GLOBAL MARITIME FORUM FRIENDS of OCEAN ACTION WORLD ECONOMIC FORUM

Getting to Zero 2030 Coalition

Definition of zero carbon energy sources

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Decarbonization as a general term refers to the reduction and control of manmade GHG emissions. For transport, and in particular shipping, this requires the development of a fleet of ships that derive their energy consumption from zero carbon energy sources, and the development of supply chains that can deliver those zero carbon energy sources at sufficient volume and in sufficient locations. The evolution of both the energy system and the shipping system that is needed, and associated timescales of development, investment, and asset life, means that there are steps that need to be initiated now, and work carried out throughout this decade. This is important for zero carbon energy sources to start to play a role in (international deep/sea) shipping from 2030, though the transition may not be complete for a further two decades.

There is recognition that zero carbon energy sources may not initially be lower cost/price than current energy sources (oil derived). This work assumes that successful substitution of current fuels by zero carbon energy sources is dependent on some combination of regulation and business model development that will both evolve over coming years. The most likely zero carbon energy source is the one that can be most competitively used in the sector. This driving principle enables the work on zero carbon energy sources to begin now, in spite of the uncertainty on how regulation and business models might evolve.

There are a number of potential ways to store energy for use on board ships that could reduce shipping's GHG emissions. There are equally numerous ways to collectively refer to these options, with no one expression fully resolving the complex issues this raises, or entering into common parlance as the accepted 'catch all'. The phrase "Zero carbon energy sources" is a compromise and deserves further explanation.

This section is intended to provide that explanation by clarifying the definition and intent behind a short phrase ("zero carbon energy sources") that can summarise the objective that frames the effort to shortlist and select from options, whilst both remaining technology / solution neutral, and attempting to avoid negative unintended consequences such as carbon leakage (or the movement of the emissions problem from ships to other sectors), and wider negative economic impacts.

IMO terminology and phrasing

The IMO spent some time debating exactly this topic (how best to refer to future energy sources) during the formulation of the IMO's Initial Strategy for GHG Reduction. The language that was selected was "Alternative low carbon and zero carbon fuels". This term has been used as the starting point by GMF, but with "low" removed (Ref. broader getting to zero literature), and with the term "fuels" substituted to the more inclusive "energy sources".

The Coalition's "zero carbon energy sources" phrase is intentionally broadly aligned to, and recognisable from the IMO Initial Strategy.

Carbon and GHGs

Carbon has become a common proxy term for GHGs and CO_2. CO_2 is the dominant GHG for shipping, which justifies this terminology. (In 2012, CO_2 accounted for 98% of shipping's GHG emission, ref Third IMO GHG Study.) Other GHG emissions (methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3)) that occur both upstream in energy production and in ship operation can be important.

Given the preponderance of CO_2, this explains the use of the word "carbon". But given the framing of the Getting to Zero Coalition around avoidance of dangerous climate change, the work will be inclusive of all six GHGs covered by the UNFCCC/Kyoto Protocol so all GHGs are included implicitly, despite not being referred to explicitly in the phrase "zero carbon energy sources".

Zero and net-zero

Hydrogen and synthetic non-carbon fuels (ammonia), as well as battery power derived from zero-carbon electricity based on solar, wind, hydro or nuclear power are some of the options for reducing GHG emissions, which could be considered (effectively) zero carbon.

Fuels derived from biomass are another option for reducing GHG emissions. In terms of carbon accountancy, this is more commonly described as "net-zero" because biomass derived energy is normally still a hydrocarbon that on combustion releases CO_2. But because the production of biomass takes CO_2 out of the atmosphere in equivalent quantity to that emitted in combustion, it can theoretically be considered as net-zero. GHG emitted in upstream processes (e.g. land-use, harvesting, processing/refining, transport) needs to be accounted for in addition and currently results in a small net positive carbon emission.

Hydrogen and synthetic non-carbon fuels (ammonia) can also be produced using fossil fuels from which emissions are captured and stored and not ever released to the atmosphere (e.g. when combustion of a fossil fuel is used with CCS (Carbon Capture and Storage)), which could make the fuel net zero if the capture and storage is sufficiently effective.

A variant of CCS is CCU (Carbon Capture and Use). This involves, for example, the capture of CO_2 from the combustion of carbon-based fuels (e.g. in a land-based power station), and the use of the CO2 to produce another fuel (this is one production pathway for methanol and other synthetic hydrocarbons). This is neither zero carbon nor net zero if it is based on the combustion of fossil fuels, because all this process does is move the responsibility for a GHG emission from one user/sector to another.

CCU based on the combustion of biomass on the other hand can theoretically be considered as net-zero, because the production of biomass takes CO_2 out of the atmosphere in equivalent quantity to that emitted in combustion.

The Coalition's "zero carbon energy sources" phrase is intended to be inclusive of fuels derived from zero carbon electricity, biomass and the use of CCS, but not of CCU derived energy sources based on the combustion of fossil fuels.

Operational, upstream emissions, lifecycle and timescales for deployment

Also known as "well-to-tank" (upstream) and "well-to-wake" lifecycle, this encompasses the fact that emissions can occur at a number of points in an energy source's life cycle and not just operational emissions (e.g. use on a ship).

IMO regulation, and therefore the main mechanism for incentivising change in shipping, is likely to be constrained to the operational emissions of shipping. However, there are several energy sources (electricity, hydrogen) that might be zero GHG in use/combustion, but could potentially have significant upstream GHG emissions (larger than the upstream emissions of current fossil fuels) depending on their energy sources and manufacturing processes. Therefore, there is a material risk that addressing shipping GHG emissions will not solve the global problem, just move it to another sector (energy production). For these reasons, the IMO is likely to further consider the topic and may publish "guidelines" that could help manage the risk, even if there is no formal policy mechanism to control the risk.

The nature of the UNFCCC (United Nations Framework Convention on Climate Change) structure is that land-based emissions (e.g. in energy production) are already included within the Paris Agreement, which is closely linked to IMO's Initial GHG Reduction Strategy. Therefore, working under this umbrella of temperature goals and obligations to decarbonize, the upstream portion of any energy source's GHG emissions is already covered. However, whilst there are obligations and therefore transitions under way in the wider energy system and global economy, these will take time and the supply of zero carbon upstream energy at appropriate volume and price may not develop exactly in step with shipping's demand for zero carbon energy sources. During the transition, it may be necessary for non-zero upstream emissions energy sources to be used by shipping, which is considered legitimate as long as these upstream emissions have the potential for full decarbonization and are on a pathway to decarbonization alongside shipping.

The Coalition's "zero carbon energy sources" phrase is inclusive of the full lifecycle emissions (well-to-wake) needing to be "zero carbon" as the ultimate end objective of 'getting to zero', but with an understanding that there could be a transition period during which upstream emissions of some energy sources are non-zero. If we rely on any energy source with an initially non-zero upstream emission, there needs to be evidence that the energy source will become zero at the latest within the timescales of completing shipping's decarbonization. Transparency of energy source carbon emissions will allow for differentiation between energy sources with different upstream emissions.

Volume and sustainability

Some energy sources (e.g. renewable electricity) have scalability in supply clearly sufficient to meet global energy needs (in shipping and other sectors). Other energy sources (e.g. biomass derived) have potential constraints (either biological/physical, or because of sustainability/economic criteria). Constraints may occur either because there is insufficient supply to meet shipping's energy demand, or because of insufficient supply to meet the whole economy's demand for the energy source. Aviation is one obvious competitor to shipping for bioenergy, but so is the energy sector which is projected to be a user of biomass energy sources in order to create negative GHG emissions (when biomass is used in conjunction with CCS).

The Coalition's "zero carbon energy sources" phrase does not explicitly include the term "sustainable", but the phrase should be understood to exclude non-sustainable energy sources, including biofuels, brown ammonia and even unsustainable wind and solar.

To enable the transition to a decarbonized shipping sector, the phrase "zero carbon energy sources" should be understood to cover energy sources and fuels that collectively have the potential to be scalable for supply of all of shipping's energy demand in 2050, taking into account foreseeable constraints of volumes available for shipping in recognition of the likely demand from other sectors.

Summary table

It is not the intention of this footnote to provide an exhaustive or exclusive list of zero carbon energy sources. But in order to further illustrate the different sub-headings above, the table below provides some indications for each of the sub-headings for some potential energy sources.

	Biomass derived (biofuel, biogas)	**Hydrogen and synthetic non-carbon fuels** (ammonia)	**Synthetic fossil fuels** (e-methanol, e-methane, etc.)
Carbon and GHG operational emissions	CO_2 and GHG	None	CO_2 and GHG
Zero or net zero	Net zero	Zero	Net zero (depending on source of carbon)
Zero carbon upstream available today	No	No	No
Zero carbon upstream possible in 2030	Not likely at volume	Not likely at volume	Not likely at volume
Zero carbon upstream possible in 2050	Yes	Yes	Yes
Potential for volume/ sustainability constraint	Yes	No	No