Attachment C

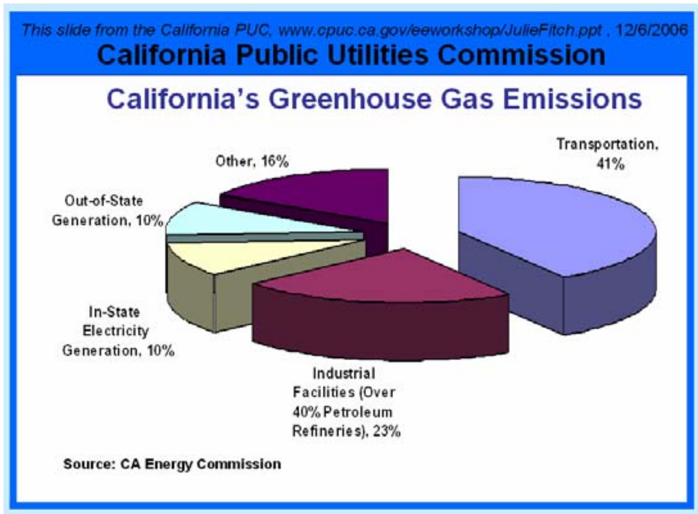
Oil Refinery Sector Recommendations

Summary: **Reduce California Refinery GHG & Other Emissions, Reduce Product Demand**

	DIRECT GHG REDUCTION METHODS	BENEFITS & BARRIERS
1. Require Oil Refineries to become more efficient *→NO TRADING: Reductions generated through cleaning up oil refineries are necessary for local, regional, and global public health*	• **Energy Efficiency Audit for every refinery →require BACT first for biggest sources** Up front BACT for already-known big energy users (don't wait to finish audits) for Hydrogen Plants, Hydrotreaters, Hydrocrackers, Cracking, Coking, including Boilers & Heaters. [Many have grandfathered exemptions from modernized emission standards.] • Cogeneration from Waste Heat, audit efficiency & indirect impacts, require BACT • **Remove all Methane Exemptions in smog regulations for refineries and all sources** • No dumping and burning of "waste" gases: Flare BACT/LAER (beyond BAAQMD & SCAQMD requirements) -- Apply Shell Martinez BACT model – far lower flaring than other refineries, Pressure Relief Devices: Ban venting to atmosphere • **Set goal for reduction in Refinery Emissions & Product Demand (e.g. 25% by 2020)**	• Local pollution down, Jobs Up • **Direct Controls avoid pollution trading pitfalls** (failure to address local health impacts, creating toxic hotspots by trading for clean-up elsewhere, major accounting errors due to poor baselines lack of monitoring, toxic co-pollutant inequalities, lack of public input) • Refiner cost up in short term, probably mid term savings
2. Stop refinery expansions & the switch to dirty crude oil	• Crude Oil carbon input standard to stop the switch to dirtier crude oils in the state • No new fossil fueled Hydrogen Plants, Hydrocrackers, Cokers, etc. associated with switch to high carbon, dirty crude, and refinery expansions • Carbon tax & windfall profit taxes to fund clean alternative energy and jobs transition • Low Carbon Fuel Standard must have full cradle-to-grave analysis of heavy crude impact on gas & diesel carbon content & must not undermine refinery regulation. LCFS must be designed not to hide high-carbon gasoline by adding corn ethanol to make the total seem lower carbon (while avoiding full cradle-to-grave ethanol carbon analysis, & smog & water pollution impacts analysis.)	• Local criteria & toxics go down • Increase in sustainable jobs when done with demand reduction -- need for green jobs transition & worker protections while reducing demand for fossil fuels, but jobs are also created in 1, 3, and 4 • Higher crude oil cost, but no need for high cost of adding new energy-intensive hydrogen, coking, etc.
3. Switch refinery grid electricity use to clean energy	• Refineries are current large users of fossil fuel grid electricity & should be required to switch to clean alternative energy electricity, frequently buildable on refinery land	• Local pollution down & Jobs go up (alternatives create more jobs) • Refiner costs up
4. Reduce demand for California Oil Refinery Products	**CARS -- Fund urban core transit systems equitably for EJ, transit system rebuilding and conservation,** CAFÉ standards, plug-in hybrids, alternative fuels **POWER PLANTS** -- Alternatives, efficiency, low carbon inputs **TRUCKS & SHIPPING** – Efficiency, electrification **ALL SOURCES** – CARBON TAX	• Many savings, solve smog • Cleaner cars -- Political barriers • Public transit - high initial costs • Shipping costs • More and different jobs from public transit, and alternatives

Background on CBE Oil Refinery Recommendations for AB32 Scoping Plan

"Refineries are the largest energy using industry in California and the most energy intensive industry in the United States. . . . After Texas and Louisiana, California has the largest petroleum refining industry in the country.**"**[1] Oil Refineries are not only a major source of Greenhouse Gases (GHGs) but also the largest point sources of smog precursors. The California Energy Commission found "**California ranks 1st in the U.S. in gasoline consumption and 2nd in jet fuel consumption.**"[2] The California Public Utilities Commission found that industrial facilities in California represent about 23% of California's greenhouse gases, and that about 40% of this comes from refineries. **This means that oil refineries cause about 10% of the state's total GHG emissions:**



Focus on direct refinery emissions alone fundamentally understates the impact of oil refining on climate. Refineries make the transportation fuels, which when used as directed, cause an additional 40% of GHGs, they make a major portion of the fossil fuels used to generate electricity (another 20% of GHGs in California), as well as agricultural chemicals . **Efficiency and Best Available Control Technology at oil refineries are essential in reducing local and global pollution from refineries now, but we must also reduce the demand for the inherently polluting refinery fossil fuel products with a planned transition.**

Currently California is going in the wrong direction by building into the oil refinery infrastructure much more energy-intensive refining processes (such as large fossil-fueled hydrogen plants for making more gasoline and diesel, more cokers, more cracking, etc.) to allow the switch to energy intensive high-carbon, high-sulfur crude oil. The state needs to stop this trend and set standards implementing readily available controls, and must identify a specific goal to reduce oil refinery fossil fuel production by a date certain. Cleaning up this inherently polluting industry represents a challenge but it is also a major opportunity to clean up local smog and toxics while making a major reduction in Greenhouse Gas (GHG) emissions.

Key Elements in Reducing GHGs, Smog Precursors, and Toxics from Oil Refineries

1. Require Refinery Energy Efficiency and BACT (Best Available Control Technology)
2. Stop refinery expansions and their switch to dirtier crude oil
3. Switch oil refinery electricity use off the grid to clean alternative electricity
4. Reduce demand for California oil refinery products

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[1] Profile of the Petroleum Refining Industry in California, California Industries of the Future Program, Lawrence Berkeley The Lawrence Berkeley National Laboratory, LBNL-55450, page iii., *Ernst Worrell and Christina Galitsky,* Environmental Energy Technologies Division, March 2004, http://ies.lbl.gov/iespubs/55450.pdf

[2] http://www.energy.ca.gov/oil/index.html

1. Require Refinery Efficiency and Best Available Control Technology (BACT)

- Energy Efficiency Audits for each refinery →require BACT for largest polluters first
- BACT for Hydrogen Plants, Distillation, Cracking, Coking, Hydrotreaters, Boilers & Heaters
- Cogeneration from Waste Heat
- No dumping of "waste gases" (through venting or flaring)

Energy Efficiency Audits and BACT for known large energy users

Oil refineries' huge emissions stem from combustion of fossil fuels, evaporation through leaks, and direct dumping to atmosphere. These emissions include practices that use energy (and many practices which waste energy) causing GHG and other emissions that impact public health. At the same time these processes are the single largest stationary source of smog precursors. Refineries emit large amounts of chemicals known to harm breathing, known carcinogens, etc. Progress towards reducing criteria emissions at refineries through smog regulation has slowed. In order to make the necessary progress both on drastically reducing GHGs and local smog and toxic pollution, readily available methods should be applied to rigorously audit and identify the biggest energy users within each refinery and to set stringent standards.

Energy efficiency audits for each refinery in California can identify uneven practices between refineries, such as use of old, inefficient equipment, new intensive energy users, but also best practices that should be more widespread. For example, many refineries have decades-old equipment exempt from current standards (such as large and very old boilers); some refineries have more routine dumping to atmosphere through flaring, Pressure Relief Devices, uncontrolled blowdown systems, and vessel depressurization; and many refineries are in the process of building large fossil-fueled hydrogen plants.

Furthermore, audits on individual refineries that have been carried out in the past have frequently been kept private from the public, and refineries are likely to fight to keep such information out of public scrutiny. The California Air Resources Board (ARB) should both begin by setting standards for known large energy users, but should also carry out its own audits for every refinery in the state and publish the results, since this energy use is an inherent cause of emissions.

While audits to rigorously evaluate each refinery should be required, Best Available Control Technology (BACT) should also be put in place as soon as possible for known large energy users. This should not wait for completion of refinery audits, because it is crucial for greenhouse gas emissions reductions to make expeditious progress.

An audit on the overall oil refining industry in California by the Lawrence Berkeley National Laboratory[3] summarized the largest energy users as follows:

[3] Ibid, page 31

Table 4. Estimated energy consumption of petroleum refineries in California (2001).

Process	Capacity b/cd	Fuel TBtu	Steam TBtu	Electr. GWh	Final TBtu	Primary TBtu
Desalter	1978132	0	0	32	0	0
CDU	1978132	46	27	322	83	84
VDU	1156155	18	20	132	44	45
Thermal Cracking	381468	11	-2	546	10	13
FCC	650588	12	0	787	15	18
Hydrocracker	476334	21	11	1794	42	49
Reforming	409173	33	6	390	42	43
Hydrotreater	1576697	35	22	1282	67	72
Deasphalting	47767	2	0	30	2	2
Alkylates	150944	2	14	226	20	21
Aromatics	1433	0	0	1	0	0
Asphalt	73354	5	0	62	5	5
Isomers	81682	12	5	52	19	19
Lubes	30953	11	0	161	12	13
Hydrogen	6417226	94	0	313	95	96
Sulfur	4037	0	-12	16	-15	-15
Other	0	13	7	950	25	29
Total	0	315	98	7094	467	496

Resorting the above processes in descending order of primary energy use and grouping similar processes together, identifies the largest process unit totals for the refining industry, aggregated, in California. The top five categories include Hydrogen Plants, Distillation Units, Cracking Units, Hydrotreaters, and Reforming, which make up about 85% of the total. The report also found: "Hydrocracking and hydrogen production are growing energy consumers in the refining industry."

Process	**Final TBtu**
Hydrogen	96
Distillation Units	**129**
CDU (Crude Distillation Unit)	84
VDU (Vacuum Distillation Unit)	45
Cracking Units:	**80**
Hydrocracker	49
FCC	18
Thermal Cracking	13
Other Large Units:	**115**
Hydrotreater	72
Reforming	43
Remaining Units:	**74**
Other	29
Alkylates	21
Isomers	19
Lubes	13
Asphalt	5
Deasphalting	2
Desalter	0
Aromatics	0
Sulfur	-15

This list forms a preliminary order of priority for beginning immediately to set energy efficiency requirements for the top units within refineries. (Coking may be included under thermal cracking, or may be a large hidden energy user.) However, overall audits for individual oil refineries in California should also be carried out to identify problem areas where individual refineries perform poorly compared to other refinery averages.

Fossil-fueled refinery hydrogen plants represent huge sources of GHG emissions, and these sources are expanding drastically in the state (and nationally) in order to process higher carbon, higher sulfur inputs (dirty crude oil) at refineries. We provided the following partial list of refinery hydrogen plants during testimony to the state in 2007 during a public hearing on GHG controls. Although only partial and probably underestimated, it showed almost 6 million metric tons per year CO2 refinery emissions from hydrogen plants alone, and these are only the new or relatively new plants. To put this in perspective, CARB included about 30 million metric tons per year of GHGs, and the CEC estimated closer to 40 million metric tons per year for the total from refineries in the state. Thus the GHGs from just this partial list of only one process within refineries represents an added 15-20% in GHGs. More refineries are planning and building new fossil fueled hydrogen plants and increased plant capacity throughout the state. Without addressing such major increases in refinery GHGs in the state, we will not be able to make progress in reducing GHG emissions. The information below should be updated and evaluated for all refineries:

Examples of CA Refinery Hydrogen Plant Expansions since 1999 (not comprehensive) (million standard cubic feet)	**Approximate CO2 Emissions Increases for these sources** (metric tons per year)
2007 ConocoPhillips Rodeo --120 MMscf	at least 1,250,000
2007 Chevron Richmond -- 100 MMscf	at least 900,000
2007 Valero Benicia – unknown MMscf	≈ 860,000 **
2003 Chevron El Segundo -- 90MMscf	≈ 940,000*
1999 Air Products Wilmington for area refineries -- 96 MMscf	≈ 1,000,000*
1996 Air Products for Ultramar, Wilmington --83 MMscf	≈ 860,000*
493 MMscf (million standard cubic feet)	≈ at least **5.8 million metric tons** per year

** CO2 emissions not yet available, estimated based on plant hydrogen capacity and assumption that emissions are approximately proportional to ConocoPhillips CO2 from Final EIR. This may underestimate emissions. For example, Chevron may be oversizing hydrogen plant for exporting, and not including these CO2 emissions in total. ConocoPhillips may be as well.*

*** Planned Valero Benicia facility's size is currently unknown – used the smallest size above as approximation*

Refinery Boilers and Heaters are major sources of the energy use within refinery processing units that should be a first priority for requiring BACT. There is a wide variation in the efficiency and emissions of Boilers and Heaters at refineries in California. Many boilers and heaters in California refineries are extremely old and have "grandfathered" permitting requirements exempting them from meeting more modernized NOx emissions standards. If refineries were required to meet strong NOx standards across the board, they would also have reduced CO2 emissions because these units are so inefficient. Furthermore, if BACT standards for heaters and boilers were required, further major reductions could be achieved. Boilers and heaters are such large sources because they fuel the refining process and operate continuously, not intermittently.

Cogeneration to capture refinery waste heat

Oil refineries are a large source of cogeneration in the state, but there is still a great additional potential for capturing waste heat and other waste at oil refineries in order to increase efficiency.

> **5.10 Power Generation**
>
> The petroleum refining industry is one of the largest users of cogeneration or Combined Heat and Power production (CHP) in the country. **The petroleum refining industry is also identified as one of the industries with the largest potential for increased application of CHP. We estimate installed CHP capacity in Californian refineries at at least 1400 MWe**.[4]

Cogeneration has the potential to capture waste energy and increase refinery efficiency, but since it introduces complex interactions with electric Power Plants, care is needed in evaluating the relative efficiency of refinery cogeneration compared to other sources, as well as any environmental impacts associated with cogeneration at refineries. The key is to capture waste energy without introducing new sources of combustion at the refinery or otherwise increasing environmental impacts. BACT standards must be in place.

Reducing the need at refineries for grid electricity can increase reliability of electric power available to the refinery, which reduces risk of power outages causing emergency refinery shutdowns. Power plant outages and emergency shutdowns at refineries have caused major flaring, resulting in GHG emissions and major local impacts from hydrocarbon, SOx emissions, and very large plumes of black smoke (particulate matter). These impacts were exacerbated when several refineries shutdown simultaneously in the South Coast region, with neighbors reporting respiratory impacts and sickness for days following one event.

The South Coast Air Quality Management District (SCAQMD) presented the following table during a flare working group meeting in 2006. This table showed which refineries in the South Coast had high, medium, and low risk of power outage and increased risk of flaring. It also listed quantities of fossil-fuel based grid electricity used by these oil refineries:[5]

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[4]Ibid, page 45, Units MWe are electrical megawatts, as opposed to thermal megawatts

[5] South Coast Air Quality Management District, Rule 1118 Working Group Meeting, October 26, 2006

REFINERIES AND ROTATING POWER OUTAGE RISKS*

Company	Location	Operating Crude Oil Atm Dist Capacity (MBPSD)	Electric Utility Service Area	Estimated Electricity Demand (MW)	Cogen Capacity (MW)	Number of Cogen Units	Cogen vs Demand - Cogen Coverage (%)
HIGH RISK							
ExxonMobil	Torrance	160	SCE	94	42	1	44.8%
Conoco-Phillips	Carson	137	SCE	26	0	0	N/A
MODERATE RISK							
Chevron	El Segundo	273	SCE	108	138	2	127.8%
Shell	Wilmington	100	SCE	58	60	2	103.4%
LOW RISK							
BP	Carson	260	SCE	82	331	1	403.5%
Ultramar	Wilmington	79	LADWP	37	0	0	N/A
Conoco-Phillips	Wilmington	0	LADWP	47	59	1	124.5%
UNDEFINED RISK							
Paramount	Paramount	48					

http://www.eia.doe.gov/emeu/steo/pub/special/california/june01artcle/carefinery.html

In this presentation, SCAQMD concluded that: *"Commercial power usage increased 67% from 79,691 megawatt-hours in 1990 to 117,573 megawatt-hours in 2004."* This indicates that not only are refineries responsible for more fossil fuel emissions (from power plants), but also that they are becoming more vulnerable to power outages. (Also see additional comments on flaring later in this comment letter.)

Remove all methane exemptions from smog regulations

As an Early Action Measure under AB32, CBE proposed the removal of methane exemptions in smog regulations, which are currently allowed by Air Quality agencies throughout the state (and also throughout the nation). While the ARB did not accept removing the exemptions as an Early Action Measure, staff did recommend in the Final Report that removing the exemptions was feasible and should be considered as part of the Scoping Plan process under AB32.

The definition of VOCs (Volatile Organic Compounds) in smog precursor control regulations exempts methane in most cases. The following examples of regulations in different regions in the state include the SCAQMD, the BAAQMD, and the SJVAPD.

SCAQMD:[6]

VOLATILE ORGANIC COMPOUND (VOC) is any volatile compound of carbon, excluding methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, and exempt compounds.

ORGANIC MATERIAL means a chemical compound of carbon excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides, metallic carbonates and ammonium carbonate.

BAAQMD:[7]

1-233 Organic Compound: Any compound of carbon, excluding methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate.

SJVUAPCD:[8]

[6] *SCAQMD Regulation 1, General Provisions, Rule 102, Definition of Terms (Amended Dec 3, 2004)*
[7] *BAAQMD Regulation 1 General Provisions and Definitions (Adopted March 17, 1982)*

3.53 **Volatile Organic Compound (VOC):** any compound containing at least one (1) atom of carbon **except for the following exempt compounds:**

- **Methane** . . . . *(Many other compounds which are non-smog precursors are also listed as exempt.)*

The methane exemption can no longer be justified for oil refineries, other stationary sources, or any pollution source in the state. Methane is not only a highly potent greenhouse gas (23 times more potent than CO2), it is also a key smog precursor (for ground-level ozone), and its reduction is highly effective in reducing smog. A Harvard study, *Linking ozone pollution and climate change: The case for controlling methane*[9] found:

> **"Methane (CH4) emission controls are found to be a powerful lever for reducing both global warming and air pollution via decreases in background tropospheric ozone (O3) "**

This study was summarized as follows in Environmental Science and Technolgy[10]:

> "Aggressive efforts to improve urban air quality could be undermined by rising levels of methane, a compound more closely linked to global warming than air pollution. Using a global model of tropospheric chemistry, researchers at Harvard University, Argonne National Laboratory, and the **U.S. EPA determined that higher methane levels could increase ozone background levels worldwide, lead to a greater frequency of days with high ozone levels in the summer, and produce a longer "season of ozone pollution days."**
>
> "It is already known that methane is a major source of worldwide tropospheric ozone background concentrations, and this study supports that finding. However, **the surprise is that a 50% reduction in anthropogenic methane in their scenario is as effective as a 50% drop in anthropogenic NOx concentrations at lowering summer afternoon ozone levels over the United States."** (page 452A)

NOAA (National Oceanic and Atmospheric Administration) also found:[11]

> **Linking climate and air pollution:**
> **Methane emission controls yield a double dividend**
>
> An important area of research at GFDL is investigating the contribution of methane to surface ozone pollution, and quantifying the potential benefits to air quality and climate from controls on methane emissions. **Methane is both a greenhouse gas and an important contributor to background levels of ozone. Tropospheric ozone, a significant greenhouse gas and the primary constituent of photochemical smog, provides an obvious link between air quality and climate.**

There is no longer any reason for exempting this pollutant from smog regulations. Excluding accounting of methane from smog precursor emissions also makes VOC controls look less cost-effective than they actually are in reducing smog.

To begin to quantify methane as identified in regional air quality plans in criteria pollutant emissions categories, an excerpt of California's 2002 statewide criteria inventory summary table from ARB is excerpted below. This table includes organic compound emissions in both TOG (Total Organic Gases) and VOCs (Volatile Organic Compounds). The year 2002 was chosen because it is the latest year that included both TOG and VOCs. Later inventory years did not provide TOG, but just VOCs.

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[8] *SJVUAPCD Rule 1020, Definitions,,* 6/17/99
[9] Fiore, et al. 2002. Harvard University. http://www.agu.org/pubs/crossref/2002/2002GL015601.shtml
[10] Environmental Science & Technology. December 2002, http://pubs.acs.org/subscribe/journals/esthag-w/2002/oct/science/an_methanelink.html
[11] http://www.research.noaa.gov/spotlite/2006/spot_methane.html

2002 Statewide Inventory: Table 2-1 Summary (tons per day)[12]

Division Major Category	TOG	ROG
Stationary Sources	2535	538
Fuel Combustion	215	49
Waste Disposal	1447	23
Cleaning And Surface Coatings	344	237
Petroleum Production And Marketing	450	164
Industrial Processes	79	65
Area-Wide Sources	2027	698
Solvent Evaporation	521	463
Miscellaneous Processes	1506	235
Mobile Sources	1530	1406
On-Road Motor Vehicles	1019	938
Other Mobile Sources	511	467
Natural Sources**	106	38
Total Statewide - All Sources	***6198***	***2680***

For example, three categories of Stationary Sources listed above (Fuel Combustion, Petroleum Production and Marketing, and Industrial Processes) add up to 744 ton per day (tpd) TOG and 278 tpd VOC, and the difference between these two is 466 tons per day (about 170,000 tons per year). The difference between TOG and VOCs includes exempt organic gases, and in this category, the difference is likely to be made up mostly of methane. If the difference is entirely methane, this is equivalent to almost 4 million US tons per year CO2Eq just for these categories. (This number is likely underestimated since exempt methane emissions receive less scrutiny.) This category of stationary source methane emissions is a significant source of GHGs, but also a huge source of unregulated smog precursors from only these three categories.

To capture the dual benefit of eliminating or greatly reducing these emissions, the organic compound definitions in the state for all smog regulations need to be modified to remove the exemption for methane. The state should require all regional air quality agencies in California to immediately begin reopening all smog regulations to remove methane exemptions, and to complete this by the most expeditious date. **Furthermore, all new smog regulatory proceedings in the state should be immediately required to include evaluation of removal of methane for each of these regulations.** In the case of such rules that are already in the process of modification, there is no need for any delay evaluating how to remove the methane exemptions. We understand that the state and regional Air Quality Management agencies are now beginning to discuss removing this exemption.

[12] *The 2003 California Almanac of Emissions and Air Quality*, (page 49), http://www.arb.ca.gov/aqd/almanac/almanac03/chap203.htm

No dumping of waste gases through venting or flaring should be allowed

Control Pressure Relief Devices (PRDs) and other venting to atmosphere

While PRDs are necessary for safety to ensure that pressure inside vessels does not get too high, most PRDs do not need to vent to the atmosphere. PRDs can be controlled to vent to refinery gas recovery systems where the gases are recycled as fuel in the refinery.

PRDs are designed to release large volumes of gases within minutes, increasing smog, GHGs, and representing a local health hazard and public nuisance especially because of H2S emissions. Some refineries have most of their PRDs connected to gas recovery systems. Other refineries have half or more PRDs vented to atmosphere. Better practices have been carried out by some refineries, demonstrating their feasibility for all refineries.

The SCAQMD found a large difference in refineries in the number of PRDs designed to vent directly to atmosphere (shown in this excerpt from an SCAQMD presentation).[13] BP had 592 out of the 770 total of PRDs dumping to atmosphere in the District, far more than the other South Coast refineries. At last count, roughly ***half*** of Bay Area refiners' PRDs were uncontrolled, although retrofits are distributed unevenly between these refineries as well, as should be expected, since an uncontrolled PRD is antiquated technology.

Atmospheric PRD Inventory

Facility	No. of Atmospheric PRDs (as of 2005)
BP	592
Chevron	49
ConocoPhillips, Carson	15
ConocoPhillips, Wilmington	8
Edgington	14
ExxonMobil	35
Lunday Thagard	9
Shell Equilon	40
Valero	8
TOTAL	770

5

PRD monitoring has historically been very poor. (Many refineries have admitted that they detected PRD releases by sound rather than through actual monitoring!) Because of this, annual inventories of emissions are very incomplete, but new regulations in the Bay Area and South Coast are beginning to improve monitoring. Dumping to the atmosphere should be considered a bad engineering practice and banned, and companies should not be allowed to avoid control through pay-to-pollute schemes allowed in the South Coast. Requiring controls and electronic monitoring will not only reduce GHG emissions but also reduce large episodic emissions of smog precursors and harmful toxics.

[13] *Proposed Amended Rule 1173, Control of VOC Leaks and Releases from Components at Petroleum Facilities and Chemical Plants*, Working Group Meeting, March 13, 2007, SCAQMD slideshow

Although PRDs do not vent continually, one PRD can vent over 100 tons of VOCs in one day (even in minutes) including emissions of methane, other VOCs, and H2S. While these emissions are episodic, the potential to emit is large because there are over a thousand of them at oil refineries in the state. Venting of these devices has been poorly tracked in the past, and emissions very likely underestimated. PRD emissions can cause large spikes in smog precursor emissions on days when they vent; they are a source of direct dumping of methane to the atmosphere. Both for purposes of controlling GHGs and especially to protect public health, these devices should be required to vent to gas recovery systems throughout the state. There is a potential for increased emissions from these sources as refineries ramp up production, and do more intensive refining of heavy crude, increasing the risk of frequent upsets. Requiring all refineries to meet the same BACT standards for PRDs will reduce public health risks, smog precursors, and GHG emissions together.

Evaluate other venting to atmosphere

Refinery energy audits should include not only the refinery's steady state emissions, but should also evaluate:

- Frequency of upsets (which can increase emissions and hazards to neighbors and workers)
- Startup/shutdown and maintenance emissions
- Vessel Depressurization, when some part of gases in vessels are uncontrolled and vent to atmosphere
- Unusual operations (one refinery had uncontrolled blowdown systems with no attached flare, and these dumped directly to atmosphere)
- Tank cleaning that could cause large evaporation on an episodic basis
- Other direct dumping either during emergency conditions or on a regular basis should be identified and prevented
- Best Practices for preventing dumping to atmosphere
- Corrosion and other increased process intensity and decreased process stability impacts of refining lower quality crude and intermediate products

Apply BACT/LAER to Refinery Flares (beyond existing regulations)

Flaring should be limited true emergencies. Planned flaring, and repeated malfunctions that cause flaring from preventable emergencies should trigger enforcement that will prevent flaring from these causes. Flares emit CO2, methane, other VOCs, sulfur compounds that are known to exacerbate asthma and other breathing impacts, and toxics. While California flare controls have improved substantially due to regulations adopted in the Bay Area and South Coast following strong public pressure, there remain major differences in flaring emissions between different refineries in the state. ARB should require statewide flare standards that meet at least the Shell Martinez BACT/LAER (Best Available Control Technology / Lowest Achievable Emissions Rate) performance standard.

The Shell refinery in Martinez, California has demonstrated sustained and drastically lower emissions compared to other refineries in the state through methods including dedicated backup compressors, a rigorous Flare Minimization Plan, and methodical follow-up after any flaring event through root cause analysis and action to ensure that the cause for each flaring event will not recur. While other refineries in California have prepared Flare Minimization Plans and root cause analysis, they have not been carried out to the degree that Shell has achieved in Martinez, as demonstrated through flare monitoring data.

Flaring levels achieved by Shell in practice should be the considered the minimum BACT/LAER for flaring, and further reductions may be achievable. Since Shell has demonstrated in practice much lower flaring levels, these should be required for all refineries in the state. This will further reduce flaring in the Bay Area and the South Coast, and also will capture emissions from the remaining refineries in the state outside these regions. (See Shell's flaring emissions, available at BAAQMD website for current and previous years.[14]) In addition, Hydrocarbon Processing has published an account of very low or zero flaring at a refinery in Texas.[15] Performance standards at this facility should also be evaluated to determine whether this facility represents BACT/LAER, and represents an improvement over the Shell Martinez performance.

Flaring is not the largest source of GHGs at oil refineries, but it is a significant source of GHGs and a large source of VOCs and SOx emissions that represent local and regional health risks. Despite the newer flare regulations, flaring emissions in the state have a great potential for increasing. This is because of increased risk of upset due to refinery expansions and more intensive refining to handle dirtier crude oil. Heavier, dirtier, more intensive refining means increasing volumes and concentrations of toxic, corrosive gases such as sulfur compounds in refineries; it means increasing process instability and upsets, and it and also means dirtier flaring events.

The expansion of refineries and introduction of heavy, high-sulfur crude oil increases the risk of flaring and the quantities of SOx, VOCs, NOx, CO, PM2.5, and toxic emissions. See CBE report *Flaring Prevention Measures.*[16] This report evaluated in great detail BAAQMD flare data reported by the refineries and Flare Minimization Plans, and found that refinery processes required for heavier crude slates caused more flaring and caused dirtier flaring than other refinery processes. The report found:

> Dirty crude refining can increase flare pollution in similar ways. It produces more gases from the expanded catalytic cracking, hydrocracking and coking that make vehicle fuels from the increased volumes of gas oil and heavy ends. This is because of the increased volumes cracked in these processes and because cracking reactions produce gases as well as fuel-sized hydrocarbons. Dirty crude may also produce more gases from distillation. See Figure 4. The bigger gas volumes will have higher concentrations of sulfur and other pollutants. See Table 13. Dirtier processes will flare more, and dirtier, unless more gases are recovered and reused. (page 17)

In addition to being a significant source of GHGs, flaring in the South Coast represented **more than half of the refinery SOx emissions**, making flaring a severe source of emissions of compounds associated with local health impacts including asthma and other respiratory diseases. Statewide

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[14] http://www.baaqmd.gov/enf/flares/

[15] *Minimize facility flaring, Flares are safety devices that prevent the release of unburned gases to atmosphere*, J. Peterson, Flint Hills Resources, et al, Hydrocarbon Processing, http://www.johnzink.com/products/flares/pdfs/flare_hydro_proc_june_2007.pdf

[16] *Flaring Prevention Measures*, Communities for a Better Environment (CBE), Greg Karras, April 2007, attached

requirements that flaring meet BACT/LAER performance standards at least as stringent as Shell Martinez will secure further improvements in reducing local SOx and VOC emissions, reduce GHG emissions, and prevent increases due to expansions and heavy crude introduction.

2. **Stop refinery expansions & the switch to dirty crude oil**

- No new fossil fueled Hydrogen Plants, cokers, etc.
  (only possible without heavy, dirty crude oil inputs)
- Low Carbon Fuel Standard for Refineries
- Limit on heavy, contaminated crude and pre-processed unconventional oil input
- Carbon tax on refineries
- Windfall profit tax to fund clean alternative energy

Heavy crude oil means long hydrocarbon chains which require more cracking and coking, and this high carbon crude oil is typically associated with higher sulfur content. (Also see earlier section on refinery energy use.) This means that refineries switching to heavier crude stocks must build new hydrogen plants, additional cracking capacity to crack the long hydrocarbon chains into gasoline, more coking and bottom of the barrel processing, more hydrotreating to remove sulfur compounds to meet low sulfur gasoline and diesel standards, and more sulfur recovery units. All of these operations require greatly increased energy use by the refineries. (See list page five showing the biggest energy users at refineries, which include these types of units). This much greater energy use means much greater CO2 emissions. **Unfortunately, we are going strongly in the wrong direction in this state as far as GHG emissions from oil refineries.** The increased sulfur at the refineries also increases the risk to neighbors of upsets that cause asthma attacks and other respiratory impacts.

Given that the state is in the process of adopting a Low Carbon Fuel Standard, this move towards higher carbon inputs to refineries must not be allowed. It is true that lighter crude oils are becoming more expensive, and use of heavy crude oils represents much cheaper inputs. Carrying this to an extreme, use of the heaviest crude oils (Canada Tar Sands) is increasing drastically at U.S. refineries, and refiners also want to introduce this dirty crude source into California. This trend is a clear and present threat to climate protection given that the billions of dollars in proposed refinery equipment tooled for unconventional oil would be locked in place for decades once built.

The state needs to perform a statewide evaluation on the alternatives to use of dirty, high carbon crude oil in the state, including a step-by-step reduction in the demand for refinery products through rigorous fuel efficiency and alternative fuels programs. A windfall profits tax for oil refineries could help fund such a switch, so that instead of expanding refineries and increasing their energy intensity, we develop a detailed planning for reducing their output and impact over time. A few decades ago, an economic analysis for power plants found that they could actually make more money by investing in conservation instead of building more plants. Companies like Dow Chemical and Dupont actually made windfall profits from phasing out ozone depleting chemicals. We need a detailed, comprehensive plan that specifically calls for reducing the need for and the outputs of oil refineries in California. This is achievable through available means, as discussion in a later section of this comment, and can be funded through a carbon tax and windfall profits tax on the oil industry.

The California Low Carbon Fuel Standard requirement in development requires:

> "The California Executive Order S-1-07(issued on January 18, 2007), calls for a reduction of at least 10 percent in the carbon intensity of California's transportation fuels by 2020. . . . In response, ARB identified the LCFS as an Early Action Measure with a regulation to be adopted and implemented by 2010.
>
> The LCFS requires a reduction of 10 percent or greater in the average fuel carbon intensity (the "*AFCI*") *[Average Fuel Carbon Intensity]* of transportation fuels in 2020 compared to the baseline year of 2006, with a phase-in period from 2010 through 2019." [17]

The LCFS needs to be defined and adopted so as to rigorously evaluate the modifications being made to refineries which enable the use of high carbon, heavy crude oil in refineries. It appears from the recently-released partial draft proposal that LCFS will use averages allowing refineries with increasingly heavier crude oil inputs to average carbon intensity and thus underestimate actual carbon intensity. Furthermore facilities with lower carbon intensity inputs appear to be allowed to bank credits if they overcomply. This leads to an inaccurate assessment which makes it appear that the state's refinery fuel products have lower carbon intensity when in reality they are much higher in intensity. Care must also be taken in assessing baselines so as not to build in an inflated baseline assuming high carbon crude oil.

The switch to heavy crude oil is a major contributor to GHGs and increased public health risk as discussed above. Some of the State's own low carbon fuel standards development experts have observed that: "these fuels are physically of lower quality, and exist naturally in less useful form than conventional oil, and thus are likely to have an excess of emissions even in the presence of technological progress."[18] Stopping this switch should be a major priority of the state to preclude this move toward building high carbon fuels from oil refineries into the state's infrastructure for many decades to come. Much more evaluation will be needed as this regulation develops. Pollution trading should not be allowed as a replacement for actual limits on carbon in the states' fuels.

It also appears that the LCFS may justify increased carbon intensity in oil refinery products (gasoline) by adding corn-based ethanol to gas and averaging the output. If this were to happen, such averaging would not include the full cradle-to-grave accounting of the carbon input caused by trucking heavy corn across the country and other energy use put into corn production. Biofuels plants in the Central Valley are a heavy industry, causing severe local impacts, and increasing smog and water pollution. Furthermore, the introduction of ethanol as an MTBE replacement in gasoline has been estimated to add 20 tons per day in VOC emissions to the South Coast due to permeation through vehicle seals, gaskets and lines, increasing fugitive emissions greatly. The South Coast cannot afford this major increase in smog precursors. Similar high impacts will occur throughout the state. Asthma is already an epidemic in the state, and any LCFS evaluation of introduction of corn ethanol must take into account the true carbon input and the health and environmental impacts. This source must also not

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[17] Email notice to listserve on Concept Outline for the California Low Carbon Fuel Standard Regulation, March 20, 2008, from , John Courtis - Manager, Alternative Fuels Section, ARB, http://www.arb.ca.gov/fuels/lcfs/lcfs.htm

[18] *Scraping the bottom of the barrel: Greenhouse gas emission consequences of a transition to low-quality and synthetic petroleum resources,* Climate Change (Journal), Brandt and Farrell, Energy and Resources Group, University of California, Berkeley, 2007, Abstract at http://www.springerlink.com/content/y283j2220jj365g4/ (Full article attached)

be used to justify heavier crude oil at refineries. The LCFS standard is still in development, and care must be taken not to allow these impacts.

3. **Switch refinery electricity use to clean energy**

Currently oil refineries use significant amounts of electric energy off the grid, from fossil-fueled power plants. Requiring that oil refineries contract with and switch to clean alternative energy sources while not directly reducing emissions at the oil refinery site, would reduce emissions that contribute significantly to Power Plant GHGs, smog precursors, and toxics. The following graph illustrates electrical energy purchases and generation by petroleum refineries from 1988-2001:

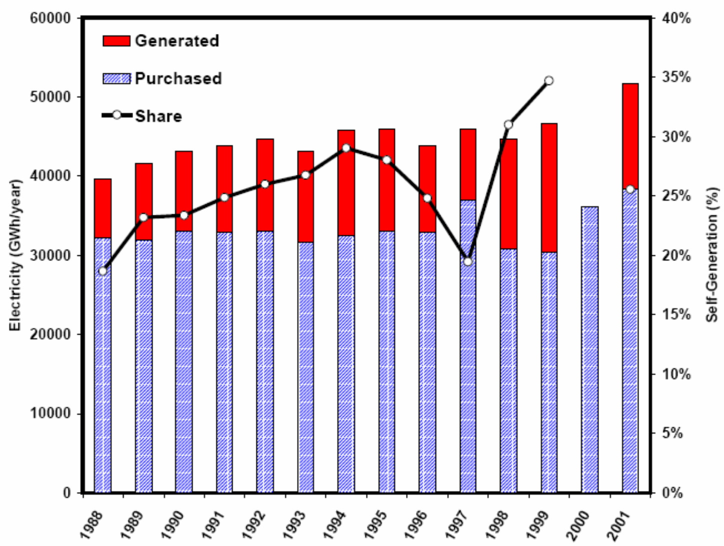


Figure 16. Electricity purchases and generation by petroleum refineries from 1988 till 2001. On the right-hand axis the share of self-generation is expressed as function of total power consumption. Source: U.S. Census, Annual Survey of Manufacturers.

(page 26)

Fossil-fueled grid electrical energy use at oil refineries results in many tons per day of local air pollution and very large GHG emissions which should be required to switch to clean alternative energy.

Oil refineries use substantial amounts of electricity which is generated at power plants by burning fossil fuels. These emissions occur near the power plants, but also cause regional smog and GHGs. Also, when reliability problems bring down the electrical grid, oil refineries shut down, causing upset conditions and huge air emissions near the oil refineries. Such events occurred in the fall of 2005, causing major flaring at several oil refineries in the South Coast region and in the Bay Area in 2002.

Alternative energy sources including wind and solar energy are now readily available and viable alternatives for replacing fossil-fuel electricity generation used at oil refineries. Such alternatives need to be evaluated and required statewide. Refineries frequently have open land where such alternatives can be put in place by the refineries. Refineries are already required to evaluate feasible alternatives under CEQA (the California Environmental Quality Act), and although we have commented on the feasibility of clean alternative electricity to replace grid electricity for refinery projects (such as the ConocoPhillips Rodeo expansion) refineries have failed to do such clean electricity alternatives analysis in their Environmental Impact Reports. Requirements under CEQA that refineries evaluate and implement feasible clean alternative electricity sources should be enforced statewide, and evaluation and standards set by the state should also be done independently from CEQA.

If the oil refineries in the South Coast example in the table on page eight were to replace either the percentage of electricity not covered by cogeneration capacity (115 megawatts - MW), or to replace all the electrical demand (452 MW) by clean alternative energy regardless of cogeneration capacity at the refineries, electricity not generated through fossil fuels at these facilities would result in many tons per day of emissions reductions calculated below.

Information is available on emissions caused by power plants generated per megawatt hour. For example, PG&E published its 2002 Environmental Report online[19] which provides estimations of air emissions associated with generation of electrical energy. A table from the report is provided below, with air emissions in terms of pounds per megawatt-hour of energy. The two columns at the right are added to calculate daily emissions by power plants generating 115MW or 452MW.

From PG&E 2002 Environmental Report

	Pounds per megawatt-hour of electricity produced	**<u>Added Columns, calculating total tons/day using PG&E lbs/MW-hr</u>:** **Emissions in 24 hours** for 115 and 452MW electrical energy needed from fossil-fueled power plant for the South Coast oil refineries	
Emissions Rates	**PG&E Corporation***1	115 MW or 2760 MW-hours per day	452MW or 10,848 MW-hours per day
SO2 Fossil-Fuel Units Only	3.2	4.4 tons/day	17.4 tons/day
NOx Fossil-Fuel Units Only	1.3	1.8 tons/day	7.1 tons/day
CO2 Fossil-Fuel Units Only	**1,454**	**>730,000 US tons/year**	**>2.8 million US tons/year**

1. Emissions rates for 2002 * Pounds per megawatt-hour of electricity produced

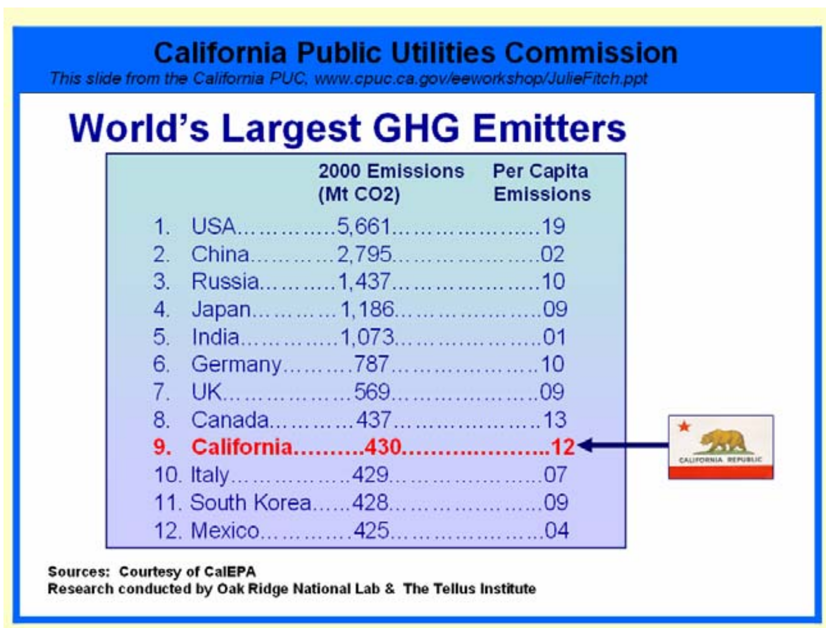
[19] *PG&E 2002 Environmental Report, 2002 Performance Results , Air Emissions: NOx, SO2, Mercury, and Greenhouse Gases,* available at http://www.pgecorp.com/corp_responsibility/environmental/report/2002/perf_results/02.html\

In a 24-hour period, refineries in the South Coast alone use 115 MW of electric energy continuously from fossil-fueled power plants, resulting in 4.4 tons per day of SOx emissions and 1.8 tons per day of NOx emissions, according to the data above. The total electrical energy use in the South Coast basin refineries of 452 MW continuously results in 17.4 tons/day of SOX emissions and 7.1 tons per day of NOx emissions. This calculation assumes that emission rates at the power plants in the state generating this electricity are similar to PG&E's, but national average pollution rates were even higher. Either way, the large air emissions caused by fossil fuel generation at Power Plants due to oil refinery electricity demand is worthy of phaseout requirements by the SCAQMD and other air quality management agencies throughout the state.

These calculations do not include VOC, CO, mercury emissions, methane, and SF6 (sulfur hexafluoride) emissions, also identified by PG&E's report. The emissions probably do not represent peak electricity use, which causes higher emissions. Clearly, refinery electrical energy use is a large source of GHG emissions.

4. Reducing demand over the medium term for California Oil Refinery Products is feasible and should be identified as a specific goal with a deadline under AB32

California emits as much GHG as many countries:



It is no longer possible to pretend that better technology alone at large industrial GHGs emitters like refineries can solve the problem of industrial GHG, smog precursor, and toxic emissions. Direct regulatory controls requiring BACT at refineries and specific plans for reducing the demand for oil refinery products are needed to make real progress. Stopping the disastrous trend to higher carbon inputs and refinery expansion is needed, with a specific plan to reduce oil refinery product demand with deadlines, percent reductions, and a map to get there. The following readily available methods are examples of ways to get big savings in the use of refinery products and to decrease energy use in general. These methods preclude the need for refinery expansions and reduce demand at oil refineries as they are implemented. These can be included in the AB 32 process:

- **CAFE Standards:**
    - If the U.S. increased fuel economy to 45% higher miles per gallon using cost-efficient techniques, we'd save over 50 billion gallons of gasoline/year. (National Academy of Sciences[20])
    - This is equivalent to saving about 3 1/3 Californias worth of gas use each year (California used about 15 billion gallons per year in 2003).[21]
    - Increasing fuel efficiency of cars & trucks by only 3 miles per gallon can save > 1 million barrels of oil / day or five times the amount of Arctic Refuge might produce."[22]
- **PLUG IN HYBRIDS:**
    - For each mile driven on electricity instead of gasoline, CO_2 emissions would be reduced 42% on average in the US (although this advantage could be hurt by coal-generated electric power plants) [23]
    - Plug-ins encourage development of renewable electricity because of they provide distributed battery storage.
    - Running a plug-in would reduce average fuel cost by about half, (based on a price of $2.77/gallon for gasoline (Sept 2005) and 8 cents per kWh for electricity, (Jan 2006)).
- **CLEAN ELECTRICITY:**
    - 80 GigaWatts of CSP could be economically deployed by 2030 (about 200 times today's US capacity) in the Southwest US.[24]
    - *"Analysis suggests that 10% of electric grid energy by 2030 could be supplied by PV without creating grid management issues."* (Equivalent to 275 GW in the US)[25]
    - Wind capacity in the US was found to be at least 245 GW, but higher amounts are possible if storage is available

- **SHIPPING EFFICIENCY IMPROVEMENTS:**
    - Shipping uses about 5% of global oil consumption
    - Reducing ship drag due to hull fouling has been found to result in at least 10% reduction in fuel use, which saves both money and reduces GHG and criteria

[20] *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards*, National Academy of Sciences, 2002
[21] *Market Power in California's Gasoline Market,* University of California Energy Institute, Center for the Study of Energy Markets, 2004, page 4, http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1035&context=ucei/csem
[22] According to the Arctic Refuge Defense Campaign, http://www.arcticrefuge.org/
[23] *Tackling Climate Change in the U.S.: Potential Carbon Emissions Reductions from Energy Efficiency and Renewable Energy by 2030*, American Solar Energy Society, Charles F. Kutscher, Editor, January 2007, http://www.ases.org/climatechange/toc/exec-summary.pdf
[24] Ibid.
[25] Ibid.

pollutant emissions.[26] Shipping in California may represent a larger portion of California's total consumption compared to the global average.

- Electrification of ports through alternative energy to replace the use of high carbon bunker fuel will reduce health risks for neighbors near ports and GHG emissions from the current use of bottom-of-the-barrel bunker fuel.

[26] *Fuel Conservation Through Managing Hull Resistance,* Motorship / BIMCO Propulsion Conference, Copenhagen April 26th, 2006, By: Torben Munk, M.Sc., Propulsion Dynamics Inc. (PDI), http://www.cleanhull.no/doc/PDF%20files/Fuel%20Conservation%20-%20CASPER.pdf