

**Cap-and-Trade Program
Technical Workshop:
Refinery Benchmark for the Second
and Third Compliance Periods**

August 28, 2012

Today's Agenda

- Introduction
Margaret Chu, ARB Staff Lead on Refinery Allocation
- The Carbon Dioxide Weighted Tonne (CWT) Benchmark
Paul Blinde, Ecofys
 - a. Introduction to the CWT approach
 - b. Steam production, use, sale, and purchase
 - c. Electricity production, use, sale, and purchases
 - d. Hydrogen production
 - e. Calcined coke benchmark
 - f. Exclusion of atypical refineries from the CWT approach
 - g. Determination of the benchmark value
- Summary and Next Steps

Cap-and-Trade Program and the CWT

- The California Cap-and-Trade Regulation uses the European Union Emission Trading System's (EU ETS) petroleum refining benchmark of 0.0295 allowances per carbon dioxide-weighted tonne (CWT) as the basis for allowance allocation starting in the second compliance period (2015)
- The California Mandatory GHG Reporting Regulation uses the EU ETS CWT factors (process unit emissions factors) as the bases for collecting product data to calculate refinery CWTs
- Additional work needed to further develop the CWT approach

CWT Adoption and Ongoing Work

- In Resolution 11-32, the Board directed ARB staff to work with stakeholders to further develop the allowance allocation approach for the petroleum refining sector and associated activities for the second and third compliance periods.
- This includes continuing analysis of the CWT approach, as well as treatment of hydrogen production, coke calcining, and other activities that may operate under a variety of ownership structures.
- ARB contracted with Ecofys, which previously supported the European Commission on benchmarking European refineries, to support ARB in the application of CWT to California's Cap-and-Trade Program, and in the development of other product benchmarks.

The Ecofys Preliminary Work Product¹

- Provides a summary of the development and features of the CWT approach
- Includes a preliminary analysis of applying the CWT approach to California refineries using publicly available data
- Provides a starting point for discussions about the application of CWT in the California Cap-and-Trade Program
- Areas covered: oil refining process and related GHG emissions, California refinery characteristics, approaches for benchmarking emissions efficiency, how the CWT method was developed, how the CWT was adopted in EU ETS, description of the elements used in the CWT approach

¹Available at <http://www.arb.ca.gov/cc/capandtrade/meetings/08282012/refinerydraft.pdf>

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Cap-and-Trade Technical Workshop to Discuss Refinery Benchmark in the Second Compliance Period

August 28, 2012

9:30 am to 3:00 pm

Cal/EPA Headquarters Building, Coastal Hearing
Room

Paul Blinde (p.blinde@ecofys.com)

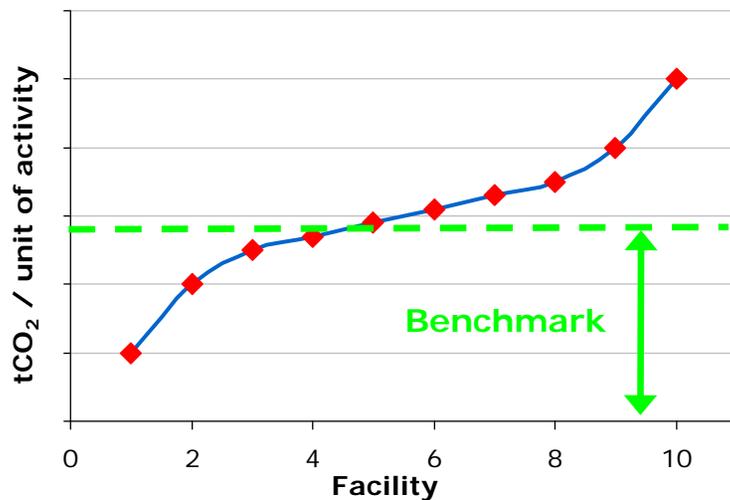
Some notes before we start

- > Role of Ecofys and its partner UC Berkeley is to support ARB in the development of product benchmarks. Ecofys is a consultancy in renewable energy, energy & carbon efficiency, energy systems & markets and energy & climate policy. Previously we supported the European Commission with benchmarking European refineries.
- > The views and opinions expressed in this presentation do not necessarily state or reflect those of CARB, the State of California, or any agency thereof.
- > This presentation as well as the report are intended to support stakeholder interaction, not to prescribe what policy is best for California.
- > This presentation refers to benchmarking methodologies owned and developed by Solomon Associates (referred to as Solomon). The information in this presentation and the accompanying report about these methodologies has been obtained through public sources, in particular material related to the development of the EU refinery benchmark. Please refer to Solomon for more detailed information about its products and services.

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Recap

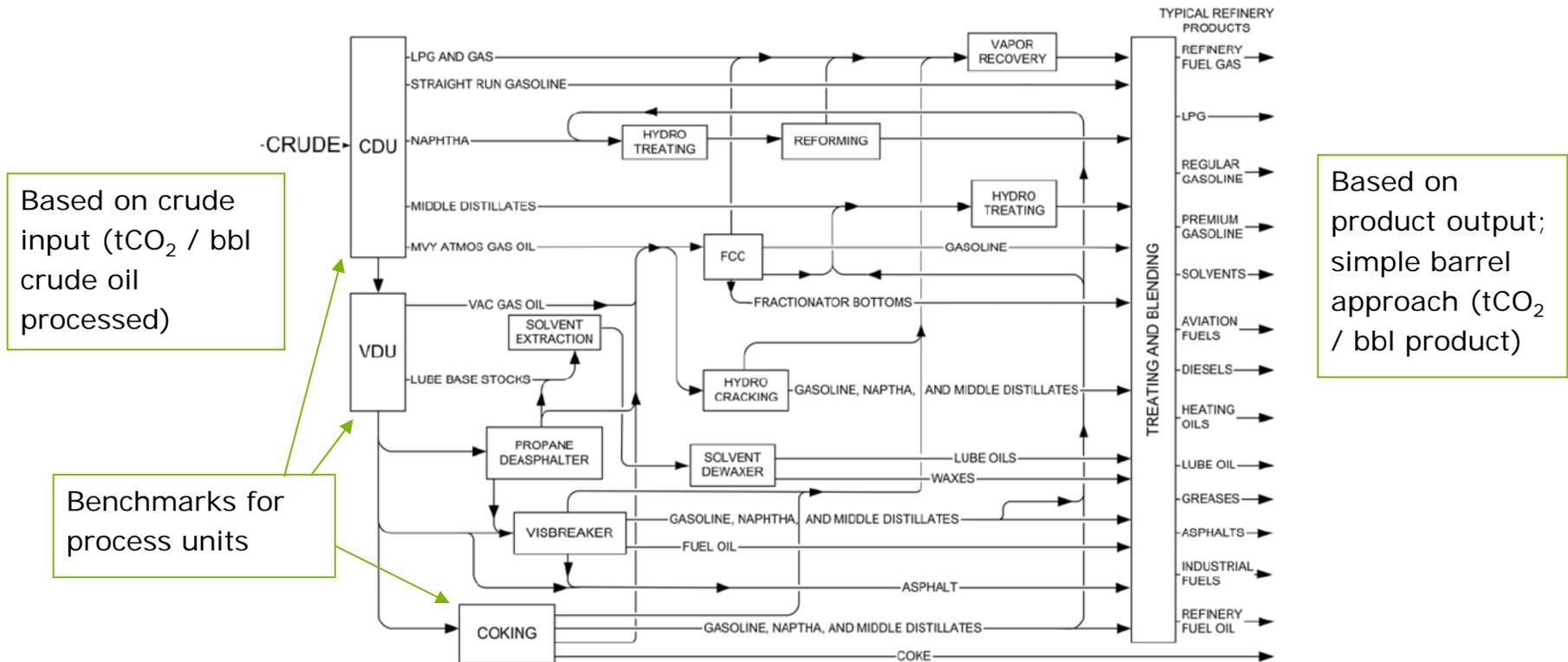
- > Industrial facilities receive an amount of allowances for free since they may not be able to pass on costs due to competition within (and across) industries and with importers, leading to:
 - Transition risk: loss of profitability inhibiting investments in emissions reductions
 - Emissions leakage risk: loss of production market share or new investment to jurisdictions with lesser climate policies increasing emissions elsewhere
- > Basing the amount of free allowances on benchmarks, if defined in a sound way, rewards early action



$$\begin{aligned} & \text{Allocation* (tCO}_2\text{/year)} \\ & = \\ & \text{Benchmark (tCO}_2\text{ / unit of activity)} \\ & \quad \times \\ & \text{Activity (unit of activity / year)} \\ & \quad \times \\ & \text{Assistance factor} \\ & \quad \times \\ & \text{Cap adjustment factor} \end{aligned}$$

*Simplified – not considering true up

Overview of approaches to benchmarking



- Other**
- > Approaches that weight the relative impact of different units (Solomon's approaches)
 - > Hybrid approach: benchmark based on crude input corrected for presence of process units
 - > A separate benchmark for each refinery based on improvement potential

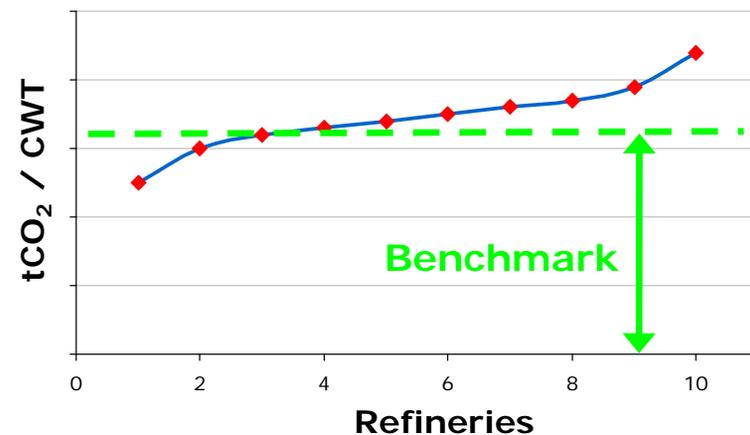
Figure taken from: LBNL, "Energy Efficiency Improvement and Cost Saving Opportunities for Petroleum Refineries - An ENERGY STAR® Guide for Energy and Plant Managers," LBNL-56183, Lawrence Berkeley National Laboratory, February 2005

Solomon's benchmarking methodologies allow comparing refineries with different sizes and configurations

- > The methodologies define generic process units
- > Each process unit has a weighting factor representative of its emissions at a standard level of performance
- > The 'product' of each refinery is defined based on these factors

Process unit	Throughput	Factor	Weighted throughput
Atmospheric crude distillation	a	1	a
Vacuum Distillation	b	0.85	0.85b
...
SUM			a + 0.85b + ..

- > A benchmark can now defined in terms of tCO₂ / CWT
- > The amount of free allowances can be determined on the basis of this benchmark and the amount of CWT of a refinery



General characteristics

- > When using the CWT approach, the single 'product' of the refinery is the CWT
- > The CWT approach does not prescribe what process units or process routes should be used
- > Refineries using exactly the same type of crude and producing an identical range of products still could theoretically get a different CWT
- > The CWT approach indirectly allows input differentiation
-> heavier, sourer crude requires more processing and hydrogen increasing the amount of CWT

Solomon's benchmarking approaches

- > Based on detailed information provided by companies on refineries' layouts, feedstock characteristics, operating rates and operating conditions
- > Approaches are known by all major refineries

Approach	Description
Energy Intensity Index (EII®)	<ul style="list-style-type: none"> > Detailed approach used for energy benchmarking > Used for the first compliance period of the California Cap-and-Trade Program
Carbon Emissions Index (CEI™)	<ul style="list-style-type: none"> > Detailed approach for benchmarking greenhouse gas emissions
Complexity Weighted Barrel (CWB), and Carbon Dioxide Weighted Tonne (CWT)	<ul style="list-style-type: none"> > Simplified approaches that have been developed for regulatory purposes > Used in Europe and will be used in the California Cap-and-Trade Program after the first compliance period > The EU CWT approach has been adapted to typical operations of European refineries > The EU CWT approach is available in public domain, others are not.

The CWT approach was adopted in the EU

Year	
2006/2007	> It became clear that the amount of free emission allowances to industrial facilities in the EU ETS in the period 2013–2020 would be based on benchmarking
2007/2008	> Europaia and CONCAWE (the European sector organizations) developed the CWT approach together with Solomon
2009	<ul style="list-style-type: none"> > European Commission commissioned Ecofys (together with partners) to develop the allocation methodology in Europe > Ecofys recommended the use of the CWT approach and worked with Europaia/CONCAWE to refine the approach to make it fully consistent with EU legislation > CONCAWE obtained the right from Solomon to use the CWT methodology in the EU ETS > CONCAWE developed a template to collect data required to calculate the benchmark
2009/2010	> CONCAWE collected data and determined the benchmark
2011	> The CWT approach and benchmark was adopted in EU legislation and entered the public domain.

! The data underlying the calculation of the CWT factors remained the property of Solomon and is not publicly available

Is it appropriate to use the EU CWT approach and benchmark in California or are modifications needed?

Certain changes to the approach require input from Solomon, which requires cooperation with and within industry

Level of detail: definition of process units

Introduction

- > The more aggregated, the less the approach takes into account differences between refineries and the less input data are required
 - Solomon has a comprehensive list of over 150 process units
 - For the CWT approach, units have been grouped together resulting in about 50 process units

Should the definition of process units be changed?

- > To a certain extent, this is a policy question:
 - How many differences should the approach account for?
 - What amount of data input is acceptable?
- > Changing the current grouping or doing an assessment of whether it would be appropriate from a technical perspective to modify the grouping would require involvement of Solomon

Weighting factors or 'CWT factors' are used to weight the contribution of different process units

Introduction

- > Each process unit has a weighting factor representative of its emissions at a standard level of performance
- > The EU CWT factors have been adapted to typical operations as well as the fuel mix of European refineries
- > The EU CWT factors are defined so that throughputs need to be expressed in metric ton instead of barrels

Should the CWT factors be changed?

- > California refineries are used to report in barrels
- > The 'typical' California refinery is different from the 'typical' European refinery -> more coking
- > Changing the CWT factors or doing an assessment of whether it would be appropriate to do so would require involvement of Solomon

Correction for off-sites and non-crude feedstock

Introduction

- > Energy is required to operate the non-process assets (off-sites) such as tank farms, blending facilities, terminals as well as ancillary facilities such as effluent treatment.
- > Non-crude feedstock may be fed (relatively) cold to units downstream of the crude distiller. Energy is required to be bring them to temperature.
- > To account for this, in Europe, a correction is made based on a simplified empirical correlation

$$\text{CWT}_{\text{corrected}} = 1.0183 \times \text{CWT}_{\text{uncorrected}} + 0.315 \times \text{Feed to Crude Distillator} + 298$$

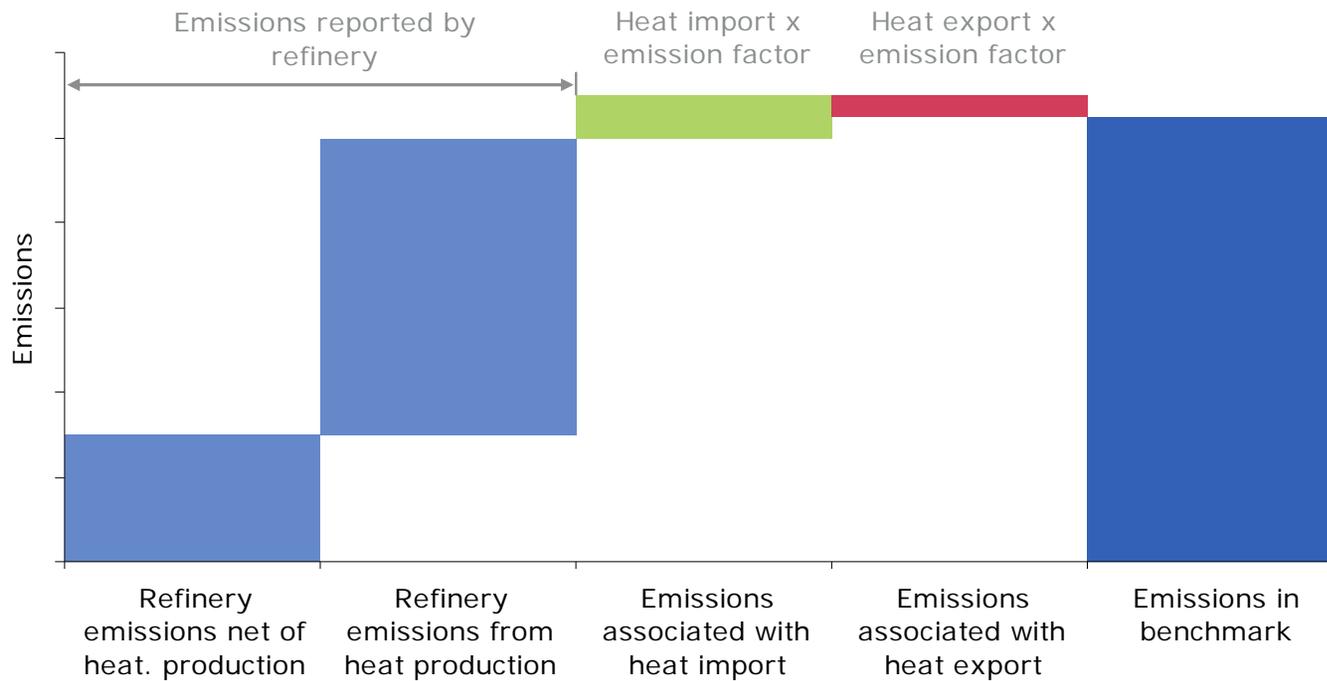
Approach for California?

- > Empirical correlation may not reflect California practices
- > Current correction and its effect on the allocation is generally modest

The benchmark includes emissions from all heat consumption and excludes emissions related to any heat export

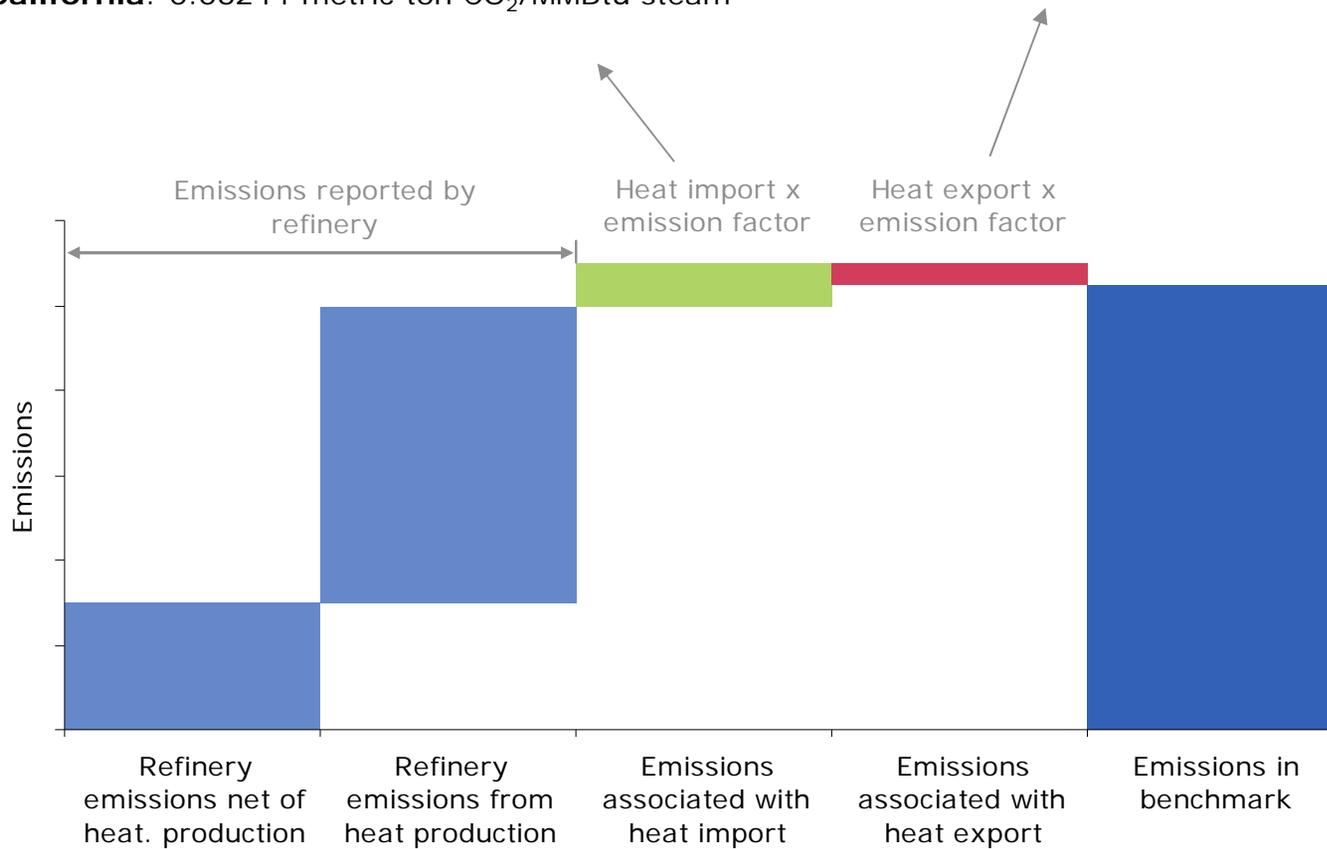
$$\text{Benchmark} = \frac{\text{Emissions}}{\text{CWT}} = \frac{\text{Needs to include emissions related to all heat consumed} \quad \text{exclude emissions related to heat exported}}{\text{incl. heat consumption; excl. heat export}}$$

- > Methodologically, with respect to heat, the benchmark is in line with the overall allocation methodology



Emissions factors used for heat import and heat export

- > **Europe:** est. avg. emissions factor for heat production of all EU refineries (at sector level does not distinguish between heat produced on site and heat import)
- > **California:** 0.06244 metric ton CO₂/MMBtu steam
- > **Europe:** est. actual emissions factor of heat exporting refinery (representative of actual performance)
- > **California:** 0.06244 metric ton CO₂/MMBtu steam

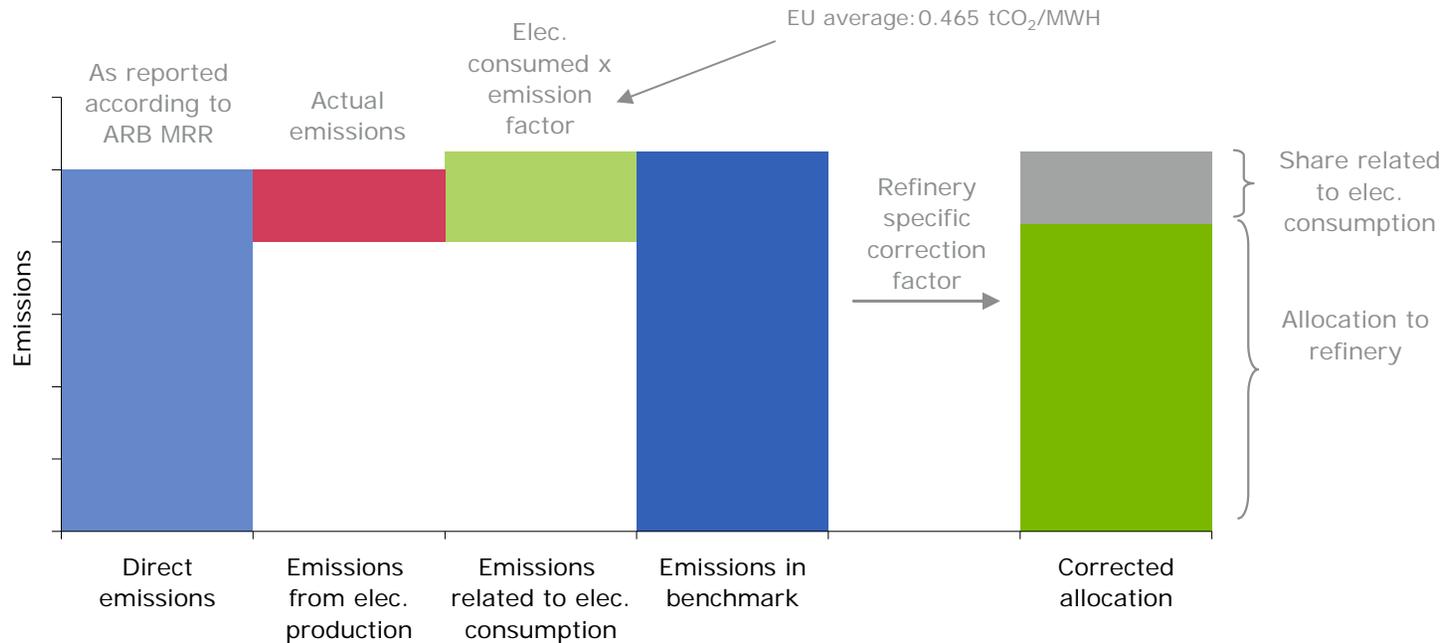


The EU benchmark includes electricity consumption and exclude electricity production

$$\text{Benchmark} = \frac{\text{Emissions}}{\text{CWT}} = \frac{\text{Needs to include emissions related to all elec consumed} \quad \text{exclude emissions related to elec. exported}}{\text{incl. elec. consumption; excl. elec. export}}$$

> So, the benchmark includes all net electricity consumption

Approach in the EU

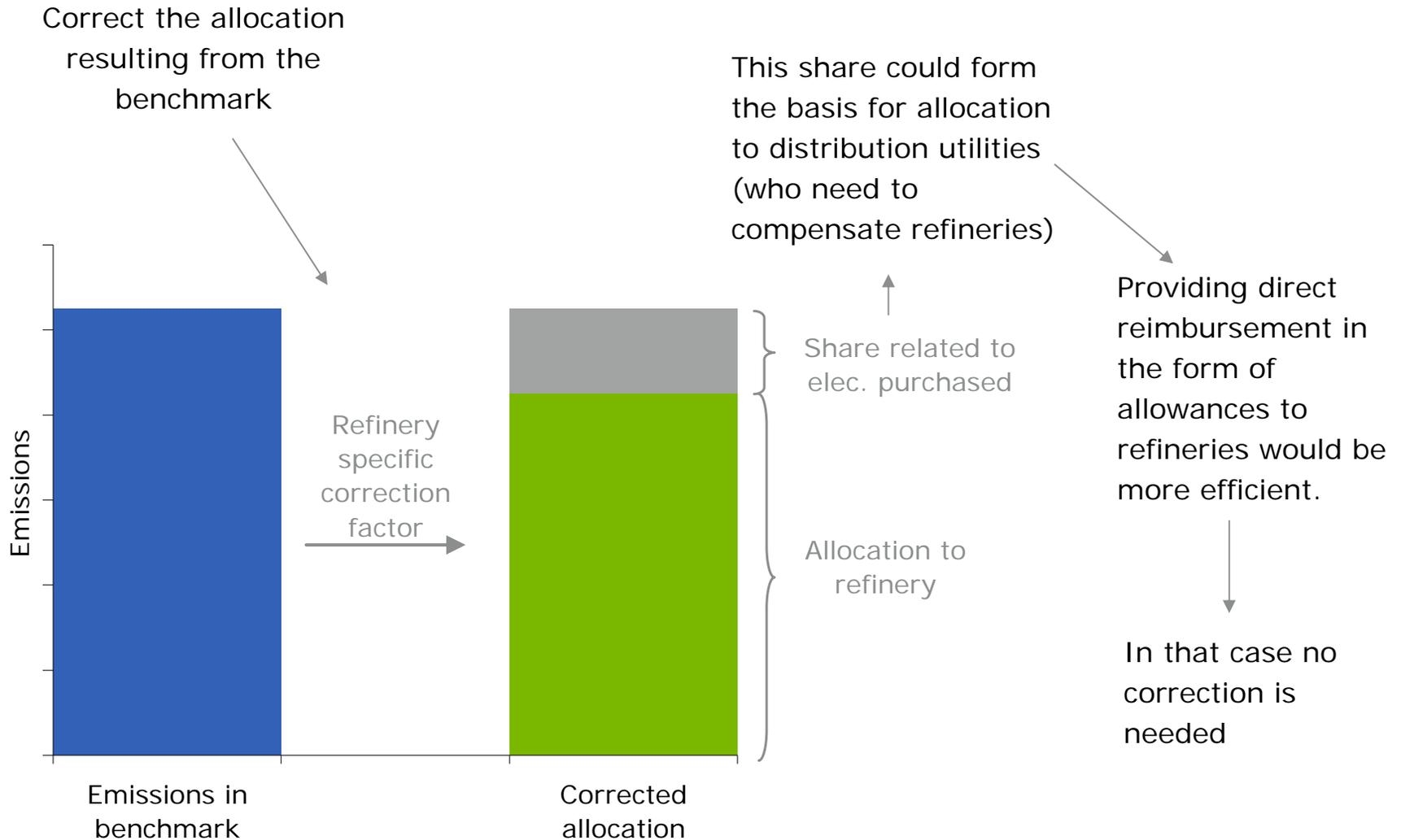


Contrary to in the EU, in California there is compensation for emissions from electricity production

	Energy Self-Generated or Imported?		
	Produced On-site	Imported from Off-site	
Source of Direct or Indirect Carbon Costs	Heat Consumed	Direct Allocation*	Direct Allocation*
	Electricity Consumed	Direct Allocation*	Compensation Through Distribution Utility [†]
*Include in emissions efficiency benchmarking exercise and final allocation. [†] Consider in benchmarking work but remove from final direct allocation.			

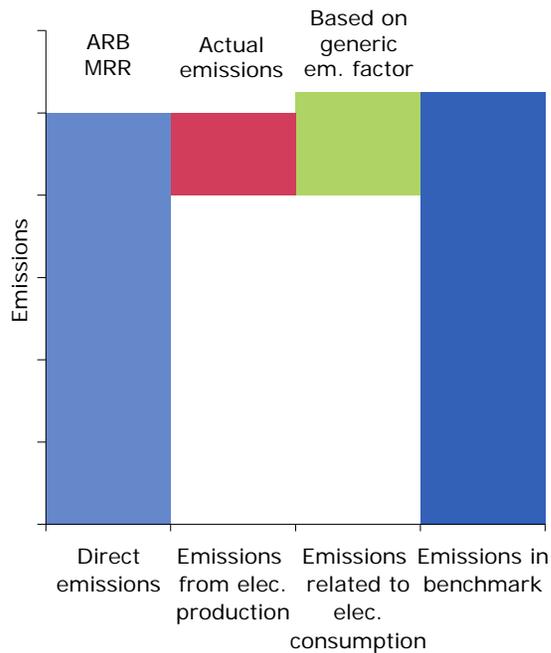
Table taken from: CARB, "Appendix J of the Initial Statement of Reasons of October 2010," October 2010

How to deal with this with the allocation?



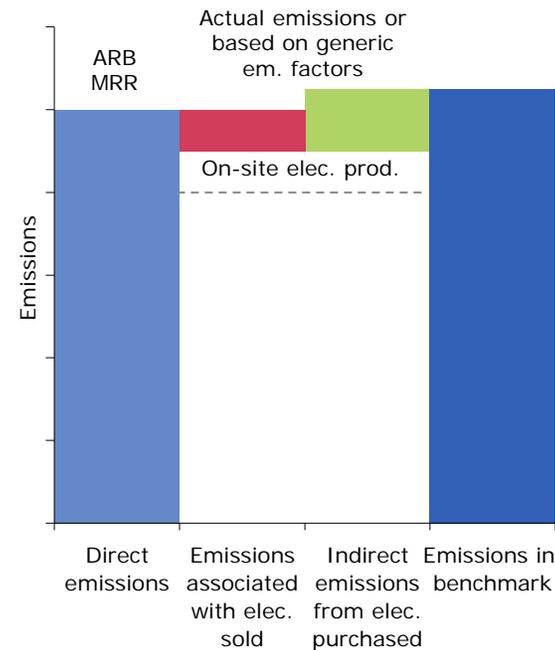
Determination of the benchmark

EU benchmark does not take into account efficiency of on-site electricity production



- > Benchmark does not distinguish between electricity generated on site and electricity purchased
- > More data requirements

Alternative: only correct for electricity purchases and sales



- > Benchmark is dependent on share of electricity produced on site and the efficiency of on-site electricity production in the baseline period

Hydrogen is produced both in refineries and merchant plants

- > Allocation should be independent of ownership structure

	Refinery	Merchant plant
1. Current approach	CWT approach	Benchmark based on CWT factor for hydrogen production and (EU) refinery benchmark
2. Alternative	CWT approach (with adapted CWT factor for hydrogen production)	Benchmark based on actual performance
3. Alternative	Benchmark based on actual performance, exclude hydrogen from CWT approach	

- > Production of liquid hydrogen involves compressing as an additional production step leading to increased consumption of electricity. Compensation for additional indirect emissions will be given to electricity utilities, which in turn will compensate rate payers such as hydrogen producers

Coke can be calcined in a refinery or independent plant

- > Allocation should be independent of ownership structure
- > Similar options as for hydrogen

	Refinery	Merchant plant
1. Current approach	CWT approach	Benchmark based on CWT factor for calcining and (EU) refinery benchmark
2. Alternative	CWT approach (with adapted CWT factor for calcining)	Benchmark based on actual performance
3. Alternative	Benchmark based on actual performance, exclude coke calcining from CWT approach	

Exclusion of atypical refineries from the CWT approach

- > The CWT approach is not suitable for atypical smaller refineries
- > The definition of “atypical” is not a law of nature

EU definition: atypical refineries do not produce a...

“Mix of refinery products with more than 40% light products (motor spirit (gasoline) including aviation spirit, spirit type (gasoline type) jet fuel, other light petroleum oils/ light preparations, kerosene including kerosene type jet fuel, gas oils)”

- > In case a smaller refinery is connected with a nearby larger refinery, these refineries could be grouped together to form one mainstream facility for the purpose of applying the CWT methodology (see report)
- > Recommend to consider suitability on a case by case basis taking EU definition as starting point
- > How to determine allocation to atypical refineries: energy benchmarking, simple barrel approach used in first compliance period, other...?

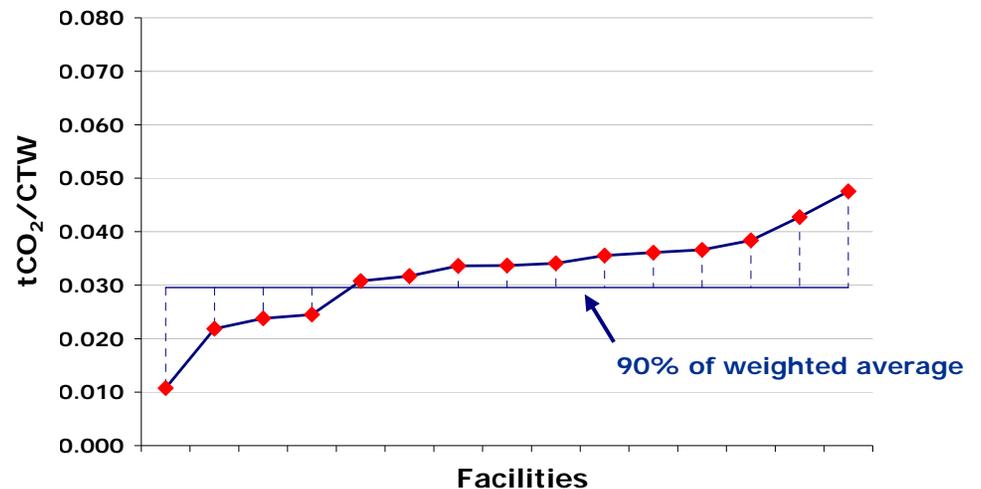
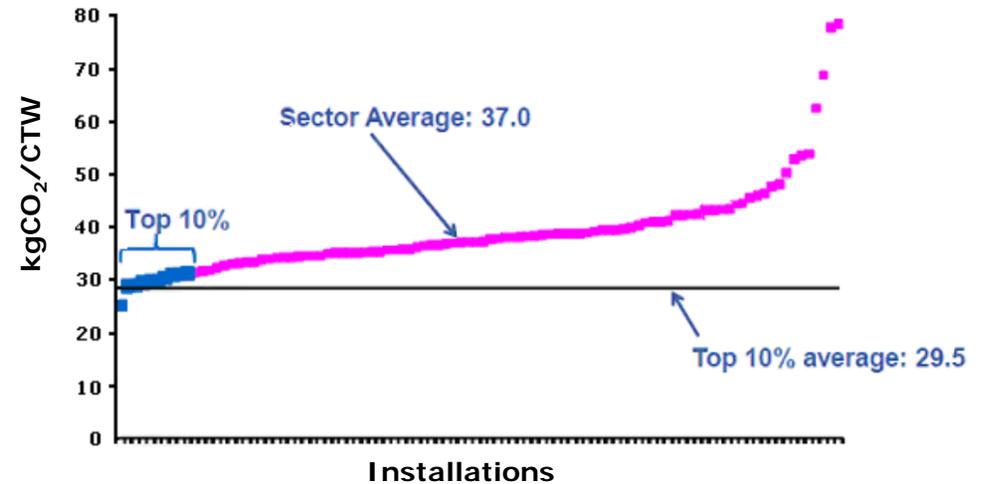
California adopted the EU benchmark

Europe

- > Benchmark stringency: arithmetic average of 10% installations with lowest emissions intensity.
- > For refineries, this corresponds to 80% of weighted average emissions intensity

California

- > General benchmark stringency: 90% of weighted average emissions intensity
- > Figure shows indicative results of preliminary assessment based on data available; results based on primary data may deviate substantially
- > Ideally, the California benchmark would be based on data from California refineries.
- > Benchmark is subject to definition of methodology (see earlier topics discussed in this presentation)



Upper figure taken from: Lane, M, (Secretary General, CONCAWE), Presentation at 4thJPEC/CONCAWE Information Exchange Meeting, Tokyo, 31 August, 2011
Lower figure from: Ecofys, "Development of GHG efficiency benchmarks for the distribution of free emissions allowances in the California Cap-and-Trade Program; Refineries – DRAFT WORKING VERSION-," Prepared for California Air Resources Board, August 2012

Thank you for your attention

Please contact us for more information

Ecofys Netherlands B.V.

Kanaalweg 15G
3526 KL Utrecht
The Netherlands

Paul Blinde

T: +31 (0)30 662-3120
E: p.blinde@ecofys.com

I: www.ecofys.com

Ecofys United States

200SW4th St, Suite 205
Corvallis, OR 97333
USA

T: +1 541 7668200

E: info@ecofys-us.com

Comments

- ARB is requesting feedback on the preliminary findings as presented in Ecofys' draft work product, and areas for additional studies
- Please submit written comments by September 25, 2012, at <http://www.arb.ca.gov/cc/capandtrade/comments.htm>