

Electricity & Natural Gas GHG Modeling

Revised Results and Sensitivities

May 13th, 2008



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Summary of Changes Since May 6th Workshop Presentation

- Major changes to the treatment of the market clearing price of carbon in multi-sector cap and trade scenarios
 - **Cost and rate impacts of allocation scenarios have changed**
- Revision to calculation of RPS % when user specifies retail provider-specific RPS target
 - 'Calibration tab', cells C64:J64
- Revision to export-to-grid CHP calculation in the supply curve
 - 'SummaryCalcs' tab, cells DB15:16
- Correction to formula to calculate percent change in cost from 2008 to 2020 user case
 - 'Outputs' tab, cells AA17:AH17
- Updated generator assignment list to reflect input from Modesto Irrigation District
- Revision to CHP capacity value
 - 'Resources' tab, cell P139



Presentation Overview

- Background
- Model Overview and Key Results
- Benchmarking: why the tool works for its purpose
- Cost and Rate Impacts of Regulatory Policies
- Sensitivity Analysis
- Cost and Rate Impacts of CO2 Market: Allocation Scenarios
- GHG Calculator Walk-Through (Web-Ex)

3

Next Steps: Process

- Final model posted for comments
 - May 13th (Moved from May 10th)
- Comments on GHG Docket including Stage 2 model
 - Due May 27th
- Reply Comments on GHG Docket including Stage 2 model
 - Due June 10th

4

CPUC, CEC, ARB Project Team

- Energy and Environmental Economics, Inc.
 - Prime, Development of the non-proprietary tool, Integration, GHG Policy
- PLEXOS Solutions LLC
 - State-of-the-art production simulation model
- Schiller Associates, Steven Schiller Lead
 - Advisor on California GHG policy and energy efficiency
- Dr. Ben Hobbs, Johns Hopkins University
 - Academic advisor, World-renowned electricity simulation expert
- Dr. Yihsu Chen, UC Merced
 - Academic advisor, Emerging capability at UC Merced

5



Project Overview

- Joint CPUC, CEC, ARB effort to evaluate AB32 compliance options in California's electricity and natural gas sectors
- Model estimates the cost and rate impact of multiple scenarios relative to reference case
- Project timeline designed to fit into 2008 Scoping Plan process for AB32
- Deliverables
 - Non-proprietary, transparent, spreadsheet-based model using publicly available data
 - Report on results and sensitivities / scenarios
 - Stakeholder process leading to CPUC/CEC proposed decision
 - Model output to be used as an input to the ARB

6



Stage 1 Key Qs

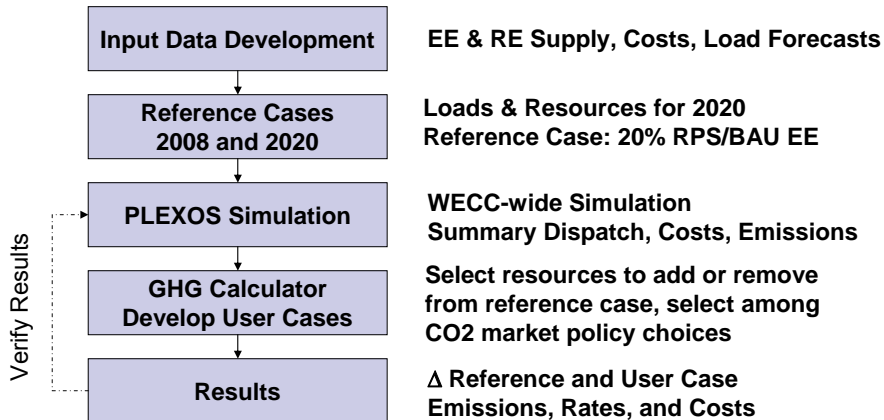
- How much will various policy options reduce CO2 emissions?
- How will these policy options affect electricity rates?
- *Underlying question: At what electricity sector target level do incremental improvements get expensive?*

Stage 2 Key Qs

- What is the cost to the electricity sector of complying with AB32 under different policy options for California?
- What is the cost to different LSEs and their customers of these options?
- *Underlying question: What option has the best combination of cost and fairness?*

Model Overview and Key Results

GHG Model Analysis Approach



9

GHG Modeling Technology Cost Assumptions

- Applies current technology cost assumptions
 - Does not project technology transformation or new technology development
- Physical costs, not market costs
 - Cost of new projects return on investment is just enough to provide equity return rates necessary for investment
 - Market price of energy set at variable costs of marginal unit

Only non-proprietary data is used
No actual or reported bid data, or contract prices of renewables

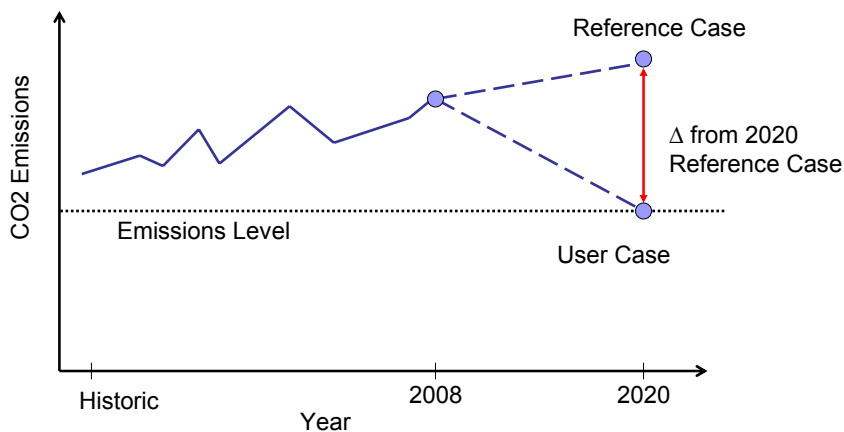
10

Building the Reference Case

- Forecast energy and loads to 2020 for all WECC Zones
- Adjust California load forecast for EE and distributed resources
 - Estimate embedded EE, behind-the-meter PV, CHP in California load forecast
 - Modify California load forecast for 5% demand response
- Add lowest cost renewable mix to hit RPS requirement
 - For all regions outside of California
 - To meet 20% RPS in California
- Add / subtract conventional resources to maintain existing reserve margins in each WECC zone
 - Add CCGT to balance energy
 - Add CT to balance capacity

11

Measuring CO₂ Change from Reference to User Cases



12

Inputs: 2020 Reference Case vs. 33%RPS/High goals EE*

Inputs	Reference Case	33% RPS/High goals EE*
Energy Efficiency (EE)	Assume 16,450 GWh EE embedded in CEC load forecast	'High goals' EE scenario based on CPUC Goals Update Study & POU AB 2021 filings: 36,559 GWh
Rooftop solar PV	847 MW nameplate of rooftop PV installed	3,000 MW nameplate of rooftop PV installed
Demand Response	5% demand response	5% of demand response
Combined heat and power (CHP)	292 MW nameplate behind-the-meter CHP No new large (>5MW) CHP	1,574 MW nameplate small CHP (< 5 MW) 2,804 MW nameplate larger CHP (>5 MW)
Renewable Energy	20% RPS (6,733 MW)	33% RPS (12,544 MW)

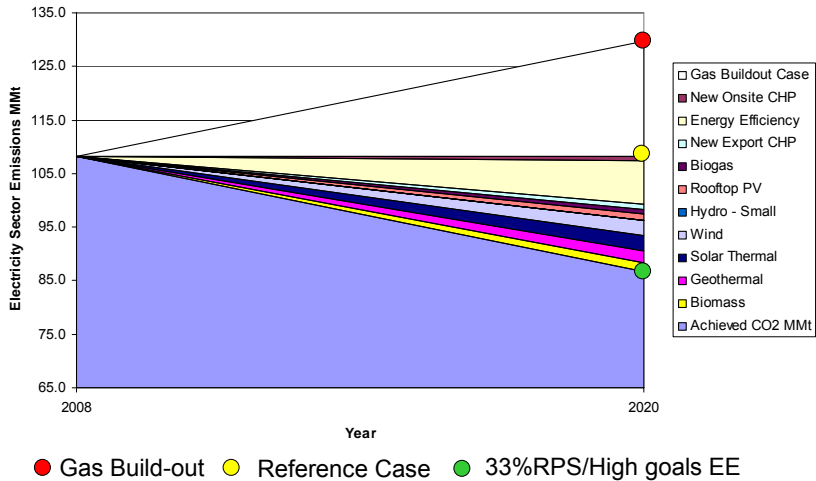
*33%RPS/High goals EE formerly called 'Aggressive Policy Case'

Revised Results: 2020 Reference Case vs. 33%RPS/High goals EE*

Results	Reference Case	33% RPS/High goals EE*
2020 Emissions	108.2 MMTCO _{2e}	78.6 MMT CO _{2e}
% Δ in Utility Cost from 2008	Δ 2008 = 31%	Δ 2008 = 27%
% Δ in Rates from 2008	Δ 2008 = 13%	Δ 2008 = 29%
% Δ in Rates from 2020 Reference Case	N/A	Δ 2020 Ref. = 14%
% Δ in Cost from 2020 Reference Case	N/A	Δ 2008 Ref. = -3%
2020 Average Rate	\$0.149/kWh	\$0.169/kWh
2020 Utility Cost	\$47.6 billion/yr	\$46.3 billion/yr
2020 Customer Cost	\$1.3 billion/yr	\$5.2 billion/yr
2020 Total: Customer & Utility Cost	\$48.9 billion/yr	\$51.5 billion/yr

CO2 Savings for Reference Case and 33%RPS/High EE goals Case

Source of Reductions for California CO2 Reduction



Net Cost of CO2 Reductions

■ Revised Comparison of Reference Case & 33%RPS/High EE Goals Cases

Summary of Costs per Tonne (\$/Tonne CO2e, \$2008)

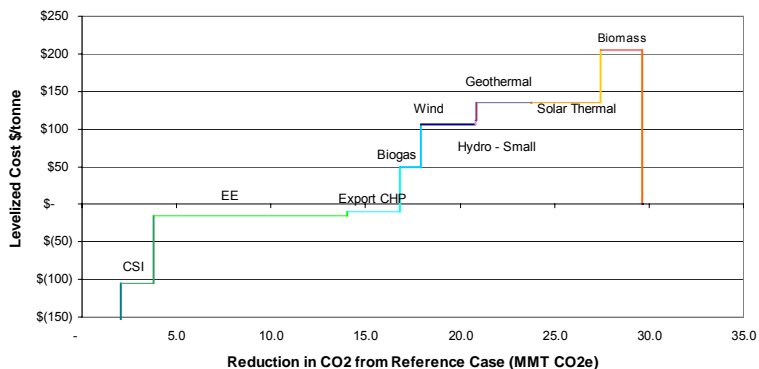
	Utility	Consumer	Total	MMt CO2e
Energy Efficiency	\$ (133)	\$ 42	\$ (90)	8.2
Renewables	\$ 76	\$ -	\$ 76	12.4
CSI	\$ (1)	\$ 841	\$ 839	0.5
CHP	\$ -	\$ -	\$ -	-
Weighted Average	\$ (7)	\$ 37	\$ 29	21.1

Summary of Costs per Tonne (\$/Tonne CO2e, \$2008)

	Utility	Consumer	Total	MMt CO2e
Energy Efficiency	\$ (16)	\$ 78	\$ 63	10.2
Renewables	\$ 133	\$ -	\$ 133	12.8
CSI	\$ (106)	\$ 1,007	\$ 902	1.7
CHP	\$ (161)	\$ 389	\$ 228	4.9
Weighted Average	\$ 19	\$ 149	\$ 168	29.6

Revised Net Utility CO2 Cost of Resources: 33%RPS/High EE Goals Case

CO2 Supply Curve of Incremental Low-Carbon Resources
(Net LSE Cost per Tonne CO2e)

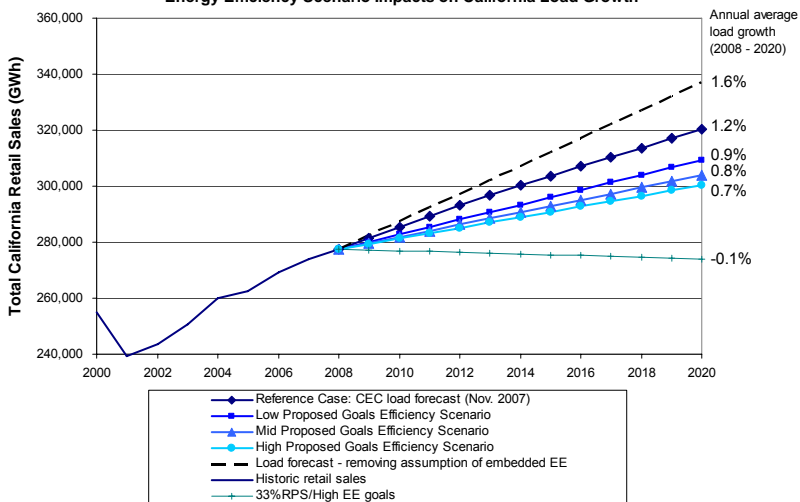


Costs and Savings Incremental to Reference, All costs in \$2008

17



Energy Efficiency Scenario Impacts on California Load Growth

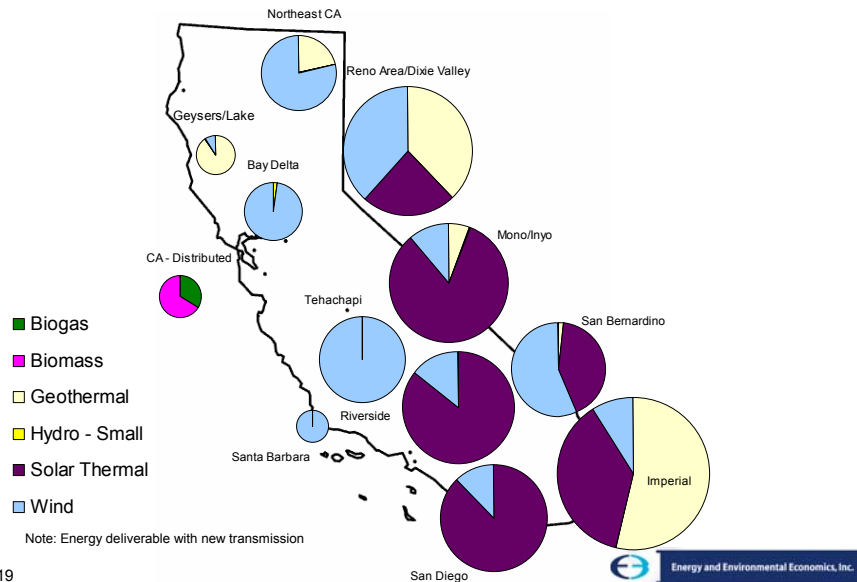


Note: 1990 – 2000 average annual CA retail sales growth rate: ~1.5%

18



CA Renewable Resource Zones



19

CO2 Cap and Trade Framework

- Energy deliverer, multi-sector cap and trade
- California-only carbon price
- Hybrid model structure (regulation & market)
 - CO2 market
 - Input market clearing price of GHG emission permits
 - No 'electricity-sector' emissions cap, just multi-sector
 - Electricity sector is assumed to be a 'price-taker' for emission permits
 - Adjust allocation, auction and offsets controls
 - Regulatory requirements
 - Input LSE policy requirements (RPS, EE)
- **Model does NOT determine the CO2 market price!**

20

Impacts of a California-only GHG Market on the Electricity Sector

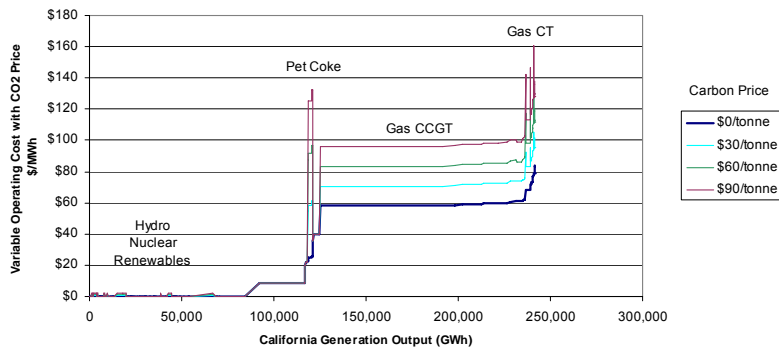
- Change in operation of existing CA plants
 - Cost of CO₂ could change the relative economics of plant dispatch
- Reduction of emissions intensity of imports
 - Increase in low-carbon specified imports and/or reduction in high-carbon specified imports
- New capital investment
 - Cost of CO₂ could make all-in costs of low-carbon resources less expensive than fossil-fuel resources
- Technology innovation (not directly modeled)
 - A higher market price for power and a CO₂ price could drive new technology innovation, resulting in new sources of emission reductions
- Distributional impacts
 - Distributional impacts due to emission allocation policy choices and impacts due to impact of CO₂ market on electricity prices

Results

- No – CA plants are dispatched in emissions order already
- Yes – with risk of shuffling. Out-of-state coal imports become uneconomic ~\$60/tonne CO₂
- No – Not at existing technology & gas cost and CO₂ price below ~\$100/t CO₂
- ? – Lots of clean technology investment could spur big changes
- Yes – there are winners and losers
Discussion on allocation later

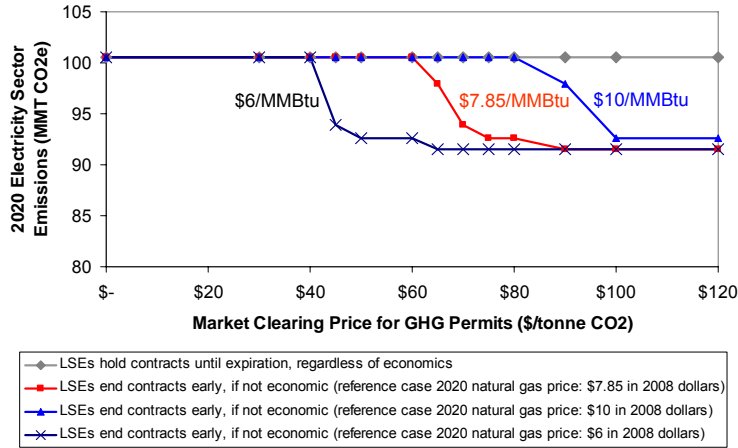
Operational changes of CA generation with carbon prices

California Generation 2020 BAU Case
Comparison of Variable Cost by CO₂ Price



CO₂ price does not change the economic dispatch order in California (much)

Change in imports of out-of-state fossil generation with different natural gas and carbon prices

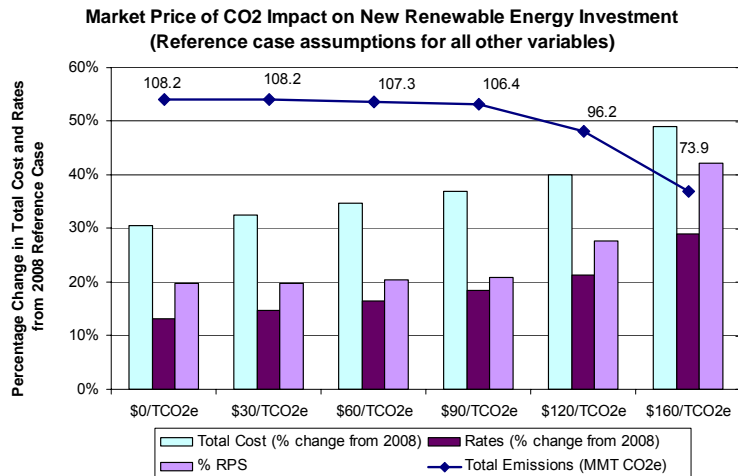


23

Scenario: 20% RPS, 'Mid goals' of EE



In-State Renewable Investment

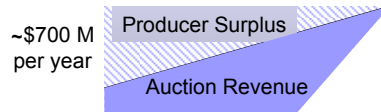


24



Profits for Clean Generation through Electricity Market Clearing Price (MCP)

- MCP with CO2 leads to increased profits for producers and importers with low carbon generation
- At \$30/t CO2: State pays approximately \$700 million to producers due to higher market clearing price for power, if auction revenue is recovered by LSEs
- Assumes utility-owned generation and long-term contracts do not capture the windfall since they are compensated at cost for CO2



Analysis affected significantly by contract assignment assumptions

Emissions Benchmarking

GHG Calculator is a Policy Tool

- Capability to model many different policy-level choices
- Should not be used for resource planning decisions!
- Requirements for reasonable accuracy for CO2 policy decisions
 - Reasonable statewide electricity sector emissions level
 - Approximately correct emissions intensity by LSE
 - Approximately correct generation or purchases from 3 categories of generators
 - Utility-owned generation by fuel type
 - Long term contracts
 - Imports
 - Approximately correct changes in above for different resource mixes

27

Key Drivers in Utility Cost and Rate Impacts to CO2 Policy Choices

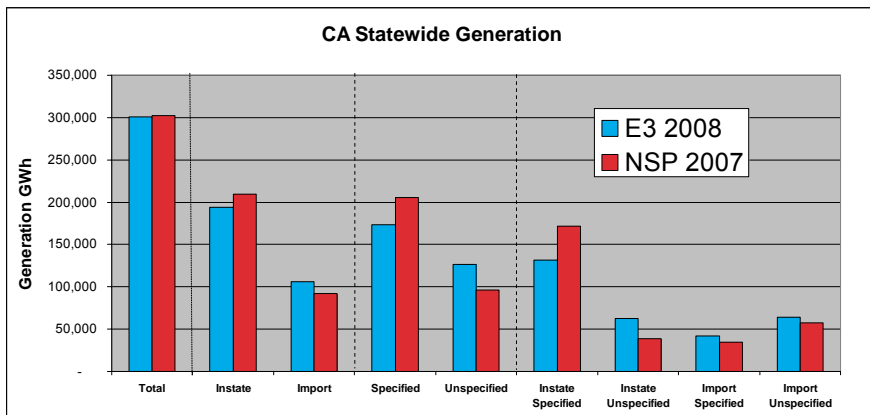
- Existing revenue requirement
- Existing sales levels
- Utility-owned generation Significant changes in the last week
- Existing long-term contracts (RPS, coal, other)
- Market purchases and imports to California
- Growth rates through 2020
- Allocation mechanisms/choices

28

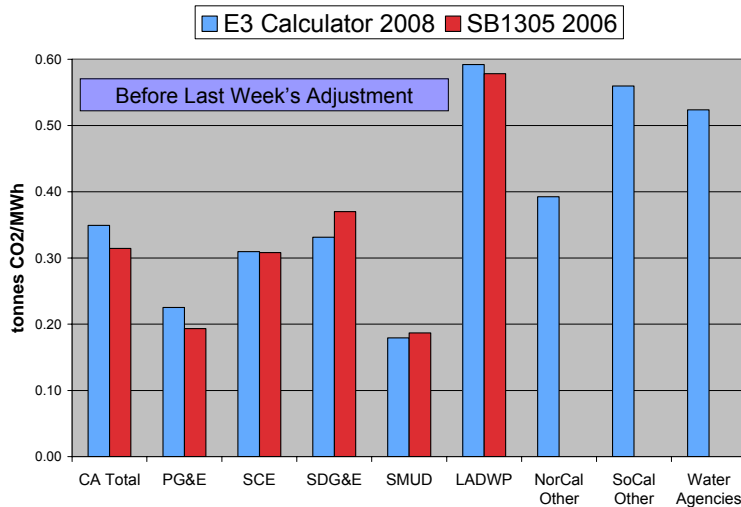
Utility-owned Generation & Contracts

- Updated since the last workshop
 - Responses received from many parties:
 - SMUD, LADWP, SCPPA, Calpine, City of Redding, SDG&E, PG&E, SCE, PacifiCorp, Mountain Utilities
- Changes incorporated into results
 - Utility-owned generation assignment
 - Long term contracts for utility generation
 - Imports adjusted based on net requirements
- Retail providers suggested additional changes that were not incorporated into model, which could improve future versions of the TEPPC database
 - Heat rate, capacity, fuel type, missing and new generators

Benchmarking E3 Calculator Statewide Generation to Public Data



Benchmarking E3 Calculator Emissions Intensity to Public Data

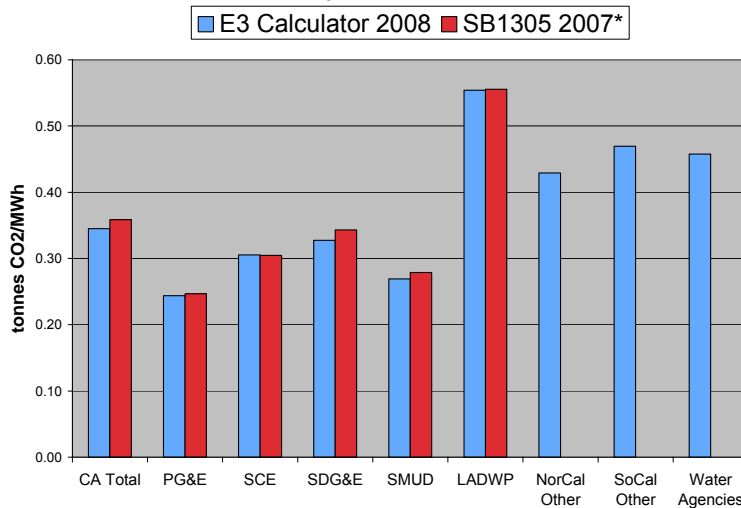


SB1305 = Power Content Label Reporting to CEC



31

Benchmarking E3 Calculator Emissions Intensity to Public Data



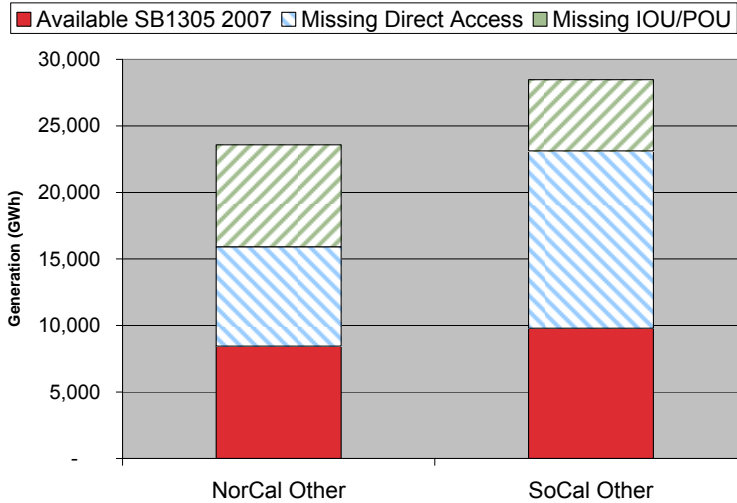
*Normalized for average hydro year

SB1305 = Power Content Label Reporting to CEC



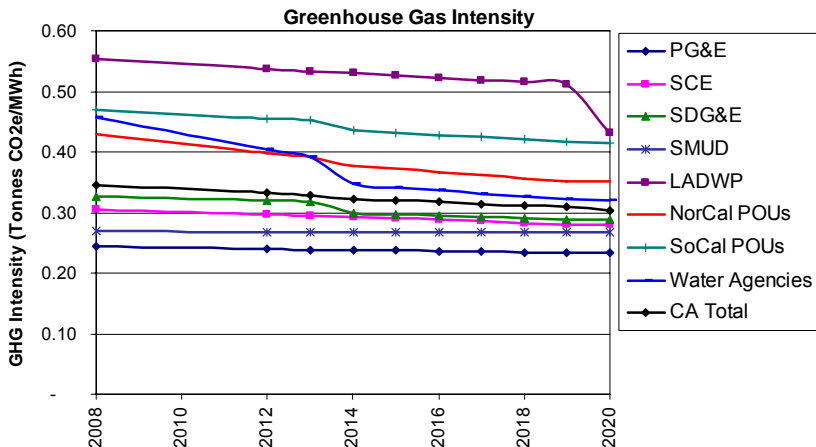
32

Data Limitations in Benchmarking Emissions Intensity of NorCal and SoCal Other



33 Hatched areas show gap between available public data and CEC load forecast for LSEs above.

Emissions Intensity by Retail Provider



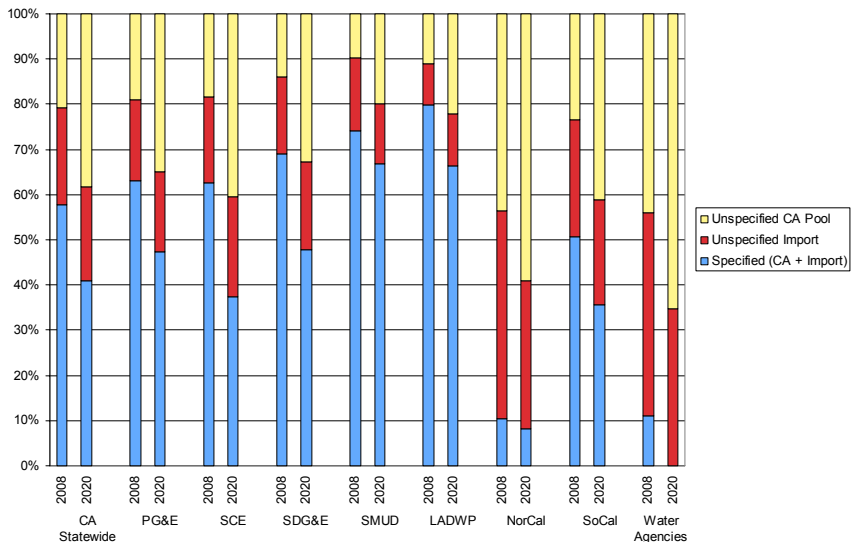
SB1305 Data Availability for NorCal, SoCal

6 Northern - Other	
Alameda	PG&E Direct Access
Biggs	Plumas-Sierra Rural Electric Cooperation
Calaveras Public Power Agency	Port of Stockton
Gridley	Power and Water Resource Purchasing Agency
Healdsburg	Redding
Lassen Municipal Utility District	Roseville
Lodi	Shasta Dam Area Public Utility District
Lompoc	Silicon Valley Power
Merced Irrigation District	Tuolumne County Public Power Agency
Modesto Irrigation District	Turlock Irrigation District
Palo Alto	Ukiah
Mountain Utilities	Pacificorp
Trinity Public Utility District	Sierra Pacific Power Company
Truckee-Donner Public Utility District	Surprise Valley Electrical Corporation
7 Southern - Other	
Anaheim	Rancho Cucamonga
Anza Electric Cooperative, Inc.	Riverside
Azusa	SCE Direct access
Banning	Valley Electric Association, Inc.
Bear Valley Electric Service	Vernon
Boulder City/Parker Davis	Victorville Municipal
Colton	Needles
Burbank	SDG&E Direct Access
Glendale	Imperial Irrigation District
Pasadena	

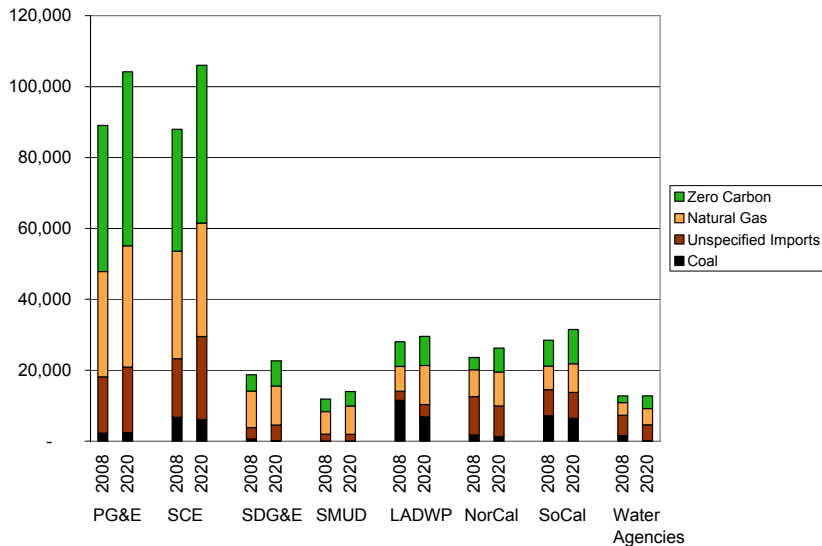
Highlighted LSEs are those for which E3 received 2006
 35 SB1305 = Power Content Label Reporting to CEC



Generation Assignment Shares in 2008 and 2020 Reference Case by LSE

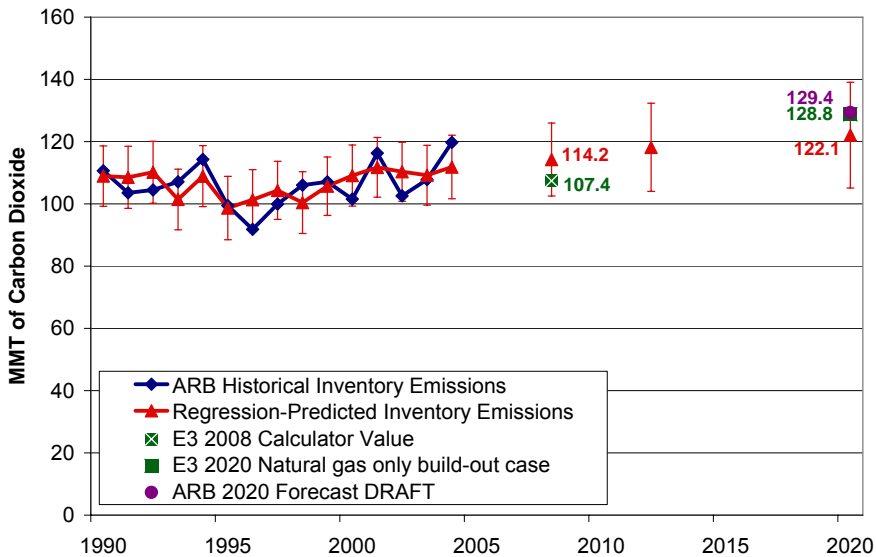


Resource Mix in 2008 and 2020 Ref. Case by LSE



37

Benchmarking Total Electricity Sector Emissions



38

Verification with PLEXOS

- Set up Test Case in both PLEXOS and the GHG Calculator to Verify Calculator Matches PLEXOS
- Comparison of Results Shows Close Match

	Business As Usual	PLEXOS TEST Case	Difference
PLEXOS Dispatch	431,810	401,641	30,169
Spreadsheet Dispatch	431,810	403,556	28,254
Hydro Adjustment	(2,196)	(2,196)	-
Onsite CHP	4,700	4,700	-
SF6	1,029	1,029	-
Export CHP	(340)	(340)	-
Total WECC	435,003	406,749	28,254
Total CA	107,033	78,779	28,254
Comparison of PLEXOS to Calculator			Difference (1000 tons) 1,915
			Difference % Savings 6%
			Difference % of CA 2%

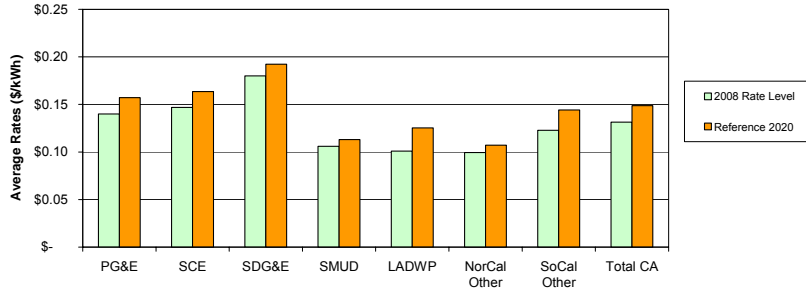
Test Case is an extreme case (stage 1 aggressive policy case)

- Very high EE (168% of High Goals)
- High RPS (33% statewide)
- No New CHP

Cost and Rate Impacts of Regulatory Policies

Rates Comparison: 2008 and 2020 Reference Case

Comparison of 2008 and 2020 Rates

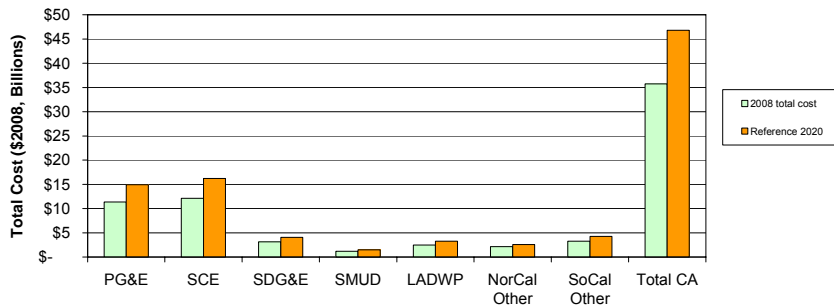


Rate Change between 2020 Reference and 2020 User Case

	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Δ 2008 to 2020 Ref. Case	12%	11%	7%	7%	24%	8%	17%	13%
2020 Ref. Case Rates (\$/kWh)	\$0.16	\$0.16	\$0.19	\$0.11	\$0.13	\$0.11	\$0.14	\$0.15

Revised Utility Cost Comparison: 2008 and 2020 Reference Case

Comparison of 2008 and 2020 Total Cost

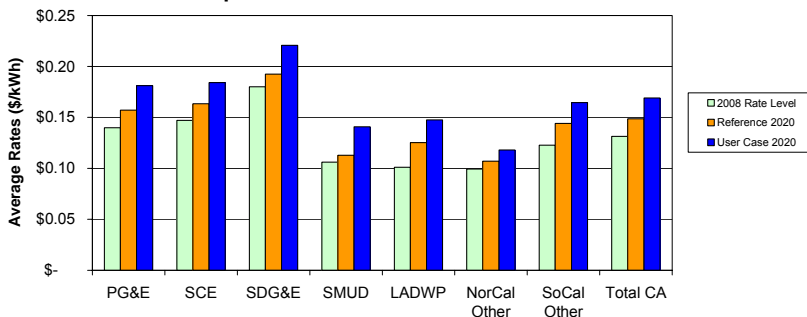


Total Cost Change between 2020 Reference and 2020 User Case

	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Δ 2008 to 2020 Ref. Case	31%	34%	30%	25%	31%	20%	30%	31%
2020 Ref. Case Cost (\$2008, billions)	\$14.9	\$16.2	\$4.1	\$1.5	\$3.3	\$2.6	\$4.3	\$47.6

Revised Rate Comparison: Reference Case vs. 33%RPS/High EE Goals Case

Comparison of 2008 and 2020 Rates

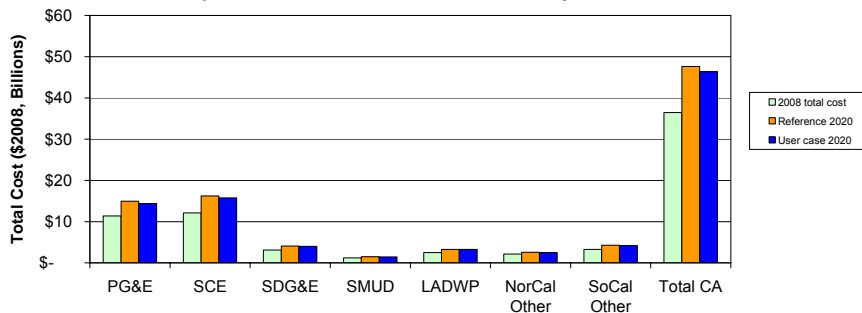


	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Rate Change between 2020 Reference and 2020 User Case	15.3%	12.7%	14.8%	24.7%	17.8%	10.3%	14.2%	13.8%
Δ 2020 Ref to 2020 User Case	29.4%	25.3%	22.7%	32.8%	46.1%	18.8%	34.1%	28.7%

Scenario: User Case = 33%RPS/High EE goals Scenario

Revised Cost Comparison: Reference Case vs. 33% RPS/High EE Goals Case

Comparison of 2008 and 2020 Total Utility Cost



	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Total Utility Cost Change between 2020 Reference and 2020 User Case	-3.6%	-2.9%	-1.2%	-2.2%	0.1%	-3.1%	-1.5%	-2.7%
Δ 2020 Ref to 2020 User Case	27%	30%	28%	23%	31%	16%	28%	27%

Scenario: User Case = 33%RPS/High EE goals Scenario



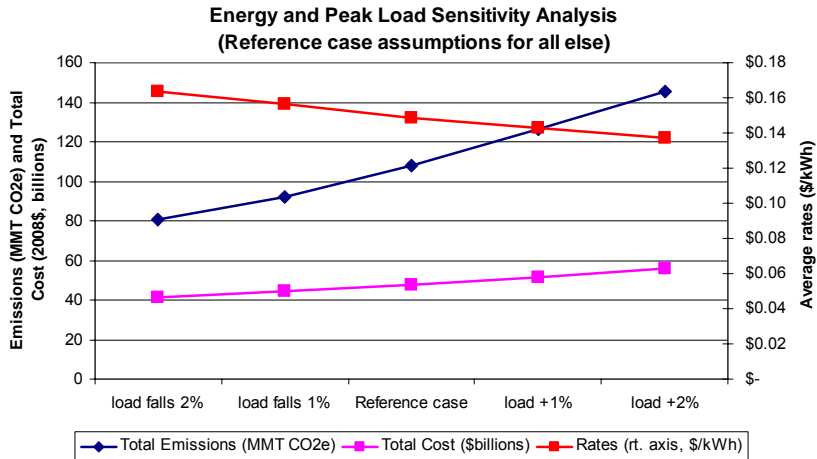
Sensitivity Analysis



Electricity Sector Key Drivers of Results

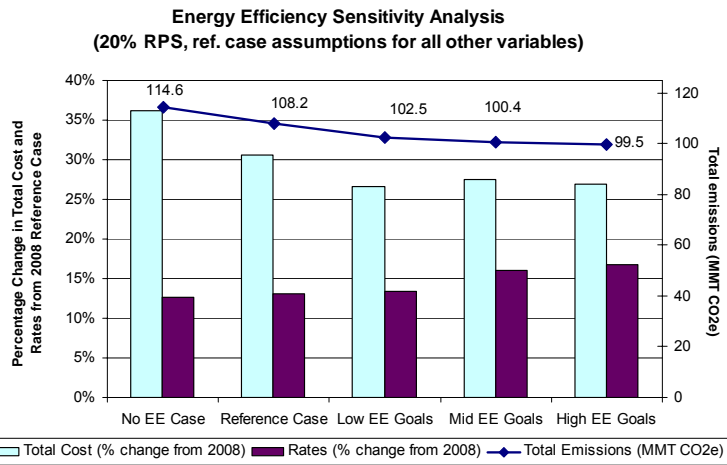
- Load growth
- Fuel prices
- EE achievements
- CO2 market costs

Load Growth Sensitivity



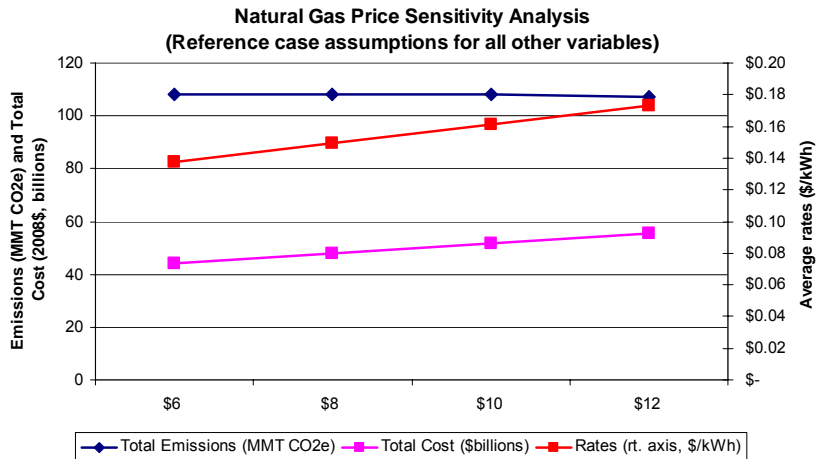
47

Energy Efficiency Sensitivity



48

Revised Natural Gas Price Sensitivity



49

Cost and Rate Impacts
of CO₂ Market:
Allocation Scenarios

Revised Allocation Scenarios

1. 'Pure Emission-Based Allocation'
2. 'Pure Output-Based Allocation'
- 2MCP. 'Pure Output-Based Allocation'*
- 2a. Pure Output-Based Allocation excluding non-fossil generators
- 2.aMCP) Pure Output-Based Allocation excluding non-fossil generators*
3. 'Pure Auction' with no Auction Revenue Recycling
4. 'Pure Auction' with Auction Revenue Recycling
5. 'Preferred Emission-Based Allocation' proposal
- 5MCP. 'Preferred Emission-Based Allocation' proposal*
6. 'Preferred Output-Based Allocation' proposal
7. 'Preferred Auction' proposal

* MCP = Market Clearing Price Effect of Output-based Allocation Scenarios, see next slide

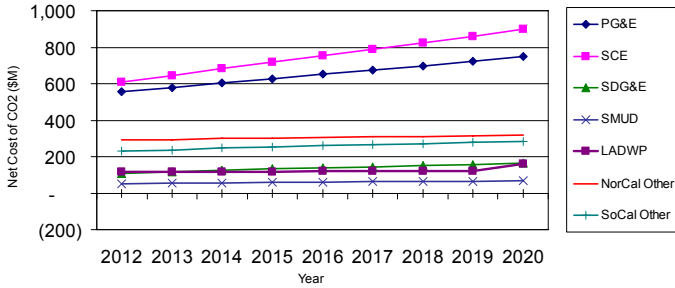
MCP Effect for Output-Based Allocation Scenarios

- These scenarios reflect the effect of an output-based allocation on the market clearing price.
- In theory, since the output based allocation is not given to energy deliverers until they generate electricity, there is no opportunity cost of the allocated CO₂, and the generator bid will not include the value of the free CO₂ allowances
- This is implemented in the model in the following ways;
 - 1) If the output-based allowance rate is higher than the emissions rate of the marginal generator, the generator is assumed to bid their variable operating cost. Note: this is a conservative assumption from the standpoint of economic theory.
 - 2) If the output-based allowance rate is lower than the emissions rate of the marginal generator, the generator is assumed to only include its actual CO₂ cost of purchasing the incremental allowances.
- The MCP effect is now an additional user input on the CO₂ Market tab in the GHG Calculator. A value of 100% means that 100% of the allowance costs are bid into the market clearing price of electricity (e.g. no MCP reduction effect). A value of 0% means that none of the allowance cost is reflected in the MCP.

Scenario 1: 'Pure Emission-Based'

100% administrative allocation based on historical 2008 emissions

Net Cost of CO2 by LSE Including Increase in Market Price



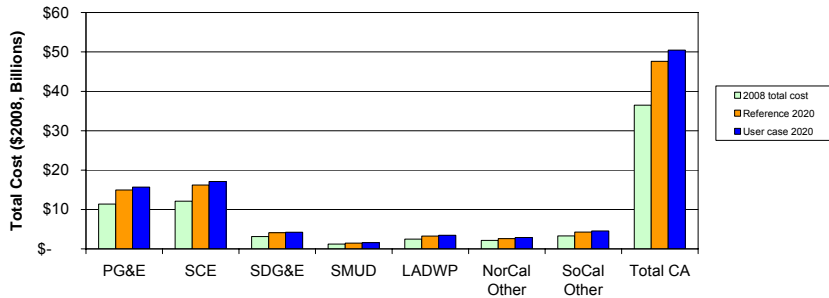
Summary
Low emissions, low self-resourced LSEs fare the worst.

Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

Scenario 1: 'Pure Emission-Based'

100% administrative allocation based on historical 2008 emissions

Comparison of 2008 and 2020 Total Utility Cost



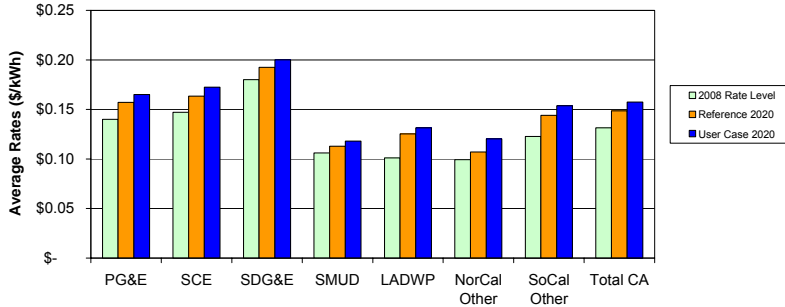
	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Total Utility Cost Change between 2020 Reference and 2020 User Case	5.0%	5.5%	4.0%	4.6%	4.9%	12.4%	6.7%	5.9%
Δ 2020 Ref to 2020 User Case								
Δ 2008 to 2020 User Case	38%	41%	35%	31%	37%	35%	39%	38%

Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

Scenario 1: 'Pure Emission-Based'

100% administrative allocation based on historical 2008 emissions

Comparison of 2008 and 2020 Rates



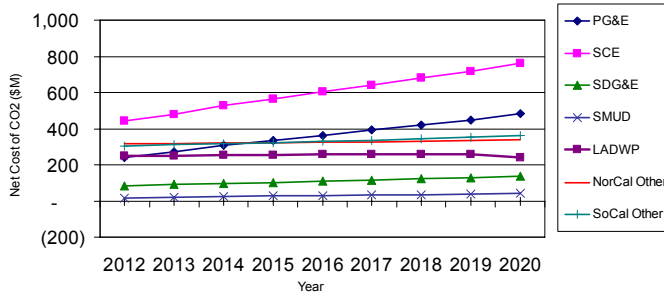
	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Δ 2020 Ref to 2020 User Case	5.0%	5.5%	4.0%	4.6%	4.9%	12.4%	6.7%	5.9%
Δ 2008 to 2020 User Case	17.9%	17.4%	11.2%	11.4%	30.1%	21.1%	25.3%	19.8%

Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

Scenario 2: 'Pure Output-Based'

100% administrative allocation based on updating yearly output (GWh)

Net Cost of CO₂ by LSE Including Increase in Market Price



Summary

High emissions retail providers fare the worst.

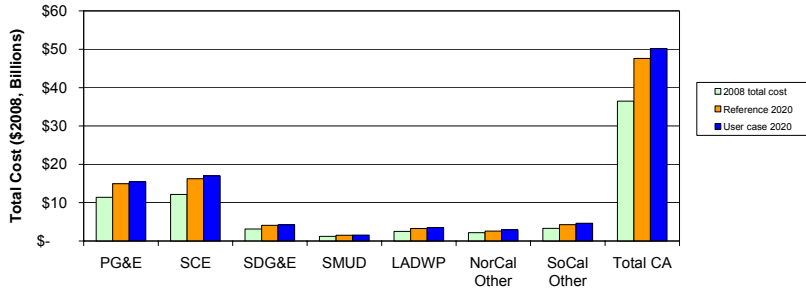
Increasing electricity market purchases at higher market price drive up slope for some retail providers.

Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

Scenario 2: 'Pure Output-Based'

100% administrative allocation based on updating yearly output (GWh)

Comparison of 2008 and 2020 Total Utility Cost



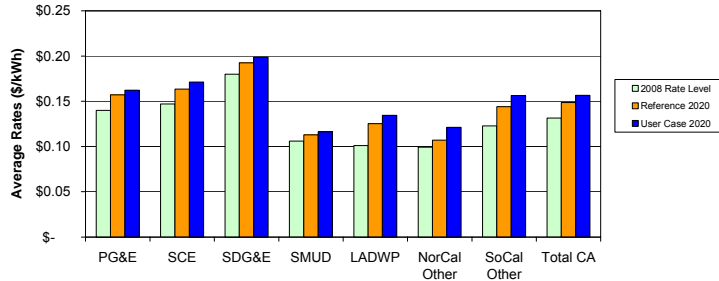
		PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Total Utility Cost Change between 2020 Reference and 2020 User Case									
Δ 2020 Ref to 2020 User Case		3.2%	4.7%	3.4%	2.9%	7.4%	13.2%	8.5%	5.4%
Δ 2008 to 2020 User Case		36%	40%	34%	29%	41%	36%	41%	38%

Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

Scenario 2: 'Pure Output-Based'

100% administrative allocation based on updating yearly output (GWh)

Comparison of 2008 and 2020 Rates



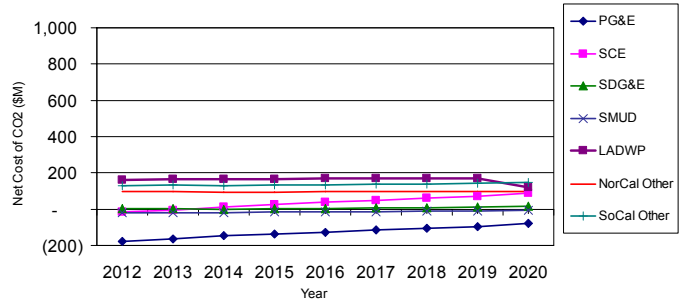
		PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Rate Change between 2020 Reference and 2020 User Case									
Δ 2020 Ref to 2020 User Case		3.2%	4.7%	3.4%	2.9%	7.4%	13.2%	8.5%	5.4%
Δ 2008 to 2020 User Case		15.9%	16.5%	10.5%	9.6%	33.2%	21.9%	27.4%	19.2%

Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

Scenario 2MCP: 'Pure Output-Based'

100% administrative allocation based on updating yearly output (GWh)
 Market clearing price for electricity includes 25% of the marginal generator's cost of CO2

Net Cost of CO2 by LSE Including Increase in Market Price

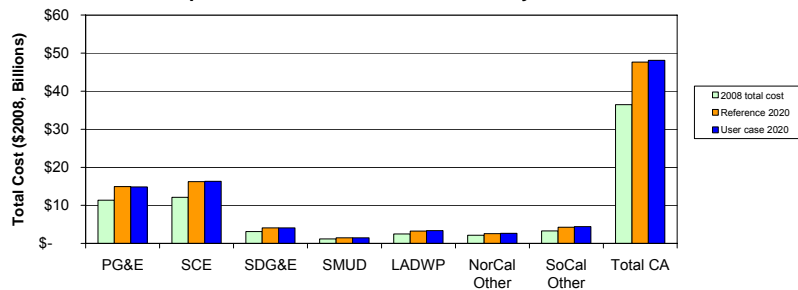


Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

Scenario 2MCP: 'Pure Output-Based'

100% administrative allocation based on updating yearly output (GWh)
 Market clearing price for electricity includes 25% of the marginal generator's cost of CO2

Comparison of 2008 and 2020 Total Utility Cost



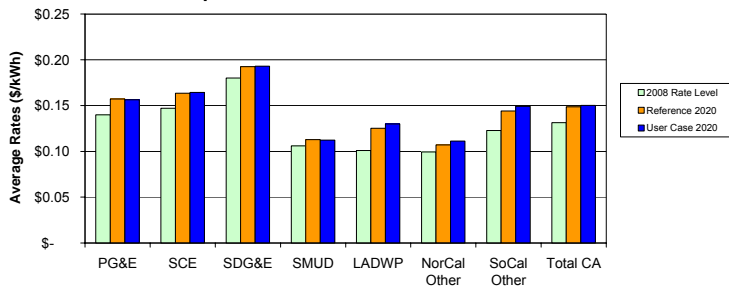
	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Δ 2020 Ref to 2020 User Case	-0.5%	0.5%	0.4%	-0.5%	3.7%	3.9%	3.4%	1.0%
Δ 2008 to 2020 User Case	31%	35%	30%	25%	36%	25%	34%	32%

Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

Scenario 2MCP: 'Pure Output-Based'

100% administrative allocation based on updating yearly output (GWh)
 Market clearing price for electricity includes 25% of the marginal generator's cost of CO2

Comparison of 2008 and 2020 Rates



	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Rate Change between 2020 Reference and 2020 User Case								
Δ 2020 Ref to 2020 User Case	-0.5%	0.5%	0.4%	-0.5%	3.7%	3.9%	3.4%	1.0%
Δ 2008 to 2020 User Case	11.7%	11.8%	7.3%	6.0%	28.7%	11.9%	21.5%	14.2%

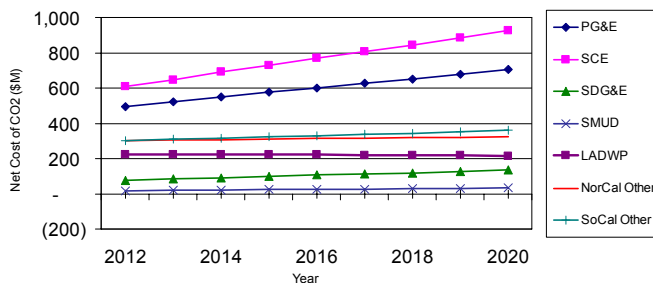
Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE
 61



Scenario 2a: Pure Output-Based Allocation excluding non-fossil generators

100% administrative allocation based on updating yearly output (GWh)

Net Cost of CO2 by LSE Including Increase in Market Price



Summary

LSEs with zero carbon resources, (nuclear, hydro and renewable energy) fare worse than in pure output based allocation.

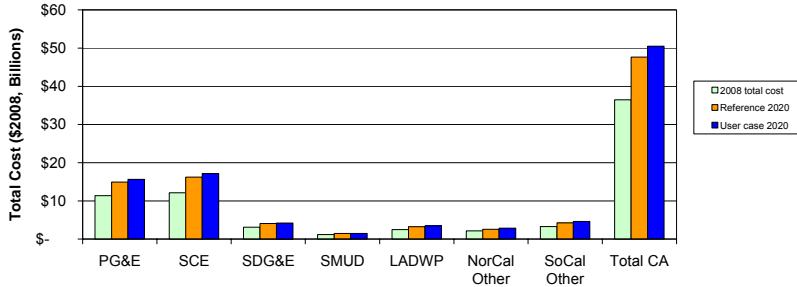
Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE



Scenario 2a: Pure Output-Based Allocation excluding non-fossil generators

100% administrative allocation based on updating yearly output (GWh)

Comparison of 2008 and 2020 Total Utility Cost



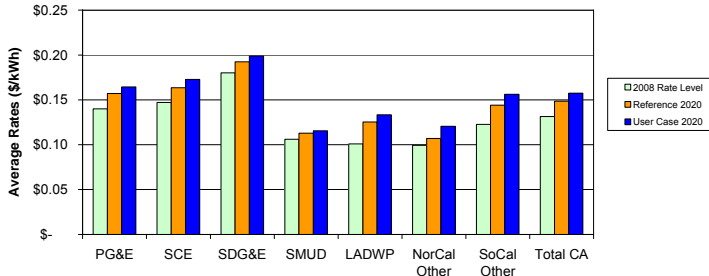
	PG&E		SCE		SDG&E		SMUD		LADWP		NorCal Other	SoCal Other	Total CA
Δ 2020 Ref to 2020 User Case	4.7%	5.7%	3.3%	2.2%	6.5%	12.7%	8.4%	6.0%					
Δ 2008 to 2020 User Case	38%	42%	34%	28%	40%	35%	41%	38%					

Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

Scenario 2a: Pure Output-Based Allocation excluding non-fossil generators

100% administrative allocation based on updating yearly output (GWh)

Comparison of 2008 and 2020 Rates



	PG&E		SCE		SDG&E		SMUD		LADWP		NorCal Other	SoCal Other	Total CA
Δ 2020 Ref to 2020 User Case	4.7%	5.7%	3.3%	2.2%	6.5%	12.7%	8.4%	6.0%					
Δ 2008 to 2020 User Case	17.5%	17.6%	10.4%	8.9%	32.2%	21.4%	27.3%	19.9%					

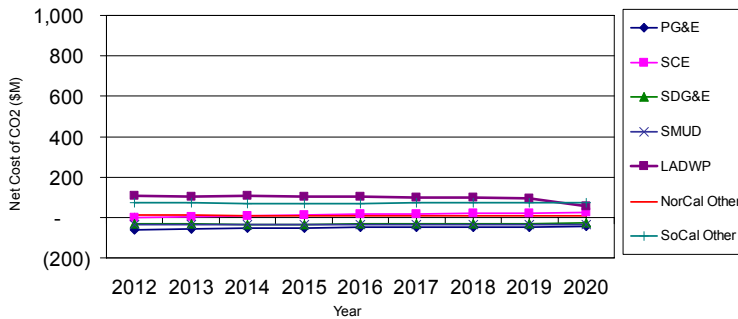
Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

Scenario 2aMCP: 'Pure Output-Based' excluding non-fossil generators

100% administrative allocation based on updating yearly output (GWh)

Market clearing price for electricity includes 0% of the marginal generator's cost of CO2

Net Cost of CO2 by LSE Including Increase in Market Price



Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE
65

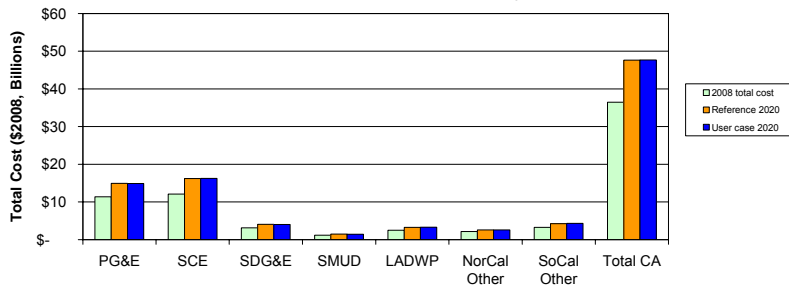


Scenario 2aMCP: 'Pure Output-Based' excluding non-fossil generators

100% administrative allocation based on updating yearly output (GWh)

Market clearing price for electricity includes 0% of the marginal generator's cost of CO2

Comparison of 2008 and 2020 Total Utility Cost



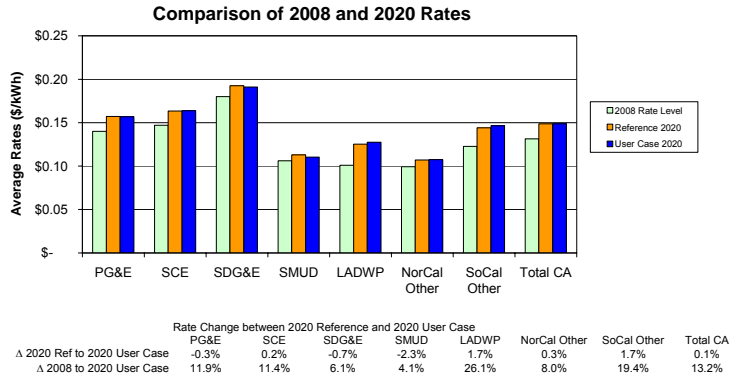
	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Total Utility Cost Change between 2020 Reference and 2020 User Case	-0.3%	0.2%	-0.7%	-2.3%	1.7%	0.3%	1.7%	0.1%
Δ 2008 to 2020 User Case	31%	34%	29%	22%	33%	20%	32%	31%

Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE
66



Scenario 2aMCP: 'Pure Output-Based' excluding non-fossil generators

100% administrative allocation based on updating yearly output (GWh)
 Market clearing price for electricity includes 0% of the marginal generator's cost of CO2

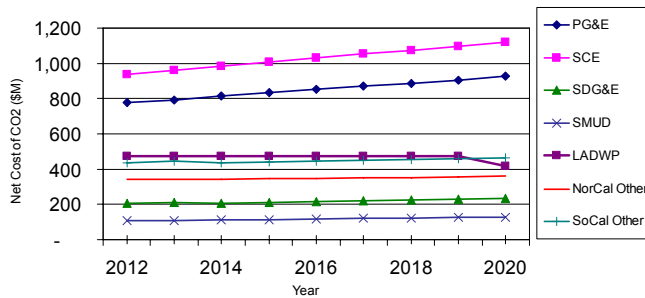


Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE
 67



Scenario 3: 'Pure Auction' – no revenue recycling

Net Cost of CO2 by LSE Including Increase in Market Price



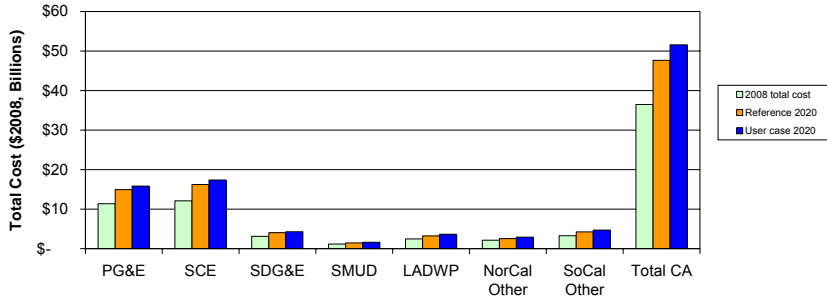
Summary
 All LSEs see high cost and rate increases.

Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE



Scenario 3: 'Pure Auction' – no revenue recycling

Comparison of 2008 and 2020 Total Utility Cost

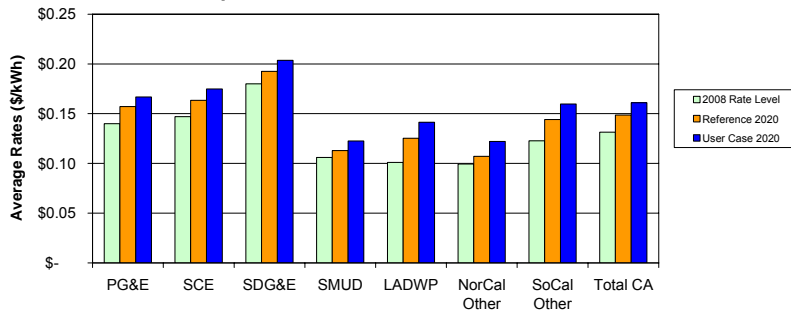


Total Utility Cost Change between 2020 Reference and 2020 User Case									
	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA	
Δ 2020 Ref to 2020 User Case	6.2%	6.9%	5.8%	8.6%	12.8%	14.0%	10.8%	8.3%	
Δ 2008 to 2020 User Case	39%	43%	37%	36%	48%	37%	44%	42%	

Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

Scenario 3: 'Pure Auction' – no revenue recycling

Comparison of 2008 and 2020 Rates



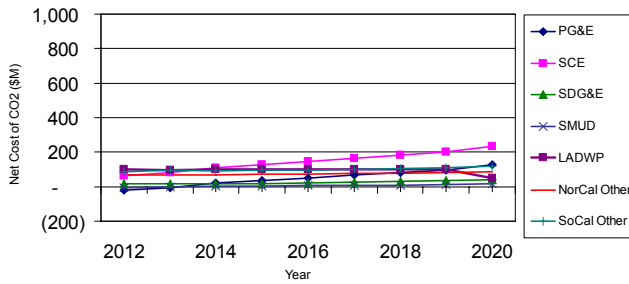
Rate Change between 2020 Reference and 2020 User Case								
	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Δ 2020 Ref to 2020 User Case	6.2%	6.9%	5.8%	8.6%	12.8%	14.0%	10.8%	8.3%
Δ 2008 to 2020 User Case	19.2%	18.9%	13.1%	15.7%	39.9%	22.8%	30.2%	22.5%

Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

Scenario 4: 'Pure Auction' with revenue recycling

50% revenue recycling based on LSE sales, 50% based on 2008 emissions

Net Cost of CO2 by LSE Including Increase in Market Price



Summary

Revenue recycling mitigates impact of auction to all LSEs.

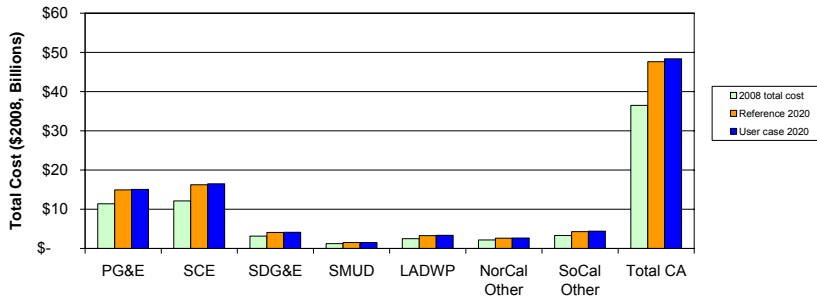
Mix of sales-based and output-based revenue recycling excluding non-fossil generators groups the LSE's impacts closer together.

Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

Scenario 4: 'Pure Auction' with revenue recycling

50% revenue recycling based on LSE sales, 50% based on 2008 emissions

Comparison of 2008 and 2020 Total Utility Cost



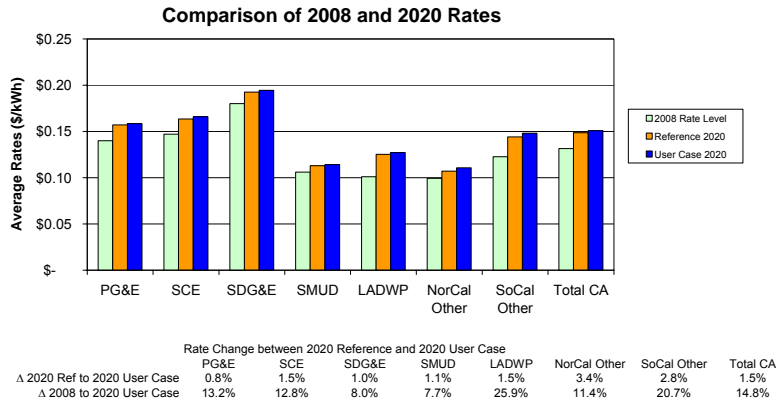
Total Utility Cost Change between 2020 Reference and 2020 User Case

	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Δ 2020 Ref to 2020 User Case	0.8%	1.5%	1.0%	1.1%	1.5%	3.4%	2.8%	1.5%
Δ 2008 to 2020 User Case	32%	36%	31%	27%	33%	24%	33%	33%

Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

Scenario 4: 'Pure Auction' with revenue recycling

50% revenue recycling based on LSE sales, 50% based on 2008 emissions



Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

Scenario 5: 'Preferred Emission-Based' Staff Straw Proposal

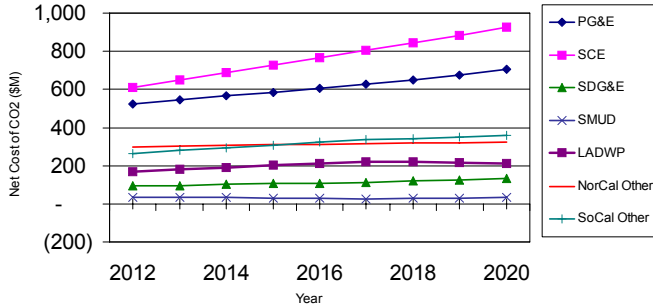
- If emission-based allocation is adopted, staff recommend:
- 100% admin. allocation starting with split between emissions and output based allocation, with transition to 100% output-based
- Allowances allocated only to fossil-fuel based generators

Year	% allocated on emissions basis	% allocated on output basis
2012	50%	50%
2013	40%	60%
2014	30%	70%
2015	20%	80%
2016	10%	90%
2017+	0%	100%

Note: The staff preference was for this scenario to reflect a transition to a partial auction, which is not reflected here.

Scenario 5: 'Preferred Emission-Based' Proposal

Net Cost of CO2 by LSE Including Increase in Market Price



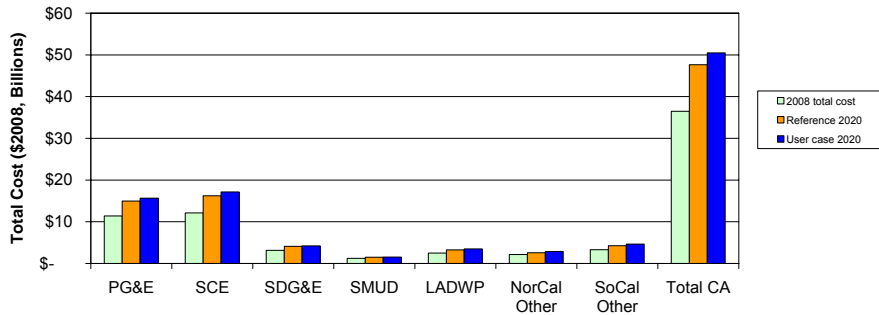
Summary
 Transition from 50% emissions, 50% output allocation to 100% output basis increases costs to high emissions LSEs and decreases costs to low emissions LSEs compared to pure emissions-based allocation.

Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

Note: The staff preference was for this scenario to reflect a transition to a partial auction, which is not reflected here.

Scenario 5: 'Preferred Emission-Based' Proposal

Comparison of 2008 and 2020 Total Cost

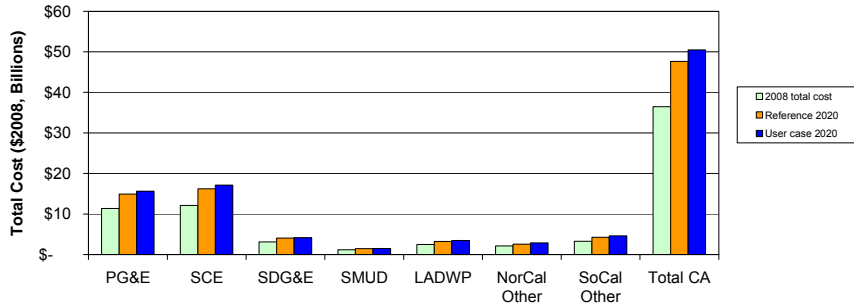


	PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Δ 2020 Ref to 2020 User Case	4.7%	5.7%	3.3%	2.2%	6.5%	12.7%	8.4%	6.0%
Δ 2008 to 2020 User Case	38%	42%	34%	28%	40%	35%	41%	38%

Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

Scenario 5: 'Preferred Emission-Based' Proposal

Comparison of 2008 and 2020 Total Utility Cost



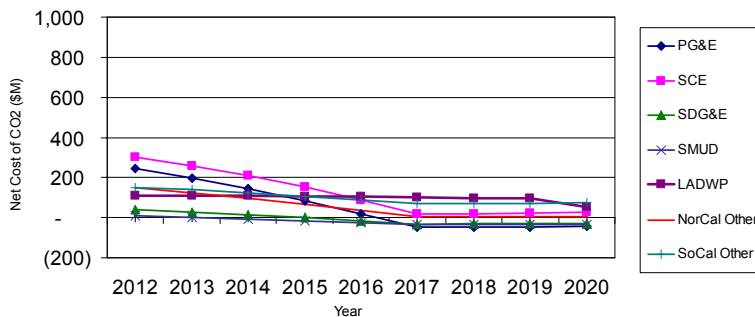
Total Utility Cost Change between 2020 Reference and 2020 User Case		PG&E	SCE	SDG&E	SMUD	LADWP	NorCal Other	SoCal Other	Total CA
Δ 2020 Ref to 2020 User Case	4.7%	4.7%	5.7%	3.3%	2.2%	6.5%	12.7%	8.4%	6.0%
Δ 2008 to 2020 User Case	38%	38%	42%	34%	28%	40%	35%	41%	38%

Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

Scenario 5MCP: 'Preferred Emission-Based' Proposal

Market clearing price for electricity includes 0% of the marginal generator's cost of CO₂

Net Cost of CO₂ by LSE Including Increase in Market Price

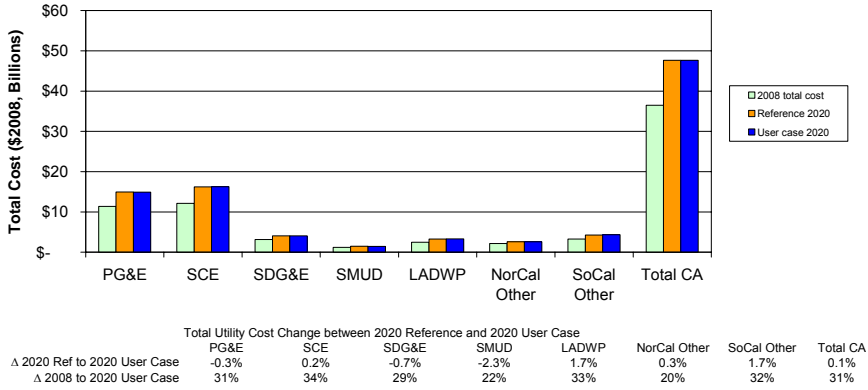


Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

Scenario 5MCP: 'Preferred Emission-Based' Proposal

Market clearing price for electricity includes 0% of the marginal generator's cost of CO2

Comparison of 2008 and 2020 Total Utility Cost

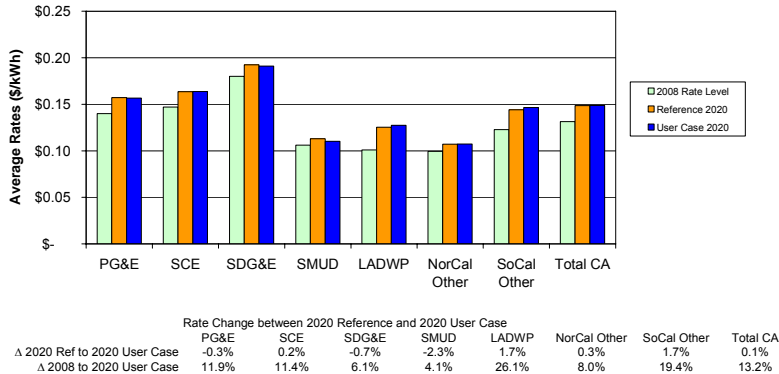


Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

Scenario 5MCP: 'Preferred Emission-Based' Proposal

Market clearing price for electricity includes 0% of the marginal generator's cost of CO2

Comparison of 2008 and 2020 Rates



Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

Scenario 6: 'Preferred Output-Based Allocation' Proposal*

- If output-based allocation is adopted, staff recommend:
- Transition to 100% auction
- Revenue recycling based on staff preferred transition btwn. 2008 emissions and LSE sales
- Allowances allocated only to non-fossil generators
 - * Note: This case is not a fuel-differentiated output based allocation as is described in the Staff Straw Proposal.
 - * Note: This includes the full price of CO2 in the market clearing price (100% MCP scenario for the output-based component).

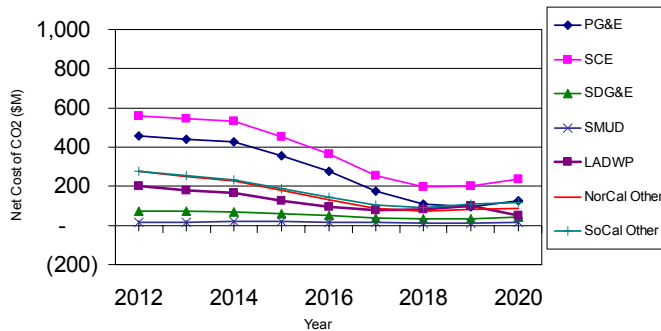
Year	% allocated on output basis	% auctioned	Revenue recycling on emissions basis	Revenue recycling on sales basis
2012	90%	10%	100%	0%
2013	80%	20%	95%	5%
2014	70%	30%	90%	10%
2015	50%	50%	85%	15%
2016	30%	70%	80%	20%
2017	10%	90%	70%	30%
2018	0%	100%	60%	40%
2019	0%	100%	50%	50%
+				

81

Scenario 6: 'Preferred Output-Based Allocation' Proposal

Transition to auction with revenue recycling

Net Cost of CO2 by LSE Including Increase in Market Price



This case is not a fuel-differentiated output based allocation as is described in the Staff Straw Proposal.

This includes the full price of CO2 in the market clearing price (100% MCP scenario for the output-based component).

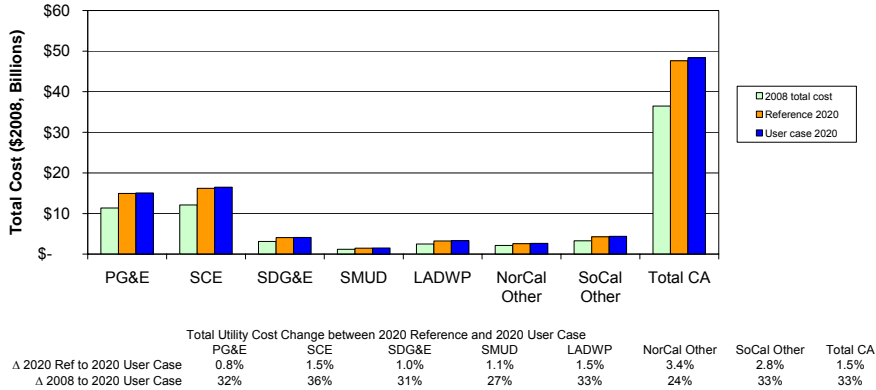
Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

82

Scenario 6: 'Preferred Output-Based Allocation' Proposal

Transition to auction with revenue recycling

Comparison of 2008 and 2020 Total Utility Cost



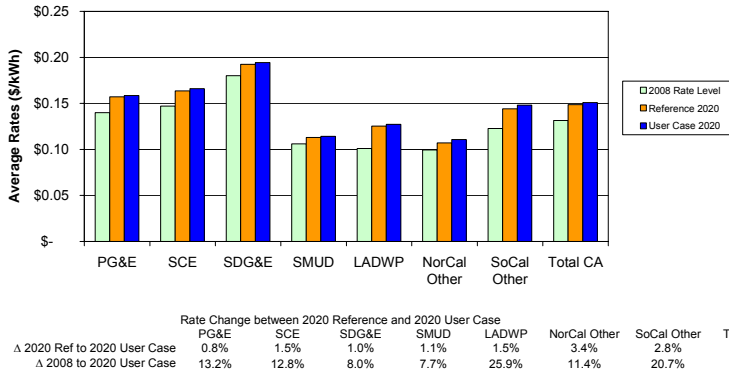
Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE



Scenario 6: 'Preferred Output-Based Allocation' Proposal

Transition to auction with revenue recycling

Comparison of 2008 and 2020 Rates



Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE



Scenario 7: 'Preferred Auction' Proposal

- 100% auction revenue recycling on historic emissions basis transitioning to sales-basis

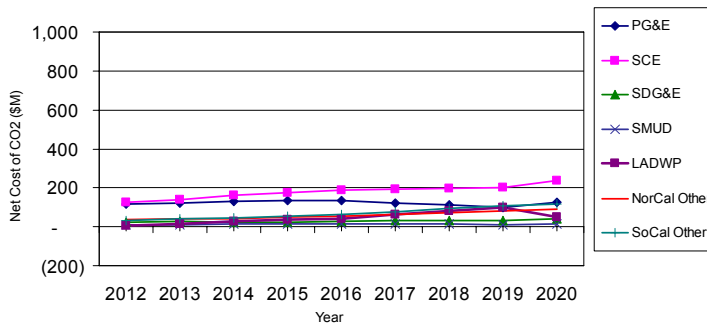
□ Note: This approach is not identical to the staff straw proposal which specifies 75% auction in the early years of the market, transitioning to 100%.

Year	Revenue recycling on emissions basis	Revenue recycling on sales basis
2012	100%	0%
2013	95%	5%
2014	90%	10%
2015	85%	15%
2016	80%	20%
2017	70%	30%
2018	60%	40%
2019+	50%	50%

85

Scenario 7: 'Preferred Auction' Proposal

Net Cost of CO2 by LSE Including Increase in Market Price



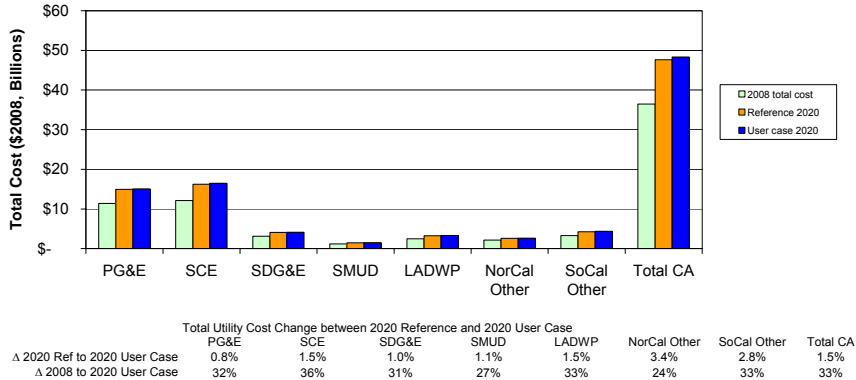
Scenario: market clearing price of \$30/t CO2, 20% RPS, BAU reference case EE

This approach is not identical to the staff straw proposal which specifies 75% auction in the early years of the market, transitioning to 100%.

86

Scenario 7: 'Preferred Auction' Proposal

Comparison of 2008 and 2020 Total Utility Cost

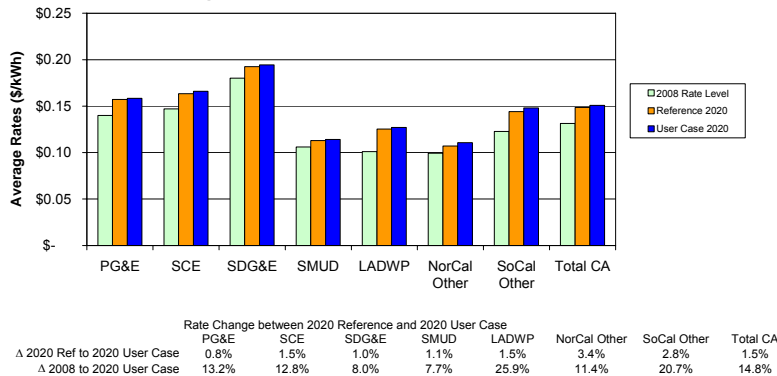


Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

This approach is not identical to the staff straw proposal which specifies 75% auction in the early years of the market, transitioning to 100%.

Scenario 7: 'Preferred Auction' Proposal

Comparison of 2008 and 2020 Rates



Scenario: market clearing price of \$30/t CO₂, 20% RPS, BAU reference case EE

This approach is not identical to the staff straw proposal which specifies 75% auction in the early years of the market, transitioning to 100%.

Thank You



Energy and Environmental Economics, Inc.