About Solomon Associates

Over 30 years as worldwide industry leader in Benchmarking and Performance Improvement Services

World’s largest databases of operating performance

Large inventory of Industry Best Practices

Staff of industry experts
Most with >30 years industry experience

Enhance performance and maximize profits
Third-party objective | Absolutely confidential
Comparative Performance Analysis
More than Benchmarking - Unique to Solomon Associates

Value

“Fair, Independent, and Accurate” representation of client performance
Objective standard for comparison to regional peer plants or other peers according to market mission
Sufficient detail and tools to identify and quantify improvement opportunities
Ability to compare all plants within company – resource allocation
Analyzing Performance Around the Globe

Companies in more than 70 countries rely on Solomon; our metrics have become the standard for gauging performance around the world.
GHG Regulatory Support
Working with our clients and regulatory agencies

- Helping to find a way forward around the world
  - Europe
  - Japan
  - Netherlands
  - Canada
  - New Zealand
  - California
  - US EPA ENERGY STAR
  - Other countries

- Customized approaches to meet specific needs of each region
CWB and CWT

Both of the Complexity-Weighted Barrels (CWB™) and the Complexity-Weighted Tonnes (CWT™) methodologies are proprietary to Solomon.

Solomon grants the client (typically a regional Industry Association) limited rights to use or promote the methodology for the purpose of GHG regulations, under a Consulting Services Agreement.
Solomon Metrics for GHG Benchmarking

For Regulatory Arena:

- **EII®**: Energy Intensity Index
  - Complexity-Weighted Barrels (CWB™)
  - Complexity-Weighted Tonnes (CWT™)

- **CEI™**: Carbon Emissions Index

(1) “Benchmark”: Divisor in an intensity metric, GHG emissions per CWB or CWT
(2) “Cap and Trade”: Basis for allocating emission allowances
What are CWB and CWT?

**CWB** – an equivalent *barrel* divisor for refinery throughput indicative of GHG emissions potential based on a refinery’s configuration and processing complexity

**CWT** – an equivalent *tonne* divisor for refinery throughput indicative of GHG emissions potential based on a refinery’s configuration and processing complexity
CWB vs CWT

CWB

• Prototype developed during an Emissions Allocation Study for WSPA around 2008
• For North American refineries measuring throughput in barrels

CWT

• Developed for CONCAWE under the EU GHG Emissions Trading Scheme (ETS) Directive (“EU-CWT”) in 2008–2009
• Customized for EU average fuel mix and feed characteristics
• Simplified vs CWB by combining a number of process unit categories and process types
• Can be modified for refineries in other regions using metric units of measure
Solomon CWB Boundary

**On a Total Emissions Basis**

- **Direct Emissions**
  - CWB
  - Adjustments for Sales and Exports of Steam/Electricity

- **Indirect Emissions**
  - Purchased Natural Gas
  - Other Purchased Fuel
  - Purchased Steam
  - Purchased Electricity
  - Process Units
  - Off-Sites & Utilities
  - Non-Crude Sensible Heat

**CWB Boundary Conditions**
Process CWB

\[ \text{Process CWB} = \sum (\text{Daily Throughput Barrel} \times \text{CWB Factor}) \]

CO₂ e Emissions Standard per barrel throughput for Unit (or Unit Grouping) X

CWB Factor for Unit (or Unit Grouping) X

\[ \frac{\text{CO₂ e Emissions Standard per barrel throughput for CDU}}{\text{CO₂ e Emissions Standard per barrel throughput for CDU}} \]

- Accounts for Refinery Process Unit Configuration and Complexity
- Approx. 60 CWB Factors

1 Units of Measure – Certain process units are based on product, rather than feed (throughput); alternative units are used in accordance with industry convention (e.g., short tons of product for coke calciner)
CWB Robustness in Allocating Emissions
Simple Barrels vs CWB

(CO$_2$e Emissions vs Crude Input)

Simple Barrels: $r^2 = 0.77$

(CO$_2$e Emissions vs CWB)

CWB: $r^2 = 0.97$

(Operating Year 2010; Approx. 200 OECD Refineries)
Summary

• CWB is robust to benchmark a wide range of refining process configurations

• CWB can be applied to big or small refineries

• CWB can be customized for
  ▪ Boundary Conditions (Total vs Direct-Only Emissions)
  ▪ Reference Fuel
  ▪ Streamlining – Combination of process units

• “Atypical” refineries may be handled separately
  ▪ Extremely small sizes
  ▪ Performing predominantly specialized functions (such as bitumen production or lube oil manufacture)
  ▪ Atypical product slate (such as <40% light products including motor gasoline, aviation gasoline, kerosene, and diesel/heating oil)
Contact Information

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