PowerCell Sweden AB

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H2 and Fuel Cells in maritime application
15-15 June 2017, Valencia

PowerCell

PowerCell - Overview

- Located in Gothenburg, Sweden
- Industrial Spin-Out from Volvo
- Public listed on Nasdaq First North Dec 2014
- Over 8000 share holders
- 50 highly skilled employees
- Advanced fuel cell and reformer laboratories
- ISO Certified 9001 & 14001

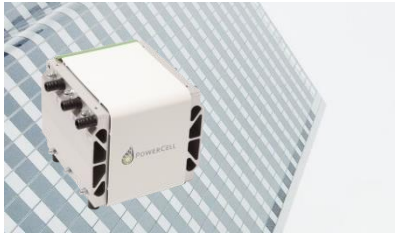
Vision

To be the world's leading innovative fuel cell company by:

- creating value for customers in selected segments
- innovative products and systems for existing and future fuels
- providing efficient products that reduce the environmental impact

Fuel Cell Stack Product Platforms

- Scalable and Modular Product Platforms
- Robust and compact using metallic bipolar plates
  - PowerCell S1 (in production)
    - 1-5 kW power
    - Runs on pure hydrogen or reformate
    - Suitable for smaller back-up systems
  - PowerCell S2 (in production)
    - 5-35 kW power
    - Runs on pure hydrogen or reformate
    - Suitable for continuous power or back-up solutions
    - Can be operated in multiples for larger systems
  - S3 (in development)
    - 20-100 kW power
    - Runs on pure hydrogen
    - Suitable for propulsion or industrial systems
    - Can be operated in multiples for larger systems (MW)



PowerCell S1 (1-5 kW)

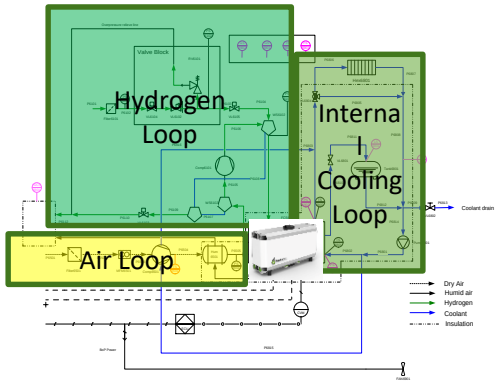
PowerCell S2 (5-35 kW)

PowerCell S3 (30-100 kW, prototype)

Powercell Fuel Cell System PS-30

Prototype specification	
Fuel Cell stack	Powercell S2
Net Power	30 $kW_{electric}$
Efficiency $_{electrical}$	40-55%
Voltage output	400 VDC
Start-up time	60 s
Useful heat for heating, liquid based	30 kW_{heat}
Temperature Ambient Range*	-20^{o} to 50^{o}C,
Volume	< 160 l
IP classification	54
Communication	CAN, Relay dry contact

*designed for sub zero stand-by with LV assistance



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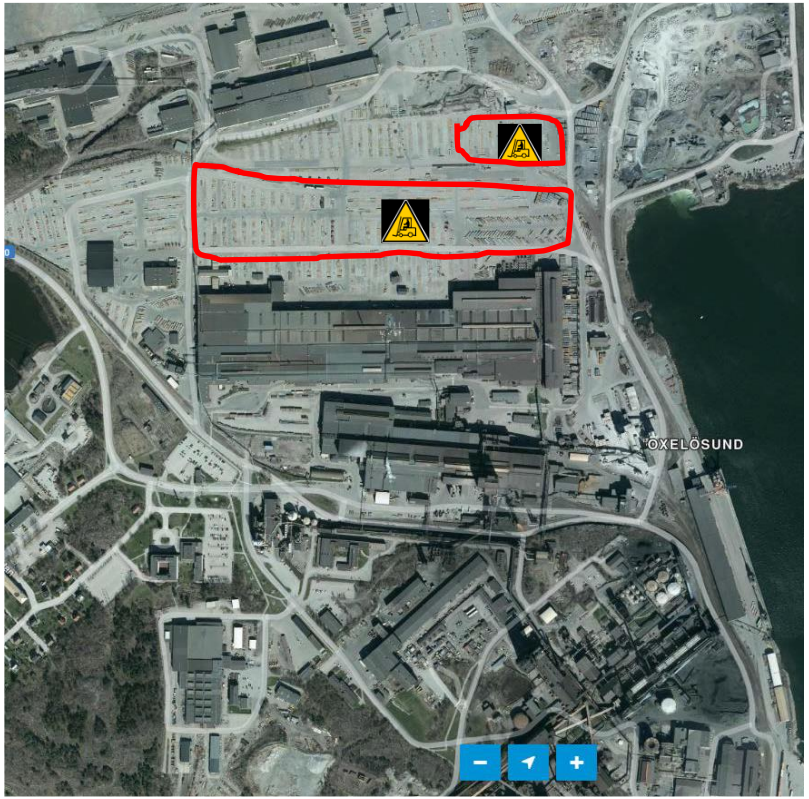
Material Handling project with Kalmar

- Fuel Cell System based on PowerCell S2
- Forklift with lift capacity 18 ton
- Test at Swedich steel company, SSAB production facility in Oxelösund until mid 2018

PowerCell S2

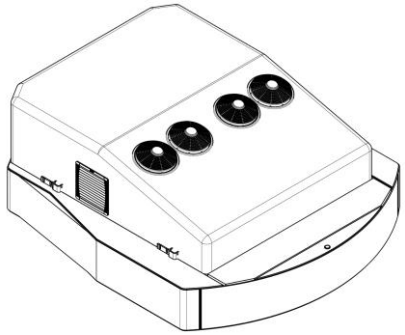
Drive cycle

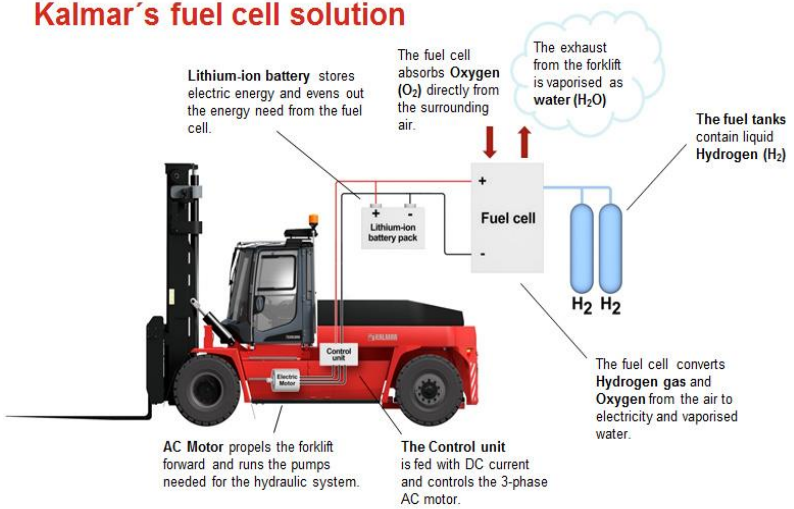
- 24/7 operation
- Moving steel plates in restricted area
  - Area 1: 1000m x 300m
  - Area 2: 150 m x 80 m
- Average distance 250 m
- Average speed 15 km/h



Fuel cell fork lift truck

system technical data	
Drivetrain	AC induction machines
Fuel cell	40 kW (2 x PS30)
Battery	Li-ion, 49 kWh
Hydrogen tank	700 bar, 9,3 kg (17kWh)
Max Power (lift + traction)	160kW
Average power	35kW
Daily energy consumption	608 kWh





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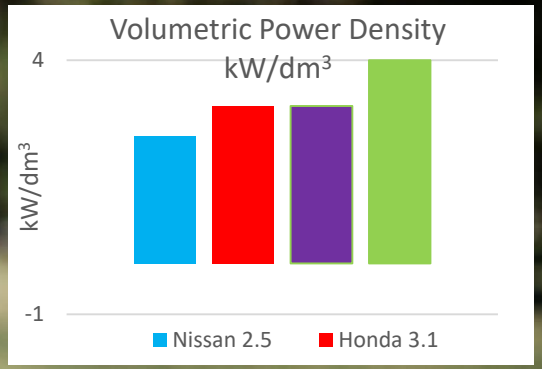
PowerCell S3 – Establishes Best-in-Class Power Density

- Powered by hydrogen gas
- High-quality fuel cell stack primarily for powering vehicles
- 20-100 kW power range
- Designed in accordance with automotive cost targets
- The design is exclusively based on industrial components and materials

Goal: Superior quality and performance to meet the requirements from the automotive industry!!



AutoStack Core Consortium

Automotive OEMs	Component and System Suppliers	Research Institutes
BMW	Swiss Hydrogen	C22
Volvo	Dana	Fraunhofer ISE
Volkswagen	Freudenberg	
	PowerCell	PSI
	SolviCore	
		SW

PowerCell MS-100, 50-100kW Fuel Cell Power System

- Based on Powercell S3
- In cooperation with our partner Swiss Hydrogen

FC system technical data	SHA-100-E
Stack	S3-455C
Max. continuous net power	100 kW
DC net out at max. cont. power	332 V; 300 A
System pressure (at full load)	2.6 bar_{abs}
Voltage range (Peak Power EOL .. OCV BOL)	250 .. 500 V
Coolant flow (pump integrated)	150 l/min
Coolant outlet temperature	80 °C
Waste Heat	82 kW
System Efficiency (LHV H2 in to DC stack out)	52 %
Dimensions (H x W x D) [1]	750 x 750 x 520 mm
Weight [2]	98 kg

1) Not included: brackets, covers, heat shields, coolant reservoir
2) All included (but Radiator and DC/DC converter not within system content)

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Marine System – MARANDA Project

- 165 kW fuel cell powertrain based on S3 stack
- Powers Artic research vessel Aranda's electrical equipment and dynamic positioning during measurements - free from vibration, noise and air pollution
- 18-month marine field testing including extreme cold and saline conditions

Photographer: Panu Hänninen

Project consortium:
- VTT Technical Research Centre of Finland Ltd
- Powercell Sweden AB
- ABB Oy
- OMB Saleri SPA
- PersEE
- The Finnish Environment Institute (SYKE)
- Swiss Hydrogen SA

EU funding 2.9 M€, 3.7 M€ total budget

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PowerCell FC solutions for > MW scale

- Example of 12 x S3-455C stack module
  - 1.14 MW at 300A operating point
  - 1.5 MW max continuous at 450A
- Stack module dimensions:
  - Height 2.4 m x Width 0.6 m x Depth 1.2 m

  => Stack module footprint: 0.72 m2
- > MW scale FC system design would be a development project based on the application

  => High level of flexibility to match customer needs

Fuel Cell system technical data	Multi-MW
Stacks	Multiples of PowerCell S3-455C
Nominal electric output	637 V; 300 A (900A)
Voltage range (max cont. power EOL .. OCV BOL)	500 .. 1000 V
Coolant outlet temperature	70 °C
System Efficiency at max cont. power BOL	50 %

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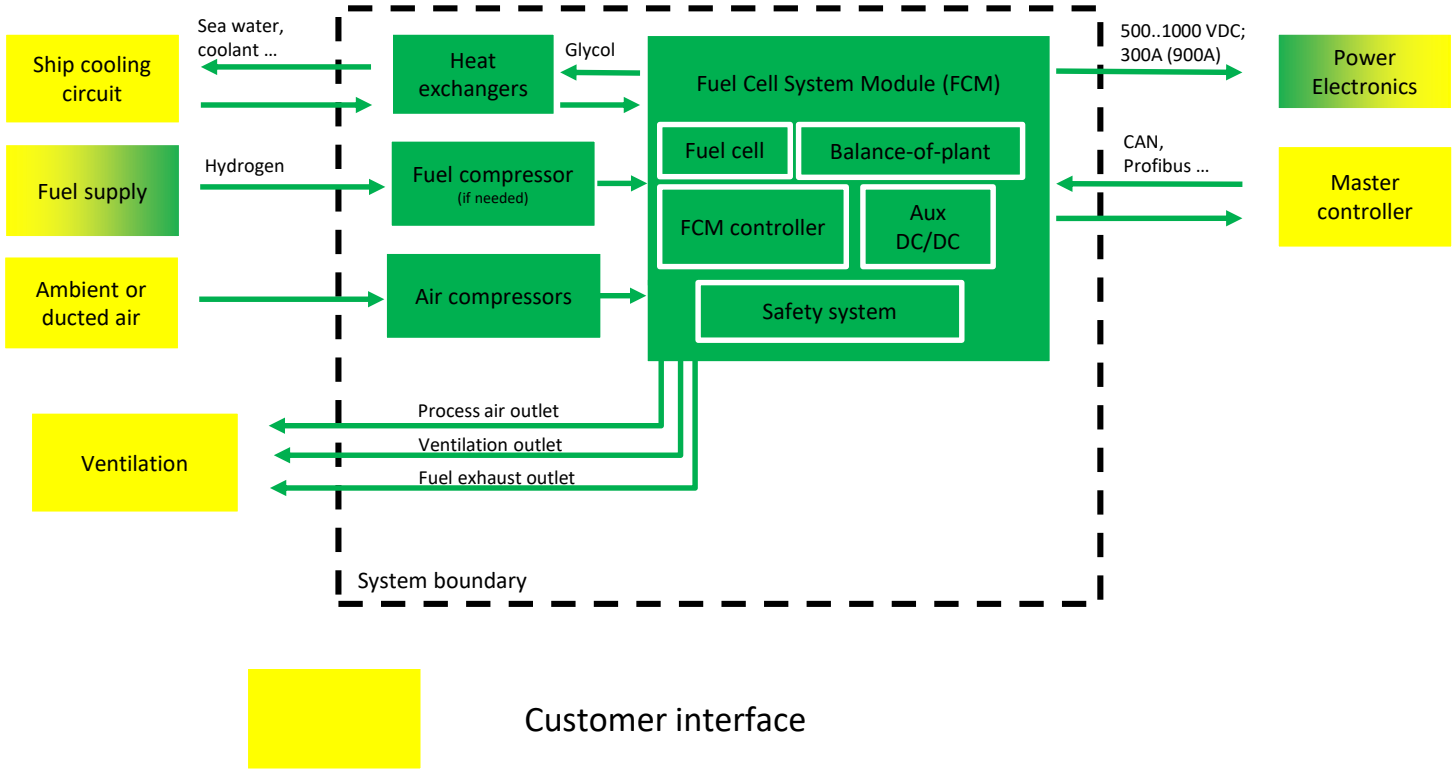
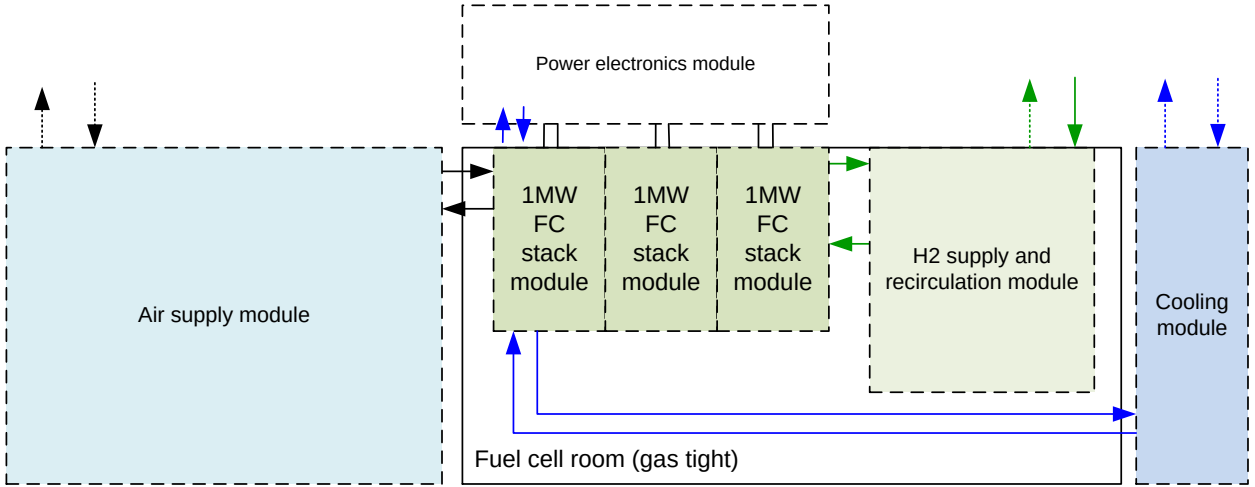
PowerCell Multi-MW system - System Boundary



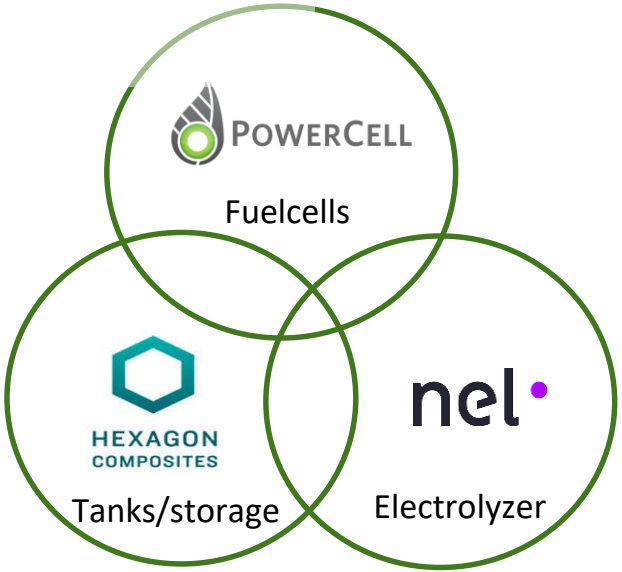
Example of a rough layout plan 3MW system

- Including auxiliar systems footprint estimated: 15-18 m^2
  (incl. stacks, aux BoP, DC/DCs & excl. maintenance space)



Joint Venture with Hexagon and Nel

- Utilize the strength of the three companies
- One customer interface
- Company based in Oslo
- 1/3 ownership each



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- the Leading Nordic Fuel Cell Company

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