Accuracy and uncertainty of monitoring in carbon offsetting projects

Climate-KIC MRV Sector: WP3 Uncertainty Analysis

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Reported vs. Actual Emission Reductions

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- Assessing the uncertainty in reported Emission Reductions for CDM is necessary to understand the possible difference between the reported emission reductions and greenhouse gases actually emitted into the atmosphere
- Offsetting projects have a principle of conservativeness – based on the uncertainty – try to ensure no ‘over reporting’
- In principle this opens the opportunity to improve knowledge of the actual ERs and report more
- Within the Climate KIC project we assessed a number a different methodologies for calculating carbon savings from activities and determine where direct measurement could increase the environmental integrity whilst avoiding additional costs.

How do we determine the uncertainty in ERs

- To calculate the uncertainty in ER we need two things
  - Knowledge of how ER is calculated
  - Knowledge of the uncertainties in the input data

- Standard approach to uncertainties is the Guide to the Expression of Uncertainty in Measurement (GUM)

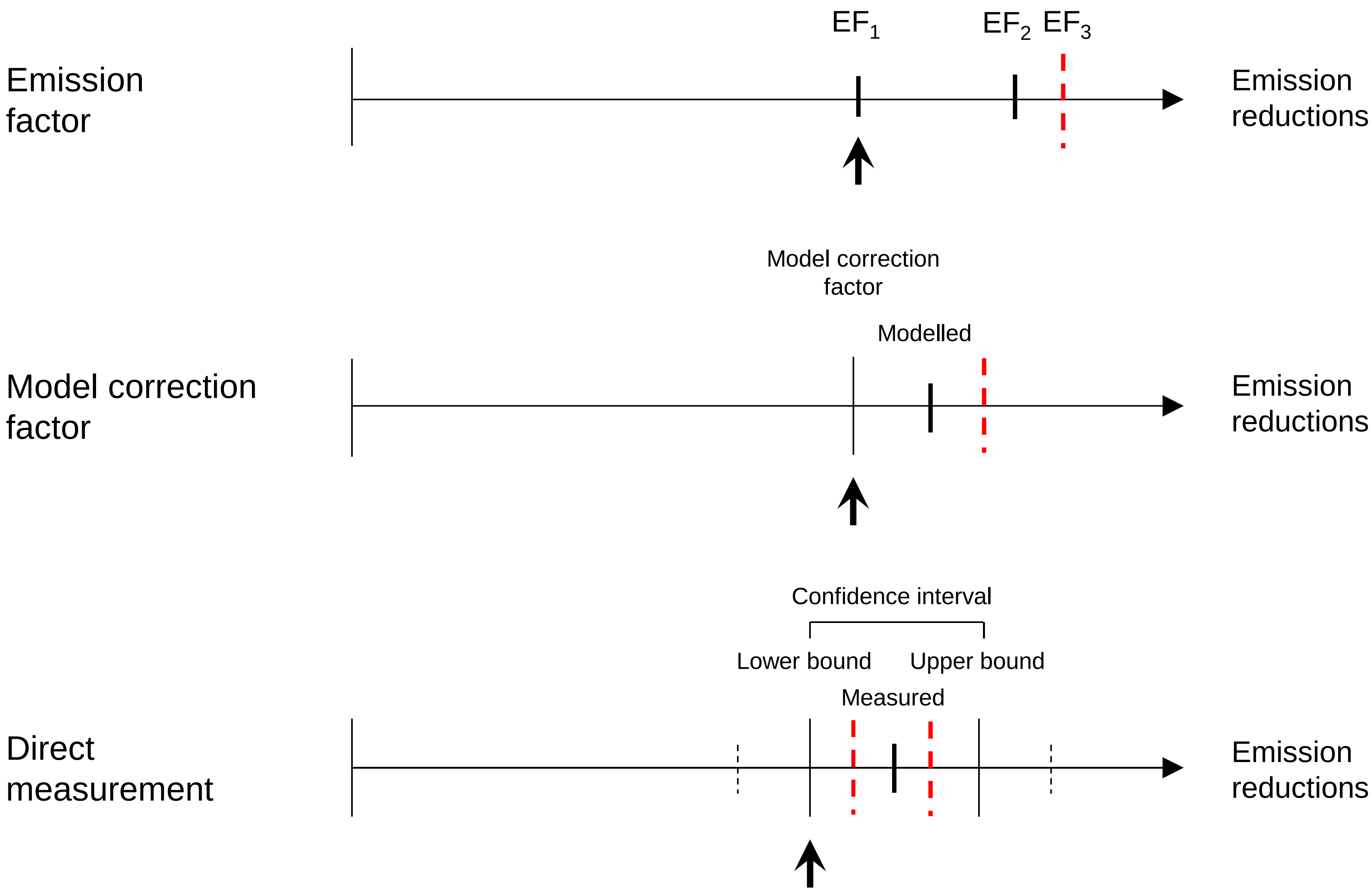
1. Combining uncertainties in input parameters using model equation

$$U_{total} = \frac{\sqrt{(U_1 * x_1)^2 + (U_2 * x_2)^2 + \ldots + (U_n * x_n)^2}}{x_1 + x_2 + \ldots + x_n}$$

2. Monte Carlo Simulation
   - series of functions run repeatedly with small perturbations in the input parameters.

- Explicit or implicit uncertainty in the calculation of emission reductions
  - Some uncertainty sources are under control of project developers, others are not

Improving Uncertainty



Six selected methodologies

CDM Method	AM0023 Leak detection and repair in gas production, processing, transmission, storage and distribution systems and in refinery facilities	AM0055 Recovery and utilization of waste gas in refinery of gas plant	AMS-III.D Methane recovery in animal manure management systems	AMS-III.F Avoidance of methane emissions through composting	AMS-III.G Landfill methane recovery	AMS-III.H Methane recovery in wastewater treatment
Emission reductions	160,000-1,200,000 tCO2e/yr	30,000-220,000 tCO2e/yr	1,500-90,000 tCO2e/yr	3,000-60,000 tCO2e/yr	10,000-50,000 tCO2e/yr	5,000-75,000 tCO2e/yr
Common method	Measured	Measured and some emission factors	Measured methane captured and emission factors for flaring	Emission factors, and measurement of proxy factors	Measured, and emission factors for flaring	Emission factors
Conservative	Uncertainty in measurement (EFs are low)	Conservative value for boiler efficiency	Two approaches to emission reductions. Conservative value for flare efficiency.	Methane generation potential is conservative. Confidence intervals applied (lower and upper bounds).	Low flare efficiency default value used.	Model correction factor and methane correction factor are conservative (used to calculate project emissions).
Uncertainty	<5%for measurement (EFs 70-150%)	<5%for measurement	<10% for measurement (Flare efficiency ~30%)	<10% for measurement*	<2% for measurement (Flare efficiency ~30%)	>5% for measurement (Flare efficiency ~30%)

IPCC Monitoring Approaches

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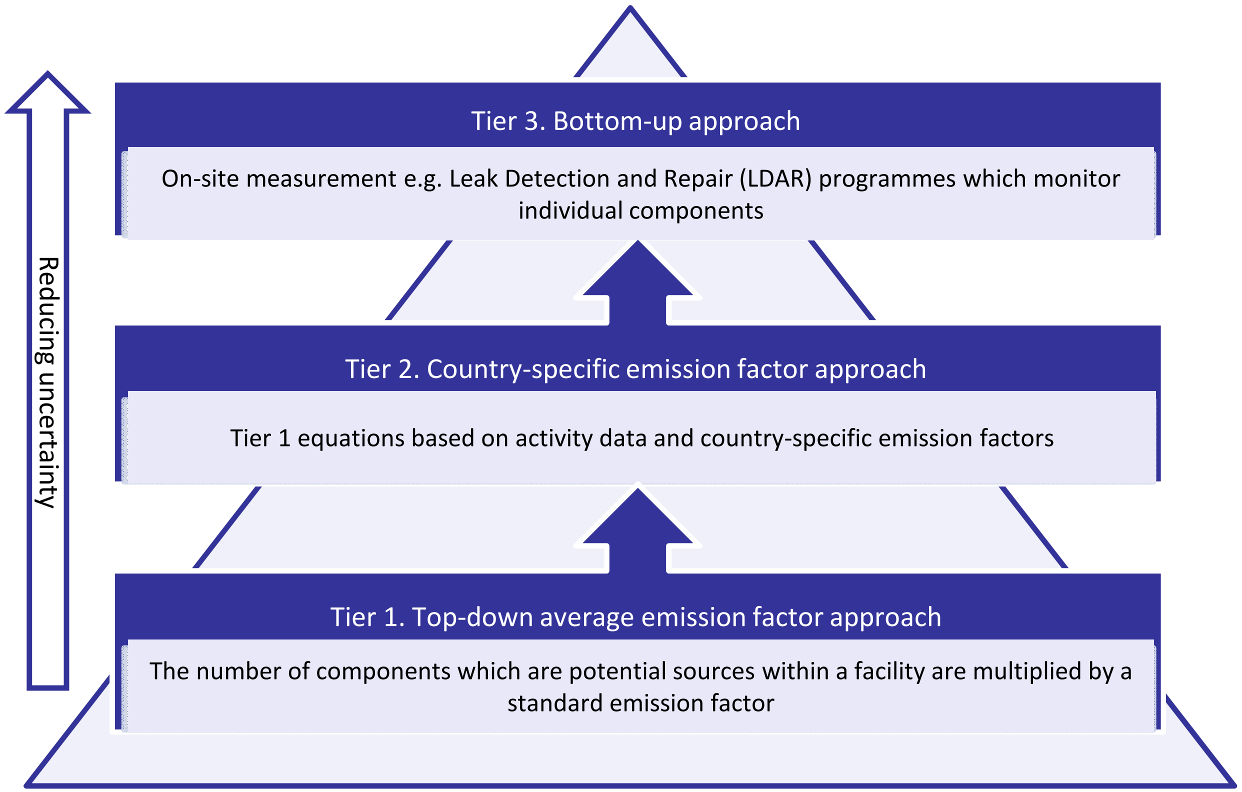
Three IPCC monitoring approaches:



Case Study:
methane emissions from agriculture

CDM methodology AMS-III.D. methane recovery in animal manure management systems

- Baseline scenario: wastewater is transported to an open lagoon for evaporation; digestion of degraded organic material produces methane.

- Project scenario: a high greenhouse gas animal waste management system is replaced with a covered in-ground anaerobic digester with capture and combustion of the output biogas.

Emission reductions can be calculated in two ways:

1) Emission reduction is the difference between baseline emissions and project emissions. This is the approach commonly used by other CDM methodologies.

$$ER_y = BE_y - PE_y$$

2) Emission reductions are calculated from project emissions and methane destroyed.

$$ER_y = MD_y - PE_y$$

Case Study:

methane emissions from agriculture

1. Default values
   - Average emission factor (principle of conservativeness)
   - Low capital cost
2. Direct measurement
   - Uncertainty explicit in calculation
   - More accurate emissions reporting

Two approaches outlined within the methodology

Emission reductions for Project using CDM methodology AMS-III.D version 17

	Parameter changed	Source	Uncertainty
Method 1	Volatile solids for livestock, $VS_{LT,y}$ (+10%)	Calculated from measurements and IPCC default values	
Method 1	Model correction factor, UF (UF = 1)	FCCC SBSTA	
Method 1	Model correction factor, UF (-10%)	FCCC SBSTA	
Method 1	Maximum methane producing potential, $B_{0,LT}$ (+10%)	IPCC	
Method 1	Annual methane conversion factor, MCF_J (+10%)	IPCC	
Method 1	Flare efficiency in the hour, $\eta_{flare,h}$ (+10%)	Measured	
Method 1	Mass flow rate of methane, $TM_{RG,h}$ (-10%)	Calculated	
Method 2	Biogas flared or combusted, $BG_{burnt,y}$ (+10%)	Measured (flowmeter)	5%
Method 2	Methane content in biogas, $W_{CH4,y}$ (+10%)	Measured (portable analyser)	-
Method 2	Flare efficiency in the year, FE (+10%)	Calculated from temperature	Potentially 8%

Flare Efficiency

- A number of CDM methodologies include flares
  - Combusting methane to carbon dioxide (to reduce the GWP)
- Flare efficiency equation:

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}}$$

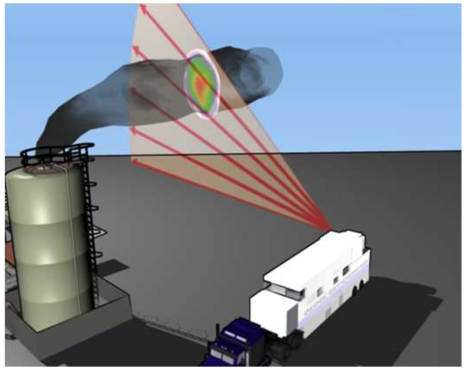
- Tend to use emission factors (high uncertainty)
  - Difficult to use point measurement
  - Variation in the flare efficiency
- Potential to use optical techniques

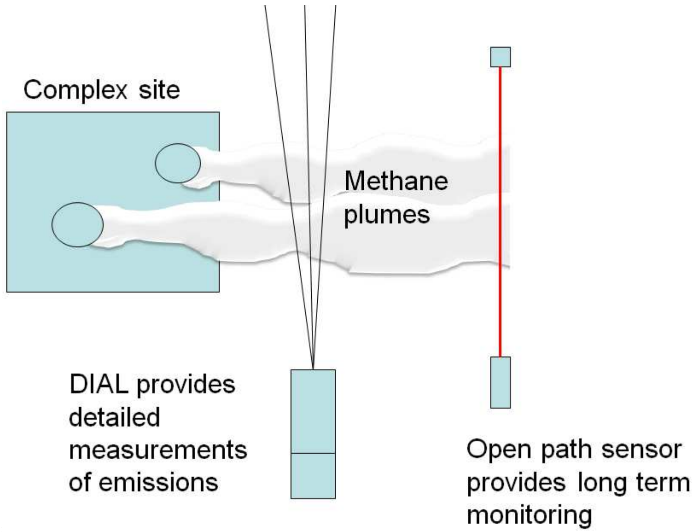
  (to improve uncertainty)
  - Direct measurements in project
  - Improved emission factor

Improved Monitoring

Example of novel techniques for direct measurement

- Identify innovative monitoring technologies to improve the quantification of fugitive emissions and flares;
  - Differential Absorption Lidar (DIAL)
  - Fourier Transform Infrared Spectroscopy (FTIR)
- Climate-KIC FuME: currently looking into new approaches of measuring methane emissions from point sources



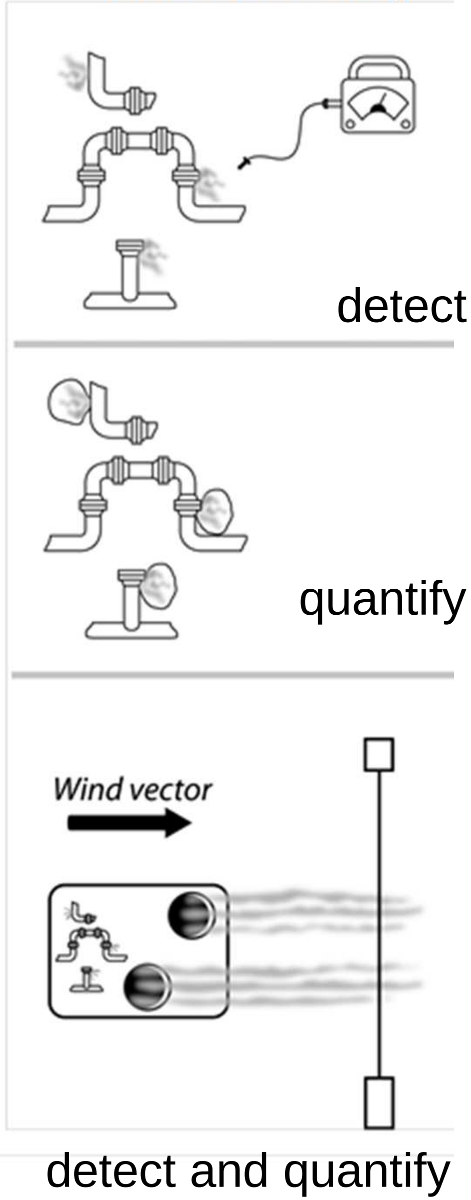


Three solutions

1) Improve or introduce direct measurement

2) Improve default emission factors (using local/regional data)

3) New/different technology
   - Change method of MRV to calculate emission reductions
   - New monitoring tools to better understand the emission reduction or improve baselines (i.e. open path techniques)



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