POWER-TO-GAS PROJECTS

2ND HIPS-NET WORKSHOP

24TH JUNE 2015 | BRUSSELS

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ITM POWER
Energy Storage | Clean Fuel

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Contents:

- Re-cap; Market Size for P2G Energy Storage, ITM's offering
- Power-to-Gas Energy Storage Projects
- New Projects
- Technology Development

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MARKET SIZE | NEW EU REPORT

Germany: 46 GW (£46bn) in 2030 | 115 – 170 GW in 2050

4.4 At realistic values of hydrogen, large installed electrolyzer capacity would be viable and able to utilize nearly all excess RES energy in the 2050 horizon

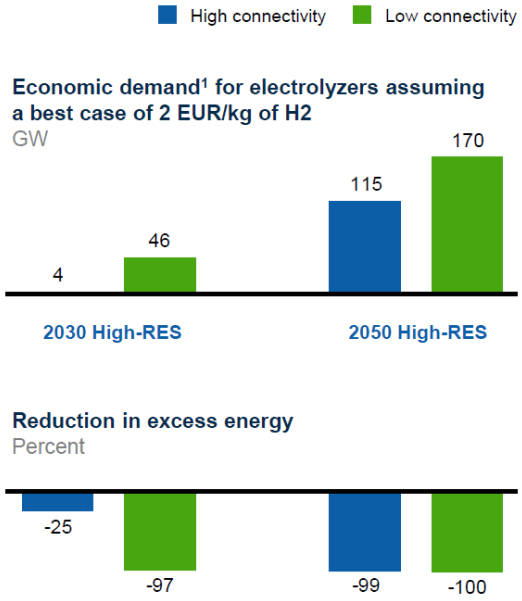
Germany archetype

Non-hydrogen P2P and heat storage will only be able to absorb a small part of the excess energy generated, resulting in the necessity of curtailment – from societal point of view, such electricity could be used at close to zero cost

The excess energy can be used to produce hydrogen via water electrolysis for re-electrification or use outside of the power sector

If the value of hydrogen at the point of production can reach a price in the range of 2-4 €/kg very large installed electrolyzer capacity would be economically viable and able to utilize nearly all of the excess electricity

Such use of the excess electricity would create value for the society and the surplus could be divided between the electricity and hydrogen producer



POWER-TO-GAS

HYDROGEN ENERGY SYSTEMS

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MARKET OFFERING

Rapid Response | High Pressure | High Efficiency | MW scale

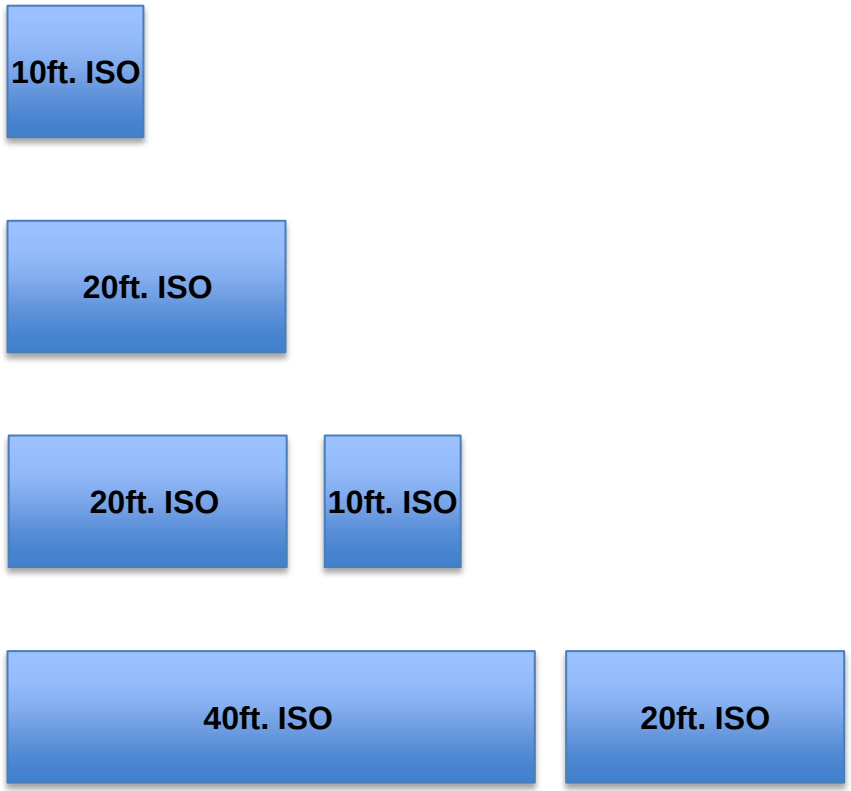
- Rapid response: less than 2s; for primary grid balancing
- High pressure: up to 80bar
- High efficiency: 75% measured by third parties in the field
- MW scale: 1MW modules available today
- Compliant: EU, USA and Asia

STANDARD PLATFORMS

Metric	HGas60		HGas180		HGas360		HGas1000	
	Nom.	Max.	Nom.	Max.	Nom.	Max.	Nom.	Max.
Number of stacks	1		3		6		10	
Output (kg/24hr)	28	42	80	125	170	255	283	425
System Power (kW)	73	113	200	320	400	635	668	1,060
System efficiency (kWhr/kg)	62	64	57	60	56	60	57	53
Container size (ISO)	1x 13ft		1x 20ft		1x 20ft*		1x 40ft**	

*Plus 1x 10 foot depending on options

** Plus 1x 20 foot depending on options



PRODUCT CONSOLIDATION

HYDROGEN ENERGY SYSTEMS

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REGULATIONS, CODES & STANDARDS

A leading role in shaping hydrogen deployment

- Secretary of BCGA Technical Steering Committee 9
- Secretary and UK Expert to ISO Technical Committee 197
- UK Expert to ISO working groups…
- …for electrolysers, dispensers & H2 quality
- Next Chair of BSI PVE/3/8

Code of Practice 41: H_2 Fuelling Stations
Design & Construction
Maintenance & Operation

ISO 19880-1: H_2 Fuelling Stations
ISO 22734: Electrolyser
ISO 14687: H_2Quality

BSI PVE/3/8: H_2 Systems Standardisation
Production & Storage
Transport, Measurement & Use

P2G PROJECTS

THÜGA
RWE

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Das große Plus für alle

ITM Power's HGas System brings together rapid response and self-pressurising PEM electrolysis into a fully integrated package which injects hydrogen into the gas distribution network at the Mainova Aktiengesellschaftsite, Frankfurt, utilising pre-existing compliant gas mixing and grid injection infrastructure. The plant has undergone an extensive acceptance, compliance and commissioning phase before going live in December 2013. The sale was the result of a competitive tender, based on price and performance, and was commissioned ahead of schedule. Capable of addressing MW scale Power-to-Gas applications, and accommodates fluctuating power profiles while generating hydrogen at pressures suitable for either direct injection into natural gas networks or via methanation processes without additional compression.

POWER-TO-GAS

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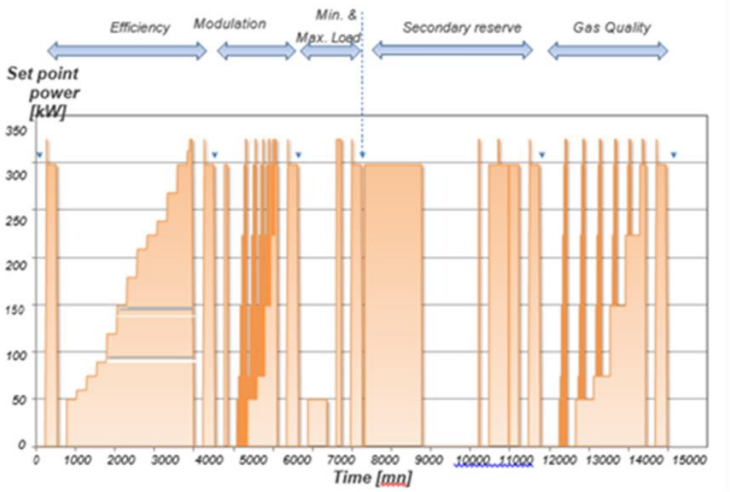
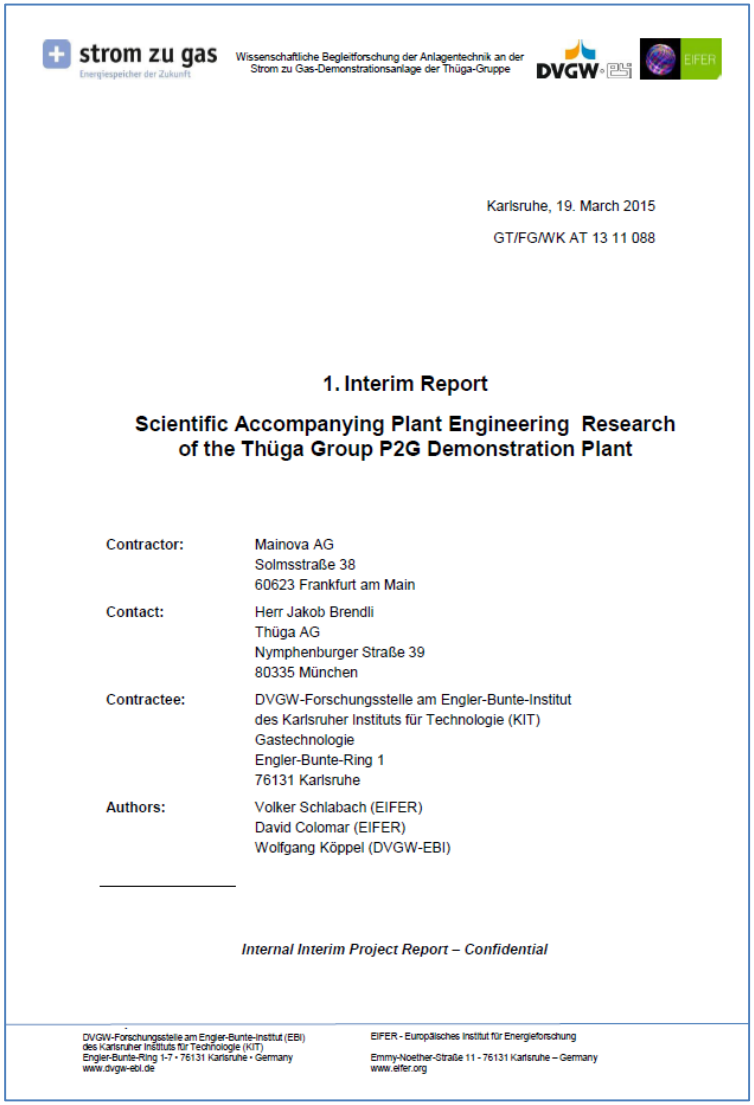
THE THÜGA REPORT

A Positive Report Compiled by EIFER

- Load behaviour
- Controllability | Modulation
- Efficiency
- Gas quality
- Commercial viability





strom zu gas
Energiespeicher der Zukunft

Wissenschaftliche Begleitforschung der Anlagentechnik an der Strom zu Gas-Demonstrationsanlage der Thüga-Gruppe

DVGW EBI

EIFER

Karlsruhe, 19. March 2015

GT/FG/WK AT 13 11 088

1. Interim Report

Scientific Accompanying Plant Engineering Research of the Thüga Group P2G Demonstration Plant

Contractor:	Mainova AG Solmsstraße 38 60623 Frankfurt am Main
Contact:	Herr Jakob Brendli Thüga AG Nymphenburger Straße 39 80335 München
Contractee:	DVGW-Forschungsstelle am Engler-Bunte-Institut des Karlsruher Instituts für Technologie (KIT) Gastechnologie Engler-Bunte-Ring 1 76131 Karlsruhe
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Internal Interim Project Report – Confidential

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POWER-TO-GAS

ENERGY STORAGE | CLEAN FUEL

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RWE

ITM Power's HGas System was delivered to RWE within 10 weeks of receiving the order, which was won as part of a competitive tender. The system is a second generation ITM Power PEM electrolyser system using a higher current density, permitting higher hydrogen output per stack. The system efficiency is also increased by simplification of the balance of plant.

POWER-TO-GAS

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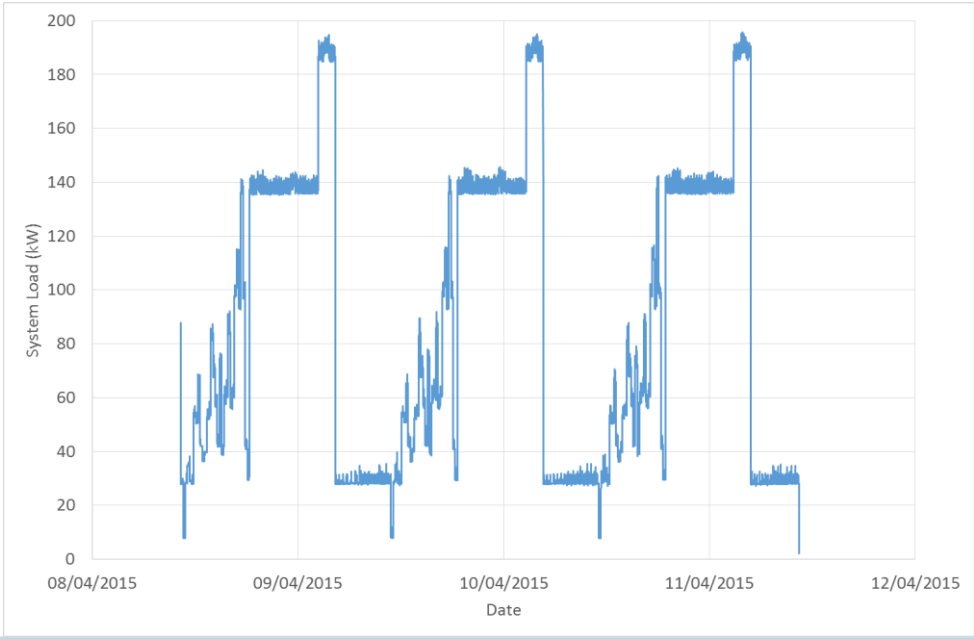
RWE ACCEPTANCE TESTING

Factory & Site Acceptance Testing

- 72 hour SAT completed
- System efficiency meets expectation



PLANT SIGN OFF

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RWE IBBENBÜREN

Seeking highest system efficiency

- Official opening and commissioning ceremony planned for 17th August
- Electrolyser to be operated exclusively using renewable ‘green’ power
- Hydrogen injected into regional gas transmission system (PN16) without compression
- RWE are seeking to increase system efficiency – more will be announced by RWE on 17th August

P2G PROJECTS

NEW PROJECTS

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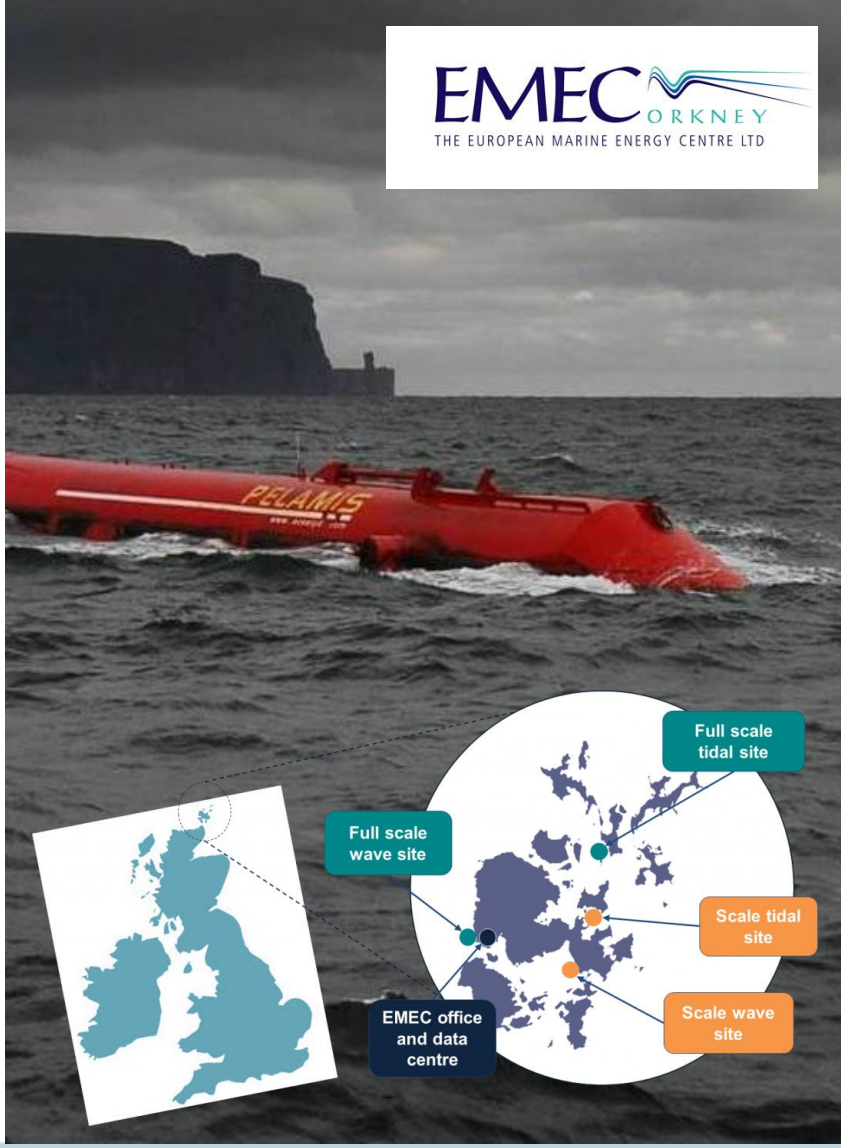
POWER-TO-GAS IN UK

EMEC | Orkney

- £1.8m sale
- Competitive tender won on price
- 0.5MW electrolyser + storage
- Complete hydrogen energy system
- Largest system to date
- Integrated hydrogen system for Tidal Energy Storage
- Eliminate island grid constraints for Tidal Testing Site
- Hydrogen for back-up power to EMEC's data & control systems
- Local community wind turbine – fully utilised for clean fuel



POWER-TO-GAS IN UK

Power-to-Methane

- Feasibility study followed by demonstration project
- Production of SNG using biological methanation and electrolytic hydrogen
- CO_2 sourced from existing biogas to biomethane upgrade facility operating at waste water treatment plant
- H_2 from rapid-response PEM electrolysis providing grid-balancing services
- Project commenced 1st June
- Funded by UK Government via Innovate UK
- Includes participation of water company & local gas distribution network operator

TECHNOLOGY DEVELOPMENT

1MW SYSTEM EVOLUTION

SYSTEM COST REDUCTION

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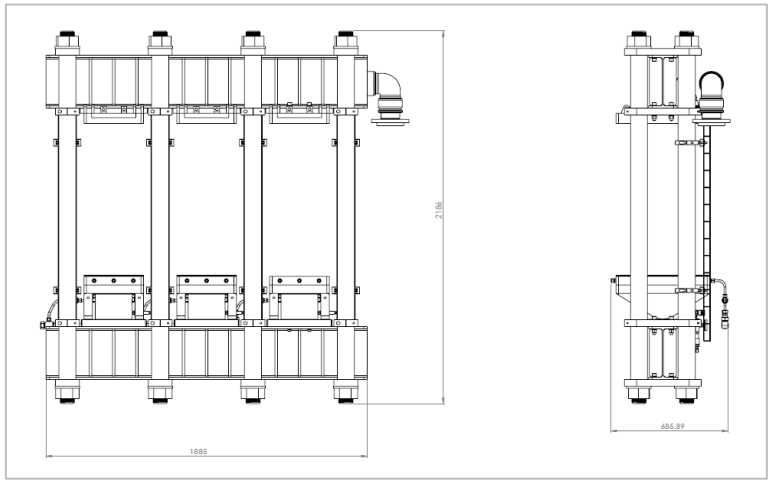
1MW P2G SKID | HANNOVER LAUNCH

New 1MW Skid | 3 x 350kW stacks

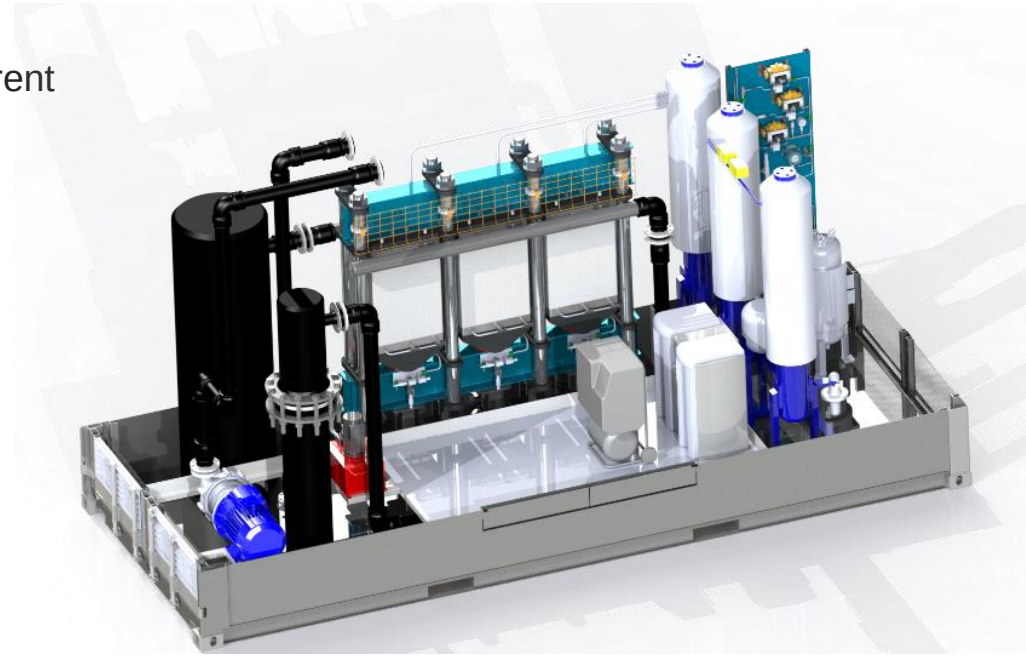
- Hannover launch April 2015
- Smallest 1MW system on the market
- Based on the new 350kW stack
- Rapid response | Modular unit
- Developing projects now



SYSTEM COST REDUCTION

Stack evolution

- 1MW required 16 LEP stacks
- Increased current rating allows use of 10 LEP stacks (30% system cost saving)
- MEP stacks being developed for higher current rating (projected 45% system cost saving)
- Bidding 1MW MEP for deployment 2017



1MW COST PROJECTIONS

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