


Carbon Capture and Storage – An Industry View

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Climate Change Risks to Business

- **Regulatory exposure** – National and international policies and institutions created to administer credits.
- **Physical exposure** – Rising temperatures, extreme weather events, new rainfall and drought patterns.
- **Competitive exposure** – Rising cost of energy and regulatory and physical limits to resources. Market responses to energy intensive products and services.
- **Reputational exposure** – Customers' and investors' perceptions of action or inaction including litigation.
- **Technological and business opportunities** – Resulting from increased demand for energy efficient and low carbon goods and services.

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Lehman Brothers: The Business of Climate Change

Climate Change Will Alter the Economic Environment



- Climate change is likely to be another major factor that alters the economic environment . It may prove to be somewhat akin to globalization: a slow, but powerful and inexorable force that progressively changes relative prices, costs, structures of demand, and hence the structure of production.
- The pace of a firm's adaptation to climate change is likely to prove to be another of the forces that will influence whether, over the next several years, any given firm survives and prospers or withers, and likely dies.

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Lehman Brothers: The Business of Climate Change



The Carbon Disclosure Project



- A coalition of institutional investors that manage over \$57 trillion.
- Pressures companies to disclose their climate change risks and responses to mitigate those risks.
- Assumes that climate change and the accompanying regulations will create winners and losers in different industries. It seeks to evaluate the long term prospects of firms with respect to greenhouse gas liabilities and opportunities and to understand:
 - What strategy the company has in place
 - What data they manage and disclose
 - What types of systems are in place to support their strategy

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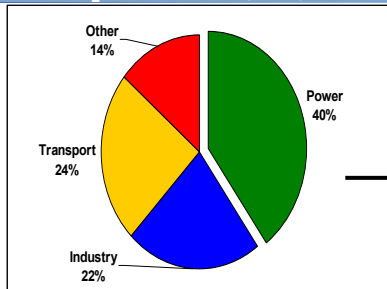


Global CO₂ Emissions



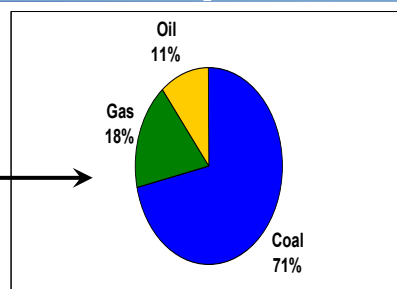
- Power sector is responsible for ~40% of global emissions
- Coal represents ~70% of emissions from power sector
- Many large stationary point sources (1GW coal plant emits 5-7MtCO₂ p.a.)
- Large opportunity for CO₂ capture and storage

2000 CO₂ Emissions by Major Sector



Global CO₂ Emissions : 21GtCO₂ p.a.

Power Industry CO₂ Emissions by Fuel



Global Power Emissions : 8.3GtCO₂ p.a.

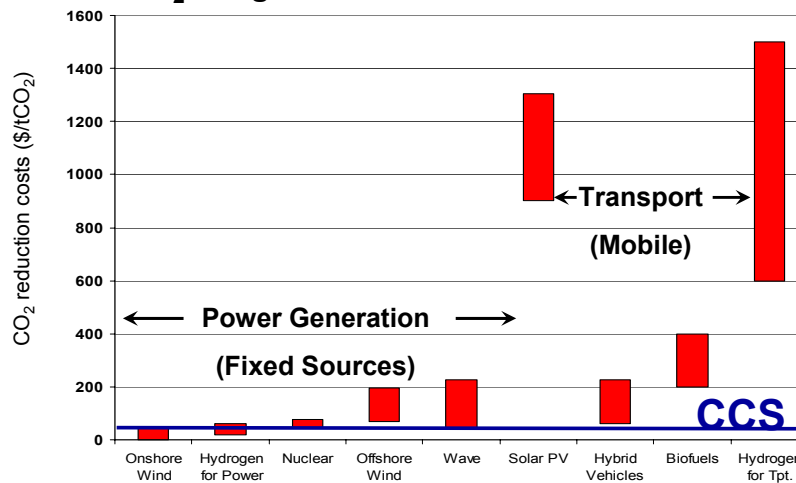
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CO₂ Reduction Options (\$/te)



Cost of CO₂ mitigation



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Source: European Commission Report (Jan 2004) , DoT, DTi (2003) , BP Analysis

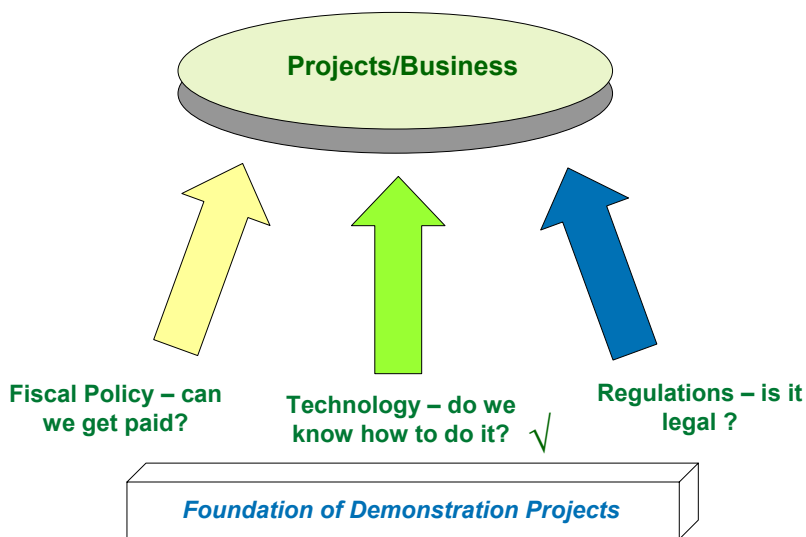
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What Volumes are Required?

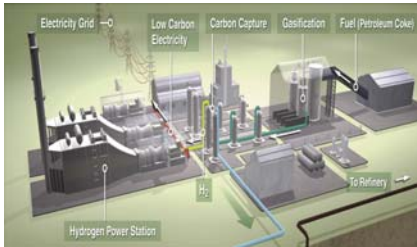


- 1) A 1,500 Mw coal fired power plant produces 10 Million tonnes/yr of CO₂ which is the equivalent of >300,000 bbl/d
- 2) In order to provide a Socolow wedge for CO₂ storage, at the end of 50 years, there will have to be injection of >100,000,000 bbl/d. Current global oil production is 82 million bbl/d.

CCS Needs: Technology, Policy and Regulations



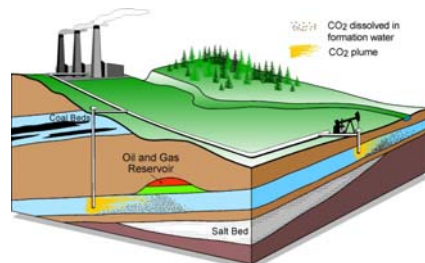
CCS: The Big Issues



•The cost of capturing CO₂

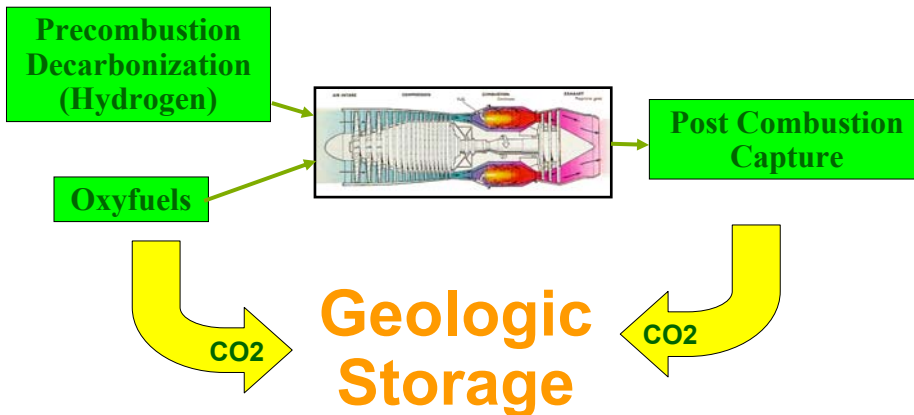
•The safety of storing CO₂

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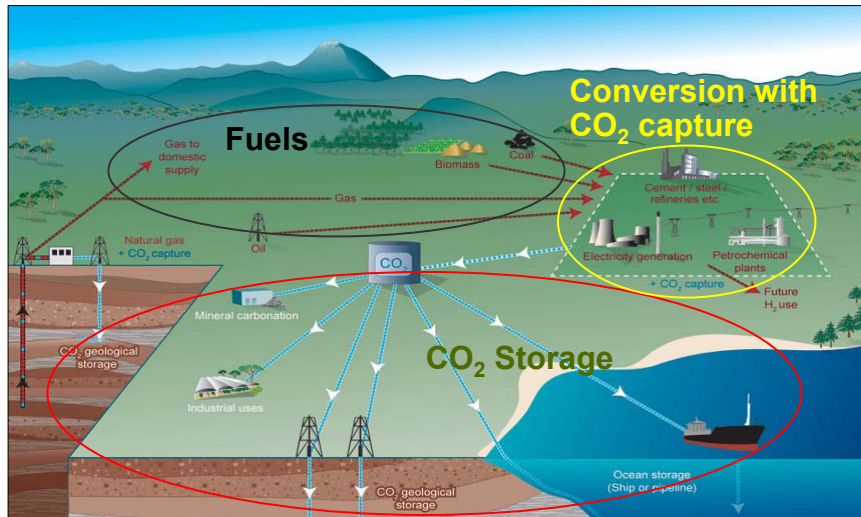
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CO₂...How To Get It



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CO₂ Capture and Storage System



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<http://www.ipcc.ch/activity/csspm.pdf>

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CCS Technology Development and Demonstration Program



Research



Industry / Academic Initiatives



Source-sink matching

CO2CRC, EUGeocapacity, Coach, US Regional partnerships

Public policy support

CSLF, ECCP, EU-ZEPP, CDM

Assurance framework

CO2CRC, CSLF, IMCO2, WRI

3rd Party Demonstrations

Sleipner, Weyburn, CO2Remove

Technical Demonstrations



Industrial Scale Projects



HE California



HE Australia



HE (other) ...

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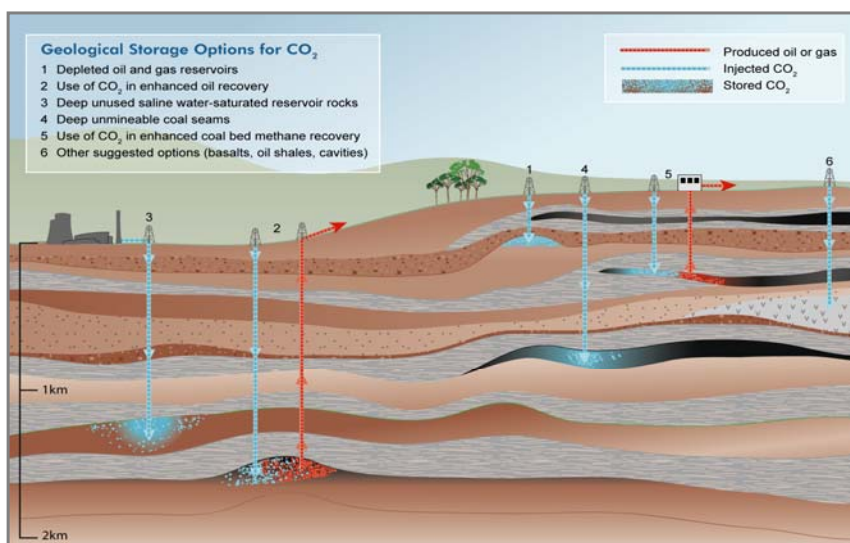


CO₂ Capture Project

- \$50 MM project started in 2000 to reduce the cost of CO₂ capture and show that geological storage was safe and effective
- About 2/3 of the effort directed towards capture and 1/3 storage
- Has made significant reductions in the cost of capture
- Evaluated technologies for monitoring as well as for insuring wellbore integrity



Potential Leakage Paths are Wells and Seals



From IPCC Special Report



CO₂ Capture Project

A Comprehensive Wellbore Integrity Program

- Analysis of current well stock
- Compilation of historical statistics on effects of CO₂
- Evaluation of wells in contact with CO₂
- Laboratory analysis of recovered cement and pipe
- Laboratory understanding of kinetics and mechanisms of attack
- Reactive transport simulation of CO₂ attack
- Statistical evaluation of large numbers of wells

Seals are next



Carbon Mitigation Initiative at Princeton University



- **Capture Group** – Assesses the potential of CO₂ capture and low carbon energy technologies
- **Storage Group** – Studies the feasibility of long term storage options
- **Science Group** – Examines the impacts of CO₂ on the climate and works to understand the carbon cycle
- **Integration** – Looks at how science can be integrated across technologies to produce innovative pathways to lower carbon emissions



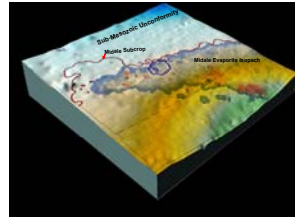
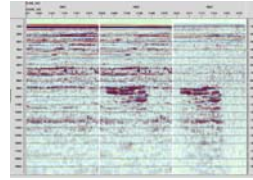
CMI

Carbon Mitigation Initiative

Megaton Commercial Scale Projects



- **Sleipner** – Offshore Norway, Injection into regional saline reservoir, one well, injection began 1996
- **Weyburn** – Saskatchewan, EOR project, 50 wells, began 9/2000
- **In-Salah** – Algeria, Gas Injection into saline formation downdip of gas reservoir, 3 wells, started 8/2004



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Megaton Commercial Scale Projects are Showing:



- CO₂ can be handled safely
- Large quantities can be injected in various subsurface environments
- Monitoring can detect the movement of CO₂ in the subsurface
- Techniques already available in the petroleum industry work well
- Providing test beds for state of the art advances

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West Texas CO2 Operations are Vast – 30 million tonnes/year Injected



- Separation



- Transportation



- Injection



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Industry Has Long Experience Handling CO2

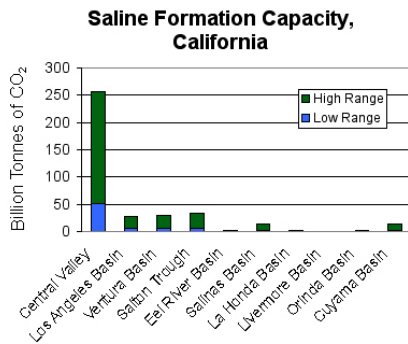


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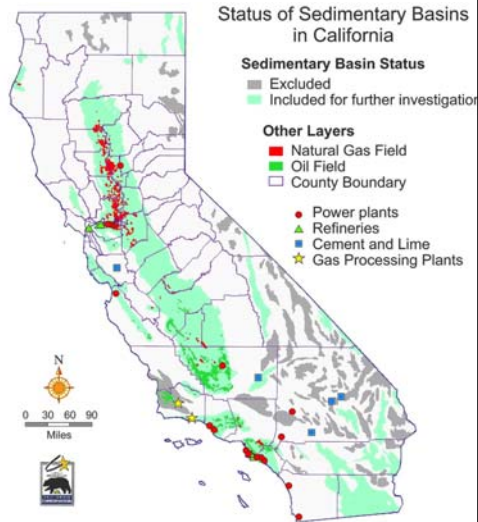


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California Basins Have Significant Potential for CO₂ Storage and Enhanced oil Recovery



Gas reservoir capacity: 1.7Gt
Oil reservoir capacity: 3.6Gt



WEST COAST REGIONAL CARBON SEQUESTRATION PARTNERSHIP

In summary ...



- CCS is one of a portfolio of technologies critical to reducing CO₂ emissions
 - CCS technologies are similar to those used in the oil industry and significant effort is underway to reduce cost and to demonstrate that geological storage is safe and effective
- BUT:**
- Widespread deployment is dependent on enabling policies that create markets for CCS technologies
 - Commercially workable regulations are required to create a clear and stable business environment.
 - Public acceptance requires effective communication and demonstration



Thank you

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