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Where are we now

• 07/09/2010

• Greenhouse gas emissions in Scotland have fallen by 20 per cent since 1990, according to the latest official statistics published today.

• The figures show a 3 per cent reduction between 2007 and 2008 with total emissions falling from 57.8 million tonnes CO2 equivalent (Mt CO2e) in 2007 to 56.1 million (Mt CO2e), in 2008.

• Taking emissions trading into account, Scotland's emissions have fallen by 21.2 per cent from 1990 - meaning Scotland has reached the halfway point in achieving its 2020 Climate Change Act target of reducing emissions by 42 per cent.
How good are we?

- UK trails EU league for renewables
- Britain is Europe's 'most glaring failure', says Greenpeace, with only 1.3% of needs sourced from clean energy in 2005
League table extracted from the Pure Power report: MW of wind energy capacity per 1,000 km² (End 2008)

- Denmark
- Germany
- Netherlands
- Spain
- Portugal
- Ireland
- EU-27
- Luxembourg
- Belgium
- Italy
- Austria
- Greece
- France
- UK
- Sweden
- Czech Republic
- Estonia
- Poland
- Bulgaria
- Hungary
- Lithuania
- Finland
- Latvia
- Slovakia
- Romania
- Slovenia
- Malta
- Cyprus
How would you like*

• > 40% carbon reduction# Combined Heat & Power

• > 36% carbon reduction# Combined Cooling Heat & Power

• Zero Carbon AD/Biogas

*All figures are approximate and specific to particular application and are based on grid supplied electricity and piped natural gas. These will vary from size and complexity of installation.

#Carbon reduction based on replacing grid electricity and grid gas fired boiler with grid gas fuelled fuel cell with absorption chiller.
Highest Efficiency Distributed Generation

- **DFC-ERG**
  - DFC/Turbine
  - 58 – 65%
  - 5,900 – 5,250 Btu/kWh

- **Direct FuelCell (DFC)**
  - 47%
  - 7,260 Btu/kWh

- **Micro-turbines**
  - 25 – 30%
  - 13,600 – 11,400 Btu/kWh

- **Small Gas Turbines**
  - 25 – 35%
  - 13,600 – 9,800 Btu/kWh

- **Natural Gas Engines**
  - 30 – 42%
  - 11,400 – 8,100 Btu/kWh
Why Fuel Cells

**Conventional Power Plant**

FUEL $\rightarrow$ COMBUSTION $\rightarrow$ HOT GAS OR STEAM $\rightarrow$ TURBINE/GENERATOR $\rightarrow$ ELECTRICITY

**Fuel Cell Power Plant**

FUEL $\rightarrow$ DIRECT FUEL CELL $\rightarrow$ ELECTRICITY

*Direct energy conversion without combustion provides high efficiency with negligible emissions, from domestic and renewable fuels*
Performance

- Low emissions
- Low noise – 65dbA
- Availability >95%
- High reliability
- Security of Supply

<table>
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<th>Emissions</th>
<th>lb/MWh</th>
<th>ppm dry</th>
<th>Tons/yr</th>
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<td>CO</td>
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Performance

- 20% extra electrical output per NG m³
- 65% net overall efficient CCHP (40-60% more than conventional power plant)
- Reduce CO₂ by over 40% using NG
- Minimise carbon footprint
- Security of supply - Increase distributed generation
- Quick to install
LEL - An Overview

- Founded 1994
- World Market Leader Fuel Cell Integration
- Project Portfolio >15 MW
- Alkaline/PEM/PAFC/MCFC/SOFC
- Fuel cell and hydrogen technology
- Independent
- Customer Solutions..... right solution for the project
- Fuel Cell integration, including associated plant for CHP, CCHP, and other hydrogen technologies

TfL Palestra
Commissioning January ’09
Pros & Cons Fuel cells

**Pros**
- Good Whole life costs
- Lower maintenance costs
- Efficient
- Reduced electrical costs
- Closer matched energy demand
- Transition technology -2020
- Versatile & integrated e.g. AD, Nuclear
- Quiet
- Clean - Air emission targets
- Carbon reduction
- Energy storage
- CSH / BREEAM

**Cons**
- Capital costs higher
- Perception ‘future technology’
- Limited number of suppliers
SE HQ Havant

- Combined Cooling Heating & Power
- Power for Call Centre
- Cooling for Call Centre
- Some Heat Dumped
Small Scale Fuel Cells
The reliability of the ‘six 9s’ computer grade electricity that Sure Power delivers isn’t a luxury for us at First National Bank of Omaha, it’s a critical difference over existing power arrangements that will substantially increase our computer uptime. The result is a tremendous leap in our competitive advantage. With Sure Power, First National can raise our customer’s service expectations while generating higher revenues.

Dennis C. Hughes
Director of Property Management
First National Buildings
DOD PAFC Experience 1996-2002

8th Air Force Hospital

NAS Jacksonville Hospital

Ft Huachuca Barracks

Laughlin AFB Hospital
Transport for London, Palestra

- Emergency Response Centre for London
- Mission Critical 24/7
- London Systems Data Centre
Dept. of Homeland Security

California Regional Data Centre
Fresno, California
US Post Office
World Interface Centre
Chevron Texaco Houston Texas Refinery Division Customer Data Base
5.6MWe in Korea
In Summary

Fuel Cells:
- Most efficient energy production
- 42% carbon reduction
- Higher availability
- More reliable
- Clean – low NOₓ/SOₓ
- Quiet
- Life cycle cost reduction
- Proven technology
- Available now
Thank You for Listening.

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