

# How emissions measurements can support emissions trading schemes

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**Perhaps the title should have been -**

*Can emissions measurements support  
emissions trading schemes ?*

To which the short answer is:

Not at the moment, but they should.

And the long answer ....

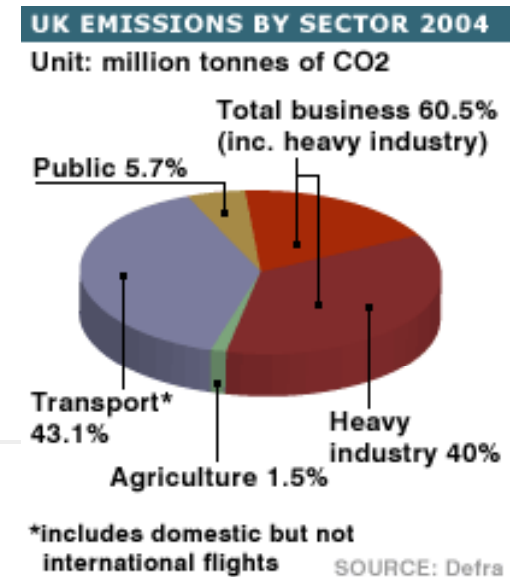
# Recap on EU trading scheme



- Directive 2003/87/EC
- Primary mechanism for EU member states to meet climate change objectives
  - EU 8% reduction by 2012
  - UK 12.5% reduction by 2012
- Cap and trade scheme
- Emissions reduced by reducing allowance
  - National Allocation Plan
- Reductions occur in most cost effective areas
  - *Marginal Abatement Cost* (MAC)

# Current status

- Phase II – running from 2008 – 2012
  - 2012 matches Kyoto reduction timeframe
  - UK emissions limit 682 Mt CO<sub>2</sub>
  - Covers energy intensive industries (Schedule 1)
    - Combustion, coke ovens, oil refineries, ferrous metal plant, mineral industries, paper/pulp, offshore flaring, refinery cat' crackers
    - Threshold of activities (ie > 20 MW power plant)
  - Phase II primarily CO<sub>2</sub>
    - Other GHGs can be opted in - so far only Netherlands have done so, for N<sub>2</sub>O



# Monitoring and reporting outline

- Reporting requirement is for annual reporting
  - Operator's GHG Permit defines specific reporting requirements
- Monitoring and reporting guidelines
  - MRG 2007 (Commission Decision 18 July 2007)
  - Tiered approach
    - Tier depends on process and level of emissions –
    - Higher Tier more stringent requirements (generally 1-4)
    - Requirements for each Tier are then given for different processes – ie combustion, petrochemical etc
    - <25 ktCO<sub>2</sub> special rules apply
- Verification
  - Paper audit / inspection
  - Not measurement based

# Approaches to determining emissions

- Calculation
  - Calculate CO<sub>2</sub> emissions from for example fuel use and emissions factor
- Measurement
  - Direct measurement is allowed, but must also compare with a calculated approach
- Fall-back approach
  - This is a get out clause allowing a particular installation with complex emissions to use a fully customised monitoring programme

# Calculation approach

- Based on

$$CO_2 Emissions = ActivityData \cdot EmissionFactor \cdot OxidationFactor$$

- Activity data – eg measurements of fuel use, or amount of product –
  - for fuel expressed as TJ
  - usually measure fuel amount and multiply by calorific value
- Emission factor
  - for fuel this will be tCO<sub>2</sub>/TJ
  - for process emissions will be tCO<sub>2</sub>/t
- Oxidation factor or conversion factor
  - Any carbon in fuel not converted to CO<sub>2</sub>

# Required uncertainties

- The MRG tiers provide details of how to determine emissions for each type of process
  - Include specific measurement uncertainty requirements for the determination of activity data
- They are designed such that if the monitoring plan is approved by the competent authority, then the data are deemed to be fit for purpose
- There are therefore no overall uncertainty statements for calculated emissions –for activity data
- ‘Trueness – it shall be ensured that the emission determination is systematically neither over nor under the true emissions’



# The Measurement Approach

- Operator may use a measurement approach (CEM) if they can demonstrate
  - It reliably provides a more accurate value of annual emissions, without unreasonable costs
    - Unreasonable costs are based on value of allowances equivalent to improved accuracy, or 1% of value of emissions from previous trading period
    - So for a typical power plant this can be ~ £1M
      - At current CO<sub>2</sub> price - £10 per tCO<sub>2</sub>
  - A comparison with a calculation approach is carried out annually

# Measurements for mass emission rate

- Continuous concentration measurement
  - CEM
  - CEN or ISO standards
  - Hourly data
  - Procedure for missing data
- Flow measurement
  - Flow meter
  - Calculation
- Annual mass emission rate by averaging hourly mass emission rates

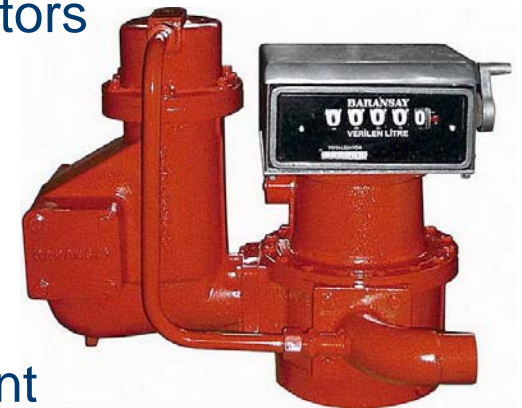
# Uncertainty Requirements for Measurement

- If using CEMs then the required uncertainties for the mass emission rate for each emission source for the reporting period (year) are :
  - Must use at least Tier 2 (uncertainty < 7.5 %)

Tier 1	10%
Tier 2	7.5%
Tier 3	5%
Tier 4	2.5%

# Measurements in the current scheme

- Metering
  - Fuel flow
  - Stock levels
- Analysis of composition
- Determination of emission factors
  - Tier 3 - need to activity specific emissions factors
  - Sampling an issue
  - Direct measurement possible ?
- Oxidation factors
  - May be included in emissions factor
  - Highest tier may require analysis of ash content

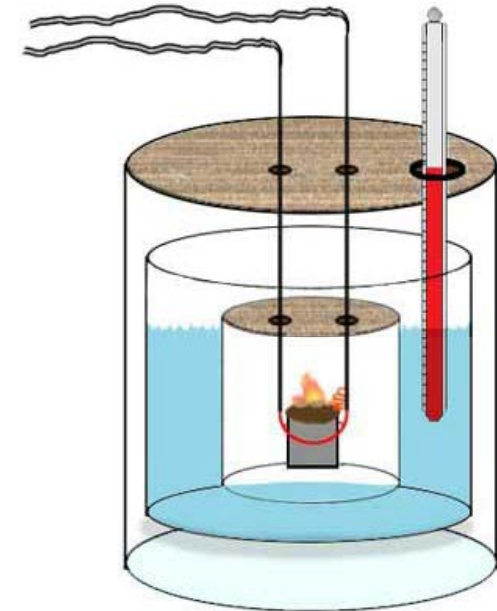


# Determining Emission Factors's

- Tiered approach for EF's
  - 1) Reference factors – from 2006 IPCC
    - Uncertainties ~ <5% from IPCC guidance
  - 2) Country specific factors – Defra website
    - Based on figures from UK inventory
    - NCV / GCV
    - Eg fuel oil – difference ~3%
    - 1% difference between 2007 inventory figure and UK ETS value

# EF's

- 3) Activity specific EF's
  - Based on analysis of fuel
  - Measure NCV, CEF and OF
  - Standards
    - EN ISO 4259
    - DIN standards ie bomb calorimeter
    - Use of accredited labs recommended
  - Fuel homogeneity, sampling important
  - Show evidence that samples free of bias
  - Determine parameters to  $< 1/3$  required uncertainty for annual average
  - Guidance on frequency – ie monthly for fuel oil



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# Future requirements

- The ETS is likely to be extended to
  - Aviation – in place - Directive 2008/101/EC
  - Marine and other transport
  - Other GHGs –  $\text{N}_2\text{O}$ , Methane, Perfluorocarbons etc
  - Other industries
  - International links / Kyoto
  - Use of CCS in trading



# Nitrous Oxide Emissions

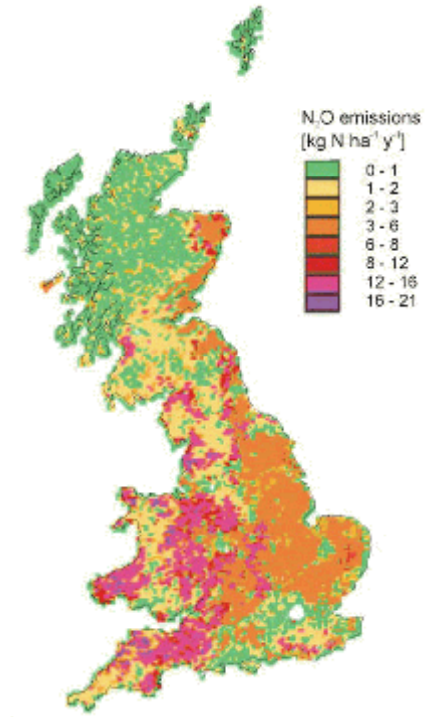
- $\text{N}_2\text{O}$  has been 'opted in' by the Netherlands
- Specific amendment of MRG covers  $\text{N}_2\text{O}$  (Dec 2008)
- CEM based approach
- Nitric acid plants – process emissions, no combustion
- $\text{NH}_3$  is oxidised – the oxygen comes from ambient air flow
- Emissions flow rate is determined from metered air input, and oxygen continuous measurements of oxygen in emission stream.
- CEMs calibration and QA/QC under EN 14181.





# Nitrous oxide emissions in UK

- $\text{N}_2\text{O}$  ~ 10% of  $\text{CO}_2$  UK emissions
- Mainly from soil (61%)
- Emissions from industry
  - Combustion 18% (ie FBC of coal)
  - Industrial processes 13%
    - Adipic acid (nylon production and pesticides)
    - Nitric acid production (fertiliser)
  - Transport (catalytic converters)
- Increasingly seeing  $\text{N}_2\text{O}$  in permits
- Measurement by FTIR, NDIR



# Putting in place the tools to enable measurements

- Developing standards in CEN to enable direct measurement of
  - Mass emission rates
  - Emissions factors
- New standard for time averaged emissions
  - EN ISO 11771 - Mike Woodfield will talk about this
- New standards for flow measurement
  - Continuous and manual reference methods
  - Specifically address requirements of ETS

# Flow measurement

- Covering
  - Pitots, including 3D pitots
  - Automated methods
  - Tracer methods – dilution and time of flight
  - Calculation approach
- Uncertainty requirements
  - Annual measurements for ETS
  - Achieve 2.5% annual average



# Trading in the US

- US are implementing trading for CO<sub>2</sub>
  - RGGI – 10 States – mandatory cap and trade
  - California – Carbon trading
  - Federal trading well established in SO<sub>2</sub>, NO<sub>x</sub> (and now mercury)
  - EPA declared GHG's a danger to public health on 17<sup>th</sup> April 2009 – first step to regulating them under the clean air act
- Measurement is key to the US markets
  - Developments of improved flow monitoring methods in US were driven by SO<sub>2</sub> trading
  - EPA trading experts see CO<sub>2</sub> measurement as key validation, though calculation approach likely to be used for routine reporting
  - Already have CO<sub>2</sub> CEMS being used and meeting trading requirements

# Uncertainty calculations

- NPL study - Assessed the uncertainties for
  - Power stations
  - Complex refinery
  - N<sub>2</sub>O in Netherlands
  - CEM approach in Belgium
  - Emission Factor determination
- Built Monte Carlo simulations
- Issues with correlated uncertainties
  - Multiple flow meters probably have correlation
- Issue with EN 14181 calibration for CEM
  - Once all the random terms have averaged out (8760 hrs) then the dominant term comes from the 15 parallel SRM measurements carried out every 3 yrs

# Issues with measurement approach

- Is it cost effective?
- Calibration regime of CEMs
- Can uncertainties be achieved?
  - Concentration and flow

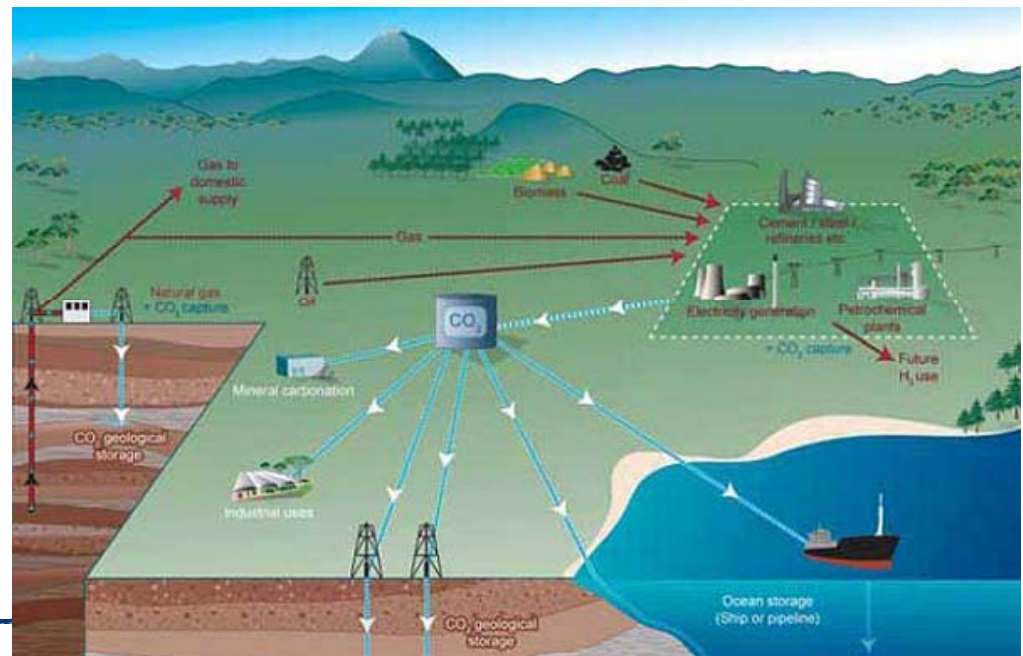


# Issues with the calculation approach

- Systematic uncertainties in measured quantities
  - If all flow meters are calibrated to one reference
- Emissions factors
  - Single emission factor for one type of fuel immediately introduces systematic effect
- Quality of emission factors
- Has any validation been carried out on actual emissions

# Measurements supporting CCS

- Carbon Capture and Storage will be included as credit in the ETS
  - Measurements of loss from CCS
    - Capture efficiency, transport and storage
      - New capture system on-line in France
      - Funding for four CCS projects in UK





# Areas where measurement will be required

- Where calculation is impractical
  - $\text{N}_2\text{O}$ , other GHGs, complex production plant
- Determination of EF's
- Will there ever be a need to check emissions directly ?

