Carbon accounting and modelling tools

Workshop on Energy Information and Knowledge Management Systems

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OUTLINE

1) Carbon accounting under the CDM
2) CDM tools for carbon accounting
    - Methodologies
    - Grid emission factors
    - Standardized baselines
3) Monitoring, Reporting & Verification
4) Final remarks

1) What is the CDM, Clean Development Mechanism?

1979	1992	1997	Nov/2001	Nov/2004	Nov/2005	2012
1st World Climate Conference, **the issue**	UN-FCCC 195 countries **CDM idea**	Kyoto Protocol 100 countries **CDM agreed**	**CDM framework** COP7, Marrakesh	**1st CDM project Landfill gas Brazil**	Kyoto Protocol Ratified, 192 countries	**1st KP period**, 2008-2012 **2nd KP period**, 2013-2030

It is a market tool that allows trading emission credits originated from cleaner technologies implemented in developing countries

1) The CDM in numbers

> 7,500 projects

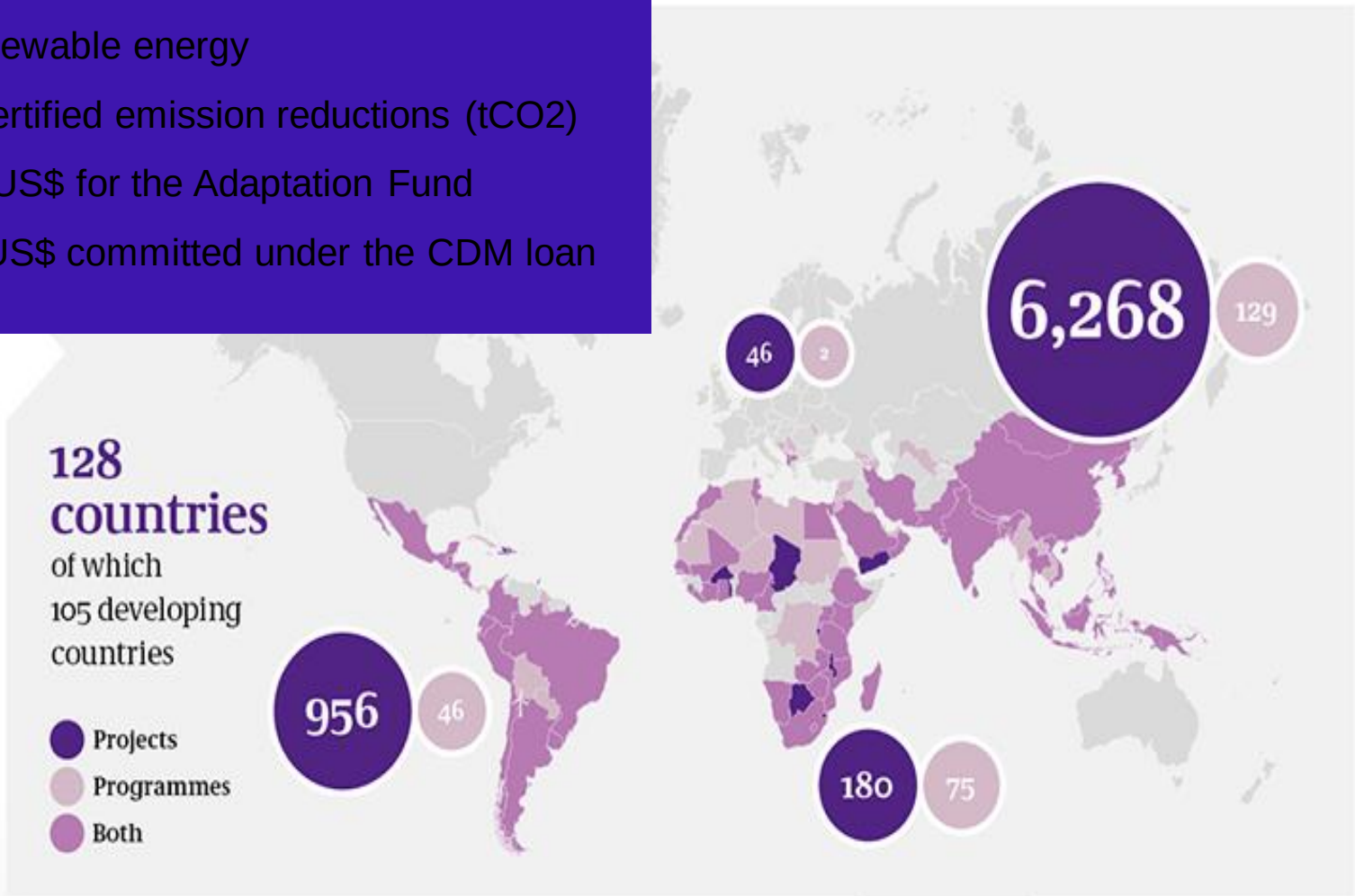
315 billion US$ invested

110 GW renewable energy

2.2 billion certified emission reductions (tCO2)

188 million US$ for the Adaptation Fund

> 5 million US$ committed under the CDM loan scheme (*)



(*) CDM loan scheme for consultancy, validation or verification. Next window: 30/09/2014

1) CDM created institutional frameworks that …

a) Developed **200+ tools (methodologies)** in 15 different sectors

b) Established **125+ national authorities, 16 in the Caribbean**

c) Accredited **40+ validators/verifiers (certifiers)**

d) Involved **4,500+ institutions** in CDM projects

e) Developed **countless CDM development experts** worldwide

f) Created CDM Board, expert panels, & UNFCCC CDM unit

2) CDM tools for carbon accounting

Methodologies

Grid emission factors

Sectoral standardized baselines

2) CDM tools

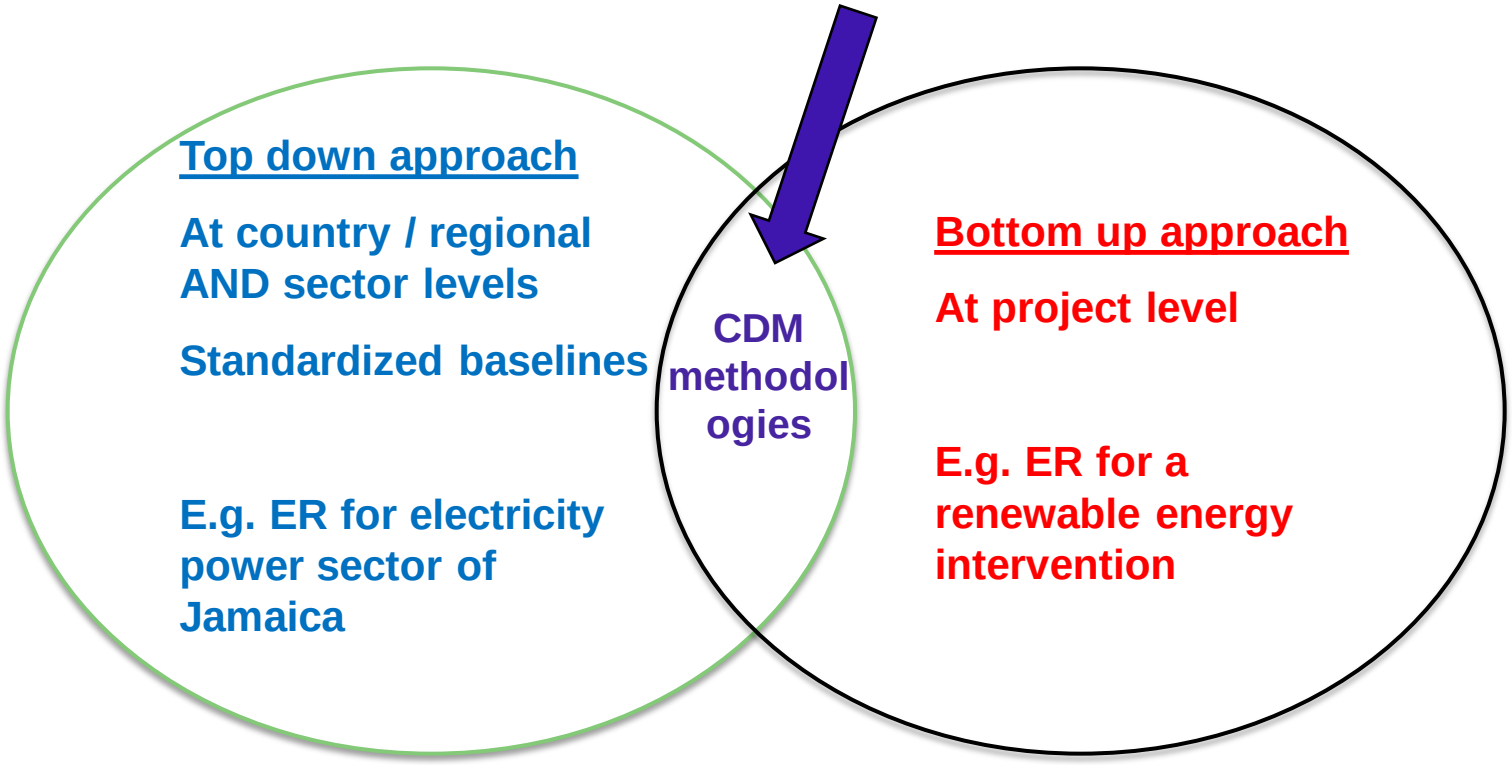
What are they used for?

1. Account emission reductions (ER) (tCO2/year)
   - E.g.: 20 MW Solar PV → **27,000 tCO2/year**
2. Establish baseline technology scenario(s)
   - E.g.: current mix (fossil fuel + other sources) grid
3. Monitor, report and verify (MRV)
   - E.g.: systems for monitoring plans, reports and accredited certifiers

What are they characterized for?

1. Developed following an stringent approval process
   - Consultants → Public input → Expert panels → CDM Board
2. Mature as they have undergone trials
3. Flexible as they are applicable to a wide range of interventions
4. Widely recognized/applied. Other carbon crediting systems such as voluntary carbon market (Gold Standard) used them

2) CDM tools – top down & bottom up approaches



2) CDM methodologies – by size and type of activity

By size

1. Small-scale
   - AMS – Approved Methodology for Small-scale

   i. Type I – renewable energy <15MW

   ii. Type II – energy efficiency, reductions <15 GWh/year

   iii. Type III – others, reductions < 60 ktCO2/year

2. Large- scale
   - AM – Approved Methodology
   - ACM – Approved Consolidated Methodology

By type of activity

- **Renewable energy** (~50% total CDM) → hydro, wind, solar, biomass
- Energy efficiency → E.g. efficient refrigerators, AC, CFL, etc.
- Fuel or feedstock switch→ from coal to natural gas
- GHG destruction →E.g. landfill gas, N2O destruction
- GHG avoidance → E.g. reduction of fertilizer use
- GHG removal by sinks → afforestation/reforestation

2) CDM methodologies – by sectoral scope (15)

Sectoral scope	Type	Electricity generation and supply	Energy for industries	Energy (fuel) for transport	Energy for households and buildings
1 Energy industries (renewable-/ non renewable sources) (continued)	Fuel/feedstock switch	AM0049 ACM0006 ACM0011 ACM0018 AMS-III.AG. AMS-III.AH. AMS-III.AM.	AM0049 AM0056 AM0069 AM0081 ACM0006 ACM0009 ACM0018 AMS-III.AM.		AM0081
2 Energy distribution	Renewable energy	AMS-III.AW. AMS-III.BB.	AM0069 AM0075		AMS-III.AW.
	Energy efficiency	AM0067 AM0097 AMS-II.A. AMS-III.BB.			
	Fuel/feedstock switch	AMS-III.BB.	AM0077		
3 Energy demand	Renewable energy				AMS-III.AE. AMS-III.AR.
	Energy efficiency	AMS-III.AL.	AM0017 AM0018 AM0020 AM0044 AM0060		AM0020 AM0044 AM0046 AM0060 AM0086 AM0091 AMS-II.C. AMS-II.E.

CDM Methodology booklet, 5th edition, 2013 → 250 pages

<https://cdm.unfccc.int/methodologies/>

2) CDM methodologies - Renewable electricity (15)

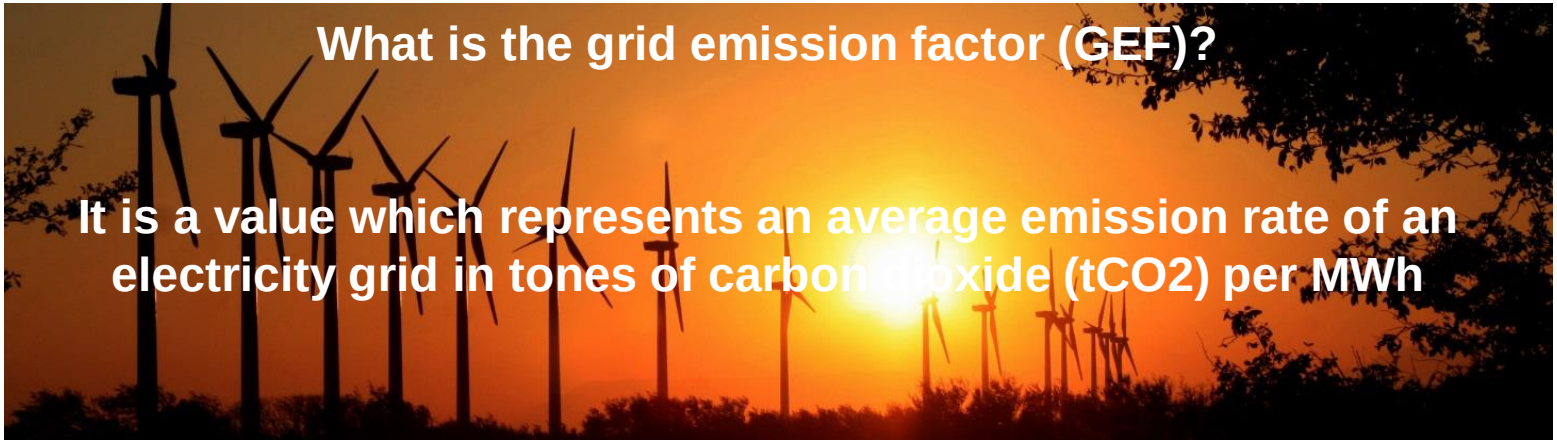
Biomass electricity	AM0007	AM0042	ACM0006
	ACM0018	ACM0020	
Grid electricity	AM0019	AM0026	AM0100
	ACM0002	AMS-I.D.	
Offgrid electricity/ isolated grids	AM0103	AMS-I.A.	AMS-I.L.
Enhanced generation	AM0052		
Captive power	AMS-I.F.		

(*) Benefiting women and children

2) Renewable energy, ACM0002 & GEF

Emissions reductions (tCO2) = Baseline emissions – project emissions

Emission reductions (tCO2) = XXX MWh/year * **grid emission factor** (tCO2/MWh) - 0

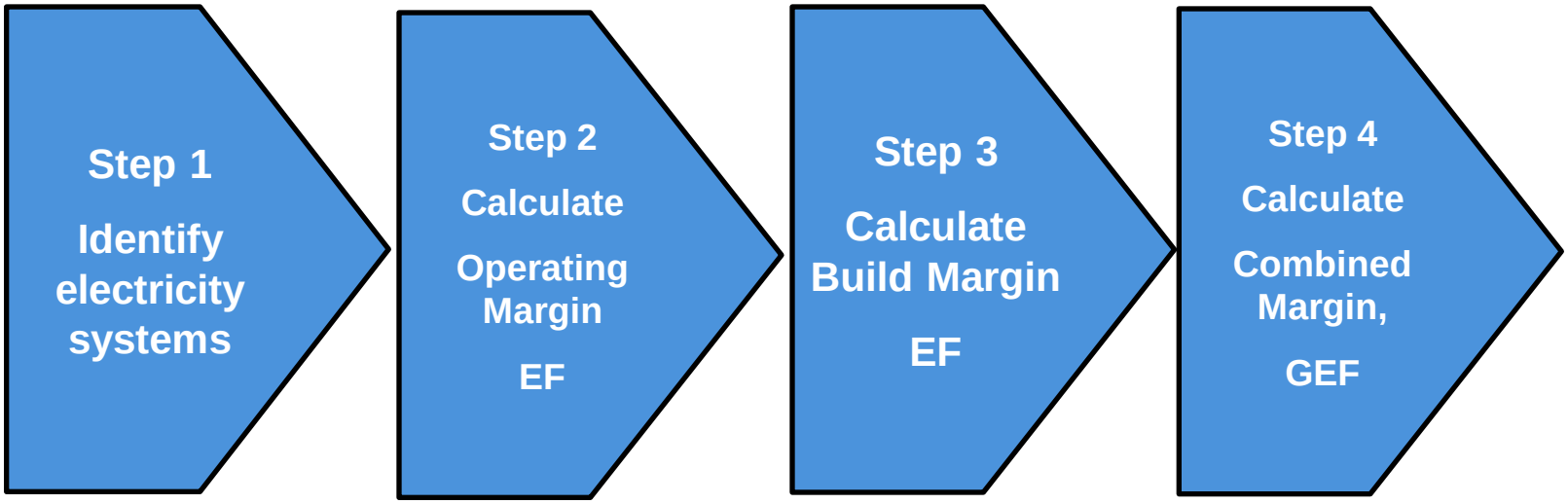


2) ACM0002 – How is GEF estimated?

Why is the GEF important? **To plan**

- ✓ As it allows estimating emission reductions of energy activities
- ✓ Facilitates decision making process to select interventions subject to GHG reductions
- ✓ Forecasts future emission reductions

How is the GEF estimated?



2) ACM0002 – How is GEF estimated?

Step 1 – Electricity system –

- Interconnected grid system of the country or region

Step 2 – Operating Margin EF (tCO2/MWh)- displacement of power in the grid which is generated by power plants operating on the margin

Data needed (year): fuel consumption, net calorific value and emission factor; electricity generated (at unit 'i' level)

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_y}$$

2) ACM0002 – How is GEF estimated?

Step 3- Build margin EF (tCO2/MWh)– *It is the generation-weighted average emission factor of all power units during the most recent year for which electricity generation data is available. → E.g.: set of 5 power units recently built or power capacity additions that account for 20% of electricity generation*

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Step 4 - Combine margin EF or GEF (tCO2/MWh)– weighted average of operating and build margins

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

•For wind and solar weighing average OM and BM is 0.75 and 0.25

•For other technologies is 0.5 each

2) Model – Grid emission factor calculation

EMISSION FACTOR DETERMINATION - SIMPLE OM - OPTION A

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_y}$$

2008	$EF_{grid,OMsimple,y}$ =	0.5433	[tCO_2/MWh]	Option A
2009	$EF_{grid,OMsimple,y}$ =	0.5433	[tCO_2/MWh]	Option A
2010	$EF_{grid,OMsimple,y}$ =	0.5433	[tCO_2/MWh]	Option A

False

year	unit_type	unit_number	unit_name	net_electricity	fossil_fuel_type	unit_fuel_type	amount_fuel_type	net_calorific_value		fuel_CO2_EF			
y		m		$EG_{m,y}$	i		$FC_{i,m,y}$	factor for NCV	$NCV_{i,y}$	factor for EF	$EF_{CO2,i,y}$ or $EF_{CO2,m,i,y}$	Partial $E_{m,y}$	$EF_{El,m,y}$
				[MWh]			[unit]		[GJ/unit]		[tCO2/GJ]	[tCO2]	[tCO2/MWh]
2009	Grid	1	Coal	82399.677	Coal	t	795737.531		22.609		0.124	2230452	1.41
2009	Grid	2	Fuel Oil	725.141	Fuel Oil	t	1602871.439		38.937		0.082	5124380	0.85
2009	Grid	3	Natural Gas	45.64	Natural Gas	m3	12566536831		0.035		0.055	24517313	0.49
2009	Grid	4	Gas Oil	325	Gas Oil								
2009	Grid	5	Impo	204									
2010	Grid	1	Coal	1582399.6	Coal								
2010	Grid	2	Fuel Oil	6021725.141	uel Oil								
2010	Grid	3	Natural Gas	49783545.64	al Gas								
2010	Grid	4	Gas Oil	3951440.325	il								
2010	Grid	5	Impo	2040098									
2008	Grid	1	Coal	1582399.677	Coal								
2008	Grid	2	Fuel Oil	6021725.141	Fuel Oil								
2008	Grid	3	Natural Gas	49783545.64	Natural Gas								
2008	Grid	4	Gas Oil	3951440.325	Gas Oil								
2008	Grid	5	Impo	2040098									

PROJECT TITLE

OPERATING MARGIN (OM) OPTIONS

1. Simple OM
   - Option A — Data | Calculation
   - Option B — Data | Calculation
2. Simple adjusted OM — Data | Calculation
3. Dispatch data analysis OM
   - Option 1 — Data | Calculation
   - Option 2 — Data | Calculation
4. Average O
   - Option A — Data | Calculation
   - Option B — Data | Calculation

BUILD MARGIN (BM)

Data | Calculation

WEIGHT OM & BM

- Solar Projects
- Wind Projects
- Other Projects
- User Specified
- Simplified

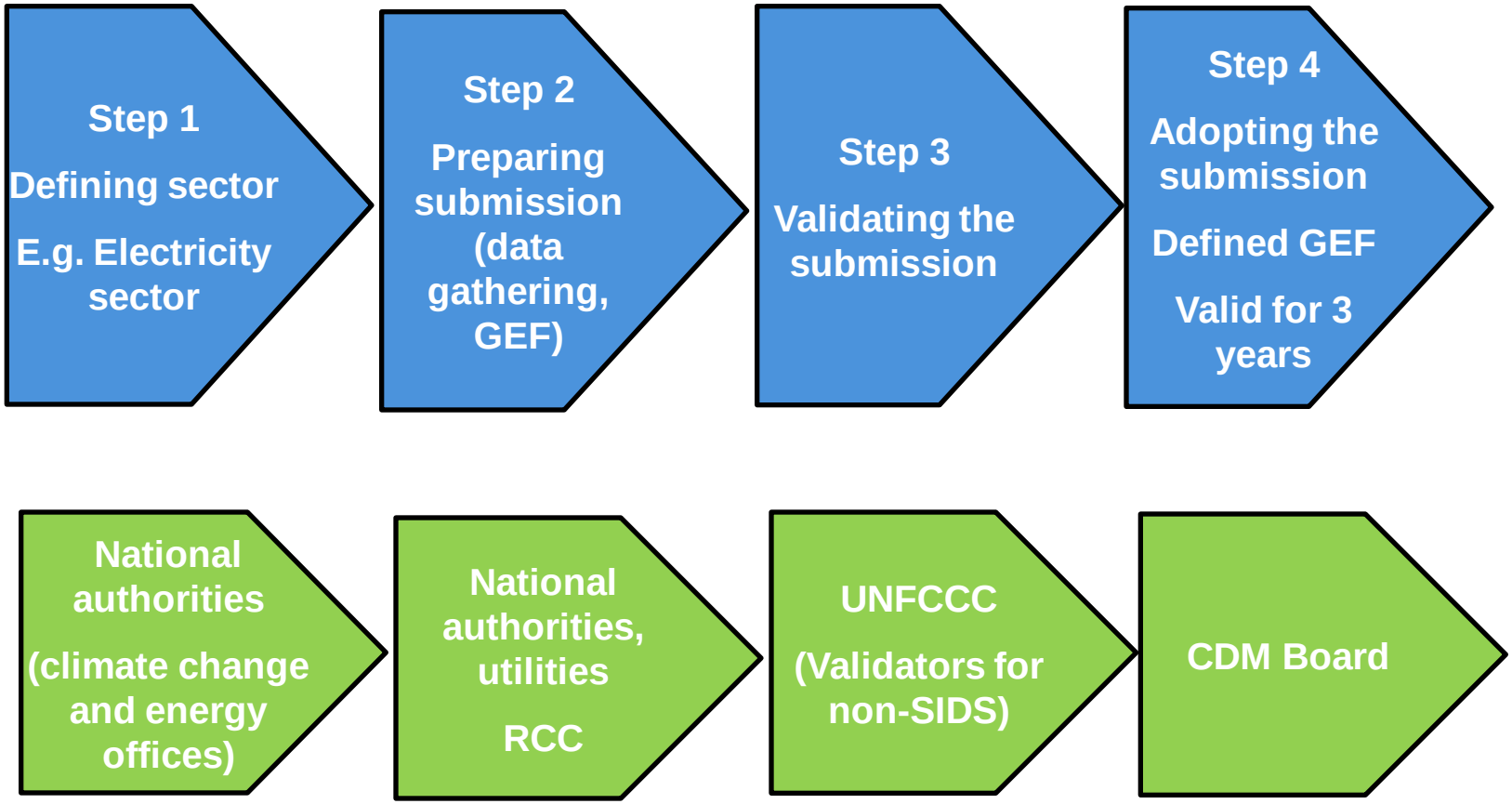
- First Credit Period
- Subsequent

OM [tCO_2/MWh] =	0.5433	w_{OM} =	0.50
BM [tCO_2/MWh] =	0.3507	w_{BM} =	0.50

Combined Margin [CM = OM x w_{OM} + BM x w_{BM}] [tCO_2/MWh] = 0.4470

2) Sectoral standardized baselines – top down approach

This approach allows establishing **baselines** for countries or group of countries in a specific sector



2) GEFs in the region (8/15)

Member state	GEF, tCO2/MWh (CDM, 4/14)	GEF, tCO2/MWh (RCC, 6/14)
Antigua & Barbuda	-	In progress
Bahamas	*0.723 (CDM 5620)*	-
Belize	-	*0.2278 (PSB0006)*
Grenada	-	Drafted
Guyana	*0.948 (CDM 1458)*	-
Jamaica	*0.834 (CDM 0239)*	*Data gathering*
St Vincent & the Grenadines	-	Drafted
Trinidad & Tobago	*0.666 (CDM 9358)*	*Drafted*

3) Monitoring, reporting and verification (MRV)

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Wigton Wind Farm Project, CDM 0239

Capacity - 20.7 MW, 23 turbines of 900 kW each.

Technology supplier - NEG Micon Holland B.V. (now Vestas).

Grid connected and estimates generation of enough electricity to feed 25,000 homes.

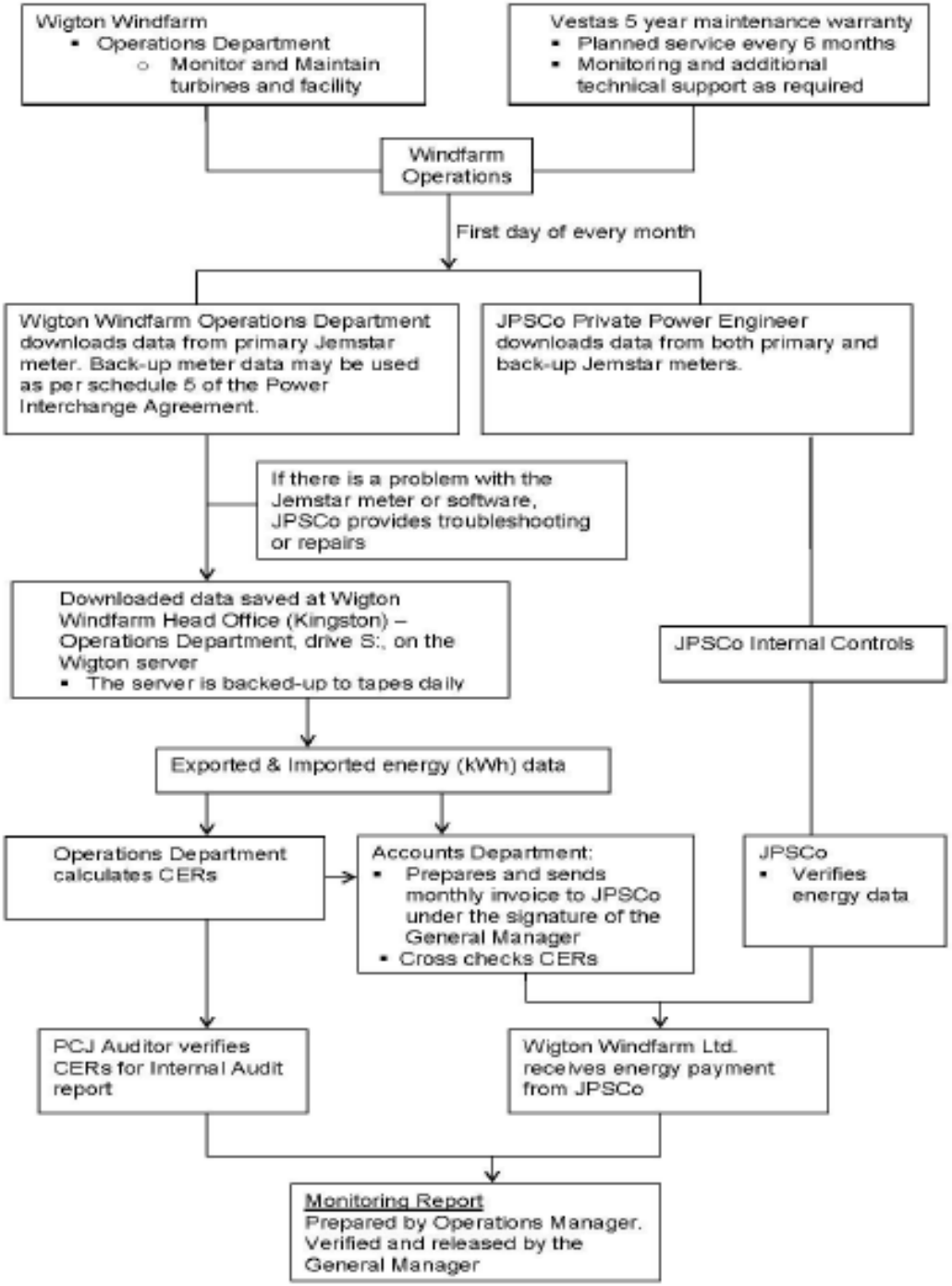
Annual electricity generation of 41,800 MWh/year, GEF 0.834 tCO2/MWh. Emission reductions is 34,890 tCO2/year.

3) Monitoring plan

Operating the RE plant

The monitoring plan sets out a systematic way to record and report generation data and emission reductions during a period of time.

It defines roles and establishes clear tasks and timelines



3) Monitoring plan – data to be monitored

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data / Parameter:	**EF_y**
Unit:	tCO_2/MWh
Description:	Grid emission factor
Source of data:	Determined ex-ante in the registered PDD.
Value(s) applied):	0.834
Purpose of data:	This value is used for the Emission Reduction calculation of this monitoring period.
Additional comment:	---

Estimated with ACM0002 methodology

Ex-ante, before the implementation of the activity

→ For CDM -during CDM project crediting period (up to 3x7 or 10 years)

3) Monitoring plan – data to be monitored

D.2. Data and parameters monitored

Data / Parameter:	EG_y
Unit:	MWh
Description:	Net electricity supplied to the grid
Measured/ Calculated / Default:	Directly measured
Source of data:	The electricity supplied to the grid by the Project is obtained by utilizing the measurement equipment installed in the plant (directly Measured)
Value(s) of monitored parameter:	41,835 MWh
Monitoring equipment:	Metering Device: Ametek, Jemstar digital multifunction electricity meter Serial Number: 035002815 (Main) Type of meter: Bidirectional Accuracy class: 0.5% Calibration frequency: once on a 365-day. Calibration date: 25/06/2012 (by Jamaica Public Service Company Limited). Last calibration date: 22/07/2011 (by Jamaica Public Service Company Limited). Validity: 365 days as established Jamaica Public Service Company Limited

Amount of electricity generated by the wind plant during 1 year

ACM0002 establishes procedures for metering process (accuracy of meter and frequency of calibration)

3) Monitoring plan – estimating emission reductions

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

In accordance with the approved consolidated methodology ACM0002 Version 4[3], the baseline emissions are given as follows:

$BE_y = EG_y * EF_y$

The grid emission factor is determined ex ante in the registered PDD: 0.834 tCO_2/MWh

BE_y = 0.834 tCO_2/MWh * 41,835 MWh

BE_y = **34,890 tCO_2**

Estimated with GEF and electricity generated as per ACM0002

When verified this is the amount of Certified Emission Reductions (1CER = 1 tCO2) to be issued

3) Reporting & verification

- Certifiers verify the amount of electricity generation based on monitoring evidence (metering reports and utility receipts) and ***monitoring report***.
- In this way, calculations of the amount of emission reductions can be cross-checked.
- Certifiers confirm that the monitoring report is valid in a ***verification report***.

The verification can be carried out by known certifiers or recognised institutions such as “schools of engineering”

TÜV NORD

VERIFICATION AND CERTIFICATION REPORT

- 8TH PERIODIC –

CORPORACIÓN ANDINA DE FOMENTO – CAF

WIGTON WIND FARM PROJECT (WWF)

UNFCCC REF. NO. : 0239

4) Final remarks

1. CDM tools are **widely applied** and freely available →Flexible and cost effective

2. CDM methodology for estimating GEF (ACM0002) is **detailed** as requires **disaggregated generation data**→ Robust

3. Accurate GEF values supports (part of) the **decision making process** to achieve renewable energy targets under C-SERMS by
   - **Selecting** type/size of interventions based on emission reductions criterion
   - Providing **MRV frameworks** that have been already applied

4. GEFs are used to estimate carbon reductions for any type of intervention that **reduces electricity consumption**. E.g. energy efficiency

5. RCC St George's can **assist** member states in
   - **Building up capacities** and transferring CDM knowledge. E.g.: Carbon accounting for renewable energy and energy efficiency technologies
   - Estimating/updating GEFs

References

- CDM methodology booklet, 5th Edition, 2013
  http://cdm.unfccc.int/methodologies/

- Grid Tool – ACM0002
  Model for grid emission factor calculation (spreadsheet)
  http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v4.0.pdf/history_view

- Project search by country, sectoral scope, methodology code, etc.:
  http://cdm.unfccc.int/Projects/projsearch.html

- Standardized baselines
  https://cdm.unfccc.int/methodologies/standard_base/new/sb8_index.html

- Regional collaboration centre (see *More information* for CDM materials)
- http://cdm.unfccc.int/stakeholder/rcc/index.html

THANK YOU!

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2) Household and building energy efficiency – CDM methodologies (24)

Cookstove	AMS-II.C.	AMS-II.G.		
Water pumping	AMS-II.C.			
Water purifier	AM0086	AMS-II.C.	AMS-III.AV.	
Water saving	AMS-II.M.			
Refrigerators/chillers	AM0060	AM0070	AMS-II.C.	AMS-II.O.
	AMS-III.X.			
Lighting	AM0046	AMS-II.N.	AMS-II.J.	AMS-II.L.
	AMS-II.N.	AMS-III.AR.		
Whole building	AM0091	AMS-II.E.	AMS-II.Q.	AMS-II.R.
	AMS-III.AE.			
Others/various technologies	AMS-II.C.			