Lessons learned from the Application of Emission Factors defined in 2006 IPCC Guidelines to the Clean Development Mechanism (CDM)

IPCC Expert Meeting:
Application of 2006 IPCC Guidelines to Other Areas
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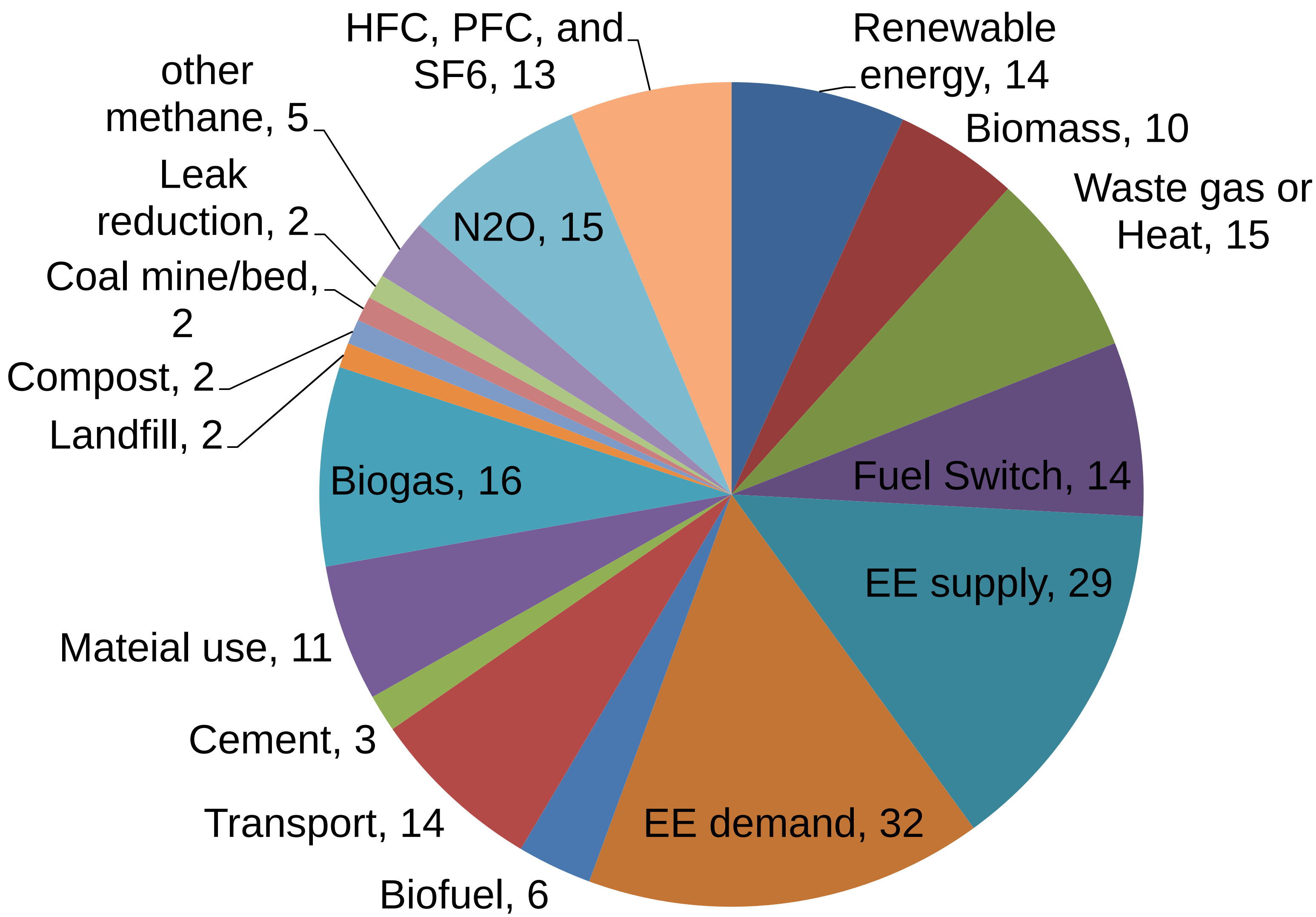
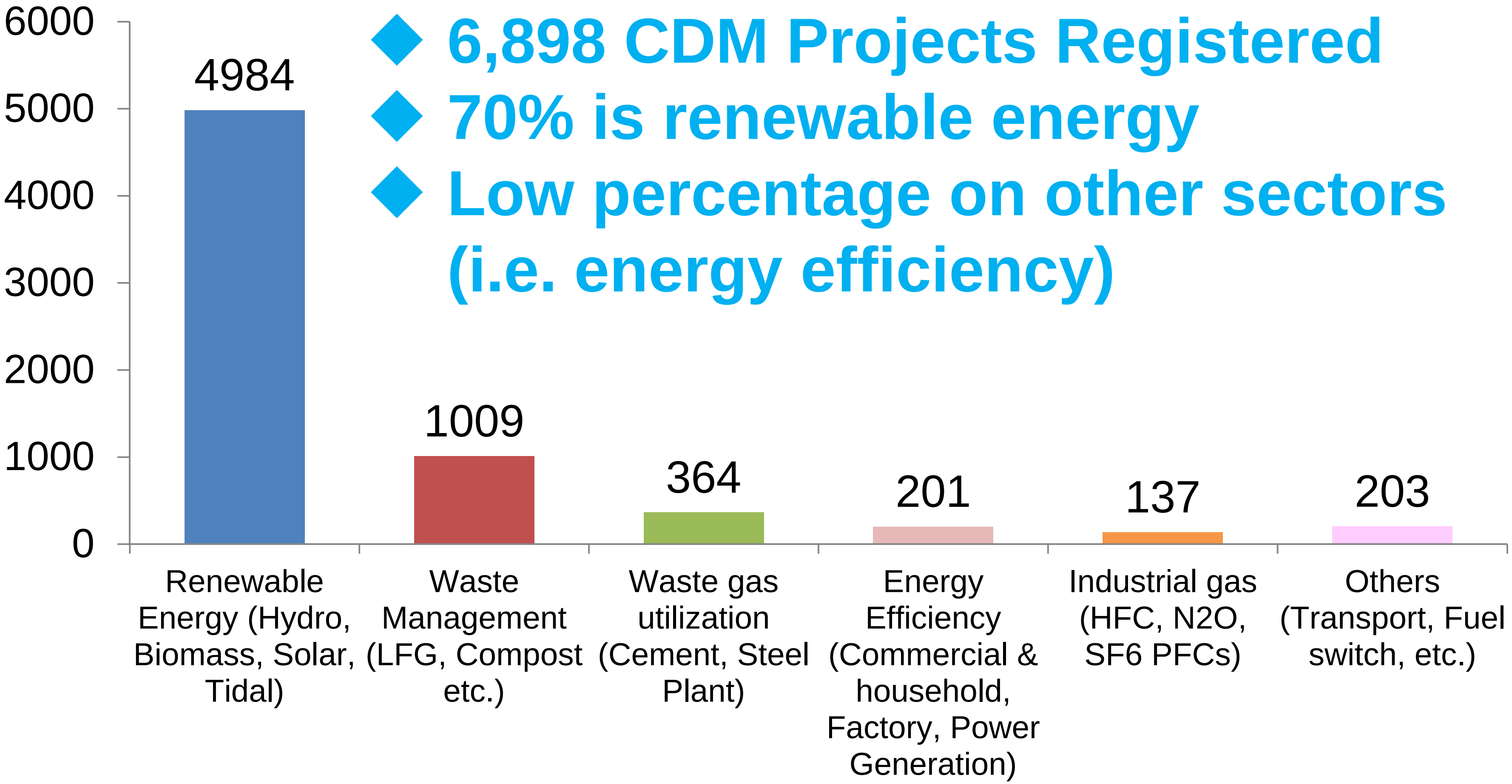
205 CDM Methodologies



Source: IGES in CHARTS (March 2014)

Majority of projects under renewables and waste management

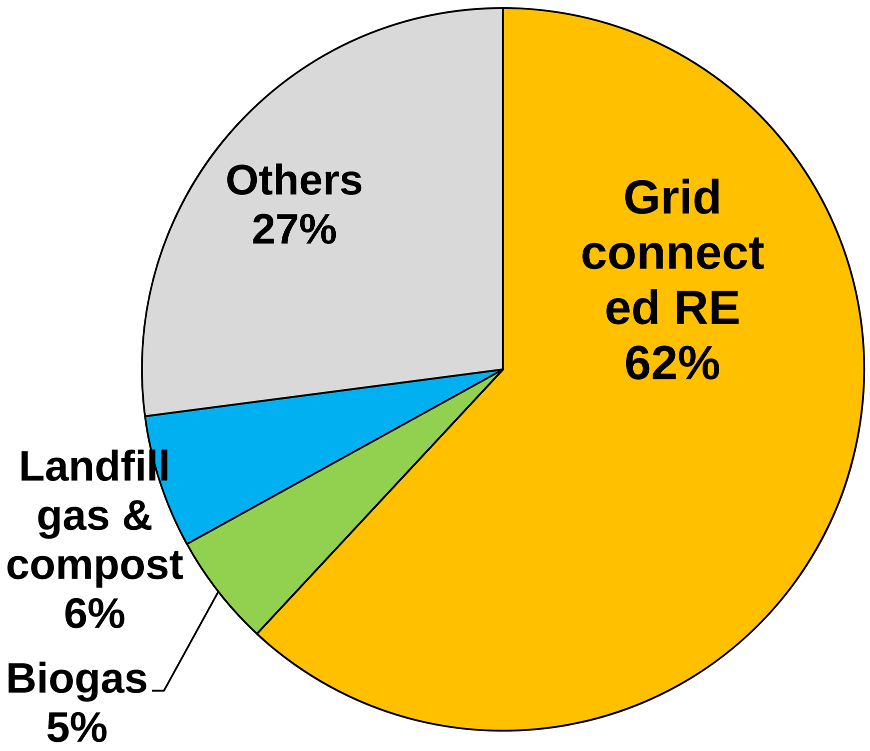
- **6,898 CDM Projects Registered**
- **70% is renewable energy**
- **Low percentage on other sectors (i.e. energy efficiency)**



Source: IGES CDM Project Database (June 2013)

More than 70% of CDM projects use the baseline as the existing emissions

Share of Registered CDM Project by types



IGES CDM Project database (1. Feb. 2012)

Grid connected= Grid Emission Factor

Biogas=Methane generation potential

Landfill/compost=Fast Order Decay model

Renewable Energy

ACM0002 (ver.12.1) Consolidated methodology for grid-connected electricity generation from renewable sources

- ◆Combined CO_2 emission factor for grid connected power
- ◆Project emissions in year y

Baseline Emissions

$$BE_y = EG_{PJ,y} \cdot EF_{grid,CM,y}$$

Tool to calculate the emission factor for an electricity system

Project Emissions

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y}$$

Tool to calculate project or leakage CO2 emissions from fossil fuel combustion

Tool to calculate EF for Grid

Based on data on fuel consumption and net electricity generation of each power plant / unit

$$EF_{grid,\ OM\text{-}ave,\ y} = \frac{\sum_{i,m} FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{\sum_{m} EG_{m,y}}$$

Net calorific value (IPCC)

CO_2 emission factor (IPCC)

Tool to calculate Project EFs

Based on fuel consumption and fraction of carbon in the fuel

$$PE_{FC,i,y} = \sum_{i} FC_{i,j,y} * COEF_{i,y}$$

Option A:

Mass fraction of carbon in the fuel

If $FC_{i,j,y}$ is measured in a mass unit: $COEF_{i,y} = w_{C,i,y} \times 44/12$

If $FC_{i,j,y}$ is measured in a volume unit: $COEF_{i,y} = w_{C,i,y} \times \rho_{i,y} \times 44/12$

Option B:

$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$

Default values can be applied by the 2006 IPCC Guidelines

Waste Management (Animal Manure)

AMS-III.D. (version17) Methane recovery in animal manure management systems

◆For many of parameters, default values are provided by 2006 IPCC inventory guideline

Baseline Emissions: Equation (1)

$$BE_y = GWP_{CH4} * \underline{D_{CH4}} * UF_b * \sum_{j,LT} \underline{MCF_j} * \underline{B_{0,LT}} * N_{LT,y} * \underline{VS_{LT,y}} * MS\%_{Bl,j}$$

IPCC IPCC IPCC IPCC

D: CH4 density
MCF: Methane correction factor
B: Methane producing capacity
VS: Volatile solids

$$VS_{LT,y} = \left(\frac{W_{site}}{\underline{W_{default}}} \right) * VS_{default} * nd_y$$

IPCC

W: Default average animal weight of a defined population

Wastewater Treatment

AMS-III.H. (version16) Methane recovery in wastewater treatment

◆For many of parameters, default values are provided by 2006 IPCC inventory guideline

Baseline Emissions: Equation (2)

$$BE_{ww,treatment,y} = \sum_i (Q_{ww,i,y} * COD_{\inf low,i,y} * \eta_{COD,BL,i} * \underline{MCF}_{ww,treatment,BL,i}) * \underline{B}_{o,ww} * UF_{BL} * GWP_{CH4}$$

IPCC IPCC

MCF: Methane correction factor
B: Methane producing capacity

Baseline Emissions: Equation (3)

$$BE_{treatment,s,y} = \sum_j S_{j,BL,y} * \underline{MCF}_{s,treatment,BL,j} * \underline{DOC}_s * UF_{BL} * \underline{DOC}_F * \underline{F} * 16/12 * GWP_{CH4}$$

IPCC IPCC IPCC IPCC

DOC: Degradable organic content
F: Fraction of CH4

Waste Management (Municipal waste)

AMS-III.F. (ver.10) Landfill methane recovery

AMS-III.G. (ver.6) Avoidance of methane emissions through controlled biological treatment of biomass

◆For many of parameters, default values are provided by 2006 IPCC inventory guideline

Baseline Emissions: AMS-III.F.

$$BE_y = \underline{BE_{CH4,SWDS,y}} + BE_{ww,y} + BE_{CH4,manure,y} - MD_{y,reg} * GWP\_CH_4$$

Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site (ver.5)

$$BE_y = \underline{BE_{CH4,SWDS,y}} - MD_{reg,y}$$

Baseline Emissions: AMS-III.G.

Tool to determine CH4 avoided

Based on Fast Order Decay Model

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-\underline{OX}) \cdot \frac{16}{12} \cdot \underline{F} \cdot DOC_f \cdot \underline{MCF} \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot \underline{DOC_j} \cdot e^{-\underline{k_j}(y-x)} \cdot (1-e^{-k_j})$$

IPCC IPCC IPCC IPCC IPCC

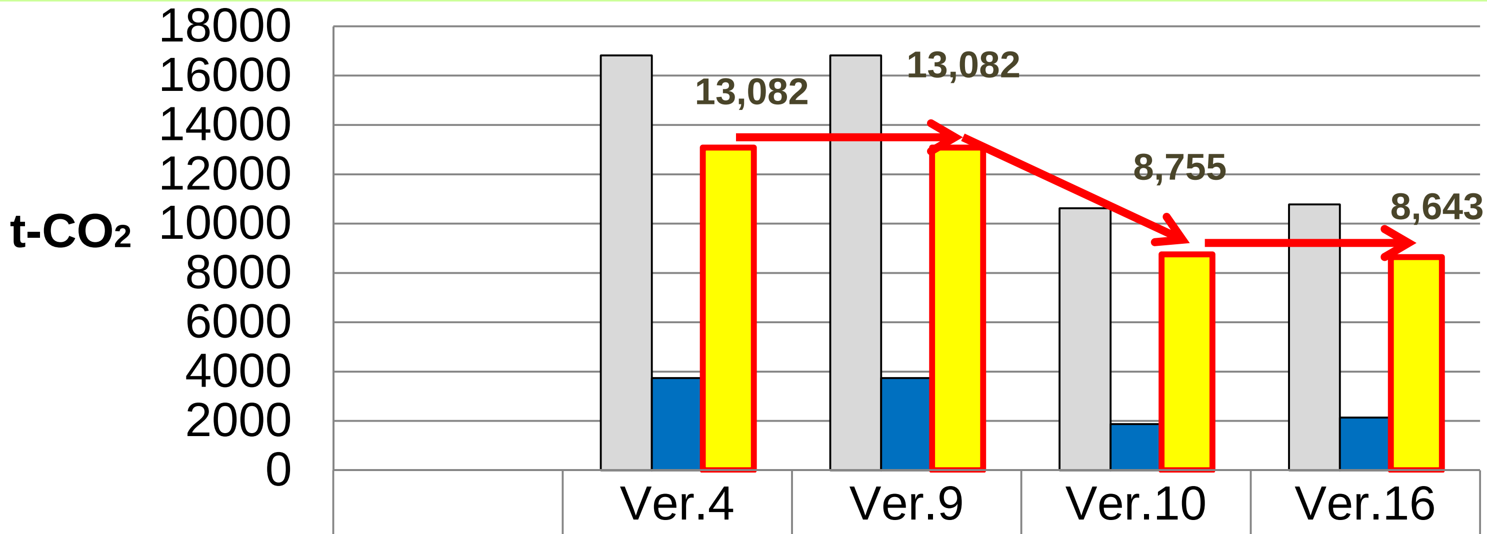
F: Fraction of methane captured
OX: Oxidation factor
MCF: methane correction factor
DOC: Fraction of degradable organic carbon
k: decay rate for the waste

Different ERs in the Same Methodology

◆Methane recovery in wastewater treatment (AMS-III.H.)

◆The same input value, but different emissions reductions

◆Differences due to the changes in calculation formula and introduction of conservative default values



		Ver.4	Ver.9	Ver.10	Ver.16
Baseline Emissions	0	16,821	16,821	10,625	10,779
Project Emissions	0	3,739	3,739	1,870	2,136
Emission Reductions	0	13,082	13,082	8,755	8,643

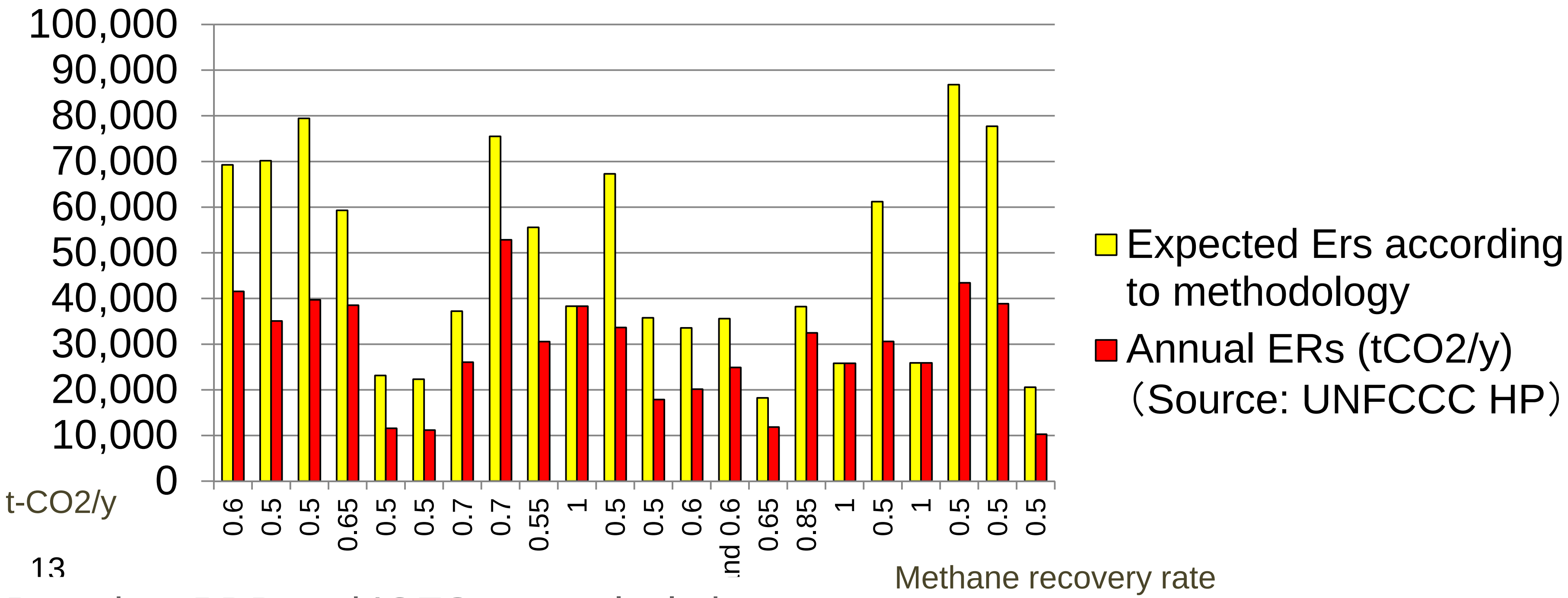
Based on IGES ER calculation Sheet (AMS-III.H.) and IGES own calculation

Methodology is not always perfect

◆Landfill methane recovery (AMS-III.G.)

◆19 reg. projects out of 22 reg. projects “voluntarily” introduces **correction factor**, **“methane recovery rate” (0.5-0.7)**, which is not in the methodology

◆Project developer, based on experience, try to make best estimates to reflect in their emission reductions.



Based on PDD and IGES own calculation

Summary of Application of IPCC default values to the CDM

- CDM methodology has been benefited by utilizing 2006 IPCC guideline for national GHG inventory, where appropriate.
- Mostly concentrated in the CDM methodology related to renewable energy and waste management.
- For those related to energy, most of the EFs offered by the IPCC are used to calculate emission reductions by displacing fossil fuels. They are typically (NCV, CO_2/CH_4 emission factor per unit of energy, mass fraction, etc.)
- For those related to waste management, extensive set of EFs are offered by the IPCC default values (MCF, B, F, OX, DOC, etc.).
- Depending on the parameters, regional (e.g. DOC) and case specific (e.g. animal weight) are also provided and they seem to be effective as the CDM is project-based mechanism.

Lessons learned from the Application of IPCC default values

- There has been tendency to revise the default values to be conservative as new findings are available. This has been the cases for the CDM methodology as it involves actual verification (filling gap between theory and practice).
- Default emission factors are much more available for waste related emission factors than any other sectors, which in turn has been extensively utilized, however, it has limited application and variety for the energy related sectors (e.g. regional values for fossil fuels.
- Some project participants have tried to calculate country specific EFs for certain fossil fuel (e.g. coal, and natural gases) in order to incorporate country specific circumstances.
- It has been difficult to ensure the level of uncertainty based on the limited experience.

Default &Country Specific Values applied

Default parameters

Parameters	Default values	Unit	Source
Average annual temperature	27	Cº	PAGASA
Average mass of feed intake per head per day	2.33 or 2.66	kg/day	PDA
Density of methane at normal condition	0.00067	t/m^3	IPCC 2006
Maximum methane producing capacity for manure produced by livestock category	0.29	m^3CH_4/kg VS	IPCC 2006
Methane Conversion Factor	80	%	IPCC 2006
Urinary energy expressed as fraction of energy intake	2	%	IPCC 2006
Digestibility	80	%	IPCC 2006
Maximum methane producing potential of the volatile solid generated	0.45	kg CH_4/kg VS	IPCC 2006
Default value for the volatile solid excretion per day on a dry-matter basis for a defined livestock (market)	0.3	kg VS/head*day	IPCC 2006
Default value for the volatile solid excretion per day on a dry-matter basis for a defined livestock (breeding)	0.46	kg VS/head*day	IPCC 2006
Average animal weight (breeding)	198	kg/head	IPCC 2006
Average animal weight (market)	50	kg/head	IPCC 2006

(Source PDDs from UNFCCC website)