



I'm Steve, a passenger here on the Pacific Adventure. I'm bothered by the fact that shipping is such an enormous emitter of CO₂, and wins hands down as the most heavily carbon-emitting way to take a holiday. At first I was reluctant to go on a cruise for that reason. But I looked into it and found out a few interesting things.

One is that despite carrying around 90% of the world's trade per ton per kilometer, globally shipping emits slightly less carbon than flying (3% vs 4%). Hard to fathom at first, until you think that millions of people fly relatively frequently. Globally there are now around 40 million flights every day.

The other thing I found is that zero-carbon shipping is relatively achievable in the medium to long term. Hence the fictitious, heavily photo-shopped demonstration on the poster you got this website from...

If you do a web search for hydrogen fuel for various forms of transport, you find a lot of information so I won't go into it here. But basically there are two main ways of using hydrogen to power a vehicle:

- 1, Using hydrogen to create electricity that can directly power an electric motor or go into battery storage (Hydrogen Fuel Cell Electric)
- 2, Using either hydrogen or ammonia (hydrogen and nitrogen in the one molecule) as fuel in an internal combustion engine.

What I've read leads me to think that, in the short term at least, burning a hydrogen-based fuel in an internal combustion engine looks like the most practical way to go for shipping. The main immediate reason is that we can convert existing diesel engines to hydrogen or ammonia meaning we can get it happening right now, starting with existing ships. Another reason, which is a long term consideration, is that fuel cell electric power is more efficient with less of a load, say a car running along a flat road, or an empty truck. Internal combustion engines are more efficient when pulling a heavy load. You can't get a greater load than trying to drag an enormous iron shopping mall like the Pacific Adventure along an ocean. Except launching a vehicle into space I suppose.

One drawback of any internal combustion engine is that whatever fuel it uses it will always produce

nitrous oxide which is 265 times stronger than carbon dioxide as a greenhouse gas. There are ways of capturing this, such as the AdBlue added to conventional engines along-side diesel fuel.

So if we're going the ICE route we then need to decide if we use straight H₂ or process it into ammonia first. Ammonia has a few advantages even though it is a dangerous chemical if it gets loose. It can be stored as a liquid at much warmer temperatures than liquid hydrogen, and has a greater energy density than H₂. It is, after all, the preferred way to transport hydrogen for any purpose.

As yet the production of green ammonia (produced using electricity from renewables) still needs to be scaled up considerably to make a serious dent in the carbon output of shipping, hence our fictitious protesters being prepared to patiently wait for the conversion of all ships to become technically feasible. But when should we start pushing for change?



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