CarbonSolutions

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Greenhouse Gas Accounting

ACEC

American Council of Engineering Companies

Greenhouse Gas Accounting Terminology

Activity Data: Data on the magnitude of a human activity resulting in emissions or removals taking place during a given period of time. Data on energy use, metal production, land areas, management systems, lime and fertilizer use and waste arisings are examples of activity data.

Additionality: Refers to a situation where a project results in emissions reductions additional to those that would have taken place in the absence of the project activity.

Base Year : A historic datum (a specific year) for comparing emissions over time

Base Year Emissions: GHG emissions in the base year

Baseline: A reference point for what emissions would have been without the intervention of the GHG reduction project.

Boundaries: GHG accounting and reporting boundaries can have several dimensions, i.e. organizational, operational, geographic, sectoral, business unit, and others.

C02 Equivalent: The quantity of a given GHG multiplied by its global warming potential. This is the standard unit for comparing the degree of harm which can be caused by emissions of different GHGs.

Cap and Trade System: A system that sets an overall emissions limit, allocates emissions allowances to participants, and allows them to trade emissions credits with each other.

Certification: Certification is the written assurance by a third party that, during a specified time period, a project activity achieved the reductions in anthropogenic emissions by sources of greenhouse gases (GHG) as verified.

Certified Emissions Reductions (CERs): Tradable units issued by the UN through the Clean Development Mechanism for emission reduction projects in developing countries. Each CER represents one metric ton of carbon emissions reduction. CERs can be used by Annex 1 countries to meet their emissions goals under the Kyoto Protocol.

Chicago Climate Exchange (CCX): The Chicago Climate Exchange (CCX) is a voluntary GHG emissions cap-and-trade scheme based in North America. Although participation is voluntary, compliance with emission reduction objectives is legally binding once a member joins. CCX has as part of its cap-and-trade scheme an offset programme with a full-fledged carbon offset standard. CCX members commit to reduce their emissions by a fixed amount below the established baseline level. Members who cannot achieve the reduction target through cutting their emissions internally can meet their compliance commitment by purchasing emission

allowances (called Carbon Financial Instruments; CFI) through CCX's electronic trading platform from other CCX Members that reduce their emissions beyond the reduction target. Total use of offsets for compliance is limited to no more that one half of the required reductions

Clean Development Mechanism: A provision of the Kyoto Protocol that allows developed countries (Annex 1) to offset their emissions by funding emissions-reduction projects in developing countries (non-Annex 1).

Climate Action Reserve (CAR): The Climate Action Reserve was launched in 2008. It is a national offsets program focused on the US carbon market. The Climate Action Reserve (Reserve) establishes standards for quantifying and verifying GHG emissions reduction projects, provides oversight to independent third-party verification bodies, and issues and tracks carbon credits called Climate Reserve Tonnes (CRTs pronounced 'carrots').

Compliance Market: The market for carbon credits (specifically CERs, EUAs, AAUs, and ERUs) used to reach emissions targets under the Kyoto Protocol or the EU ETS. Also called the Regulated Market.

Direct GHG Emissions: Emissions from sources that are owned or controlled by the reporting company

Emission Reduction Units (ERUs): A tradable unit, equivalent to one metric tonne of CO2 emissions, generated by a Joint Implementation project and used to quantify emissions reductions for the purpose of buying and selling credits between Annex 1 countries under the Kyoto Protocol.

Emissions: The intentional and unintentional release of GHGs into the atmosphere.

Emissions Credit: A commodity giving its holder the right to emit a certain quantity of GHGs. Emissions credits will, in the future, be tradable between countries and other legal entities.

Emissions Factor: A factor relating activity data (e.g. tonnes of fuel consumed, tonnes of product produced) and absolute GHG emissions.

Emissions Trading: A provision of the Kyoto Protocol that allows Annex 1 countries to trade emissions reduction credits in order to comply with their Kyoto-assigned targets.This system allows countries to pay and take credit for emissions reduction projects in developing countries where the cost of these projects may be lower, thus ensuring that overall emissions are lessened in the most cost-effective manner.

European Union Trading Scheme – (EU ETS): The EU ETS is a greenhouse gas emissions trading scheme which aims to limit emissions by imposing progressively lower limits on power plants

and other sources of greenhouse gases. The scheme consists of two phases: Phase I (2005-07) and Phase II (2008-12).

Fugitive Emissions: Intentional and unintentional releases of GHGs from joints, seals, packing, gaskets, etc.

GHG Protocol Initiative and GHG Protocol: A multi-stakeholder collaboration convened by the World Resources Institute and the World Business Council for Sustainable Development to design, develop and promote the use of an international standard for calculating and reporting business GHGs.

Global Warming Potential: A factor describing the radiative forcing impact (degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of CO2.

Greenhouse Effect: Trapping and build-up of heat in the atmosphere (troposphere) near the earth's surface. Some of the heat flowing back toward space from the earth's surface is absorbed by water vapor, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase.

Greenhouse Gases (GHGs): For the purposes of this standard/guidance, GHGs are the six gases listed in the Kyoto Protocol: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydroflurocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6).

Indirect GHG Emissions: Emissions that are a consequence of the activities of the reporting company, but occur from sources owned or controlled by another company

Intergovernmental Panel on Climate Change (IPCC): International body of climate change scientists. The role of the IPCC is to assess the scientific, technical and socio-economic information relevant to the understanding of the risk of human-induced climate change.

Inventory: A list of an organization’s GHG emissions and sources.

Joint Implementation (JI): A provision of the Kyoto Protocol that allows those in Annex 1 (developed) countries to undertake projects in other Annex 1 (developed or transitional) countries (as opposed to those undertaken in non-Annex 1 countries through the CDM).

Kyoto Protocol: A protocol to the International Convention on Climate Change – once entered into force it will require countries listed in its Annex B (developed nations) to meet reduction targets of GHG emissions relative to their 1990 levels during the period 2008-12.

Mobile Combustion: Burning of fuels by transportation devices such as cars, trucks, trains, aeroplanes, ships etc.

Offset: An emissions reduction achieved by undertaking a GHG reduction project

Offset Company: A company whose primary purpose is to create or sell offsets, either directly to consumers or through another organization that wish to offer offsets to their clients.

Offset Provider: Offset providers include both offset companies and other businesses that utilize the services of offset companies to provide offsets to their clients.

Permit: A marketable instrument giving its holder the right to emit a certain quantity of GHGs

Process Emissions: Emissions from industrial processes involving chemical transformations other than combustion.

Project boundary: The project boundary shall encompass all anthropogenic emissions by sources of greenhouse gases (GHG) under the control of the project participants that are significant and reasonably attributable to the project activity.

Project Design Document (PDD): A project specific document required under the CDM rules which will enable the Operational Entity to determine whether the project (i) has been approved by the parties involved in a project, (ii) would result in reductions of greenhouse gas emissions that are additional, (iii) has an appropriate baseline and monitoring plan.

Regional Greenhouse Gas Initiative (RGGI): RGGI is a multi-state regional cap-and-trade program for the power sector in the Northeast United States. The RGGI cap-and-trade program is proposed to start in 2009 and lead to a stabilization of emissions at current levels (an average of 2002-2004 levels) by 2015, followed by a 10% reduction in emissions between 2015 and 2020. Some of the program reductions will be achieved outside the electricity sector through emissions offset projects. Offsets serve as the primary cost containment mechanism in RGGI; if allowance prices rise above trigger prices, the ability for regulated sources to use offsets increases.

Registration: The formal acceptance by the CDM Executive Board of a validated project as a CDM project activity.

Renewable Energy Certificates (RECs): A Renewable Energy Certificate represents a unit of electricity generated from renewable energy with low net greenhouse gas emissions. One REC represents 1 megawatt-hour.

Retirement: Retirement is a way of reducing overall emissions by purchasing carbon offsets and retiring them so that they may not be used to offset others' emissions. Retired credits can no longer be traded.

Scope 1 Inventory: A reporting organization's direct GHG emissions

Scope 2 Inventory: A reporting organization's emissions from imports of electricity, heat, or steam

Scope 3 Inventory: A reporting organization's indirect emissions other than those covered in scope 2

Sequestration: The uptake and storage of CO2. CO2 can be sequestered by plants and in underground/deep sea reservoirs.

Stationary Combustion: Burning of fuels to generate electricity, steam or heat

The California Climate Action Registry (CCAR): The California Climate Action Registry is the predecessor of the Climate Action Reserve. It is a voluntary GHG registry established by theCalifornia State Legislature in September 2000 to encourage and promote early actions to measure, manage and reduce GHG emissions.

The Climate Registry: In 2007, CCAR worked with other regional non-governmental organizations to build and launch the Climate Registry, a voluntary GHG registry for the North American region covering states in the US, Native Sovereign Nations, Canada and Mexico. The last year for which the California Registry will accept emissions reports is 2009 and, thereafter, its members will transition to The Climate Registry.

United Nations Framework Convention on Climate Change (UNFCCC): An international treaty, developed at the 1992 UN Conference on Environment and Development, which aims to combat climate change by reducing global greenhouse gas emissions. The original treaty was considered legally non-binding, but made provisions for future protocols, such as the Kyoto Protocol, to set mandatory emissions limits.

Validation: The assessment of a project's Project Design Document, which describes its design, including its baseline and monitoring plan, by an independent third party, before the implementation of the project against the requirements of a specific standard.

Verification: Verification is the objective and independent assessment of whether the reported GHG inventory properly reflects the GHG impact of the company in conformance with the pre-established GHG accounting and reporting standards

Verified or Voluntary Emissions Reductions (VERs): Reductions that, unlike CERs, are sold on the voluntary market. VERs are linked neither to the Kyoto Protocol nor to the EU ETS. VERs are sometimes referred to as Voluntary Emissions Reductions.

Voluntary Carbon Standard (VCS): VCS is a full-fledged carbon offset standard. It focuses on GHG reduction attributes only and does not require projects to have additional environmental or social benefits. The VCS 2007 is broadly supported by the carbon offset industry (project developers, large offset buyers, verifiers, projects consultants). VCS approved carbon offsets are registered and traded as Voluntary Carbon Units (VCUs) and represent emissions reductions of 1 metric tonne of CO2.

Voluntary Market: The non-regulated market for carbon credits (especially VERs) that operates independently from Kyoto and the EU ETS. Also called the Non-Regulated Market.

I. Carbon and CO_2 Conversions

To Convert	To	Multiply By
Carbon (short tons)	CO_2 (short tons)	3.667 or 44/12
CO_2 (short tons)	Carbon (short tons)	0.2727 or 12/44
CO_2 (metric tons)	CO_2 (short tons)	1.1023
CO_2 (short tons)	CO_2 (metric tons)	0.9072
CO_2 (pounds)	CO_2 (metric tons)	4.5359×10^{-4}
CO_2 (metric tons)	CO_2 (pounds)	2,204.6
CO_2 (pounds)	CO_2 (kilograms)	0.45359
CO_2 (kilograms)	CO_2 (pounds)	2.2046
Carbon (million metric tons carbon or carbon equivalent, MMTCE)	CO_2 (billion pounds)	8.0835
CO_2 (billion pounds)	Carbon (million metric tons carbon or equivalent, MMTCE)	0.1237

Other Conversions*:*

Energy Unit Conversions:

To Convert	To	Multiply By
mmBtu	Btu	10^6
Quads	Btu	10^{15}
kWh	Wh	10^3
MWh	kWh	10^3
GWh	MWh	10^3
TWh	MWh	10^6
kWh	Btu	3,412 (delivered**)
kWh	Quads	3.412×10^{-12} (delivered)
kWh	Btu	10,107 (primary)* (10,000 is often used for convenience)
Therms	Btu	10^5
Horsepower (hp) (mechanical)	kW	0.7456
Btu	Joule (J)	1,054.2
kWh	Joule (J)	3.6×10^6 (delivered)

Source: Primary kWh to Btu number from U.S. DOE/EIA, *2004 Annual Energy Outlook*, 2004, Appendix H.
* Based on this heat rate, electric generation is approximately 34% efficient.
** The term *Source* may also be used for Primary, and the term *Site* may also be used for Delivered energy. Electricity, delivered is the amount of electric energy delivered to the final customer after electric losses. Electricity, primary is the amount of energy (fuel) an electric generator must consume to generate and supply electric energy to consumers.

Energy (Heat) Content (kWh, Btu) of Fuels:

Fuel	Energy Content (Btu)
Coal (1 ton)	2.1×10^7
Oil (1 barrel)	5.8×10^6
Natural Gas (1 cubic foot)	0.97×10^3 (1,000 is often used for convenience)
Gasoline (1 gallon)	1.2×10^5

Mass Conversions Between the Following:

To Convert	To	Multiply By
Grams	Pounds	2.205×10^{-3}
Pounds	Grams	453.59
Pounds	Short Tons	5×10^{-4}
Short Tons	Pounds	2,000
Short Tons	Metric Tons	0.9072
Metric Tons	Short Tons	1.1023

Volume Conversions:

To Convert	To	Multiply By
Barrels (Oil)	Gallons	42
Gallons	Liters	3.785
Cubic Feet	Liters	28.317

Methane Conversions:

1 cubic foot (cf) of natural gas	= 1,030 Btu (1,000 is often used for convenience)
1 cubic foot of methane	= 1,014.6 Btu (HHV) (1,000 is often used for convenience)
1,000 cubic feet (mcf)	= 1 million Btu*
1 billion cubic feet (bcf)	= 1 trillion Btu*
1 cubic foot	19.26 grams
52 billion cubic feet (bcf)	= 1 teragram (10^{12} grams)
1 cubic foot landfill gas (50% methane)	= 500 Btu*

Source: U.S. DOE/EIA, *1997 Annual Energy Review*, 1998, Appendix B and U.S. DOE/EIA, *1996 Emissions of Greenhouse Gases in the United States*, 1997, Appendix E.
* Based on a 1,000 Btu to 1 cf conversion

CO_2 Emission Factors by Fuel Type per Unit Volume, Mass, and Energy

Fossil Fuel	***Emission Factor***	***Emission Factor***	***Carbon Factor***	***Heat Content (HHV)***	***Carbon Content Coefficient***
Coal	(lb CO_2/ short ton)	(lb CO_2/ MMBtu)	(kg C/ short ton)	(MMBtu/ short ton)	(kg C/ MMBtu)
Anthracite Coal	5,675.29	226.16	709.04	25.09	28.26
Bituminous Coal	5,086.36	203.99	635.47	24.93	25.49
Sub-bituminous Coal	3,656.14	211.91	456.78	17.25	26.48
Lignite	2,991.33	210.47	373.72	14.21	26.30
Unspecified (industrial coking)	5,444.58	205.11	680.22	26.54	25.63
Unspecified (industrial other)	4,744.80	205.99	592.79	23.03	25.74
Unspecified (electric utility)	4,289.96	207.91	535.97	20.63	25.98
Unspecified (residential/commercial)	4,779.26	208.39	597.10	22.93	26.04
Natural Gas	(lb CO_2/ft^3)		(kg C/ft^3)	(Btu/ft^3)	
Natural Gas	0.120	116.39	0.0149	1,027	14.47
Petroleum	(lb CO_2/bbl)		(kg C/bbl)	(MMBtu/bbl)	
Distillate Fuel Oil (#1, 2, & 4)	930.15	159.66	116.21	5.825	19.95
Residual Fuel Oil (#5 & 6)	1,081.42	171.98	135.11	6.287	21.49
Petroleum Coke	1,342.84	222.88	167.77	6.024	27.85
LPG (average for fuel use)	535.79	138.75	66.60	3.861	17.25
Petroleum (Mobile Fuels)	(lb CO_2/gal)		(kg C/gal)	(MMBtu/gal)	
Motor Gasoline	19.37	154.91	2.42	0.125	19.36
Diesel Fuel	22.23	160.30	2.78	0.139	20.03
Avation Gasoline	18.15	151.01	2.27	0.120	18.87
Jet Fuel	20.89	154.69	2.61	0.135	19.33
LPG (HD-5)	12.70	138.58	1.58	0.092	17.23

Source: See end of document for table sources.

II. Global Warming Potentials (GWP)

GWPs allow scientists and policymakers to compare the ability of each greenhouse gas to trap heat in the atmosphere relative to other gases. GWP of a greenhouse gas is the ratio of radiative forcing (both direct and indirect), from one kilogram of greenhouse gas to one kilogram of CO_2 over a period of time, 100 years in this case as recommended by the Intergovernmental Panel on Climate Change (IPCC) and employed for US policymaking and reporting purposes. CO_2 was chosen as the reference gas to be consistent with the IPCC guidelines.

The IPCC has published its Third Assessment Report (TAR), providing the most current and comprehensive scientific assessment of climate change (IPCC 2001). Within this report, the GWPs of several gases were revised relative to the IPCC's Second Assessment Report (SAR) (IPCC 1996), and new GWPs have been calculated for an expanded set of gases. The table below compares both sets of GWP values. Government documents still frequently use the SAR values (e.g., national GHG inventory reports), but the TAR values are also now being used in non-government publications.

List of GWPs of the six Kyoto-covered gases:

Chemical	GWP, 100 Years (SAR)	GWP, 100 Years (TAR)
CO_2	1	1
Methane	21	23
N_2O	310	296
HFCs	140-12,100	120 – 12,000
SF_6	23,900	22,200
PFCs	6,500-9,200	5,700 – 11,900

Source: U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2002*, Annex 6.

To determine the carbon equivalent of a greenhouse gas (mass):

1. Convert million metric tons (MMT) of greenhouse gas to MMT CO_2-equivalent = MMT of GHG x GWP

2. Convert CO_2-equivalent to Carbon Equivalent = CO_2 x 0.2727

For example:

1. 2 MMT methane x 21 (SAR GWP of Methane) = 42 MMT CO_2-equivalent

2. 42 MMT CO_2 x 0.2727 = 11.45 MMTCE

VI. List of Abbreviations

Btu	British Thermal Unit
KBtu	Thousand Btu
mmBtu	Million Btu
TBtu	Trillion Btu
Quad	Quadrillion Btu
kWh	Kilowatt-hour
MW	Megawatt
cf	Cubic Feet
HHV	High Heating Value
GHG	Greenhouse Gas
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
MMT	Million Metric Tons
MMTCE	Million Metric Tons Carbon Equivalent
C	Carbon
CE	Carbon Equivalent
CO_2	Carbon Dioxide
CH_4	Methane
N_2O	Nitrous Oxide
NO_x	Nitrogen Oxides
PFC	Perfluorocarbon
SF_6	Sulfur Hexafluoride
LPG	Liquefied Petroleum Gas