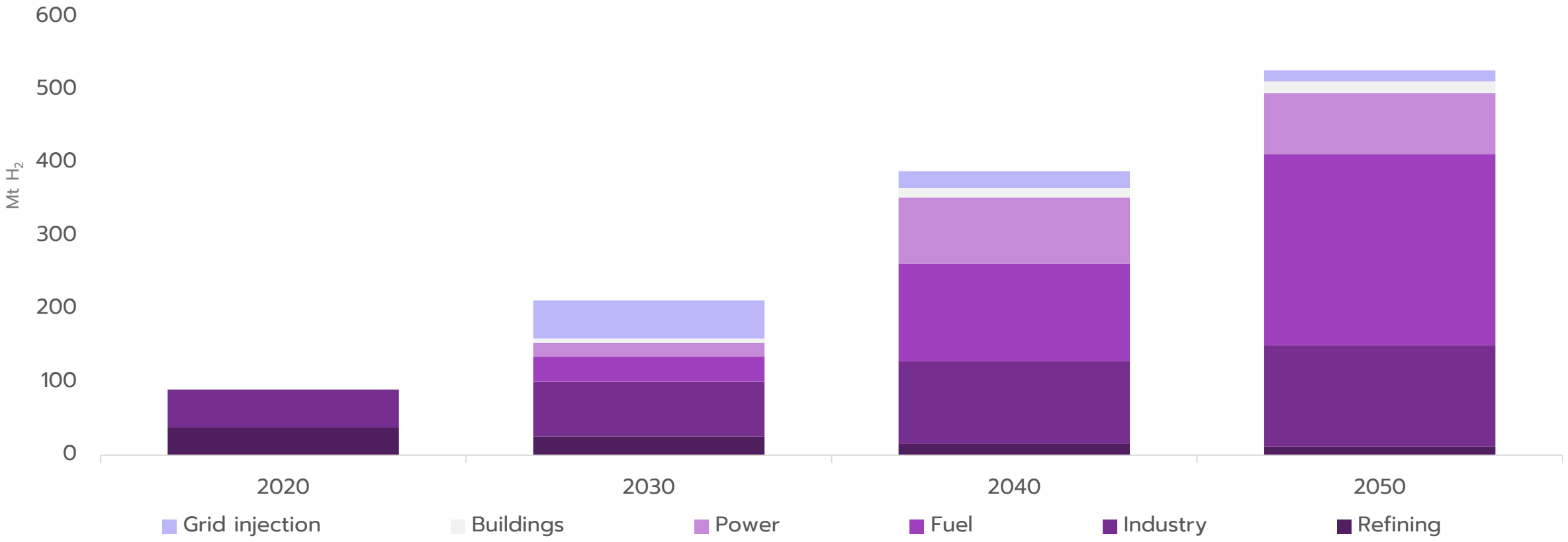
Next generation liquid hydrogen storage and transportation

Leiv Låte, CEO

Global demand for hydrogen will see significant growth towards 2050 to reach net zero

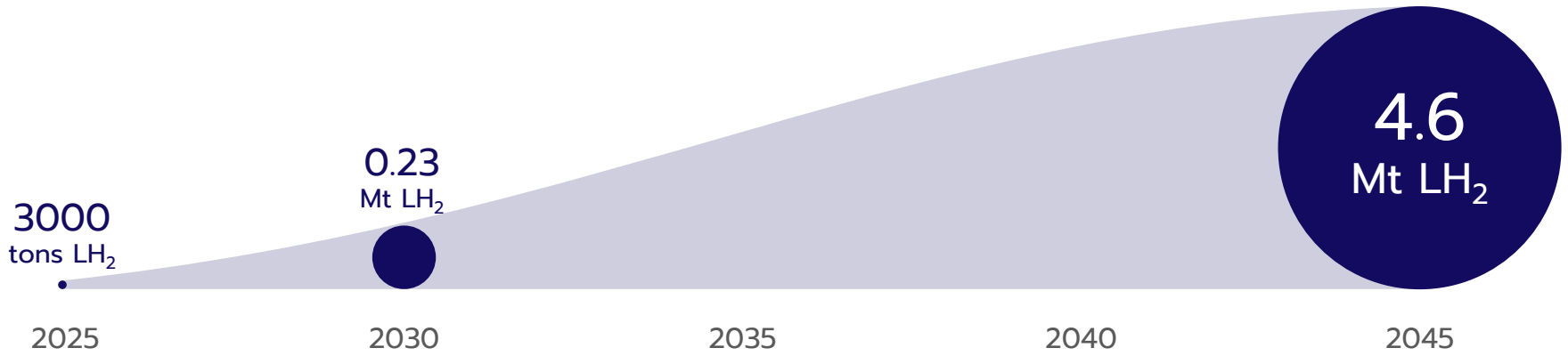
Hydrogen demand by sector needed to achieve Net Zero Emissions by 2050*



* IEA Global Hydrogen Review 2021. Note: "Fuel" in chart is the compound volume of "Transport", "NH3-fuels" and "Synfuels" from original report

Global liquid hydrogen (LH_2) market expected to grow rapidly in the coming years

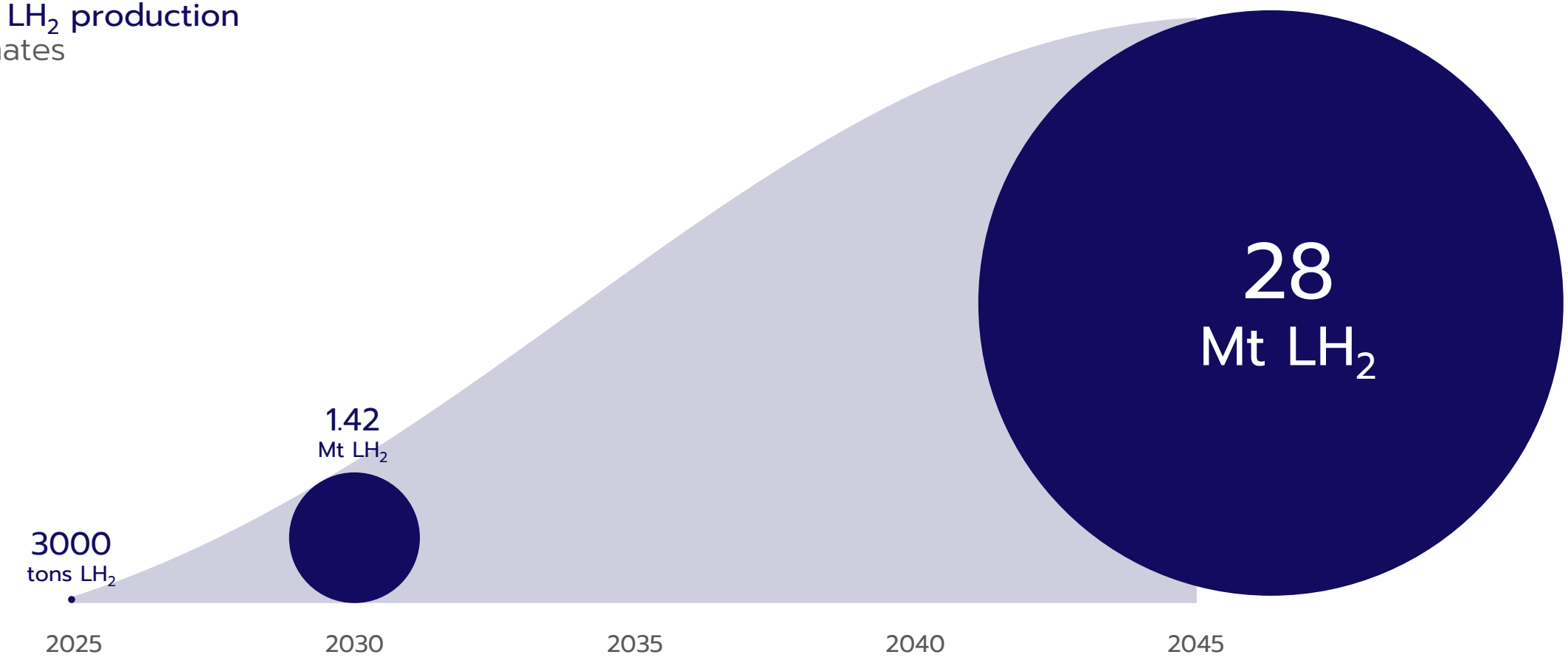
Expected LH_2 production
IRENA estimates



IRENA, Green Hydrogen Supply, 2021

New technologies can increase the addressable market substantially from IRENA estimates

Potential LH_2 production
ICT estimates



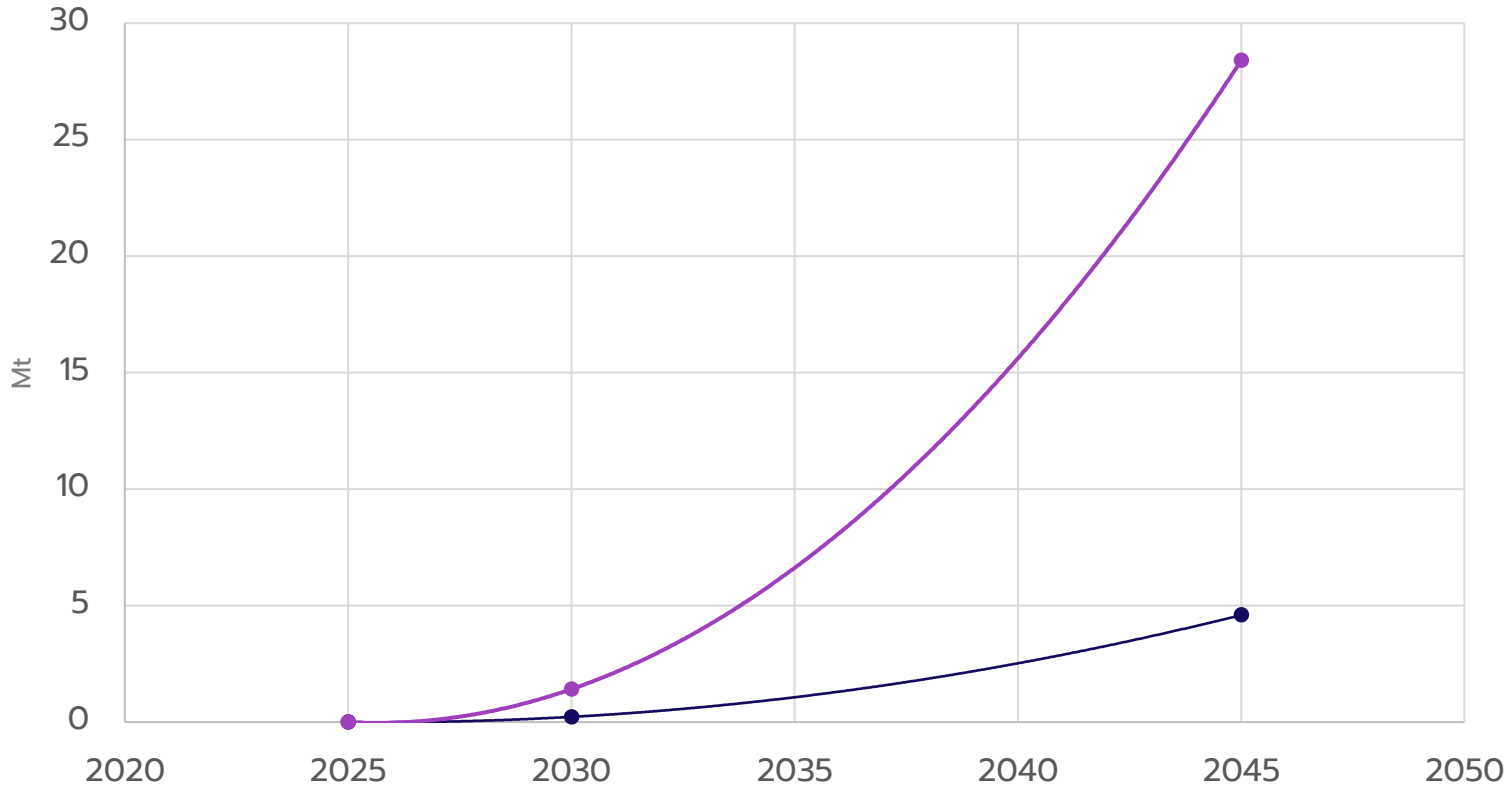
Company estimates

How fast can the liquid hydrogen (LH_2) market grow?

- In 2021, a total of 350 tons LH_2 is produced
- In 2020, shipping consumed a total of 412 Mt fuel, corresponding to 11 exajoules
- The expected maritime consumption, based on tenders and signed contracts, corresponds to a consumption of ~3,000 tons of LH_2 in 2025
- IRENA: 10% of the energy mix for ship fuels will be LH_2-based in 2050, corresponding to 4.6 Mt LH_2
- Company estimates: Based on the physical properties of LH_2 stores with ICT storage tanks, 62% of the fuel mix for ships will be the addressable market for LH_2, corresponding to 28.4 Mt

Expected LH_2 production

ICT and IRENA estimates



Liquid hydrogen has great benefits, but also challenges that need to be addressed

The key challenge is enabling long-term storage and transport of large quantities of hydrogen

Pros of LH_2

- ⊕ Zero emission, non-toxic energy carrier
- ⊕ High energy density (energy/kg)
- ⊕ Allows for high fueling/bunkering rate
- ⊕ Low pressure, giving lower risk of explosion and lighter storage and transportation tanks

Cons of LH_2

- ⊖ Low temperature
- ⊖ Prone to high boil-off/evaporation rates
- ⊖ Limited infrastructure in place – high capex
- ⊖ Energy demanding liquefaction process – high opex

ICT

ICT reduces constraints related to storage and transportation of liquid hydrogen

Creating the basis for both large- and small-scale storage and transportation infrastructure for LH_2

Near unlimited storage time with very low boil-off

Enabling large-scale, seaborne LH_2 transportation

Enabling lower weight of LH_2 tanks

No need for expansion volume (ullage) through use of the full geometrical tank volume

Flexible tank shape with prismatic design (free form) able to fit into any ship's hull

LH_2 may provide a large "seasonal battery", balancing variable renewable power production to customer needs

ICT

Low-pressure LH_2 tanks have clear benefits

Lower pressure (<0.5 barg vs 6 barg)
→ higher energy density, less strain on tank

Lower tank weight
→ High efficiency factor (kg LH_2/kg steel)

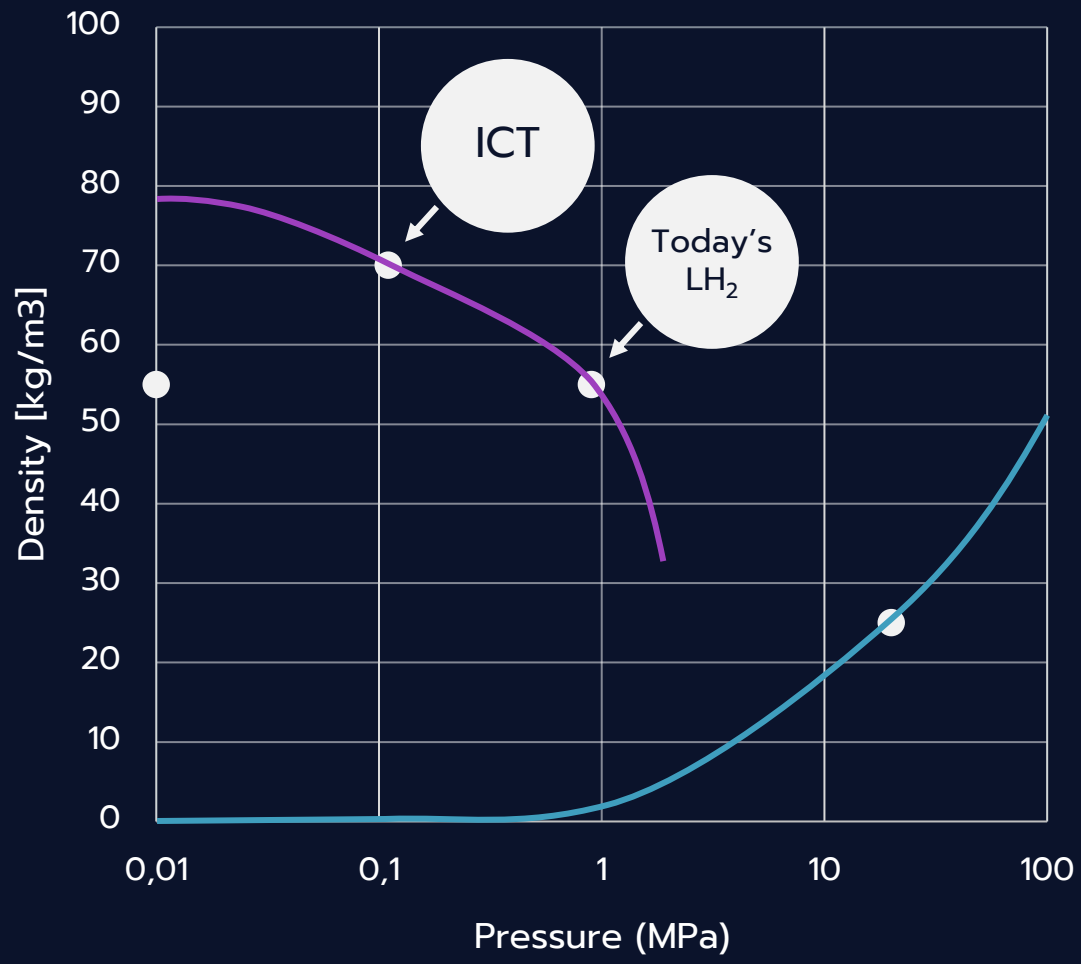
Customizable to any shape
→ Adaptable to any ship's hull (prismatic design)

Active cooling if required
→ Ultra low boil-off
→ Minimal ullage/expansion volume

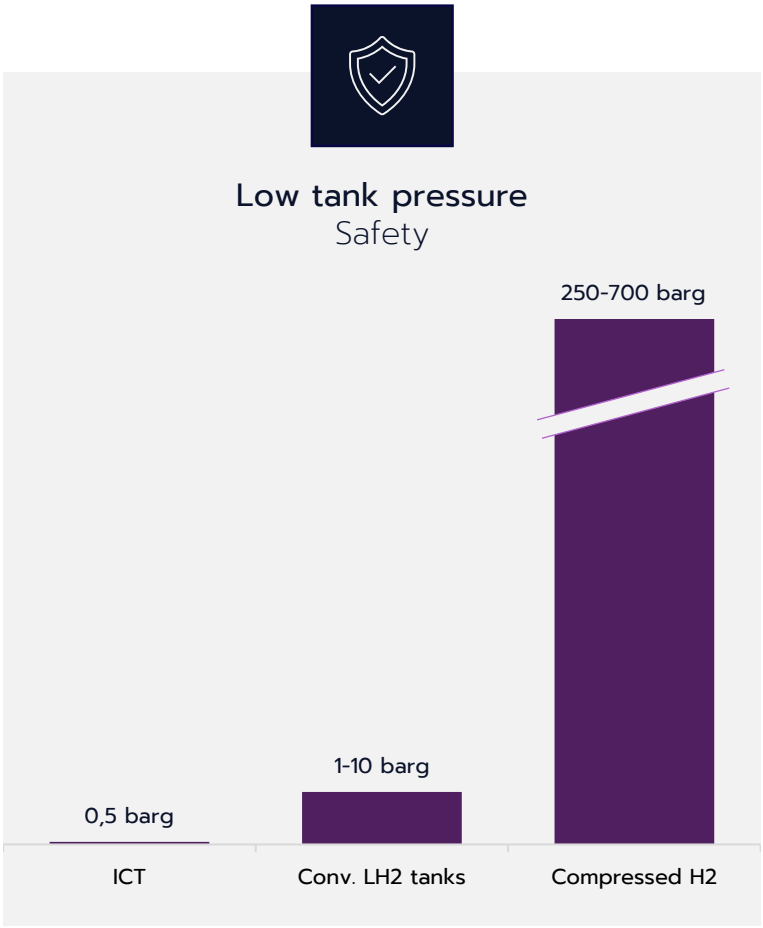
Energy efficient insulation
→ Low heat flux into the tank

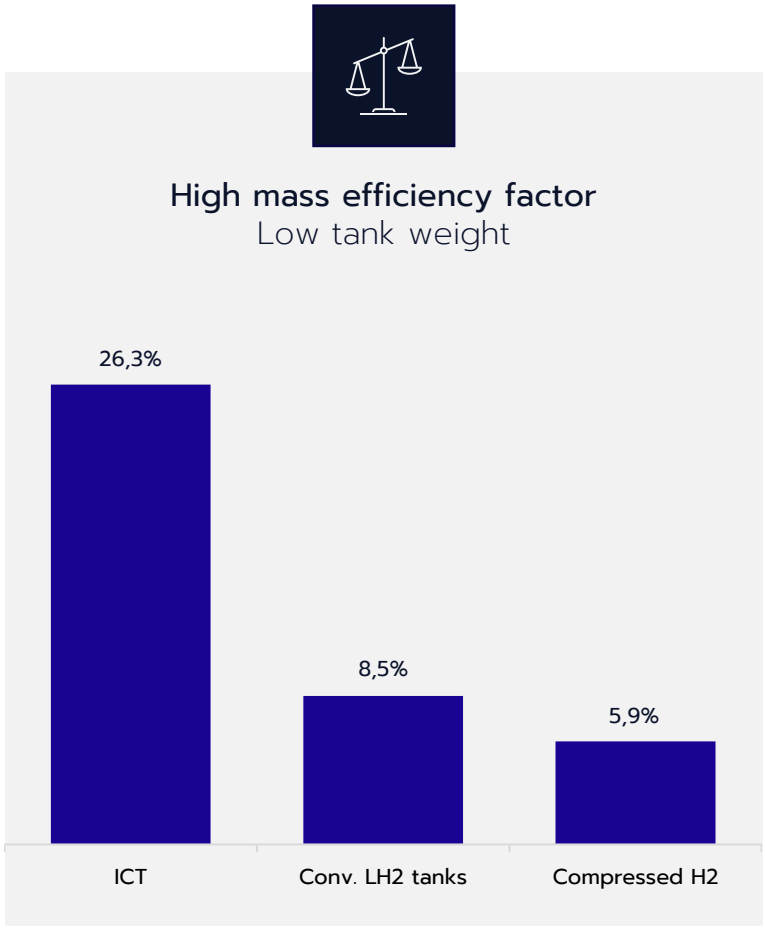
Increased safety
→ Near atmospheric pressure and double barrier due to membrane

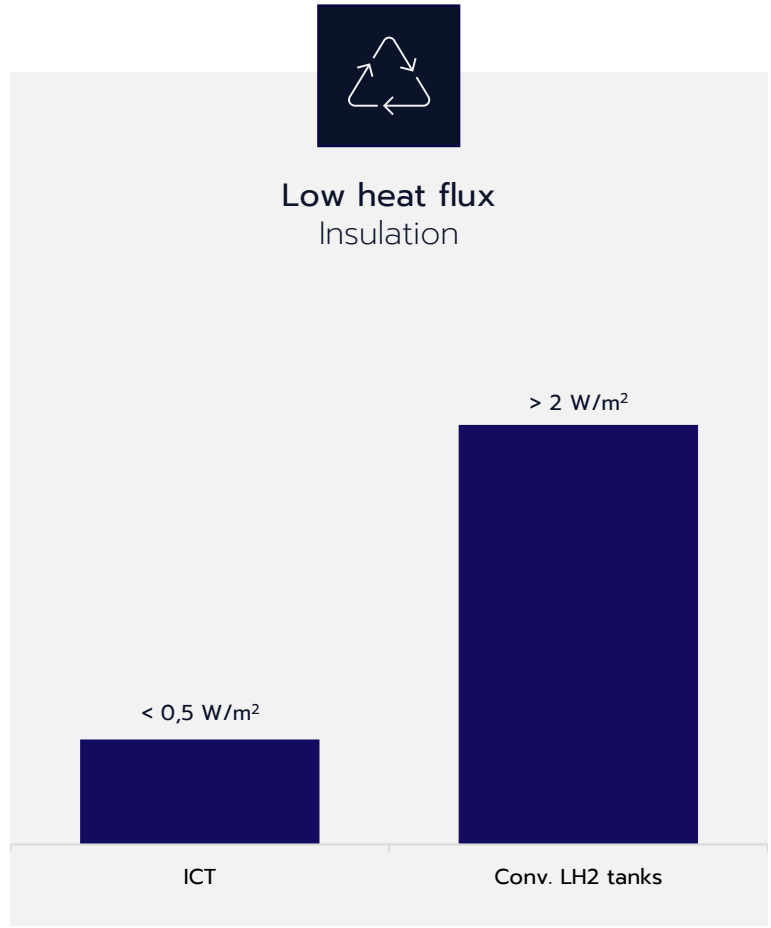
Thermodynamics explains why LH_2 will be the preferred energy carrier



ICT's technologies have clear benefits compared to existing solutions*

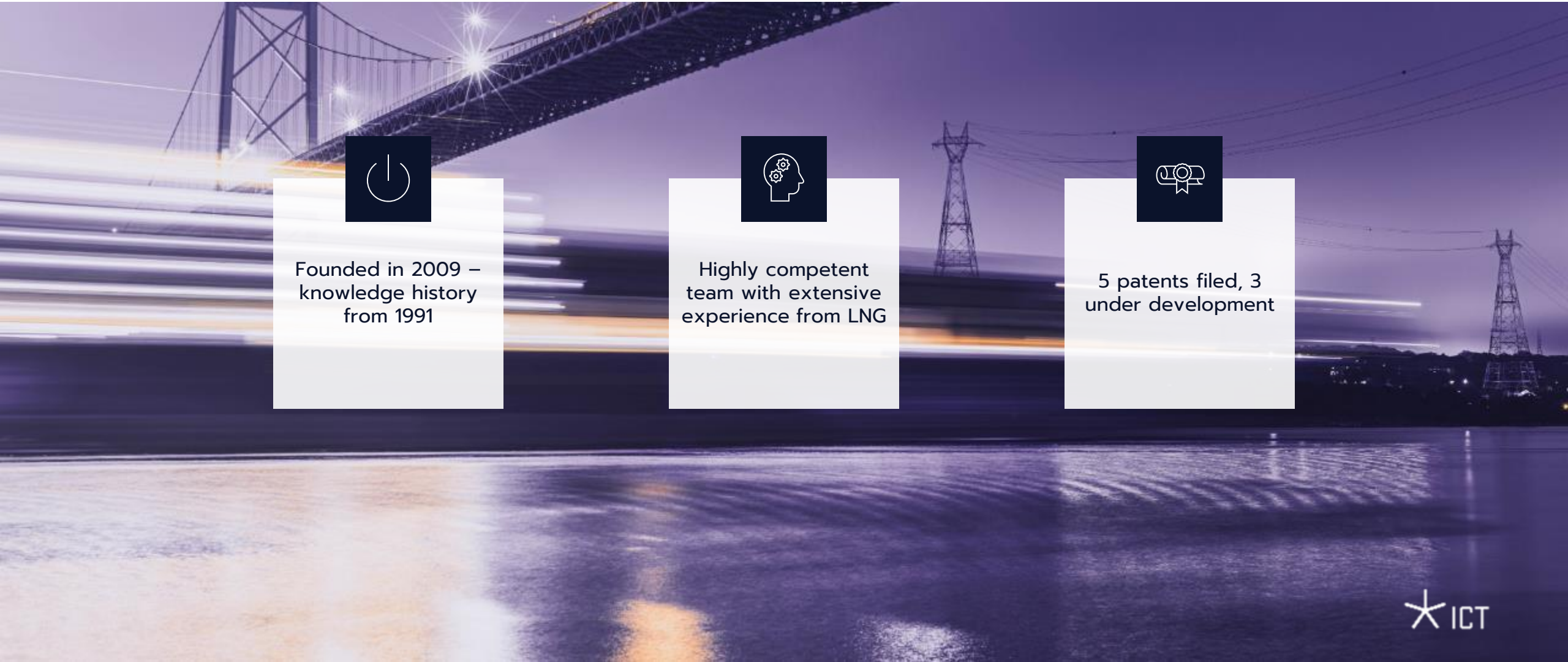






* Conventional LH2 storage tanks, referred to as "dewar", is a double-walled flask of metal or silvered glass with a vacuum between the walls, used to hold liquids at well below ambient temperature.

Norwegian technology company developing LH_2 applications, built on leading LNG competence



Founded in 2009 – knowledge history from 1991

Highly competent team with extensive experience from LNG

5 patents filed, 3 under development

ICT improves the competitiveness of liquid hydrogen through two primary technologies

Membrane technology

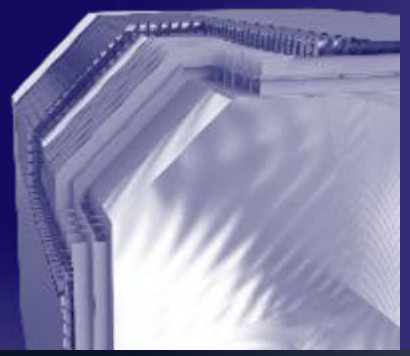
Fuel tank and portable storage technology

ICT

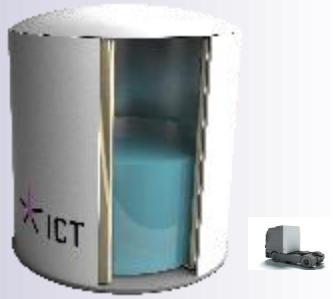
ICT's technology is suitable for a wide range of applications, from small-scale to large-scale

Membrane technology

400.000 m^3



Membrane tank for medium to very large carriers and land tanks



ICT – Deep sea and seasonal storage

Fuel tank and portable storage technology

2.000 m^3

0,5 m^3

Fuel tank and small to medium scale portable storage technology

ICT – Short sea and distribution

ICT

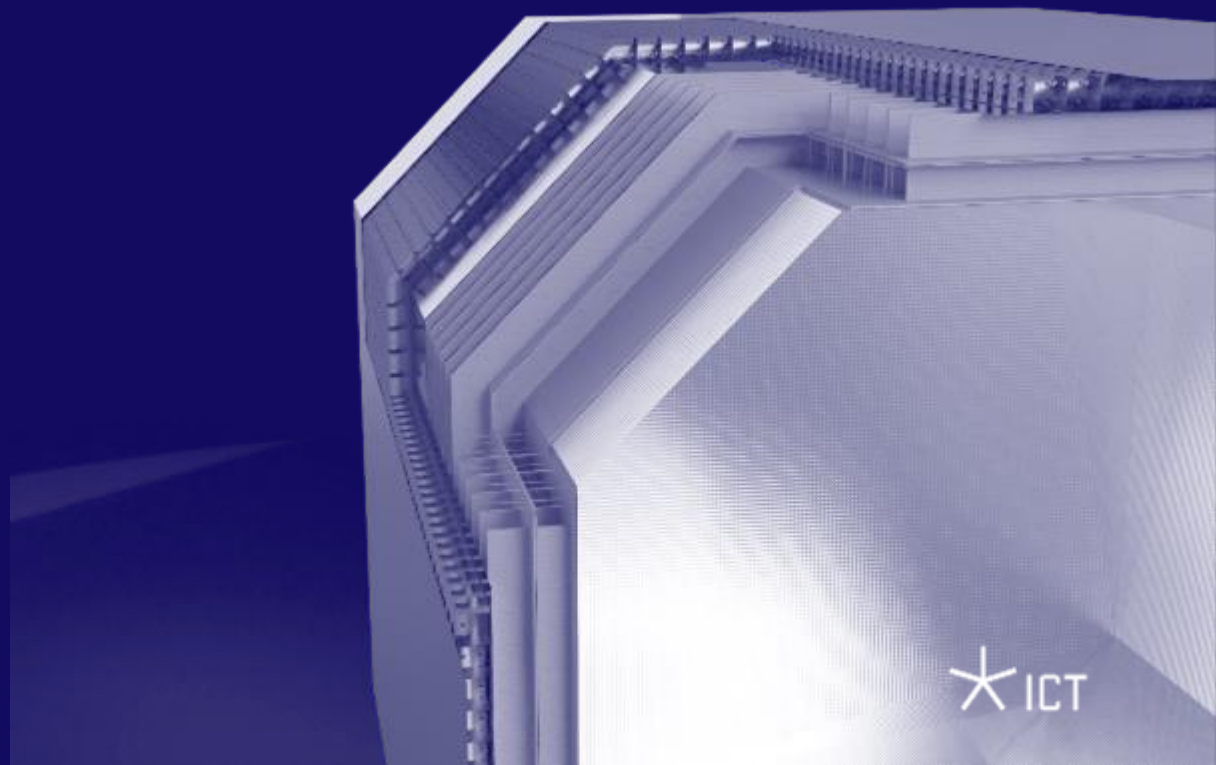
ICT's membrane technology represents the future of large-scale storage and transportation of hydrogen

Two separate vacuum insulation compartments	Twin primary membrane with leak detection	Modular design and construction	Solid and robust vs. sloshing* or earthquake loads

Use
Membrane tank for large to very large carriers and land tanks

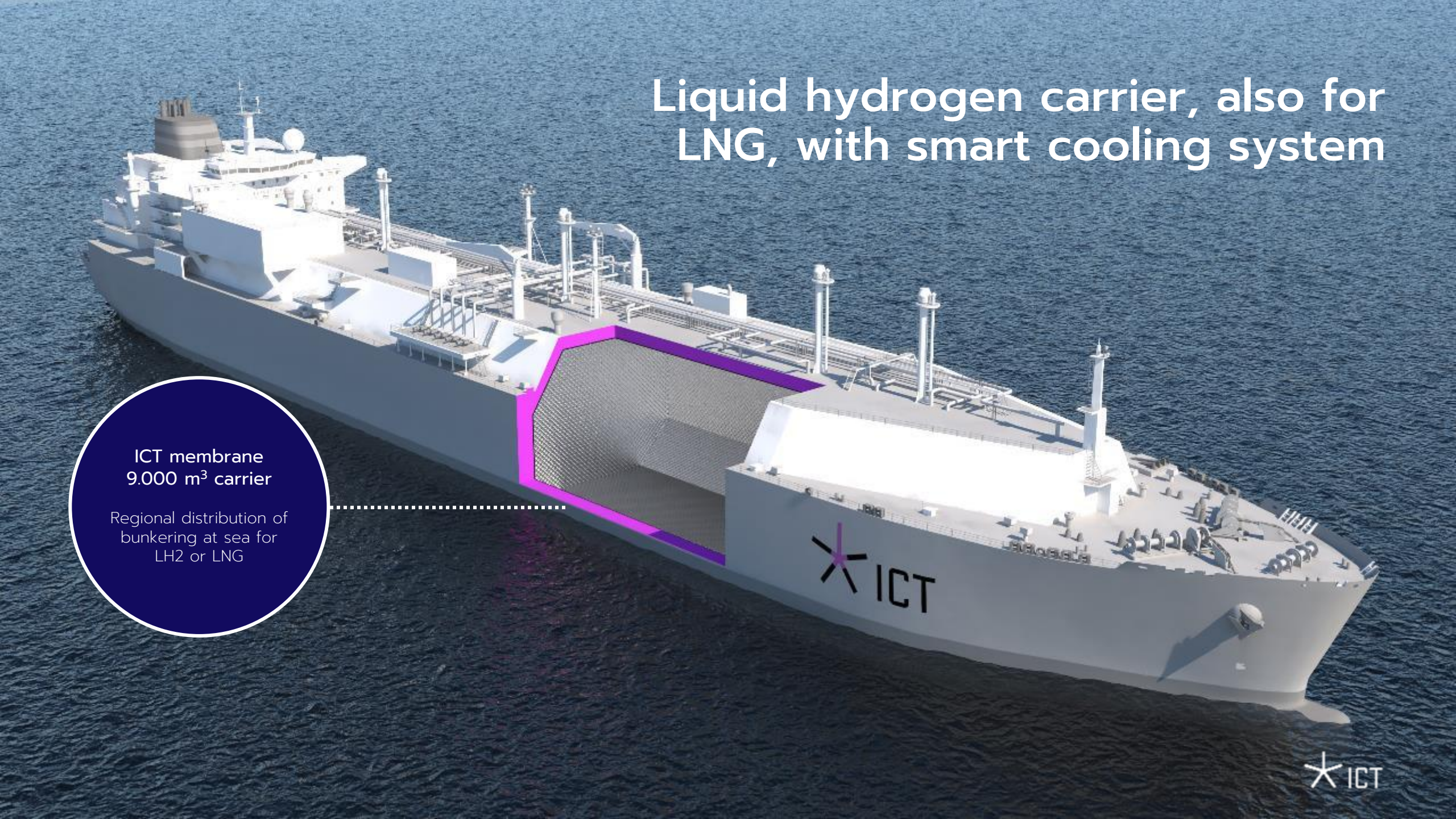
Tank size
1.000 – 400.000 m^3

Status
- ✓ Patent approved in EU, US, China & Japan
- ✓ Approval In Principle
- ✓ Designed for liquid hydrogen – excellent for LNG and NH3
- ✓ Digital twin on pilot tank



* Sloshing: Liquid waves inside partly filled tanks

Liquid hydrogen carrier, also for LNG, with smart cooling system



ICT's fuel and distribution tank combines low weight with flexible, prismatic design and optional cooling system

Light weight | Integrated evaporator | Flexibility in shape | Portable

Use
Fuel and distribution tank for small to large marine vessels, trains, HDV and possibly aviation

Tank size
0,5 – 2.000 m^3

Status
✓ Pilot tank construction ongoing

ICT enables low weight fuel tanks for LH_2 where weight saving is essential

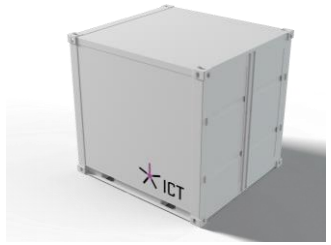
Large potential within several market segments, covering small to large scale applications

Suitable for carriers, fuel tanks, distribution and energy segments

Small-scale LH2 fuel tank < 1000 m3

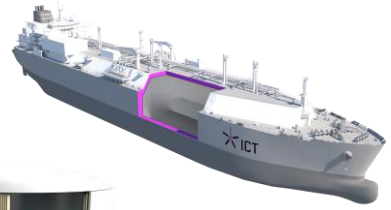
HDV, buses, trains and aviation

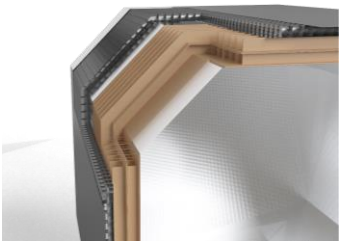
Fast ferries and car ferries



Medium-scale LH2 logistics
< 6.000 m^3

Large-scale LH2 logistics
> 6.000 m^3





ICT aims to bring new opportunities to the cryogenic liquid storage and transportation sectors

Full speed ahead toward making liquid hydrogen accessible

Timeline

Completed	Ongoing	Next steps
✓ Approval In Principle (AIP) for membrane tank	• Approval In Principle (AIP) for fuel and distribution tank • Pilot tank construction ongoing, scheduled to start testing in H1-22 • Evaporation system design on going, construction and testing in H2-22 • Customer dialogs world wide	• Proof of concept by representative pilot tank size in close cooperation with potential users, designer and yard, DNV and Maritime Authorization • Building organization • Fuel tank onboard installation • Large-scale applications (international)

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