CLEANTECH COMPETENCE

Proton Motor Fuel Cell GmbH
Renewable energy projects for the future – From SURF `n` TURF to BIG HIT from stationary to mobile

Uwe Halbmeier, WES 11th October 2017, Stuttgart

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Company Proton Motor

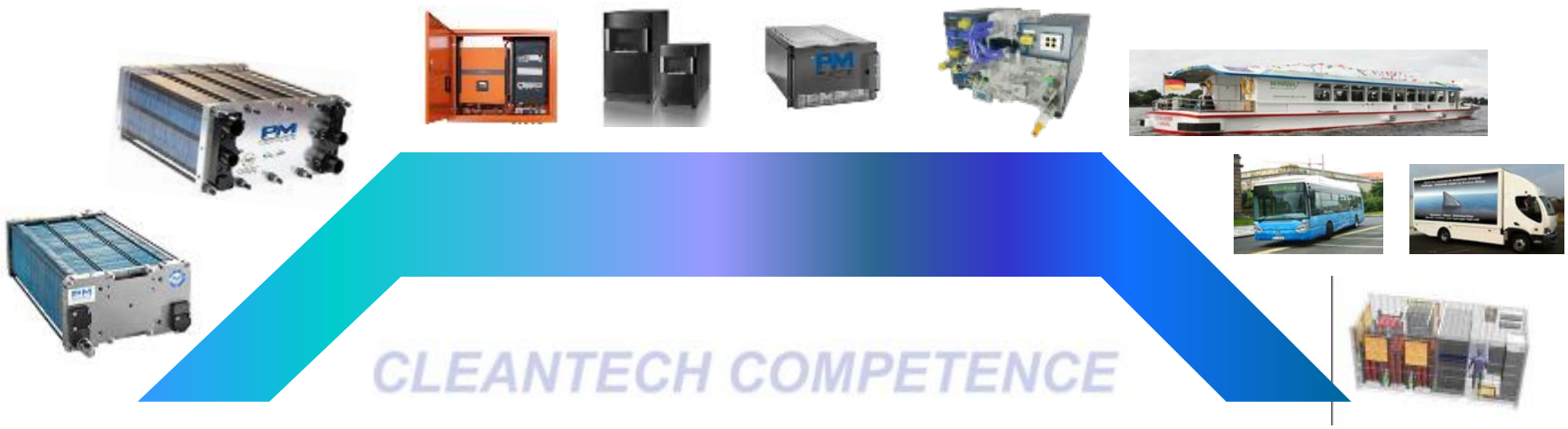
Proton Motor Fuel Cell GmbH provides Solutions for a clean energy supply and clean mobility.

German manufacturer of fuel cell stacks and fuel cell systems for maritime, stationary and mobile applications.

- 1994: Start of fuel cell development
- 1998: Founding of Proton Motor Fuel Cell GmbH
- 2006: Stock market launch of Proton Power Systems
- 2007: Relocation from Starnberg to Munich
- 2015: Integration SPower GmbH into Proton Motor

More than 20 years experience in Fuel Cell Technology

CLEANTECH Power Supply



Stack Technology | **Products** | **Solutions**

LT-PEM Stacks

Power Range
2..30 kW_{elect}

Solar Batterie Storage

Power Range
3 .. 10 kW (1-3ph)

PM Module

S5: 2 .. 6 kW
S25: 10 .. 25 kW

Batterie – UPS

Power Range
1.5 .. 600 kVA

HyRange®

Power Range
9 .. 30 kW

Indoor & Outdoor containerized Solutions for secure power supply

Drive train solutions for

- City busses and
- Light duty vehicles
- Boats and ships

Technology & Products

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Fuel Cells · Power Systems

PEM-Stacks

PM200 PM400


Automotive – Stationary – Maritime

Developed by Proton Motor

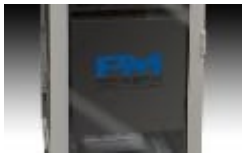
Manufactured in Germany

Power Range

2 .. 30 $kW_{elect.}$

PM Module

S5 S25

Stationary applications

UPS applications

Parallel operation possible

Power Range

5 $kW_{elect.}$ and 25 $kW_{elect.}$

HyRange®


Automotive applications

Range – Extender (electric drive)

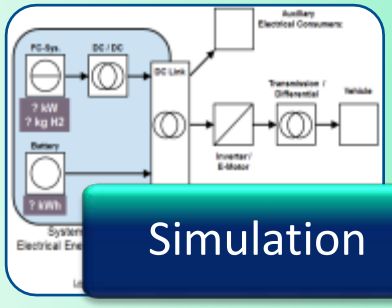
Logistic and public transport

Power Range

25 $kW_{elect.}$

Core Competences

Feasibility Studies



Simulation

Development

Engineering

(Serial-)Produktion

Stack Manufacturing

System Manufacturing

FAT

Customer Support

Integration

Commissioning

Service

Markets: Stationary / Mobile / Maritime

Power supply

UPS Applications
- TETRA / BOS Broadcast
- Telecom base stations
- Industry
- Datacenters
- Hospitals, Office Buildings

Energy Supply
- Seasonal Energy Storage
- Peak shaving
- Balancing energy
- Repowering of process hydrogen
- Onshore power supply for ships

Mobility

Urban Applications
- Logistics
- Bus Fleets
- Distribution service
- Municipalities

Airport Applications
- Airport services
- Terminal shuttle
- Towing tractors
- Ground Power Units (GPU)

Maritime

Power Train
- Tourist boats
- Sport boats
- Small yachts
- Tug boats
- Coast guard

Auxiliary Power Supply
- Sport boats
- Small yachts
- Coast guard

Stationary Systems – Target Markets

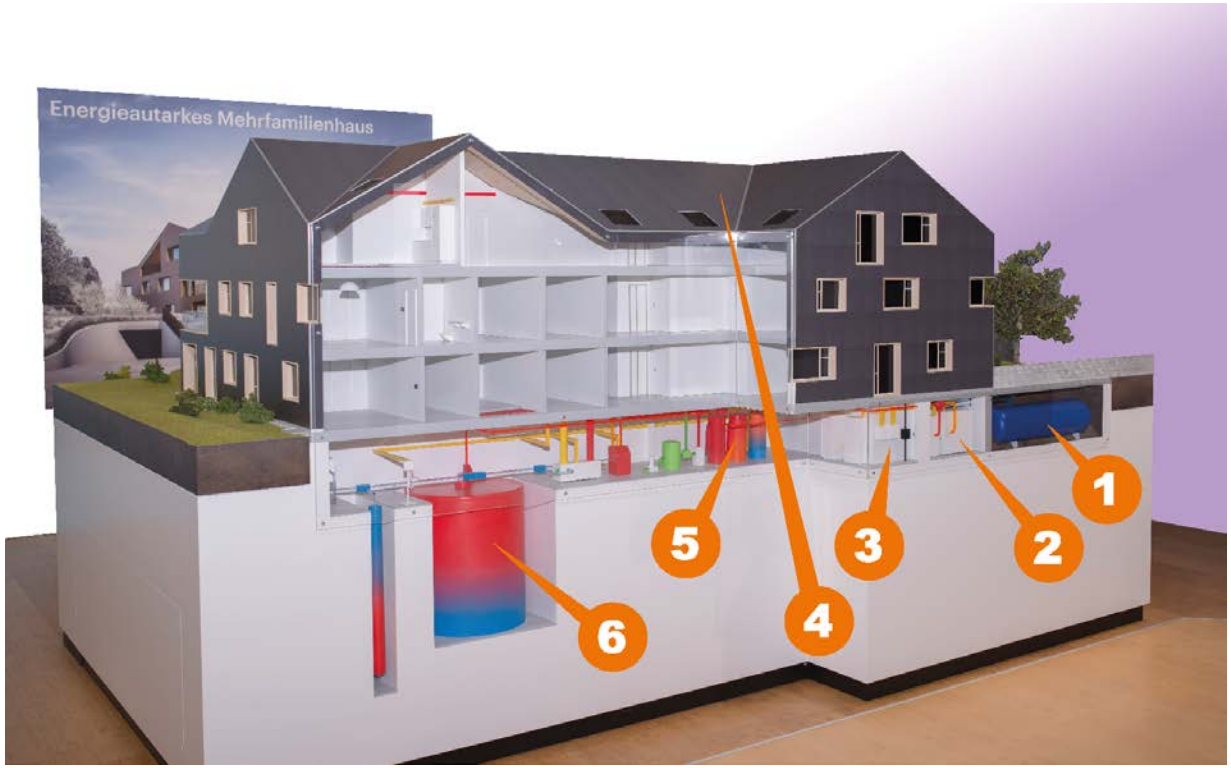
UPS Applications	Energy Supply
• TETRA / BOS broadcast • Telecom base stations • Industry • Datacenters • Hospitals, Office Buildings	• Seasonal Energy Storage • Peak shaving • Balancing energy • Repowering of process hydrogen • Onshore power supply for ships

On Site Storage - Seasonal Energy Storage

Sector coupling:

Use heat from electrolyser and fuel cell for heating buildings and producing warm water

Seasonal Energy Storage



Bruetten / Switzerland

A Project of W.Schmid and Proton Motor

1) H2 – Storage (under ground)
2) Electrolyser (Hydrogen production)
3) Fuel Cell (Re-Energizing H2 to electrical power and heat)
4) PV – Solar on roof and walls
5) Hot water system and heating system
6) Storage of thermal energy

Customer Application EPS - TETRA/BOS radio

BZ EPS < 10 kVA

Generally solutions:

- AC or DC
- 2 kVA to 10kVA
- Modular Gas Storage up to 72 h
- Server connection for data transfer and monitoring

Modular Cubical based Outdoor - EPS System

As Customer Application for Mains Backup reinforcement for radio stations BOS.
4 / 6 / 8 kW Fuel Cell based Emergency Power Supply.

In this Project, with the following technical data:

Output Voltage:	- 230VAC; 50Hz
Output Power:	- 2 - 10kVA nominal
Bridging time:	- 72 Std.
Fuel:	- H2 at 300bar
Vandalism protection class:	- RC4
Fire resistance cass:	- F30

Customer Application UPS/EPS

5 kVA - 250 kVA FC EPS

Cooperation with DB Bahnbau Gruppe GmbH

Proton Motor provides fuel cell based emergency power supply units to the customer. DB Bahnbau Gruppe will utilize the FC EPS systems to replace their diesel generator EPS systems based on the commercial aspect in near future.

Proton Motor will deliver containerized fuel cell EPS systems with different power outputs:

- 5 kVA
- 25 kVA
- 50 kVA
- 75 kVA
- 100 kVA
- 250 kVA

DB Bahnbau Gruppe

Customer Application UPS/EPS

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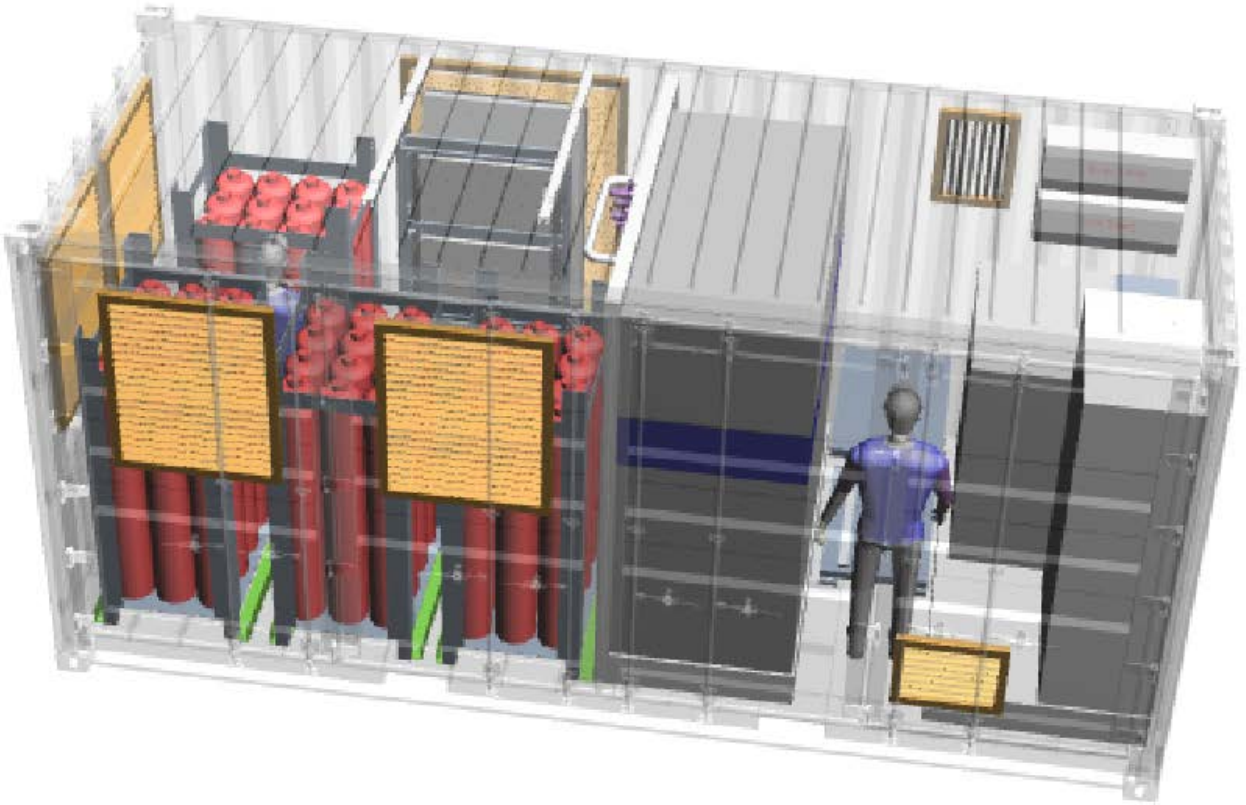
Containerized Solution 5 kVA to 250kVA



Hydrogen Power Plant MW class

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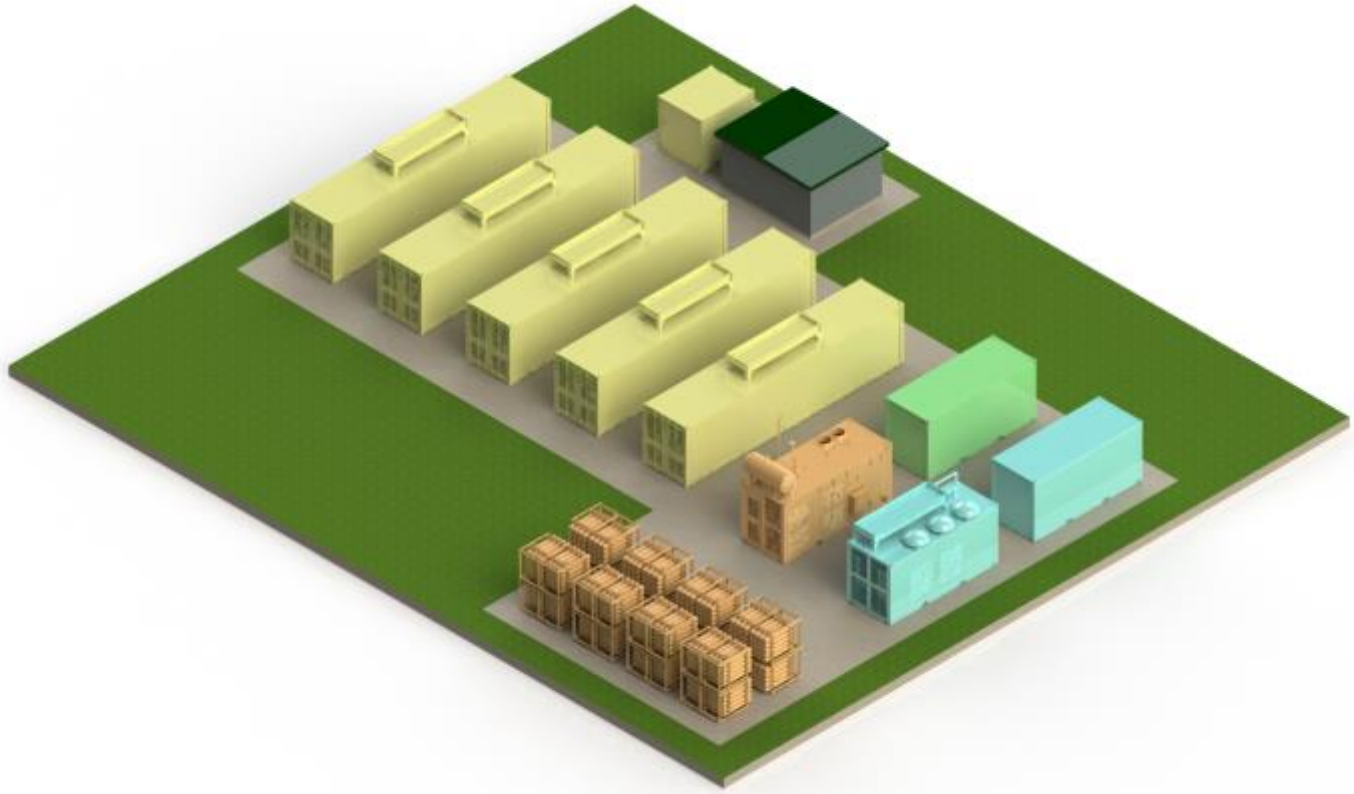
- Big scale Output: 1 to 2 MW (FC)
- Output voltage: MV
- 40 feet sea container



SURF 'N' TURF

A project to integrate tidal & wind electricity,
To generate and transport hydrogen,
Bypass Orkney's grid pinch points, and
Smartly supply local energy demands.

THIS PROJECT HAS BEEN SUPPORTED BY THE SCOTTISH GOVERNMENT'S LOCAL ENERGY CHALLENGE FUND

LOCAL ENERGY SCOTLAND

THE CHALLENGE FUND

Greener Scotland
Scottish Government

SURF 'N' TURF

What will be its legacy?

- Put in place a self sustaining credible local H_2 supply chain/use
- A world first, integrating curtailed wind & tide for H_2 production
- Grid can not carry the renewable energy production >115%
- Strengthen the Grid by shifting to Hydrogen
- Reduce local authority CO_2 emissions immediately
- Create a platform for increased local H_2 use and OIC investment
- A unique MCA backed UK facility for maritime H_2 training.
- BIG HIT/Dual Ports...

LOCAL ENERGY SCOTLAND

THE CHALLENGE FUND

Greener Scotland Scottish Government

Clean Energy Supply – Orkney stationary

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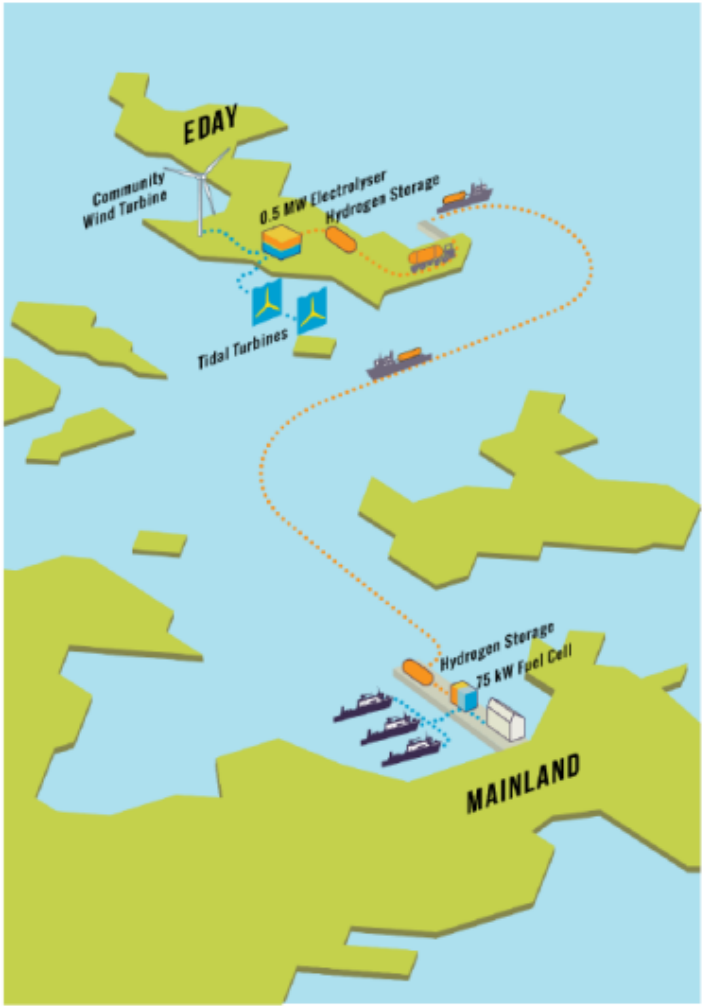
Surf n Turf:

- Infrastructure linking wind and tidal turbines to electrolyser
- 3x bespoke tube trailers to transfer hydrogen
- Permission from Marine and Coastguard Agency to use ferries
- 75 kW Fuel Cell making electricity to cold iron the ferries & supply the local harbour with el. power and heat for buildings



Community Energy Scotland
Empowering Communities

EMEC ORKNEY
THE EUROPEAN MARINE ENERGY CENTRE LTD

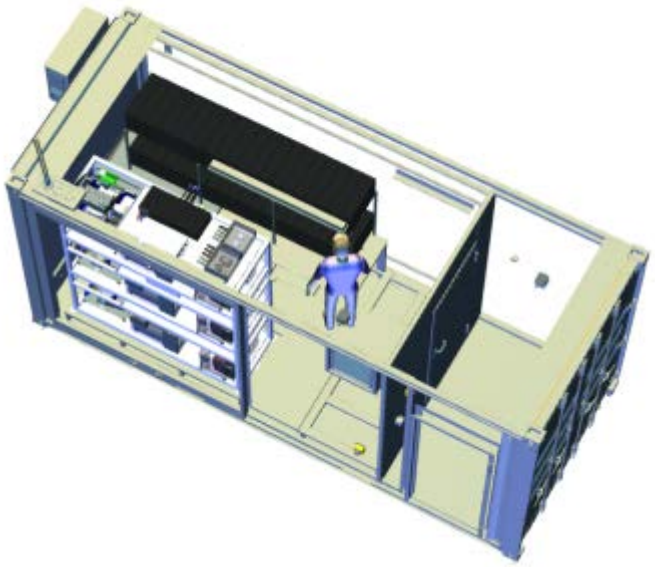
ORKNEY ISLANDS COUNCIL

University of the Highlands and Islands
Orkney College

EDAY PARTNERSHIP

ITM POWER
Energy Storage | Clean Fuel

Hydrogen Power Plant from PM for Orkney



- Power Output: 75 kW (FC)
- Output voltage: 3~ 400 VAC, 50 Hz
- 20 feet sea container

- Service partner nearby

Opening-Ceremony at Kirkwall harbour

***Surf `n` Turf* - Opening through the scottish Minister for Business, Innovation & Energy Paul Wheelhouse (End of September 2017)**

More than 70 guests from UK & Europe

Model caracter as an innovative renewable „Energy Region"
-> Storage in H_2

From EDAY to Mainland ORKNEY

Surf `n` Turf - H_2 from 500 kW Elektrolyser on EDAY

Tide- & Wind- Power
to the Grid & in Hydrogen

Logistic: 3 x H_2 – Trailer
from EDAY to Mainland

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The BIG HIT Plan

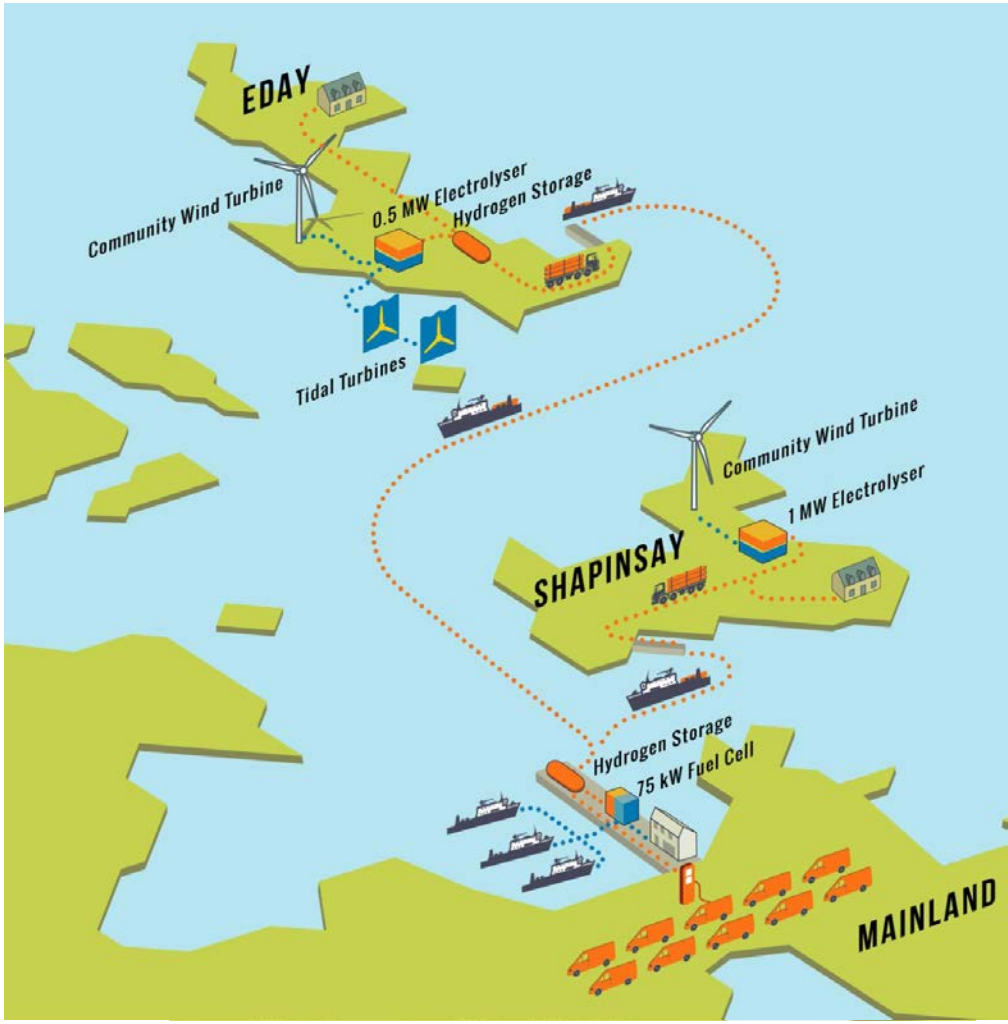
To include and expand upon existing H_2 infrastructure in Orkney

EMEC 0.5MW electrolyser,
CES's 3x tube trailers & 75kW fuel cell powering Kirkwall harbour

To add:

1MW electrolyser on Shapinsay
H_2 heating for council buildings
2x tube trailers
H_2 refuelling station &
10 fuel cell vehicles in Kirkwall

EC-funded & operational for 4 years
post-demo commercial operation via OHT



Hydrogen Logistics LOHC

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Hydrogenious HQ (Erlangen)

98kWp PV
@ Hydrogenious HQ

Exess heat
10 kW

50kW SIEMENS
PEM Electrolyser

30kW Hydration system

Transportation of
loaded LOHC

Fraunhofer IAO (Stuttgart)

100kW Dehydration system

PEM Fuel Cell
PM Module S25

E-chargers for
electric cars

hydrogenious TECHNOLOGIES

Powered by: PROTON MOTOR Fuel Cells · Power Systems

Hydrogen Storage in Metal Hydrid

- A safe storage with high density, Metal Hydrids come back
- PM is involved in Pilot projects to make experience together with our Fuel Cells, especially in the stationary sector, because of the weight
- GKN is using low temperature metal hydrid powder for a quick load / unload process
- For PM is the most interesting feature: The temperature level is at 60-90 degree Celsius, perfect for the heat use of a LT-PEM Fuel Cell (in the past it was approx. 350°C)

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Source: GKN

Proton Motor as a Partner

- Research and development
- Consulting, solution design, market survey
- Partner in national and European funded projects
- Simulation and design of hybrid propulsion and energy supply systems
- Engineering and mechanical design of fuel cell systems for stationary and mobile applications
- Testing and validating of system components
- Prototyping and production
- Project management
- Training for customer and operator / service 24/7

CLEANTECH COMPETENCE

Thank you for your attention!

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