UK’s non-domestic energy and buildings context

Tadj Oreszczyn
Figure 1: The recommended fifth carbon budget would continue emissions reduction on the path to the UK’s 2050 target.
United Kingdom
Quotes from ACEEE Energy Score Card 2016
This year the United Kingdom fell behind Germany, Japan, Italy, and France, with a score of 65 points. The United Kingdom has had a challenging year for energy and climate policies, as the government has rolled back a slew of energy efficiency policies. These rollbacks include

• A 33% cut to the country’s Energy Efficiency Obligations target in 2014
• A 20% cut to future Energy Efficiency Obligations spending in 2015
• Cancellation of the Green Deal

The collapse of building retrofit policy since 2012 and the subsequent lack of ambition require major policy change.
“Melbourne’s best buildings are using three times less energy on a like for like basis than London’s best performing new buildings and, quite conceivably, around six times less energy than more typical new buildings in London.”

Reasons given include:

- A design for compliance culture pervades the UK market
- Energy performance analysis at the design stage in the UK ignores HVAC detail
- A monitoring and evaluation skills gap in the UK.
- HVAC performance in UK buildings in not measured and rated.
- A blurring of responsibilities for HVAC control between landlord and tenants
- The UK market does not value energy performance
Energy use in Buildings

[Image: Diagram illustrating energy flows in a typical dwelling, showing solar gains, total space heating load, window heat losses, wall heat losses, ventilation heat losses, flue losses, drainage losses, and ground floor heat loss.]
History: Domestic Buildings

% change in Domestic Delivered Energy DUKES (Actual) and CCC 5th Carbon Budget

- DUKES
- Baseline
- Central CCC 5th Carbon Budget
UK’s non-domestic energy and buildings context

Tadj Oreszczyn
Why, researchers default to Domestic?: Diversity

1. Diversity in types (12 main classifications – but a cold store is radically different from a unconditioned warehouse)

2. Diversity in energy uses: Non-constrained problem: (heating and cooling) when does a computer suite manufacturing bit coins become an industrial process?

3. Diversity in size.

4. Diversity in occupants - SME’s, global corporations, nuns.

5. Diversity in occupation - 24 hr call centre – 2 hrs a week sports pavilion.

6. Diversity of responsibility – landlord tenants – different govt. departments, is it offices, businesses, non-domestic buildings – non-industrial processes. Nobody knows what it is and leadership is lacking?

7. What is the unit of assessment-building (What is a building?) premise, business, self contained unit (SCU)?

8. Need to be brave - Will you ever find another academic to talk to? Challenge for the number of researchers: UK 100?
Insert 3D Stock image of floor area of different sectors
Figure 14: Distribution of energy use, turnover, and employment by business size (2016)

- **Energy use (all uses)**: 34% Micro (<10 employees) 20% Small (10-49) 45% Large (250+)
- **Energy use (buildings only)**: 14% Micro (<10 employees) 13% Small (10-49) 16% Medium (50-249) 58% Large (250+)
- **Turnover**: 19% Micro (<10 employees) 15% Small (10-49) 14% Medium (50-249) 53% Large (250+)
- **Employment**: 32% Micro (<10 employees) 15% Small (10-49) 12% Medium (50-249) 40% Large (250+)
- **Businesses**: 96% Micro (<10 employees) 4% Large (250+)

Source: Derived from Business population estimates, Non-Domestic National Energy Efficiency Data-Framework and Business Energy Efficiency Survey

Of the 5.5 million businesses in the UK, the majority of energy use comes from around 7,000 large companies.
Figure 16: Actual and projected emissions in business and industry, taking into account the clean growth pathway, 1990-2050

Emissions from the business and industry sectors have decreased by 47% since 1990.

By 2032 emissions could be as low as 83 Mt.

Emissions from business and industry could need to be as low as 49 Mt by 2050.

Source: BEIS

UCL ENERGY INSTITUTE
Chart 1.04: Final Energy Consumption by Sector

In addition, we have also improved the energy efficiency of non-domestic buildings since 1990 with emissions 18 per cent lower in 2015\textsuperscript{156}. The number of properties registering as having the lowest Energy Performance Certificates (EPC Bands F and G) has dropped from 19 per cent to 13 per cent between 2010 and 2016\textsuperscript{157}.

Source: BEIS ECUK Table 1.01
Current Policy Landscape
Based on Mallaburn report to CCC, 2016

• **Performance labeling for electrical goods** - EU product labelling scheme.

• **Performance labelling for buildings**. If well executed e.g. the Australian NABERS, creates higher value.

• **Regulation** Building codes and technology standards are common to many countries.

• **Energy audits** are formal reviews of energy performance with recommendations for improvement. Force the organisation to measure energy consumption and set out options for reducing it. The best researched examples are in the US and Sweden.

• **Voluntary or Long Term Agreements** are formal sectoral agreements to reduce emissions over a time period. They can include incentives to help member companies. The UK’s Climate Change Agreements.
Current Policy Landscape

- **Energy management systems (EMS) and standards** set out a range of formal, integrated practices for measuring, reporting, managing and reducing energy use. EMS can be national, such as the US Portfolio Manager for commercial buildings or bespoke programmes for SMEs, or internationally certified such as ISO 50001.

- **Technical information and advice** One of the best examples of an information programme was the UK’s Energy Efficiency Best Practice Programme that ran from 1983 to 2002.

- **Public procurement** exploits the buying power of public bodies by specifying efficient products or services. The Swedish Technology Procurement Groups programme is a good, well-established example.

- **Financial support** (grants, loans, tax breaks) facilitates low carbon investment capital costs are high, e.g. for SMEs. Germany has many of the most innovative financial programmes managed by the German state bank KfW.
Introduction

Historical UK Energy Benchmarks

- Most UK benchmarks derived based on empirical data using statistical methods
- Data used for producing some benchmarks date back to the 1990s
- No new benchmarks since CIBSE *TM46*

Source: Dr Sung Min Hong
UCL Institute for Environmental Design and Engineering
Energy Performance Certificate (EPC)

Assessor carries out an appraisal of the design or existing National Calculation Method (NCM) for assessing CO2 emissions from buildings other than dwellings. All buildings new and old at point of sale or rent. Asset rating.

Display Energy Certificates (DECS)

In use. Public authorities, and institutions providing public services to a large number of persons, who occupy space in a building with a total useful floor area greater than 1000m².
Results

Changes in Patterns of Energy Use

<table>
<thead>
<tr>
<th>Main Benchmark Category</th>
<th>Overall Changes in Median Electrical Rating (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Office</td>
<td>-14%</td>
</tr>
<tr>
<td>Schools And Seasonal Public Buildings</td>
<td>5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main Benchmark Category</th>
<th>Overall Changes in Median Fossil-thermal Rating (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Office</td>
<td>-17%</td>
</tr>
<tr>
<td>Schools And Seasonal Public Buildings</td>
<td>-13%</td>
</tr>
</tbody>
</table>

Source: Dr Sung Min Hong
UCL Institute for Environmental Design and Engineering
3DStock (all buildings)
Non-Domestic
Commercial not rated
Domestic
Unclassified
Unclassifiable

Volume, Surface, Aspect, Roof area, Roof slope, Density...

VOA
Road network
OSAB
HMLR
LiDAR
OSMM

Energy
EPC

UCL ENERGY INSTITUTE
Domestic/non-domestic building mix

Islington
- Pure domestic
- Pure non-domestic
- Mixed non-domestic
- Mixed domestic/non-domestic

Leicester

Westminster
SimStock Applications

- Scenario analyses (Stock level)
  - Retrofitting
  - Renewables
- Urban planning & Early stage predictions
  - Tall buildings
  - Schools
- Stock segment analyses
UCL-Energy 'High-Rise Buildings: Energy and Density' research project results

Data sources:
- 3DStock
- GLA BEC
- BBP
The 3rd Age of Energy Efficiency: Power and Energy

1973 Oil Crisis
Embargo due to Yom Kippur War

1989 Margaret Thatcher addresses UN Assembly on climate change

UK Climate Change Act 2008
80% reduction in Greenhouse Gases

50% electricity From low-carbon sources

1st Security Age

2nd Low Carbon Age

3rd Decarbonised Power Age

schizophrenia
3rd Age: Decarbonised Power, Carbon Targets Bite

• Driven by:
  – Decarbonisation of supply, electrification.
  – Pervasive IT enablers.
  – End of evolutionary road for key technologies.
  – Whole-system, infrastructural approach required to meet future targets

• Policy Focus:
  – Not known – systemic nature of problem not easy for fragmented government to handle. Requires: planning, market transformation.
  – Policy instruments not yet developed for tackling large high hanging fruits (coconuts) e.g. solid wall insulation, ventilation, decarbonised heat supply

• Research Focus:
  – Systems, participatory, socio-technical
  – Dynamic modelling needed to cope with power not energy.
  – Systemic impacts and interactions need to be understood.
Kick start the 3rd Age of Building Energy Efficiency
Where innovation is and isn’t happening and why?

1. Long Term Policy and Markets: which facilitate disruptive technology and systems. Strategy, confidence and leadership. This is a long game and the built infrastructure lasts a long time. Market structure to create value of upstream benefits to offer “heat as a service” – essential to tackle “coconuts”

2. Smarter Buildings: Data, analytics, IoT including smart meters. – support performance contracting, regulation and understanding the performance gap

3. Tools to support Integrated Planning: Integrated dynamic modelling (grounded in real data) to support planning at local level and roll out of pilot projects tuned to provide locally appropriate solutions


Most of the building blocks for the above are in place. What is missing is the clear strategy, leadership and co-ordination to enable it to happen.
Any Questions?
1st Age - More useful energy for less primary: SECURITY AGE

End-user Energy Demand

Practices

- More
- Less

Technological Losses

Energy system internal use, and losses from conversion, transmission and distribution

Uranium
Renewables
Coal
Oil
Gas

More

Delivered Energy

Usable Energy
Light, Heat, Appliances
People & Controls
Used Energy Services
Cleaning
Thermal Comfort
1st Age - More useful energy for less primary: SECURITY AGE

2nd Age – More useful energy for less carbon emissions: LOW CARBON AGE
1st Age - More useful energy for less primary: SECURITY AGE

2nd Age – More useful energy for less carbon emissions

3rd Age – More used energy for less power: DECARBONISED POWER
1st Age: Security

- Driven by: high oil prices, declining domestic production and concerns about security of fossil fuel supply. Breaking the link between growth (GDP) and energy use.

- Policy Focus:
  - Cost of energy – “Monergy” (govt. campaign launched in 1985)
  - New buildings - changes to building regulations
  - Existing buildings – “low hanging fruit” measures that individuals could easily, cost effectively implement against high fossil fuel prices

- Research Focus:
  - Building Physics (theory, demonstration and field trial)
  - Mono-disciplinary
  - (mostly) component/sub-system focused
2nd Age: Low Carbon

• Driven by: climate change concerns during a period of falling energy prices.

• Policy Focus:
  – Climate Change Act and carbon budgets providing clear high level pathways for short term action.
  – Practical policies driven by short term alleviation of Fuel Poverty.
  – Emphasis on cheap measures in existing buildings.
  – Labelling (SAP) and target-driven; uncoordinated policy landscape.

• Research Focus:
  – Multi-disciplinary
  – Steady State Modelling focused
The future?

- Power not CO2 or energy?
- AI replaces building control?

Domestic energy efficiency can generate 8,000 “negawatts” per dwelling during peak periods.
Bigger, Better Operational Energy Use Data

This scoping study considers how Bigger (more widely available) and Better (more accurate and insightful) operational energy use data can unlock the huge energy efficiency opportunities available by enabling industry and government to quantify and understand consumption, prioritise actions and design (and/or respond to) policy accordingly.

Business Energy Challenge

Over 50 of London’s leading businesses sent in data for 1,000 London buildings (including shops, restaurants, banks and office premises). UCL will use this data to create energy performance benchmarks for wider use across the private sector.
UK Centre for Research in Energy Demand
5 years, £18M, (25% unallocated – 2 Challenges and Flexible fund) Champion - Nick Eyre supported by 7 theme and challenge leads.

UCL (approx. £3.5M) leading - Buildings, Heat, & Policy WP on Distributed Ledgers.

New Energy Demand call July 2018 (£15M)
Figure 15: 2015 final energy expenditure\textsuperscript{164} on energy by end use and fuel, £ billion, 2016 prices.

Expenditure of business varies by sector, for some expenditure is driven by process, for others by building use.

Source: Energy Consumption in the UK & Building Energy Efficiency Survey
Display Energy Certificates

Figure 3-6 Distribution of DEC grades in each benchmark category