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Hydrogen Gas Inject

Project Update

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Project Summary – Hydrogen Gas Inject

- **Technical, economic and operational feasibility of injection into the UK gas network of hydrogen generated by electrolysis powered by excess renewables**
- **Project partners: ITM Power (Trading) Ltd, SSE plc, SHFCA, Kiwa Gastec**
- **£164k, Part funded by grant from UK Technology Strategy Board**

Technology Strategy Board
Driving Innovation

Methodology – Five work packages

1. Preliminary logistic research
2. Preliminary system research
3. Modelling
4. Simulation
5. Management and Communications

- Results to be published 24th October 2013

- Cannot present key findings but will introduce methodology and illustrate some of the principles applied with regard to Hydrogen and low carbon heat

Logistic research

- Geographic plot of wind farms, gas terminals, compressors and venting storage sites
  - Other hydrogen intercept locations (eg distribution bottlenecks)
  - Industrial thermal process opportunities
- Selected wind farm (~5km) performance detail
  - 1 year 1 minute resolution
  - Number of curtailments
- Performance data for fossil and nuclear generation
  - Gas flow and power demand records
- Alternative technologies for absorbing renewables

System research

- Evaluation of production and storage issues at a German wind turbine gas injection facility
- Options for storage systems, flow metering and mixing processes
- Investigate Health and Safety aspects of usage
  - Review of NaturalHy and Hythane (2000-2007)
  - Odorisation
  - Variable composition and billing
  - Impact of elevated H2 concentration on UK gas appliance stock
  - Other impacts

Modelling

- Define generation model to calculate aggregate surplus capacity
  - Historic demand, conventional power and aggregated wind power
- Construct 2nd model to include parameters H2 production, storage and release/injection
  - Historic gas flow, definable injection rates, calculate theoretical H2 supply to gas grid
  - Projections of future capacity and curtailment
- Techno-economic analysis
  - Injection v H2 pipeline
  - Value of stored energy, value of lost wind farm production
  - H2 v battery etc
  - Electrolyser costs
  - Risk quantification

Simulation

- **Integration of models**
  - Incremental implementation
  - Simulating H2 production from single wind turbine farms (3-20MW)
- **Predict scaled UK roll-out**
  - Introduction scenario – effect of limited addition
  - Transition scenario – larger scale introduction
  - Large H2 capacity introduction - fluctations in demand and atmospheric temperature
  - Analysis of DSM provision
- **Determine benefits:**
  - CO2 emission , wind curtailment, removal of need to improve electrical grid infrastructure
- **Use of electrolysis to produce sufficient H2 to decarbonise gas network as per HMG's Heat Strategy**

Management and Communications

- **Steering Committee**
  - **quarterly reports**
  - **Work programme review**

- **Results to be presented at Seminar 24th October 2013**

Hydrogen and low carbon heat - Principles

- **Envisage Hydrogen can be injected into the grid:**
  - **Very low/Low – 0-10%v/v (0-3% by energy)**
  - **Intermediate - 17-20% v/v**
  - **Town gas - ~55% v/v, or**
- **Hydrogen can be used at 100%**
- **At intermediate, towns gas and 100% - where consistent quality required – H2 production and storage requirements similar**
  - **Note that if you fix %H2 ex-grid storage is necessary (production could be out of sync with demand – sunny, windy day in August)**

Domestic scale usage

- Very low/Low levels – majority of existing appliances probably ok – tbc
- Intermediate levels– possibly a major appliance change programme required in UK context
- Towns gas levels – major appliance replacement programme –
  - Singapore Gas works very well - bespoke appliances
  - PE pipeline distribution
- 100% H2 - major appliance replacement programme

↳ so to use H2 to decarbonise domestic heat there are a number of options

Domestic lower carbon heat using H2

- Consider replacement of 18million kWh natural gas by H2, displacing 3500t of CO2 (zero carbon Hydrogen)
- Options to supply the following number of properties at a variety of v/v%:
  - 30000 @10%
  - 14085 @20%
  - 4485 @55%
  - 1000 @100%

↳ Easier to make no/little change to 30000 or change 1000 completely?

Implications for such a hydrogen facility

- Load swing – 250kW to 10MW - summer to winter
- Without storage this is extremely challenging
- But significant increase of low cost renewables coming into production which should be used in a productive fashion

↳ Useful to present a couple of extreme examples

100% H2 – 1000 house supply facility

From electrolyser when surplus renewable energy available.

- **Disadvantage:**
  - CAPEX electrolysis
  - Storage requirement
- **Advantages:**
  - Use of renewables-low C
  - Can be scaled up

From range of supplies plus electrolyser:

- Natural Gas via SMR
- Plasma gasification of RDF

- **Disadvantage:**
  - Storage
  - Opex Natural Gas
  - RDF supplies
- **Advantages:**
  - Lower CAPEX
  - Can be scaled up

Very low/Low % H2 addition

- **Above production options but rolled out to inject into the grid at say 10% H2**

- **Number of houses become the limiting factor:**

  - **For example 2.5MW electrolyser –**
    - 300,000 homes (Bristol) for 100d per summer,
    - Or
    - one new generation gas turbine?

Next steps – Kiwa Gastec thoughts

- Technological challenges are surmountable - we can take positive steps quickly if the will is there at any %H2
- If low C hydrogen (less than biomass?) is available in large quantities, pipeline distribution becomes attractive for:
  - Heating
  - Industry
  - Transport
- Long term future 100% H2 could be most feasible?
- Perhaps start with small localised grids?

Next steps – Kiwa Gastec thoughts

- **Pressing DECC to compare end to end costs of:**
  - **Hydrogen**
  - **Heat pumps**
  - **Low carbon sourced district heating**

- **Safety is vital and pushing for widespread engagement – new project:**
  - **60kW gas from internal pipework leak**
  - **Substantial volume form mains leak**
  - **Simulated leak from low pressure system in car**
  - **Compare gases: CH4, low%H2, 55% H2, 100%H2**

- **Thank you**

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Kiwa Gastec and H2

- ***Testing & Certification***
- ***Compliance***
- ***Risk assessment***
- ***DSEAR***
- ***Technology evaluation***
- ***Training***
- ***Consultancy***
- ***Technical services***
- ***Automotive component testing***