Hybrid Heat Pump: A Whole-system Analysis

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Outline

• Introduction to CIREGS

• Integrated modelling of Electricity-Gas-Heat

• Hybrid heat pump: A whole-system analysis
Centre for Integrated Renewable Energy Generation and Supply (CIREGS)

- Established in 2008
- £3M+ investment by EPSRC and HEFCW to establish a research centre in Renewables
- £700k for equipment
  - Power System Simulator
  - Real Time Digital Simulator
  - Multi-terminal HVDC Rig
  - Wind Turbine Rig

**Research Team**
- Prof. NICK JENKINS (Director)
- Prof. JIANZHONG WU
- Prof. JUN LIANG
- Dr. JANAKA EKANAYAKE
- Dr. LIANA CIPCIGAN
- Dr. CARLOS UGALDE-LOO
- Dr. MEYSAM QADRQDAN
- Dr. WENLONG MING
- 12 postdocs
- 20 PhD students
Research activities

**Significant focus on:**

- Multi-disciplinary research on energy system
- Cross-vector and cross-scale integration of energy systems
Integrated and whole-system energy modelling

- Simulation and Analysis of GB Combined Ele./Gas Networks (CGEN & CGEN+ models)
- Simulation and Analysis of Community-Level Multi-Vector Energy Networks
- Simulation and Analysis of Building-Level Multi-Vector Energy Systems

- Modelling of European Energy Systems
- Modelling and study of interdependent infrastructure
Recent research projects

- 2 UK-India Smart Grid Projects on DC
- 2 EU FP7 projects on HVDC
- UK-China OPEN on Smart Distribution
- UK-China ERIFT on Renewable Integration
- UK-China project on Electric Vehicles
- UK-China project on Energy Storage
- EU FP7 Smart city project District of Future
- H2020 Peer to Peer Networks
- H2020 MAGNITUDE
- National Grid Dynamic Demand project
- Flexis
Integrated model of electricity-gas-heat

- Currently, in UK, gas supplies >70% heat demand in buildings

- Decarbonisation of heat sector is crucial – electrification of heat is a popular option

- Impacts on electricity and gas networks need to be investigated
Smart Hybrid Heating in a Whole Energy System
£5.2m collaborative project funded by Western Power Distribution and Wales & West Utilities to evaluate Hybrid Heating Systems

Installed into 75 homes in 2017 in the Bridgend ‘Living Heat Lab’

Low cost retrofit to existing wet system with unique smart controller
Locations – South Wales, Bridgend
75 installations are now completed:

- 16 x Daikin Combined Unit (WDS Clean Energy installer)
- 16 x Samsung & Worcester Bosch Boiler (Spire Renewables installer)
- 43 x MasterTherm & Vaillant Boiler (Thermal Earth installer)
Example: Samsung HP – 5kw
Property Information

Property Type Mix

- Detached: 13
- Semi-detached: 22
- End-terrace: 19
- Mid-terrace: 4
- Flat: 9
- Bungalow: 8

Property Age Mix

- Recently Built (post-1990s): 30
- 1950s-1990s: 30
- 1900-1950s: 2
- Pre-1900s: 13

Bedroom Types

- 1 bedroom: 5
- 2 bedrooms: 23
- 3 bedrooms: 37
- 4 bedrooms: 9
- 5 bedrooms: 1
- 6+ bedrooms: 0

Private and Social Occupancy Mix

- Private: 47%
- Social: 53%
System Uptake Scenarios

- Increase in the evening peak will drive network reinforcement
- Hybrid heating systems are flexible and will perform fuel switching
- No increase in peak loading of the distribution network attributable to hybrid heating systems
Modelling hybrid heating system

Half-hourly temperature and ASHP's COP

Performance of a typical ASHP during heating seasons

Source: http://www.wconline.com
Gas load duration curve

The role-out of hybrid heat pumps will:

• Reduce annual gas demand, but not the peak
• Affect low-pressure gas networks more than the high-pressure transmission system
• During cold days with no wind power, gas demand and also emission is lower in hybrid heating system compared to only ASHP
Key Messages

Offers a trilemma solution

• Affordability:
  • Provides easy to use **lowest cost heat** – smart controls with demand aggregation unlock the full flexibility value of hybrid heating from fuel arbitrage, pre-heating and balancing and capacity markets
  • Opens potential for **zero capital cost** to consumer through a heat service proposition
  • Simulated to create value – **not reliant on further domestic incentives**

• Sustainability:
  • Complete load flexibility which **favours low carbon electricity**, topped up by gas
  • Compounds the **benefits from a greening gas network**

• Security
  • **Uncompromised heat** delivered, which **avoids DNO peaks & reinforcement**
  • **Storage & flexibility in gas network** fills renewable generation intermittency troughs