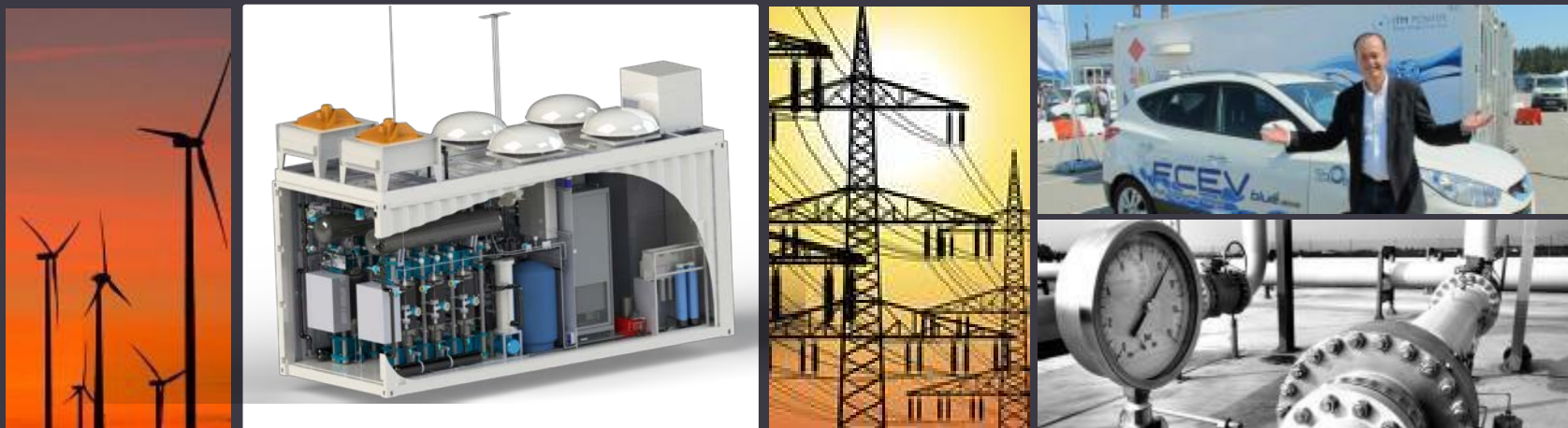


# ITM POWER ENERGY STORAGE | CLEAN FUEL HTAC April 21, 2015



**HYDROGEN = ENERGY + FUEL**

# ITM POWER ENERGY STORAGE | CLEAN FUEL

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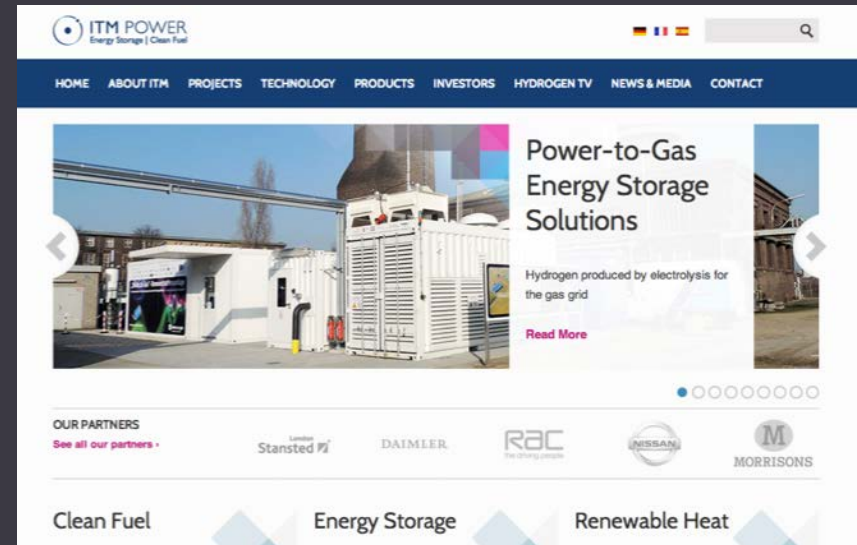
- Introduction to ITM Power Inc.
- Energy - Power to Gas (P2G)
- Fuel - Hydrogen Mobility
- The Link
- Summary

HYDROGEN = ENERGY + FUEL

# ITM POWER ENERGY STORAGE | CLEAN FUEL

## ITM Power | History

- First AIM listed fuel cell & hydrogen company
- 2004 Initial Public Offering
- 2011 Established ITM Power GmbH
- 2012 Established ITM Power Inc.
- 75 staff
- 2 active projects in US for refuelling
- 2015 JCB Research Strategic Investment in ITM



# ITM POWER INC.

## The Team so far.....

### Exec.



Graham Cooley

Graham joined ITM Power as CEO in 2009. Before that Graham was Business Development Manager in National Power plc and spent 11 years in the power industry developing energy storage and generation technologies. Before joining ITM Power Graham was CEO of Sensortec Ltd, Metalysis Ltd and Antenova Ltd.

### MD



Steve Jones

Steve has been with ITM since 2005 and has worked within core research, product testing and product development. Steve now heads up ITM's business development function and is MD of ITM Power Inc.

### BD



Geoff Budd

Geoff since August 2012 as ITM's North American Representative has focused on business development activities in the USA. Prior to that he spent 13 years with Ballard Power Systems in various roles, the last of which was as the Business Development Director in Europe. Geoff holds a BSc and a MBA.

### Advisors



Gary Higginbottom

Gary is a market development and sales consultant to product and supply-chain firms in the renewable energy business. Gary is also Executive Director of the Hydrogen Energy Center of Portland, Maine USA. He has over 30 years of experience in business development.



Alan Lloyd

Alan Lloyd has served as the President of the International Council on Clean Transportation (ICCT) since 2006. He served as the Secretary of the California Environmental Protection Agency from 2004 through February 2006 and as the Chairman of the California Air Resources Board (CARB) from 1999 to 2004.

# CLEAN FUEL | ENERGY STORAGE | RENEWABLE HEAT



Wind Power



Grid



Solar Power



Electrolyser



Clean Fuel



Energy Storage



Renewable Heat

HYDROGEN IS THE ONLY VIABLE HYBRID SOLUTION

# ENERGY STORAGE | CLEAN FUEL

## Two significant emerging markets

### Energy Storage:

- Follows the deployment of renewables
- Adds value to renewable energy (RE) and balances the grid
- Boston Consulting Group estimates a cum. global market in 2030 of ~\$370B
- H<sub>2</sub> projects starting around the world

### Clean Fuel:

- Fuel is the largest global market commodity (91M barrels per day)
- Hydrogen from renewable power offers fuel security
- Fuel cell vehicle roll out is underway worldwide
- California a world leader



Energy Storage



Clean Fuel

ENERGY STORAGE | CLEAN FUEL  
HYDROGEN ENERGY SYSTEMS



# ENERGY STORAGE

POWER TO GAS  
(P2G)/ HYDROGEN  
ENERGY STORAGE  
(HES)  
THE NEED  
THE MARKET



# CURTAILMENT = WASTED ENERGY AND MONEY

- RE curtailment is a growing occurrence
- Storage is required not just for hours but days/weeks/months
- The traditional route of storing energy has limitations of capacity
- GWhrs (weeks/months) of energy storage is only achievable with hydrogen

Europe leading the way so far.....

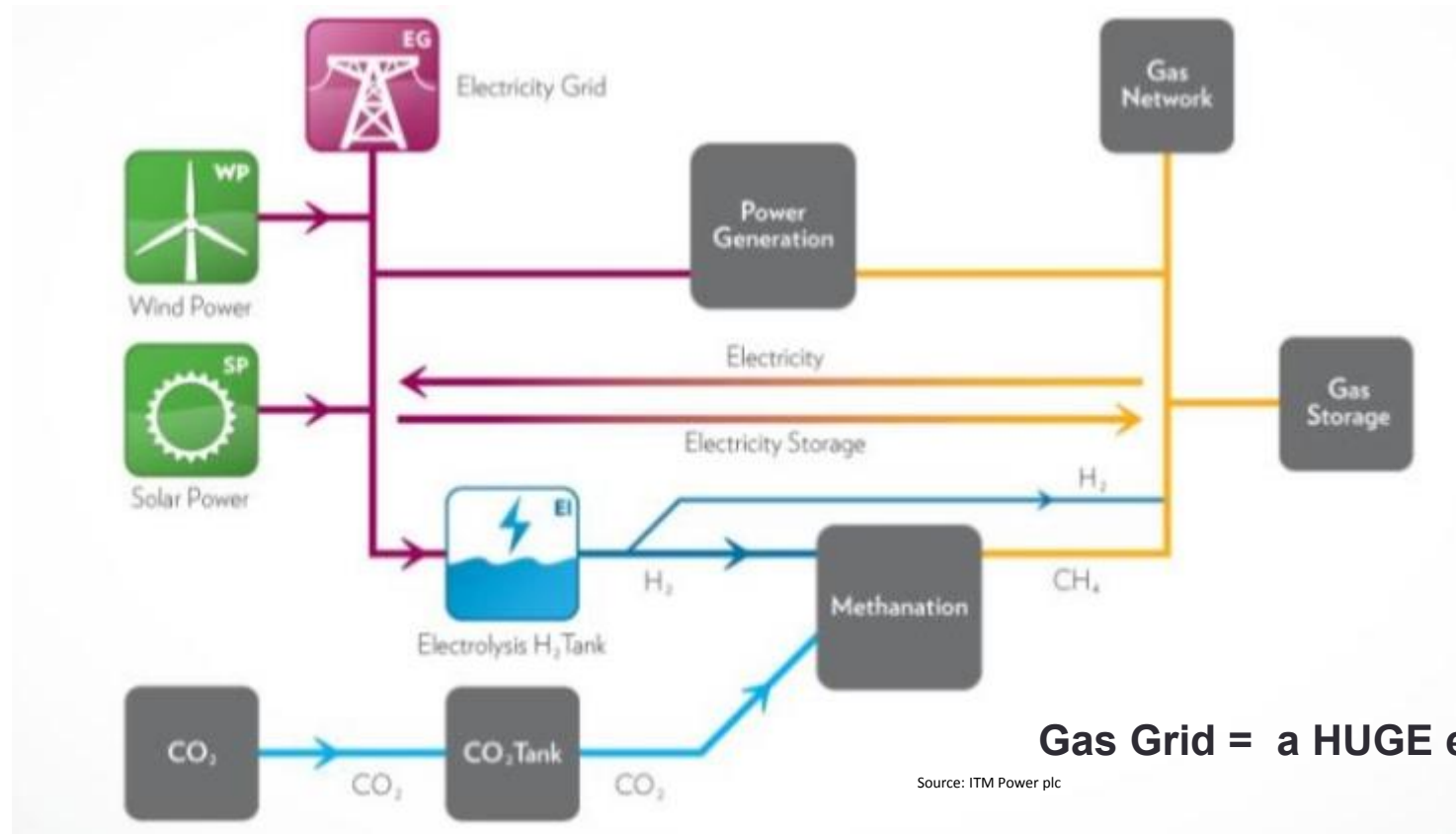
ENERGY STORAGE

ENERGY STORAGE | CLEAN FUEL



# WHAT IS POWER-TO-GAS?

Electricity cannot be stored easily | Hydrogen can be stored easily in the gas grid



**Gas Grid = a HUGE existing asset!!**

POWER-TO-GAS RATIONALE  
ENERGY STORAGE | CLEAN FUEL

## P2G (HES): ELEMENTS OF VALUE

- Value to the power grid
- Value to the gas grid
- Value to the economy

### Value to the Power Grid

- Avoided wind curtailment
- Avoided infrastructure upgrades
- Reduced reserve power
- Reduce CO<sub>2</sub> from open cycle GTs
- Absorbing reactive power

### Value to the Gas Grid

- Decarbonising gas
- Providing renewable heat
- Reducing GHG emissions from gas transportation

### Value to the US Economy

- Reducing fuel imports
- Improved energy security
- Creating jobs in manufacturing

P2G: ELEMENTS OF VALUE

ENERGY STORAGE | CLEAN FUEL

# BALANCING SUPPLY AND DEMAND – ANCILLARY SERVICES: SECOND BY SECOND – GRID BALANCING



THE NEED: GRID BALANCING

ENERGY STORAGE | CLEAN FUEL

# CORE TECHNOLOGY

## PEM Stack Platform | BoP Integration

- Modular
- Rapid response

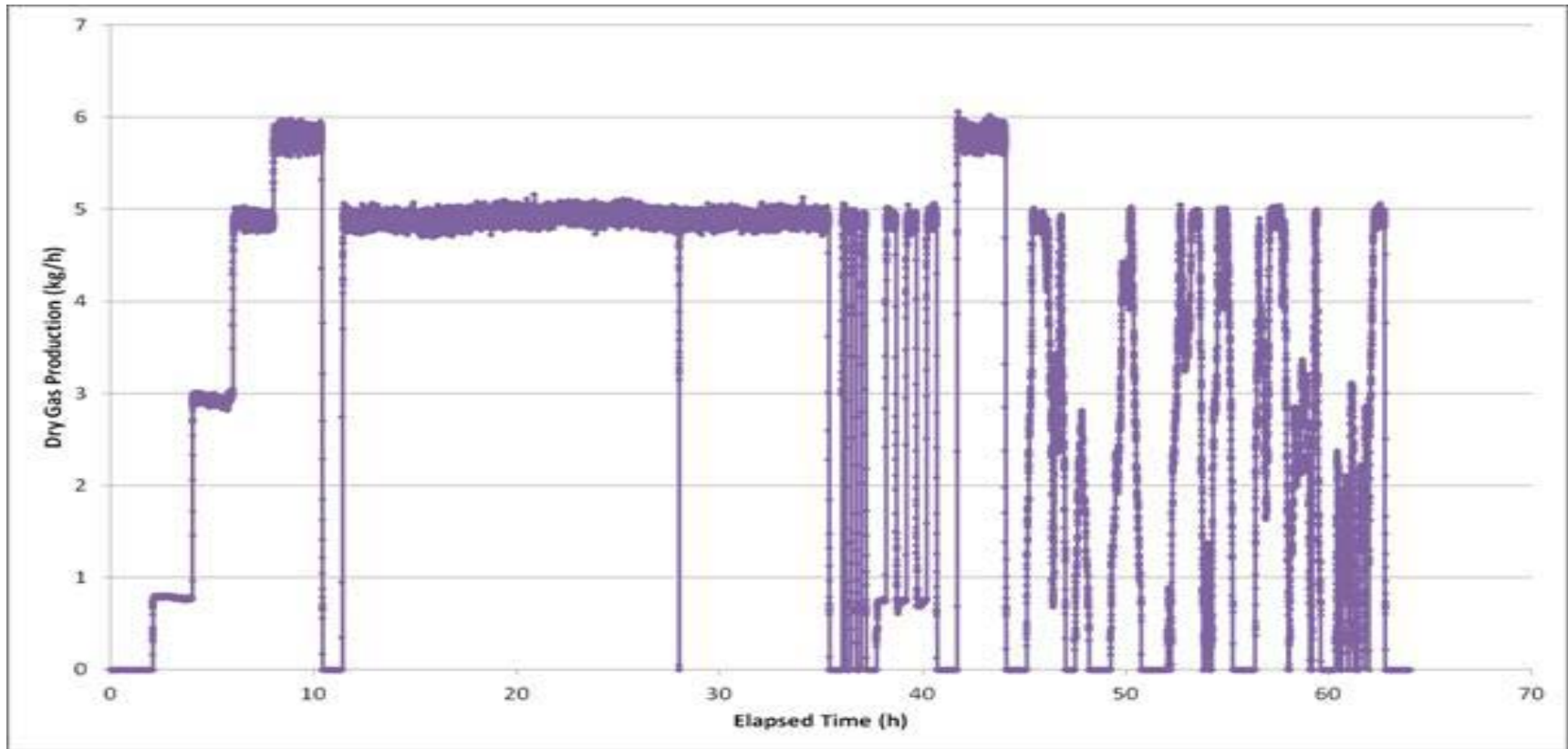


STACK PLATFORM

HYDROGEN ENERGY SYSTEMS

# SUCCESSFUL ACCEPTANCE TESTING

Detailed assessment of each system parameter



DYNAMIC OPERATION

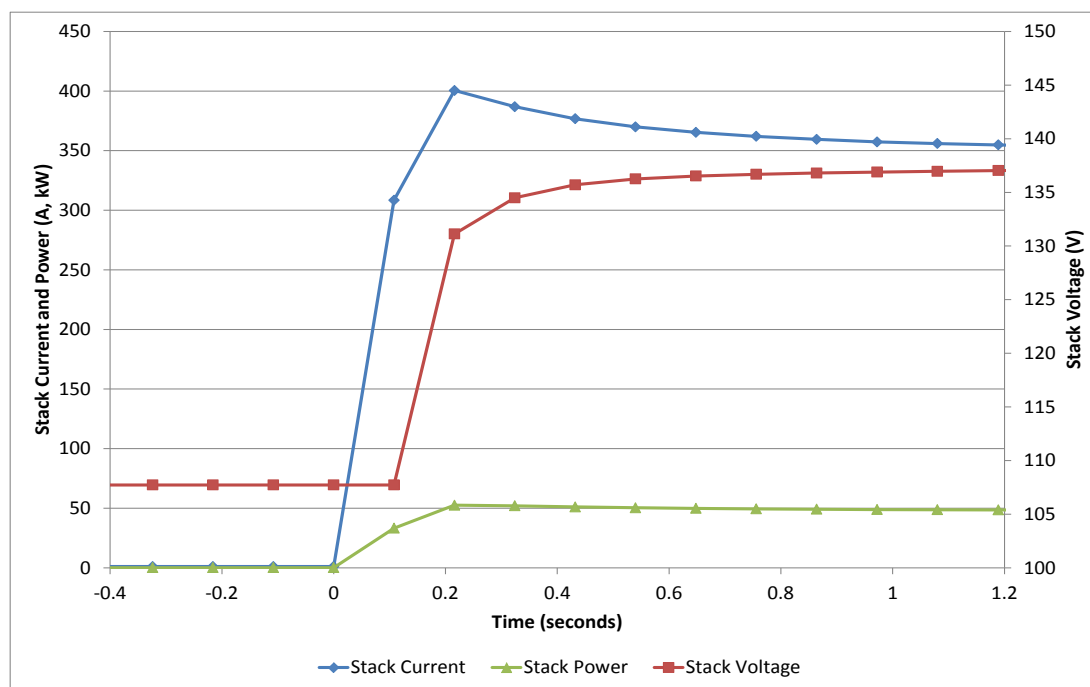
HYDROGEN ENERGY SYSTEMS



# DYNAMIC OPERATION

## Rigorous testing

- PEM enables rapid modulation
- Integrated power conversion electronics
- BoP & control system



STACK PLATFORM

HYDROGEN ENERGY SYSTEMS

## P2G PROJECTS

### THÜGA PROJECT METHANATION UREA



# FIRST P2G SALE: THÜGA GROUP

## Won competitive tender on performance & price

- One of the world's largest utility groupings
- 18,200 employees
- 5.7M customers (electricity, 3.6M, gas 2.1M)
- Sales of €21.3B
- Plant located at Mainova AG in Frankfurt
- 1 year of operation – exceeded average efficiency. Achieved up to 77%



Source: Thüga-Gruppe

360KW POWER-TO-GAS MODULE  
ENERGY STORAGE | CLEAN FUEL



## P2G PLANT & VISITOR CENTER THÜGA

### ENERGY STORAGE | CLEAN FUEL





MIXING PLANT

HYDROGEN ENERGY SYSTEMS





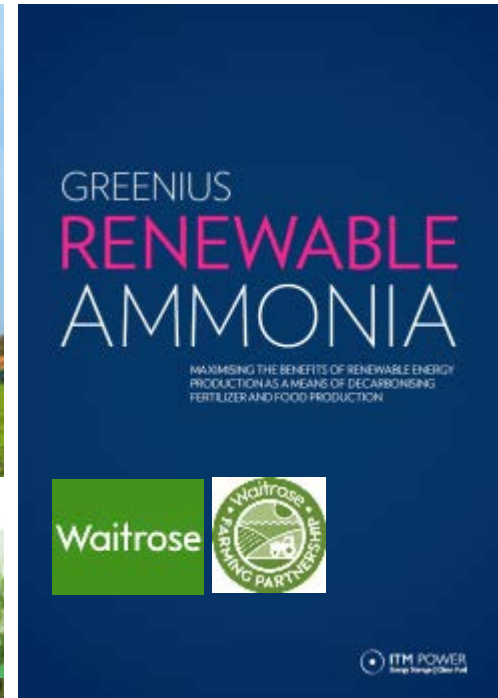
## P2G PLANT IBENBÜREN RWE

### HYDROGEN ENERGY SYSTEMS

# POWER-TO-GAS PROJECTS PIPELINE

## Beyond the Thüga project

- Thüga II
- P2G in Germany, USA, and UK
- Methanation | Biogas upgrading
- Ammonia | Urea (2% of global energy)



POWER-TO-GAS PROJECTS PIPELINE

HYDROGEN ENERGY SYSTEMS

# CLEAN FUEL

## HYDROGEN REFUELLING STATIONS

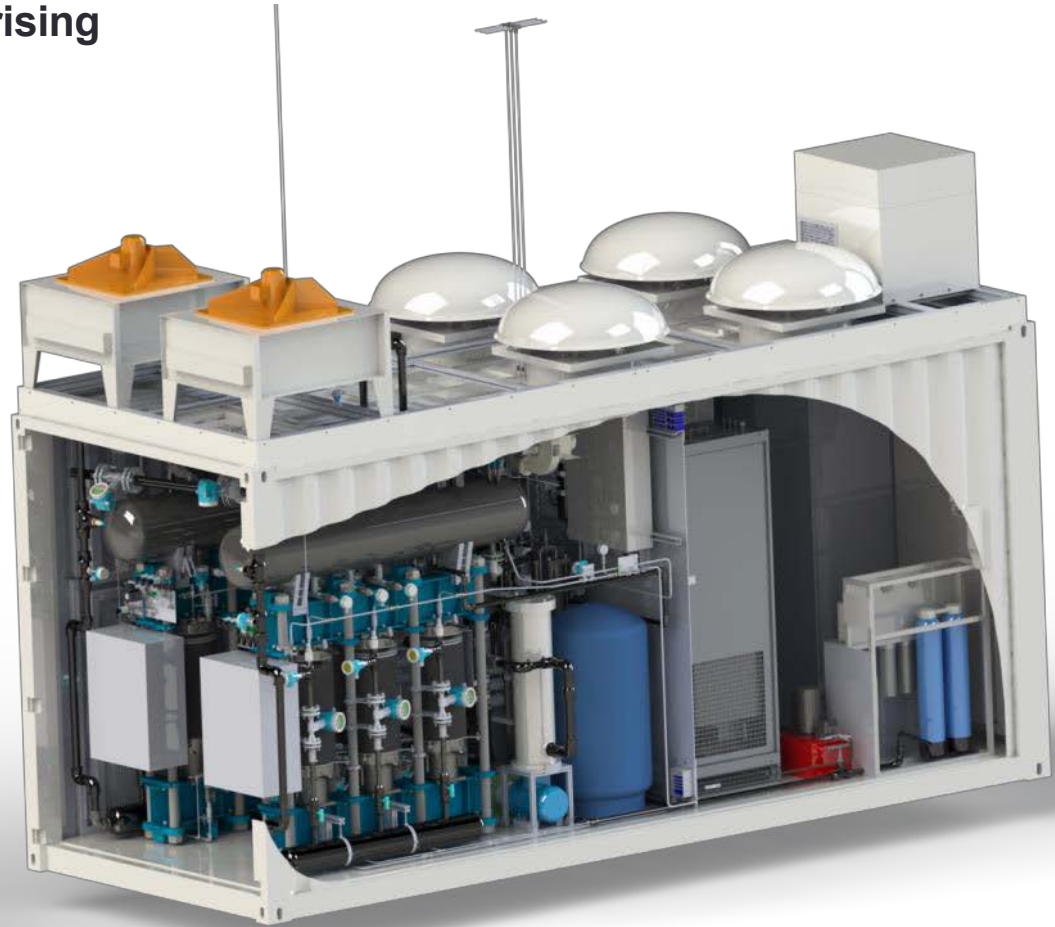




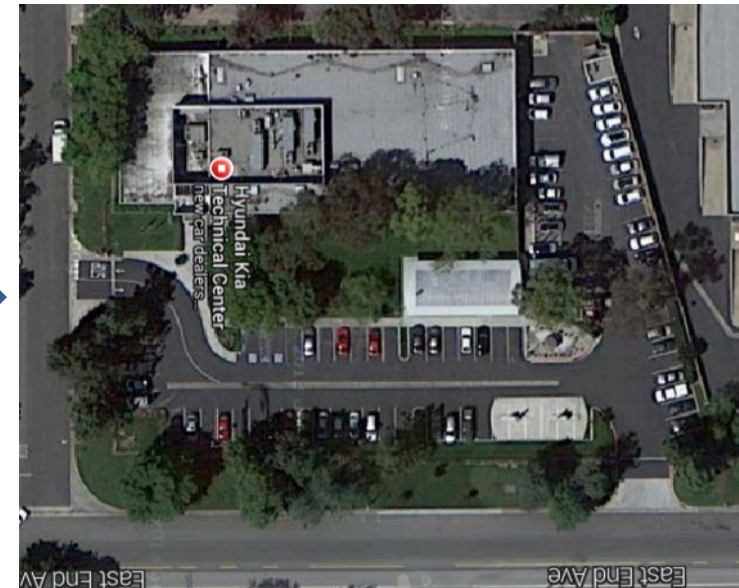
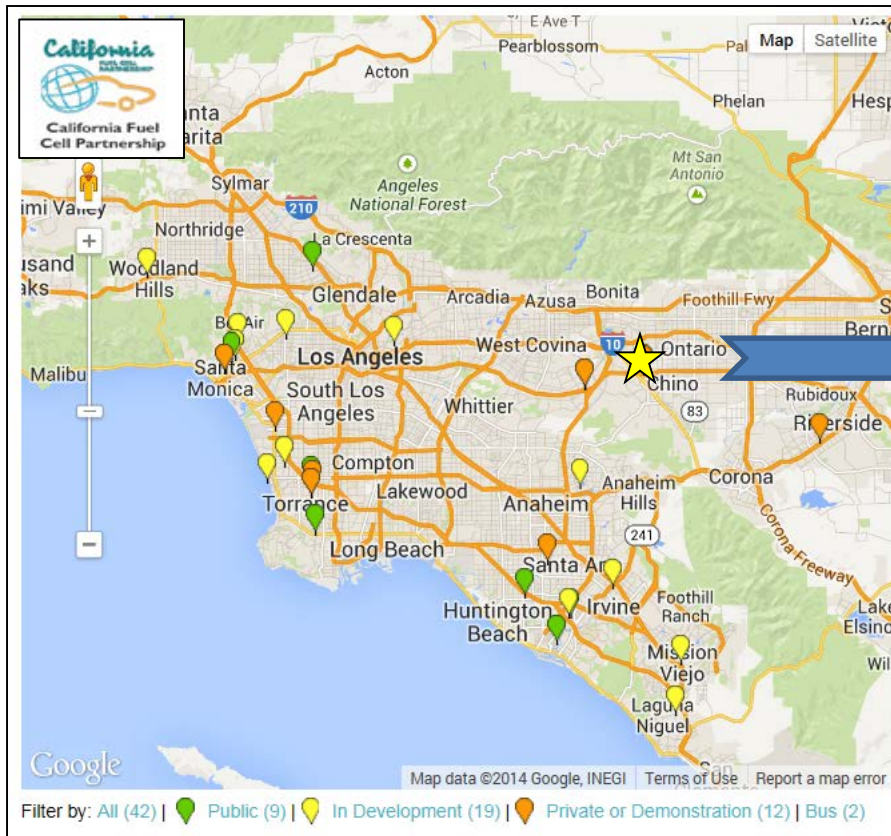
# WHAT'S UNIQUE ABOUT ITM ELECTROLYZERS?

## Rapid response | Self pressurising

- 1 sec response time
- 80bar self pressurising
- 1MW and modular



HES MODULE  
ENERGY STORAGE | CLEAN FUEL



H2 Frontier Inc



# STATION LOCATION

## ENERGY STORAGE | CLEAN FUEL



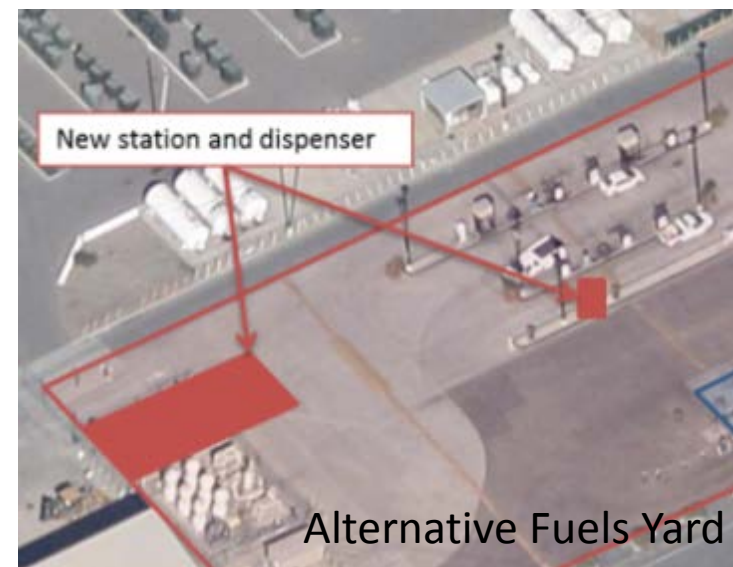
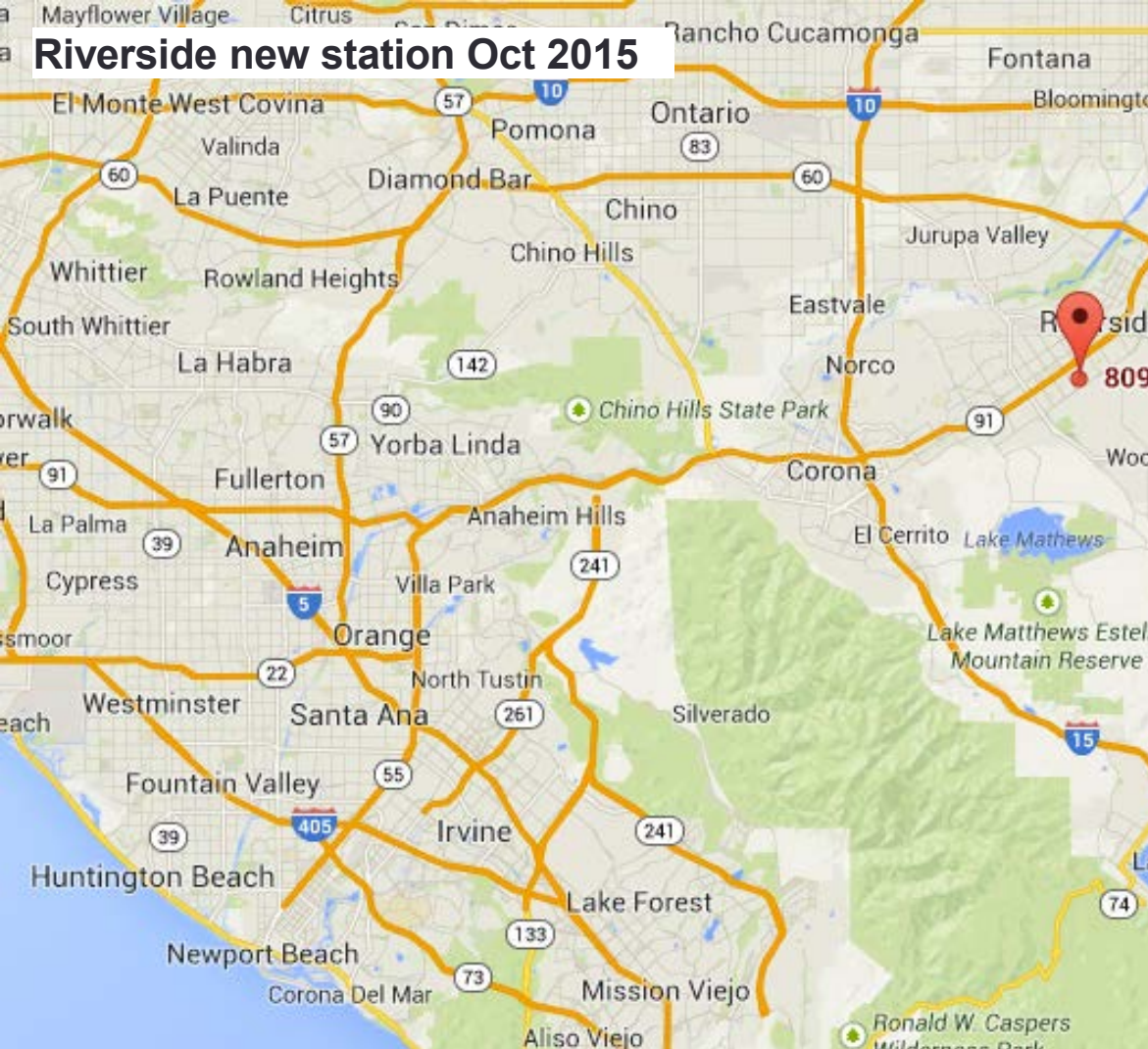
# Hyundai, Chino 100% Renewable Hydrogen Station



H2 Frontier Inc



# Riverside new station Oct 2015



H2 Frontier Inc





# REFUELLING STATIONS IN THE UK

**Selected by the London Hydrogen Partnership as the 2013 Hydrogen Refuelling Station partner**

- Joint Technology Initiative 2013 grant under the HyFIVE Project
- 100 Fuel Cell Electric Vehicles from 5 OEMs
- ITM - 3 refuelling stations in London (80-100 kg per day)
- Stations currently under construction. Commissioning in 2015

**Selected in 2015 by OLEV to Install 2 fuelling stations in London**

- Office of Low Emission Vehicles award to fund:
  - The installation of 2 new stations
  - Upgrades to 4 new stations including the 3 above in London and 1 in Rotherham
- Working in partnership with OEMs and global energy company on sites for these new stations



HyFIVE and OLEV  
ENERGY STORAGE | CLEAN FUEL

# ROTHERHAM MINI GRID

## Hydrogen Mini Grid

- Sited on the Advanced Manufacturing Park 2 mi from the M1 motorway network in South Yorkshire
- 225kW wind turbine coupled directly to an electrolyzer
- Hydrogen dispensing unit
- 30kW fuel cell system capable of providing backup power generation
- M1 motorway was highlighted BY UKH2 MOBILITY as a key connector route



REFUELLING  
ENERGY STORAGE | CLEAN FUEL

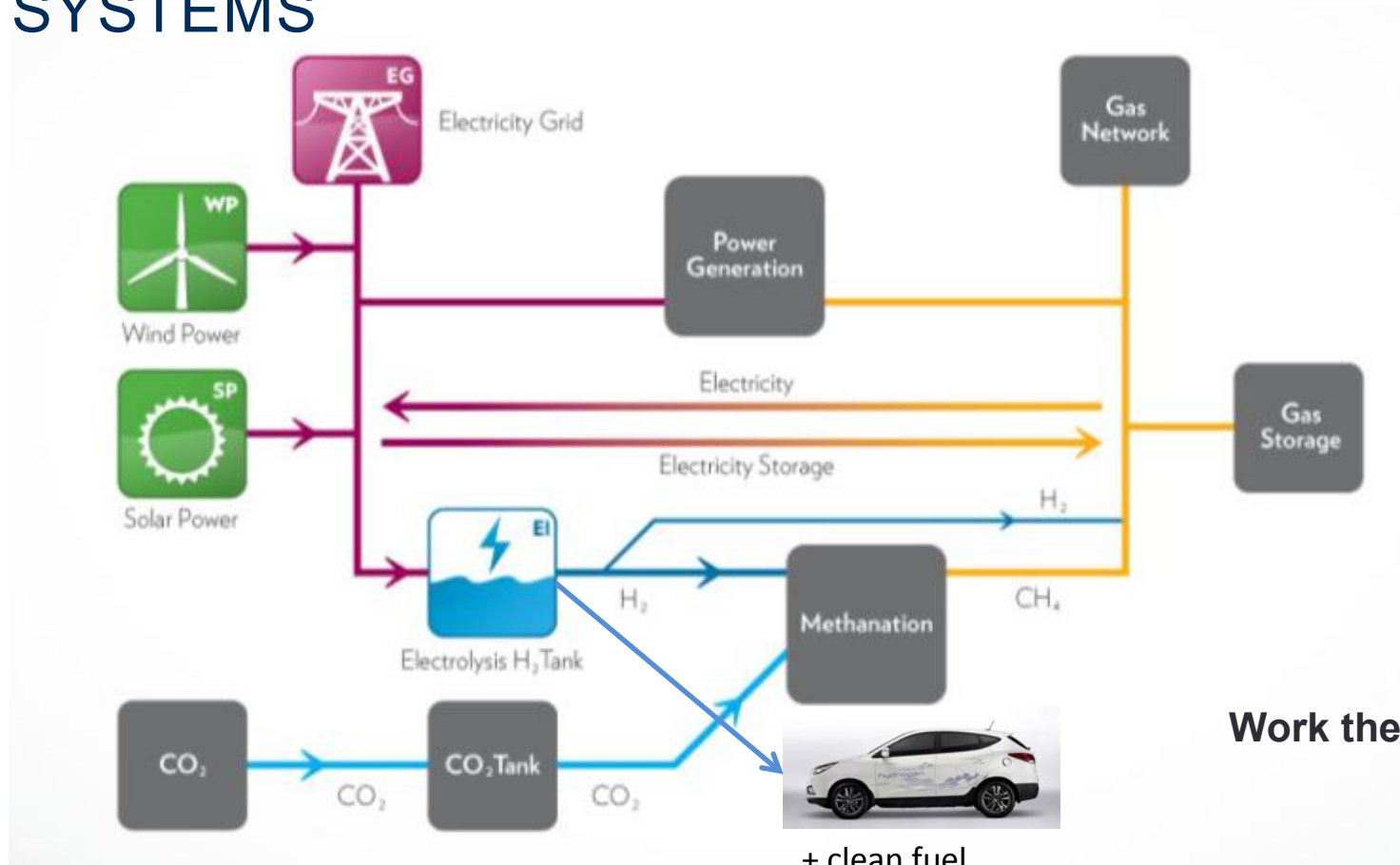
# ENERGY STORAGE AND CLEAN FUEL

## THE LINK - OPPORTUNITY





# POWER TO GAS: RATIONALE – HYBRID SYSTEMS



POWER TO GAS: RATIONALE  
HYDROGEN ENERGY SYSTEMS

# ENERGY STORAGE AND CLEAN FUEL

- HES – recognised as a viable technology in the mix
- Link with utility providers (Gas and Electric)
- Link to fuelling infrastructure
- Joint strategy and synergies
- Install demo projects
- Evaluate



ZEV FUEL

ENERGY STORAGE | CLEAN FUEL

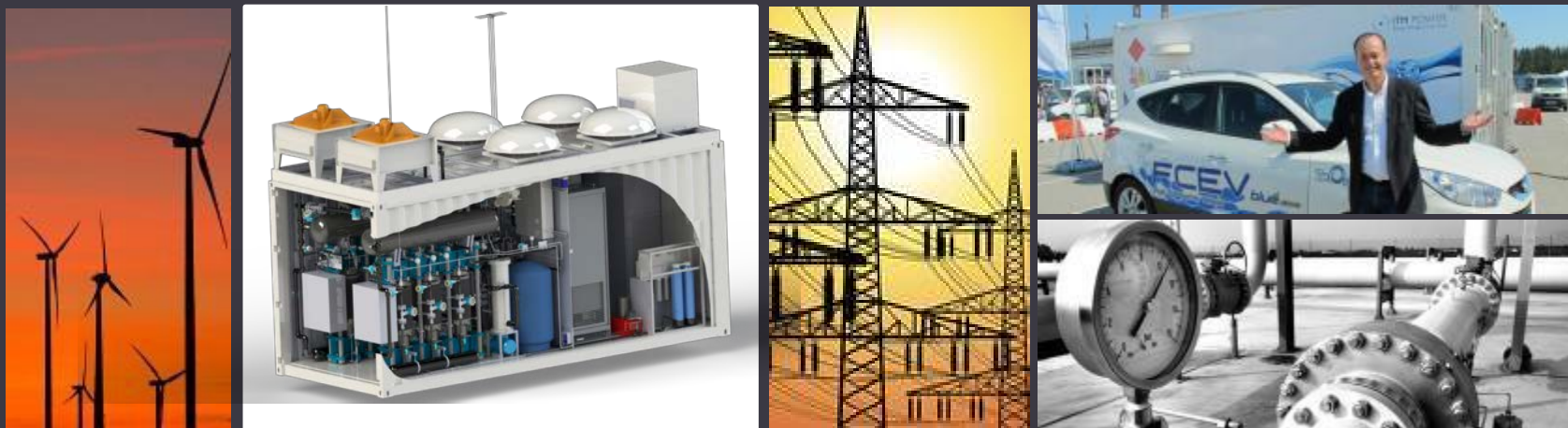
# ITM POWER ENERGY STORAGE | CLEAN FUEL

## Summary:

- Renewable energy needs storage
- Zero emission vehicles ultimately need zero emission fuels
- Electrolysis is the only technology that links electricity and gas networks
- Energy storage links fuel and energy
- Work to be done to ensure the pathway is successfully achieved

HYDROGEN = ENERGY + FUEL

# ITM POWER ENERGY STORAGE | CLEAN FUEL



HYDROGEN = ENERGY + FUEL