

The PEAR/UVA Study: Testing AB 32's Market Design - Allowance Holding Limits, the APCR, CPUC Purchase Limits and the CA Allowance Strategy Calculator

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The PEAR/UVA Study



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Testing AB 32's Market Design

- Power & Energy Analytic Resources (PEAR, Inc.) in Arlington, VA and the University of Virginia simulated allowance auction behaviors under varying market conditions.

VeconLab

- UVA's Vecon Lab combined with EPA's ET-Sim software and PEAR electric power modeling of the WECC simulated California's GHG allowance auctions using UVA student subjects and, separately, professional traders, market experts, regulators and academics.
- In the auction simulations experimental auction participants managed and traded hypothetical portfolios of assets and allowances.
- The PEAR Team that conducted the study: Thad Huetteman, Andy Van Horn, John Melby, Kedin Kilgore and Jan Mazurek.
- UVA economics professors are William Shobe and Charles Holt.
- Project sponsors are Pacific Gas & Electric Company, Sacramento Municipal Utility District, Southern California Edison Company, Chevron, NRG Energy, Northern California Power Authority, Southern California Public Power Authority, and the Los Angeles Department of Water and Power.

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Testing AB 32's Market Design^{cont'd}

- The PEAR and UVA auction experiments, market modeling and analysis examined
 - Auction Pricing and Banking behaviors,
 - The Role of the Allowance Price Containment Reserve,
 - Allowance Holding Limits & the Limited Exemption, and
 - CPUC Allowance Purchase Limits,for their effects on
 - Auction purchases and allowance banking,
 - Allowance price discovery, efficiency and volatility,
 - Market flexibility and liquidity.
- Stress case scenarios included conditions likely to lead to high allowance demand, such as low hydro conditions and high electric load growth.



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The PEAR/UVA Study Concludes

- The 3-tier Allowance Price Containment Reserve serves as an effective “insurance mechanism” (“seller of last resort”) and will help mitigate near-term price spikes by borrowing from future years’ allowances.
- Improving the liquidity of the market is the best defense against market manipulation. High liquidity makes market manipulation more risky, harder to achieve and less profitable.
- Tight holding limits reduced banking & market liquidity, increased price volatility, lowered efficiency and delayed reductions in greenhouse gas emissions.
- Facing the prospect of future high allowance demand periods, participants benefited from market flexibility, and costs were lower when flexibility was maximized.



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The PEAR/UVA Study Raises Issues

- Since ARB does not have authority over the futures market, it regulated holding of allowances instead.
 - This mixes together the concern about potential hold-ups by a dominant market player at compliance time with the concern over using derivatives to manipulate underlying asset prices during periods of low liquidity.
 - These concerns have different causes and different solutions.
- The quantum jump in allowance demand in 2015 increases concerns over the adverse effects of holding limits and about the buffering ability of the 3-tier APCR.
 - Should a hard price cap be added?
 - Would the in-auction release of reserves reduce the likelihood of exhausting the APCR?
 - Would using “accountability levels” instead of holding limits be more effective for California?

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For Reference

- The UVA/PEAR, Inc. Report: *“Investigation of the Effects of Emission Market Design on the Market-Based Compliance Mechanism of the California Cap on Greenhouse Gas Emissions,”* February 12, 2013.

is available for download on the University of Virginia Frank Batten School of Leadership and Public Policy website:

<http://batten.virginia.edu/content/news-events/investigation-effects-emission-market-design-market-based-compliance-mechanism>



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ARB's GHG Allowance Holding Limits, Limited Exemptions and the CPUC's Allowance Purchase Limits



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Why Are Holding Limits Important?

- Holding Limits are intended to reduce the likelihood of market power and prevent market manipulation in the relatively small California GHG allowance market.
- Holding Limits will be applied to all Current allowances combined in each entity's Holding & Compliance Accounts, and separately to Advance Allowances.
 - The Holding Limits for all Current Allowances will be reduced in each successive Budget year.
 - The Holding Limits for Advance Allowances apply separately to Advance Allowances of each specific vintage.
- Holding Limits may have unintended effects on GHG allowance banking, market liquidity, price discovery, efficiency and price volatility.

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What Effects Will Holding Limits Have?

- Each year's GHG allowance Holding Limits will be above the annual emissions of most of the affected entities. However, these limits are below the future compliance obligations of several large, higher emitting entities.
- ARB provides a Limited Exemption to holding limits for Current allowances that have been transferred from each entity's Holding Account into its Compliance Account.
 - Nevertheless, management of Limited Exemptions will be complex for firms with GHG emissions above the annual Holding Limits.
 - The need for large emitters to use Limited Exemptions will remove some Current allowances from being available for trading, leading to concerns about reduced liquidity and inadvertent market power.



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How Are CA Holding Limits Calculated?

- For all current and past vintage allowances (Current allowances) in the general Holding Account and in the Compliance Account, the combined holding limit is:

$$\text{Holding Limit} = 0.1 * \text{Base} + 0.025 * (\text{Annual Allowance Budget} - \text{Base})$$

(Where “Base” equals 25 million metric tons of CO₂e and “Annual Allowance Budget” is the number of CA GHG allowances issued for the current budget year.)

- The Holding Limit formula will be applied separately for Advance allowances from each future vintage year.



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A CFTC Formula Was Adapted by ARB

- ARB borrowed a Commodity Futures Trading Commission two-tier formula designed to address systematic risk and set federal limits on agricultural products:
 - Ten percent of the lagged open interest in contracts up to 25,000 contracts and 2.5 percent of the open interest,
 - CFTC limits may be re-set each year after review of each market's size and liquidity.
- The CFTC framework allows for higher market share in less liquid markets, but
- Established commodity markets are different from emission allowance markets, which are likely to function differently.



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ARB Holding Limits for Each Year

Year	Holding Limit (million tonnes)
2013	5.945
2014	5.868
2015	11.738
2016	11.435
2017	11.135
2018	10.833
2019	10.533
2020	10.230



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Limited Exemptions to Holding Limits

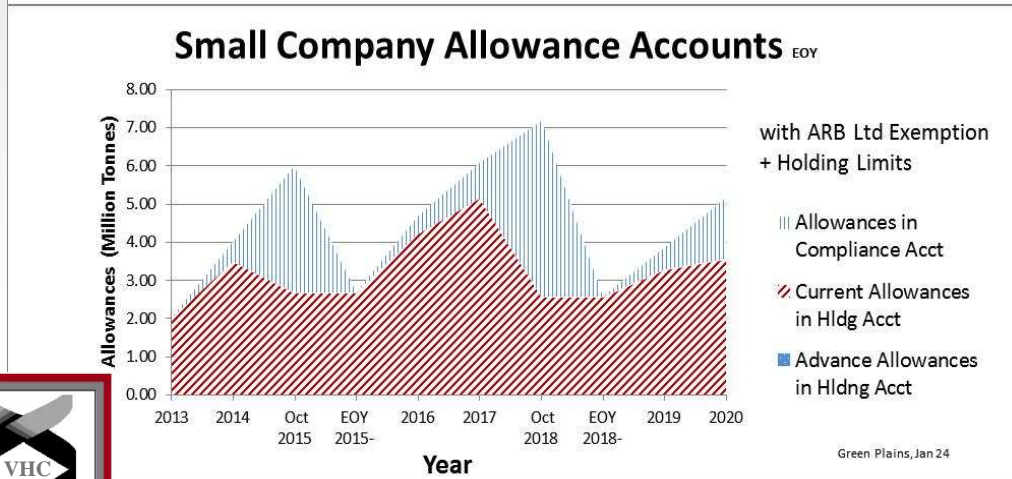
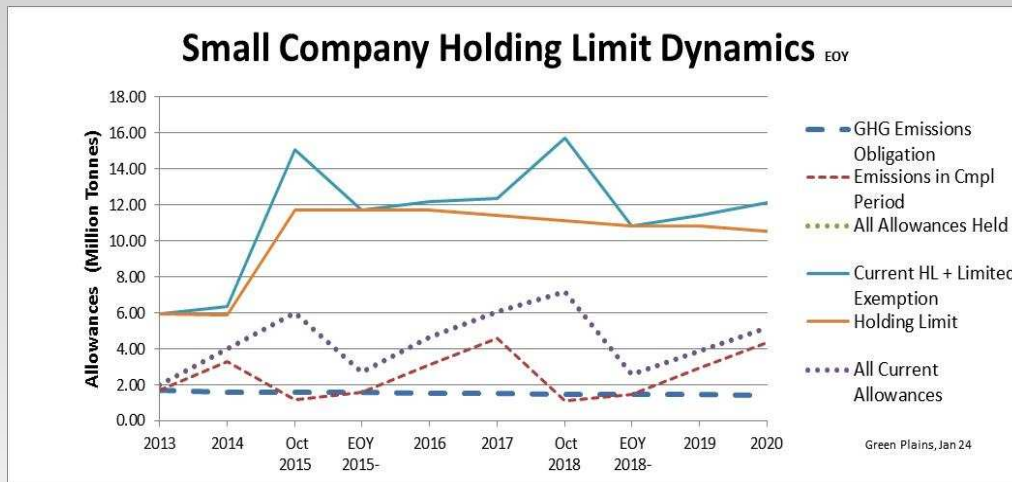
- Limited Exemptions from the Current allowance Holding Limits will exclude only allowances transferred by a covered entity or an opt-in covered entity to its Compliance Account.
 - On June 1, 2012, the maximum limited exemption will equal the annual emissions from the most recent verified emissions data report,
 - Beginning in 2013 on October 1 of each year, the maximum limited exemption will be increased by the amount of emissions contained in the most recent verified emissions data report.
 - On December 31 of the calendar year following the end of a compliance period, the limited exemption will be reduced by the sum of the entity's compliance obligation over that compliance period.



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Holding Limits Won't Directly Affect Firms with Low Annual GHG Emissions



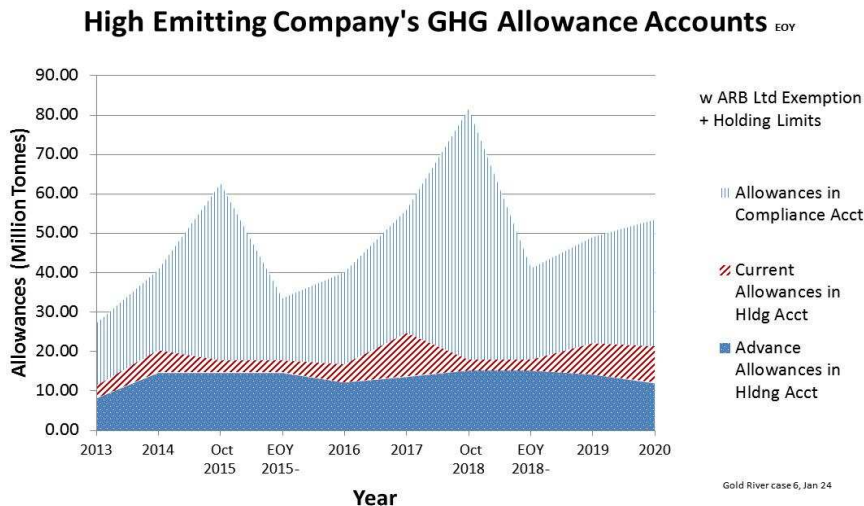
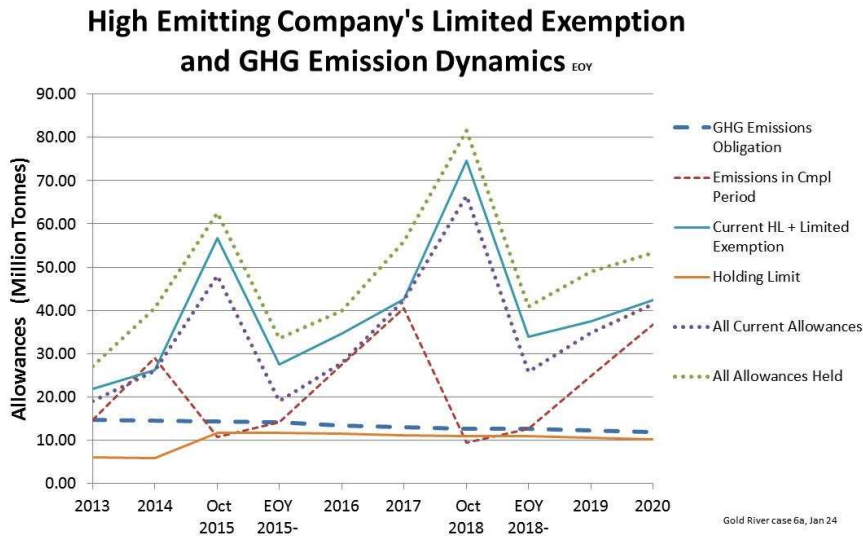
- Companies with annual emissions well below the Holding Limits are likely to purchase allowances as needed each year, rather than buying Advance allowances.
- The majority of these allowances will remain available for trading until their surrender.



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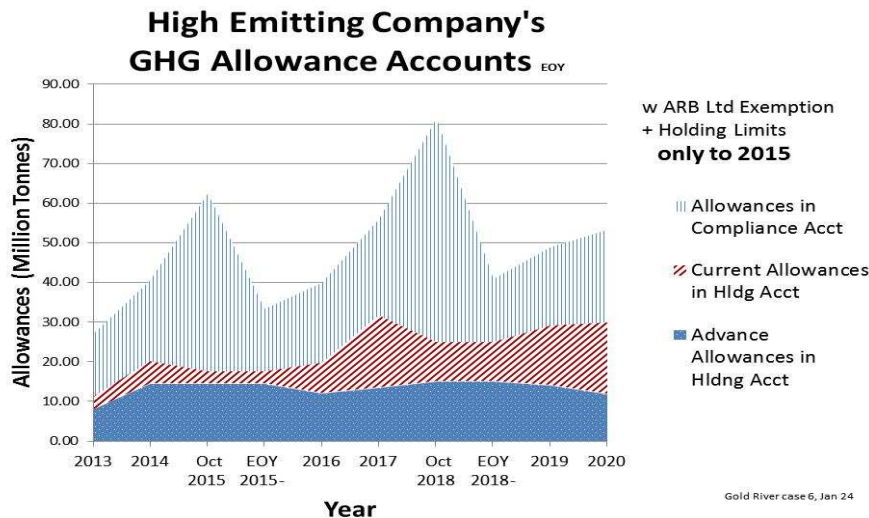
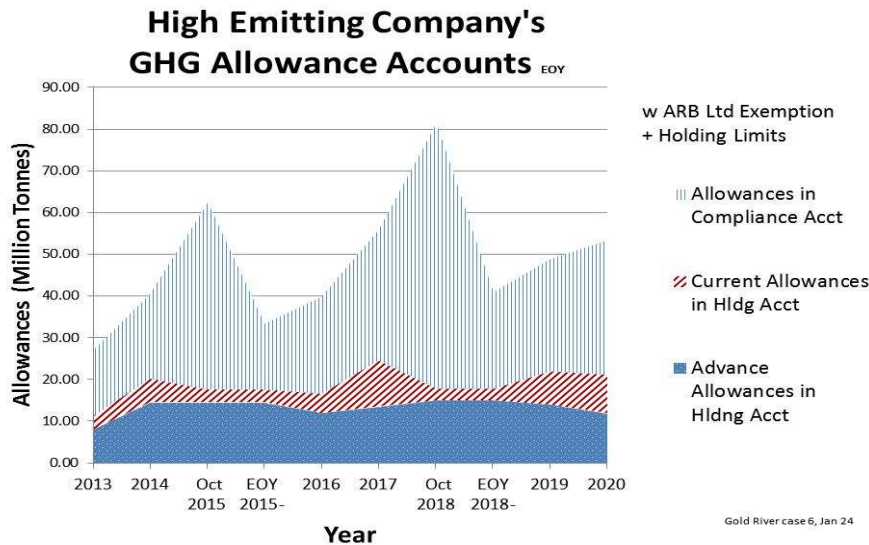


But Limits Will Affect High Emitters



- Managing the Limited Exemption (LE) will be essential for firms emitting more than the annual Holding Limits.
- The LE must be built up by acquiring & placing CA GHG allowances into the firm's Compliance Account.
- One year after the end of each Compliance Period the LE will be reduced by the amount of allowances surrendered to comply.

Allowances for Trading Will Be Reduced



- Allowances in the Compliance Account cannot be removed.
- The Holding Limit + LE requirement reduces the size of allowance banks built to accommodate uncertainties and will reduce Current allowances available for trading.
- Yet, a large entity must maintain its LE to hold sufficient allowances to comply.

Firms Constrained by ARB Holding Limits Have A Large Market Share

- ARB's holding limits will force several of the largest allowance market participants to put almost all their Current allowances into Compliance Accounts, especially before and after allowances must be surrendered in 2015 & 2018;
- In 2011, in the electricity sector there are three Electric Distribution Utilities (EDUs) in this position:
 - PG&E, SCE, and LADWP.
 - These three companies account for 74% of the total allowances allocated to the electricity sector.
- Chevron, other refiners and in 2015 fuel distributors also have an important role in market performance.



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CPUC Purchase Limits for IOUs

- ALJ Allen's LTPP decision in April 2012 defines a purchase as taking title to the allowance instrument when it is delivered. (D.12-04-046)
- Two formulae specify the CPUC's annual purchase limits:
 - Direct Compliance Obligation Purchase Limit,
 - Financial Exposure Purchase Limit.
- Under the CPUC framework, IOUs would not be allowed to purchase allowances or offsets for direct compliance needs or hedging purposes with vintages more than 3 years from the current year.



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CPUC Direct Compliance Obligation Purchase Limit

- $L_{CY} = A + (100\% * FDCY) + (60\% * FDCY+1) + (40\% * FDCY+2) + (20\% * FDCY+3)$
- Where, “L” is the maximum number of GHG compliance instruments a CPUC regulated utility “can purchase for purposes of meeting its direct compliance obligation.
- “A” is the utility’s net remaining compliance obligation to date”, calculated as the sum of the actual emissions for which the utility is responsible for retiring allowances (or purchasing on behalf of a third party) up to the Current Year (CY) minus the total allowances or offsets the utility has purchased up to the Current Year that could be retired against those obligations. This term in the calculation ensures the IOUs are always able to buy sufficient allowance to cover any prior years’ shortfalls, given that actual emissions may end up being less than forecast and/or prior decisions about how much procurement to do.
- “FD” is the utility’s forecasted compliance obligation”, the projected amount of emissions for which the utility is responsible for retiring allowances, or responsible for purchasing on behalf of a third party, calculated using an implied market heat rate (IMHR) that is two-standard deviations above the expected IMHR consistent with the approach described by PG&E.
- “CY” is the current year, i.e., the year in which the utility is transacting in the market.”



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CPUC Financial Exposure Purchase Limit

- This CPUC formula sets the specific limit on “the amount of GHG compliance instruments the IOUs can purchase to hedge their financial exposure to greenhouse gas costs under the cap & trade regime.”
- $$FL_{CY} = (20\% * FE_{CY}) + (10\% * FE_{CY+1}) + (5\% * FE_{CY+2}) + (2.5\% * FE_{CY+3}) - B$$
- “Where: “FL” is the maximum number of GHG compliance instruments that a utility can purchase for purposes of hedging their financial exposure to GHG costs.
- “FE” is an estimate of the utility’s financial exposure to GHG costs that will, or are anticipated to be, embedded in the price of energy, calculated based on the tons of CO2 for which a given IOU believes it will bear the costs through an embedded cost of carbon as reflected in energy prices. This amount does not include the costs the IOUs anticipate incurring as a result of their direct compliance obligation as “direct compliance obligation” is defined above.
- “CY” is the current year, i.e., the year in which the utility is transacting in the market.
- “B” is the utility’s net purchases of GHG compliance instruments to date for hedging purposes, calculated as the total purchases of GHG compliance instruments for purposes of hedging an IOU’s Financial Exposure up to the Current Year minus those GHG compliance instruments sold up to the Current Year. This term helps ensure that if the IOUs have hedged a lot in prior years and those hedges didn’t pay out (e.g. the price they saw in the market for carbon stayed below what they paid for a compliance instrument and so they didn’t sell the instrument) that gets factored into the amount of additional hedging they are allowed to undertake.”



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The CA Allowance Strategy Calculator



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Allowance Accounts Must Be Managed

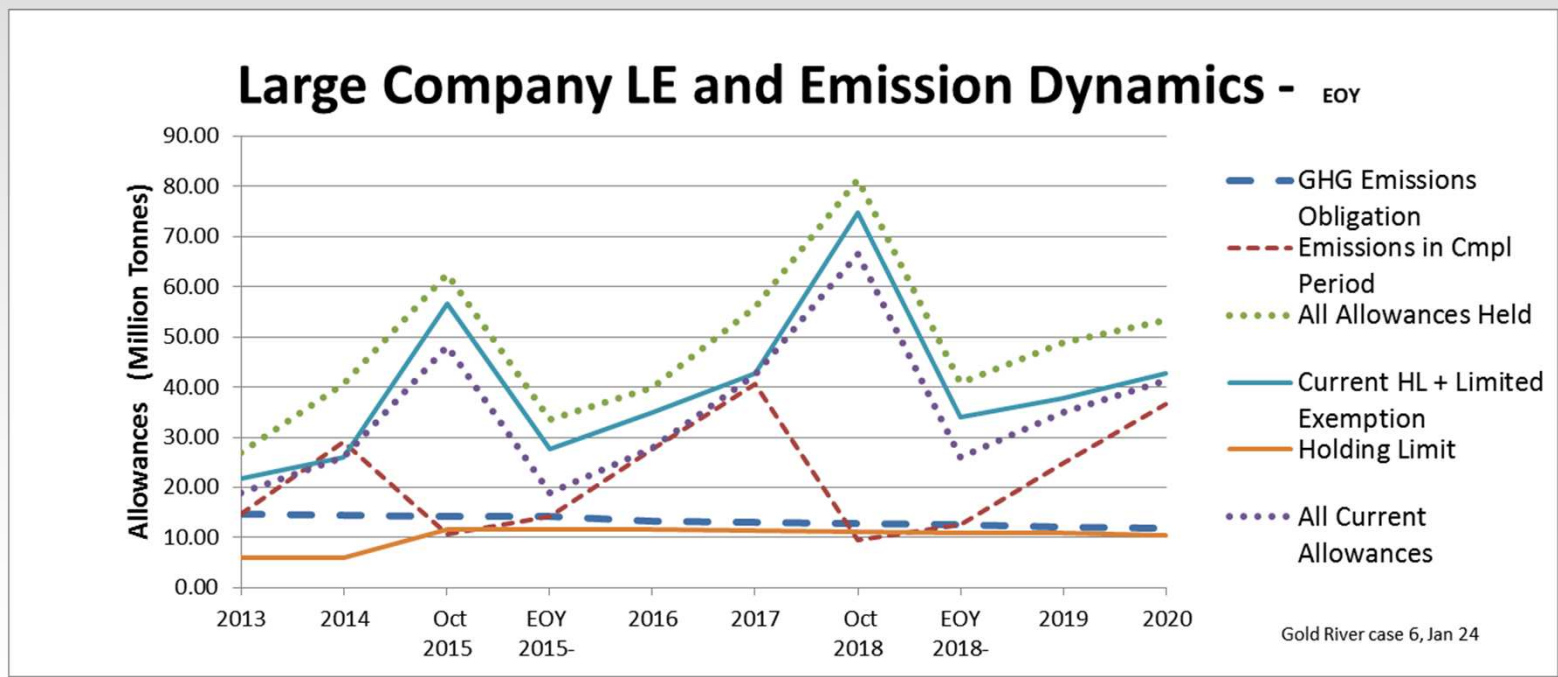
- Several account types apply to participants:
 - Holding Account – Current or Advance allowances for future compliance, which are subject to the ARB holding limits,
 - Compliance Account – from which allowances cannot be removed by the complying entity, with limited exemptions to holding limits.
 - Limited-Use Holding Account (LUHA) – only for allowances allocated to entities qualifying for direct allocations, e.g. EDUs.
 - Allowances in LUHA can only be transferred to CARB’s AHA.
 - Initially all allowances allocated to IOUs will go into LUHAs and then are consigned by each IOU across the auctions to be held in each year.
 - POU’s and co-ops must designate which allocated allowances go into their Compliance Accounts or their LUHAs.
 - Exchange Clearing Holding Account – for transactions by Voluntarily Associated Entities (VAEs), like brokers & offset project operators.
- The CA Allowance Strategy Calculator treats the Holding Account and the Compliance Account.

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Limited Exemptions Will Be Needed

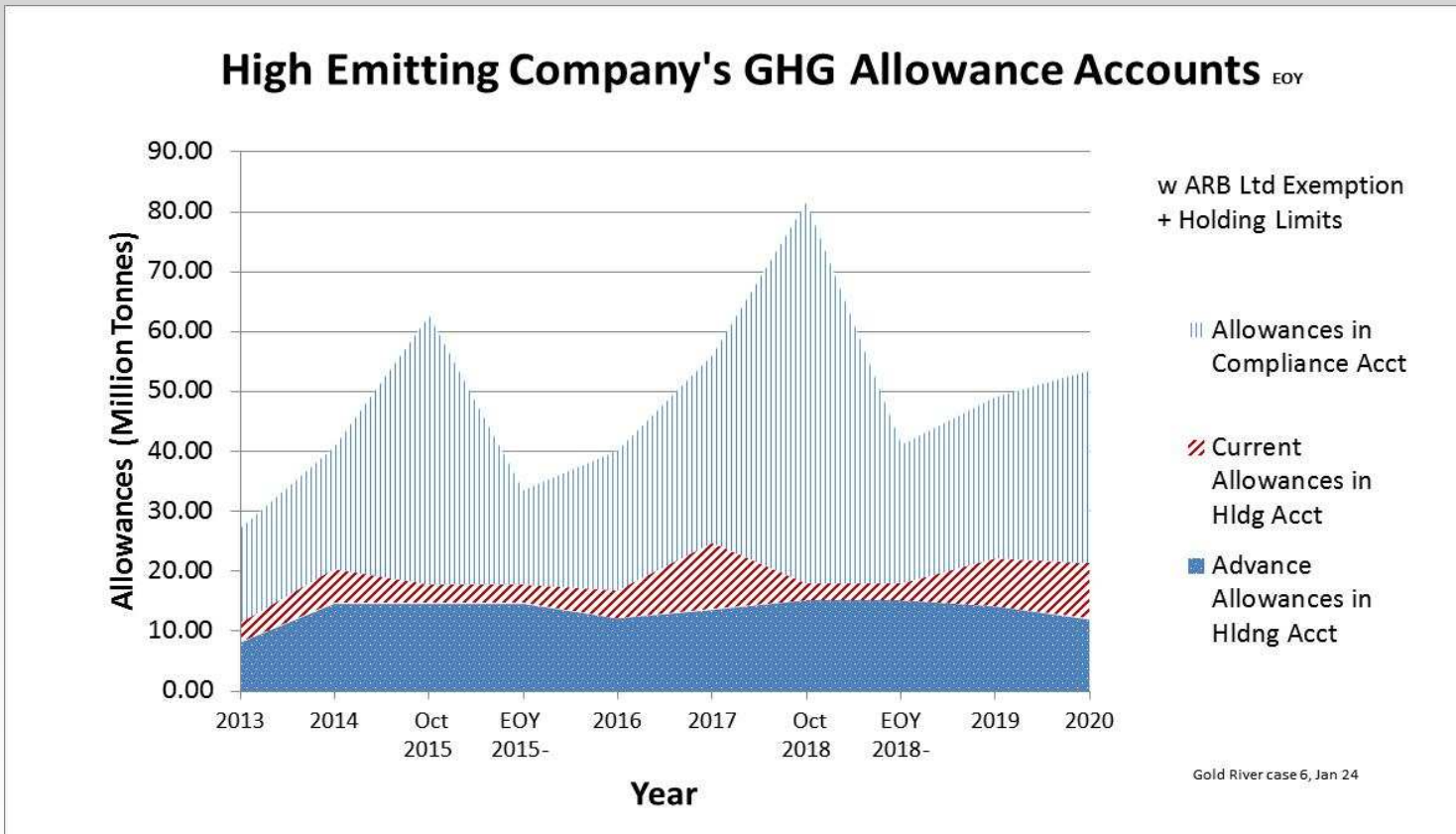
- Only Current, including this year's and prior years,' allowances in the Compliance Account can be counted toward each year's Limited Exemption (LE).
- Developing a strategy will be complex for large firms.



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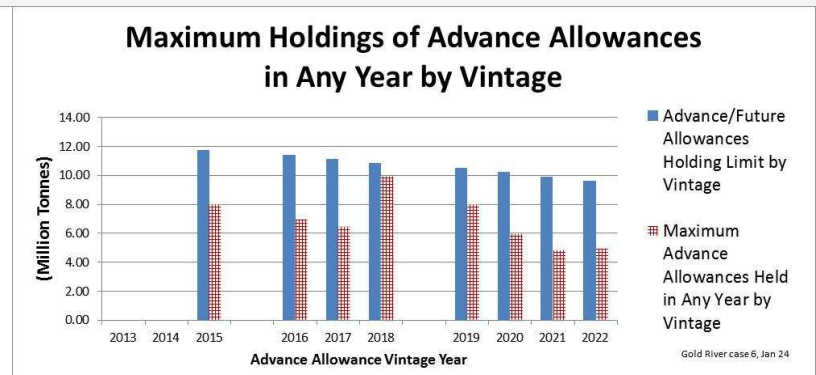
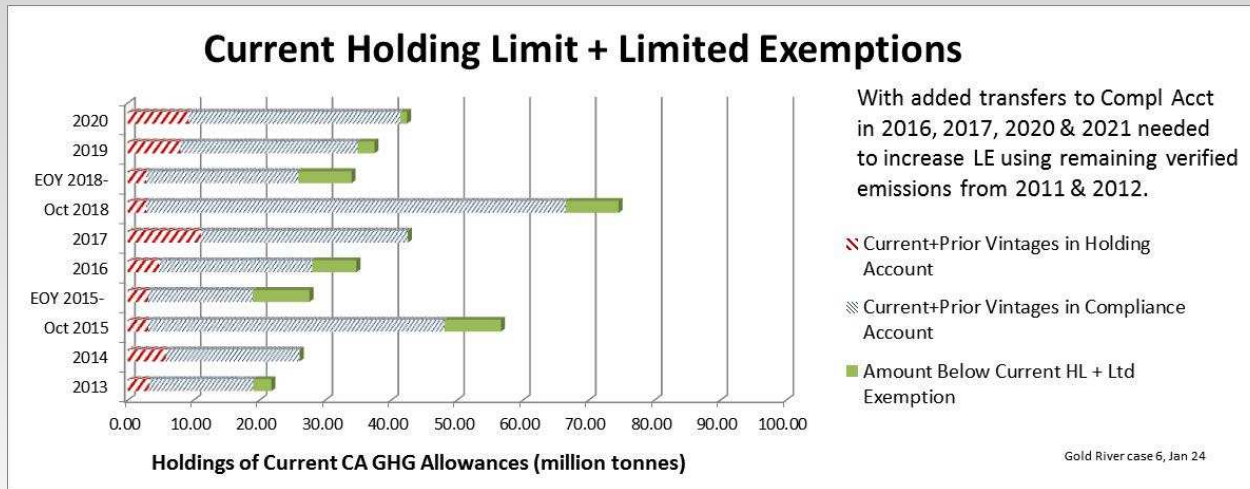
Different ARB Holding Limits Apply to Current and Advance Allowances



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The CA Allowance Strategy Calculator Compares Purchases with ARB Holding Limits & CPUC Purchase Limits



GHG ALLOWANCE COSTS Worksheet Data

These cases are for alternative CA GHG Allowance Price Trajectories applied to the purchases shown in cells Q8 to Z17 in this worksheet and in the range E8 to N1

Allowance Prices and NPV calculations

The only data to be entered in this worksheet are in green shaded cells B22 ai

Enter Data Only in Green shaded cells

Name of this case: **This Case**

Average Price Paid for Net California Carbon Allowances Acquired

CCA Acquisition Year:	CCA Vintage Year:					
	v2013	v2014	v2015	v2016	v2017	v2018
Before 2013	\$10.50	N.A.	\$10.00	N.A.	N.A.	N.A.
2013	\$15.50	N.A.	\$18.00	\$20.00	N.A.	N.A.
2014	\$20.00	\$20.00	\$25.00	\$20.29	\$23.40	N.A.
2015	\$31.00	\$31.00	\$31.00	\$22.52	\$25.97	\$29.98
2016	\$25.00	\$25.00	\$25.00	\$25.00	\$28.83	\$33.28
2017	\$32.00	\$32.00	\$32.00	\$32.00	\$32.00	\$36.94
2018	\$41.00	\$41.00	\$41.00	\$41.00	\$41.00	\$41.00
2019	\$48.00	\$48.00	\$48.00	\$48.00	\$48.00	\$48.00
2020	\$50.00	\$50.00	\$50.00	\$50.00	\$50.00	\$50.00
2021	\$50.00	\$50.00	\$50.00	\$50.00	\$50.00	\$50.00

Enter Prices Only in Green Shaded Cells (Nominal \$/tonne)

cells Q8 to Z17 in this worksheet and in the range E8 to N1

(Million Tonnes)	(Nominal \$/Tonne)			
	v2019	v2020	v2021	v2022
	N.A.	N.A.	N.A.	N.A.
	N.A.	N.A.	N.A.	N.A.
	N.A.	N.A.	N.A.	N.A.
	N.A.	N.A.	N.A.	N.A.
	\$35.10	N.A.	N.A.	N.A.
	\$38.96	\$36.56	N.A.	N.A.
	\$43.24	\$40.58	\$36.56	N.A.
	\$48.00	\$45.05	\$40.58	\$40.58
	\$50.00	\$50.00	\$45.05	\$45.05
	\$50.00	\$50.00	\$50.00	\$50.00

Data Entered in GHG ALLOWANCE COSTS cells E8 to N17

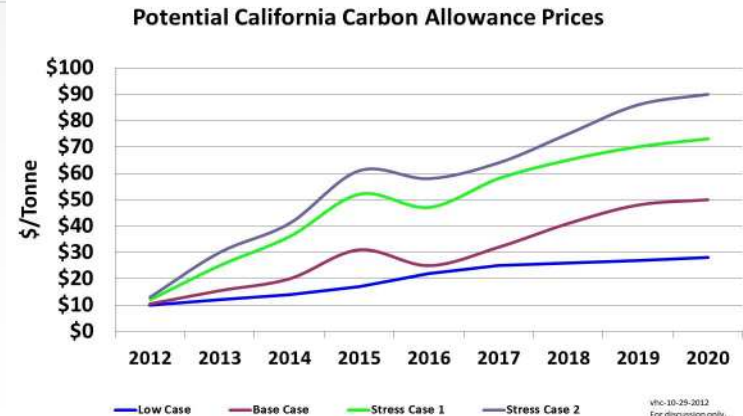


CCA PRICES Wrksheet – Alternate Prices

11/5/2012		CCA GHG Allowance Prices	Scenario Price Expectations	Nov 2012 Auction									
			Annual Avg. Price				Nominal \$/Tonne						
Enter rates here:			Scenarios	2012	2013	2014	2015	2016	2017	2018	2019	2020	
nominal year \$			Low Case	\$10.00	\$12.00	\$14.00	\$17.00	\$22.00	\$25.00	\$26.00	\$27.00	\$28.00	
Average CPI inflation rate:			Base Case	\$10.50	\$15.50	\$20.00	\$31.00	\$25.00	\$32.00	\$41.00	\$48.00	\$50.00	
will vary each year 2.50%			Stress Case 1	\$12.00	\$25.00	\$36.00	\$52.00	\$47.00	\$58.00	\$65.00	\$70.00	\$73.00	
Fixed APCR & Reserve Price Escalation			Stress Case 2	\$13.00	\$30.00	\$41.00	\$61.00	\$58.00	\$64.00	\$75.00	\$86.00	\$90.00	
fixed by regulation 5.00%			Price of Allowance Price Containment Reserve (APCR) Tiers										
Annual Escalation			APCR Tier 1	\$40	\$40.00	\$42.86	\$46.08	\$49.53	\$53.25	\$57.24	\$61.54	\$66.15	\$71.11
Allowance Price Escalation 1.1100			APCR Tier 2	\$45	\$45.00	\$48.22	\$51.84	\$55.73	\$59.91	\$64.40	\$69.23	\$74.42	\$80.00
APCR Tier Price Escalation 1.0750			APCR Tier 3	\$50	\$50.00	\$53.58	\$57.60	\$61.92	\$66.56	\$71.55	\$76.92	\$82.69	\$88.89
Discounting Adder for Prices to be paid for Advance Allowances 3.50%			Minimum Reserve Price	\$10.00	\$10.71	\$11.51	\$12.38	\$13.30	\$14.30	\$15.38	\$16.53	\$17.77	
Discount Rate for NPV: 8.50%													
from GHG ALLOWANCE COSTS													

**Base Case CA GHG Allowance Prices
Are Entered In GHG Allowance Costs worksheet
All other price scenarios are entered in this Worksheet**

	2021	2022	2023
	\$30.00	\$32.00	
	\$50.00	\$50.00	
	\$75.00	\$75.00	
	\$93.00	\$95.00	
	\$76.45	\$82.18	
	\$86.00	\$92.45	
	\$95.56	\$102.73	
	\$19.10	\$20.53	



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DATA Worksheet – Data & Flags

Cap-and-Trade Holding Limits	California GHG Allowance Calculations
§ 95920. Trading.	
Enter total company annual emissions in columns F & G	
Enter (UOG + covered purchases) emissions percentage in column G	
Instructions are below:	
DO NOT CHANGE ANY CELLS OTHER THAN THOSE FOR DATA ENTRY:	See cells A1 to C26 in DATA
If this hypothetical company is NOT an IOU , enter: NOTIOU in cell B10	
Otherwise leave blank =====>	
or enter: IOU in cell B9	IOU
CPUC Emission Forecast Multiplier > or = 1.0	
CPUC 2 std dev multiplier based on IMHR applies for all years.	
suggested range from 1.2 to 1.3	1.2
DATA ENTRY: Only enter data in these cells:	
Historical and Forecast Emissions by Year	
for Emissions in Compliance Period 1 Scope:	
Cells F11 to F23	
for Emissions Added in Compliance Period 2	
Cells G13 to G23	
California GHG Allowance Purchases	
Cells B30 to K39, Avoid N.A., Check Limits	
Allowance Transfers: Gen'I Holding to Compliance Account	
Cells X12 to AG21, Avoid N.A., Check X24,Y24, X23-AG23	
CHECK LIMITS and TRANSFER VIOLATIONS	
Watch E24-E25, F24, L31-L38, D58-K67, B68-K68, O30-O38,	
X24, Y24 & X23 to AG 23, C42, E43, H43, & R55, V55	
to check for violations or to buy or transfer more allowances.	

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DATA Worksheet – Data & Flags^{cont'd}

Verified Historical & Forecasted Future GHG Emissions

Input Emissions Data in DATA cells F11 to G23				cells J11 to J23 in DATA	
Year	Million Tonnes CO2e Annual Total Electric + Fuel Emissions Forecast			Percent Emissions Obligation for UOG+Electric EDU Compliance	
	CP1 scope	Added in CP2		Year	Year
2011	25.00	0.00	25.00	65.00%	2011
2012	23.75	0.00	23.75	65.00%	2012
2013	22.56	0.00	22.56	65.00%	2013
2014	22.18	0.00	22.18	65.00%	2014
2015	21.85	0.00	21.85	65.00%	2015
2016	20.59	0.00	20.59	65.00%	2016
2017	19.97	0.00	19.97	65.00%	2017
2018	19.38	0.00	19.38	65.00%	2018
2019	18.79	0.00	18.79	65.00%	2019
2020	18.23	0.00	18.23	65.00%	2020
2021	18.15	0.00	18.15	65.00%	2021
2022	18.40	0.00	18.40	65.00%	2022
2023	18.05	0.00	18.05	65.00%	2023
Flags to	O.K.	O.K.			
Watch	CHECK the HOLDING ACCT BALANCE AND LIMITS CAREFULLY as per DATA cells A25 & A26				

Only enter data in green shaded cells. Protect all other cells.

See also cells B9 and B12 in DATA worksheet

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DATA Worksheet – Data & Flags^{cont'd}

Net Allowance Acquisitions in each year Are Entered in this Array.

Net California Carbon Allowances Acquired in Each Year by Vintage										
GHG Allowance Acquisition Year:	(Million Tonnes)			California GHG Allowance Vintage (Million Tonnes)						
	v2013	v2014	v2015	v2016	v2017	v2018	v2019	v2020	v2021	v2022
Before 2013	4.05	N.A.	2.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
In 2013	15.00	N.A.	3.00	3.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
2014	0.00	7.00	3.00	2.00	1.50	N.A.	N.A.	N.A.	N.A.	N.A.
2015	0.00	10.00	4.00	2.00	1.00	2.50	N.A.	N.A.	N.A.	N.A.
2016	0.00	0.00	0.00	2.00	4.00	3.50	1.00	N.A.	N.A.	N.A.
2017	0.00	0.00	0.00	2.00	6.00	4.00	2.00	2.00	N.A.	N.A.
2018	0.00	0.00	0.00	0.00	5.00	9.00	5.00	2.00	2.00	N.A.
2019	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.00	1.90	2.00
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	1.00	2.00
2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	7.00	1.00
Total Bought by Vintage	19.05	17.00	12.00	11.00	17.50	19.00	9.00	7.50	11.90	5.00
		February 13, 2013								

CA GHG Allowance Acquisitions by Year & Vintage

As Entered in DATA worksheet Cells B30 to K39

Only enter data in green shaded cells. Protect all other cells.



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DATA Worksheet – Data & Flags^{cont'd}

Flags Indicate Compliance with ARB Holding Limits for Current Allowances and CPUC Purchase Limits

Allowed in Each Year by Vintage					ARB Holding	CPUC IOU		
Advance Vint: (Million Tonnes)					Limit Test	Total CCAs	Purchase Limit	
v2018	v2019	v2020	v2021	v2022	Current & Prior	Required each Year	This Year	
					Year Vintages	Including Offsets		
N.A.	N.A.	N.A.	N.A.	N.A.		6.05	20.89	O.K. w CPUC
N.A.	N.A.	N.A.	N.A.	N.A.	O.K. w ARB	21.00	33.96	O.K. w CPUC
N.A.	N.A.	N.A.	N.A.	N.A.	O.K. w ARB	13.50	32.68	O.K. w CPUC
2.50	N.A.	N.A.	N.A.	N.A.	O.K. w ARB	19.50	38.97	O.K. w CPUC
3.50	1.00	N.A.	N.A.	N.A.	O.K. w ARB	10.50	29.62	O.K. w CPUC
4.00	2.00	2.00	N.A.	N.A.	O.K. w ARB	16.00	32.98	O.K. w CPUC
9.00	5.00	2.00	2.00	N.A.	O.K. w ARB	23.00	30.53	O.K. w CPUC
0.00	1.00	2.00	1.90	2.00	O.K. w ARB	6.90	18.42	O.K. w CPUC
0.00	0.00	0.50	1.00	2.00	O.K. w ARB	3.50	21.18	O.K. w CPUC
0.00	0.00	1.00	7.00	1.00	O.K. w ARB	9.00		
19.00	9.00	7.50	11.90	5.00	O.K. w ARB	113.90		
					All Purchases			
					Assumed by Oct 1.			Check cells L30 to Q39
					of each year.			

Only enter data in green shaded cells. Protect all other cells.
ARB Limit Flags for Advance Allowances are in cells DATA B58 to K67

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DATA Worksheet – Data & Flags^{cont'd}

ARB Holding Limits for Advance Allowances Are Flagged by Vintage

Holding Limit for Advance CCAs

These cells are linked to purchases above in corresponding cells. If "ARB violation" shows below, then reduce purchases of future vintage allowances. Check row 69.

DO NOT ENTER DATA in this matrix

Year:	Advance / Future CCAs Held in Each Year by Vintage							
	v2013	v2014	v2015	v2016	v2017	v2018	v2019	v2020
Before 2013	N.A.	N.A.	2.00	N.A.	N.A.	N.A.	N.A.	N.A.
2013		N.A.	3.00	3.00	N.A.	N.A.	N.A.	N.A.
2014			3.00	2.00	1.50	N.A.	N.A.	N.A.
2015				2.00	1.00	2.50	N.A.	N.A.
2016					4.00	3.50	1.00	N.A.
2017						ARB VIOLATION	2.00	2.00
2018							5.00	2.00
2019								2.00
2020								
2021								
Future CCAs by Vintage	0.000	0.000	8.000	7.000	6.500	11.000	8.000	6.000
Advance / Future Vintage CCAs	N.A.	N.A.	11.738	11.435	11.135	10.833	10.533	10.230
Holding Limit by Vintage Year								
Not by Calendar Year								

Check cells B58 to K69 in DATA for Advance Allowance holding violation flags.



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DATA Worksheet – Data & Flags^{cont'd}

Transfers to the Compliance Account and Use of Verified Emissions to Create Limited Exemptions Are Entered Here

Annual Transfer of CCAs to Compliance Account Used to Calculate Limited Exemption & Holding Limits, subject to ARB Holding Limits and CPUC Purchase Limits,
cols Fraction of Each Year's Emissions Compliance Obligation to Transfer in the Designated Years after the Emissions Year, assuming sufficient purchases
====> X & Y: Prior Emissions Year: ARB Holding limits and allowed purchases will be maximized if 2011 and 2012 L.E. emissions are fully c

CCA Transfer Year: to Compliance Account	E 2011 2012		E2013 2014		Emissions Year:						CCAs to try to by EOYr in this Year
	Electric LE	Fuel LE	E2013	E2014	E2015	E2016	E2017	E2018	E2019	E2020	
2013 2011 GHG	0.50	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	
2013 2012GHG	0.50	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	15.84
2014 2013FuelGHG		1.00	0.30	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	4.40
2015 2014FuelGHG		1.00	0.70	1.00	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	24.68
2016	0.10		N.A.	N.A.	0.30	N.A.	N.A.	N.A.	N.A.	N.A.	7.43
2017	0.13		N.A.	N.A.		0.30	N.A.	N.A.	N.A.	N.A.	8.13
2018			N.A.	N.A.	0.70	0.70	1.00	N.A.	N.A.	N.A.	32.29
2019			N.A.	N.A.	N.A.	N.A.	N.A.	0.30	N.A.	N.A.	3.78
2020	0.05		N.A.	N.A.	N.A.	N.A.	N.A.		0.30	N.A.	5.25
2021	0.30		N.A.	N.A.	N.A.	N.A.	N.A.	0.70	0.70	1.00	38.72
2022											
2023	See R55	See V55	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	AI to CALC D77-C
Total CCAs	34.22	0.00	14.67	14.42	14.20	13.38	12.98	12.59	12.22	11.85	128.69
to try to transfer to	31.69	0.00	Z23 to AG 23 should all = 1.0. Use X12-X21 and Y14-Y21 to build Limited Exemptions.						140.54		
Compliance Acct by vintage	Do Not Exceed Historical Verified Emissions				Transfers will be deferred to the next year,						
Ratio Genl/Total	Ensure x24<x25 and Y24<Y25.				if not enough allowances are in the General Account.						
	TOO MANY TR	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.	

Enter transfer fractions in DATA X12 to AG21



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DATA Worksheet – Data & Flags^{cont'd}

Key Cells to Check Holding Limits, Banking Ratios, Compliance and Estimated NPV of Allowance Purchases

To test purchases check results in DATA cells M45 to O53 & B42 to J50	Year	All Purchases Assumed by Oct 1. of each year.		Current & Prior Year - L.E.+ Holding Limits	Reduction in Current or Prior Year Purchases Needed! Negative # is required! to meet Holding Limit	
		113.90				
		Current & Prior Yr CCAs Held in Year				
	2013	19.05	21.79	-2.74	-2.74	
	2014	26.05	26.11	-0.06	-0.06	
	2015	18.97	27.58	-8.61	-8.61	
	2016	27.97	34.71	-6.74	-6.74	
	2017	42.47	42.54	-0.08	-0.08	
	2018	25.90	33.96	-8.07	-8.07	
	2019	34.90	37.44	-2.55	-2.55	
	2020	41.40	42.39	-0.99	-0.99	
	2021	17.64	36.23	-18.59	-18.59	

		Check cells L31 to L38, D58 to K67 and B68 to K68 for ARB Holding Limit Violations								
	21.79	O.K.	Check cells O30 to O38 for CPUC Purchase Limit Violations							
Useful in Compliance Period if in Compl Acct		36.05	O.K.	47.47	O.K.	42.40				
CCA Obligation in ComPeriod		29.08		40.57		36.66				
~Ratio of Bank to CP Need	0.66	0.90	0.70	0.85	1.29	1.03	1.12	1.13		
	end 2013	end 2014	end 2015	end 2016	end 2017	end 2018	end 2019	end 2020		
		by Nov 1, 2015:	1.24		by Nov 1, 2018:	1.17		by Nov 1, 2021:		
No Advance / Future CCAs are put in Compliance Account			(Millions of Nominal Dollars)	Net Present Value of Allowance Acquisition thru 2020 as of 1/1/2013						
Advance Holding Limit Applies by Yr for each Advance Vintage			NPV 2013 thru 2020 =	\$2,510	\$2,558	\$1,679	\$4,164			
			NPV as 1/01/2013	This Case	Base Case	Low Case	Stress Case 1			

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GRAPHS Worksheet – Tables & Graphs

GHG Emissions Obligation		Results for this Strategy		
Base Scenario	Emissions in Cmpl Period			
GHG tonnes				
Emissions	Cumulative	CPUC Purchase Limit - ^A Allowances Purchased - All Vintages		
Compliance	Emissions in	by Calendar Year	by Calendar Year	
Obligation	Cmpl Period	All Vintages	All Vintages	
(million tonnes)	(million tonnes)			
		20.89	6.05	Before 2013
14.67	14.67	33.96	21.00	2013
14.42	29.08	32.68	13.50	2014
14.26	10.65	38.97	19.50	Oct 2015
14.20	14.20	0.00	0.00	EOY 2015-
13.38	27.59	29.62	10.50	2016
12.98	40.57	32.98	16.00	2017
12.69	9.45	30.53	23.00	Oct 2018
12.59	12.59	0.00	0.00	EOY 2018-
12.22	24.81	18.42	6.90	2019
11.85	36.66	21.18	3.50	2020
			9.00	2021
				2022



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GRAPHS Worksheet – Tables & Graphs

Results for this Strategy

Case 6 with Holding Limits in All Years								Holding Limit For Current & Prior Year Allowances in General Holding & Compliance Accts for each Budget Year (million tonnes)
PEAR-VHC CA Allowance Strategy Calculator_GoldRiver-Feb14-Case6a.xlsx								
Year	Total Advance CCAs Held in Year (All Advance CCAs Are in Gen'l Holding Acct) (million tonnes)	Total Current+Prior Year CCAs in Gen'l Holding Acct (End-of-Year) (million tonnes)	Total Allowances in Compliance Account	All Allowances Held Current + Prior + Advance	All Current Allowances + Prior Yr	Limited Exemptior LE. Year CCAs in Compl Acct (million tonnes)	Holding Limit plus Limited Exemptions for Current + Prior Year CCAs (million tonnes)	
Before 2013	2.00		0.00	2.00		0.00		
2013	8.00	3.21	15.84	27.05	19.05	15.84	21.79	
2014	14.50	5.81	20.24	40.55	26.05	20.24	26.11	
Oct 2015	14.50	3.12	44.93	62.55	48.05	44.93	56.66	
EOY 2015-	14.50	3.12	15.84	33.47	18.97	15.84	27.58	
2016	12.00	4.69	23.27	39.97	27.97	23.27	34.71	
2017	13.50	11.06	31.41	55.97	42.47	31.41	42.54	
Oct 2018	15.00	2.76	63.70	81.47	66.47	63.70	74.54	
EOY 2018-	15.00	2.76	23.13	40.90	25.90	23.13	33.96	
2019	14.00	7.99	26.91	48.90	34.90	26.91	37.44	
2020	11.90	9.24	32.16	53.30	41.40	32.16	42.39	
							9.930	



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GHG ALLOWANCE COSTS Worksheet

– NPV Calculation Results

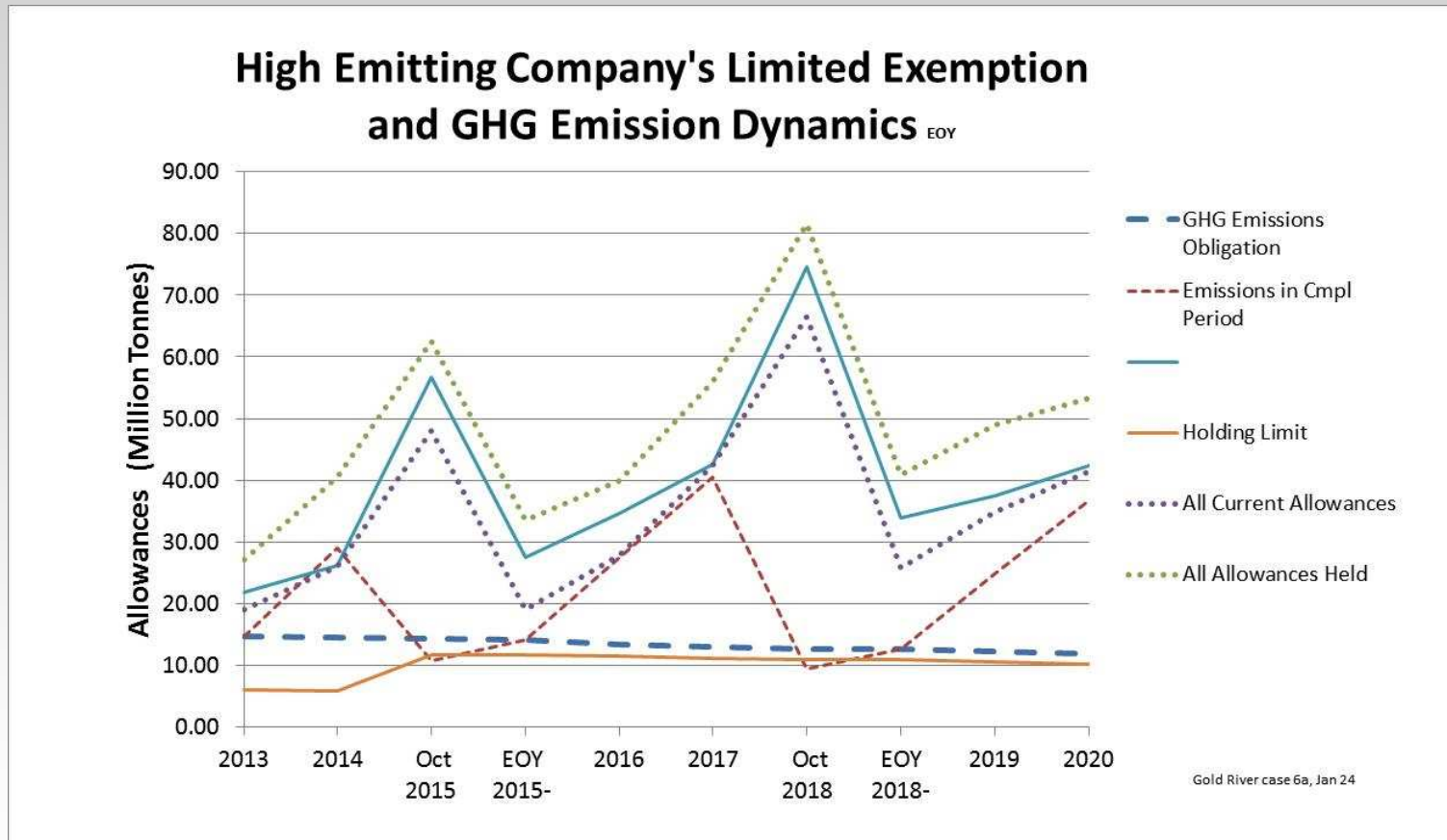
Discount Rate for NPV:	Nominal \$ (million \$)	Projected Costs of Allowance Purchases with NPV thru 2020 as of January 1, 2013						Average of Five Cases' Annual Cost
		Case 1 This Case	Case 2 Base Case	Case 3 Low Case	Case 4 Stress Case 1	Case 5 Stress Case 2		
8.50%	Year							
	Before 2013	\$62.5	\$87.9	\$65.4	\$124.6	\$141.9	\$96.4	
	2013	\$346.5	\$362.8	\$269.7	\$604.7	\$725.8	\$461.9	
	2014	\$290.7	\$299.5	\$207.1	\$532.4	\$616.2	\$389.2	
	2015	\$580.0	\$580.0	\$345.5	\$978.6	\$1,147.5	\$726.3	
	2016	\$316.9	\$316.9	\$227.7	\$538.8	\$622.6	\$404.6	
	2017	\$554.8	\$554.8	\$378.5	\$918.6	\$1,053.5	\$692.0	
	2018	\$944.5	\$944.5	\$574.9	\$1,453.5	\$1,719.5	\$1,127.4	
	2019	\$296.4	\$296.4	\$175.7	\$438.9	\$545.8	\$350.6	
	2020	\$160.1	\$160.1	\$98.7	\$239.2	\$300.0	\$191.6	
	2021	\$450.0	\$450.0	\$272.0	\$675.0	\$839.0	\$537.2	
		NPV 2013 thru 2020	\$2,510.2	\$2,558.0	\$1,679.3	\$4,163.6	\$4,900.9	\$3,162.4
	NPV as 1/01/2013		Million \$					



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Principal Results Are Given in the RESULTS & GRAPHS Worksheets



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