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Europäischer Fonds für regionale Entwicklung  
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EUROPEAN UNION



AUTONOME  
PROVINZ  
BOZEN  
SÜDTIROL



PROVINCIA  
AUTONOMA  
DI BOLZANO  
ALTO ADIGE

## Energy sector coupling: electric-thermal interaction through heat pumps

**eurac** Tuesday 23th of October 2018  
**research** – *Institute for Renewable Energy*  
*NOI Tech Park, via A. Volta 13/A, Bolzano*



*This workshop has received funding from the EFRE- FESR 2014- 2020 programme- project “INTEGRIDS” n. 1042*



# *Hybrid Heat Pump: A Whole-system Analysis*

Dr. Meysam Qadrdan, Senior Lecturer  
Cardiff School of Engineering

23rd Oct 2018

Energy Sector Coupling workshop, Bolzano, Italy

# Outline

- Introduction to CIREGS
- Integrated modelling of Electricity-Gas-Heat
- Hybrid heat pump: A whole-system analysis

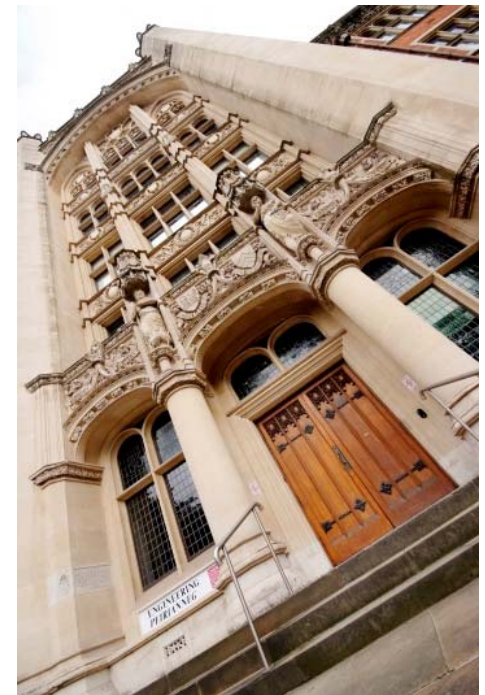
# Centre for Integrated Renewable Energy Generation and Supply (CIREGS)

- 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

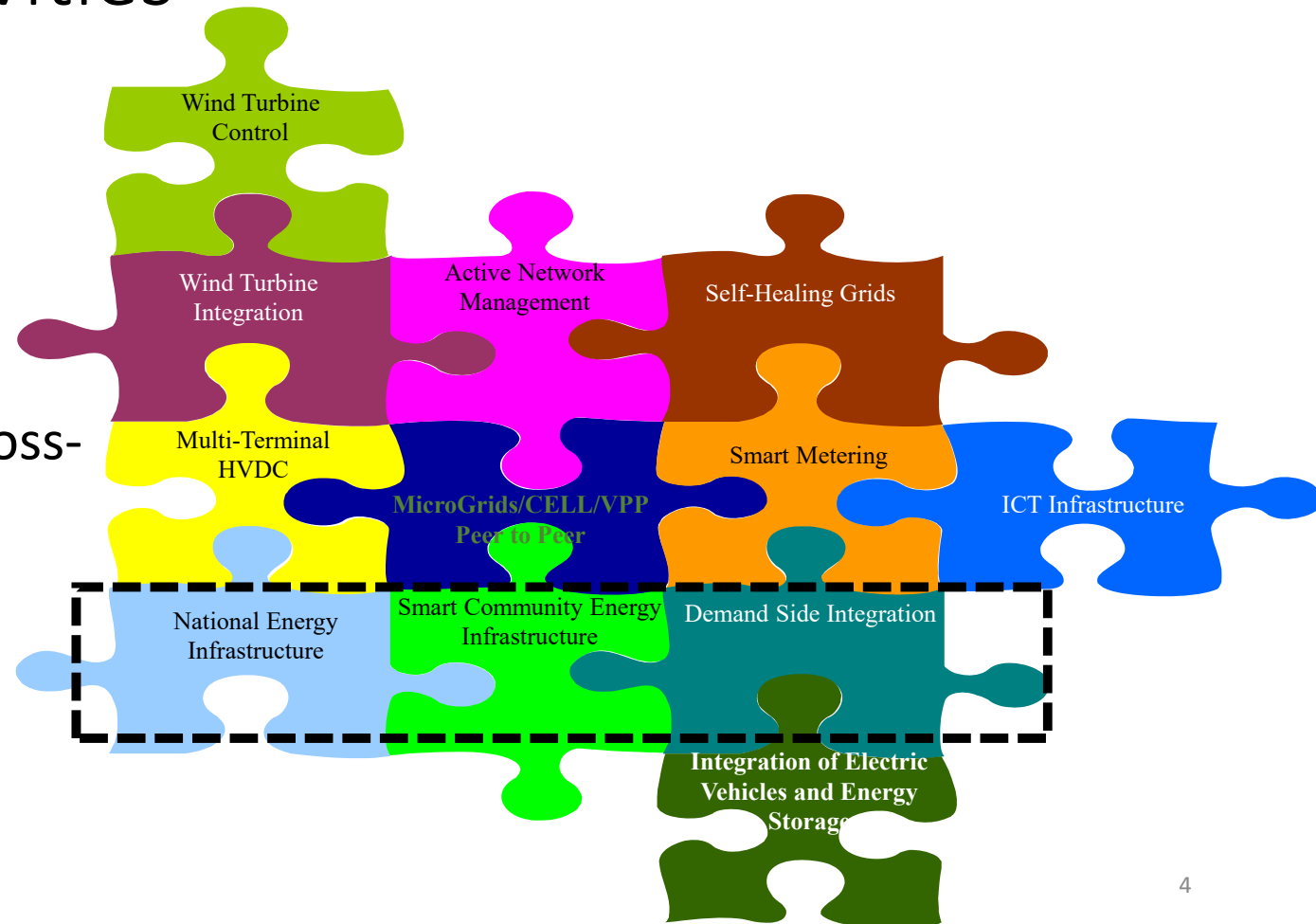
Dr. CARLOS UGALDE-LOO  
Dr. MEYSAM QADRAN  
Dr WENLONG MING  
+ 12 postdocs  
+ 20 PhD students



# Research activities

## Significant focus on:

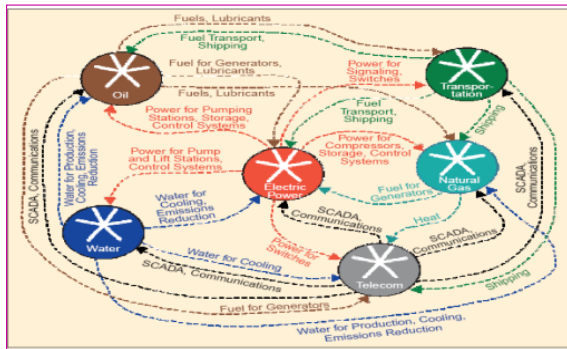
- Multi-disciplinary research on energy system
- Cross-vector and cross-scale integration of energy systems



# Integrated and whole-system energy modelling

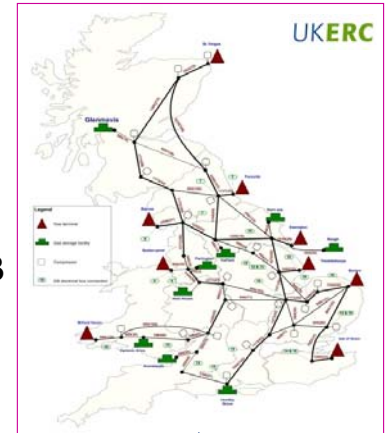


- Modelling of European Energy Systems



ITRC  
nationalgrid

- Modelling and study of interdependent infrastructure



- 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

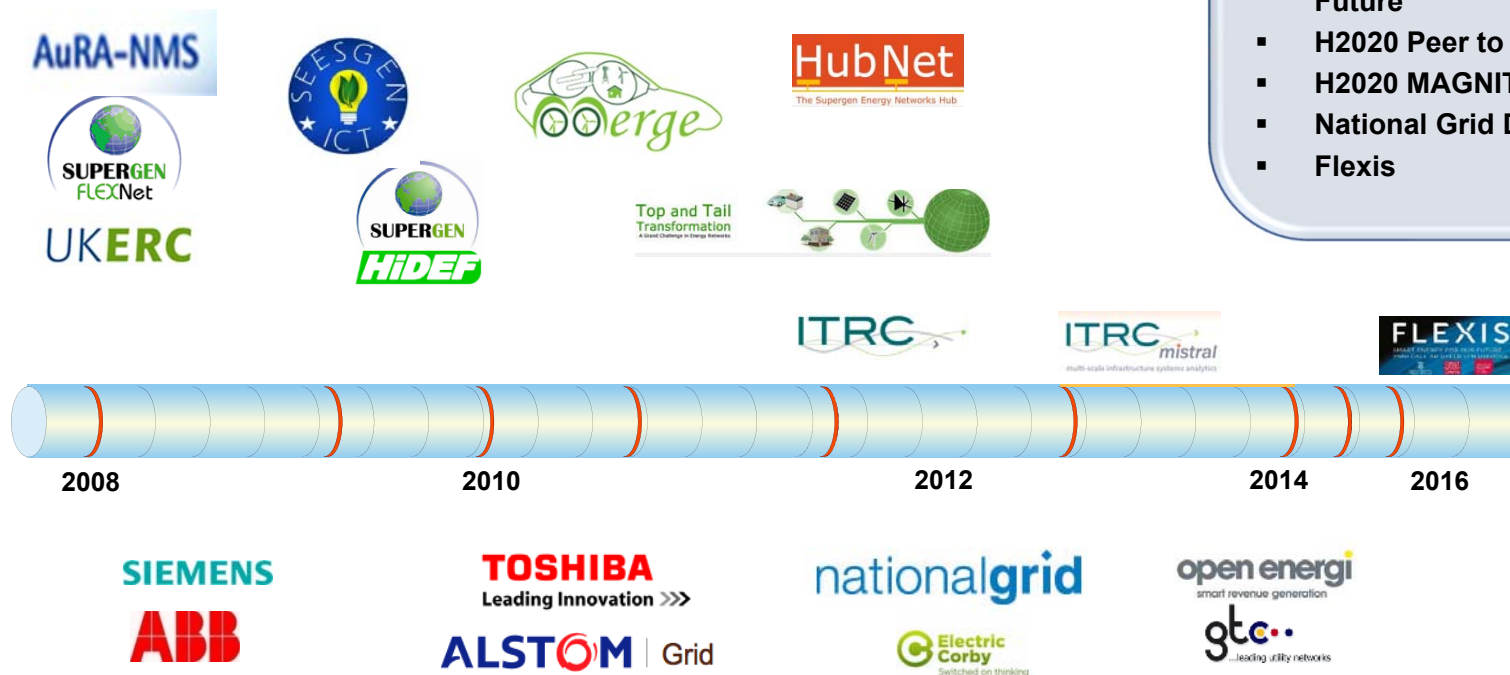
SUPERGEN  
HIDEP  
TOSHIBA  
gtec

DF  
Electric  
Corby

Top and Tail

# Recent research projects

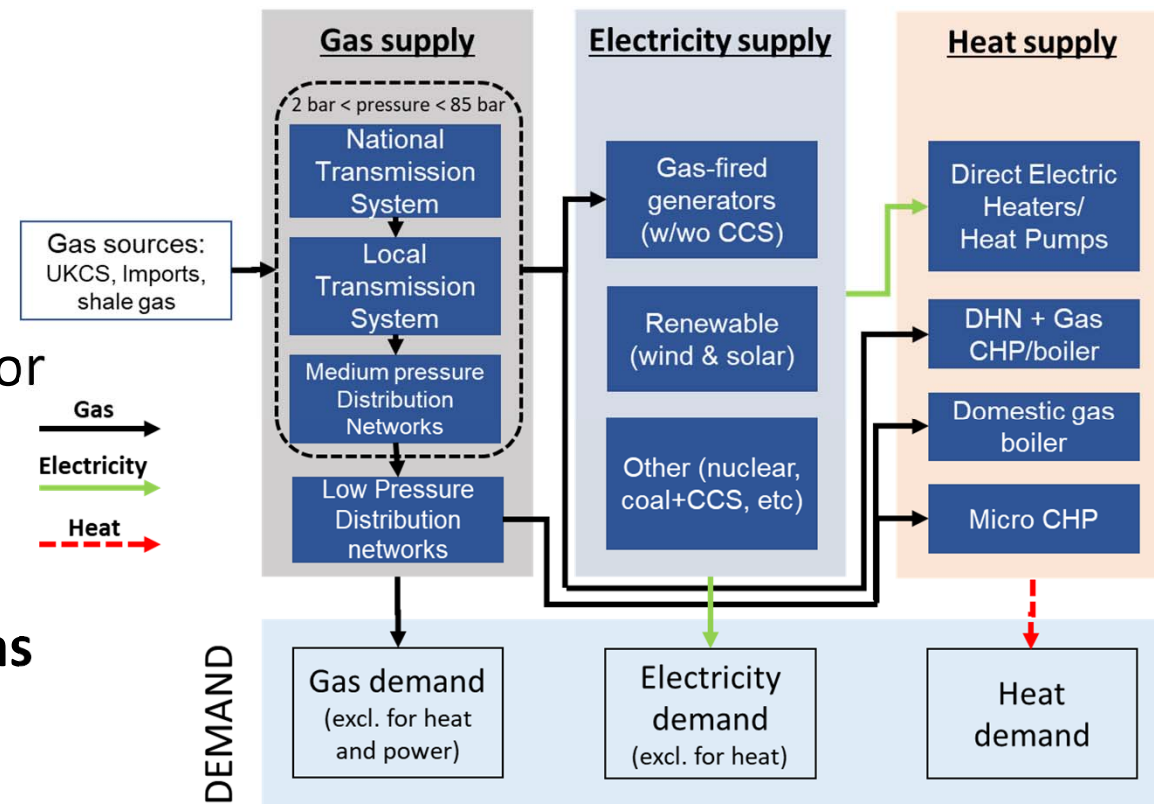
- 2 UK-India Smart Grid Projects on DC
- 2 EU FP7 projects on HVDC
- UK-China OPEN on Smart Distribution
- UK-China ERIFT on Renewable Integration
- UK-China project on Electric Vehicles
- UK-China project on Energy Storage
- EU FP7 Smart city project District of Future
- H2020 Peer to Peer Networks
- 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**







**Freedom  
Project**

# Smart Hybrid Heating in a Whole Energy System



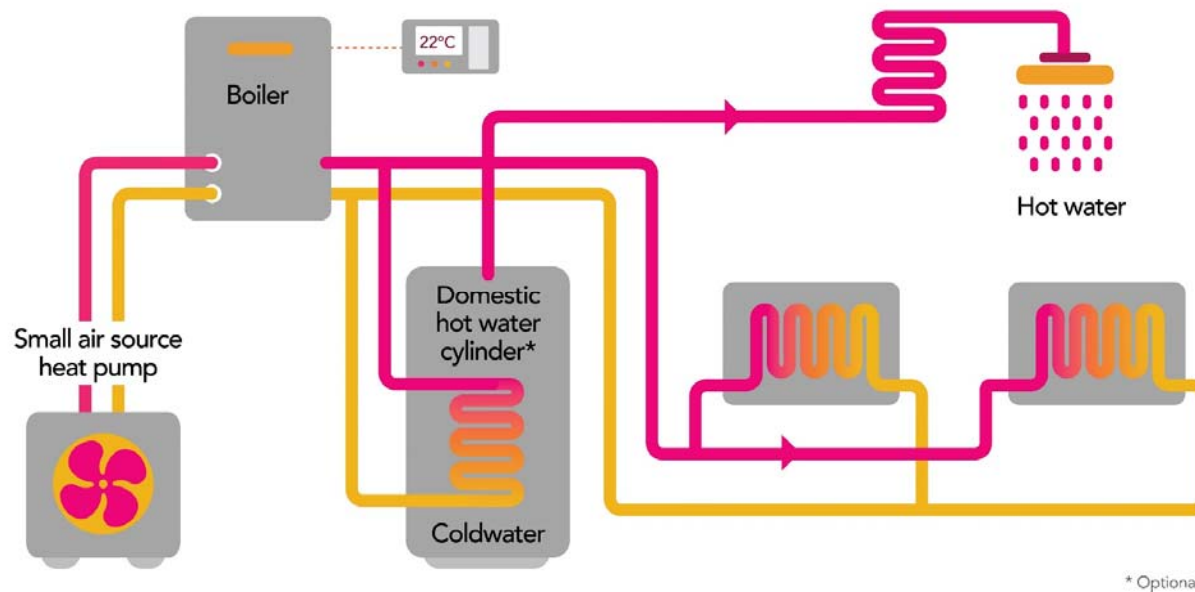
# Introduction



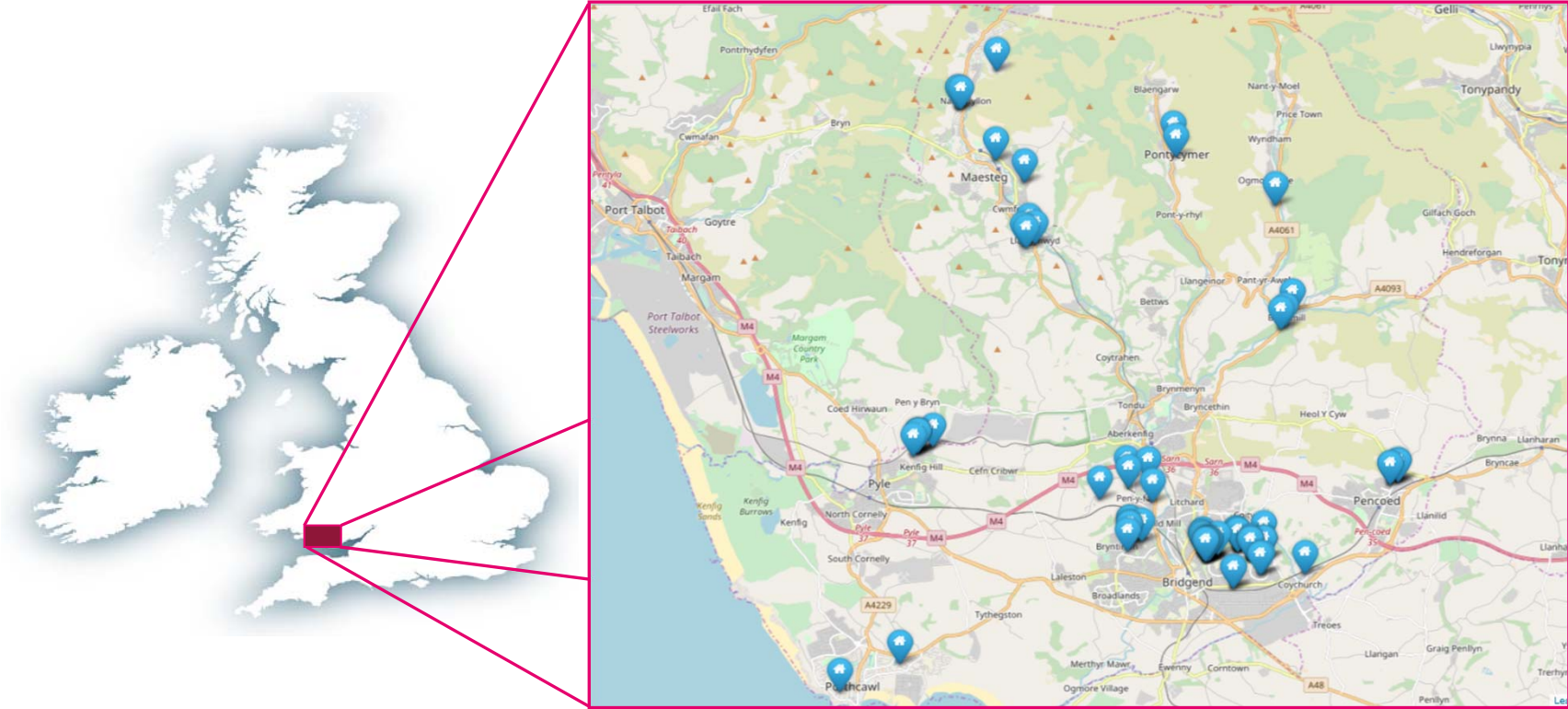
£5.2m collaborative project funded by Western Power Distribution and Wales & West Utilities to evaluate Hybrid Heating Systems

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



# Installations



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)



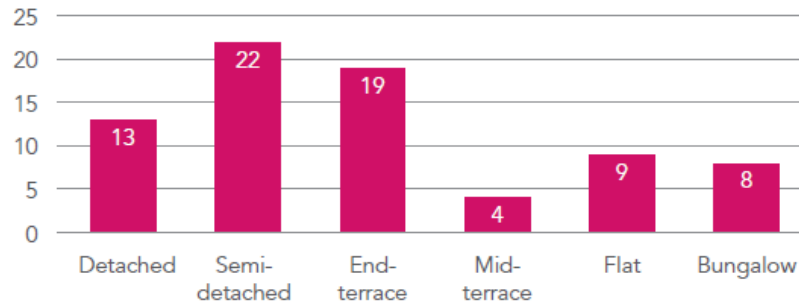
# Example: Samsung HP – 5kw



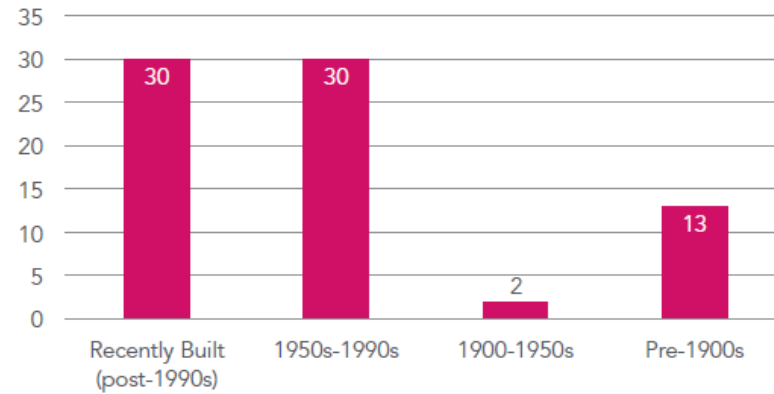
# Property Information



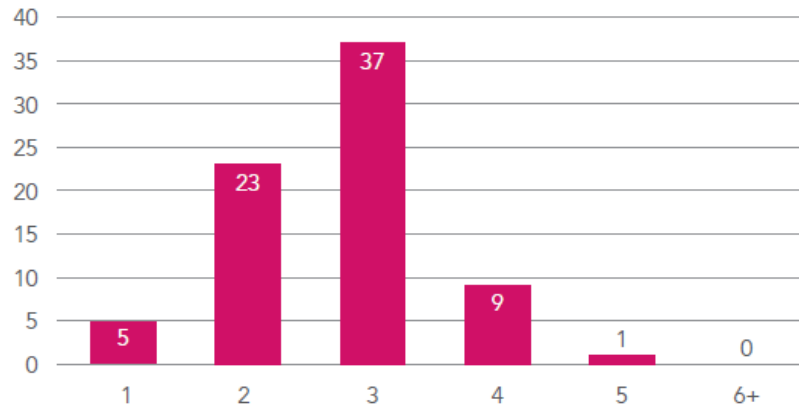
Property Type Mix



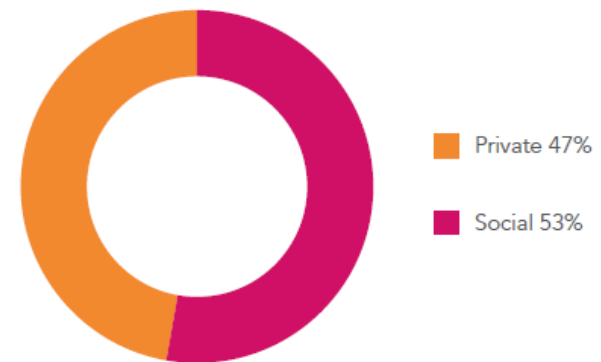
Property Age Mix



Bedroom Types



Private and Social Occupancy Mix

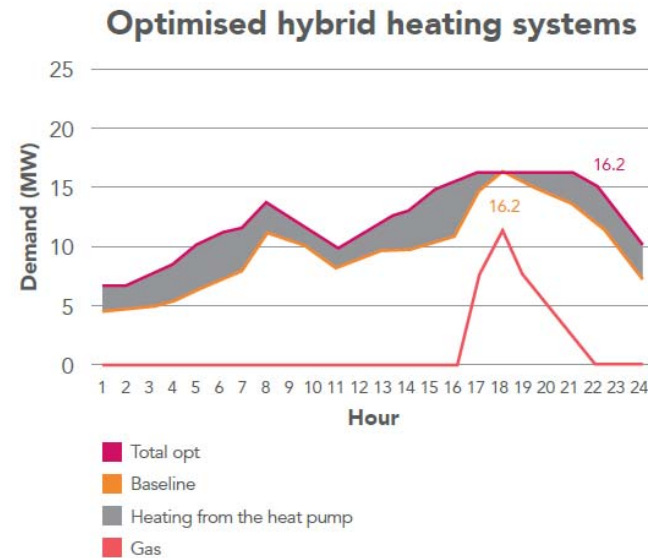
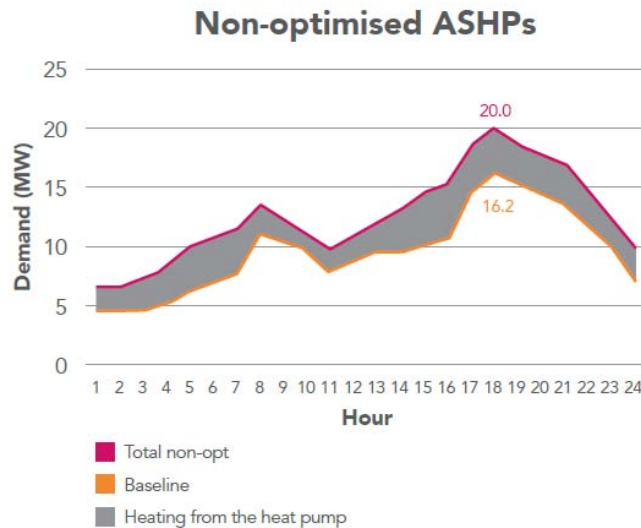




# System Uptake Scenarios



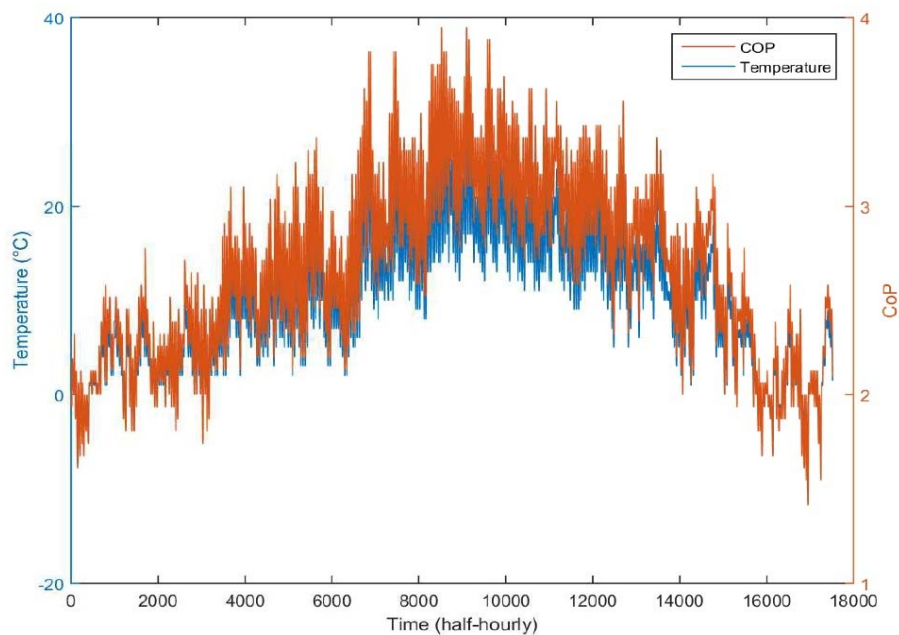
- Increase in the evening peak will drive network reinforcement
- Hybrid heating systems are flexible and will perform fuel switching
- No increase in peak loading of the distribution network attributable to hybrid heating systems



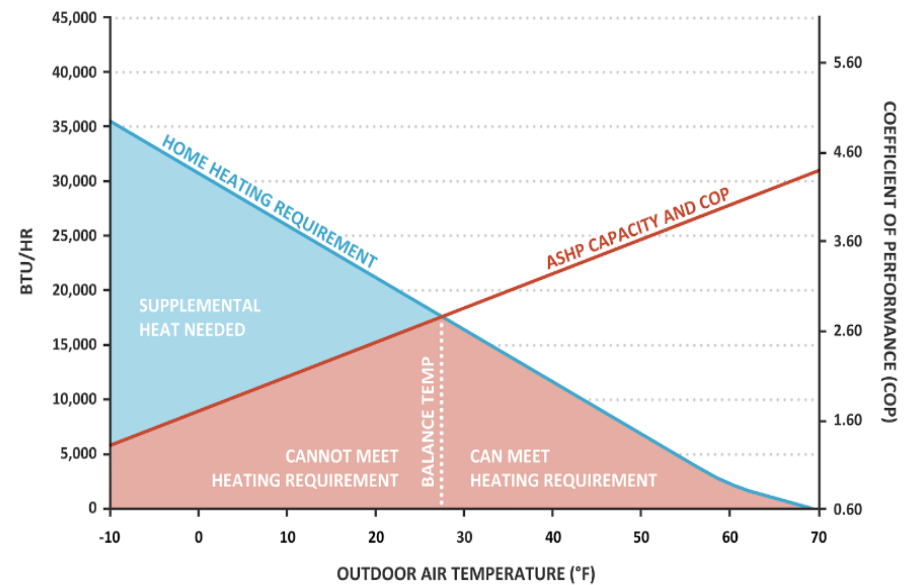


# Modelling hybrid heating system

## Half-hourly temperature and ASHP's COP



## Performance of a typical ASHP during heating seasons

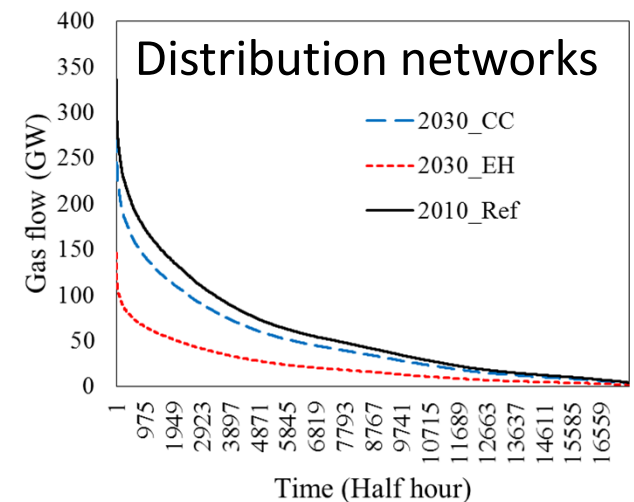
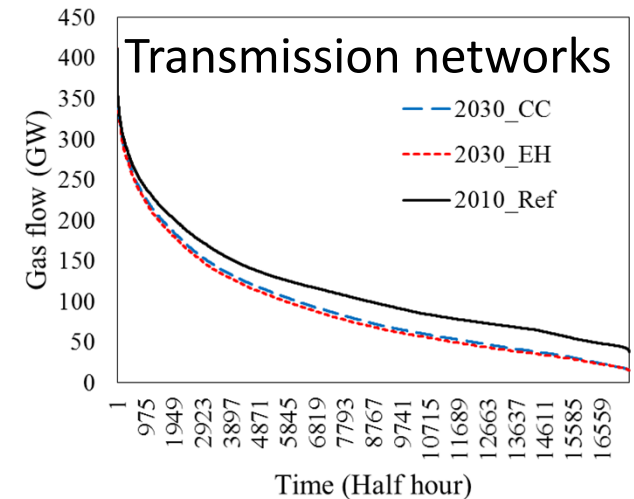
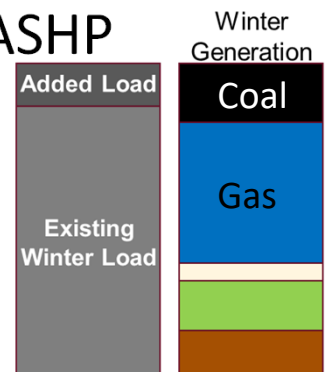


Source: <http://www.wconline.com>

# 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

