AMBARTEC

HyCS-TECHNOLOGY

We are THE H_2 Storage and Transportation Company!

10.05.2023

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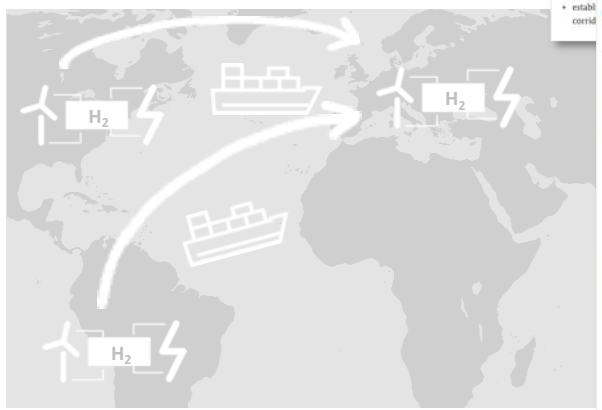
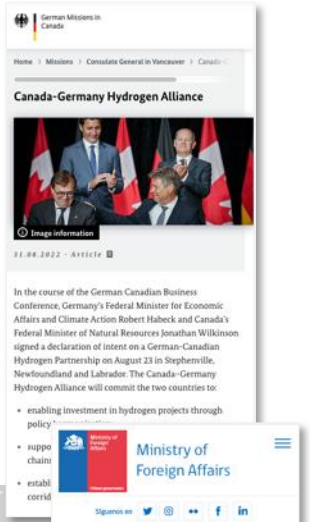
How Does Green H_2 Get to Europe?

Europe needs H_2 import

Europe strives for CO_2 neutrality. Only 1/3 of the Green H_2 required in the future can be produced inside the EU.




German Missions in Canada

Canada-Germany Hydrogen Alliance

Image information

In the course of the German Canadian Business Conference, Germany's Federal Minister for Economic Affairs and Climate Action Robert Habeck and Canada's Federal Minister of Natural Resources Jonathan Wilkinson signed a declaration of intent on a German-Canadian Hydrogen Partnership on August 23 in Stephenville, Newfoundland and Labrador. The Canada–Germany Hydrogen Alliance will commit the two countries to:

- enabling investment in hydrogen projects through policy
- suppo chain
- establ corrid


Ministry of Foreign Affairs

Síguenos en

Chile signs agreement with Germany's largest port for green hydrogen exports

The Port of Hamburg will be the gateway for Chilean-produced hydrogen to German markets. This event marks a new milestone on the road to making Chile the most competitive renewable energy exporter in the world by 2030.

Wednesday, August 24th 2022

The Minister of Energy, Claudio Huepe, the Ministry of Economy and Innovation of the City-State of Hamburg, represented by its Mayor and Governor, and the Port Authority of the same German city, signed a Memorandum of Understanding (MoU) to join forces and make green hydrogen flows between Chile and Europe a reality.

Today's solutions are not satisfying

Liquid H_2 (LH_2)

- Low efficiency (cooling to -253°C, boil-off-losses)
- High investment costs for new infrastructure

Ammonia

- Low efficiency
- Difficult to get pure H_2 again
- Difficult to handle, poisonous

LOHC

- High energy demand for offloading/H_2-separation
- Environmentally hazardous

Our vision

We make **H_2-transport simple, cost-effective and safe** by using existing container transport infrastructure.

We **reduce** the consumption of clean **water for electrolysis** in sunny arid countries **by 90 %.**

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Regional H_2-Transport

Costs reduction by factor >2

Additional Advantages AMBARtec

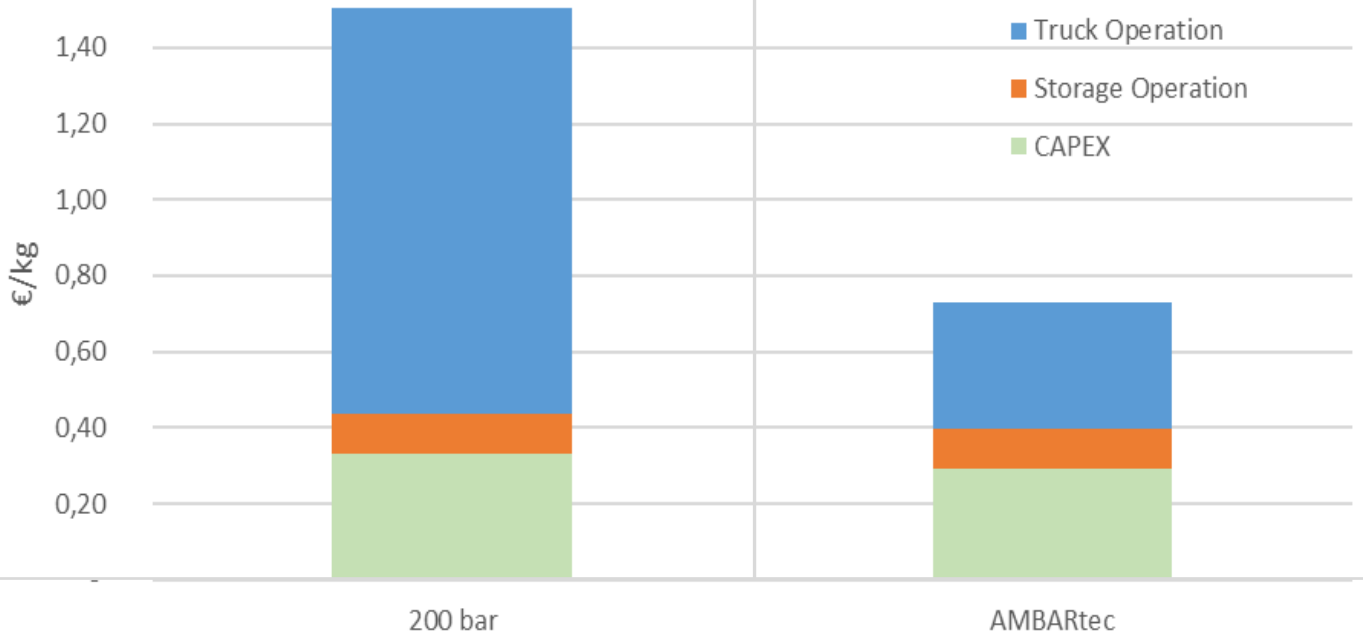
- Lower CAPEX at electrolizer
- Quick unloading: <15 Minutes/20 MWh
- No self unloading (boil-off losses)
- High safety
- Sustainable, widely spread and low cost materials

H_2-Transport Costs (€/kg)

260 kg H_2/day, 100 km, 20 years

H_2-Transport today
200 bar/ 440 kg H_2/truck

H_2-Transport with AMBARtec
1 bar/ 1.200 kg H_2/truck



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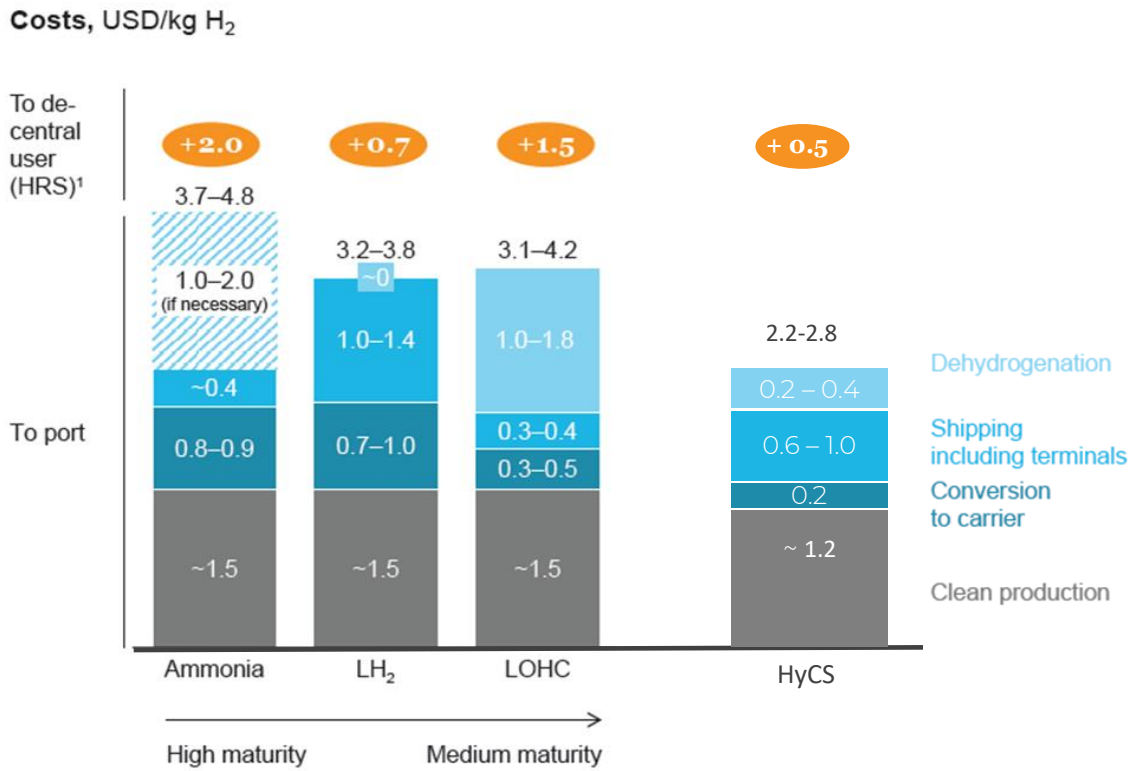
25% lower costs in transport

Landed costs at port of renewable H_2 shipped from Saudi Arabia to Europe

Shipping route from Saudia Arabia to Europe through Suez Canal, 8,700km

Costs for at scale production and shipping transportation in 2030



1. Assumes liquid (for LH_2) or gaseous (for ammonia, LOHC) distribution with truck for 300km, also includes: purification to FCEV standard using a PSA for LOHC and NH_3, boil-off losses for LH_2, storage costs at port and HRS operating costs

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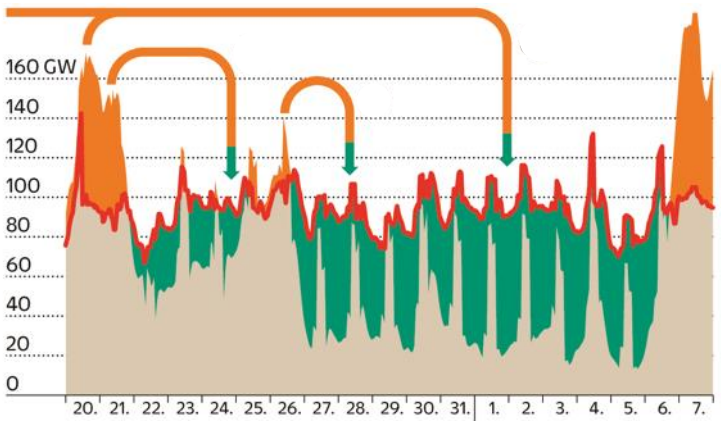
No Sun – No Wind.
Where Does the Energy Come From?

Renewables are not always available

How can we store power surpluses from wind and sun to compensate the dark lull?



Source: Energy Brainpool

Potential alternatives are not satisfying

Electric battery
- Low energy density
- material constraints (e.g. rare-earth elements)

Pressurized H_2
- Space consuming
- Hazardeous (permitting challenge)

H_2 caverns
- Only few available
- Require H_2 grid connection for users and producers

Our vision

- We make mid- to long-term **energy storage cost efficient and safe.**
- We support local energy storage by **transportable units.**

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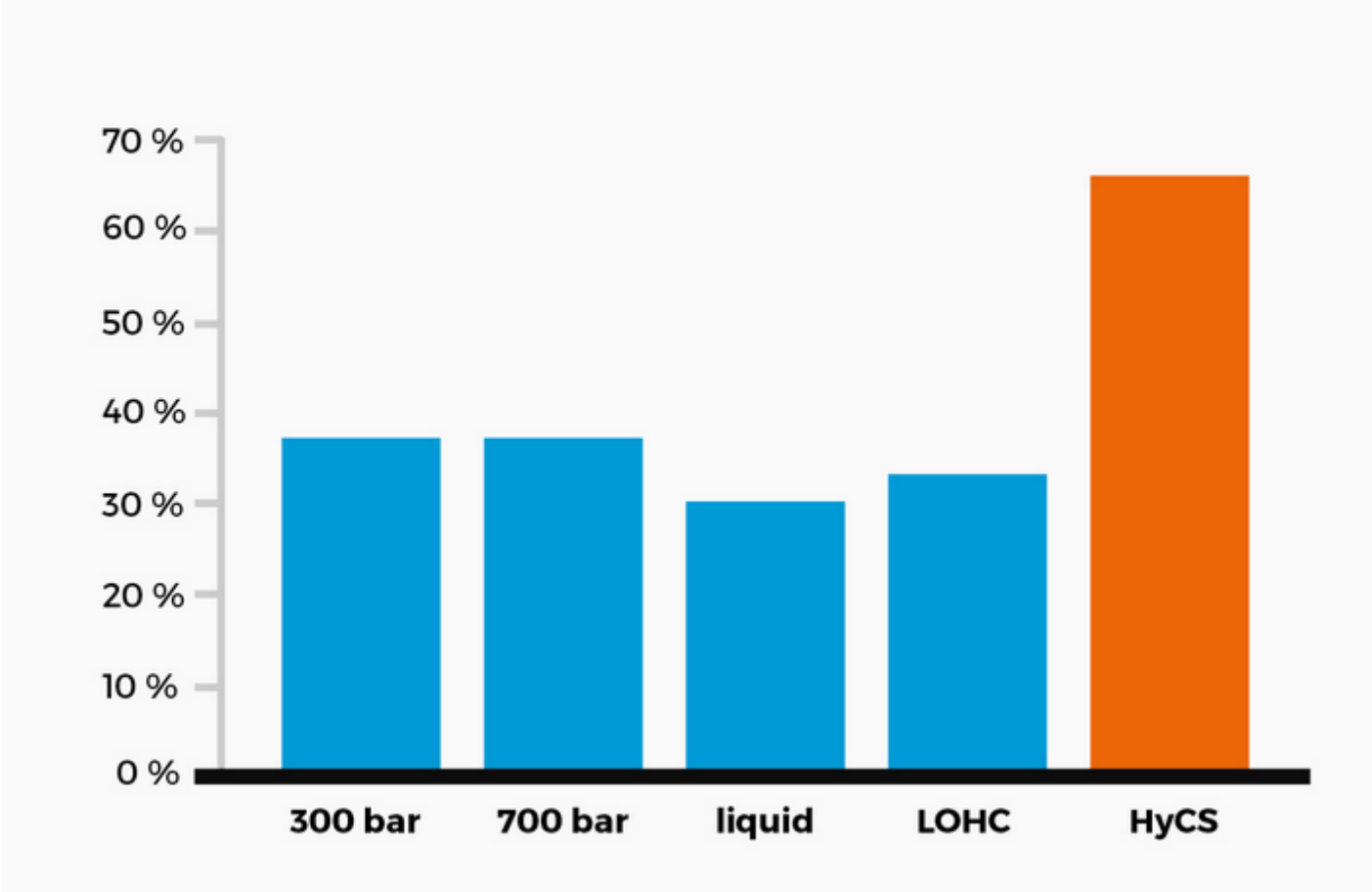
Power – Power Efficency of H_2-Systems

Elektrolizer –Storage – Re-Electrification

HyCS-Potential for the highest Power to Power efficiency

Precondition:
Lifting synergies of the whole process chain



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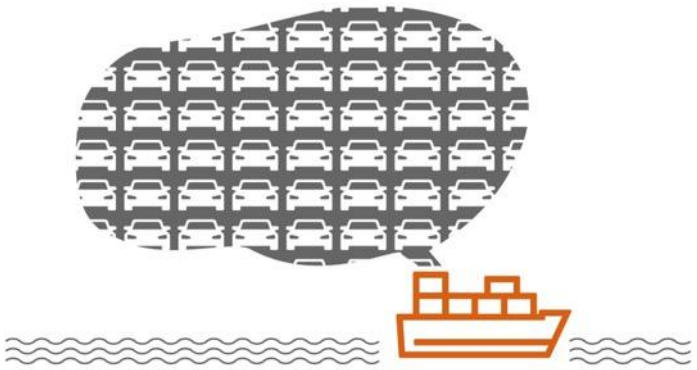
How to Get Ships CO_2-Neutral?

The maritime sector is one of the major CO_2-emitters

- Worldwide shipping causes as many CO_2 emissions as the whole of Germany.
- Heavy fuel oil: massive air pollution

An average **cruise ship** emits as much **CO_2** per day as almost **84,000 cars.**



Potential alternatives are not satisfying

Liquefied natural gas (LNG)

- Improves air quality, but low impact on climate gas reduction

Ammonia

- High energy demand for production
- Poisonous and difficult to handle

Green Methanol

- High energy demand for production
- Low energy density per kg

Pressurized H_2

- Space consuming
- Certification challenging

Our vision

- **Sustainable fuel solutions for ships** with AMBARtec's HyCS®-Technology together with maritime partner Liberty Pier.
- We make **maritime green energy** supply simple and safe.

Source : NABU – Naturschutzbund Deutschland e.V.

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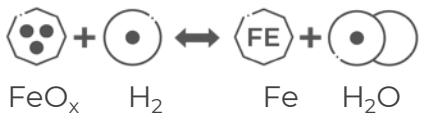
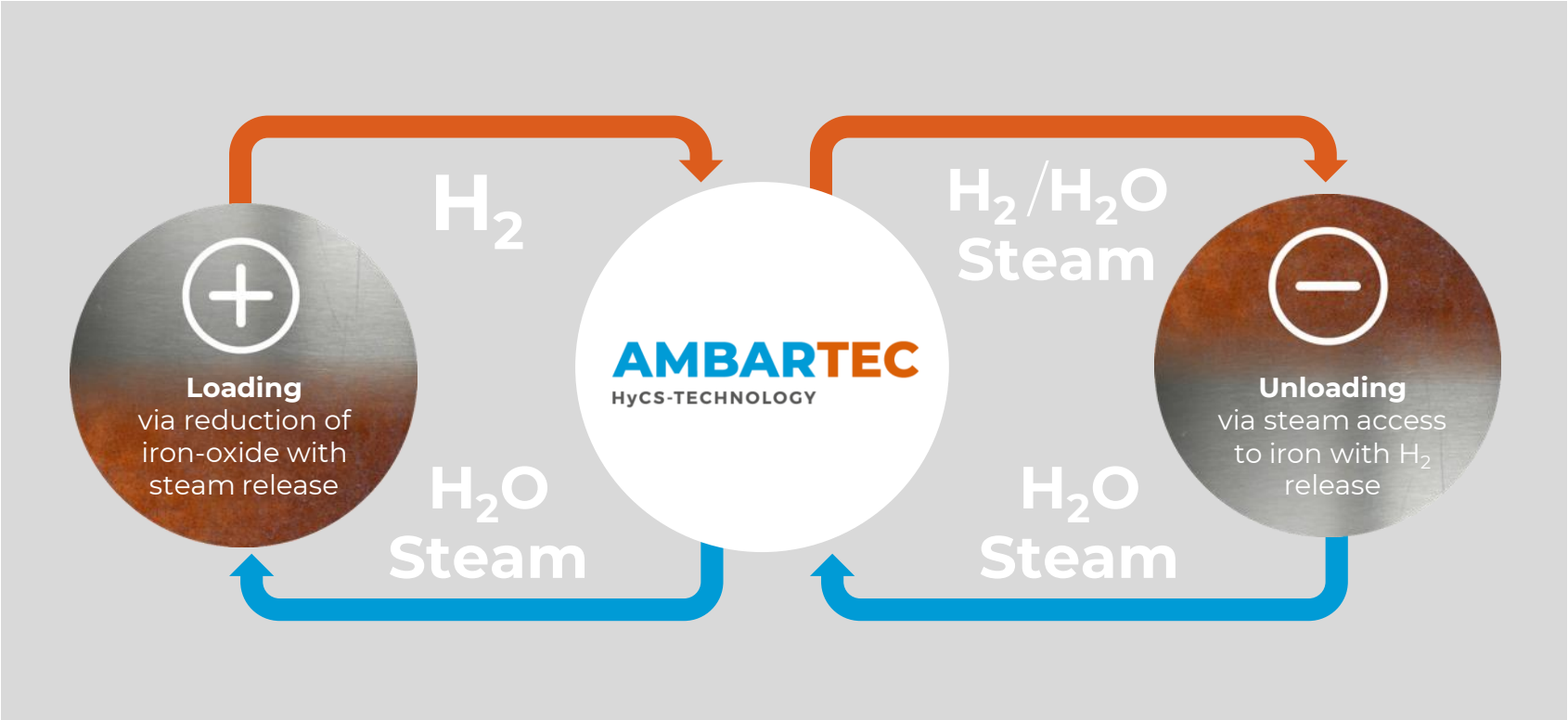
Iron Reduction and Oxidation in a Container

Hydrogen Compact Storage Technology

Our innovative HyCS®-Technology is based on a well known reverse chemical process.





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Fe-Storage Elements

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Benefits

Our HyCS®-Technology is …

Compact

- Up to **900 kg of H_2 in a 20-feet container – 2 to 4 times more** than other systems
- Use of existing infrastructure (ship, rail, road)

Efficient

- **50 % less electricity** and **90 % less water** in combination with H_2 electrolysis
- Charge / discharge in 30 mins
- **No cooling required,** no H_2 evaporation

Sustainable

- Iron as storage medium is widely available
- **Non-hazardous** – easy permitting
- Long lifetime (no degeneration)

Lowest total cost of ownership

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Team and Pilot Facility

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HyCS®-Products: Storage Units

H_2compact 100

Storage Capacity: 250 kWh/7,5kg H2

H_2compact 1000

Storage Capacity : 3 MWh/90 kg H2

Available in 10/23

H_2compact 6000 – 20‘ Container

Storage Capacity : 20 MWh/600 kg H2,
up to 10 bar, weight: <18 t

Available in 06/24

H_2compact 6000 Plus – 20‘ Container

Storage Capacity: 30 MWh/up to 900 kg H2,
up to 100 bar, weight: 32 t

Available in 09/24

Large Scale Units on request

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The HyCS®-Standard (Un)Loading-Units

Status: 05/2023

Loading Units	Power kW	H_2 kg/h	H_2 Nm³/h	Pressure bar
HyCS-L 0.3	300	9	100	
HyCS-L 1.0	1,000	30	334	
HyCS-L 10.0	10,000	300	3,340	

Unloading Units				
HyCS-U 0.3	300	9	100	max 30
HyCS-U 2.5	2,500	75	835	max 63
HyCS-U 10.0	10,000	300	3,340	max 100
HyCS-U 100.0	100,000	3,000	33,400	max 63

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Customer Acquisition

Wide range of marketing activities:

- Own booth and keynote speeches on relevant international fairs and exhibitions
- Member in international networks
- Press releases and Articles in trade journals
- Social Media and Website activities

Canadian Hydrogen Convention

energy saxony

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wintershall dea

GENERAL ATOMICS EUROPE

UIT GmbH Dresden

LIBERTY PIER
MARITIME PROJECTS

VoltAsset

HANNOVER MESSE

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Projects

Be Part of Our Success.

Thank you for your attention.

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