Climate Change Policy and Economics: Implications and Opportunities for Agriculture

Susan M. Capalbo

Oregon State University

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Outline

- How ag fits into the picture
- Mitigation vs adaptation
- Economic 101: considerations for addressing impacts
- Challenges for growers/ranchers and for policy makers: critical research needs

Photo by Bart Eleveld

Take home messages:

- Prices matter, and they matter a lot
- Agriculture has a role to play in addressing Climate change
- Policy design needs good (great) science
- There are winners and losers

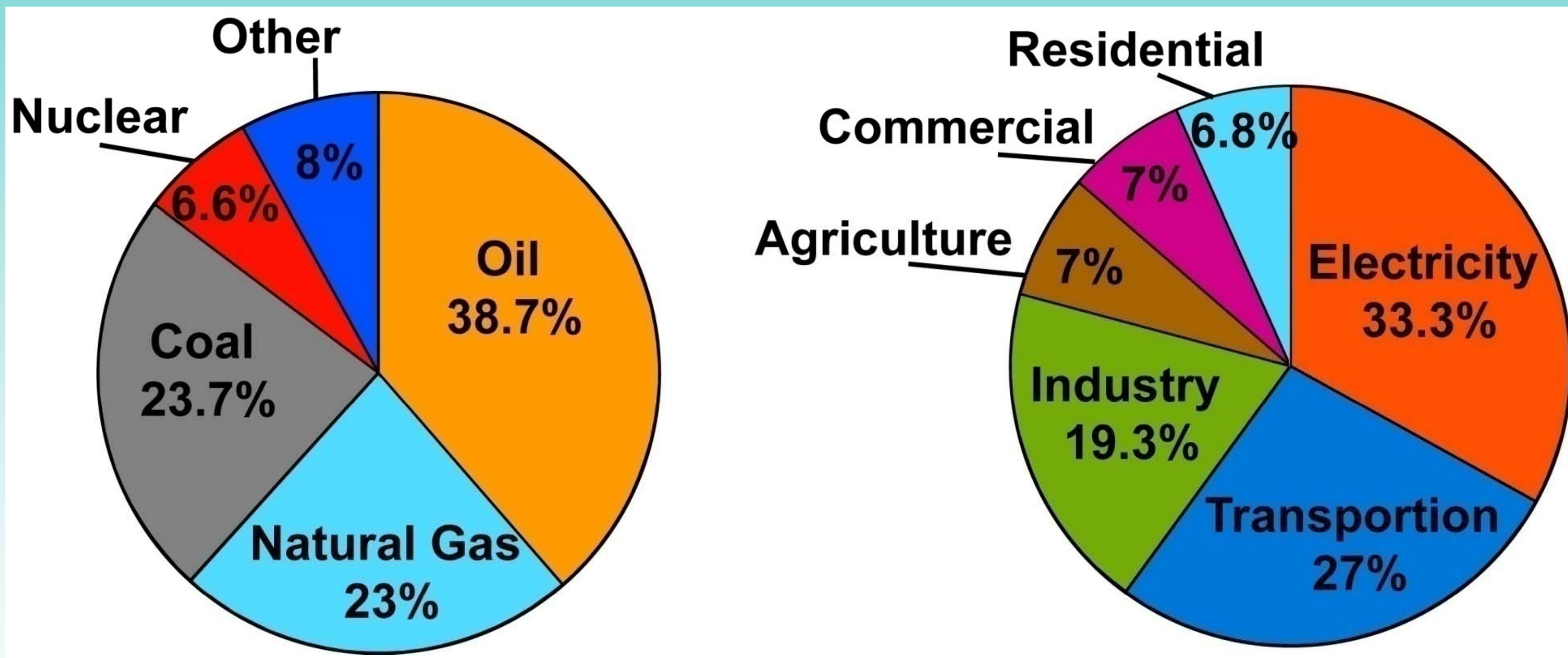
There will be some winners and some losers as Earth's climate changes.

Why Sequester Carbon?

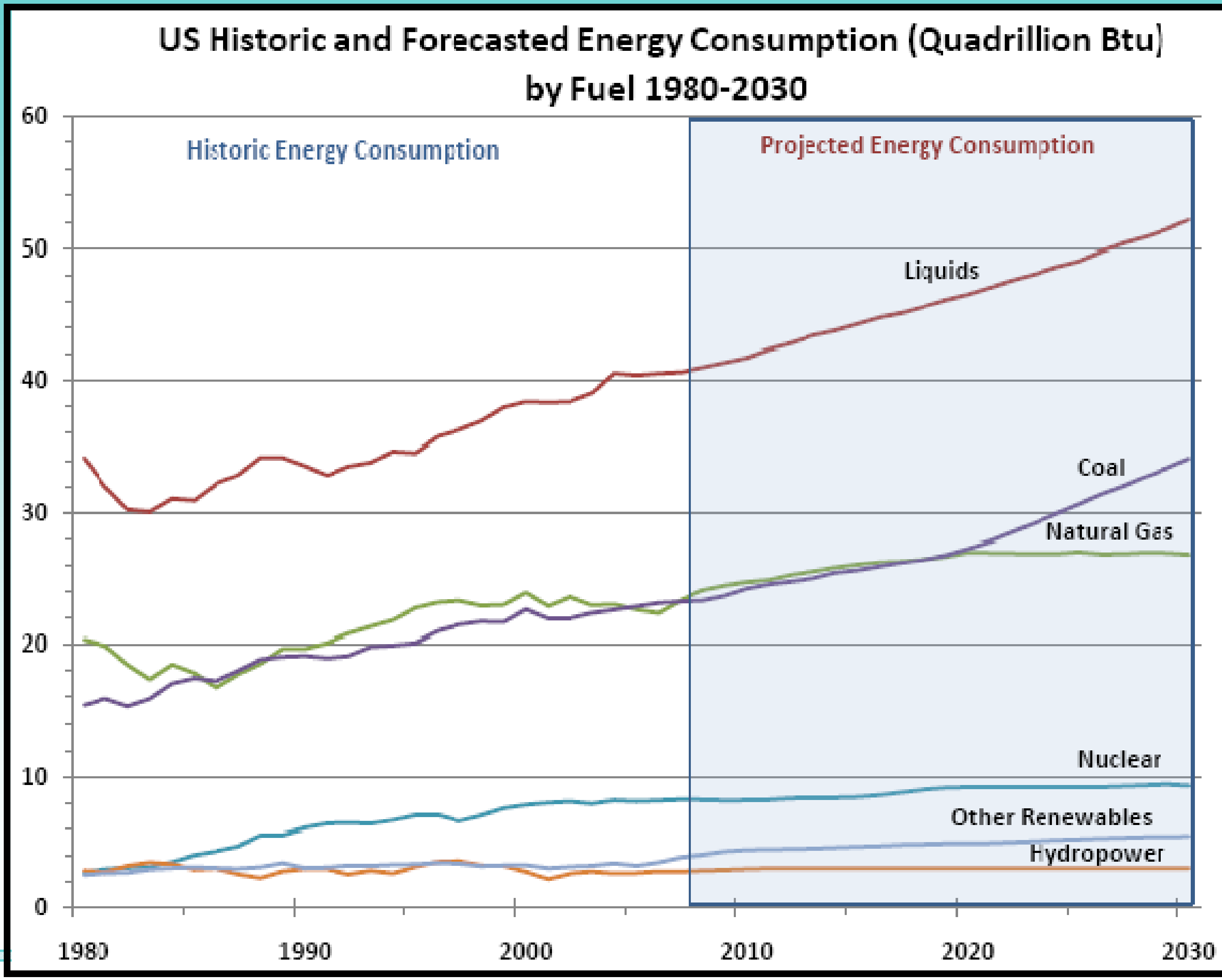
- Fossil fuels are dominant and world demand is growing rapidly.
- Fossil fuels are plentiful.
- Fossil fuels will remain the lowest-cost option for the foreseeable future.
- Price of oil in 1981 = $90/barrel (2006 $)

Current Dominance of Fossil Fuels

Energy Consumption (USA, 2001) GHG Emission Sources (USA, 2003)

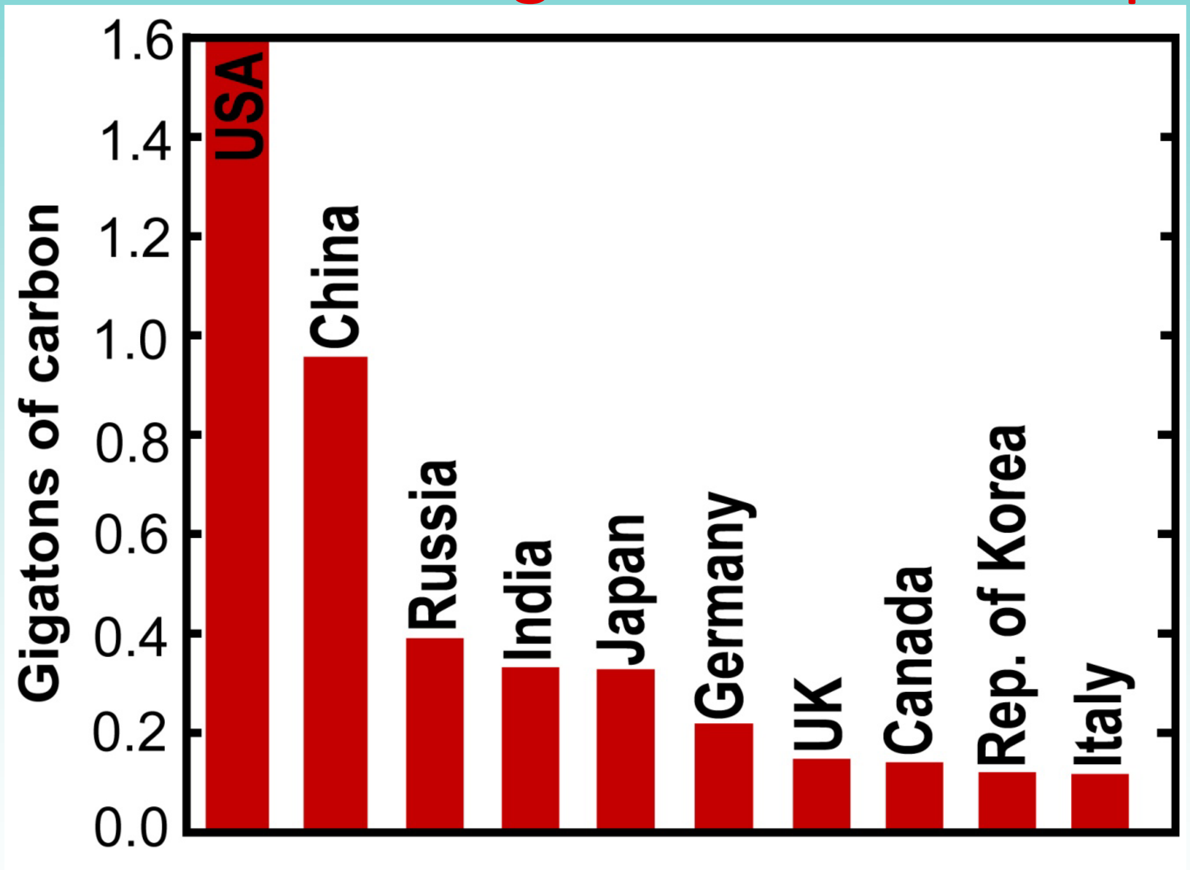


Source: EIA Energy Information Administration , 2001, 2005


US Historic and Forecasted Energy Consumption (Quadrillion Btu)
by Fuel 1980-2030
Historic Energy Consumption
Projected Energy Consumption
Liquids
Coal
Natural Gas
Nuclear
Other Renewables
Hydropower
60
50
40
30
20
10
0
1980
1990
2000
2010
2020
2030

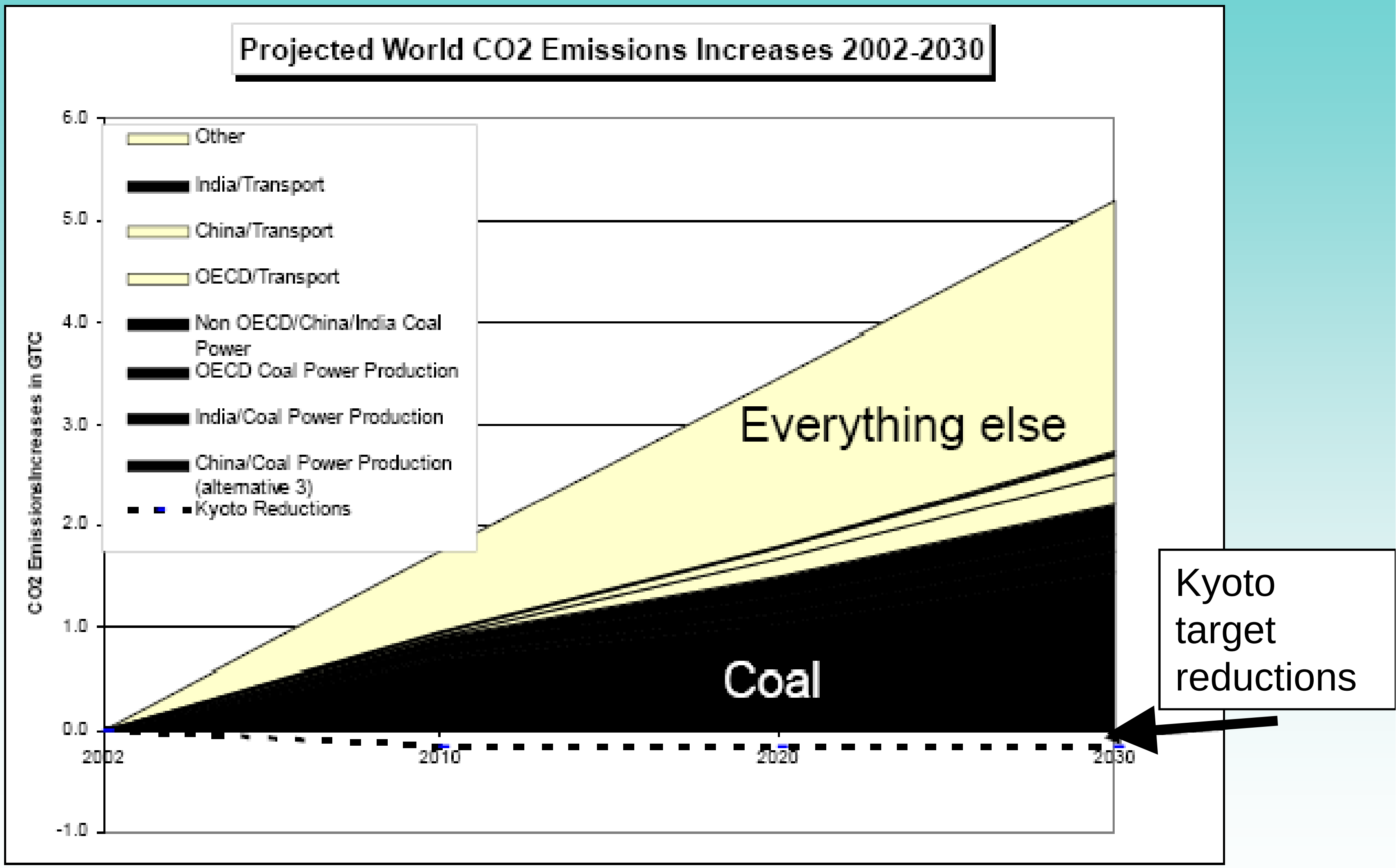
Global Carbon Emissions

6 Gigatons of Carbon per Year



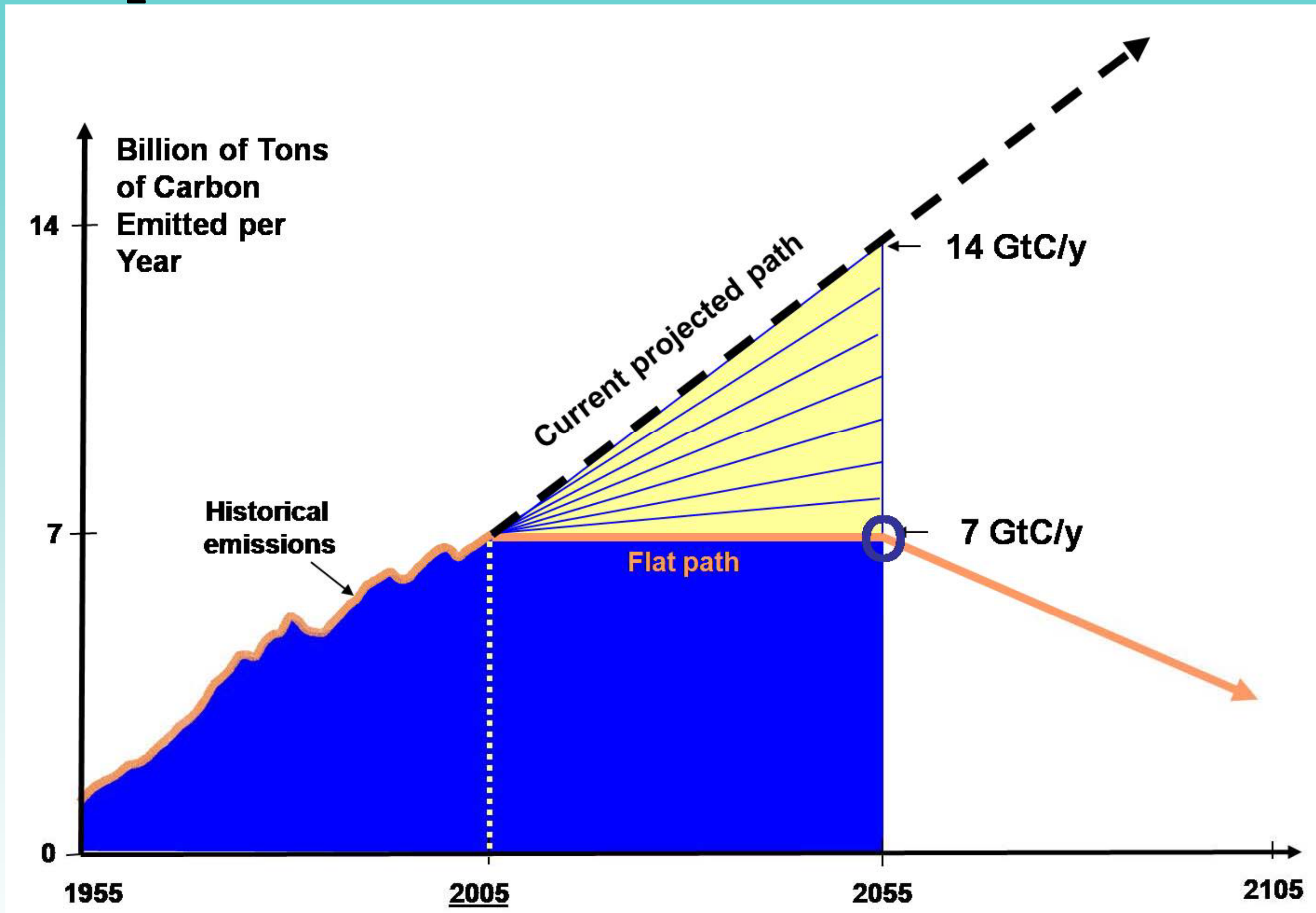
2002 total carbon emissions from fossil-fuel burning, cement production and gas flaring

Coal Drives CO_2 Emissions



Source: International Energy Agency 2004

The CO_2 Stabilization and Wedges Framework



Source: Princeton Carbon Mitigation Initiative

Seven possible wedges (these are the easy ones!)

- Replace 1400 coal-fired plants with gas-fired plants
- Increase fuel economy of 2 billion cars (30-60mpg)
- Add twice today's nuclear power to displace coal
- Increase solar power 700-fold
- Cut electricity use in homes, offices, stores by 25%

- **Install CCS at 800 large coal-fired plants**

- **TERRESTRIAL SEQUESTRATION**

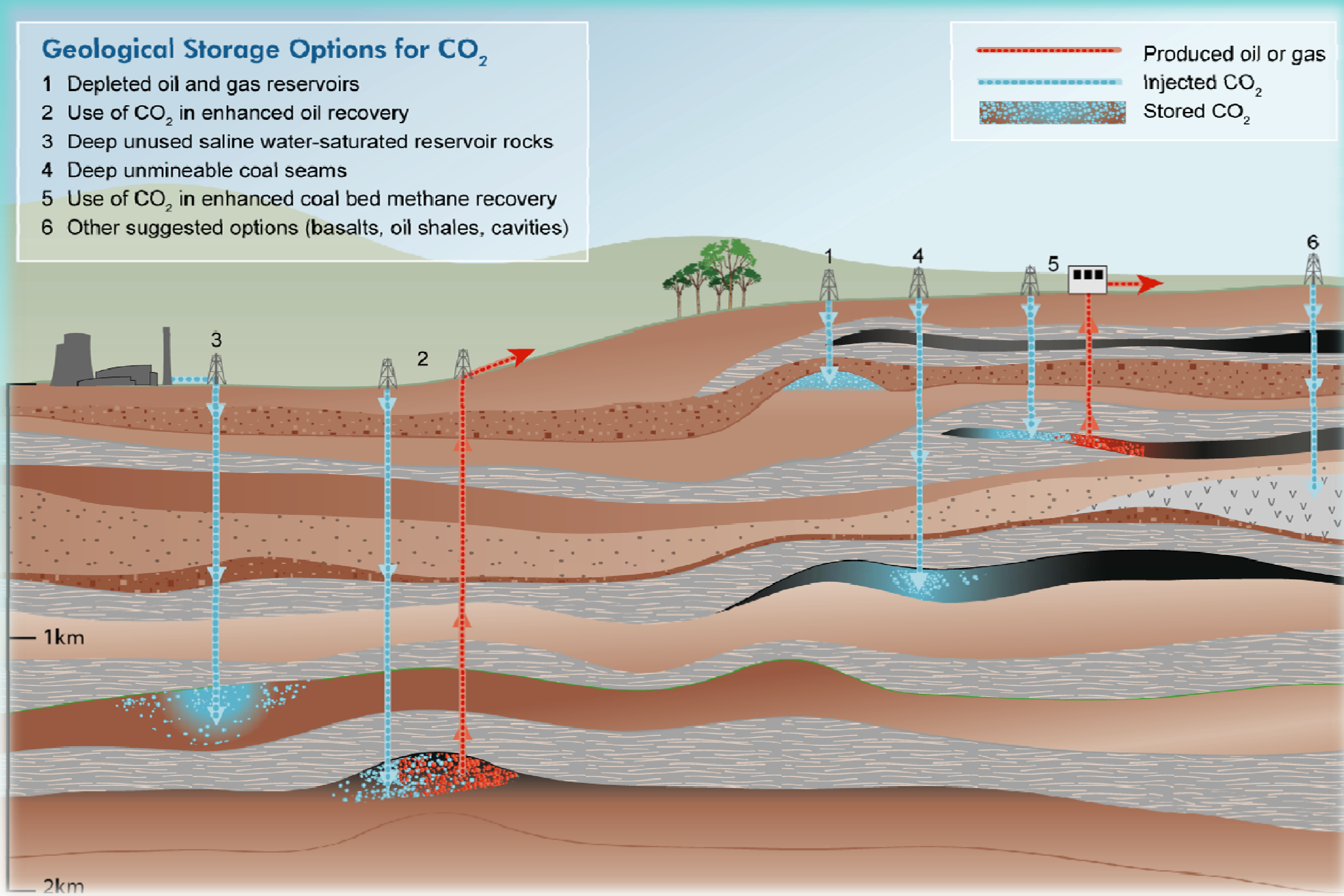
Types of Sequestration or Storage:

Geological (Directly capture the CO_2 from Point sources)

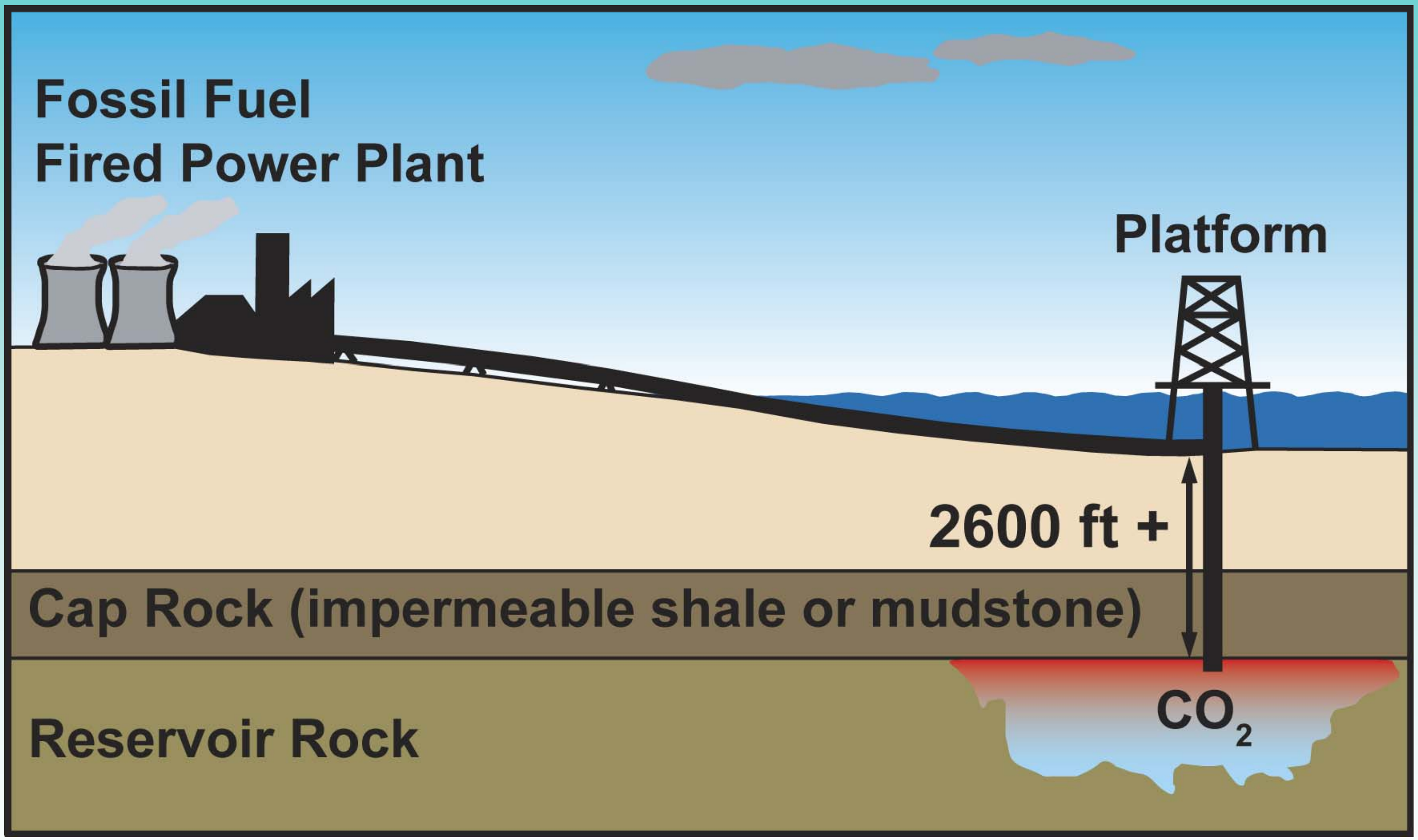
Terrestrial (Indirect capture and storage)

POINT: the two are related through the carbon markets and policy

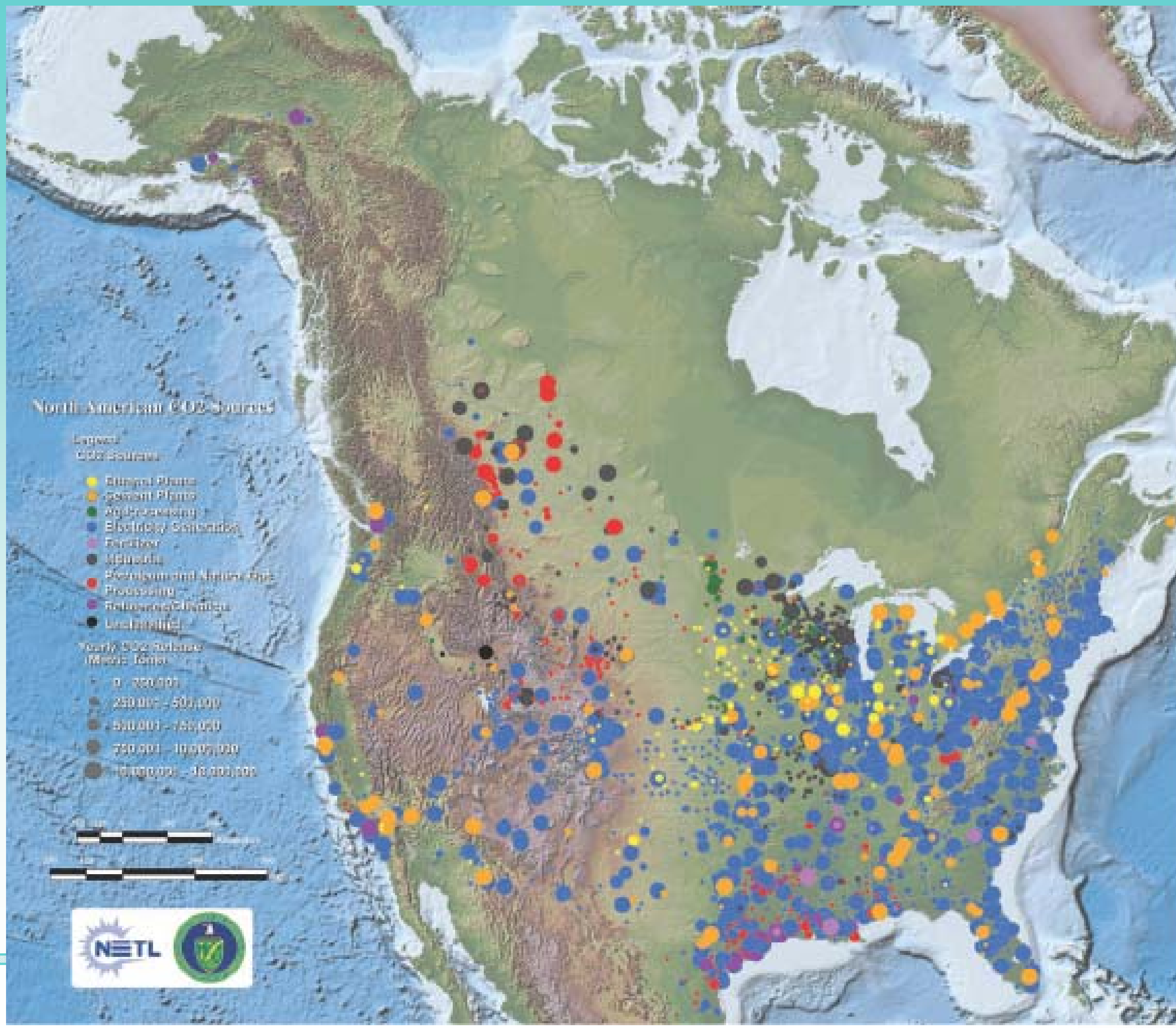
Options for Geological Storage



Geologic Storage



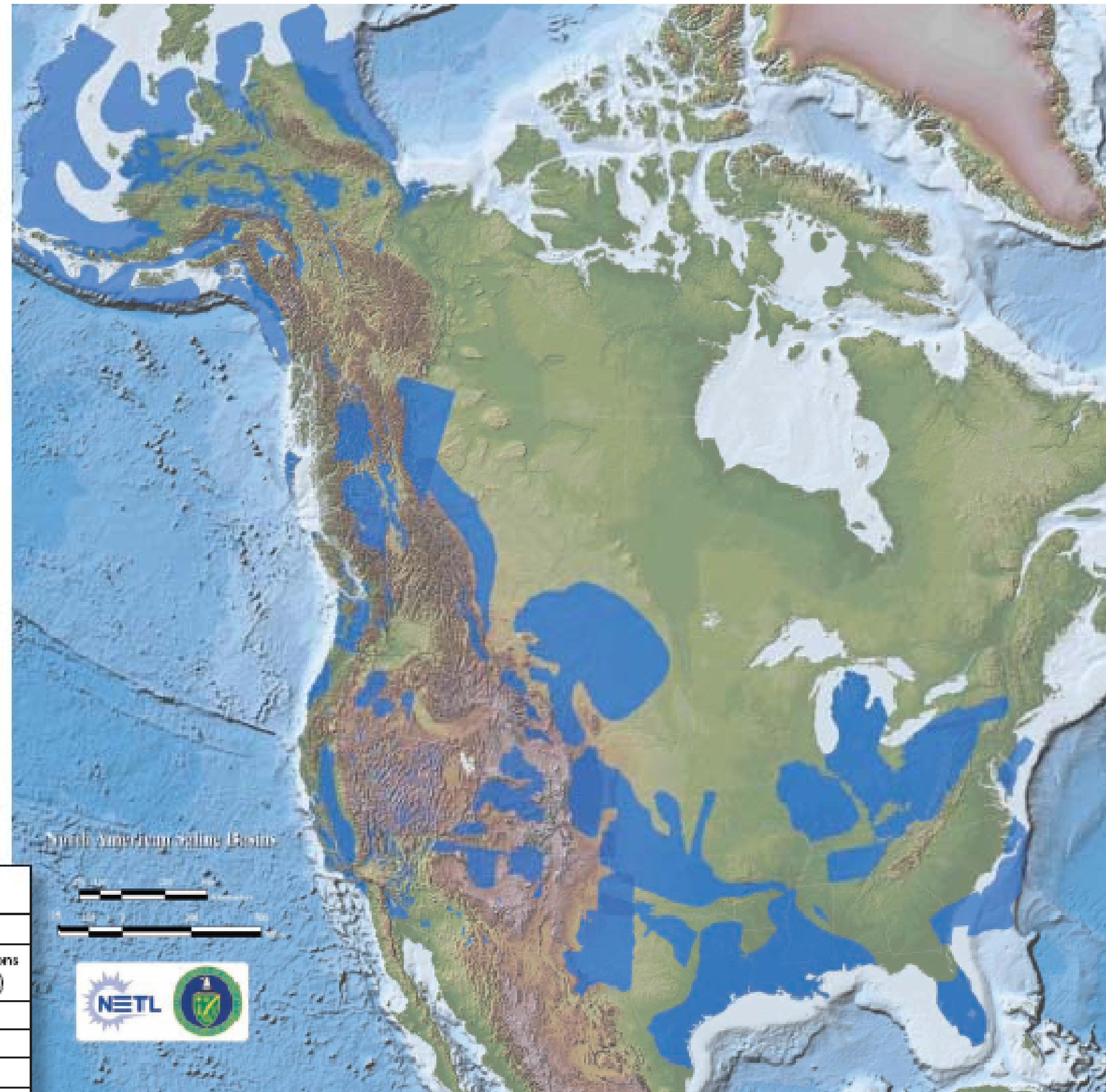
CO2 point sources



Deep Saline Formations

Saline formations are layers of porous rock that are saturated with brine. They are much more extensive than coal seams or oil- and gas-bearing rock, and represent an enormous potential for CO_2 storage. However, much less is known about saline formations because they lack the characterization experience that industry has acquired through resource recovery from oil and gas reservoirs and coal seams. Therefore, there is a greater amount of uncertainty regarding the suitability of saline formations for CO_2 storage.

While not all saline formations in the U.S have been examined, the RCSPs have documented the locations of such formations with an estimated sequestration potential ranging from 919 to more than 3,300 billion metric tons (from 1,014 to more than 3,700 billion tons) of CO_2.

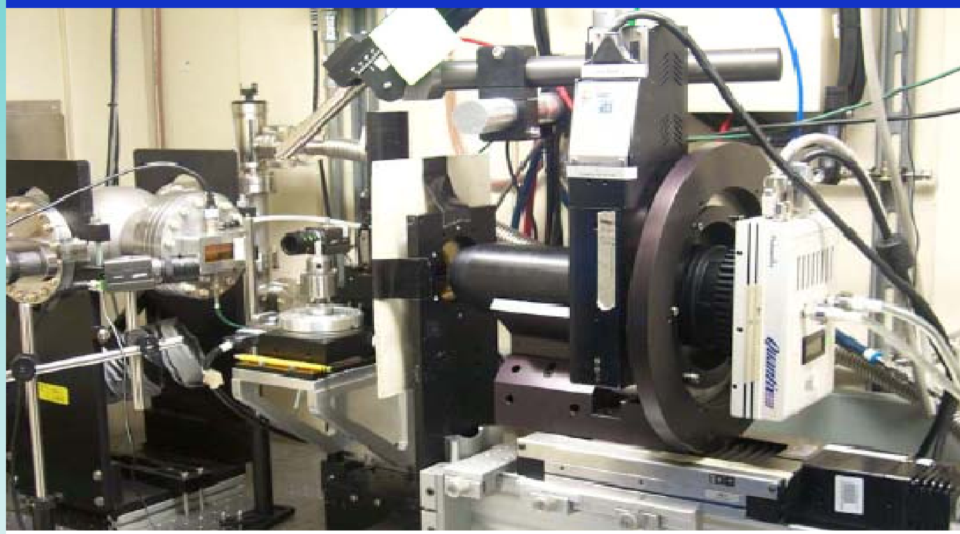


This map displays saline formation data which were obtained from the RCSPs and other external sources and compiled by NATCARB.

CO_2 Capacity Estimates by Partnership Saline Formations

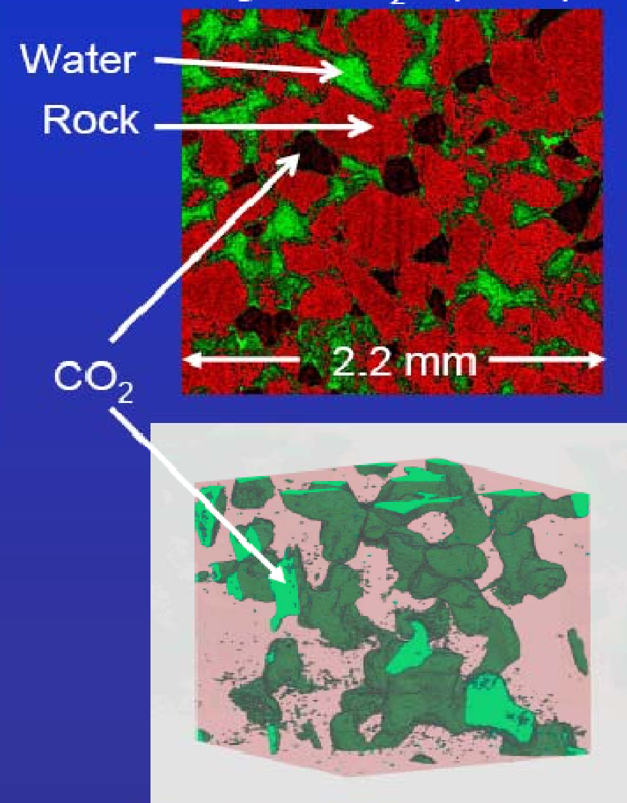
	Low		High	
	(Billion Metric Tons of CO_2)	(Billion Tons of CO_2)	(Billion Metric Tons of CO_2)	(Billion Tons of CO_2)
BIG SKY	271	299	1,085	1196
MGSC	29	32	115	127
MRCSP	47	52	189	208
PCOR	97	107	97	107
SECARB	360	397	1,440	1587
SOUTHWEST	18	20	64	71
WESTCARB	97	107	388	428
Total	**919**	**1,014**	**3,378**	**3,724**

What happens when the CO_2 is pumped underground?

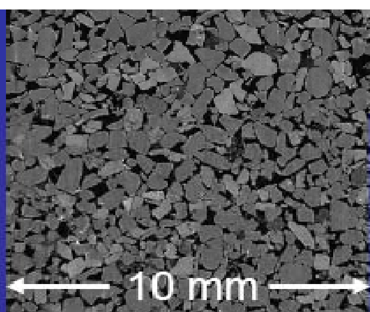


Microtomography at the Advanced Light Source

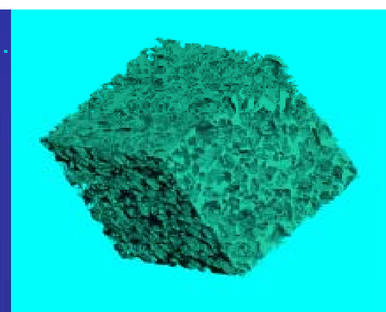
2-D image of CO_2 in pore space



3-D image of CO_2 in pore space

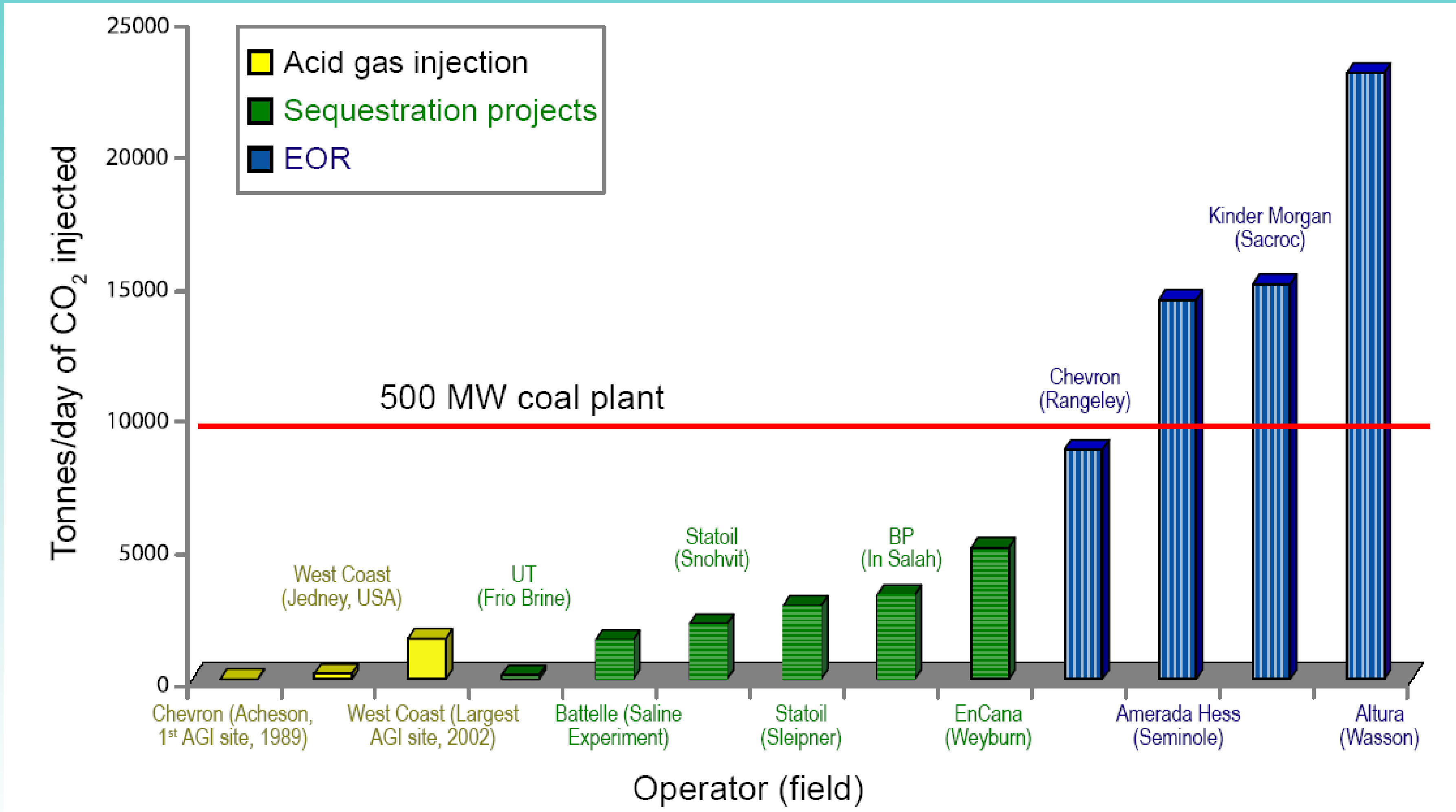


2-D pore space image

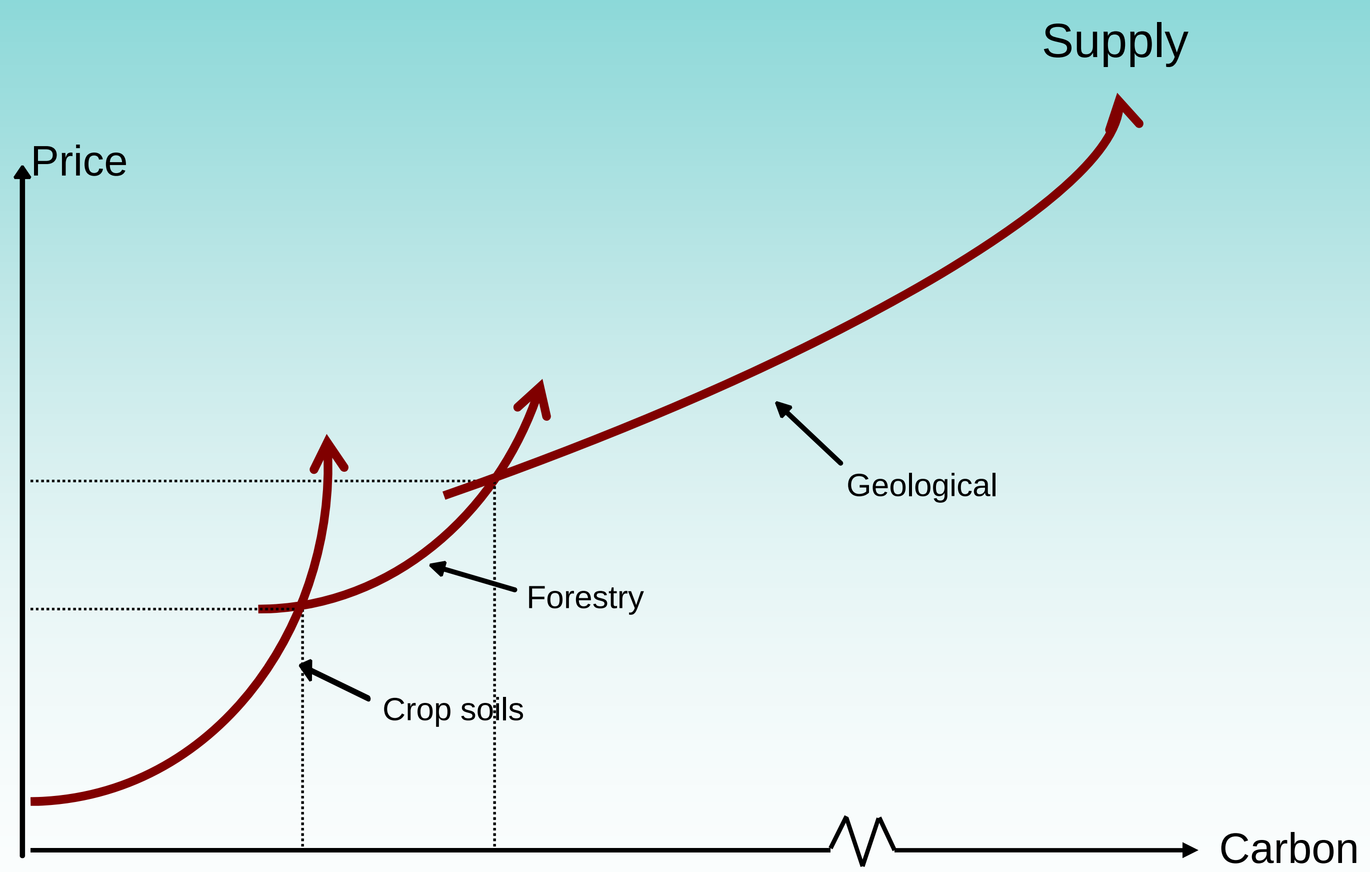


3-D pore space image

Current Storage Projects



CARBON SUPPLY CURVE



Adaptation and mitigation

- ADAPTATION:
  - Cumulative past emissions already committed planet to a climate change and associated impacts (rate and nature of impacts)
  - Adaptation is the norm in agriculture
  - Adaptation strategies will vary location and ag systems
- MITIGATION:
  - Ag has been/is an emitter of GHG to the atmosphere AND is a sequester of CO_2 in the form of soil carbon
    - Question: how much potential exists for increasing the amt sequestered
    - Question: potential for decreasing net GHG emissions

Photo by Bart Eleveld

Mitigation: Terrestrial Sequestration

- Technical vs economic potential for sequestration

  - technical potential cannot be achieved unless farmers are willing to adopt management practices that increase soil C
  - economic potential: At what cost can farmers change practices to increase soil C?
  - how can farmers be provided an incentive to change practices?

- Technical component: carbon rates vary due to bio-physical conditions (soils, climate)

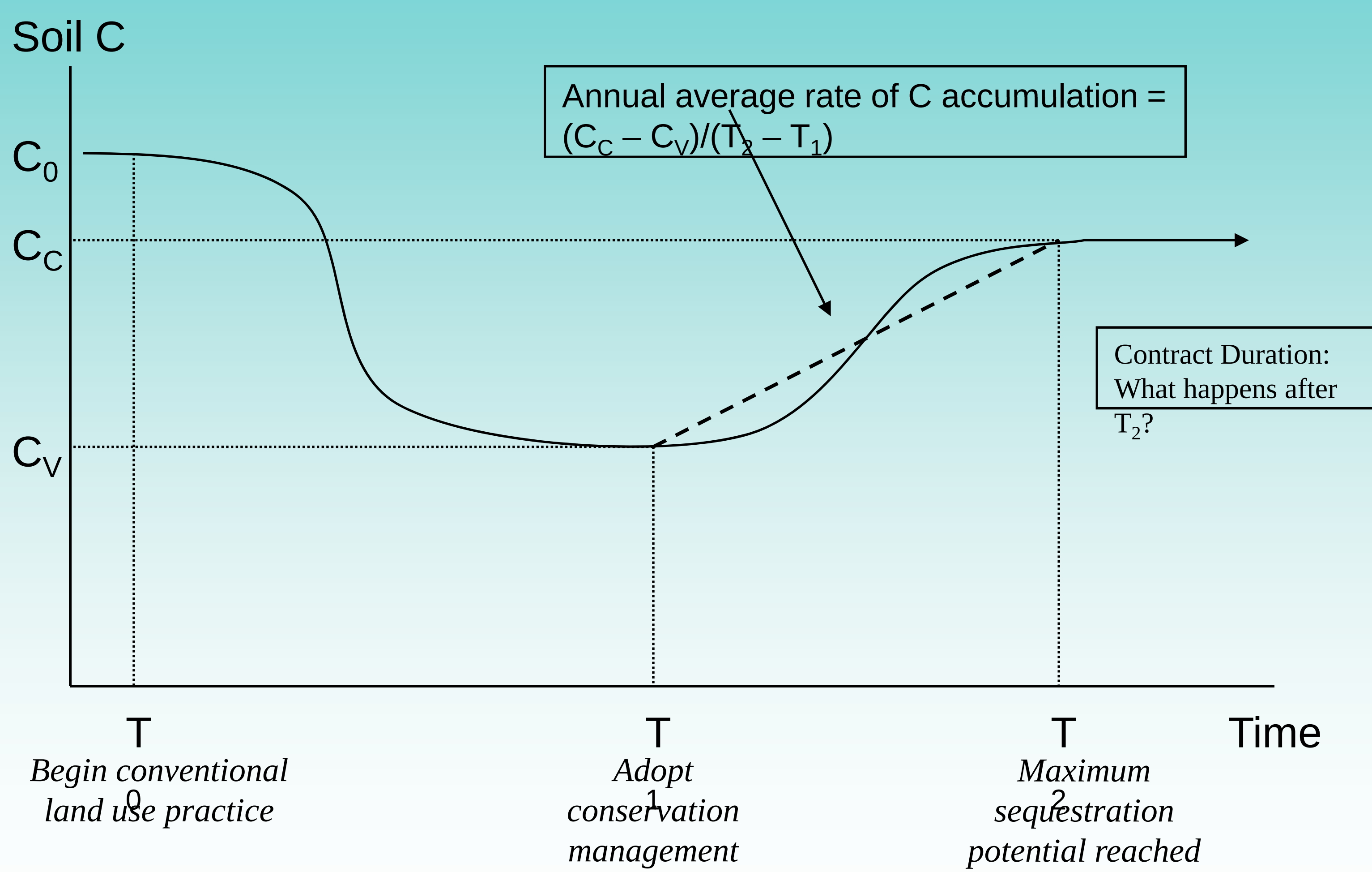
- Economic component: Opportunity costs vary spatially due to factors affecting productivity and profitability

How does all this work at a farm scale: Factors Determining the Cost of C Sequestered in Agricultural Soil

- **Rates of change in soil C** associated with a change in management

- Farm **Opportunity Costs**: *What does the producer have to do to increase soil C, and how does that affect profitability?*
  - Change tillage practices?
  - Change crop rotation?
  - Change fertilizer rates?

Technical Potential: Changing farm land use and management practices can restore soil C lost from use of "conventional" practices

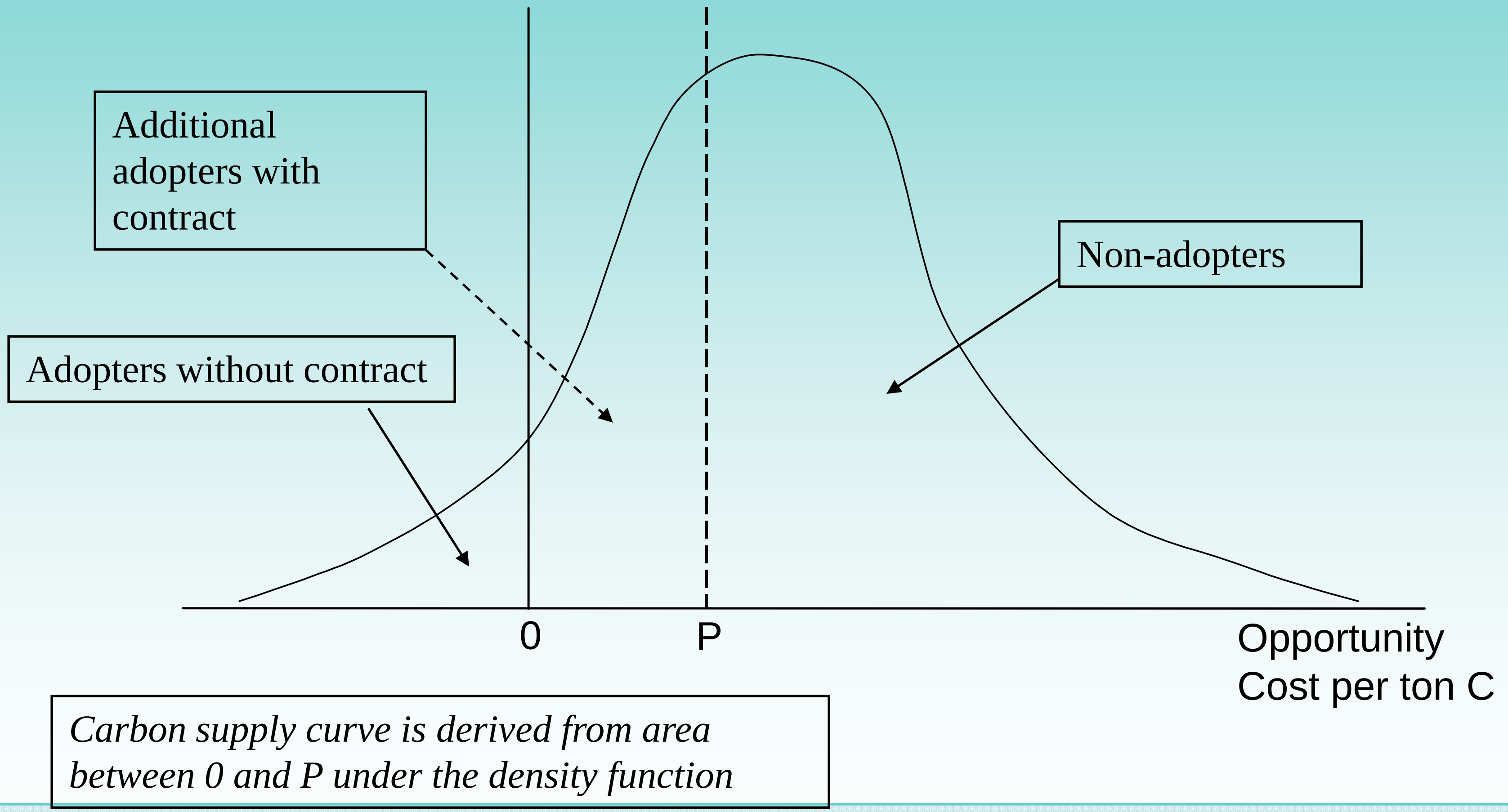


But technical potential cannot be achieved unless farmers are willing to adopt management practices that increase soil C.

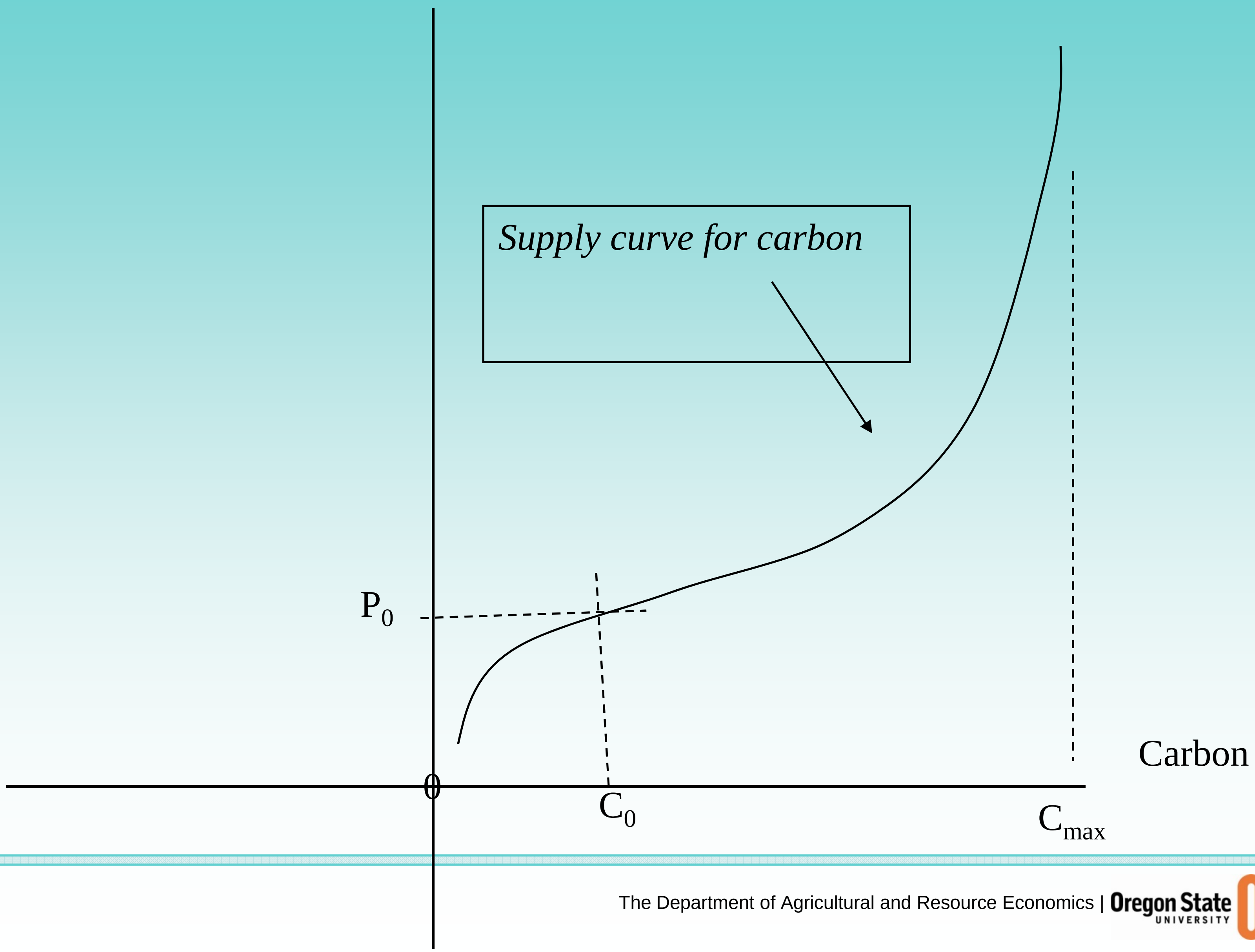
At what cost can farmers change practices to increase soil C?

How can farmers be provided an incentive to change practices?

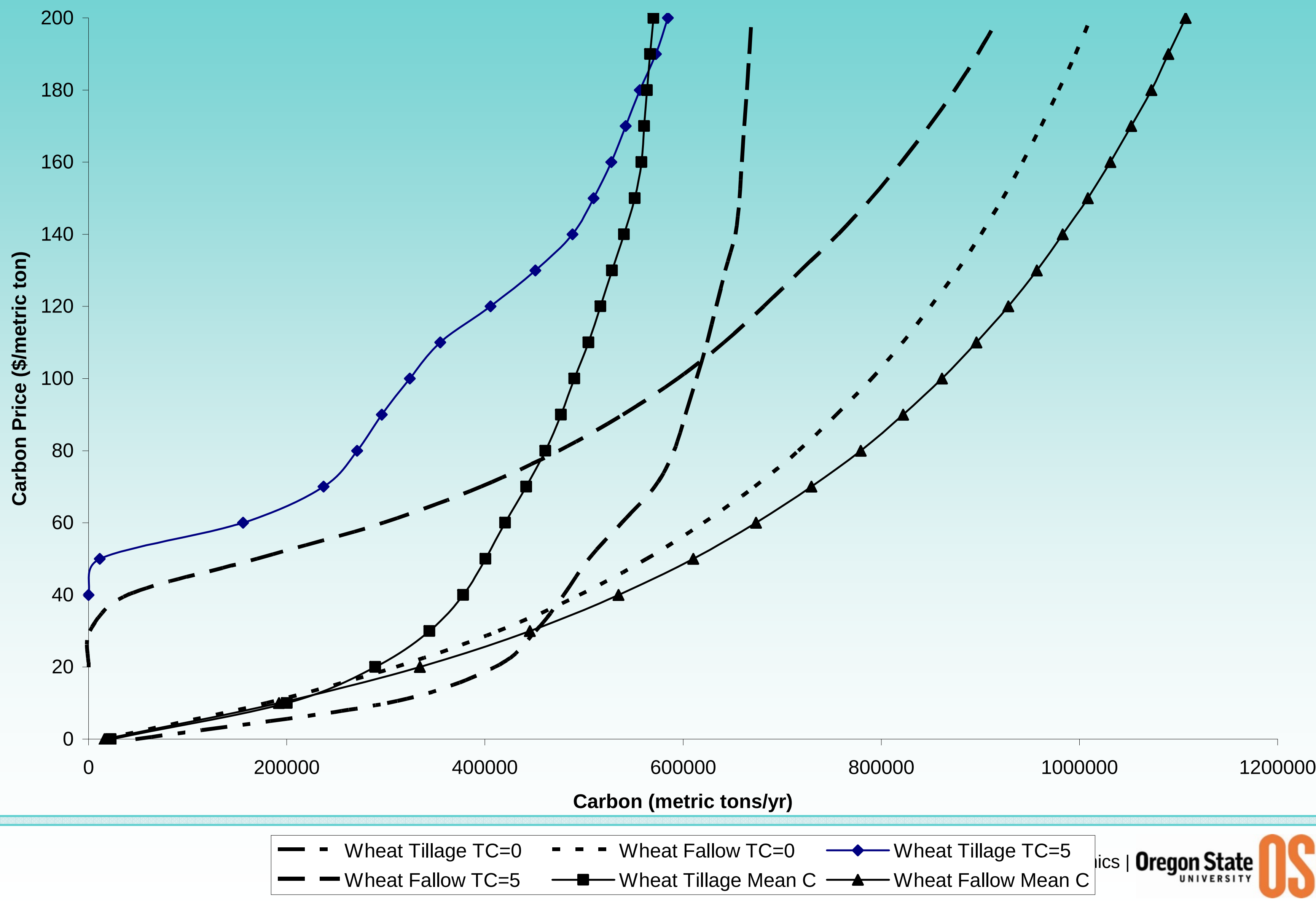
Opportunity Cost, Contract Participation Decisions, and Carbon Supply Curves

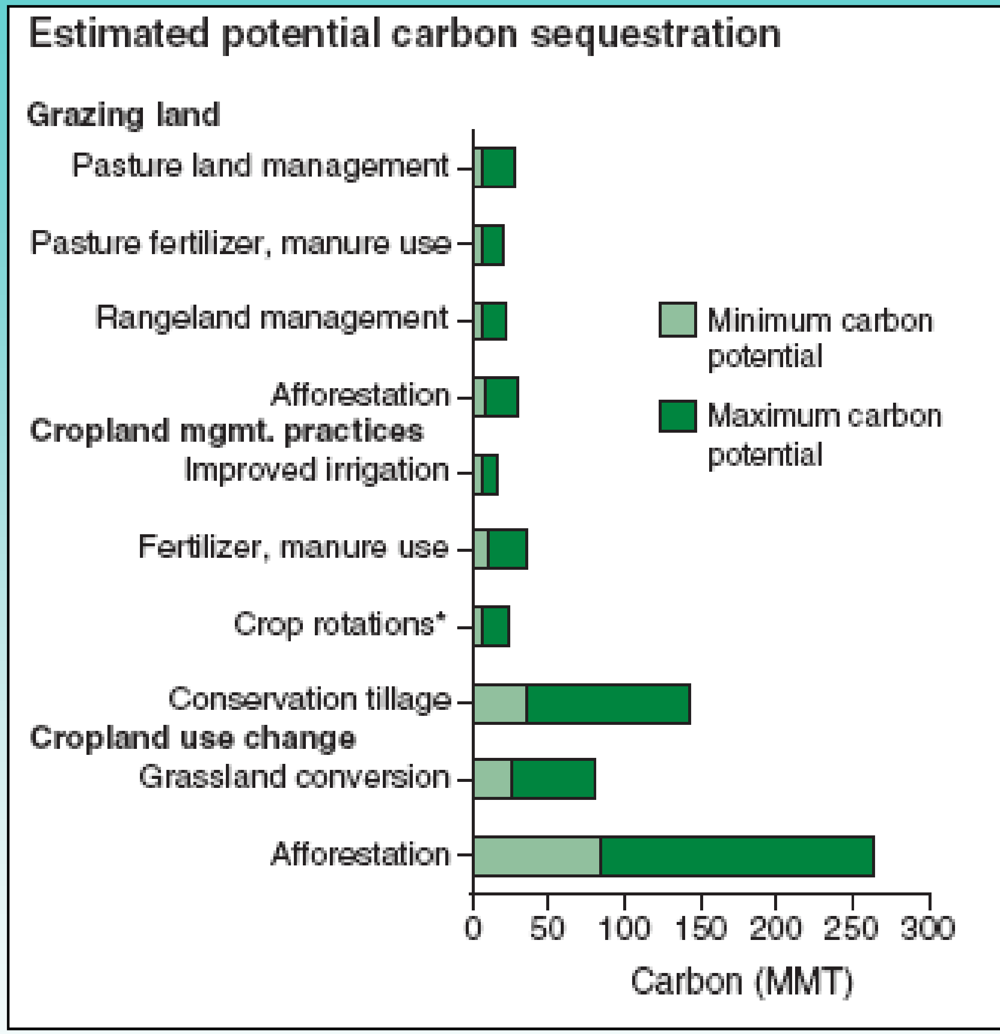


Carbon Supply Curve



Central US C supply curves for grain/pasture system





Source USDA 2004 Economics of Sequestering Carbon in the U.S. Agricultural Sector (http://www.ers.usda.gov/publications/tb1909

Farmers are Businessmen

- Farmers adopt management practices that increase soil carbon, if those are in their best interests.

- What will these changes cost farmers?
- Incentive: motivate farmers to change

- At $50/t C, or $13/t CO_2, up to 70 MMT C/yr on ag lands.

- Up to 270 MMT C/yr through afforestation of ag lands.

Aggregate Assessment (Pew and USDA)

Carbon stocks in agricultural soils are currently increasing by **12 million metric tonnes (MMT)** of carbon annually.

If farmers widely adopt the best management techniques now available, an estimated **70 to 220 MMT** of carbon could be stored in U.S. agricultural soils annually. (TECHNICAL)

With moderate incentives (up to $50/tonne of carbon, or $13 per tonne of CO2), up to **70 MMT** of carbon per year might be stored on agricultural lands and up to **270 MMT** of carbon per year might be stored through converting agricultural land to forests (ECONOMIC)

Using existing technology, US ag could mitigate 5-14% of current US GHG emissions over 20 years

CARBON CREDITS: How are Credits Created?

- Emissions reductions
  - Energy conservation
  - New technologies
  - Landfill gases

- Terrestrial sequestration
  - In soils via photosynthesis
  - In biomass (trees, grassland)

- Geologic sequestration

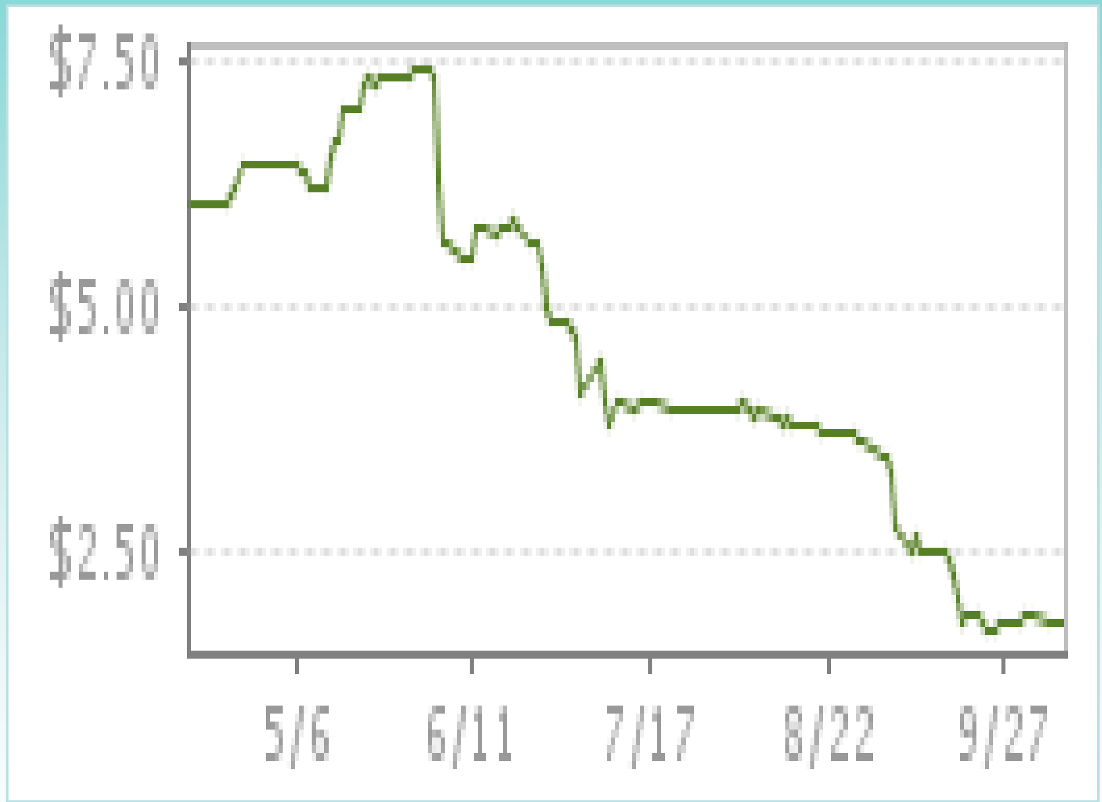
Who Buys Carbon Credits?

Who Sells Them?

- Credit price < cost of emission reduction:
  - *buy credits*
- Credit price > cost of emission reduction:
  - *sell credits*

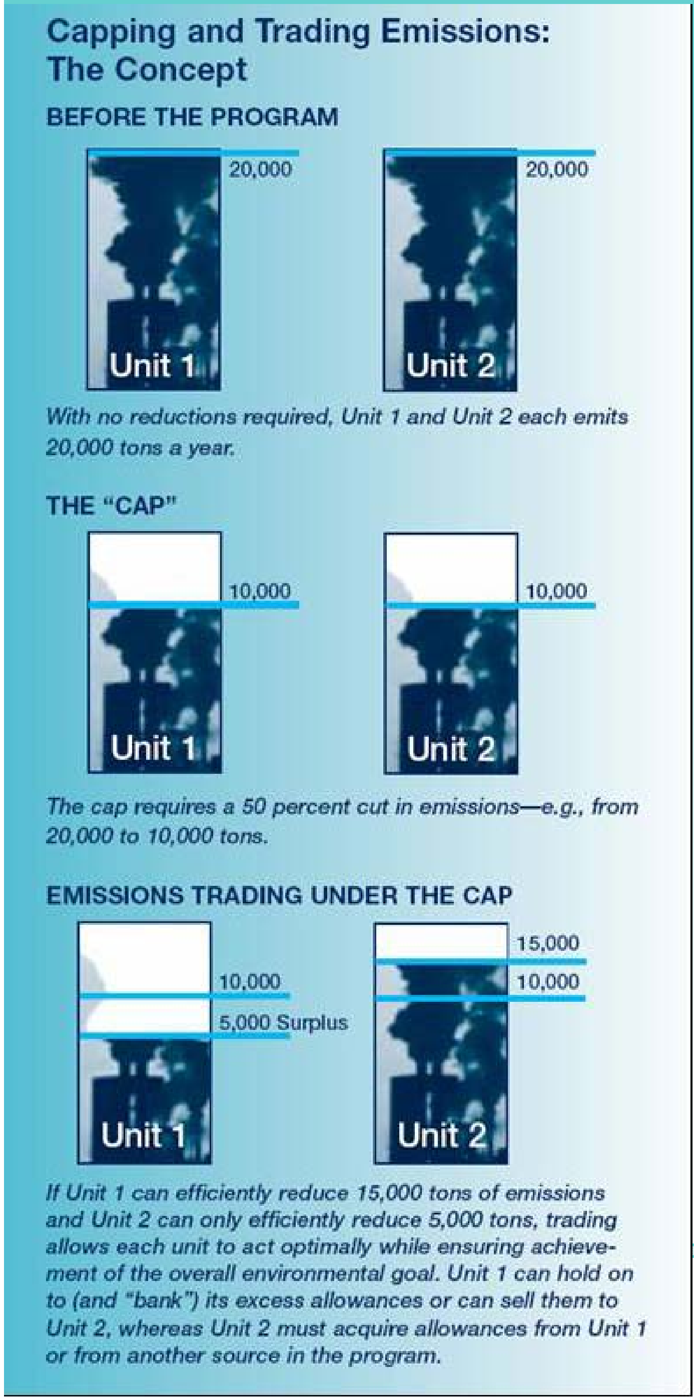
- ***REMEMBER: need a market, need a policy***

US Carbon Prices, 2008



2007 Prices

- Price range in US market (2007):
  - <u>\$3.30 to \$4.05/ton</u> CO_{2e}
- Price range in EU market (2007):
  - <u>\$22 to \$30.30/ton</u> CO_{2e}
- Why do EU and US prices differ?

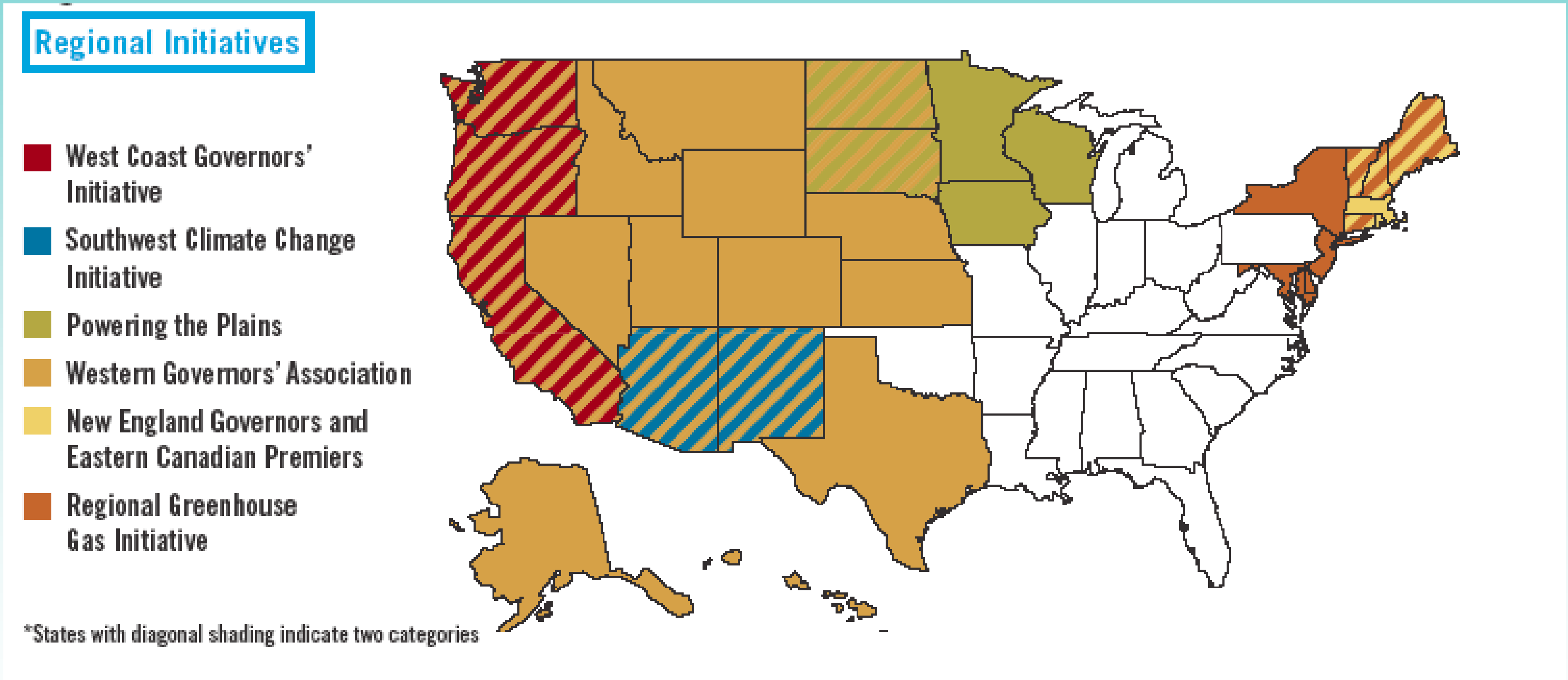


Cap and Trade System

- Set a cap on emissions
- Allocate credit allowances
- Monitor emissions during compliance period
- Surrender credit allowances at end of compliance period
- Fines/penalties if emissions > credits

Source: EPA. 2003. Tools of the Trade: A Guide to Designing and Operating a Cap and Trade Program for Pollution Control. EPA430-B-03-002.

State Initiatives within the US



Source: Pew Center on Global Climate Change. 2007. Climate Change 101: State Action

Why is this so difficult to design and implement a climate change policy?

- Global problem, intertemporal --“rock in a landslide”
- Decoupled costs and benefits
- Need to get the prices of energy sources to reflect their social costs
- Three complications for designing economic policy:

  Uncertainty
  Irreversibilities
  Very long time horizons
  Winners and losers

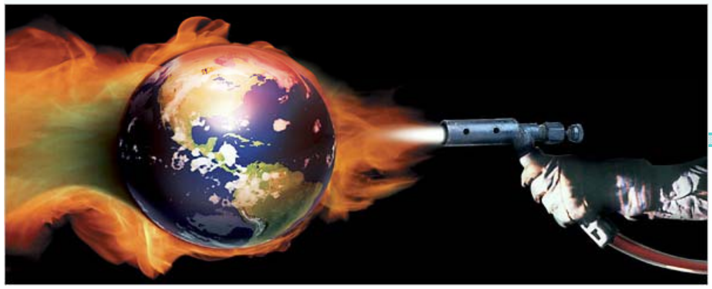
(photo credit: NYT)

Uncertainty—lots of it

1. underlying physical and ecological processes
2. uncertainty over the economic impacts of the Climate change
3. uncertainty over rate of technological change

Are there tipping points?

Policy should be precautionary, but how precautionary? Do we roll back to 1930 emission levels or 1990?

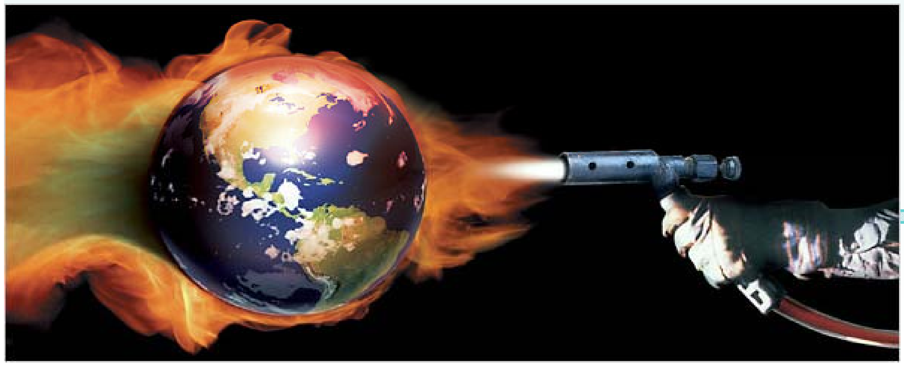


What type of policy? To tax or not to tax?

Quantity-oriented mechanism: cap and trade

- •Allocation of allowances is critical issue
- •Creates new wealth, how it is distributed will affect well-being
- •Example: price carbon =$10t co2e, total value of allowances is $50billion annually
- •Choice for allocation: give it away or auction
- •Still need to ratchet down the allowances over time

Price-type control mechanism: carbon taxes



(photo credit: NYT)

Research Needs and Directions: Expanded Role for Land Grants

- Measurement technologies, environmental-economic-biophysical modeling.
- Baseline information on soil carbon content.
- Research on the technical potential for additional sequestration by cropping systems and regions.
- Information on the opportunity costs of changing cropping systems.
- Protocols for monitoring and verifying carbon – credible carbon.

Thank you

Susan Capalbo
Oregon State University

Susan.capalbo@oregpnstate.edu

541-737-5639