Cap and Trade and Structural Transition in the California Economy

A Briefing for the California Environmental Protection Agency on Results from the Berkeley Energy and Resources Model

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Objectives

1. Estimate aggregate state impacts of AB32 and related policies.
2. Identify adjustment challenges for leading industries.

AB32

- The "California Global Warming Solutions Act of 2006," is the first law to comprehensively limit greenhouse gas (GHG) emissions at the state level.
- The bill's stated objective is to return GHG emissions to 1990 levels, using some kind of cap and trade mechanism.
- Negotiations on the precise mechanisms will take about two years, but salient features are already discernable.

Three Economic Principles

1. Demand Shifting: New demand for California goods and services.
2. Benefits Exceed Costs: Direct adjustment costs for some stakeholders, but these are outweighed by indirect statewide benefits.
3. Early Action Pays: Conversion costs are fixed, but efficiency benefits compound like interest.

Scenarios for Climate Action

- Baseline (no emission reduction target) [1]
- 8 CAT policies (direct regulation) [2]

CAT policies plus emission cap to meet remainder of 2020 target

- Industries in Group 1 covered by an aggregate cap [3]
- Industries in Groups 1 and 2 covered by an aggregate cap [4]
- Industries in Groups 1, 2 and 3 covered by an aggregate cap [5]
- CAT policies plus emission cap on industries in Groups 1, 2 and 3 with revenues recycled into innovation investment [6]
- CAT policies plus emission cap on all emitting industries with revenues recycled into innovation investment [7]

Aggregate Results

Scenario	2 CAT	3 Group1	4 Group12	5 Group123	6 G123Gr	7 AllIn
Total GHG*	-13	-28	-28	-28	-28	-28
Household GHG*	-32	-32	-32	-32	-31	-30
Industry GHG*	-3	-26	-26	-26	-26	-27
Annual GSP Growth*	2.4	2.4	2.4	2.4	3.1	4.7
Employment*	.10	.06	.08	.08	.44	1.07

*Percent change from Baseline scenario in the year 2020.

Jobs (thousands)	20	13	16	17	89	219
Percent of GHG Target	47	101	100	100	100	100

Macroeconomic Impacts of 8 CAT policies plus a 2020 GHG Cap

Annual Impact	8 CAT policies + Cap	8 CAT policies + Cap w/Innovation Incentives
Gross State Product (2006 dollars) *% change from 2020 baseline*	**+$60 Billion** *(+2.4%)*	**+$74 Billion** *(+3.1%)*
Employment (thousands) *% change from 2020 baseline*	**+17** *(+.08%)*	**+89** *(+0.44%)*

Preliminary Conclusions

- California's GHG targets are attainable, but too ambitious to be met by voluntary initiative. Policy action to meet the targets should be relatively inclusive, with mandatory participation by all sectors representing a significant share of emissions.
- An Emissions Cap, supported by regulatory and market-based implementation programs, can return California's GHG emissions to 1990 levels by 2020 and stimulate the state economy.
- Climate policies that create direct incentives for industries to invest in new technologies can provide additional stimulus for new employment and growth.

Industry Level Adjustments

- Individual industries will experience significant adjustment challenges, particularly electric power, cement, and oil refining.
- Depending upon the design of the cap and trade system, their response can facilitate or inhibit state economic growth.

Potential Target Sectors

- **Group 1: First Tier Emitters**

A04DistElc Electricity Suppliers
A17OilRef Oil and Gas Refineries
A20Cement

- **Group 2: Second Tier Emitters**

A01Agric Agriculture
A12Constr Transport Infrastructure
A15WoodPlp Wood, Pulp, and Paper
A18Chemicl Chemicals
A21Metal Metal Manufacture and Fab.
A22Aluminm Aluminium Production

- **Group3: Other Industry Emitters**

A02Cattle Cattle Production
A03Dairy Dairy Production
A04Forest Forestry, Fishery, Mining, Quarrying
A05OilGas Oil and Gas Extraction
A06OthPrim Other Primary Activities
A07DistElec Generation and Distribution of Electricity
A08DistGas Natural Gas Distribution
A09DistOth Water, Sewage, Steam
A10ConRes Residential Construction
A11ConNRes Non-Residential Construction
A13FoodPrc Food Processing
A14TxtAprl Textiles and Apparel
A16PapPrnt Printing and Publishing
A19Pharma Pharmaceuticals
A23Machnry General Machinery
A24AirCon Air Conditioner, Refrigerator, Manufacturing
A25SemiCon Semiconductors
A26ElecApp Electrical Appliances
A27Autos Automobiles and Light Trucks
A28OthVeh Other Vehicle Manufacturing
A29AeroMfg Aeroplane and Aerospace Manufacturing
A30OthInd Other Industry

Implied Annual Emission Reductions Could be Substantial

Scenario	2	3	4	5	6	7
Sector	CAT	Group1	Group12	Group123	G123Gr	AllIn
A01Agric	.00	-.01	-3.64	-2.95	-2.94	-2.36
A02Cattle	.00	-.01	-.01	-2.95	-2.95	-2.37
A03Dairy	-.47	-.48	-.48	-3.16	-3.15	-2.60
A04Forest	.00	-.01	-.01	-2.95	-2.93	-2.27
A05OilGas	.00	-.03	-.01	-2.96	-2.93	-2.30
A06OthPrim	.00	-.01	-.01	-2.96	-2.90	-2.50
A07DistElec	.00	-4.40	-3.61	-2.93	-2.97	-2.42
A08DistGas	.00	-.01	.00	-2.95	-3.00	-2.52
A09DistOth	.00	-.01	-.01	-2.96	-2.89	-2.21
A10ConRes	.00	-.01	.00	-2.95	-2.85	-2.28
A11ConNRes	.00	.00	.00	-2.95	-2.87	-2.24
A12Constr	.00	-.01	-3.65	-2.96	-2.86	-2.35
A13FoodPrc	.00	-.01	.00	-2.96	-3.00	-2.54
A14TxtAprl	.00	-.01	.00	-2.95	-2.90	-2.48
A15WoodPlp	.00	-.01	-3.65	-2.96	-2.85	-2.17
A16PapPrnt	.00	-.01	.00	-2.95	-2.93	-2.44
A17OilRef	.00	-4.35	-3.58	-2.90	-2.92	-2.34
A18ChemicI	.00	-.01	-3.65	-2.95	-2.91	-2.30
A19Pharma	.00	-.01	.00	-2.95	-2.95	-2.41
A20Cement	-.35	-4.54	-3.78	-3.13	-3.09	-2.60
A21Metal	.00	-.01	-3.65	-2.96	-2.80	-2.08
A22Aluminm	.00	-.01	-3.65	-2.96	-2.82	-2.16
A23Machnry	.00	-.01	.00	-2.95	-2.90	-2.48
A24AirCon	-4.74	-4.74	-4.74	-5.65	-5.62	-5.45
A25SemiCon	-4.44	-4.45	-4.45	-5.47	-5.45	-5.29
A26ElecApp	.00	.00	.00	-2.95	-2.98	-2.82
A27Autos	.00	.00	.00	-2.95	-2.99	-2.73
A28OthVeh	.00	-.01	.00	-2.95	-2.87	-2.32
A29AeroMfg	.00	.00	.00	-2.95	-2.95	-2.70
A30OthInd	.00	-.01	.00	-2.95	-2.87	-2.32

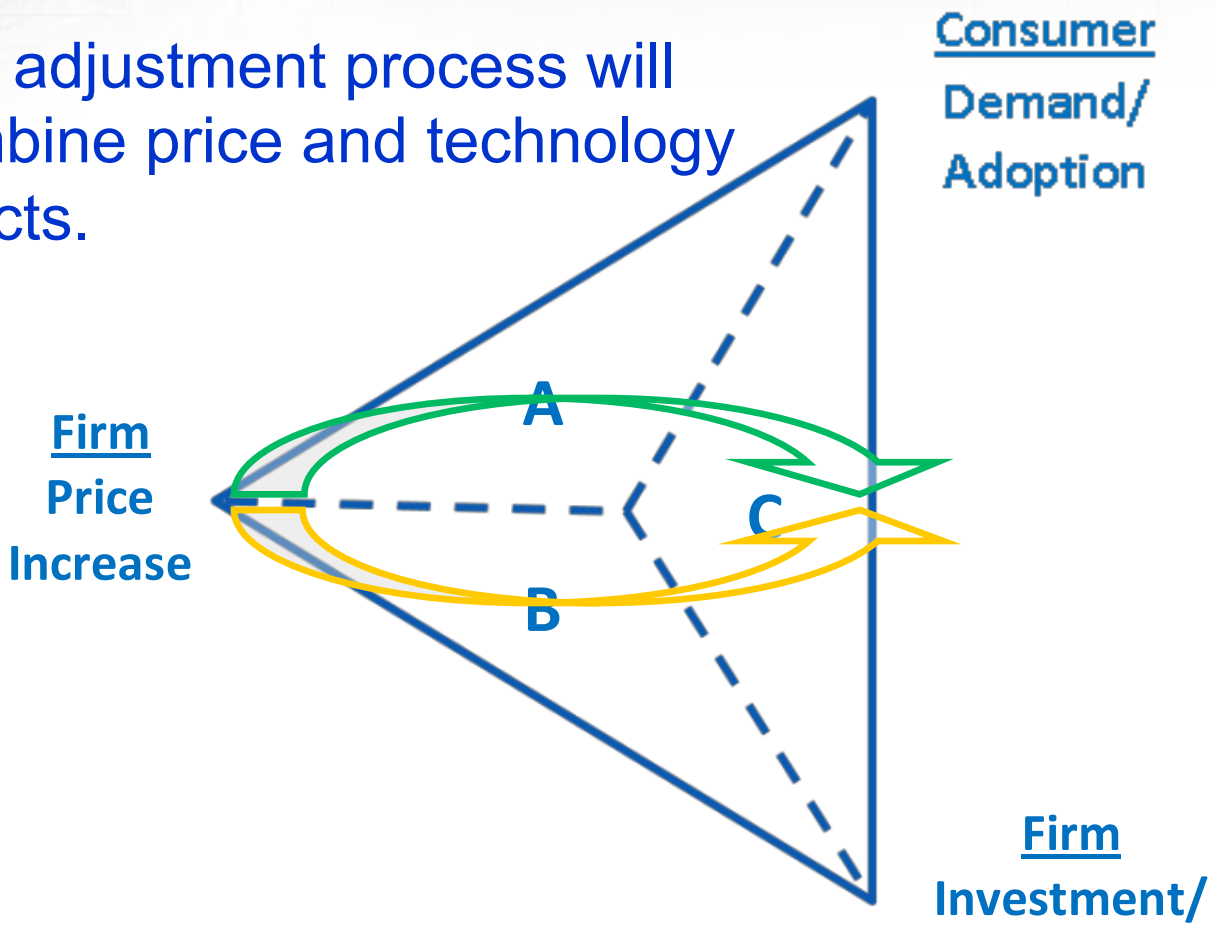
Structural Transition I

Economic Structure defined:

1. Firms, technology, and supply
2. Consumers, taste, and demand
3. Market prices and transactions
4. Government policy

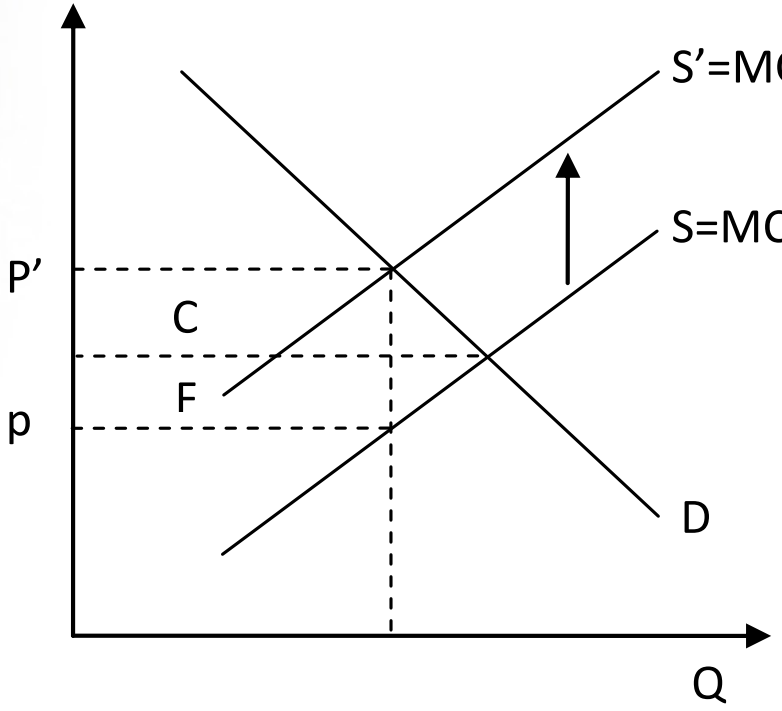
Structural Transition II

The adjustment process will combine price and technology effects.

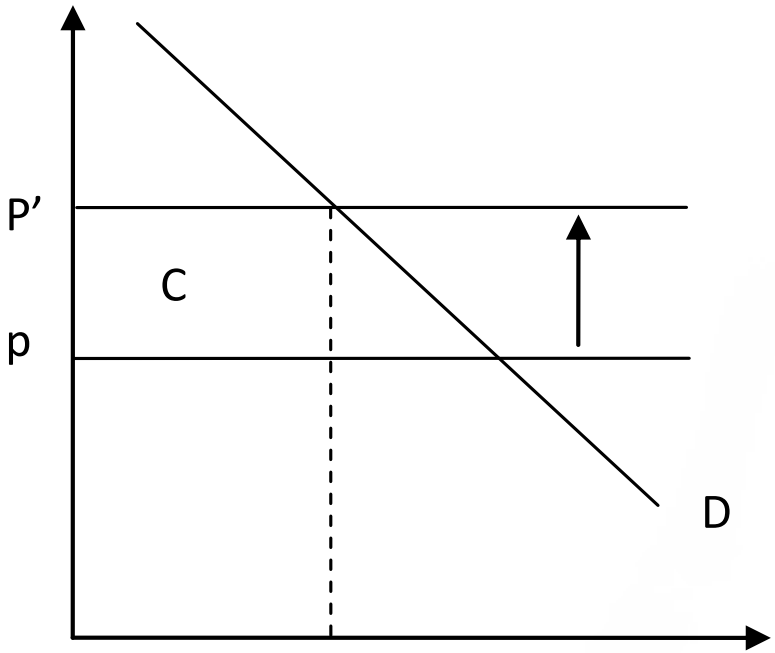


Price Effects Depend on Supply

Cost-price pass through depends on industry supply curves.

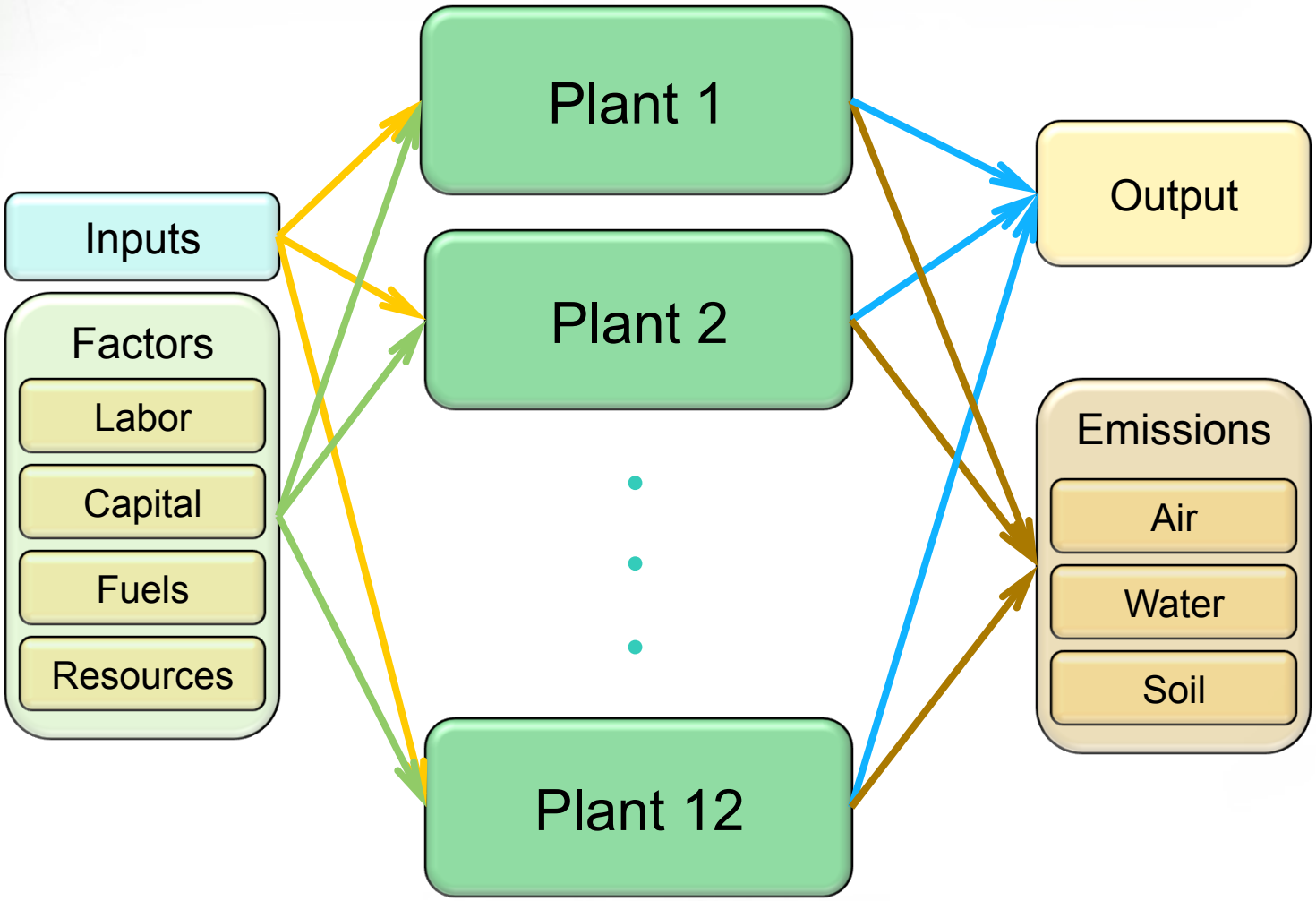


Partial Pass Through

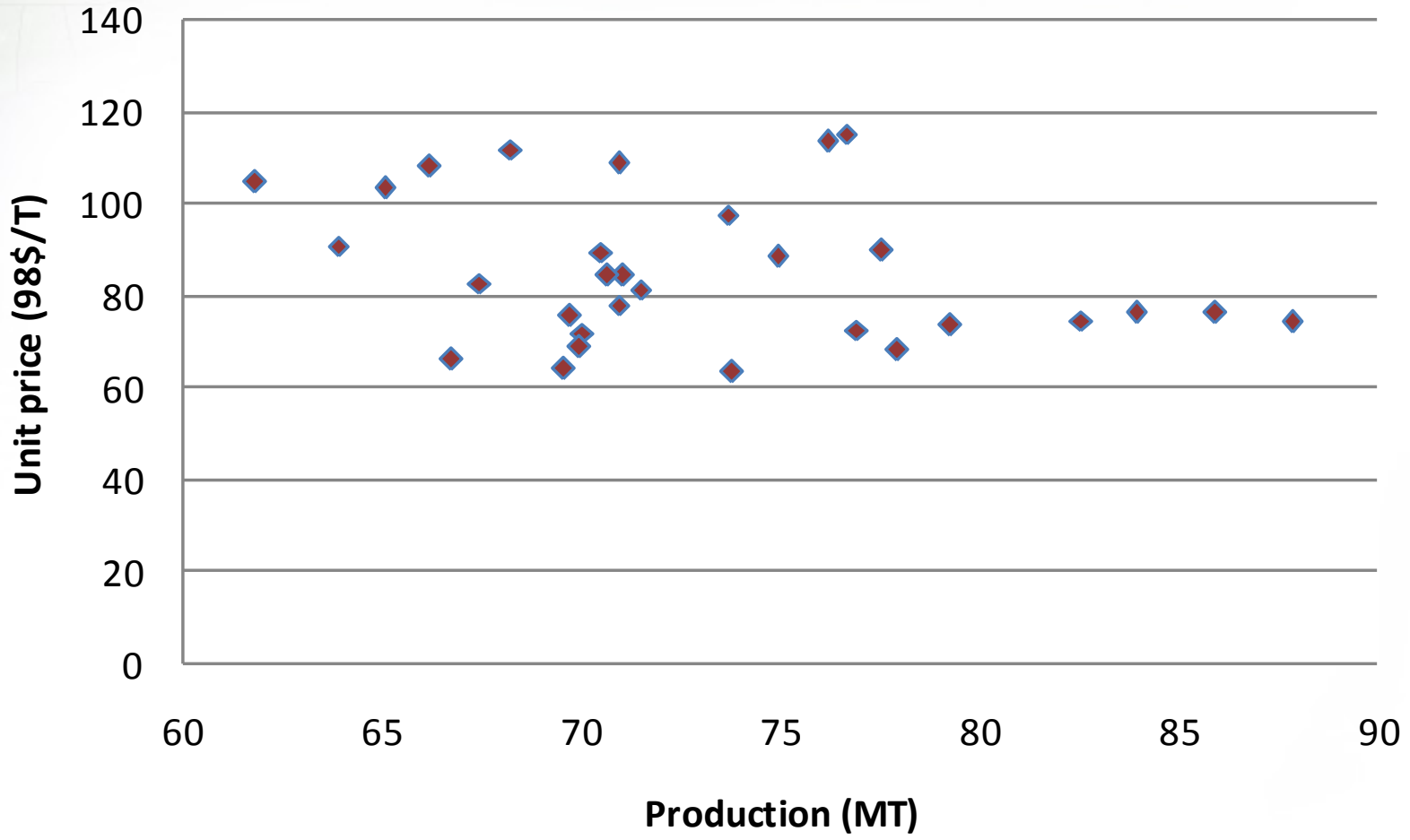


Complete Pass Through

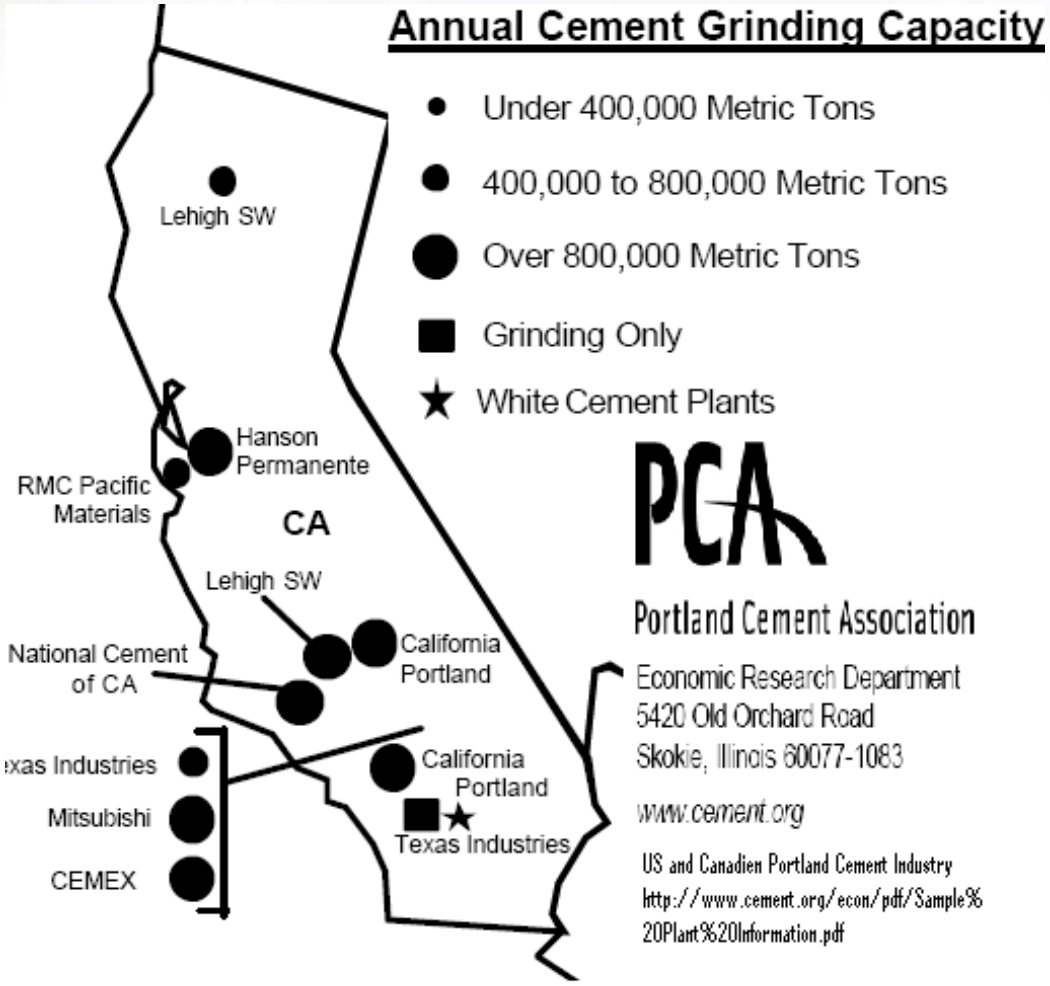
How We Model: Oil Refining and Cement



Cement Industry Supply, 1970-2000



California Cement Production Facilities and Levels



Cement Sector Results

Only modest price increases, even in the 3 industry cap and trade scheme.

	CAT	G1CAT	G12CAT	G123CAT	G123RR	GAll
Emissions	-3%	-55%	-43%	-34%	-35%	-28%
Price	0%	6%	3%	2%	0%	-1%
Output	0%	-2%	-1%	-1%	0%	2%
Imports	0%	11%	5%	3%	0%	-1%
Exports	0%	-5%	-2%	-1%	0%	2%

Our detailed review of the industry also indicates that the threat of migration is negligible.

Electric Power

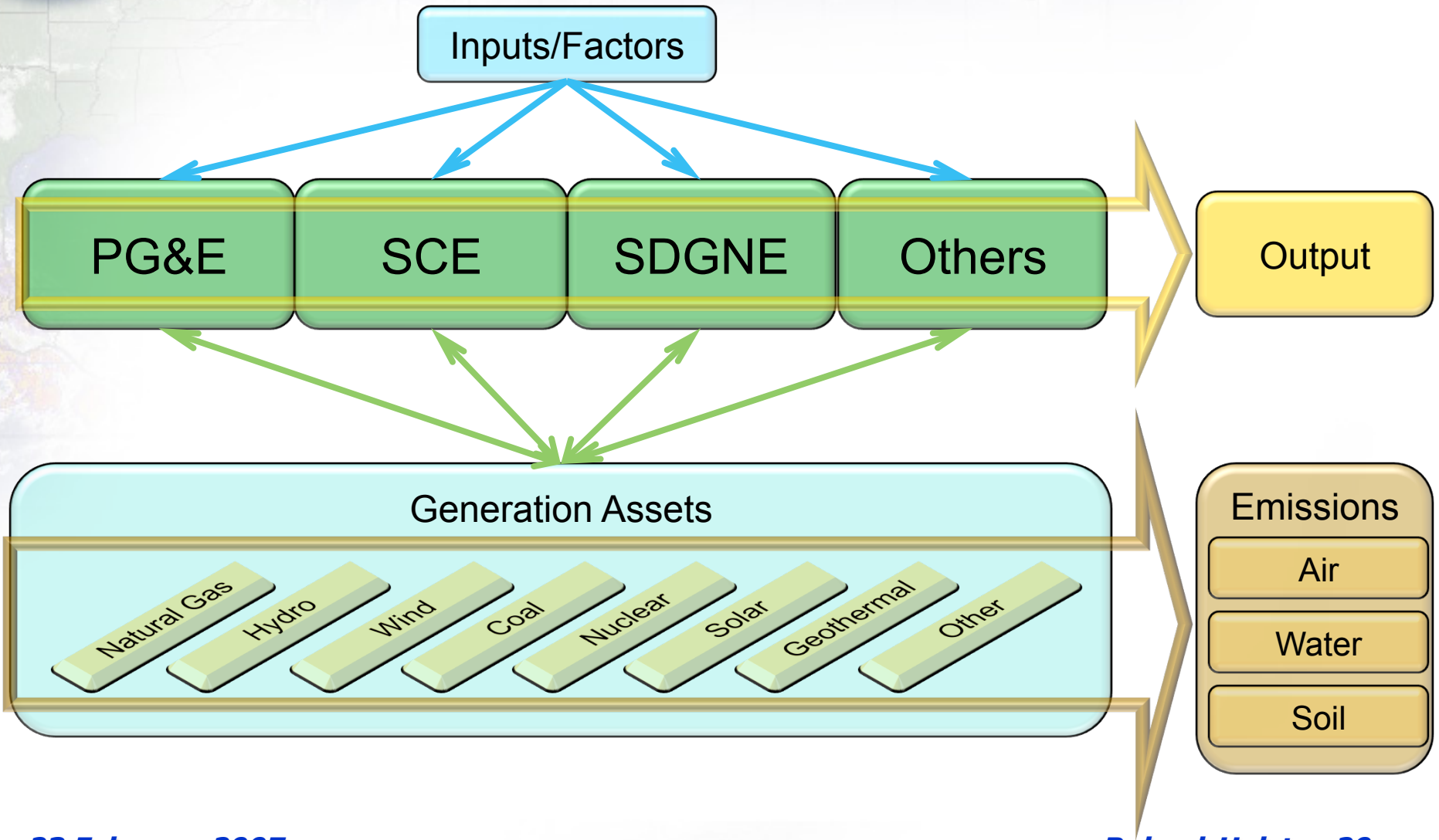
Distinctive features:

1. A portfolio of production technologies
2. Rigid output prices
3. Excess capacity

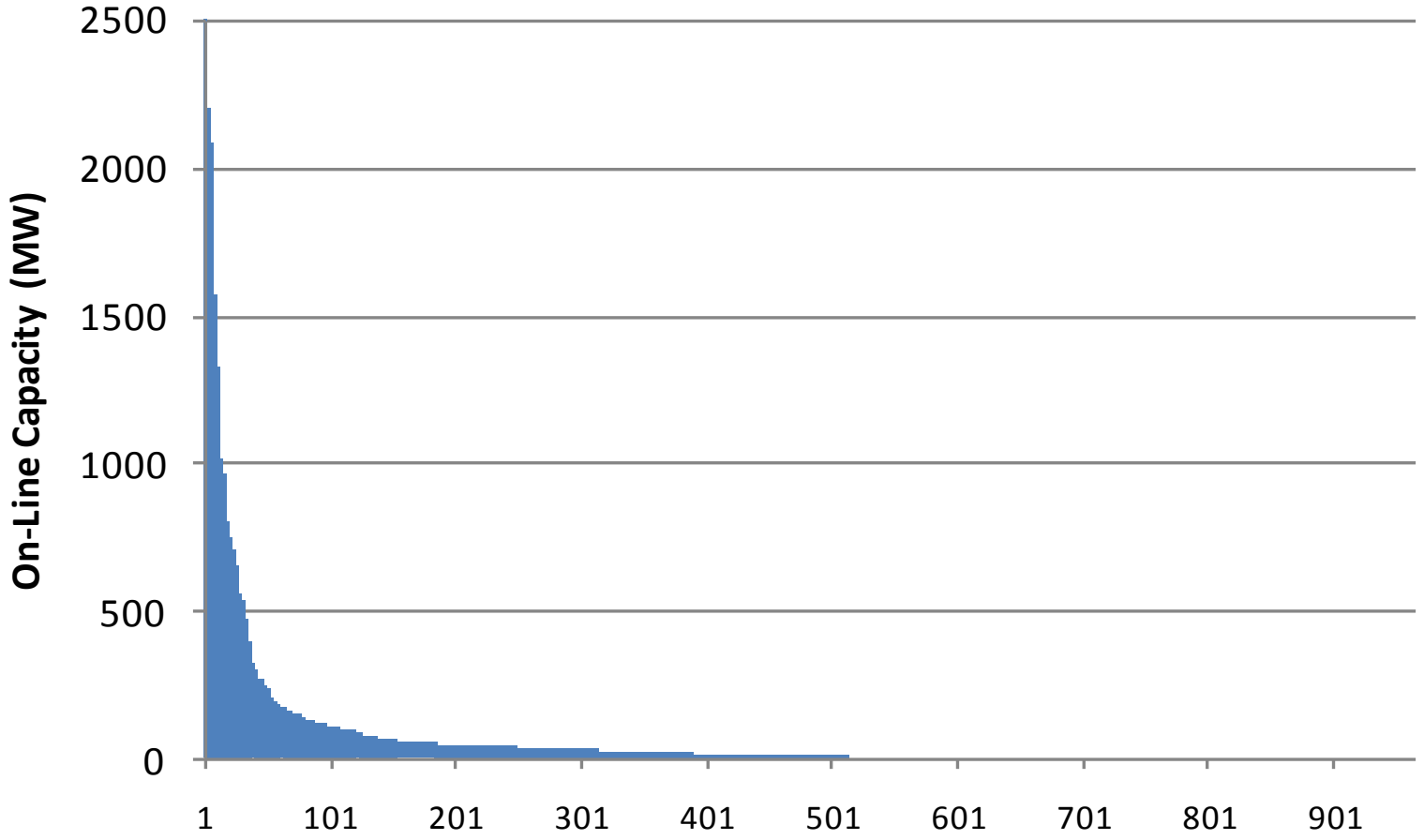
Modeling strategy:

1. Fixed price, demand-driven market
2. Producers choose:
    1. Short run: capacity utilization rate
    2. Long run: Capacity (contracts, investment)

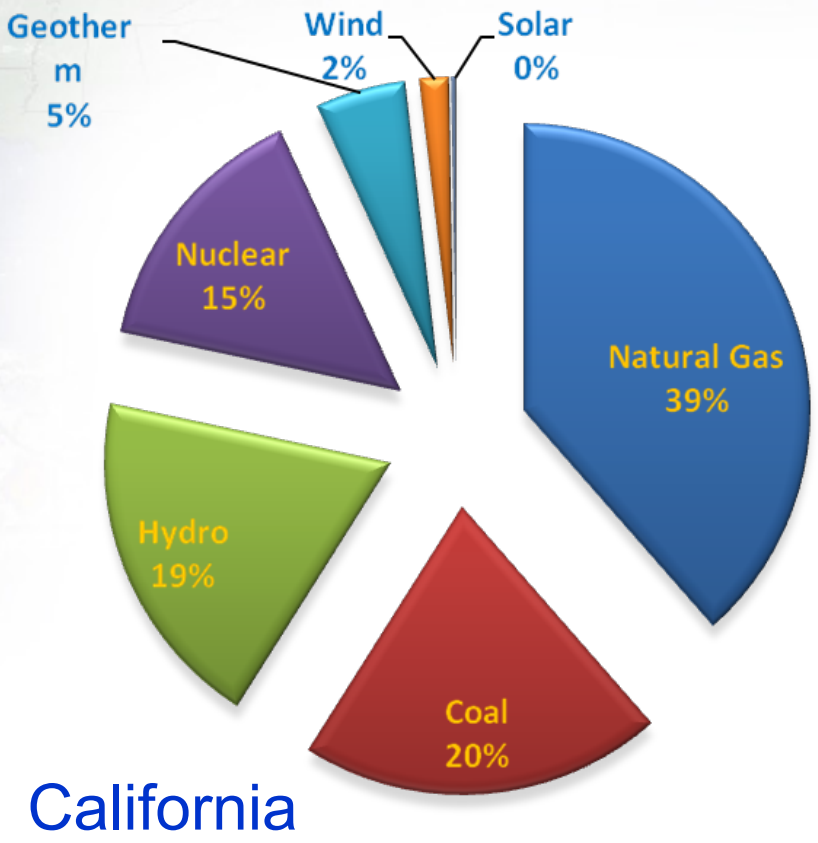
Electricity Sector



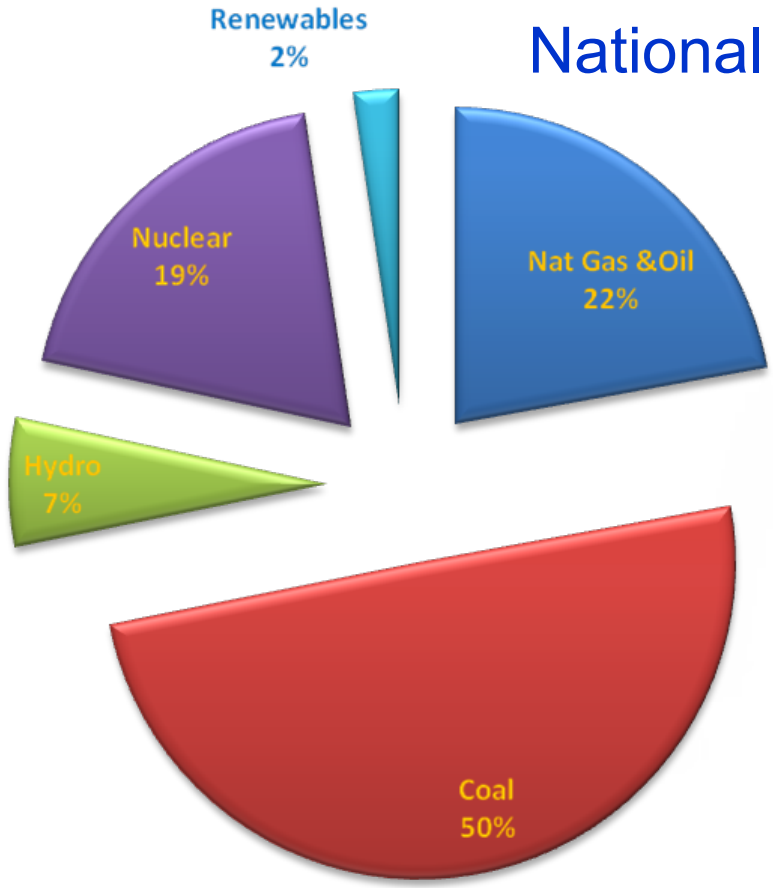
Size Distribution of Electric Power Facilities



Generation Portfolio, 2005

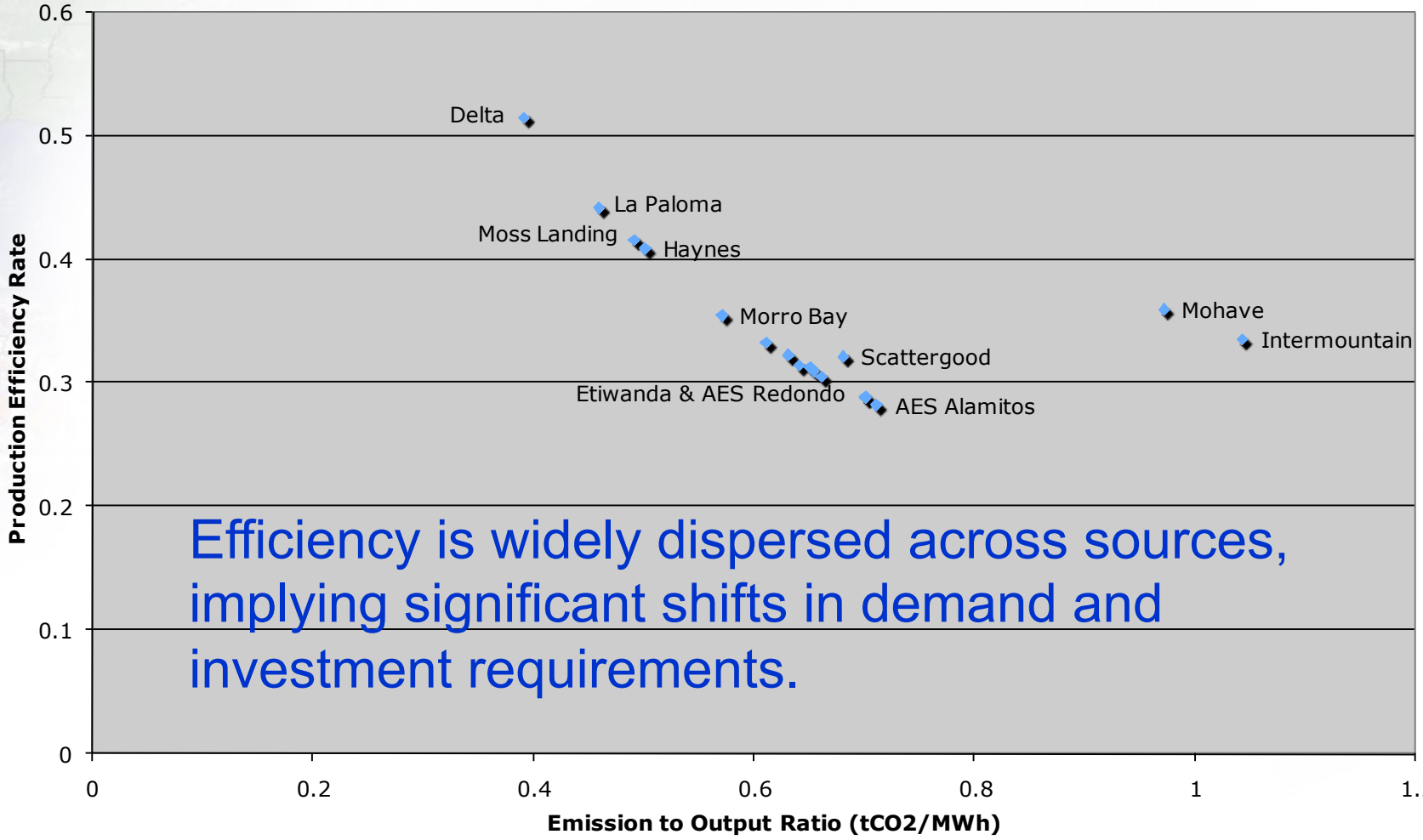


California



National

Electric Power: Emission Efficiency

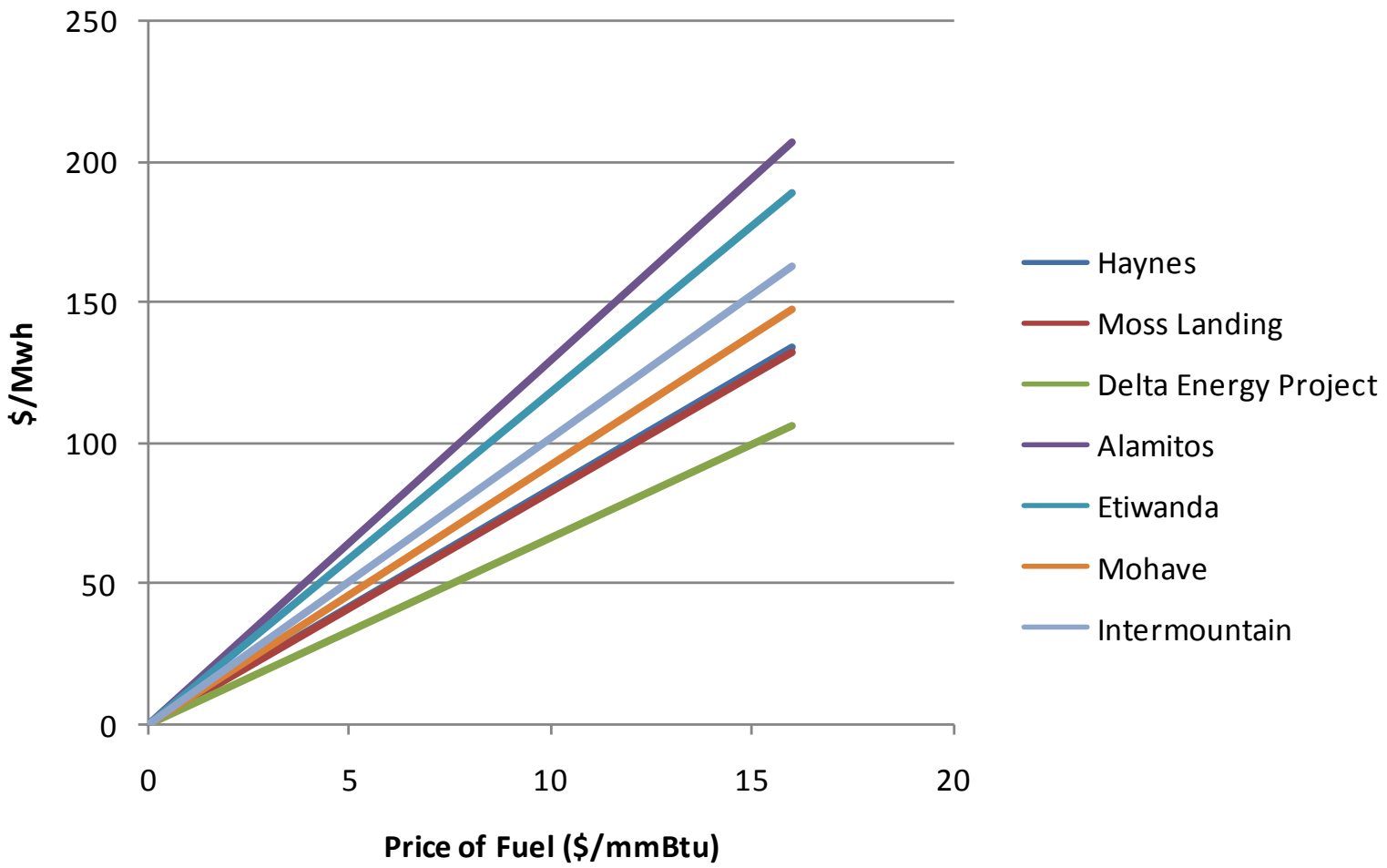


Efficiency is widely dispersed across sources, implying significant shifts in demand and investment requirements.

Emissions, Efficiency, and Competitiveness by Plant

Plant	Tons CO2/MWH	Efficiency	Competitiveness Index
Delta Energy	.39	.52	1.32
La Poloma	.46	.44	.97
Moss Landing	.49	.42	.85
Haynes	.50	.41	.82
Morro Bay	.57	.36	.62
Coolwater	.61	.33	.55
Ormond Beach	.63	.32	.51
AES Huntington	.64	.31	.49
Pittsburg	.65	.31	.48
High Desert	.65	.31	.47
Scattergood	.68	.32	.47
Cabrillo/Encina Power	.66	.31	.46
AES Redondo	.70	.29	.41
Etiwanda	.70	.29	.41
AES Alamitos	.71	.28	.40
Mohave*	.97	.36	.37
Intermountain*	1.04	.34	.32

Estimated Marginal Cost with Respect to Fuel Prices



Electric Power

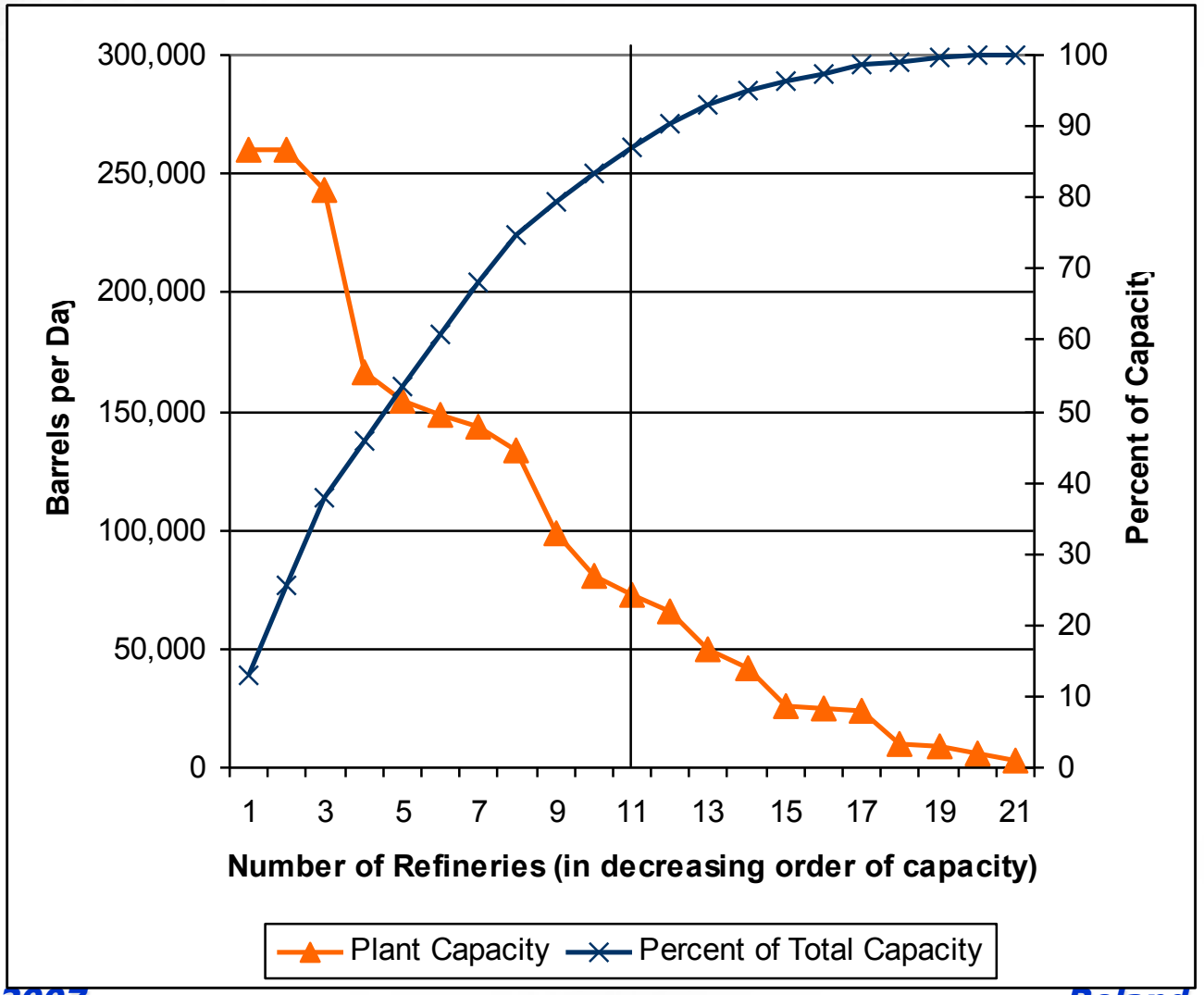
Potentially significant price increases.

	CAT	G1CAT	G12CAT	G123CAT	G123RR	GAll
Emissions	0%	-51%	-39%	-30%	-32%	-25%
Price	0%	20%	9%	5%	1%	-1%
Output	0%	-8%	-4%	-2%	0%	2%
Imports	0%	11%	5%	3%	1%	0%

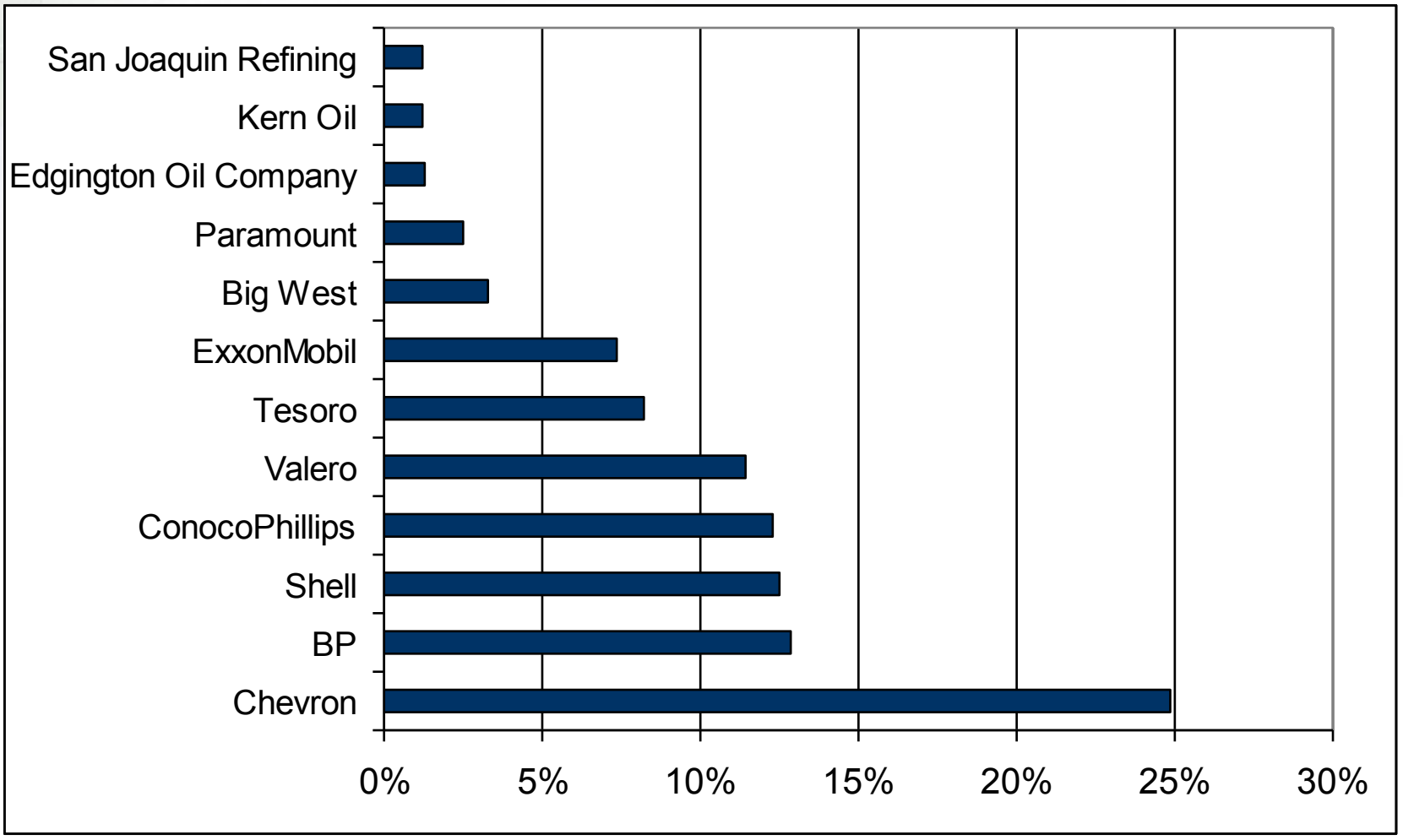
Likely to make significant adjustments in its generation portfolio over the next decade.

Because the working life of these capital goods spans several decades, these adjustments will establish new baselines for emission intensity and accelerate the need for future efficiency improvements.

Oil Refining Capacity in California, 2006



Top Refiners in California, Percent of State Production



Petroleum Refining

Moderate price effects, but we need much better cost data.

	CAT	G1CAT	G12CAT	G123CAT	G123RR	GAll
Emissions	0%	-46%	-36%	-28%	-30%	-23%
Price	0%	6%	3%	2%	1%	-2%
Output	0%	-2%	-1%	-1%	0%	2%
Imports	0%	3%	1%	1%	1%	0%
Exports	0%	-5%	-2%	-1%	-1%	2%

Significant opportunities for process innovation to achieve higher efficiency levels in this sector, although restrictions on new capacity development may retard this process.

Extensions

- More detailed cost data.
- Mechanism Design: Testing detailed Cap and Trade characteristics.
- A larger set of climate action policies: update CAT estimates.
- Mobile sources: too important to omit?
- Location/GIS

The Next Step: Mechanism Design

1. Recognition – which emissions?
    1. Legacy emissions
    2. Existing in-state emissions
    3. Embodied emissions
    4. Remote emissions
2. Coverage – who is included?
3. Allocation – property rights
4. Trading – mechanisms and incentives

Cap and Trade Canons 1

Scope:

There are two components to the scope of a cap and trade scheme: Which emissions and which entities are to be covered by the policy.

The first of these is self-evident, and depends on the target for environmental mitigation (GHG, toxics, particulates, etc.).

In the second category, there are many practical issues of monitoring, regulation, and incentives. A basic distinction is usually made between upstream (resource oriented), and downstream (end use) entities. For example, to manage carbon emissions, one could regulate fuel producers or consumers.

Cap and Trade Canons 2

Allocation:

This is the rule by which property rights are assigned. For example, in a cap and trade scheme, emission rights are usually a privately tradable financial asset. How these are allocated policy inception obviously influences private economic behaviour.

Cap and Trade Canons 3

Banking:

This term refers to the potential for inter-temporal transfer of pollution rights. In an uncertain and cyclical economic environment, banking can improve efficiency.

Cap and Trade Canons 4

Safety Valves:

These mechanisms permit conditional and temporary flexibility in emission constraints (caps).

Understandably, they have complex behavioral properties, including risks of moral hazard and market manipulation, but they can also improve prospects for policy adoption and sustainability.

Cap and Trade Canons 5

Linkage:

This term refers to interactions between different policies, either in different places or contexts.

Beware of the “spaghetti bowl”

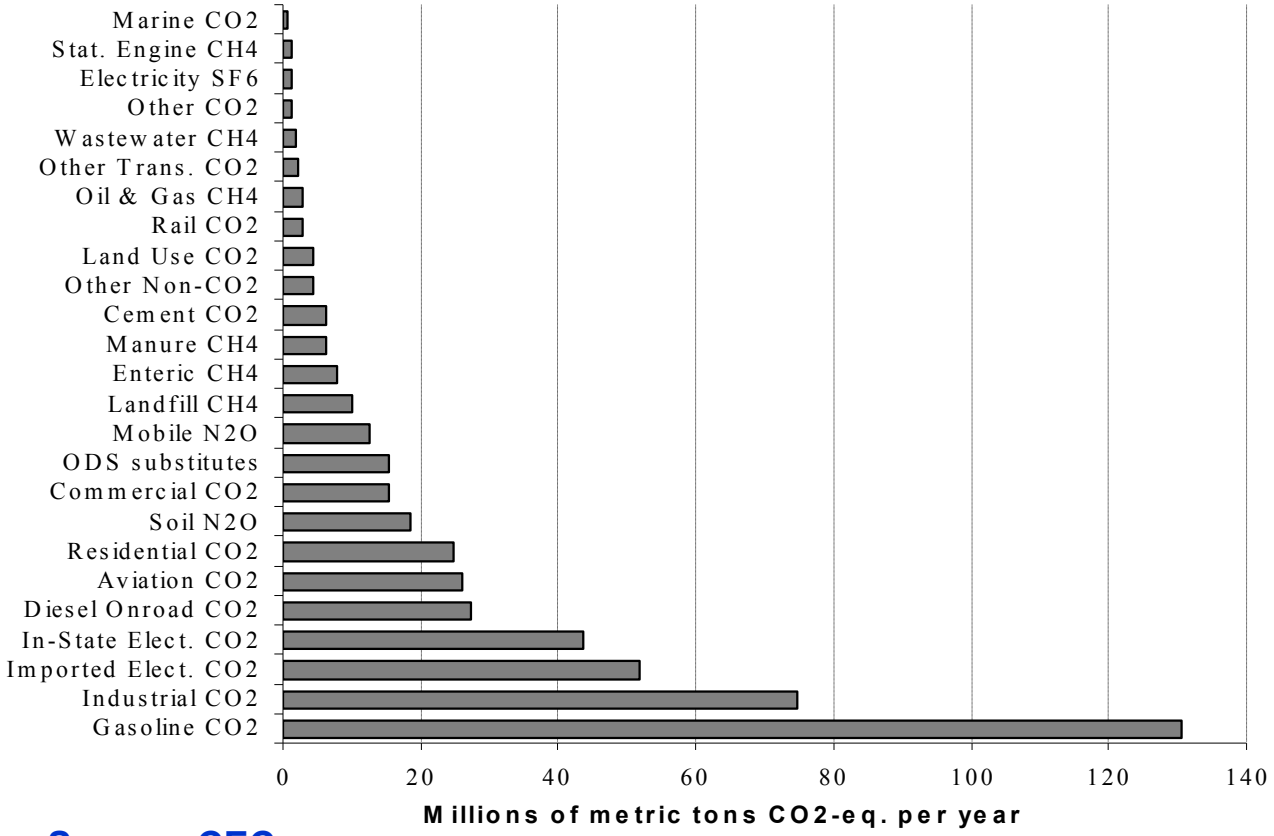
Cap and Trade Canons 6

Justice:

Policies toward the economy and environment can have complex welfare implications and should be designed to be equitable.

Scope of Coverage

The focus on stationary sources, and among these more concentrated emitting industries

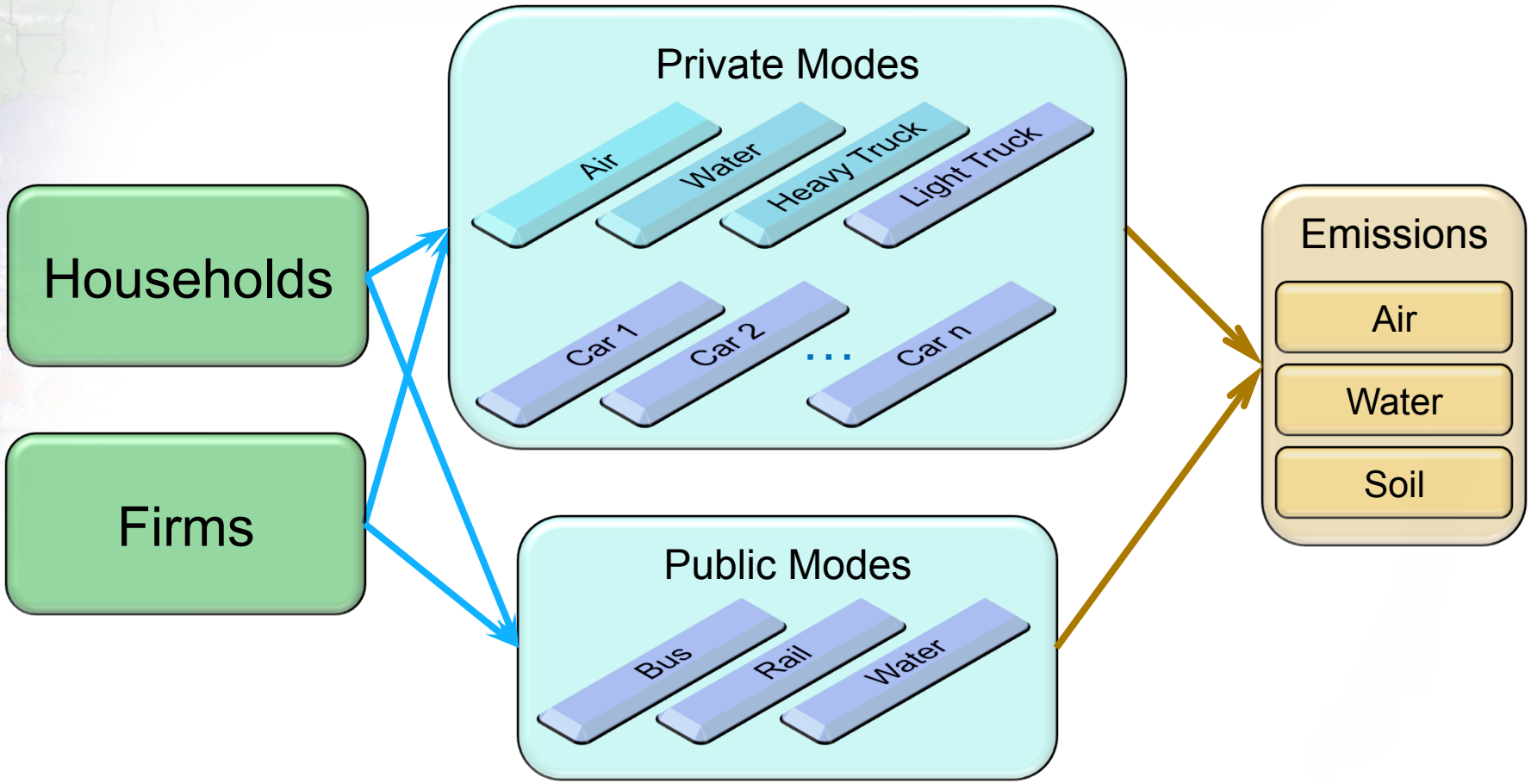


Source: CEC

Transportation Demand

- The transport sector accounts for up to 48% of California C02 emissions
- To elucidate the path to our emission goals, patterns of vehicle use and adoption need to be better understood
- We are currently working to estimate demand systems that take explicit account of public/private modal choice and a larger universe of vehicle alternatives.

Transport Choice



Innovation, Efficiency, Growth

The Growth-Environment tradeoff is a fallacy, and in California we can prove this.

- California is the world's premiere innovation economy.
- Efficiency is a potent stimulus for economic growth.
- Energy, transportation, and others can join IT, Biotech, and California's knowledge-intensive state industries to establish global standards for more sustainable economic growth.

Thank you