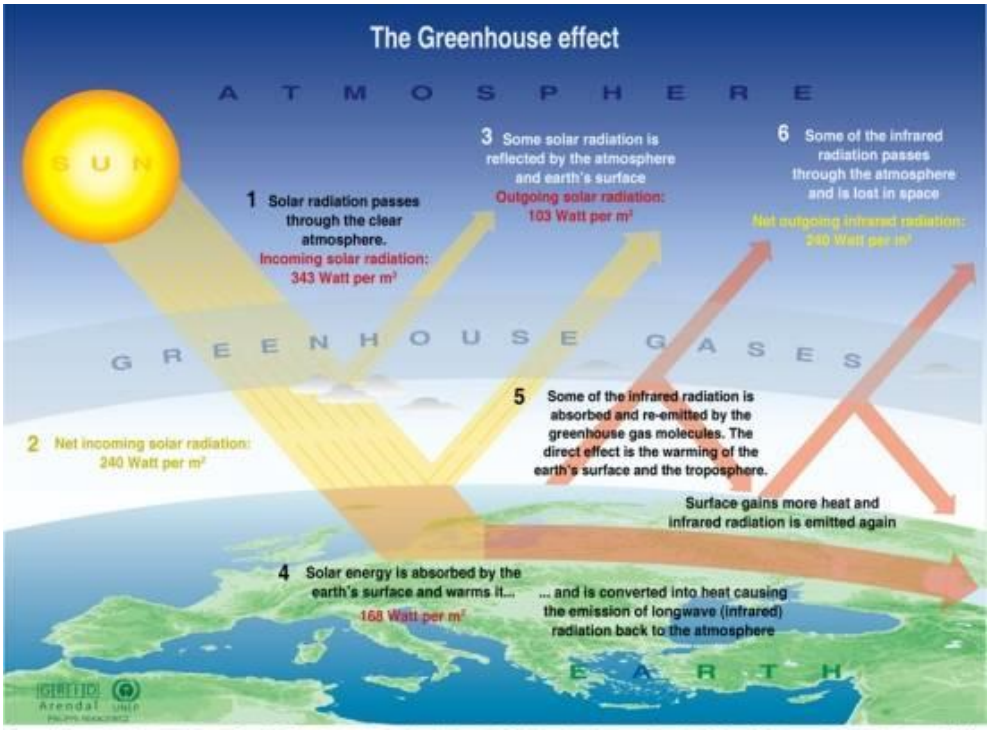
How Carbon Offsetting Works

1. What are Greenhouse Gases?

A greenhouse gas (GHG) is any gas that absorbs heat reflected from the Earth's surface in the form of infrared radiation, trapping it in the atmosphere. The heat contributes to the heating of the planet and is known as the greenhouse effect.



Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

Source: UNEP/GRID-Arendal. Greenhouse effect. UNEP/GRID-Arendal Maps and Graphics Library. 2002

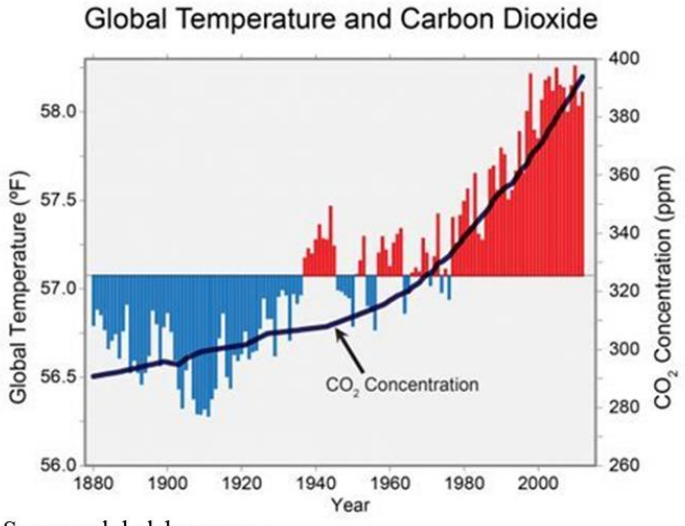
Carbon dioxide (CO_2), methane (CH_4) and water vapour are the most abundant GHGs, along with surface-level ozone (O_3), nitrous oxide (N_2O) and fluorinated gases. N_2O is an especially potent greenhouse gas, trapping far more infrared radiation than both CO_2 and methane, despite only a tiny concentration being present in the atmosphere.

Other gases, such as nitrogen oxides (NOx), act as *indirect* greenhouse gases by producing ozone via photochemical reactions in the atmosphere. At the same time, however, the photochemical reaction reduces the level of methane in the atmosphere, thereby partially counterbalancing its negative impact. Consequently, NOx emissions are not as bad as direct GHG emissions.

Fully addressing climate change will require reducing emissions of all GHGs.

Scientists and policy-makers have established 'global warming potentials' (GWPs) to express the heat-trapping effects of all GHGs in terms of CO_2-equivalents (CO_2e). This makes is easier to compare the effects of different GHGs and to denominate carbon offset credits in units of CO_2e emission reductions.

Concentrations of GHGs have varied substantially during Earth's history and these variations have driven substantial climate changes at a wide range of timescales. In general, GHG concentrations have been particularly high during warm periods and low during cold periods.



Source: globalchange.gov

CO_2 is the most prevalent GHG, the concentration of which has risen since the mid-1900s, coinciding with an increase in post-war industrial activity. CO_2 in the atmosphere has accumulated at an average rate of 1.4 parts per million (ppm) by volume per year between 1959 and 2006 and roughly 2.0 ppm per year between 2006 and 2018.

Human activities are responsible for steady increases in atmospheric concentrations of various greenhouse gases.

Burning fossil-fuels (principally oil and coal, and secondarily natural gas) for transportation, heating and electricity production, increases the levels of atmospheric CO_2 and methane. Farming practices and waste landfills are other significant contributors to man-made GHG.

There are numerous naturally occurring physical, chemical, or biological processes, called 'sinks', that remove CO_2 from the atmosphere. Significant natural sinks include terrestrial vegetation, which absorbs CO_2 during photosynthesis. Several oceanic processes also act as carbon sinks, such as the consumption of dissolved CO_2 by marine vegetation or by marine organisms that use CO_2 to build skeletons. A long-term balance between *natural* sources of GHG and sinks leads to the natural background level of CO_2 in the atmosphere.

2. What is Carbon Offsetting?

The process of carbon offsetting comprises the balancing of an individual's or organisation's GHG emissions with GHG emission reductions from green energy projects located elsewhere.

The key concept of carbon offsetting is that carbon offset credits are used to convey a net climate benefit from one entity to another. The GHG emission reductions – otherwise

known as ‘savings’ - are made through independently approved projects, such as renewable energy projects that displace fossil-fuelled power generation, or energy saving programmes. Given that GHGs mix globally in the atmosphere, it does not matter where exactly the ‘savings’ are made.

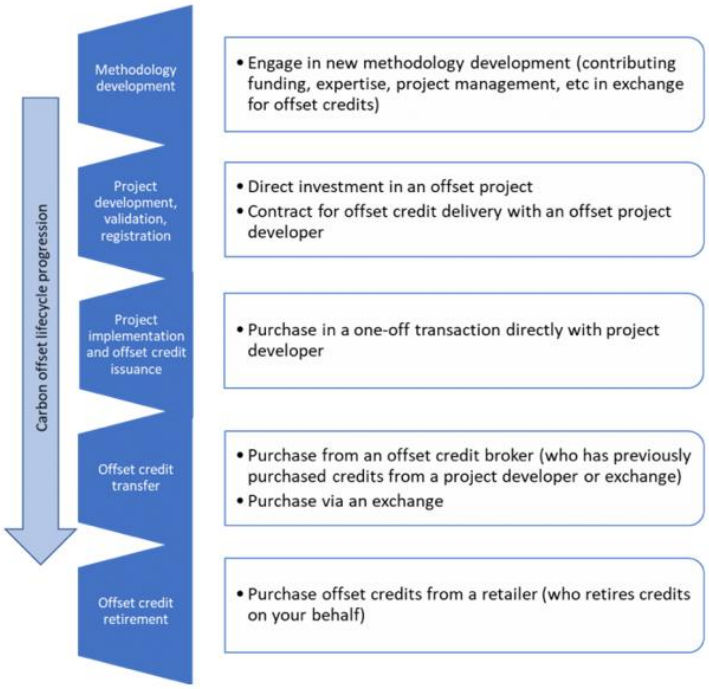
From a climate change perspective, the effects are the same if an organization: (a) ceases an emission-causing activity; or (b) enables an equivalent emission-reducing activity somewhere else in the world. Carbon offsets are intended to make it easier and more cost-effective for individuals or organisations to pursue the second option.

Carbon Offsetting is well established internationally, following the development of international carbon offset credit trading systems and the mechanisms established under the Kyoto Protocol.

These commodity markets involve trading of transferable instruments, known as carbon offset credits. One carbon offset credit represents an emission reduction equivalent of one metric tonne of CO_2e. The purchaser must “retire” the Carbon Offset Credit from the registry in order to claim the underlying reduction benefit.

The emission reduction projects are awarded the right to issue carbon offset credits by independent approval bodies, having achieved stringent project requirements. The project owners sell the credits through the carbon markets and the money they receive subsidises the projects. Importantly, the projects are not financially viable without the revenues generated by the carbon offset credits. The projects range from renewable energy, energy efficiency, forestry, and other actions that reduce the emissions of more potent greenhouse gases.

Carbon offset credit lifecycle and buyer purchase options at each stage:



The carbon offset credit is certified by governments or independent certification bodies and verified by independent auditors.

Government and Kyoto Protocol Regulated Emission Markets		
Government-run "Compliance" carbon offset programs	Geographic Coverage	Label used of offset credits
Clean Development Mechanism	Low & middle income countries	Certified Emissions Reductions (CERs)
Joint Implementation	High income countries	Emission Reduction Units (ERUs)
California Compliance Offset Program	United States	Aire Resources Board Offset Credit (ARBOC)
Regional Greenhouse Gas Initiative	Northeast United States	RGGI CO_2 Offset Allowance (ROA)
Alberta Emission Offset Program	Alberta, Canada	Alberta Emissions Offset Credit (AEOC)

The Kyoto protocol established mechanisms which gave rise to carbon credits known as Certified Emissions Reductions (CERs) and Emission Reduction Units (ERUs), depending on the country in which the project is undertaken. CERs and ERUs are subject to full project oversight and verification under the UN Framework Convention on Climate Change. CERs and ERUs fall within Yacht Carbon Offset selection criteria.

Voluntary Emission Markets		
NGO*-run carbon offset programs	Geographic Coverage	Label used of offset credits
The Gold Standard	International	Verified Emission Reductions (VERs)
The Verified Carbon Standard	International	Verified Carbon Units (VCUs)
Plan Vivo	International	Plan Vivo Certificate (PVC)
American Carbon Registry	United States, some International	Emission Reduction Tonne (ERT)
Climate Action Reserve	United States, Mexico	Climate Reserve Tonne (CRT)

*NGO: Non-governmental organisations

Carbon credits from projects falling outside the government or Kyoto regulated markets are generally referred to as Voluntary Emissions Reductions (VERs). These support smaller projects, including those in developing countries, which may not have the resources to complete the Kyoto compliance process, but generate real emissions savings and often bring associated social benefits. Due to some inconsistencies in validation methods, not all VERs fall within Yacht Carbon Offset selection criteria.

The Gold Standard VERs for carbon credits, which focuses on renewable energy and energy efficiency projects with sustainable development benefits, do fall within Yacht Carbon Offset selection criteria. Gold Standard VERs require independent validation and verification of the projects by UN-accredited organisations.

The Voluntary Carbon Standard, which was updated in 2007 with the participation of Lloyds Register Quality Assurance, also guarantees that project validation and verification is performed by accredited organisations. Compliant Voluntary Carbon Units (VCUs) are held

within an approved registry to provide assurance against double-counting of credits. VCUs fall within Yacht Carbon Offset selection criteria.

3. Green Energy Project Selection

Carbon credits can be produced by a variety of activities that either: i) reduce GHG emissions, or ii) increase CO_2 absorption, from the atmosphere (sequestration). In most cases, these activities are undertaken as projects, which are often referred to as 'Green Energy Projects'. A Green Energy Project, may involve:

- **Renewable energy**: displacing fossil-fuel emissions generated by conventional power plants. Examples include solar, wind and geothermal power projects.
- **Carbon Sequestration:** Examples include tree plantation and forest conservation projects. Trees (as all plants) absorb carbon dioxide from the atmosphere during photosynthesis.
- **Energy Efficiency:** Projects that reduce carbon fuel consumption or improve the energy capture from combustion. Examples include cookstove projects that replace traditional wood and charcoal stoves with energy-efficient liquefied petroleum gas (LPG) cook stoves.
- **GHG capture and destruction:** The capture and destruction of high-potency GHGs like methane, nitrous oxide, or hydrofluorocarbons. Examples include landfill gas collection, coal mine methane collection and livestock manure digesters. Methane gas can be collected and combusted to generate electricity.

Projects can range in scale, with smaller projects reducing only a few hundred tonnes of CO_2e per year to very large projects that reduce millions of tonnes per year. Some projects produce social and economic benefits beyond just GHG reductions. These "co-benefits" can include: community employment opportunities; enhanced air or water quality; biodiversity and habitat conservation; improved energy access; and better access to community health and education services. Many offset credit buyers seek projects that yield a broad range of benefits. Carbon offsets can thus be part of a comprehensive strategy for corporate social responsibility, combining efforts to address climate change with contributions to other public goods.

Forestry projects, where the compensating action to provide the offset is achieved by the absorption (or "sequestration") of atmospheric CO_2 during photosynthesis, are not currently favoured by Yacht Carbon Offset as a mechanism to offset the GHG emissions of a yachting activity. Firstly, the pay-back period of a forestry project can be long, it taking a number of years to reduce CO_2 amounts by a level that offsets the impact of a week's charter, for example. Secondly, pure tree-planting schemes are only worthwhile if the trees will in reality be protected forever - otherwise the carbon is released again when the trees are cut down. Even then, the methodology for quantifying the equivalent CO_2 saving today is both complex and controversial. Furthermore, there is no point in simply buying existing forests that are not under threat, since this makes no difference to atmospheric CO_2 levels at all.

To find out more about the Green Energy Projects selected by Yacht Carbon Offset visit our website: www.yachtcarbonoffset.com.

Key Reference for this document: Broekhoff, D., Gillenwater, M., Colbert-Sangree, T., and Cage, P. 2019. "Securing Climate Benefit: A Guide to Using Carbon Offsets." Stockholm Environment Institute & Greenhouse Gas Management Institute. Offsetguide.org/pdf-download/