Sustainable Development Methodology

PART IV : QUANTITATIVE APPROACH TO IMPACT ASSESSMENT

ICAT INITIATIVE FOR Climate Action Transparency

Overview of ICAT

ICAT | INITIATIVE FOR Climate Action Transparency

Introductory Guide

Impact Assessment Methodologies

Greenhouse gas impacts

- Renewable Energy
- Buildings Efficiency
- Transport Pricing
- Agriculture
- Forestry

- Sustainable Development
- Transformational Change
- Non-State and Subnational Action

Process Guidance Documents

- Stakeholder Participation
- Technical Review

Overview of the SD methodology

Part I: Introduction, objectives and key concepts

Understand the purpose and applicability of the methodology (Chapter 1)
Determine the objectives of the assessment (Chapter 2)
Understand key concepts and steps, and plan the assessment (Chapter 3)

Part II: Defining the assessment

Clearly define the policy to be assessed (Chapter 4)
Choose which impact categories and indicators to assess (Chapter 5)

Part III: Qualitative approach to impact assessment

Identify specific impacts of the policy within chosen impact categories (Chapter 6)
Qualitatively assess each specific impact (Chapter 7)

Part IV: Quantitative approach to impact assessment

Estimate baseline values for impacts included in the quantitative assessment boundary (Chapter 8)
Estimate policy scenario values for the same impacts (ex-ante) (Chapter 9)
Estimate policy scenario values for the same impacts (ex-post) (Chapter 10)
Assess uncertainty (Chapter 11)

Part V: Monitoring and reporting

Monitor the performance of indicators over time (Chapter 12)
Report the results and methodology used (Chapter 13)

Part VI: Decision-making and using results

Evaluate synergies and trade-offs, and decice which policies to implement (Chapter 14)

Part IV: Overview

Part IV: Quantitative approach to impact assessment

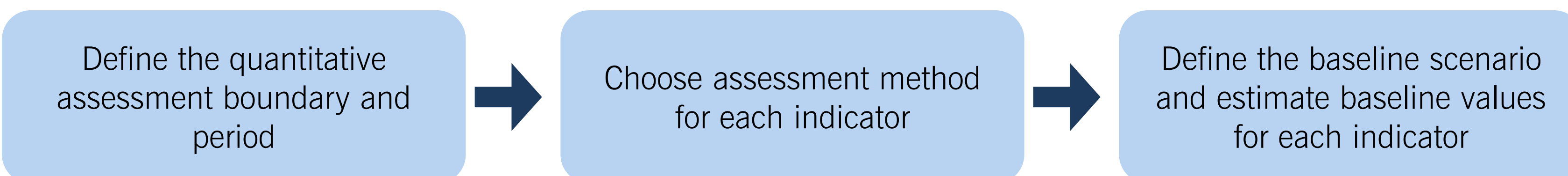
- Estimate baseline values for impacts included in the quantitative assessment boundary (Chapter 8)
- Estimate policy scenario values for the same impacts (ex-ante) (Chapter 9)
- Estimate policy scenario values for the same impacts (ex-post) (Chapter 10)
- Assessing uncertainty (Chapter 11)

This button indicates a key recommendation

This is an interactive panel: navigate by clicking on a particular step

Chapter 8. Estimate baseline values for impacts included in the quantitative assessment boundary

Estimating the baseline scenario, that represents the events or conditions that would most likely occur in the absence of the policy or action being assessed.



8.1 Define the quantitative assessment boundary and period

SCOPE

RANGE OF DIMENSIONS

IMPACT CATEGORIES | Indicator(s) and needed parameters

Significant impact | **Significant impact** | **Significant impact**

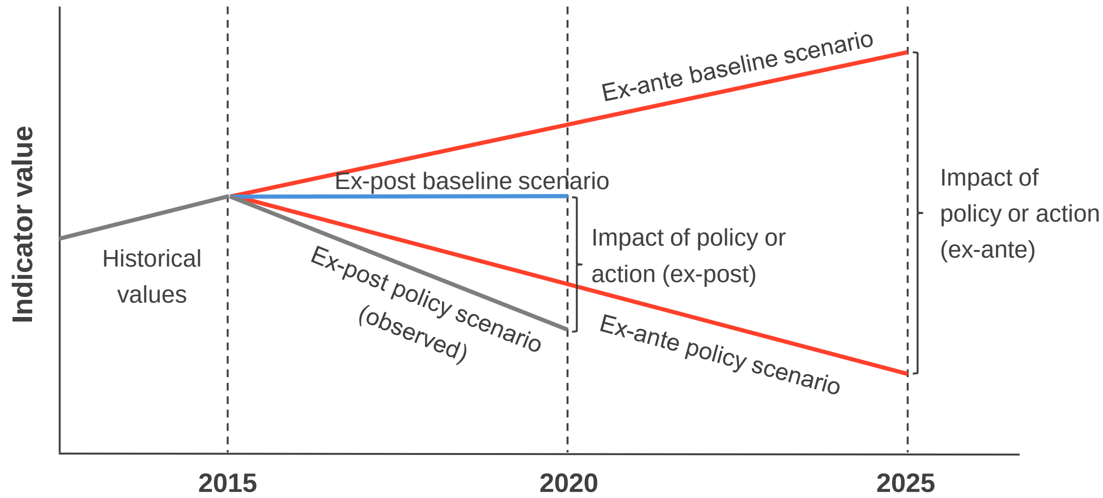
- Impacts to include
  - **Significant**: combination of likelihood and magnitude (Chapter 7)
  - **Feasible to assess**: data availability, technical capacity, resources available
- Indicators selection
  - Relevant to **quantify** identified impacts
  - **Data collection** possible
- Define the assessment period
  - Usually the same as the one defined in the qualitative assessment

- Include all significant impacts in the quantitative assessment boundary, where feasible.
- Define one or more appropriate indicators for each impact category included in the quantitative assessment boundary.
- Define the assessment period.

8.2 Choose an assessment method for each indicator

- Comparison of the outcome of the policy against an estimate of what would mostly have happened in the absence of policy.
  - **Scenario** method (ex-ante and ex-post assessment)
  - **Deemed estimates** method (ex-ante and ex-post assessment)
  - **Comparison group** method (ex-post assessment only GO TO Chapter 10)

- Scenario method



8.3 Estimate baseline values for each indicator

- Valid for the scenario method (both ex-ante and ex-post assessments)
- Method for separate assessments for each impact category

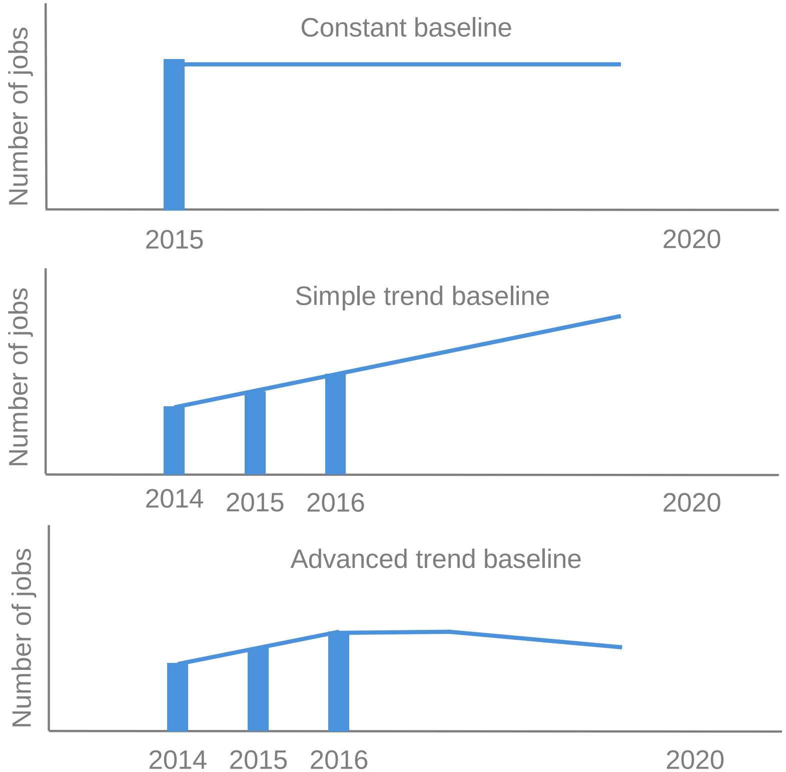
STEP 1	STEP 2	STEP 3	STEP 4	STEP 5
Select a desired level of **accuracy** and **complexity.**	Define **the most likely baseline** scenario for each indicator.	Define the **methods** and **parameters** needed to estimate baseline values.	**Collect data** for each indicator.	Estimate baseline **values** for **each indicator**.

8.3.1 Select a desired level of accuracy and complexity

- Achieve a sufficient level of accuracy to meet the objectives of the assessment.

- Constant baseline
- Simple trend baseline
- Advanced trend baseline

The choice can be tailored for each impact category.

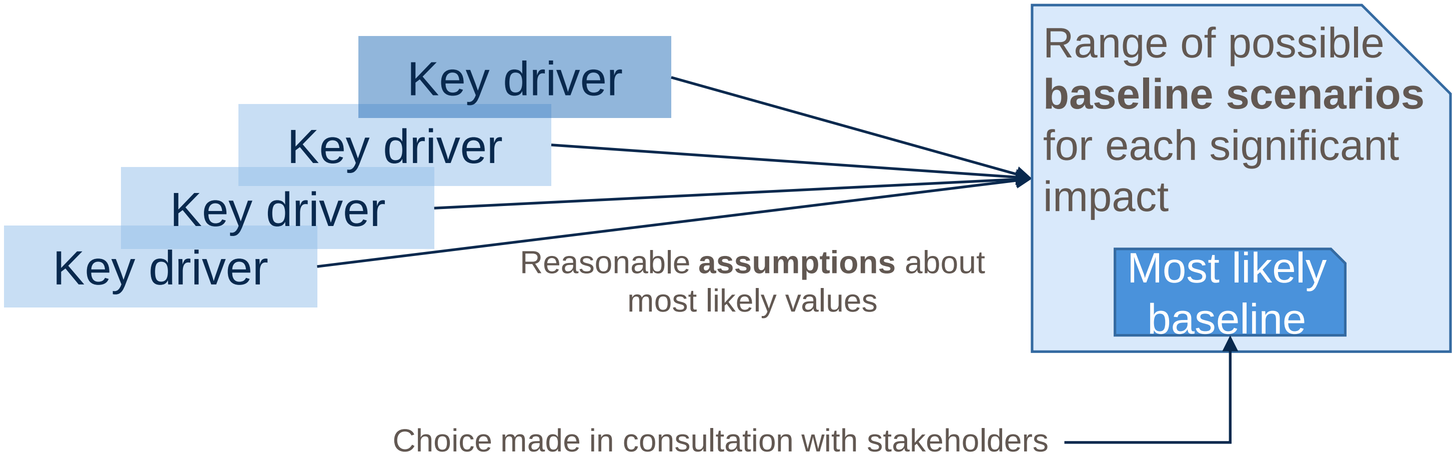


Chapter 8 | Chapter 9 | Chapter 10 | Chapter 11 | More details about different baselines

ICAT Initiative for Climate Action Transparency

8.3.2 Define the most likely baseline scenario

STEP 1
STEP 2
STEP 3
STEP 4
STEP 5



KEY DRIVERS

Other policies or actions
- With key parameters in common with the assessed policy
- Have a significant effect on the included impacts
- Implemented or adopted in the assessment period

Non-policy drivers
- Wide range of exogenous factors that have a significant change in calculated impacts.

Define a baseline scenario that represents the conditions most likely to occur in the absence of the policy or action for each indicator included in the assessment boundary.

8.3.3 Define necessary methods and parameters to estimate baseline values

STEP 1
STEP 2
STEP 3
STEP 4
STEP 5

1) Identification of a method for estimating the baseline scenario

- Achieves **sufficiently accurate results** in the context of objectives, data availability and resource constraints.
- Large variety of methods: from very simple to very complex
- Considerations for choosing a method:
  - model capabilities
  - costs
  - ease of use
  - data needs
  - data availability

2) Identify the data requirements for the chosen method

8.3.4 Estimate the baseline values for each indicator

STEP 1
STEP 2
STEP 3
STEP 4
STEP 5

STEP 4: Collect data for each indicator

	Option 1: Using baseline values from published data sources	Option 2: Estimating new baseline values
Data availability	• High-quality, up-to-date and peer-reviewed data from recognized, publicly available, credible sources is available.	• No published baseline data and assumptions available for historical or projected data, • Existing data may be incomplete, of poor quality, or in need of supplementation or further disaggregation.
Guidelines	Apply data quality indicators: data most representative in terms of technologies and practices, time and geography, completeness and reliability.	1.Collect historical data for the indicator 2.Identify other policies and non-policy drivers that affect each indicator over the assessment period, and make assumptions for those drivers 3.Estimate baseline values for each indicator, based on historical data and assumptions about drivers.
Reporting	• Baseline values for each indicator being estimated over defined time periods • Assumptions and references	

STEP 5: Apply the chosen method with the data collected to estimate the baseline values for each indicator

Estimate baseline values over the assessment period for each indicator included in the assessment boundary.

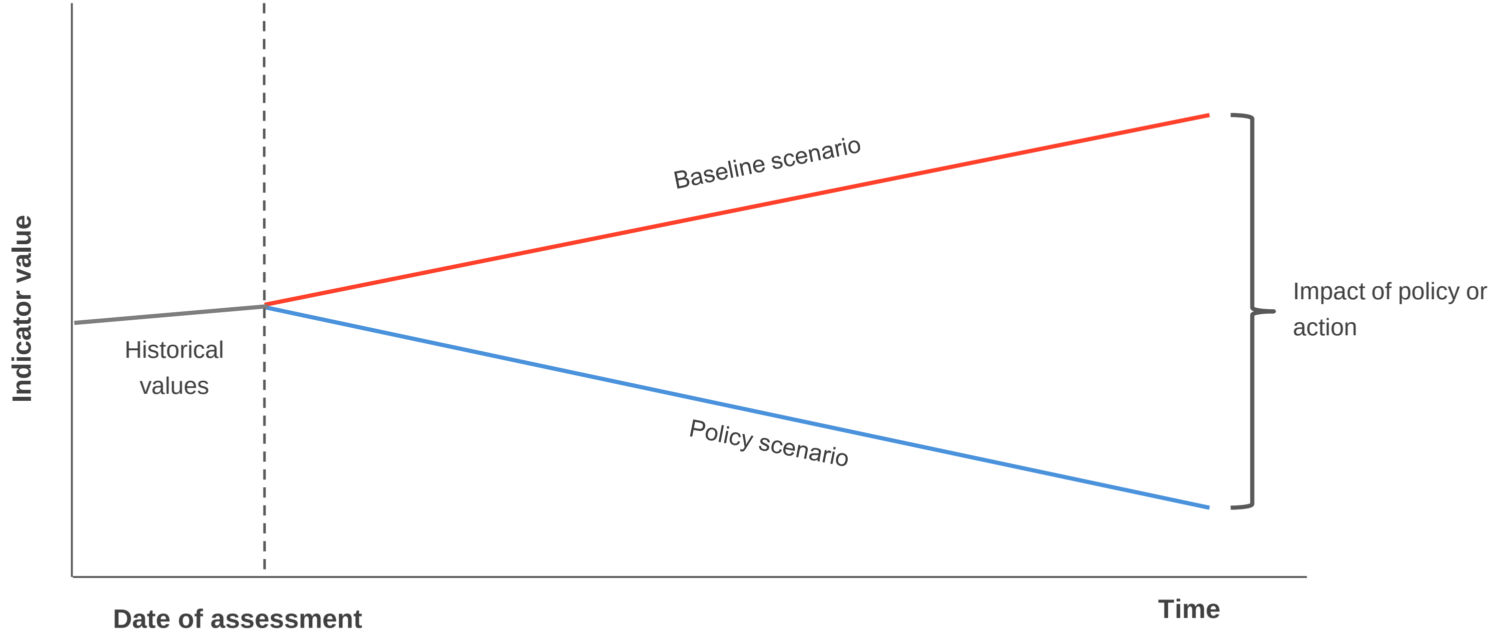
Chapter 9. Estimate policy scenario values for the same impacts (ex-ante)

How to estimate the expected future impacts of the policy or action.

Define and describe the policy scenario for each indicator → Estimate the policy scenario values for each indicator → Estimate the net impact of the policy or action on each indicator

9.1 Describe the policy scenario for each indicator

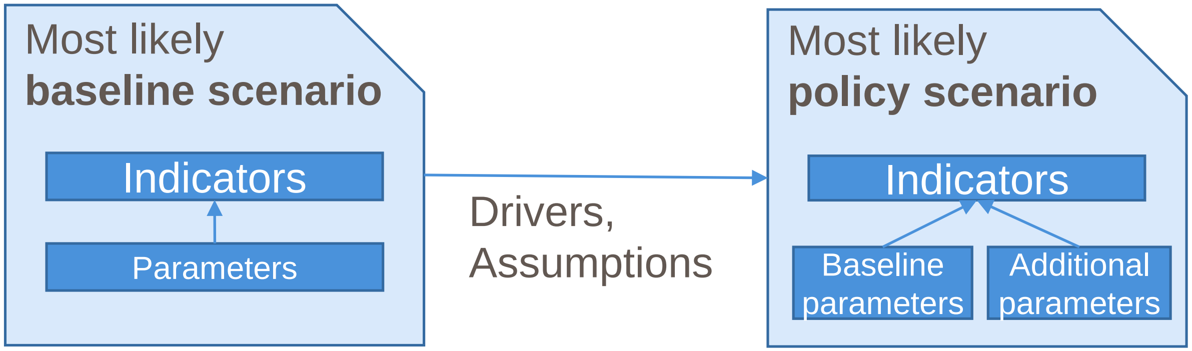
- Ensure consistency of methods between baseline and policy scenarios
- Identification of various scenario options and choose the most likely to occur with stakeholder consultation



Define a policy scenario for each indicator that represents the conditions most likely to occur in the presence of the policy or action over time.

Chapter 8 | Chapter 9 | Chapter 10 | Chapter 11

9.2 Estimate policy scenario values for each indicator



1. Identify which parameters are affected by the policy or action
2. Estimate the most likely policy values for affected parameters (same steps as in **8.3**)
   - Option 1: Using policy scenario values from published data sources
   - Option 2: Estimating new policy scenario values
3. Report values, assumptions and data sources

9.3 Estimate the net impact of the policy on each indicator

SCOPE

RANGE OF DIMENSIONS

IMPACT CATEGORIES — Indicator(s) and needed parameters

Significant impact | Significant impact | Significant impact

1. Estimate **baseline scenario** values for each specific impact
2. Estimate **policy scenario** values for each specific impact

for each significant impact in the quantitative assessment boundary

3. **Change due to the policy = Policy scenario value - Baseline scenario value**
4. Aggregation across all specific impacts to estimate the total net impact for one impact category.
5. Repeat the process for each indicator and for all impact categories.

Estimate the net impact of the policy or action on each indicator by subtracting baseline values from policy scenario values, taking into account all specific impacts included in the quantitative assessment boundary.

Chapter 8 | Chapter 9 | Chapter 10 | Chapter 11 | Example for estimating impacts

Chapter 10. Estimate policy scenario values for the same impacts (ex-post)

For both qualitative or quantitative approaches and either ex-ante or ex-post assessments, how to qualitatively assess specific impacts and summarize the assessment results.

Update baseline or ex-ante assessment if relevant → Choose assessment methodfor each indicator → Estimate policy scenario values for each indicator → Estimate the net impact of the policy on each indicator → Use comparison group method if relevant

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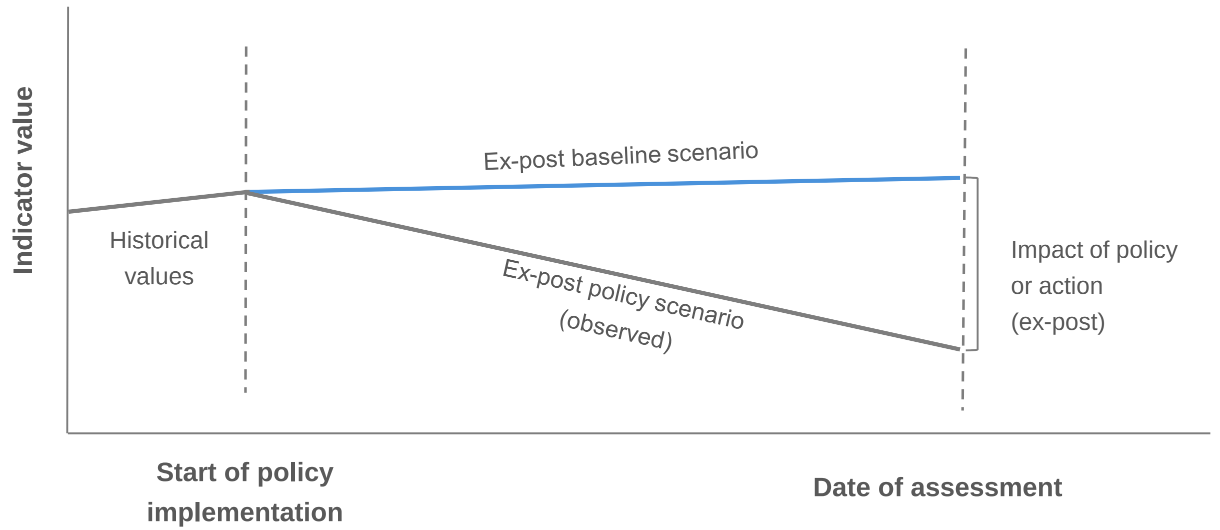
10.1 Update baseline values or ex-ante assessment

- The ex-post baseline scenario should include all other policies with significant impacts:
  - implemented before the implementation of the policy being assessed
  - implemented after the implementation of the policy being assessed, but before the ex-post assessment.



Recalculate baseline values (as described in Chapter 8) every time an ex-post assessment is undertaken.

Chapter 8 | Chapter 9 | Chapter 10 | Chapter 11

10.2 Choose an assessment method and estimate values for each indicator (10.3)

Choose an **assessment method for each indicator**, based on:

- data availability
- type of policy and sector
- number of actors influenced by the policy
- number of interacting policies
- capacity, resources and expertise available for each method
- Consistency between baseline and policy scenarios

Estimate **policy scenario values** for each indicator

- Observed data collected during the implementation period of the policy
- Assessing the degree of policy implementation
- Update identified impacts before quantification
- Report methods, assumptions and data sources used for calculation

10.4 Estimate the net impact of the policy for each indicator

SCOPE

RANGE OF DIMENSIONS

IMPACT CATEGORIES   Indicator(s) and needed parameters

Significant impact | **Significant impact** | **Significant impact**

1. Estimate **baseline scenario** values for each specific impact
2. Estimate **policy scenario** values for each specific impact

for each significant impact in the quantitative assessment boundary

3. **Change due to the policy = Policy scenario value - Baseline scenario value**
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5. Repeat the process for each indicator and for all impact categories.

Estimate the net impact of the policy or action on each indicator by subtracting baseline values from policy scenario values, taking into account all specific impacts included in the quantitative assessment boundary.

10.5 Using the group comparison method

POLICY GROUP

Groups of people, facilities, companies, jurisdictions, sectors or other relevant groups.

STEP 1

Identify the **policy** and **comparison groups.**

Equivalent in terms of:

- Geography
- Time
- Technology
- Other policies or actions
- Non-policy drivers

STEP 2

Collect data from the policy and comparison groups.

Data collection:

- At multiple points in time
- Top-down or bottom-up

STEP 3

Estimate the impact of the policy or action.

Determination of:

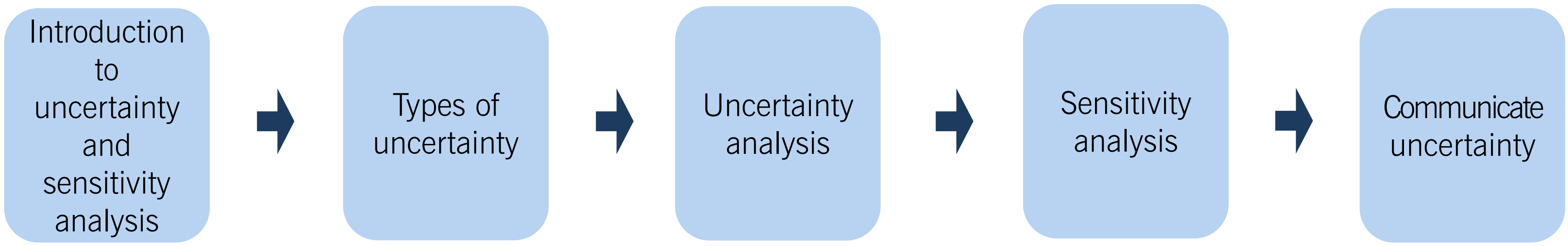
- Baseline values (comparison group)
- Policy values (policy group)

- Identify an equivalent comparison group for each impact category in the assessment boundary.
- Collect data from the comparison group and the policy group over the assessment period for each indicator included in the assessment boundary

Chapter 8 Chapter 9 Chapter 10 Chapter 11

Chapter 11. Assessing uncertainty

Overview of concepts and procedures for understanding and evaluating the uncertainty of the assessment.



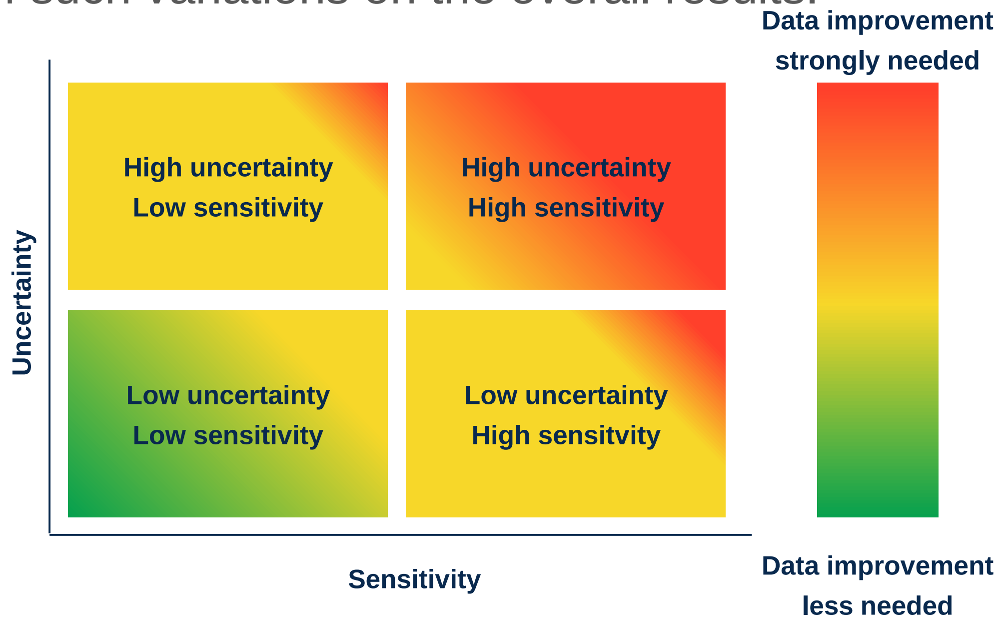
11.1 Introduction to uncertainty analysis and sensitivity analysis

- **Uncertainty analysis**

  Systematic procedure to quantify and/or qualify the uncertainty associated with the impact assessment results.

- **Sensitivity analysis**

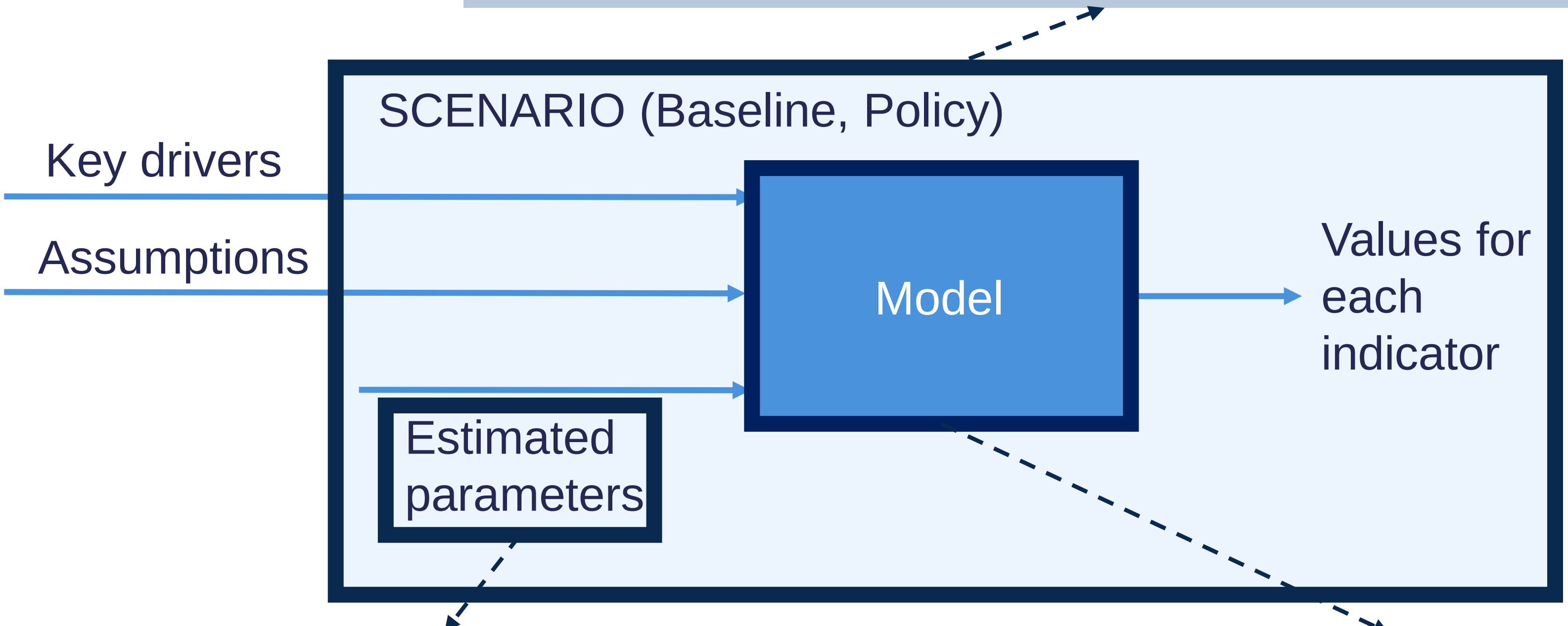
  Varying the value of key (combination of) parameters to determine the impact of such variations on the overall results.



11.2 Three types of uncertainty

→ Sensitivity analysis for key parameters in the assumptions

Scenarios based on a set of uncertain assumptions, which creates scenario uncertainty.



Parameter uncertainty may arise from insufficient data, measurement errors, inaccurate approximation, or geographical and temporal variability.

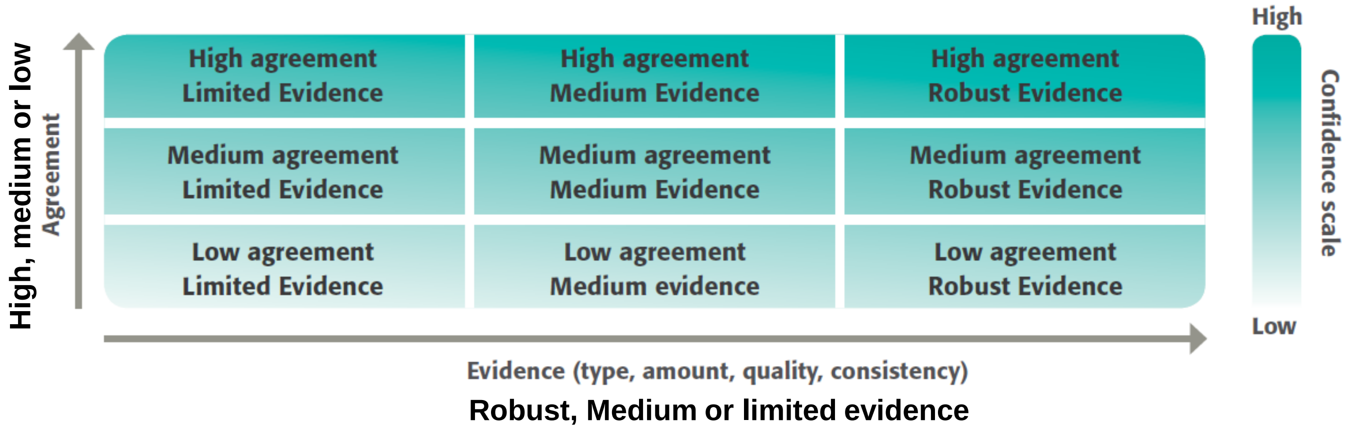
→ Probability distribution, propagation of individual parameter uncertainties

Imperfect representation of **modelling** approaches, equations or algorithms to reflect the real world.

→ Report model limitations qualitatively

11.3 Uncertainty analysis

- **Qualitative** uncertainty analysis based on evidence and agreement on evidence



- **Quantitative** uncertainty analysis
  - Default uncertainty estimates for parameters reported in literature.
  - Uncertainty factors for parameters reported in literature.
  - Pedigree matrix approach from life cycle assessment
  - Survey of experts to generate upper- and lower-bound estimates
  - Approaches to combining uncertainties: Monte Carlo simulations, error propagation equations

Assess the uncertainty of the results of the assessment, either quantitatively or qualitatively.

11.4 Sensitivity analysis

- **Sensitivity analysis:** varying the value of key parameters (or combinations of parameters) to determine the impact of such variations on the overall results.
- Useful for:
  - Understanding the differences resulting from methodological choices and assumptions.
  - Explore model sensitivities to input parameters
- Relative sensitivity for one parameter:

$$x = \frac{\Delta output/output}{\Delta input/input}$$

Conduct a sensitivity analysis for key parameters and assumptions in the assessment.

11.4 Communicate uncertainty

- **Usefulness**
  - Help users and stakeholders assess the accuracy and uncertainty of the reported results
  - Inform about the information should be used

- **Reporting requirements**
  - Quantitative estimate or qualitative description of the uncertainty of the results
  - Range of possible outcomes based on different parameter values
  - Appropriate number of significant figures
  - Thorough yet practical effort to communicate key sources of uncertainty
  - Efforts to reduce uncertainty in future revisions of the assessment

Case Studies using this Methodology

ICAT Case Studies:

- Sustainable Development Impact of the Cities Footprint Project on the Sustainable Development Goals in Five Cities of Bolivia

- An Assessment of the Sustainable Development Impact of Biodiversity Policy in South Africa through the ICAT SD Guidance

Scientific studies employing the Methodology:

- Lisboa SN, Mate R, Manjate A, Sitoe A. Applying the ICAT Sustainable Development Methodology to Assess the Impacts of Promoting a Greater Sustainability of the Charcoal Value Chain in Mozambique. *Sustainability*. 2020; 12(24):10390.

- Dal Maso M, Olsen KH, Dong Y, Brix Pedersen M, Zwicky Hauschild M. Sustainable development impacts of nationally determined contributions: assessing the case of mini-grids in Kenya. *Climate Policy*. 20(7): 815.

Thank You

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Checklist of key recommendations

Chapter	Key recommendation
Chapter 8. Estimating the baseline	Include all significant impacts in the quantitative assessment boundary, where feasible.
	Define one or more appropriate indicators for each impact category included in the quantitative assessment boundary.
	Define the assessment period.
	Define a baseline scenario that represents the conditions most likely to occur in the absence of the policy or action for each indicator included in the assessment boundary.
	Estimate baseline values over the assessment period for each indicator included in the assessment boundary.
	Separately estimate baseline values for different groups in society where relevant.
Chapter 9. Estimating impacts ex-ante	Define a policy scenario that represents the conditions most likely to occur in the presence of the policy or action over time for each indicator being estimated, taking into account all specific impacts included in the quantitative assessment boundary.
	Estimate the net impact of the policy or action on each indicator by subtracting baseline values from policy scenario values, taking into account all specific impacts included in the quantitative assessment boundary.
	Separately assess the impacts of the policy or action on different groups in society where relevant.
Chapter 10. Estimating impacts ex-post	Recalculate baseline values (as described in Chapter 8) every time an ex-post assessment is undertaken.
	Estimate the net impact of the policy on each indicator in the quantitative assessment boundary by subtracting baseline values from policy scenario values, taking into account all specific impacts included in the quantitative assessment boundary.
	Separately assess the impacts of the policy on different groups in society, where relevant.
	For users following the comparison group method, identify an equivalent comparison group for each impact category in the assessment boundary, and collect data from the comparison group and the policy group over the assessment period for each indicator included in the assessment boundary.
Chapter 11 Assessing uncertainty	Assess the uncertainty of the assessment results, either qualitatively or quantitatively.
	For quantitative assessments: Conduct a sensitivity analysis for key parameters and assumptions in the assessment.

8.1 Reporting template, for the example of the solar PV incentive policy

Chapter 5	Chapter 6	Chapter 8 : Defining the quantitative assessment boundary		
Impact categories included in the assessment	**Specific impacts included in the quantitative assessment boundary**	**Indicators to quantify**	**Feasible to quantify ?**	**Included in the quantitative assessment boundary ?**
Climate change mitigation	Reduced GHG emissions from grid-connected fossil fuel-based power plants	GHG emissions (tCO2e/year)	Yes	Yes
Air quality / health impacts of air pollution	Reduced air pollution from grid-connected fossil fuel-based power plants	Emissions of PM2.5, PM10, SO2, and NOx (t/year); number of deaths due to air pollution	Yes	Yes
Energy	Increased renewable energy generation from more solar generation	Solar installed capacity (MW); % solar of total installed capacity; % solar of total installed capacity of renewable energy sources	Yes	Yes
Access to clean, affordable, and reliable energy	Increased access to clean, affordable, and reliable electricity	Number of houses/buildings/facilities with access to clean energy resulting from the policy	Yes	Yes
Capacity, skills, and knowledge development	Increase in training for skilled workers in solar relevant sectors	Number of new skilled trainees and workers on the ground	Yes	Yes
Jobs	Increased jobs in the solar installation, operations maintenance sectors;	Number of new jobs resulting from the policy	Yes	Yes
	Increased jobs in the solar panel manufacturing sector	Number of new jobs resulting from the policy	Yes	Yes
	Decreased jobs in fossil fuel sectors	Number of new jobs resulting from the policy	Yes	Yes
Income	Increased income for households, institutions and other organizations due to reduction in energy costs	Savings in annual electric bill (USD/year)	Yes	Yes
Energy Independence	Increased energy independence from reduced imports of fossil fuel	Reduction in coal imports from the policy (t/year)	Yes	Yes

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8.1 Example of a policy in Mexico: how results vary based on different assessment periods

The sustainable development impacts of two climate actions in public buildings in Mexico, installing PV panels and changing of fluorescent lamps to LED lamps, which are both part of the Mexican State of Jalisco's Carbon Management Plan. The assessment illustrates how the impacts of a policy can change over time.

		Cumulative impact over 5 years				Cumulative impact over 17 years			
Impact category	Unit	Baseline scenario (5 yr)	Policy scenario (5 yr)	Net impact (5 yr)	% net impact (5 yr)	Baseline scenario (17 yr)	Policy scenario (17 yr)	Net impact (17 yr)	% net impact (17 yr)
GHG emissions	tCO_2e	239	146	**Reduction of 93**	**–39**	724	409	**Reduction of 315**	**–43**
Depletion of mineral resources	kg Cu eq	66	243	**Increase of 177**	**267**	288	315	**Increase of 27**	**9**
Depletion of fossil resources	kg oil eq	74,990	46,104	**Reduction of 28,886**	**–39**	226,106	128,755	**Reduction of 97,351**	**–43**
Freshwater consumption	m^3	531	467	**Reduction of 64**	**–12**	1,851	1,170	**Reduction of 681**	**–37**
Air quality	DALY	0.24	0.16	**Reduction of 0.08**	**–34**	0.64	0.37	**Reduction of 0.27**	**–42**
Human toxicity	DALY	0.025	0.029	**Increase of 0.004**	**15**	0.088	0.061	**Reduction of 0.027**	**–30**
Water ecotoxicity	kg 1,4-DCB	6,255	7,190	**Increase of 936**	**15**	24,739	18,549	**Reduction of 6,190**	**–25**

8.2 Deemed estimates method

- Simplified variation of the scenario method
  - Deemed estimate = implicit representation of the difference between a baseline and policy scenario value
- Principle: calculating the impact of a policy without separately defining and estimating the baseline and policy scenarios and comparing the two
- Applicability: common or homogeneous policies where deemed estimate values are reliable
- Pros: simplification of the calculation and data collection
- Cons: many factors potentially influencing the indicator are kept constant, calculations often oversimplified and inaccurate

8.3.1 Different baseline trends

Method	Characteristics	When to use
Constant baseline	Uses historical or current values as baseline values (kept constant).	Appropriate when indicators are likely to remain stable over time.
Simple trend baseline	Uses historical trends as the basis for the baseline scenario, assumes the trend will remain the same into the future.	Appropriate when change in indicators values are likely to remain stable over time.
Advanced trend baseline	Models the impacts of many interacting elements that are likely to change conditions in the future.	In more complex situations, if data and methods to integrate the impacts of multiple drivers are robust.

8.3.2 Definitions of implemented, adopted and planned policies

Policy status	Definition	Guidance for inclusion in the baseline scenario
Implemented	Policies that are currently in effect, as evidenced by one or more of the following: (1) relevant legislation or regulation is in force, (2) one or more voluntary agreements have been established and are in force, (3) financial resources have been allocated, (4) human resources have been mobilized.	Should be included for both ex-ante and ex-post assessments.
Adopted	Policies for which an official government decision has been made and there is a clear commitment to proceed with implementation, but implementation has not yet begun (e.g. a law has been passed, but regulations to implement the law have not yet been established or are not being enforced).	Should be included for ex-ante assessment if polices are likely to be implemented and there is enough information to estimate the impacts. Should not be included for ex-post assessment.
Planned	Policy options that are under discussion, and have a realistic chance of being adopted and implemented in the future, but have not yet been adopted or implemented.	In some cases, users may want to include planned policies for ex-ante assessment – for example, if the objective is to assess the impact of one planned policy relative to other planned policies. Should not be included for ex-post assessment.

8.3.3 Types of data and applicability

Choice depends on data availability and needs of the assessment.

Type of data	Description	Applicability
Bottom-up	Bottom-up data are measured, monitored or collected at the facility, entity or project level. Examples are energy used at a facility (e.g. using a measuring device such as a fuel meter) and production output.	Most appropriate for national policies
Top-down	Top-down data are macro-level data or statistics collected at the jurisdiction or sector level. Examples are national energy use, population, GDP and fuel prices. In some cases, top-down data are aggregated from bottom-up data sources.	Better suited to smaller scale policies and actions

Level of depth/ accuracy[a]	Model capabilities	Cost	Ease of use	Data inputs
Higher	Assumptions embedded in the model are dynamic; can optimize for a specific variable or output; may produce a range of quantitative outputs	Up to tens of thousands of dollars	Highly complex; use requires trained experts, and significant time to gather input data and produce model output (several weeks or months)	Highly data intensive; may rely on software of models for inputs
↓	↓	↓	↓	↓
Lower	Assumptions embedded in the model are static; cannot optimize for a specific variable or output; may produce limited quantitative outputs	No cost or low cost	Designed for use by the public: easy to navigate and run; requires limited time to run (several hours or days)	Not data intensive; relies on pre-populated data and default assumptions

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8.3.4 Data quality indicators

When selecting data sources, users should apply the data quality indicators as a guide to obtaining the highest-quality data available.

Indicator	Description
Technological representativeness	The degree to which the data set reflects the relevant technologies, processes or practices
Temporal representativeness	The degree to which the data set reflects the relevant time period
Geographical representativeness	The degree to which the data set reflects the relevant geographic location (e.g. country, city, site)
Completeness	The degree to which the data are statistically representative of the relevant activity. Completeness includes the percentage of locations for which data are available and used out of the total number that relate to a specific activity. Completeness also addresses seasonal and other normal fluctuations in data.
Reliability	The degree to which the sources, data collection methods and verification procedures used to obtain the data are dependable. Data should represent the most likely value of the parameter over the assessment period.

9.2 Option 1: Using policy scenario values from published data sources

- Data requirements: High-quality, up-to-date and peer-reviewed data from recognized, publicly available, credible sources
- Guidelines: Apply data quality indicators

  Data most representative in terms of technologies and practices, time and geography, completeness and reliability.
- Data sources (non-exhaustive):
  - Published studies of similar policies and impact categories in the same or other jurisdictions, peer-reviewed scientific literature, government statistics, reports published by international institutions (such as IEA, IPCC, World Bank, FAO), and economic and engineering analyses and models.
- Range of data: International default values, national average values, jurisdiction- or activity-specific data

9.2 Option 2: Estimating new policy scenario values

- Ensure consistency: use of the same methods for a given indicator between the baseline and policy scenarios.
- Indicators: either static or dynamic (preferred when possible)

Indicator	Description
Historical trends and expected values in the baseline scenario	Historical data informs the expected future values of each indicator, in both the baseline scenario and the policy scenario.
Timing of impacts	Policy scenario values over time depend on the timing of expected impacts. There may be a delay between when the policy or action is implemented and when impacts begin to occur. Impacts may also occur before policy implementation begins because of early action taken in anticipation of the policy or action. Users should consider whether the policy or action is designed to operate indefinitely or is limited in duration and how the implementation of the policy or action is expected to change over the assessment period.
Barriers to policy implementation or effectiveness	Depending on what is considered most likely in an individual context, users should either (1) estimate the maximum impacts of the policy or action if full implementation and enforcement is most likely or (2) discount the maximum impacts based on expected limitations in policy implementation, enforcement, or effectiveness that would prevent the policy or action from achieving its maximum potential. Users should apply conservative assumptions if there is uncertainty about the extent of policy implementation and effectiveness.
Policy interactions	The policy or action assessed may interact with implemented or adopted policies and actions included in the baseline scenario. To accurately estimate policy scenario values and the impacts of the policy or action, users should determine whether the policy or action assessed interacts with any policies included in the baseline scenario (either in reinforcing or overlapping ways, see part II).
Sensitivity of parameters to assumptions	Users should use sensitivity analysis to understand the range of possible values of key indicators and parameters and determine which scenario is most likely. Users should also understand the range of uncertainty associated with key indicators and parameters. For more information on assessing uncertainty and sensitivity analysis, see Chapter 11.
Additional factors	Non policy-drivers included in the baseline scenario, Learning curves, Economies of scalem Technology penetration or adoption rates.

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9.3 Quantitative ex-ante impact assessment for PV mini-grids in Kenya

Environmental impact category	Indicator	Baseline scenario (1 year)	Policy scenario (1 year)	Net impact (1 year)	Net impact (2024-30)
CC mitigation	GHG emissions [t CO_2 eq.]	6900	2000	-4900	-34,000
Air pollution	Particulate matter [Disability Adjusted Life Years lost: DALY]	88	3	-85	-592
Human Toxicity	Human carcinogenic & non-carcinogenic toxicity [DALY]	2.2	1.5	-0.7	-5
Depletion of non-renewable resources	Fossil fuel resource depletion [USD]	3300	3400	100	+720
	Mineral resource depletion [USD]	960,000	210,000	-750,000	-5,200,000

For a complete analysis of the impacts of minigrids on sustainable development in Kenya, see: Dal Maso M, Olsen KH, Dong Y, Brix Pedersen M, Zwicky Hauschild M. Sustainable development impacts of nationally determined contributions: assessing the case of mini-grids in Kenya. *Climate Policy*. 20(7): 815.

10.2 Examples of ex-post assessment methods

Method	Description
Collection of data from affected participants, facilities or actors	Indicator values in the policy scenario are determined using data collected from affected participants, facilities or other actors. Data collection methods may include monitoring of parameters (e.g. metering of energy consumption), collection of expenditure or billing data (e.g. purchase records), or sampling methods.
Deemed estimates method	The change in indicator values (rather than the policy scenario value of indicators) is estimated using previously estimated effects of similar policies. This involves collecting data on the number of actions taken (e.g. number of buildings that install rooftop solar PV) and applying default values for the estimated impact or other relevant parameter per action taken (e.g. average reduction in grid-connected electricity use per building that installs solar PV). The deemed estimate may be based on published studies, equipment specifications, surveys or other methods. Deemed estimates are used as a lower-cost method for policies that are homogeneous across policy contexts, such that deemed estimates from other contexts are representative of the policy being assessed. Deemed estimates can be complemented by sampling the affected participants or sources to determine whether the estimates are sufficiently accurate and representative. In this approach, the impact is estimated directly, without subtracting baseline values from policy scenario values. Baseline values may be estimated as a subsequent step by adding or subtracting the deemed estimates from observed policy scenario values.
Monitoring of indicators	Indicator values in the policy scenario are monitored using sector or subsector activity changes. In this case, the user may have limited or no information on end use or stock statistics, but may have information on changes in relevant indicators for a sector (e.g. transportation, buildings) or subsector (e.g. space heating in buildings). Policy scenario indicator values should be compared with baseline indicator values to estimate the change.
Economic modelling	The change in indicator values (rather than the policy scenario value of indicators) is estimated by using econometric models, regression analysis, extended modelling such as input–output analysis with price elasticities, or computable general equilibrium models. These types of models are most appropriate for estimating economic impacts or estimating other types of impacts from fiscal policies, such as taxes or subsidies. Economic models may specify that a dependent variable (the indicator being assessed) is a function of various independent variables, such as the policy being assessed, other policies and various non-policy drivers (e.g. prices, price elasticities of fuels, economic activity, population). By doing so, models can control for various factors that affect the impact category other than the policy being assessed.

11.2 Types of uncertainties

Type of uncertainty	Description
Parameter	Uncertainty regarding whether a parameter value used in the assessment accurately represents the true value of the parameter
Scenario	Uncertainty of the calculated result due to various assumptions made in the baseline and policy scenarios
Model	Imperfect representation of modelling approaches, equations or algorithms to reflect the real world

11.2 Approaches to quantifying the uncertainty of individual parameters

Approaches	Description
Default uncertainty estimates for parameters reported in literature	-
Probability distributions and standard deviations	Method feasible and preferred when a large amount of data is available for a given parameter. In such cases, it is possible to generate a probability distribution and other statistical values, such as standard deviations, which can be propagated to the uncertainty of the final output.
Uncertainty factors for parameters reported in literature	One application of uncertainty factors is in environmental assessments relating to risk and safety. For example, when assessing the toxicity impact of a certain chemical, experiments may be conducted on a small group of people. To extrapolate the test results to a larger group, an uncertainty factor is applied to ensure maximum protection and safety. This method is especially relevant when conservative methods are applied.
Pedigree matrix approach from life cycle assessment	This method provides a way to quantify uncertainties based on a qualitative assessment of data. Five criteria are provided in Table 8.7 to assess data quality from different perspectives. For each criterion, a value is assigned by the practitioner to describe the data quality. These values can then be translated into the standard deviation of the data set.

11.2 Sensitivity analysis of three key parameters for a solar PV incentive policy.

Assumptions:

- 186,306,371 grid-connected households in India, with an annual consumption of 900 kilowatt hours (kWh) electricity per year per household.
- In the original policy scenario, 10% of existing grid-connected households are expected to adopt rooftop solar PV systems and will be able to rely on solar for the entire household electricity demand. The other 90% of grid-connected households will rely on a combination of grid-connected electricity and back-up diesel generators for electricity, assuming that 90% (810 kWh) is supplied by the grid and 10% (90 kWh) is supplied by a diesel-fuelled power generator when blackouts occur.
- The remaining electricity demand for combined electricity supply is met by diesel-fueled power generator.

Chosen parameters for sensitivity analysis:

- Annual electricity consumption per household
- Percentage of households that will adopt solar PV
- Percentage of electricity supplied by grid for the households that use combined electricity supply

Parameter	Annual electricity consumption	Percentage of households that adopt solar PV	Percentage of electricity supplied by grid
Input			
Original value (kWh)	900	10%	90%
Scenario value (kWh)	1,800	80%	50%
Δinput/input	100%	700%	–44%
Output: emission reduction			
Original value (t PM_{10})	300,817	300,817	300,817
Scenario value (t PM_{10})	601,635	71,886	171,695
Δoutput/output	100%	–76%	–43%
Sensitivity analysis result			
Relative sensitivity	100%	–11%	97%