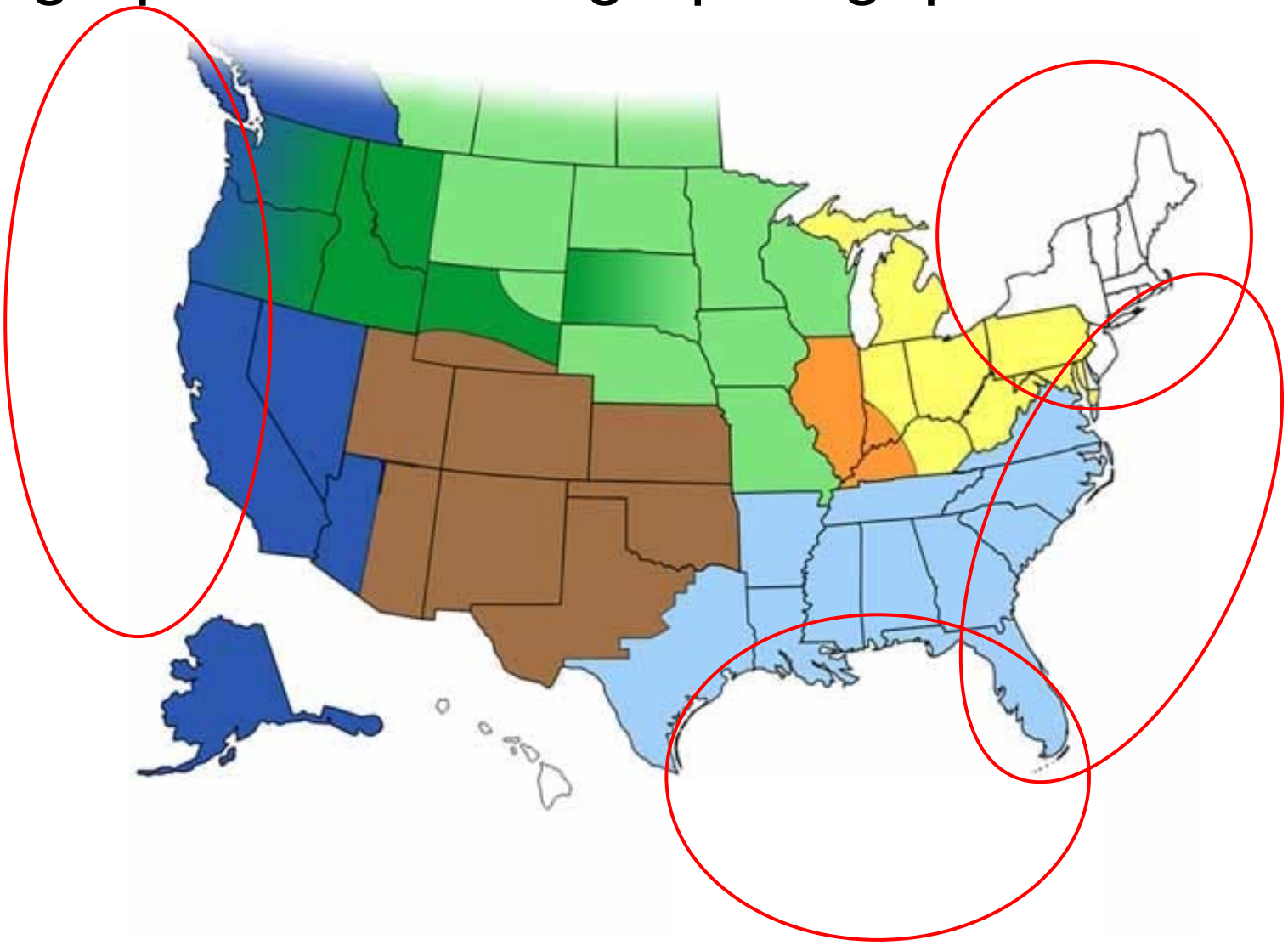
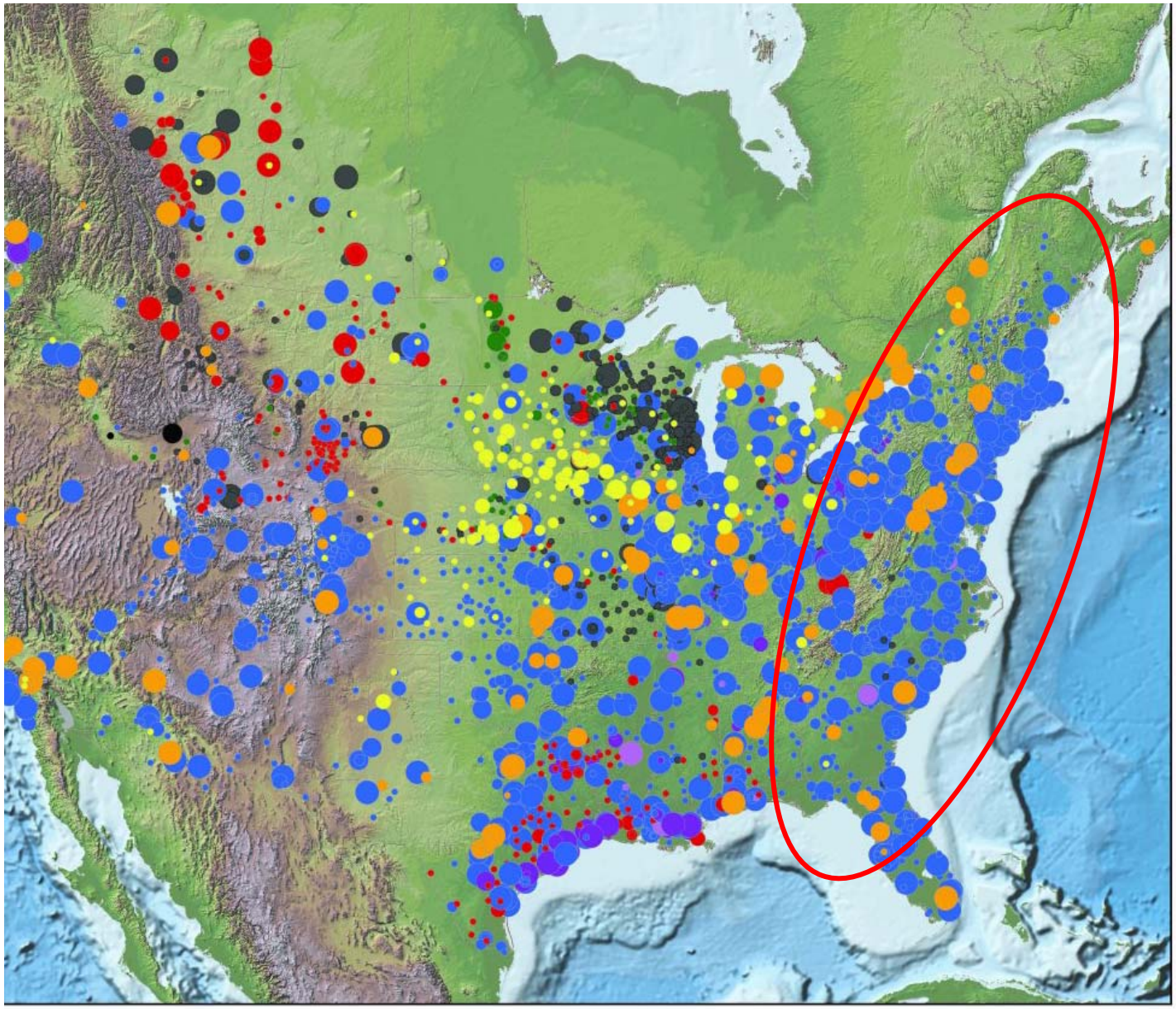


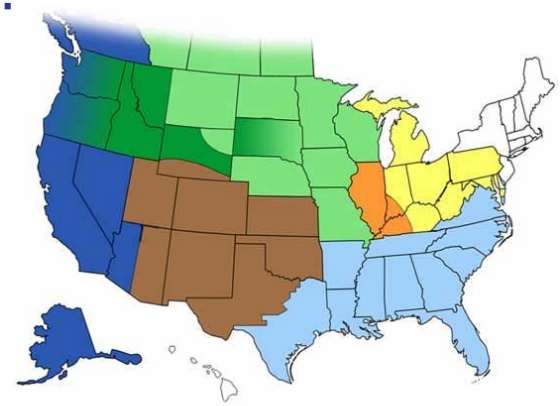
Image source: Natcarb



Source: Natcarb

Regional approach

- Regional approach works well for some aspects of the program
  - Public education / perception / outreach
  - Regulatory / permitting issues
  - Involvement of local organisations / companies
- Does not work as well for the (national) geological assessment component. Issues with:
  - Consistency
  - Integration
  - Competition
  - Lack of direction on some issues



Other issues to consider

- Data – access, availability, organisation
- Organisation and leadership
  - In terms of assessment, more successful where led by technically suited organisations e.g. state geological surveys
  - Some of the right organisations aren't involved
- Geology
  - Very complicated geology in some areas
- Understanding CO_2 storage mechanisms, injectivity, scale of assessment - for capacity estimates
- Risking – all sites look comparable; no ranking
- Focus more on required large-capacity options (saline aquifers)
  - Overly focused on early opportunity or potentially economic options (EOR, ECBM); and less mature shale and basalt storage options

To summarise:

- RCSP program appears to have been in several ways with respect to potential CO_2 storage in US
- However, recognise that still have need of a complementary national geological assessment for CO_2 storage in the USA
- Small scale validation tests help answer some questions, but there is a great need for large scale demonstration projects in the US (and worldwide)

References and further information

Australia:

- http://www.apcrc.com.au/Programs/geodisc_res.html
- http://www.co2crc.com.au

USA:

- http://www.netl.doe.gov/technologies/carbon_seq/index.html
- http://www.netl.doe.gov/technologies/carbon_seq/partnerships/partnerships.html

(relevant publications can be found on these sites)

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