

AB 32 and California's Petroleum Refinery Sector

Greenhouse Gas Mandatory Reporting and Statewide Inventory

Technical Discussion



**April 24, 2007
Sacramento**

Purposes of Technical Discussion

- **Mandatory Reporting**
 - AB 32 requirements
 - Review reporting principles and resources
 - Consider questions of boundaries and scope
 - Consider appropriate source categories, approaches and formulas for calculations
- **Statewide emissions inventory**
 - AB 32 requirements
 - Refinery sector 1990 emissions estimates
 - Calculations and emissions factors
 - Potential improvements to 1990 refinery emissions

Timeline

- 1/1/07:** ARB assumes responsibility for statewide inventory
- 6/30/07:** Board adopts discrete early actions
- 1/1/08:** Board adopts mandatory reporting regulation
Board adopts 1990 baseline/2020 target
- 1/1/09:** Board adopts Scoping Plan of Reduction Strategies
- 7/1/09:** Mandatory reporting begins

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AB 32 Statutory Requirements

- Regulation by January 1, 2008
- Begin with sources contributing the most to statewide emissions
- Account for all electricity consumed
- Use Registry protocols
- Provide reporting tools

Existing Resources for Reporting

Corporate Reporting Standard – WRI/WBCSD, 2004

General Reporting Protocol – CCAR, 2006

Guidance for National GHG Inventories – IPCC 2006

Climate Leaders Program – USEPA

International Organization for Standardization – ISO 14064

Canadian Association of Petroleum Producers – CAPP

IPIECA – Guidelines for Reporting GHG Emissions, 2003

American Petroleum Institute Compendium, 2004

Principles for Reporting (WRI/WBCSD, IPIECA)

- Relevance
- Completeness
- Consistency
- Transparency
- Accuracy

Present Federal and State Reporting Requirements

- U.S. Energy Information Administration
- U.S. EPA -- VOC, HAPs
- CEC -- PIIRA
- Air districts -- LDAR, flare reporting programs

Developing Mandatory Reporting for Refineries

CCAR

Refinery Discussion Paper,
Protocol Development

Continue to support
voluntary GHG reporting



ARB

Stakeholder Meetings
Regulation Development
October 2007 Staff Report
December 2007 Board Action



Mandatory Reporting

To begin in 2009

Supports improvement of the emissions
inventory, sector analysis and future
strategy development

California Climate Action Registry

Preparation of Discussion Paper
Protocol Development

Proposed Reporting Basics

- Annual Reporting on a Facility Basis
- Combustion, process, fugitive emissions (direct emissions)
- Purchased energy usage (indirect emissions)
- All 6 Kyoto gases -- unless methods not specified in the regulation

Questions of Scope

- Should mobile emissions be included?
 - Vehicles on-site?
 - Vehicles under control of facility?
 - Off-road equipment?

- Should indirect emissions be included?
 - Purchased energy?
 - Manufacture and transport of hydrogen?
 - Crude oil shipment within California?

Boundaries

- Facility-wide emissions
 - Use the fence line
 - Tie to process (SIC/NAIC code)?
- Operational control = environmental, health and safety authority
- Options for “other” on-site sources?

Refinery Specific Methodologies

API Compendium 2004

- Combustion
Stationary – Mobile – Indirect
- Vented
Process – Maintenance – Non-routine – Other
- Fugitive

API/Methodology Development Discussion Points

- Sources with existing methodologies
- Preferred and alternative calculation methods
- Additional gases and sources
- Areas where methodologies may be needed

Stationary Combustion Sources (Refinery Fuel)

**Are Multiple Methodologies Required?
What fuel parameters are measured – HHV, g Carbon/g Fuel?**

API Preferred

$$F(\text{m}^3/\text{unit time}) \times CF(\text{gmole}/\text{m}^3) \times M(\text{g}/\text{gmole}) \times \\ C(\text{g C}/\text{g fuel}) \times 44\text{g CO}_2/12 \text{ g C} \times \text{Mt}/10^6\text{g}$$

API Alternative and CCAR

$$F(\text{scf}/\text{unit time}) \times \text{HHV}(\text{Btu}/\text{scf}) \times \text{EF}(\text{tonnes C}/10^6 \text{ Btu}) \times 44 \text{ g CO}_2/12 \text{ g C}$$

**Areas of concern: use of refinery fuel as feedstock for boilers,
heaters, H₂ production, etc.**

Refinery Specific Sources

[1] Catalytic Cracker Units, Cokers – Coke Burned Method

USEPA 40 Part 63 (40CFR63.1564) Subpart UUU_National Emission Standards for Hazardous Air Pollutants for Petroleum Refineries: Catalytic Cracking Units, Catalytic Reforming Units, and Sulfur Recovery Units. Refineries calculate coke burn rate (R_c)

$$R_c = K_1 Q_r (\%CO_2 + \%CO) + K_2 Q_a - K_3 Q_r [(\%CO/2) + \%CO_2 + \%O_2] + K_3 Q_{oxy} (\%O_{xy})$$

where K_1 , K_2 , K_3 are material balance and conversion factors

R_c can then be used in the API methodology

$$ECO_2 = R_c \times CF \times [44 \text{ mass units of } CO_2 / 12 \text{ Mass units of C}]$$

Do all refineries calculate R_c ?

Are measurements of CF (fraction of carbon in coke) available? (=1)

Cracker Emissions, cont'd.

**Catalytic Cracker Units, Cokers – Air rates and flue gas
CO/CO₂ based method**

$$\text{ECO}_2 = (\text{AR} + \text{SOR}) \times (\text{FCO}_2 + \text{FCO}) \times 44 / \text{molar conversion factor} \times 525,600 \text{ min/yr}$$

AR = air rate to regenerator

SOR = supplemental O₂ rate

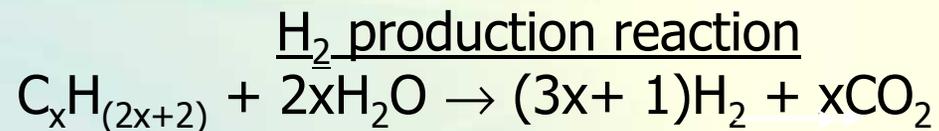
FCO₂ = fraction of CO₂ in flue gas

FCO = fraction of CO in flue gas

Is this as accurate a methodology as the "coke burned" method and are these parameters measured routinely?

Hydrogen Production

[2] API Preferred Methods – 1) Mass balance or 2) H₂ production rate based



1) $\text{ECO}_2 = \text{FR} \times \text{CF} \times 44\text{g CO}_2/12\text{g C}$ or

2) $\text{ECO}_2 = \text{H}_2\text{R} \times (x \text{ mole CO}_2)/(3x + 1) \times 44/\text{molar volume conversion}$

where:

FR = feedstock rate

CF = carbon fraction (fuel composition)

H₂R = hydrogen production rate

X = stoichiometry derived from feedstock composition

If feedstock is refinery fuel- we need accurate fuel composition data.
How well do we know H₂R?

Refinery Specific Sources

[3] Fugitive Emissions – fuel gas system and process equipment leaks

Leak Detection and Repair Programs

Do all refineries have LDAR programs?

Are these programs uniform from AQMD to AQMD?

Questions of data availability, VOC measurements and CH₄ EFs

Modeling Approaches to Fugitive Emissions

EPA TANKS Model--

Are model parameters suited to refinery specific sources such as heated crude oil storage tanks where CH₄ emissions may be significantly higher?

EPA WATER 9 or TOXCHEM+ for wastewater treatment emissions

Refinery Specific Sources

[4] Flares

What data do refineries routinely collect? Does data quality and availability vary with AQMD?

Gas flow rate

Gas composition

**API – no CO₂ or N₂O emission factors available, CH₄
scf/1000 bbl refinery feed**

Emissions calculation methods

$$E = F \times EF$$

Additional GHG Sources and Inclusion of all Six Kyoto Gases

- API considers CO₂, CH₄, and N₂O

Other important sources of these three gases?

Additional methods required?

--Wastewater treatment

--Sulfur Recovery Units (SRU)

- HFCs, PFCs and SF₆ not yet addressed

Potential Sources of high GWP gases?

--Cryogenic, refrigeration sources

Other Questions

Additional methodologies required?

Sources of emission factors?

Other GHG sources?

Need to split cogeneration emissions?

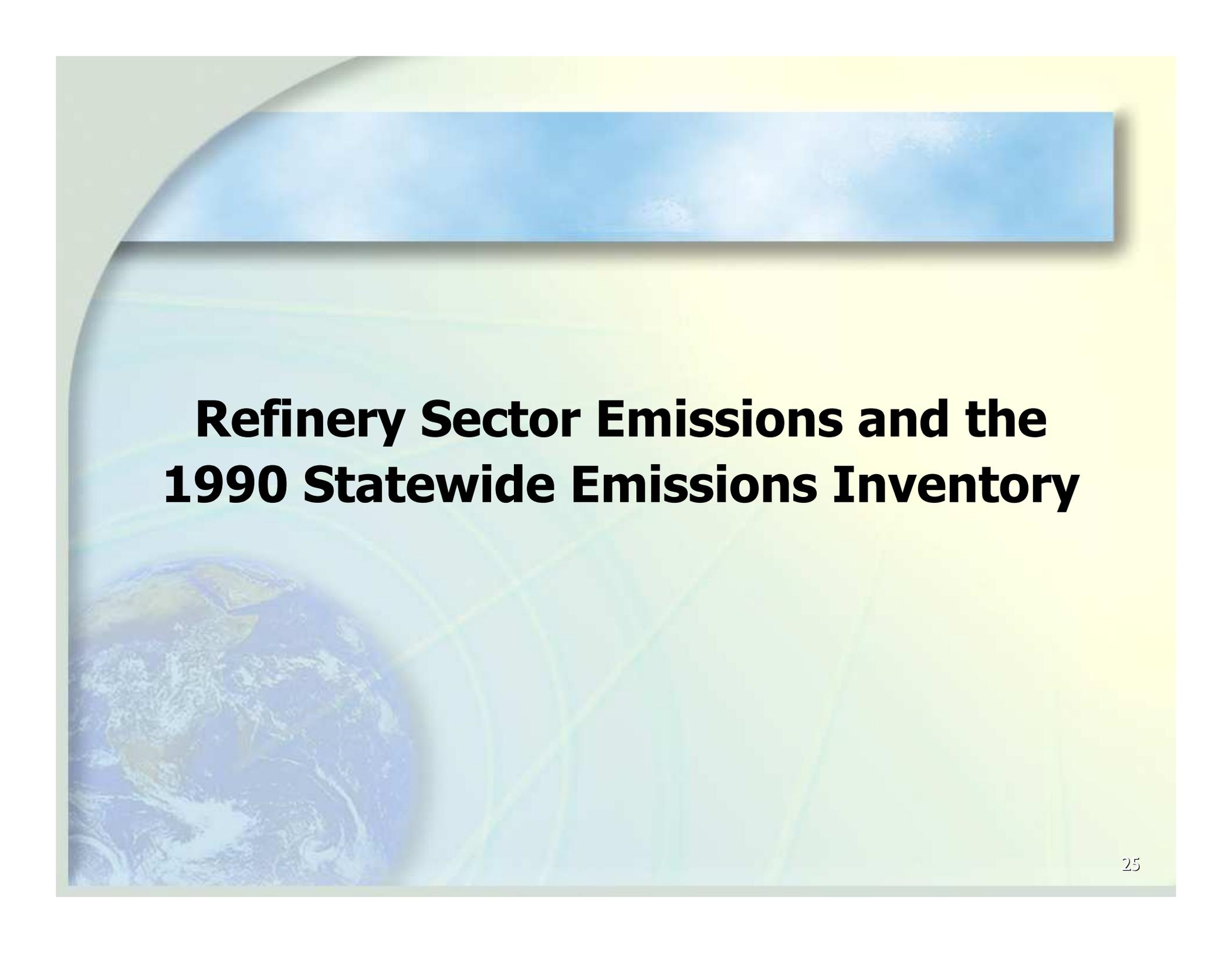
--Electricity and steam, on-site and off-site

Ideas on verification?

Other general or specific concerns?

Opportunities for Further Input on Mandatory Reporting

- Refinery Technical Discussions
 - May 22, June 19, July 6
- Next Mandatory Reporting Workshop
 - May 23
- Meetings with interested parties



Refinery Sector Emissions and the 1990 Statewide Emissions Inventory

AB32 Inventory Mandate

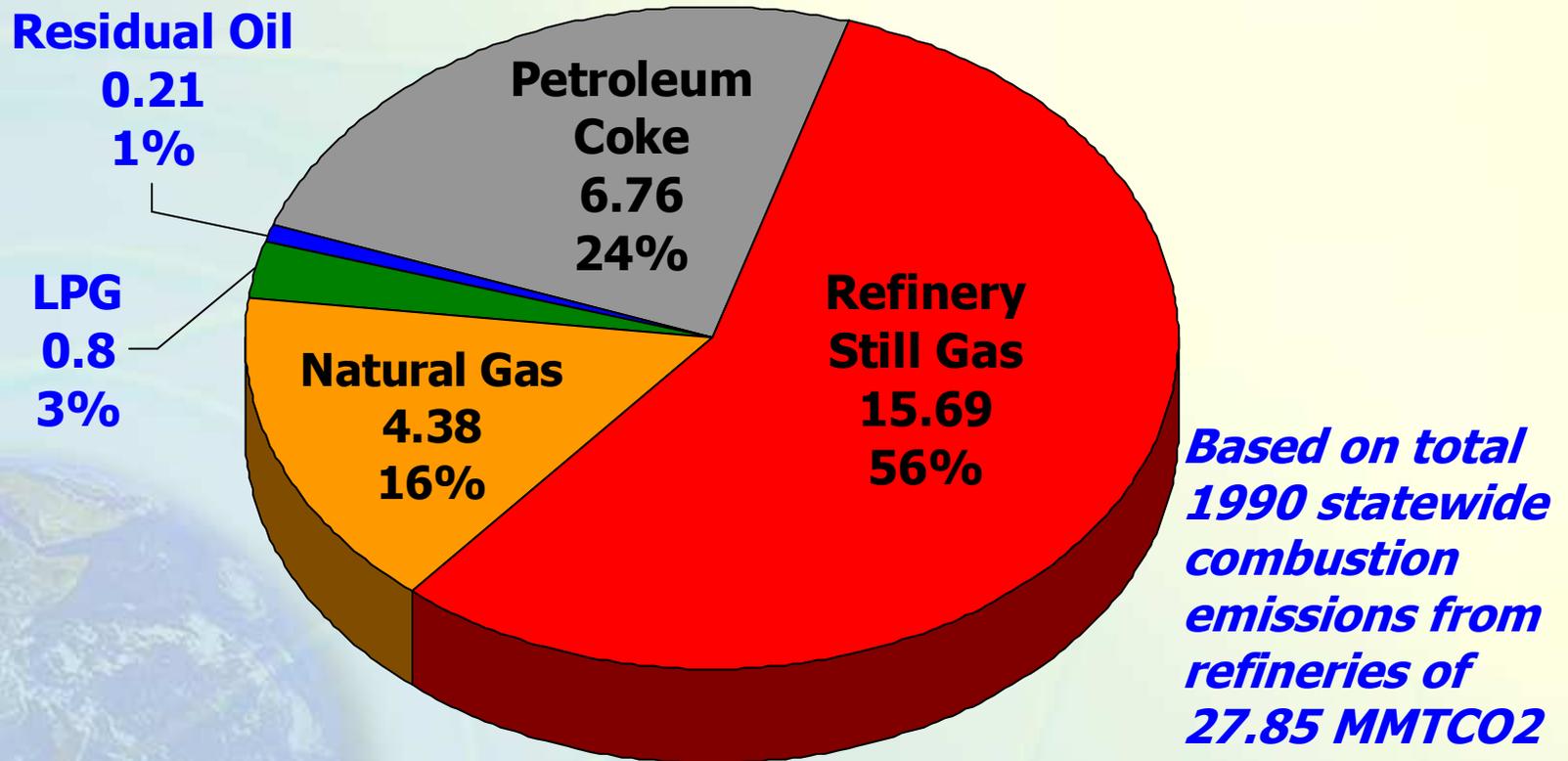
- “By January 1, 2008, the state board shall...determine what the statewide greenhouse gas emissions level was in 1990, and approve in a public hearing, a statewide greenhouse gas emissions limit that is equivalent to that level, to be achieved by 2020.”
- Focus is on 1990 statewide emissions level
- Staff will use best available data to determine the 1990 level

Refinery Sector GHG Emissions Inventory

- Refinery sector emissions from the Energy Information Administration (DOE) and the California Energy Commission
- Refinery fuel combustion emissions by fuel type

SECTOR	1990	2004
Total Refining Combustion Emissions	27.85	29.16
<i>Natural Gas</i>	<i>4.38</i>	<i>7.33</i>
<i>LPG</i>	<i>0.80</i>	<i>0.37</i>
<i>Distillate</i>	<i>0.00</i>	<i>0.00</i>
<i>Residual Oil</i>	<i>0.21</i>	<i>0.00</i>
<i>Petroleum Coke</i>	<i>6.76</i>	<i>6.63</i>
<i>Refinery Still Gas</i>	<i>15.69</i>	<i>14.84</i>

1990 Refinery GHG Emissions (by fuel consumed)



Note: 1990 Refinery emissions are 6.4% of the total 1990 statewide GHG Emissions

GHG Combustion Emissions Calculation & Factors

- $MTCO_2 = \text{Fuel Burned} \times EF$ (MTCO₂/fuel unit burned)
- GHG Emission Factors Currently Used

Fuel (Units)	MTCO ₂ /Unit	MTCO ₂ /MMBTU
Natural Gas (MMCF)	54.8	0.05
Refinery Gas (MMCF)	10.8 - 85.1	0.05 - 0.07
LPG (MGAL)	5.4	0.06
Distillate Fuel (MGAL)	10.2	0.07
Residual Fuel (MGAL)	11.8	0.08
Petroleum Coke (TONS)	3.1	0.10

MTCO₂ = Metric Tons of CO₂

Source: California Energy Balance & IPCC

Potential 1990 Refinery GHG Inventory Improvements

- Refinery specific fuel use
- Refinery specific EFs for refinery gas (varies considerably by refinery)
- Include flaring emissions
- Include wastewater emissions (CH₄ & CO₂)
- Include fugitive emissions from valve/flange leaks (CH₄)
- Include Sulfur Recovery Unit tail gas emissions (CO₂)
- Others?

Emissions Inventory Schedule

- Additional discussions
 - On-going

- Staff report
 - Initial draft anticipated in late summer

- Presentation to ARB Board
 - End of 2007

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Discussion Topics

- AB 32 Reporting Requirements
- Reporting Principles, Existing Requirements
- Developing a Regulation and Protocol
- Boundaries
- Refinery Specific GHG Sources, Calculation Methods
- 1990 Statewide Inventory