Approaches to identify and report support needed

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Why map support needed

For your own national planning and climate finance strategy, as it is the result of an assessment of available national resources and needed support to ensure implementation

To identify existing barriers for investments and potentially unlock private and international financial flows towards low carbon development

To attract financial support, lowering the cost of financing, potentially enhancing ambition and cover the incremental cost of climate action

Financial support – NDC costing (and benefits)

You cannot communicate financial support needs without an overview of costs.

- Map costs / investment needs for the NDC, action by action
- Translate policies and programmes into activity data and assign costs to the activities (e.g. number of PV systems, type of early warning system, trees to be planted, number of rangers for forest protection etc.)
- Identify technology and capacity needs and estimate costs of technical assistance

Financial support –
Estimate revenue streams / savings

Climate action is not only costs. Many actions will generate revenues or lead to savings (e.g. electricity sales / savings, reduced damage from flooding etc.)

- For each costed action identify revenue streams / savings to identify the cost/revenues expected from each action
- Compare Costs and Benefits
- Costs should include the cost of financing

Efficient residential air conditioner (1000 units)

Costs in US$	Reduction Option	Reference Option	Increase (Red.-Ref.)
Total investment	130,000		
Project life	8		
Lev. investment	21,771	0	
Annual O&M	0	0	
Annual electricity cost	315,000	471,910	-156,910
Total annual cost	336,771	471,910	**-135,139**
Annual emissions (tons)	Tons	Tons	Reduction
Fuel CO2-eq. emission	2,580	3,865	1,285
Other			
Total CO2-eq. emission	2,580	3,865	**1,285**
US$/ton CO2-eq.			**-105**

Notes:
COP=Coefficient Of Performance = cooling capacity divided by input power Most airconditioner have input power of 9000 Btu/hr (995W) or 12000 Btu/hr (1120 W) Conventional COP from PWC Energy Audit Efficient COP from most used efficient air conditioner

General inputs:		
Discount rate	7%	
Average electricity price	0.12	US$/kWh
CO2-eq. emission coefficient	0.80	ton CO2-eq./MWh
Grid loss	18.6%	
Reduction option: Efficient air conditioner		
O&M	0%	US$
Activity	1,000	Air conditioner
Lifetime	5	yrs
Extra cost for eff. air conditioner	130.0	US$
Cooling capacity	2.50	kW
COP	4.00	
Input power	0.63	kW
Annual usage	4,200	hrs
Annual electricity used	2625	MWh
Reference option: Conventional air conditioner		
O&M	-	US$
Activity	1000	Air conditioner
Cooling capacity	2.50	kW
COP	2.67	
Input power	0.94	kW
Daily usage	14	Hours/day
Days used	300	Days/year
Annual usage	4,200	hrs
Annual electricity used	3933	MWh
Electricity saved 1 unit	1308	MWh
Electricity saved compared to reference	0	Saving

1 MW Biomass power from biomass residues - 2025

Costs in US$	Reduction Option	Reference Option	Increase (Red.-Ref.)
Total investment	1,489,720		
Project life	20		
Lev. investment	140,619		140,619
Annual O&M	59,589		59,589
Annual fuelcost	169,541	600,000	-430,459
Total annual cost	369,749	600,000	**-230,251**
Annual emissions (tons)	Tons	Tons	Reduction
Fuel CO2-eq. emission		4,000	4,000
Other			
Total CO2-eq. emission	0	4,000	**4,000**
US$/ton CO2-eq.			**-57.6**

Notes:
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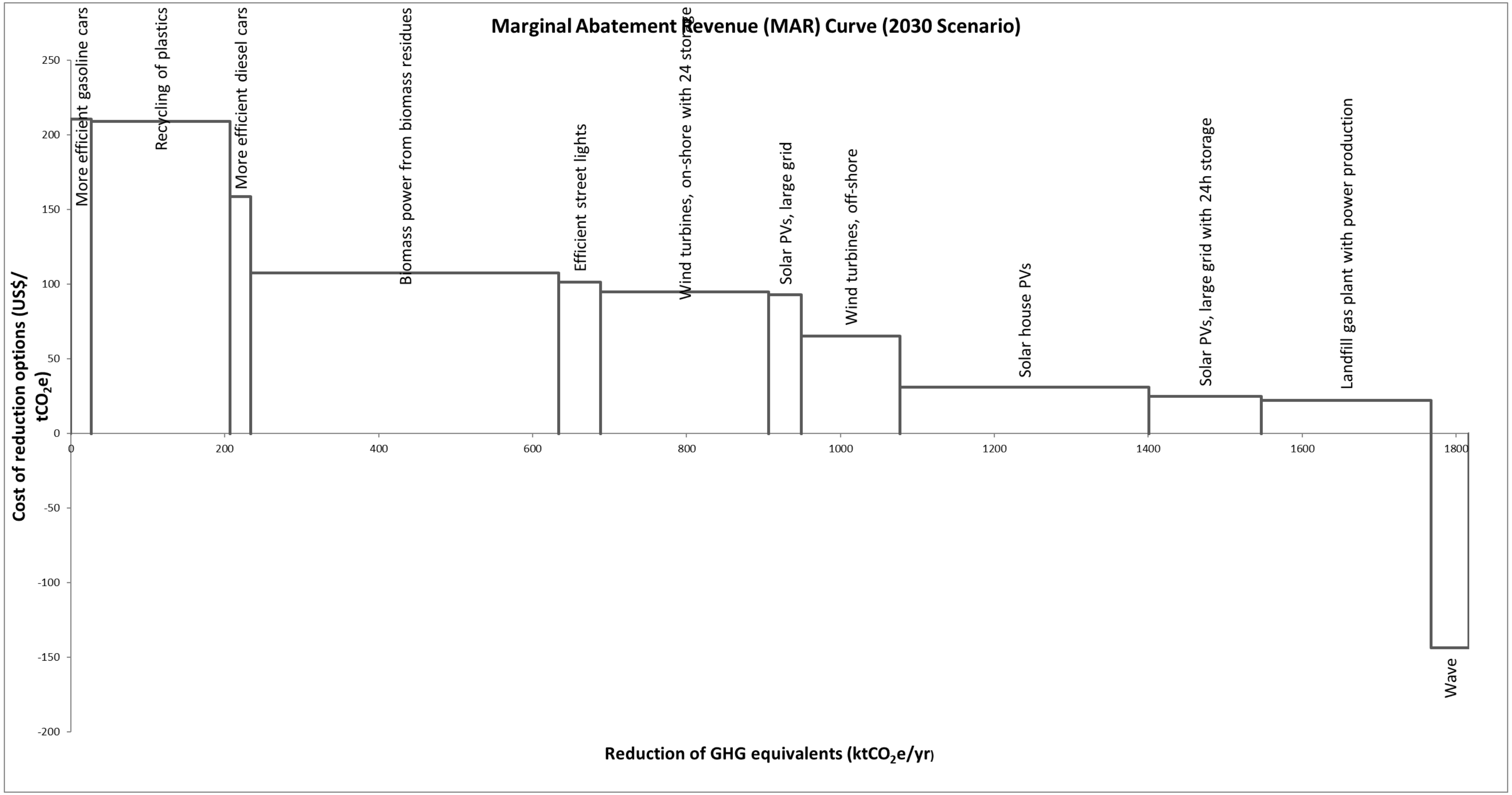
General inputs:		
Discount rate	7%	
Reference electricity price	0.12	US$/kWh
CO2-eq. emission coefficient	0.80	tCO2/MWh
Reduction option: Biomass residues power plant		
O&M	4.0%	
Activity	1	MW
Investment in Activity	1489.7	Million US$
Capacity factor	5000	Full time hours
Electricity production	5000	MWh/ year
Calorific value of biomass	13.0	GJ/t
El. efficiency of power plant	30.0%	
Specific use of biomass	0.93	ton biomass/MWh
Use of biomass	4626	ton/year
Price of biomass	36.6	$/ton
Cost of electricity produced	0.337	US$/kWh
Reference option: No Biomass power		

Assess which actions have incremental cost



Assess national sources of finance

Climate action operates seldom in a vacuum and is usually part of the general development of a country

- Estimate available sources of finance for each action (relates to unconditional component, if relevant)
    - Public programmes, infrastructure and interventions

    National financial resources allocated, the national budget
    - Private sector investments

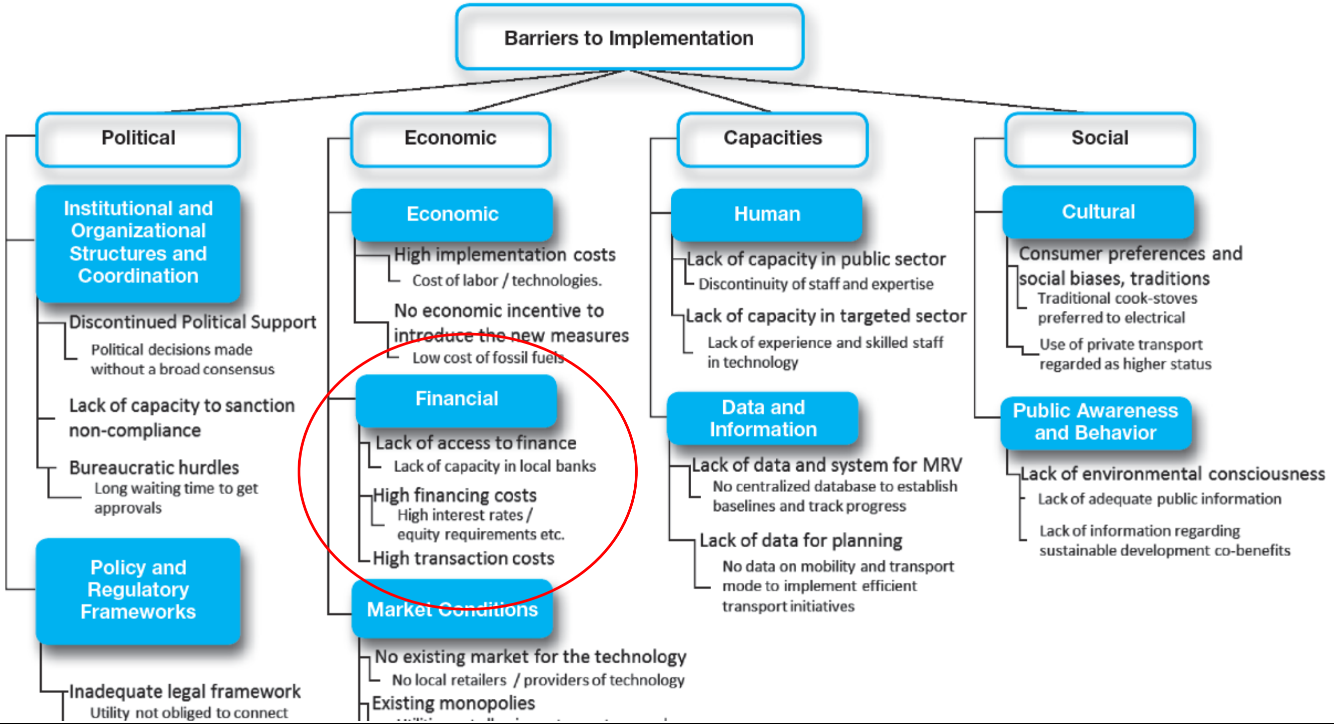
    Market trends, costs of technology and assumptions for future developments

- National sources of finance should be subtracted from needed amounts

Assess financial / investment barriers

E.g.:

- High cost of capital (e.g. interest rates)
- Risk profile of investments (e.g. currency exchange)
- Long term nature of investments and pay-back
- Expected IRR for investors in local context
- Level of indebtedness

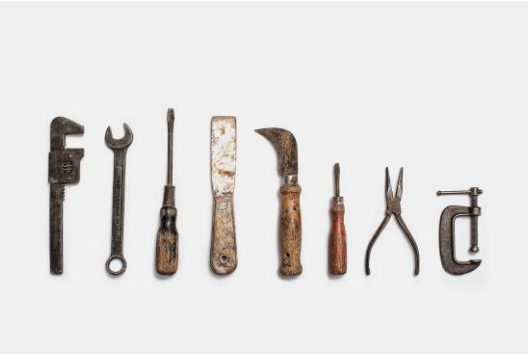


Financial Barriers	• Local financial institutions are unfamiliar with the energy efficiency financing mechanism with persistent implementation failure of precedents. • Banks are highly risk-averse in energy efficiency financing, thereby imposing high interest rates and asking a borrower for providing stringent credit and/or collateral and high equity injection which local SMEs are remotely capable of clinging to. • No credit mitigation technique including the de-risking mechanism (such as guarantee or insurance) for energy efficiency in the local market. • Financial institutions, in particular large-sized banking institutions, have little interest in financing energy efficiency projects since many are relatively small-scale projects led by SMEs with low credit. • High interest rates or collateral requirements for energy efficiency projects due to risk analysis difficulties.

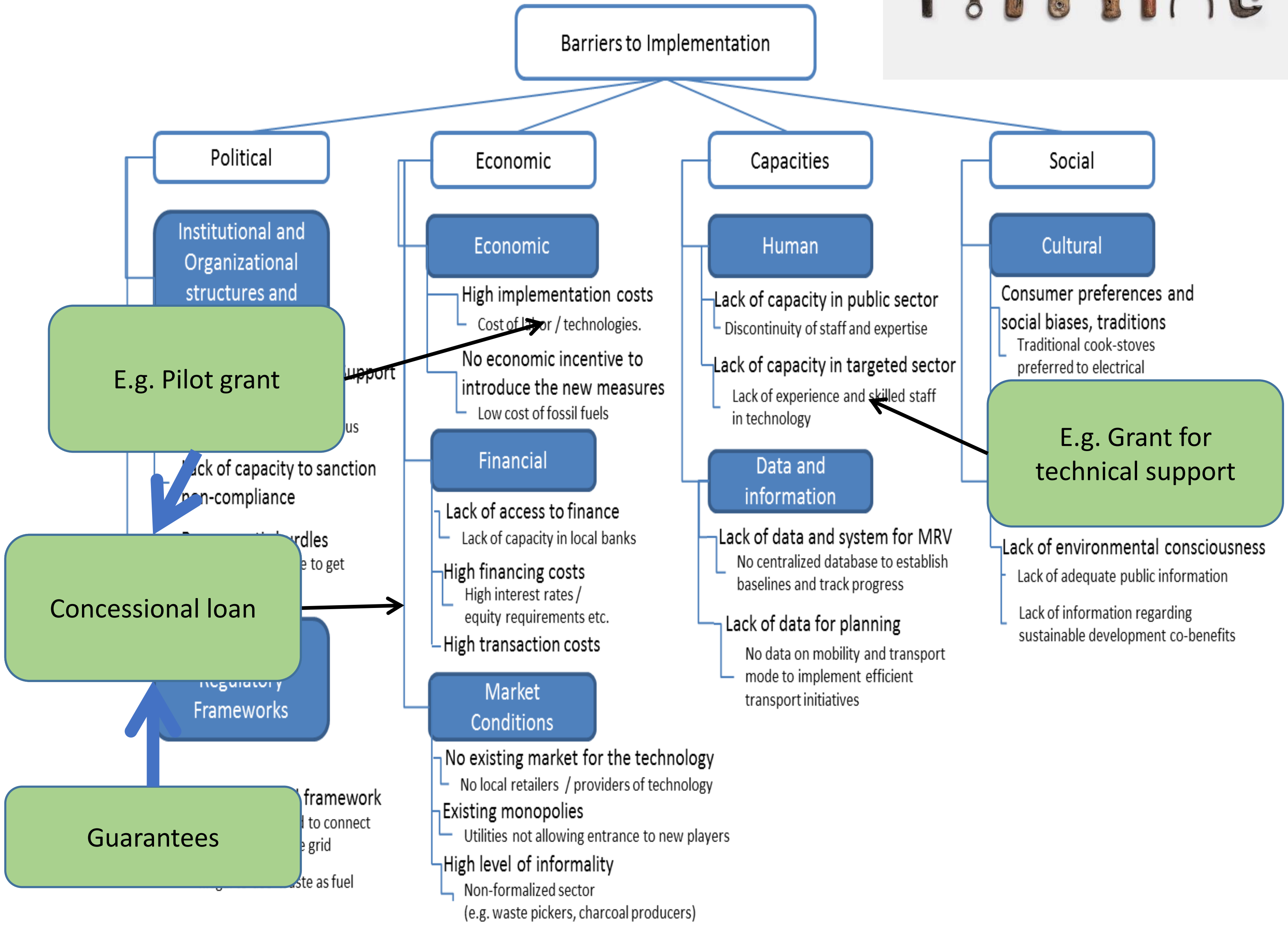
Identify appropriate financial instruments

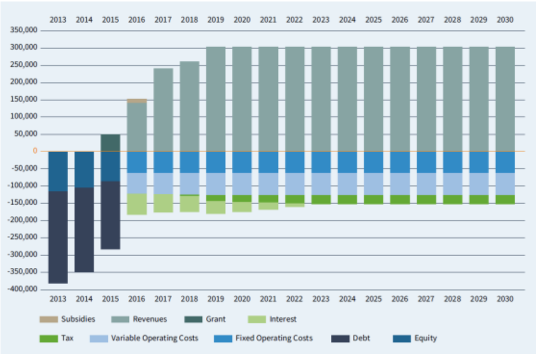
Instruments	Description
Grant	Transfers made in cash, goods, or services for which no repayment is required.
Concessional loan	These are loans that are extended on terms substantially more generous than market loans. The concessionality is achieved either through interest rates below those available on the market or by grace periods, or a combination of these. Concessional loans typically have long grace periods.
Market loan	A marketing loan is a variation of the non- recourse loan whereby, for specified commodities, a producer may repay a loan at a lower rate than the loan rate, equivalent to the prevailing world market price.
Lines of credit	Credit is an amount for which there is a specific obligation of repayment. Credits include loans, trade credits, bonds, bills, etc., and other agreements which give rise to specific obligations to repay over a period of time usually, but not always, with interest.
Risk or credit guarantee	Commitment by an export credit agency to reimburse a lender if the borrower fails to repay a loan. The lender pays a guarantee fee.
Equity	Equity refers to the value of the interest of an owner or partial owner in an asset.

Identify appropriate financial instruments



- Consider the most effective instrument to achieve the desired outcome (remove identified barriers)





Identify appropriate financial instruments

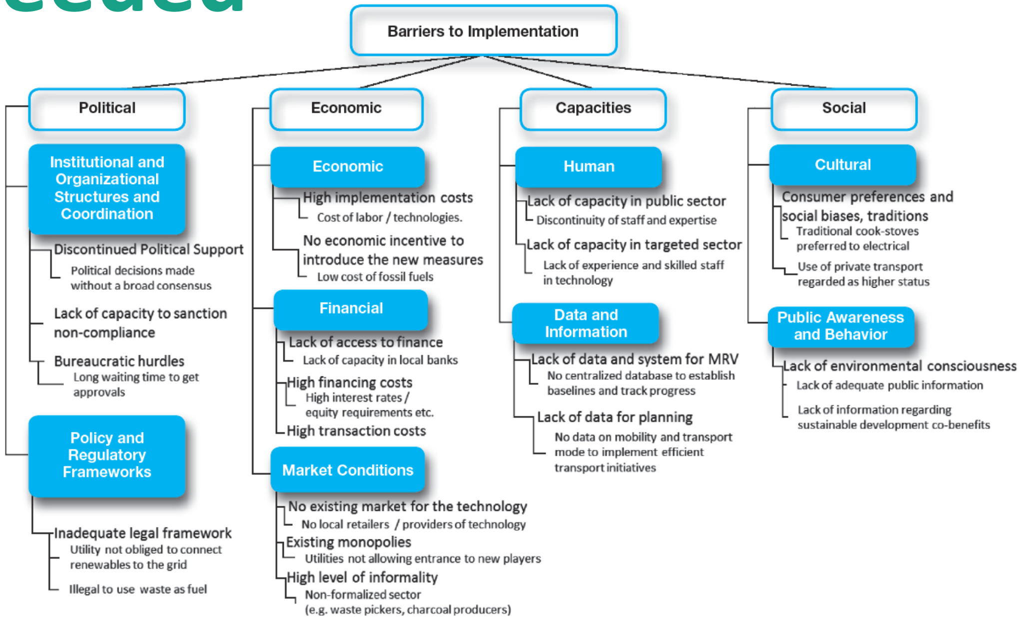
- Consider the most effective instrument to achieve the desired outcome (remove identified barriers)
- Grants are usually not provided for investments, but can be applied for technical assistance, preparatory activities and potentially investments in pilots
- Debt finance is usually used to cover CAPEX and concessional finance (support) is an effective instrument to improve the overall attractiveness of the investment
- Guarantees ensuring expected revenues are realised or losses by investors prevented are effective at lowering financing costs without the need for upfront disbursements
- Financial support dedicated for O&M unrealistic
- Adaptation more likely to receive grants than mitigation

	Activities	Estimated cost	Month start	Month finish
	Proposal preparation			
P1	Permits	15,000	1	12
P2	Technical analysis	15,000	1	24
P3	Consultancy contracts	15,000	1	24
	Subtotal	*45,000*		
	Construction & pre-operation			
C1	Land acquisition	240,000	6	12
C2	Engineering	110,000	6	12
C3	Machinery 1	2,381	6	12
C4	Machinery 2	200,000	13	24
C5	Machinery 3	111,000	13	24
C6	Machinery 4	22,333	13	24
C7	Testing 1	300,000	25	36
C8	Testing 2	33,334	25	36
C9	Interest payment during construction	50,952	6	36
	Total	*1,070,000*		
	Operation Phase			
	Revenue			
R1	Revenue	Table 4	37	216
	Operating costs			
O1	Labour	Table 5	37	216
O2	Rent	Table 5	37	216
O3	Communication	Table 5	37	216
O4	Fuels	Table 5	37	216
O5	General & administration	Table 5	37	216

UNEP DTU Partnership, 2020: *Finance Guide for Implementation of Technology Action Plans*

Technology and capacity support needed

- Identify technology and capacity constraints
- Assign monetary value to support needed and incorporate in financial support needed
- Cross-reference between financial and technology and capacity support needed



Regulatory Barriers	• The subsidised energy tariff is a disincentive for industries to invest in energy savings; the price of electricity is U$ 0.078/kWh for businesses (medium voltage),[10] which is lower than that of other ASEAN Member states.[11] As part of the COVID-19 recovery measure, an incentive of 100% (later reduced to 50%) discount on electricity was provided, especially for low-income households and small businesses. • No minimum energy performance standard (MEPS) for industrial equipment and appliance is available to serve as guidance. • No regulation to encourage less energy intensive sectors (motor, boiler, etc.) due to lack of awareness amongst policy makers, despite the large GHG emission from those sectors. • Existing fiscal or non-fiscal incentives from the government to promote the energy efficiency area have not been disseminated to industries or financiers, nor been sufficient enough to boost the market. For instance, Article 20 of Government Regulation No.70/2009 (Energy Conservation) states that incentives may vary in the form of provision from taxation facility for energy saver equipment to low interest-rate funds for the need of investment in energy conservation. It, however, does not work in the market.

Demand-side Barriers	• Low demand for high-energy efficiency facilities due to low energy tariffs. • Market players lack awareness of assessing energy efficiency technologies and capacity and resources in carrying out its cost-benefit analysis, which partially results in a low prioritisation of investing in energy efficient projects. • Industries are yet to recognise the regulatory requirements with respect to energy efficiency reporting and implementation. • There are not many well-trained in-house energy managers nor extensive pools of experienced experts in energy efficiency, mainly due to little

Take home points

- Map costs AND benefits
- Identify national sources of finance available and gaps to achieve implementation
- Identify financial barriers for implementation and appropriate financial instruments
- Assign monetary value to technology and capacity support needed and include in financial support

Thank you for your attention!

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Excercise

1. Read the example of a fictive NDC action (policy/programme),
2. Estimate total investment costs and revenue streams for the Policy /programme
3. Estimate financial support needed
   a. Indicate financial instrument
   b. Indicate amount
   c. Indicate use
4. Input the information in the BTR reporting table
5. Communicate back to plenary on challenges and considerations regarding to the topics of the presentation (availability in own country of data for Cost-benefit analysis, financial barriers, challenges in identifying appropriate financial instruments and amounts etc.)

Exercise

Support Needed

1. NDC action example

The Kingdom of Arrakis is a committed to reduce emissions derived from Melange mining used for energy purposes. The country has ample solar resources and has included a solar PV programme as part of its NDC to the UNFCCC. Implementation is foreseen to happen between 2023 and 2033 to cover all households, but could be implemented within the next 5 years if enough financial support is provided. In case implementation is to be made within the next NDC cycle, technology development and transfer and capacity building support will be needed, in order to ensure capacity to deliver components and enough technicians to install equipment.

2. Cost of technology and needed investments

- Financial analysis shows that the technology makes a good investment case, but why aren't households and SMEs investing in the technology.

- Total potential 1 million units for a total investment cost of 750.000.000 USD

New technology costs

Baseline energy costs

Solar house PVs, 500 W

Costs in US$	Reduction Option	Reference Option	Increase (Red.-Ref.)
Total investment	750.0		
Project life	20.0		
Lev. investment	70.8		70.8
Annual O&M	7.5		7.5
Annual fuelcost		98.6	-98.6
Total annual cost	78.3	98.6	**-20.3**
Annual emissions (tons)	Tons	Tons	Reduction
Fuel CO_2-eq. emission		0.66	0.66
Other			
Total CO_2-eq. emission	0.00	0.66	**0.66**
US$/ton CO_2-eq.			**-30.8**

General inputs:		
Discount rate	7%	
Reference electricity price	0.12	US$/kWh
CO_2-eq. emission coefficient	0.80	tCO_2/MWh
Activity: Solar PV		
Size of solar PV	0.5	kW
Size of PV	3.7	m2
Investment in Activity	1500	US$/kW
Daily insolation	5	hours
Annual capacity factor	1825	Full time hours
Efficiency factor	0.9	
O&M	1.0%	Of investment
Electricity production	0.821	MWh
Cost of electricity produced	0.095	US$/kWh
Reference option: No solar PVs		
Electricity production	0.821	MWh

Notes:
This calculation for an urban house is made for a country with an avarage daily insolation of 5 hours.
3 KW of solar PV will need a roof area of 20 m2.

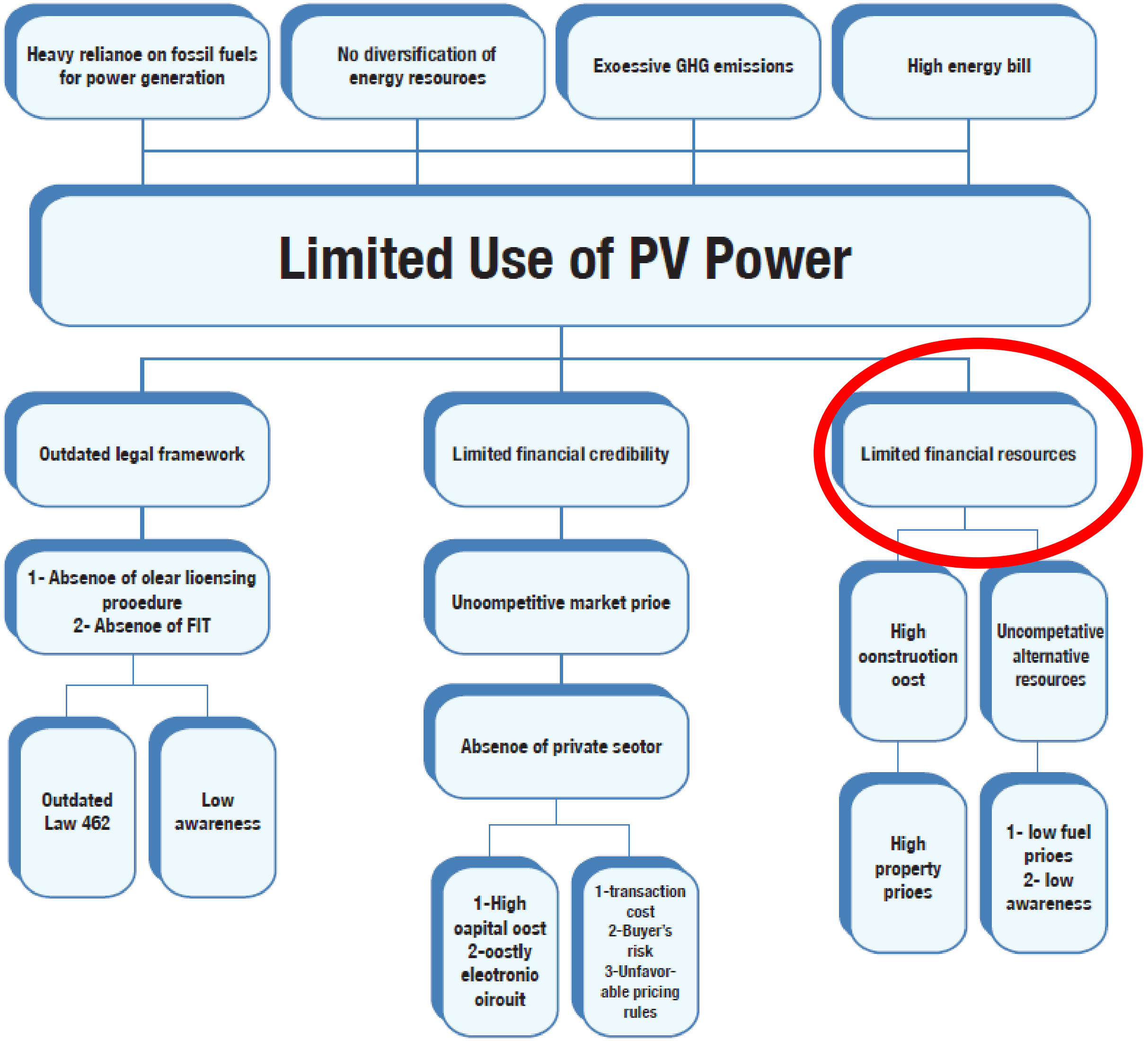
Emission reductions

3. Government contribution

- The government has dedicated 10.000.000 USD
- The total potential is 1.000.000 million units, the government still wishes to achieve full implementation unconditionally by 2033, but seeks support to achieve implementation in the next 5 years.

4. Cost of technology and needed investments

- The barrier analysis shows that the main target group households have limited financial resources.
- Local banks can provide loans, but the high interest rates make the investment unattractive.

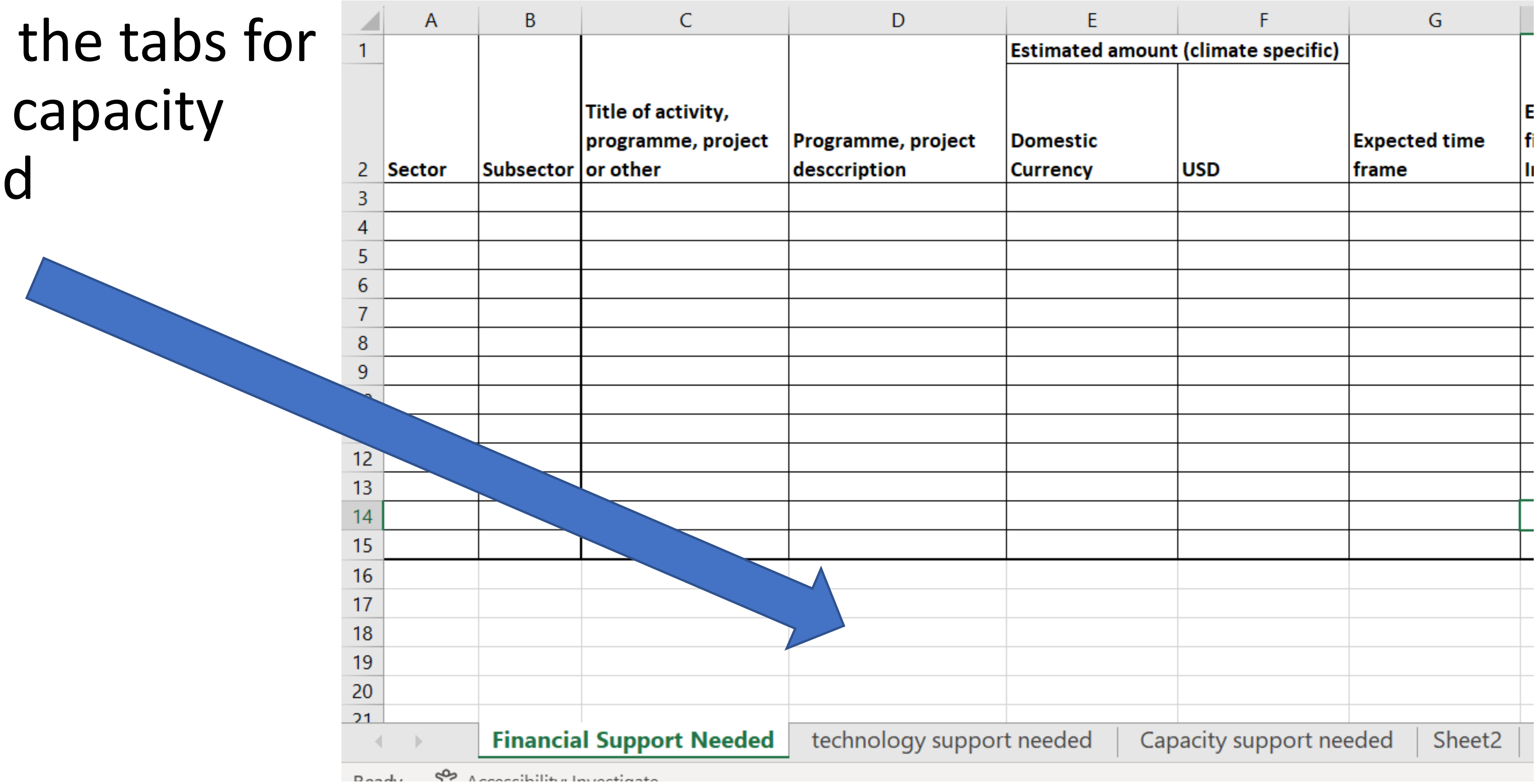


5. Answer the questions

- What are the total investment costs for the programme?
- What will be the government contribution?
- What is the difference?
- What other financial instruments could the government use?
- What financial instruments could be requested as financial support to address the identified financial barriers in a cost-effective manner?
- What amount would you consider to request as support?
- What financial instrument would you apply for to address the technology and capacity barriers?

6. Fill in the BTR table

- Try to also fill in the tabs for technology and capacity support received



7. Communicate back to plenary

- Challenges and considerations related to the topics of the presentation
  - How many different approaches were there to potential financial instruments and quantification of amount of support needed?
    - What were the main challenges?
  - What are the challenges in your own country related to:
    - Availability of data for Cost-benefit analysis
    - Identification of financial barriers,
    - Challenges in identifying appropriate financial instruments and amounts
    - Other central challenges etc.
  - Challenges related to identifying financial vs technology and capacity support and putting a price tag on them?

Follow up on Exercise

Support Needed

Answer to the questions

1. What are the total investment costs for the programme?

   750.000.000 USD

2. What will be the government contribution?

   10.000.000 USD

3. What is the difference?

   740.000.000 (should the government buy and install)

4. What other financial instruments could the government use?

   Households will achieve benefits (savings) and should invest

   - Partial grants on technology, or
   - Feed-in-tariff (not to facilitate initial investment, but makes the business case more attractive)
   - Tax credit e.g. on import of equipment (facilitate initial investment)
   - Guarantees to national private banks
   - Finance green credit lines through the national development bank

Answer to the questions

5. What financial instruments could be requested as financial support to address the identified financial barriers in a cost-effective manner?

- Grants (how much investments can grants unlock?)
- Concessional loans to be channeled through national financial institutions
- Guarantees on loans from national financial institutions to lower interest rates

6. What amount would you consider to request as support?

- Grant, you need the full amount, but unrealistic
- If support is channeled through loans to national financial institutions or guarantees, they could be expected to provide the largest part of the amount and the requested amount would be smaller than the 740.000.000

- Here grants can be easily justified for training and capacity building purposes

7. What financial instrument

Communicate back to plenary

- Challenges and considerations related to the topics of the presentation
  - How many different approaches were there to potential financial instruments and quantification of amount of support needed?
    - What were the main challenges?
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    - Identification of financial barriers,
    - Challenges in identifying appropriate financial instruments and amounts
    - Other central challenges etc.
  - Challenges related to identifying financial vs technology and capacity support and putting a price tag on them?

GACMO - a tool that provides a selection of mitigation actions including assumed costs and calculates potential revenues (and GHG scenarios)

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 The Greenhouse Gas Abatement Cost Model (GACMO) – UNEP-CCC (unepccc.org)

GACMO is a simple tool

You do not have much time to prepare your NDC, you therefore need 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.

Use of GACMO

The first version of GACMO was developed 25 years ago for Zimbabwe by Jorgen Fenhann

GACMO has been used by several countries to make an analysis of the GHG mitigation options for their country to be used in the National Communication: Colombia, Makedonia, Albania, Ghana, Sao Tome and Principe, etc.

GACMO has been used to make Low Carbon Development Strategies, e.g. by the Maldives

GACMO has been used by some countries to make their NDCs: e.g. Eritrea, Afghanistan, Maldives, Djibouti, Sri Lanka, Myanmar, etc.

GACMO has been used in regional low carbon studies: "Zero Carbon Latin America, A Pathway for Net Decarbonisation of the Regional Economy by mid-century".
We have now with UNEP in Panama and Walter Vergara updated this study for the transport and power sectors in Chile.

GACMO is a simple tool

We are trying to make our GACMO model able to follow these rule:

1. The model start with an energy balance for the start year (e.g. 2015) in mass units (tonnes and m3) or in energy units (ktoe or GJ). We often use an OECD like energy balance which we can get from ENERDATA.

2. The projection for the BAU to 2025/2030/2035/2050 is made quick and dirty by using an annual growth factor for each sector, which are then transformed into factors bringing the BAU value forward to the future.

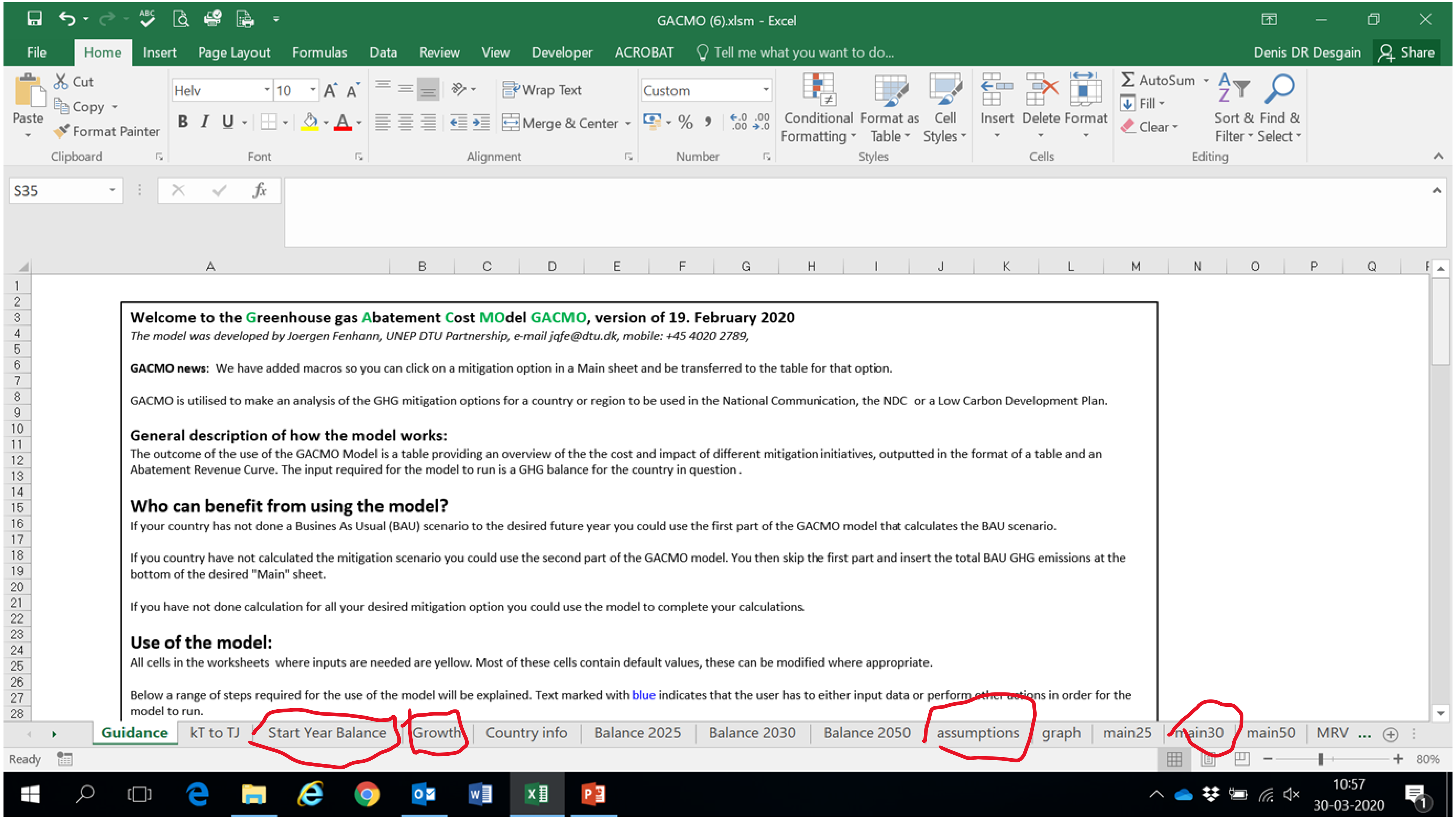
3. The energy balances for the start year are changed to GHG balances by multiplying with IPCC default factors.

4. An excel sheet is prepared for each mitigation option, and added together in the "Main" sheet.

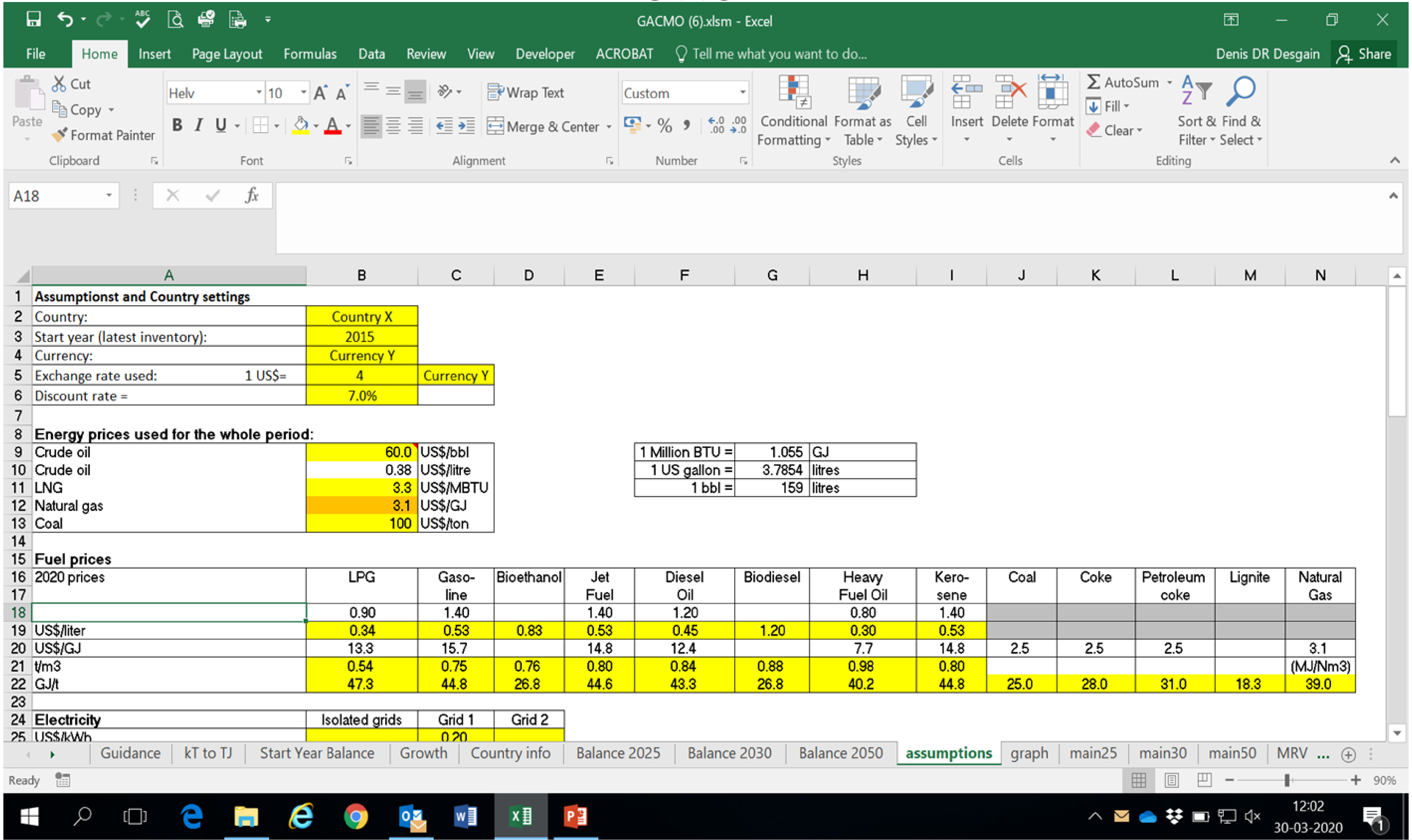
5. A mitigation revenue curve is made.

6. The resulting NDC is simple to compare with other countries.

GACMO contains different sheets: Start year balance, growth, assumptions, main, technologies



Assumptions



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Assumptionst and Country settings**													
2	Country:	Country X												
3	Start year (latest inventory):	2015												
4	Currency:	Currency Y												
5	Exchange rate used: 1 US$=	4	Currency Y											
6	Discount rate =	7.0%												
7														
8	**Energy prices used for the whole period:**													
9	Crude oil	60.0	US$/bbl			1 Million BTU =	1.055	GJ						
10	Crude oil	0.38	US$/litre			1 US gallon =	3.7854	litres						
11	LNG	3.3	US$/MBTU			1 bbl =	159	litres						
12	Natural gas	3.1	US$/GJ											
13	Coal	100	US$/ton											
14														
15	**Fuel prices**													
16	2020 prices	LPG	Gaso-	Bioethanol	Jet	Diesel	Biodiesel	Heavy	Kero-	Coal	Coke	Petroleum	Lignite	Natural
17			line		Fuel	Oil		Fuel Oil	sene			coke		Gas
18		0.90	1.40		1.40	1.20		0.80	1.40					
19	US$/liter	0.34	0.53	0.83	0.53	0.45	1.20	0.30	0.53					
20	US$/GJ	13.3	15.7		14.8	12.4		7.7	14.8	2.5	2.5	2.5		3.1
21	t/m3	0.54	0.75	0.76	0.80	0.84	0.88	0.98	0.80					(MJ/Nm3)
22	GJ/t	47.3	44.8	26.8	44.6	43.3	26.8	40.2	44.8	25.0	28.0	31.0	18.3	39.0
23														
24	**Electricity**	Isolated grids	Grid 1	Grid 2										
25	US$/kWh		0.20											

Start Year Energy Balance for Country X

Unit : ktCO2-e	Total	LPG	Gasoline	Jet Fuel	Diesel	HFO	Kerosene and other	Total oil products	Coal	Lignite	Natural Gas
Total	**18,666.5**	**962.8**	**4,373.7**	**52.3**	**6,073.4**	**1,809.7**	**14.7**	**13,286.6**	**0.0**	**0.0**	**5,379.9**
Fossil power plants	6,187.8	113.4	0.0	0.0	36.0	1,634.6	0.0	1,784.0	0.0	0.0	4,403.8
FINAL CONSUMPTION	12,478.6	849.4	4,373.7	52.3	6,037.4	175.1	14.7	11,502.6	0.0	0.0	976.0
Industry - steel	22.7	2.4	0.0	0.0	3.8	16.6	0.0	22.7	0.0	0.0	0.0
Industry - chemical	5.4	0.0	0.0	0.0	2.5	2.9	0.0	5.4	0.0	0.0	0.0
Industry - non metallic mineral	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Industry - food processing and beverage	149.4	61.6	0.0	0.0	7.7	80.1	0.0	149.4	0.0	0.0	0.0
Industry - construction	71.2	0.0	0.0	0.0	71.2	0.0	0.0	71.2	0.0	0.0	0.0
Industry - mining	917.5	0.0	0.0	0.0	917.5	0.0	0.0	917.5	0.0	0.0	0.0
Industry - machinery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Industry - non ferrous metals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Industry - paper and pulp	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Industry - transport equipment	3.4	0.0	0.0	0.0	3.4	0.0	0.0	3.4	0.0	0.0	0.0
Industry - textile and leather	24.1	0.1	0.0	0.0	1.4	22.6	0.0	24.1	0.0	0.0	0.0
Industry - miscellaneous	187.5	0.9	0.0	0.0	9.5	3.7	0.0	14.2	0.0	0.0	173.3
Transport - road	8,969.3	166.4	4,233.9	0.0	4,569.0	0.0	0.0	8,969.3	0.0	0.0	0.0
Transport - rail	2.8	0.0	0.0	0.0	2.8	0.0	0.0	2.8	0.0	0.0	0.0
Transport - domestic air	52.3	0.0	0.0	52.3	0.0	0.0	0.0	52.3	0.0	0.0	0.0
Transport - navigation	3.1	0.0	0.0	0.0	3.1	0.0	0.0	3.1	0.0	0.0	0.0
Households	575.6	564.1	0.0	0.0	0.0	0.0	11.4	575.6	0.0	0.0	0.0
Services	53.7	53.7	0.0	0.0	0.0	0.0	0.0	53.7	0.0	0.0	0.0
Agriculture & Fishery	301.0	0.0	95.7	0.0	205.3	0.0	0.0	301.0	0.0	0.0	0.0
Energy Industry - Refinery	73.4	0.0	0.0	0.0	0.0	49.1	0.0	49.1	0.0	0.0	24.3
Energy Industry - Other energy industries	1,066.0	0.0	44.0	0.0	240.2	0.0	3.3	287.6	0.0	0.0	778.4

Start year:	2015							
Growth from the start year	**Annual % increase in the period**				**% increase from start year values**			
Growth and multiplication factors	2015 to 2020	2020 to 2025	2025 to 2030	2030 to 2050	2020	2025	2030	2050
Population growth	0.83%	0.83%	0.83%	0.50%	4%	9%	13%	25%
GDP growth	4.10%	4.10%	4.10%	3.00%	22%	49%	83%	230%
Industry - fuel in steel	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - fuel in chemical	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - fuel in non metallic mineral	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - fuel in food and beverage	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - fuel in construction	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - fuel in mining	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - fuel in machinery	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - fuel in non ferrous metals	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - fuel in paper and pulp	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - fuel in transport equipment	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - fuel in textile and leather	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - fuel in miscellaneous	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Industry - electricity consumption	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Transport - fuel in road	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Transport - fuel in rail	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Transport - fuel in air	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Transport - fuel in navigation	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Transport - electricity consumption	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Households - LPG	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Households - Kerosene	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Households - electricity consumption	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Services - fuel	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Services - electricity consumption	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Agriculture - fuel	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Agriculture - electricity consumption	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Non energy - fuel in chemical feedstocs	6.0%	6.0%	6.0%	2.0%	34%	79%	140%	256%
Livestock emissions	3.0%	3.0%	3.0%	1.0%	16%	34%	56%	90%
Rice emissions	3.0%	3.0%	3.0%	1.0%	16%	34%	56%	90%
N2O from agricultural soils	3.0%	3.0%	3.0%	1.0%	16%	34%	56%	90%
Biomass burning	3.0%	3.0%	3.0%	1.0%	16%	34%	56%	90%
Forestry emission	0.0%	0.0%	0.0%	0.0%	0%	0%	0%	0%
Solid waste emissions	0.0%	0.0%	0.0%	0.0%	0%	0%	0%	0%
Liquid waste emissions	0.0%	0.0%	0.0%	0.0%	0%	0%	0%	0%
Industrial processes	0.0%	0.0%	0.0%	0.0%	0%	0%	0%	0%

Example of the calculations in the GACMO model in the Country X

Solar PVs, large grid, 1 MW - 2020			
Costs in US$	Reduction Option	Reference Option	Increase (Red.-Ref.)
Total investment	1,500,000		
Project life	20		
Lev. investment	176,189		176,189
Annual O&M	15,000		15,000
Annual fuelcost		365,000	-365,000
Total annual cost	191,189	365,000	**-173,811**
Annual emissions (tons)	Tons	Tons	Reduction
Fuel CO_2-eq. emission		840	840
Other			
Total CO_2-eq. emission	0	840	**840**
US$/ton CO_2-eq.			**-207.0**

Notes:
This calculation is made for a country with an avarage daily insolation of 5 hours.

General inputs:		
Discount rate	10%	
Reference electricity price	0.20	US$/kWh
CO_2-eq. emission coefficient	0.46	tCO_2/MWh

Activity: Solar PV		
Size of solar PV	1.0	MW
Investment in Activity	1500	US$/kW
Daily insolation	5	hours
Annual capacity factor	1825	Full time hours
Efficiency factor	1	
O&M	1.0%	Of investment
Electricity production	1825	MWh
Cost of electricity produced	0.105	US$/kWh
Reference option: No solar PVs		
Electricity production	1825	MWh

The GACMO model contain sheets like this for the each GHG reduction options

2030 GHG Balance for Country X

Unit : ktCO2-e	Total	LPG	Gasoline	Jet Fuel	Diesel	Fueloil	Kerosene and other	Total oil products	Coal	Lignite	Gas
Total	***33,700.2***	***1,805.0***	***7,030.7***	***137.6***	***10,456.1***	***3,587.0***	***9.0***	***23,025.5***	***0.0***	***0.0***	***10,674.7***
Fossil power plants	*12,428.3*	227.8	0.0	0.0	72.2	3,283.1	0.0	*3,583.2*	0.0	0.0	8,845.2
FINAL CONSUMPTION	*21,271.8*	*1,577.2*	*7,030.7*	*137.6*	*10,383.8*	*303.9*	*9.0*	*19,442.3*	*0.0*	*0.0*	*1,829.5*
Industry - steel	*50.5*	5.2	0.0	0.0	8.3	36.9	0.0	*50.5*	0.0	0.0	0.0
Industry - chemical	*12.1*	0.0	0.0	0.0	5.6	6.5	0.0	*12.1*	0.0	0.0	0.0
Industry - non metallic mineral	*0.0*	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*	0.0	0.0	0.0
Industry - food processing and beverage	*332.3*	137.1	0.0	0.0	17.1	178.2	0.0	*332.3*	0.0	0.0	0.0
Industry - construction	*158.4*	0.0	0.0	0.0	158.4	0.0	0.0	*158.4*	0.0	0.0	0.0
Industry - mining	*2,040.3*	0.0	0.0	0.0	2,040.3	0.0	0.0	*2,040.3*	0.0	0.0	0.0
Industry - machinery	*0.0*	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*	0.0	0.0	0.0
Industry - non ferrous metals	*0.0*	0.0	0.0	0.0	0.0	0.0	0.0	*0.0*	0.0	0.0	0.0
Industry - paper and pulp	*0.6*	0.5	0.0	0.0	0.1	0.0	0.0	*0.6*	0.0	0.0	0.0
Industry - transport equipment	*7.6*	0.0	0.0	0.0	7.6	0.0	0.0	*7.6*	0.0	0.0	0.0
Industry - textile and leather	*53.5*	0.2	0.0	0.0	3.0	50.3	0.0	*53.5*	0.0	0.0	0.0
Industry - miscellaneous	*417.0*	2.0	0.0	0.0	21.2	8.3	0.0	*31.5*	0.0	0.0	385.5
Transport - road	*14,395.0*	267.0	6,795.1	0.0	7,332.9	0.0	0.0	*14,395.0*	0.0	0.0	0.0
Transport - rail	*10.8*	0.0	0.0	0.0	10.8	0.0	0.0	*10.8*	0.0	0.0	0.0
Transport - domestic air	*137.6*	0.0	0.0	137.6	0.0	0.0	0.0	*137.6*	0.0	0.0	0.0
Transport - navigation	*5.0*	0.0	0.0	0.0	5.0	0.0	0.0	*5.0*	0.0	0.0	0.0
Households	*1,026.2*	1,023.4	0.0	0.0	0.0	0.0	2.8	*1,026.2*	0.0	0.0	0.0
Services	*141.8*	141.8	0.0	0.0	0.0	0.0	0.0	*141.8*	0.0	0.0	0.0
Agriculture & Fishery	*486.1*	0.0	154.6	0.0	331.6	0.0	0.0	*486.1*	0.0	0.0	0.0
Energy Industry - Refinery	*35.6*	0.0	0.0	0.0	0.0	23.8	0.0	*23.8*	0.0	0.0	11.8
Energy Industry - Other energy industries	*1,961.4*	0.0	81.0	0.0	442.0	0.0	6.1	*529.2*	0.0	0.0	1,432.3

The structure of the GHG calculations for the options:

Looking a the Solar PV option we can see the structure:
The first column to the left contains the data for the mitigation option.
The second column contains the data for the BAU technology.
the third calculate the difference between these two.

The upper box calculate the cost increase. The investment cost is levelized using a discount rate and a lifetime.
The lower box calculate the GHG reduction.

In the bottom the US$/tCO2e result is calculated.

To the right of the calculations all inputs are stated in a transparent way.
Some input parameters that are similar for all options (like discount rate, energy prices, electricity prices, emission factors) are combined in an "assumption sheet".

In the "Main" sheet where all options are collected, you must decide how large the options is (number of MWs, units etc.

The data gaps and how to address them:

The problem with the NDC calculation is that you need a lot of data.

All countries have made an energy balance that can be used as input. We can also get the data from ENERDATA.

The collection of policies in the countries can be used to decide on the growth factors to use in the projection to 2025/2030/2035/2050. Models like LEAP etc can be used.

First all the existing GHG reduction reports and studies in the country must be used to get data for the desired mitigation options.

For option where there is no data the information in submitted CDM and PoA projects can be used. We have collected all this useful information in the pipelines for CDM projects and Programme of Activities (PoAs) at www.cdmpipeline.org. Here information for all kinds of GHG mitigation options is available: Investments, how to calculate emission reductions etc.

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

Mitigation options	Abatement costs US$/tonCO$_2$	Unit Type	Emission reduction t CO2/unit	Units penetrating in 2020	Investment MUS$	Annualized costs MUS$/year	Emission reduction in 2020 Per option kt/year	Cumulative fracion
LED tubes for public sector	-784	1 light tube replaced	0.015	70,000	0.0	-0.8	1.1	0.1%
Better maintenance of motor bikes	-413	All motor bikes	24304	1	0.0	-10.0	24.3	1.3%
Air conditioning at resorts	-398	1 Aircondinioner	0.87	36,467	4.7	-12.7	31.8	2.9%
Cooling new service buildings	-369	1 m2	0.046	270,336	1.8	-4.6	12.4	3.5%
Solar water heater	-323	1 unit	24	102	0.7	-0.8	2.5	3.7%
Efficient air conditioning	-313	1 Airconditioner	1.19	74,186	9.6	-27.7	88.5	8.2%
LED tubes for street light	-292	2200 street lights	1505	1.48	0.1	-0.6	2.2	8.3%
Upgrade of system efficiencies	-260	All eligible Islands	43199	1	61.1	-11.2	43.2	10.5%
PVs outer islands	-252	1 kW	1.22	12,100	42.4	-3.7	14.7	11.2%
Regional waste-to-energy projects	-228	100 ton/day of waste	9535	1	10.4	-2.2	9.5	11.7%
PVs with Net Meters	-189	1 kW	1.13	10,500	42.0	-2.2	11.9	12.3%
Energy efficient refrigerators	-158	1 refrigerator	0.51	82,823	41.2	-6.6	42.0	14.4%
PVs Malé Region (existing plans)	-133	1 kW	1.05	15,000	45.0	-2.1	15.8	15.2%
PVs Malé Region (additional options)	-133	1 kW	1.05	15,000	45.0	-2.1	15.8	16.0%
Efficient water pumping	-117	1 household	0.10	72,470	14.5	-0.9	7.6	16.4%
PVs on resorts	-108	1 kW	1.22	47,815	167.4	-6.3	58.2	19.4%
20 MW wind power & 25 MW LNG	-105	45 MW	26502	1	97.3	-2.8	26.5	20.7%
Thilafushi waste-to-energy project	-68	A 4 MW plant	23061	1	57.8	-1.6	23.1	21.9%
PVs with storage at small islands	-52	1 kW	1.2	29,000	167.1	-1.8	35.3	23.7%
LEDs for domestic lighting	199	All domestic bulps	8467	1	42.4	1.7	8.5	24.1%
Biodiesel 20% blend	336	20% blend	213000	1	0.0	71.6	213.0	34.9%
Bioethanol 15% blend	337	15% blend	14637	1	0.0	4.9	14.6	35.7%
			Totals	Million US$	850.3	-22.6	702.4	35.7%

Total baseline emission in 2020:	1968 ktCO2-eq.

The type of mitigation options used in GACMO are similar to the ones in the CDMPipeline:

GACMO contains a sheet for each type, which then contains several sub-types

Afforestation
Agriculture
Biomass energy
Cement
CO2 usage
Coal bed/mine methane
Energy distribution
EE households
EE industry
EE own generation
EE service
EE supply side
Fossil fuel switch
Forestry
Fugitive
Geothermal
HFCs, PFCs and SF6
Hydro
Landfill gas
Methane avoidance
Mixed renewables
N2O
Solar
Tidal
Transport
Wind

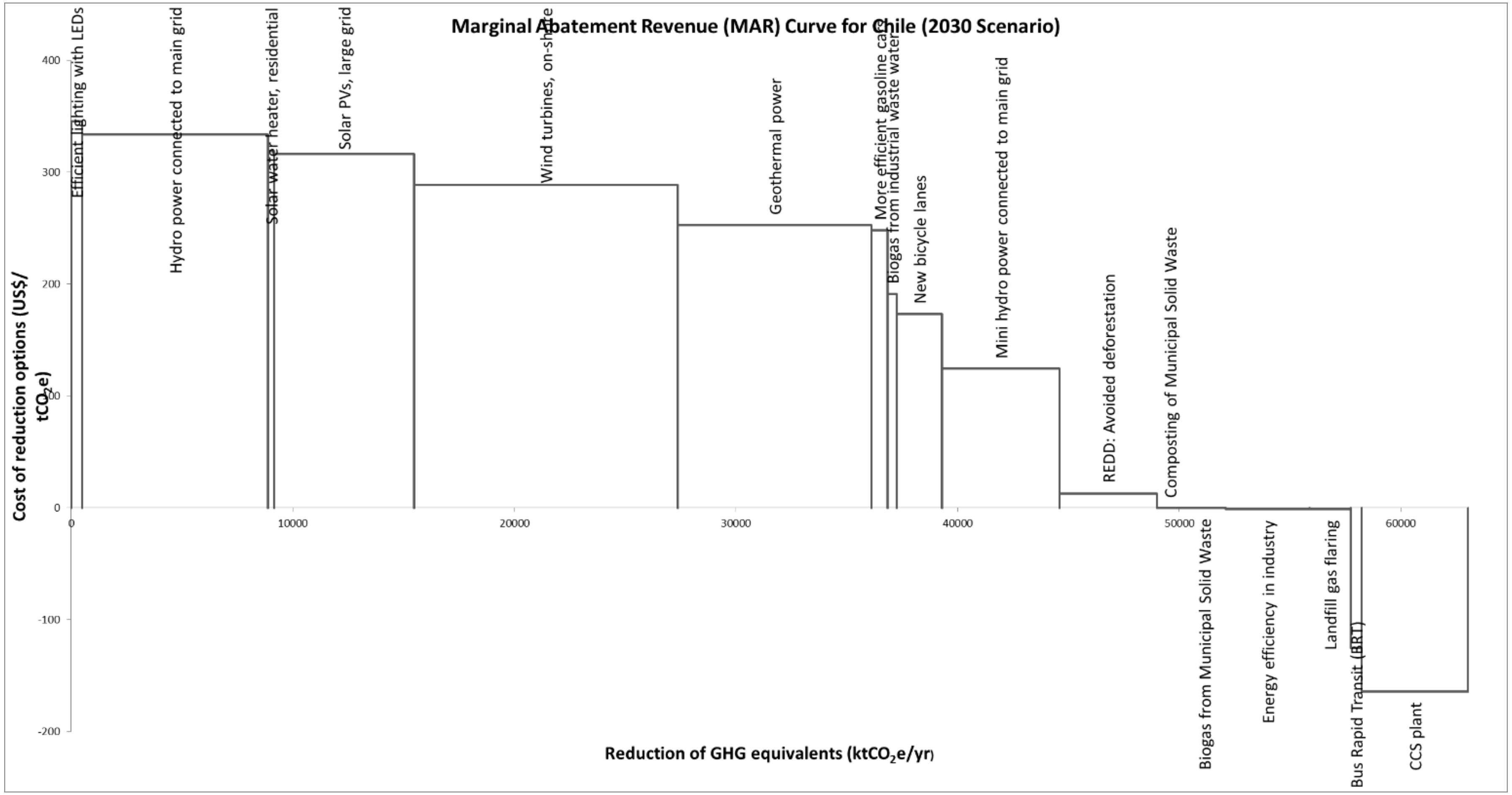
Mitigation options included/excluded in the MAR curve for Chile

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

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 fue	-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

Marginal Abatement Revenue (MAR) curve for Chile



Example of work in a country based on GACMO

- Training of Environment, Forest and Climate Change Commission on the use of GACMO.
- Adapting the tool to Ethiopian context (energy balance, assumptions. etc.
- Mitigation options and their size.
- Using GACMO as a NDC tracking tool.
- Conduct meetings with relevant ministries and agencies to get relevant data.
- Develop a draft set of mitigation options and present them ot the sectoral working groups.
- Finalize the set of mitigation options in GACMO, and insert the result in the NDC.

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