



Uncertainties in national inventory methane emissions from landfills – a UK case study

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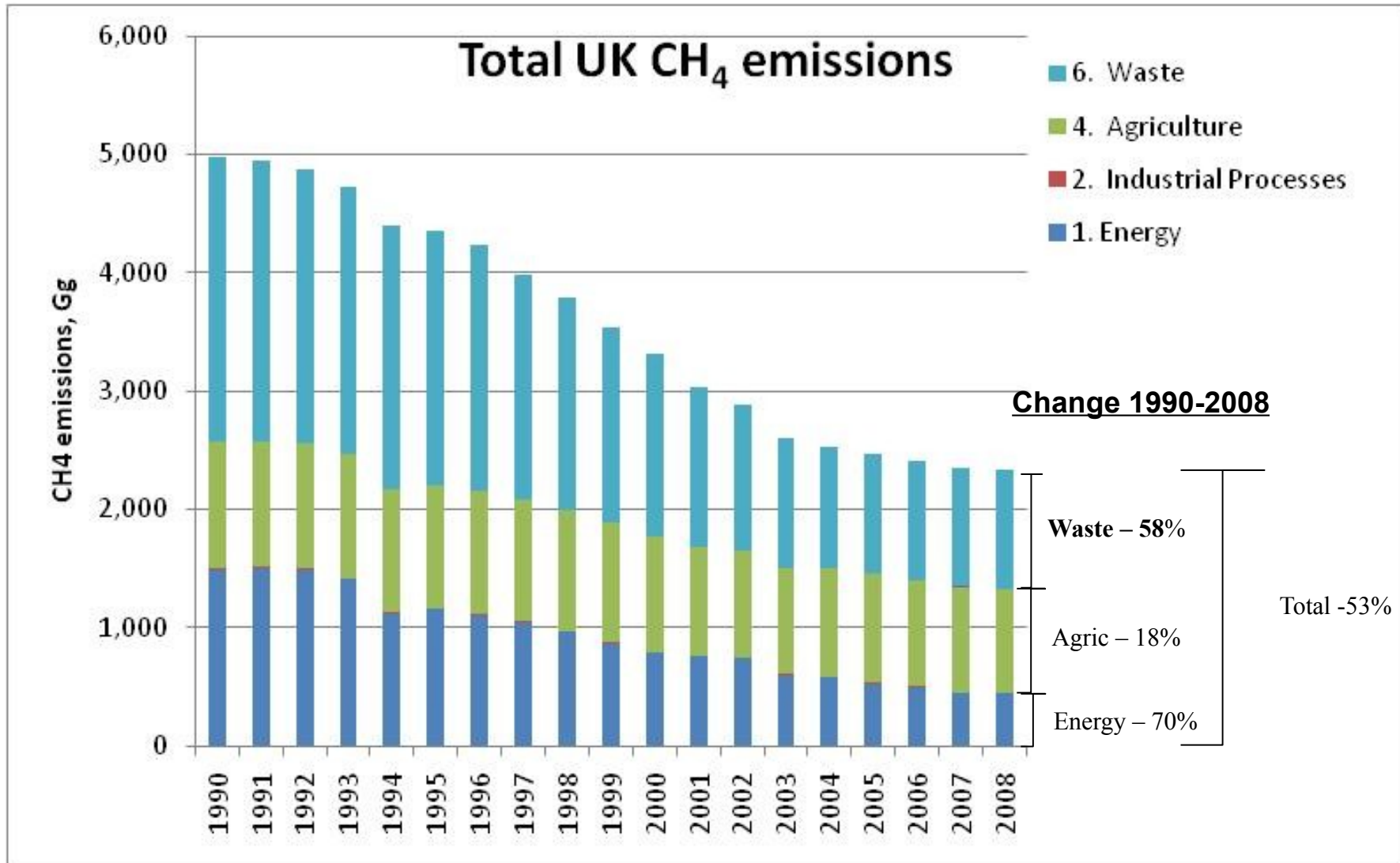
Presentation Outline

- **Context and trends**
- **Methodologies – measurements and modeling**
- **Sources of uncertainty**
 - Methane formation
 - Methane recovery
- **Verification**
- **Conclusions and future work...**

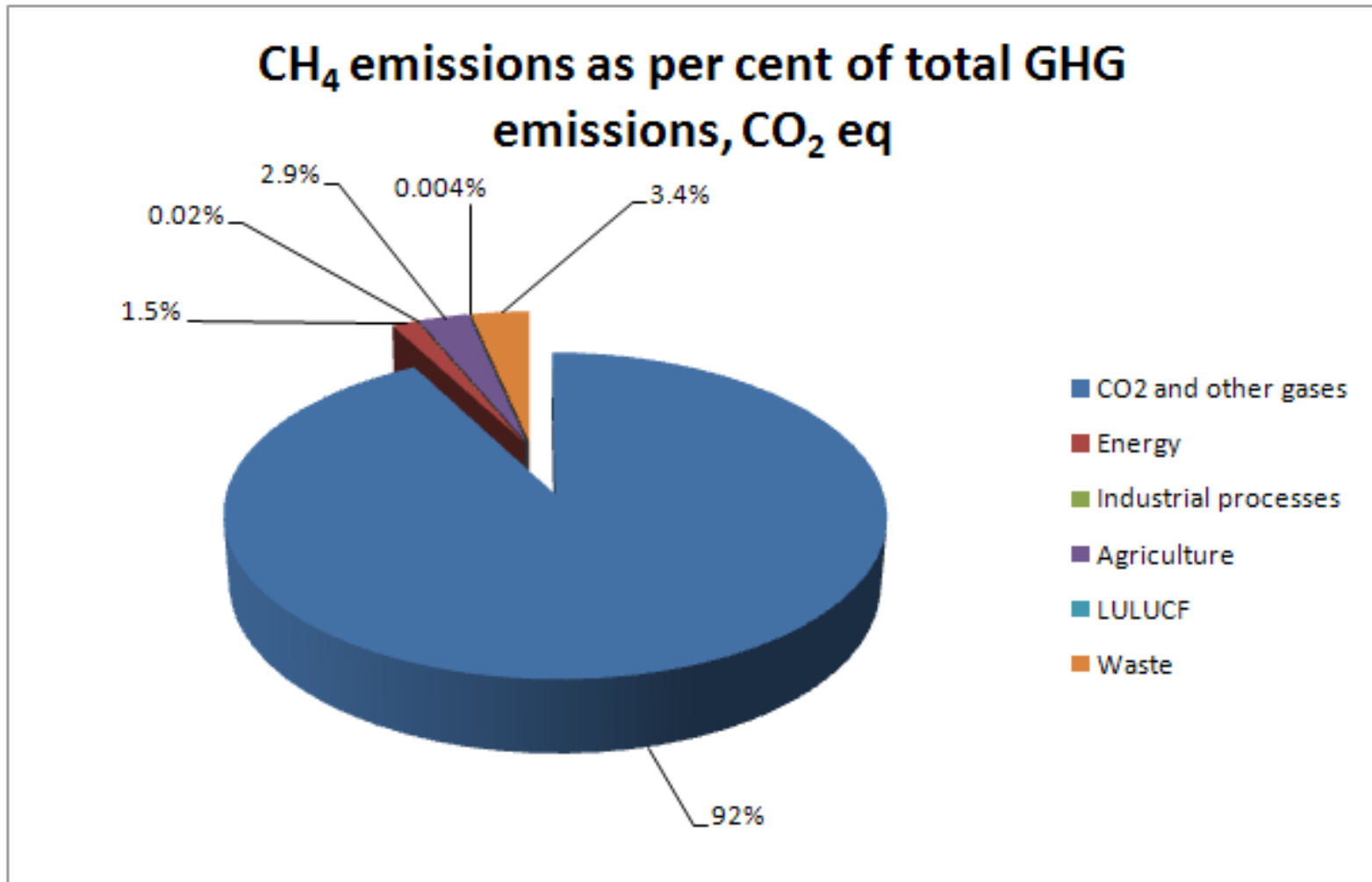
Context

- **UNFCCC sector 6 – Emissions from Waste**
- **Sector 6.A – Solid Waste Disposal on Land**
- **6.A.1 – Managed Waste Disposal on Land – a Key Sector**
- **6.A.2. – Unmanaged Waste Disposal Sites (deep or shallow) – not occurring in UK.**

Context - Trends and sources



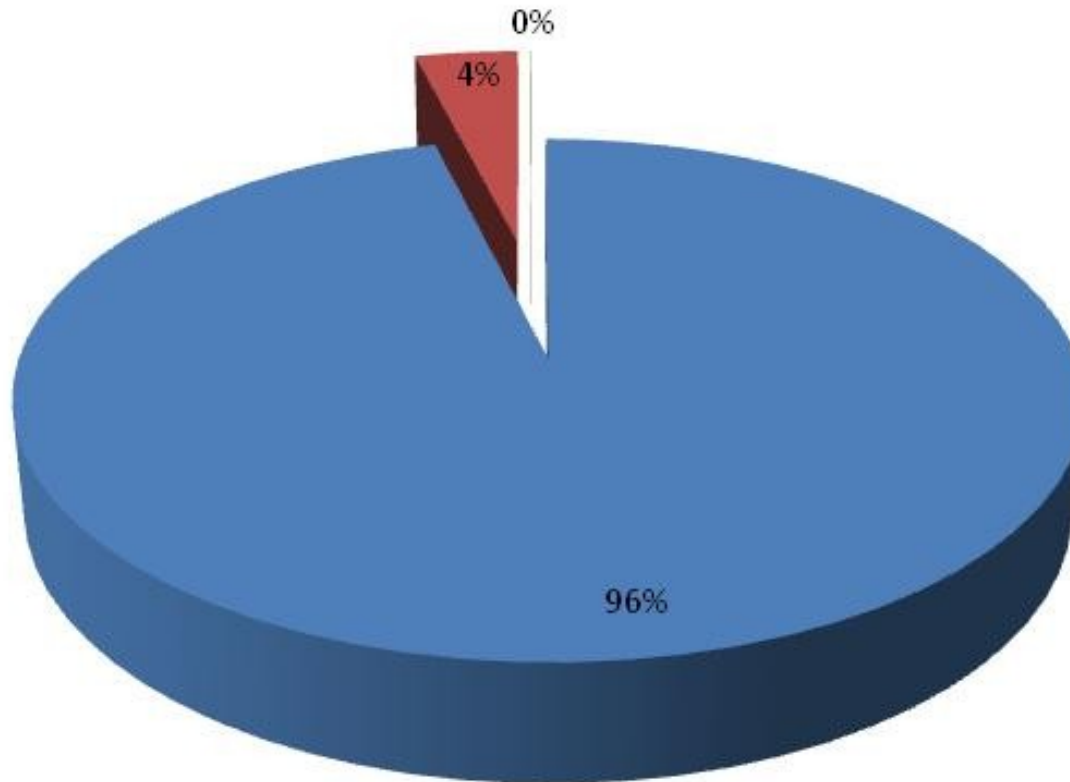
Context - CH₄ sources...



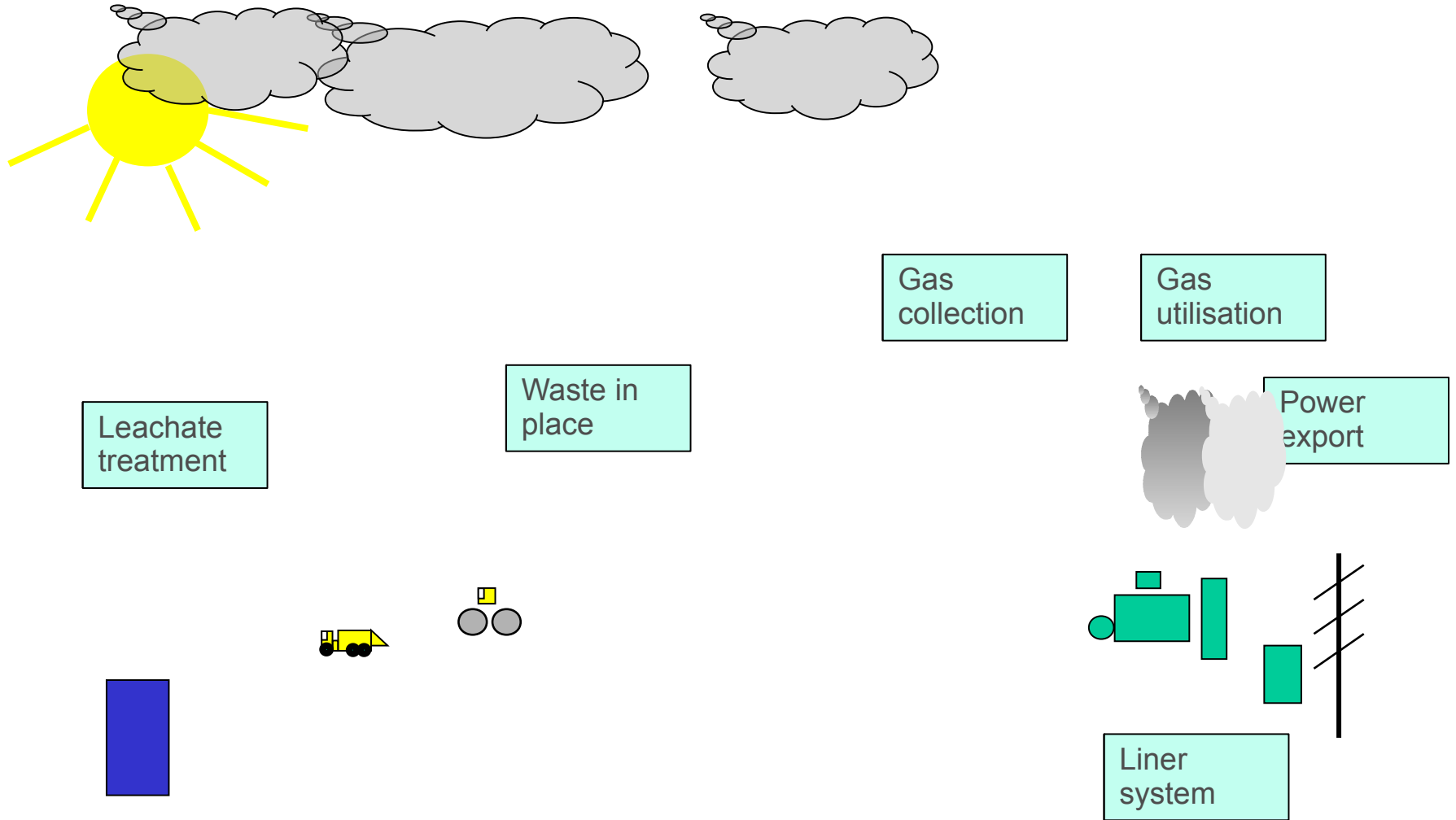
Context - Waste sector sources

CH₄ emissions from Waste Sector 2008

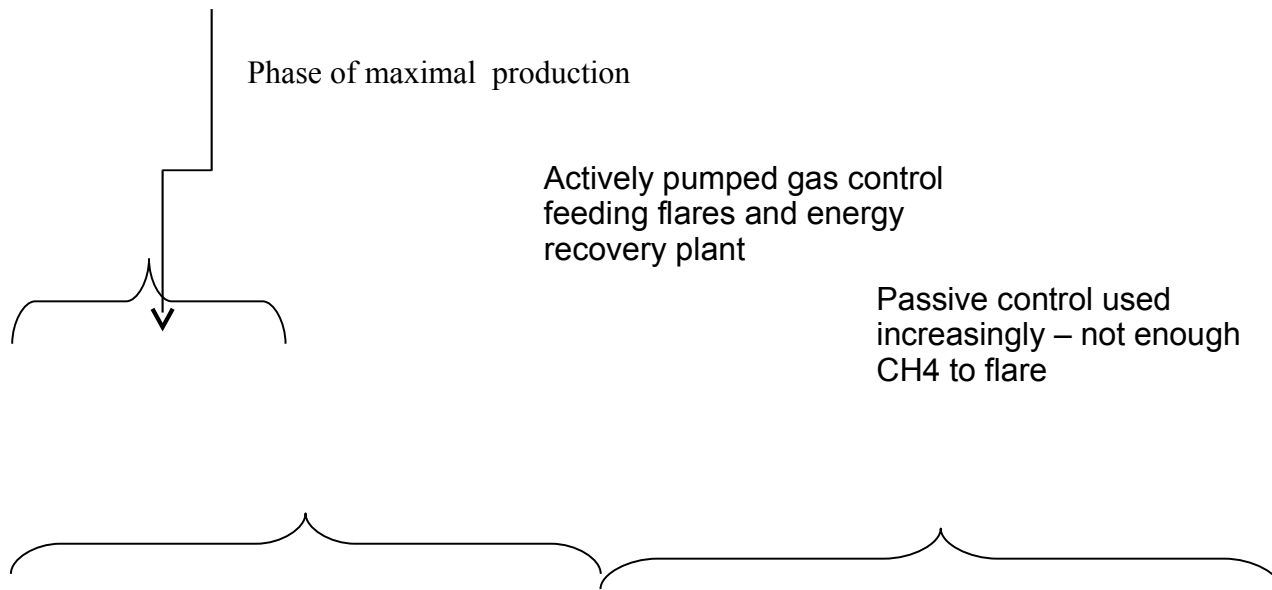
■ A. Solid Waste Disposal on Land ■ B. Waste-water Handling ■ C. Waste Incineration



Methodology - CH₄ pathways in landfills



Time course of CH₄ formation



Methodology – measurements and models

Direct measurement techniques?

- Flux boxes
- Long path length spectrographic methods
- Tracer methods
- Measurements have to cope with high levels of temporal and spatial variability over a wide range of scales – hence are very expensive
- Cannot predict the future...

Modelling approach - IPCC “Tier 2” first order decay approach

CH₄ emissions = [$\sum_x \text{CH}_4 \text{ generated}_x, T - RT$] (1-OXT)

- CH₄ emissions = methane emitted in year T, Gg
- T = inventory year
- x = waste category or type of material
- RT = recovered CH₄ in year T, Gg
- OXT = oxidation factor in year T (fraction)

Sources of uncertainty

Overall uncertainty in CH₄ emissions from landfills estimated by Monte Carlo: +/- 48% (95% CI)

Details in UK NI report –

- http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories

Activity data :

Amount of waste sent to landfill each year

- Good data now for municipal solid waste
- Data on biodegradable

Composition of waste – how it affects Dissimilable Degradable Organic Carbon (the C that is converted to CH₄ and CO₂)

First order decay rate constants

Sources of uncertainty – emission factors

Recovery efficiency averaged over the life of a landfill

- Operators typically report collection efficiency of >85% in active landfills
- But what about overall average collection efficiency?
- Overall collection efficiency estimated at 70%, averaged over old and modern sites.

Methane recovered for use (electricity generation) ~32% recovery

- Electricity from landfill gas is subsidised
- Site operators only get the subsidy if they report energy production
- Methane used for electricity generation is well characterised.

Methane flared – poor quality data - ~38% recovery

- Operators are required to prevent escape of landfill gas. To do this they need to use flares.
- There is no obligation to report landfill gas sent to flaring
- Current estimates are based on flare stack capacity and estimated duty
- Further work is needed to update these estimates

Sources of uncertainty – emission factors

Methane oxidation

- Microbial process occurring in surface layers
- Requires oxygen, moisture and moderate temperature

Role of oxidation

- Depends on contact time – which also depends on cap condition
- Can account for ~90% of methane formed under optimal conditions
- In practice, much less over the life of a site
- IPCC default value is 10% for managed landfills.
- UK inventory uses IPCC default 10%

Verification studies

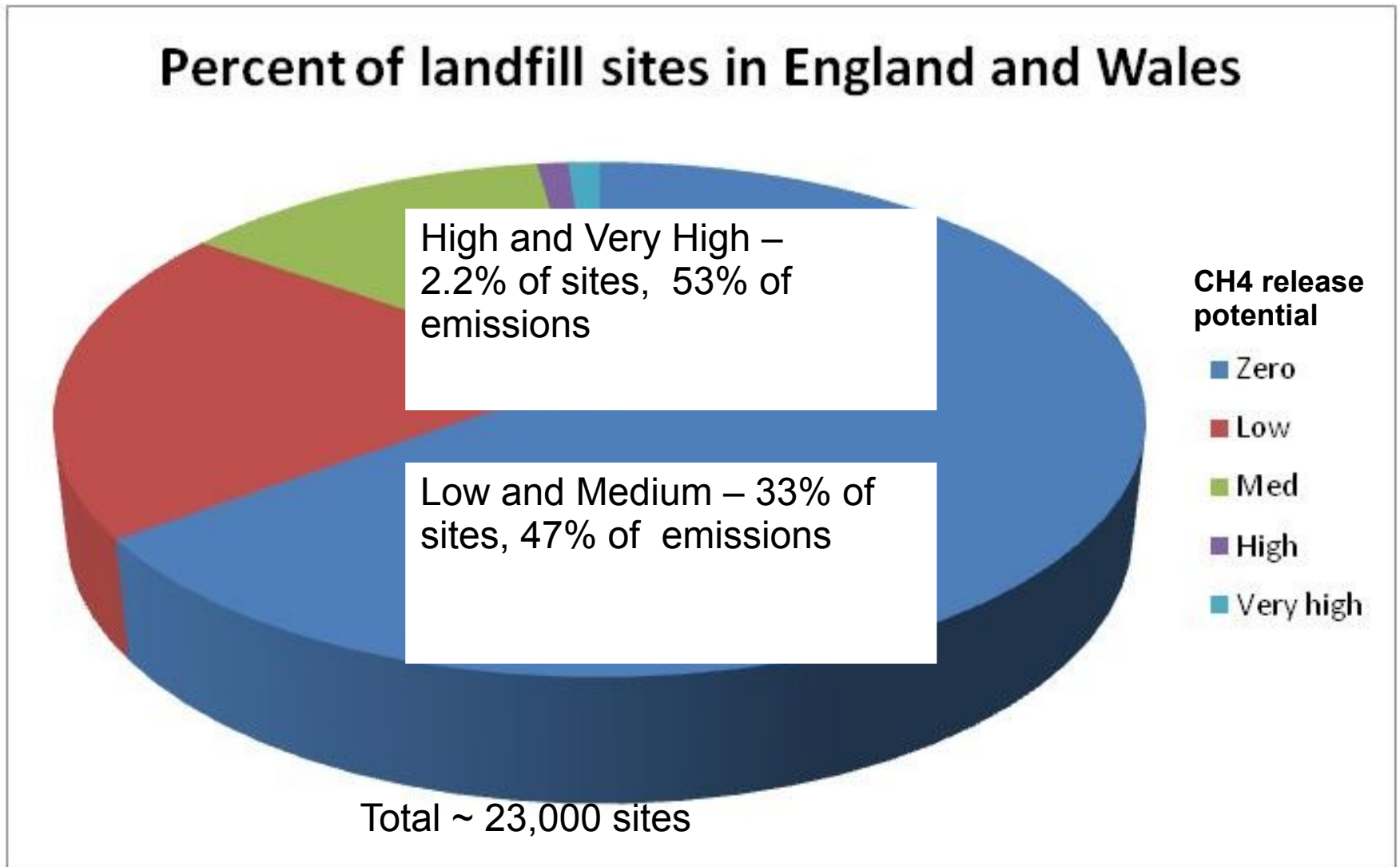
CH₄ from landfills

- Statistical stratification of landfills, based on waste input and landfill characteristics
- Undertaken by Jacobs Engineering Ltd for Environment Agency

Total emissions studies

- Air quality monitoring and “air history” modelling

CH4 release potential of landfills (2007)



Comparison with NIR data...

- **Modelled CH₄ generation at a selection of sites using GasSim model**
- **Corrected for CH₄ recovery**
- **England and Wales emissions estimated at 732 +/- 253 (95% CI) Gg CH₄/year.**
- **Scale to UK on populations (England and Wales is about 88% of UK population) gives**
 - **831 +/- 287 Gg CH₄/year in 2007**
 - **(NIR 963 Gg CH₄/year)**

Verification 1 – CH₄ from landfills

UK inventory data

Verification 2 – CH₄ from landfills

UK inventory data

Verification studies – all sources 2006

Based on 3- hourly measurements of atmospheric concentrations of GHGs at European air quality monitoring stations under the FP6 NitroEurope project.

Modelled 10-day “air history” using the NAME model, discounting biogenic sources (eg peat bogs) developed by Met Office

Results determined for 2006 were very close to inventory emissions of total anthropogenic CH₄

Verification 3 – CH₄ from all sources

UK inventory data

Verification 4 – CH₄ from all sources

UK inventory data

Verification 5 – CH₄ from all sources

Conclusions and future work...

CH₄ emissions from landfills:

- Inventory estimates for emissions from landfills agree well with results from a stratification study of landfills.

Total UK emissions anthropogenic CH₄ emissions:

- We know that emissions have decreased markedly since 1990 for landfills, energy and agriculture sectors.
- Since ~2001, air history modelling results agree reasonably well with inventory estimates.
- But we don't know why the air history modelling does not reflect the overall decline in emissions since 1990.

Future work is underway to reduce uncertainty in activity and emission factors for landfill methane.

**Thank you for your
attention!**