# IEA HYDROGEN WORKSHOP

PARIS, 10TH JULY 2013

## ITM POWER DESIGNS AND MANUFACTURES HYDROGEN ENERGY SYSTEMS FOR ENERGY STORAGE AND CLEAN FUEL PRODUCTION

ITM POWER
Energy Storage | Clean Fuel

# UNIQUE RAPID RESPONSE ELECTROLYSER

**Available in 1MW modules | Responds in 1sec | Self pressurises to 80bar**

Wind Power

Grid

Solar Power


ITM Electrolyser

Clean Fuel

Energy Storage

Renewable Heat

## ENERGY STORAGE: THE NEED

HYDROGEN ENERGY SYSTEMS

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# ENERGY STORAGE

## NEED
## MARKET
## POWER-TO-GAS

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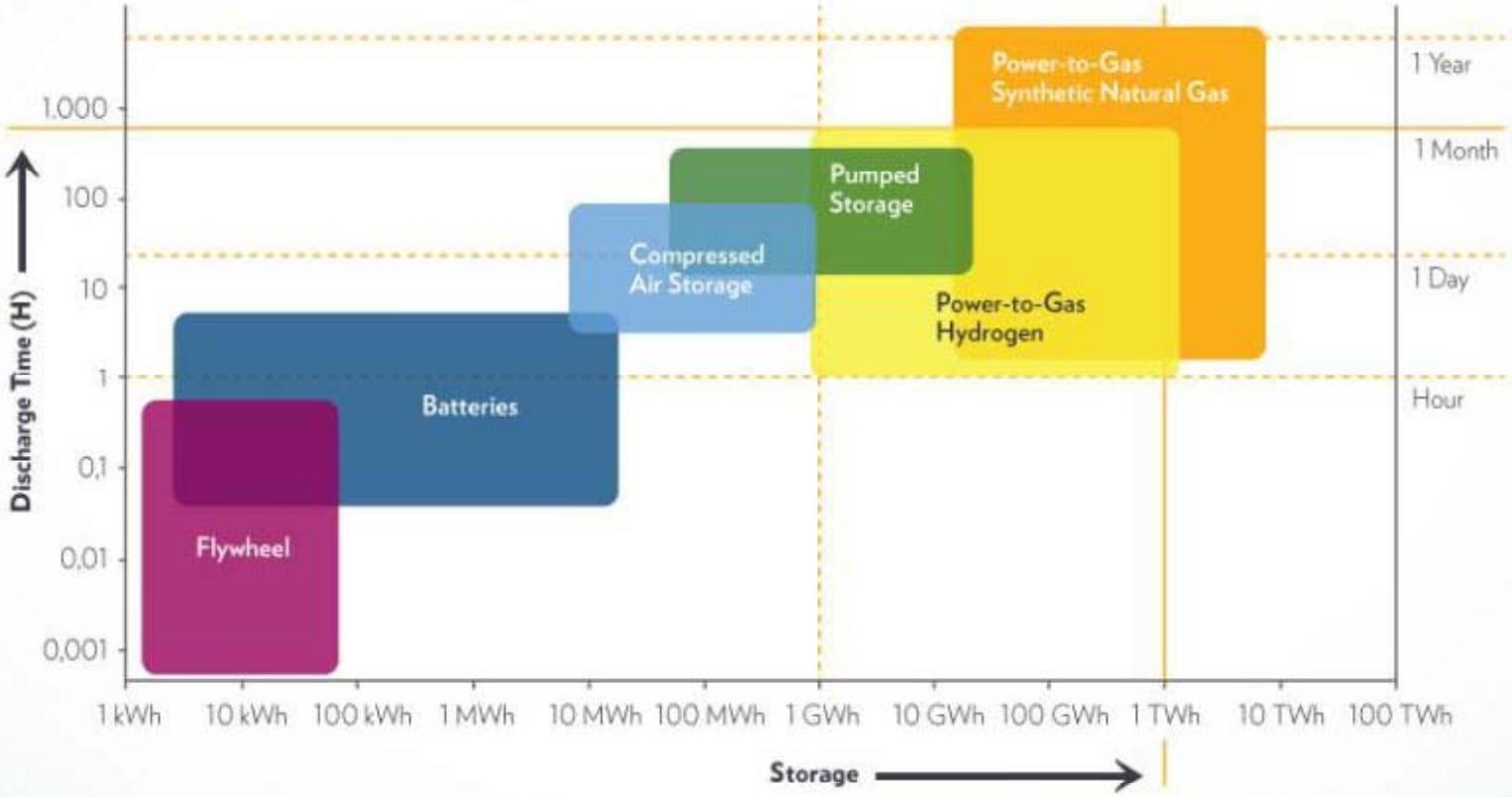
# ENERGY STORAGE TECHNOLOGIES




ENERGY STORAGE TECHNOLOGIES

ENERGY STORAGE | CLEAN FUEL

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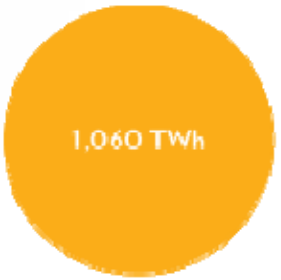
Energy Storage | Clean Fuel

# GAS GRID | FUEL INFRASTRUCTURE | POWER GRID




GAS GRID

**1,060 TWh**


FUEL INFRASTRUCTURE

**770 TWh**


POWER GRID

**350 TWh**

## UK GAS | FUEL | POWER

ENERGY STORAGE | CLEAN FUEL

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# SHUT DOWN: £1M PER DAY

**Wind curtailment is a regular occurrence**

- Priority of dispatch
- High curtailment payments
- An increasing problem
- Solved by energy storage

The Telegraph

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## Scottish wind farms paid £1 million to shut down one day

Wind farm companies operating in Scotland were paid more than £1 million to shut down their turbines for a single day last month, it has emerged.

Wind farm companies receive constraint payments to switch off their turbines when supply exceeds demand Photo: PA

By Simon Johnson, Scottish Political Editor
12:38PM BST 05 May 2013

Print this article

# UK GOVERNMENT BACKING

ENERGY STORAGE | CLEAN FUEL

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# GRID BALANCING

## FREQUENCY
## SUPPLY SIDE
## DEMAND SIDE

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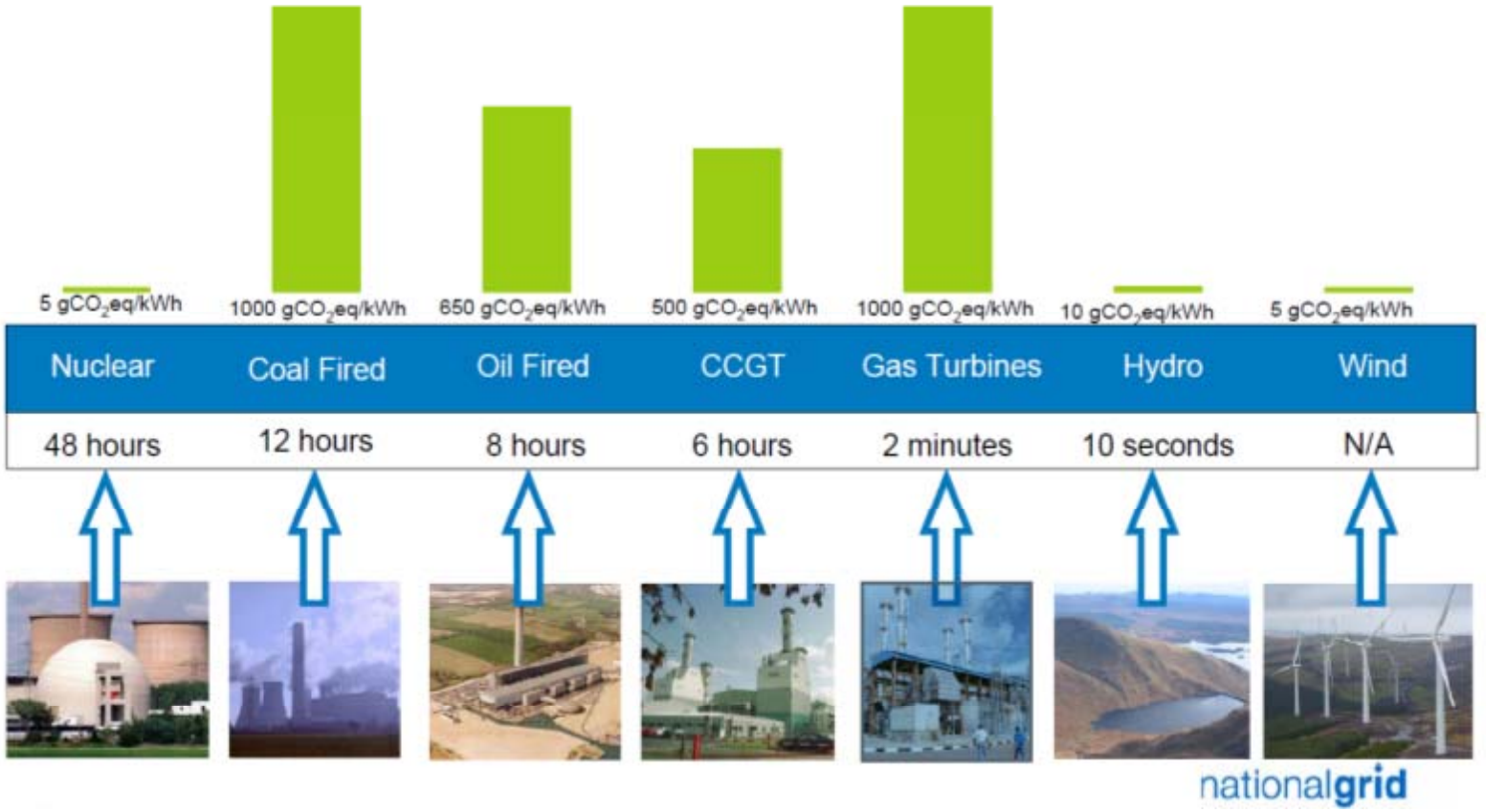
# BALANCING SUPPLY AND DEMAND:

## DIFFICULT TO IMPLEMENT ON THE SUPPLY SIDE




## THE NEED: GRID BALANCING

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# RAPID RESPONSE

## PRIMARY
## SECONDARY
## RESERVE

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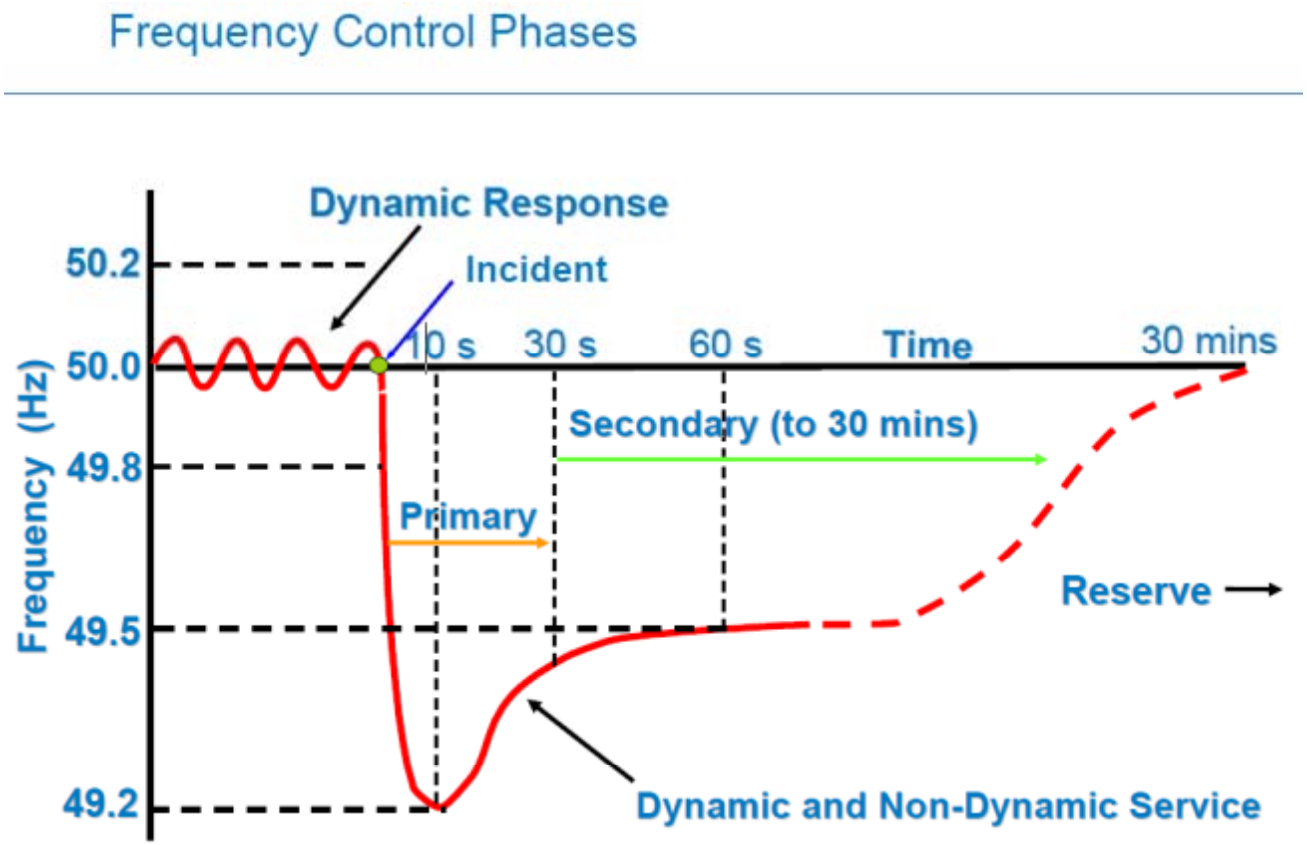
# PRIMARY VS SECONDARY RESPONSE



# POWER TO GAS ENERGY STORAGE

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# HGAS PLATFORM

## ON SITE HYDROGEN GENERATION

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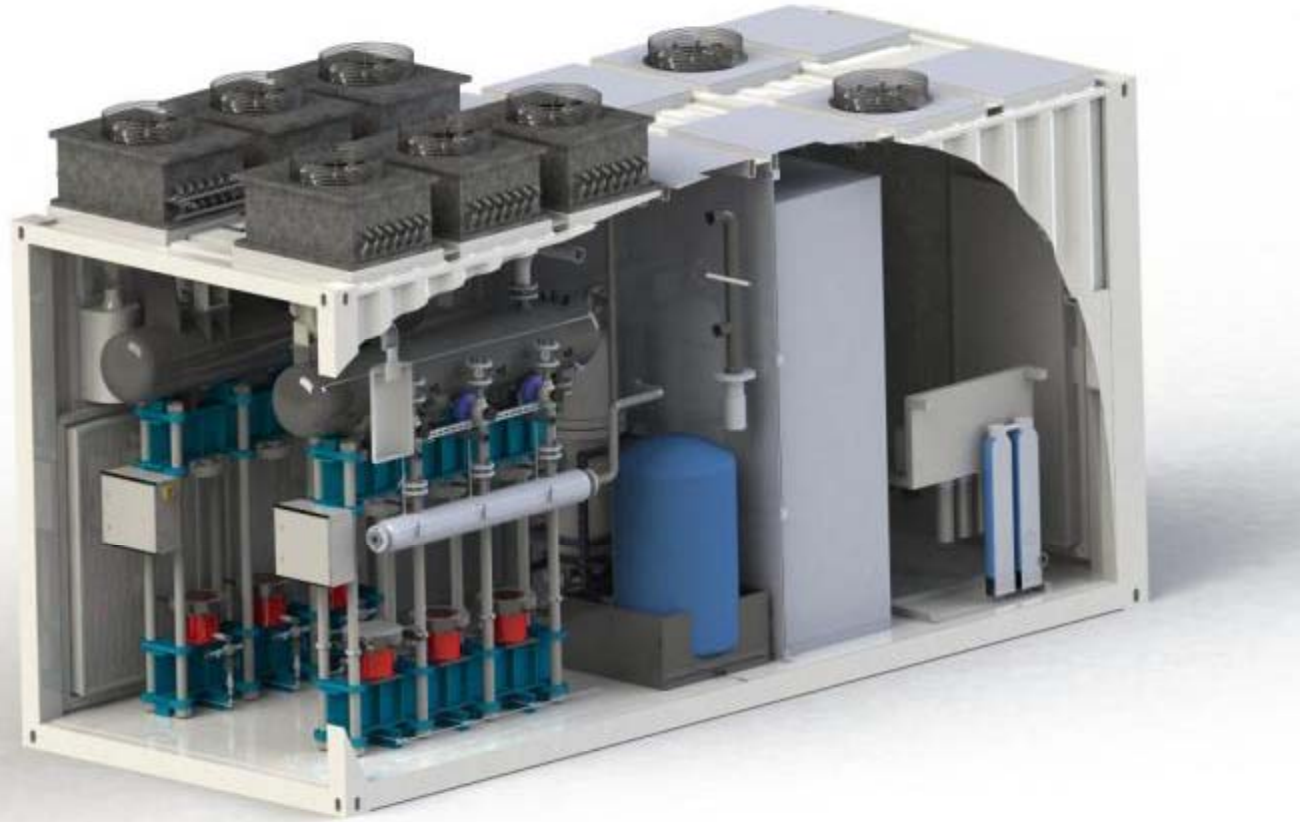
# 360KW POWER TO GAS MODULE

**Available in 1MW modules**

- 80bar self pressurising
- 1 sec response
- 1MW | 8760MWhr



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AEG
POWER SOLUTIONS

## 360KW POWER TO GAS

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Visitor center

Mixing Plant

$H_2$ generation

ecoisland
www.eco-island.org

## Hydrogen Energy Storage Smart Grid

- £2.4m TSB consortium grant
- First installations 100kg/day & 15kg/day refueller
- Fleet of 20 vehicles (HICE and FC)
- Hydrogen energy storage system
- Balancing supply and demand

Technology Strategy Board
Driving Innovation

ECOISLAND PARTNERS

- SSE
- Arcola
- Cheetah Marine
- IBM
- Vodafone
- Ecoisland Partnership CIC
- University of Nottingham
- University of South Wales
- NPL
- Toshiba

VEHICLE STEERING GROUP

- Toyota
- Hyundai

CAR CLUB

- River Simple
- Micro Cab

# UK INFRASTRUCTURE ROLL OUT

## ENERGY STORAGE | CLEAN FUEL

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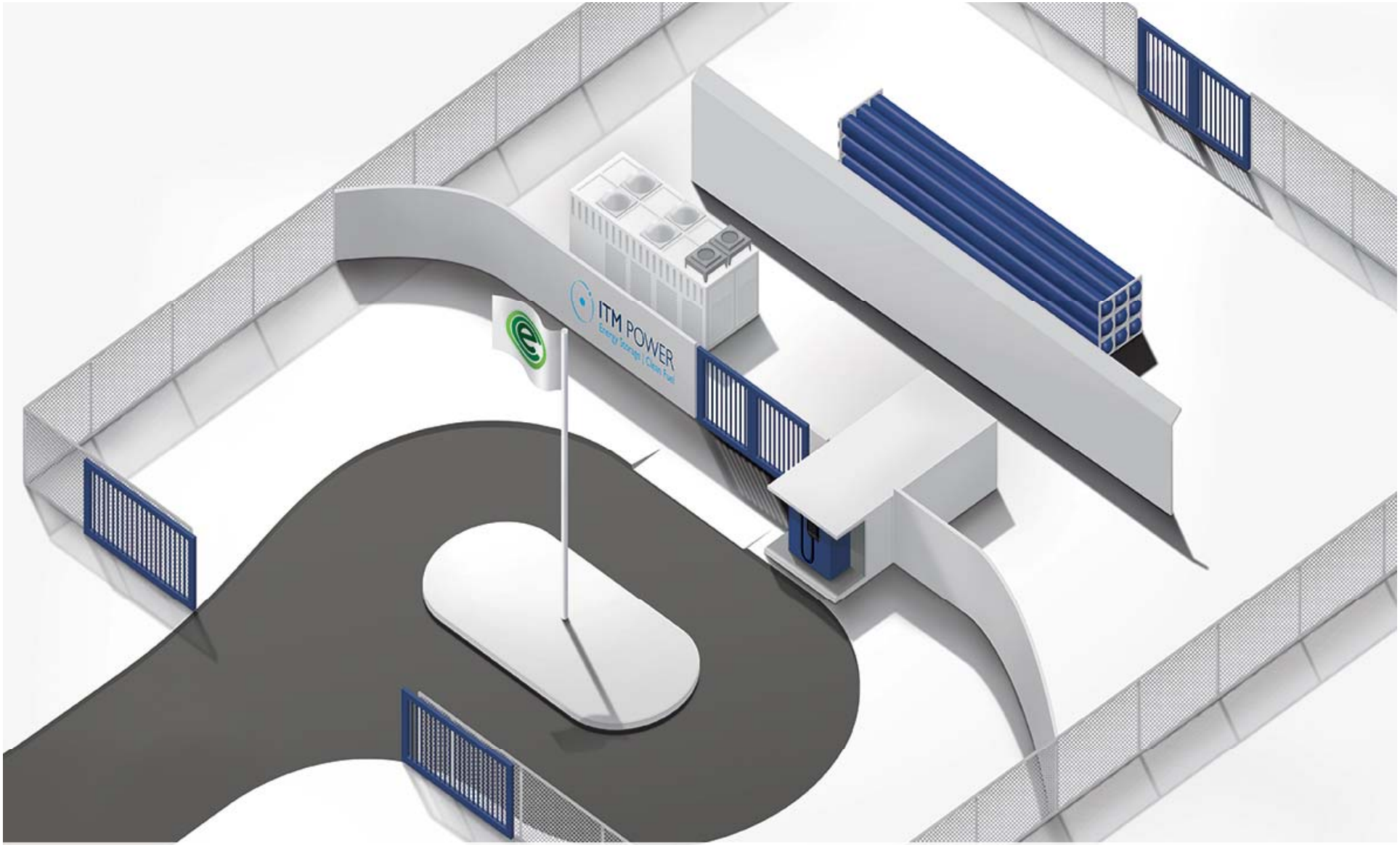


ecoisland
www.eco-island.org

CHEETAH MARINE CATAMARANS

SSE

IBM

vodafone

arcola

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The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

University of South Wales
Prifysgol De Cymru

NPL
National Physical Laboratory

TOSHIBA

# FUEL CELL CARS: ARE HERE!


FUEL CELL CARS: ARE HERE!

HYDROGEN ENERGY SYSTEMS

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# FUEL CELL CARS: RACE TO MARKET

**Five of the big seven rewrite the rules: Jan 2013**

- Hyundai 2012
- Toyota, BMW 2015
- Honda 2015
- Daimler, Renault-Nissan, Ford 2016

24th Jan: Toyota | BMW


28th Jan: Daimler | Ford | Nissan

# NATIONAL MOBILITY INITIATIVES

| Country | Involvement |
|---|---|
| Germany | Associate |
| South Korea | None |
| Japan | None |
| UK | Full Member |
| Denmark | Partner Identified |
| France | Full Member |
| Switzerland | Full Member |
| USA | Full Member |

## INFRASTRUCTURE ROLL OUT

ENERGY STORAGE | CLEAN FUEL

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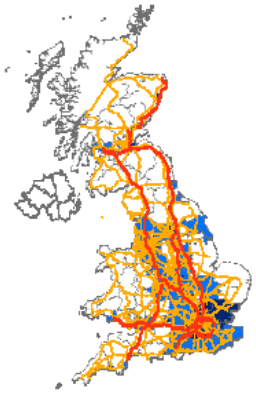
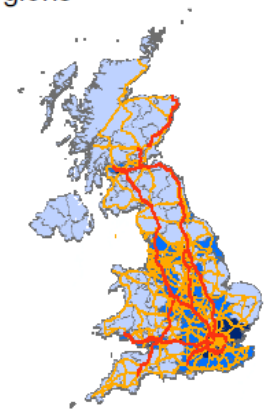
# 1 The proposed HRS network provides full coverage of major UK roads by 2025, reaching 955 stations by 2030

Tier 1 roads | Tier 2 roads | Tier 1 | Tier 2 | Tier 3

| | Tier 1 (2015-19) – Major cities and key motorways | Tier 2 (2020-24) – Full coverage of major roads | Tier 3 (2025-29) – Full population coverage |
|---|---|---|---|
| **Objective** | ▪ Focus on **major population centres**, enable long distance **travel between Tier 1 regions** | ▪ Extend close-to-home refuelling to **70%** of the population, **full coverage** of major road network | ▪ Extend close-to-home refuelling to the **whole of the UK**, including less populated regions |
| |  |  |  |
| **Number of stations** | **183** | **603** | **955** |
| **Population coverage** | 30% | 70% | 100% |

SOURCE: UK $H_2$Mobility

UK $H_2$ Mobility

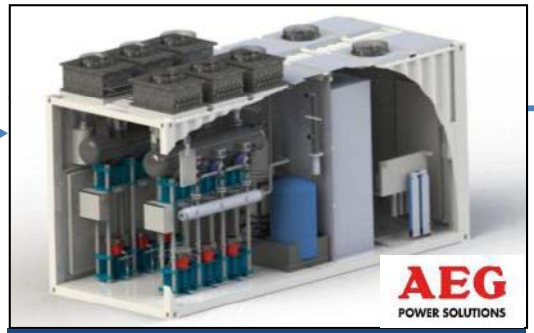
# ENERGY STORAGE | CLEAN FUEL

**Energy Storage Sale:** **The Thuga Group | Germany**
**Clean Fuel Sale:** **Califonia Energy Commission**

Wind Power

Grid

Solar Power




ITM Electrolyser


HRS $H_2$USA

Energy Storage

P2G Thuga

## ENERGY STORAGE: THE NEED

HYDROGEN ENERGY SYSTEMS

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# IEA HYDROGEN WORKSHOP

## PARIS, 10TH JULY 2013

**Summary:**


•Energy storage firmly on the energy map

•The case for hydrogen Power-to-gas Energy Storage is very strong

- •Technologies and supply chains have matured
- •Need to unbundle value to provide payment structures

- Hydrogen vehicles are being rolled out world-wide
  - Mobility programs essential for vehicle | fuel coordination
- Germany | USA | UK | Denmark | France | Japan


ITM POWER DESIGNS AND MANUFACTURES HYDROGEN ENERGY SYSTEMS FOR ENERGY STORAGE AND CLEAN FUEL PRODUCTION

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# THANK YOU !

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# IEA HYDROGEN WORKSHOP - APPENDIX

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# CLEAN FUEL | ENERGY STORAGE | RENEWABLE HEAT

## Three massive emerging markets

**Clean Fuel:**

- Fuel is the largest global market (400m barrels per day)
- Hydrogen from renewable power provides fuel security
- Fuel security a key political issue
- Fuel cell vehicle roll out is underway worldwide

**Energy Storage:**

- Follows the deployment of renewables
- Adds value to RE and balances the grid
- BCG estimates a global market in 2030 of $400bn

**Renewable Heat:**

- Very difficult using any other method
- Power-to-gas a unique solution


Clean Fuel

Energy Storage

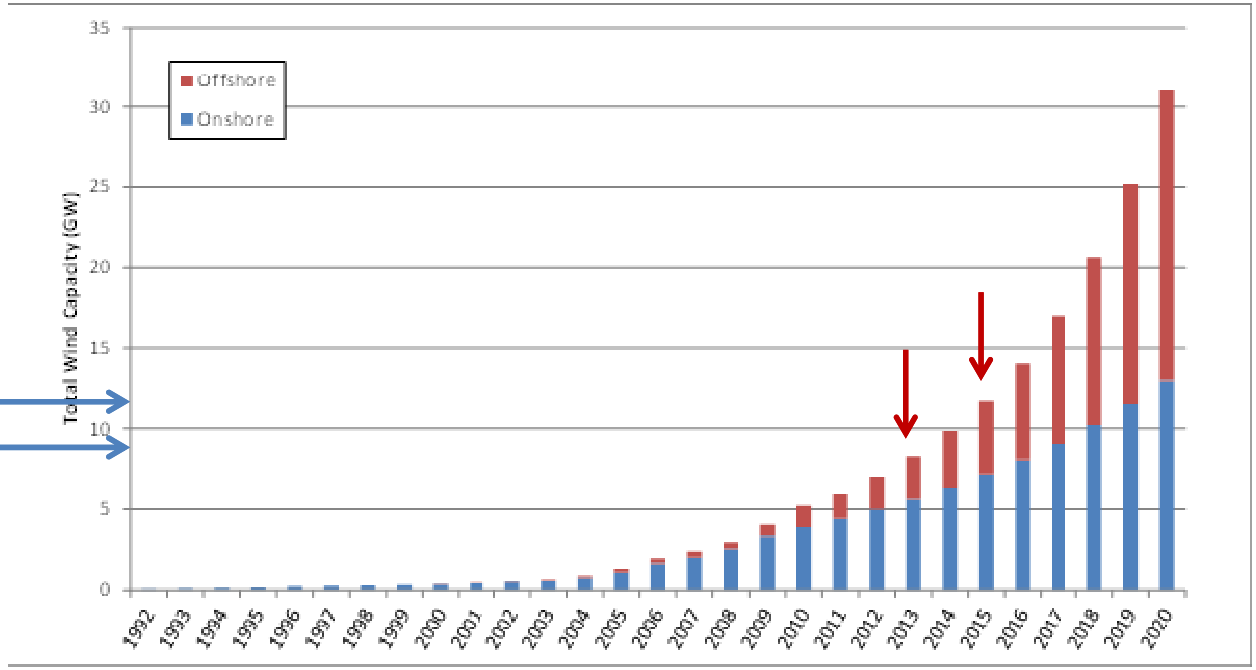
Renewable Heat

# GROWING WIND GENERATION

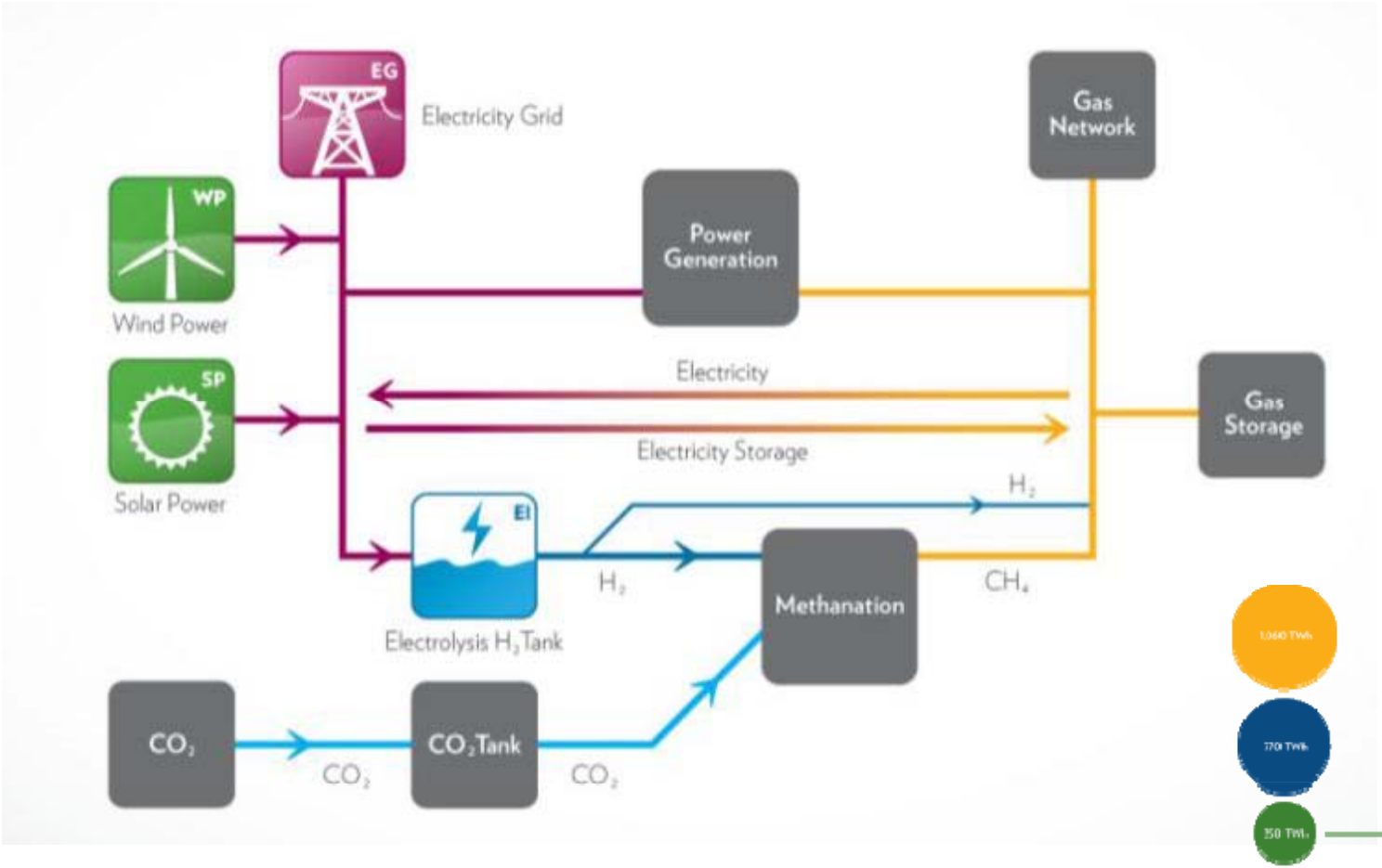
- Evidence from Germany and Denmark
- Problems start at 20% capacity; UK hits threshold from 2013
- Problems start at 8% energy; UK at 10% by the end of 2013 (DECC)

20% of peak capacity (60GW) in Winter

20% of peak capacity (40GW) in Summer



# POWER TO GAS: RATIONALE





# POWER TO GAS: RATIONALE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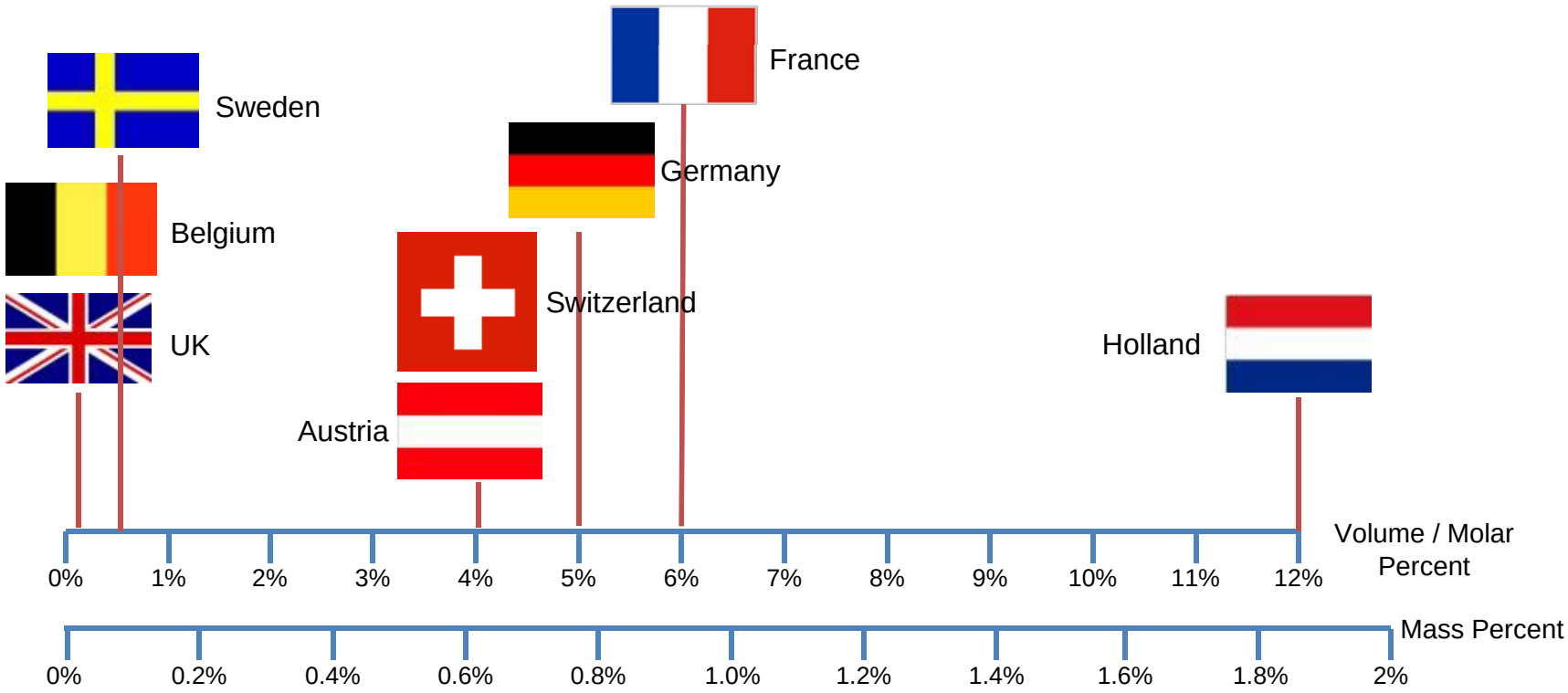
# EU Hydrogen Limits for Injection into the HP Gas Grid

Covered by a range of local laws and EU Directives Note: interpretation of these rules is complex



# POWER TO GAS

Technology Strategy Board
Driving Innovation

## The TSB funded GridGas study

- Opportunity analysis
- Compliance of gas injection
- Rapid response electrolysis
- Gas mixing
- Location of stranded gas assets in the UK
- Potential in Scotland
- Website: [www.gridgas.co.uk](http://www.gridgas.co.uk)


GASTEC at CRE — Compliance

Scottish Hydrogen & Fuel Cell Association — Stranded Grids

Logan hydrogen — Installation

SSE — Deployment

POWER TO GAS

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# POWER TO GAS

**The DECC funded Methanation study**

- Opportunity analysis
- Process definition
- Compliance of gas injection
- Project definition


GASTEC at CRE — Compliance

Logan hydrogen — Installation

SSE — Deployment

Scotia Gas Networks — Deployment

## METHANATION: POWER TO GAS

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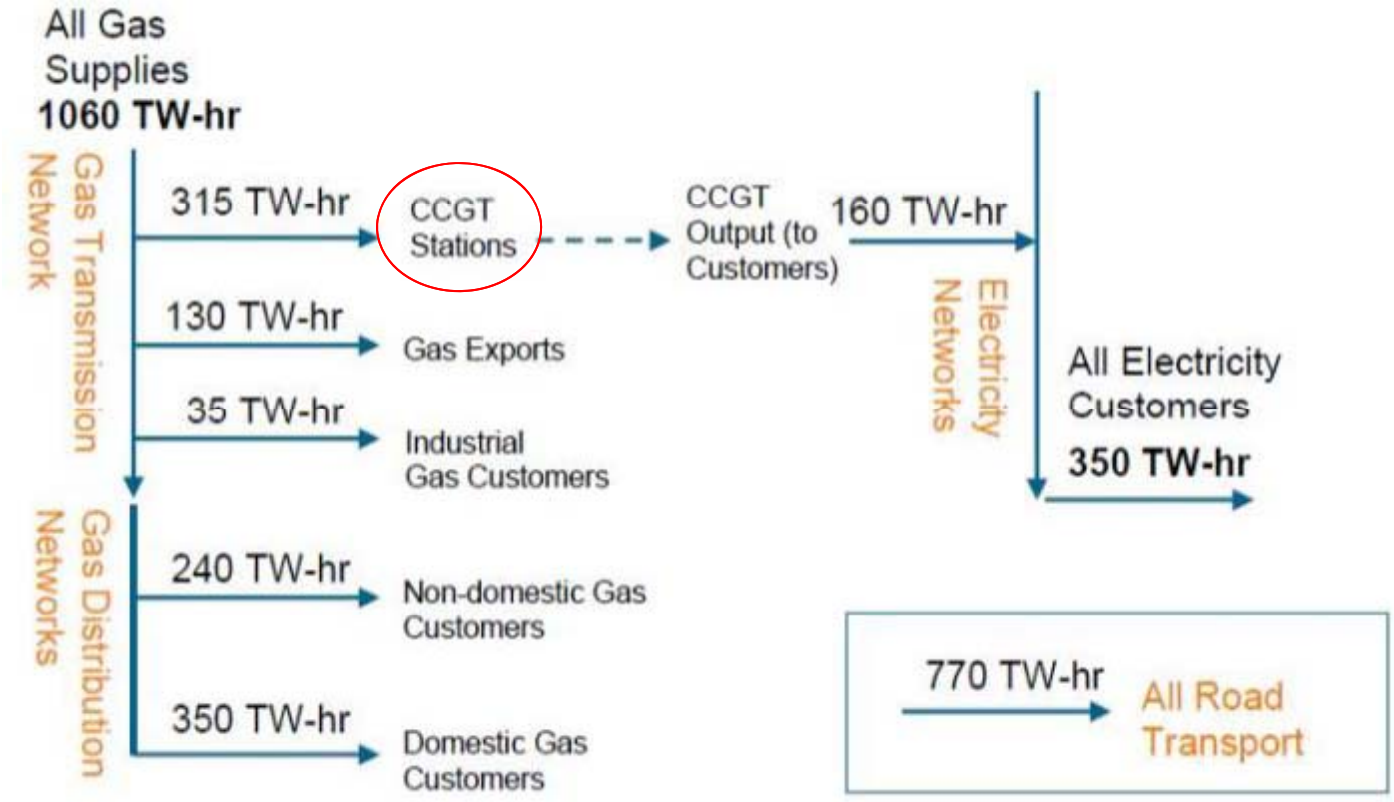
# GAS GRID | POWER GRID | FUEL INFRASTRUCTURE




## POWER TO GAS

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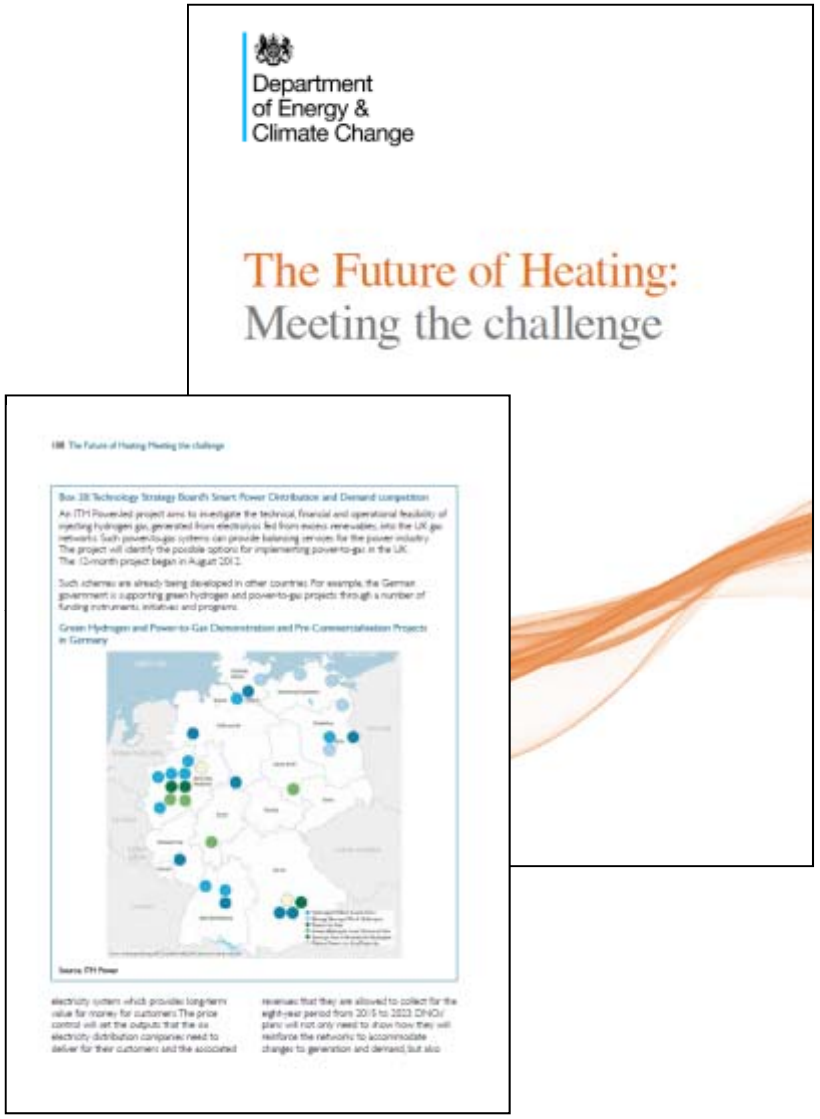
# DECC: UK HEAT STRATEGY

**The Future of Heating: Meeting the challenge**

- 70% of UK heat comes from natural gas
- 1060 TWh of natural gas consumed in the UK in 2011
- 52% was used to provide heat
- 34% burned in power stations to make electricity
- Low penetration of renewable heat in the UK

**RHI launched Nov. 2011**

- 12% of heating from renewables by 2020
- Saving of 44 $MtCO_2$
- Includes a section on P2G




DECC: UK HEAT STRATEGY

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NORTHSEA POWERTOGAS

## Developing Power-to-Gas Projects

- Concentration of renewable energy
- Concentration of oil and gas assets
- Energy storage market pull
- Excellent consortium


# NORTHSEA POWER-TO-GAS

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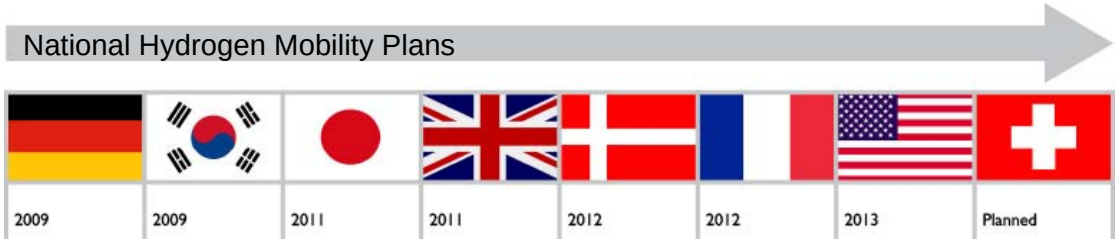
UK $H_2$ Mobility

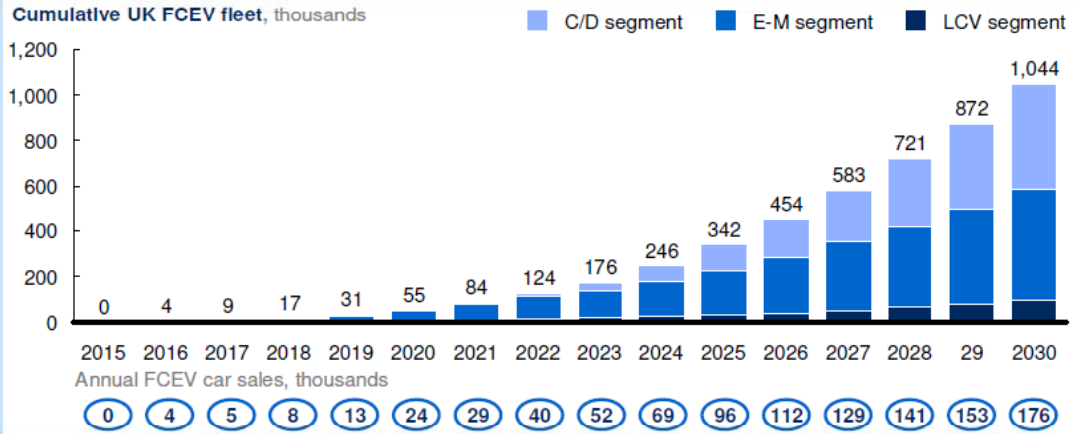
## Development of a national HRS plan

- Full report published April 25th 2013
- Phase 2 underway

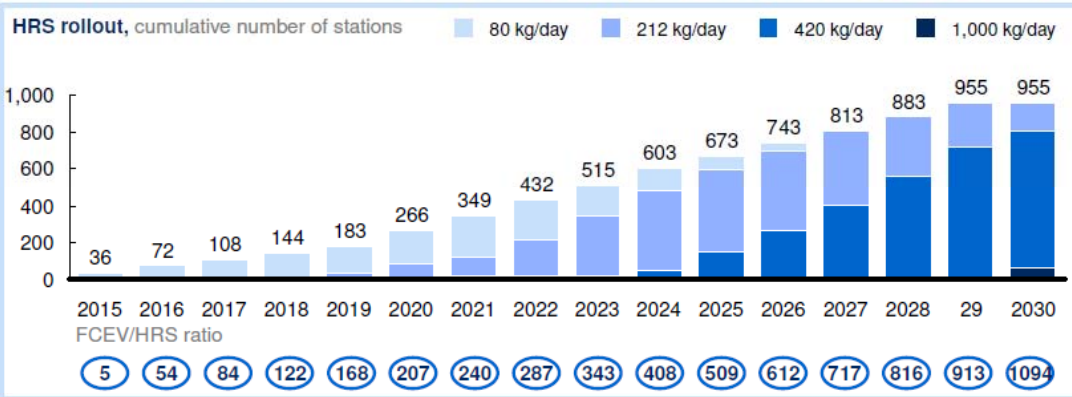



Air Liquide · ITM Power · BOC · Johnson Matthey · Toyota · Nissan · Daimler · Vauxhall · Hyundai · SSE · Intelligent Energy · Dept for Business Innovation & Skills · Dept of Energy & Climate Change · Morrisons · Sainsbury's

# 1+2 Projections suggest ramp-up of FCEVs to 55k in 2020 and 1 million in 2030 with 266 and 955 HRS respectively




- FCEV ramp-up derived though clean team data collection and bounded by estimates of potential regulation and customers willingness to pay
- High take up case chosen in line with corridor created by above mentioned estimates
- OEMs not part of coalition account for approx. 26% of volume in total, phased in up from 2019




- Extra-small HRS dominate until 2021
- 85% of HRS are medium or large by 2030
- Low FCEV/HRS ratio in early years

SOURCE: UK $H_2$Mobility

UK $H_2$ Mobility

# $H_2$ USA

## Major Californian Solicitation of $150m over 5yrs

- $29m available per annum for 5yrs
- Up to $3m per station 65% grant
- ITM Power Inc. established in California
- Bid with 2 local partners at Hyundai, Chino
- Technology platform same as EcoIsland
- Ready to bid in further USA solicitations

National Hydrogen Mobility Plans


U.S. Department of Energy
Association of Global Automakers
Fuel Cell and Hydrogen Energy Association
Mercedes-Benz USA
Nissan North America
Toyota Motor North America
Hyundai Motor America
Electric Drive Transportation Association
California Fuel Cell Partnership
ITM Power
Proton OnSite
Massachusetts Hydrogen Coalition
American Gas Association
Plug Power Inc.
National Renewable Energy Laboratory

# MOBILITE HYDROGENE FRANCE

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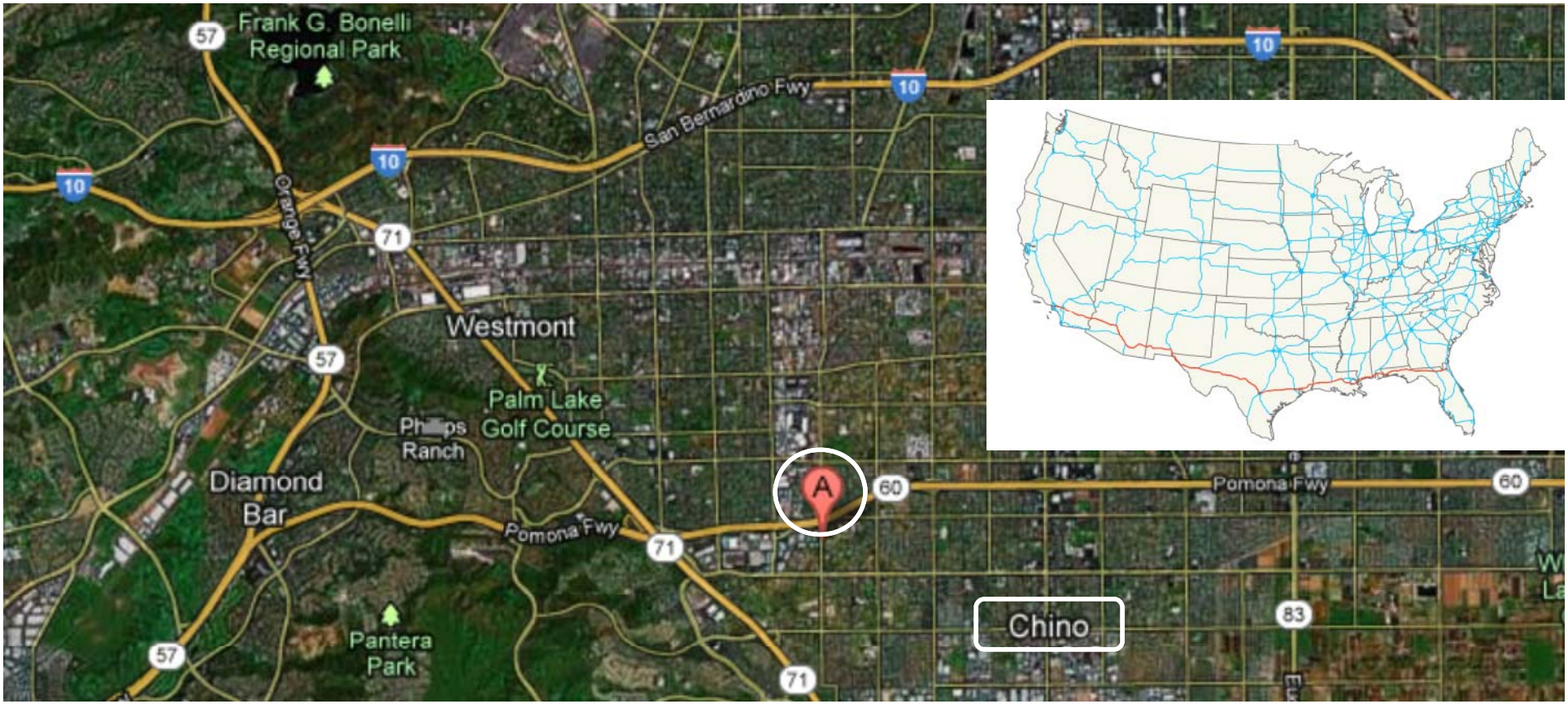
# $H_2$ USA




$H_2$USA

ENERGY STORAGE | CLEAN FUEL

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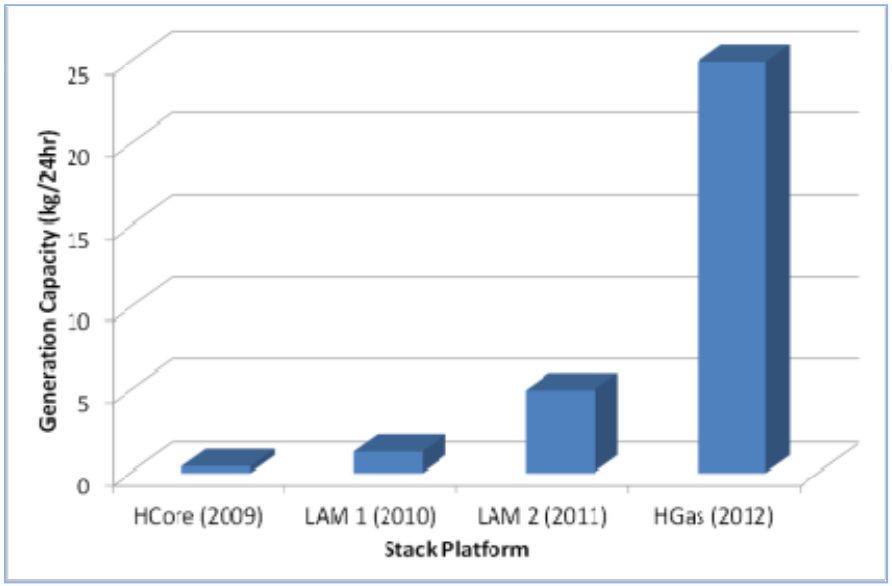
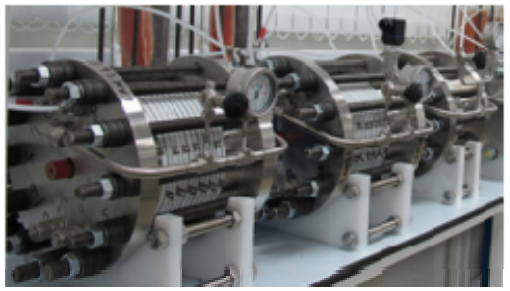
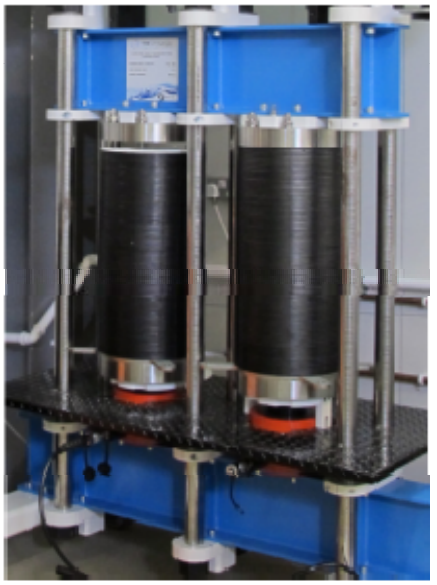
# STACK SCALE UP

**The stack is key to reliable scale up**

- 2009: HCore; 0.4kg/day
- 2010: LAM1; 1.3kg/day
- 2011: LAM2; 5.0kg/day
- 2012: HGas; 25kg/day





# ENERGY STORAGE HYBRID SYSTEM

**Battery | Transport Fuel | Gas Grid Injection**

- Battery Up to 2hrs
- HFuel Up to days (determined by tank size)
- Hinject Continuous