Petroleum Refinery Benchmarking Concepts
Cap and Trade Allocations and Benchmarking Workshop
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The value of benchmarking.

• Repeated studies show that 80% of car drivers believe that they are “better than average” drivers.

• Benchmarking provides externally grounded data to prove what’s good…what’s average…what’s bad.

• The petroleum refining industry has participated in broad benchmarking initiatives over the past 25+ years.
Complex refining processing needs to be accounted for.

• “Production”, as measured by inputs or outputs, is not an adequate performance measure for petroleum refineries.

• “Complexity” – the ability to produce a high yield of clean fuels from a range of crude types – has to be taken into account.
Why complexity?

• No two refineries are alike
  – Each was designed with a combination of technologies:
    • to suit the perceived market opportunities
    • feed availabilities
    • adapt to an ever-changing market place
    • owner financial capability
    • new environmental realities.

• Crude quality is declining = more processing.
• Products are getting cleaner = more processing.
• There is a range of refining capability out there.
Separation

- Fractions of the crude boil at different temperatures.
- Components are separated by distillation and drawn off as they condense.
- Distillation is found in every process area.
- May be at high pressure, low pressure or under a vacuum.
Crude types vs. Demand

- Naturally occurring hydrocarbon molecules do not meet customer needs.
- The refining processes must adjust the molecules, reshape them and remove contaminants to ensure they meet requirements for:
  - end-use performance
  - environmental performance.
Conversion

- Upgrading Separation products by changing their chemical structure.

- Processes mainly use high temperature, Hydrogen and a catalyst Pt/Co/Ni.

- Reforming, Cracking (FCCU and Hydrocracking), Alkylation, Isomerization, Polymerization, some Coking processes.

- Delayed Coking is also a conversion process but does not use a catalyst or Hydrogen.
First generation petroleum refineries were simple separation processes.

[Adapted from National Petroleum Council June 2000, refinery circa 1915]
Modern refineries produce clean fuels through intensive processing.
Solomon benchmarking is unique to the petroleum refining industry.

- Refining benchmarking concept developed by Solomon Associates Inc.
  - over the last 20+ years
  - involving a massive database: 300 refineries world-wide.

- From this, the Canadian Petroleum Products Institute (CPPI) has worked with Environment Canada to develop a complexity measure called Refinery Activity Index (RAI).

- Industry is reporting on this basis to Alberta Environment.

- Complexity measures continue to evolve as “Complexity Weighted Barrel” (CWB) is being studied by the industry and may have a stronger correlation to GHGs than RAI.
CPPI has also worked on benchmarking for air pollutants.

• National Framework Petroleum Refinery Emissions Reduction (NFPRER) developed under the CCME umbrella.
• Started in 2001 as a ‘new approach to reduce emissions.
• Developed through a unique Multi-stakeholder approach.
• Alberta and Environment Canada co-chaired a Steering Committee of Federal, Provincial and Municipal Agencies, Environmental and Health NGOs, CPPI.
• Developed to help jurisdictions establish facility-wide emissions caps.
• Core of approach is to achieve similar performance to US (confirmed to be the most stringent globally), but with greater flexibility on how to achieve those levels thus preserving competitiveness.
• Published in 2005 and lauded by former Environment Canada DM as an example of «smart regulation». 
National Framework Petroleum Refinery Emissions Reduction (NFPRER)

Key principles & expected outcomes

- Preserve competitiveness of the petroleum refining sector in Canada.
- «Performance» based approach where each refinery is independently treated rather than ‘prescriptive’ approach.
- Maintain any superior performance that already exists in Canada.
- Facility wide caps on emissions to allow flexibility consistent with emissions trading.
- Convergence of the environmental performance (current and anticipated) of Canadian refineries with comparable U.S. refineries.
- Continuous improvement of environmental performance in a prioritized and phased manner over a ten-year implementation and update strategy.
National Framework Petroleum Refinery Emissions Reduction (NFPRER)

Summary of approach

1. Perform statistical correlation
2. Calculate 75% confidence interval to capture uncertainty and include as many refineries as possible
3. Compare Canadian refineries to benchmark
4. Achieve convergence. All CDN refineries at top of confidence interval or better
National Framework Petroleum Refinery Emissions Reduction (NFPRER)

- Benchmarking is central to the objective of convergence with comparable US refinery performance.

- Benchmarking CDN refineries with respective peer US group is feasible and credible but imperfect.

- Correlation do have uncertainty and confidence intervals recognize the imperfections and scatter in the data.

- 75% confidence intervals reflect the statistical uncertainty associated with:
  - Reporting accuracy in historical US/CDN data (has improved over time)
  - Varying reporting methodology
  - Emissions reduction projections variability
  - Feedstock, processes and operation variability

- Confidence intervals also addresses the issue of correlation fit ($R^2$) of the regressions.
Petroleum industry is experienced with benchmarking.

- Benchmarking is a valuable tool to measure industry and facility performance.
- Large database of refineries world wide lends credibility and practicality to the concept.
- Benchmarking is necessary for establishing appropriate targets.