

Tracking Progress of the Mitigation Commitments of Nationally Determined Contributions (NDCs)

Presentation: Supporting tools to develop
economy wide GHG emissions projections:
GACMO

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What is GACMO

Model GACMO = Greenhouse gas Abatement Cost Model

Bottom-up modelling tool for greenhouse gas emissions based on Excel

IPCC / CDM Methodologies

Developed by Jørgen Fenhann at UNEP CCC

Available for free on the UNEP CCC website [GACMO tool - UNEP-CCC \(unepccc.org\)](http://www.unepccc.org)

GACMO is a simple tool

The tool should be able to make Business As Usual (BAU) projection to:2025/2030/2035/2050

GACMO can make a NDC with a reduction of a percentage reduction of the GHG emission compared to the BAU.

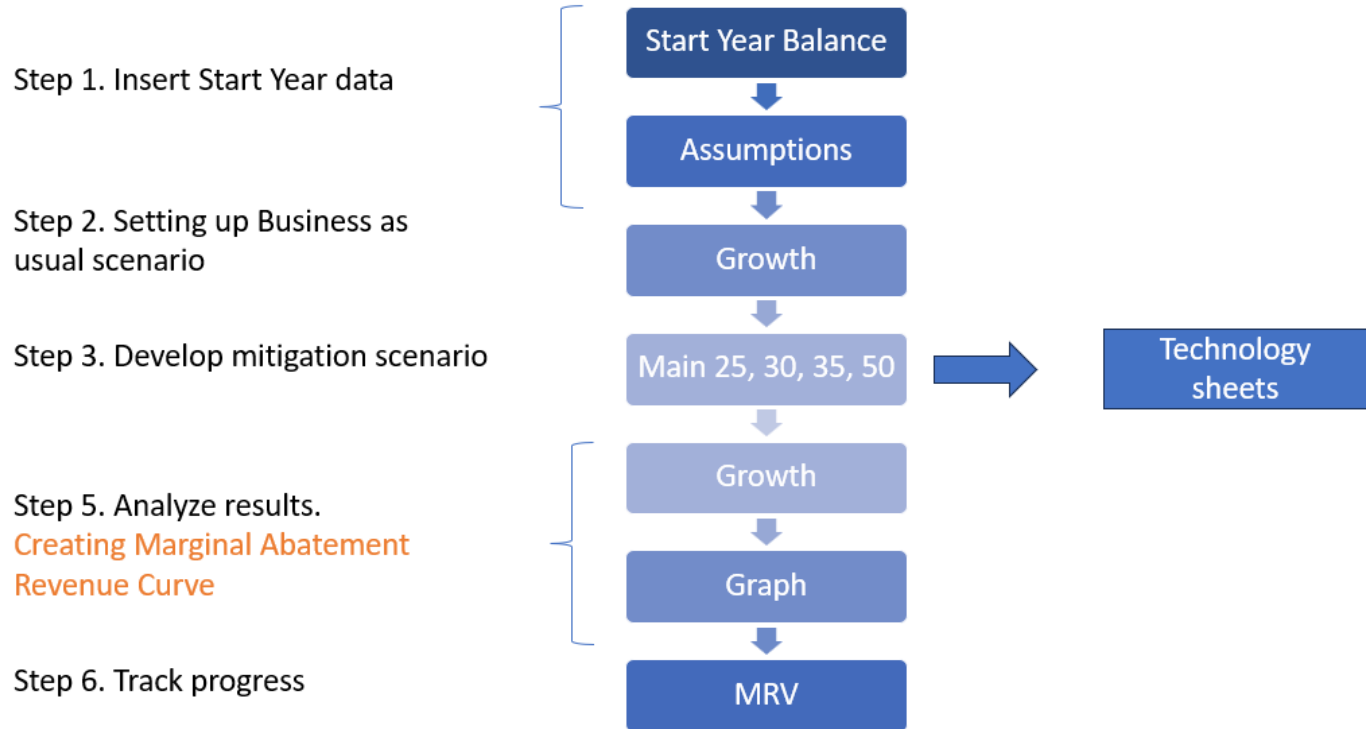
The tool should be able to calculate the GHG reduction and the cost for each mitigation option compared to the technology used in the baseline.

The tool should be able to scale the size of the mitigations option up and down.

The tool should give a clear overview of the total mitigation effort: total GHG reduction, total investment, and total annual cost.

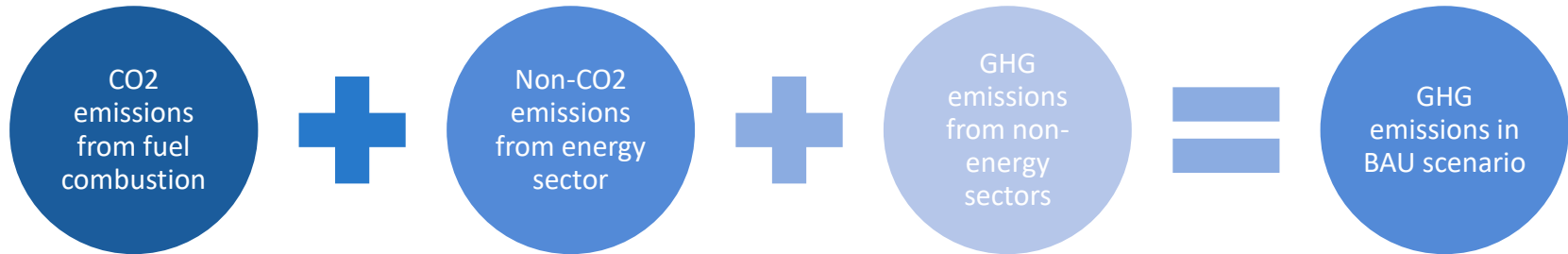
The calculation should be transparent and easy to follow.

Steps to develop GACMO model



BAU scenario

Total GHG emissions



Input data for GACMO

**GHG emissions inventory
by sectors**
(latest available year).

Energy Balance
(same year as GHG
emissions inventory year).

Emission factors
(if national emission factors
are available).

**Growth rates of energy
consumption by sectors**
(annual % change up to
2025, 2030, 2035 and
2050).

**Mitigation actions by 2025,
2030, 2035, 2050.**

**Technical and economical
parameters** of the
technology/mitigation
options (new technology
and baseline technology).

Key assumptions
(e.g. grid emission factor,
energy prices, etc.).

Mitigation options in GACMO

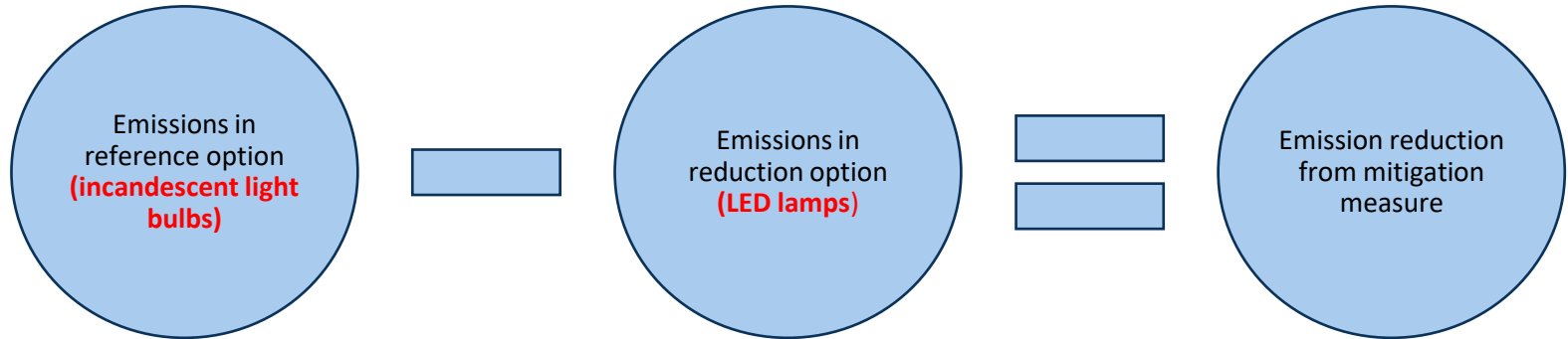
- There are 119 pre-defined mitigation options available in GACMO
- The user can select and adjust mitigation option applicable for the country

Annex. Mitigation options available in the GACMO tool

Type	Reduction option	Sub-type unit
Agriculture	Rice crop CH4 reduction	Rice crop CH4 red.(1000 ha)
	Zero tillage	1000 ha
	Cover crops	1000 ha
	Nitrification inhibitors (1000 ha)	1000 ha
	Covering slurry stores (1 slurry store)	1 slurry store
	Fat supplementation in ruminants diets (%DM fat added)	%DM fat added
	Tobacco curing	100 t tobacco/yr
Biomass energy	Rice husk cogeneration plants	1 MW cogeneration
	Biomass power from biomass residues	1 MW CHP plant
	Bagasse power	100 kt sugar cane/year
CCS	CCS plant	1 MW
Cement	Clinker replacement	1000 tonnes cement/day
Coal bed/mine methane	Coal mine methane	10 Mm3 CMM/year
EE households	Efficient residential airconditioning	1000 Airconditioners
	Efficient lighting with CFLs	1000 Bulbs
	Efficient lighting with LEDs	1000 Bulbs
	Efficient lighting with LEDs replacing CFL	1000 Bulbs
	Efficient wood stoves	1000 stoves
	Efficient charcoal stoves	1000 stoves
	LPG stoves replacing wood stoves	1000 stoves
	Efficient electric stoves	1000 stoves
	Induction based cooking	1000 stoves
	New passive home	1000 new homes
Efficient refrigerators	1000 refrigerators	

Approach for the calculation of emission reduction for a mitigation option

- Example of efficient lighting
- LED lamps replacing incandescent light bulbs



Approach for the calculation of emission reduction for a mitigation option

1. Estimate CO₂ emissions in the reference option (incandescent light bulbs)

$$\begin{aligned} & \text{Emissions}_{\text{reference option}} (tCO_2) \\ &= \frac{\text{Electricity incandescent lighting} (MWh) \times \text{Grid emission factor} \left(\frac{tCO_2}{MWh} \right)}{(1 - \text{Grid losses } \%)} \end{aligned}$$

2. Estimate CO₂ emissions in the reduction option (LED lamps)

$$\text{Emissions}_{\text{reduction option}} (tCO_2) = \frac{\text{Electricity LED lamps} (MWh) \times \text{Grid emission factor} \left(\frac{tCO_2}{MWh} \right)}{(1 - \text{Grid losses } \%)}$$

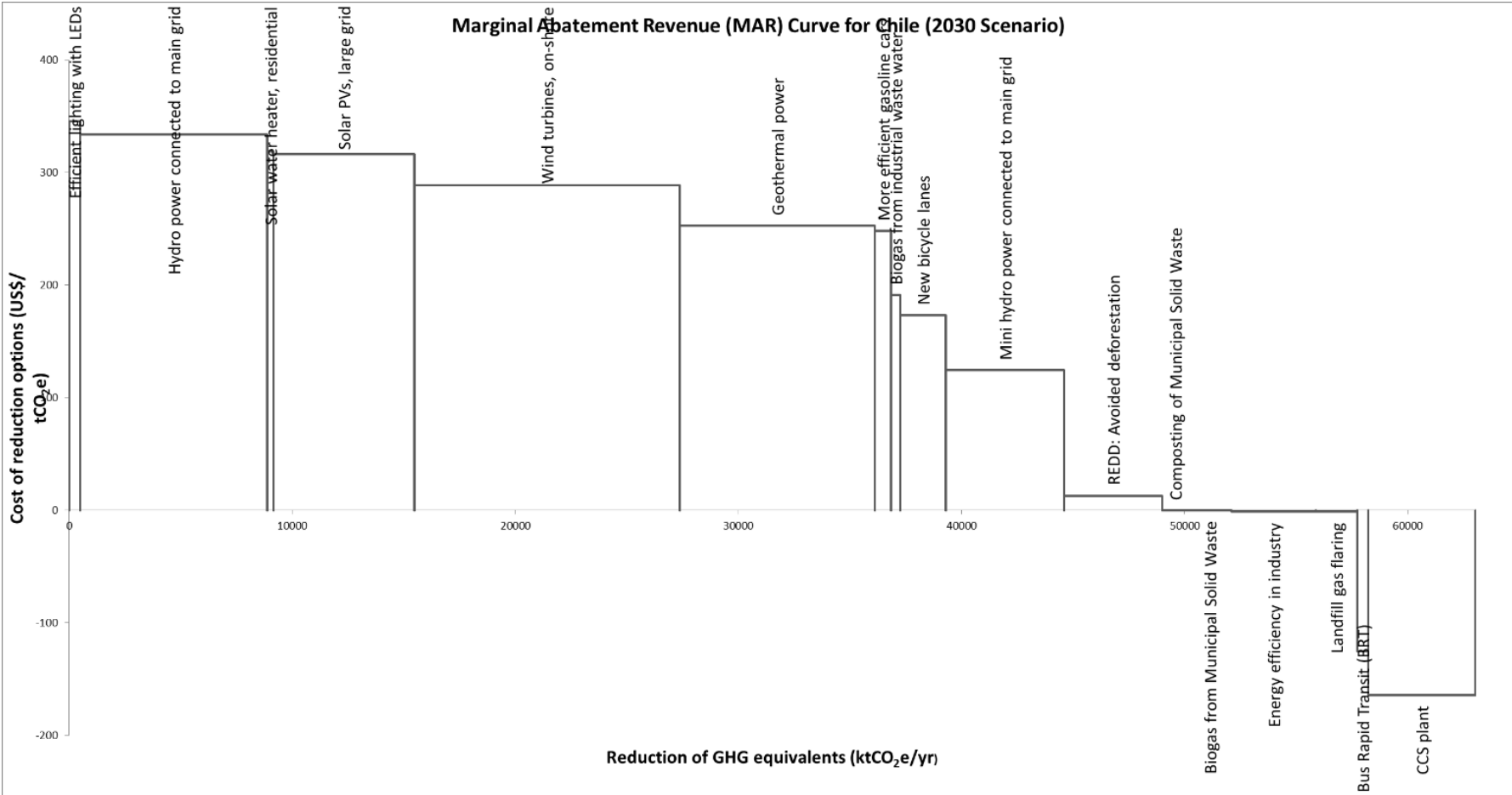
GACMO summary table for the 22 GHG mitigation options in the Maldives

Mitigation options	Abatement costs	Unit Type	Emission reduction	Units penetrating in 2020	Investment	Annualized costs	Emission reduction in 2020	
	US\$/tonCO ₂						t CO ₂ /unit	MUS\$
LED tubes for public sector	-784	1 light tube replaced	0.015	70,000	0.0	-0.8	1.1	0.1%
Better maintenance of motor bikes	-413	All motor bikes	24304	1	0.0	-10.0	24.3	1.3%
Air conditioning at resorts	-398	1 Aircondinioner	0.87	36,467	4.7	-12.7	31.8	2.9%
Cooling new service buildings	-369	1 m2	0.046	270,336	1.8	-4.6	12.4	3.5%
Solar water heater	-323	1 unit	24	102	0.7	-0.8	2.5	3.7%
Efficient air conditioning	-313	1 Airconditioner	1.19	74,186	9.6	-27.7	88.5	8.2%
LED tubes for street light	-292	2200 street lights	1505	1.48	0.1	-0.6	2.2	8.3%
Upgrade of system efficiencies	-260	All eligible Islands	43199	1	61.1	-11.2	43.2	10.5%
PVs outer islands	-252	1 kW	1.22	12,100	42.4	-3.7	14.7	11.2%
Regional waste-to-energy projects	-228	100 ton/day of waste	9535	1	10.4	-2.2	9.5	11.7%
PVs with Net Meters	-189	1 kW	1.13	10,500	42.0	-2.2	11.9	12.3%
Energy efficient refrigerators	-158	1 refrigerator	0.51	82,823	41.2	-6.6	42.0	14.4%
PVs Malé Region (existing plans)	-133	1 kW	1.05	15,000	45.0	-2.1	15.8	15.2%
PVs Malé Region (additional options)	-133	1 kW	1.05	15,000	45.0	-2.1	15.8	16.0%
Efficient water pumping	-117	1 household	0.10	72,470	14.5	-0.9	7.6	16.4%
PVs on resorts	-108	1 kW	1.22	47,815	167.4	-6.3	58.2	19.4%
20 MW wind power & 25 MW LNG	-105	45 MW	26502	1	97.3	-2.8	26.5	20.7%
Thilafushi waste-to-energy project	-68	A 4 MW plant	23061	1	57.8	-1.6	23.1	21.9%
PVs with storage at small islands	-52	1 kW	1.2	29,000	167.1	-1.8	35.3	23.7%
LEDs for domestic lighting	199	All domestic bulbs	8467	1	42.4	1.7	8.5	24.1%
Biodiesel 20% blend	336	20% blend	213000	1	0.0	71.6	213.0	34.9%
Bioethanol 15% blend	337	15% blend	14637	1	0.0	4.9	14.6	35.7%
Totals				Million US\$	850.3	-22.6	702.4	35.7%

Total baseline emission in 2020:

1968 ktCO₂-eq.

Marginal Abatement Revenue (MAR) Curve for Chile (2030 Scenario)



Mitigation options included/excluded in the MAR curve for Chile

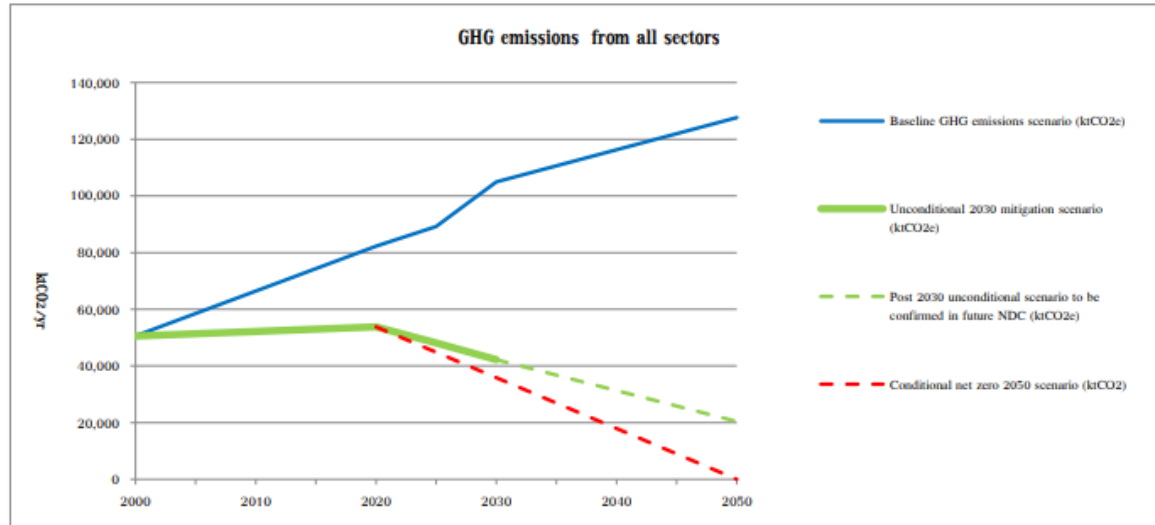
Options included in MAR Curve		
Reduction option	US\$/tonCO2	Emission reduction in 2030 per option kt/year
Efficient lighting with LEDs	345.66	504.25
Hydro power connected to main grid	333.82	8377.52
Solar water heater, residential	319.16	289.72
Solar PVs, large grid	316.19	6298.99
Wind turbines, on-shore	288.73	11900.00
Geothermal power	252.54	8753.50
More efficient gasoline cars	248.36	727.85
Biogas from industrial waste water	191.45	393.39
New bicycle lanes	173.53	2059.75
Mini hydro power connected to main grid	124.47	5298.00
REDD: Avoided deforestation	12.92	4400.00
Composting of Municipal Solid Waste	0.01	1158.30
Biogas from Municipal Solid Waste	-0.26	1949.88
Energy efficiency in industry	-1.17	3759.38
Landfill gas flaring	-1.28	1866.23
Bus Rapid Transit (BRT)	-125.30	493.88
CCS plant	-164.50	4811.00

Options excluded in MAR Curve		
Reduction option	US\$/tonCO2	Emission reduction in 2020 per option kt/year
New natural gas power plant	2546.69	861.00
Cogeneration in industry	2371.03	620.50
Shifting freight transport from road to rail (1000	1562.82	30.17
Efficient electric motors	296.40	50.16
Efficient residential airconditioning	295.26	32.13
Efficient office lighting with LEDs	255.18	45.74
Zero tillage	198.80	42.86
Electric cars	118.82	165.27
Efficient refrigerators	32.65	102.94
Assisted forest regeneration	4.81	18.33
Reforestation with Silvopasture	0.87	36.67
Biogas at rural farms using non-renewable fuel	-2.84	112.74
Nitrification inhibitors (1000 ha)	-67.69	102.70
Fat supplementation in ruminants diets (%DM)	-80.50	0.77
Efficient electric grids	-185.27	-6863.98
Solar tower CSP, with storage	-374.07	3567.31
Electric trucks	-615.93	6783.28
Electric 12m buses	-965.37	7641.60

Threshold for smallest value on x-axis (ktCO2e/yr)	200
Threshold for smallest value on y-axis (US\$/ktCO2e)	-200
Threshold for largest value on y-axis (US\$/ktCO2e)	800

Results of GACMO: GHG emissions projections in BAU and Mitigation scenario

- [Example of use of GACMO for NDC for Lao PDR](#)



Conclusion

GACMO is a **simple tool, easily adaptable** to a specific national context used to make analysis of mitigation options and their effects in terms of GHG emissions reduction in the context of NDC preparation or update

The GACMO calculations are transparent and easy to follow, in line with the methodologies established by the IPCC and CDM

GACMO allows to establish a Business As Usual (BAU) project 2025/2030/2050

GACMO allows to establish a mitigation scenario projection (percentage of reduction of GHG emissions in comparison with BAU)

GACMO allows you to calculate the reduction of GHG and the cost related to each mitigation option compared to a technology used as a reference

GACMO allows to "play" with the scale of application of any mitigation option to reach a global reduction target

GACMO offers a clear description of the total reduction of GHG emissions, total inversion and total annual cost

Thank you!

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