



Reducing Greenhouse Gas Emissions from California Refineries

April 11, 2008

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The Global Warming Solutions Act of 2006 (AB 32)

- The Act requires
 - GHG emission reductions
 - ✓ Maximum technologically feasible
 - ✓ Cost-effective
 - ✓ Real, permanent, quantifiable, verifiable, and enforceable
 - ARB is working with other departments, boards, and agencies
 - Identify discrete and early action control/reduction measures
 - Adopt Scoping Plan by the end of 2008

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Total 2004 CA Refinery GHG Emissions		
	MMT CO2 eq.	% of Total Emissions
Process Heaters & Boilers	14	40%
FCC catalyst regeneration (coke burn off)	6	18%
Hydrogen Production	6	17%
In-Process fuel use (e.g., natural gas & coke combustion)	5	13%
Turbine Electric Cogeneration	3	9%
Turbine Combustion		
IC reciprocating engines		
Industrial process miscellaneous combustion		
Incinerators	1	3%
Asphalt heaters		
ICE electricity generation		
Flares	0.3	< 1%
Fugitives	0.03	< 0.1%
Total	35	100%

Based on ARB GHG Inventory: http://www.arb.ca.gov/cc/inventory/doc/doc_index.php

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**Four Potential Control/Reduction Measures
 for Refining Sector**

- Reduce refinery fugitive emissions by removing methane exemption from existing regulations.

- Develop and expand requirements to curtail flaring emissions at refineries. Example: BAAQMD Flare Minimization Plans operations (FMPs.).

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Potential Measures (continued)

- Establish criteria for requirements to replace existing process heaters, boilers, and IC engines with electrification, and combined cycle cogeneration; recommend reduction of existing barriers (related to permitting) for expanding combined cycle cogeneration.
- Develop a refinery cap and trade system; establish benchmarks for overall refinery efficiency or for specific refinery operations and criteria for refinery emissions trading system.

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Reducing Refinery GHG Fugitive Emissions

Fugitive Emission Sources	Measure	Potential GHG Reduction (MMT CO2 eq.)
Storage Tanks	Removing Methane Exemption	0.012
WW Treatment	Removing Methane Exemption	Up to 0.07
Process Losses (pumps, compressors, valves, connections and other miscellaneous equipment) ⁽¹⁾	Removing Methane Exemption	0.014
Cooling Towers ⁽²⁾	Removing Methane Exemption	Undetermined
Measures Total		0.03 – 0.1
1) Existing Air District Rules require control of NMHC fugitive emissions; inclusion of methane could result in 80-90% reductions in methane emissions.		
2) The EPA rule has proposed options to require a leak detection and repair program for cooling towers under section 112(d)(2) and (f)(2)		

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Reducing Flare GHG Emissions	
Measure	Potential GHG Reduction (MMT CO ₂ eq.)
Replace with Gas Recovery ⁽¹⁾	0.20
1) Example is the BAAQMD FMPs (Flare Minimization Plans)	

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Reducing Process Heater & Boiler GHG Emissions	
Measure ⁽¹⁾	Potential GHG Reduction (MMT CO ₂ eq.)
Replace low efficiency units with new	2.9
Replace with electrical heaters (uses combined cycle cogeneration)	3.5
Replace distillation with Membrane-Distillation hybrid process ⁽²⁾	2.8
1) - Energy Efficiency & Industrial Boiler Efficiency (CIBO http://cibo.org/pubs/whitepaper1.pdf); - BAAQMD Regulation 9, Rule 7: NOx and CO FROM INDUSTRIAL, INSTITUTIONAL, AND COMMERCIAL BOILERS, STEAM GENERATORS, AND PROCESS HEATERS, May 2007, (Bay Area Planning, Rules and Research Division)	
2) Distillation accounts for nearly 40% of refinery's energy use (US DOE). Membrane-Distillation hybrid process can reduce energy use by 20% http://www1.eere.energy.gov/industry/petroleum_refining/pdfs/separtech.pdf	

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Reducing FCC & Coke Combustion GHG Emissions	
Measure	Potential GHG Reduction (MMT CO ₂ eq.)
Replace Coke Combustion FCC catalyst based on crude slate	0.61
Optimize carbon on regenerated catalyst (CRC) ratio with CO boiler or incinerator	0.61
Replacement of FCC regenerator air compressors with axial flow compressor	0.06
Heavy Oil slurry-Catalyst Technology (eliminates coke byproduct but requires hydrogen plant) ⁽¹⁾	0.61

1) - Chevron Vacuum Resid Slurry Hydrocracking (VRSH) pre-commercial plant in Pascagoula, Miss 2010;
 - Eni Slurry Technology (Snamprogetti S.p.A., Eni Italy) recent agreement PDVSA, Venezuela

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Reducing Turbine Combustion GHG Emissions	
Measure ⁽¹⁾	Potential GHG Reduction (MMT CO ₂ eq.)
Replace Single Cycle with Combined Cycle	0.46
Replace Single Cycle with Combined Cycle Cogeneration	0.80

1) Council of Industrial Boiler Owners, <http://cibo.org/pubs/whitepaper1.pdf>

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Reducing IC Engines, Miscellaneous Combustion, Incinerators, & Asphalt GHG Emissions	
Measure	Potential GHG Reduction (MMT CO ₂ eq.)
Replace with Simple Cycle Turbine	0.13
Replace with Combined Cycle Cogeneration	0.40

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Tentative Schedule	
May 2008	Establish a working/advisory group
May 2008 – June 2009	Workshops
May 2008 – June 2009	Evaluation of benefits and costs of proposed measures
June - 2008	Draft scoping plan
November 2008	Board's consideration of scoping plan
June 2009	Draft measures
November 2009	Board's consideration of the measures
January 2010	Implementation begins

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