

How engineers can reduce building's carbon emissions in reality, not virtual reality...

Nigel Banks *MEng (Hons) CEng MCIBSE*
Associate Director, Advanced Design Group, AECOM

CIBSE ASHRAE Group, CIBSE Young Engineers Network and IMechE Greater London Region

10th February 2010

AECOM

In the next hour ...

- Brief introductions
- What can virtual reality teach us?
- What does reality show us?
- EPCs Vs DEC's
- Your top 5 and my top 5 carbon saving tips
- Saving Carbon in Reality – the basics
- Existing Buildings
- Tools to help you out
- Summary and discussion

CIBSE ASHRAE Group, CIBSE
Young Engineers Network and
IMechE Greater London Region

February 10th 2010

Page 2

AECOM

AECOM

- Changed name from Faber Maunsell and EDAW
- **Key Markets:** Facilities, Transportation, Federal Services, Environmental and Energy
- **Primary Services:** Planning, Architecture, Engineering, Project and Construction Management, Program Management and Operations
- **Global Workforce:** 43,000+ employees operating in over 60 countries



AECOM

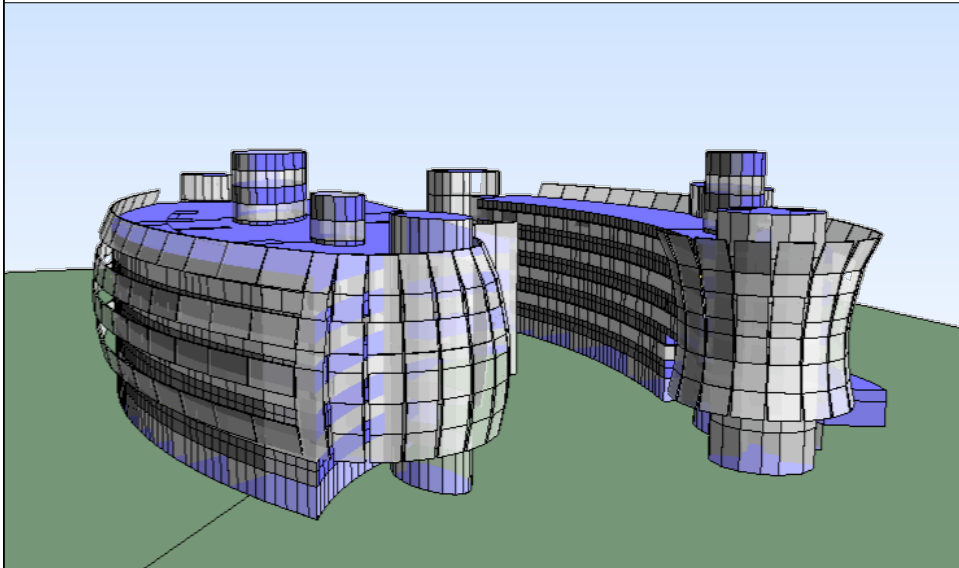
3

Nigel Banks *MEng (Hons) CEng MCIBSE*

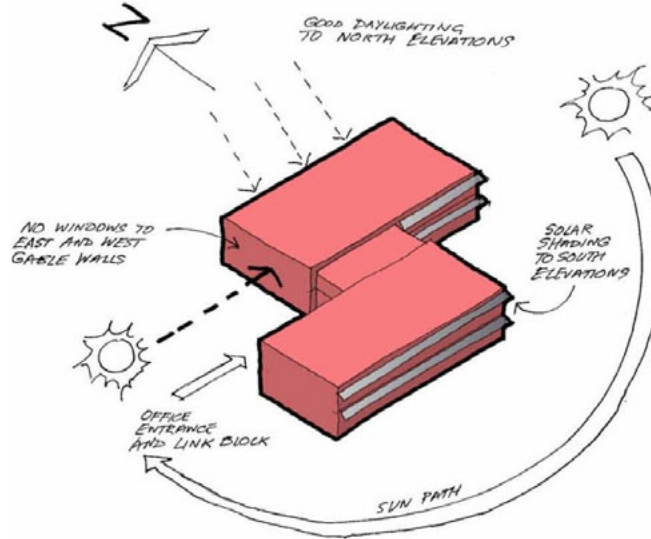
- Associate Director, Advanced Design, AECOM
 - Chartered Engineer, studied in UK and France
 - 10+ years in building design and research projects
- Worked on projects in the UK, USA, Qatar, UAE & Saudi Arabia
- Award winning projects:
 - CIBSE Low Carbon Project of the Year 2008
 - CIBSE Low Carbon Project of the Year 2009
 - BREEAM 2009 Award for Offices
 - (BREEAM 2009 Award for Retail)
 - (BREEAM 2009 Award for Bespoke)

VIRTUAL *REALITY*

What can virtual reality teach us?



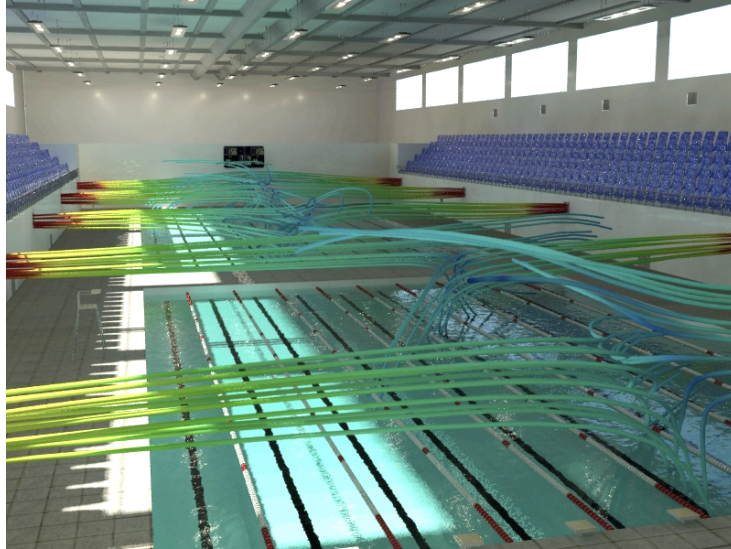
The basics of good building physics



The ability to test variables



The ability to check designs should work



CIBSE ASHRAE Group, CIBSE
Young Engineers Network and
IMechE Greater London Region

February 10th 2010

Page 9

AECOM

REALITY

Energy audits bring reality home...
of PEOPLE

Top 5 from energy audits last week



Top 5 from energy audits last week



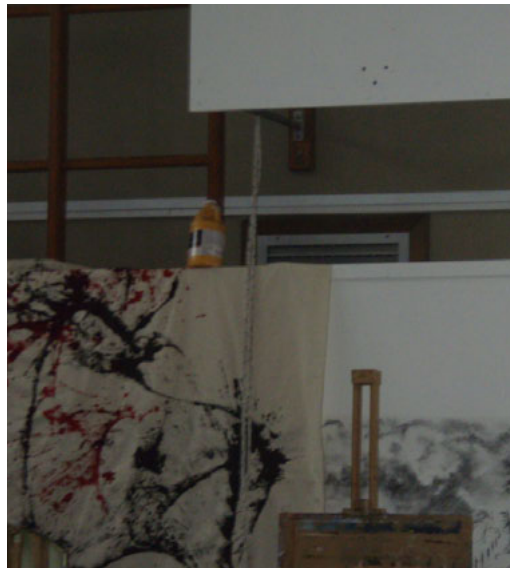
CIBSE ASHRAE Group, CIBSE
Young Engineers Network and
IMechE Greater London Region

February 10th 2010

Page 13

AECOM

Top 5 from energy audits last week



CIBSE ASHRAE Group, CIBSE
Young Engineers Network and
IMechE Greater London Region

February 10th 2010

Page 14

AECOM

Top 5 from energy audits last week



CIBSE ASHRAE Group, CIBSE
Young Engineers Network and
IMechE Greater London Region

February 10th 2010

Page 15

AECOM

Top 5 from energy audits last week



CIBSE ASHRAE Group, CIBSE
Young Engineers Network and
IMechE Greater London Region

February 10th 2010

Page 16

AECOM

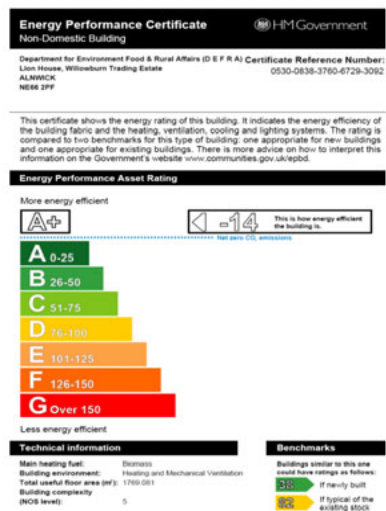
EPCs Vs DEC's:

Virtual reality Vs "Reality"

Virtual Reality

Why EPC's are great ...

- Standardised **benchmark**
- **Rewards** good design intent
- **Absolute** scale
- **Easy** to understand

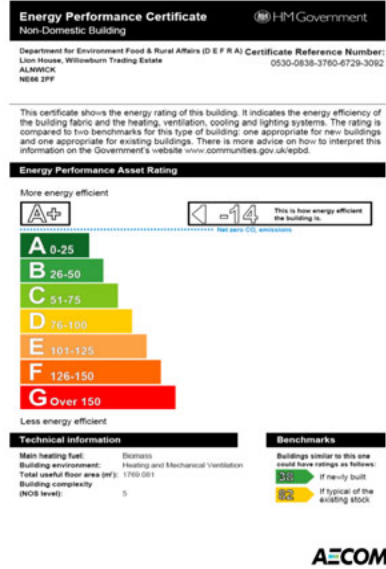


AECOM

Virtual Reality

Why EPC's aren't perfect ...

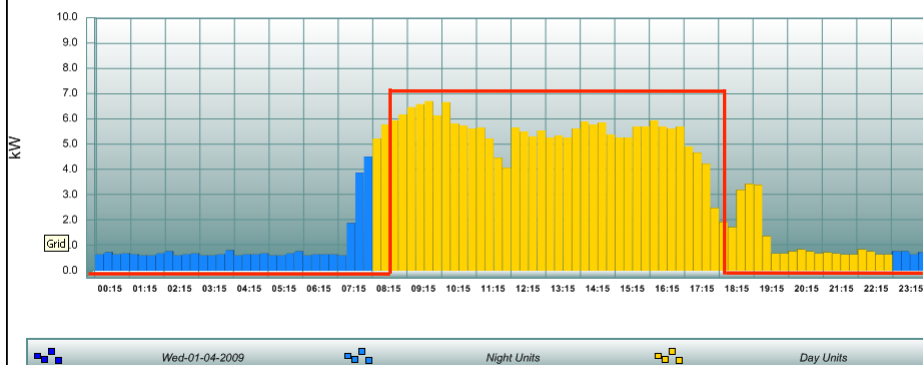
- **Standardised** benchmark
- Rewards good design **intent**
- Numbers on **scale** mean?
- **Easy** to get wrong



Reality Vs Virtual Reality

➤ First Floor Southern Block (350m² open plan office ~35 staff)

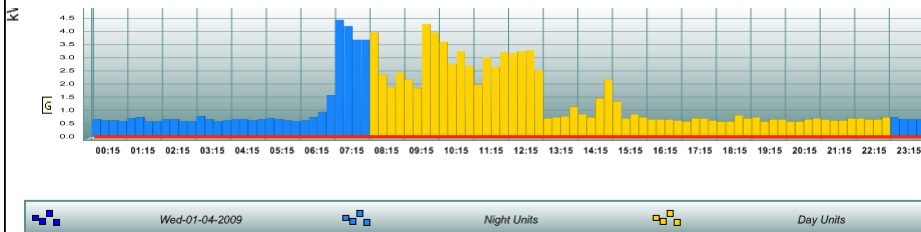
DB 4 - First Floor South



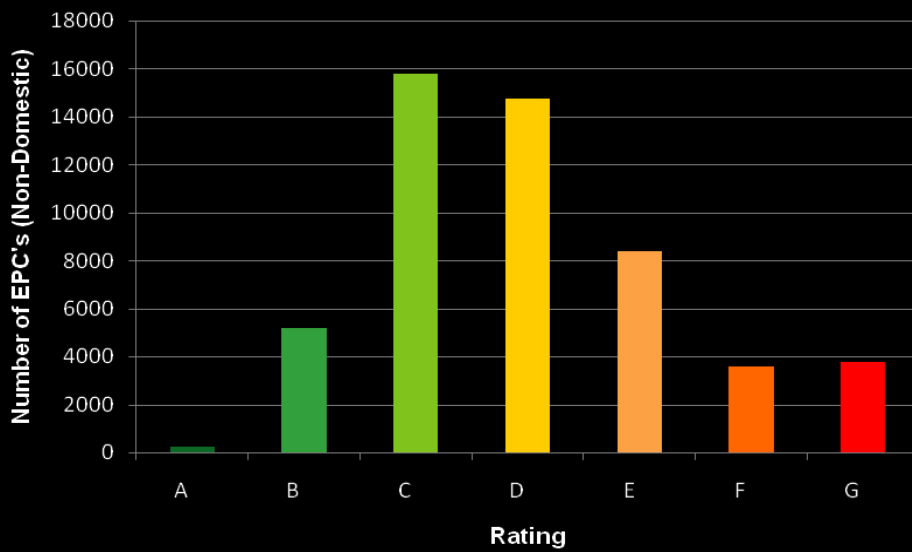
Reality Vs Virtual Reality

➤ First Floor Southern Block (350m² open plan office ~35 staff)

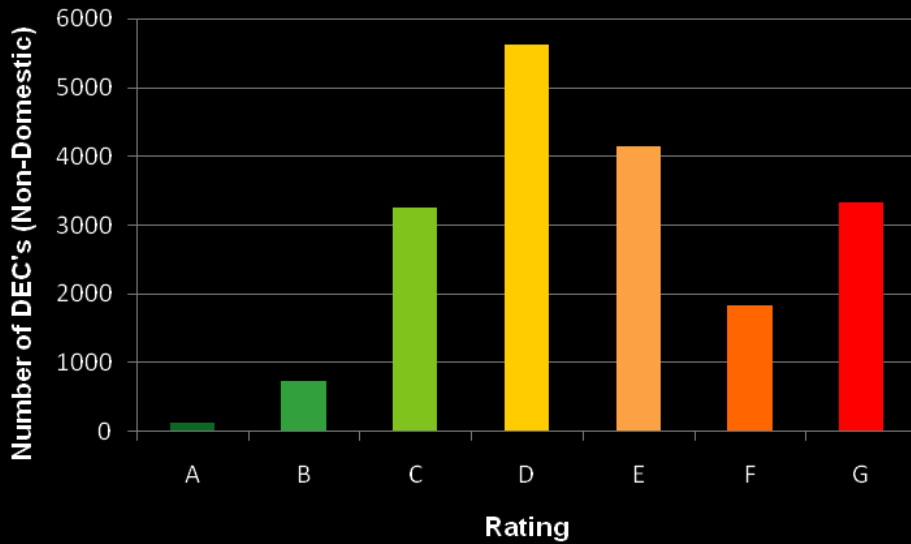
DB 4 - First Floor South



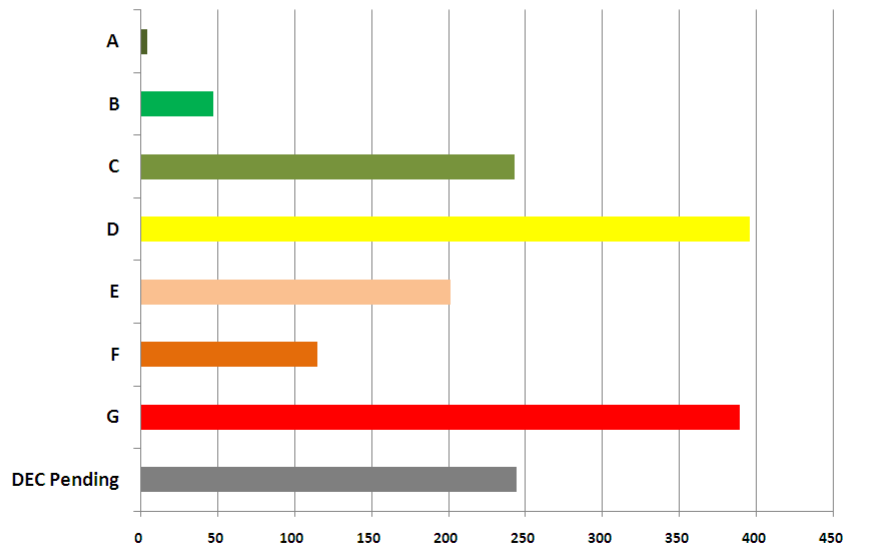
EPCs Vs DECs



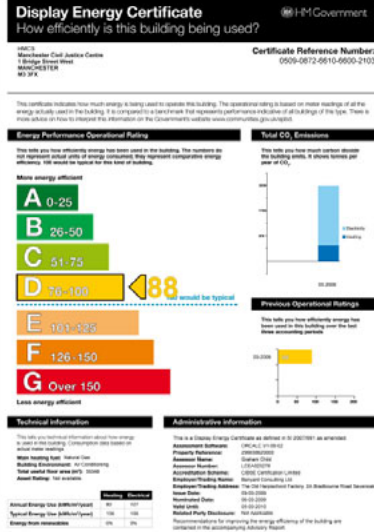
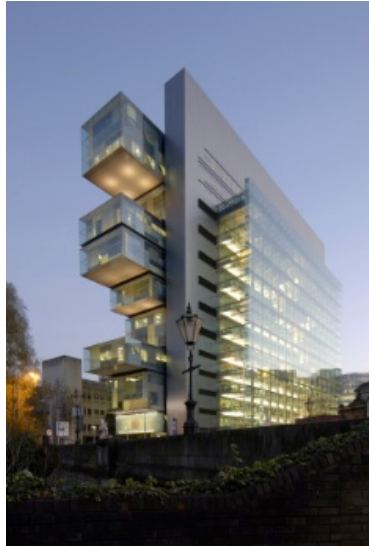
EPCs Vs DECs



DECs of Government Buildings (OGC - Sept 2009)



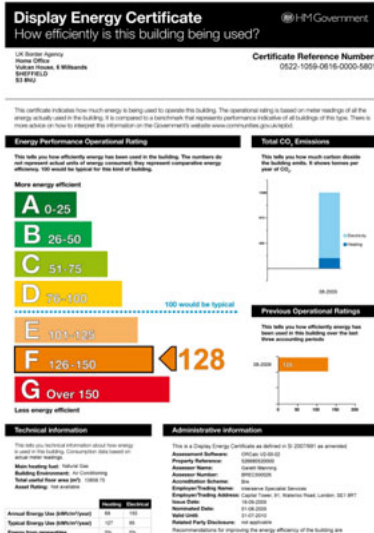
Civil Justice Centre - RIBA Sustainability Award



CIBSE ASHRAE Group, CIBSE Young Engineers Network and IMechE Greater London Region



Vulcan House, Sheffield



Vulcan House is the second highest BREEAM scoring building in the UK and Sheffield's first BREEAM 'Excellent' building.

CIBSE ASHRAE Group, CIBSE Young Engineers Network and IMechE Greater London Region



WHY DOES ALL THIS MATTER?

66 Hot Air Balloons = ~300 tCO₂

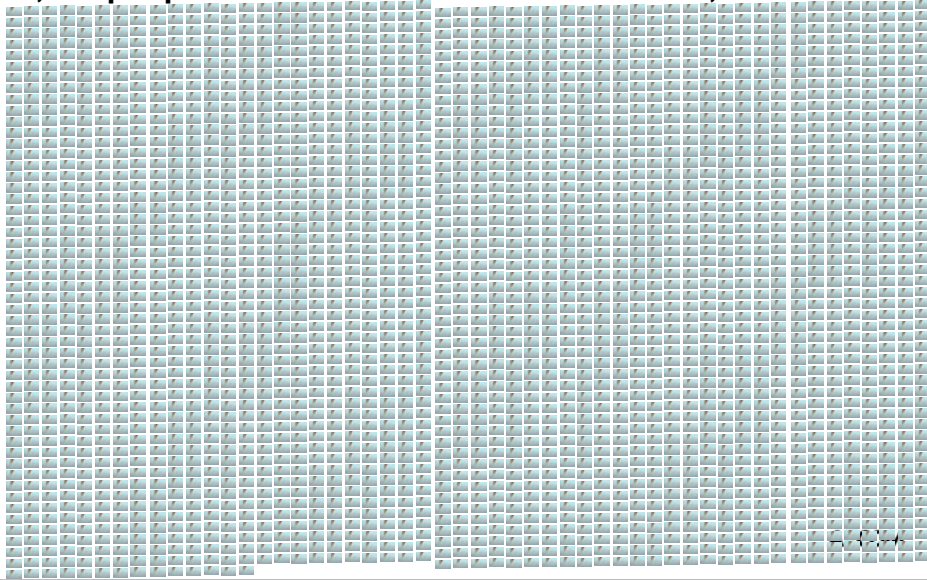


In the past 15 mins, the UK has emitted = 16,038 tCO₂



AECOM

**In the past 15 mins, the world population has grown by
2,146 people and the World has emitted = 791,486 tCO₂**



TOP 5 CARBON SAVING TIPS

YOUR TOP 5 CARBON SAVING TIPS

1. User manuals
2. Able to switch off
3. movement detectors
4. Not using it
5. minimise loads at source
6. Low energy lighting
7. BMS
8. Brief to include re-visit

MY TOP 5 CARBON SAVING TIPS

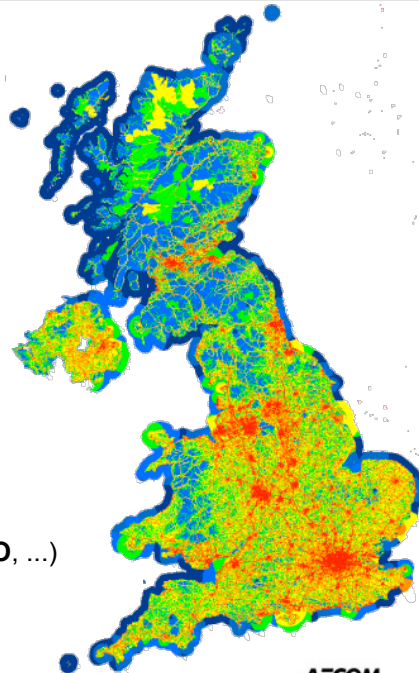
1. Incentives for designers and facilities managers to deliver real low carbon performance
2. Engage users in saving energy (reducing demand time)
3. Design in things which can't really go wrong like orientation, form and façade treatment.
4. High level (easy to understand) controls with local adjustment (in right direction) by users (reduce demand and demand time)
5. Investigate on site low carbon energy sources and highlight the real financial returns to clients

SAVING CARBON IN REALITY

SAVING CARBON IN REALITY

HOW IS CO₂ GENERATED?

- Combustion of organic matter:
 - Oil
 - Gas
 - Coal
 - Wood
- Other sources:
 - Animal & plant respiration & decay
 - Chemical Reactions (**Cement**)
 - CO₂e other GHG's (CH₄, H/CFC, N₂O, ...)



SAVING CARBON IN REALITY

HOW IS CO₂ GENERATED FROM OUR BUILDINGS?

- Indirect emissions due to **electricity** use
- Direct emissions due **heat** use
- **Embodied** carbon of construction and maintenance
- Other GHGs – **Refrigerant** Leaks, **NO_x** emissions

SAVING CARBON IN REALITY

HOW IS CO₂ GENERATED FROM OUR BUILDINGS?

- Indirect emissions due to **electricity** use:
- 1kWh electricity use = 2.5 kWh of fuel in UK
- Electricity use (J) = **Power (W) x Time (s)**
- Most design focuses on Power (W) but this can only be reduced so far...
- The key is time (s) ... every second counts...

SAVING CARBON IN REALITY

HOW IS CO₂ GENERATED FROM OUR BUILDINGS?

- Direct emissions due **heat** use:
- Typically 1kWh heat use = 1.16 kWh of fuel in UK
- Heat use (J) = **Heat demand (W) x Time (s)**
- Most design focuses on Heat demand (W) but again this can only be reduced so far...
- The key is time (s) ... every second counts...

SAVING CARBON IN REALITY

HOW IS CO₂ GENERATED FROM OUR BUILDINGS?

- **Embodied** carbon of construction and maintenance:
- UK net emissions have continued to rise ...
- Embodied carbon = **Amount (t) x Material Emissions**
- Good design focuses on **both** the material and the amount

SAVING CARBON IN REALITY

HOW IS CO₂ GENERATED FROM OUR BUILDINGS?

- Other GHGs – **Refrigerant Leaks, NO_x emissions**
- Refrigerant Leaks = 20% of Tesco's emissions!
- Refrigerant Leaks = **Refrigerant x Leakage rate**
- NO_x emissions = from combustion especially bio-fuels
- NO_x emissions = **Fuel use x Emission Factor**

Will this *really* save carbon?



Will these *really* save carbon?



CIBSE ASHRAE Group, CIBSE
Young Engineers Network and
IMechE Greater London Region

February 10th 2010

Page 43

AECOM

Will this *really* save carbon?



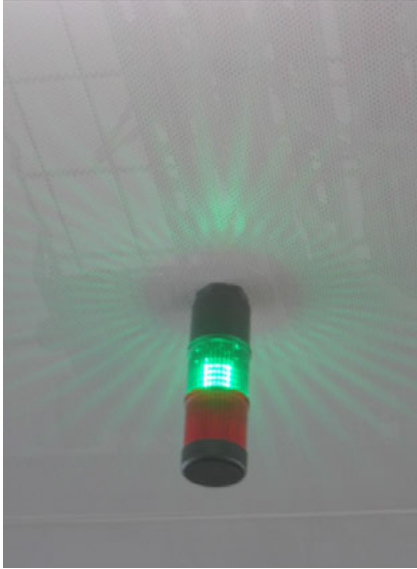
CIBSE ASHRAE Group, CIBSE
Young Engineers Network and
IMechE Greater London Region

February 10th 2010

Page 44

AECOM

Will this *really* save carbon?



CIBSE ASHRAE Group, CIBSE
Young Engineers Network and
IMechE Greater London Region

February 10th 2010

Page 45

AECOM

Will these *really* save carbon?



CIBSE ASHRAE Group, CIBSE
Young Engineers Network and
IMechE Greater London Region

February 10th 2010

Page 46

AECOM

EXISTING BUILDINGS

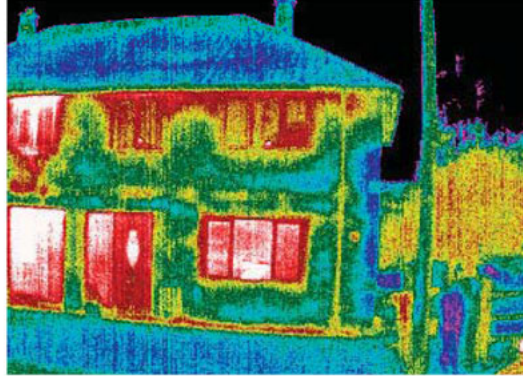
Existing Buildings – *almost always the same quick wins*

Carbon Trust Surveys:

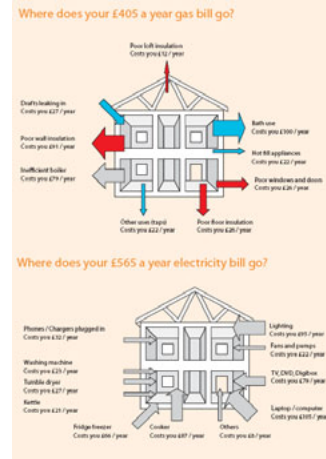
- Reduce heating and hot water run hours
- Computers to standby OR off instead of on idle
- Install PIR sensors in suitable rooms
- Replace incandescent/tungsten/T12 lamps when they fail
- Replace all old boilers over 20 years old with ...
- Fit insulation on valves and pipe work currently without insulation

Great British Refurb Campaign

Home Energy Report



Peter and Emma, Bristol



Great British Refurb – free measures

- **Dry laundry on a clothes line** rather than use a tumble drier.
- **Turn thermostats down to 18°C** and review the hours for which heating is turned on.
- Set the washing machine to **wash clothes at 30°C**, rather than higher temperatures, to reduce the energy requirement.
- **Use microwave** more often in preference to conventional ovens where possible. Microwaves are a more efficient way of heating food.
- Ensure there is a clear **space behind the fridge** and freezer to allow air to circulate thus allowing the appliances to reject heat more efficiently.
- **TV brightness** and contrast default settings are for showroom purposes, not living room. Turn the brightness down to save energy.
- Ensure that **chargers** for mobile phones, laptops and other appliances are not plugged in when not in use.



Great British Refurb – *cheap measures*

- **Replace** standard tungsten filament light bulbs with low energy compact fluorescent bulbs which save around 80% of the energy.
- **Insulate and draught** proof your loft hatch. A standard wooden board can let out more heat than a leaky single glazed window.
- **Install an energy monitor** device which will show you how much electricity you are using and help you to reduce you electricity use.
- **Replace** you current kettle with an “Eco-kettle” which helps you only boil the amount of water that you need.
- Install an additional **insulation jacket** around the hot water cylinder to reduce its heat loss.
- Install a **chimney balloon**; an inflatable bag which seals chimneys and flues to prevent cold draughts. Ensure that a marker hangs down so that users realise the fire should not be lit.
- ...

Great British Refurb – *more expensive measures*

- Replace halogen spotlights with new **LED spot light** bulbs which use even less energy than compact fluorescent bulbs. Replacement bulbs currently cannot be dimmed so any dimmer switches may also need replacing.
- Install **cavity wall insulation**. This can be done in half a day by a specialist installer; all work can be done from outside the house.
- Install a **voltage reduction device** which reduces the voltage supplied to your house to that required by your appliances rather than that supplied by the national grid.
- Switch from current electric hob to a **new gas hob**. The use of gas currently emits less carbon than electricity and is cheaper to run.
- **Change electric showers** to a traditional bath/shower mixer tap with shower hose which allows you to run your shower off the main hot water system.
- Install **loft insulation** to a depth of 400mm.
- ...

Great British Refurb – *expensive measures*

- Install 5m² (~0.5kWp) **photovoltaic solar panels** to generate zero carbon electricity. The ideal orientation is South facing at 30° above the horizontal, but other orientations and angles still generate reasonable amounts of power. Savings include feed-in-tariff benefits.
- Install **internal or external wall insulation** to dramatically reduce the heat lost through the walls of the house (note price does not include cost of replacing wall coverings or items fixed to walls such as kitchen cabinets).
- Install a **shower/bath heat recovery device**. This will recover the heat from water leaving the plug hole and use it to preheat the hot water before it gets to the boiler.
- Install a **new modulating gas boiler and heating system**.
- Install a **wood-burning stove** to heat a central room. Trees absorb carbon dioxide when growing, this is released when burnt.
-

TOOLS *AT HAND*

Tools in my bag:

- Building Physics & virtual reality - develop and test design
- Understanding of psychology and behavioural change
- Understanding of real costs and opportunities
- Challenging the brief – Demanding performance
- Working with contractors and facilities management
- A soft landing for a building
- Visiting buildings and monitoring performance

AECOM

IN SUMMARY

SUMMARY

- Virtual reality is very useful *but*
- Reality teaches us the most useful lessons
- Design must focus on performance not points
- Designers main focus must be on people (in and operate)
- Designers must understand people (in and operate)
- We can reduce the carbon impact of buildings *but*
- Can we reduce our emissions enough and keep “growing”?
A philosophical question to finish on...

AECOM

How engineers can reduce building
carbon emissions in reality, not virtual
reality...

DISCUSSION

Nigel Banks MEng (Hons) CEng MCIBSE
Associate Director, Advanced Design Group, AECOM
Nigel.Banks@aecom.com
T: 0113 391 6800
M: 0759 014 6899