Designing a Least-Cost Cap and Trade Mechanism for Limiting California's Greenhouse Gases

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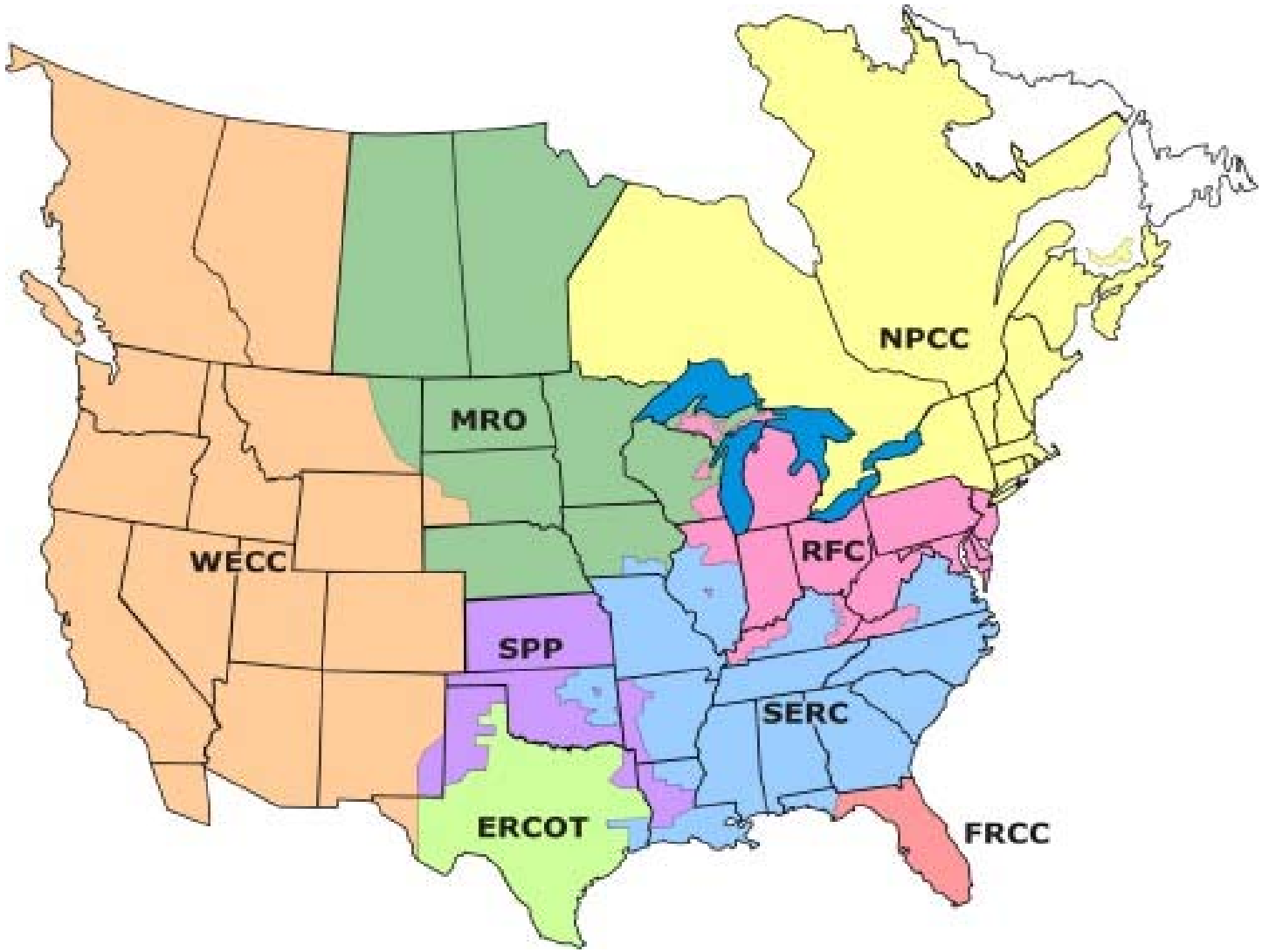
Outline of Talk

- Inform discussion of construction of cap and trade mechanism to control GHGs caused by California's electricity consumption
- Characteristics of electricity and California electricity market
- Dispatch of electricity generation units located outside of California ISO control area
- Administrative costs of cap and trade mechanism

California Electricity Facts

- Stylized facts about electricity in California
  - California obtains more than 20% of its energy from imports
  - California is part of electrically interconnected Western Electricity Coordinating Council (WECC)
- Physics of electricity delivery implies that it is impossible to tell which plant is selling to which customer
  - Electricity injected into network flows according to path of least resistance
  - Supply must equal demand at every instance in time and at every location in network
    - Automatic Generation Control (AGC) units ensure this is the case
- Bathtub model of electricity network
  - Suppliers inject electricity into network
  - Consumers withdraw electricity from network

NERC Regional Reliability Councils



California Electricity Facts

- Many ways to create “source of electricity” consumed by a specific customer
- Historically generation unit “selling energy” to customer is created by a forward financial contract
  - Buy 200 MWh contract from generation unit
  - Verify that generation unit produced at least 200 MWh during that hour
  - Generation unit is deemed to have delivered 200 MWh of electricity to customer

“Sources of Supply” to California

Table 2 2006 Gross System Power (GSP) in Gigawatt Hours

Fuel Type	In-State	NW	SW	GSP	GSP %
Coal	17,573	5,467	23,195	46,235	15.7%
Large Hydro	43,088	10,608	2,343	56,039	19.0%
Natural Gas	106,968	2,051	13,207	122,226	41.5%
Nuclear	31,959	556	5,635	38,150	12.9%
Renewables	30,514	1,122	579	32,215	10.9%
Biomass	5,735	430	120	6,285	2.1%
Geothermal	13,448	0	260	13,708	4.7%
Small Hydro	5,788	448	0	6,236	2.1%
Solar	616	0	0	616	0.2%
Wind	4,927	244	199	5,370	1.8%
Total	230,102	19,804	44,959	294,865	100.0%

Source: “2006 Net System Power Report,” California Energy Commission Publication # CEC-300-2007-007.

Electricity Supply in Rest of WECC

- Significant amount of hydroelectricity capacity in Pacific Northwest
  - Bonneville Power Administration has roughly 32,000 MW of hydro capacity
  - Significant amount of coal-fired units throughout WECC

Table 2: Energy Produced in 2004 by Major Fuel Source and Sub-Region (TWh)

	California	AZ-NM	OR-WA	Rest of WECC	*Total WECC*	*% Total WECC*
Large Hydro	29.6	6.9	101.5	17.5	*155.5*	*23%*
Nuclear	30.3	28.1	9.0	0	*67.4*	*10%*
Renewables	28.5	1.0	5.1	6.1	*40.7*	*6%*
Natural Gas	96.2	32.4	22.5	36.9	*188*	*27%*
Oil	3.4	<.1	.3	.2	*3.9*	*1%*
Coal	3.0	65.8	14.0	146.2	*229*	*33%*

- Source: Bushnell, Peterman, and Wolfram "California's Greenhouse Gas Policies: Local Solutions to a Global Problem?" CSEM WP 166.

Electricity Supply in Rest of WECC

- Do California's GHG policies alone have any ability to influence which units outside of California operate and how intensively they operate them?
- Coal is low variable cost source electricity relative to natural gas-fired units at current natural gas prices
  - Will operate if rest of WECC does adopt GHG policies that price GHG emissions
- Nuclear and renewables will operate if available
- Can California alone impact which natural gas and oil-fired units operate outside of California?
  - Neighboring control areas want to dispatch units in least cost manner which implies most efficient gas-fired units will operate outside of California

Electricity Supply in Rest of WECC

- Conclusion: California's GHG policies will have little if any impact on how electricity outside of California is produced
- California only source-based approach to GHG emissions has lower administrative and compliance costs than load-based approach
  - Set cap on overall amount GHG produced by units located in California
    - Can achieve tangible verifiable goals
- Work to bring more WECC states into source-based cap

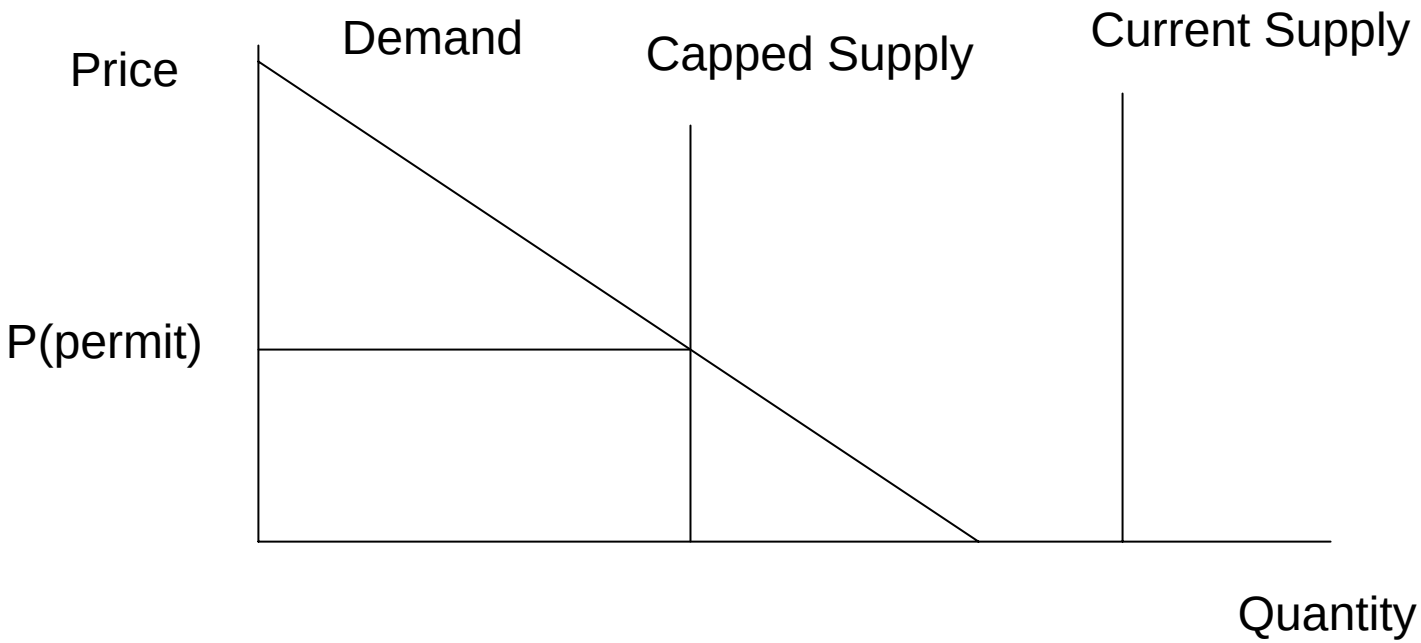
Cap and Trade versus Carbon Tax

- Investors want price certainty into distant future for GHG emissions to justify investments in control technologies
  - GHG tax provides this price certainty
- Cap and trade mechanisms typically yield volatile prices for GHG emissions allowances
  - Dulls incentive to invest in GHG-reducing technologies
  - Greater price volatility implies higher probability that investment in GHG control technology will be ex post unprofitable

Protecting Against Permit Price Volatility with Cap and Trade Mechanisms

Cap and Trade Program

- Cap and trade program sets an overall cap on GHCs
  - Create a scarcity price of GHCs emissions allowances
- Currently supply of GHC emissions exceeds demand to emit which implies a zero price



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The Best of Both Worlds

- California should consider rising floor and ceiling on price of GHG permits
  - Set nominal price floor that increases at rate of price inflation
  - Set nominal price ceiling that increases at rate higher than rate of price inflation
- Price floor enforced by state standing ready to purchase GHGs if price falls below floor
  - A floor of $20/ton of carbon implies that a household could purchase their annual carbon production from electricity, driving and flying (~10 tons per year) for around $200
- Price ceiling enforced by state standing ready to issue permits at this price ceiling
- Price ceiling and price floor provide certainly to producers of GHG to allow them to justify investment in GHG reducing technologies

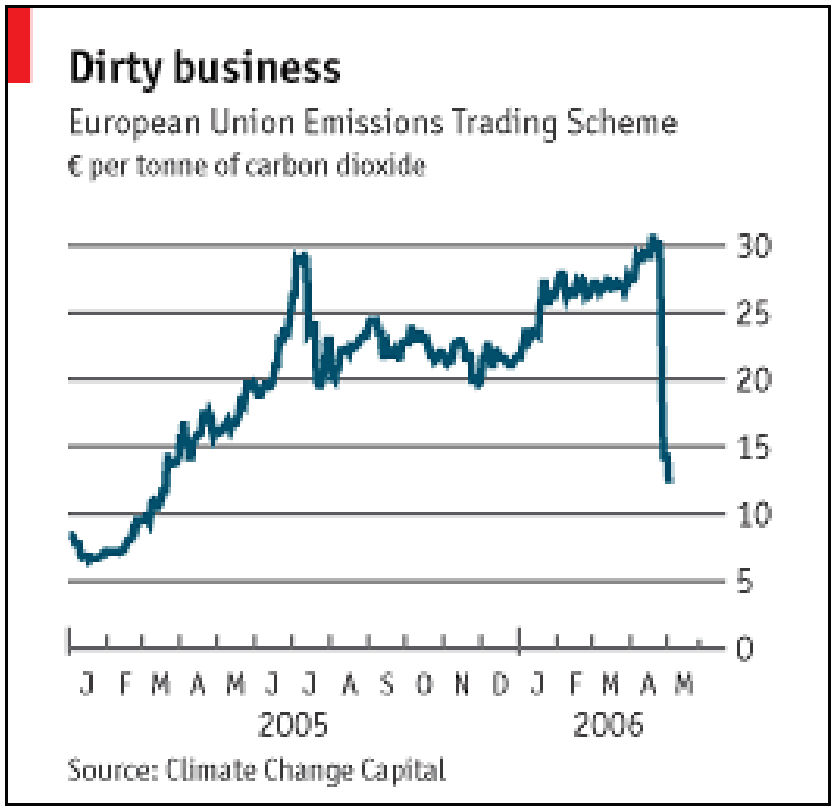
Auctions versus Allocation of Permits

Who Should Get Permits?

- Allocation of permits to producers of electricity at start of market can transfer significant financial wealth
  - Can then use permits to raise electricity prices as appears to have been the case in California and Europe
- Permits could be allocated to consumers of electricity
  - Producers would then purchase them from consumers and raise electricity prices
  - Mitigates wealth transfer associated with higher electricity prices
- Trading potentially extremely valuable right similar to financial assets
  - Need similar rules governing market participant behavior as in securities markets
- Commodity Futures Trading Commission (CFTC) or Securities and Exchange Commission (SEC) oversight of permit market

The European Experience

- Experience of European Union with GHG permits
  - European governments handed out many permits to firms in their countries
    - More permits than GHG emissions in 2006
  - Prices were initially high because market participants didn't know how many there were
- *The Economist* magazine argues that only beneficiary of program is electricity suppliers in Europe who were able to increase price of all electricity they sold because of permit prices
  - This could have been anticipated from California experience



Permits can enhance market power or inefficiencies in downstream industries that use fossil fuels—RECLAIM market experience

Scalability of Market Mechanism

- Achieve modest positive and predictable price of GHG emissions into distant future
  - Many rigorous estimates of cost achieving various GHG reductions
  - Use these cost estimates to set ceiling and floor on GHG emission permit prices
- Demonstrate the trading of GHG emissions permits yields lower cost solution to achieving market-wide GHG reduction goals
  - Encourage countries to join mechanism
  - China can sell permits to US and EU GHG producers
    - Recall carbon intensity of output in China versus US
    - EU carbon intensity of output even lower than US
- High initial cost of compliance will only discourage other jurisdictions from joining and may increase GHG emissions
  - Recall long term nature of problem and solution

Questions/Comments

For more information

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