Huella de Carbono

Curso ¨Desarrollo Sostenible y Energía”

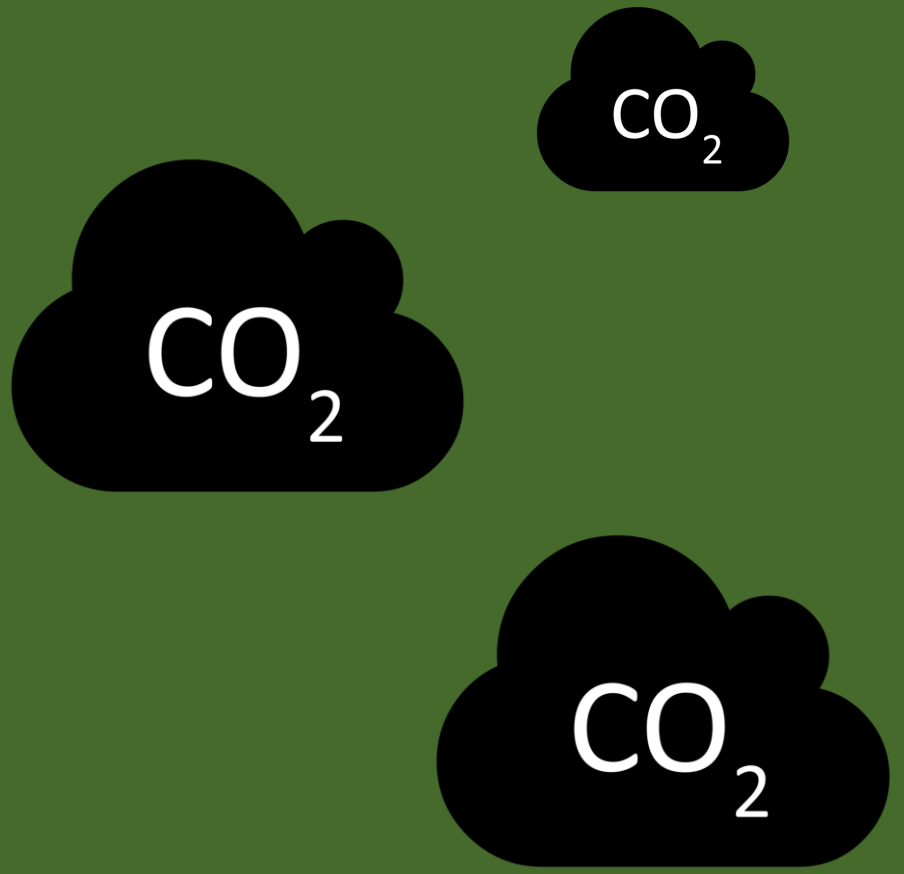
Dra. Ing. Quím. Valeria Larnaudie

Setiembre 2024

¿Por qué enfocarnos en el Carbono?

Conceptos importantes asociados:

- Efecto Invernadero
- Ciclo de Carbono
- Calentamiento Global
- Cambio Climático

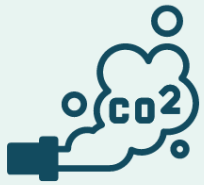


Efecto invernadero

3

Efecto invernadero

Five Major Greenhouse Gases



Carbon dioxide
(CO2)

Methane
(CH4)

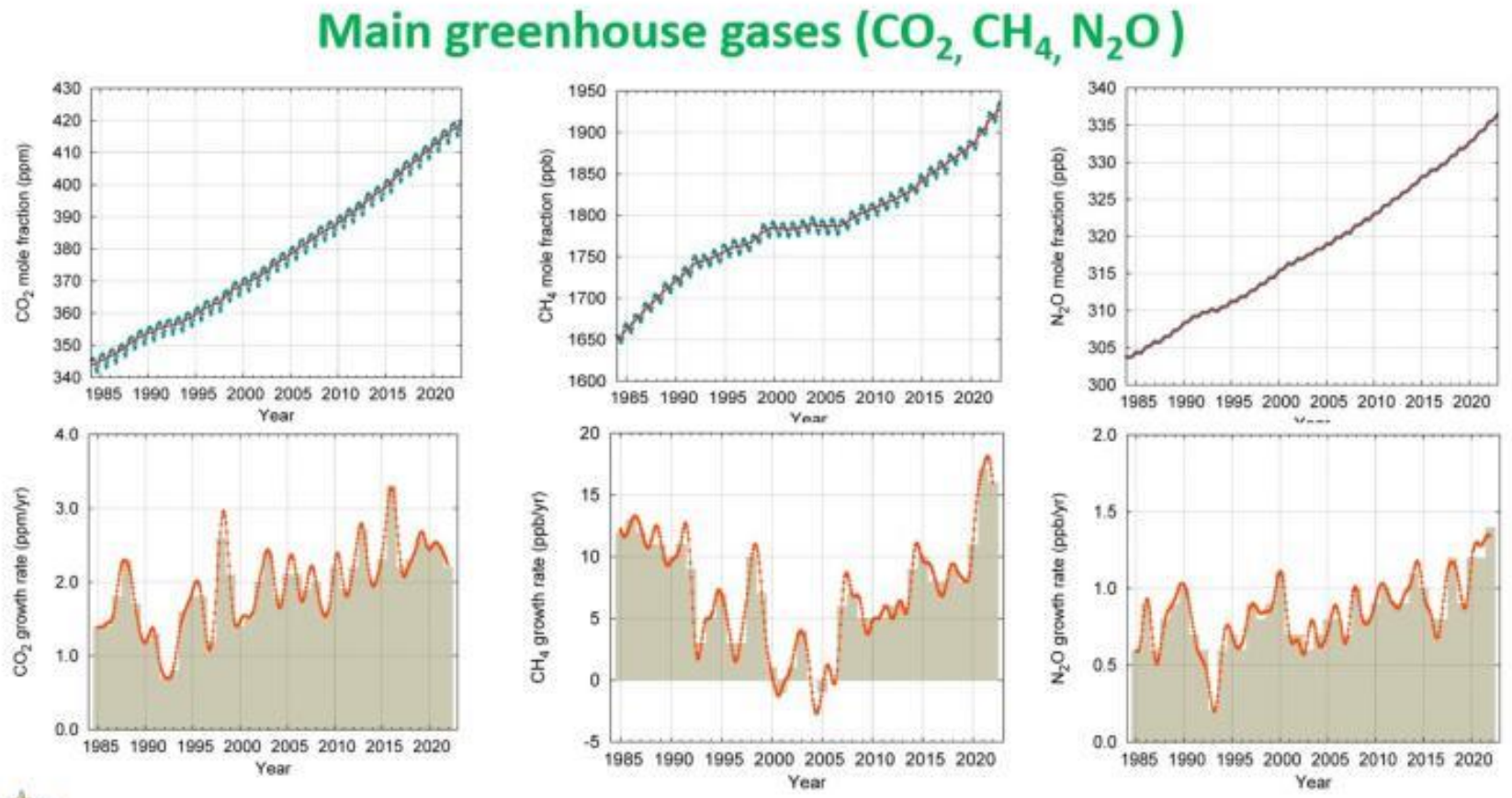
Nitrous Oxide
(N2O)

Fluorinated
Gases

Water Vapor
(H2O)

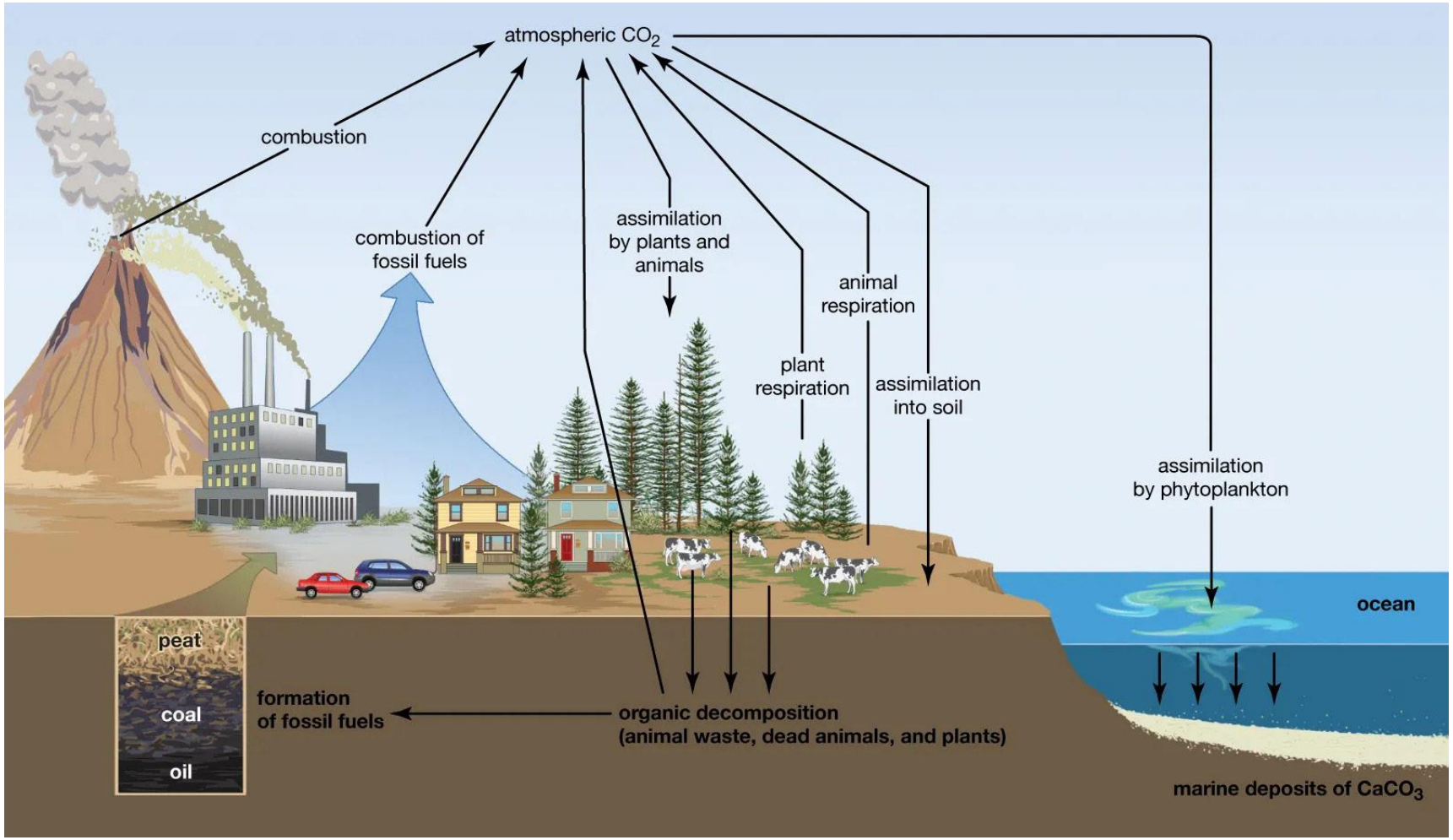
carbon collective

Dióxido de Carbono en la atmósfera



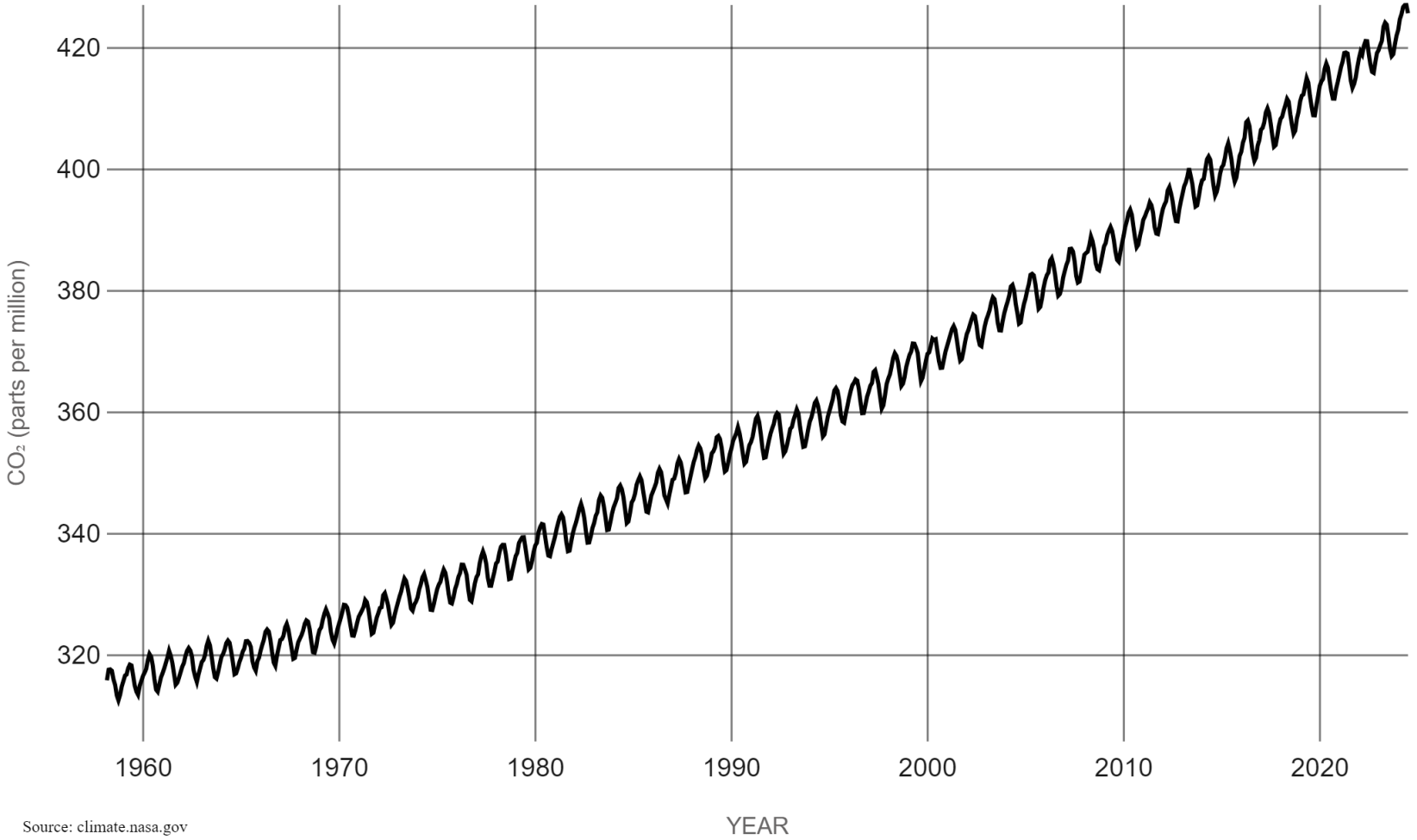
Fuente: WMO.int

Ciclo de Carbono



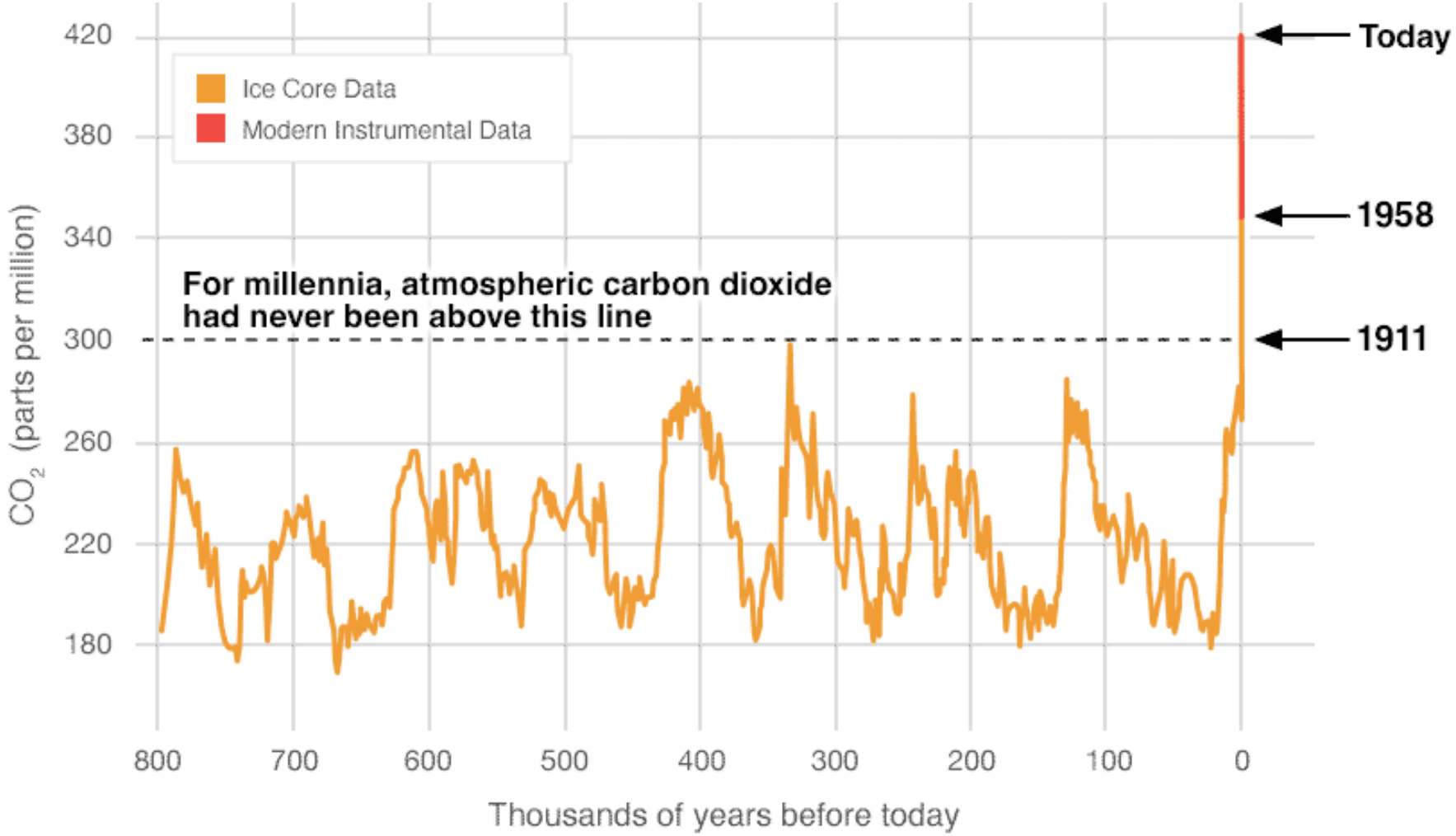
Fuente: https://sciencediagrams.com/carbon-cycle/

Dióxido de Carbono en la atmósfera



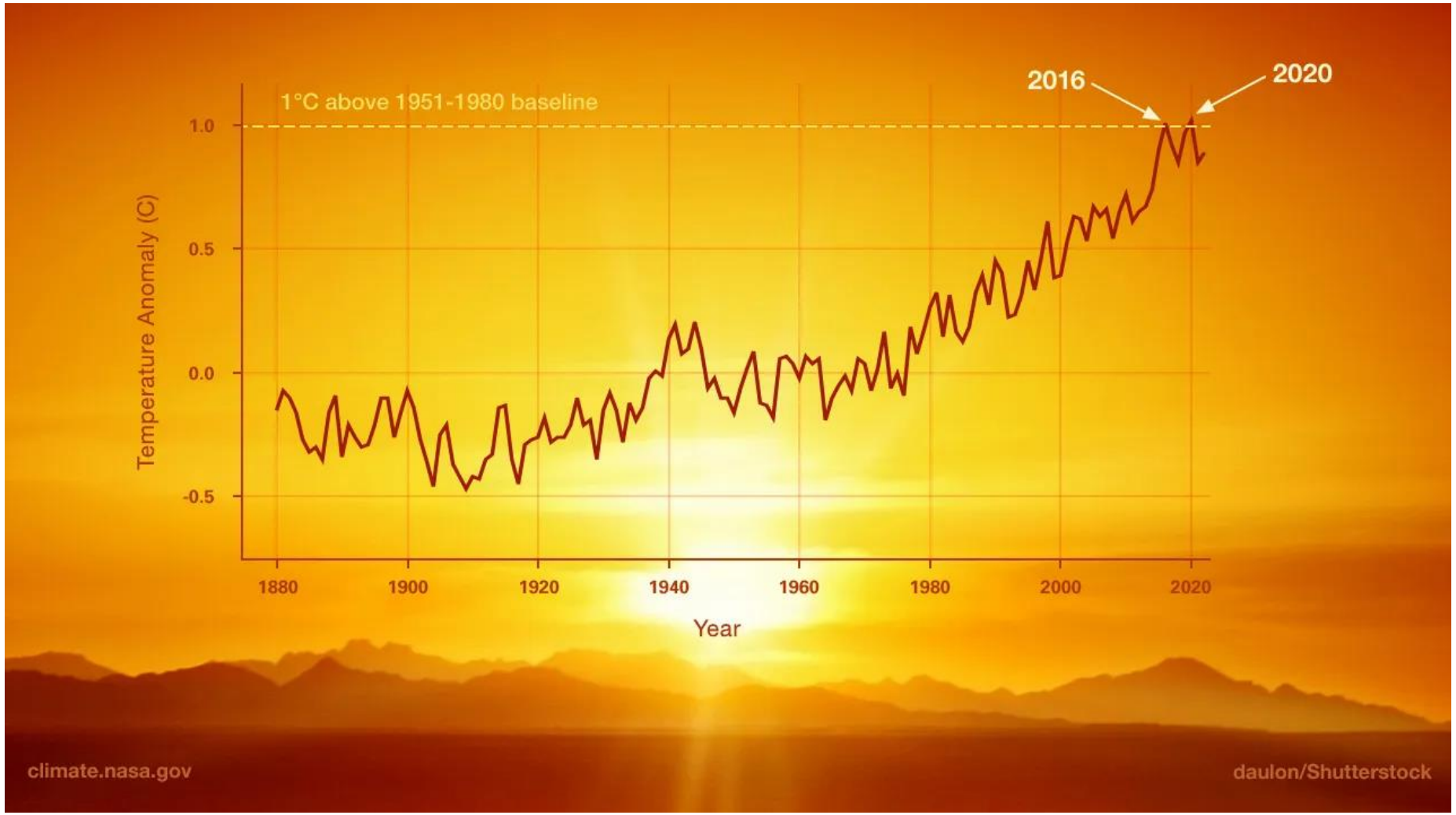
Source: climate.nasa.gov

Dióxido de Carbono en la atmósfera



Fuente: Climate.nasa.gov

Calentamiento Global



Cambio climático

"If you don't like the weather in New England, just wait a few minutes."
- Mark Twain

Fuente: Climate.nasa.gov

Calentamiento global y cambio climático: Evidencias

- Aumento de la temperatura global
- Aumento de la temperatura de los océanos
- Disminución de casquetes polares
- Reducción de los glaciares
- Reducción de las capas de nieve
- Aumento del nivel del mar
- Aumenta la frecuencia de eventos extremos
- Acidificación de los océanos

Fuente: Climate.nasa.gov

Calentamiento global y cambio climático: Causas

382 *On the Heat in the Sun's Rays.*

ART. XXXI.—*Circumstances affecting the Heat of the Sun's Rays;* by EUNICE FOOTE.

(Read before the American Association, August 23d, 1856.)

MY investigations have had for their object to determine the different circumstances that affect the thermal action of the rays of light that proceed from the sun.

Several results have been obtained.

REMARKABLE WEATHER OF 1911

The Effect of the Combustion of Coal on the Climate — What Scientists Predict for the Future

By FRANCIS MOLENA

THE year 1911 will long be remembered for the violence of its weather. The spring opened mild and delightful, but in June a torrid wave of unparalleled severity swept over the country. The cities baked and gasped for breath, while the burning sun and hot winds withered the corn and cost the farmers a million dollars a day. A little later England was scorched and France and Germany sweltered. The mercury went above 100 deg. in western Canada, and whalers brought back reports from the Arctic regions of open water where always before there had been solid ice. The reports from Mexico and Central America would well describe the lower regions, but it is said that the summer in Iceland was enjoyable.

In August the elements took a different turn. The mean temperature of every month except November was above the average of that of the 40 years covered by the records of the United States Weather Bureau. The average daily excess was from four to six degrees.

With only one month out of twelve below normal, one may well ask if the climate is not changing and getting warmer. There is a general impression among older men that the good old-fashioned winters in which "the snow was fifteen feet deep and lasted six months" do not come any more. In spite of the fact that the year just past was above the average in temperature, there is no clear indication that there is any progressive change in the direction of a warmer climate. The average temperature of the year 1878 was as high as that of

Popular Mechanics

The Rodney & Otamatea Times

WAITEMATA & KAIPARA GAZETTE.

PRICE—10s per annum in advance

WARKWORTH, WEDNESDAY, AUGUST 14, 1912.

3d. per Copy.

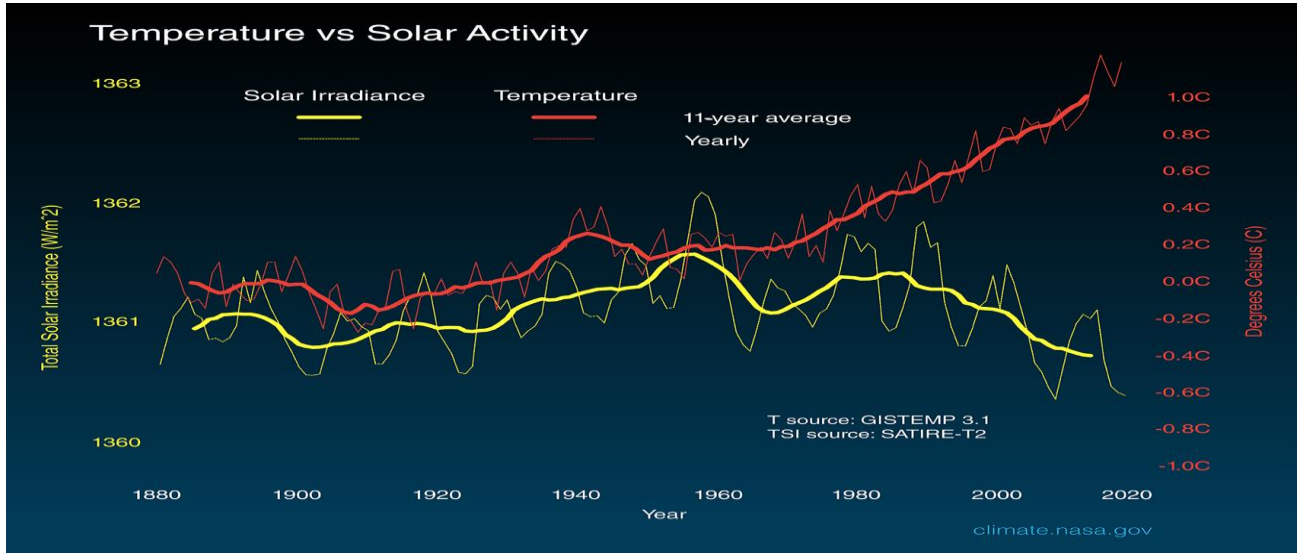
Science Notes and News.

COAL CONSUMPTION AFFECTING CLIMATE.

The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.

Calentamiento global y cambio climático: Causas

- La actividad humana es la causa del aumento en la concentración de gases de efecto invernadero
- El IPCC concluyó que es inequívoco que el aumento de las concentraciones de CO2, CH4 y N2O en la atmósfera en la era industrial son el resultado de actividades humanas.
- El calentamiento global actual no puede ser explicado por los cambios en la radiación solar.



Calentamiento global y cambio climático: Consecuencias

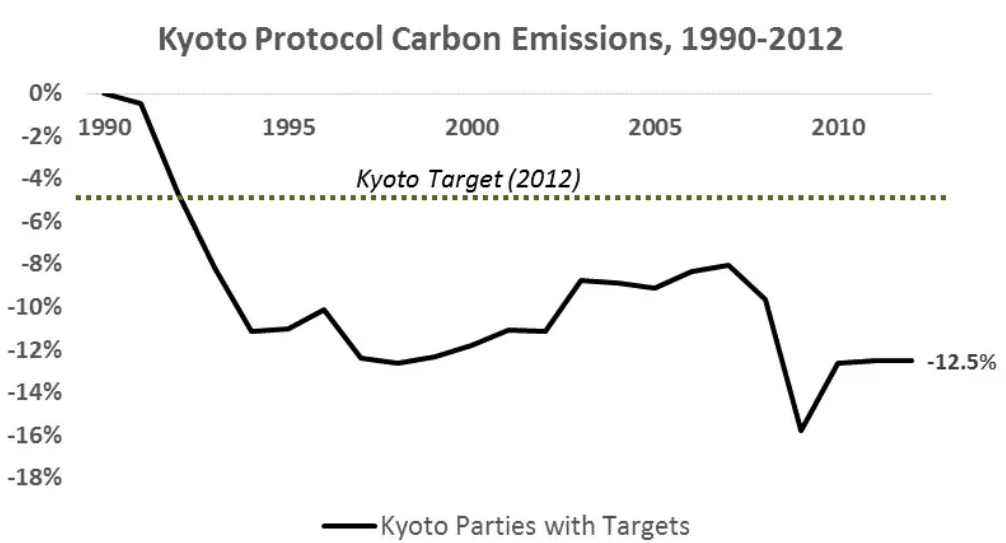
- Aumento del nivel del mar
- Cambios en el clima
- Aumento en frecuencia e intensidad de huracanes
- Más sequías y holas de calor

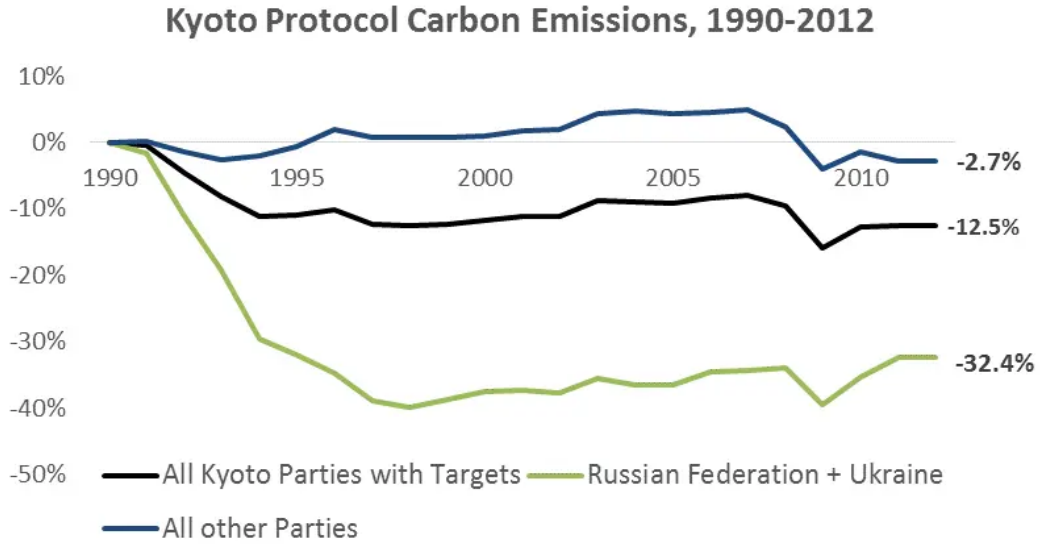
Calentamiento global y cambio climático: Consecuencias

- Temporadas de incendios más largas
- Cambio en patrones de precipitación
- Temporada de crecimiento sin heladas más largas
- Aumento en la temperatura
- Ártico sin hielo en verano

Acciones y acuerdos para disminuir el calentamiento global

- Protocolo de Kyoto

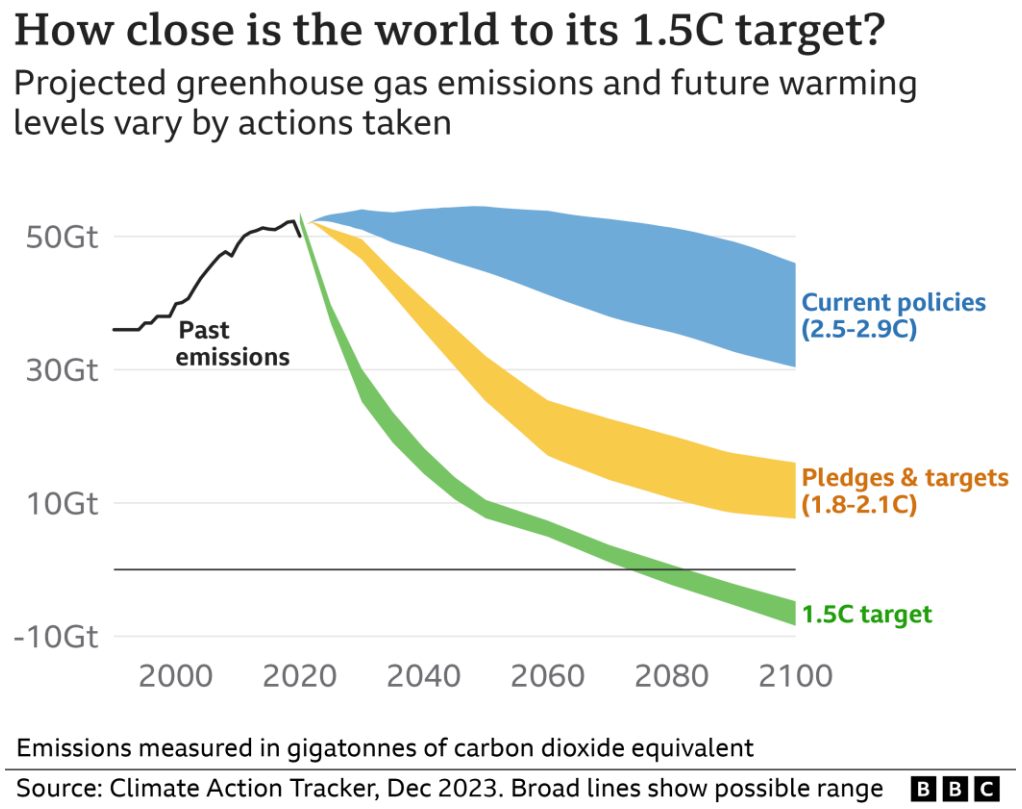




Source: https://circularecology.com/news/the-kyoto-protocol-climate-change-success-or-global-warming-failure

Acciones y acuerdos para disminuir el calentamiento global

- Acuerdo de Paris



Carbono neutral

vs

Cero Neto

vs

Cero emisiones

Carbono neutral

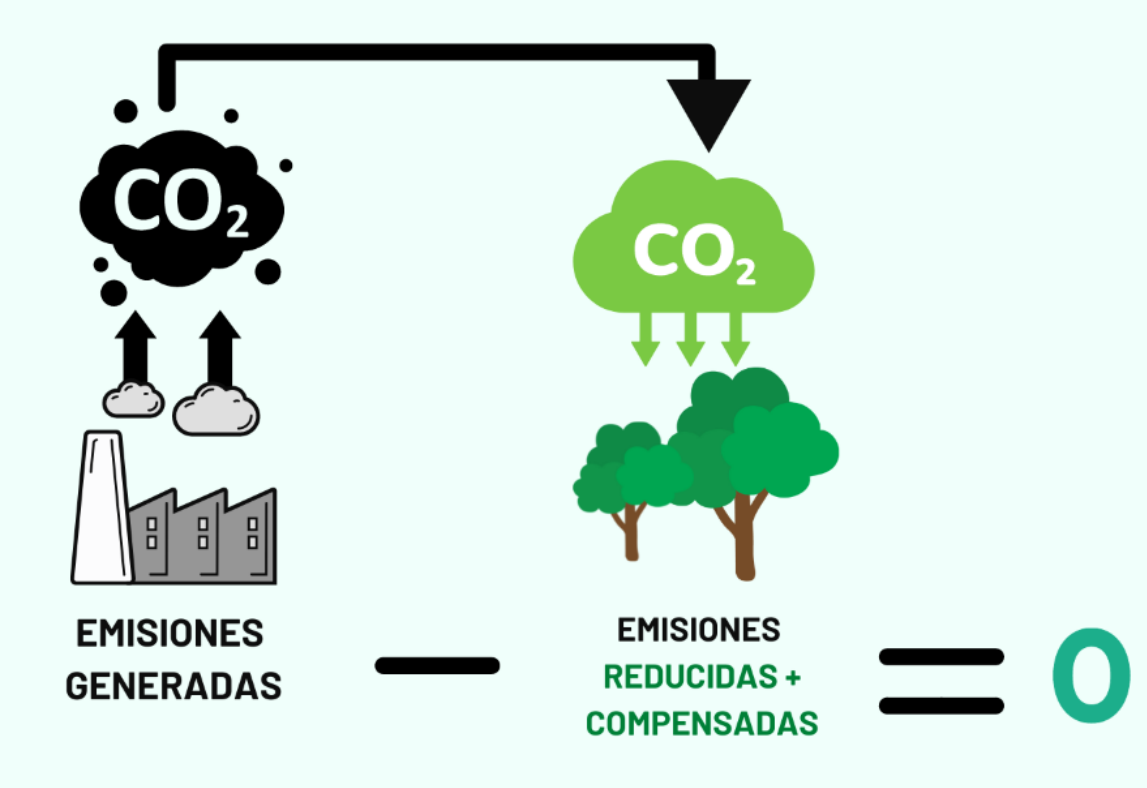
vs

Cero Neto

vs

Cero emisiones

Carbono neutral



Source: https://www.carbonneutralplus.com/que-es-la-carbono-neutralidad/

Carbono neutral

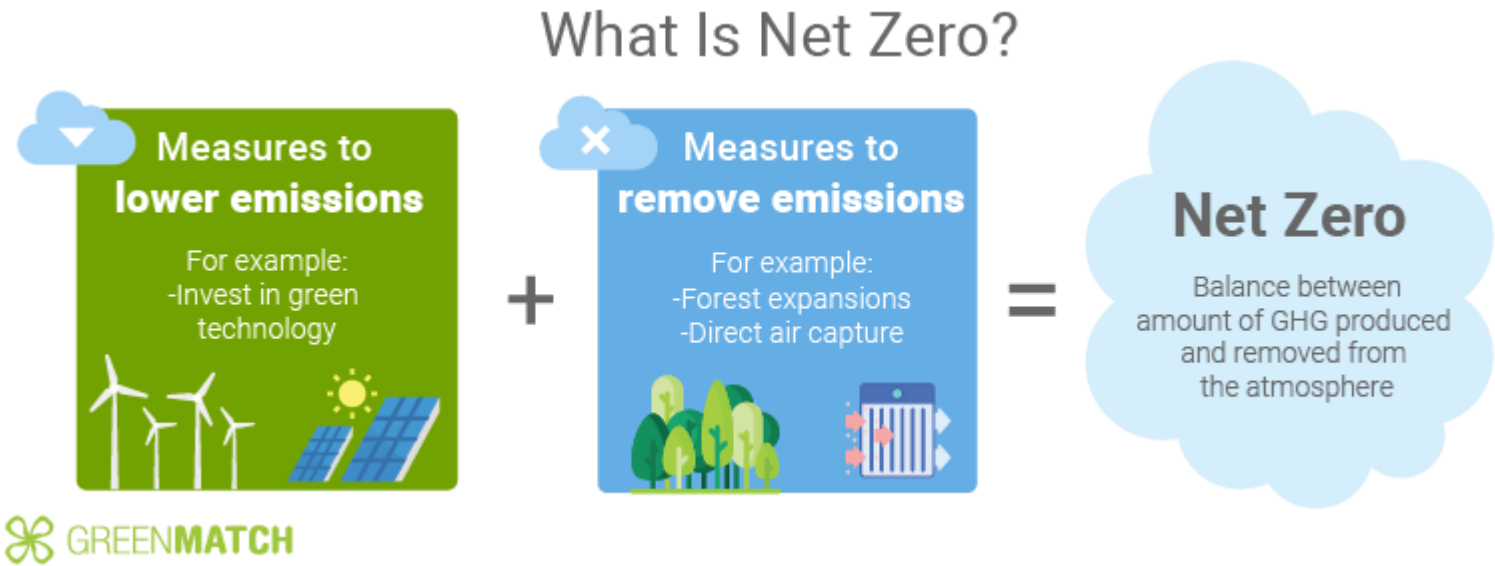
vs

Cero Neto

vs

Cero emisiones

Cero Neto de emisiones



Carbono neutral

vs

Cero Neto

vs

Cero emisiones

Cero emisiones o Carbono cero

¿Qué es la Huella de Carbono?

- Concepto original asociado a huellas ecológicas:

"La Huella de Carbono se refiere al área de tierra requerida para asimilar el dióxido de carbono producido por la humanidad"

- Actualmente deriva su nombre de las huellas pero conceptualmente es un indicador del potencial de calentamiento global:

"La Huella de Carbono es la cantidad de gases de efecto invernadero expresada en términos de dioxido de carbono equivalente emitido a la atmósfera por un individuo, una organización, un proceso, un producto un evento dentro de un límite definido"

Normas y Guías para el cálculo de la Huella de Carbono

Normas y Guías para el cálculo de la Huella de Carbono

- GHG protocol of World Resource Institute

  - Standards
  - Corporate Standard
  - Scope 2
  - Scope 3 Standard
  - GHG Protocol for Cities
  - Project Protocol
  - Mitigation Goals Standards
  - Product Life Cycle Standard
  - Policy and Action Standard
  - Guidance
  - Calculation Tools
  - Online Training
  - Review Service

https://www.wri.org/initiatives/greenhouse-gas-protocol

Normas y Guías para el cálculo de la Huella de Carbono

- ISO 14064 Gases de efecto invernadero

  — Parte 1: Especificación con orientación, a nivel de las organizaciones, para la cuantificación y el informe de las emisiones y remociones de gases de efecto invernadero

  — Parte 2 Especificación con orientación, a nivel de proyecto, para la cuantificación, el seguimiento y el informe de la reducción de emisiones o el aumento en las remociones de gases de efecto invernadero

https://www.iso.org/obp/ui/#iso:std:iso:14064:-1:ed-2:v1:es

https://www.iso.org/obp/ui#iso:std:iso:14064:-2:ed-2:v1:es

Normas y Guías para el cálculo de la Huella de Carbono

- Publicly Available Specifications-2050 (PAS 2050) of British Standard Institution (BSI):

Especificaciones para la evaluación de las emisiones de gases de efecto invernadero del ciclo de vida de bienes y servicios

https://knowledge.bsigroup.com/products/specification-for-the-assessment-of-the-life-cycle-greenhouse-gas-emissions-of-goods-and-services?version=standard

Normas y Guías para el cálculo de la Huella de Carbono

- IPCC guidelines for National Greenhouse Gas inventories

Volume 1 General Guidance and Reporting

Volume 2 Energy

Volume 3 Industrial Processes and Product Use

Volume 4 Agriculture, Forestry and Other Land Use

Volume 5 Waste

https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html

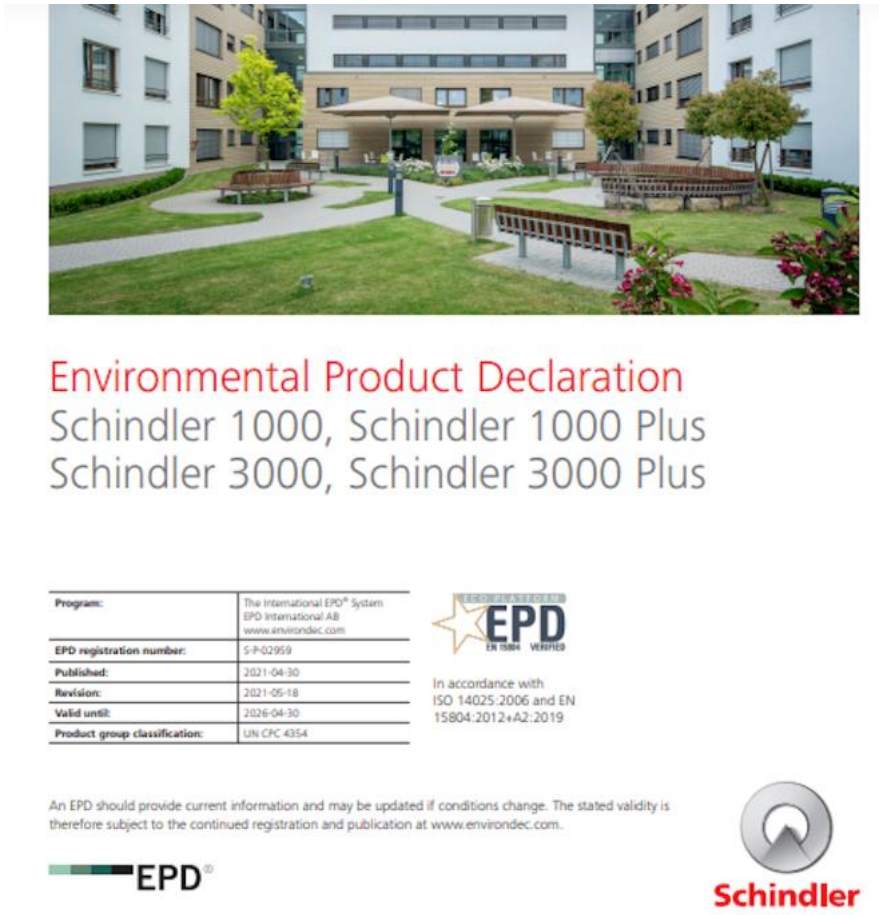
Normas y Guías para el cálculo de la Huella de Carbono

- ISO 14025: Etiquetas y declaraciones ambientales — Declaraciones ambientales tipo III — Principios y procedimientos

- https://www.iso.org/obp/ui/#iso:std:iso:14025:ed-1:v1:es

Normas y Guías para el cálculo de la Huella de Carbono

EPD (Environmental Product Declarations)
Declaración Ambiental de Producto(DAP)



Environmental Product Declaration
Schindler 1000, Schindler 1000 Plus
Schindler 3000, Schindler 3000 Plus

Program:	The International EPD® System EPD International AB www.environdec.com
EPD registration number:	S-P-02959
Published:	2021-04-30
Revision:	2021-05-18
Valid until:	2026-04-30
Product group classification:	UN CPC 4354

In accordance with
ISO 14025:2006 and EN
15804:2012+A2:2019

An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com.

EPD®

Schindler

https://www.environdec.com/library

Normas y Guías para el cálculo de la Huella de Carbono

- ISO 14067 Gases de efecto invernadero — Huella de carbono de productos — Requisitos y directrices para cuantificación

- https://www.iso.org/obp/ui#iso:std:iso:14067:ed-1:v1:es

Normas y Guías para el cálculo de la Huella de Carbono

- *Guías específicas por país*

Normas y Guías para verificar el cálculo de la Huella de Carbono

- ISO 14065 Principios generales y requisitos para los organismos que realizan la validación y la verificación de la información ambiental

- https://www.iso.org/obp/ui#iso:std:iso:14065:ed-3:v1:es

Etapas para el cálculo de la Huella de Carbono

- Selección de los Gases de Efecto Invernadero
- Definición de los límites del estudio
- Recolección de datos de emisiones de Gases de Efecto Invernadero
- Cálculo de la Huella de Carbono

Selección de los Gases de Efecto Invernadero

- Depende de:
  - La guía o norma que se siga
  - El tipo de actividad para la que se calcula
  - El objetivo del cálculo de la huella

Todas las guías y normas indican que se deben incluir todos los gases de efecto invernadero de larga duración.

Definición de los límites del estudio

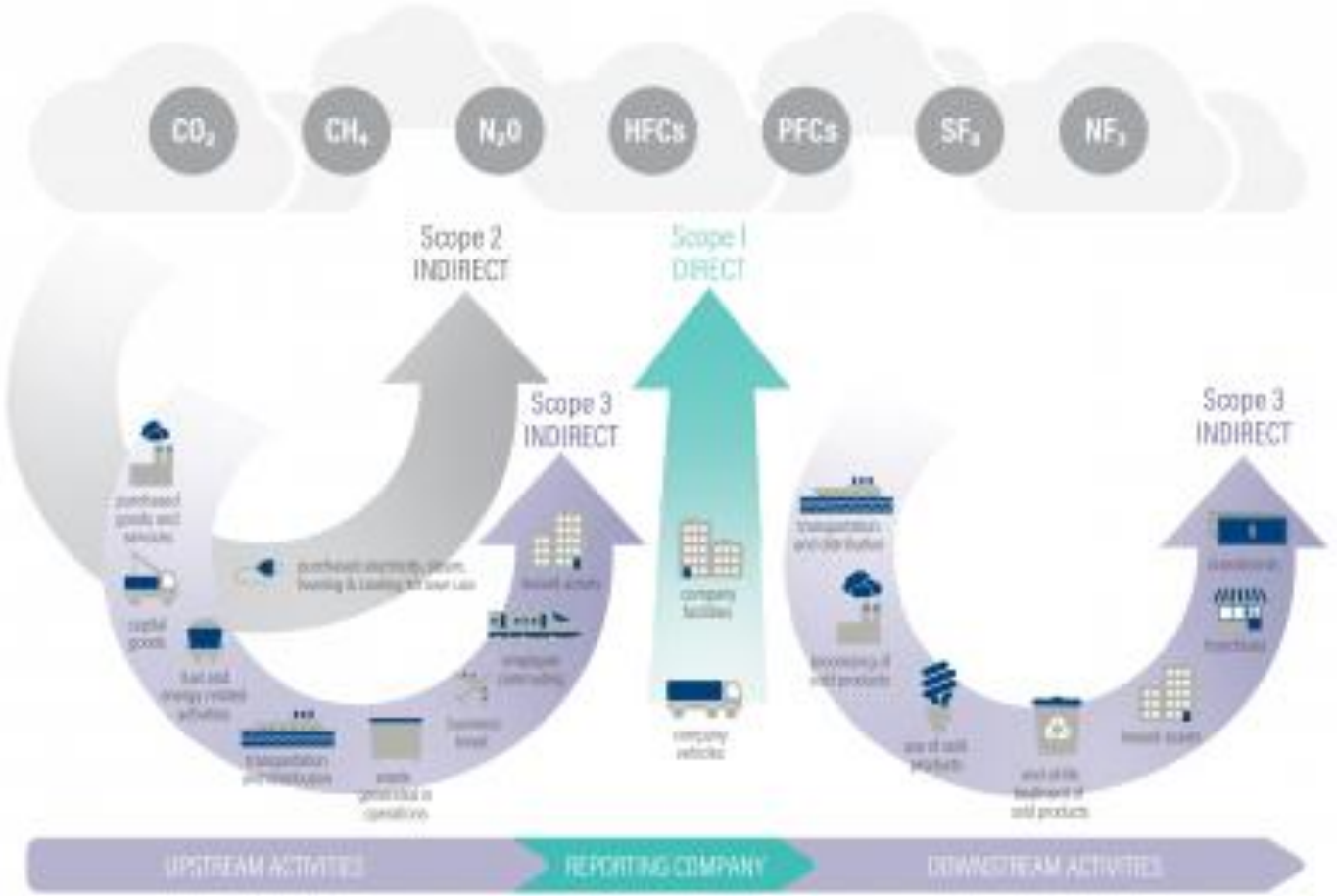
- Depende de:

    La guía o norma que se siga

    El objetivo del cálculo de la huella

    Límite organizacional: uede basarse en aspectos legales, financieros o de control de negocio para la asignación de la huella

Definición de los límites del estudio



https://www.wri.org/initiatives/greenhouse-gas-protocol

Recolección de datos de emisiones de Gases de Efecto Invernadero

- Pueden obtenerse de:

  -Medidas directas

  -Estimaciones basadas en factores de emisión y modelos

- Depende de:

  -Objetivo

  -Credibilidad

  -Viabilidad

  -Costo

Cálculo de la Huella de Carbono

- Los datos de emisiones de gases de efecto invernadero se convierten a CO_2 equivalente utilizando los factores de IPCC

Common name (chemical formula)	Lifetime (years)	GWP			GTP		
		20-year	100-year	500-year	20-year	100-year	500-year
Carbon dioxide (CO_2)	150†	1	1	1	1	1	1
Methane (CH_4)	12	72	25	7.6	57	12	4
Nitrous oxide (N_2O)	114	289	298	153	303	322	265
Sulphur hexafluoride (SF_6)	3200	16,300	22,800	32,600	17,500	23,400	28,000
Black carbon	0.020	1600	460	140	470	77	64

Lifetimes and metric values are taken from Table 2.14 of [4], and [5].
†CO_2 lifetime is representative and cannot be expressed by a single estimate because of the multiple timescales on which CO_2 is removed. (e.g., [26]).
GTP: Global Temperature Change Potential; GWP: Global Warming Potential; IPCC: Intergovernmental Panel on Climate Change.

Fuente: Tanaka, K., Peters, G. P., & Fuglestvedt, J. S. (2010). Policy update: multicomponent climate policy: why do emission metrics matter?.

- La dimension de tiempo debe ser mencionada (única, periódica, usual, annual o combinaciones).

Referencias

Climate.nasa.gov

https://circularecology.com/news/the-kyoto-protocol-climate-change-success-or-global-warming-failure

https://unfccc.int/es/acerca-de-las-ndc/el-acuerdo-de-paris

Pandey, D., Agrawal, M., & Pandey, J. S. (2011). Carbon footprint: current methods of estimation. Environmental monitoring and assessment, 178, 135-160.

https://www.workforclimate.org/post/whats-the-difference-between-carbon-neutral-net-zero-and-zero-emissions?gad_source=1&gclid=CjwKCAjwuMC2BhA7EiwAmJKRrBPdHCEewF_DaF_JWzY0BSiq8muoJdcsnjOkLSCnHmifBO166IAUARoCo4gQAvD_BwE

. IPCC Sixth Assessment Report, WGI, Technical Summary.

B.D. Santer et.al., “A search for human influences on the thermal structure of the atmosphere.” Nature 382 (04 July 1996): 39-46. https://doi.org/10.1038/382039a0.

Gabriele C. Hegerl et al., “Detecting Greenhouse-Gas-Induced Climate Change with an Optimal Fingerprint Method.” Journal of Climate 9 (October 1996): 2281-2306. https://doi.org/10.1175/1520-0442(1996)009<2281:DGGICC>2.0.CO;2.

V. Ramaswamy, et al., “Anthropogenic and Natural Influences in the Evolution of Lower Stratospheric Cooling.” Science 311 (24 February 2006): 1138-1141. https://doi.org/10.1126/science.1122587.

B.D. Santer et al., “Contributions of Anthropogenic and Natural Forcing to Recent Tropopause Height Changes.” Science 301 (25 July 2003): 479-483. https://doi.org/10.1126/science.1084123.

T. Westerhold et al., "An astronomically dated record of Earth’s climate and its predictability over the last 66 million years." Science 369 (11 Sept. 2020): 1383-1387. https://doi.org/10.1126/science.1094123

Tanaka, K., Peters, G. P., & Fuglestvedt, J. S. (2010). Policy update: multicomponent climate policy: why do emission metrics matter?.

Referencias

IPCC Sixth Assessment Report, WG1, Chapter 2
Vostok ice core data; NOAA Mauna Loa CO2 record
O. Gaffney, W. Steffen, "The Anthropocene Equation." The Anthropocene Review 4, issue 1 (April 2017): 53-61. https://doi.org/abs/10.1177/2053019616688022.
https://www.ncei.noaa.gov/monitoring
https://crudata.uea.ac.uk/cru/data/temperature/
http://data.giss.nasa.gov/gistemp
https://www.giss.nasa.gov/research/news/20170118/
S. Levitus, J. Antonov, T. Boyer, O Baranova, H. Garcia, R. Locarnini, A. Mishonov, J. Reagan, D. Seidov, E. Yarosh, M. Zweng, "NCEI ocean heat content, temperature anomalies, salinity anomalies, thermosteric sea level anomalies, halosteric sea level anomalies, and total steric sea level anomalies from 1955 to present calculated from in situ oceanographic subsurface profile data (NCEI Accession 0164586), Version 4.4. (2017) NOAA National Centers for Environmental Information.
https://www.nodc.noaa.gov/OC5/3M_HEAT_CONTENT/index3.html
K. von Schuckmann, L. Cheng, L,. D. Palmer, J. Hansen, C. Tassone, V. Aich, S. Adusumilli, H. Beltrami, H., T. Boyer, F. Cuesta-Valero, D. Desbruyeres, C. Domingues, A. Garcia-Garcia, P. Gentine, J. Gilson, M. Gorfer, L. Haimberger, M. Ishii, M., G. Johnson, R. Killick, B. King, G. Kirchengast, N. Kolodziejczyk, J. Lyman, B. Marzeion, M. Mayer, M. Monier, D. Monselesan, S. Purkey, D. Roemmich, A. Schweiger, S. Seneviratne, A. Shepherd, D. Slater, A. Steiner, F. Straneo, M.L. Timmermans, S. Wijffels. "Heat stored in the Earth system: where does the energy go?" Earth System Science Data 12, Issue 3 (07 September 2020): 2013-2041. https://doi.org/10.5194/essd-12-2013-2020.
I. Velicogna, Yara Mohajerani, A. Geruo, F. Landerer, J. Mouginot, B. Noel, E. Rignot, T. Sutterly, M. van den Broeke, M. Wessem, D. Wiese, "Continuity of Ice Sheet Mass Loss in Greenland and Antarctica From the GRACE and GRACE Follow-On Missions." Geophysical Research Letters 47, Issue 8 (28 April 2020): e2020GL087291. https://doi.org/10.1029/2020GL087291.
National Snow and Ice Data Center
World Glacier Monitoring Service
National Snow and Ice Data Center
D.A. Robinson, D. K. Hall, and T. L. Mote, "MEaSUREs Northern Hemisphere Terrestrial Snow Cover Extent Daily 25km EASE-Grid 2.0, Version 1 (2017). Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/MEASURES/CRYOSPHERE/nsidc-0530.001. http://nsidc.org/cryosphere/sotc/snow_extent.html
Rutgers University Global Snow Lab. Data History

Referencias

IPCC Sixth Assessment Report, WG1, Chapter 2
Vostok ice core data; NOAA Mauna Loa CO2 record
O. Gaffney, W. Steffen, "The Anthropocene Equation." The Anthropocene Review 4, issue 1 (April 2017): 53-61. https://doi.org/abs/10.1177/2053019616688022.
https://www.ncei.noaa.gov/monitoring
https://crudata.uea.ac.uk/cru/data/temperature/
http://data.giss.nasa.gov/gistemp
https://www.giss.nasa.gov/research/news/20170118/
S. Levitus, J. Antonov, T. Boyer, O Baranova, H. Garcia, R. Locarnini, A. Mishonov, J. Reagan, D. Seidov, E. Yarosh, M. Zweng, "NCEI ocean heat content, temperature anomalies, salinity anomalies, thermosteric sea level anomalies, halosteric sea level anomalies, and total steric sea level anomalies from 1955 to present calculated from in situ oceanographic subsurface profile data (NCEI Accession 0164586), Version 4.4. (2017) NOAA National Centers for Environmental Information.
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Muchas gracias