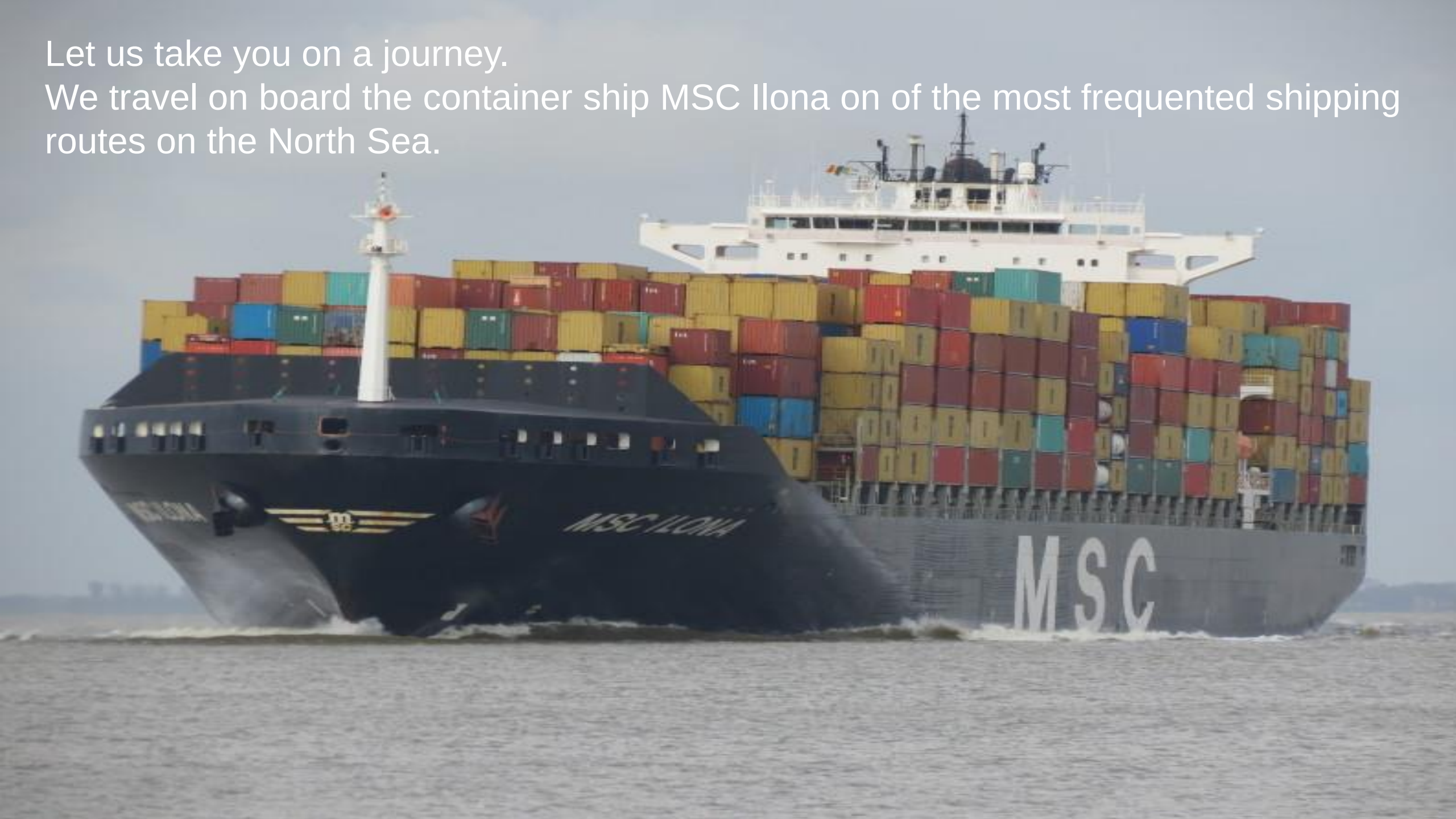
Let us take you on a journey.
We travel on board the container ship MSC Ilona on of the most frequented shipping routes on the North Sea.

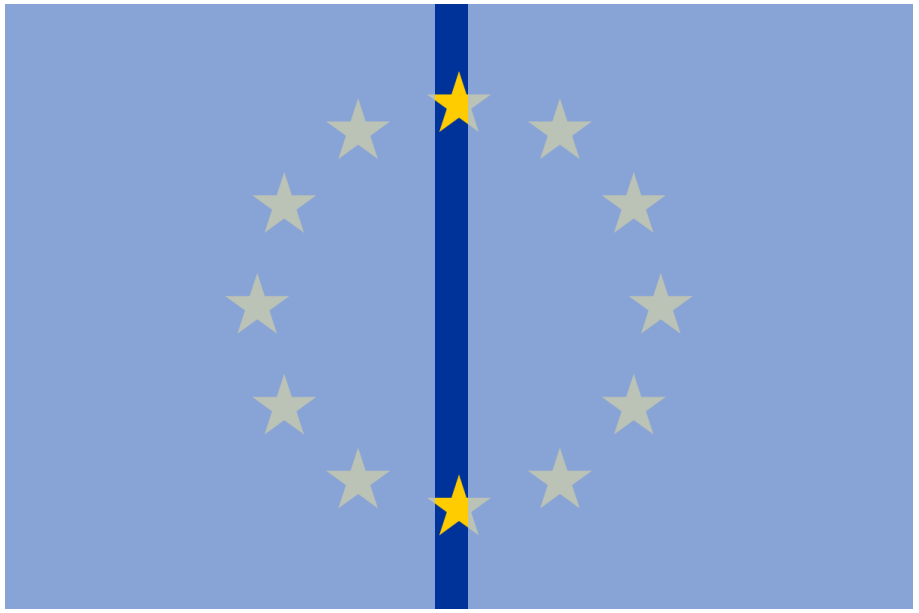


The voyage takes us from the port of Rotterdam to Hamburg, where we stop shortly to exchange part of the cargo. After another day travelling, we reach Goteborg in Sweden.

During the journey, the MSC Ilona is burning diesel fuel, emitting **nearly 500 tonnes of carbon dioxide**.

Every day, thousands of container ships like the MSC Ilona travel the North and the Baltic sea.

In fact, **90% of the goods** you use every day have been transported in a container at some point.



As a result, shipping causes **3% of total emissions** in Europe.

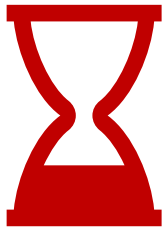
This is a massive problem, of which governments and companies are becoming increasingly aware.

For example, **Maersk**, the world's biggest shipping company, plans to start operating **zero-carbon vessels** by 2030.

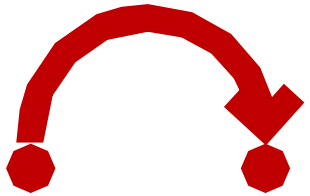
In a recent report, experts from the Sustainability in Business Lab here at ETH Zurich showed that **hydrogen** is one of the most promising solutions. Why?

1. Compressed hydrogen contains **five times** as much energy per unit volume as conventional Lithium-ion batteries.
2. Widespread adoption of hydrogen for powering trucks is driving **prices** down rapidly.
3. Hydrogen can be produced by splitting water with renewable electricity, which makes it a **zero-carbon fuel**.

However, there are still **three obstacles** why shipping companies do not yet adopt hydrogen to power freight ships such as the MSC Ilona:



Refuelling of compressed hydrogen takes several hours and requires expensive new infrastructure.



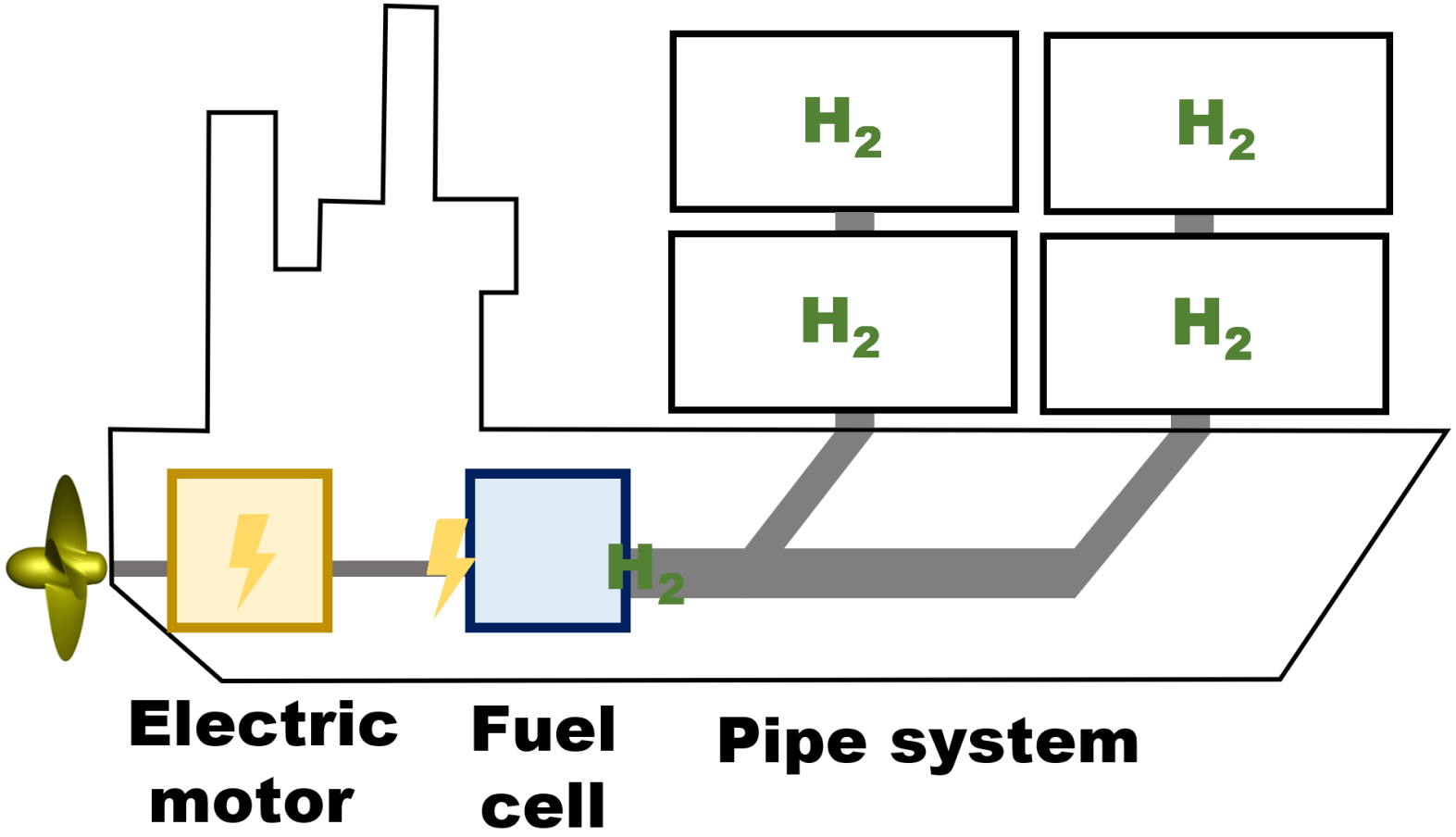
Shipping companies are concerned about lower **range**.

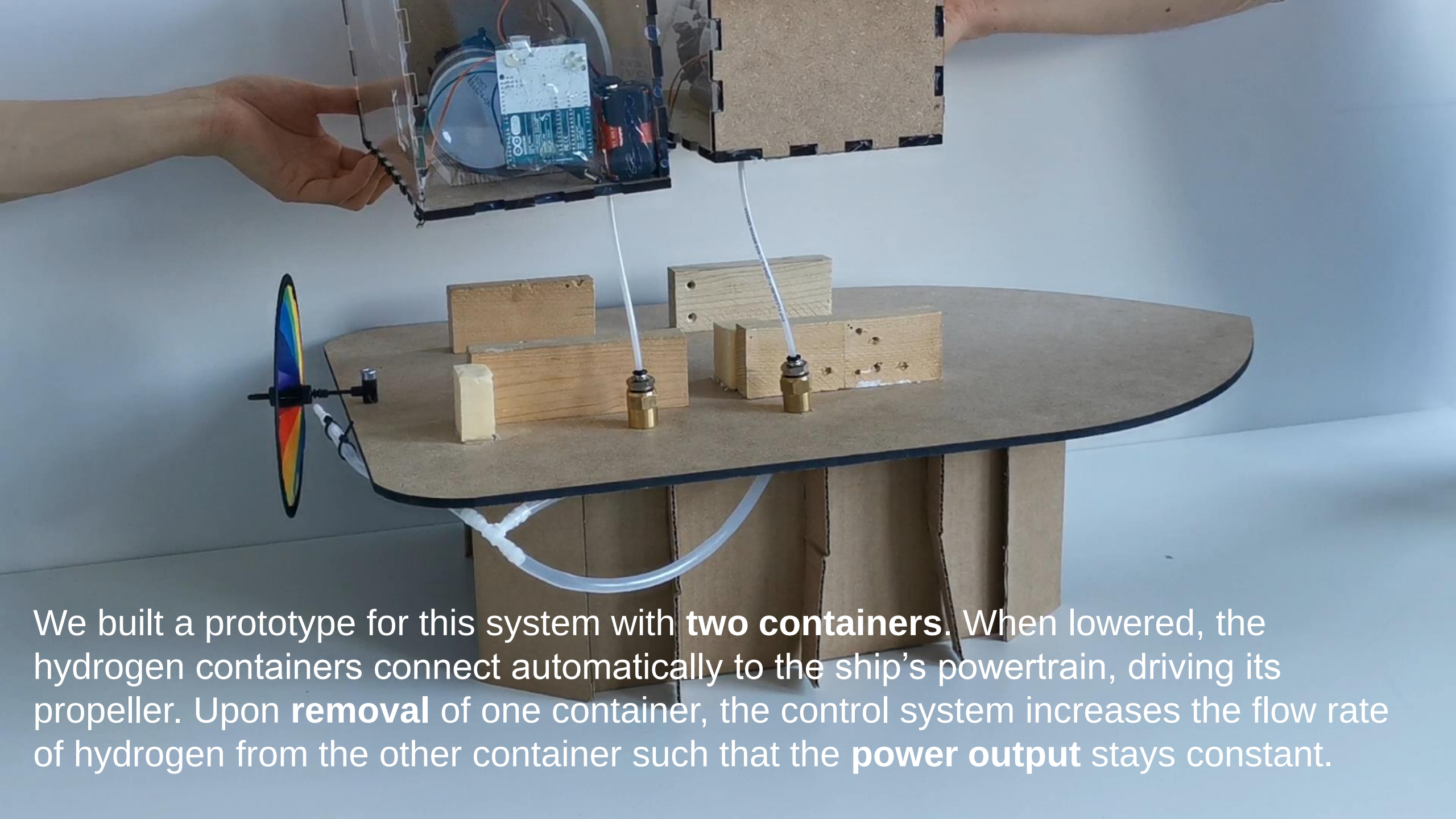
Even though prices are falling, existing hydrogen propulsion technology remains **more expensive** than using a diesel engine.

To overcome these obstacles, we developed the Züroship:
a containerized hydrogen tank system.

Züroship

The hydrogen is stored at a pressure of 700 bars in a **standard 40 foot container**. These containers connect **automatically** to each other. The integrated control system ensures that the **optimum volume flow rate** of hydrogen is supplied to the ship's hydrogen **fuel cell**. The fuel cell converts the hydrogen to electricity which drives the **electric motors** that move the ship.





We built a prototype for this system with **two containers**. When lowered, the hydrogen containers connect automatically to the ship’s powertrain, driving its propeller. Upon **removal** of one container, the control system increases the flow rate of hydrogen from the other container such that the **power output** stays constant.

Let’s go back to the MSC Ilona. It’s now 2025 and she has the Züroship system installed.

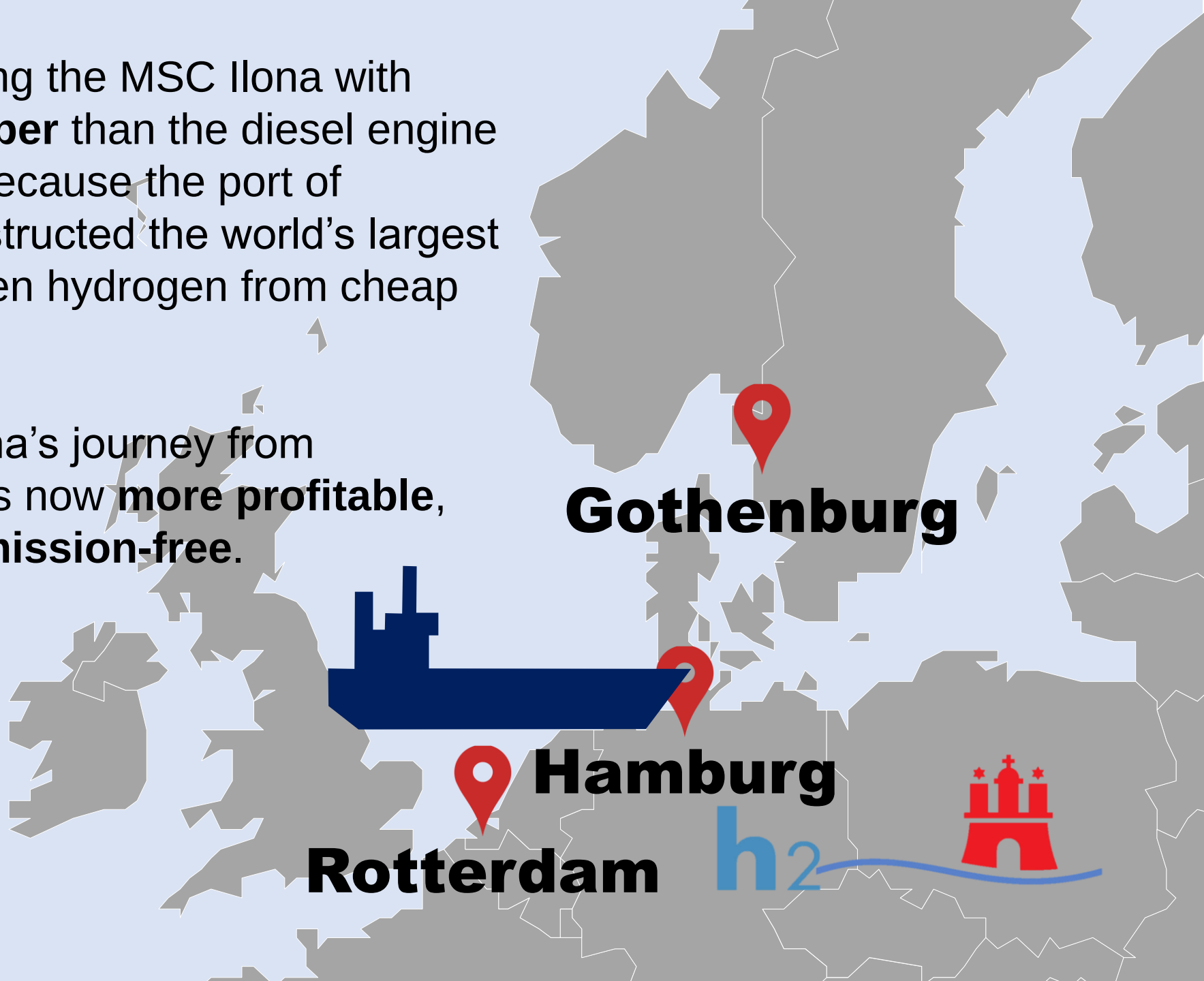
On her journey from Rotterdam to Hamburg, she uses **12 containers** of hydrogen, which take up **0.5%** of the total freight volume.

In Hamburg, using the existing **crane infrastructure**, it only takes **30 min** to swap the empty hydrogen containers for full ones.

Because of the exceptionally short refuelling time, the ship’s schedule is not disrupted, which solves the issue of **range**.

And even better, operating the MSC Ilona with hydrogen power is **cheaper** than the diesel engine it used in 2019. This is because the port of Hamburg has since constructed the world's largest facility for producing green hydrogen from cheap offshore wind power.

As a result, the MSC Ilona's journey from Rotterdam to Goteborg is now **more profitable**, and most importantly, **emission-free**.



Adopting the Züroship technology for freight shipping in the North and Baltic Sea will reduce emissions by **40 mio. tonnes** – that's as much as Switzerland produces in one year.

Züroship