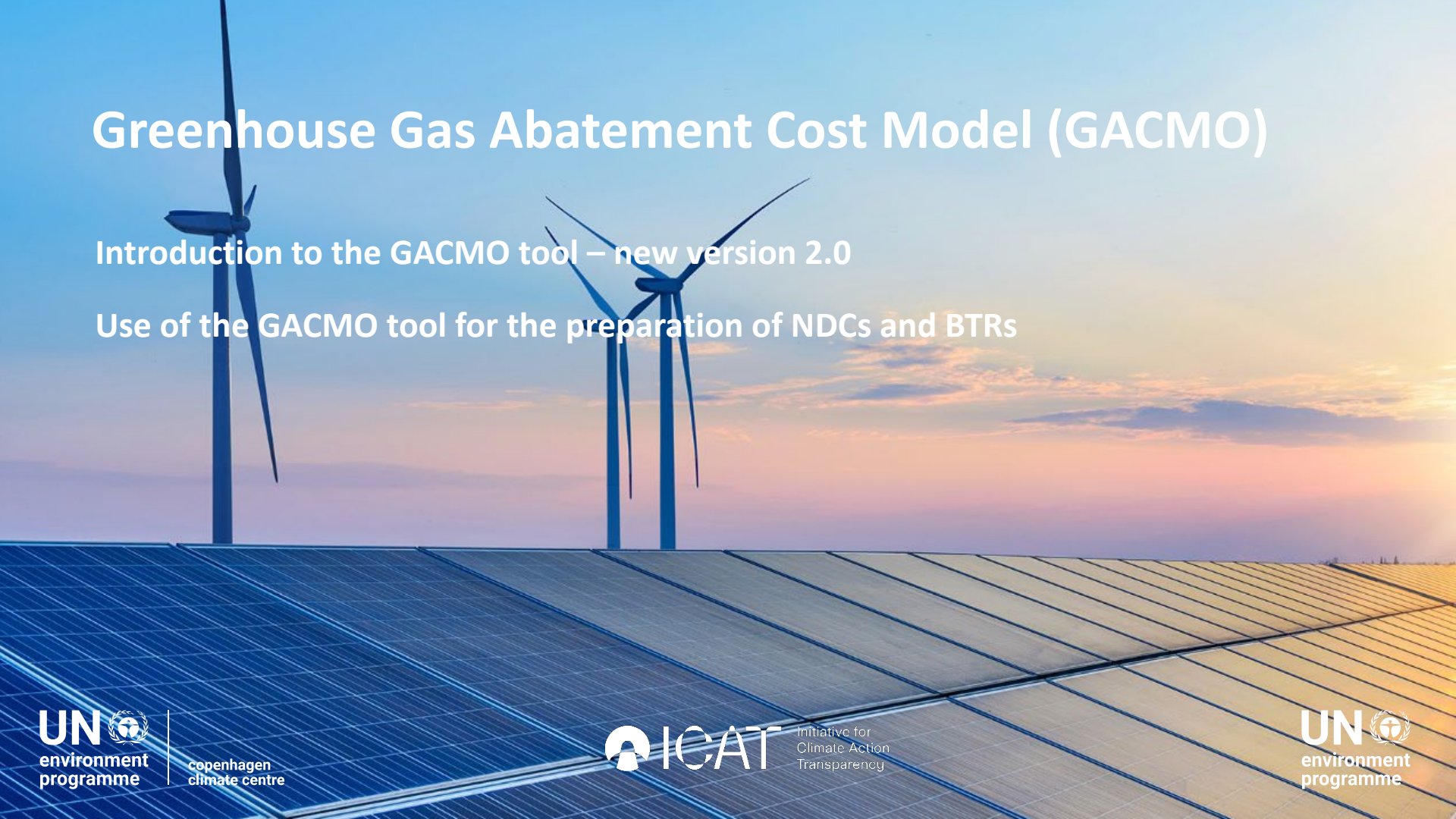
Greenhouse Gas Abatement Cost Model (GACMO)

Introduction to the GACMO tool – new version 2.0

Use of the GACMO tool for the preparation of NDCs and BTRs



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ICAT Initiative for Climate Action Transparency

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Content

GACMO tool

- GACMO = Greenhouse gas Abatement Cost Model
- Excel based bottom-up modelling tool for greenhouse gas emissions projections
- IPCC/CDM Methodologies
- Developed by Jørgen Fenhann at the UNEP CCC
- Available for free on the UNEP CCC website [GACMO tool - UNEP-CCC (unepccc.org)]

New version of the GACMO tool

Step-wise approach for model development

- Spreadsheets are hidden
- Navigation throughout the tables by clicking on buttons

Detailed guidance

- Step-by-step guidance in each spreadsheet

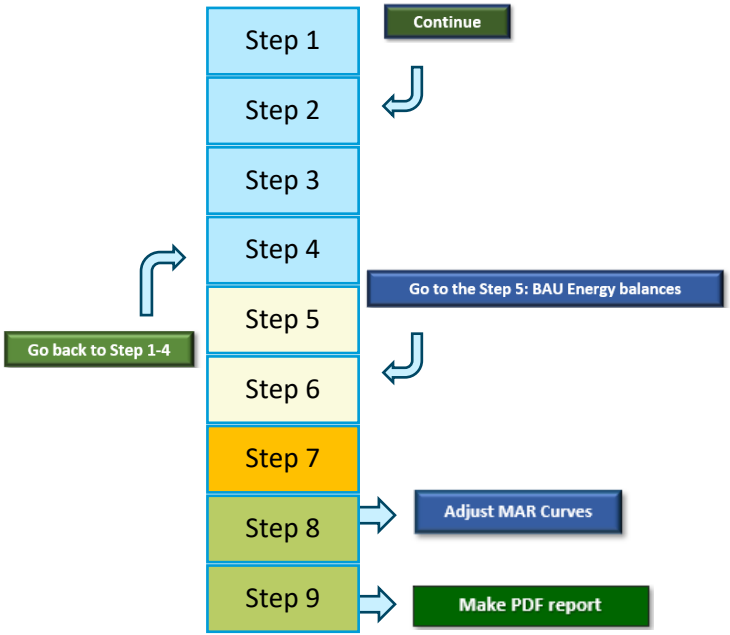
PDF report

- Main results

Improved interface

- Improved tables, figures

Main buttons for navigation in GACMO



Use of the GACMO tool

GHG emissions projections for Business As Usual (BAU) scenario in 2025, 2030, 2035 and 2050

Mitigation scenario as % reduction in the GHG emissions compared to the BAU in 2025, 2030, 2035 and 2050 (mitigation scenarios for **NDC development/update**)

Expected and achieved emissions reduction (annual, cumulative) from specific mitigation options

GHG reduction and the cost **for each mitigation option** compared to the technology used in the baseline.

Overview of the total mitigation effort: total GHG reduction, total investment, and total annual cost.

Input data requirements

Basic country data	•Population, GDP
Key assumptions	•Grid emission factor, energy prices, emission factors, calorific values of fuels, GWPs, etc.
Energy balance	• Production and consumption data of fuels and electricity by sectors for the start year
GHG emissions for non-energy sectors	• Agriculture, Forestry, Waste, Industrial processes and Fugitive emissions
Growth factors	•Annual % change up to 2025, 2030, 2035 and 2050 (BAU scenario)
Mitigation options	•Units penetrating in the years 2025, 2030, 2035, and/or 2050
Technical and economical parameters of the technology/mitigation options	•E.g. solar insolation, annual distance for transport, number of hours usage of lighting, investment costs etc.

Use of the GACMO tool

National Communications

- Albania has used this for its NC1 (2002), NC2 (2009), NC3 (2016), NC4 (2022)

INDC/NDC

- Maldives (INDC, 2014); Cameroon (NDC1, 2021); Ghana (NDC1, 2021); Niger (NDC1, 2021)

BUR

- Maldives (BUR1, 2019); Albania (BUR1, 2021); Ghana (BUR3, 2021)

BTR

- Many countries are using the GACMO tool to prepare their first BTR

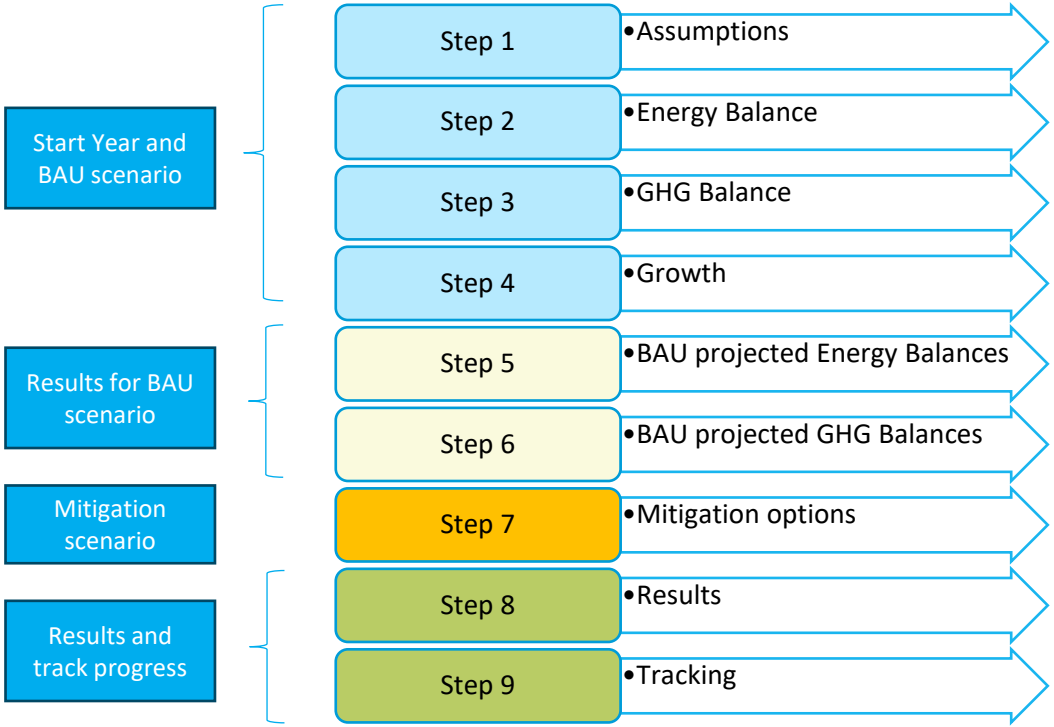
National Action Plan or Long-Term Strategy

- Maldives (National action plan on air pollutants, 2019); Tunisia (inputs for LTS); Jordan (inputs for LTS)

Regional analysis

- Zero carbon Latin America a pathway for net decarbonisation of the regional economy by mid-century (UNEP, 2015);
- Net Zero Carbon Scenarios for the Energy Sector in West Asia (UNEP, 2022)

Main steps to develop the GACMO tool



Main steps to develop the GACMO tool

Start Year and BAU scenario

Step 1
Step 2
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Step 1 - Assumptions

Basic country information

Country:	Country X
Start year (latest inventory):	2015
Currency:	Currency Y
Exchange rate used (1US$=):	4
Discount rate =	7.0%

The Assumptions sheet includes all the basic country, cost, and technical data that the GACMO tool needs as inputs for the calculations.
This sheet must be filled in by the user.

All the cells in the six tables displayed on the sheet must be considered by the user. Some of these cells may already include default values for some data, but the user can adjust those values if national values are available for the same.

Please refer to the Guidance for further details on the data included in this sheet and on how to fill in it.

Once all the data on the Assumptions sheet have been filled, you can click "go to step 2: Energy balance".

Energy prices used for the entire future period:		
Crude oil	50.0	US$/bbl
Crude oil	0.31	US$/litre
LNG	3.3	US$/MBTU
Natural gas	3.1	US$/GJ
Coal	50	US$/ton

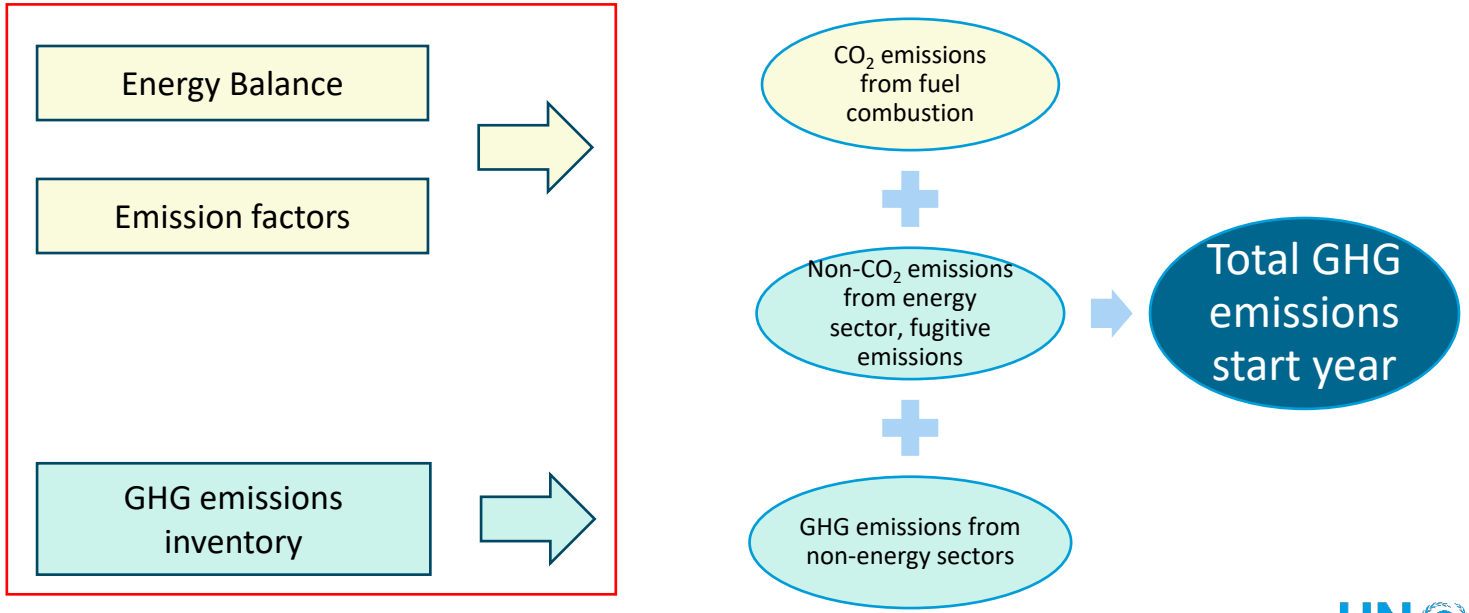
See Energy conversion factors

Fuel prices for the entire future period	LPG	Gasoline	Bioethanol	Jet Fuel	Diesel oil	Biodiesel	Heavy Fuel Oil	Kerosene	Coal	Coke	Petroleum coke	Lignite	Natural Gas
Distillate price/crude oil price (litre/litre)	0.90	1.40		1.40	1.20		0.80	1.40					
Price, US$/liter	0.28	0.44	0.83	0.44	0.38	1.20	0.25	0.44					
Price, US$/GJ	11.1	13.1		12.3	10.4		6.4	12.3	2.0	2.0	2.0		3.1
Density, t/m3	0.54	0.75	0.76	0.80	0.84	0.88	0.98	0.80					(MJ/Nm3)

BAU scenario

GHG emissions in the Start year

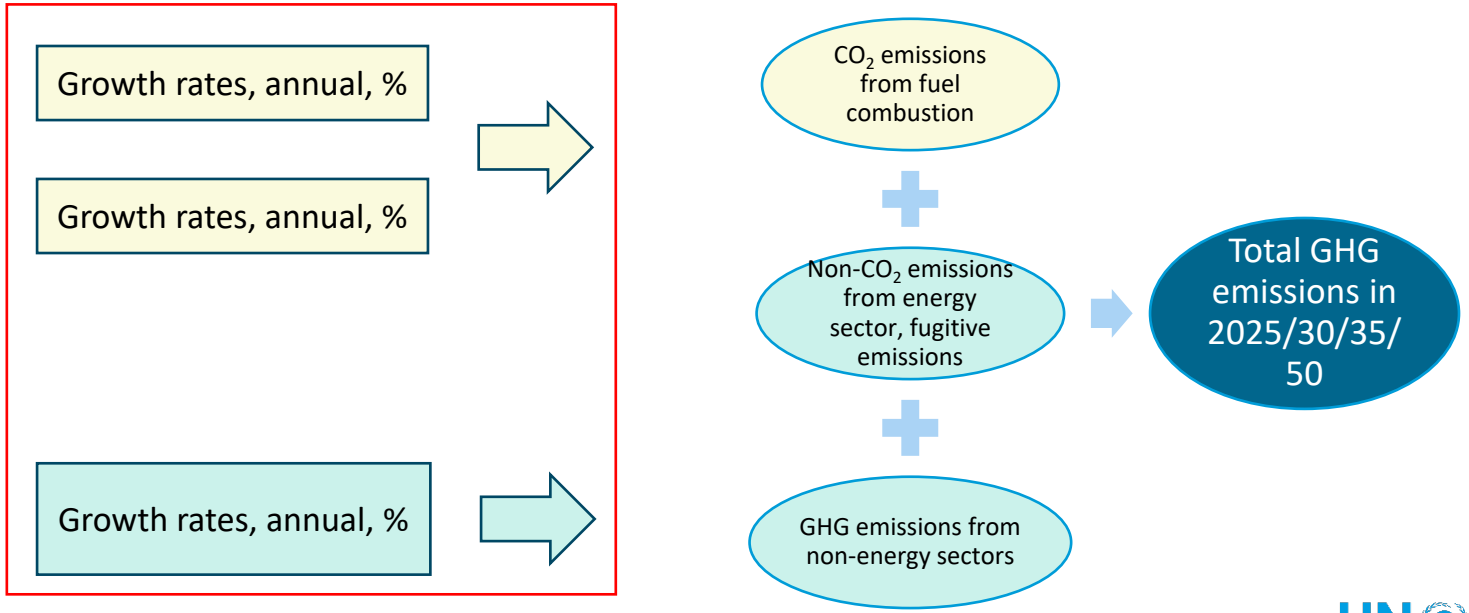
Input data provided by the user



BAU scenario

GHG emissions in the BAU scenario

Input data provided by the user



Main steps to develop the GACMO tool

Results for BAU scenario

Step 5: BAU projected Energy Balances for year 2025, 2030, 2035, and 2050

Go back to Step 1-4

Select year to display: 2025 | 2030 | 2035 | 2050

Select unit to display: TJ | ktoe

Selected year: 2025
Selected unit: TJ

The BAU projected energy balances sheet includes the future energy balances for the years 2025, 2030, 2035 and 2050. The data in this sheet are automatically calculated by GACMO.
The user should not modify any of the data in the tables Fossil fuel balance – year – Country X and Electricity balance – year. However, a user may exceptionally decide to modify a specific data in one of these tables in the case that the user would like to reflect a change in the energy matrix which is not taken into account by the projections made by GACMO. The user should only make such a change if he/she is completely familiar with those type of data as the change will have an impact on the emissions scenarios and results obtained.

TJ units													Total energy (fossil)
Unit	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ	TJ
Total	**338,405**	**162,706**	**105,327**	**1,562,114**	**33,684**	**4,648**	**2,206,884**	**1,263,344**	**1,848,566**	**3,108,575**	**247,459**	**227,173**	**8,902,001**
Fossil power plants	-	-	-	18,468	16,338	-	**34,806**	718,367	1,613,948	1,369,413			**3,736,534**
FINAL CONSUMPTION	338,405	162,706	105,327	1,543,646	17,346	4,648	**2,172,078**	544,977	234,618	1,739,162	247,459	227,173	**5,165,468**
Industry - steel	-	-	-	1,319	-	-	**1,319**	760	852	16,064	-	-	**18,995**
Industry - chemical	762	-	-	310	216	-	**1,289**	17,612	10,651	180,894	-	-	**210,445**
Industry - non metallic mineral	254	-	-	1,862	1,296	-	**3,412**	147,821	46,078	131,584	-	226,784	**555,680**
Industry - food processing and beverage	1,694	-	-	466	2,663	-	**4,823**	10,191	25,792	68,586	2,457	389	**112,238**
Industry - construction	-	-	-	11,407	-	-	**11,407**	45	98	25,144	-	-	**36,693**
Industry - mining	-	-	-	29,177	-	-	**29,177**	849	3,081	9,080	-	-	**42,186**
Industry - machinery	424	-	-	233	-	-	**656**	134	557	4,819	-	-	**6,167**
Industry - non ferrous metals	3,134	-	-	1,009	-	-	**4,143**	48,544	2,229	143,667	242,595	-	**441,178**
Industry - paper and pulp	85	-	-	776	-	-	**861**	1,922	6,620	15,505	-	-	**24,908**
Industry - transport equipment	1,948	-	-	543	-	-	**2,491**	-	262	12,432	-	-	**15,186**
Industry - textile and leather	1,016	-	-	466	-	-	**1,482**	15,868	35,591	83,672	-	-	**136,613**
Industry - miscellaneous	-	-	-	-	-	-	-	-	33	43,373	-	-	**43,405**
Transport - road	259,966	162,706	-	1,274,771	-	-	**1,697,443**	-	-	6,007	-	-	**1,703,450**
Transport - rail	-	-	-	10,476	-	-	**10,476**	-	-	-	-	-	**10,476**
Transport - domestic air	-	-	105,327	-	-	-	**105,327**	-	-	-	-	-	**105,327**
Transport - navigation	-	-	-	-	13,171	-	**13,171**	-	-	-	-	-	**13,171**
Households	20,753	-	-	-	-	4,648	**25,401**	67,765	76,229	768,274	-	-	**937,668**
Services	48,368	-	-	-	-	-	**48,368**	233,466	26,546	220,774	2,407	-	**531,560**
Agriculture & Fishery	-	-	-	210,832	-	-	**210,832**	-	-	9,289	-	-	**220,121**
Non energy uses	-	-	-	-	-	-	-	-	-	-	-	-	-

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Main steps to develop the GACMO tool

Mitigation scenario

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Step 7 - Selection of the mitigation options for year 2025, 2030, 2035 and 2050

Go back to Step 1-4

Adjust MAR Curves

2025 | 2030 | 2035 | 2050

Select reduction option sector/type

Selected year: 2030

Total GHG mitigation in Country X

Type	Reduction option	US$/tCO2e	Sub-type unit	Emission reduction tCO2e/unit	Investment Million US$	Annual costs MUS$/year	Units penetrating in 2030	Emission reduction in 2030 Per option ktCO2e/year	Added ktCO2e/year	Frac. of total	Diesel saved ktoe	Gasoline saved ktoe	Electricity saved GWh	Electricity produced GWh
Agriculture	Rice crop CH4 reduction	1.20	Rice crop CH4 red.(1000 ha)	2,520	1	0.10	1	2.52	3	0.0%				
	Zero tillage	-166.39	1000 ha	86	0	0.01	1	0.09	3	0.0%				
	Cover crops	81.04	1000 ha	1,490	-	0.12	1	1.49	4	0.0%				
	Nitrification inhibitors (1000 ha)	67.69	1000 ha	790	-	0.05	1	0.79	5	0.0%				
	Covering slurry stores (1 slurry store)	937.83	1 slurry store	0.20	0	0.00	1	0.00	5	0.0%				
	Fat supplementation in ruminants diets (%DM fat added)	80.50	%DM fat added	5,027	-	0.40	1	5.03	10	0.0%				
	Tobacco curing	-20.80	100 t tobacco/yr	562	0	0.01	1	0.56	10	0.0%				
Biomass energy	Rice husk cogeneration plants	-87.68	1 MW cogeneration	9,719	1	0.85	1	9.72	20	0.0%				8
	Biomass power from biomass residues	-191.87	1 MW CHP plant	2,428	3	0.47	1	2.43	23	0.0%				5
	Bagasse power	-341.74	100 kt sugar cane/year	6,791	2	2.32	1	6.79	29	0.0%				14
CCS	CCS plant	203.82	1 MW	5,412	12	1.10	1	5.41	35	0.0%				0
Cement	Clinker replacement	7.55	1000 tonnes cement/day	166,584	-	1.26	1	166.58	201	0.0%				
Coal bed mine methane	Coal mine methane	-30.71	10 Mm3 CMM/year	37,353	-	0.04	1	37.35	239	0.0%				7
EE households	Efficient residential airconditioning	-307.41	1000 Airconditioners	780	0	0.24	1	0.78	240	0.0%			1	
	Efficient lighting with CFLs	-321.07	1000 Bulps	38	0	0.01	1	0.04	240	0.0%			0	
	Efficient lighting with LEDs	-354.68	1000 Bulps	78	0	0.03	1	0.08	240	0.0%			0	
	Efficient lighting with LEDs replacing CFL	-213.84	1000 Bulps	9	0	0.00	1	0.01	240	0.0%			0	
	Efficient wood stoves	-933.25	1000 stoves	1,338	0	1.25	1	1.34	241	0.0%				
	Efficient charcoal stoves	-62.01	1000 stoves	293	0	0.02	1	0.29	241	0.0%				
	LPG stoves replacing wood stoves	74.17	1000 stoves	2,055	0	0.15	1	2.05	243	0.0%				
	Efficient electric stoves	-273.81	1000 stoves	155	0	0.04	1	0.16	244	0.0%			0	
	Induction based cooking	504.90	1000 stoves	11	0	0.01	1	0.01	244	0.0%			0	
	New passive home	-141.19	1000 new homes	8,499	-	1.20	1	8.50	252	0.0%			14	
	Efficient refrigerators	-37.24	1000 refrigerators	1,203.8	0	0.04	1	1.20	253	0.0%			0	

Mitigation scenario

Defining the list of mitigation options for the mitigation scenario

119 pre-defined mitigation options

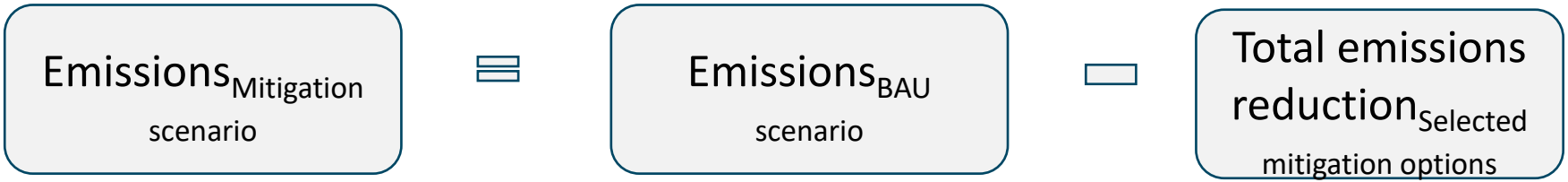
User selects mitigation options applicable for the country

For each mitigation option chosen, **the user will have to insert** (in the column I) **the number of units in** the year 2025, 2030, 2035, or 2050.

User can refer to national reports such as sectoral policy planning documents, national development strategies, NDCs, etc.

It is good practice to **involve a representative group of national experts** from the different sectors/ministries in the development of list of mitigation options

Mitigation scenario



Main steps to develop the GACMO tool

Results

Step 8 - Results

Go back to Step 1-4

Make PDF report

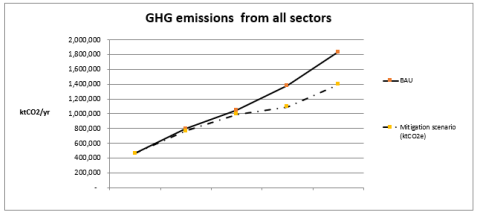
The Results sheet includes all the final results for the greenhouse gas emissions reductions and costs calculations. The sheet also displays the graphical results from the data analysis. In the Results sheet, the user will find the following information:

- A table with the total greenhouse gas emissions levels in the different years (start year, 2025, 2030, 2035 and 2050) for the BAU scenario and for the mitigation scenario.
- The graph showing the curves for the total emissions in the BAU and the mitigation scenarios.
- A table showing the sectoral split of the emissions in the different years (start year, 2025, 2030, 2035 and 2050) for the BAU scenario.
- The graph showing the curves for the sectoral emissions in the BAU scenario.
- A table showing the sectoral split of the emissions in the different years (start year, 2025, 2030, 2035 and 2050) for the mitigation scenario.
- A Marginal Abatement Revenue Curve (MAR curve) comparing the relevant mitigation options for the year 2025, 2030, 2035 or 2050.

Please refer to the Guidance for further details on the Results sheet.

Once you are done with the Results sheet, you can click "go to step 9: MRV".

GHG emissions from all sectors		2015	2025	2030	2035	2050
Population (thousands)		1,877	2,038	2,124	2,214	2,386
GDP (Current MUS$)		141	210	257	314	489
BAU energy CO2 emissions (ktCO2)	Fossil fuel emissions	381,068	682,435	913,252	1,222,137	1,644,835
BAU other gases GHG emissions (ktCO2e)	Other emissions	83,259	113,063	133,095	157,735	188,688
BAU GHG emissions (ktCO2e)	**All GHG emissions**	**464,327**	**795,497**	**1,046,347**	**1,379,872**	**1,833,523**
Emissions reduction in Mitigation scenario	All GHG emissions	-	29,569	56,262	289,136	441,073
Mitigation scenario (ktCO2e)	All GHG emissions	**464,327**	**765,928**	**990,085**	**1,090,736**	**1,392,451**
Mitigation scenario reduction (%)	All GHG emissions	0.0%	3.7%	5.4%	21.0%	24.1%
Fill the table below only in case if you have a second mitigation scenario. Use the second GACMO file to create second mitigation scenario.						
Second Mitigation scenario (ktCO2)	All GHG emissions	0	0	0	0	0
Second Mitigation scenario (ktCO2)	All GHG emissions	464,327	795,497	1,046,347	1,379,872	1,833,523
Second mitigation scenario reduction (%)	All GHG emissions	0.0%	0.0%	0.0%	0.0%	0.0%
Total tCO2-e/capita in BAU	All GHG emissions	247.4	390.3	492.5	623.3	768.5
Total tCO2-e/US$ in BAU	All GHG emissions	3,302	3,785	4,072	4,393	3,747



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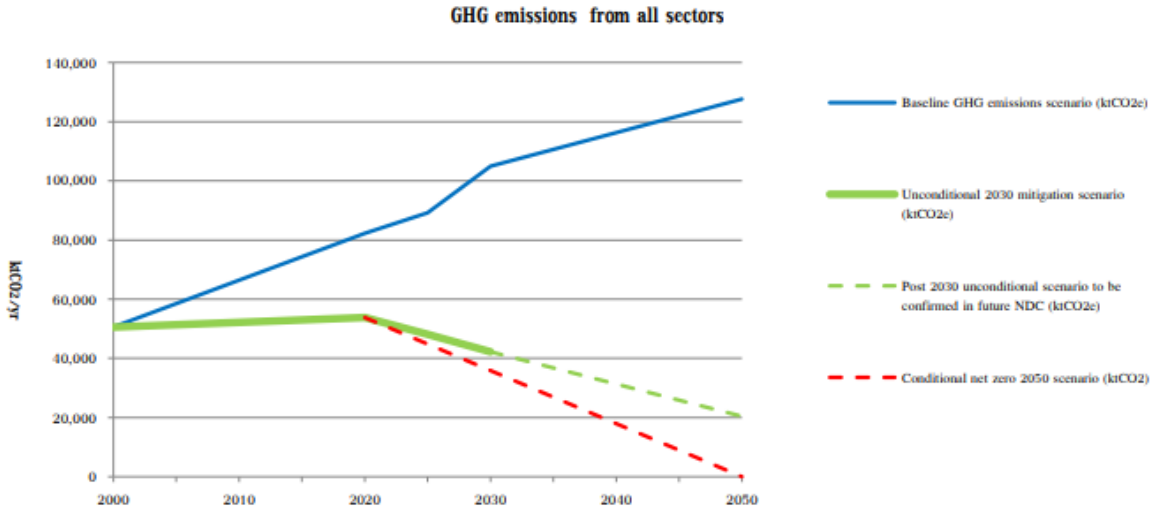
Results

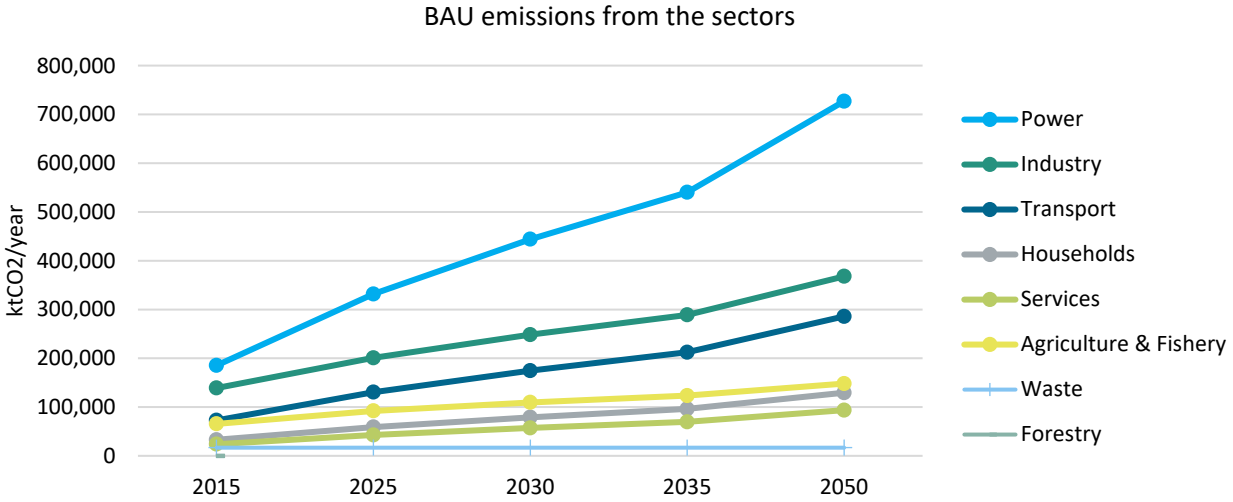
Total GHG emissions

GHG emissions projections in the Lao PDR's NDC



Results

Example of GHG emissions projections by sectors

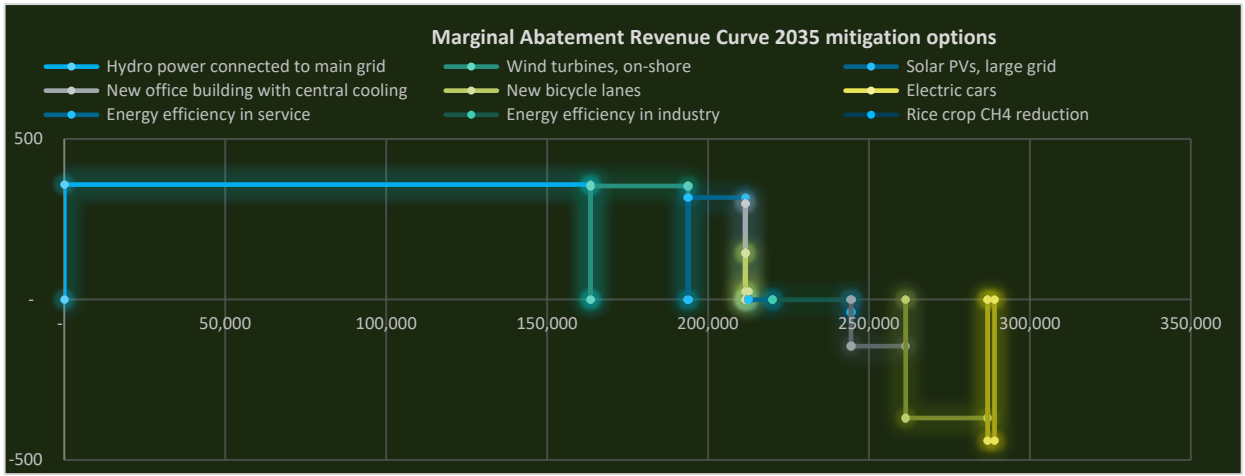


Results are presented for 8 sectors for BAU and mitigation scenario

Results

Example of Marginal abatement revenue curve (MAR curve)

- Y-axis: Revenue of an option to reduce one tonne of CO_2 equivalent (expressed in US$/t$CO_2$-eq)
- X axis: GHG emission reduction potential of an option (expressed in ktCO_2-eq / year)



Main steps to develop the GACMO tool

Tracking

The Tracking step is used **ex-post**, once the mitigation options **have been implemented**, to **monitor the progress** in implementing and achieving a country´s NDC.

User defines the values for implemented mitigation options

Accumulated GHG reductions for the implementation period

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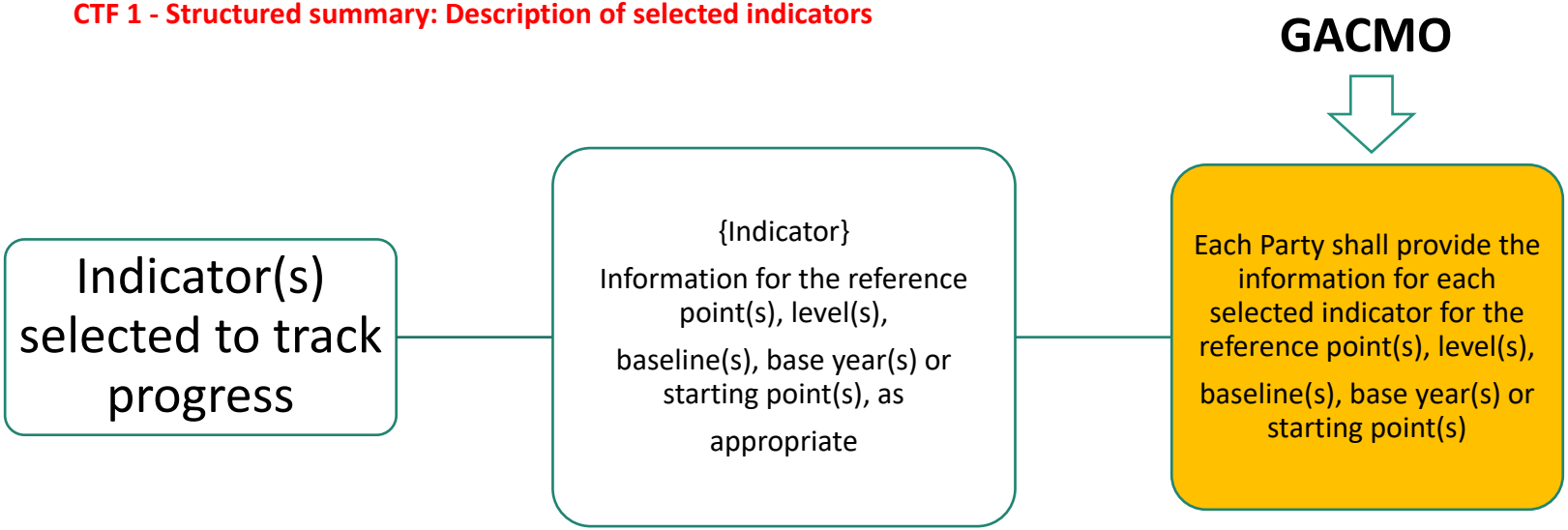
Use of the GACMO tool for the NDC planning and tracking

Identification of NDC target levels	• Economy-wide GHG emissions target • Sectoral targets consistent with the economy-wide target
Selection of appropriate list mitigation options	• MAR curve can be useful to select the set of mitigation options based on the costs and emissions reduction
Tracking progress	• Expected and achieved emission reduction from mitigation measures

Use of the GACMO tool for the Biennial Transparency Report (BTR) preparation

Definition of the indicators

CTF 1 - Structured summary: Description of selected indicators

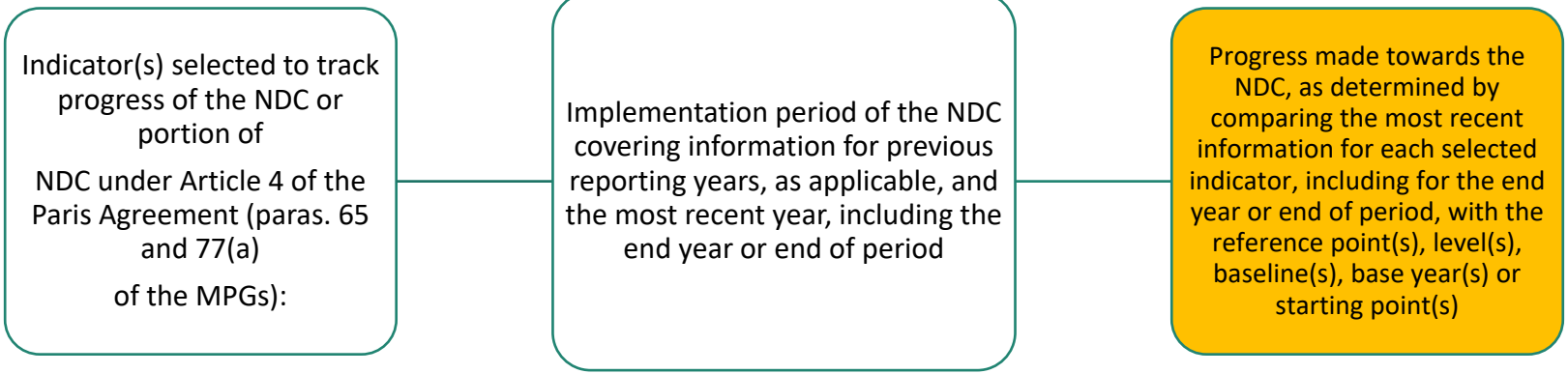


Use of the GACMO tool for the Biennial Transparency Report (BTR) preparation

Tracking of the indicators

CTF 4 - Structured summary: Tracking progress made in implementing and achieving the NDC under Article 4 of the Paris Agreement

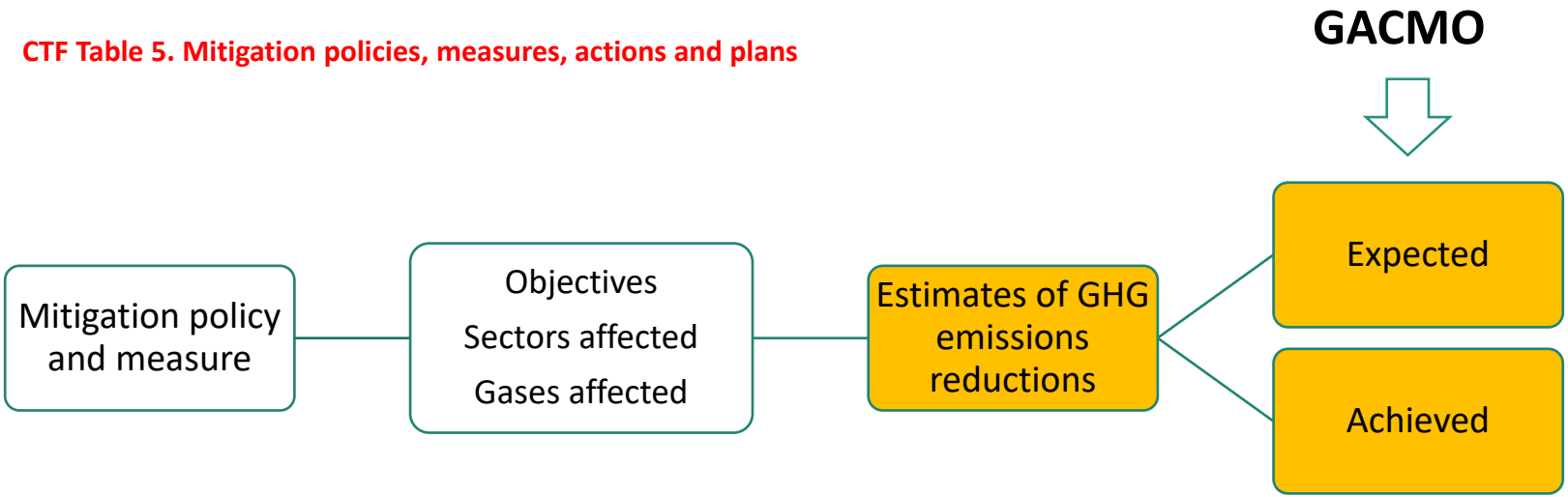
GACMO



Use of the GACMO tool for the Biennial Transparency Report (BTR) preparation

Assessment of the impact of the individual policies and measures

CTF Table 5. Mitigation policies, measures, actions and plans



Use of GACMO tool for the Biennial Transparency Report (BTR) preparation

Information necessary to track progress made in implementing and achieving NDCs

GACMO:
GHG emissions projections

CTF tables 7, 8, 9

Projections
(with and without LULUCF)

- With measures (shall) → Implemented and adopted policies and measures
- With additional measures (may) → Implemented, adopted and **planned** policies and measures
- Without measures (may) → **Excludes** all policies and measures after the cut-off date

Conclusions

- GACMO tool 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
- The GACMO tool can be used for **preparation of NDCs**
  - Establishing GHG emissions targets
  - GACMO tool allows to establish a Business As Usual (BAU) - projections towards 2025/2030/2035/2050
  - GACMO tool allows to establish a mitigation scenario (percentage of reduction of GHG emissions in comparison with BAU)
  - GACMO tool allows to calculate the reduction of GHG emissions, and the cost related to each mitigation option compared to a technology used as a reference
- The GACMO tool can be used for **NDC tracking** and **preparation of BTR**
  - Tracking progress of implementation (specific mitigation options) and tracking achievement of GHG emissions targets
  - Preparation of the CTF tables of the BTR

ICAT Initiative for Climate Action Transparency

ICAT

https://climateactiontransparency.org/

https://climateactiontransparency.org/our-work/icat-toolbox/gacmo/

GACMO tool

https://unepccc.org/gacmo-tool/

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