Training Workshop for the countries of Eurasia, Central Asia and the Caucasus: Deep dive into tracking NDC mitigation commitments under the Paris Agreement

Presentation: Supporting tools to develop economy wide GHG emissions projections (GACMO and LEAP) and linking tables and software

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Content

Overview of supporting tools to develop economy wide GHG emissions projections

LEAP model

GACMO model

GHG emissions projections

- Greenhouse gas projections are an estimate of a country's future GHG emissions based on a set of assumptions.

Understanding future GHG emissions can help a country:
  - to define a GHG reduction target
  - check if they are on track to meeting an existing target
  - estimate the impacts of certain mitigation measures
  - help plan mitigation measures in the medium and long-term.

Tools for GHG emissions projections

- **Top-down models** evaluate the system from aggregate economic

- **Bottom-up models** consider technological options or project-specific climate change mitigation policies.
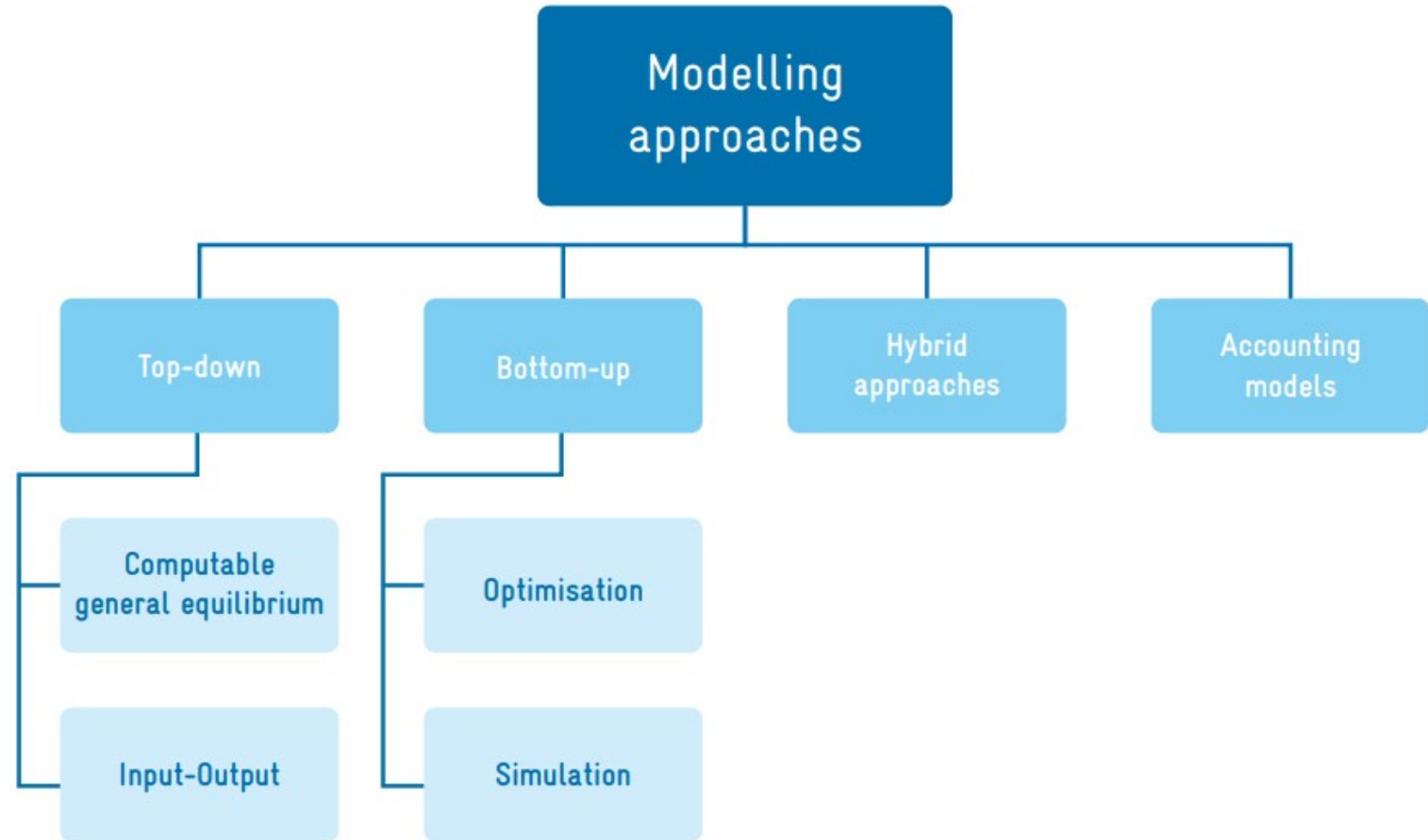
Source: Partnership on Transparency in the Paris Agreement

Choice of the model

- There is no "best model".
- The choice of model needs to consider a wide range of factors concerning what the users aim to achieve by using the model

Source: Partnership on Transparency in the Paris Agreement
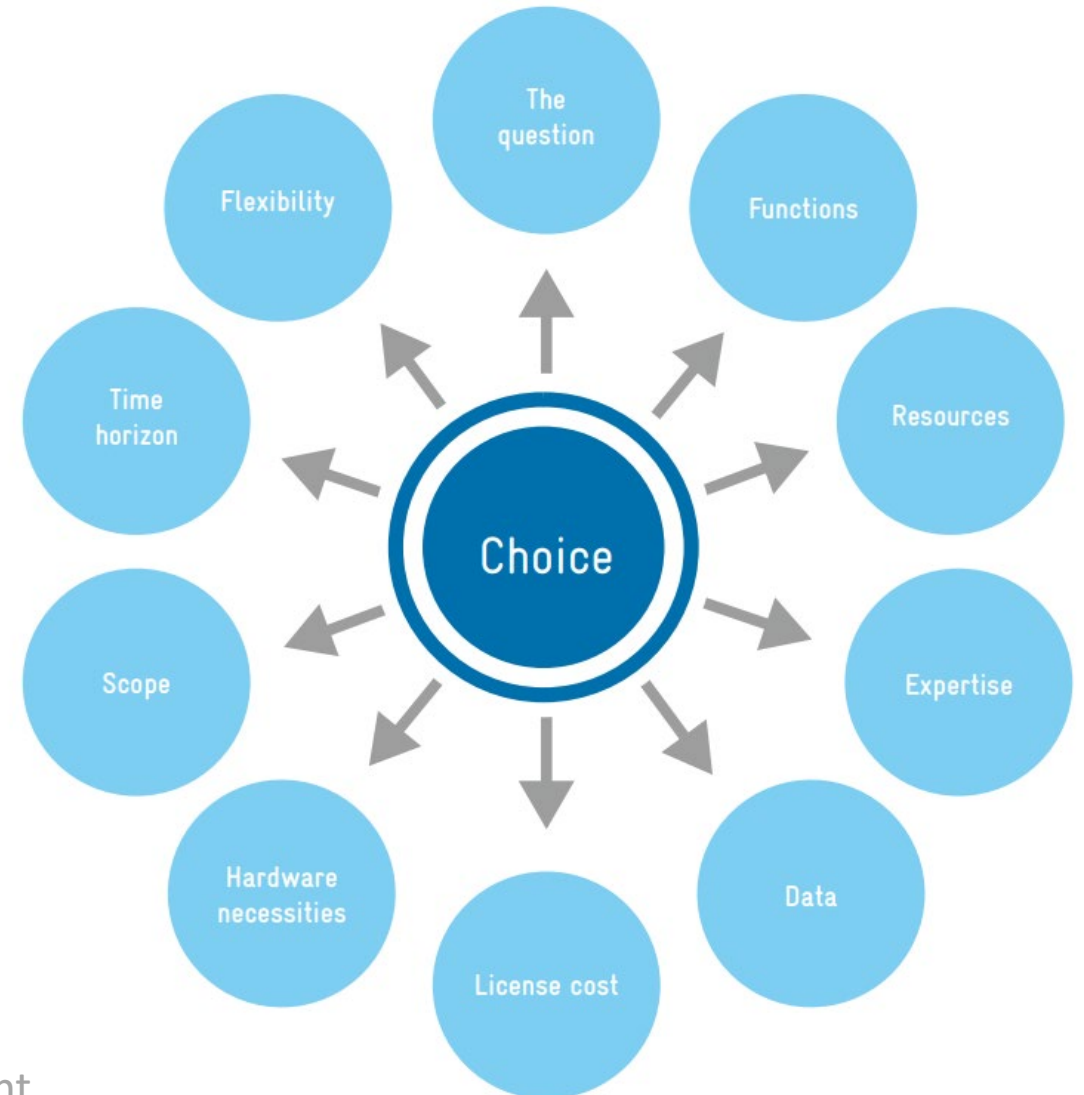
Comparison of models
Functionality

FUNCTIONALITY		GACMO	PROSPECTS	LEAP	TIMES
	Coverage of emission sources	High-level	Mid / High-level	More detailed, particulary for energy sector	Detailed focus on energy sector
	Breadth/ granularity of technology	Mid breadth / limited granularity	Low-Mid	Low to high (user defined)	High
	Sectoral interlinkages	No	Energy supply and demand	Energy and some material flows	Energy and some material flows
	Temporal granularity	2020, 2025, 2030, 2050	Annual to 2050	Annual, unlimited timeframe. Within-year breakdown for seasonal and hourly variations.	Annual / multi-year time steps. Within-year breakdown for seasonal and hourly variations.
	Representation of costs	Yes (limited variation over time)	No	Yes (annual variation)	Yes
	Optimisation functionality	No	No	Within electricity supply sector	Yes, within energy system
	Summary	Low	Low	Mid	High

Source https://newclimate.org/

Comparison of models
Accessibility

ACCESSIBILITY	GACMO	PROSPECTS	LEAP	TIMES
Platform	Excel, open-source	Excel, open-source	Windows relational database; requires licence	Windows; requires licence (for GAMS)
User fee	Free	Free; optional use of IEA input data requires licence	Free to certain users in low & middle-income countries; fee charged for others	Fee charged for GAMS license and user tools (e.g. interface)
User guidance	Limited	Limited	Extensive	Limited
User community	Limited	None	Extensive	Mid
Language options	English	English	Multiple: English, French, Spanish, Chinese, Portuguese + others under development	English
Ease of navigation	High	Mid	High	Mid

Comparison of models
Analytical options

ANALYTICAL OPTIONS	GACMO	PROSPECTS	LEAP	TIMES
Scenario building and analysis	Limited to BAU and one alternative	Facilitates multi-scenario analysis (simulation possible)	Facilitates multi-scenario analysis and simulation	Facilitates multi-scenario analysis and simulation
Assessment of non-climate SD impacts	None	None (energy security indicators under development)	Air pollution-related impacts on health and agriculture; energy security indicators	Energy security indicators
Analysis of carbon pricing policies	No	No	In energy sector	In energy sector
Analysis of other policy instruments	No	Limited to simple representation of emission standards or national/sector carbon budgets	Limited to emission standards for some technologies or national/sector carbon budgets	Emission standards, carbon budgets and additional flow constraints
Linkages to other models	Low granularity limits linkage options	Yes, soft links to sector deep-dive modules and SD impact assessments	Yes, with API (programming code), or soft-links via Excel	High granularity facilitates many options for hard and soft links
Summary	Analytical options limited to specific abatement measures	Facilitates multi-scenario analysis; deep-dive analysis requires links to other tools	Facilitates multi-scenario analysis and energy sector planning	Extensive analysis of energy sector and options for linking to other tools

Source https://newclimate.org/

LEAP model

LEAP model

- A Windows-based tool for energy planning and GHG mitigation assessment developed over the last 40 years by the Stockholm Environment Institute (SEI).

- Applied in almost 200 countries. At least 60 countries used LEAP to help develop their INDCs. > 5000 active users.

- A scenario-based modeling tool that explores how emissions may change in the future under alternative policy settings (e.g. baselines and low emissions development scenarios).

- Typically used at the national scale but also works for cities, regions and multi-country analyses.

- Primarily focused on energy sector

- Examines GHGs, SLCPs, local air pollutant emissions, economic costs, energy security, resource requirements, and technology and activity trends.

- Closely follows IPCC Inventory Guidelines.

Source: SEI

How Do You Get LEAP?

- Download from LEAP web site: https://leap.sei.org/download.

- User name and password required to fully enable downloaded software. Provided to licensed users.

- Licenses are available at no charge to non-profit, academic and governmental institutions based in low-income and lower-middle-income countries. Available at low cost in upper-middle income countries. All others required to purchase a standard license. Simple and quick process to apply online.

- Technical support from SEI though LEAP web site or via email.

- Most users will need training: available through SEI or regional partner organizations.

- Check LEAP web site for news of training workshops.

LEAP for GHG Mitigation Analysis

Low initial data requirements make LEAP usable in situations where good data is in short supply and expertise is limited.

User-friendly design and emphasis on results communication helps make NDC analyses more broadly accessible: to planners, decision makers and other stakeholders (not just modelers).
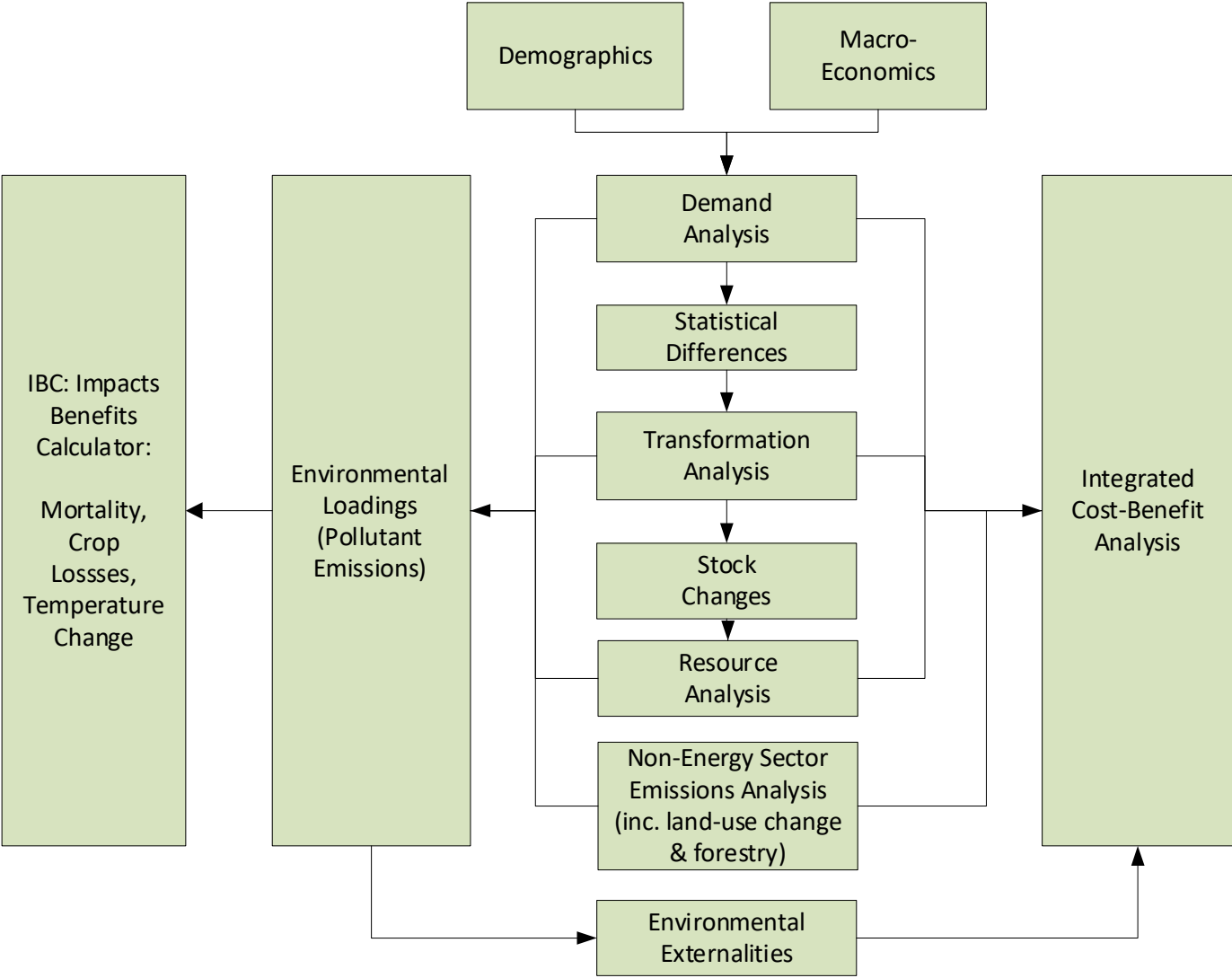
Demand-first, end-use oriented structure helps frame mitigation analysis within broader development goals.

Fast, interactive calculations encourage users to take an iterative "build and refine" approach to mitigation modeling.

LEAP's bottom-up approach is well suited for exploring **technology-oriented** energy and climate policies.

Its linkage to the Integrated **Benefits Calculator (IBC),** allows important climate mitigation co-benefits such as air pollution health impacts to be quantified and explored.

Source: SEI

LEAP Structure

Demographics

Macro-Economics

Demand Analysis

Statistical Differences

Transformation Analysis

Stock Changes

Resource Analysis

Non-Energy Sector Emissions Analysis (inc. land-use change & forestry)

Environmental Externalities

Environmental Loadings (Pollutant Emissions)

IBC: Impacts Benefits Calculator:

Mortality, Crop Lossses, Temperature Change

Integrated Cost-Benefit Analysis

Source: SEI

Scenarios in LEAP

- Scenarios are consistent and plausible stories of how a system might evolve over time. Used for policy and/or sensitivity analysis.

- *Inheritance* allows you to create hierarchies of scenarios that inherit defaults from their parent scenarios: minimizes data entry and streamlines data management.

- *Multiple inheritance* allows scenarios to inherit from more than one parent scenario. E.g. combining packages of measures (NAMAs) to create overall integrated scenarios (LEDS).

- The Scenario Manager screen is used to organize scenarios and specify inheritance.

- Powerful reports for analyzing and comparing scenarios.
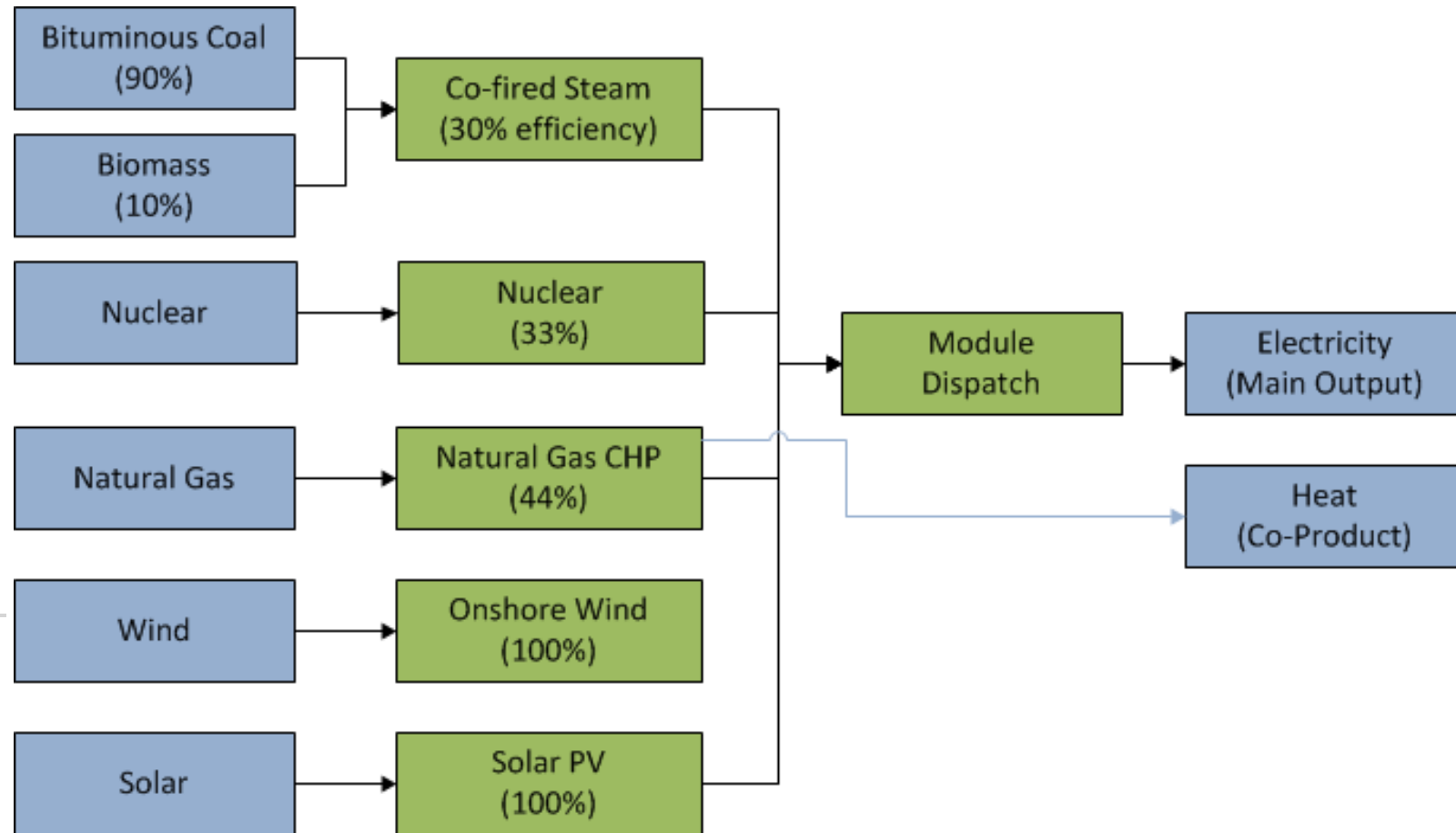
Source: SEI

Demand Analysis in LEAP

E = A x I

Energy demand (E) = Activity Level (A) x Energy Intensity (I).

- Hierarchical data structure breaks down overall activity level (A) into smaller, manageable pieces.
  - For example: number of urban households using efficient electric lighting is broken down by multiplying total households x urban fraction x electrified fraction x saturation of lighting x efficient device share of lighting.
- Scenario analysis involves describing how each part might change over time in each different scenario.
- For example: total number of households grow as population increases, urban fraction increases due to urbanization, policies promote efficient lighting, etc.
- Structure can be detailed and end-use oriented, or highly aggregate (e.g. sector by fuel).
- Detail and structure can be varied from sector to sector.
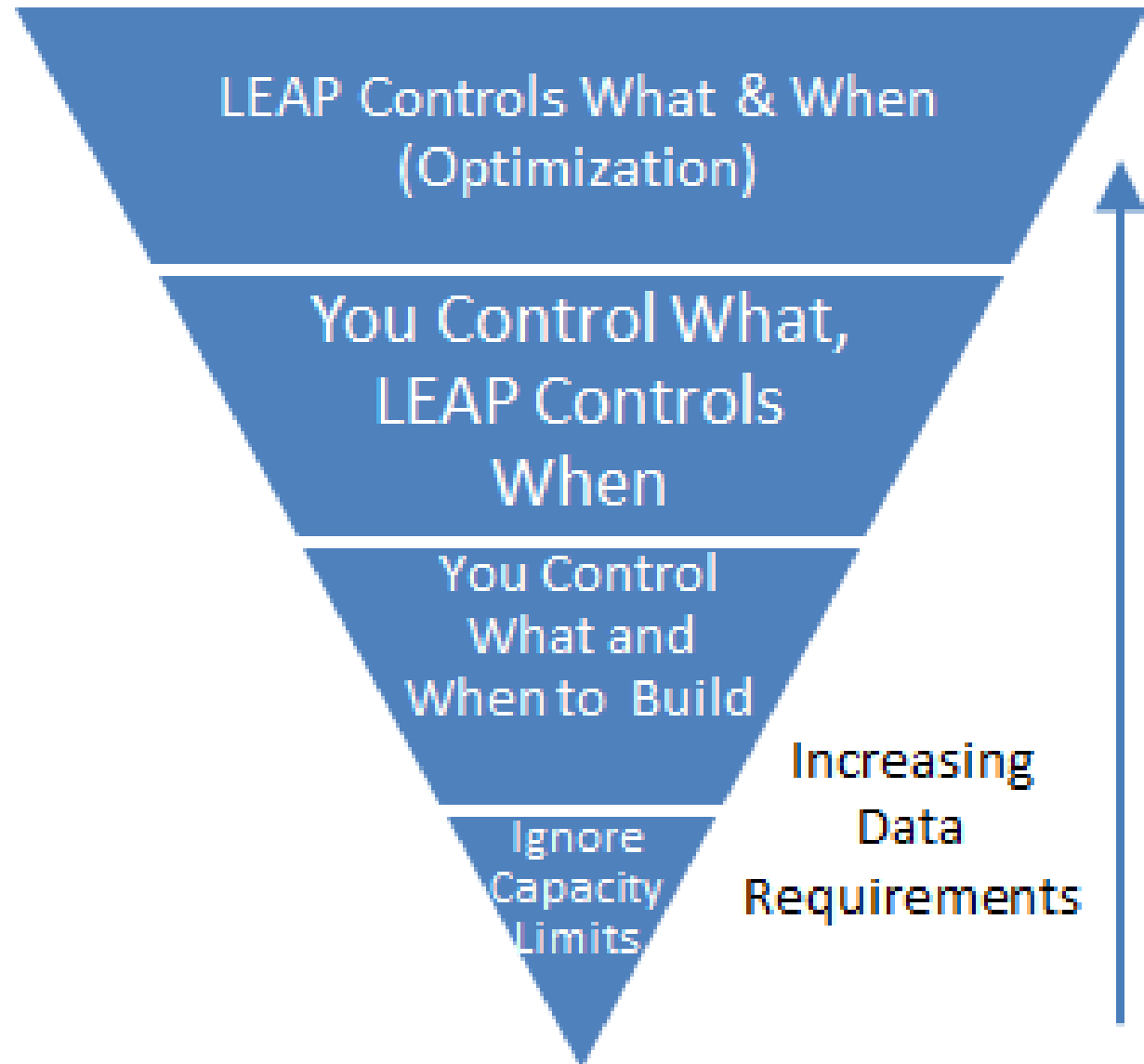- LEAP's expressions are used to tell the story about how each variable changes over time.

Transformation Analysis in LEAP

- Analysis of energy conversion, transmission and distribution, and resource extraction.

- Demand-driven engineering-based simulation.

- Basic hierarchy: "modules" (sectors), each containing one or more "processes". Each process can have one or more feedstock fuels and one or more auxiliary fuels.

- Allows for simulation of both capacity expansion and process dispatch.

- Calculates imports, exports and primary resource requirements.

- Tracks costs and environmental loadings.

- Choice of two overall methodologies: **simulation** or **optimization**.

Electricity and heat generation representation in LEAP

Modeling Capacity Expansion

LEAP Controls What & When (Optimization)

You Control What, LEAP Controls When

You Control What and When to Build

Ignore Capacity Limits

Increasing Data Requirements

Source: SEI

Putting Demand & Supply Together: Energy Balances

- Balances can be viewed in table, chart, or sankey diagram formats.
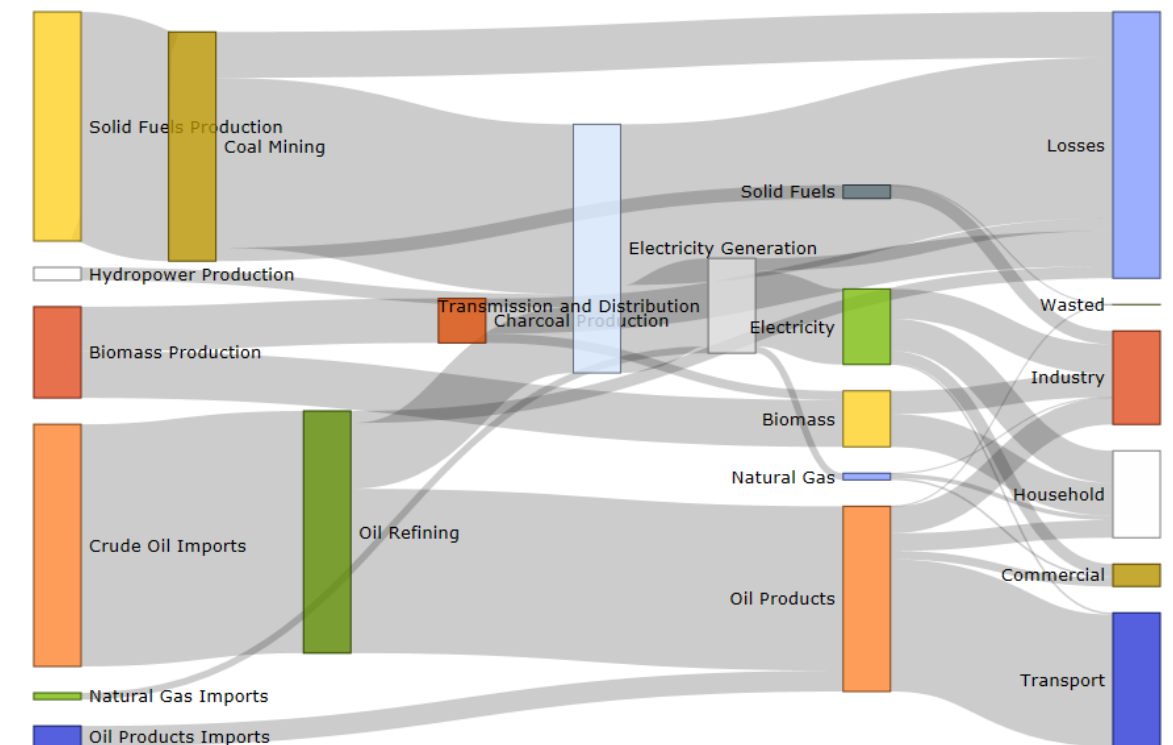

Energy Balance for Area "Freedonia"
Scenario: Reference, Year: 2020, Units: Thousand Tonnes of Oil Equivalent

	Solid Fuels	Natural Gas	Crude Oil	Hydropower	Biomass	Electricity	Oil Products	Total
Production	5,685	-	-	321	2,263	-	-	8,269
Imports	-	170	6,006	-	-	-	517	6,693
Exports	-	-	-	-	-	-	-	-
Total Primary Supply	5,685	170	6,006	321	2,263	-	517	14,962
Coal Mining	-1,137	-	-	-	-	-	-	-1,137
Oil Refining	-	-	-6,006	-	-	-	5,705	-300
Charcoal Production	-	-	-	-	-874	-	-	-874
Electricity Generation	-4,215	-	-	-321	-	2,182	-1,632	-3,986
Transmission and Distribution	-	-3	-	-	-	-306	-	-309
Total Transformation	-5,352	-3	-6,006	-321	-874	1,877	4,073	-6,606
Household	-	108	-	-	815	797	436	2,157
Industry	332	10	-	-	573	736	667	2,320
Transport	-	-	-	-	-	46	3,280	3,326
Commercial	-	49	-	-	-	297	207	554
Total Demand	332	167	-	-	1,389	1,877	4,590	8,356
Unmet Requirements	0	-	-	-	-	0	0	0

Source: SEI

Emissions Analysis

- Emission factors for any GHG or local air pollutant can be entered in LEAP and used to calculate emissions loadings.

- These can be specified in any physical unit and denominated by units of either energy consumption or production (e.g. kg/ton of coal) or distance driven for transport factors (e.g. grams/mile).

- They can also be specified in terms of the chemical composition of fuels (e.g. sulfur). This automatically adjusts standard emission factors based on specific fuels used in each area.

- LEAP includes default IPCC Tier 1 emission factors for GHG inventories.

- Results can be shown for individual pollutants or summed to show overall Global Warming Potential (GWP).

- Results can be displayed in terms of direct emissions from each demand, supply and non-energy sector branch, or allocated back to show which consuming branches are responsible for supply-side emissions.

- In national models, emissions can be linked to IBC to calculate human health impacts.
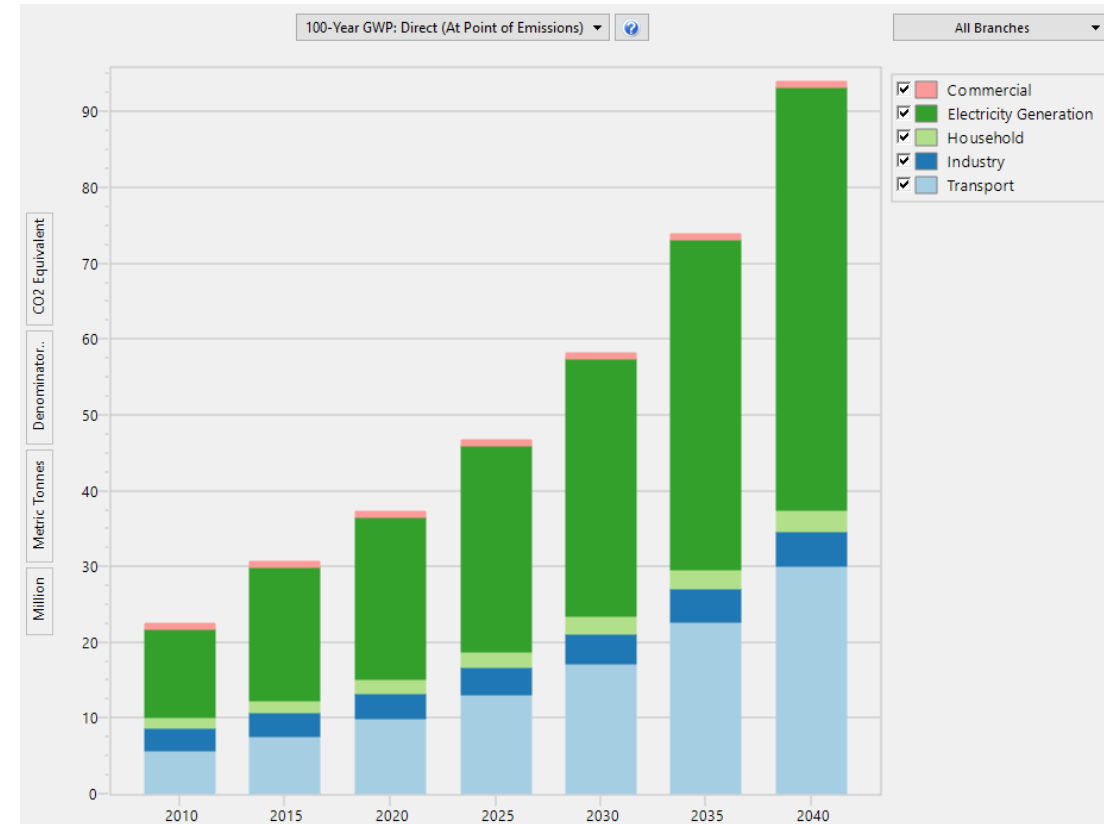
GACMO model

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)

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.

Use of GACMO

The first version of GACMO was developed 25 years ago for Zimbabwe.

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"

Steps to develop GACMO model

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).

The projection for the BAU to 2025/2030/2035/2050 is made by using an **annual growth factor** for each sector.

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

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

A **mitigation revenue curve** is made.

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

Input data requirements

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

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

- **Emission factors** by fuels for fuel combustion sectors (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 Bulps
	Efficient lighting with LEDs	1000 Bulps
	Efficient lighting with LEDs replacing CFL	1000 Bulps
	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

Results of GACMO
## Marginal Abatement Revenue (MAR) curve for Chile

Marginal Abatement Cost Curve (MACC) or Marginal Abatement Revenue Curve (MARC) can be created.

A MACC/MARC presents the costs or savings of the mitigation actions and expected emissions reductions from those mitigation actions.

MACC/MARC can be useful tool to select mitigation actions appropriate for the country based on the emissions reductions and costs/revenues.

Marginal Abatement Revenue (MAR) Curve for Chile (2030 Scenario)
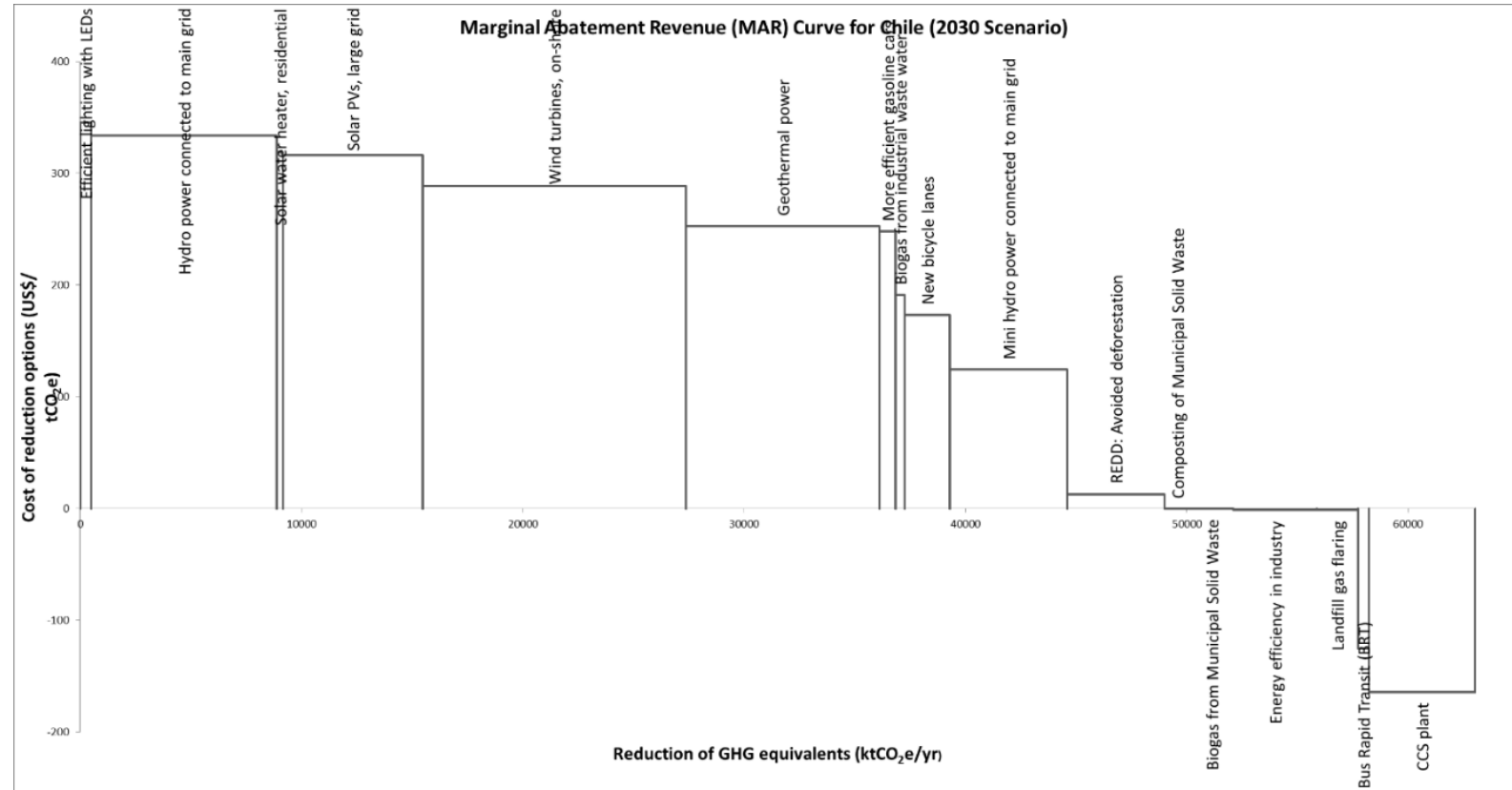
Results of GACMO:
GHG emissions projections in BAU and Mitigation scenario
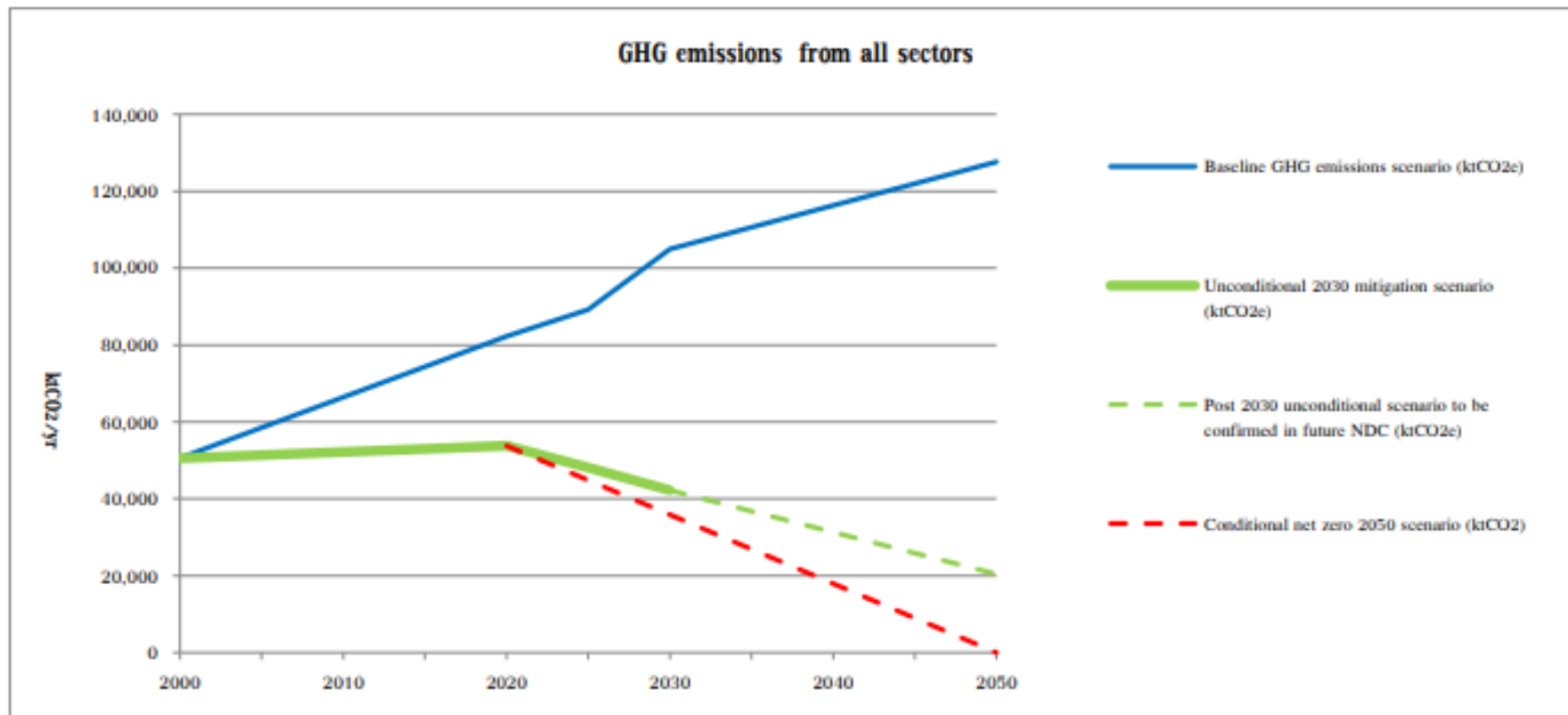
Thank you for your attention!

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