

Carbon Footprint in Chemical Industry – Fuels and Gases

PEP Review 2025-06

Jamie Lacson, Research and Analysis Associate Director, Process Economics Program

To learn more or to request a demo, visit www.spglobal.com/commodityinsights.

Table of contents

1	Introduction	7
2	Summary	8
3	Methodology	12
	Technical basis	12
	Carbon dioxide	12
	Methane	12
	Nitrous oxide	12
	CFCs	12
	PFCs	13
	Other fluorinated gases	13
	Our convention for accounting for emissions	13
	Process emissions	13
	Emissions from on-site combustion	13
	Emissions from off-site electrical generation	14
	How we arrived at these emissions estimates	14
	Process description	19
	Calculating process emissions	20
	Calculating emissions from on-site combustion	21
	Calculating emissions from off-site electrical generation	22
	Appendix A — Design and cost basis	23
	Design conditions	24
	Cost basis	24
	Capital investment	24
	Project construction timing	25
	Available utilities	25
	Production costs	26
	Effect of operating level on production costs	26
	Appendix B — Cited references	27
	Appendix C — Process flow diagrams	29
	Appendix D — Carbon footprint data	31

Tables

Table 2.1 List of products	8
Table 3.1 EVAs by a tubular reactor process — Major equipment	15
Table 3.2 EVAs by a tubular reactor process — Stream flows	18

Table 3.3 EVAs by a tubular reactor process — Production costs	19
Table 3.4 Scope 1 and 2 CO ₂ e emissions details	19
Table 3.5 Streams exiting process of Figure C1 — Stream flows	20
Table 3.6 Carbon content of streams exiting process of Figure 1 — Stream flows	21
Table 3.7 CO ₂ uncontrolled emissions factors from combustion	21

Figures

Figure 2.1 CO ₂ emissions from fuels and gases (t CO ₂ /t product)	9
Figure 2.2 CO ₂ emissions from fuels (t CO ₂ /t product)	10
Figure 2.3 CO ₂ emissions from gas processes (t CO ₂ /t product)	10
Figure 2.4 CO ₂ emissions from NGL processes (t CO ₂ /t product)	11

Appendix C Figures

Figure C1 Ethylene vinyl acetate copolymers by a tubular reactor process	30
--	----

Appendix D Tables

Table D1 Carbon dioxide emissions from fuels and gases products (ton CO ₂ /ton product)	32
--	----

Glossary

¢/kWh	Cents per kilowatt-hour
¢/lb	Cents per pound
¢/Mgal	Cents per thousand gallons
¢/Mlb	Cents per thousand pounds
¢/t-h	Cents per ton hour
°C	Degree Celsius
ARU	Amine regeneration unit
ATR	Autothermal reforming
bhp	Brake horsepower
BTL	Biomass-to-liquids
Btu	British thermal units
BTX	Benzene, toluene and xylene
C3MR	Propane precooled mixed refrigerant
CaL	Calcium looping
CCS	Carbon capture and storage
CD	Continuous deglycerolization
CDM	Clean Development Mechanism
CFCs	Chlorofluorocarbons
CO ₂ e	Carbon dioxide equivalent
CO ₂ e/GJ	Carbon dioxide equivalent per gigajoule
CO ₂ e/MWh	Carbon dioxide equivalent per megawatt-hour
CPOX	Catalytic partial oxidation
DME	Dimethyl ether
DMR	Dual mixed refrigeration
EIA	Energy Information Administration
EPC	Engineering, procurement and construction
EU-ETS	EU European Trading Scheme
EVA	Ethylene-acetate
FCC	Fluid catalytic cracking
FCCU	Fluid catalytic cracking unit
FT	Fischer-Tropsch
ft	Feet
ft dia	Feet diameter
g	Gram(s)
G&A	General and administrative
gal	Gallon
GHG	Greenhouse gas
GJ/ton	Gigajoules per ton
GTL	Gas-to-liquids
GWP	Global warming potential
h	Hour
HFC	Hydrofluorocarbon
IEA	International Energy Agency
IH ₂	Integrated Hydropyrolysis and Hydroconversion
IPCC	Intergovernmental Panel on Climate Change
kg	Kilogram
kg/cm ²	Kilograms per square centimeter
kg/h	Kilograms per hour
lb	Pounds
lb/h	Pounds per hour
lb/y	Pounds per year
MEA	Monoethanolamine
mgal	Thousand gallons
Misc.	Miscellaneous
mlb	Thousand pounds

MMBtu/h	Million British thermal units per hour
MMt	Million metric tons
MMt/y	Million metric tons per year
Mol wt	Molecular weight
MTBE	Methyl t-butyl ether
MTG	Methanol-to-Gasoline
MWh	Megawatt-hour
MWh/ton	Megawatt-hour per ton
Negl.	Negligible
NGL	Natural gas liquid
PBR	Photobioreactor
PEP	Process Economics Program
PFCs	Perfluorinated compounds
POX	Partial oxidation
PSA	Pressure swing adsorption
psia	Pounds per square inch absolute
psig	Pounds per square inch gauge
RVP	Reid Vapor Pressure
SAF	Sustainable aviation fuel
SMR	Steam methane reforming
sq ft	Square feet
SS	Stainless steel
Syngas	Synthetic gas
t	Metric tons
TAC	Thermal Advanced Chemical
t-h	Ton-hour
TIGAS	Topsoe Improved Gasoline Synthesis
t/y	Metric tons per year
TFC	Total fixed capital
USGC	United States Gulf Coast
VA	Vinyl acetate
VCC	Veba Combi Cracking
VR	Vacuum residue
wt%	Weight percent

Abstract

There has been a growing urgency to curb greenhouse gas (GHG) emissions. While viable solutions to reduce GHG emissions are being explored, the chemical industry has been a primary focus of many international environmental organizations. Numerous opportunities exist for emissions reductions in the chemical industry. Quantifying the carbon emissions for chemical processes is necessary to understand potential reductions. However, carbon emissions estimates for many chemical processes have not been established.

To help determine potential emissions reductions, the Process Economics Program has prepared an estimate of the carbon footprint of the processes for the production of fuels and gases. This review presents carbon dioxide emissions factors for 204 processes. Estimates have been broken down into Scope 1 (direct emissions) and Scope 2 (indirect emissions). Direct emissions occur at the plant site, while indirect emissions arise from remotely located electrical generators. GHG emissions factors calculations are presented on a US Gulf Coast basis.

Contacts

Rajiv Narang

Executive Director, Process Economics Program
rajiv.narang@spglobal.com

Jamie Lacson

Research and Analysis Associate Director, Process Economics Program
jamie.lacson@spglobal.com

CONTACTS

Europe, Middle East, Africa: +44 (0) 203 367 0681

Americas: +1 800 332 6077

Asia-Pacific: +60 4 296 1125

www.spglobal.com/commodityinsights/en

www.spglobal.com/en/enterprise/about/contact-us.html

© 2025 by S&P Global Inc. All rights reserved.

S&P Global, the S&P Global logo, S&P Global Commodity Insights, and Platts are trademarks of S&P Global Inc. Permission for any commercial use of these trademarks must be obtained in writing from S&P Global Inc.

You may view or otherwise use the information, prices, indices, assessments and other related information, graphs, tables and images ("Data") in this publication only for your personal use or, if you or your company has a license for the Data from S&P Global Commodity Insights and you are an authorized user, for your company's internal business use only. You may not publish, reproduce, extract, distribute, retransmit, resell, create any derivative work from and/or otherwise provide access to the Data or any portion thereof to any person (either within or outside your company, including as part of or via any internal electronic system or intranet), firm or entity, including any subsidiary, parent, or other entity that is affiliated with your company, without S&P Global Commodity Insights' prior written consent or as otherwise authorized under license from S&P Global Commodity Insights. Any use or distribution of the Data beyond the express uses authorized in this paragraph above is subject to the payment of additional fees to S&P Global Commodity Insights.

S&P Global Commodity Insights, its affiliates and all of their third-party licensors disclaim any and all warranties, express or implied, including, but not limited to, any warranties of merchantability or fitness for a particular purpose or use as to the Data, or the results obtained by its use or as to the performance thereof. Data in this publication includes independent and verifiable data collected from actual market participants. Any user of the Data should not rely on any information and/or assessment contained therein in making any investment, trading, risk management or other decision. S&P Global Commodity Insights, its affiliates and their third-party licensors do not guarantee the adequacy, accuracy, timeliness and/or completeness of the Data or any component thereof or any communications (whether written, oral, electronic or in other format), and shall not be subject to any damages or liability, including but not limited to any indirect, special, incidental, punitive or consequential damages (including but not limited to, loss of profits, trading losses and loss of goodwill).

ICE index data and NYMEX futures data used herein are provided under S&P Global Commodity Insights' commercial licensing agreements with ICE and with NYMEX. You acknowledge that the ICE index data and NYMEX futures data herein are confidential and are proprietary trade secrets and data of ICE and NYMEX or its licensors/suppliers, and you shall use best efforts to prevent the unauthorized publication, disclosure or copying of the ICE index data and/or NYMEX futures data.

Permission is granted for those registered with the Copyright Clearance Center (CCC) to copy material herein for internal reference or personal use only, provided that appropriate payment is made to the CCC, 222 Rosewood Drive, Danvers, MA 01923, phone +1-978-750-8400. Reproduction in any other form, or for any other purpose, is forbidden without the express prior permission of S&P Global Inc. For article reprints contact: The YGS Group, phone +1-717-505-9701 x105 (800-501-9571 from the U.S.).

For all other queries or requests pursuant to this notice, please contact S&P Global Inc. via email at ci.support@spglobal.com