Modelling reduction potential

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BaU Scenario

Definition

"A scenario is a coherent, internally consistent and plausible description of a possible future state of the world given a pre-established set of assumptions. Several scenarios can be adopted to reflect, as well as possible, the range of uncertainty in those assumptions."

Scenarios…

…are not projections (and projections are not forecasts)

…help engage stakeholders, which increases legitimacy

…promote a comprehensive coverage of issues - by providing an analytical framework

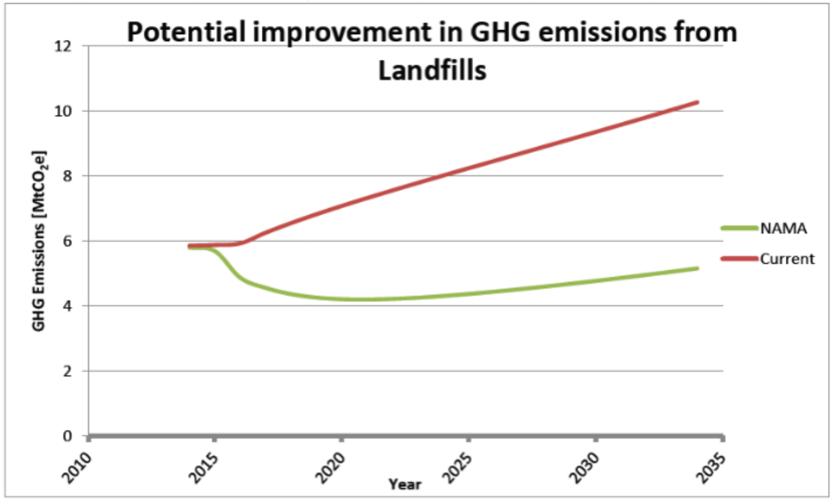
Scenarios are not…

…forecasts, projections or predictions of what is to come. Nor are they preferred views of the future. Rather, they are plausible alternative futures: they provide reasonable and consistent answers to the 'what if?' questions relevant to decision-makers in government and industry.

Baseline – Uruguay Solar Water Heater NAMA

Lifetime of system (years)	20
Lifetime of the project (years)	30
Electricity Savings per system (kWh/month)	79
Electricity Savings per system (kWh/ year)	944
Grid factor (tCO_2e/MWh)	0.644
Total electricity savings (MWh/year) from year 21	75,519
Total electricity savings (MWh/year) average of the first 20 years	39,648
Total electricity savings (MWh) All Project	1,548,143
Total emissions avoided (tCO_2e)	997,004

Baseline – Colombia Waste NAMA

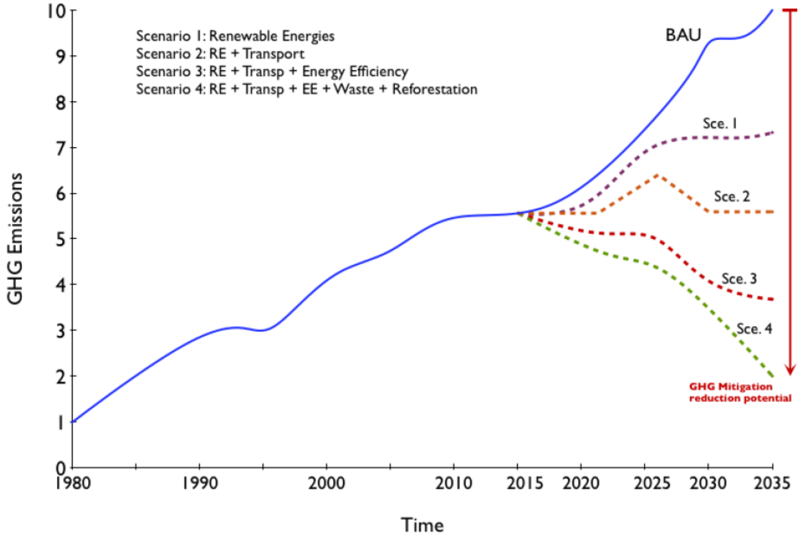


What should the baseline and NAMA scenario include?

The baseline scenario is made to identify how several parameters, including GHG emissions, would develop in the absence of the NAMA.

The baseline scenario specifies:

- NAMA boundaries
- Scope
- Sector
- Current financial flows
- Technology base
- Value chain



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Which activities to include in a NAMA for the charcoal sector?

Sce.1: Introducing efficient kilns

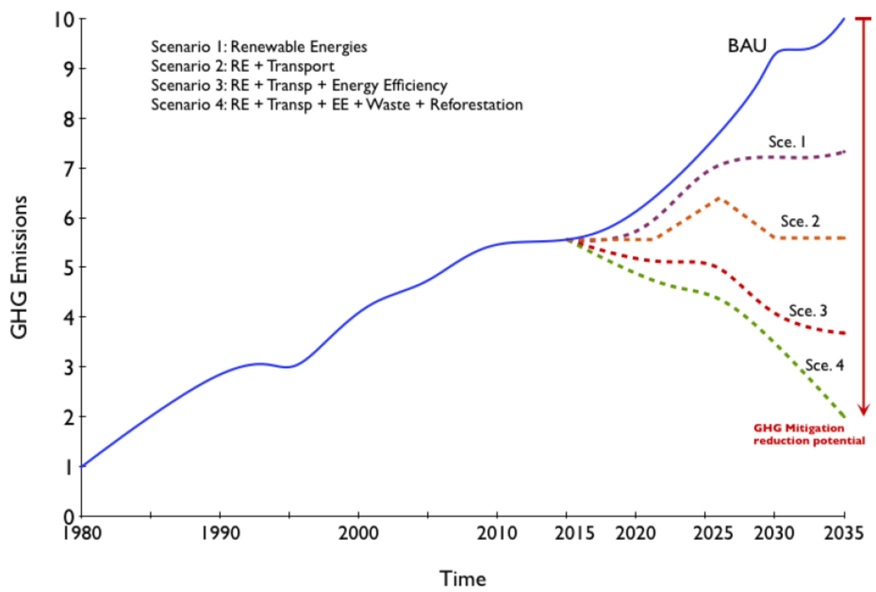
Sce.2: Sustainable Forest Management

Sce.3: Briquetting of charcoal residues

Sce.4: Torrefaction and SFM by the private sector

(1) Briquetting charcoal residues	(2) Modern kilns and Sustainable Forest Management	(3) Private sector Plantations with native trees.
Project 1	Project 2	Project?

Source: EES, 2014: Sustainable Charcoal Value Chain Mozambique



Scenarios and other aspects of MRV:

- GHG
- Sustainable development
  - Which parameters?
- Finances
- Support
- More?

Table 25: Cumulative kiln costs

Total cumulative cost for both kilns ($/year)		
	SCENARIO 1	SCENARIO 2
2011	0	0
2012	0	0
2013	0	0
2014	734,004	573,480
2015	2,344,776	1,850,048
2016	4,995,905	3,981,277
2017	8,874,507	7,144,021
2018	14,460,240	11,764,197
2019	22,165,199	18,228,747
2020	32,925,175	27,386,076
2021	47,542,602	40,004,876
2022	68,362,421	58,236,008
2023	97,975,722	84,539,480
2024	136,781,880	119,503,107
2025	137,188,237	123,001,779
2026	195,310,015	176,882,558
2027	263,989,837	241,464,890
2028	344,731,553	318,479,321
2029	433,325,402	404,196,382
2030	530,535,002	499,599,471

Source: UNDP: *Nationally Appropriate Mitigation Action Study on Sustainable Charcoal in Uganda*

Is GHG reduction estimation and calculation the same as MRV?

- Estimation and modelling is just the start
- Other parameters to be measured than just GHG
- Adjustment of assumptions and estimates
- Need for a sound MRV structure

The GACMO Model

About GACMO

GACMO can be used to make an analysis of the GHG mitigation options for a country, to be used in the National Communication, the INDC etc.

The GHG/energy/fossil fuel balance for the latest year is in the "Start year Balance" sheet
The expected annual/periodic growth in energy consumption until 2020/2025/2030
in the "Growth sheet", are used to calculate the balances for 2020/2025/2030.

In order to make the calculation for all the GHG mitigation option, the assumptions used in all options must be entered in the "Assumptions" sheet: Energy prices/calorific values for all fossil fuels, CO2 emission factor for electricity production .

All the GHG mitigation options are located according to the types, and subtypes used in the CDMpipeline (www.cdmpipeline.org). Each type-worksheet contains tables below each other for all the sub-types we have managed to cover.

All the calculation in the GHG reduction options are summarized in the "Mains" table.

A Cost curve is calculated based on the costs for the reduction options
in US$/tCO2 (y-axis), and the size of the GHG emission reduction in kt/year (x-axis).

Start year GHG Balance

GHG Balance	Country X	2010									
Ton CO2/Toe (IPCC):		2.64	2.90	2.99	3.10	3.24	3.01		3.96	4.24	2.35
Unit : ktCO2	Total	LPG	Gasoline	Jet Fuel	Diesel	Fueloil	Kerosene and other	Total oil products	Coal	Lignite	Gas
Total	***369082***	***26588***	***105191***	***8098***	***63803***	***37564***	***96***	***241341***	***0***	***27761***	***99980***
Fossil power plants	123740	298	0	0	1392	28202	0	29892	0	27353	66495
Refineries	9067	0	1087	0	3036	4944	0	9067	0	0	0
FINAL CONSUMPTION	*236276*	*26290*	*104105*	*8098*	*59376*	*4418*	*96*	*202383*	*0*	*407*	*33485*
Industry - steel	5617	0	0	0	101	429	0	530	0	0	5087
Industry - chemical	6289	42	0	0	338	454	0	834	0	0	5455
Industry - non metallic mineral	4847	6	0	0	35	1688	0	1729	0	407	2711
Industry - food and tobacco	1823	104	0	0	332	650	0	1086	0	0	736
Industry - construction	797	0	0	0	797	0	0	797	0	0	0
Industry - mining	2824	316	0	0	304	330	0	949	0	0	1874
Industry - machinery	15	15	0	0	0	0	0	15	0	0	0
Industry - non ferrous metals	97	3	0	0	0	0	0	3	0	0	94
Industry - paper and pulp	2520	21	0	0	101	591	0	713	0	0	1807
Industry - transport equipment	145	0	0	0	44	0	0	44	0	0	100
Industry - textile and leather	0	0	0	0	0	0	0	0	0	0	0
Industry - miscellaneous	10372	2157	0	0	2347	47	0	4550	0	0	5822
Transport - road	148966	2267	104099	0	42569	0	0	148935	0	0	31
Transport - rail	1803	0	0	0	1803	0	0	1803	0	0	0
Transport - air	8098	0	0	8098	0	0	0	8098	0	0	0
Transport - navigation	2223	0	0	0	1992	230	0	2223	0	0	0
Households	19380	17332	6	0	9	0	96	17444	0	0	1937
Services	4619	3669	0	0	348	0	0	4017	0	0	602
Agriculture	8612	358	0	0	8255	0	0	8612	0	0	0
Non energy - chemical feedstocs	7230	0	0	0	0	0	0	0	0	0	7230

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Annual growth factors or %increase from the start year for the periods until 2020, 2025, and 2030 must be inserted in order to calculate the BAU.

Start year:	2010					
Growth from the start year	**Annual % increase in the period**			**% increase from start year values**		
Growth and multiplication factors	2010 to 2020	2020 to 2025	2025 to 2030	2020	2025	2030
Refineries	1.9%	1.9%	1.9%	21%	33%	46%
Industry - fuel in steel	0.7%	0.7%	0.7%	7%	11%	15%
Industry - fuel in chemical	0.7%	0.7%	0.7%	7%	11%	15%
Industry - fuel in non metallic mineral	0.7%	0.7%	0.7%	7%	11%	15%
Industry - fuel in food and tobacco	0.7%	0.7%	0.7%	7%	11%	15%
Industry - fuel in construction	0.7%	0.7%	0.7%	7%	11%	15%
Industry - fuel in mining	0.7%	0.7%	0.7%	7%	11%	15%
Industry - fuel in machinery	0.7%	0.7%	0.7%	7%	11%	15%
Industry - fuel in non ferrous metals	0.7%	0.7%	0.7%	7%	11%	15%
Industry - fuel in paper and pulp	0.7%	0.7%	0.7%	7%	11%	15%
Industry - fuel in transport equipment	0.7%	0.7%	0.7%	7%	11%	15%
Industry - fuel in textile and leather	0.7%	0.7%	0.7%	7%	11%	15%
Industry - fuel in miscellaneous	0.7%	0.7%	0.7%	7%	11%	15%
Industry - electricity consumption	1.0%	1.0%	1.0%	10%	16%	22%
Transport - fuel in road	3.0%	3.0%	3.0%	34%	56%	81%
Transport - fuel in rail	3.0%	3.0%	3.0%	34%	56%	81%
Transport - fuel in air	3.0%	3.0%	3.0%	34%	56%	81%
Transport - fuel in navigation	3.0%	3.0%	3.0%	34%	56%	81%
Transport - electricity consumption	2.0%	2.0%	2.0%	22%	35%	49%
Households - fuel	1.7%	1.7%	1.7%	18%	29%	40%
Households - electricity consumption	2.0%	2.0%	2.0%	22%	35%	49%
Services - fuel	1.7%	1.7%	1.7%	18%	29%	40%
Services - electricity consumption	2.0%	2.0%	2.0%	22%	35%	49%
Agriculture - fuel	0.9%	0.9%	0.9%	9%	14%	20%
Agriculture - electricity consumption	2.0%	2.0%	2.0%	22%	35%	49%
Non energy - fuel in chemical feedstocs	0.7%	0.7%	0.7%	7%	11%	15%
Forestry emission	-0.4%	-0.4%	-0.4%	-4%	-6%	-8%
Waste emission	1.5%	1.5%	1.5%	16%	25%	35%
Industrial processes	0.7%	0.7%	0.7%	7%	11%	15%

Example of a GHG calculation table in GACMO.
At the moment GACMO contains 63 different mitigation options

Solar PVs, large grid, 1 MW

Costs in US$	Reduction Option	Reference Option	Increase (Red.-Ref.)
Total investment	1,500,000		
Project life	20		
Lev. investment	141,589		141,589
Annual O&M	15,000		15,000
Annual fuelcost		328,500	-328,500
Total annual cost	156,589	328,500	**-171,911**
Annual emissions (tons)	Tons	Tons	Reduction
Fuel CO2-eq. emission		1,273	1,273
Other			
Total CO2-eq. emission	0	1,273	**1,273**
US$/ton CO2-eq.			**-135.1**

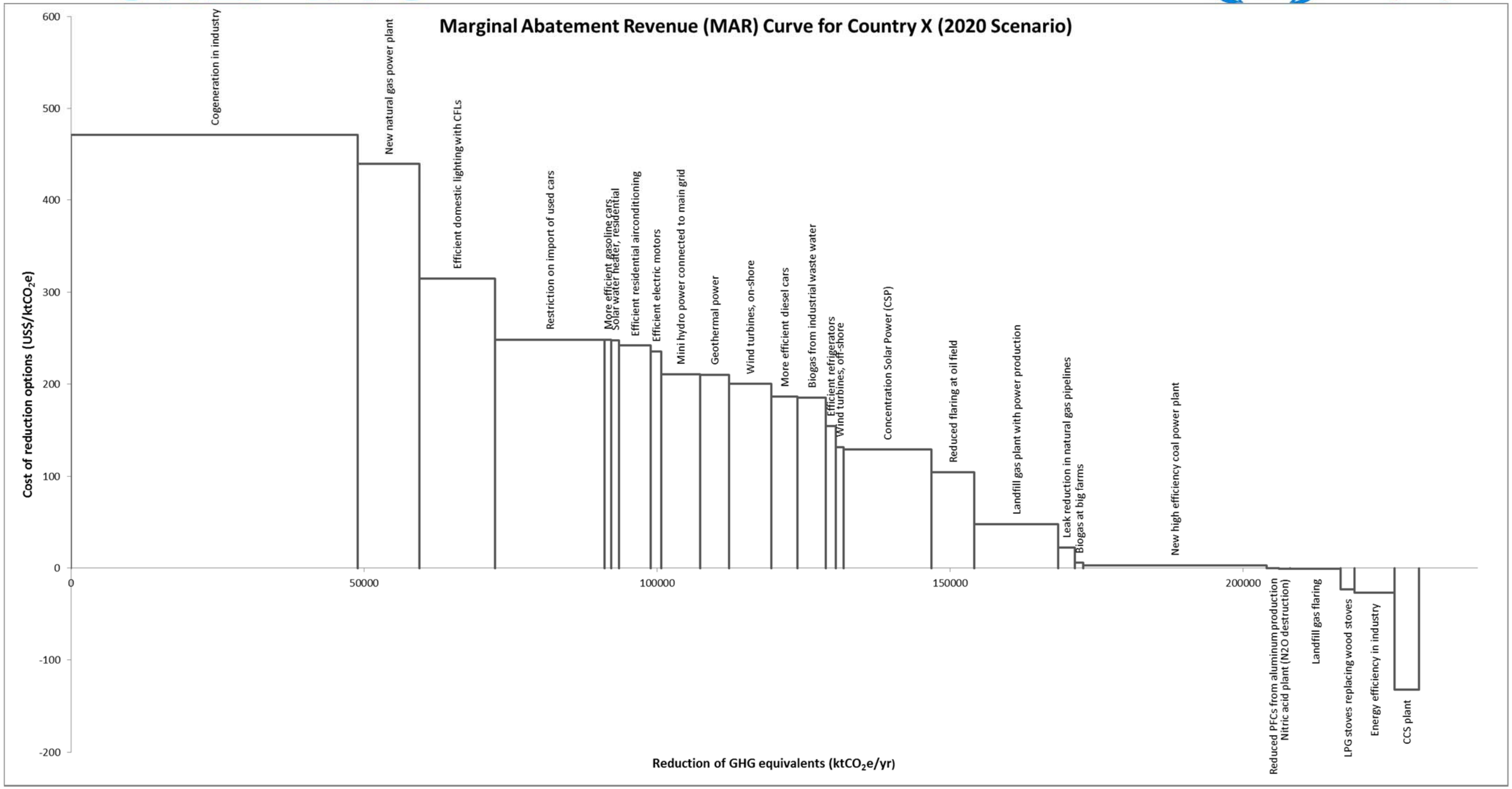
Notes:

General inputs:		
Discount rate	7%	
Reference electricity price	0.20	US$/kWh
CO2-eq. emission coefficient	0.78	tCO2/MWh

Activity: Solar PV		
Size of solar PV	1.0	MW
Investment in Activity	1500	US$/kW
Capacity factor	1825	Full time hours
Efficiency factor	0.9	
O&M	1.0%	Of investment
Electricity production	1643	MWh
Cost of electricity produced	0.095	US$/kWh
Reference option: No solar PVs		
Electricity production	1643	MWh

GACMO summary table for the first 31 GHG mitigation options

Type	Reduction option	Sort reduction options US$/tonCO2	Unit Type	Emission reduction t CO2/unit	Investment Million US$	Levelized costs MUS$/year	Units penetrating in 2020
Agriculture	Rice crop CH4 reduction						
Biomass energy	Rice husk cogeneration plants	-74.01	1 MW cogeneration	11877.3	4.9	-4.4	5
	Biomass power from other biomass residues	-128.67	1 MW CHP plant	6125.7	3.6	-3.2	4
	Bagasse power	-2,621.22	100 kt sugar cane/year	10491.4	24.3	-275.0	10
CCS	CCS plant	132.19	1 MW	6,014	5895.4	556.5	700
Cement	Clinker replacement	6.92	1000 tonnes cement	167,896	35.7	5.8	5
Coal bed/mine methane	Coal mine methane	-29.21	10 Mm3 CMM/year	39,278	2.4	0.1	2
EE households	Efficient residential airconditioning	-218.14	1000 Airconditioners	1,099.1	650.0	-1198.7	5,000
	Efficient domestic lighting with CFLs	-290.94	1000 Bulps	65	316.0	-3761.3	200,000
	Efficient domestic lighting with LEDs	-39.92	1000 Bulps	9	256.0	-7.35	20,000
	Efficient wood stoves	0.25	1000 stoves	5,836	2.9	0.1	100
	Efficient refrigerators	-130.46	1000 refrigerators	343.6	1297.0	-224.1	5,000
EE industry	Efficient electric motors	-211.81	1 kW	0.7	324.0	-373.9	2,700,000
	Energy efficiency in industry	27.01	100 TJ reduction	6,764.9	1858.7	182.7	1,000
	Building materials	-23.55	1 million bricks	937	0.2	-0.2	10
EE own generation	Waste heat recovery at cement plant	-243.15	1 Cement plant	61,565	11.1	-15.0	1
	Waste heat recovery at steel plant	-252.97	1 Steel plant	56,700	6.0	-14.3	1
EE service	Efficient electric motors	-235.20	1 kW	0.6	0.1	-0.14	1,000
	Efficient office lighting with CFLs	-214.68	1000 lights	60	0.1	-0.1	10
	Efficient street lights	-206.93	1000 lights	552	7.1	-11.4	100
	Efficient water pumping	-220.40	4 Million m3 water	1,076	2.0	-2.4	10
	New office building with central cooling	-185.38	1000 m2	49	0.0	0.0	
EE supply side	New high efficiency coal power plant	-2.85	1 MW	31,340	1388.0	-89.3	1,000
	New natural gas power plant	-370.98	1 MW	1,746	5526.8	-3886.4	6,000
	Switch away from fuel oil to diesel	-4.44	1 MW	332	0.0	0.0	0
	Cogeneration in industry	-404.85	1 MW	4,452	3839.0	-19824.6	11,000
	Single cycle to combined cycle	19.79	100 MW increase	210,600	0.0	0.0	
Energy distribution	Efficient electric grids	143.91	1 GWh loss reduction	490	7775.8	7775.8	8,109
	Connection of isolated grid to central grid	-35.64	1 GWh consumption	490	2.7	-1.7	100
Forestry	Reforestation	17.96	Reforestation of 1000 ha	7,181	160.0	12.9	100
	Avoided deforestation	0.47	No deforestation/1000ha	10,313	2.6	0.2	50


Marginal Abatement Revenue (MAR) Curve for Country X (2020 Scenario)
Cost of reduction options (US$/ktCO2e)
Reduction of GHG equivalents (ktCO2e/yr)
600
500
400
300
200
100
0
-100
-200
0
50000
100000
150000
200000
Cogeneration in industry
New natural gas power plant
Efficient domestic lighting with CFLs
Restriction on import of used cars
More efficient gasoline cars
Solar water heater, residential
Efficient residential airconditioning
Efficient electric motors
Mini hydro power connected to main grid
Geothermal power
Wind turbines, on-shore
More efficient diesel cars
Biogas from industrial waste water
Efficient refrigerators
Wind turbines, off-shore
Concentration Solar Power (CSP)
Reduced flaring at oil field
Landfill gas plant with power production
Leak reduction in natural gas pipelines
Biogas at big farms
New high efficiency coal power plant
Reduced PFCs from aluminum production
Nitric acid plant (N2O destruction)
Landfill gas flaring
LPG stoves replacing wood stoves
Energy efficiency in industry
CCS plant

MRV Charcoal in Uganda

Table 8: Monitoring parameters overview

CHARCOAL PRODUCTION	TRANSPORTATION	CHARCOAL RETAIL
Number of producers of each type and affiliated charcoal association	Number of transport licenses granted	Number of registered retailers
Number of labelled charcoal bags provided to producers	Number of bags of each type checked at road blocks	Bags of charcoal brought into the warehouse
Number of labelled bags of each charcoal type purchased by the charcoal unit	Taxes collected from unlabeled BAU charcoal	Bags of charcoal sold to retailers
NCV of different types		
Tax revenue collected from the purchased charcoal		
Tax from charcoal put into forest fund		

Source: UNDP: *Nationally Appropriate Mitigation Action Study on Sustainable Charcoal in Uganda*

Table 7: Four types of charcoal included in monitoring plan

CASE	TYPE	TECHNOLOGY	FEEDSTOCK	IMPACT ON FOREST CARBON STOCKS
PJ_{sus}	Sustainable charcoal	Improved (preferred option) or traditional	Forests which are now sustainably managed, biomass wastes, newly established forests, etc.	**Zero impact**
PJ_{imp}	Improved charcoal	Only improved carbonization	Common wood mix from local forests	**Reduced impact:** reduced deforestation or forest degradation
BAU_{lab}	Unimproved charcoal which has been put into Government issued labelled bags	Traditional	Common wood mix from local forests	**Strong impact:** strong deforestation or forest degradation
BAU_{unlab}	Unimproved charcoal which has not been labelled or collected at collection points	Traditional	Common wood mix from local forests	**Very strong impact:** strong deforestation or forest degradation (impact is very strong due to value chain inefficiencies)

Source: UNDP: *Nationally Appropriate Mitigation Action Study on Sustainable Charcoal in Uganda*

Table 6: Baseline parameters for charcoal production

TEM	SUB-ITEM	
Sectors	Sectors included	The baseline is applicable to: • the production and consumption chain of charcoal products as a household fuel. • the production chain of charcoal products as a fuel for small- and medium-sized enterprises (SME).
System boundary	–	**Baseline:** Charcoal production site, charcoal transport, charcoal sale to wholesalers and retailers. No "associated upstream emissions" occur
Key performance Indicator	–	tCO_2e per equivalent amount of charcoal produced – corrected for the charcoal NCV
Aggregation level	1) Process	**Baseline emission factor:** **i.** Baseline: the charcoal consumed by households and SME is produced by the "informal sector" on the basis of traditional kilns. **ii.** Other baselines: this current study is not applicable for cases in which other production technologies (e.g. the Casamance kiln) form a substantial share of the baseline charcoal production.
	2) Product	**Baseline inputs:** all inputs whose use lead to a decrease in forest carbon stock as they are partly or totally non-renewable shall take into account the following elements: **i.** the fraction of non-renewable biomass (X_{NRB}) in inputs[8] **ii.** the amount of wood used **iii.** the carbon content in the wood used (expressed on an oven-dry wood basis).
		Baseline outputs: **i.** NCV of the charcoal produced **ii.** The volume of charcoal produced (enabling calculation of the amount of wood needed to produce a unit of charcoal)
	3) Time	Baseline emission factor: No autonomous improvements in the technologies used have been observed. This has two consequences: • The baseline emission factor does not need to be updated over time • Performance test from any point in time can be included in the vintage used to derive values for the baseline emission factor (e.g. a performance test from the 1950´s would still be valid).
Stringency	Specific levels	**Baseline emission factor:** CO_2 emissions: Determined based on the "average" observed on all adequate performance tests. This represents the continuation of the current practice. CH_4 emissions: Weighted average for the region as there is no "most economically attractive course of action" for CH_4 emissions from pyrolysis gases – as there is no economic incentive for charcoal producers to reduce CH_4 emissions. These emissions are the result of both the technology and operating conditions.
	Unaccounted for emission reductions	Estimated to represent around 30% of the baseline emissions. This is an overly conservative default and could be reduced if other emissions are properly accounted for.

Source: UNDP: *Nationally Appropriate Mitigation Action Study on Sustainable Charcoal in Uganda*

Obrigado