GLOSSARY OF
CLIMATE CHANGE DEFINITIONS
IN RELATION TO SHIPPING

Co-sponsors:

BIMCO

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international association of ports and harbors

UNITY FOR SAFETY AT SEA
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International Parcel Tankers Association

IUMI
International Union of Marine Insurance

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Glossary of climate change definitions in relation to shipping

Purpose: To clarify and harmonize definitions and terminology to ensure that the discussions around climate change and potential solutions for the shipping industry are based on a mutual understanding of what the commonly used terms mean.

Interpretation: The glossary is designed to contain encyclopaedic definitions. This means that the definition provides some elaboration and differences between what might be considered similar definitions. The inclusion of a definition does not imply that it is a position adopted by the co-sponsors and definitions should always be considered neutral. For example, the inclusion of the term “offsetting” should not be interpreted as the co-sponsors having a positive or negative position on offsetting as a concept.

Sources: Wherever possible (and if relevant) definitions are based on those used by the Intergovernmental Panel on Climate Change (IPCC) or other competent bodies and as such agreed by scientific and/or political consensus. Where changes have been made to an original definition, they have been done so with the intent to make the definition more applicable to shipping or to make the definition easier to understand for the reader. Where used, references are provided at the end of the document.

Where a high-level definition (ie one which is agreed at international level by consensus) does not exist, novel definitions have been created. These have been sense-checked for scientific integrity against common usage of such terms in scientific literature and subsequently approved by BIMCO’s Sub-group on alternative fuels.

Where a definition includes reference to another definition these are indicated in *italics*.

Peer review: This document was peer reviewed by:

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Part 1 – Fundamental definitions

1. Climate change

Climate change refers to a change in the state of the climate that can be identified (eg by using long-term observations and statistical tests) and which persists for an extended period, typically decades or longer. It is used in climate policy specifically to describe a change of climate, which is attributed directly or indirectly to human activity, that alters the composition of the global atmosphere, and which is in addition to natural climate variability observed over comparable time periods. (IPCC, 2018)

2. Global warming

Global warming refers to an increase in global surface temperature expressed relative to a baseline (eg pre-industrial times 1850 to 1900) and averaged over a specified period (eg 20 or 30 years).

3. Greenhouse gases (GHGs)

Greenhouse gases are those within the earth's atmosphere that contribute towards global warming as listed in the latest report of the Intergovernmental Panel on Climate Change (IPCC). (IPCC, 2021)

4. Carbon dioxide (CO_2)

Carbon dioxide (CO_2) is a naturally occurring gas and is also a by-product of burning fossil fuels (such as oil, gas, and coal), of burning biomass, of land use changes (LUC) and of industrial processes (eg, cement production). It is the principal *greenhouse gas (GHG)* produced by, or resulting from, human activities that affects the earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a *global warming potential (GWP)* of 1. (IPCC, 2021)

5. CO_2-equivalent (CO_2-eq) emissions

Carbon dioxide equivalent (CO_2-eq)[1] emissions is a metric measure used to compare emissions from various *greenhouse gases (GHGs)* and other substances based on their *global warming potential (GWP)*. Equivalent emissions are calculated by multiplying the mass of a substance by the GWP of that substance, using values given by the latest report of the Intergovernmental Panel on Climate Change (IPCC). It provides a way to compare the impact on *global warming* of different substances. For a mix of GHGs it is obtained by summing the CO_2-equivalent emissions of each gas. (IPCC, 2021)

[1] Carbon dioxide equivalent is also commonly abbreviated as (CO_2e) or (CO_2eq), while (CO_2-eq) is used by IPCC in AR6.

6. Global warming potential (GWP)

Global warming potential (GWP) is an index measuring the radiative forcing (ie changes in the Earth's energy balance) following an emission of a unit mass of a given substance, accumulated over a chosen time horizon, relative to that of an equal unit mass of the reference substance, *carbon dioxide (CO_2)* over the same time period. The GWP represents the combined effect of the differing times these substances remain in the atmosphere and their effectiveness in causing radiative forcing. CO_2 is assigned a GWP value of 1. Therefore, GWP measures the relative warming impact of one unit mass of a given substance relative to CO_2. (IPCC, 2021)

7. Short-lived climate forcers (SLCF)

Short-lived climate forcers (SLCF) are substances that have significantly shorter lifetimes in the atmosphere than *carbon dioxide (CO_2)* (hours to decades), but which have an impact on climate. They include some *greenhouse gases (GHGs)* such as ozone, methane, and hydrofluorocarbons (HFCs), but also other substances such as aerosols and black carbon. They can either have a direct warming effect or cooling effect; or can be a precursor to another compound that impacts climate; or have an indirect impact on the climate system such as affecting the reflection of radiation from the Earth or influencing cloud formation and, in turn, rainfall. (IPCC, 2021)

8. Short-lived climate pollutants (SLCP)

Short-lived climate pollutants (SLCP) are a subset of *short-lived climate forcers (SLCF)* that are also classified as air pollutants. In addition to impacting the climate they can have adverse effects on human health and/or ecosystems. (IPCC, 2021)

9. Carbon footprint

A carbon footprint is a general term used to represent the total volume of *greenhouse gases (GHGs)* resulting from everyday economic and human activity. It can be considered a misnomer as it covers all GHG emissions, including *carbon dioxide (CO_2)*, and is normally measured in mass units of CO_2 and using *CO_2-equivalents (CO_2-eq)* for other GHGs. It is expressed as "per person or activity" and is most often used to compare sectors, products, and countries eg, per capita CO_2 emissions are used to compare country A to country B.

10. Decarbonisation

Decarbonisation is an overarching term that describes acts, pathways, or processes, by which countries, individuals or other entities aim to reduce and ultimately eliminate *greenhouse gas (GHG)* emissions from human activities. (IPCC, 2018)

Part 2 – Definitions related to the measurement and accounting of emissions

11. Life cycle

A life cycle describes consecutive and interlinked stages of an activity from raw material acquisition or generation from natural resources through to final disposal of any products. A life cycle analysis (also called a life cycle assessment) provides a compilation and evaluation of the inputs, outputs, and the potential environmental impacts of a product system or activity throughout its life cycle. (ISO, 2006)

12. Life cycle emissions

Life cycle emissions refer to (but are not limited to), the *greenhouse gases (GHGs)* emitted throughout the consecutive and interlinked stages of the life cycle of a product system or activity from raw material acquisition to final disposal. For a ship, it would include emissions from elements such as material production, shipbuilding, maintenance, ship operation (see definition of *Well-to-Wake*), and activities at the ship's end of life (eg recycling). A life cycle analysis (or assessment) provides a compilation and evaluation of the inputs, outputs, and the GHG emissions (and other potential environmental impacts) of the ship throughout its life cycle.

13. Scope emissions

Scope emissions describe the categorisation of *greenhouse gas (GHG)* emissions into groups to facilitate universal international accounting and reporting. There are four distinct groups, namely *scope 1*, *2* and *3* as well as "*outside of scopes*". (WBCSD & WRI, 2015)

14. Scope 1 emissions

Scope 1 emissions or direct emissions are *greenhouse gas (GHG)* emissions from the sources that are owned or controlled by the reporting entity. For shipping this refers primarily to emissions from fuel consumption. (WBCSD & WRI, 2015)

15. Scope 2 emissions

Scope 2 or indirect emissions are greenhouse gas emissions specifically from the generation of purchased or acquired electricity, steam, heat, or cooling consumed by the reporting entity. (WBCSD & WRI, 2015)

16. Scope 3 emissions

Scope 3 refers to all indirect greenhouse gas emissions from all sources whether upstream or downstream of a value chain and which are not owned or controlled by the reporting entity directly. This includes (but is not limited to) emissions due to production of goods and services used by an activity, upstream emissions from feedstock or energy used that are not included in *scope 1* or *scope 2* such as the emissions associated with fuel extraction, production, and transportation, emissions indirectly caused by transportation, emissions due to disposal and treatment of waste including end-of-life treatment of products and emissions due to service or product use. (WBCSD & WRI, 2015)

17. Outside of scopes emissions

"Outside of scopes emissions" is a term that at present specifically refers to emissions from biofuels for the purpose of accounting by some nations. The emissions are labelled "outside of scopes" because the *scope 1* impact of the *carbon dioxide (CO_2)* released through these fuels has been determined to be net zero (since the fuel source itself absorbs an equivalent amount

of CO_2 during the growth phase to that which is released through combustion). The CO_2 component is quantified but may be placed “outside of scopes” (as opposed to in *scope 1* which is usual for directly combusted fuels). (UK Department for Environment, 2014)

18. Offsetting

Offsetting describes the climate action that enables individuals and organisations to compensate for their emissions, by supporting worthy projects that reduce emissions somewhere else. More specifically, it is a term used to describe the act of reducing *greenhouse gas (GHG)* emissions (including through avoided emissions) or increasing GHG removals through activities external to an activity or outside of the supply chain, to reduce the net contribution to global emissions. Offsetting is typically arranged through a marketplace for carbon credits or other exchange mechanism. Offsetting claims are only valid under a rigorous set of conditions, including ensuring that the reductions/removals involved are additional, not over-estimated, and exclusively claimed. (UNFCCC, 2021)

19. Insetting

Insetting is similar of *offsetting* but whilst the principles are the same it differs as it applies to a company offsetting its emissions through a project within its own value chain. (UNFCCC, 2021)

Part 3 – Definitions related to measurement and accounting of emissions for ships

20. Well-to-Tank emissions

Well-to Tank emissions are the total *greenhouse gas (GHG)* emissions associated with the growing or extraction of raw materials, the production of the fuel and the transportation of the fuel to the point of use. (IMO Working Group on Reduction of GHG Emissions from Ships, 2021)

21. Tank-to-Wake emissions

Tank-to-Wake emissions are the total *greenhouse gas (GHG)* emissions from when the fuel is received onboard to the point of final use including combustion or from the use of other energy carriers for the operation of the ship. Tank-to-Wake emissions also include all onboard venting and leaks. (IMO Working Group on Reduction of GHG Emissions from Ships, 2021)

22. Well-to-Wake emissions

Well-to-Wake emissions are the total *greenhouse gas (GHG)* emissions taking into account the impact of fuel or energy production, transportation of fuel, and distribution and use onboard, including during combustion. It is the sum of *Well-to-Tank* and *Tank-to-Wake emissions*. (IMO Working Group on Reduction of GHG Emissions from Ships, 2021)

23. Carbon Intensity Indicators

In its most simple form, the attained annual operational carbon intensity indicators (CIIs) of individual ships are calculated as the ratio of the total mass of *carbon dioxide* (CO_2) (M) emitted to the total transport work (W) undertaken in a given calendar year.

A specific CII, which has been calculated on the basis of the actual or estimated mass or volume of the shipment carried on board a ship, is generally referred to as demand-based CII. Whereas a specific CII, in which calculation the capacity of a ship is taken as proxy of the actual mass or volume of the shipment carried on board, is generally referred to as supply-based CII. (IMO MEPC, 2021)

Part 4 – Definitions related to climate targets and goals

Sub-part 4A – Neutrality [2]

24. Carbon neutrality

Carbon neutrality describes where *carbon dioxide (CO_2)* emissions produced by, or as a result of, human activities are balanced by CO_2 removals as a result of human activities. Carbon neutrality is assessed over an entire *life cycle* and includes direct (*scope 1*) and indirect emissions (*scope 2* and *3*).

For ships, *life cycle emissions* might include, for example, those generated during the manufacturing of the ship, in the extraction and production of fuels, in the operation of the ship, through the disposal and treatment of waste and in activities arising at end of use (eg in recycling).

Carbon neutrality can mean that supplementary use of carbon *offsets* and/or *insets* that lead to carbon reductions or efficiencies are being used. (IPCC, 2021)

25. Greenhouse gas neutrality

Greenhouse gas (GHG) neutrality describes where GHG emissions produced by, or as a result of, human activities are balanced by removals as a result of human activities. GHG neutrality is assessed over an entire *life cycle* including direct (*scope 1*) and indirect emissions (*scope 2* and *3*). GHGs are calculated as *CO_2-equivalents (CO_2-eq)*.

For ships, *life cycle emissions* might include, for example, those generated during the manufacturing of the ship, in the extraction and production of fuels, in the operation of the ship, through the disposal and treatment of waste and in activities arising at end of use (eg in recycling).

GHG neutrality can mean that supplementary use of GHG *offsets* and/or *insets* that lead to GHG reductions or efficiencies are being used. (IPCC, 2021)

[2] The terms “net zero” and “neutrality” have been, and in some instances are still, used interchangeably and to mean the same. However, clarification of the terms including providing a distinction between where offsetting is included and where life cycle emissions are counted is important to enable the development of climate targets and climate actions that cannot be misinterpreted. With this in mind, distinct and different definitions are included here for net zero and neutrality. These definitions are based on the notes to the relevant definitions included in the IPCC AR6.

26. Climate neutrality

Climate neutrality describes a state where activities are resulting in no net effect on the climate system. Achieving such a state would require both balancing of residual emissions (such as greenhouse gases and particulate matter) with emission removal as well as accounting for regional or local biogeophysical effects of human activities that, for example, affect the reflectiveness of the earth's surface or local climate. (IPCC, 2021)

27. Carbon neutral ship operations

Carbon neutral ship operations are assessed across the *life cycle* for the fuel used (referred to as *Well-to-Wake*). This includes emissions generated in the production of the fuel (*scope 3*) which is used for the operation of the ship as well as the direct (*scope 1*) emissions from combustion and indirect emissions from, for example, electricity provided from shore and used by the ship in port (*scope 2*).[3]

For carbon neutral ship operations, the *carbon dioxide (CO_2)* produced by, or as a result of human activities, is balanced by removals of CO_2. Carbon neutral ship operations means the operations may rely on supplementary use of carbon *offsets* and/or *insets* that lead to carbon reductions or efficiencies.

28. GHG neutral ship operations

Greenhouse gas (GHG) neutral ship operations are assessed across the *life cycle* for the fuel used (referred to as *Well-to-Wake*). This includes emissions generated in the production of the fuel (*scope 3*) which is used for the operation of the ship as well as the direct (*scope 1*) emissions from combustion and indirect emissions from, for example, electricity provided from shore and used by the ship in port (*scope 2*).[3]

For GHG neutral ship operations, the GHG produced by, or as a result of human activities, is balanced by removals of GHG. GHG neutral ship operations means the operations may rely on supplementary use of *offsets* and/or *insets* that lead to GHG reductions or efficiencies.

29. Carbon neutral fuel

A carbon neutral fuel means that *carbon dioxide (CO_2)* emissions associated with the fuel are balanced by CO_2 removals, assessed over the *life cycle* of the fuel (ie from *Well-to-Wake*). It includes indirect (*scope 3*) emissions such as extraction and production and transportation as well as direct emissions (*scope 1*). Carbon neutral fuels may include carbon capture and storage (CCS) or *offsets* and/or *insets* to balance emissions anywhere in the supply chain as well as directly related to fuel consumption.

30. GHG neutral fuel

A greenhouse gases (GHG) neutral fuel means that emissions associated with the fuel are balanced by GHG removals, assessed over the *life cycle* of the fuel (ie from *Well-to-Wake*). It includes indirect (*scope 3*) emissions such as extraction and production and transportation as well as direct emissions (*scope 1*). GHG neutral fuels may include carbon capture and storage (CCS) or *offsets* and/or *insets* to balance emissions anywhere in the supply chain as well as directly related to fuel consumption.

[3] "Ship operations" include all energy produced and/or used by the ship.

Sub-part 4B – Net zero [4]

31. Net zero CO_2 emissions

Net zero carbon dioxide (CO_2) emissions describes when CO_2 emissions resulting from human activities are either zero or are balanced by CO_2 removals resulting from human activities over a specified period. It includes direct CO_2 emissions to air associated with fuel consumption and indirect CO_2 emissions associated with purchase of electricity (ie, *scope 1* and *scope 2 emissions*).

Net zero means reducing emissions and balancing the remaining residual emissions through carbon removal rather than through carbon *offsets* and/or *insets*.

The carbon removal can be achieved either by removing the CO_2 when the fuel is produced or after combustion. (IPCC, 2021)

32. Net zero GHG emissions

Net zero greenhouse gas (GHG) emissions describes when GHG emissions resulting from human activities are either zero or are balanced by GHG removals resulting from human activities over a specified period. The quantification of net zero GHG emissions depends on the GHG emission metric chosen to compare emissions and removals of different gases, as well as the time horizon chosen for that metric.

Net zero means reducing emissions and balancing the remaining residual emissions through removal rather than using *offsets* and/or *insets*.

The GHG removal can be achieved either by removing the GHG emissions when the fuel is produced or after combustion. (IPCC, 2021)

33. Net zero carbon ship operations

Net zero carbon ship operations describes when the *carbon dioxide (CO_2)* emissions resulting from the operation of the ship[5] are balanced by removals resulting from human activities over a specified period.

Net zero carbon ship operations means reducing emissions and balancing the remaining residual emissions through removal rather than using *offsets* and/or *insets*. The emissions removal can be achieved during fuel production and/or after combustion.

34. Net zero GHG ship operations

Net zero greenhouse gas (GHG) ship operations describes when GHG emissions resulting from the operation of the ship[5] are balanced by removals resulting from human activities over a specified period.

[4] The terms “net zero” and “neutrality” have been, and in some instances are still, used interchangeably and to mean the same. However, clarification of the terms including providing a distinction between where offsetting is included and where life cycle emissions are counted is important to enable the development of climate targets and climate actions that cannot be misinterpreted. With this in mind, distinct and different definitions are included here for net zero and neutrality. These definitions are based on the notes to the relevant definitions included in the IPCC AR6.

[5] “Ship operations” include all energy produced and/or used by the ship.

Net zero GHG ship operations means reducing emissions and balancing the remaining residual emissions through removal rather than using *offsets* and/or *insets*. The emissions removal can be achieved during fuel production and/or after combustion.

35. Net zero carbon fuel

A net zero carbon fuel is one where a balance of zero is achieved on *carbon dioxide (CO_2)* emissions when the fuel is used by the ship, in terms of direct emissions to air associated with fuel consumption.

A net zero carbon fuel will either produce no CO_2 emissions on combustion at all (ie a carbon-free fuel), or will require any CO_2 emissions to be captured from the air and stored (or utilised) within the combustion process.

Alternatively, a fuel may be considered a net zero carbon fuel if it is formally certified as such, or commonly accepted to be "*outside of scopes*" within *greenhouse gas (GHG)* reporting systems. In this case a net zero carbon fuel is one where the carbon dioxide (CO_2) emissions from the fuel being used by the ship, which includes direct emissions to air associated with fuel consumption, is balanced by carbon removal, which can be at any point of the supply chain for production of the fuel as long as certified as such.

36. Net zero GHG fuel

A net zero GHG fuel is one where a balance of zero is achieved in terms of direct *greenhouse gas (GHG)* emissions to air, associated with fuel consumption; this includes both *carbon dioxide (CO_2)* and other GHG emissions.

A net zero GHG fuel will either produce no GHG emissions on combustion at all or will require any GHG emissions to be captured from the air and stored (or utilised) within the combustion process.

A fuel may be considered net zero if it is formally certified as such or commonly accepted to be "*outside of scopes*" within GHG reporting systems and this should be for all GHGs rather than just carbon. In this case, a net zero fuel is one where the greenhouse gas (GHG) emissions from the fuel being used by the ship, which includes carbon dioxide (CO_2) and direct emissions to air associated with fuel consumption, is balanced by GHG removal, which can be at any point of the supply chain for production of the fuel.

Sub-part 4C – Zero

37. Absolute zero emissions

Absolute zero emissions describes where there are no emissions of *carbon dioxide (CO_2)* or other *greenhouse gases (GHG)* across all scopes, ie there are no direct emissions from fuel consumption or indirect emissions from energy purchased or anywhere from production to end use, ie entire value chain.

38. Zero carbon ship operations

Zero carbon ship operations describes when no *carbon dioxide (CO_2)* is produced from fuel consumption or by any other energy source used by the ship and any onshore power used is from renewable sources.[6]

39. Zero GHG ship operations

Zero greenhouse gas (GHG) ship operations describes when no GHG emissions are produced from fuel consumption or by any other energy source used by the ship and any onshore power used is from renewable sources.[6]

40. Carbon-free fuel

Carbon-free fuels are those that do not include carbon as part of their molecular composition e.g., *hydrogen (H_2)* and *ammonia (NH_3)*.

[6] "Ship operations" include all energy produced and/or used by the ship.

Part 5 – Definitions related to alternative fuels

41. Fossil fuels

Fossil fuels are carbon-based fuels from fossil hydrocarbon deposits, including coal, oil, and natural gas. (IPCC, 2018)

42. Alternative fuels

Alternative fuels are fuels which serve, at least partly, as a substitute for traditionally used fossil fuels in the energy supply and which have the potential to contribute to *decarbonisation*. (European Parliament & Council of the European Union, 2021)

43. Alternative energy

Alternative energy refers to renewable or non-renewable energy sources which in their nature may be non-combustible, combustible, or nuclear, and which have the potential to contribute to *decarbonisation*.

44. Biofuels

Biofuels are liquid fuels produced from biomass. Biomass means the biodegradable fraction of products, waste, and residues from biological origin from agriculture, including plants, vegetables, and animal substances, from forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction of waste, including industrial and municipal waste of biological origin. (European Parliament & Council of the European Union, 2018; Jeswani et al., 2020)

45. Synthetic fuels

Synthetic fuel is a generic term applied to any manufactured fuel with the approximate composition and comparable specific energy of a natural fuel. It is primarily used to refer to carbon-based liquid or gaseous fuels manufactured, via chemical conversion processes, from a carbon source such as coal, *carbon dioxide (CO_2)*, natural gas, biogas, or biomass. This includes using established conventional fossil-based processes.

46. Electrofuels (eFuels)

Electrofuels are advanced gaseous and liquid fuels normally produced from hydrogen and often captured *carbon dioxide (CO_2)* and which use sustainable electricity as the principal power source for the generation of the fuel. The "e" refers to the method of production of the fuel.

47. Grey/Black/Brown fuels

Grey/Black and Brown[7] fuels are generated from traditional fossil fuels sources with the shades normally referring to the fossil fuel feedstock which is used in the process (eg brown/black for coal and grey for natural gas). The *carbon dioxide (CO_2)* and any carbon monoxide (CO) generated during the process of fuel production are not recaptured.

48. Green fuels

Green[7] fuels are those where the production employs electrolysis—the separation of hydrogen and oxygen molecules by applying electrical energy to water. To be a green fuel, renewable sources such as wind and solar power are used to generate the electricity for the separation

[7] Whilst there are criticisms of the usage of colours to define and describe fuels as overly simplistic this glossary takes account of the fact that colours are currently in common use and provides definitions based on the primary feedstock or method of energy generation.

process. When applied to fuels such a methanol, it normally means that the hydrogen is produced in this way and the *carbon dioxide (CO_2)* used has been captured from the air. For ammonia, it means the hydrogen has been produced in this way and the nitrogen used has been separated from air using renewable energy.

49. Blue fuels

Blue[7] fuels are those which use hydrogen produced from traditional fossil fuels but where the *carbon dioxide (CO_2)* from steam reforming is captured and stored- using carbon capture and storage (CCS). Blue ammonia therefore means that the carbon generated in the production of hydrogen has been captured and stored using industrial CCS. The term blue is also used when the gases used to generate the fuel have been recycled or are reused from another industrial purpose eg blue methanol.

50. Turquoise fuels

Turquoise[7] fuels are those which use hydrogen that is generated from the decomposition of methane by pyrolysis (which creates hydrogen and solid carbon) and where the electricity used in the pyrolysis is generated by renewable energy sources.

51. Pink fuels

Pink[7] fuels are those where the hydrogen used is generated through electrolysis powered by nuclear energy. Nuclear-produced hydrogen can also be referred to as purple hydrogen or red hydrogen.

52. White fuels

White[7] fuels are those where hydrogen, which is naturally occurring and geological found in underground deposits, is created through fracking. There are no strategies to exploit this hydrogen at present.

53. Yellow fuels

Yellow[7] fuels are those where the hydrogen used is generated through electrolysis using solar power.

Part 6 – Supporting definitions related to fundamental chemistry

54. Ammonia (NH_3)

Ammonia (NH_3) is a compound of nitrogen and hydrogen and at atmospheric pressure and normal temperatures is a colourless gas with a characteristic pungent smell. Ammonia is a highly toxic substance. At higher pressures ammonia becomes a liquid, making it easier to transport and store. Ammonia is manufactured in a two-step process. Firstly, from the manufacture of hydrogen followed by the synthesis of ammonia (though the Haber-Bosch Process).

55. Hydrogen (H_2)

Hydrogen is the lightest element in the universe and the most abundant. Hydrogen normally exists as a gas made of two molecules having the formula H_2. It is colourless, odourless, non-toxic, and highly combustible. Hydrogen is commonly produced from fossil fuels- primarily natural gas, followed by coal and then oil. It is produced using a process known as steam reformation that releases *carbon dioxide (CO_2)*. It can also be produced from water molecules, producing only oxygen as a by-product. Hydrogen acts as a chemical energy carrier that can be piped or transported to where it is needed for energy conversion.

56. Methanol (CH_3OH)

Methanol (CH_3OH) is a clear, colourless liquid that is soluble in water and is composed of carbon, hydrogen, and oxygen. It is also known as methyl alcohol or wood alcohol. Liquid methanol can be toxic to humans. It is most commonly produced on a commercial scale from natural gas, but it can also be produced from renewable sources such as biomass, or by means of electrolysis powered by renewable power and supported with carbon capture technology.

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