CARBON FOOTPRINTS : A PROPOSED METHODOLOGY

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Carbon Footprints : Outline of the Lecture

- A Proposed Methodology
- Green House Gases (GHG) Accounting
- Conclusions

Carbon Footprints : A Proposed Methodology (1)

The following is an outline of a methodology to estimate the carbon footprint of a process plant. Some points to note:

- The method has still to be tried and tested
- The computation of direct CO_2 emissions is relatively simple. The computation of indirect emissions will require a more substantial investment in effort.
- Direct emissions can be considered the equivalent of OPEX, indirect emissions would be the equivalent of CAPEX.
- Development of the method and associated workflow will require more disciplines to take ownership of a process that on first sight, many might consider to be the responsibility of the environmental group.

Carbon Footprints : A Proposed Methodology (2)

1. The methodology will be broken down into 3 phases:
   - Screening
   - FEED
   - Detailed Design
2. A new document – the carbon load list – will be used to track carbon emissions as the design of a facility is developed.
3. Process should be custodian of the load list during screening and FEED. Responsibility and duties will then pass to the ‘carbon load engineer’. This will be a new role, somewhat similar to that of a weight control engineer.

Carbon Footprints : A Proposed Methodology (3)

4. The carbon load list shall provide an auditable trail of data used, decisions and assumptions made in determining the selection of the final process. The objective shall be to demonstrate that all measures have been taken to minimise the carbon footprint of the process.
5. In this respect, the document should be developed as a data-centric tool, **not** as an Excel spreadsheet.
6. Early projects will develop data that will form the basis of a knowledge bank. This will be particular useful for screening activities when typical values of indirect (embodied) carbon emissions will be sought for generic types of plant.

Carbon Footprints : A Proposed Methodology (4)

SCREENING

7. Estimate the direct CO_2 emissions of the facility that is being developed. These are associated with its operation and include:
   - Stationary combustion units - turbines, fired heaters, reformers, etc.
   - Off gases – flare, tails gas from absorption processes, etc.
   - Fugitive – leakage from valve stems, etc.
8. Emissions from stationary combustion units and off-gases can be estimated early in the project. Fugitive emissions shall be addressed during detailed design.

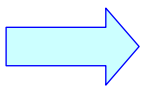
Carbon Footprints : A Proposed Methodology (5)

9. Use a simulation model (HYSYS, etc.) to identify power requirements of the process (compressors, pumps, etc). Apply an energy conversion factor and then estimate a total power generation requirement.
10. Use typical heat rate curves for prime movers (turbines, reciprocating engines, etc.) to determine fuel demand.
11. Determine net calorific value of the fuel to be used.
12. CO_2 emissions = energy content of fuel consumed (TJ)
    x emission factor (tonnes CO2 / TJ)
    x oxidation factor (typically, 0.995)
13. Identify tails gas and flue gases from other combustion sources - fired heaters, etc.

Carbon Footprints : A Proposed Methodology (6)

14. Enter details onto the carbon load list. At this stage, this can be envisaged as 2 additional columns on an equipment list:

Tag No	Description	Capacity	Duty KW
xxxx	Turbine ..		xxxx
xxxx	Turbine ..		xxxx
xxxx	Heater ..		xxxx



CO2e emissions	
Direct	Indirect
xxxx	
xxxx	
xxxx	
Total **xxxx**	

Carbon Footprints : A Proposed Methodology (7)

15. Ensure the carbon equivalency of any methane (CH_4) is included in the estimate of direct emissions.
16. Complete a summary sheet with details of designs screened and direct emissions calculated (example to follow). Values are to be checked against a standard to be developed with the client at the start of the project (example to follow).
17. Present summary sheet and carbon load list at an Environmental Review (ENVID) meeting. Assess results against project standard and as appropriate, update summary sheet and load list.
18. Issue documentation as part of project material to be approved by client.

Carbon Footprints : A Proposed Methodology (8)

FEED

19. Develop a Level II equipment list and then use weights (kg) with a modified version of the cost estimating tool (BEST) to determine indirect carbon emissions.

20. The modified version of BEST could be named CEST (Carbon Estimating Tool). Values of indirect carbon (tonnes CO_2e/kg) or embodied energy (kJ/kg) would be used in place of cost estimating data ($/kg).

21. Preliminary values of embodied carbon are available for bulk materials (steel, concrete, etc.) Values for manufactured items (equipment, etc.) will become available as the methodology of carbon footprints develops.

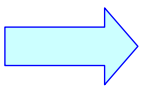
Carbon Footprints : A Proposed Methodology (9)

22. Use assumed values where published data does not exist (manufactured items, etc). These values should be agreed with the client and initially, used for sensitivity analysis.
23. The carbon load engineer shall be responsible for maintaining a record of indirect (embodied) carbon factors used and shall ensure the associated database is updated as new values become available.
24. It has been proposed that indirect carbon content may be proportional to cost. It is too early to say if this is the case. Use tool to explore the relationship between cost and carbon footprint.

Carbon Footprints : A Proposed Methodology (10)

25. Enter details of indirect (embodied) CO_2 emissions onto the carbon load list:

Tag No	Description	Capacity	Duty KW
xxxx	Turbine ..		xxxx
xxxx	Turbine ..		xxxx
xxxx	Heater ..		xxxx
xxxx	Separator	xxxx	
xxxx	Exchanger	xxxx	
xxxx	Pump ..		xxxx
xxxx	Pump ..		xxxx



CO2e emissions	
Direct	Indirect
xxxx	xxxx
xxxx	xxxx
xxxx	xxxx
-	xxxx
-	xxxx
xxxx	xxxx
xxxx	xxxx
Total xxxx	xxxx

Carbon Footprints : A Proposed Methodology (11)

DETAILED DESIGN

26. Maintain the carbon load list.
27. Ensure equipment list is updated to reflect changes in information received from vendors.
28. Add the embodied energy content of bulks as material take-offs are developed.
29. Prepare estimates of fugitive emissions by using piping and instrument diagrams (P&IDs) and isometrics (number of flanges, valves, etc.)
30. Refine energy consumption data, e.g. HVAC loads, waste heat recovery, etc.

Carbon Footprints : A Proposed Methodology (12)

DETAILED DESIGN

31. Invoke the services of an approved verification agency to check the consistency of data input.
32. More suggestions to follow … !!

Carbon Footprints : Accounting for GHGs

- Petroleum Industry Guidelines for Reporting GHG Emissions, IPIECA 2003
- The Greenhouse Gas Protocol : A Corporate Accounting and Reporting Standard , 2004
- ISO 14064-2 : 2006
- Carbon-Label.co.uk : Carbon Footprint Measurement Methodology , 2007

Carbon Footprints : Conclusions

- Talk has explained the term carbon footprint and outlined the concepts of direct and indirect (embodied) carbon emissions.
- Talk has outline a methodology for determining the carbon footprint of a process.
- A procedure for determining direct emissions can be implement fairly quickly.
- A procedure for determining indirect emissions of CO_2 will require additional time and resources.
- Operators have expressed an interest in assessing the operating emissions of their plants. This is an opportunity for the industry to develop the methodolgy of carbon footprints.

Carbon Footprints : Questions & Answers

Your Questions …

Carbon Footprints : End

THANK YOU !!