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CALIFORNIA HYDROGEN BUSINESS COUNCIL

Hydrogen Means Business in California!

Hydrogen and Fuel Cells in Ports and Shipping Workshop

Towards Zero Emission Port Container Operations

Port of Los Angeles – California 10th October 2018

ÍNDEX OF CONTENTS

ÍNDEX OF CONTENTS

28 Port Authorities

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Valenciaport Cluster 2017

Port of Sagunto

5.72 Mio. Tonnes

52,401 TEU

271,155 Vehicles

Port of Valencia

67.49 Mio. Tonnes

4.78 Mio. TEUs

1,029,288 Passengers

616,960 Regular Lines Passengers

412,328 Cruise Passengers

523,791 Vehicles

Port of Gandia

0.35 Mio. Tons

Valenciaport: 73 Mio Tonnes

4.83 Mio TEUs

World and Europe TEU Volume Ranking 2017

1st Shanghai (40.2 M)
2nd Singapore (33.6 M)
3rd Shenzhen (25.2 M)
.
.
11th Rotterdam (13.6 M)
.
.
17th Los Angeles (9.3 M)
.
.
21st Long Beach (7.5 M)
22nd New York (6.3 M)
.
.
26th Bremerhaven (5.5 M)
.
.
29th Valencia (4.78 M)

Ranking	Port	Country	2016	2017	%
1	Rotterdam	The Netherlands	12,38	13,73	10,9
2	Antwerp	Belgium	10,03	10,45	4,19
3	Hamburg	Germany	8,90	8,80	-1,12
4	Bremen	Germany	5,53	5,50	-0,54
5	Valencia	Spain	4,73	4,83	2,11
6	Algeciras	Spain	4,76	4,38	-7,98
7	Duisburg	Germany	3,70	4,10	10,81
8	Piraeus	Greece	3,67	4,06	10,63
9	Felixstowe	UK	4,01	4,01	0,00
10	Tanger Med	Morocco	2,96	3,31	11,82

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APM TERMINALS VALENCIA

MSC: SPECIALISED TERMINAL

NOATUM-COSCO: PUBLIC TERMINAL

ÍNDEX OF CONTENTS

80%		90%	
	12,522,629 kWh (43%)		4,049,138 L (58%)
	11,006,280 kWh (37%)		2,245,147 L (32%)
	4,801,013 kWh (15%)		611,460 L (9%)
	1,815,477 kWh (5%)		80,819 L (1%)
30,145,399 kWh (30.1 GWh)		**6,986,564 L**	

Carbon Footprint (Fuel): **11.7 Kg CO2eq / TEU**

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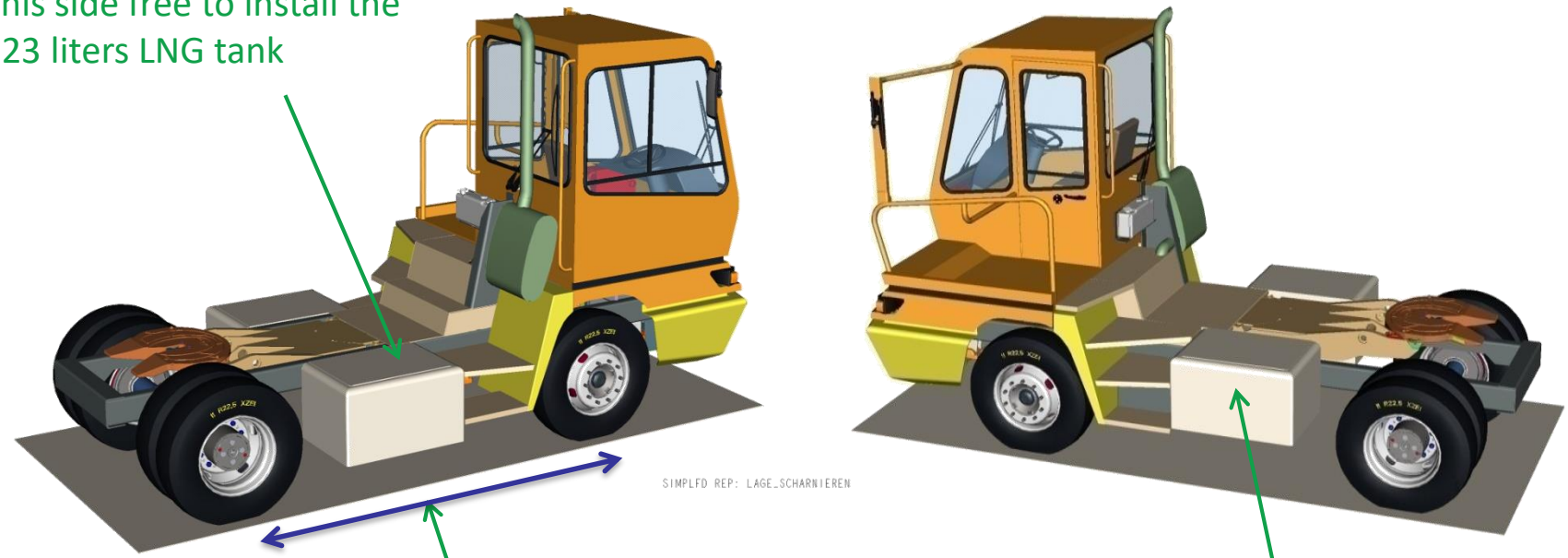
LNG TERMINAL TRACTOR PROTOTYPE

LNG Terminal Tractor Prototype Design Requirements

This side free to install the 323 liters LNG tank



3.500 mm wheelbase
Instead 3.300 mm standard

Hydraulic tank, battery and air compressor moved to the same side

ÍNDEX OF CONTENTS

Full Electrical Tractor

Batteries

Traction battery capacity 206[kWh]
Traction battery type Lithium Iron Phosphate
Nominal voltage 299 [V] (260-380 Volt)
Current 700Ah

Driveline

Power/torque 160/180 hp @ 1800-2800
RPM 633/712 Nm @0-1800 RPM

Autonomy

6 hours (1 operational shift)

Recharging Time

Between 3-5 hours (depending on plug type)

LNG vs Electrification

LNG Terminal Truck

Refuelling time similar to Diesel
Equipment cost similar to Diesel
LNG availability
Less Autonomy than Diesel
Not Zero-Emission solution

Full Electric Terminal Truck

Zero-Emission solution
Electricity price lower than Diesel
Charging time higher than Diesel refuelling
Low autonomy (less than 6 hours)
Equipment cost much higher than Diesel

ÍNDEX OF CONTENTS

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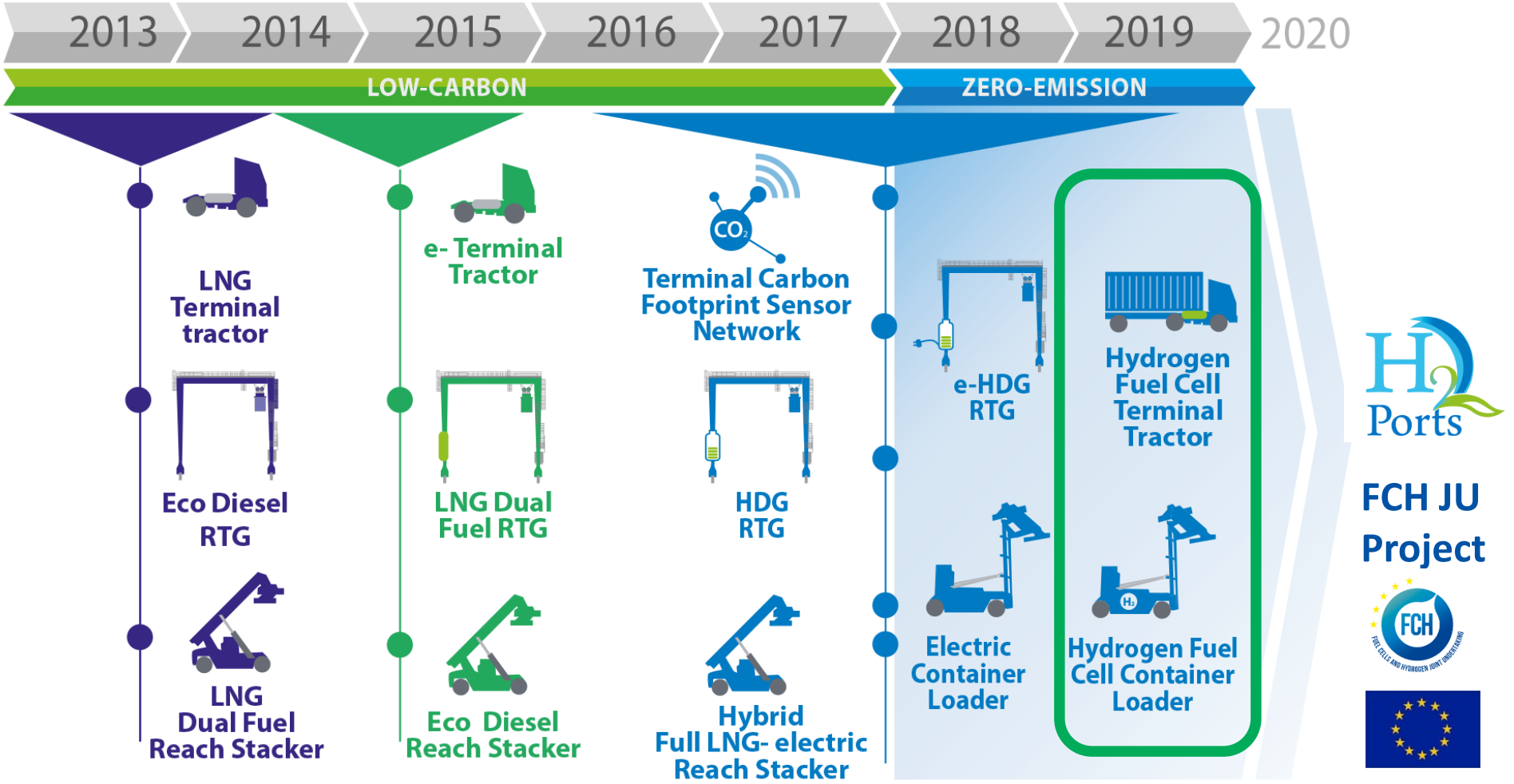
Towards Zero-Emission Port Operations



H2 Ports

FCH JU Project

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Hydrogen Fuel Cell Reach Stacker and Yard Truck

Location: **MSC Container Terminal Valencia**

Fleet Fuel Consumption: 2 Mio L / year

Operational Time: 5,000 h (2 years)

Fuel Cell Power Range: 90-120 kW Reach Stacker

60-80 kW Yard Truck

H2 Ports

Benefits:

- Local zero emissions and powertrain noise;
- Reduced vehicle maintenance costs with the elimination of the engine, transmission and other mechanical-driven components;
- Downsizing of the battery pack, keeping an autonomy of 8 hours ;
- Improved total energy consumption with electrification of the powertrain and energy recovery through regenerative braking/load management.

Open Questions

Hydrogen supply logistics: supply vs on-site production

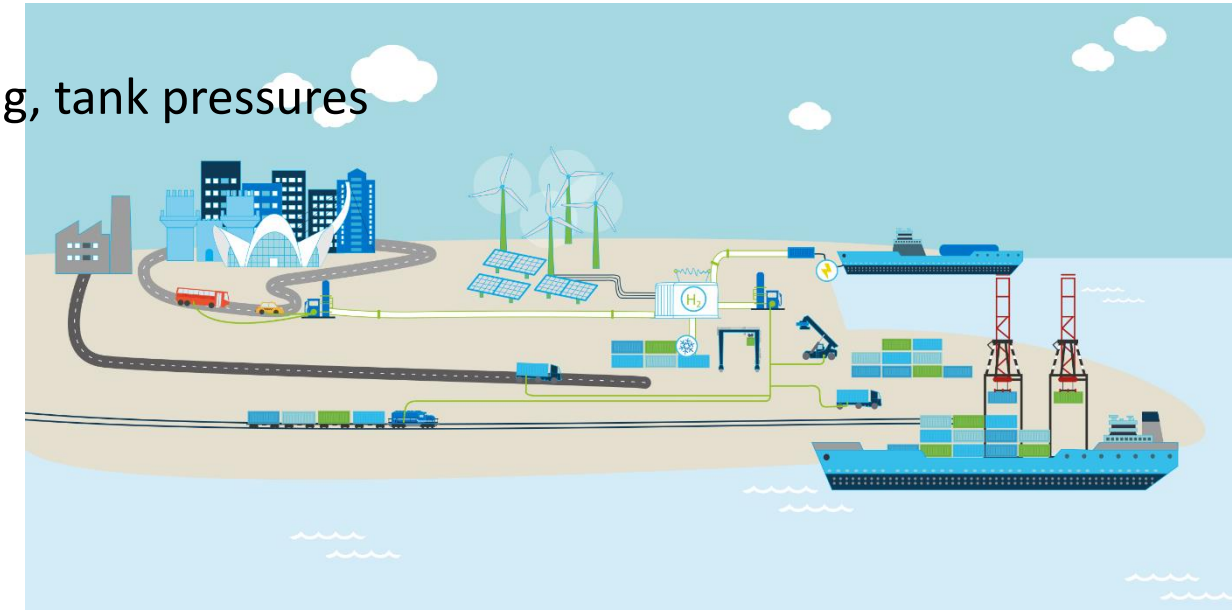
Compatibility with port operations: autonomy, performance

User's acceptance: terminal operator and stevedoring

Port Regulatory Framework: new alternative fuel

Safety procedures: refuelling, tank pressures

City perception



Conclusions

- Port container operations can (and must) be decarbonised: electrification and low carbon / zero-emission fuels;
- This task is challenging: not all port operators are prepared for making the transition towards zero-emission solutions;
- There are knowledge and awareness gaps in the port industry about zero-emission alternatives. Need to bridge the gaps with successful stories;
- Need for cooperative innovation among technology providers and end users;
- Financial feasibility and short pay-backs are critical factors for real implementation of disruptive technologies (like Hydrogen).

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