Designing for Structural Change: Modification of the California Cap and Trade Program

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Organization of Presentation

Could an alternative Cap and Trade permit pricing rule help to more strongly encourage electricity sector emissions reductions as part of the goal of 80% below 1990 GHG emissions by 2050?

- Overview of California Cap and Trade Program and associated initiatives
- Overview of key electricity sector issues
- Discussion of an alternative permit pricing option

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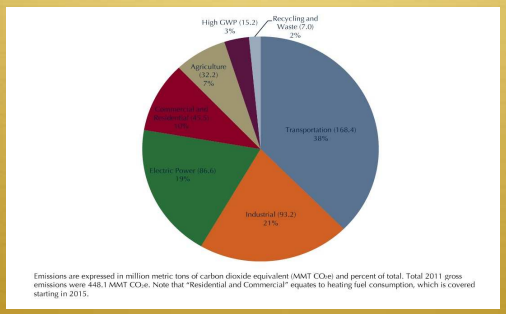
California Cap and Trade Program

- Derives from the Global Warming Solutions Act of 2006
- Combines with Renewable Portfolio Standard (2003)
- First Cap and Trade compliance period began in 2013

California Cap and Trade

- The California program is expected to cover roughly 85% of total state GHG when fully implemented in 2017
- This presentation is exclusively concerned with the electricity sector

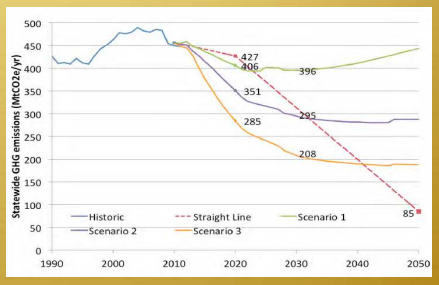


Source: California Air Resource Board, Greenhouse Gas Inventory Data – Graphs
http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_scopingplan_00-11_2013-08-01.pdf

Increasing Stringency

- **2006 Law**: 1990 levels by 2020 (relatively easy)
- **New Proposal**:
  80% below 1990 by 2050

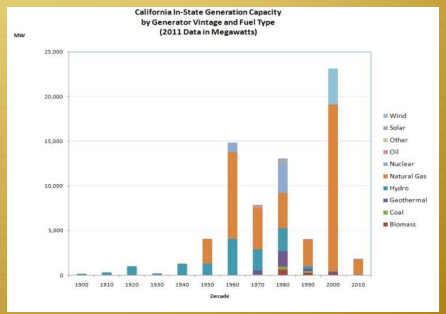
Three Scenarios for California's GHGs



Source: Greenblatt J. (2013). "Estimating Policy-Driven Greenhouse Gas Emissions Trajectories in California: The California Greenhouse Gas Inventory Spreadsheet (GHGIS) Model", Lawrence Berkeley National Laboratory. Accessed at: http://eetd.lbl.gov/sites/all/files/lbnl-6451e.p)

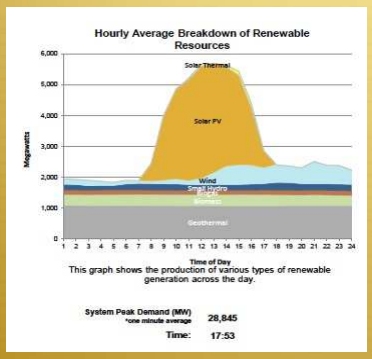
California Electricity Sector

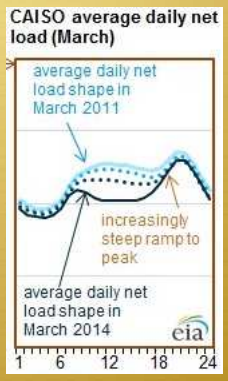
- Combination of deregulated (marginal auction process) wholesale market and regulated retail market.
- Dominated by natural gas electricity generating technology, but renewables portion large and expanding.



Source: Californa Energy Commission (2014) "Energy Almanac". Available at: http://http://energyalmanac.ca.gov/electricity/generating_units.html

Renewables approach 20% of total

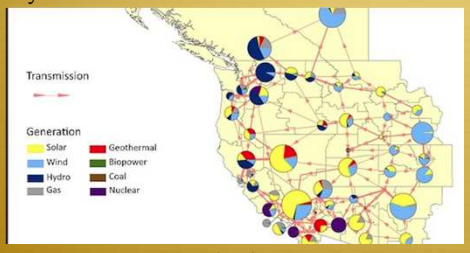




Source: : California ISO Renewables Watch, available at: http://www.caiso.com/green/renewableswatch. CAISO, Daily Renewables Watch, Jan 2014 and EIA Today in Energy, Dec. 2014

Over-generation and integration become key issues with high use of renewables

Potential types of power and flow between loads for GHG emissions 80% below 1990 by 2050



Source: Kammen,D. and Mileva, A, RAEL lab, UC Berkeley, 2013

% of incremental MWh resulting in over-generation by technology for various 2030 RPS scenarios

Technology	33% RPS	40% RPS	50% RPS Large Solar	50% RPS Diversi
Biomass		9%	23%	15%
Geothermal	2%	9%	23%	15%
Hydro	2%	10%	25%	16%
Solar PV	5%	26%	65%	42%
Wind	2%	10%	22%	15%

Source: Energy Plus Environmental Economics (2014). "Investigating Higher Renewable Portfolio Standards in California". Accessed at: https://ethree.com/documents/E3_Final_RPS_Report_2014_01_06_with_appendices.pdf

Grid Modernization

- Updates expected to cost on the order of $6-8 billion
- Optimal technology mix co-determined with system design

Source: Electric Power Research Institute. (2014) The integrated grid: Realizing the full value of central and distributed resources. Accessed at: http://

Current Permit Pricing Rule

- Participants are allocated permits on a historic basis.
- The program through 2020 includes annual settlement as well as 3 multi-year settlement periods.
- Auctions take place 4 times a year. The settlement price is the (single lowest) bid price that clears the all qualified bids or the supply of bids.
- Purchase and holding limits for allowances as well as an auction reserve price (floor) apply. Additional allocations are available under certain conditions.

Reform Proposal: Unchanged rules for permit allocation or trading

- Permits initially allocated on historical basis
- Individual entities buy or sell permits at the prevailing price

Reform proposal: Alternate permit pricing rule

- **OBJECTIVE**: To provide a transparent rule that creates a stronger incentive for the sector to invest in low/zero emission technology, including integration.
- **RULE**: Scaled price to make the short run cost (operating and maintenance) of fossil fuel electric power generation equal to the total cost of renewable fuel electric power generation, adjusting for emission efficiency

Setting the permit price (sector level)

- **EQ. Permit Price = F{ (T_{REN} - C_{BAT-OM})/CO_2e}**

- T_{REN} = Average Total cost of Renewables
- C_{BAT-OM} = Average Operation and Management costs for **B**est **A**vailable fossil fuel **T**echnology
- CO_2e = carbon dioxide equivalent rate for **B**est **A**vailable fossil fuel **T**echnology

How would the permit price evolve under the alternative rule?

Evaluating EQ1;

27 cases mathematically possible;

18 cases are programmatically feasible;

11 cases have determined signs (no off-setting effects)

7 cases have indeterminate signs (off-setting effects)

Table 1: Direction of change in permit price, given change in values

	$\Delta T_{REN} = 0$	$\Delta T_{REN} > 0$	$\Delta T_{REN} < 0$
$\Delta CO_2e < 0$ and $\Delta C_{BAT\text{-}OM} = 0$	+	+	I
$\Delta C_{BAT\text{-}OM} > 0$ and $\Delta CO_2e = 0$	-	I	-
$\Delta C_{BAT\text{-}OM} < 0$ and $\Delta CO_2e = 0$	+	+	I
$\Delta C_{BAT\text{-}OM} < 0$ and $\Delta CO_2e < 0$	+	+	I
$\Delta C_{BAT\text{-}OM} > 0$ and $\Delta CO_2e < 0$	I	I	I
$\Delta C_{BAT\text{-}OM} = 0$ and $\Delta CO_2e = 0$	0	+	-

I = indeterminate effect

Intuitive examples of permit price response

- Permit price declines if renewables generation become cheaper or fossil fuel generation becomes more expensive
- Permit price rises as fossil fuel BAT becomes more emission efficient
- If CCS is required, raising fossil fuel generation cost but also raising emission efficiency, the permit price may rise or decline depending on how the cost of renewables generation is changing

Some pros and cons of the alternative

- Pros:
  - A transparent rule based on industry-level conditions provides stronger incentives for clean investment
  - Integrate renewable fuel electricity generating technology investment into the fossil fuel profit function encourages strategizing *for* rather than *against* lowering emissions
- Cons:
  - Limits the co-ordination role played by an economy-wide carbon price operating across a variety of production processes
  - Potentially obscures compliance cost

Conclusion

- California is actively pursuing a very ambitious GHG reduction path with increasing attention to longer-run issues
- Success will require deep and innovative structural solutions
- To stimulate discussion on how policy could better encourage private investment toward a low/zero emission path, a reform proposal for Cap and Trade permit pricing has been proposed