Getting Housing off the Gas Grid

UK housing: Fit for the future?
Committee on Climate Change
February 2019
Getting Housing off Gas Grid

Jake Attwood-Harris - Sustainable Design Advisor - Hawkins\Brown Architects
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Introducing Hawkins\Brown
The Challenge

“A cleaner greener Britain

“At least halve the energy use of new buildings by 2030”
## Legislation

### Primary Legislation

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### Mandatory Drivers

#### Planning
- National Planning Policy Framework (NPPF)
  - ‘Presumption in favour of sustainable development’
  - ‘Energy from low and zero carbon sources’
- Local Plan – Local Authority planning policy to implement NPPF
- London Plan (a ‘Local Plan’)
  - Favours Heat Pumps now

#### Building Regulations
- Part L – fabric and CO2 emissions
  - Mandatory Target for Developers
- SAP is the assessment tool
- 2019 review will use lower CO2 content for grid electricity:
  - Gas boilers no longer comply
  - Gas-fired CHP no longer complies
  = STEP CHANGE
# Guidance

## Key Policy Drivers

### Green Growth Strategy 2017
- Direction of travel to low carbon / hydrogen economy

### Committee on Climate Change - ‘Homes Fit For Purpose’ – Feb 2019
- All new homes *timber construction*
- High level thermal insulation = Low heat demand
- No new homes connected to gas 2025

### Committee on Climate Change
- ‘Net Zero’ - May 2019 - CCA target 100% CO2 reduction
  - Hydrogen – ‘necessity’ - Carbon Capture & Storage (CCUS) essential
    - First cluster 2026, 10 Mt CO2 by 2030
  - 4 x Renewable Electricity generation
  - Electric Vehicles – all new cars by 2035
  - *Hybrid heat system to 29m existing homes*
  - Develop Electricity / Hydrogen networks
  - Large scale deployment low carbon heating before 2030

### BEIS Commons Select Committee Carbon Capture & Storage (CCUS) April 2019
- Prioritise conversion gas grid to hydrogen
- store 10 million tonnes CO2 by 2030, 20 million by 2035
Using known technologies, the UK can end its contribution to global warming by reducing emissions to Net Zero by 2050.

This transition will require a concerted effort and action by all.
Annual costs of achieving net-zero emissions are between 1-2% of GDP in 2050, comparable to those estimated in 2008 for achieving an 80% target.

- 80% reductions in emissions relative to 1990 levels estimated 2008
- 100% reduction in emissions in 2050 estimated today

Innovation has driven down the costs of key technologies, such as offshore wind & battery storage.

- Some costs to consumers, such as increased heating bills, can be offset by cheaper transport costs (thanks to a widespread shift to electric vehicles) and cheaper electricity bills (thanks to low cost renewable electricity).

There are many benefits of phasing out harmful emissions

- **For the economy**
  New green industries with new jobs and export opportunities for the UK.

- **For the Individual**
  Quieter streets, cleaner air, less congestion.
  Smarter cities and more comfortable homes.
  Healthier lifestyles, with more active travel and healthier diets.

- **For the country**
  More biodiversity, cleaner water, more green space to enjoy.
  Reduced global warming, avoiding climate damages like flooding.

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CIBSE Energy Performance Group

@CIBSEepg
The London Energy Transformation Initiative
• **Be Seen** – Energy Use Disclosure

• Referable scheme to **calculate whole life-cycle carbon emissions**

• SAP 10 **carbon emission factors** (e.g. 233gCO2/kWh for elec)

• The **heating hierarchy** – zero emission and secondary source top

• **Gas CHP discouraged**

• **A Zero Carbon Plan** for all developments and heat networks
100% of all built new buildings are Zero Carbon

20% NZ by 2021
60% NZ by 2023
80% NZ by 2024
40% NZ by 2022

100% of all Designed new buildings are Zero Carbon

LETI to publish technical guidance

#GettingToZero #LETI
“In homes using gas stoves, children whose parents reported using ventilation when using the stove had higher lung function and lower odds of asthma, wheeze, bronchitis compared to homes that never used ventilation”

ARCADIS Geraghty & Miller, Inc. on behalf of California Environmental Protection Agency, Air Resources Board
https://ww2.arb.ca.gov/resources/documents/indoor-air-pollution-cooking
together we get London to Zero

https://www.leti.london/get-involved
Thank you!

Jake Attwood-Harris - Sustainable Design Advisor - Hawkins\Brown Architects
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The consultant’s view

Kartik Amrania, Head of Building Sustainability

(Swedish Consultancy)

SWECO
The answer is “yes!”

Our Scandinavian colleagues are designing high efficiency Heat-Pump based solution since decades.

The real question as designers; “is to provide heating solution which is at right cost, to the end-users and developers.”

The low-temperature district heating networks harvesting “waste heat” is the solution.
How does Scandinavia differ?

Scandinavian Low Carbon Energy Model

- Client Awareness. Strong Demand for Sustainability
- Facility Managers have know-how of operating heat-pumps
- Technical Expertise in Low Temperature solution
- Taxes on Natural Gas and reducing Tax on Electricity
- Established District Heating Networks, using waste
- Limited Natural Gas network exists
Sweden Climate Action Champion

Why is Sweden Leading?

- It is not the regulation alone but the mind set.
- Designs driven purely on point of view of innovation & change.
- Fossil fuels are discounted from the out-set of concept design.
- DH networks and moving to ultra low temperature networks
Netherlands have banned use of Natural Gas for new houses (<40m³/hr) from 2018

Netherlands Natural Gas network is similar to the UK

• From 2012 onwards building regulation made it hard to get natural gas on site. (Similar to Draft London Plan 2018)
• Dutch engineers adapted to use of heat-pumps with focus on end-user costs.
• Majority of medium to large application (Sweco) have been water or ground source heat-pumps

Source (plot): CBS (Dutch governmental office for Statistics), www.cbs.nl
Salient Points on Dutch Adaptation

• Identifying site opportunities in early stage design.

• Upskilling not limited to design engineers but also operators.

• Solutions most often: “not air-source heat pump based”. & “use of waste heat directly if at high temperature Or via heat pump”

Sweco Netherlands
We need a “rethink” on approach to energy with view to long term not focusing on “SAP 10” regulation alone

• We are reluctant on hydrogen
• No clear guidelines on Hydrogen from Government
• We are assuming natural gas grid infrastructure will be made redundant

Hydrogen Master Plan, Sweco Sweden
Thank you!

Kartik Amrania, Head of Building Sustainability
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The Developer

Aaron Caffrey Technical Director Ballymore
acaffrey@ballymoregroup.com
Relative PM$_{2.5}$ emissions in your home from domestic heating methods

- Solid fuel open fire: 2,950 g/MWh
- Non-Defra exempt stove: 2,660 g/MWh
- Defra-exempt / Ecodesign stove: 335 g/MWh
- Pellet fired boiler: 216 g/MWh

Relative emissions from different solid fuels:
- Coal: 16 g/MWh
- Wet wood: 0.72 g/MWh
- Low-sulphur manufactured solid fuel: 0 g/MWh
- Dry wood: VERY DIRTY

Smoke plumes are not to scale. Emission factors show emissions in the home - emissions during production of fuel or electricity are not included here. Emission factors taken from EMEP 2016 Guidebook (1A4 - small combustion tables). The following definitions were used: Solid fuel open fire: wood burned in an open fire; Non-Defra approved stove: wood in a conventional stove; Defra-approved / Ecodesign stove: wood in an advanced / ecolabelled stove; Pellet fired boiler: wood in pellet stoves and boilers; Oil fired boiler: fuel oil in a medium (>50KWth <1MWth) boiler; Gas fired boiler: natural gas in a small (≤50 kWth) boiler.
• However, the very high cost of Electricity is a significant impediment to moving from Gas as fuel source to Electricity.

**Table 54 – Selected products for profiles G1 and G2 in the United Kingdom**

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<thead>
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<td>24.77</td>
<td>3.55</td>
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<tr>
<td>Green Network Energy –</td>
<td>22.03</td>
<td>2.62</td>
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<td>Family 18 Month Fixed v14</td>
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**Table 34 – Selected products for profiles E1 and E2 in the United Kingdom**

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The End consumer

Millharbour comparison

- Communal gas boiler: Price per kWh (heating) - 4.2, Efficiency - 0.6
- Communal gas CHP: Price per kWh (heating) - 4.0, Efficiency - 0.4
- Heat pump: Price per kWh (heating) - 6.7, Efficiency - 2.1
- All electric: Price per kWh (heating) - 16.5, Efficiency - 1.0

Green bars represent price per kWh (heating), while blue bars represent efficiency or coefficient of performance.
Educate people

SAP predicted Energy versus actual consumption
60 flats over 1 year

Actual Energy used
100% of SAP predicted Energy
New Energy Targets

New Build Energy target versus actual Energy used
60 flats – 1 year
Gas has no place in the new Energy Landscape?
Heat Pumps – Housing versus Apartment Blocks
Hybrid Energy solutions

• Practical implication when assessing very energy efficient ways to support large buildings just using heat pumps alone may not prove the most effective solution.

• Combustion plant still very effective at dealing with peak loads and at very low ambient temperatures.

• Legal & Contractual issues block good energy sharing solutions. Data centres and existing district heating networks and other heat sources often not used because of these challenges.
Challenges with no gas

- Financial incentives are now more difficult to acquire, ECA will finish in April 2020 therefore the most efficient solutions such as Ground Source Heat Pumps may struggle.
- We find that when you have mixed loads heat pumps are efficient but if there is only heat loads then heat pumps struggle to be cost effective.
- Larger Developers have more of a chance because of resources with new systems as they can support detailed design development but smaller developers will struggle to move quickly to the new technologies.
• Believe getting all housing off the gas grid by 2025 is unlikely for new build and even more of a challenge for existing apartment buildings.

• In some cases removing gas is not necessarily desirable – combined hybrid systems with Heat Pumps and combustion plant make sense.

• Moving wholesale to Electricity may not be the solution

• Hydrogen looks like a long term solution but 2025?
Thank you!

Aaron Caffrey – Ballymore – Technical Director
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The Utility Providers View

John Marsh, Director Metropolitan
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We Provide Utility Infrastructure

- Focus on new developments – Last Mile networks
- Gas / Electricity / Fibre / Water / Wastewater / Heat / Cooling
- Regulated Utility Asset Owner - IDNO / IGT / NAV / ESCo
- 2.3m property connections to our utility networks across UK
- Add 3,000 connections each week
Case Study – King’s Cross

• 67 acres, 2,500 residential, 3.5m ft² commercial
  Over 35,000 people will live, work and study
  60% buildings connected

• Unique – BUUK own 7 energy networks;
  Electricity / Fibre / Gas / Water / Wastewater / Heat / Cooling

• District Heating & Cooling
  o Inc 2 x 2MW Gas-fired CHP
  o 60% Co2 saving

• Smart Grid Hardware?
  Add battery storage / Private wire / Fuel Cell
# Drivers For Change & ‘No Gas 2025’

## Key Policy Drivers

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  - ‘Energy from low and zero carbon sources’
- Local Authority Planning Policy
- London Plan - Favours Heat Pumps now

**Building Regulations**
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- SAP is the assessment tool
- 2020 review will use lower CO2 content for grid electricity:
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## Developers Today:
- What is solution 2025? ‘No Gas’
- Transition 2020 -2025?
- Who pays?
- Expect more detail in Energy White Paper
- Been here in 2016??

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Developers Mandatory drivers force change
- Planning Policy
- Building Regs
Vision – 2050 UK Energy System

• Conversion of gas network to hydrogen
• Needs carbon capture – **gap after 2025**
• Heat networks in high density sites
• Electrification – EV, Battery, Smart Grid
• Heat Pumps
  o Retrofit into 28m existing homes
Closing The Gap – Co2 Content Grid Electricity

- Co2 content grid electricity
  - SAP 2012 - Gas still okay
  - Not in London – Heat Pump

- SAP 10 has lower Co2

- Actual Co2 even lower

- Metropolitan London schemes
  - Central ASHP / Ambient Loop / WSHP in home
  - Per block or central energy centre options
  - Can we invest in the infrastructure?
  - What does the home-owner pay?

![Carbon Intensity of Grid Electricity (gCO2/kWh) (Source: UK FES 2018)](image-url)

- SAP 2012: 519gCO2/kWh (still in use)
- Average 2018: 270gCO2/kWh
- Proposed SAP 10: 233gCO2/kWh
Low Density Sites

- Today Gas still okay – big new sites signing up

- 2020 – 2025 (SAP 2010) Need Gas boiler + on-site renewables (PV, solar thermal)

- Post 2025 and ‘No Gas’ - How low will Co2 content of grid get to? What is the gap for the site?
  - Central ASHP / Ground Array / Waste Heat to feed a site ambient temperature heat network
  - Site network at 55°C (35°C in future) allows plastic pipe – lower capital cost and system losses
  - WSHP in homes have CoP 5:1
  - Or ASHP / PV panels / PV Array
  - Battery storage

- Metropolitan appointed NW Bicester Eco Town - Multi Utility (electricity / fibre / water / wastewater) + District Energy. Options;
  - Use waste heat from EfW plant for district heat network?
  - Separate Heat Pumps + PV on roof + site PV array
  - Energy centre with large Heat Pump (ASHP / GSHP) + ambient site loop + separate WSHP in homes
Impact Electricity System – EV & Heat Pumps

- Move energy demand away from gas & forecourt fuels onto electricity network
- ENA focus and several projects
- Graph shows National Grid’s 2019 FES forecast
- Grid could cope with EV – assuming ‘smart’ use, batteries etc to spread demand?
- Heat Pumps double capacity
  - Install bigger cables on new sites now?
  - Allow for double substation capacity?
Thank you!

John Marsh, Director Metropolitan
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