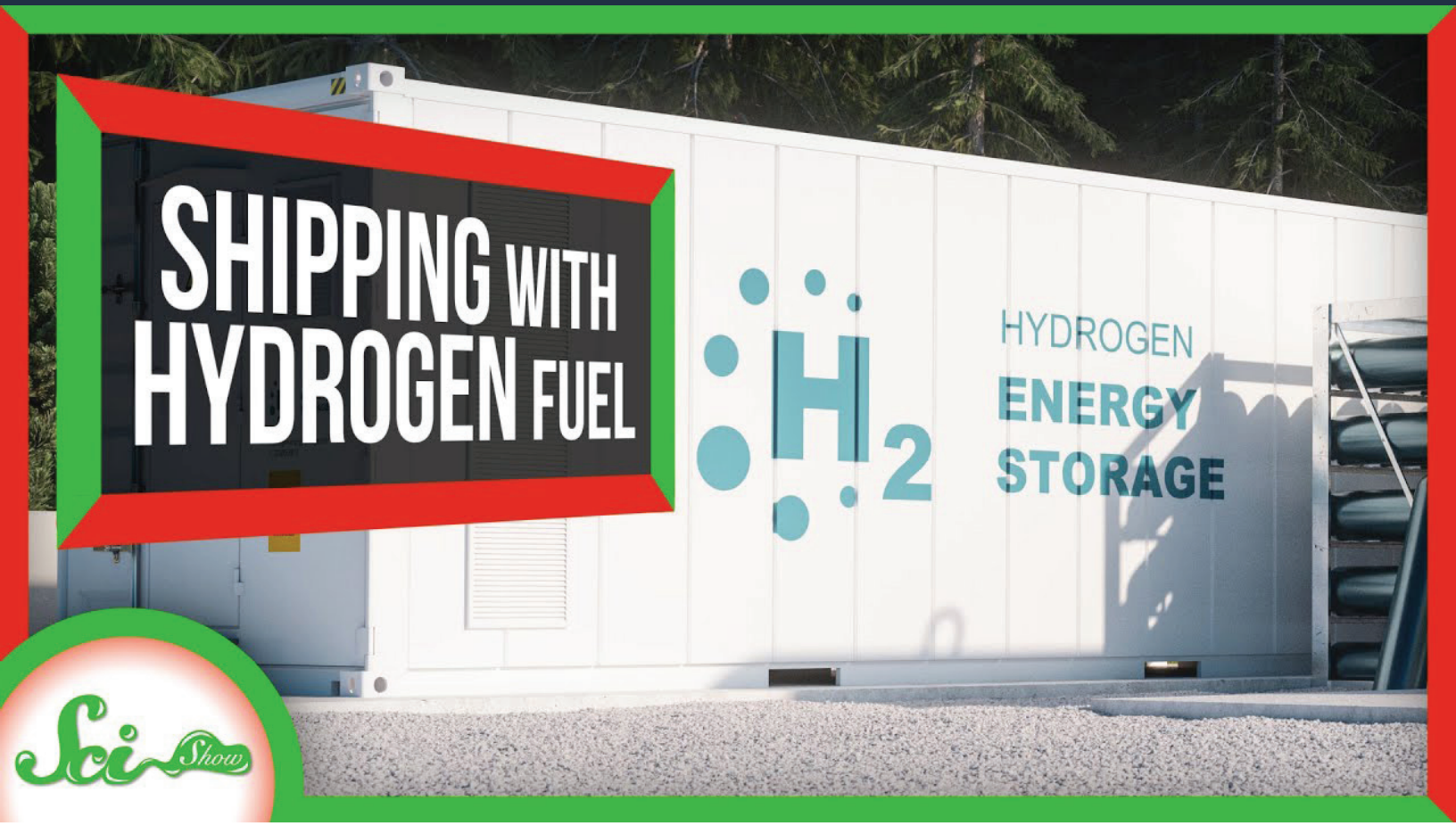

Hydrogen: The Savior of the Shipping Industry

Overseas shipping accounts for at least 3% of all global carbon emissions and emits dangerous sulfur- and nitrogen-containing compounds. This video investigates the promising green alternative energy sources the shipping industry may be ready for.

0:03

Video clips of a container ship and waves.

The economy as we know it relies on huge container ships to transport goods across the ocean. Over 9 billion metric tons of goods cross the seas every year.

In some ways, that is amazing. It means we get to enjoy stuff from all over the world.

But that kind of global trade also has prices. For one those ships rely on fossil fuels, creating a huge climate change impact. The good news is, some industry members and green energy advocates think this sector is ripe for change; a change powered by, of all things, water. And it's all thanks to the science of hydrogen fuel cells.

0:42

Images of heavy fuel oil and a container ship.

Now overseas shipping accounts for at least 3% of all global CO2 emissions. In 2012, the industry put out over 960 million metric tons of carbon dioxide.

And it'd be one thing if all they were pumping into the atmosphere was climate-altering carbon. But many of these ships run on heavy, sludgy, petroleum-based fuels like heavy fuel oil. Burning that stuff spits out sulfur- and nitrogen-containing compounds that can contribute to smog, acidify the oceans, and cause respiratory issues in humans.

But we don't have to do things this way. Because from a social and political standpoint, many experts think the shipping industry is finally ready for greener alternative fuels.

In fact, Maersk, the biggest container shipping company in the world, has promised to go to zero emissions by the year 2050. And that sounds impossible, but one way they might make it happen is through the use of hydrogen fuel cells.

1:37

Animation of production of hydrogen fuel cells.

When you combine hydrogen and oxygen, you get a nice little chemical reaction that produces heat and plain, good old-fashioned water.

And while we can and do use heat to generate power, there's a way to trick this reaction into doing work for us more directly. What you have to do is split the reaction in half. To do this, you need a setup called an electrochemical cell: two electrodes, some sort of catalyst to help the reaction along, and an electrolyte that allows hydrogen ions to flow freely.

At one electrode, a molecule of hydrogen splits to produce two positively charged hydrogen ions, also known as protons, along with two electrons. At the other end, the electrons and the hydrogen ions recombine with oxygen to produce water. But because the steps are separated in space, the electrons have to travel through a wire to reach their destination. And that creates an electrical current, which you can use to power whatever you'd like. It's nice and neat!

2:34

Animation of a container ship.

Chemistry textbooks will typically portray just one of these cells, with an electrolyte dissolved in water. But in practice, you can build as many cells as you like, and link them all up.

Rather than a bucket of water, the electrolyte can also take the form of a membrane that lets hydrogen through. That kind of fuel cell is called a proton exchange membrane fuel cell. Fancy dancy! Those cells can be easily combined into large stacks, so you can theoretically build a fuel cell big enough to do just about anything.

Like, for example, you guessed it, power a giant container ship. A 2017 report published by Sandia National Laboratories, a private research lab working with the US Department of Energy, looked at how existing commercial shipping vessels could be retrofitted with fuel cells.

They weren't interested in building a whole new fleet of futuristic ships. Instead, they asked whether ships already in service could have their combustion engines converted to green energy using technology that already exists. After all, ships are built to last a long time, and this way, we wouldn't have to take existing ones out of the seas.

3:39

Animation of options to renovate container ships.

The team looked at three options: using batteries, like in an electric car, or using two different versions of a fuel cell. One would use hydrogen in its gaseous form; the other, liquid.

Their calculations suggested that liquid hydrogen was the most practical, in part because it would take up the least space. See, the ships would need to carry their hydrogen with them in big tanks. That's not actually different from petroleum fuel, but the hydrogen is less dense, and would require more space.

But the researchers argued that because the fuel cells themselves are smaller, and because they're also more efficient than internal combustion engines, they should fit easily enough, and even make more room for cargo.

That was not the case with batteries, which would likely be too big to be practical on big ships, and even with gaseous hydrogen, which would demand a lot more space.

4:28

Diagram of methane.

Overall, they came to the conclusion that it should be easy enough to retrofit existing ships with fuel cells, as long as their ports of call had access to a source of hydrogen.

But that brings us to one significant caveat. In the report, the researchers talked about how hydrogen can be produced from water. However, right now, at industrial scales, hydrogen is usually derived from methane, a fossil fuel. And the carbon in that methane gets converted to CO2 as part of the process. You get one molecule of CO2 for every four molecules of hydrogen you produce, so making hydrogen and using it to power fuel cells still leads to some CO2 emission.

It does get around the problem of all that sulfur from the heavy fuel oil, though. And as hydrogen production gets greener, so do fuel cells. If we can figure out how to produce hydrogen from water at industrial scales, so much the better.

5:21

Animations of transportation.

Also, as a nice bonus, other parts of the transportation sector are considering fuel cells, as well. So these developments wouldn't just help the shipping industry.

In particular, because these cells are lighter than batteries, some startups have looked into using them to power small aircraft. And there's a lively debate surrounding batteries versus fuel cells for use in ground shipping, too; there are pros and cons to each.

It's a nice debate to have, since either way represents an attempt to help the planet. But because of how fuel cells scale and the fact that companies are actually considering them for the near future, the shipping industry seems poised to embrace hydrogen.

Which is great, because that 3% of that carbon dioxide emissions is not nothing. To use a common comparison, if the shipping industry were a country, it would be the sixth biggest contributor to climate change.

Which means it's an important sector to focus on if we're gonna curb our emissions. And the sooner we can do that, the better

6:14 This episode of SciShow was supported by Bill Gates, who, through Breakthrough Energy, is working with some of the world's top tech and business leaders to advance clean, reliable, and affordable energy and to scale the technologies we need to help the world reach a net-zero emissions future.