CGE Training materials - Mitigation Assessment

Module D

Mitigation Assessment

Consultative Group of Experts (CGE)

United Nations
Climate Change Secretariat

Outline

I. Benefits of mitigation assessment

II. Steps for conducting a mitigation assessment

III. Methods and tools for assessment

IV. Available support

Module objectives and expectations

The objective of this session is to provide participants with an overview of the purpose, key steps and key design considerations involved in conducting a Greenhouse Gas (GHG) mitigation assessment, including:

- The purpose and benefits of conducting mitigation assessment.
- Steps involved in the mitigation assessment, including understanding of key terminology.
- Considerations for selecting appropriate tools and methods.

Expectation: Participants will have a broad but sound understanding of how to conduct GHG mitigation assessment and what is important in selecting appropriate tools and methods.

MODULE D1

BENEFITS OF MITIGATION ASSESSMENT

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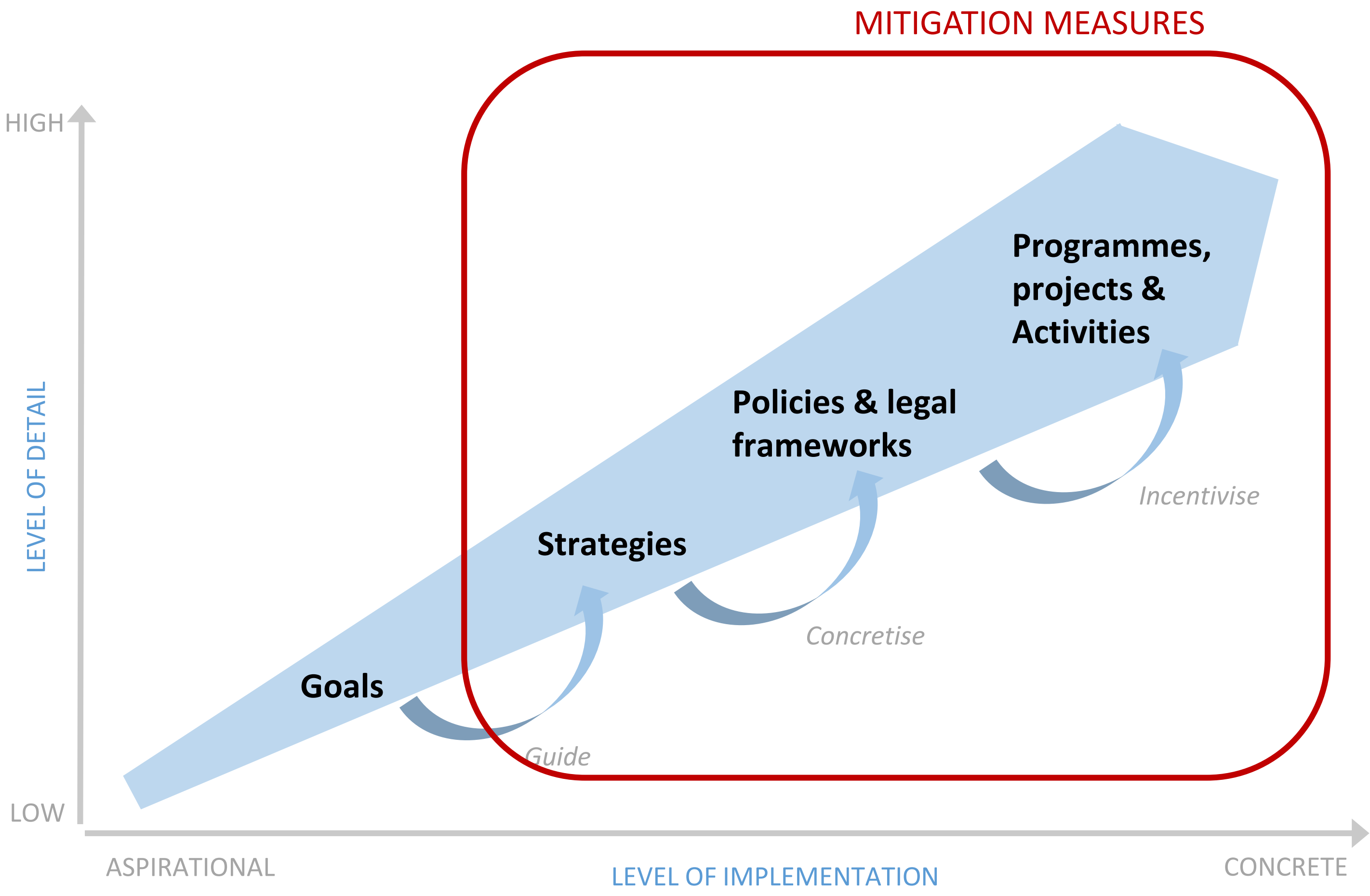
Defining mitigation measures

For the purpose of this training, we define 'mitigation measures' in a broad sense, to cover:

- Strategies & strategic documents.
- Policies & legal frameworks.
- Programmes, projects & activities.



Multiple benefits of mitigation assessment

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International reporting

- Meeting reporting requirements under the UNFCCC

National policy-making

- Providing policy-makers a robust basis for decisions
- Enhance understanding of available options and associated GHG results, cost and benefits
- Enable tracking of effectiveness of measures to facilitate corrective measures and gain acceptance

Financing of measures

- Prioritization of support
- Demonstrate potential to funders and investors
- Enable MRV of projects and programs
- Build trust

Benefits at different stages of implementation

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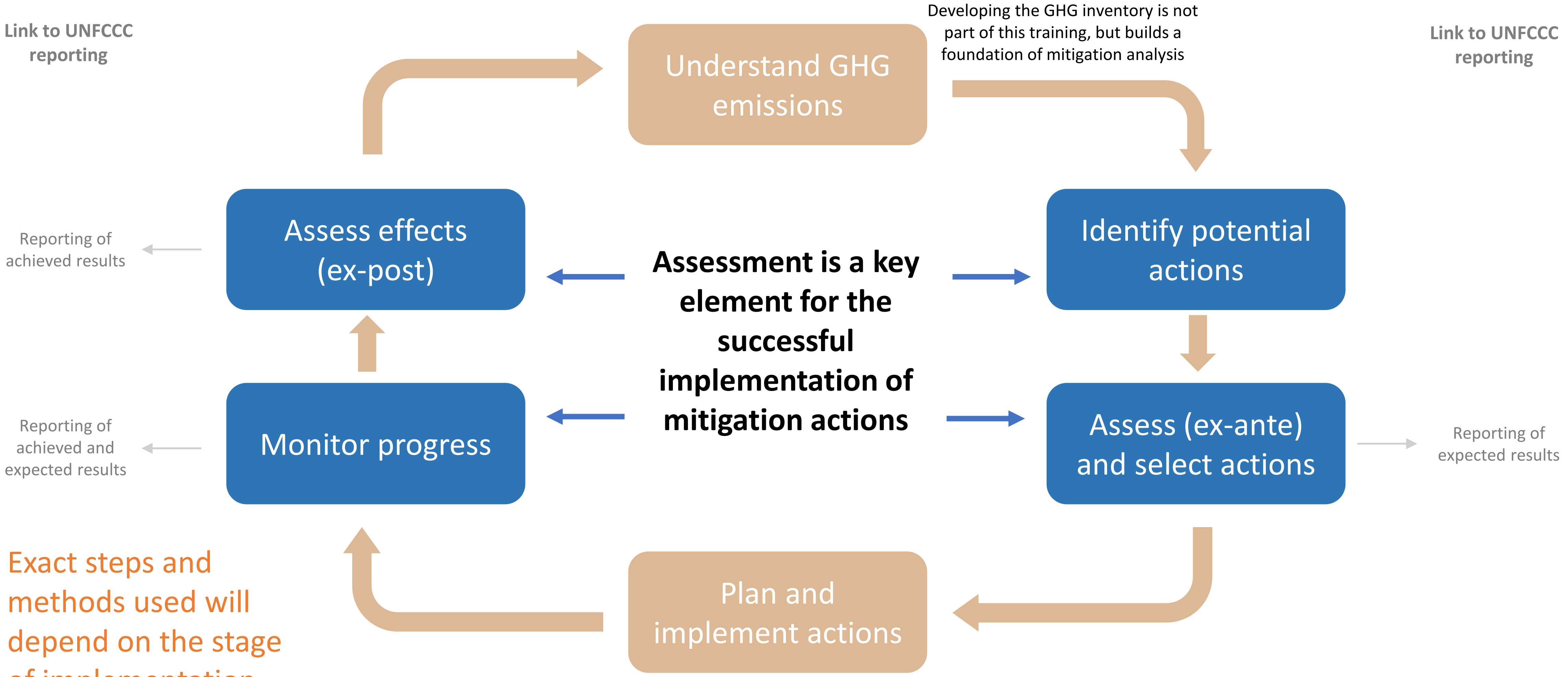
Before implementation

- Choose among mitigation options based on their expected GHG effects.
- Improve the design of measures by understanding the GHG effects of different design choices.
- Understand potential GHG reductions from options to inform GHG reduction goals.
- Report on expected future GHG effects of measures being considered or implemented (for domestic or international purposes).
- Attract and facilitate financial support for mitigation actions.

After implementation

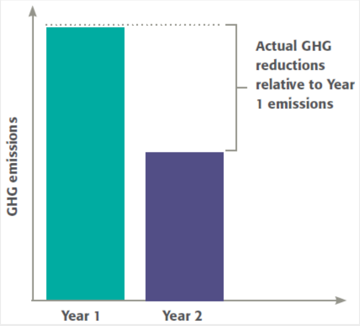
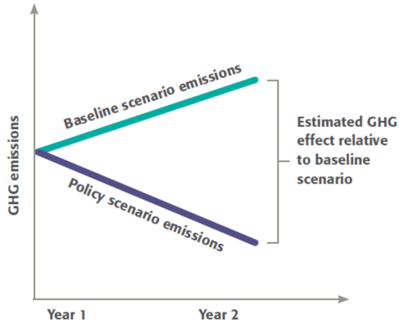
- Understand whether measures are effective in delivering the intended results.
- Inform and improve implementation.
- Decide whether to continue current activities or implement additional measures.
- Learn from experience and share best practices.
- Evaluate the contribution of measures toward the NDC.
- Ensure that policies and actions are cost-effective and that limited resources are invested efficiently.
- Report on the GHG effects of measures over time.
- Meet funder requirements to report GHG reductions from mitigation actions.

Assessment requirements throughout the design and implementation process



Exact steps and methods used will depend on the stage of implementation and the type of action

Relationship of mitigation assessment to GHG inventories

Type of accounting		Purpose	Limitations
GHG inventory accounting		• Comprehensive accounting of a jurisdiction's or organization's GHG emissions impact on the atmosphere • Provides information on the sources of emissions and trends over time • Necessary to track overall progress toward GHG reduction goals	• May not explain why emissions change over time • Does not reveal the effects of individual policies
Mitigation policy/action accounting		• Attributes changes in emissions to specific policies and actions • Informs policy design and evaluation	• Not a comprehensive accounting of total emissions; a jurisdiction's emissions may increase even if individual policies and actions are reducing emissions (compared to a baseline scenario or a base year)

MODULE D2

STEPS FOR CONDUCTING A MITIGATION ASSESSMENT

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Definitions

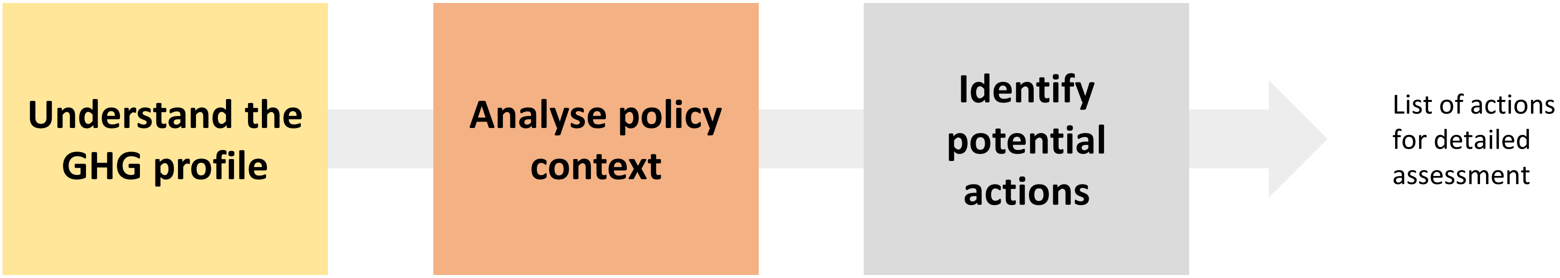
Process & steps: This section covers the general process and the steps that are usually relevant for a mitigation assessment aiming to estimate GHG effects of actions. Not all of these will be relevant for all mitigation assessments.

Methodology: The assessment methodology defines the actual steps that will be conducted for the planned mitigation assessment. More importantly, it defines the methods and tools to be used, especially for the steps that quantify effects. The methodology includes the justification why choices are appropriate for the purpose.

Method: A method is a systematic procedure, technique, or mode of inquiry. This includes qualitative methods, e.g. how to select representative samples for data collection, and quantitative methods, such as equations used for calculations. A method is the theoretical foundation of the assessment.

Tools: Tools support the application of methods, often through computer-based solutions, but are not limited to this. Tools can support various methods and steps, from apps that support data collection, databases that help process and archive data, to spreadsheets and complex models that calculate effects based on input parameters.

Steps for identifying potential actions



- This stage is only relevant in contexts where decision-makers are aiming to identify mitigation activities to implement.
- Where mitigation policies and actions are already decided or even implemented, these steps can be skipped.

Many countries have already identified potential mitigation actions during the development of their NDC.

However, it may be useful to repeat this exercise in view of advancing technological developments, changing cost and the need to enhance ambition

Identifying the highest potentials

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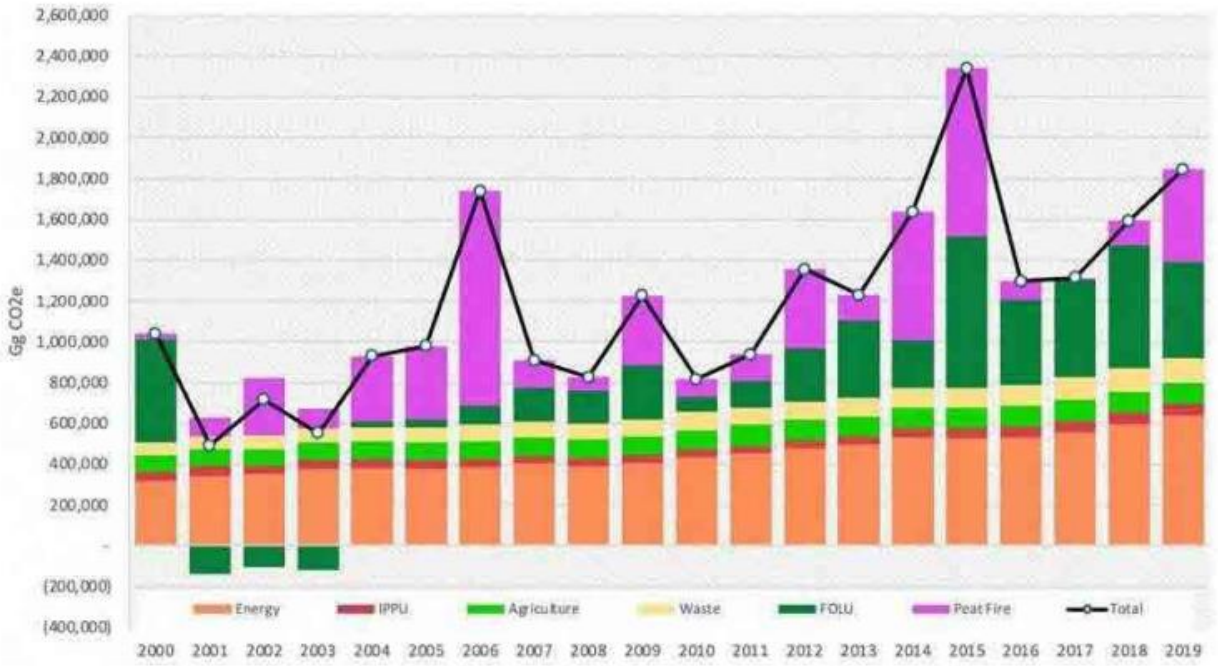
Understand the GHG profile

Analyse policy context

Identify potential actions

The GHG inventory and observed trends can provide a good insight into where mitigation potential is high



The relative importance of sectors

The trend over time to understand which sectors may become important in the future

This gives a good first indication of where the highest potentials can be found to start a 'long-list' of possible mitigation measures.

Existing frameworks influence effectiveness

Understand the GHG profile

Analyse policy context

Identify potential actions

With respect to potential mitigation measures, **policy frameworks** can:

+ Reinforce
- Provide barriers to implementation
- Actively counteract

Institutions and administrative processes linked to the policy framework are also important. They can provide

- The required enabling environment for the implementation of mitigation actions
- Pose barriers, for example through lack of resources

The analysis of policy and institutional frameworks can be useful for the initial screening, to ensure that possible mitigation measures can be implemented effectively.

Aligning mitigation with development priorities

Understand the GHG profile

Analyse policy context

Identify potential actions

- Mitigation measures that are in line with and support the development priorities of countries will likely be more successful and effective.

- Development priorities depend on the national context and can include a wide range of economy-wide or sector-specific goals and objectives, such as:
    - Overall economic growth;
    - Job creation;
    - Poverty reduction;
    - Rural development;
    - Reduced pollution;
    - Enhanced education;
    - Improved health;
    - Strengthening national identity;
    - Socio-political stability;
    - Reduced misplaced government spending (fuel subsidies).

Specific experts and stakeholders may be needed to assess such impacts

This analysis can add measures that have high sustainable benefits to the ‘long-list’ of possible mitigation measures and provides input to the selection process.

Using multi-criteria analysis to identify best options

Understand the GHG profile

Analyse policy context

Identify potential actions

Greenhouse gas effects

- Significance of emissions impact (t CO_2e);
- Cost-effectiveness (e.g. marginal abatement cost).

In this step the ‘long-list’ is narrowed down to those measures likely to be implemented and that will be assessed in more detail.

Sustainable development effects

- Consistency with national development plans and goals;
- Social and macroeconomic impact (employment, trade);
- Equity (differential impacts on income groups);
- Environmental impact (e.g. local air quality, biodiversity, etc.).

Other considerations

- Feasibility, including institutional capacity (data collection, monitoring, enforcement, permitting, etc.) and political acceptability;
- Replicability (adaptability to different settings);
- Technology transfer.

Steps for GHG assessment of mitigation actions

List of actions for detailed assessment → Define objectives and stakeholders → Identify potential effects and set boundary → Define methodology & collect data → Estimate baseline emissions → Estimate mitigation effects → Assess uncertainty → Verify (optional) & report results and methodologies used (module E)

For a detailed description of the steps and process to conduct a mitigation assessment, also see the GHG Protocol Policy and Action Standard, available at https://ghgprotocol.org/policy-and-action-standard

- This section of the training module will summarise key elements outlined in the standard, supplemented with additional material.
- It concentrates on the **process** of the assessment.
- The next section will then review methods and tools in more detail.

Objectives and methods depend on the stage of implementation

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- Define objectives and stakeholders
- Identify potential effects and set boundary
- Define methodology & collect data
- Estimate baseline emissions
- Estimate mitigation effects
- Assess uncertainty

Ex-ante assessment

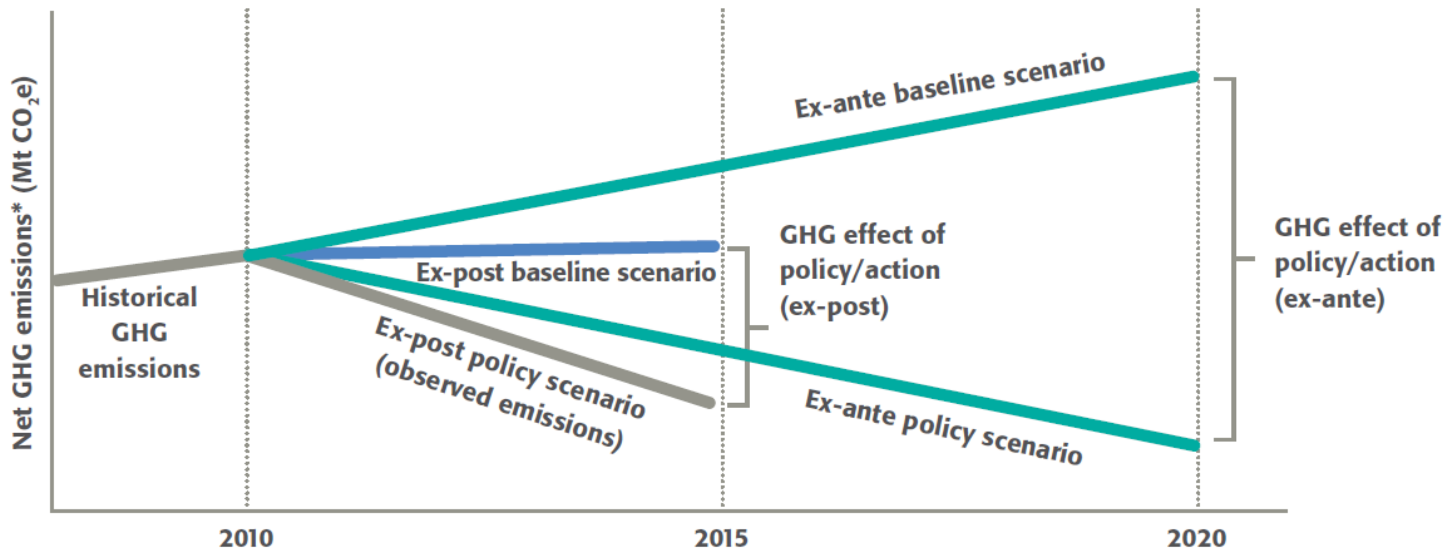
Objective: Estimate expected future GHG emission reductions.

Method: Estimate and compare ex-ante baseline with ex-ante policy scenario.

Ex-post assessment

Objective: Estimate achieved GHG emission reductions.

Method: Estimate ex-post baseline scenario and compare with observed emissions (ex-post policy scenario).



Note: * Net GHG emissions from sources and sinks in the GHG assessment boundary.

Actors and stakeholders

Define objectives and stakeholders

Identify potential effects and set boundary

Define methodology & collect data

Estimate baseline emissions

Estimate mitigation effects

Assess uncertainty

Actors

Are directly involved in tasks for the assessment, such as:

- Sectoral policy analysis;
- Data collection & management;
- Provision of estimates for future trends;
- Modelling;
- Writing of technical reports.

Active engagement

Stakeholders

Engaging a broad range of relevant stakeholders from early stages of planning can:

- Alleviate fears;
- Tap existing knowledge;
- Cultivate a sense of ownership and buy-in;
- Enable mutually beneficial solutions;
- Prevent future barriers to effective implementation.

! Permanent setups will help to ensure continuity of expertise

Clarifying clear responsibilities and processes is key, ideally in a permanent institutional setting

Defining key stakeholders

The development of mitigation assessments will require close cooperation among a wide range of stakeholders:

- Policy makers from:
  - Different departments, like energy, agriculture, environment, finance, etc.
  - Different levels of legislation: national, regional, community level.
- National agencies, like environment agencies, electricity boards, etc.
- Research institutions, national or international, like universities or institutes.
- Civil society representatives from environmental groups, but also from other areas, for example:
  - Private sector groups.
  - Unions.
  - Local woman's groups, etc.

Who the relevant groups and individuals are, will depend on the type of mitigation action and the local context

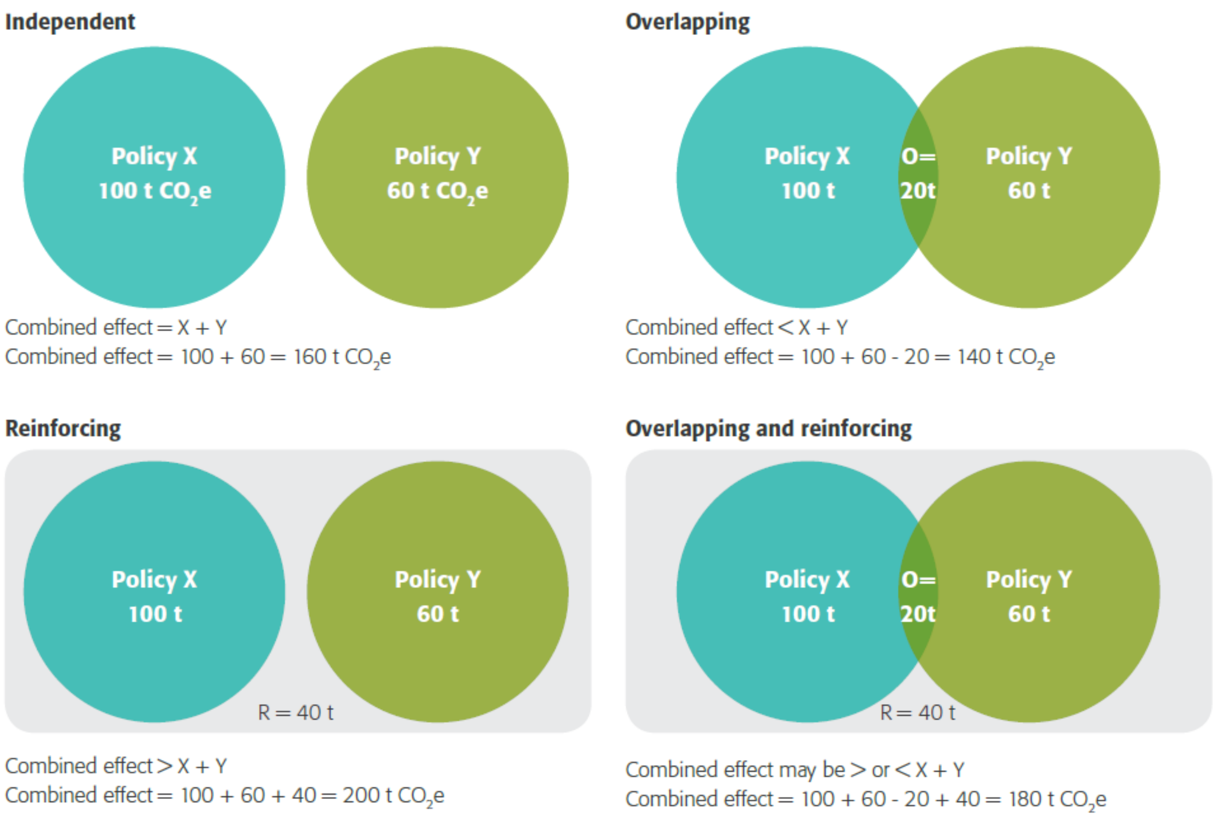
It is important to consider interactions of measures

Measures can interact with existing and planned policies and actions.

Measures can be assessed individually or as packages.*

The decision to assess individual measures or packages depends on:

- Objectives of the assessment: for funding purposes, individual measures may be more appropriate, for the assessment of progress towards a national or sectoral goal, packages.
- Degree of interaction: The higher the interaction, the more joint assessment should be considered.
- Feasibility: available capacity.



Note: Effect O represents an overlapping effect. Effect R represents a reinforcing effect.

* For packages it is important to not overlap with measures that are included in the baseline. Interactions with measures included in the baseline also need to be considered.

Identifying effects is key for robust assessment

- Define objectives and stakeholders
- **Identify potential effects and set boundary**
- Define methodology & collect data
- Estimate baseline emissions
- Estimate mitigation effects
- Assess uncertainty

Intended & unintended effects

- Intended effects: Objectives of the intervention, e.g. GHG reduction
- Unintended effects, including:
  - Rebound effects
  - Effects in other sectors
  - Spillover effects

In-jurisdiction & out-of-jurisdiction effects

- Inside / outside the geopolitical boundary
- Within / outside the authority of actors

Short-term & long-term effects

- Need to define time frames
- Based on nature of intervention

Permanent & temporary effects

- Special interventions needed to ensure permanence?

Likelihood of effects

- Likely
- Possible
- Unlikely

! Consideration of all possible effects improves the analysis and enables an enhanced design of measures

The ‘results chain’ or ‘causal chain’ is a useful method

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Define objectives and stakeholders

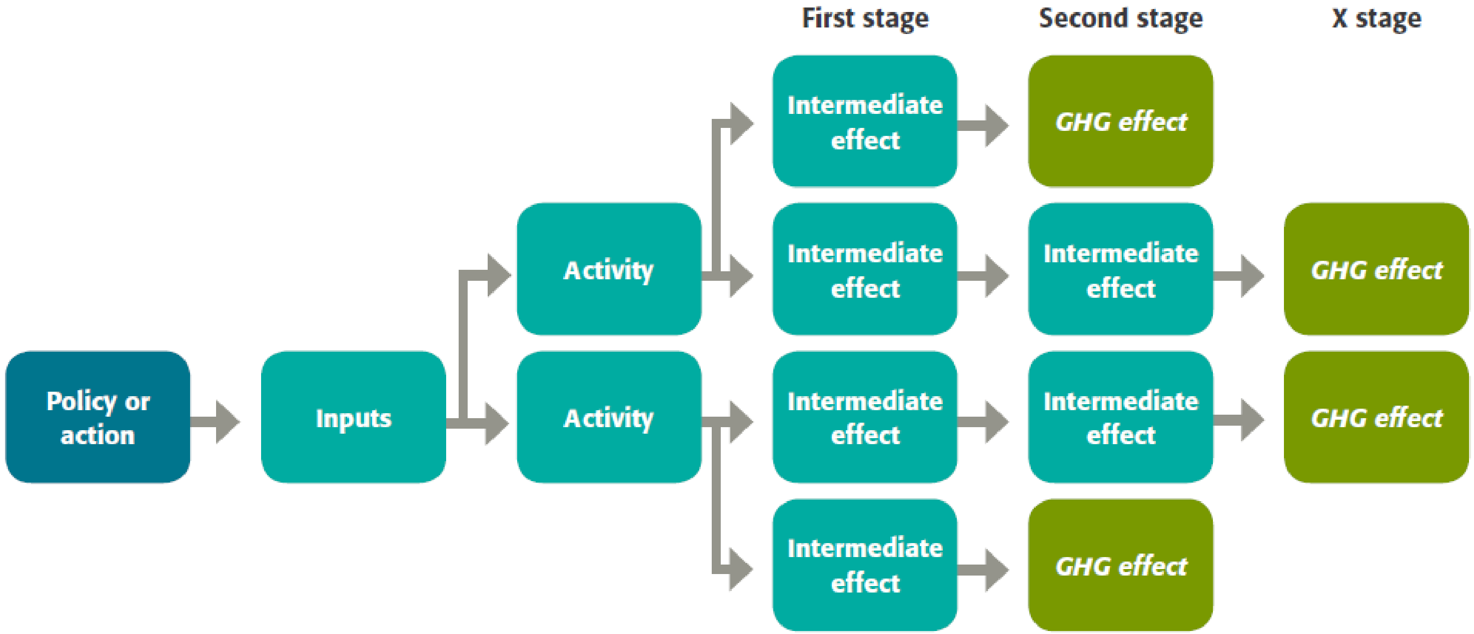
Identify potential effects and set boundary

Define methodology & collect data

Estimate baseline emissions

Estimate mitigation effects

Assess uncertainty



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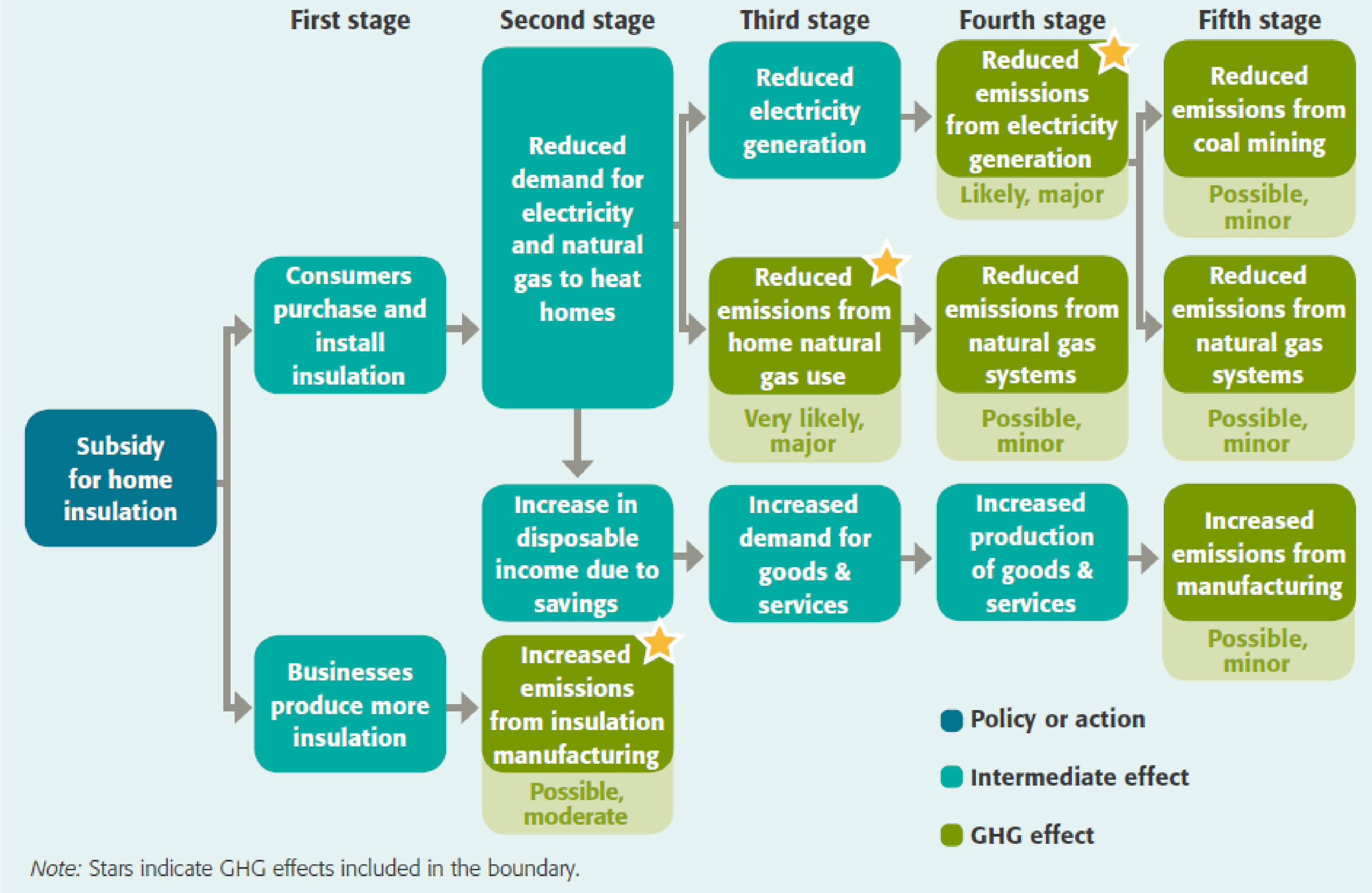
Involving a broad set of stakeholders in the process will provide additional perspectives and likely capture effects more comprehensively

A ‘results chain’ or ‘causal chain’ is a conceptual diagram tracing the process from the intervention to GHG effect.

It includes interlinked logical and sequential stages of cause-and-effect relationships.

Defining the boundary will help transparency

- Define objectives and stakeholders
- **Identify potential effects and set boundary**
- Define methodology & collect data
- Estimate baseline emissions
- Estimate mitigation effects
- Assess uncertainty



This illustrates one possible method of defining boundaries using the 'causal chain'.

To prioritise effects, it is useful to assign:

- The likelihood of the effect occurring.
- The expected magnitude of the effect, based on rough estimates.

You can additionally include information on:

- The time-frame of effects
- The geographic location of effects

Defining the time frame for mitigation assessment

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- Define objectives and stakeholders
- **Identify potential effects and set boundary**
- Define methodology & collect data
- Estimate baseline emissions
- Estimate mitigation effects
- Assess uncertainty

- The timeframe for an assessment refers to the period over which emissions are projected.
- The start year can depend on:
  - Availability of data
  - Objective of the assessment
  - Starting point of implemented or planned mitigation activities
- The end year can depend on:
  - The time frame set for a goal
  - The time frame set for mitigation actions
  - Political cycles
  - Internationally relevant points in time
  - Availability of reliable data projections for key assumptions
  - Rate of technological change and lifetime of capital stock
  - Estimated time frame of effects

The **base year** is normally the last available historic data year for ex-ante assessments.

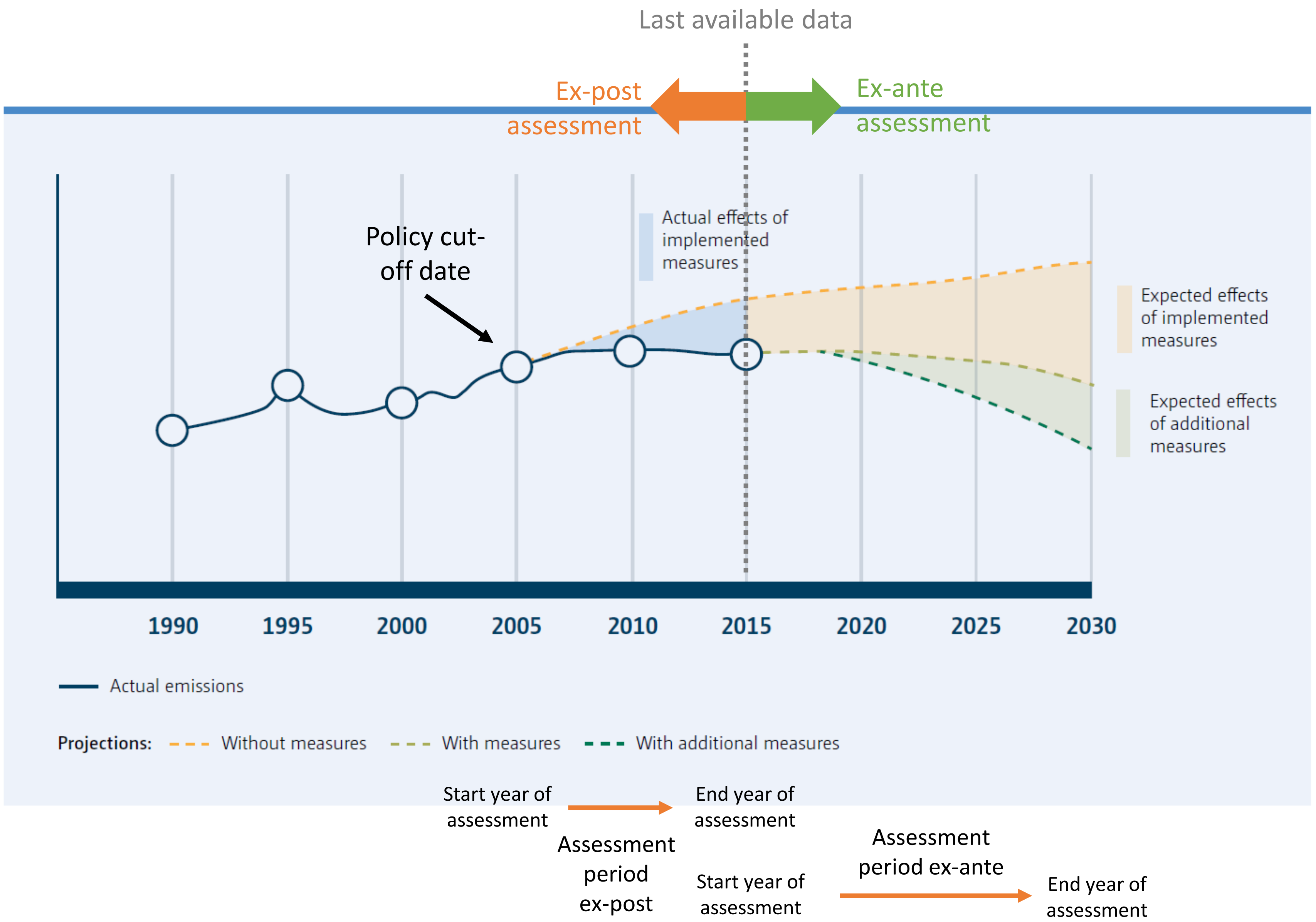
The **policy cut-off date** can differ from this. It represents the date up to which implemented policies are reflected in the baseline.

→ This is mostly relevant for sectoral or national assessments.

→ For individual measures, the relevant date is when the measure is implemented.

Time frames: illustrative example

- Define objectives and stakeholders
- **Identify potential effects and set boundary**
- Define methodology & collect data
- Estimate baseline emissions
- Estimate mitigation effects
- Assess uncertainty



Defining the methodology

Which methods are used for:

- Data collection & processing:
- Calculation of baseline (if applicable)
- Estimation of mitigation effects
- Uncertainty assessment

The methods selected will determine which tools are suited

Availability of tools can be one criteria to select methods but should not be the decisive factor!

Data can be differentiated in three ways

By the level where it is collected

Bottom-up data are measured, monitored, or collected at the source-, facility-, entity-, or project-level.

Top-down data are macro-level statistics collected at the jurisdiction or sector level. Examples include national energy use, population, GDP and fuel prices. In some cases, top-down data are aggregated from bottom-up data sources.

By the way it is derived

Measured, i.e. derived with a measuring device.

Modelled, data derived from quantitative models.

Calculated, using simple equations, like multiplying activity with emission factors.

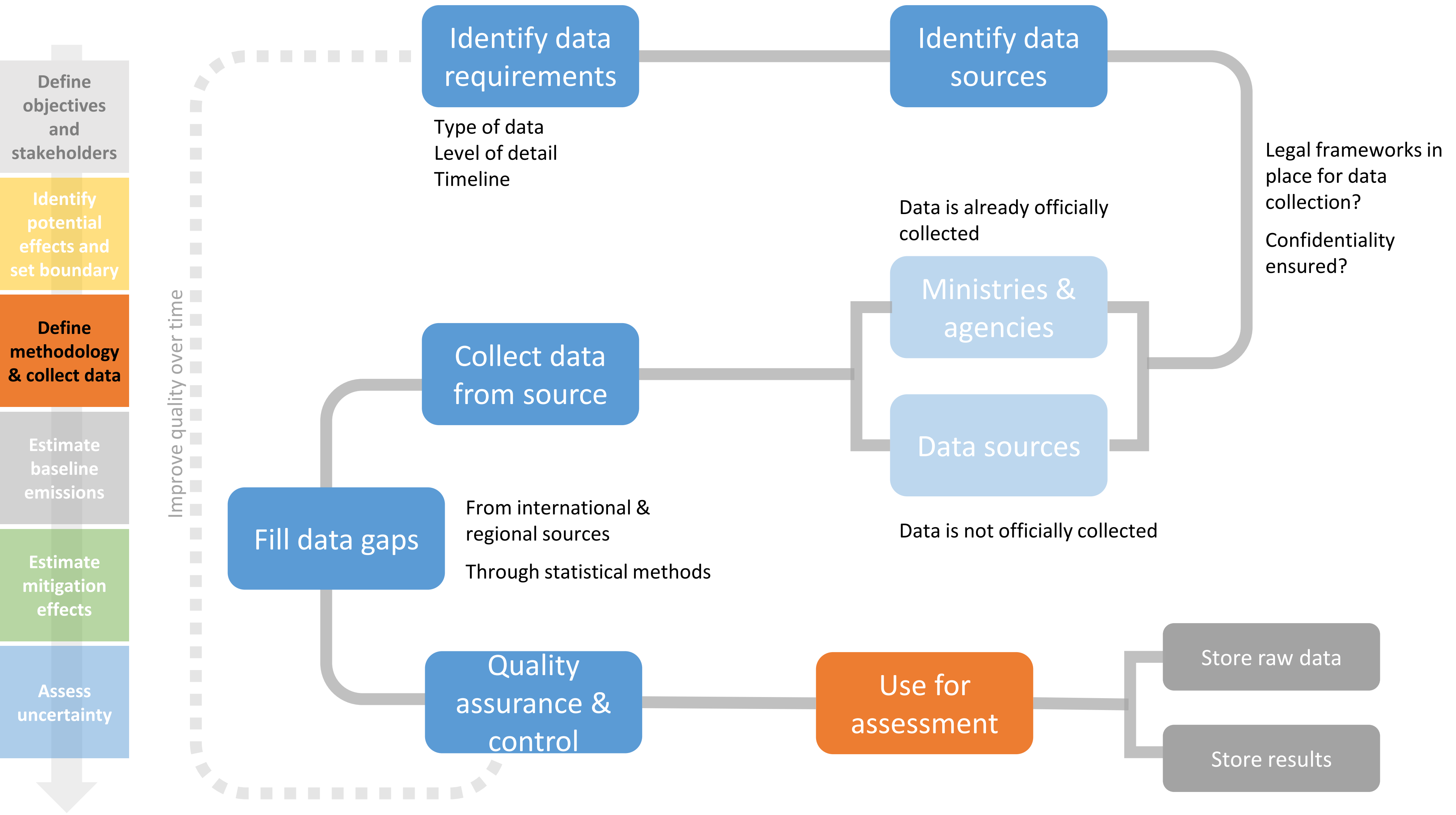
Estimated, using proxy data or other data sources.

By the level of detail

Primary data is collected from specific sources or sinks.

Secondary data is not source/sink specific and normally available in aggregated form.

Data collection as an iterative process



Data requirements and level of disaggregation depend on:

- Scope & objectives of analysis
- Methods & tools selected

The role of methods and tools in data collection

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Define objectives and stakeholders
Identify potential effects and set boundary
Define methodology & collect data
Estimate baseline emissions
Estimate mitigation effects
Assess uncertainty

Possible methods

Comprehensive data collection from all sources

Data collection from representative sample

Observation

Survey of random sample

Data collection from secondary sources

Possible tools

Online portal for (mandatory) data submission

Standardised data submission sheet (electronic, paper)

Video, apps, questionnaires

Online survey tools

Standardised data submission sheet (electronic, paper)

!

Tools need to fit the selected method and methods need to fit the intended purpose!

Baseline terminology

Define objectives and stakeholders

Identify potential effects and set boundary

Define methodology & collect data

Estimate baseline emissions

Estimate mitigation effects

Assess uncertainty

This definition is general and applies to baseline scenarios and mitigation scenarios!

A **scenario** represents 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 (DEA, OECD & URC, 2013).

A **baseline** is a scenario that aims to represent likely developments under a given (existing) policy framework as accurately as possible. There are other terms that are used as synonyms:

- **Counterfactual**: Normally used in the context of an ex-post assessment;
- **Business-as-usual**: Normally used for an ex-ante baseline, although the term can also be used ex-post;
- **Reference scenario**: Especially used where the scenario serves as the reference for determining other values, for example goals.

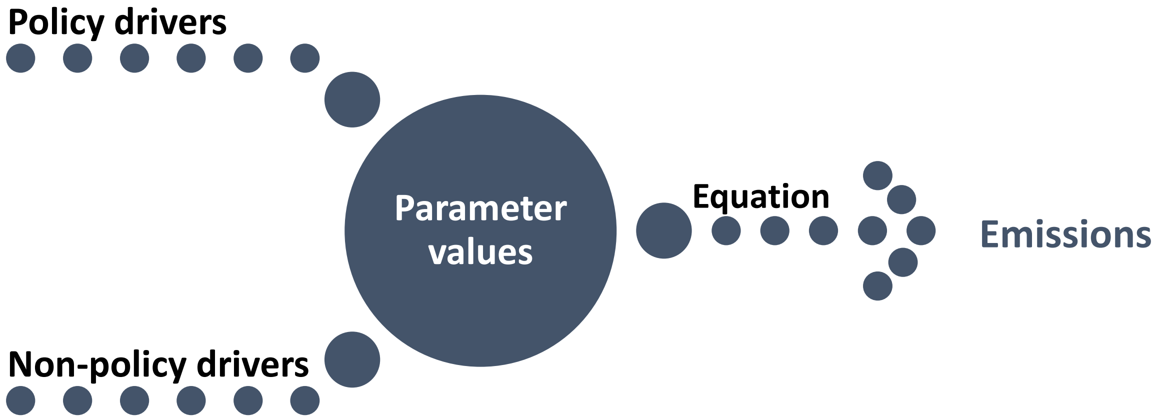
Not to be confused with '**trend**'

Projection: A more general term for estimating future values, based on formal statistical methods. The term should mainly be applied to individual parameters, but is often also used as synonymous to 'scenario', i.e. to a full set of assumptions on future developments.

Baseline terminology (continued)

- Define objectives and stakeholders
- Identify potential effects and set boundary
- Define methodology & collect data
- **Estimate baseline emissions**
- Estimate mitigation effects
- Assess uncertainty

Drivers affect parameters (variables) in the calculation



Methods and tools will have different requirements on how many parameters need to be estimated for baseline development!

Example equation

Parameters

Equation 2.5: GHG Emissions from the Electricity Sector

$$Emissions_{GHG,fuel} = \sum_{tech} Fuel\ Consumption_{fuel} \times Emission\ Factor_{GHG,fuel,tech}$$

Activity data — Emission factors

Technology choices in baseline development

Frozen technology

No technological change is assumed to occur over the assessment period.

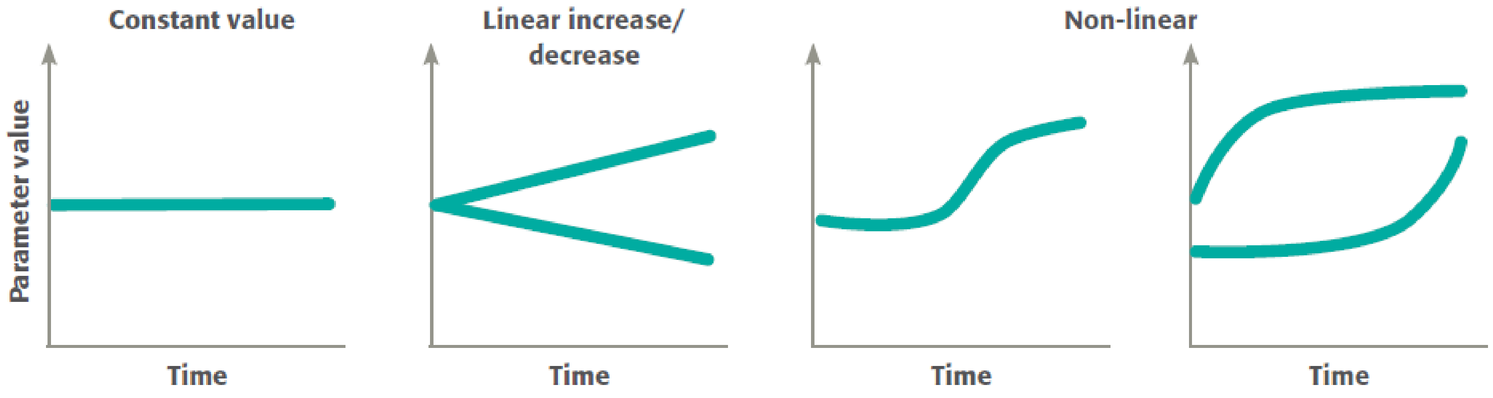
Autonomous improvement

Technological change is assumed to happen, based on different assumptions regarding availability, efficiency improvements and development of prices of different technologies.

Estimating baseline emissions

Collect historical data for parameters (see data collection) → Identify drivers that affect parameters → Estimate baseline values for each parameter → Estimate baseline emissions from parameter values → Conduct sensitivity analysis → Assess uncertainty

Parameter values need to be estimated across the entire assessment period and may change over time



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Making assumptions on the future development of each parameter is the key activity in baseline development

Example: Estimating baseline parameter values

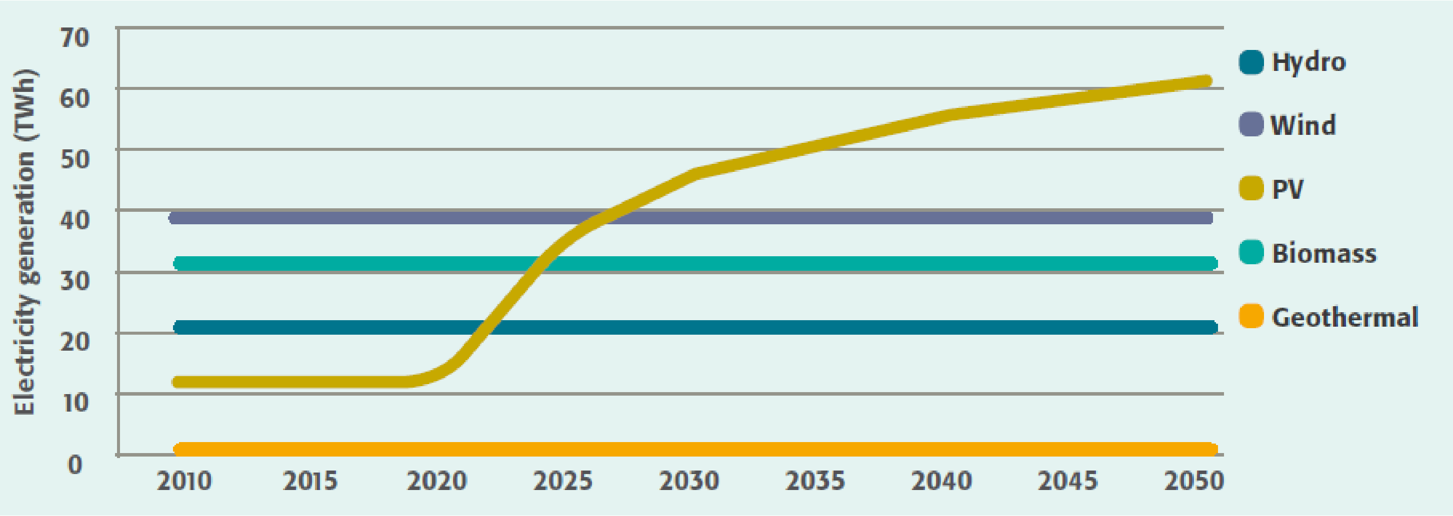
Define objectives and stakeholders
Identify potential effects and set boundary
Define methodology & collect data
Estimate baseline emissions
Estimate mitigation effects
Assess uncertainty

Developing assumptions for the baseline scenario for the German Renewable Energy Act

Drivers: In the absence of the Act, renewable electricity generation for all technologies is not cost-competitive, except solar PV, which is assumed to become cost-competitive from 2020.

Parameters: As a result, electricity generation for all technologies remains at 2010 levels, except solar, where additional capacity additions from 2020 lead to increasing production.

Ex-ante assessment
Assessment period 2010-2050
Conducted in 2012



Mitigation scenario terminology

Define objectives and stakeholders

Identify potential effects and set boundary

Define methodology & collect data

Estimate baseline emissions

Estimate mitigation effects

Assess uncertainty

Total net change

Represents the net change from the baseline and is expressed as a negative number if the mitigation scenario reduces emissions below baseline and a positive number if emissions are increased above the baseline scenario.

f_x *Total net change in GHG emissions and removals resulting from the mitigation action (t CO_2e) = Total net **mitigation** scenario emissions (t CO_2e) – Total net **baseline** scenario emissions (t CO_2e)*

Total net reduction

Here the calculation is tailored to represent reductions, which means that positive numbers indicate a reduction in emissions below baseline, a negative number indicates an increase.

f_x *Total net reduction in GHG emissions and removals resulting from the mitigation action (t CO2e) = Total net **baseline** scenario emissions (t CO2e) – Total net **mitigation** scenario emissions (t CO2e)*

'Net' refers to the aggregation of GHG emissions and removals.

'Total' refers to the aggregation of emissions and removals across all sources and sinks included in the GHG assessment boundary.

Mitigation assessment: concepts

- Define objectives and stakeholders
- Identify potential effects and set boundary
- Define methodology & collect data
- Estimate baseline emissions
- **Estimate mitigation effects**
- Assess uncertainty

Input	Selected mitigation measure(s) (e.g. based on steps described)	Selected mitigation measure(s) (e.g. based on steps described)	Models with pre-defined mitigation measures
Objective	Assessment of individual or groups of planned or implemented mitigation measures	Assessment of sector- or economy-wide developments (mitigation scenarios)	Selection of measures based on reduction targets, using pre-defined rules
Output	Expected or achieved reductions of individual or groups of measures	Expected or achieved sectoral or economy-wide reductions and remaining emissions levels	Mitigation measure(s) delivering result according to set rules

Estimating mitigation scenario emissions

Define objectives and stakeholders
Identify potential effects and set boundary
Define methodology & collect data
Estimate baseline emissions
Estimate mitigation effects
Assess uncertainty

Identify parameters affected by the measure → Estimate mitigation scenario values for each parameter → Estimate mitigation scenario emissions from parameter values → Conduct sensitivity analysis

- The methods used for calculating emissions for each source and sink category and the aggregation across sources and sinks should be the same as for determining baseline scenario emissions.
- The only difference is in those parameter values that have been identified in the previous steps.
- These differences in parameter values should be clearly reported.

Example: Estimating mitigation scenario parameter values

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Define objectives and stakeholders

Identify potential effects and set boundary

Define methodology & collect data

Estimate baseline emissions

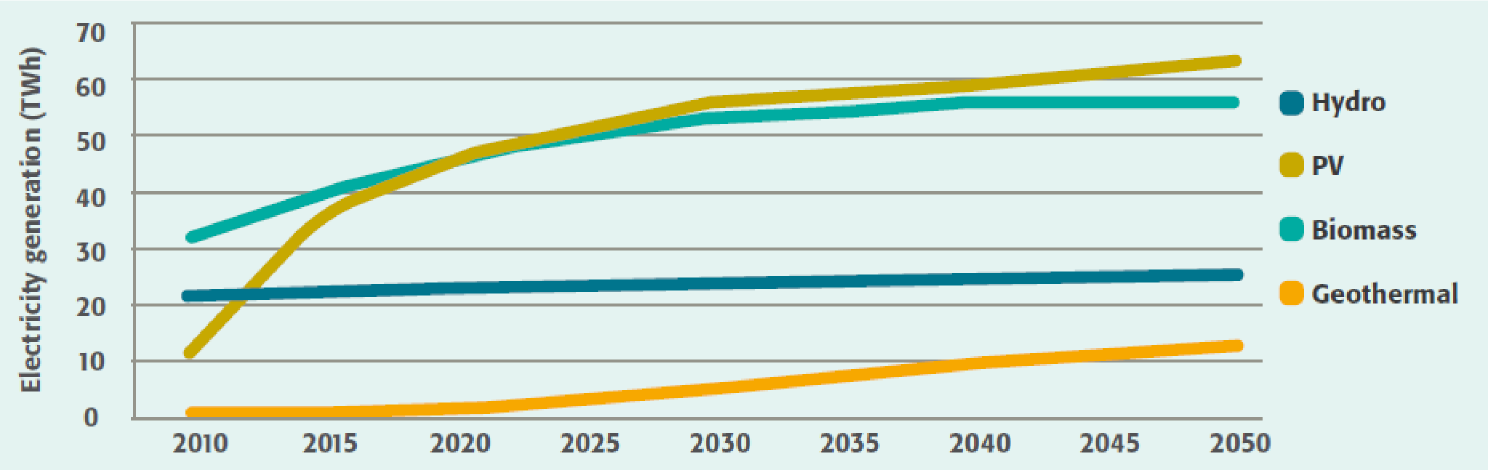
Estimate mitigation effects

Assess uncertainty

Developing assumptions for the mitigation scenario for the German Renewable Energy Act

Drivers: Cost-competitiveness is affected through the incentives provided in the Renewable Energy Act; cost of fossil fuel technologies remain the same as in the baseline scenario.

Parameters: As a result, the generation of all renewable energy technologies increases, and solar PV increases already before 2020.



Calculating mitigation effects

Define objectives and stakeholders

Identify potential effects and set boundary

Define methodology & collect data

Estimate baseline emissions

Estimate mitigation effects

Assess uncertainty

Total net change in GHG emissions resulting from the policy or action (t CO_2e) =

Total net policy scenario emissions (t CO_2e) – Total net baseline scenario emissions (t CO_2e)

Note: "Net" refers to the aggregation of emissions and removals. "Total" refers to the aggregation of emissions and removals across all sources and sinks included in the GHG assessment boundary.

- The above equation applies only within the defined assessment boundary.
- If you are conducting separate assessments of individual measures, you cannot automatically add up mitigation potential as there may be interactions between different measures.

➡ Adding up individual measures to sectoral or national levels needs to consider interactions between measures!

Types of uncertainty

Parameter uncertainty

From measurement errors, inaccurate approximation, or the way the data was modelled to fit the conditions of the activity.

- Usually represented as a probability distribution of possible values.

Scenario uncertainty

When multiple methodological choices are available, such as the selection of baseline assumptions.

- Conduct sensitivity analysis for key parameters to identify the influence of these choices on the results.

Model uncertainty

Simplifying the real world into a numeric model always introduces some inaccuracies.

- Acknowledge model uncertainties and state model limitations qualitatively.
- Compare with results from other models, if available.
- Compare with independent data, if available.
- Use expert judgement to assess uncertainty.

Topics for discussion

- What are the most challenging and resource intensive steps, and how can these challenges be addressed?
- What are the biggest challenges in defining a baseline?
- What are your experiences with data availability in your country? How have you addressed gaps?

MODULE D3

METHODS AND TOOLS FOR ASSESSMENT

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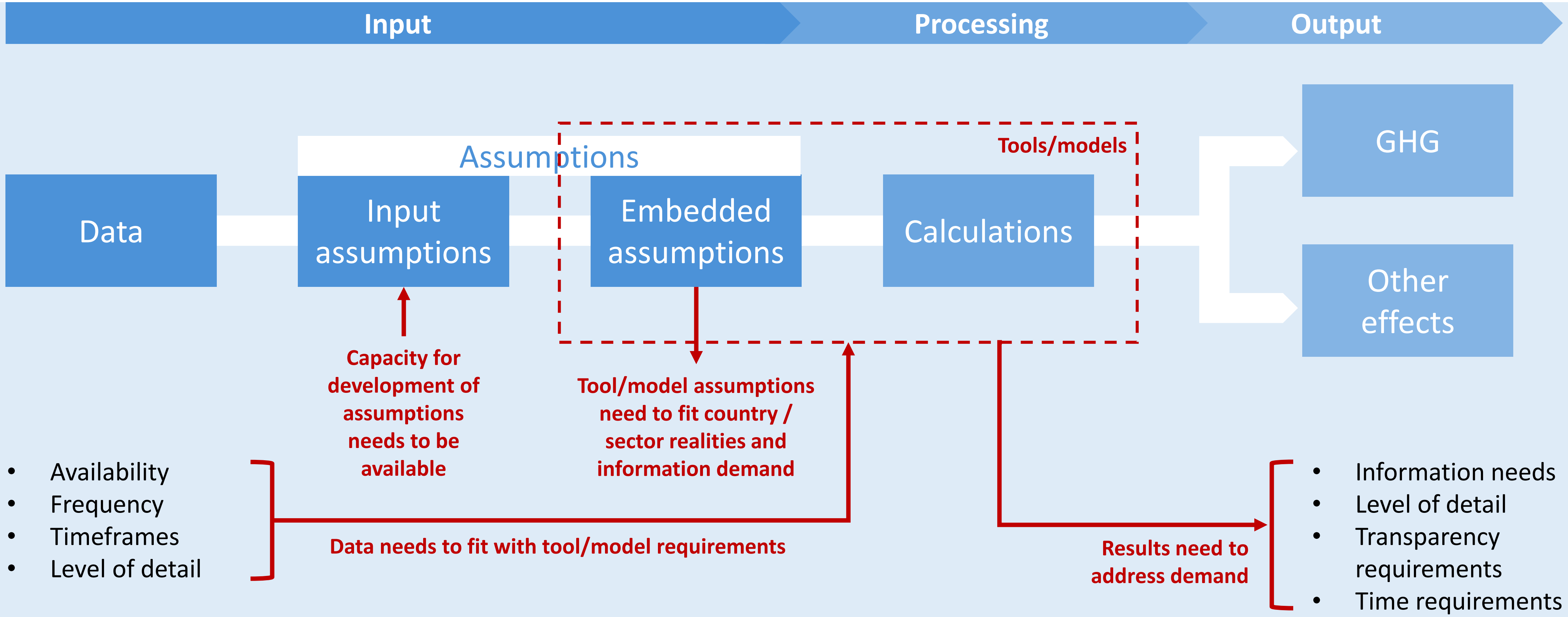
Methods & tools are important at each step

Focus of this section (Estimate baseline emissions; Estimate mitigation effects)

	Define objectives and stakeholders	Identify potential effects and set boundary	Define methodology & collect data	Estimate baseline emissions	Estimate mitigation effects	Assess uncertainty
Method examples	Stakeholder mapping	'Causal chain'	Data collection from representative sample	Scenario method	Direct calculation method	Trend analysis
Tool examples	Proximity charts	Whiteboard	Online survey tools	Model	Excel spreadsheet (own development)	Same tools as used for baseline / mitigation analysis

Quality of input will determine usefulness of output



Key questions for selecting methods / tools

Inputs

- What are the **data requirements** for the use of the method / tool? Is data available or can it be obtained?
- Are sufficient **capacity & resources** available to define high-quality assumptions needed for the method / tool?

Methods

- Is the underlying **approach** and **method** of existing tools suited to the objective of the assessment? Is a new tool needed?
- Can embedded assumptions in the tool be changed to **reflect country and/or sector realities**?
- How high is the need for sensitivity and uncertainty analysis (adding to resource needs)?

Outputs

- What is the **time** required to get results? Does that fit with when information is needed?
- Does the method / tool provide all information needed for the **objective** of the analysis? Or too much?
- Does the method / tool provide the geographic **scope** required?

Available approaches

Top down

Top-down models are standard tools for assessing the macroeconomic costs of GHG abatement and its economy-wide feedbacks on prices, commodity and factor substitution, income and economic welfare. The focus is on economy-wide assessment. Top down methods usually work with highly aggregated data.

Bottom up

Bottom-up models are used to investigate emission reductions delivered by the deployment of portfolios of technologies or techniques. Most bottom up methods are sector-specific and work with disaggregated data.

Hybrid

Integrate technology detail to the macroeconomic framework of top-down methods through the coupling of models or creating integrated models.

Top-down and bottom-up approaches

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	Advantages	Disadvantages
Top down	• Data needs are limited to mostly aggregated level and few parameters. • Can usually provide non-GHG effects. • Insights to feedback and spillover effects.	• Complex – Difficult to understand underlying assumptions. • No representation of technology choices, so most suited for measures that directly affect prices. • Highly sensitive to price and elasticity assumptions. • Not well-suited to measures in the AFOLU sector. • Assumptions on technology development difficult to incorporate.
Bottom up	• Can represent the actual technical and structural composition of sectors. • Allows to assess effects of technology-based and regulatory measures. • Dedicated AFOLU methods available.	• Lack of macroeconomic feedback. • High level of detail of data needed.
Hybrid	• Assessment of macroeconomic effects as well as technology-based and regulatory measures.	• Complex calibration needed.

Overview of methods

Identifying measure(s) delivering result according to set rules

- Integrated assessment*

Baseline and mitigation effect estimates

- Economic analysis*
- Trend / regression analysis
- Accounting frameworks
- Bottom-up optimisation
- Technology screening

Estimation of mitigation effects only

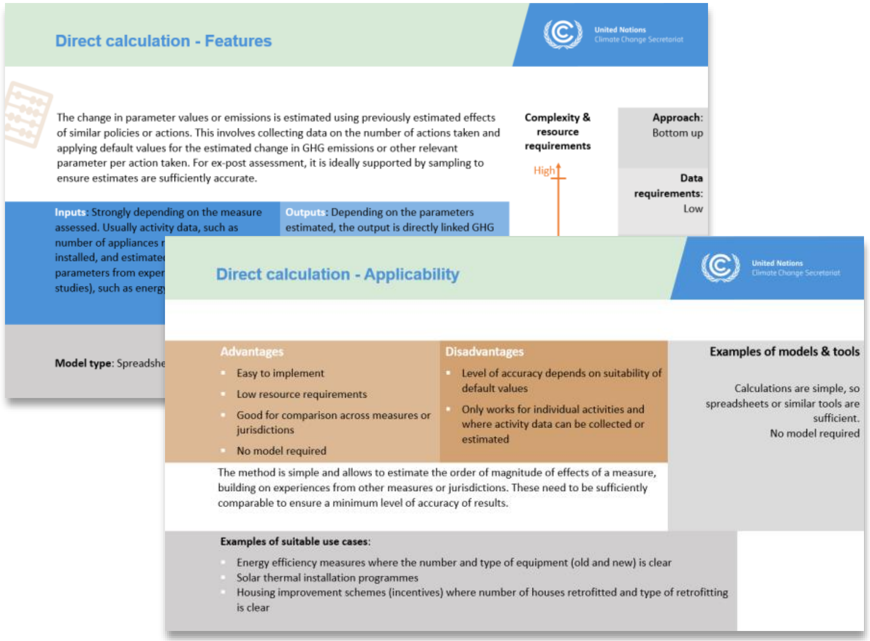
- Direct calculation (deemed estimates)

Variations

- Specific data sources: Comparison group method (ex-post only)
- Specific way to present results: Marginal abatement cost (MAC) curve

These represent variations but do not constitute methods in themselves, as the actual estimation requires the choice of one of the shown methods.

The next slides will introduce summary profiles for each method with information relevant for selection



* Top down methods – all others are considered bottom up methods

Integrated assessment - Features

Integrated analysis links the economy with energy consumption and impacts on the climate – ideally with a representation of land-use. They tend to be based on physical/technological descriptions of systems and their interconnections (energy, water, land, agriculture, forestry, food, etc.).

Inputs Depending on the model – mostly:

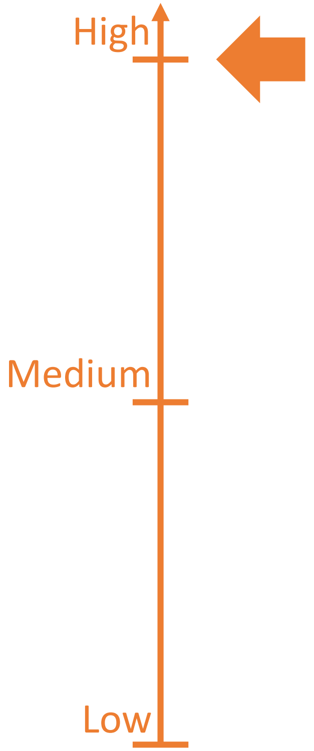
- Economic data,
- Energy supply & demand, emission data linked to use of energy,
- Climate data,
- Crop & livestock production (if included)

Outputs

- Emission projections,
- Energy supply & consumption,
- Aggregate economic indicators, economic welfare, health effects,
- Climate impacts

Model type: Integrated assessment models (IAMs)

Complexity & resource requirements



Approach: Top down or hybrid

Data requirements: High

Scope: Global, Economy-wide

Applicability: Measure(s) delivering result according to set rules

Integrated assessment - Applicability

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Advantages

- Provide estimates of changes in climate factors and economic damage from impacts
- Multiple outputs, depending on the model, including on land use

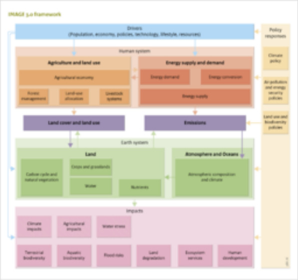
Disadvantages

- Highly complex
- High level of detail of data needed
- Usually global in scope, outputs not available for all countries, especially smaller countries

The data requirements of IAMs are model-dependent, as they can cover many modules, all of which require different data. They are broadly similar to economic models. Climate data are the main additional requirement. The possible integration of land-use modules is the most interesting feature for many developing countries.

Examples of models & tools

IMAGE - Integrated Model to Assess the Global Environment



ECE analysis framework: MESSAGEix, MAGICC, MACRO, GLOBIOM, GAINS

Examples of suitable use cases

- Understanding cost-effective pathways that are compatible with defined temperature limits at the global level
- Understanding climate impacts connected to different levels of mitigation

Economic analysis - Features

A macroeconomic model is used widely to assess policies and measures that have economy-wide effects. It captures the linkage between markets across the entire economy, thus reflecting not only the direct impact of a policy but also indirect impacts on other linked markets.

Inputs Depending on the model – mostly:

- Economic data (national accounts)
- Energy supply & demand, emission data linked to use of energy
- **CGE**: economic transactions for one year & elasticities
- **ME**: data series required

Outputs

- GDP impacts (usually growth)
- Depending on model, also: tax revenues, labour market dynamics, trade, prices, sectoral impacts

Model types: Computational General Equilibrium (**CGE**), Macroeconometric (**ME**)

! The model types have different underlying economic theories!

Complexity & resource requirements

High

Medium

Approach: Top down or hybrid

Data requirements: High

Scope: Global or economy-wide

Applicability: Baseline & mitigation effects

Economic analysis - Applicability

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Advantages

- Provide non-GHG effects, especially economic
- Can reveal indirect or unintended effects
- Highly flexible
- Captures cross-sectoral effects

Disadvantages

- High level of expertise needed
- Extensive programming skills needed
- **CGE**: underlying economic theory not suited to short-term assessment
- **ME**: high data requirements

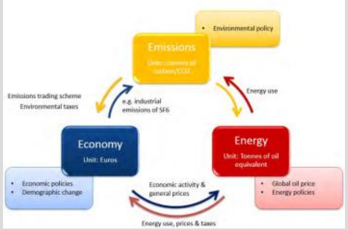
Model assumptions may not always fit the requirements of the assessor. If the focus of the assessment is not specifically on economic outcomes, the usual strengths of these modelling efforts may not be applicable.

Examples of models & tools

GTAP (CGE) model & database

GEMPACK (CGE)

E3ME (ME)



Country-specific examples

NCAER-CGE (India)

Examples of suitable use cases

- Estimation of national-level baselines and mitigation scenarios
- Understanding economic and non-GHG effects of mitigation efforts

Trend / regression analysis - Features

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Trend and regression analyses relies on having a large amount of data for the indicators covered. The method relies on the assumption that trends observed in the past are likely to be perpetuated in the future. Trend analysis focuses on extrapolating an observed pattern in a historic time series of a given indicator. Regression analysis estimates the relationship between 'dependent' and 'independent' variables.

Inputs

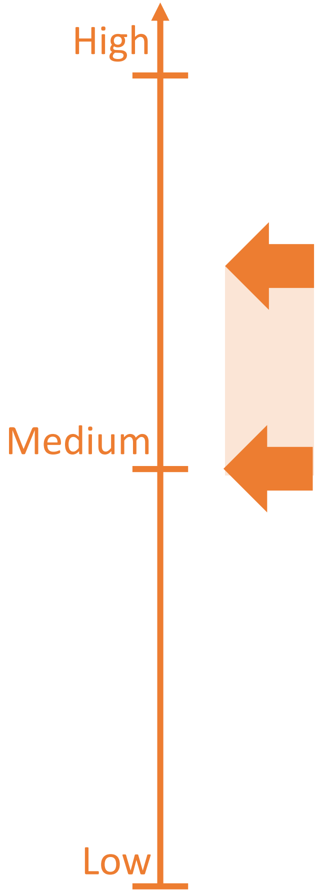
- Time series data depending on the level of detail and objective of the assessment:
  - Trend: of the indicator assessed
  - Regression: of dependent and independent variables

Outputs

- Trend: Extrapolation of indicator values
- Regression: Prediction of dependent variables

Model types: Trend analysis, regression analysis

Complexity & resource requirements



Approach: Bottom up

Data requirements: High

Scope: Economy-wide, sectoral or measure

Applicability: Baseline & mitigation effects

Trend / regression analysis - Applicability

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Advantages

- Relatively simple and fast to implement
- Applicable to different levels of detail

Disadvantages

- Time series data required
- Reliance on strong, sometimes oversimple, assumptions
- Extreme reliance on quality of input

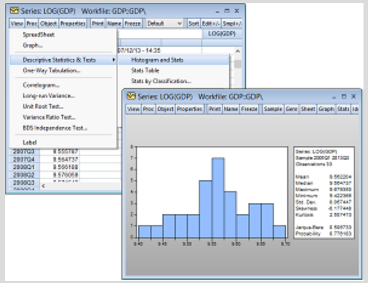
Examples of models & tools

GACMO

Stata

eViews

Excel



Regressions by themselves only reveal relationships between a dependent variable and a collection of independent variables in a fixed dataset. To use the method to extrapolate future developments there must be a clear justification why existing relationships have predictive power or why a relationship between two variables has a causal interpretation.

Examples of suitable use cases

- Estimation of order of magnitude of effects for technology or measure screening
- Estimation of future developments of individual indicators
- Development of parameter assumptions for developing baselines

Accounting frameworks - Features

Accounting frameworks account for physical stocks and flows in systems based primarily on engineering or physical relationships. They are used for energy systems as well as non-energy applications, such as carbon stock accounting in forests. The methods rely on explicit assumptions about the future, such as technology improvements, market penetration rates or harvesting rates.

Inputs

- Detailed representation of the sector
- Technology development and penetration rates or sector composition (e.g. carbon pools)
- Macroeconomic data (depending on model)
- System constraints

Outputs

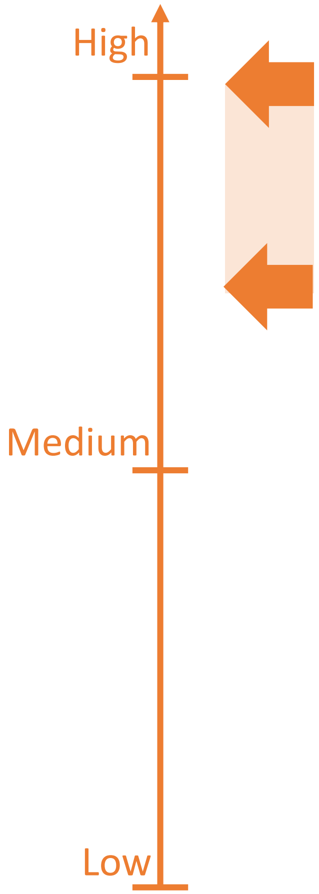
- GHG emissions and / or carbon sequestration

plus

- For energy sector: energy demand and supply
- For land use: carbon pool development
- For waste: air pollutants

Model types: Engineering models, energy system models, stock models

Complexity & resource requirements



Approach: Bottom up

Data requirements: Medium to high

Scope: Sectoral

Applicability: Baseline & mitigation effects

Accounting frameworks - Applicability

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Advantages

- Detailed representation of the sector
- High level of technical feasibility for implementation
- Realistic representation of local context

Disadvantages

- No interaction outside the sector
- No wider economic feedback on energy consumption
- High expertise requirements

Accounting frameworks are widely used in all sectors as they manage to capture the specific context and can be used to assess a wide range of interventions. Sector-specific models can also be combined with existing macroeconomic models to assess wider implications on the economy and welfare.

Examples of models & tools

LEAP (energy demand & supply)*

GREET (vehicle technologies)

GLOBIOM (land-use competition for bioenergy)

G4M (forests)

Ex-ACT (AFOLU)

LandGEM (landfill gas)

Examples of suitable use cases

- Estimation of sectoral baselines and mitigation scenarios
- Estimation of effects of individual measures
- Understanding technical feasibility of measures

* Note that LEAP supports a range of methods, accounting being one of them

Bottom up optimisation - Features

This method uses mathematical programming to identify configurations of energy systems that minimize the total cost of providing services, combining accounting frameworks with economic analysis. The method aims to determine the energy system that meets the energy service demands over the assessment time horizon at least cost

Inputs

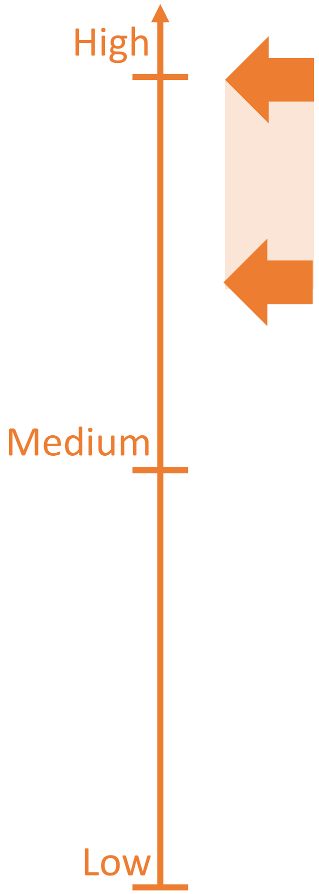
- Detailed representation of the sector
- Technology development and penetration rates
- Macroeconomic data
- System constraints

Outputs

- Energy demand and supply
- Technology and fuel mix
- GHG and other emissions
- Cost
- Prices

Model types: Optimisation models, simulation models

Complexity & resource requirements



Approach: Bottom up

Data requirements: High

Scope: Sectoral (mostly energy)

Applicability: Baseline & mitigation effects

Bottom up optimisation - Applicability

Advantages

- Combination of technical representation of local situation with economic analysis
- Enhanced understanding of overall system behaviour

Disadvantages

- No interaction outside the sector
- High expertise requirements

Examples of models & tools

Optimisation:

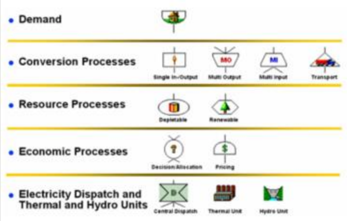
TIMES (MARKAL)

NEMO / LEAP

MESSAGEix

Simulation:

ENPEP-BALANCE



The method aims to develop technology strategies and related investment portfolios to meet a range of user-specified policy objectives. In contrast to economic analysis, the method allows an assessment of individual technical and behavioural choices.

Examples of suitable use cases

- Understanding cost-effective pathways to achieve pre-defined objectives

Technology screening - Features

Technology screening is used to determine the most suitable technology or project design in each context. Like bottom up optimisation, the underlying methods and calculations are usually based on accounting frameworks combined with economic analysis, but here on the project or project portfolio level to determine least-cost options for individual projects. The focus is on technology-based measures.

Inputs

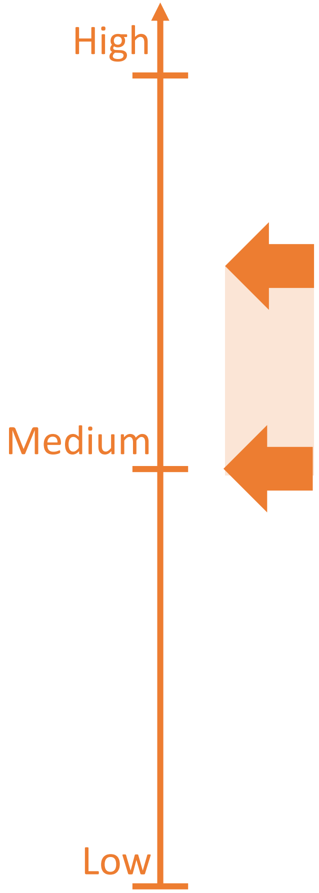
- Detailed representation of the sector
- Technology development and penetration rates
- Macroeconomic data

Outputs

- Least-cost options
- Financial risk
- Performance

Model types: Specialised software

Complexity & resource requirements



Approach: Bottom up

Data requirements: High

Scope: Measure

Applicability: Baseline & mitigation effects

Technology screening - Applicability

Advantages

- Supports optimisation of project design
- Ensures technical and financial feasibility of projects
- Helps select most appropriate projects

Disadvantages

- High level of detailed facility-level data needed
- Not suited for behaviour-based measures
- Location-specific

Examples of models & tools

RETScreen (energy & transport)

HOMER (energy)

Tools usually come with a wide range of default data that can be adapted, if location-specific data is available.

Examples of suitable use cases

- Determine feasibility of projects & technologies
- Select least-cost / cost-effective projects & technologies

Direct calculation - Features

The change in parameter values or emissions is estimated using previously estimated effects of similar policies or actions. This involves collecting data on the number of actions taken and applying default values for the estimated change in GHG emissions or other relevant parameter per action taken. For ex-post assessment, it is ideally supported by sampling to ensure estimates are sufficiently accurate.

Inputs Depending on the measure assessed, usually:

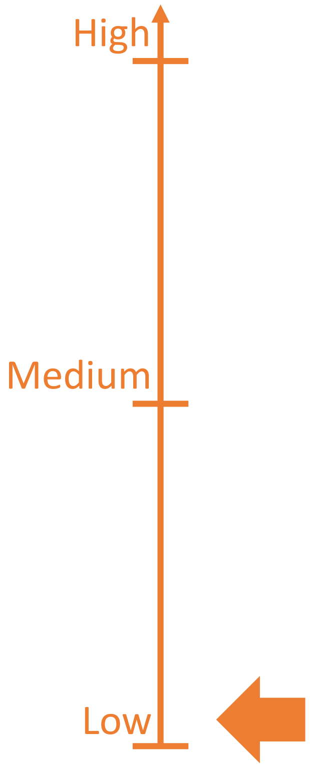
- Activity data (e.g. number of appliances replaced, capacity of PV installed)
- Estimated change of relevant parameters from experience (e.g. energy savings per unit)

Outputs Depending on the parameters estimated:

- GHG effects
- A parameter that can be easily converted to GHG using default values, such as change in energy consumed

Model type: Simple spreadsheet calculation

Complexity & resource requirements



Approach: Bottom up

Data requirements: Low

Scope: Measure

Used for estimation of: Mitigation effects

Direct calculation - Applicability

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Advantages

- Easy to implement
- Low resource requirements
- Good for comparison across measures or jurisdictions
- No model required

Disadvantages

- Level of accuracy depends on suitability of default values
- Only works for individual activities and where activity data can be collected or estimated

Examples of models & tools

Calculations are simple, so spreadsheets or similar tools are sufficient.
No model required

The method is simple and allows to estimate the order of magnitude of effects of a measure, building on experiences from other measures or jurisdictions. These need to be sufficiently comparable to ensure a minimum level of accuracy of results.

Examples of suitable use cases

- Energy efficiency measures where the number and type of equipment (old and new) is clear
- Solar thermal installation programmes
- Housing improvement schemes (incentives) where number of houses retrofitted and type of retrofitting is clear

Comparison group method - Features

This is a variation of the scenario method. The difference is in the scope of data collection for baseline and mitigation effect estimates.

The comparison group method involves comparing one group or region affected by a measure with an equivalent group or region that is not affected by that measure or collects data from the same group before and after the implementation of the measure.

The type of data to be collected depends on the estimation method selected. Normally this approach is used in combination with bottom up methods.

Inputs

- Data from comparison group or from before implementation
- Data from affected group or from after implementation

Emissions estimates from the control group constitute the baseline. Emissions estimates from the group affected by the measure constitute the mitigation scenario. The difference is the achieved mitigation effect.

Approach: Bottom up

Data requirements: Depending on method

Scope: Measure

Applicability: Ex-post mitigation effects only

Marginal abatement cost (MAC) curve - Features

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MAC curves constitute a special form to illustrate assessment results. The graphs show the direct cost of reducing GHG emissions through a range of measures or technologies, starting with the lowest-cost options. The curve builds up these options sequentially, with any point on the curve depicting the marginal cost of the last abated unit of emissions (usually in dollars per tonne of CO_2e) on the y-axis and the magnitude of mitigation potential on the x-axis. MAC curves are useful for analysing data graphically and communicating the costs of a wide range of carbon mitigation measures.

Approach: Bottom up

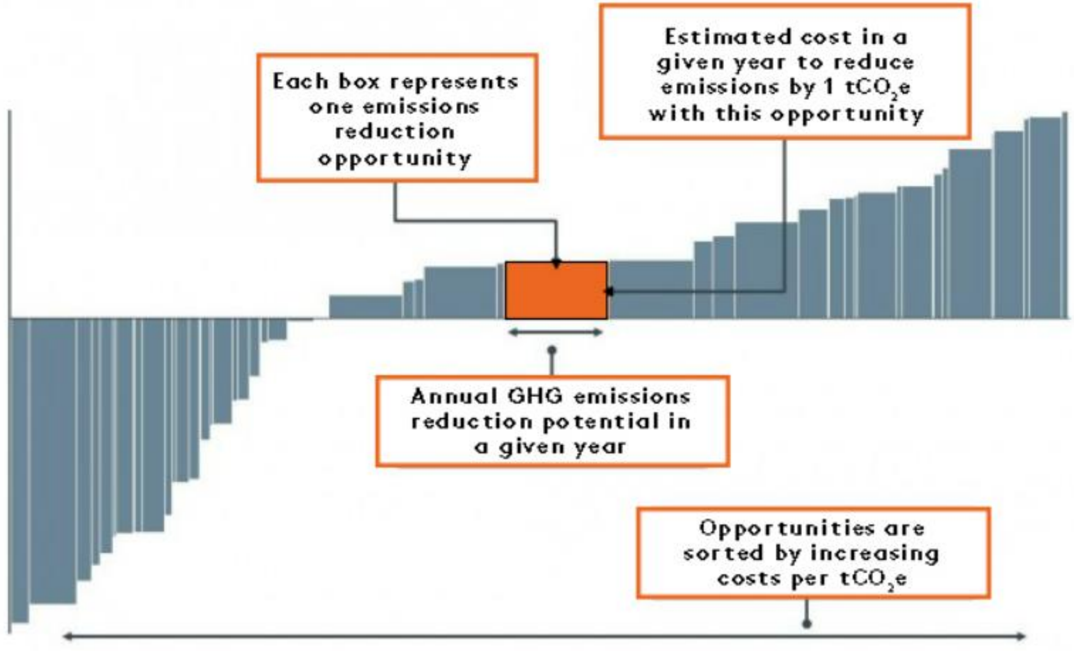
Data requirements: Medium

Scope: Measure

Applicability: Mitigation effects

Outputs

- Graphic illustration of marginal abatement cost and potential across a range of measures for a particular year



Matching methods and tools with objectives

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		Type of outputs			Suitability for objectives		
Method	**Model type**	**Non-GHG effects**	**Time series scenarios**	**Time range of assessment**	**Setting targets**	**Estimate achieved results**	**Estimate future effects**
Integrated assessment	**IAM**	GDP, welfare, health, etc.	x	Long-term	xxx	o	x
Economic	**CGE (static)**	GDP, prices, tax revenue, labour	o	Medium-term	xx	o	x
Economic	**CGE (dynamic)**		x	Medium-term	xx	o	x
Economic	**ME**	Economic	x	Short- to medium term	xx	x	x
Trend	**Statistics**	o	x	Short- to medium term	x	o	x
Bottom-up optimisation	**Optimisation, simulation**	Economic, (pollutants)	x	Medium- to long-term	x	o	xx

o = not suited

o/x = limited suitability or depending on model

x = suitable (number of ‘x’ indicate level of suitability)

Matching methods and tools with objectives

Method	Model type	Type of outputs			Suitability for objectives		
		Non-GHG effects	Time series scenarios	Time range of assessment	Setting targets	Estimate achieved results	Estimate future effects
Accounting frameworks	**Specialised**	o/x	x	Short- to medium term	o/x	xx	xxx
Technology screening	**Specialised**	x	x	Short- to medium term	o	xx	x
Direct calculation	**Spreadsheet**	o	x	Short-term	o	x	xx
Comparison group	**N/A**	o	o	N/A	o	xxx	o
MAC curves	**N/A**	Marginal cost	o	Depending on method	x	o	o

o = not suited   o/x = limited suitability or depending on model   x = suitable (number of ‘x’ indicate level of suitability)

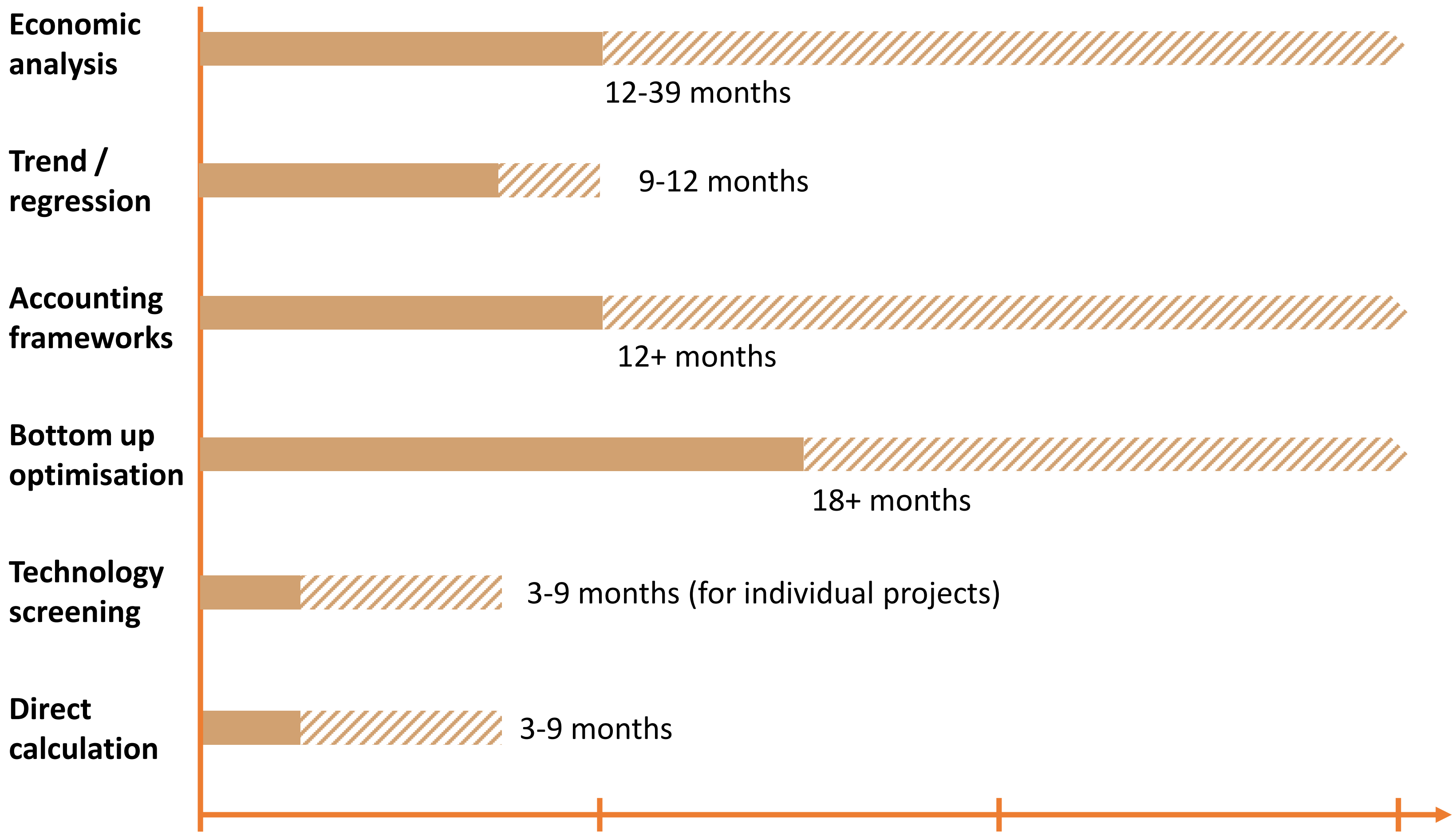
Time requirements for different methods

These are indicative estimates of the time required to:

- Understand the method and tools
- Set up
- Calculations and quality control
- Analysis of results

This does not include the time required for data collection, which will vary based on:

- The method selected
- Available data
- Ease of collecting missing data in the specific context



Criteria for choosing a method

- **Objectives**: Which method is best suited to deliver the objectives of the assessment?
- **Time frame**: By when are results needed and how long does the implementation of methods take?
- **Available resources**: Is personnel available that is familiar with the method? How much budget is available?
- **Transparency**: What is the need for transparency of calculation vs. the requirement for complexity?

Criteria for selecting models/tools

- Suitability to selected method
- Available ‘in-house’ capacity within institutions
- Available capacity in the country (local experts)
- Training and support availability (type, languages, cost)
- Suited to country context or able to be configured to country context
- Level of detail and flexibility of data needs
- Availability of default data and ability to replace with own data
- Availability of hardware to run models / tools
- Languages available

Increasing complexity of models will not always increase usefulness

- Integrating an increasing number of interactions and interrelations between actors, systems and sectors makes models more complex.
- This can be useful and needed to answer specific information needs.
- However, using complex models may not always be better compared to simple tools, if
  - The quality of inputs is not sufficiently high,
  - The embedded assumptions are not suited to the context,
  - They deliver results that are not actually required in the provided detail for the given purpose, and
  - The lack of transparency endangers credibility of results with stakeholders.

➡ It may be more effective to put more effort into the collection of data and determining realistic assumptions for future development than in acquiring and using complex models

The institutional setup is important

- Mitigation assessment is a team-effort.
- A strong and coordinated team is needed that may need to include experts from various sectors and fields of expertise, including, as appropriate: economists, engineers, energy and industrial engineers, agriculture and land-use change and forestry (LULUCF) experts.
- Close coordination with the team working on the GHG inventory is critical.
- Consultants can provide a ready source of expertise but should work closely with the team to build own capacity.

➡ Ideally there is a permanent team responsible for mitigation assessment to ensure continuity of expertise.

In-house development, licensing or contracting

	Advantages	Disadvantages
Contract out modelling	• Simple and fast • No internal expertise required • Analysis carries weight and branding of contracted organisation	• No development of internal capacity
Licensing an existing model to use in-house	• Lower cost than in-house development • Opportunity to train experts without full commitment to one model	• Little control over future development • Reliance on external providers for updates • Internal cost for understanding and running the model
In-house development of a new model	• Suitable for long-term use • Model can be shaped by future policy requirements	• High time requirements • High level of programming skill and expertise in economics required • High cost

! Important to ensure access to data, assumptions & method documentation!

Internalising analysis and building capacity over time

Topics for discussion

- Which factors do you find most important in deciding whether to outsource an assessment?
- What is the most difficult part in selecting appropriate methods and tools?
- Have you worked with assessment tools in the past? If yes, what are your experiences with using these tools?

MODULE D4

AVAILABLE SUPPORT

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Types of support for mitigation assessment

Capacity-building support

- Overall assessment process
- Stakeholder engagement
- Methodology selection

Model-/tool-specific support

- Understanding data requirements and outputs of the specific model/tool
- Understanding configuration options

Financial support

- Funding for UNFCCC reporting
- Funding for strengthening the institutional setup

Capacity-building support under the UNFCCC

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Training activities

- Workshops and webinars under the CGE
- E-learning courses
- Blended courses (hybrid with in-person and online components)
- Training programme for technical experts participating in the TER of BTRs

Material and tools

- MRV training material
- Compendium on Greenhouse Gas Emissions Baselines & Monitoring

MRV/Transparency helpdesk and Facebook exchange group

- Providing opportunity to exchange, an expert database and a library

UNFCCC support links:

https://unfccc.int/CGE

https://unfccc.int/universal-participation-ETF#tab_home

Compendium on greenhouse gas baselines and monitoring:

National level mitigation actions

Building and construction sector

Passenger and freight transport

Integrating gender considerations into reporting on support needed and received

- A number of decisions have strengthened the way in which gender issues are addressed in the UNFCCC process.
- Gender-responsive public finance has to be more effective and efficient.
- Multilateral climate change funds have been front-runners in mainstreaming gender considerations in governance and operations.
- Those under the Financial Mechanism now have a mandate to include information on gender considerations in their annual reports to the COP.
- While advances are being made, there is scarce information on gender-responsive budgeting, suggesting that work remains to be done in integrating gender considerations on the ground.

Development Finance Corporation (DFC) five-year strategic plan, “Strategy 2021: Building Resilience Against Climate Change & Economic Volatility”

DFC will aim at mainstreaming gender and climate resiliency in all operations, provide co-financing and risk-sharing in projects with government participation through project financing and guarantees, and explore new products, including export finance, venture capital and other forms of equity financing.

Some key principles for gender-responsive financing

- Gender equality and women's empowerment as guiding principles and a **crosscutting mandate** for all climate finance instruments rooted in a human-rights-based approach
- **Gender-responsive funding guidelines**, allocation criteria and financial instruments for each thematic funding window or sub-fund
- A **beneficiary and people-centred approach**, paying particular attention to some of the small-scale and community-based actions in which women are over-represented, including as owners of micro, small and medium-sized enterprises in developing countries
- Explicit **gender criteria** in performance objectives and results measurement frameworks and for the evaluation of funding options.
- **Gender-balance and gender-expertise of an institution's staff** as well as its technical advisory bodies and panels.
- Special efforts to seek the meaningful **input and participation of women** as key stakeholders and beneficiaries in fund-related country-coordinating mechanisms to determine a country's funding priorities.
- A regular **audit of the gender impacts** of funding allocations in order to ensure balance between mitigation and adaptation activities and gender-responsive delivery across different scales and geographical foci of activities.
- A robust set of **social, gender and environmental safeguards** and **guidelines** and **capacity-building support** for their implementation that guarantee gender equality, women's rights and women's full participation.
- **Independent evaluation and recourse mechanisms** easily accessible to groups and individuals, including women, affected by climate change funding in recipient countries to allow them to voice their grievances and seek compensation and restitution.

The Capacity-building Initiative for Transparency

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Objectives

- To strengthen national institutions for transparency related activities in line with national priorities
- To provide relevant tools, training and assistance for meeting the provisions stipulated in Article 13 of the Paris Agreement
- To assist with the improvement of transparency over time

https://www.thegef.org/what-we-do/topics/capacity-building-initiative-transparency-cbit

Capacity-building support from other sources

ICAT – The Initiative for Climate Action Transparency is a multi-stakeholder partnership providing support and practical tools and methodologies to build transparency frameworks: https://climateactiontransparency.org/

Initiative for Climate Action Transparency

GHGMI – The Greenhouse Gas Management Institute is an NGO providing training in GHG accounting, auditing and management: https://ghginstitute.org/

ghg management institute

FAO – The Food and Agricultural Organisation of the United Nations supports countries with tools, training, networking and an expert roster related to transparency in the AFOLU sector: https://www.fao.org/climate-change/our-work/what-we-do/transparency/en/

Food and Agriculture Organization of the United Nations

Most **development agencies** provide support relevant to mitigation assessment.

Collaboration between Parties and others

The Partnership on Transparency in the Paris Agreement is a semi-formal forum launched originally in 2010 at the Petersburg dialogue. It aims to support practical exchanges and policy dialogue on climate transparency.
https://transparency-partnership.net/

The Global Climate Action Partnership (GCAP) (formerly LEDS-GP) engages leaders from over 300 institutions across government agencies, technical institutes, international agencies, and NGOs. It provides technical assistance and knowledge products, including toolkits and a good practice database.
https://globalclimateactionpartnership.org/?loclang=en_gb

The NDC Partnership is supporting member countries with tailored services through a large network of partners. The in-country experience is shared across members and beyond.
https://ndcpartnership.org/

Model-/tool-specific support

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From model developers

Most model/tool developers offer:

- Documentation with varying levels of detail
- Training and training materials
- Individual technical support

Some of this support is available free of charge for everyone, some only for developing countries (and/or educational institutions and NGOs).

From third parties

For some of the more widely used models and tools training and support are available from other sources, such as commercial consultancies, academia or development agencies.

The availability and cost of training and technical support for individual models & tools can be a criteria for selection

Financial support

GEF funding for NC/BTR reporting

Modality 1: Prepare a stand-alone BTR (indicative: US$600,000)

Modality 2: Prepare a combined BTR and National Communication (NC) (indicative: US$633,000)

Modality 3: Top-up financing to an ongoing enabling activity project (up to US$250,000)

Other funding under the GEF

Capacity-building Initiative for Transparency (CBIT)

https://www.thegef.org/what-we-do/topics/capacity-building-initiative-transparency-cbit

Topics for discussion

United Nations
Climate Change Secretariat

- What are the largest challenges you are encountering in accessing support?
- Are there any areas in mitigation assessment where it is difficult or impossible to find support, i.e. areas where more or different support would be required?

THANK YOU FOR YOUR ATTENTION.

https://unfccc.int/CGE

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Climate Change Secretariat