Implementing Fuel Cells and Hydrogen Technologies in Ports

Fuel cell ReachStacker

03/12/2025

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Contents

OUR VISION

Transforming the way the world moves materials from Port to Home.

Clean Hydrogen Partnership

H2 PORTS

OUR MISSION

Is defined by two customer promises

OPTIMAL SOLUTIONS

Deliver optimal solutions to meet the specific materials handling industry needs to customers, at the lowest cost of ownership through a portfolio of exceptional brands.

EXCEPTIONAL CUSTOMER CARE

Provide exceptional customer care by never letting customers down, and by creating increasing value from first engagement through the product lifecycle and beyond.

Clean Hydrogen Partnership

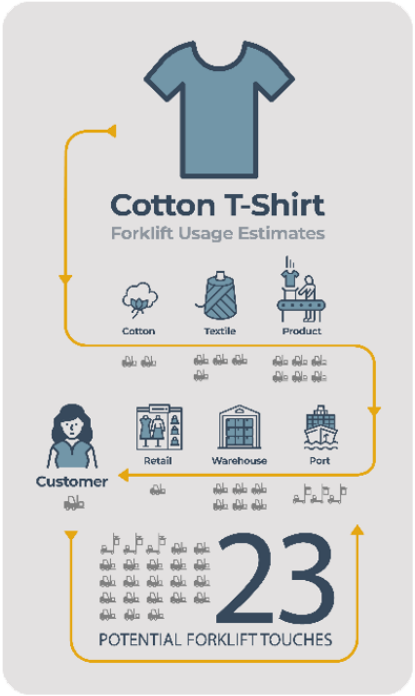
H2 PORTS

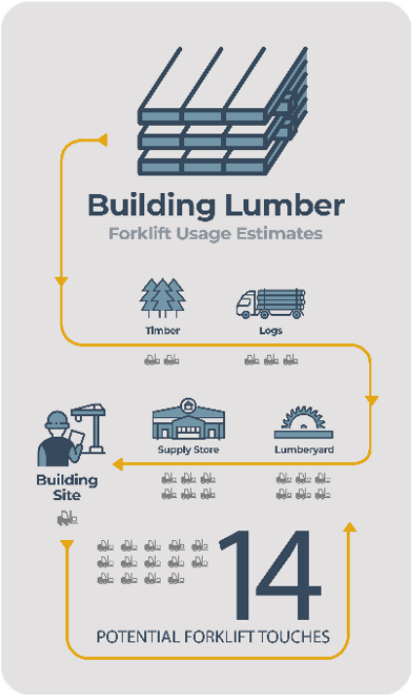
BUILT TO MOVE THE WORLD FORWARD

Lift trucks are integral to the supply chain and our lives

From the shirt on your back to the walls around you, forklifts are the unsung heroes behind it all – driving the global supply chain every step of the way.

For over a century, we've been integral to connecting the world with goods and empowering customers for long-term success.





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H2 PORTS

GLOBAL COVERAGE

5	11	8	250+
Continent Coverage	Development & Testing Centers	Manufacturing Plants	Dealer Locations

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H2 PORTS

LIFT TRUCKS, TECHNOLOGIES & POWER OPTIONS

CAPACITY RANGES: 2,000 – 115,000 LBS

ELECTRIC			INTERNAL COMBUSTION (ICE)		CLASS 1	CLASS 5
CB*	WAREHOUSE		COUNTERBALANCED		BATTERY/FUEL CELL	ICE
						
CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 5	BIG TRUCKS: 8 to 52 TON	

TECHNOLOGY SOLUTIONS	POWER OPTIONS
Automation • Operator Assist • Telematics	Electric • Hydrogen • ICE
	

*CB – Counterbalanced

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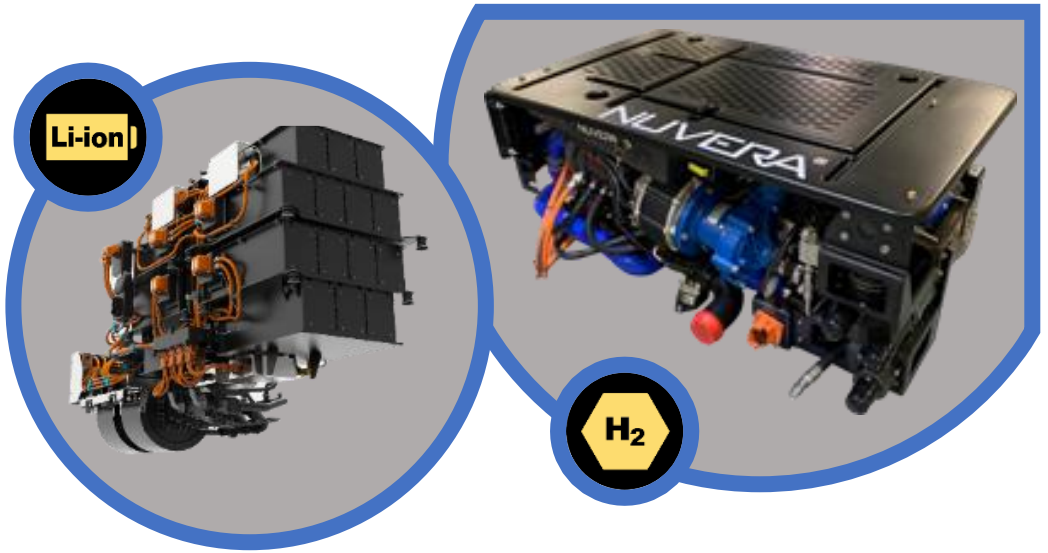
H2 PORTS

Introduction

HYSTER-YALE MATERIALS HANDLING

Hyster® develops full line zero emission offering for port operations:

- Full battery electric (LITHIUM-ION)
- Fuel cell hybrid (HYDROGEN – LI-ION)



- "Our efforts aim to lessen the impact of material movement on people, the environment, and the economy guided by the creativity and imagination of our team."

Clean Hydrogen Partnership

H2 PORTS

Introduction

Main goals:

- Training and acceptance of a HFC ReachStacker to the port operators

- Deploying the HFC ReachStacker in normal operation at the MSC Terminal in Valencia

- Collect data to confirm and/or improve the design of future HFC ReachStackers

ReachStacker overview

150 kW + 164 kW Hydraulic E-Motors

1x 130kWh Battery pack

220kW Traction E-motor

2x 45 kW Nuvera Fuel Cell

32kg Hydrogen storage

Truck requirements:

- ICE like performance
- H2 Refueling time under 30 minutes
- Full shift operation on 1 tank
- Improved handling and productivity

Performance analysis

Automatic Operation

Truck hours accumulation

MSC daily planned refueling

Manually coordinated refueling

Category	KPI	Value	Unit
Operational	Hydrogen consumption	2.46	kg/h
	Availability	0.50	%
	Cost of Spare parts	709	€/h
	Labour cost	t.b.d	manh/kh
	MTBF	73	h
	Hours of operation	675	h
	Average number of movements/hour	7.5	mov/h
	Average distance per hour	1.35	km/h
	Average Energy Generated / h	4.8	kwh/h
Refuelings	Number of H2 refuellings	303	n
	Total Hydrogen Consumption	1660	kg
	Hydrogen refuelled/refueling	1630	kg
	Mean refueling time	1500 (25)	s (min)
Mainitenance	Downtime, overall	336	h
	Downtime for scheduled maintenance/upgrades	40	h
	Downtime due to electrical components	16	h
	Downtime due to the high voltage battery	80	h
	Downtime due to the on-board hydrogen storage tank	40	h
	Downtime due to peripheric mechanical components	16	h
	Downtime due to stack issues	72	h
	Downtime due to software issues	72	h
	Number of unforeseen stops / hour operation	4	
	Number of critical failures / hour operation	16	n

/11/2023 22/12/2023 22/01/2024 22/02/2024 22/03/2024 22/04/2024 22/05/2024 22/06/2024

H2 hose and refueling issue

FC isolation issue

Contamination in H2 buffer

Startup + Charging issue

03 Performance analysis

Operator feedback

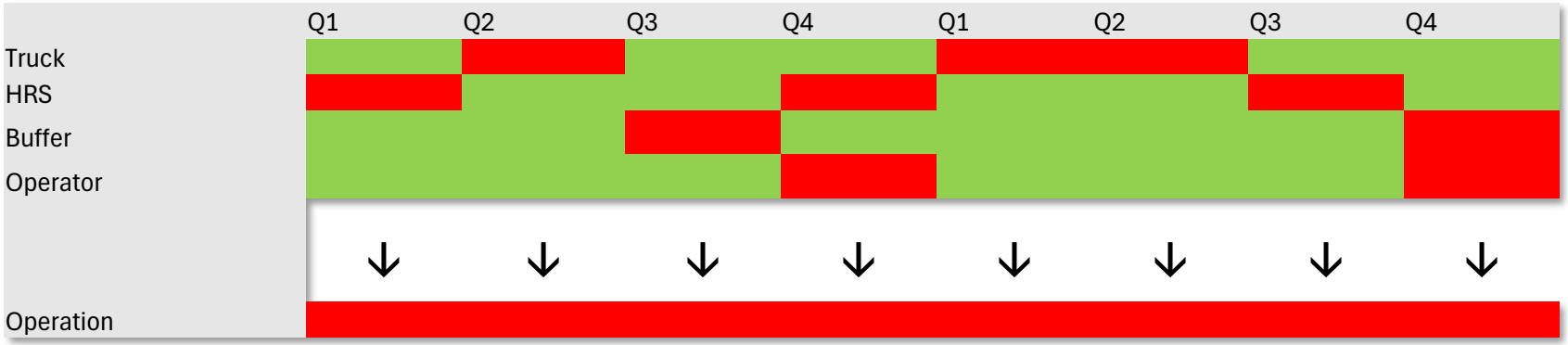
- **Comparison**: Acceptable
- **Future Wish**: “Zeroing button for the spreader”
- **Main Reason**: Maneuverability
- **Experience Rating**: 7/10

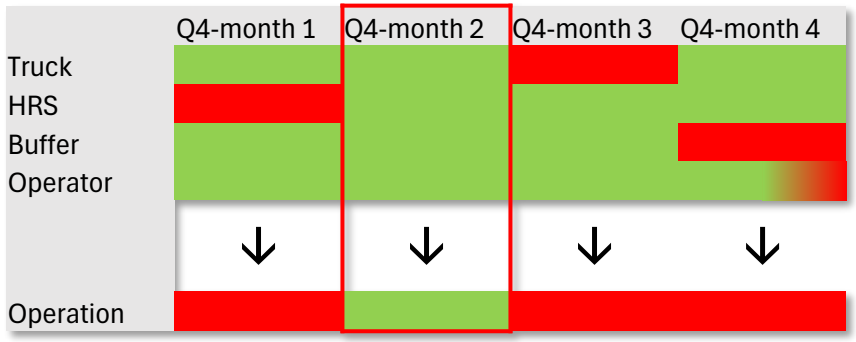
- **Comparison**: “When it works, it has a lot of power, more stable, intuitive and easy controls”
- **Future Wish**: “Container well designed for handling”
- **Main Reason**: Stability, power, and maneuverability
- **Experience Rating**: 9/10

- **Comparison**: Better stability and strength
- **Future Wish**: Longer hydrogen charge duration
- **Experience Rating**: 8/10

- **Comparison**: “Very powerful and precise compared to other brands”
- **Future Wish**: “Longer operation with faster recharges and operational improvements”
- **Main Reason**: “Works well and tasks are done comfortably”
- **Experience Rating**: 6/10

04 Lessons learned





04 Lessons learned

Charging

FC sy

tance

Truck

By collaborating with customers, suppliers, dealers, and operations in a new way, we will build a solid foundation to ensure the success of the next generation of zero-emission vehicles

Operation

05 Conclusion

Main project goals for Hyster:

- Training and acceptance of the FC ReachStacker of the port operators – YES
- Deploying the HFC ReachStacker in normal operation at the MSC Terminal in Valencia - YES
- Collect data to confirm or improve the design of the HFC ReachStacker – YES

Thank you

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Clean Hydrogen Partnership

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Partners:

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GRIMALDI GROUP

msc TERMINAL VALENCIA S.A.U

BALLARD

HYSTER-YALE MATERIALS HANDLING

ATENA FUTURE TECHNOLOGY

Centro Nacional del Hidrógeno

enagas

CARBUROS METALICOS Grupo Air Products