

# What Can California Hope to Achieve from AB32?

The Economic Challenges to Implementing a Greenhouse Gas Emissions Cap

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## Outline of Talk

- What is AB 32?
- Implementation challenges
  - Compliance with regulation
    - Defining the GHG emissions allowance product
  - Leakage of GHGs emissions
    - Example of electricity in the Western US
  - Cap and trade program
    - Secondary market impacts of emissions permit costs
    - Credit issues with long-term emissions permits
  - Market power in downstream markets
    - South Coast Air Quality Management District (SCAQMD)
  - Auction versus allocation of emissions permits
    - Market power versus efficient allocations
  - Scalability of market mechanisms
    - Criteria for judging success of AB 32

## AB 32

- State Air Resources Board (ARB) adopts statewide greenhouse gas emissions (GHGs) limit equivalent to 1990 emissions levels to be achieved by 2020
  - Controls all greenhouse gases—carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride
  - Sets GHG limit in terms of annual maximum GHGs emissions in tons of carbon dioxide equivalents
    - Exchange rate to convert each GHG to carbon dioxide equivalent
  - Statewide GHG = total annual emissions in the state, including all emissions from GHG from the generation of electricity delivered to and consumed in California, accounting for transmission and distribution losses, whether the electricity generated in the state or imported

## AB 32

- Emissions limit applies to all electricity consumed in the state
  - Investor-owned utility sales—Pacific Gas and Electricity, Southern California Edison, and San Diego Gas and Electric
  - Municipal utilities—Los Angeles Department of Water and Power, Sacramento Municipal Utility District, Palo Alto Utilities
- ARB may use market-based compliance mechanisms
  - Allows trading of GHGs emissions allowances
  - Distribute emissions allowances “in a manner that is equitable, seeks to minimize costs and maximize the total benefits to California, and encourages early action to reduce GHGs emissions”

## AB 32

- Minimize “administrative burden of implementing and complying with” regulations
- Ensure that compliance activities “do not disproportionately impact low-income communities”
- Ensure that parties that have voluntarily reduced their GHGs prior to implementation of AB 32 receive “appropriate credit for early voluntary reductions.”
- If mobile source standards in AB 1493 do not remain in effect, ARB will implement “alternative regulations to control mobile sources of GHG to achieve equivalent or greater reductions
  - AB 1493 fleet-wide tailpipe GHG emissions standards
    - Legal question--Is California setting Corporate Average Fuel Efficiency (CAFE) standard?

## Compliance

- Major compliance tasks
  - Define units of measurement
  - Measure amount consumed
  - Exchange rate between other GHGs and carbon dioxide
  - Define 1990 GHG emissions levels
- Lessons from US Environmental Protection Agency (EPA)
  - In January of 1993, EPA’s Acid Rain Program (ARP) established a continuous emission monitoring program (CEM)
    - ARP regulates electricity generation units that burn fossil fuel with greater than 25 MW of capacity
      - On-site back-up generation less than 25 MW is omitted
    - Part 75 CEM rule requires continuous monitoring and reporting of sulfur dioxide, carbon dioxide, nitrogen oxides, and heat input
      - Sulfur dioxide component is part of ARP cap and trade program
  - In October 1998, EPA added Subpart H to Part 75 to monitor nitrogen oxides
    - NO<sub>x</sub> Budget Program (NBP) is a cap and trade program

## Compliance

- Continuous emission monitoring technology must be installed and working properly
  - Similar to measuring electricity consumption
    - Metering and recording consumption
- Massive administrative procedure to determine how to measure sulfur dioxide, carbon dioxide, nitrogen oxides, and heat input under all possible circumstances
  - “Plain English Guide to the Part 75 Rule” is over 120 pages long
  - Technology does not always work as designed
    - If technology fails must still “record” an emissions amount
  - Establish acceptable standards for accuracy of measurements
    - 100 % accuracy is impossible

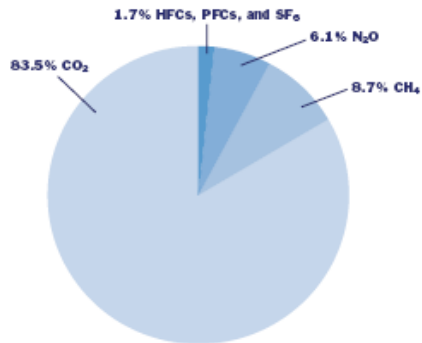
## Compliance

- Example of heat rate calculation using CEM data
  - $(\text{BTU input})/(\text{kWh output})$  thought to be technological feature of generation unit
  - Measured value of  $(\text{Hourly value of heat input})/(\text{Hour kWh output})$  can fluctuate substantially across hours of the day
    - Significant data inaccuracies are possible and do occur
- Need to install technology in generation facilities and other GHG-producing facilities to measure all GHGs
  - Significant up-front cost for monitoring technology
  - Substantial and enforceable penalties for failure to comply with regulation
    - Ongoing South Coast Air Quality Management District litigation
  - Periodic validation of accuracy of monitoring technology
- Consistency in accuracy of recording across GHG emitters
  - 99% recording accuracy for some GHG emitters and 80% for others can create incentives for more accurately recorded emitters to exit

# Composition of GHG Emissions

Figure 2

U.S. **GHG Emissions** by Gas (2000)

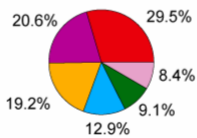
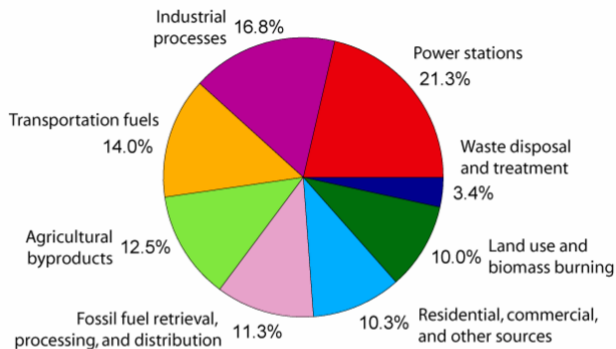


Note: Totals may not sum due to independent rounding. Emissions associated with purchased electricity are allocated based on aggregate natural electricity for each end-use sector.

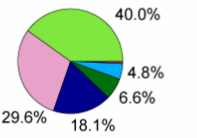
Source: Adapted from U.S. EPA, 2002. *Inventory of U.S. Greenhouse Gas Emissions in Sinks: 1990-2000*.

# Sources of GHG Emissions

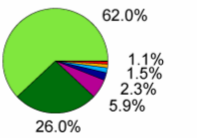
## Annual Greenhouse Gas Emissions by Sector



**Carbon Dioxide**  
(72% of total)



**Methane**  
(18% of total)



**Nitrous Oxide**  
(9% of total)

## Compliance

- Many scientifically valid ways to translate different GHG into carbon dioxide equivalents
  - Setting exchange rate wrong can provide incentives for firms to take actions to exploit this
  - Create incentives for litigation of exchange rates
- Costs and benefits of re-visiting exchange rates
  - Beneficial long-term investments may not occur because of risk of exchange rate changes
  - Prevent large potential errors in setting exchange rates
- May be preferable to focus exclusively on carbon dioxide emissions in initial implementation
  - Can use pre-existing CEM technology for carbon dioxide
  - Difficulty in monitoring CH<sub>4</sub>, HFCs, PFCs, and SF<sub>6</sub> and converting them to carbon dioxide equivalents

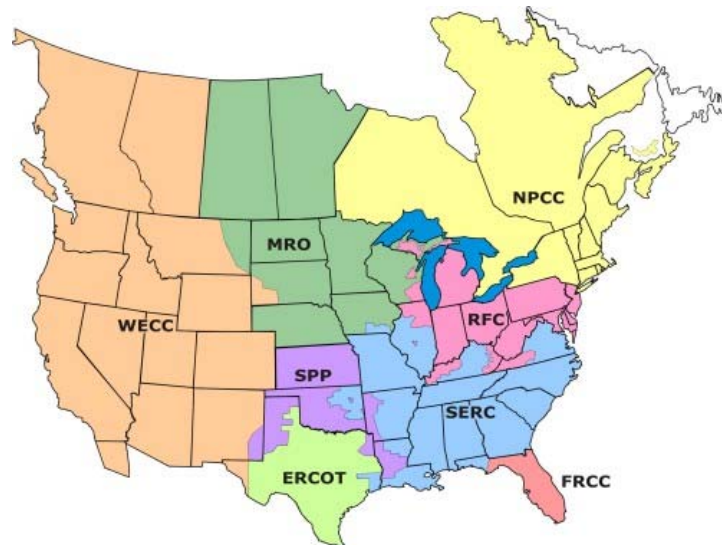
## Compliance

- Public availability of emissions data and permit holdings is important part of compliance process
  - Third parties should be able to monitor compliance process
- Suppliers will make argument that data is confidential and public release could destroy shareholder value
- Experience with CEM System data suggests this is not the case
  - Hourly output of fossil fuel generation output and input fuel data is publicly available
  - This data has been used in a number of studies of electricity market performance
  - These analysis have been very beneficial in improving electricity market performance in US

## Leakage of GHG Emissions

- Stylized facts about electricity in California
  - Peak demand in California is roughly 55,000 MWh
  - Instate generation capacity is approximately 55,000 MW
  - Import capacity into state approximately 12,000 MW
  - 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 outside of California is selling into state
  - Can only measure flow on transmission line into California
  - More electricity is being produced outside of California than is being consumed there
- Which generation unit is “selling energy into California” is a financial fiction created by a forward financial contract
  - Buy 200 MWh from generation unit outside of California
  - Verify that generation unit produced at least 200 MWh during that hour

## NERC Regional Reliability Councils



## Leakage of GHG Emissions

- How would leakage occur in electricity supply?
  - California load-serving entities sign long-term supply arrangements with green and high-efficiency fossil fuel suppliers in and outside of California
  - These actions bid up price of electricity from these sources
- Utilities outside of California need to purchase electricity to sell their consumers, but they are not restricted to purchase from brown suppliers
  - These suppliers have less demand for their output and sell at lower prices
- Virtually all of generation capacity in WECC is needed to meet annual demand peaks
  - Less than 200 MW of spare capacity was available in entire WECC during July 2006 heat storm in California
- Implications of above facts--If there is sufficient green and high-efficiency fossil fuel to capacity to meet California's 1992 GHG emissions standards then leakage could be complete
  - Same WECC generation units operate and same GHGs produced, but California just pays higher price for electricity than surrounding states
  - Higher GHG emissions are also possible because of inefficient dispatch of generation resources in WECC

## Leakage of GHG Emissions

Summary of Capacity and Generation Supply and Demand Able to Meet California GHG Cap			
	Annual MWh	MW of Capacity	Excess EPS compliant supply (MWh)
Total WECC Supply	582,000,000	112,222.80	
Total WECC Supply Able to Meet GHG Cap	325,000,000	77,925.69	
Average Demand CA	289,000,000	32,968.73	36,000,000
Average Demand Rest of WECC	490,000,000	55,898.54	
Total Demand WECC	779,000,000	88,867.27	

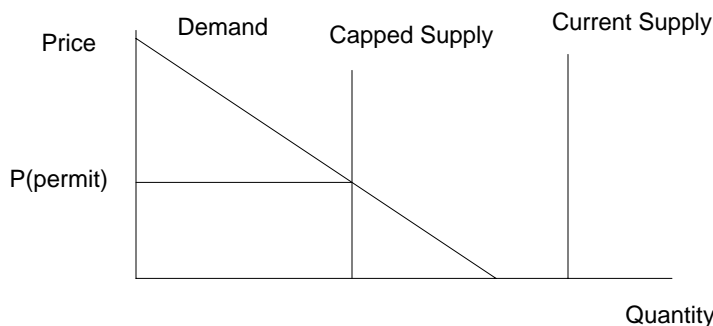


## Can Leakage Be Prevented?

- Complete leakage most likely outcome in near term
  - Increase in total GHG from electricity in WECC seems probable
- Cannot prevent leakage unless prohibit California from importing electricity
  - Not possible in near term
  - Severe reliability consequences in long-term from this policy
- Operate system to manage N-1 contingency
  - In system with two 500 MW units, N-1 contingency is 500 MW
  - In system with 40,000 MW and largest unit is 500 MW, N-1 contingency is 500 MW
- System peak occurs at different times of the day
  - Larger control area can get by with less total generation capacity because peaking capacity can be shared

## 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



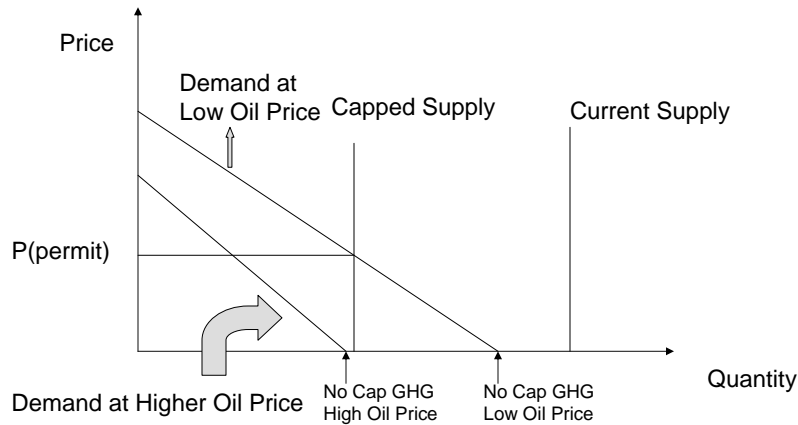
## Important Caveats

- When price of permits is close to zero there is little incentive not to comply with emissions cap
  - Not very costly to purchase needed permits
- As permit prices rise incentive not to comply increases
  - Can avoid purchase of very expensive emissions permits
- Because permit prices are initially close to zero, there is little need to devote much effort to compliance during early stages of market
- Ultimate goal of cap and trade program is to set a binding constraint on emissions that results in a price for permits that is close to marginal damage to environment from emissions
  - When price of permits does rise to this level it may be impossible to put in necessary safeguards and penalties to ensure compliance with cap
- Conclusion--From start of market, implement safeguards and penalties that ensure compliance with cap a highest conceivable price for permits

## Important Caveats

- Unless  $P(\text{permit}) > 0$ , emissions cap is has no impact
  - Expense to set monitoring and compliance system may be wasted
- Higher fossil fuel prices will shift in demand for GHG emissions
  - GHG are joint product with BTUs consumed
  - Higher fossil fuel prices make fuel efficiency investments economic
    - Less BTU consumed per KWh of electrical energy produced
    - Less GHG emissions produced per KWh of electrical energy produced
- Should reductions in GHG emissions that are profitable for suppliers to undertake because of higher fossil fuel prices be compensated for in permit allocation process?
  - More generally should energy efficiency investments that firms make because of beneficial impacts on their bottom line be compensated in permit allocation process?
  - Hard come up with an economic rationale for this provision in AB 32

## Fossil Prices and GHG Emissions



Higher Fossil Fuel Prices Make Voluntarily GHG Reductions Profit-Maximizing  
 --High enough fossil fuel prices make voluntary attainment of cap possible

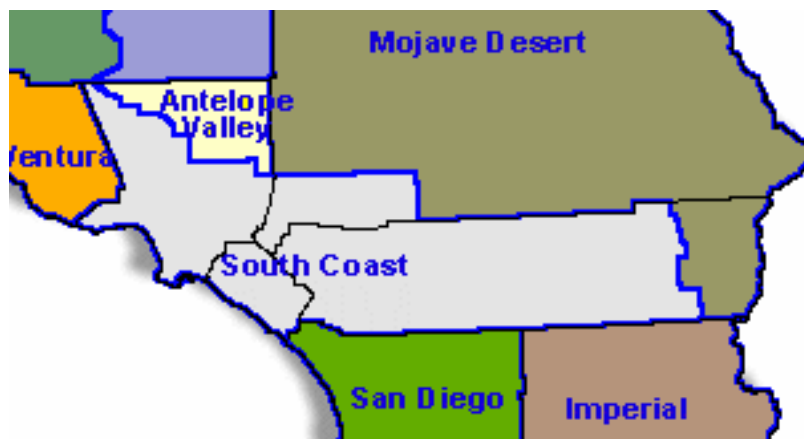
## Downstream Impacts

- Fossil-fuel intensive industries adversely impacted
- Some industries will be forced to exit California
  - Electricity generation, petroleum refining and cement manufacturing
  - Further source of leakage of GHGs to neighboring regions
- To ensure that optimal long-term exit and entry decisions are made permit market designers should focus on developing forward market for emissions permits
  - Establish prices for GHG emissions in 2020 and beyond as soon as possible
- Provide as much information as possible in advance
  - Magnitude of 1990 GHG emissions level
  - Which entities cap applies to
  - Maximum flexibility to trade emissions permits
- Permits can enhance market power or inefficiencies in downstream industries that use energy
  - South Coast Quality Management District NOx Permit Market and California Electricity Market

## SCAQMD Experience

- South Coast Air Quality Management District (SCAQMD)
  - Regional Clear Air Incentive Market (RECLAIM) for NOx emissions permits
  - Opaque bilateral market for trading NOx permits
- Kolstad and Wolak (2004) “Using Environmental Emissions Permit Prices to Raise Electricity Prices: Evidence from the California Electricity Market” (on web-site)
  - Presents evidence that suppliers used NOx emissions permit prices to raise electricity prices in California
- Three lines of empirical evidence in favor of this view
  - Prices paid for NOx permits by electricity generation unit owners versus other market participants in SCAQMD
  - Operating behavior of in-state fossil fuel generation units as a function of plant location, ownership and NOx emissions rate
  - Relationship between implied marginal cost from profit-maximizing bidding behavior and actual fuel costs and NOx emissions costs

## South Coast Air Quality Management District (SCAQMD)

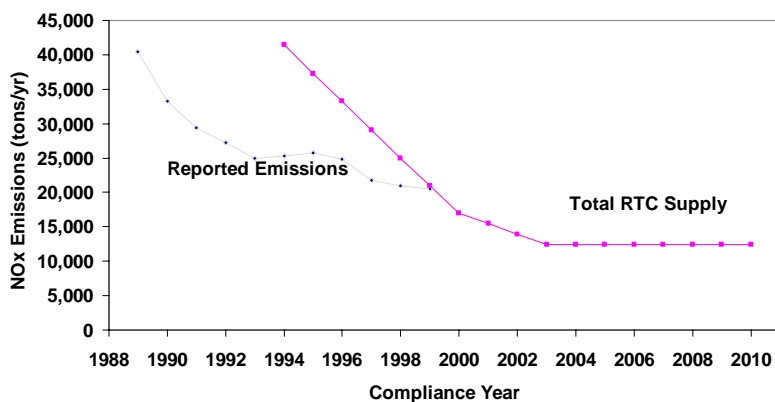




## RECLAIM Market

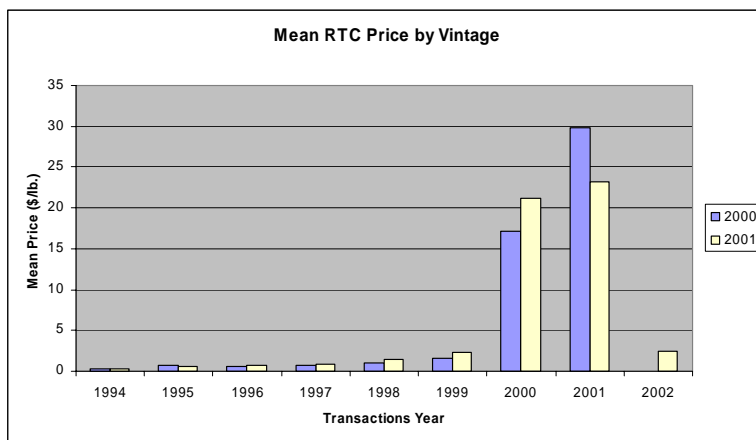
- Began operation in 1994
  - Started with 390 market participants
  - Currently 364 market participants
- Each actor receives an allocation of RECLAIM Trading Credits (RTCs) each year
  - One RTC allows owner to emit one pound of NO<sub>x</sub> emissions during that year
- RTC allocations initially set very conservatively
  - Above emissions levels that existed at the time
- Each year, two vintages of permits are issued
  - Cycle 1— January 1 to December 31 of vintage year
  - Cycle 2— July 1 of vintage year to June 30 of following year
  - Either vintage can be used to rationalize NO<sub>x</sub> emissions during period permit is valid
- Firms are randomly assigned to the two emissions cycles
  - Firm must rationalize its emissions with qualifying RTCs that it holds within three months of the end of its permit cycle
- Aggregate RECLAIM RTC allocations were to be reduced at 8.3% relative initial allocations until 2003
  - Larger emissions reductions were demanded from electricity generating facilities and oil refineries
- Firms can purchase RTCs through bilateral negotiations from other RECLAIM market participants to rationalize their actual emissions
  - While maintaining market-wide compliance with SCAQMD NO<sub>x</sub> emissions limits

## RTC Allocations and NOx Emissions

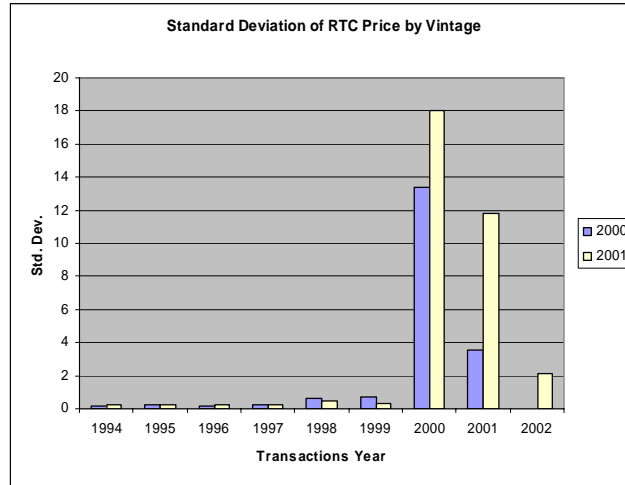


Source: Coy et al. "SCAQMD White Paper on Stabilization of NOx RTC Prices," 2001.

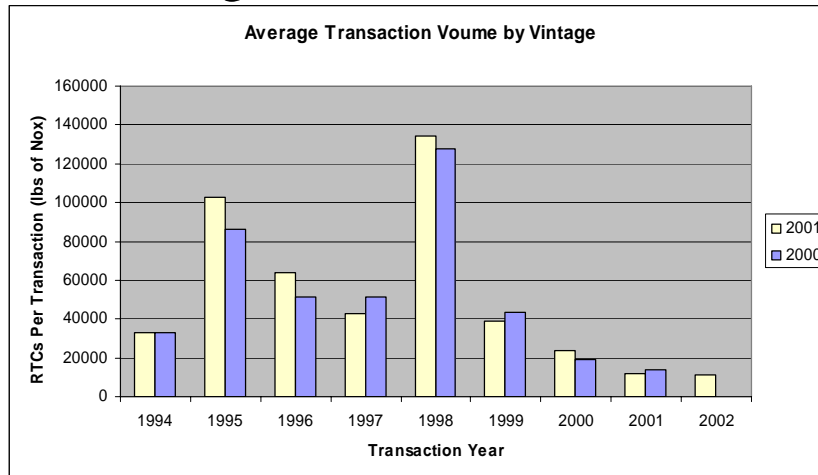
## Mean RTC Prices Over Time



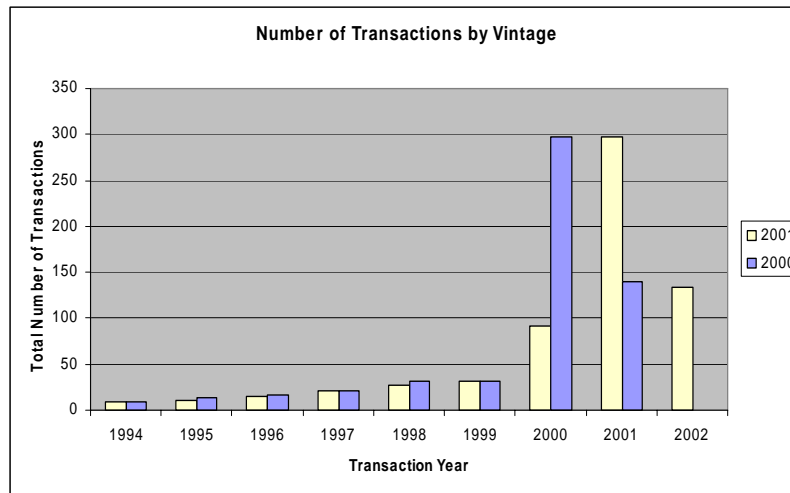
## Standard Deviation of RTC Prices Over Time



## Average Transactions Volume



## Number of Transactions



## Summary of Figures

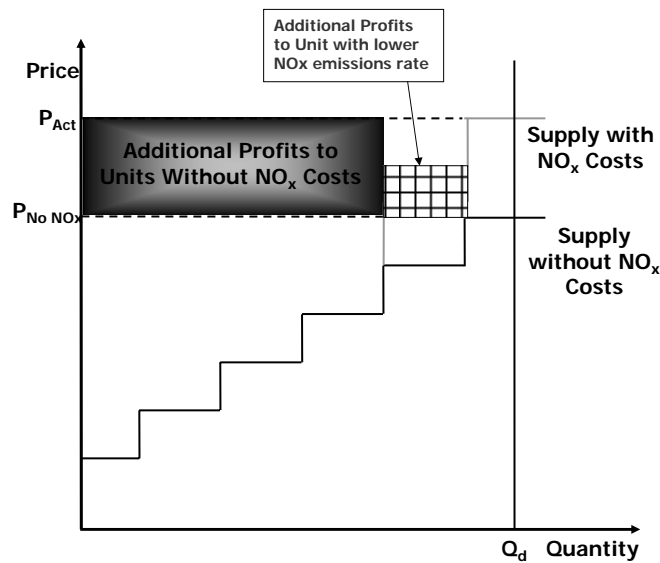
- For 2000 and 2001 vintage RTCs
  - Dramatic increase in average transactions prices in 2000 and 2001
  - Enormous increase in standard deviation of transactions prices in 2000 and 2001
  - Reduction in average transactions volume in 2000 and 2001
  - Substantial increase in number of transactions in 2000 and 2001
- Many small RTC purchases at very high prices (and low prices) in 2000 and 2001
  - Figures are consistent with use of RTCs permits prices to raise electricity prices



## Two Benefits from Raising NOx Emissions Permit Prices

- Generation units that do not require NOx emissions permits will earn higher profits
  - If market price set by bid from a unit requiring NOx permits
- Generation units that require NOx emissions permits will earn higher profits
  - If market price set by bid from a unit requiring NOx permits with a higher NOx emission rate

## Using NOx Permits To Raise Electricity Prices



## Summary of Kolstad and Wolak Results

- Suppliers with units located in SCAQMD paid substantially more for small amount of same vintage permits as other RECLAIM market participants
- Suppliers with units located in SCAQMD operated units with high emissions rates more intensively than would be the case if permits were a tangible cost of production
- Suppliers with units located in SCAQMD did not bid as if NO<sub>x</sub> emission costs entered marginal costs in same manner as fuel costs
  - Marginal cost implied by expected profit-maximizing bidding behavior was much less sensitive to NO<sub>x</sub> emissions costs than to fuel costs

## Postscript on SCAQMD Market

- Effective February 8, 2001, Rule 118 of Executive Order #01-03 exempted all generating units above 50 MW from SCAQMD market
- In May 2001, SCAQMD rules modified to include this exemption
- Generation unit owners that used more than their annual allocation were penalized \$7.50/lb of NO<sub>x</sub>
- SCAQMD market still operates with these units exempted from trading process
- Events of 2000 and 2001 in RECLAIM market argue in favor of periodic trading of emissions permits through anonymous multi-unit auction mechanism rather than through bilateral negotiation

## Financial Aspects of Permits

- Long-term allocation of permits at start of market can create significant financial wealth
  - Entities could remain in business simply to obtain and trade permits
- Entities could use future permits as an asset to borrow against for other investments
- 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

## Auction versus Allocation of Rights

- How should emissions rights be allocated?
  - Many current significant GHG producers did not exist in 1990
- Possible allocation rule
  - Compute current emissions and award each existing facility a pro-rata share of the 1992 aggregate level
- The upside of auctioning emissions rights
  - Entities pay for what they use and buy only what they need
  - Revenues can be used to reduce distorting taxes
    - Reduce California income taxes
  - If there is no market power in permit market this results in an efficient allocation of permits
    - Entities that value permits most will get permits
    - Potential for market power in initial auction because of large demand from electricity generation and refining sector

## Auction versus Allocation of Rights

- The downside of auctioning emissions rights
  - Auctions allocate product to entity that values it most
  - Value of permit can be enhanced by actions of owner
- Actions to enhance of value of GHG emissions permits can have adverse consequences in downstream markets
  - SCAQMD and California Electricity Market
- By allocating GHG emissions permits can limit likelihood they are fall into hands of entities that will use them to increase market power in downstream market

## Scalability of Market Mechanism

- Success of AB 32 should not be judged by reduction in GHG emissions that results
  - AB 32 very unlikely to reduce GHG emissions for reasons discussed above
- Success of AB 32 should be judged by extent to which California can convince other states and countries to join its cap and trade program
  - Recent promise of integration with eastern US program