World Resources Institute, UNEP DTU Partnership

Sustainable Development Methodology

Assessing the environmental, social and economic impacts of policies and actions[1]

June 2019

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Part I: Introduction, Objectives and Key Concepts

1. Introduction

With the adoption of the Paris Agreement and the 2030 Agenda for Sustainable Development, including the Sustainable Development Goals (SDGs), in 2015, governments around the world are increasingly focused on implementing policies and actions that achieve sustainable development and climate change objectives in an integrated manner. In this context, there is an increasing need to assess and communicate the multiple impacts of policies and actions to ensure they are effective in delivering a variety of sustainable development and climate change benefits.

1.1 Purpose of the methodology

The purpose is to help users assess the sustainable development impacts of policies and actions. Sustainable development impacts include a wide variety of impacts across three dimensions: environmental impacts, social impacts and economic impacts. Examples of impacts include improved health from reduced air pollution, job creation, poverty reduction, increased energy access, gender equality, and many others outlined in Chapter 5.

This methodology helps users answer the following questions:

- What sustainable development impacts is a given policy or action likely to have in the future?
- Is a given policy or action on track and delivering expected results?
- What impacts has a given policy or action had to date?

The methodology was developed with the following objectives in mind:

- To help users assess all relevant sustainable development impacts of policies and actions in an integrated way
- To help policymakers and other decision makers develop effective strategies for achieving sustainable development objectives through a better understanding of the various impacts of policies and actions
- To support consistent and transparent reporting of sustainable development impacts and policy effectiveness

This methodology supports multiple objectives users may have for assessing sustainable development impacts of policies and actions. Objectives may include advancing policies and actions that contribute to multiple SDGs and priorities at the same time, building support for climate actions by assessing and communicating the various impacts that are most relevant to national audiences, and informing policy design and implementation to maximize positive impacts across multiple impact categories. These objectives are further elaborated in Chapter 2.

The methodology is intended to help policymakers and analysts systematically assess multiple development and climate impacts to help achieve the objectives of both the SDGs and the Paris Agreement. By assessing a broad set of climate and sustainable development impacts before and after policy implementation, actions are more likely to be effective, durable, generate positive benefits for society, and better achieve desired climate and development outcomes. This type of assessment can help integrate SDGs and climate targets into a unified process, for example by identifying and reporting on the sustainable development benefits of actions taken to achieve nationally determined contributions (NDCs) under the Paris Agreement. It may also facilitate increased access to climate finance, given the inclusion of sustainable development priorities in the UNFCCC, the Paris Agreement and the Green Climate Fund.

1.2 Intended users

This methodology is intended for use by a wide range of organizations and institutions. Throughout this document, the term "user" refers to the entity using the methodology.

The following examples explain how different types of users can use the methodology:

- **Governments**: Assess the various environmental, social and economic impacts of policies and actions to inform and enhance policy design and implementation, improve monitoring of progress of implemented policies and actions, retrospectively evaluate impacts to learn from experience, report on progress toward SDGs, and facilitate access to financing for policies and actions.
- **Donor agencies and financial institutions**: Assess the various impacts of finance provided, such as grants or loans to support sustainable development policies and actions, including results-based financing and development policy loans.
- **Businesses**: Assess the various impacts of private sector actions, such as voluntary commitments, implementation of new technologies or private sector financing, or assess the impacts of government policies and actions on businesses and the economy.
- **Research institutions and non-governmental organizations (NGOs)**: Assess the various environmental, social and economic impacts of policies or actions to assess performance or provide support to decision makers.
- **Stakeholders affected by policies and actions, such as local communities and civil society organizations**: Participate more effectively in the design, implementation and assessment of policies and actions to ensure their concerns and interests are addressed.

1.3 Scope and applicability

This methodology provides an overarching framework and process for assessing sustainable development impacts. It provides general principles, concepts and procedures applicable to all types of policies and actions, all sectors, and all types of sustainable development impacts. It does not provide specific guidance for individual impact categories, such as jobs, air quality or health, or prescribe specific calculation methods, tools or data sources. Other guidelines, methods, and tools can be used in combination that provide more in-depth methods for specific impact categories, such as air quality and health, or that focus specifically on economic, social, or environmental impacts, rather than covering all impacts in an integrated framework (see the ICAT website[2] for a list of complementary resources).

This document is organized into six parts (Figure 1.1). Part I provides an introduction, including objectives, key concepts and steps. Part II provides guidance on defining the assessment. Part III

[2] Available at http://www.climateactiontransparency.org/methodological-framework/sustainable-development/

provides a qualitative approach to impact assessment, while Part IV provides a quantitative approach to impact assessment. Parts III and IV cover both ex-ante (forward-looking) assessments and ex-post (backward-looking) assessments. Part V covers monitoring and reporting, while Part VI provides guidance on decision making and using results.

Figure 1.1: Overview of the methodology

Part I: Introduction, objectives and key concepts

Understand 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 describe the policy or action 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 or action 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 tradeoffs and decide which policies and actions to implement (Chapter 14)

Types of policies and actions

In this methodology, "policy or action" refers to interventions taken or mandated by a government, institution or other entity, and can include laws, directives and decrees; regulations and standards; taxes, charges, subsidies and incentives; information instruments; voluntary agreements; implementation of new technologies, processes or practices; and public or private sector financing and investment.

The methodology is applicable to policies and actions:

- At any level of government (national, subnational, municipal) in all countries and regions
- In any sector, such as agriculture, forestry, energy, transport, industry and waste, as well as cross-sector policy instruments
- That are planned, adopted or implemented
- That are new policies or actions, or extensions, modifications or eliminations of existing policies or actions

Table 1.1 presents general types of policies and actions that may be assessed. The list is not exhaustive, and some users may have policies and actions of other types. Some types of policies and actions are more difficult to assess than others, since the causal relationship between implementation of the policy and its impacts may be less direct. For example, information instruments and research, development and deployment (RD&D) policies may have less direct and measurable impacts than regulations and standards. While the methodology can be applied to any policy type, subsequent chapters may pose data collection and estimation challenges that hinder a complete and credible assessment.

Table 1.1: Types of policies and actions

Type of policy or action	**Description**
Regulations and standards	Regulations or standards that specify abatement technologies (technology standard) or minimum requirements for energy consumption, pollution output, or other activities (performance standard). They typically include penalties for noncompliance.
Taxes and charges	A levy imposed on each unit of activity by a source, such as a fuel tax, carbon tax, traffic congestion charge, or import or export tax.
Subsidies and incentives	Direct payments, tax reductions, price supports or the equivalent thereof from a government to an entity for implementing a practice or performing a specified action.
Voluntary agreements or actions	An agreement, commitment or action undertaken voluntarily by public or private sector actors, either unilaterally or jointly in a negotiated agreement. Some voluntary agreements include rewards or penalties associated with participating in the agreement or achieving the commitments.
Information instruments	Requirements for public disclosure of information. These include labeling programmes, reporting programmes, rating and certification systems, benchmarking, and information or education campaigns aimed at changing behaviour by increasing awareness.
Emissions trading programmes	A programme that establishes a limit on aggregate emissions of various pollutants from specified sources, requires sources to hold permits, allowances, or other units equal to their actual emissions, and allows permits to be traded among sources. These programmes are also referred to as emissions trading systems (ETS) or cap-and-trade programmes.

Research, development, and deployment (RD&D) policies	Policies aimed at supporting technological advancement, through direct government funding or investment, or facilitation of investment, in technology research, development, demonstration, and deployment activities.
Public procurement policies	Policies requiring that specific attributes (such as social or environmental benefits) are considered as part of public procurement processes.
Infrastructure programmes	Provision of (or granting a government permit for) infrastructure, such as roads, water, urban services and high-speed rail.
Implementation of new technologies, processes or practices	Implementation of new technologies, processes or practices at a broad scale (e.g., those that reduce emissions compared to existing technologies, processes or practices).
Financing and investment	Public or private sector grants or loans (e.g., those supporting development strategies or policies such as a development policy loans (DPL) or development policy operations (DPO) which includes loans, credits and grants).

Source: Adapted from WRI 2014, based on IPCC 2007.

The methodology is developed under the Initiative for Climate Action Transparency (ICAT), so its focus is on assessing the sustainable development impacts of policies and actions that have an impact on climate change. This includes policies and actions implemented primarily to achieve climate goals, as well as policies and actions primarily implemented to achieve other environmental, social or economic objectives, but that have an impact, either positive or negative, on greenhouse gas (GHG) emissions.

The methodology is primarily designed for actions at a larger scale than individual projects, but users assessing the impacts of individual projects may also find this methodology helpful. The focus is on policies and actions, given the ongoing shift to broader policies and actions as represented by countries' NDCs.

Policies and actions along a policy-making continuum

Policies and actions may refer to interventions at various stages along a policy-making continuum, from (1) broad strategies, plans or goals that define high-level objectives or desired outcomes; to (2) specific policy instruments to carry out a broad strategy, plan or goal; to (3) the implementation of technologies, processes or practices (sometimes called "measures") that result from policy instruments. These are illustrated in Figure 1.2, which shows the range of interventions from more aspirational to more concrete.

Figure 1.2: Types of interventions along a policy-making continuum

Type of intervention	Example	Applicability of methodology
Broad strategies, plans or goals	Intent to increase energy efficiency by 30% by 2030	Partial; should further define the specific policy instruments to achieve the broad strategy
Policy instruments	Energy efficiency standard for appliances	Applicable
Implementation of technologies, processes or practices	Replacement of old appliances with new efficient ones	Applicable

This methodology is primarily designed to assess specific policy instruments and the implementation of technologies, processes and practices. Users that intend to assess the effects of broad strategies, plans or goals should first define the individual policy instruments or technologies, processes or practices that will be implemented to achieve the strategy or plan. Broad strategies or plans can be difficult to assess since the level of detail needed to assess impacts may not be available without further specificity, and different policies or actions used to achieve the same goal could have different impacts.

Flexible approach

This methodology provides flexibility in how to assess the sustainable development impacts of policies and actions to enable users to apply it in the context of their own objectives and available resources. It provides guidance rather than requirements and is non-prescriptive to accommodate various national circumstances. Users do not need to follow all steps, but instead can follow different steps based on their own needs. Each step can be implemented using a more simplified or more sophisticated approach, depending on data availability, available resources, and user objectives. Different options for applying the methodology, including whether to follow a qualitative or quantitative approach, are explained in Chapter 3. Certain objectives may call for greater accuracy, consistency and transparency in the way impacts are assessed and reported, such as accessing financing or reporting on progress toward the SDGs and the Paris Agreement.

As a result of this flexibility, users applying the methodology and readers of the resulting impact assessment reports should be aware of potential uncertainties when interpreting the results. Users that intend to compare or aggregate the results of multiple impact assessments should be aware that differences in reported results may be a result of different methodological choices rather than real-world differences. For example, two assessments of the jobs and economic development impacts of the same policy may come to two different conclusions based on differences in methods and assumptions. To help overcome this challenge, this methodology encourages transparent reporting (in Chapter 13) to explain the methods and assumptions used to help ensure results are properly interpreted.

1.4 When to use the methodology

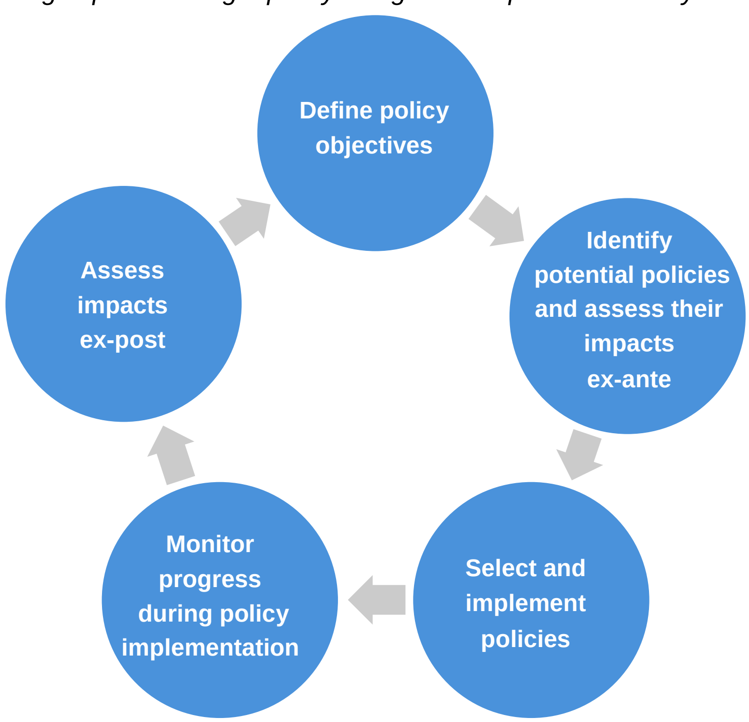
The methodology may be used at multiple points in time throughout a policy[3] design and implementation process, including:

- **Before policy implementation**: To assess the expected future impacts of a policy or action (through ex-ante assessment)
- **During policy implementation**: To assess the achieved impacts to date, ongoing performance of key performance indicators, and expected future impacts of a policy or action
- **After policy implementation**: To assess what impacts have occurred as a result of a policy or action (through ex-post assessment)

Depending on the objectives and when the methodology is applied, users can follow the steps related to ex-ante assessment, ex-post assessment, or both. The most comprehensive approach is to apply the methodology first before implementation, regularly during policy implementation, and again after implementation. Users carrying out an ex-post assessment only can skip Chapter 9. Users carrying out an ex-ante assessment only can skip Chapter 10.

Figure 1.3 outlines a sequence of steps to monitor and assess impacts at multiple stages in a policy design and implementation cycle. In the figure, the process is iterative such that insights from previous experience inform improvements to policy design and implementation and the development of new policies.

Figure 1.3: Assessing impacts during a policy design and implementation cycle



[3] Throughout this document, where the word "policy" is used without "action," it is used as shorthand to refer to both policies and actions.

1.5 Key recommendations

The methodology includes *key recommendations* that represent recommended steps to follow when assessing and reporting impacts. These recommendations are intended to assist users in producing credible impact assessments that pursue high quality and are based on the principles of relevance, completeness, consistency, transparency and accuracy.

Key recommendations are indicated in subsequent chapters by the phrase "It is a *key recommendation* to…." All key recommendations are also compiled in a checklist at the beginning of each chapter.

Users that want to follow a more flexible approach may choose to use the methodology without adhering to the key recommendations. The ICAT *Introductory Guide* provides further description on how and why key recommendations are used within the ICAT methodology documents, as well as more information about following either the "flexible approach" or the "key recommendations" approach when using the methodology. Refer to the *Introductory Guide* before deciding on which approach to follow.

1.6 Alignment with Sustainable Development Goals

This methodology is informed by and compatible with the United Nations SDGs and is intended to help users assess the impact of policies and actions in relation to SDGs. Chapter 5 describes sustainable development impact categories that users can assess using this methodology, which are consistent with the SDGs. Chapter 12 provides guidance on monitoring progress toward SDGs. For more information on the SDGs, see https://sustainabledevelopment.un.org/sdgs.

1.7 Relationship to other methodologies and resources

This methodology is part of the ICAT series of methodologies for assessing impacts of policies and actions, available at https://climateactiontransparency.org/icat-guidance. It is intended to be used in combination with any other ICAT documents that users choose to apply, including:

- Sector-level methodologies for assessing greenhouse gas impacts of policies and actions in the renewable energy, buildings, transport, agriculture and forestry sectors
- Transformational change methodology on how to assess the transformational impacts or potential of policies and actions
- Stakeholder participation guide on how to carry out effective stakeholder participation when designing, implementing and assessing policies and actions, including when assessing sustainable development impacts using this methodology
- Technical review guide on how to review assessment reports, covering greenhouse gas, sustainable development and transformational impacts

The ICAT series of methodologies is intended to enable users that choose to assess the greenhouse gas impacts, sustainable development impacts and transformational impacts of a policy or action to do so in an integrated and consistent way within a single impact assessment process. For example, users assessing a renewable energy policy or action could follow both the ICAT *Renewable Energy Methodology* to assess the GHG impacts and this *Sustainable Development Methodology* to assess other environmental, social, and economic impacts within an integrated assessment. Refer to the ICAT

Introductory Guide for more information about the ICAT methodologies and how to apply them in combination.

This methodology builds on existing resources such as the Greenhouse Gas Protocol *Policy and Action Standard* (WRI, 2014) and the *Framework for Measuring Sustainable Development in NAMAs* (IISD and UNEP DTU Partnership, 2015).

This methodology is consistent with the *Policy and Action Standard*,[4] which provides guidance on how to estimate the greenhouse gas impacts of policies and actions and can be used in parallel. This methodology document adapts the structure and some of the tables, figures and text from the *Policy and Action Standard* where relevant to assessing sustainable development impacts. Figures and tables adapted from the *Policy and Action Standard* are cited, but for readability not all text taken directly or adapted from the *Policy and Action Standard* is cited.

1.8 Calculation methods, models and tools for assessing impacts

This document outlines a general process that users should follow when assessing the impacts of policies and actions, but it does not prescribe specific calculation methods or tools that should be used. Users should supplement the methodology with models, calculation tools, spreadsheets or other methods to carry out calculations.

To help users apply the methodology, the ICAT website provides a list of calculation tools, models, and resources for estimating the social, economic and environmental impacts of policies and actions, organized by impact category, available at http://www.climateactiontransparency.org/methodological-framework/sustainable-development. These supplemental resources provide more detailed calculation guidance for various impact categories.

This methodology can be used in tandem with models by providing an overarching framework to guide the impact assessment process, including defining the scope of the assessment and making deliberate assumptions and transparently reporting those assumptions. The methodology may also be useful to inform model or tool development.

1.9 Process for developing the methodology

This methodology has been developed through an inclusive, multi-stakeholder process convened by the Initiative for Climate Action Transparency. The *Sustainable Development Methodology* is led by the World Resources Institute (lead) and UNEP DTU Partnership (co-lead) who serve as the Secretariat and guide the development process. The first draft was developed by drafting teams, consisting of a subset of a broader Technical Working Group and the Secretariat. The Technical Working Group consists of experts and stakeholders[5] from a range of countries identified through a public call for expressions of interest. The Technical Working Group contributed to the development of the first draft through participation in regular meetings and written comments. A Review Group provided written feedback on the first draft.

The second draft was applied by ICAT participating countries and other non-state actors to ensure that it can be practically implemented. This version of the methodology was informed by the feedback gathered

[4] The *Policy and Action Standard* is available at http://www.ghgprotocol.org/policy-and-action-standard

[5] Listed at www.climateactiontransparency.org

from that experience and includes case studies from those applications. ICAT's Advisory Committee provides strategic advice to the initiative. More information about the development process, including governance of the initiative and the participating countries, is available on the ICAT website.

All contributors are listed in the "Contributors" section.

2. Objectives of Assessing Sustainable Development Impacts

This chapter provides an overview of objectives users may have in assessing the sustainable development impacts of policies and actions. Determining the assessment objectives is an important first step, since decisions made in later chapters should be guided by the stated objectives.

Checklist of key recommendations

- Determine the objectives of the assessment at the beginning of the impact assessment process

Assessing the impacts of policies and actions is a key step towards developing effective sustainable development strategies. Impact assessment supports evidence-based decision making by enabling policymakers and stakeholders to understand the relationship between policies and actions and expected or achieved changes in various sustainable development impact categories.

It is a *key recommendation* to determine the objectives of the assessment at the beginning of the impact assessment process. Examples of objectives for assessing the sustainable development impacts of a policy or action are provided below.

General objectives

- **Identify and promote policies and actions that address multiple priorities, contribute to multiple goals and lead to multiple benefits**, such as improved health from reduced air pollution, job creation, poverty reduction, climate change mitigation, increased energy access, gender equality and others identified in development strategies, sustainable development goals (SDGs), nationally determined contributions (NDCs) under the Paris Agreement, and other national plans to promote policy coherence and integrated national strategies
- **Integrate climate policy into broader national development policy and broaden support for climate actions** by assessing and communicating the various impacts of climate actions (environmental, social and economic) that are most relevant to national priorities and stakeholders
- **Maximize positive impacts and minimize and mitigate negative impacts** of policies or actions across multiple impact categories and across different groups in society
- **Ensure that policies and actions are cost-effective** and that limited resources are invested efficiently
- **Align policies and actions** with national and international laws and principles on sustainable development, climate change and human rights and with national environmental and social impact assessment laws and regulations

Objectives of assessing impacts before policy implementation

- **Improve policy selection, design and implementation** by comparing policy options based on their expected future impacts across multiple impact categories and understanding the impacts of different design and implementation choices

- **Inform goal setting** by assessing the potential contribution of policy options to national or subnational goals, such as SDGs and NDCs, and understand whether planned policies are sufficient to meet goals
- **Report** on the multiple expected future impacts of policies and actions, domestically or internationally
- **Access financing** for policies and actions under consideration by demonstrating net benefits across multiple impact categories

Objectives of assessing impacts during or after policy implementation

- **Assess policy effectiveness and improve implementation** by determining whether policies and actions are being implemented as planned and delivering the intended results across multiple impact categories and across different groups in society
- **Inform adjustments to policy design and implementation** and decide whether to continue current actions, enhance current actions, or implement additional actions
- **Learn from experience and share best practices** about the impacts of policies and actions
- **Track progress toward national goals** such as NDCs and SDGs and understand the contribution of policies and actions toward achieving them
- **Report** on the multiple impacts of policies and actions achieved to date, domestically and/or internationally
- **Meet funder requirements** to report on sustainable development impacts of policies and actions, if applicable

Users should also identify the intended audience(s) of the assessment report. Possible audiences include policymakers, the general public, NGOs, companies, funders, financial institutions, analysts, research institutions, or other stakeholders affected by or who can influence the policy or action. For more information on identifying stakeholders, refer to the ICAT *Stakeholder Participation Guide*.

Subsequent chapters provide flexibility to enable users to choose how best to assess the impacts of policies and actions in the context of their objectives, including which impacts to include in the assessment boundary and which methods and data sources to use. Users can follow a qualitative and/or quantitative assessment approach depending on their objectives (further explained in Chapter 3). The appropriate level of accuracy and completeness is likely to vary by objective. Users should assess the impacts of policies and actions with a sufficient level of accuracy and completeness to meet the stated objectives of the assessment.

3. Key Concepts, Steps and Planning the Assessment

This chapter introduces key concepts contained in the methodology, an overview of the steps involved in assessing sustainable development impacts of policies and actions, and provides guidance on planning the assessment.

Checklist of key recommendations

- Base the assessment on the principles of relevance, completeness, consistency, transparency and accuracy

3.1 Key concepts

This section describes key concepts that are relevant to multiple chapters in the methodology. It introduces concepts and steps that are elaborated in more detail in later chapters. It is intended as an overview, but not to provide practical guidance, which begins in Chapter 4.

3.1.1 Sustainable development dimensions, impact categories and specific impacts

Impact assessment is the qualitative or quantitative assessment of impacts resulting from a policy or action. In this methodology, sustainable development impacts include all types of impacts across three overarching *dimensions*: environmental, social and economic.

Within each dimension are various *impact categories*, which are types of sustainable development impacts affected by a policy or action, such as air quality, health, jobs, poverty reduction, access to energy, gender equality, biodiversity, and energy independence, among others outlined in Chapter 5. Users choose which impact categories to include in the assessment in Chapter 5.

Finally, a *specific impact* is a more specific change (within a selected impact category) that results from a policy or action, such an increase in jobs in the solar PV manufacturing industry resulting from a solar PV incentive policy. Users identify specific impacts of the policy or action (within selected impact categories) in Chapter 6. Users are encouraged to include both positive and negative impacts to enable decision makers to understand the full range of impacts and maximize net benefits resulting from policies and actions.

3.1.2 Indicators and parameters

An *indicator* is a metric that can be estimated to indicate the impact of a policy or action on a given impact category, or monitored over time to enable tracking of changes toward targeted outcomes. For example, to measure the impact of a policy on jobs, a key indicator is the *number of people employed*. Indicators are what the user aims to calculate to assess the impact of the policy or action.

Calculating the impact of a policy or action on a given indicator may require collecting data on multiple parameters. *Parameters* are data needed to calculate the value of an indicator, in cases where the indicator cannot be directly measured. In some cases, indicators are sufficient and additional parameters are not necessary. For example, it may be possible to measure the indicator *number of people employed* directly. In other cases, parameters are necessary to measure the indicator value. For example, estimating household cost savings from an energy efficiency programme requires estimating the electricity price and the quantity of energy consumed in the baseline scenario and policy scenario. In this example, *household cost savings* is the indicator, while *electricity price* and *quantity of energy consumed* are parameters. These two parameters are not themselves indicators of interest, but are necessary to calculate the value of the indicator of interest (i.e., household cost savings). Whether a given metric is labeled an indicator or a parameter depends on the specific context. In the previous example, *quantity of energy consumed* would be an indicator rather than a parameter if the user intends to assess the impact of the policy or action on energy use.

Figure 3.1 provides a summary of these concepts. In the figure, the level of detail, specificity and disaggregation increases from the top of the figure (dimensions) to the bottom (parameter).

Figure 3.1: Overview of sustainable development dimensions, impact categories, specific impacts, indicators, and parameters

Term	Definition	Examples
Dimension	An overarching category of sustainable development impacts	Environmental Social Economic
Impact category	A type of sustainable development impact affected by a policy or action	Jobs Air quality Energy access Gender equality Poverty Health
Specific impact	A specific change that results from a policy or action (within a given impact category)	An increase in jobs in the solar PV manufacturing industry resulting from a solar PV incentive policy (specific impact within the jobs impact category)
Indicator	A metric that can be estimated to indicate the impact of a policy or action on a given impact category, or monitored over time to enable tracking of changes toward targeted outcomes	Number of people employed Emissions of $PM_{2.5}$ % of energy from domestic sources
Parameter	Data needed to calculate the value of an indicator, in cases where the indicator value cannot be directly measured	Installed capacity of solar PV Emission factor for $PM_{2.5}$ Electricity price

3.1.3 Assessment boundary and assessment period

The assessment boundary defines the scope of the assessment in terms of the range of dimensions, impact categories, and specific impacts that are included in the assessment. This methodology encourages a comprehensive assessment that includes the full range of impacts considered to be significant. For this reason, the assessment boundary may be broader than the geographic and sectoral boundary within which the policy or action is implemented.

Chapter 7 provides guidance on defining the qualitative assessment boundary. Chapter 8 provides guidance on defining the quantitative assessment boundary. All specific impacts identified in Chapter 6 should be included in the qualitative assessment boundary, whereas the quantitative assessment boundary should include all significant impacts, where feasible.

The assessment period is the time period over which impacts resulting from the policy or action are assessed. The assessment period may differ from the policy implementation period, which is the time period during which the policy or action is in effect. Chapters 7 and 8 provide more information on defining the assessment period.

3.1.4 Attribution of impacts to policies and actions

This methodology is designed to support users in attributing sustainable development impacts to a specific policy or action (or package of policies or actions) and to understand how effective various policies are in achieving desired results, which supports the various objectives listed in Chapter 2.

Attributing impacts to specific policies and actions is difficult, since changes in the world are the result many factors, including (1) the policy or action being assessed, (2) other policies or actions that directly or indirectly affect the same impact categories, and (3) various external drivers that affect the same impact categories. To overcome this challenge, it is necessary to define a baseline scenario that represents what is most likely to happen in the absence of the policy or action being assessed.

For example, a city may implement a green jobs programme and then observe that the following year jobs have declined. However, the fact that jobs declined does not mean that the policy has been unsuccessful or caused the decrease in jobs. A correlation between a policy being implemented and jobs decreasing is not sufficient to establish causation. Instead, jobs may have declined because of a broader economic downturn. The policy may still have been effective by increasing jobs relative to a baseline scenario.

Attribution of impacts is embedded in the quantitative impact assessment method included in this methodology. To estimate an impact resulting from a policy or action, users follow three basic steps:

1. Define the baseline scenario and estimate baseline scenario conditions (Chapter 8)
2. Define the policy scenario and estimate policy scenario conditions Chapters 9 and 10)
3. Subtract the baseline scenario value from the policy scenario value to estimate the impact of the policy or action (Chapters 9 and 10)

Attributing impacts to policies and actions is also part of the qualitative impact assessment method, which involves identifying impacts through a causal chain that illustrates the cause-and-effect relationships resulting from a policy or action.

In complex situations, a causal link between a given policy and a given result cannot always be demonstrated with a high degree of certainty or accuracy. Users and stakeholders should exercise caution in interpreting the assessment results, which are only as reliable as the data and methods used. In situations with high complexity or uncertainty, it may be more appropriate to conclude that a policy contributes to achieving a desired outcome rather than attributing a specific change to a given policy.

3.1.5 Tracking progress of indicators over time

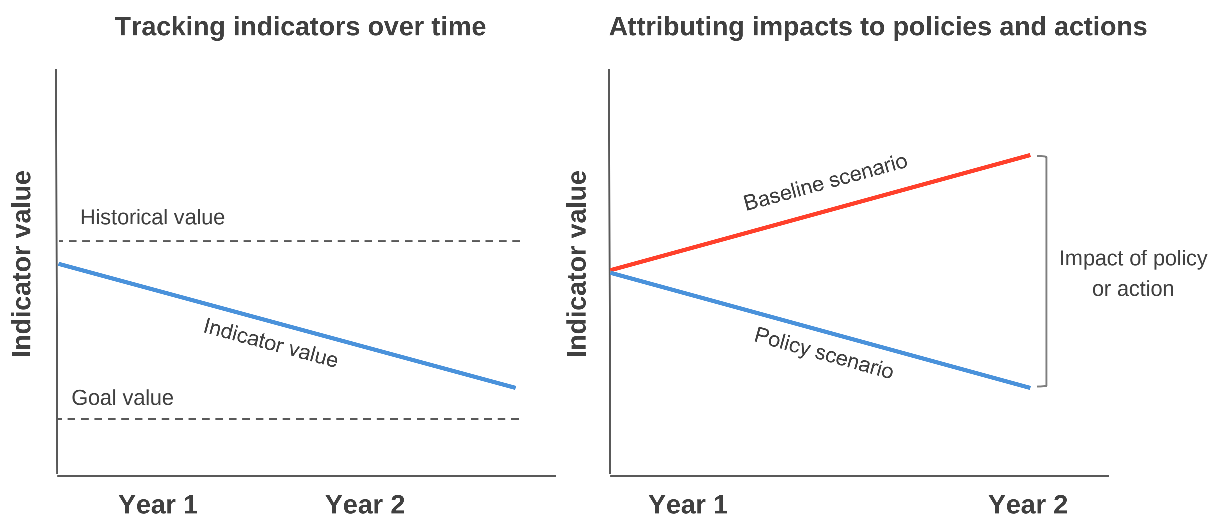
An alternative to attributing impacts to specific policies and actions is to track trends in overall national statistics or monitor indicators over time relative to historical values, goal values, and values at the start of policy implementation (detailed in Chapter 12).

Monitoring trends in indicators highlights changes in the targeted outcomes of a policy or action, which is helpful to understand whether a policy or action is on track. Monitoring key indicators is also necessary to assess progress toward goals and shows whether desired results are being achieved. For example, to track the progress of an energy efficiency policy, a user may track electricity consumption over time in relation to the date the policy was implemented and observe that energy consumption is declining over time.

However, tracking indicators does not explain why changes have occurred or demonstrate cause-and-effect relationships between interventions and impacts, since it does not involve defining a baseline scenario. For example, if energy consumption declines from one year to the next, the change could be the result of the energy efficiency policy or could be the result of a mild winter, which reduces demand for home heating. To attribute impacts to a policy, a baseline scenario is needed.

Figure 3.2 illustrates the difference between attributing impacts to specific policies and actions relative to a baseline scenario versus tracking changes in indicators over time relative to historical values. Users can follow the attribution approach, the tracking indicators over time approach, or both approaches.

Figure 3.2: Tracking indicators over time versus attributing impacts to policies and actions



3.1.6 Qualitative and quantitative approaches to impact assessment

Impacts can be assessed qualitatively and/or quantitatively. Qualitative assessment involves describing the impacts of a policy or action in descriptive terms, which can be useful for concepts that are harder to measure such as quality, behaviour or experiences. Quantitative assessment involves estimating the impacts of a policy or action in numerical terms using measured or estimated data.

Users can follow a qualitative and/or quantitative approach, further described in Section 3.3.2. The qualitative approach to impact assessment is provided in Part III, while the quantitative approach is provided in Part IV. The quantitative approach involves first following the qualitative approach in Part III as a precursor step to identify and prioritize impacts before quantifying significant impacts in the later chapters.

3.1.7 Baseline scenario and policy scenario

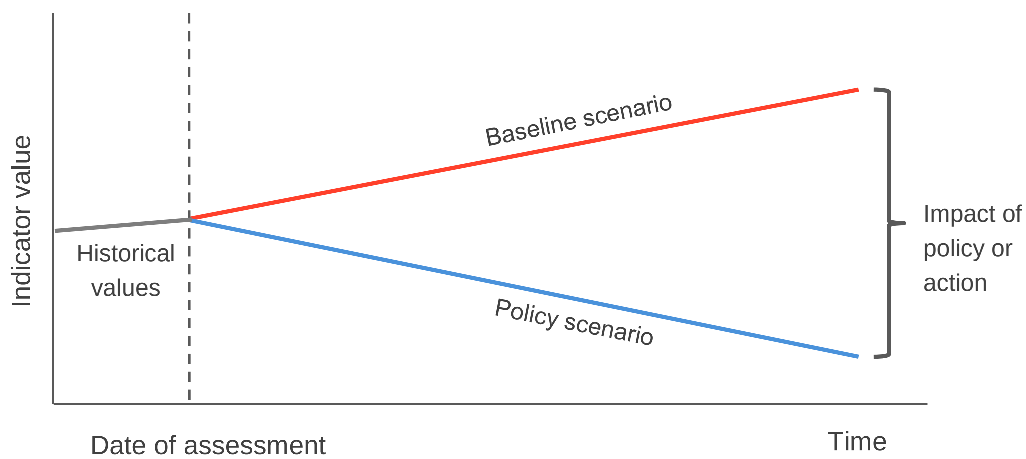
Assessing the impacts resulting from a given policy or action requires a reference case, or baseline scenario, against which the change is assessed. The baseline scenario represents the events or conditions most likely to occur in the absence of the policy or action being assessed. The baseline scenario is not a historical reference point but is instead an assumption about conditions that would exist over the assessment period if the policy or action assessed were not implemented. The baseline scenario depends on assumptions related to other policies or actions that are also implemented, as well as various external drivers and market forces that affect the impact category being assessed.

In contrast to the baseline scenario, the policy scenario represents the events or conditions most likely to occur in the presence of the policy or action being assessed. The policy scenario is the same as the baseline scenario except that it includes the policy or action (or package of policies/actions) being assessed. The difference between the policy scenario and the baseline scenario represents the impact of the policy or action (see Figure 3.3).

The baseline scenario can be higher or lower than the policy scenario, depending on the situation. In the case of a policy that reduces air pollution, the baseline scenario would be higher than the policy scenario, since emissions are lower in the policy scenario in the baseline scenario. In the case of a policy that increases jobs, the baseline scenario would be lower than the policy scenario, since the number of jobs is greater in the policy scenario than in the baseline scenario.

Chapter 8 provides guidance on developing the baseline scenario, while Chapters 9 and 10 provide guidance on developing the policy scenario, either ex-ante or ex-post.

Figure 3.3: Baseline and policy scenarios



3.1.8 Ex-ante and ex-post assessment

An assessment is classified as either ex-ante or ex-post depending on whether it is prospective (forward-looking) or retrospective (backward-looking). Ex-ante assessment is the process of assessing expected future impacts of a policy or action. Ex-post assessment is the process of assessing historical impacts of a policy or action. Ex-ante assessment can be carried out before or during policy implementation, while ex-post assessment can be carried out either during or after policy implementation.

3.1.9 Distributional impacts

In many cases, it may be important to separately assess the impacts of policies or actions on different groups in society, such as men and women, people of different income groups, people of different racial or ethnic groups, people of different education levels, people from various geographic regions, people in urban versus rural locations, among others. This allows users to understand distributional impacts on different groups, manage tradeoffs in cases where policies or actions have positive impacts on some groups and negative impacts on other groups, and avoid situations where policies or actions would be discriminatory or have adverse effects on disadvantaged or vulnerable populations. For example, a tax policy may be regressive by imposing more costs on poorer people than on wealthier people. In several steps throughout the methodology, users should collect disaggregated data and assess impacts separately for different groups, where relevant, in addition to assessing total impacts based on aggregated data. For example, users could collect data separately for women and men in combination with data on socioeconomic status.

3.2 Overview of steps

This document is organized according to the steps a user follows in assessing the sustainable development impacts of a policy or action (see Figure 3.4). Users can skip certain parts or chapters depending on when the methodology is applied and the methodological approach chosen. Users that only want to assess impacts qualitatively without quantifying any impacts can skip Part IV. Within Part IV, users assessing impacts ex-post but not ex-ante should skip Chapter 9, while users assessing impacts ex-ante but not ex-post should skip Chapter 10. Figure 3.5 provides an example of following the steps for a solar PV incentive policy.

Figure 3.4: Overview of steps

Part I: Introduction, objectives and key concepts

Understand 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 describe the policy or action 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 or action 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 tradeoffs and decide which policies and actions to implement (Chapter 14)

Figure 3.5: Example of following the steps for a solar PV incentive policy

Part I: Introduction, objectives and key concepts

Determine the objectives of the assessment (Chapter 2): The primary objective is to improve the design of a policy by understanding the environmental, social and economic impacts of various policy design options to maximize net benefits of the policy.

Part II: Defining the assessment

Clearly describe the policy or action to be assessed (Chapter 4): The policy is the Grid-Connected Solar Rooftop Programme (further elaborated in Table 4.1).

Choose which impact categories and indicators to assess (Chapter 5): The following impact categories are relevant and significant and will be assessed: climate change mitigation; air quality and health; waste; renewable energy generation; access to clean, affordable and reliable energy; capacity, skills and knowledge development; quality and safety of working conditions; jobs; income; new business opportunities; energy independence (see Table 5.2). Indicators for each impact category are selected.

Part III: Qualitative approach to impact assessment

Identify specific impacts of the policy or action within chosen impact categories (Chapter 6): Many specific impacts are identified, such as reduced GHG emissions and air pollution from fossil fuel based power plants; increased access to clean, affordable and reliable electricity; increased jobs and business opportunities in the solar manufacturing, installation, operation and maintenance sectors; decreased business opportunities in the fossil fuel extraction and related sectors; and increased energy independence from reduced imports of fossil fuels (see Table 6.3).

Qualitatively assess each specific impact (Chapter 7): Each specific impact is assessed based on its likelihood of occurring, its expected magnitude (major, moderate or minor), and the nature of the change (positive or negative) (see Table 7.5).

Part IV: Quantitative approach to impact assessment

Estimate baseline values for impacts included in the quantitative assessment boundary (Chapter 8): For each indicator in the quantitative assessment (e.g., number of jobs), baseline scenario values (the conditions most likely to occur in the absence of the policy or action) are estimated, such as 100,000 jobs in the solar sector per year over the assessment period (2020-2030) without the policy in place.

Estimate policy scenario values and estimate policy impact (ex-ante) (Chapter 9): For each indicator in the assessment (e.g., number of jobs), policy scenario values (i.e., the conditions most likely to occur in the presence of the policy or action) are estimated, such as 200,000 jobs in the solar sector per year over the assessment period (2020-2030) with the policy in place. The policy impact is estimated by subtracting baseline values from policy scenario values (in this case, a forecasted increase of 100,000 jobs per year resulting from the policy).

Estimate policy scenario values and estimate policy impact (ex-post) (Chapter 10): After the policy is implemented, the baseline scenario is revised for each indicator (e.g., there would have been 125,000 jobs per year without the policy in place, due to costs of solar panels falling more than expected leading to higher demand for solar electricity). The actual number of jobs with the policy in place is determined (such as 250,000 jobs in the solar sector) and the policy impact is estimated by subtracting baseline values from policy scenario values (e.g., an increase of 125,000 jobs per year resulting from the policy). (See Table 9.1.)

Assess uncertainty (Chapter 11): Uncertainty and sensitivity of the results are assessed, resulting in an uncertainty range or description (e.g., the policy is expected to create 100,000 ± 25,000 jobs per year).

Figure 3.5: Example of following the steps for a solar PV incentive policy (continued)

Part V: Monitoring and reporting

Monitor the performance of indicators over time (Chapter 12): Various indicators are tracked over time relative to historical values, goal values, and values at the start of policy implementation, such as tracking the number of jobs over time.

Report the results and methodology used (Chapter 13): The results (such as the estimated impact of the solar PV incentive policy on the various impact categories included in the assessment) are reported and the assumptions, methods, and data sources used are transparently documented.

↓

Part VI: Decision making and using results

Interpret results, evaluate synergies and tradeoffs and decide which policies and actions to implement (Chapter 14): Cost-effectiveness analysis is used to determine which policy design option delivers the greatest positive impact on a given impact category (e.g., jobs) for a given level of resources. Cost-benefit analysis and multicriteria analysis are used to determine which policy design option delivers the greatest net benefits across multiple impact categories. Based on the results, a recommendation is made on which policy design option to implement.

3.3 Planning the assessment

Users should review this methodology and plan in advance the steps, responsibilities and resources needed to meet their objectives for assessing sustainable development impacts. The time and human resources required to implement the methodology and carry out an impact assessment depend on a variety of factors, such as the complexity of the policy or action being assessed, the range of sustainable development impact categories included in the assessment, the extent of data collection needed and whether relevant data is available or has already been collected, whether analysis related to the policy or action has previously been done, and the desired level of accuracy and completeness needed to meet the user's stated objectives. Users should document their plans for the assessment.

3.3.1 Choosing a desired level of accuracy based on objectives

This methodology provides a range of approaches to allow users to manage trade-offs between the accuracy of the results and the resources, time, and data needed to complete the assessment, based on individual objectives. Some objectives require more detailed assessments that yield more accurate results (to demonstrate that a specific change in a sustainable development outcome is attributed to a specific policy, with a high level of certainty), while other objectives may be achieved with simplified assessments that yield less accurate results (to show that a policy contributes to improving a sustainable development outcome, but with less certainty around the magnitude of the impact).

Users should choose methods that are sufficiently accurate to meet the stated objectives of the assessment and ensure that the resulting claims are appropriate, for example whether a policy contributes to achieving an outcome or whether a certain outcome can be attributed to that policy. Two key choices in this regard are whether to apply a qualitative and/or quantitative approach and what types of data and methods to use, summarized in Table 3.1 and further described in the following sections.

Data constraints may limit the scope of the assessment and therefore may limit the objectives served by the assessment results. Users should consider data availability when determining the assessment objectives and scope. Given the uncertainties resulting from the range of data and methods that can be used, assessment results should be interpreted as “estimates” of the impact of policies and actions.

Table 3.1: Range of approaches that can be taken to balance robustness of the results with resources required for the assessment

Methodological options	**Less robust results; fewer resources required**	**Intermediate results; intermediate resources required**	**More robust results; more resources required**
Number of impact categories to assess	Relatively few impact categories are assessed	Multiple impact categories are assessed, but not all relevant and significant impact categories are assessed	All relevant and significant impact categories are assessed
Qualitative versus quantitative impact assessment	Most or all impact categories are assessed qualitatively; only the most significant impacts are assessed quantitatively, or no impact categories are quantified	Some impact categories are assessed qualitatively; some impact categories are quantified	Most impacts are quantified; impacts where quantification is not feasible are assessed qualitatively
Data	Data is largely sourced from international defaults or proxy data from other regions; data quality is relatively low	Mix of data sources with varying quality are used	Data is locally-specific; new values are estimated specific to the local context; data quality is relatively high
Methods	Simplified calculation methods and assumptions are used	Mix of methods are used	More sophisticated calculation methods and assumptions are used

3.3.2 Choosing an overarching approach to applying the methodology

Users should decide how to apply the methodology in the context of their objectives and available resources. The methodology contains steps related to (1) qualitative impact assessment, (2) quantitative impact assessment, and (3) tracking progress of indicators over time:

- **Qualitative impact assessment** involves describing and characterizing the expected or achieved impacts of a policy or action on selected impact categories using qualitative classifications of likelihood, magnitude and the nature of the change (positive or negative). This approach is covered in Part III.
- **Quantitative impact assessment** involves estimating the quantitative impacts of a policy or action on selected impact categories relative to a baseline scenario. Quantification includes qualitative impact assessment as a preliminary step. The quantitative approach is covered in Part IV.

- **Tracking progress of indicators over time** involves monitoring trends in key indicators over time relative to historical values, goal values and values at the start of policy implementation to track progress in selected indicators over time. This approach is covered in Part V.

Each approach is useful for different purposes. The recommended approach is to follow all chapters and therefore use all three approaches in combination, which involves qualitatively assessing all identified impacts and then quantifying the subset of impacts that are determined to be significant and feasible to quantify. However, users can choose to follow only certain steps and approaches depending on their objectives. Table 3.2 outlines advantages and disadvantages of each approach. Box 3.1 provides more information on choosing an approach based on the assessment objectives.

To ensure proper interpretation of the results, users should report whether the assessment consists of a qualitative impact assessment, quantitative impact assessment, and/or tracking progress of indicators over time.

Table 3.2: Advantages and disadvantages of different approaches for applying the methodology

Approach	Advantages	Disadvantages
Assess impacts qualitatively only	• Gives an understanding of expected impacts in descriptive rather than numerical terms • Easier, simpler, requires less time, resources and capacity	• Does not enable a quantified estimate of the impacts of a policy or action, which limits the range of objectives the assessment can meet • Risk of over-simplification or limited understanding of relevant impact drivers
Assess impacts quantitatively (which includes qualitative assessment as a step)	• Enables more robust and accurate understanding of the impacts of policies and actions • Best enables an understanding of tradeoffs between impact categories • Meets wider set of objectives (related to understanding policy impact) • Meets widest set of stakeholder needs	• Increased time, cost, data and capacity needs, depending on approach taken (simpler to more complex)
Track progress of indicators over time only	• Enables understanding of whether indicators of interest are moving in the right direction in relation to goal levels, such as SDGs • Easier, simpler, requires less resources/capacity • In some cases, sufficient to meet objectives, such as tracking progress towards national goals	• Does not enable an estimate of “impact” of a policy or action, because changes in indicators are not attributed to individual policies/actions, which limits the range of objectives the assessment can meet
Use all three approaches in combination (the default approach presented in the methodology)	• Meets widest set of objectives (related to understanding policy impact and tracking progress of indicators over time)	• Increased time, cost, data and capacity needs, depending on approach taken (simpler to more complex)

	• Provides flexibility to use the most appropriate method for various impacts	

Box 3.1: Choosing an approach based on objectives

If the user's objective is to understand policy impact to meet a variety of objectives—such as informing policy design, improving policy implementation, evaluating policy effectiveness, reporting on policy impacts, and attracting finance based on policy impacts—users should assess impacts qualitatively and/or quantitatively, rather than only tracking indicators over time. Such users should also track progress of indicators over time, where relevant.

Whether to follow a qualitative and/or quantitative approach should be guided by the user's objectives, capacity and resources. Some objectives may be achieved with a qualitative approach, such as getting an understanding of a wide variety of impacts in a short amount of time to guide decision making. Other objectives may require a more rigorous quantitative approach, such as attracting public or private financing to implement an intervention and achieve specific results. The quantitative approach to impact assessment better supports several objectives, but generally requires more time and resources, while the qualitative approach is less resource-intensive, but may not fully meet all objectives a user has. In general, users should quantify significant impacts of the policy or action where feasible. Where quantification is not feasible, users should qualitatively assess impacts.

If the objective is to track national or subnational progress over time, track progress toward goals such as SDGs, or track progress of indicators to understand whether the policy or action is being implemented as planned, users should track progress of indicators over time. Such users can also assess impacts qualitatively and/or quantitatively. Monitoring indicators is useful for understanding overall progress over time and progress toward meeting goals (such as SDGs or various national goals) and enables an understanding of whether indicators are moving in the right direction in relation to goal levels (if relevant), but does not attribute changes in indicators to individual policies or actions.

3.3.3 Planning data collection

Collecting data is a key step in the assessment process. Data needs will vary depending on the impact categories selected for the assessment in Chapter 5 and the methods used to quantitatively or qualitatively assess impacts in Chapters 6-11. Users should identify data needs and collect the necessary data as early as possible in the process. Where possible, data collection should begin prior to policy implementation to demonstrate before and after trends in key indicators, especially for ex-post assessments. Chapter 12 provides further guidance on collecting data and preparing a monitoring plan

In some cases, the availability of certain data and the lack of other data will dictate which methods can be used. Table 3.3 outlines different options for applying the methodology depending on the range of data available. In cases of low data availability, users should consider whether new data collection is possible to carry out a more rigorous assessment. To guide the types of data that should be collected, users should consider the intended level of accuracy and completeness of the assessment, based on the objectives of the assessment as well as the time, resources, and capacity available for the assessment.

Table 3.3: Range of approaches for applying the methodology based on data availability

Chapter	Approaches to take with less data available	Approaches to take with more data available
Chapter 2: Objectives	• Limit the objectives to those that can be achieved with fewer data requirements	• Choose from a wider range of objectives, including those for which a more accurate and complete assessment is needed
Chapter 5: Choosing which impact categories and indicators to assess	• Include a more limited set of impact categories and indicators in the assessment	• Include a wider set of impact categories and indicators in the assessment
Chapter 6: Identifying specific impacts within each impact category	• Use simplified or subjective methods to identify specific impacts	• Use evidence-based and objective methods to identify specific impacts
Chapter 7: Qualitatively assessing impacts	• Use simplified or subjective methods to qualitatively assess impacts	• Use evidence-based and objective methods to qualitatively assess impacts
Chapter 8: Estimating the baseline	• Quantify fewer impacts and indicators; assess more impacts and indicators qualitatively • Use baseline values from published data sources or proxy data from other regions • Use simplified baseline assumptions and methods • Include fewer drivers in the baseline scenario	• Quantify a wider set of impacts and indicators • Estimate new baseline values specific to the local context • Use more sophisticated baseline assumptions and methods • Include more drivers in the baseline scenario
Chapter 9: Estimating impacts ex-ante	• Use policy scenario values from published data sources or proxy data from other regions • Use international default values or national average data • Use simplified assumptions and methods	• Estimate new policy scenario values specific to the local context • Use locally-specific data • Use more sophisticated assumptions and methods
Chapter 10: Estimating impacts ex-post	• Use international default values or national average data • Use simplified calculation methods	• Use locally-specific data • Use more sophisticated calculation methods
Chapter 11: Assessing uncertainty	• Use qualitative uncertainty methods along • Use sensitivity analysis for a more limited set of indicators	• Use quantitative uncertainty methods • Use sensitivity analysis for a wider set of indicators
Chapter 12: Monitoring	• Monitor a more limited set of indicators • Monitor indicators less frequently	• Monitor a wider set of indicators • Monitor indicators more frequently

performance over time		
Chapter 13: Reporting	• Report on all assumptions, data sources, methods, and limitations to ensure transparency • Ensure the uncertainty of the results is communicated clearly, given data limitations	• Report on all assumptions, data sources, methods, and limitations to ensure transparency
Chapter 14: Evaluating synergies and tradeoffs and using results	• Use less data-intensive evaluation methods, such as CEA and MCA, rather than CBA • Apply these methods to a more limited set of impact categories and indicators	• Use a wider set of evaluation methods, such as CEA, CBA, and MCA • Apply these methods to a wider set of impact categories and indicators

3.3.4 Planning stakeholder participation

Stakeholder participation is recommended in many steps throughout the methodology. It can strengthen the impact assessment and the contribution of policies and actions to sustainable development in many ways, including by:

- Providing a mechanism through which people who are likely to be affected by a given policy or action or who can influence the policy or action are provided with an opportunity to raise issues and to have these issues considered before, during and after the policy implementation
- Raising awareness and enabling better understanding of complex issues for all parties involved, building their capacity to contribute effectively
- Building trust, collaboration, shared ownership and support for policies and actions among stakeholder groups, leading to less conflict and easier implementation
- Addressing stakeholder perceptions of risks and impacts and helping to develop measures to reduce negative impacts and enhance benefits for all stakeholder groups, including the most vulnerable
- Enhancing the credibility, accuracy and comprehensiveness of the assessment, drawing on diverse expert, local and traditional knowledge and practices, for example, to provide inputs on data sources, methods and assumptions
- Enhancing transparency, accountability, legitimacy and respect for stakeholders' rights
- Enabling enhanced ambition and finance by strengthening the effectiveness of policies and credibility of reporting

Various sections throughout this methodology explain where stakeholder participation is recommended—for example, in choosing which impact categories to assess (Chapter 5), identifying specific impacts within each impact category (Chapter 6), qualitatively assessing impacts (Chapter 7), monitoring performance over time (Chapter 12), reporting (Chapter 13) and decision making, evaluating tradeoffs and interpreting results (Chapter 14).

Before beginning the assessment process, users should consider how stakeholder participation can support their objectives and include relevant activities and associated resources in their assessment plans. It may be helpful to combine stakeholder participation for sustainable development impact assessment with other participatory processes involving similar stakeholders for the same or related policies and actions, such as those being conducted for assessment of GHG and transformational impacts and for technical review.

Users should ensure conformity with national legal requirements and norms for stakeholder participation in public policies and actions, as well as requirements of specific donors and of international treaties, conventions and other instruments that the country is party to. These are likely to include requirements for disclosure, impact assessments and consultations, and may include specific requirements for certain stakeholder groups (e.g., UN Declaration of the Rights of Indigenous Peoples, International Labour Organisation Convention 169) or specific types of policies and actions (e.g., UNFCCC guidance on safeguards for activities reducing emissions from deforestation and degradation in developing countries).

During the planning phase, users should identify stakeholder groups that may be affected by or may influence the policy or action. Appropriate approaches should be identified to engage with the identified stakeholder groups, including through their legitimate representatives. To facilitate effective stakeholder participation, users should consider establishing a multi-stakeholder working group or advisory body consisting of stakeholders and experts with relevant and diverse knowledge and experience. Such a group may advise and potentially contribute to decision making to ensure that stakeholder interests are reflected in design, implementation and assessment of policies and actions, including on stakeholder participation in the assessment of sustainable development impacts of a particular policy or action. It is also important to ensure that stakeholders have access to a grievance redress mechanism to secure adequate protection of stakeholders' rights related to the impacts of the policy or action.

Refer to the ICAT *Stakeholder Participation Guide* for more information, such as how to plan effective stakeholder participation (Chapter 4), identify and analyze different stakeholder groups (Chapter 5), establish multi-stakeholder bodies (Chapter 6), provide information (Chapter 7), design and conduct consultations (Chapter 8) and establish grievance redress mechanisms (Chapter 9). Appendix B summarizes the steps in this methodology where stakeholder participation is recommended along with specific references to relevant guidance in the *Stakeholder Participation Guide*.

3.3.5 Planning technical review (if relevant)

Before beginning the assessment process, users should consider whether technical review of the assessment report will be pursued. The technical review process emphasises learning and continual improvement and can help users identify areas for improving future impact assessments. Technical review can also provide confidence that the impacts of policies and actions have been estimated and reported according to ICAT key recommendations. Refer to the ICAT *Technical Review Guide* for more information on the technical review process.

3.4 Assessment principles

Assessment principles are intended to underpin and guide the impact assessment process, especially where the methodology provides flexibility. It is a *key recommendation* to base the assessment on the principles of relevance, completeness, consistency, transparency and accuracy, as follows:[6]

[6] Adapted from WRI 2014.

- **Relevance**: Ensure the assessment appropriately reflects the sustainable development impacts of the policy or action and serves the decision-making needs of users and stakeholders, both internal and external to the reporting entity. Applying the principle of relevance depends on the objectives of the assessment, broader policy objectives, national circumstances and stakeholder priorities. This principle should be applied, for example, when choosing which impact categories to assess in Chapter 5.
- **Completeness**: Include all significant impacts in the assessment boundary, including both positive and negative impacts. Document and justify any specific exclusions. This principle should be applied when identifying impact categories and specific impacts in Chapters 5 and 6.
- **Consistency**: Use consistent assessment approaches, data collection methods and calculation methods to allow for meaningful performance tracking over time. Transparently document any changes to the data sources, assessment boundary, methods, or any other relevant factors in the time series.
- **Transparency**: Provide clear and complete information for stakeholders to assess the credibility and reliability of the results. Document all relevant methods, data sources, calculations, assumptions and uncertainties, as well as the processes, procedures and limitations of the assessment in a clear, factual, neutral, and understandable manner. The information should be sufficient to enable a party external to the assessment process to derive the same results if provided with the same source data. Chapter 13 provides a list of recommended information to report to ensure transparency.

Accuracy: Ensure that the estimated impacts are systematically neither over nor under actual values, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users and stakeholders to make appropriate and informed decisions with reasonable confidence as to the integrity of the reported information. If accurate data for a given impact category is not currently available, users should strive to improve accuracy over time as better data becomes available. Accuracy should be pursued as far as possible, but once uncertainty can no longer be practically reduced, conservative estimates should be used. Box 3.2 provides guidance on conservativeness.

In addition to the principles above, users should follow the principle of comparability if it is relevant to the assessment objectives, for example if the objective is to compare multiple policies based on their sustainable development impacts or to aggregate the results of multiple impact assessments and compare the collective impacts to national goals (described further in Box 3.3).

- **Comparability**: Ensure common methods, data sources, assumptions and reporting formats such that the estimated impacts of multiple policies or actions can be compared.

Box 3.2: Conservativeness

Conservative values and assumptions are those more likely to overestimate negative impacts or underestimate positive impacts resulting from a policy or action. Users should consider conservativeness in addition to accuracy when uncertainty can no longer be practically reduced, when a range of possible values or probabilities exists (e.g., when developing baseline scenarios), or when uncertainty is high.

Whether to use conservative estimates and how conservative to be depends on the objectives and the intended use of the results. For some objectives, accuracy should be prioritized over conservativeness in order to obtain unbiased results. The principle of relevance can help guide what approach to use and how conservative to be.

Box 3.3: Applying the principle of comparability when comparing or aggregating results

Users may want to compare the estimated impacts of multiple policies or actions, for example to determine which has the greatest positive impacts. Valid comparisons require that assessments have followed a consistent methodology, for example regarding the assessment period, the types of impact categories, impacts, and indicators included in the assessment boundary, baseline assumptions, calculation methods and data sources. Users should exercise caution when comparing the results of multiple assessments, since differences in reported impacts may be a result of differences in methodology rather than real-world differences. To understand whether comparisons are valid, all methods, assumptions and data sources used should be transparently reported. Comparability can be more easily achieved if a single person or organization assesses and compares multiple policies or actions using the same methodology.

Users may also want to aggregate the impacts of multiple policies or actions, for example to compare the collective impact of multiple policies in relation to a national goal. Users should likewise exercise caution when aggregating the results if different methods have been used and if there are potential overlaps or interactions between the policies being aggregated. In such a case, the sum would either over or underestimate the impacts resulting from the combination of policies. For example, the combined impact of a local energy efficiency policy and a national energy efficiency policy in the same country is likely less than the sum of the impacts had they been implemented separately, since they affect the same activities. Chapter 4 provides more information on policy interactions.

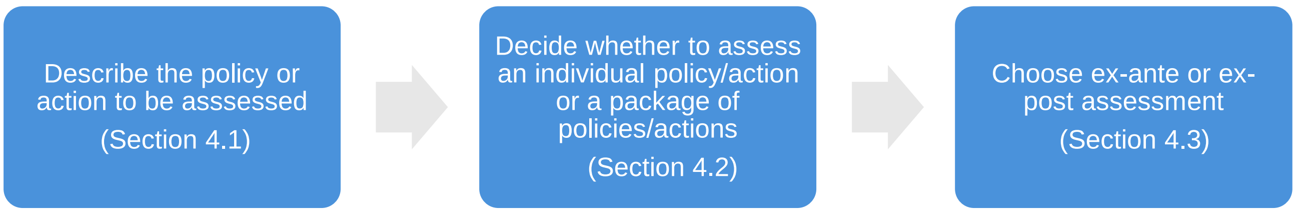
In practice, users may encounter trade-offs between principles when developing an assessment. For example, a user may find that achieving the most complete assessment requires using less accurate data for a portion of the assessment, which could compromise overall accuracy. Users should balance trade-offs between principles depending on their objectives. Over time, as the accuracy and completeness of data increases, the trade-off between these principles will likely diminish.

Part II: Defining the Assessment

4. Describing the Policy or Action

This chapter provides guidance on clearly defining the policy or action. In order to assess the impacts of a policy or action, users first need to understand and describe the policy or action that will be assessed, decide whether to assess an individual policy or action or a package of related policies or actions, and choose whether to carry out an ex-ante or ex-post assessment.

Figure 4.1: Overview of steps in the chapter



Checklist of key recommendations

- Clearly describe the policy or action (or package of policies/actions) that is being assessed

4.1 Describe the policy or action to be assessed

In order to effectively carry out an impact assessment in subsequent chapters, it is necessary to first have a detailed understanding and description of the policy or action being assessed. It is a *key recommendation* to clearly describe the policy or action (or package of policies and actions) that is being assessed. Table 4.1 provides a checklist of recommended information that should be provided to enable an effective assessment. Table 4.2 outlines additional information that may be relevant depending on the context.

Users assessing a package of policies and actions can apply Table 4.1 either to the package as a whole or separately to each policy or action within the package. Users that assess a modification of an existing policy or action, rather than a new policy or action, may define the policy to be assessed as either the modification of the policy or the policy as a whole, depending on the objectives.

Users that are assessing the greenhouse gas impacts and/or transformational impacts of the policy or action should describe the policy or action in the same way to ensure a consistent and integrated assessment.

Table 4.1 introduces an illustrative example of a solar PV incentive policy, which is used as a running example throughout the methodology.

Table 4.1: Checklist of recommended information to describe the policy or action being assessed

Information	Description	Example
Title of the policy or action	Policy or action name	"Grid-Connected Solar Rooftop Programme." Throughout this methodology, it is referred to as the "Solar PV incentive policy."
Type of policy or action	The type of policy or action, such as those presented in Table 1.1, or other categories of policies or actions that may be more relevant	Financial incentive policy
Description of specific interventions	The specific intervention(s) carried out as part of the policy or action, such as the technologies, processes or practices implemented to achieve the policy or action	• Description of financial incentives: The policy provides a financial subsidy up to 30% of project/benchmark cost for rooftop solar projects in the residential/institutional and social sectors. It also provides concessional loans to solar rooftop project developers • Description of eligible technology: Grid-connected rooftop and small solar power plants with installed capacity ranging from 1 to 500 kW • Description of eligible sectors: Residential (all types of residential buildings), institutional (schools, health institutions), social sectors (community centres, welfare homes, old age homes, orphanages, common service centres), commercial and industrial facilities • Description of contract and payment duration: Up to 30% of the eligible financial assistance and services charges at the time of sanction of the proposal. The remaining 70% after successful commissioning of the projects after sample verification on submission of requisite claims. • Description of national budget allocated to the policy: Approximately USD 750 million • Other enabling actions under the policy: • Training and capacity building of various stakeholders involved in the programme such as government staff, utilities, regulatory commissions, banks and workers • Development of online portal for rooftop solar systems development programme and registration of partners, approvals and project monitoring
Status of the policy or action	Whether the policy or action is planned, adopted or implemented	The policy has been implemented (currently in effect)
Date of implementation	The date the policy or action comes into effect (not the date that any supporting legislation is enacted)	1 January 2016
Date of completion (if applicable)	If applicable, the date the policy or action ceases, such	The provision of financial incentives ends on 31 December 2022

	as the date a tax is no longer levied or the end date of an incentive scheme with a limited duration (not the date that the policy/action no longer has an impact)	
Implementing entity or entities	The entity or entities that implement(s) the policy or action, including the role of various local, subnational, national, international or any other entities	India's Ministry of New and Renewable Energy (MNRE) implements the policy. Government funds are disbursed by the ministry to state agencies, financial institutions, implementing agencies and other government approved channel partners that includes renewable energy service providers, system integrators, manufacturers, vendors and NGOs.
Objectives and intended impacts or benefits of the policy or action	The intended impact(s) or benefit(s) the policy or action intends to achieve (e.g., the purpose stated in the legislation or regulation)	The policy is intended to increase deployment of solar energy, increase access to clean energy, increase energy independence, create jobs, reduce greenhouse gas emissions, and create an enabling environment for investment, installation, capacity building, research and development in the solar energy sector
Level of the policy or action	The level of implementation, such as national level, subnational level, city level, sector level or project level	National
Geographic coverage	The jurisdiction or geographic area where the policy or action is implemented or enforced, which may be more limited than all the jurisdictions where the policy or action has an impact	India
Sectors targeted	Which sectors or subsectors are targeted	Energy supply (grid-connected solar PV)
Other related policies or actions	Other policies or actions that may interact with the policy or action being assessed	The Government of India targets installation of 100,000 MW of solar power by 2022 of which 40,000 MW is to be achieved through rooftop solar power plants though the solar PV incentive policy.

Source: Adapted from WRI 2014. Example adapted from India's Ministry of New & Renewable Energy (MNRE).

Table 4.2: Checklist of additional information that may be relevant to describe the policy or action being assessed

Information	Description	Example
Relevant SDGs	Sustainable Development Goals the policy or action focuses on or contributes to	The policy is focused primarily on SDG 3 (Good health and well-being), SDG 7 (Affordable and clean energy), SDG 8 (Decent work and economic growth), SDG 9 (Industry, innovation and infrastructure), SDG 11 (Sustainable cities and communities), SDG 12 (Responsible consumption and production), and SDG 13 (Climate action), while also contributing to other SDGs

Specific intended targets, such as intended level of indicators	Target level of key indicators, if applicable	The policy aims to install 40,000 MW of rooftop solar PV by 2022. The policy will lead to increased solar power generation in the country, contributing to greater energy independence and increased jobs in the solar PV installation and maintenance sectors. Solar energy will also provide quick alternative power during severe climate changes that may occur.
Title of establishing legislation, regulations, or other founding documents	The name(s) of legislation or regulations authorizing or establishing the policy or action (or other founding documents if there is no legislative basis)	National renewable energy law
Monitoring, reporting and verification procedures	References to any monitoring, reporting and verification procedures associated with implementing the policy or action	Monitoring and evaluation studies of the policy will be carried out during the implementation period as follows: • At the primary level of monitoring, channel partners are responsible for monitoring parameters such as end-use verification and compliance and also compilation of statistical information such as number of companies involved in the installation • National monitors on number of companies and employees active within the sector • National monitors, consultants, institutions, civil society groups, corporations with relevant experience, other government organizations would be involved, for ground verification/performance evaluation on a random sample basis • The electricity generation data should be available at the beneficiary level. However, for projects above 5 kW, the system providers would also make available generation data to the government at intervals specified • For projects 50 kWp and above, 100% field inspection is required
Enforcement mechanisms	Any enforcement or compliance procedures, such as penalties for noncompliance	If evidence is presented that the applicant's information is found to be incorrect, distributed funds will be paid back.
Reference to relevant documents	Information to allow practitioners and other interested parties to access any guidance documents related to the policy or action (e.g., through websites)	For more information, see: http://mnre.gov.in/schemes/decentralized-systems/solar-rooftop-grid-connected/
The broader context or significance of the policy or action	Broader context for understanding the policy or action	The current energy mix mainly consists of imported fossil fuels. Coal power remains a dominant source of power generation in India. BMI Research forecasted in 2017 that coal will contribute 66 per cent to India's power generation mix in 2025 and coal electricity generation will increase by 5.8% between 2016 and 2025. In 2000, 67% of emissions in India were from energy generation and use.

		India plans a rapid increase in the renewable energy share in national electricity generation mix, including plans to install 175 GW of renewable generation capacity by 2022. Solar is projected to contribute 100 GW of installed capacity by 2022 from the current 4 GW, where recent auctions have resulted in record low tariffs of Rs 3 per kWh (USD 0.0446 per kWh). Rooftop solar has significant potential to contribute to national energy supply. Rooftop solar installed capacity reached 525 MW in 2015. This accounts for less than 10% of the installed utility-scale solar capacity and a very small portion of the total power consumption in the country. The government's target of 40 GW of solar rooftop capacity by 2022 has injected increased ambition into the sector.
Key stakeholders	Key stakeholder groups affected by the policy or action	Households, institutions (schools, health institutions), businesses, project developers, workers, utilities, banks, energy access programmes, women's organizations and cooperatives, micro-credit institutions, and others
Other relevant information	Any other relevant information	Various implementation models are possible under the policy: • Solar installations owned and operated by consumer • Solar rooftop facility owned by consumer but operated and maintained by a third party • Solar installations owned, operated and maintained by a third party • Solar lease model, with sale of electricity to the grid • Solar installations owned by the utility or distribution company

Source: Adapted from WRI 2014. Example adapted from India's Ministry of New & Renewable Energy (MNRE).

4.2 Decide whether to assess an individual policy/action or a package of policies/actions

If multiple policies or actions are being developed or implemented in the same timeframe, users can assess the policies or actions either individually or together as a package. When making this decision, users should consider the assessment objectives, the feasibility of assessing impacts individually or as a package, and the degree of interaction between the policies and actions under consideration.

In subsequent chapters, users follow the same general steps and requirements, whether they choose to assess an individual policy or action or a package of related policies or actions. Depending on the choice, the impacts estimated in later chapters will either apply to the individual policy or action assessed or to the package of policies and actions assessed.

Users that are assessing the greenhouse gas impacts and/or transformational impacts of the policy or action, following other ICAT methodologies should define the policy or policy package in the same way to ensure a consistent and integrated assessment, or explain why there are differences in how the policy package is defined across the assessments.

Overview of policy interactions

Multiple policies or actions can either be independent of each other or interact with each other. Policies or actions interact if they produce total impacts, when implemented together, that differ from the sum of the individual impacts had they been implemented separately. For example, national and subnational policies in the same sector are likely to interact. Two policies implemented at the same level may also interact—for example, a fuel tax that reduces the emissions intensity of the electricity grid and an energy efficiency policy that reduces electricity consumption.

Table 4.3 and Figure 4.2 provide an overview of four possible relationships between policies and actions.

Given the interrelated nature of the SDGs, multiple policies and actions are likely to be interrelated in their impacts on various sustainable development impact categories and have potential synergies and tradeoffs among them. Some policies may be in conflict with one another, while others may work together to achieve sustainable development outcomes. Users should consider possible synergies and tradeoffs between policies when deciding whether to assess a single policy or a package of related policies. Assessing a broader package of policies may help to avoid possible negative or unintended impacts beyond the scope of a single policy. At the end of the assessment, users should also consider potential tradeoffs between impact categories in Chapter 14.

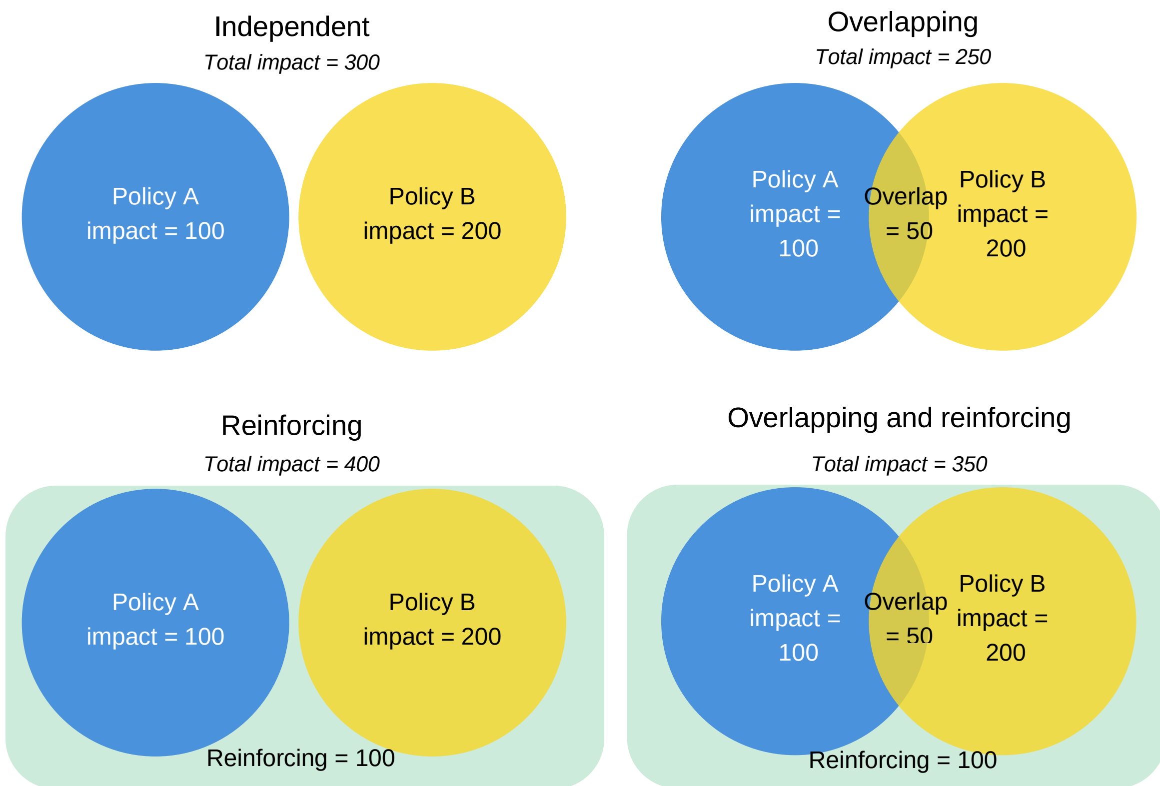
The relationship between policies and actions will likely differ by sustainable development impact category, such as air quality, health, jobs, or poverty reduction (further described in Chapter 5). Users should consider a range of relevant impact categories when deciding whether to assess an individual or package of policies/actions. Users should consider the primary intended objectives of the policy or action when determining which impact categories to include in the analysis of policy interactions. For example, if the primary objective of the policy or action is greenhouse gas mitigation, the user should consider analyzing policy interactions from the perspective of greenhouse gas emissions, rather than considering all other sustainable development impact categories. However, in this case, other relevant sustainable development impact categories should still be included in the assessment in later chapters.

Table 4.3: Types of relationships between policies and actions

Type	Description
Independent	Multiple policies do not interact with each other. The combined effect of implementing the policies together is equal to the sum of the individual effects of implementing them separately.
Overlapping	Multiple policies interact, and the combined effect of implementing the policies together is less than the sum of the individual effects of implementing them separately. This includes policies that have the same or complementary goals (such as national and subnational energy efficiency standards), as well as counteracting policies that have different or opposing goals (such as a fuel tax and a fuel subsidy).
Reinforcing	Multiple policies interact, and the combined effect of implementing the policies together is greater than the sum of the individual effects of implementing them separately.
Overlapping and reinforcing	Multiple policies interact, and have both overlapping and reinforcing interactions. The combined effect of implementing the policies together may be greater than or less than the sum of the individual effects of implementing them separately.

Source: WRI 2014, adapted from Boonekamp 2006.

Figure 4.2: Types of relationships between policies and actions



Source: Adapted from WRI 2014

4.2.1 Guidance for choosing whether to assess an individual or package of policies and actions

This section outlines a qualitative process to understand the expected relationship between policies and actions under consideration, as one consideration when deciding whether to assess an individual or package of policies and actions. The most robust approach is to qualitatively assess the extent of policy interactions at this stage, but it is not a necessary step when deciding whether to assess an individual policy/action or package of policies and actions if it is not feasible.

To assess the extent of policy interactions when deciding whether to assess an individual policy/action or a package of policies/actions, users should follow the steps below:

- Step 1: Characterize the type and degree of interaction between the policies or actions under consideration
- Step 2: Apply criteria to determine whether to assess an individual policy/action or a package of policies/actions

Step 1: Characterize the type and degree of interaction between the policies or actions under consideration

Potentially interacting policies and actions can be identified by identifying activities targeted by the policy or action, then identifying other policies and actions that target the activities. Once these are identified, users should assess the relationship between the policies/actions (independent, overlapping or reinforcing) and the degree of interaction (major, moderate or minor). Some relationships between the same policies may be overlapping for some impact categories and reinforcing or independent for other impact categories, depending on the impact categories considered. The assessment of interaction should be based on expert judgment, published studies of similar combinations of policies/actions, or consultations with relevant experts. The assessment should be limited to a preliminary qualitative assessment at this stage, rather than a more detailed qualitative or quantitative assessment as described in later chapters.

Step 2: Apply criteria to determine whether to assess an individual policy/action or a package of policies/actions

If policy interactions exist, there can be advantages and disadvantages to assessing the interacting policies and actions individually or as a package (see Table 4.4). To help decide, users should apply the criteria in Table 4.5. In some cases, certain criteria may suggest assessing an individual policy/action, while other criteria suggest assessing a package. Users should exercise judgment based on the specific circumstances of the assessment. For example, related policies may have significant interactions (suggesting a package), but it may not be feasible to model the whole package (suggesting an individual assessment). In this case, a user may undertake an assessment of an individual policy (since a package is not feasible) but acknowledge in a disclaimer that any subsequent aggregation of the results from individual assessments would be inaccurate given the interactions between the policies.

Users can also conduct assessments for both individual policies/actions and packages of policies/actions. Doing so will yield more information than conducting only one option or the other. Undertaking both individual assessments and assessments for combinations of policies should be considered if the end-user requires information on both, resources are available to undertake multiple analyses, and undertaking both is feasible.

If users choose to assess both an individual policy/action and a package of policies/actions that includes the individual policy/action assessed, users should define each assessment separately and treat each as a discrete application of this standard in order to avoid confusion of the results.

Table 4.4: Advantages and disadvantages of assessing policies/actions individually or as a package

Approach	Advantages	Disadvantages
Assessing policies/ actions individually	• Shows the effectiveness of individual policies/actions, which decision makers may require to make decisions about which individual policies/actions to support • May be simpler than assessing a package in some cases, since the causal chain and range of impacts for a package may be significantly more complex	• The estimated impacts from assessments of individual policies cannot be straightforwardly summed to determine total impacts, if interactions are not accounted for
Assessing policies/ actions as a package	• Captures the interactions between policies/actions in the package and better reflects the total impacts of the package • May be simpler than undertaking individual assessments in some cases, since it	• Does not show the effectiveness of individual policies or actions • May be difficult to quantify

	avoids the need to disaggregate the effects of individual policies/actions	

Source: Adapted from WRI 2014

Table 4.5: Criteria for determining whether to assess policies/actions individually or as a package

Criteria	Questions	Recommendation
Objectives and use of results	Do the end users of the assessment results want to know the impact of individual policies or actions?	If "Yes" then undertake an individual assessment
Significant interactions	Are there significant (major or moderate) interactions between the identified policies or actions, either overlapping or reinforcing, that will be difficult to estimate if policies or actions are assessed individually?	If "Yes" then consider assessing a package of policies or actions
Feasibility	Is it possible (e.g., is data available) to assess a package of policies or actions?	If "No" then undertake an individual assessment
	For ex-post assessments, is it possible to disaggregate the observed impacts of interacting policies or actions?	If "No" then consider assessing a package of policies or actions

Source: Adapted from WRI 2014

4.3 Choose ex-ante or ex-post assessment

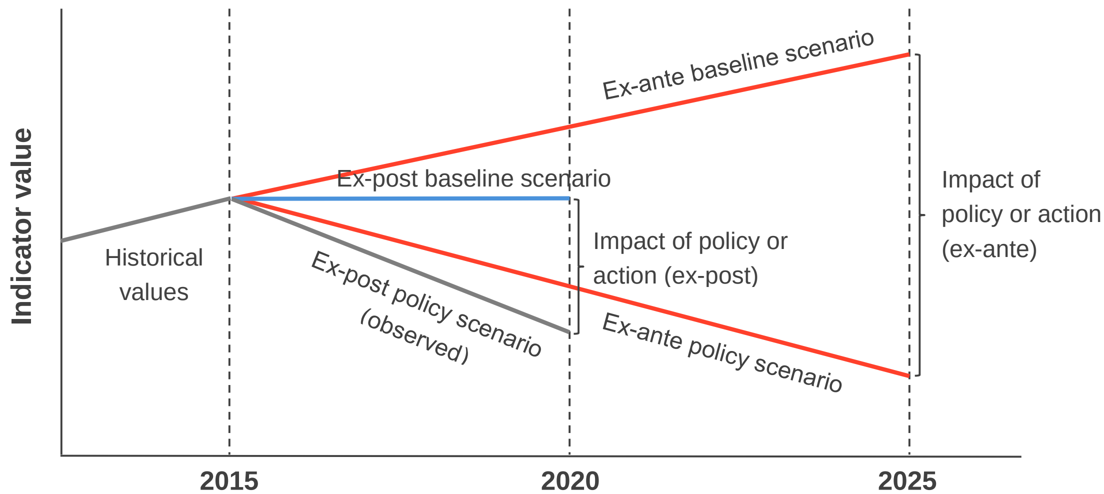
Users can carry out an ex-ante (forward-looking) assessment, an ex-post (backward-looking) assessment, or a combined ex-ante and ex-post assessment. Choosing between ex-ante or ex-post assessment depends on the status of the policy or action. If the policy or action is planned or adopted, but not yet implemented, the assessment will be ex-ante by definition. Alternatively, if the policy has been implemented, the assessment can be ex-ante, ex-post, or a combination of ex-ante and ex-post. In this case, users should carry out an ex-post assessment if the objective is to estimate the impacts of the policy or action to date; an ex-ante assessment if the objective is to estimate the expected impacts in the future;[7] or a combined ex-ante and ex-post assessment to estimate both the past and future impacts of the policy or action. In general, effective policy evaluation and management involves both ex-ante and ex-post assessment.

Figure 4.3 illustrates the relationship between ex-ante and ex-post assessment. In the figure, a policy comes into effect in 2015. The user carries out an ex-ante assessment in 2015 to estimate the expected future impacts of the policy on a given indicator through to 2025 by defining an ex-ante baseline scenario and an ex-ante policy scenario. The difference between the ex-ante policy scenario and the ex-ante baseline scenario is the estimated impact of the policy on that indicator (ex-ante). In 2020, the user carries out an ex-post assessment of the same policy to assess the historical impacts of the policy to date, by observing actual conditions over the policy implementation period—that is, the ex-post policy

[7] An ex-ante assessment may include historical data if the policy or action is already implemented, but it is still an ex-ante rather than an ex-post assessment if the objective is to estimate future effects of the policy or action.

scenario—and defining a revised ex-post baseline scenario. The difference between the ex-post policy scenario and the ex-post baseline scenario is the estimated impact of the policy (ex-post).

Figure 4.3: Ex-ante and ex-post assessment



Source: Adapted from WRI 2014.

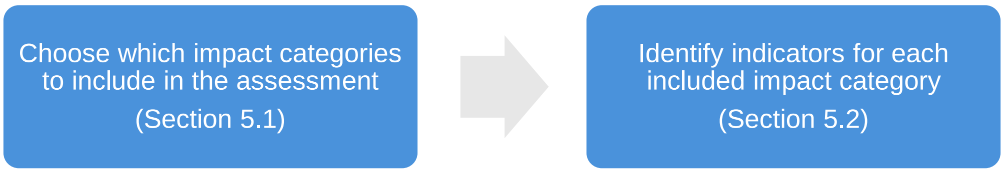
If conditions unrelated to the policy or action unexpectedly change between 2015 and 2020, the ex-post baseline scenario will differ from the ex-ante baseline scenario. For example, the ex-post and ex-ante baseline scenarios will differ if external factors such as economic conditions differ from ex-ante forecasts made in 2010, or if significant new policies are introduced. The ex-post policy scenario may differ from the ex-ante policy scenario for the same reasons, or if the policy is less effective in practice than it was assumed to be. In such cases, the ex-ante and ex-post estimates of the policy's impact will differ.

In an ex-ante assessment, the baseline scenario and policy scenario are both hypothetical or forecasted, rather than observed. In an ex-post assessment, only the baseline scenario is hypothetical, since the ex-post policy scenario can be observed.

5. Choosing Which Impact Categories and Indicators to Assess

This chapter outlines the various sustainable development impact categories that users can assess and assists users in determining which impact categories to assess for their policy or action. In this chapter, users also identify indicators for each included impact category that will be used in subsequent chapters.

Figure 5.1: Overview of steps in the chapter



Checklist of key recommendations

- Include all sustainable development impact categories in the assessment that are expected to be (1) relevant (based on the objectives of the assessment, national or local policy objectives, sustainable development goals and priorities, local circumstances, and stakeholder priorities) and (2) significantly affected by the policy or action (either positively or negatively)
- Consult stakeholders when choosing which impact categories to assess

5.1 Choose which impact categories to include in the assessment

Users can assess a wide variety of sustainable development impact categories across the three dimensions of environmental, social and economic impacts. Examples of impacts include improved health from reduced air pollution, job creation, poverty reduction, increased energy access, and gender equality. This section provides examples of impact categories and provides guidance on choosing which impact categories to assess.

The policy or action being assessed is likely to have positive impacts on some impact categories and negative impacts on others. Users should choose a comprehensive set of impact categories that are relevant to the assessment. In subsequent chapters, users determine how the policy or action affects each impact category. In Chapter 14, users evaluate potential synergies and tradeoffs between the selected impact categories to inform decision making.

5.1.1 Examples of impact categories

Table 5.1 presents a list of examples of impact categories that can be assessed. Users should review the list of examples with their policy or action in mind to identify which impact categories may be relevant or significant for their assessment.

The list is illustrative, rather than comprehensive or prescriptive. Users can choose a subset of impact categories from this list or use it as a starting point in preparing their own list of impact categories to assess. In consultation with stakeholders, users should brainstorm to identify additional possible impact categories not included in the list that may be relevant or significant.

In Table 5.1, impact categories are organized into groups to help users navigate the list. The names of impact categories and their classification into different dimensions and groups are suggestions and can be adapted by users. Some impact categories blur the line between the social, economic and environmental dimensions, and could reasonably appear under more than one dimension. As an example, poverty and jobs could be considered either social or economic impacts. Users are invited to use Table 5.1 as a starting point and prepare the list of impact categories that best meets their needs. See Box 5.1 for an explanation of the relationship of the list of impact categories to the UN SDGs.

Box 5.1: Relationship to the UN Sustainable Development Goals (SDGs)

This methodology is intended to be consistent with the SDGs to help countries assess the impacts of policies and actions in contributing to achieving the SDGs. The 17 SDGs, outlined in Figure 5.2, and the associated 169 targets are framed as aspirations or desired outcomes rather than as a neutral list of impact categories. Table 5.1 adapts many of the SDG goals and targets to express impact categories in neutral terms, to allow users to assess positive or negative impacts on each impact category. Other sources were also reviewed when developing the list of impact categories.[8] To keep Table 5.1 relatively comprehensive yet still concise and user-friendly, not all 169 SDG targets are reflected in the table and certain impact categories were merged. The SDG most directly relevant to each impact category is indicated in parentheses throughout the table. In some cases, there is not an SDG directly associated with each impact category, so not every impact category indicates an associated SDG. Users should refer to the full list of SDG goals, targets, and indicators for more information when deciding which impact categories to assess, available at https://sustainabledevelopment.un.org/sdgs.

Figure 5.2: The Sustainable Development Goals

[8] This includes the United Nations Framework Convention on Climate Change (UNFCCC), the Paris Agreement, decisions from the Conference of the Parties to the UNFCCC, the Declaration of the United Nations Conference on the Human Environment. (Stockholm Declaration), the Rio Declaration on Environment and Development (Rio Declaration), the United Nations Millennium Declaration, the Johannesburg Declaration on Sustainable Development, and The Future We Want.

Table 5.1: Examples of impact categories

Dimension	Groups of impact categories	Impact categories
Environmental impacts	Air	• Climate change mitigation (SDG 13) • Ozone depletion • Air quality and health impacts of air pollution • Visibility • Odors
	Water	• Availability of freshwater (SDG 6) • Water quality (SDG 6, SDG 14) • Biodiversity of freshwater and coastal ecosystems (SDG 6, SDG 14) • Fish stocks sustainability (SDG 14)
	Land	• Biodiversity of terrestrial ecosystems (SDG 15) • Land use change, including deforestation, forest degradation, and desertification (SDG 15) • Soil quality (SDG 2)
	Waste	• Waste generation and disposal (SDG 12) • Treatment of solid waste and wastewater (SDG 6)
	Other/cross-cutting	• Resilience of ecosystems to climate change (SDG 13) • Adverse effects of climate change • Energy (SDG 7) • Depletion of nonrenewable resources • Material intensity • Toxic chemicals released to air, water and soil • Genetic diversity and fair use of genetic resources (SDG 2, SDG 15) • Terrestrial and water acidification (SDG 14) • Infrastructure damage from acid gases and acid deposition • Loss of ecosystem services from air pollution • Nuclear radiation • Noise pollution • Aesthetic impacts
Social impacts	Health and well-being	• Accessibility and quality of health care (SDG 3) • Hunger, nutrition, and food security (SDG 2) • Illness and death (SDG 3) • Access to safe drinking water (SDG 6) • Access to adequate sanitation (SDG 6) • Access to clean, reliable and affordable energy (SDG 7) • Access to land (SDG 2) • Livability and adequate standard of living • Quality of life and well-being (SDG 3)
	Education and culture	• Accessibility and quality of education (SDG 4) • Capacity, skills, and knowledge development (SDG 4, SDG 12) • Climate change education, public awareness, capacity-building and research • Preservation of local and indigenous culture and heritage (SDG 11)

	Institutions and laws	• Quality of institutions (SDG 10) • Corruption, bribery and rule of law (SDG 16) • Public participation in policy-making processes • Access to information and public awareness (SDG 12) • Compensation for victims of pollution • Access to administrative and judicial remedies (SDG 16) • Protection of environmental defenders • Freedom of expression
	Welfare and equality	• Poverty reduction (SDG 1) • Economic inequality (SDG 8, SDG 10) • Equality of opportunities and equality of outcomes (SDG 10) • Protection of poor and negatively affected communities (SDG 12) • Removal of social disparities • Climate justice and distribution of climate impacts on different groups • Gender equality and empowerment of women (SDG 5) • Racial equality • Indigenous rights • Youth participation and intergenerational equity • Income of small-scale food producers (SDG 2) • Migration and mobility of people (SDG 10)
	Labour conditions	• Labour rights (SDG 8) • Quality of jobs (SDG 8) • Fairness of wages (SDG 8) • Quality and safety of working conditions (SDG 8) • Freedom of association (SDG 8) • Just transition of the workforce (SDG 8) • Prevention of child exploitation and child labour (SDG 8, SDG 16) • Prevention of forced labour and human trafficking (SDG 8)
	Communities	• City and community climate resilience (SDG 11) • Mobility (SDG 11) • Traffic congestion (SDG 11) • Walkability of communities (SDG 11) • Road safety (SDG 3, SDG 11) • Community/rural development • Accessibility and quality of housing (SDG 11)
	Peace and security	• Resilience to dangerous climate change and extreme weather events (SDG 13) • Security (SDG 16) • Maintaining global peace (SDG 16)
Economic impacts	Overall economic activity	• Economic activity (SDG 8) • Economic productivity (SDG 8, SDG 2) • Economic diversification (SDG 8) • Decoupling economic growth from environmental degradation (SDG 8)
	Employment	• Jobs (SDG 8) • Wages (SDG 8) • Worker productivity
		• New business opportunities (SDG 8)

	Business and technology	• Growth of new sustainable industries (SDG 7, SDG 17) • Innovation (SDG 8, SDG 9) • Competitiveness of domestic industry in global markets • Agricultural productivity and sustainability (SDG 2) • Economic development from tourism and ecotourism (SDG 8) • Transportation supply chains • Infrastructure creation, improvement and depreciation
	Income, prices and costs	• Income (SDG 10) • Prices of goods and services • Costs and cost savings • Inflation • Market distortions (SDG 12) • Internalization of environmental costs/externalities • Loss and damage associated with environmental impacts (SDG 11) • Cost of policy implementation and cost-effectiveness of policies
	Trade and balance of payments	• Balance of payments • Balance of trade (imports and exports) • Foreign exchange • Government budget surplus/deficit • Energy independence, security or sovereignty • Global economic partnership

5.1.2 Choosing which impact categories to assess

Choosing which impact categories to assess is one of the most important choices in the assessment process. To ensure a complete and relevant assessment of the impacts resulting from the policy or action, users should choose which impact categories to assess based on three criteria (further described below):

- Significance
- Relevance
- Comprehensiveness

It is a *key recommendation* to include all sustainable development impact categories in the assessment that are expected to be (1) relevant (based on the objectives of the assessment, national or local policy objectives, sustainable development goals and priorities, local circumstances, and stakeholder priorities) and (2) significantly affected by the policy or action (either positively or negatively). It is also a *key recommendation* to consult stakeholders when choosing which impact categories to assess.

The choice should be made in a principled, transparent and participatory way, in the context of the user's objectives and the needs of stakeholders. Selecting too few impact categories may not provide an adequate reflection of a policy or action's full impact, while selecting too many could make the process burdensome. Only selecting impact categories that are expected to show positive impacts would lead to an incomplete and biased assessment, as would selecting impact categories that only show negative impacts.

When choosing impact categories to include in the assessment, users should be aware that there are interlinkages and interrelationships between the various sustainable development impact categories. For example, gender equality and empowerment of women is intertwined with many other impact categories in Table 5.1 even if they are not explicitly focused on gender, such as ensuring equal access to education, skills development, jobs, new business opportunities, equality of wages, and others. Therefore, it is important to consider a wide range of potentially relevant and significant impact categories that may be interconnected when choosing which impact categories to assess. For further information on linkages between impact categories, see Box 5.2.

Box 5.2: Interlinkages between sustainable development impact categories

When selecting which impact categories to assess, users should consider related impact categories that are likely to be interrelated. Examples of interrelated impact categories, often called "nexuses" include:

- Health, poverty, gender and education
- Water, soil and waste
- Education, health, food and water
- Water, energy, food, land and climate
- Infrastructure, inequality and resilience

For more information on interactions between impact categories and SDGs, see:

- International Council for Science. *A Guide to SDG Interactions: From Science to Implementation*. Available at: https://council.science/cms/2017/05/SDGs-Guide-to-Interactions.pdf. Particularly relevant for policies or impact categories with a relationship to hunger, food security, nutrition, and agriculture (SDG 2); health and well-being (SDG 3); affordable and clean energy (SDG 7); and oceans and life below water (SDG 14).
- Jungcurt, Stefan. 2016. *Towards Integrated Implementation: Tools for Understanding Linkages and Developing Strategies for Policy Coherence*. IISD. Available at: https://sdg.iisd.org/commentary/policy-briefs/towards-integrated-implementation-tools-for-understanding-linkages-and-developing-strategies-for-policy-coherence/.
- Nerini, Francesco Funo, et al. 2017. *Mapping synergies and trade-offs between energy and the Sustainable Development Goals*. Nature Energy. Volume 3. Available at: https://www.nature.com/articles/s41560-017-0036-5.
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- Melamed, Megan, et al. 2016. *Sustainable policy—key considerations for air quality and climate change*. Current Opinion in Environmental Sustainability. Volume 23. Available at https://doi.org/10.1016/j.cosust.2016.12.003.

As users proceed through subsequent chapters in this methodology, the decision of which impact categories are relevant and significant and should be included in the assessment is likely to become clearer. As a result, users should develop an initial list of impact categories to assess in this chapter and then revisit the choice after completing the steps in Chapters 6 and 7. Box 5.3 provides more information on this iterative process.

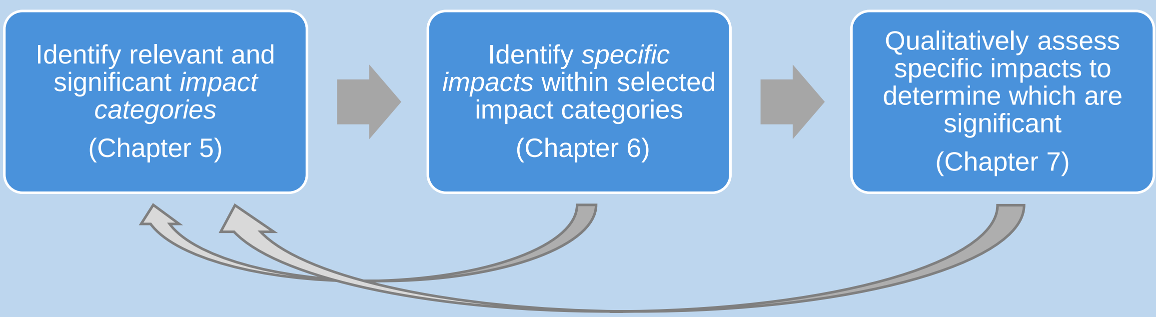
Box 5.3: Iterative process to identify relevant and significant impact categories in Chapters 5, 6, and 7

Chapters 5, 6 and 7 present a stepwise prioritization process for identifying impact categories and specific impacts of the policy or action. In Chapter 5, users consider a broad array of possible *impact categories* (e.g., jobs) across the environmental, social and economic dimensions and identify which are relevant and significant to the policy or action being assessed. Next, in Chapter 6, users identify *specific impacts* within those chosen impact categories (e.g., an increase in jobs from solar PV installation due to the policy). In Chapter 7, users qualitatively assess those specific impacts and determine which should be quantified (in Chapters 8-11) based on the criteria of significance and feasibility (e.g., the increase in jobs from solar PV installation is significant and feasible to quantify).

By following these three chapters, users begin Chapter 5 considering a long list of impact categories and end Chapter 7 with a short list of specific impacts to be quantified. These steps are illustrated through the example of a solar PV incentive policy in Table 5.2, Table 6.3 and Table 7.5.

The steps are iterative, such that users may find in Chapter 6 or 7 that certain impact categories not deemed significant in Chapter 5 are in fact significant and should be included in the assessment. Users should revisit Chapter 5 after going through the steps in Chapter 6 and 7 to make sure that all potentially significant and relevant impact categories are included in the assessment, as illustrated in Figure 5.3.

Figure 5.3: Iterative process to identify relevant and significant impact categories and specific impacts



Identifying significant impact categories

The most objective of the criteria is to determine which impact categories are expected to be significantly affected by the policy or action, including both positive and negative impacts. Users should review the list of impact categories in Table 5.1 and consider which may be significantly affected by the policy or action. For example, a solar PV incentive policy may be reasonably expected to have greater impacts on air quality and energy independence than on tourism or waste generation. As a consequence, users should choose the impact categories that are significantly affected by the policy or action. Table 5.2 provides a template, with an example, that can be used to assess each impact category.

To ensure a complete assessment, users should consider a wide range of potential impacts, including positive and negative, intended and unintended, short-term and long-term, and in-jurisdiction and out-of-jurisdiction impacts. These types of impacts are detailed further in the next chapter (in Table 6.1).

Users should rely on evidence when determining which impact categories may be significantly affected by the policy or action in order to consider potentially significant impact categories that are not immediately obvious. For example, a solar PV incentive policy could in fact increase waste generation significantly depending on the frequency at which photovoltaic panels or batteries need to be replaced and whether these can be recycled.

Evidence for determining the significance of impact categories may include published studies on similar policies and impact categories in the same or other jurisdictions, regulations, development plans, regulatory impact analyses, environmental impact assessments, risk assessments, economic studies, relevant media reports, consultation with experts and stakeholders, prior experience, or other methods. If evidence does not exist, expert judgment should be used.

If it is not clear whether the policy or action is expected to significantly affect a given impact category, or if the assessment objectives or other factors suggest an impact category should be included even if it may not be significant, the most robust approach is to include it in the assessment for further analysis in later chapters. Chapters 6 and 7 provide detailed guidance on identifying and assessing the significance of specific impacts.

Identifying relevant impact categories

Another criterion for the selection of impact categories is their relevance, understood from the perspective of users, decision makers and stakeholders. Relevance is a more subjective criterion and may be determined based on the objectives of the assessment, national or local policy objectives, sustainable development goals and priorities, local circumstances, and stakeholder priorities, as voiced during stakeholder consultation processes.

Applying the criteria of relevance involves a policy decision by the user regarding which impact categories are priorities. For example, a solar PV incentive policy may be explicitly designed to reduce greenhouse gas emissions and reduce negative health impacts caused by air pollutants, so both impact categories are relevant to the policy objectives. Stakeholders such as workers in the energy sector may also be interested in how the policy will affect employment in affected regions, such that the impact category of jobs is also relevant to assess. Users should include as many relevant impact categories as possible to properly assess the policy's intended aims and address stakeholders' priorities and concerns.

Ensuring comprehensiveness

Policies and actions may have both positive and negative impacts on sustainable development. Identifying possible adverse impacts is important to make any necessary adjustments to the policy and to assist those who may be negatively affected. As a consequence, users should develop a list of impact categories to assess that represents a comprehensive assessment of sustainable development impacts, both positive and negative. Including possible adverse impacts in the list and later finding that such impacts have not manifested or are insignificant is a useful way of demonstrating that the policy in question is appropriate. In the case of a solar PV incentive policy, for example, it may be relevant to include *electricity prices* and *access to clean, reliable and affordable energy* as impact categories to monitor any possible adverse impact of the policy on electricity prices and energy access.

Furthermore, a comprehensive list should include impact categories from each of the three dimensions of sustainable development (economic, social, and environmental). The goal of sustainable development calls for striking a balance between each of its three dimensions. A policy that would have highly positive environmental and economic impacts, but highly negative social consequences would not be regarded as truly sustainable.

Consulting stakeholders

Users should consult stakeholders to identify which impact categories are priorities of different stakeholder groups and which meet the criteria of significance, relevance and comprehensiveness. Different groups of stakeholders approach a policy or action from different perspectives. By conducting stakeholder consultations to identify impacts, users can enhance the completeness of the assessment, identify and address possible unintended or negative impacts early on, and increase acceptance of the final assessment results.

Users should identify the range of stakeholder groups that may be affected by or may influence the implementation of a policy or action and should ensure that legitimate representatives of these different stakeholder groups are included in the consultations. Users should recognize that stakeholder groups are not homogeneous, and that age, ethnicity and gender may shape the perceptions and impacts that policies will have on different individuals. Therefore, efforts should be made to ensure stakeholder engagement is as representative and inclusive as possible. The ICAT *Stakeholder Participation Guide* provides more information on how to identify stakeholders (Chapter 5), provide information to them (Chapter 7), and conduct consultations (Chapter 8) to identify all significant and relevant impact categories. Box 5.4 provides an example of identifying stakeholders for an assessment in Mexico.

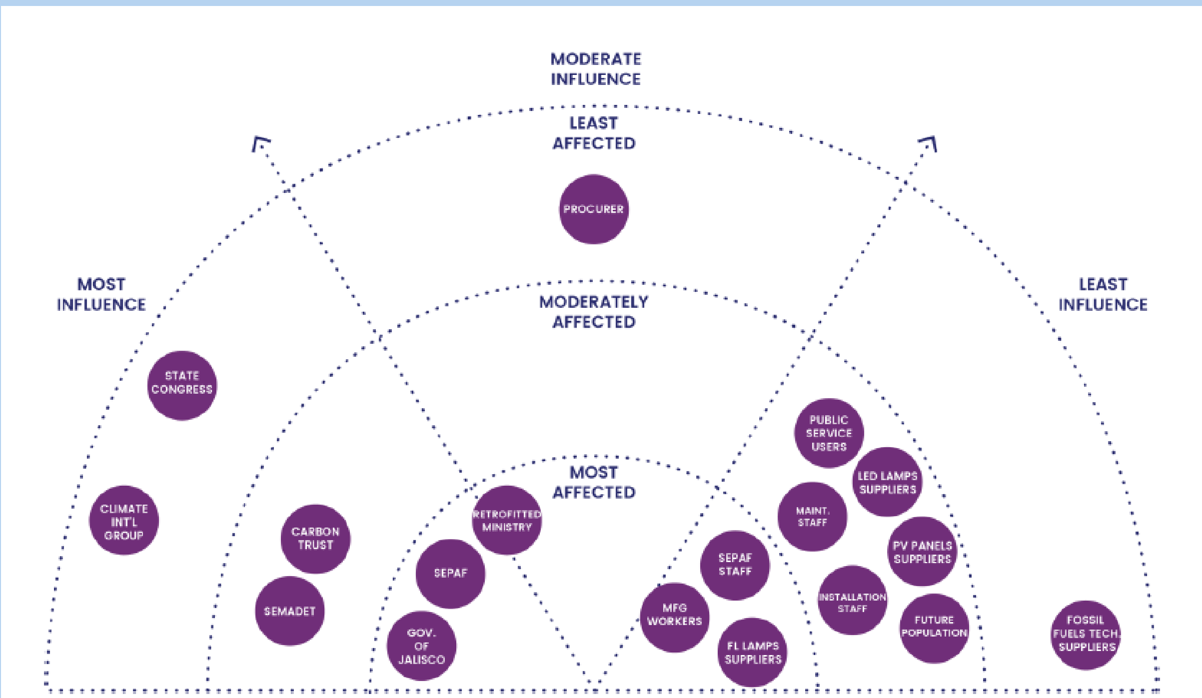
Public participation is a means of ensuring good governance, transparency, accountability and integrity of the sustainable development assessment. Adequate access to information and opportunities to provide input, including through effective consultations will allow stakeholders to contribute their knowledge and experience to the evaluation of the sustainable development impacts of policies and actions. Local communities, indigenous peoples, industry representatives, trade unions, civil society organizations, including women and youth organizations, and researchers may have very valuable input to offer as to what impact categories are significant and relevant, in order to achieve a comprehensive and balanced assessment of sustainable development impacts. In most countries, laws require access to information and public participation in assessment of social and environmental impacts of proposed interventions. In the case of a solar PV incentive policy, public consultations open to citizens at large, municipal governments, professional associations from the energy sector and public health researchers may bring impact categories to the attention of the user that would otherwise have been left out.

Box 5.4: Identifying and consulting stakeholders for a sustainable development assessment in Mexico

A researcher at Aalto University assessed the sustainable development impacts of two climate actions in public buildings in Mexico: installing PV panels and changing of fluorescent lamps to LED lamps. Both actions are part of the Mexican State of Jalisco's Carbon Management Plan, which was developed by the Ministry of Environment and Territorial Development (SEMADET) in cooperation with Carbon Trust. The office buildings of the Sub-Administration of the Ministry of Planning, Administration, and Finance (SEPAF) was the first to undergo the retrofit.

As part of the assessment, it was important to identify a balanced group of stakeholders to provide a comprehensive and robust range of information and insights. To identify stakeholders to engage, the study used a rainbow diagram (Figure 5.4) from the ICAT *Stakeholder Participation Guide*. The diagram helped identify and classify specific people or groups of people that are both affected by the policy and have influence over the policy to varying levels, which helped identify key impact categories for the assessment.

Figure 5.4: Rainbow diagram to identify relevant stakeholders for the assessment.



Reporting

Reporting which impact categories are included and excluded is important to ensure that the sustainable development impact assessment is conducted in a transparent way, which in turn will increase its legitimacy, usefulness and replicability. Users should report which impact categories are included and excluded from the assessment boundary, with justification for exclusions of impact categories that may be relevant, significant, or identified by stakeholders.

Table 5.2 provides an example of reporting which impact categories are included and excluded for the example of the solar PV incentive policy. This table can be used as a template to help decide which impact categories to assess and to report which impact categories are included in the assessment boundary. It contains several of the impact categories in Table 5.1, as well as columns for users to indicate 1) whether each impact category is relevant (from the perspective of the user, decision makers, or stakeholders), 2) whether the policy or action is expected to significantly affect each impact category, and 3) whether each impact category is included in the assessment boundary. Users should provide a brief description for the decision to include or exclude a given impact category and to explain the expected impacts of the policy or action on the impact category.

Table 5.2: Example of reporting which impact categories are included in the assessment for a solar PV incentive policy

Dimension	Impact category	Relevant?	Significant?	Included in the assessment boundary?	Brief description (rationale for the determination of relevance and significance)
Environmental	Climate change mitigation	Yes	Yes	Yes	The policy is expected to significantly reduce greenhouse gas (GHG) emissions by replacing fossil energy with solar energy
	Air quality / health impacts of air pollution	Yes	Yes	Yes	The policy is expected to significantly reduce air pollution by replacing fossil energy with solar energy
	Waste generation and disposal	Yes	Yes	Yes	The policy is expected to have both positive and negative impacts on waste by reducing fossil energy waste and increasing solar energy waste (e.g., replacement of PV panels or batteries)
	Energy	Yes	Yes	Yes	The policy is expected to significantly increase renewable energy generation by replacing fossil energy with solar energy
	Availability of freshwater	Yes	No	No	The policy is not expected to significantly affect these impact categories
	Land use change	Yes	No	No	
	Biodiversity of terrestrial ecosystems	Yes	No	No	
	Soil quality	Yes	No	No	
	Nuclear radiation	Yes	No	No	
Social	Access to clean, affordable, and reliable energy	Yes	Yes	Yes	The policy is not expected to increase access to energy, since all eligible households and buildings are already connected to the electric grid, but the policy is expected to significantly improve access to clean, affordable and reliable energy
	Capacity, skills, and knowledge development	Yes	Yes	Yes	The policy is expected to significantly improve training for skilled workers in the solar manufacturing, installation and maintenance sectors

	Quality and safety of working conditions	Yes	Yes	Yes	The policy is expected to improve working conditions by having more workers in the solar sector and relatively fewer in the fossil fuel sector
	Diseases	Yes	No	No	The policy is not expected to significantly affect these impact categories, though reduced energy costs may reduce poverty
	Freedom of expression	Yes	No	No	
	Access to safe drinking water	Yes	No	No	
	Poverty	Yes	No	No	
	Gender equality	Yes	No	No	Gender equality is a high policy priority and some solar energy policies are expected to increase women's participation in the labour force through new jobs and women's entrepreneurship through new business opportunities, but this specific policy design is not expected to have a significant impact.
	Mobility	No	No	No	This impact category is not relevant to the assessment or policy objectives and was not expressed as a priority of stakeholders
Economic	Jobs	Yes	Yes	Yes	The policy is expected to create a significant number of new jobs in the solar manufacturing, installation and maintenance sectors
	Income	Yes	Yes	Yes	The policy is expected to lead to significant financial savings for households, institutions and other organizations through reduced energy costs
	Wages	No	Yes	No	The policy is expected to increase wages for workers in the solar sector, but assessing wages is not relevant to the objectives and was not expressed as a priority of stakeholders.
	New business opportunities	Yes	Yes	Yes	The policy is expected to create a significant number of new business opportunities in the solar manufacturing, installation and maintenance sectors
	Energy independence	Yes	Yes	Yes	The policy is expected to lead to significant improvement in energy independence by reduced energy imports
	Economic activity	No	No	No	The policy may affect these impact categories, but the impact is not expected to be significant. They are also not relevant to the
	Economic productivity	No	No	No	

	Prices of goods and services	No	No	No	assessment or policy objectives and were not expressed as a priority of stakeholders.
	Balance of payments	No	No	No	

5.2 Identify indicators for each included impact category

An *indicator* is a metric that can be estimated to indicate the impact of a policy or action on a given impact category, or monitored over time to enable tracking of changes toward targeted outcomes. In order to assess impacts in later chapters, indicators need to be identified for each impact category that can be used as an appropriate measure to assess the impacts of the policy or action. One or more indicators may be relevant for each impact category. For example, if one of the impact categories included in the assessment is *Gender equality and empowerment of women*, a user may select the indicators *average income of women*, *number of women in the labour force*, and *proportion of women in senior management positions* to assess the impact of the policy or action.

Identifying indicators can be useful for qualitative assessments (Chapters 6 and 7). Defining indicators is necessary for quantitative assessments, since it is necessary to define the specific indicators that will be estimated in the baseline and policy scenarios (in Chapters 8-10) and monitored over time (Chapter 12).

For quantitative assessments, users should identify possible indicators at this stage to inform the qualitative assessment in Chapters 6 and 7. Users should revisit which are the most appropriate indicators to quantify after identifying the specific impacts of the policy and action in Chapter 6 and determining which are significant in Chapter 7. The decision on which indicators to quantify is described in Section 8.1.

Selecting indicators

Indicators should enable users to adequately assess if a policy or action affects a given impact category, and how. Indicators may be qualitative or quantitative.

Indicators can be defined in a variety of ways for a given impact category. For example, to measure a policy's impact on the number of jobs, indicators could include the number of people employed, the number of people unemployed, the employment rate, the unemployment rate, the number of women and men employed, the number of short-term and long-term jobs, the number of full-time equivalent jobs, the number of jobs in various economic sectors, and the number of new jobs created. Additional indicators are needed to measure a policy's impact on the quality of jobs, such as indicators related to wages, benefits, job security, and worker safety. Users can also decide whether to estimate the number of direct jobs (for example, the number of people installing solar PV panels), indirect jobs (for example, jobs involved in solar panel manufacturing, distribution, and marketing) and/or induced jobs (for example, jobs in other sectors such as food services supported by increased wages from new solar PV installation jobs). As a conservative and simplifying assumption, users may decide to only assess direct jobs.

The choice of specific indicators, representing the specific aspects of each impact category to be measured, should be based on the objectives of the assessment, in the context of what types of data are available. When selecting appropriate indicators, users should consider the criteria outlined in Table 5.3.

Table 5.3: Criteria for selecting indicators

Criteria	Description
Relevance	Does the indicator measure what really matters as opposed to what is easiest to measure? Users should avoid measuring what is easy to measure instead of what is needed.
Credibility	How trustworthy or believable are the data collected to the intended audiences of the evaluation report? Stakeholders and experts consulted may help identify credible sources of information. Technical review of data can help improve credibility.
Validity	Will the indicator reflect what the evaluator set out to measure? Validity is the term used to indicate whether a measurement actually measures what it is supposed to measure.
Reliability	If data on the indicator are collected in the same way from the same source using the same decision rules every time, will the same results be obtained? One way of improving reliability is ensuring that monitoring occurs regularly.
Feasibility	Users should avoid trying to measure too much. Users should consider what indicators are already being monitored in order to limit the costs of data collection. Users should also consider whether the indicator can be measured directly or whether (and how many) parameters are needed to calculate the value of the indicator.

Users should consider defining indicators separately for various groups in society in addition to aggregated statistics. For example, for the impact category of jobs, users should consider defining indicators for the number of men and women employed, in addition to the total number of people employed, to show the impacts of a policy or action by gender. As another example, since water scarcity and air quality have locally-specific impacts, users should consider defining indicators for different regions within a country to assess the local impacts of a policy or action on water scarcity or air quality. Indicators may be disaggregated by gender, income groups, racial or ethnic groups, people of different education levels, geographic regions, urban versus rural, among others.

Table 5.4 provides examples of indicators that can be disaggregated by gender.

Table 5.4: Examples of disaggregating indicators by gender

Impact categories	Examples of indicators disaggregated by gender
Access to health-care services	Proportion of women/men, girls/boys with health insurance or access to public health system
Hunger, nutrition, and food security	Prevalence rate of undernourished girls/boys, women/men
Illness and death	Life expectancy women/men (years)
Access to safe drinking water	Percentage of population (women/men) with access to safe drinking water
Access to adequate sanitation	Percentage of population (women/men) with access to sanitation facilities
Access to clean, reliable and affordable energy	Percentage of population (women/men) with access to clean, reliable, and affordable energy
Access to land	Percentage of population (women/men) with access to land
Accessibility and quality of education	Proportion of girls/boys getting secondary school education Average years of schooling for girls/boys

Capacity, skills, and knowledge development	Number of women/men, girls/boys that have received training
Climate change education, public awareness, capacity-building and research	Number of women/men, girls/boys that have received training
Economic inequality	Average income for women/men Average wealth for women/men, difference in wealth between women and men Average wages for women/men, gender wage gap
Gender equality and empowerment of women	Average income for women and men Gender wage gap Proportion of girls and women in schools Proportion of women in tertiary education Proportion of women in the labour force Proportion of women in senior management positions Proportion of women in senior government positions
Jobs	Number of people women and men employed Number of women and men unemployed Employment rate for women and men Unemployment rate for women and men Number of jobs, including short-term jobs and long-term jobs in different sectors for women and men Number of new jobs created in different sectors for women and men
New business opportunities	Number of new companies headed by women/men

Users should define indicators in a way that avoids duplication and overlap to avoid any possible double counting. Defining distinct indicators for how each impact category will be measured helps avoid duplication between impact categories included in the assessment.

Examples of indicators

Table 5.5 provides examples of indicators for selected impact categories in Table 5.1. For further guidance and examples of indicators that can be used, see:

- The UN Sustainable Development Goals website (https://sustainabledevelopment.un.org/sdgs)
- UN SDG indicators website (http://unstats.un.org/sdgs/), including the global SDG indicators database (http://unstats.un.org/sdgs/indicators/database/) and list of indicators (http://unstats.un.org/sdgs/indicators/indicators-list/)
- The UN Commission on Sustainable Development Indicators of Sustainable Development: Guidelines and Methodologies (https://sustainabledevelopment.un.org/content/documents/guidelines.pdf)

Table 5.5: Examples of indicators for selected impact categories

Examples of impact categories	**Examples of indicators for each impact category**
Environmental impacts	
Climate change mitigation (SDG 13)	• Net emissions of greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and NF_3, and if relevant, other gases identified by the IPCC) (metric tonnes/year) and in carbon dioxide equivalent (CO_2e) using global warming potential • Net emissions of short-lived climate pollutants (SLCPs): black carbon, organic carbon, CO, NMVOCs, sulfates
Ozone depletion	• Net emissions of ozone depleting substances (such as CFC-11, CFC-113, Halon 1211, Methyl Chloroform) (tonnes/year) • Stratospheric ozone concentration (tonnes/m^3)
Air quality and health impacts of air pollution (SDG 3, SDG 11, SDG 12)	• Emissions of air pollutants such as particulate matter (PM2.5, PM10), ammonia, ground-level ozone (resulting from volatile organic compounds (VOCs) and nitrogen oxides (NOx)), carbon monoxide, sulphur dioxide, nitrogen dioxide, fly ash, dust, lead, mercury, and other toxic pollutants (tonnes/year) • Air pollutants concentration (mg/m^3) • Aerosol particles concentration (mg/m^3) • Indoor and outdoor air quality • Morbidity (disability-adjusted life years (DALYs), quality-adjusted life year (QALY), and averted disability-adjusted life years (ADALYs)) • Mortality (avoided premature deaths per year)
Visibility	• Visual range (in units of distance) • Deciview (dv)
Availability of freshwater (SDG 6)	• Water consumption (m^3) or total amount of water removed from freshwater sources for human use • Proportion of total water resources used (water scarcity) • Water use efficiency or intensity • Stress-weighted water footprint (liters)
Water quality (SDG 6, SDG 14)	• Net emissions of sulphur dioxide, nitrogen oxides, phosphorus, nitrogen, toxic pollutants (tonnes/year) • Acidity (pH) • Accumulated exceedance • Eutrophication from nutrient pollution (such as phosphorus and nitrogen compounds) • Toxicity from emissions of toxic chemicals (such as metals, PAH)
Biodiversity of freshwater and coastal ecosystems (SDG 6, SDG 14)	• Proportion of marine area protected • Proportion of fish stocks within safe biological limits • Percentage of fish tonnage landed with Maximum Sustainable Yield (MSY) • Damage on ecosystem (PDF-Potential affected fraction of species) • Marine trophic index • Extinction rate • Biodiversity intactness index
Biodiversity of terrestrial ecosystems (SDG 15)	• Species diversity (number of species or species richness) • Change in threat status of species (abundance of selected key species, invasive alien species or endangered species) • Proportion of terrestrial area protected • Damage on ecosystem (PDF-Potential affected fraction of species) • Extinction rate • Biodiversity intactness index

	• Quality of ecosystem services
Land use change, including deforestation, forest degradation, and desertification (SDG 15)	• Annual change in degraded or desertified arable land (% or ha) • Area of forested land as a percentage of original or potential forest cover • Proportion of land area covered by forests • Area of forest under sustainable forest management • Arable and permanent cropland area • Area under organic farming
Soil quality (SDG 2)	• Net emissions of sulphur dioxide (SO_2), ammonia (NH_3), and nitrogen oxides (NO_x) (t/year) • Soil organic matter • Acidity (pH) • Extent of soil erosion
Waste generation and disposal (SDG 12)	• Solid waste generated (tonnes/year) • Wastewater generated • Recycling rate (percentage of waste recycled) • Proportion of materials reused • Proportion of waste composted
Treatment of solid waste and wastewater (SDG 6)	• Proportion of wastewater/solid waste safely treated
Terrestrial and water acidification (SDG 14)	• Proportion of land exceeding critical loads
Energy (SDG 7)	• Energy consumption • Energy efficiency • Energy generated by source • Renewable energy generation • Renewable energy share of total final energy consumption • Primary energy intensity of the economy (e.g., tonnes of oil equivalent/GDP)
Material intensity	• Quantity of embedded materials in products
Depletion of nonrenewable resources	• Consumption of mineral resources • Consumption of fossil fuels • Scarcity of resources
Toxic chemicals released to air, water, and soil	• Emissions (tonnes/year)
Genetic diversity and fair use of genetic resources (SDG 2, SDG 15)	• Genetic diversity of seeds, plants, and animals
Nuclear radiation	• Human exposure efficiency relative to U235 • Morbidity (DALYs - Disability Adjusted Life Years)
Noise pollution	• Noise level (dB)
Social impacts	
Accessibility and quality of health care (SDG 3)	• Proportion of people with health insurance or access to public health system
Hunger, nutrition, and food security (SDG 2)	• Prevalence rate of undernourished people • Average share of food expenditures in total household expenditures • Per capita total amount of net calories available in a given country • Level of nutrition or malnutrition • Agricultural crop diversity

Illness and death (SDG 3)	• Life expectancy (years) • Avoided premature deaths per year • Morbidity (Disability-adjusted life years (DALYs), Quality-adjusted life year (QALY), and Averted disability-adjusted life years (ADALYs)) • Maternal mortality • Infant mortality • Prevalence of diseases • Proportion of population with diagnosed diseases or hospitalized from specific diseases • Illnesses from hazardous chemicals, air pollution, water pollution, and soil pollution • Prevalence or reduction in respiratory illnesses • Bioaccumulation of POPs and heavy metals
Access to safe drinking water (SDG 6)	• Percentage of population with access to safe drinking water
Access to adequate sanitation (SDG 6)	• Percentage of population with access to sanitation facilities
Access to clean, reliable and affordable energy (SDG 7)	• Percentage of population with access to clean, reliable, and affordable energy • Price of energy • Emissions per unit of energy • Number and length of service interruptions
Access to land (SDG 2)	• Percentage of population with access to land
Livability and adequate standard of living	• Gross national income per capita (adjusted according to PPP$)
Quality of life and well-being (SDG 3)	• Gross National Happiness (GNH)
Accessibility and quality of education (SDG 4)	• Proportion of children getting primary and secondary school education • Average years of schooling
Capacity, skills, and knowledge development (SDG 4, SDG 12)	• Proportion of youth and adults with scientific, technological, or other skills, by type of skill • Number of people that have received training
Climate change education, public awareness, capacity-building and research	• Extent to which climate change education is mainstreamed in national education policies, curricula, teacher education and student assessment • Proportion of population aware of climate change • Number of people that have received training
Quality of institutions (SDG 10)	• Effectiveness of institutions • Credibility of institutions • Accountability of institutions • Legitimacy of institutions
Poverty (SDG 1)	• Poverty rate (proportion of population living below national poverty line) • Proportion of people living on less than one dollar (or other amount) per day • Number of people living in poverty • Multidimensional poverty index (see http://hdr.undp.org/sites/default/files/hdr2015_technical_notes.pdf)
Economic inequality (SDG 8, SDG 10)	• Income equality/inequality, average income for different groups, share of national income by income quintile • Wealth equality/inequality, average wealth for different groups, share of national wealth by wealth quintile • Wage equality/inequality, average wages for different groups

Gender equality and empowerment of women (SDG 5)	• Average income for women and men • Gender wage gap • Proportion or number of girls and women in schools • Proportion or number of women in tertiary education • Proportion or number of women in the labour force • Proportion or number of women in senior management positions • Proportion or number of women in senior government positions
Racial equality	• Average income by racial/ethnic group • Proportion of people in schools by racial/ethnic group • Proportion of people in the labour force by racial/ethnic group • Proportion of people in senior management positions by racial/ethnic group
Indigenous rights	• Extent of recognition of ancestral land titles • Extent of free, prior and informed consent • Extent of protection of Indigenous traditional knowledge • Extent of empowerment of Indigenous communities
Mobility (SDG 11)	• Number of people or proportion of population with convenient access to employment, schools, healthcare, or recreation, by sex, age, and persons with disabilities
Traffic congestion	• Time lost during transportation • Economic cost of time lost
Road safety (SDG 3, SDG 11)	• Number of deaths and injuries from road traffic accidents per year
Resilience to dangerous climate change and extreme weather events (SDG 13)	• Creation and maintenance of climate-resilient infrastructure • Reduction of natural disaster risks
Economic impacts	
Economic activity (SDG 8)	• Gross domestic product (GDP) • Gross national income (GNI) • Local or state/provincial GDP • Annual growth rate of real GDP per capita
Economic productivity (SDG 8, SDG 2)	• Agricultural productivity (harvested crop yields per hectare)
Jobs (SDG 8)	• Number of people employed • Number of people unemployed • Employment rate • Unemployment rate • Number of jobs, including short-term jobs and long-term jobs in different sectors • Number of new jobs created in different sectors
Wages (SDG 8)	• Average hourly wage (nationally or in different economic sectors) • Average hourly wage for different groups (by gender, income, etc.)

Worker productivity	• Labour productivity per hour or per unit of labour • Total employment or number of hours worked per GDP
New business opportunities (SDG 8)	• Number of new companies • Revenue and profit • Amount of new investment • Number of active long-term partnerships
Growth of new sustainable industries (SDG 7, SDG 17)	• Amount of investment in clean tech sector • Revenue and profit from clean tech sector • Number of projects
Competitiveness of domestic industry in global markets	• Market share • Quantity/value of exports • Balance of trade
Economic development from tourism and ecotourism (SDG 8)	• Revenue from tourism • Tourism GDP as a proportion of total GDP • Number of jobs in tourism industries as a proportion of total jobs and growth rate of jobs (by women/men)
Income (SDG 10)	• Income per capita • Median household income • Annual growth in household income
Prices of goods and services	• Energy prices
Costs and cost savings	• Fuel costs or cost savings • Health care costs or cost savings • Economic costs of human health losses from air pollution based on social welfare indicator (ADALYs monetized in terms of social welfare valuation (USD) based on willingness to pay VSL estimates) or national accounts indicator (ADALYs monetized based on foregone output estimates based on productivity/wage approaches)
Inflation	• Inflation rate
Balance of trade	• Total imports • Total exports • Net imports
Government budget surplus/deficit	• Annual revenue • Annual expenditures • Annual surplus or deficit
Energy independence	• Net imports of fossil fuels (coal, oil, natural gas)

1

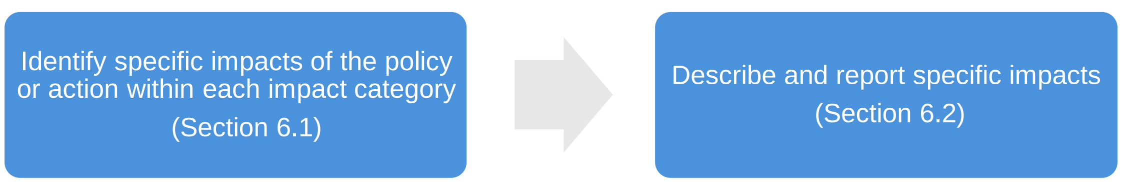
PART III: QUALITATIVE APPROACH TO IMPACT ASSESSMENT

6. IDENTIFYING SPECIFIC IMPACTS WITHIN EACH IMPACT CATEGORY

After choosing which impact categories to assess in Chapter 5, the next step is to identify the specific impacts within each selected impact category. This chapter explains how to identify all potential impacts of the policy or action within each sustainable development impact category that has been included in the assessment boundary.

This step is relevant for all users, including those following qualitative and quantitative approaches, for either ex-ante or ex-post assessment. For all users, the set of impacts identified in this chapter will be included in the qualitative assessment boundary and qualitatively assessed in Chapter 7. For users following a quantitative approach, it is not necessary to estimate all of the impacts identified in this chapter. Instead, the qualitative assessment step in Chapter 7 will be used to determine which impacts are significant and therefore recommended to be included in the quantitative assessment boundary and estimated (in Chapter 8). It is important to comprehensively consider all potential impacts in this chapter before setting the quantitative assessment boundary.

Figure 6.1: Overview of steps in the chapter



Checklist of key recommendations

- Identify all potential sustainable development impacts of the policy or action within each impact category included in the assessment, using a causal chain and table format if relevant and feasible, and in consultation with stakeholders
- Separately identify and categorize in- and out-of-jurisdiction sustainable development impacts, if relevant and feasible

6.1 Identify specific impacts of the policy or action within each impact category

A comprehensive understanding of impacts is crucial to the completeness and accuracy of the assessment. For each impact category included in the assessment boundary in Chapter 5, it is a *key recommendation* to identify all potential sustainable development impacts of the policy or action within each impact category included in the assessment, using a causal chain and table format, if relevant and feasible, and in consultation with stakeholders.

If significant sustainable development impacts are identified during this step that were not considered in Chapter 5, users should consider revising the list of impact categories included in the assessment.

6.1.1 Types of specific impacts

In order to identify sustainable development impacts, it can be useful to first identify the intermediate impacts resulting from the policy or action that lead to sustainable development impacts. *Intermediate impacts* are changes in behaviour, technology, processes or practices that result from the policy or action and lead to sustainable development impacts. S*ustainable development impacts* are changes in specific sustainable development impact categories, such as changes in air quality, jobs or health, among others outlined in Chapter 5. Figure 6.2 illustrates the relationship between intermediate impacts and sustainable development impacts.

The distinction between intermediate impacts and sustainable development impacts is whether an impact is a sustainable development impact of interest (such as increased jobs in the solar manufacturing sector) or an intermediate impact that leads to an impact of interest (such as increased demand for solar PV systems, which in turn leads to increased solar PV manufacturing). Both intermediate and sustainable development impacts can be short-term or long-term.

An intermediate impact in one context may be a sustainable development impact in another context, depending on the policy objectives and circumstances. For example, cost savings may be a sustainable development impact in one context, while in another context, it might be an intermediate impact toward using those savings to achieve improved nutrition, health care, education or quality of life.

Figure 6.2: Intermediate impacts and sustainable development impacts

Each impact category included in the assessment may have multiple distinct impacts. For example, a solar PV incentive policy may have five distinct sustainable development impacts within a single impact category of jobs: an increase of jobs in the solar installation, operations and maintenance sectors; an increase of jobs in the solar manufacturing sector; an increase of job in the solar and grid technology sectors including mining of rare earth minerals for solar cells; a decrease of jobs in the fossil fuel power plant design, operations and maintenance sectors; and a decrease of jobs in fossil fuel sectors.

To ensure a complete assessment, users should consider a wide range of potential impacts outlined in Table 6.1, including positive and negative, intended and unintended, short-term and long-term, and in-jurisdiction and out-of-jurisdiction impacts. It is important to identify not only positive, intended impacts, but also potential negative and unintended impacts in order to comprehensively assess the total net impact of the policy or action on the impact categories included in the assessment. In the next chapter, each impact will be qualitatively assessed to determine whether it is significant. Insignificant impacts will be excluded from the quantitative assessment boundary (for users following a quantitative approach).

1 *Table 6.1: Types of impacts, definitions and examples*

Types of impacts	Definition	Examples for a solar PV incentive policy
Positive and negative impacts	Impacts that are perceived as favourable or unfavourable from the perspectives of different stakeholder groups	Positive: Reduced air pollution from distributed fossil fuel generation Negative: Increased air pollution from solar production, transportation and installation
Intended and unintended impacts	Impacts that are intentional or unintentional, based on the original objectives of the policy or action and from the perspective of policymakers and stakeholders. (In some contexts, intentional impacts are called primary impacts and unintended impacts are called secondary impacts.)	Intended: Reduced air pollution from distributed fossil fuel generation Unintended: Increased air pollution from solar production, transportation and installation
Short-term and long-term impacts	Impacts that are nearer or more distant in time, based on the amount of time between implementation of the policy and the impact	Short-term: Increased renewable energy generation from more solar generation Long-term: Increased energy independence from reduced imports of fossil fuel
In-jurisdiction and out-of-jurisdiction impacts	Impacts that occur inside the geopolitical boundary over which the implementing entity has authority, such as a city boundary or national boundary, as well as impacts that occur outside of the geopolitical boundary	In-jurisdiction: Increased domestic jobs for solar installation, operations and maintenance Out-of-jurisdiction: Increased jobs in other countries for solar manufacturing, since solar PV is imported
Technology impacts	Changes in technology such as design or deployment of new technologies	Replacement of diesel generators with solar PV technology
Business and consumer impacts	Changes of business practices or behaviour (such as manufacturing decisions) or consumer practices or behaviour (such as purchasing decisions)	Business: Increased business opportunities for solar manufacturing, mining, transportation, solar power plants and grid associated technologies Consumer: Increased household/business income due to reduction in energy costs
Infrastructure Impacts	Changes in existing infrastructure or development of new infrastructure	Reduced GHG emissions associated with decreased manufacturing of new fossil fuel generation plants
Market impacts	Changes in supply and demand, prices, market structure or market share	Increased business opportunities for solar installation, operations, and maintenance
Life-cycle impacts	Changes in upstream and downstream activities, such as extraction and production of energy and materials, or impacts in sectors not targeted by the policy or action	Increased air pollution from solar PV production, transportation and installation
Macroeconomic impacts	Changes in macroeconomic conditions, such as GDP, income, employment, or structural changes in economic sectors	Increased household and business income and spending due to reduction in energy costs
Trade impacts	Changes in imports and exports	Increased energy independence from reduced imports of fossil fuel
Institutional impacts	Changes in institutional arrangements	Establishment of a new government unit to implement the solar incentive policy
Distributional impacts	Changes in how income, resources or costs are distributed among a population, or changes among different demographic groups, such as gender or income groups	Increased income for households, institutions and other organizations that install solar PV systems

2 *Source*: Adapted from WRI 2014

The types of impacts are intended to guide the development of a comprehensive list of potential impacts. The types of impacts are not mutually exclusive, so each impact will fit into multiple types. For example, a single impact may be positive, intended, in-jurisdiction and long-term. Table 6.1 provides users with different lenses to think of impacts in different ways, in order to help identify all potential impacts of the policy or action. However, the list is neither prescriptive nor exhaustive, and not all types of impacts may be relevant to the policy or action being assessed.

In-jurisdiction and out-of-jurisdiction impacts

It is a *key recommendation* to separately identify and categorize in- and out-of-jurisdiction sustainable development impacts, if relevant and feasible. Users should define the jurisdictional boundary based on what is most relevant and be transparent about what jurisdictional boundary is used.

Separately tracking each can help link the policy or action to the implementing jurisdiction's sustainable development goals by separately tracking impacts that affect the implementing jurisdiction's goals versus impacts that occur outside of the jurisdiction. Separate tracking can also address potential double counting of out-of-jurisdiction impacts between jurisdictions.

Out-of-jurisdiction impacts may be especially relevant for subnational policies and actions that have impacts in other subnational regions within the same country. Transnational impacts in neighboring countries may also be relevant. In cases where collecting data from other jurisdictions is difficult, users may need to estimate impacts rather than using more accurate data collection methods that can be used within the implementing jurisdiction.

In certain cases, a single impact may be both in-jurisdiction and out-of-jurisdiction and separate tracking may not be feasible. Alternatively, users can apportion the impact between in-jurisdiction and out-of-jurisdiction based on assumptions.

6.1.2 Methods for identifying and organizing specific impacts

A variety of methods may be used to identify specific impacts resulting from the policy or action, including developing a causal chain and using an impact matrix table. For either approach, stakeholder consultation, literature review, and expert judgment can be used to identify impacts. These methods are not mutually exclusive and should be used in combination to identify all potential impacts.

Each specific impact should be characterized relative to a baseline scenario, that is, the conditions most likely to occur in the absence of the policy or action. For example, in a country where coal production is increasing significantly over time, jobs in the coal mining sector may continue to increase even with a new solar incentive policy. However, jobs would have increased by a greater amount if the new solar policy did not exist, since it reduces demand for coal relative to the baseline scenario. Therefore, in this case, the user should identify this impact as a decrease of jobs in the coal mining sector resulting from the solar PV policy, even though it does not reduce jobs in absolute terms. In Chapters 6 and 7, users should identify and characterize impacts relative to baseline scenarios in conceptual terms, even if baseline scenarios are not explicitly defined. Chapter 8 provides detailed guidance on estimating baseline values in a quantitative assessment and may also be useful when identifying impacts relative to baseline scenarios.

Causal chain

A causal chain is a conceptual diagram tracing the process by which the policy or action leads to various sustainable development impacts through a series of interlinked logical and sequential stages of cause-and-effect relationships. Developing a causal chain is a useful tool to identify, organize, and communicate all potential sustainable development impacts of the policy or action. It helps users and stakeholders understand the logic and underlying assumptions of impacts by articulating how the policy or action leads to changes through a series of intermediate impacts. To help identify a comprehensive list of impacts, users should develop a causal chain that includes all potential impacts of the policy or action within each impact category included in the assessment, to the extent feasible.

To develop the causal chain, users should first identify the proximate (first stage) impacts of the policy or action. It may be useful to first consider the inputs or resources made available to implement the policy or action and the activities involved in implementing the policy or action to help identify the proximate (first stage) intermediate impacts, or changes in behaviour, technology, processes or practices. Each first-stage impact represents a distinct “branch” of the causal chain. Each branch of the causal chain may lead to one or more intermediate impacts or sustainable development impacts. Users should extend each branch of the causal chain through a series of cause-and-effect relationships—that is, a series of intermediate effects—until it leads to all potential sustainable development impacts in the selected impact categories, to the extent feasible.

Figure 6.3 provides an example of a causal chain for a solar incentive policy that includes intermediate impacts and sustainable development impacts for one impact category (jobs). Users should identify all intermediate impacts that may lead to sustainable development impacts, and identify as many sustainable development impacts as possible, considering different types of impacts outlined in Table 6.1.

It is possible that a sustainable development impact in one category may lead to another sustainable development impact in another category. For example, an increase of household income (a sustainable development impact related to income) that results from a solar PV incentive policy may in turn lead to increased demand for goods and services, which may lead to increased economic activity (a sustainable development impact related to economic activity). Box 5.2 provides more information on interlinkages between related sustainable development impact categories.

Users can either develop (1) a single causal chain that contains all sustainable development impact categories included in the assessment, or (2) separate causal chains for each impact category, depending on what is most appropriate for a given situation. In cases where the number of impact categories is relatively limited and where impact categories are interrelated, users may find it useful to include all sustainable development impact categories in a single integrated causal chain. A single causal chain can help stakeholders understand all of the impact categories in a single diagram and better understand the relationships between impact categories. On the other hand, if the different impact categories included in the assessment are relatively unrelated and do not have many intermediate impacts in common, or if developing an integrated causal chain would be too complex, users can develop separate causal chains for each selected impact category.

Figure 6.4 provides an example of a causal chain that include multiple impact categories. It can be difficult to comprehensively include all impact categories and specific impacts within a single causal chain, depending on the number of impact categories and specific impacts identified. Figure 6.4 includes all impact categories included in the assessment, but does not include all specific impacts within each impact category. Figure 6.5 separately illustrates social and economic impacts rather than combining them in a single diagram.

Figure 6.3: Example of a causal chain for one impact category

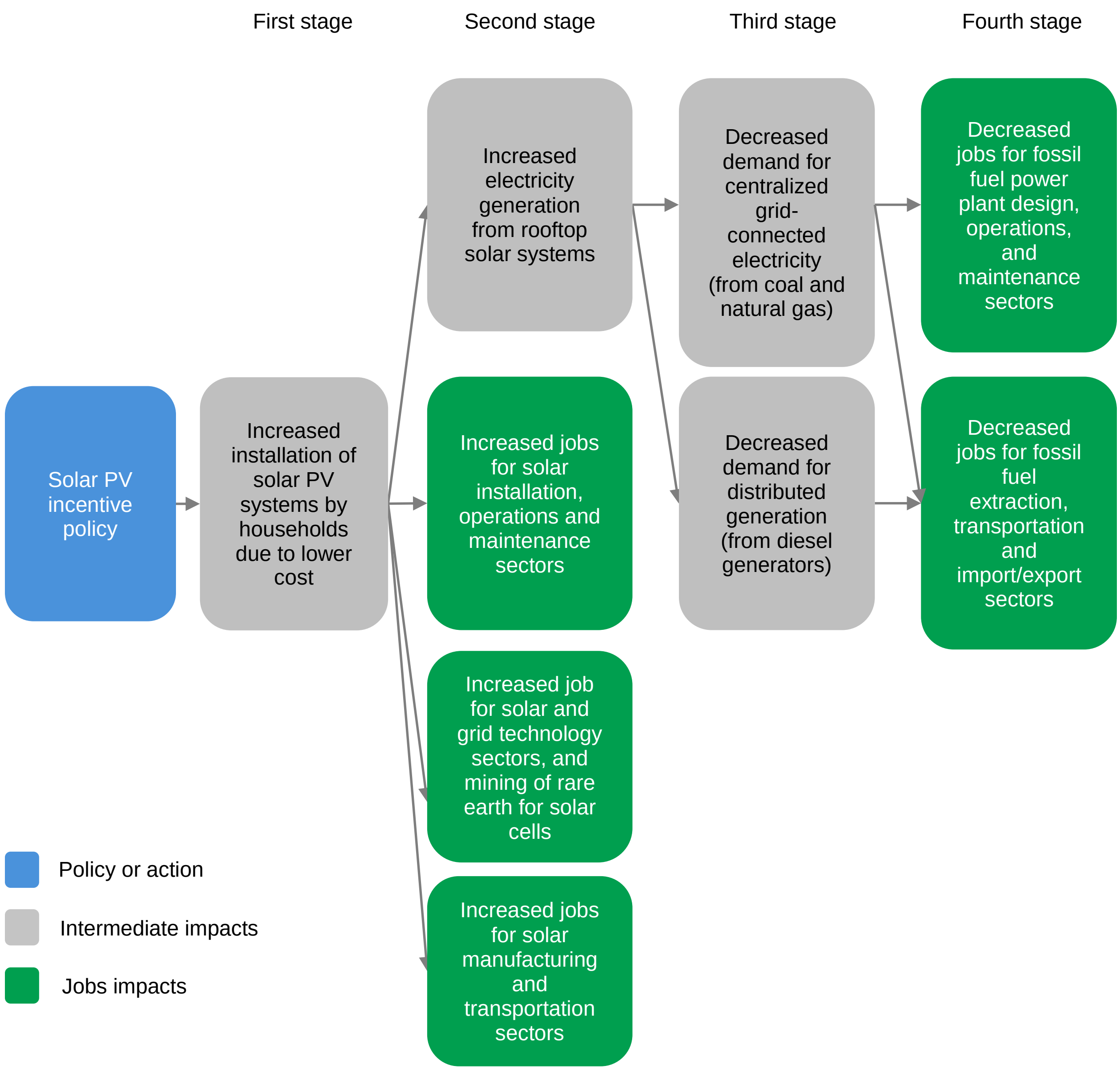
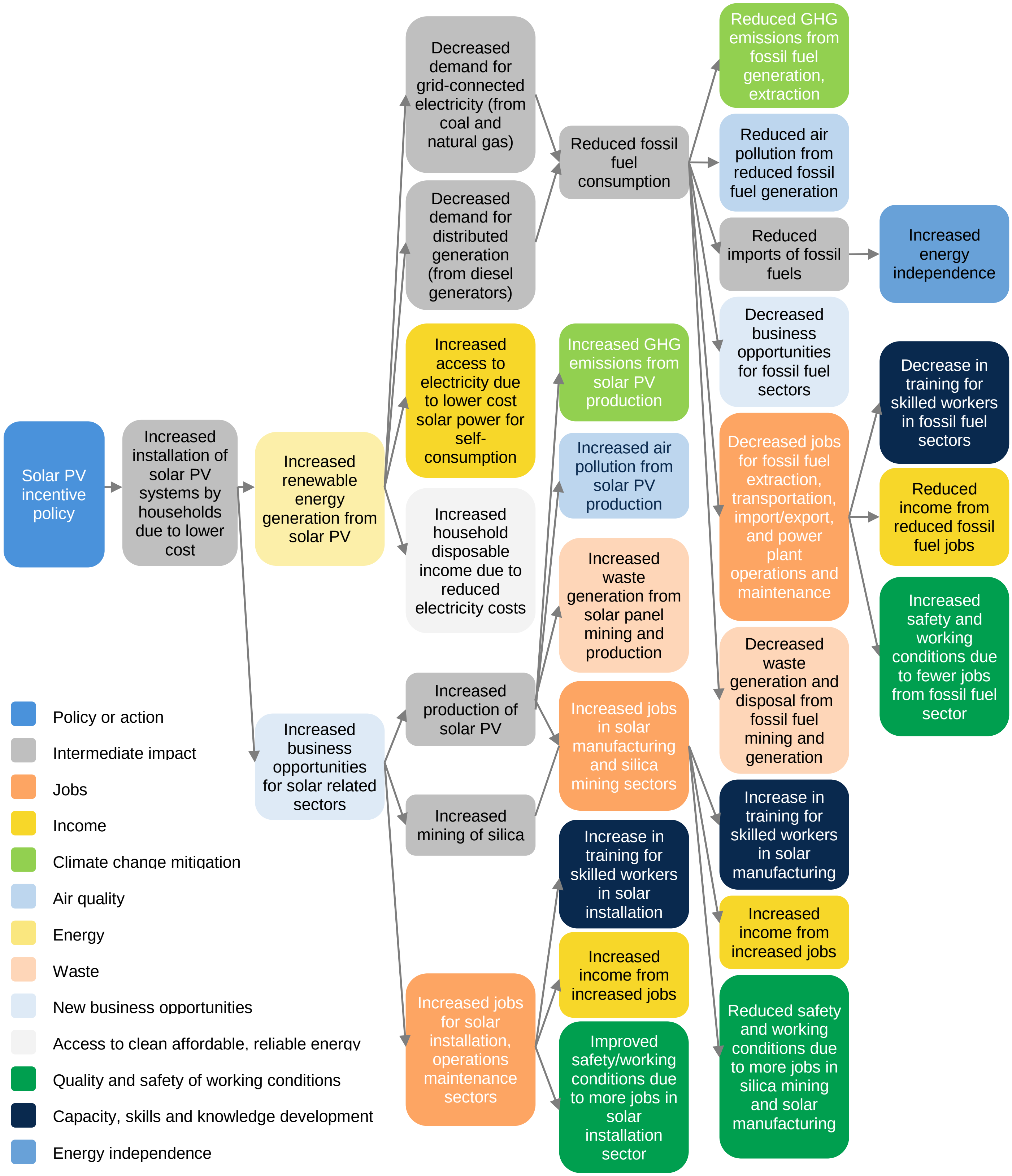
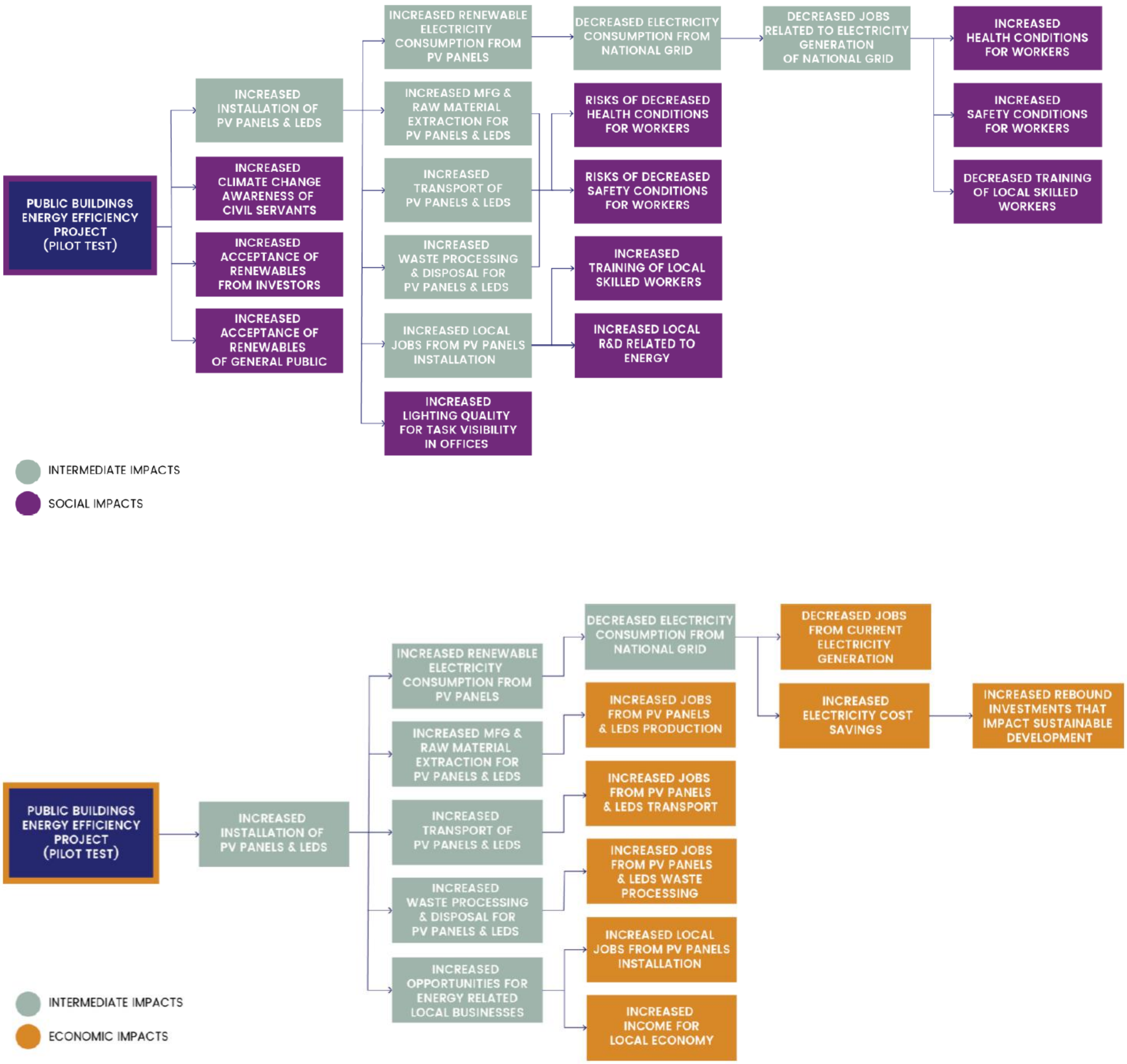


Figure 6.4: Example of a causal chain that includes all impact categories included in the assessment



Note: This example includes all impact categories included in the assessment but does not include all identified specific impacts within each impact category.

Figure 6.5: Example of causal chains that separately illustrate social and economic impacts



Source: Cuesta Claros 2018.

If useful, the causal chain can be color-coded or include symbols to designate different impact categories or types of impacts, such as positive versus negative impacts or in-jurisdiction versus out-of-jurisdiction impacts.

The causal chain should be as comprehensive as possible, rather than limited by geographic or temporal boundaries. To make the reporting more practical, users should only include those branches of the causal chain that are reasonably expected to lead to sustainable development impacts in categories selected for assessment. If the causal chain becomes too complex, users can summarize the sustainable development impacts for each branch without mapping each intermediate impact for each stage separately.

Impact matrix table

Users may also find it helpful to develop an impact matrix table to identify specific impacts. To do so, users should select a set of impact types to put in the column headers and a different set of impact types in the row headers. Then, proceed to identify impacts for each combination of impact types. See Table 6.2 for an example. Users can develop multiple impact matrix tables for the policy or action to ensure all impacts are identified. Note that the purpose of the table is to help identify all potential impacts; whether a specific impact is classified as one type of impact or another is less important than developing a comprehensive list of potential impacts.

Table 6.2: Example of an impact matrix table for an illustrative solar PV incentive policy for one impact category

Types of impacts	Short-term	Long-term
Intended impacts	Increased jobs in domestic solar PV installation, operations and maintenance sectors	Increased jobs in domestic solar PV manufacturing sector
Unintended impacts	Reduced jobs in domestic fossil fuel sector	

Note: Increases in jobs are in green and decreases in jobs are in red.

6.1.3 Literature review, stakeholder consultations and expert judgment

Users should review literature and conduct stakeholder consultations to identify impacts and develop a map of causal chain. Users can also use expert judgement to supplement these efforts.

Literature may document existing theoretical and empirical knowledge about similar impact categories related to the policy or action being assessed. To the extent feasible, users should review prior assessments or case studies of similar policies and impact categories. Additional literature that may be useful includes regulations, development plans, regulatory impact analyses, environmental impact assessments, risk assessments and economic studies. It may also be useful to refer to sector- and/or impact-category-specific assessment guidance or methods. The ICAT website provides references to methods and models for assessing specific impacts, which can help users identify impacts.[9]

Users should also consult relevant experts and stakeholders when identifying impacts and mapping the causal chain. Different stakeholder groups approach a policy or action from different perspectives. By conducting stakeholder consultations to identify impacts, users can enhance the completeness of the impacts identified, identify and address possible unintended or negative impacts early on and increase acceptance of the final assessment results. Stakeholder consultation may include interviews, surveys or focus groups. Chapter 8 of the ICAT *Stakeholder Participation Guide* provides information on how to consult stakeholders which can be helpful when identifying all potential impacts.

[9] Available at http://www.climateactiontransparency.org/methodological-framework/sustainable-development/

6.2 Describe and report specific impacts

Communicating all identified impacts helps stakeholders understand the various impacts of the policy or action and helps users determine the most relevant impacts to assess in a transparent and consistent manner. This is important to enable decision makers to take actions to address any negative impacts and enhance positive impacts.

Users should report all identified sustainable development impacts through a causal chain and a table format, if relevant and feasible. Reporting impacts through the causal chain helps users and decision makers understand in visual terms how the policy or action leads to changes across sustainable development impact categories, which can serve as a useful tool to enhance policy design, improve understanding of policy effectiveness, and communicate the impacts of the policy to stakeholders. Reporting the impacts through a table format such as the reporting template helps users go through the subsequent steps in the following chapters by using a single template across multiple steps.

To provide clarity for each identified impact, users should describe each specific impact, including the direction of change, such as an increase or decrease, and the underlying logic and causal relationship of how the impact is expected to occur. For example, impacts on jobs resulting from a solar PV incentive policy may include an "increase of jobs in solar manufacturing due to increased demand," an "increase of jobs in solar PV installation due to increased demand" and a "decrease of jobs in the coal mining sector due to decreased demand." The level of detail should depend on user's objectives and context.

When reporting impacts through a table format, users should report all identified sustainable development impacts. To keep the report simple for readers, it is not necessary to include intermediate impacts in the table. Users should specify the impact category for each impact and whether it is in-jurisdiction, out-of-jurisdiction, or mixed. If helpful, users can report the type of impact, such as intended or unintended, short-term or long-term, or positive or negative, and the methods or sources used to identify each impact. Table 6.3 provides a reporting template that can be used to report the identified impacts, using an illustrative example of a solar PV incentive policy.

Table 6.3: Example of reporting impacts through reporting template for a solar PV incentive policy

Impact categories included in the assessment (from Chapter 5)	Specific impacts identified (within each impact category)	In- or out-of-jurisdiction	Type of impacts (optional)	Methods/ sources used to identify impacts (optional)
Climate change mitigation	Reduced GHG emissions from grid-connected fossil fuel-based power plants	In		
	Reduced GHG emissions from distributed fossil fuel generation	In		
	Reduced GHG emissions associated manufacturing of new fossil fuel generation plants	In		
	Reduced GHG emissions from fossil fuel extraction and transportation	Both		
	Increased GHG emissions from solar power production	Both		
	Increased GHG emissions from solar power transportation and installation	In		

	Increased GHG emissions from increased production of goods and services due to increased income	In		
Air quality / health impacts of air pollution	Reduced air pollution from grid-connected fossil fuel-based power plants	In		
	Reduced air pollution from distributed fossil fuel generation	In		
	Reduced indoor air pollution from traditional use of biomass	In		
	Reduced air pollution from manufacturing of new fossil fuel generation plants	In		
	Reduced air pollution from fossil fuel extraction and transportation	Both		
	Increased air pollution from solar power production	Both		
	Increased air pollution from solar power transportation and installation			
	Increased air pollution from increased production of goods and services due to increased income	In		
Waste generation and disposal	Decreased waste generation and disposal from reduced fossil fuel generation (e.g., coal ash)	In		
	Decreased waste generation and disposal from reduced fossil fuel production and transportation	Both		
	Increased waste generation and disposal from increased solar mining and panel production (e.g., silicon tetrachloride waste)	Both		
	Increased waste generation and disposal for solar panels (e.g., cadmium and tellurium)	In		
Renewable energy generation	Increased renewable energy generation from increased solar generation	In		
Access to clean, affordable, and reliable energy	Increased access to clean, affordable and reliable electricity	In		
	Decreased access to electricity due to fewer new coal power plants	In		
Capacity, skills, and knowledge development	Increase in training for skilled workers in solar-relevant sectors	Both		
	Decrease in training for skilled workers in fossil fuel sectors	Both		
Quality and safety of working conditions	Increased safety and working conditions due to more jobs from the solar installation sector, where workers have better working conditions	In		
	Increased safety and working conditions due to fewer jobs in coal sector where workers have worse working condition	Both		
	Decreased safety and working conditions due to more jobs from silica mining and solar cell manufacturing, where workers have worse working condition (e.g., the lung disease silicosis, exposure to Hydrofluoric acid and cadmium)	Both		
Jobs	Increased jobs in the solar installation, operations maintenance sectors	In		
	Increased jobs in the solar panel manufacturing sector	Both		

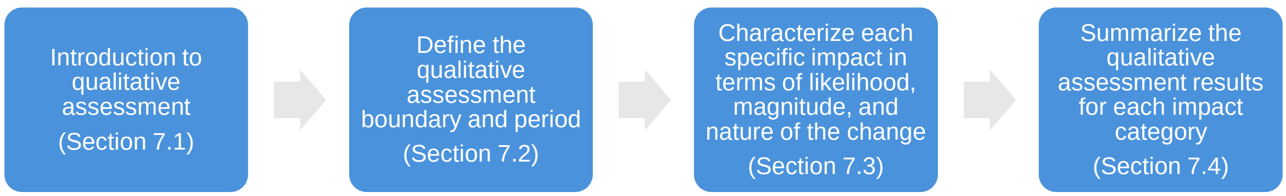
	Increased jobs for solar and grid technology sectors, and mining of rare earth for solar cells	Both		
	Decreased jobs in the fossil fuel power operations and maintenance sectors	In		
	Decreased jobs in fossil fuel sectors	Both		
	Decreased job for fossil fuel generation technology sectors (e.g., super critical and ultra-super critical generation)	Both		
Income	Increased income for households, institutions and other organizations due to reduction in energy costs	In		
New business opportunities	Increased business opportunities for solar manufacturing, mining, transportation, solar power plants and grid associated technologies	Both		
	Decreased business opportunities for fossil fuel extraction, transportation, fossil fuel power plants, and fossil fuel generated associated technologies	Both		
Energy Independence	Increased energy independence from reduced imports of fossil fuels (e.g., oil and gas)	In		
	Decreased energy independence from foreign control over scarce resources needed to manufacture solar panels	In		

7. Qualitatively Assessing Impacts

This chapter provides guidance on assessing sustainable development impacts qualitatively. This step is relevant for users following both a qualitative or quantitative approach, for either ex-ante or ex-post assessment. The chapter explains how to qualitatively assess each specific impact identified in Chapter 6 and to summarize the qualitative assessment results for each impact category.

For users following a quantitative approach, this qualitative step is used to prioritize which specific impacts to quantify in later chapters. The quantitative assessment boundary (defined in Chapter 8) should include all impacts determined to be significant based on the qualitative assessment in this chapter, where feasible.

Figure 7.1: Overview of steps in this chapter



Checklist of key recommendations

- Include all impact categories included in Chapter 5 and all specific impacts identified in Chapter 6 in the qualitative assessment boundary
- Define the assessment period
- Characterize each identified impact based on the likelihood that each impact will occur, the magnitude of each impact, and the nature of the change (positive or negative)
- Based on the assessment of likelihood and magnitude, determine which identified impacts are significant, in consultation with stakeholders
- Summarize the qualitative assessment results for each impact category, taking into account all significant impacts
- Separately assess the impacts of the policy or action on different groups in society where relevant

7.1 Introduction to qualitative assessment

Qualitative assessment is an impact assessment approach that involves describing the impacts of a policy or action on selected impact categories in qualitative terms. This is in contrast to quantitative assessment, which involves estimating the impacts of a policy or action on selected impact categories in quantitative terms.

Qualitatively assessing is simpler and requires less resources compared to the quantitative assessment method outlined in later chapters. In some cases, the qualitative approach to impact assessment may be sufficient to meet the stated objectives of the assessment. However, the qualitative approach does not enable an accurate or quantified estimate of the impacts of a policy or action, which limits its ability to meet a wider set of objectives related to understanding policy impact with greater certainty.

A qualitative assessment can use both qualitative and quantitative data. Qualitative data are descriptive and can be used to describe concepts that are harder to measure such as quality, behaviour or experiences, while quantitative data are measurable and can be used to measure or estimate quantities such as cost, time, area and energy. While quantitative data can show how a policy or action is doing and whether it has led to a given impact, qualitative methods such as stakeholder interviews, focus groups and case studies can show a more nuanced story of change, such as understanding how or why a change happened for specific stakeholders, who has benefited and why, and different experiences or impacts of different stakeholder groups, which can help policymakers improve the policy over time. These can provide additional insights into a policy's specific local context and impacts from experiences and perspectives of affected stakeholders.

In certain cases, qualitative assessments can be more subjective and uncertain than quantitative assessments and therefore could lead to inaccurate and misleading results without combining it with a quantitative assessment. Depending on the level of sampling from different stakeholder groups, qualitative assessments can also be limited in coverage and therefore non-representative of broader conditions or impacts, which can produce less reliable results with less ability to generalize impacts. Therefore, it can be helpful to use a combination of qualitative and quantitative data and approaches. For more information on qualitative methods, see Appendix C.

7.2 Define the qualitative assessment boundary and period

The qualitative assessment boundary defines the scope of the qualitative assessment in terms of the range of dimensions, impact categories and specific impacts that are included in the qualitative assessment. It is a key recommendation to include all impact categories included in Chapter 5 and all specific impacts identified in Chapter 6 in the qualitative assessment boundary.

Both short-term and long-term impacts may result from the policy or action, as identified in Chapter 6. It is a *key recommendation* to define the assessment period. The assessment period is the time period over which impacts resulting from the policy or action are assessed. The assessment period can be shorter or longer than the policy implementation period (i.e., the period during which the policy or action is in effect).

For an ex-ante assessment, users should consider the assessment objectives and stakeholders' needs when determining the assessment period. For example, a five-year assessment period may be appropriate if the objective is to inform policymakers on sustainable development progress by the end of a five-year planning cycle. If the objective is to understand the expected contribution of the policy or action toward achieving a country's NDC, it may be most appropriate to align the assessment period with the NDC implementation period (e.g., ending in 2030). Similarly, to align the results with the achievement of SDGs under the 2030 Agenda for Sustainable Development, users may define an assessment period ending in 2030. To align with longer-term trends and planning, users should select an end date such as 2040 or 2050. If the objective is to have a comprehensive understanding of all impacts resulting from the policy or action, the assessment period should be based on when the full range of impacts are expected to occur.

For an ex-post assessment, the assessment period can be the period between the date the policy or action is implemented and the date of the assessment or it can be a shorter period between those two dates. The assessment period for a combined ex-ante and ex-post assessment should consist of both an ex-ante assessment period and an ex-post assessment period.

In addition, users can separately estimate and report impacts over any other time periods that are relevant. For example, if the assessment period is 2020–2040, a user may separately estimate and report impacts over the periods 2020–2030, 2030–2040, and 2020–2040.

If an appropriate assessment period cannot easily be determined, users can use short-term, medium-term or long-term classifications to define the assessment period. Table 7.1 provides rules of thumb for assessment period lengths. Users can also define the time periods differently and in that case should report the time periods used.

Table 7.1: Rule of thumb for different ex-ante assessment periods

Assessment period	Approximate assessment periods (rule of thumb)
Short-term	<5 years
Medium-term	≥5 years and <15 years
Long-term	≥15 years

Users that are assessing the greenhouse gas impacts and/or transformational impacts of the policy or action, following other ICAT methodologies should align the assessment periods to ensure a consistent and integrated assessment, or explain why there are differences in how the assessment periods are defined.

7.3 Characterize each specific impact in terms of likelihood, magnitude and nature of the change

It is a *key recommendation* to characterize each specific impact identified in Chapter 6 based on:

- The likelihood that each impact will occur
- The magnitude of each impact
- The nature of the change (positive or negative)

Based on the assessment of likelihood and magnitude, it is a *key recommendation* to determine which identified impacts are significant, in consultation with stakeholders. Assessing the significance of each specific impact is an important step for the qualitative assessment. It is also useful to identify which specific impacts should be included in the quantitative assessment boundary, where significance is used to determine which impacts should be quantified (in Section 8.1).

The following steps can be used to characterize each specific impact:

- Step 1: Assess the likelihood that each sustainable development impact will occur
- Step 2: Assess the expected magnitude of each sustainable development impact
- Step 3: Determine which identified impacts are significant based on their likelihood and expected magnitude
- Step 4: Determine the nature of the change (positive or negative)
- Step 5: Report the results

7.3.1 Step 1: Assess the likelihood that each sustainable development impact will occur

For each sustainable development impact identified in Chapter 6, users should assess the likelihood that it will occur by classifying each impact according to the options in Table 7.2. For ex-ante assessments, this involves predicting the likelihood of each impact occurring in the future as a result of the policy or action. For ex-post assessments, this involves assessing the likelihood that the impact occurred in the past as a result of the policy or action, since impacts may have occurred during the assessment period for reasons unrelated to the policy or action being assessed. If a given impact is unlikely to occur, the subsequent impacts that follow from that impact can also be considered unlikely to occur. If users cannot determine the likelihood of a specific impact, it should be classified as "possible."

Table 7.2: Assessing likelihood of sustainable development impacts

Likelihood	Description	Approximate likelihood (rule of thumb)
Very likely	Reason to believe the impact will happen (or did happen) as a result of the policy or action.	≥90%
Likely	Reason to believe the impact will probably happen (or probably happened) as a result of the policy or action.	<90% and ≥66%
Possible	Reason to believe the impact may or may not happen (or may or may not have happened) as a result of the policy or action. About as likely as not. Cases where the likelihood is unknown or cannot be determined should be considered possible.	<66% and ≥33%
Unlikely	Reason to believe the impact probably will not happen (or probably did not happen) as a result of the policy or action.	<33% and ≥10%
Very unlikely	Reason to believe the impact will not happen (or did not happen) as a result of the policy or action.	<10%

Source: Adapted from WRI 2014

The likelihood classification should be based on evidence to the extent possible, such as published studies on similar policies and impact categories in the same or other jurisdictions, prior experience, modelling results, risk management methods, life cycle assessment (LCA) databases and studies, relevant media reports, consultation with stakeholders, expert judgment, or other methods.

Users can conduct other types of qualitative studies, including longitudinal impact assessment, sampling, interviews and ethnography to inform the assessment. Appendix C provides an overview of qualitative research methods.

Because the determination can be subjective, users should solicit multiple viewpoints and consult stakeholders when assessing the likelihood of impacts. The ICAT *Stakeholder Participation Guide* (Chapter 8) provides more information on how to consult with stakeholders.

7.3.2 Step 2: Assess the magnitude of each sustainable development impact

Next, users should classify the magnitude of each sustainable development impact as major, moderate, or minor (see Table 7.3).

It is not necessary to accurately calculate the relative magnitude of sustainable development impacts at this stage, but the classification should be based on evidence to the extent possible. Evidence may include published studies on similar policies and impact categories in the same or other jurisdictions, prior experience, modelling results, LCA databases and studies, relevant media reports, consultation with experts and stakeholders, expert judgment, or other methods. Appendix C provides an overview of qualitative research methods which may also be helpful.

If no data or evidence exists to estimate relative magnitudes, expert judgment and stakeholder consultation should be used to classify impacts as major, moderate or minor as best as possible. If this is not possible, users should classify a given impact as “uncertain” or “cannot be determined.”

Table 7.3: Estimating relative magnitude of sustainable development impacts

Relative magnitude	Description
Major	The change in the impact category is (or is expected to be) substantial in size (either positive or negative).* The impact significantly influences the effectiveness of the policy or action with respect to that impact category.
Moderate	The change in the impact category is (or is expected to be) moderate in size (either positive or negative).* The impact somewhat influences the effectiveness of the policy or action with respect to that impact category.
Minor	The change in the impact category is (or is expected to be) insignificant in size (either positive or negative).* The impact is inconsequential to the effectiveness of the policy or action with respect to that impact category.

Note: * The magnitude of the change should be considered relative to the broader conditions related to the impact category or to the maximum potential impact from policy options considered feasible.

Source: Adapted from WRI 2014

Magnitude represents the degree of change resulting or expected to result from the policy or action. Conceptually, the degree of change should be characterized relative to a baseline scenario that represents the events or conditions that would most likely occur in the absence of the policy or action. Since it is a qualitative assessment, this step does not require a detailed baseline assessment.

When determining the magnitude of the change, it may be useful to consider the extent of the area affected by the policy or action, such as:

- A single site (e.g., the impacts are restricted to areas within the boundaries of the site)
- Local impacts (e.g., affecting the water supplies of a local community)
- Regional impacts (e.g., affecting habitat areas that support species of regional significance)
- National impacts

- International impacts

It may also be useful to consider the duration of the change in terms of the length of time over which impacts may occur, such as short term (up to 5 years), medium term (5 to 15 years), and long term (greater than 15 years).

It may also be useful to consider the size of the groups (such as businesses or consumers) affected by the policy and the scale of change in the underlying activities (such as changes in vehicle kilometres traveled or electricity consumption).

Determining whether an impact is major, moderate or minor requires comparing the expected impact to a reference point. Users should choose a reference point that produces the most meaningful results based on the specific context and circumstances.

In general, users should assess the magnitude of each impact relative to the broader conditions related to a given impact category (such as the total level of air pollution in a region or the total number of jobs) rather than in comparison to other impacts resulting from the policy or action.

Users can also classify impacts as major, moderate or minor in relation to the maximum level of impact considered feasible from various policy options available in a jurisdiction (e.g., the maximum level of air quality improvement or job creation considered feasible and realistic). Users should report the approaches and reference points used to determine the magnitude of impacts.

For example, a solar PV incentive policy may have three impacts in the impact category of air quality. Each impact should be assessed relative to the broader conditions—absolute levels of air pollution in the region—to determine whether a given impact is minor, moderate or major. The determination of major, moderate or minor can alternatively be in relation to the maximum level of air pollution reduction considered feasible from various policy options that are available. See Box 7.1 for an example. Note that impacts should be compared based on their absolute value, regardless of whether each impact is increasing or decreasing.

Box 7.1: Example of using estimate to assess relative magnitude for a solar PV incentive policy

A solar PV incentive policy has multiple impacts on the impact category of air quality, as measured by the indicator of sulphur dioxide (SO_2) emissions. These include (1) reduced SO_2 emissions from fossil fuel combustion at power plants (assumed to be approximately 5,000 kg/year), (2) reduced SO_2 emissions from extraction and transportation of fossil fuels (assumed to be approximately 2,000 kg/year), and (3) increased SO_2 emissions from extraction and transportation of materials associated with solar panels (assumed to be approximately 200 kg/year).

Users should first decide the reference point used. In this case, a user decides to use the maximum potential impact from policy options considered feasible as the reference point, and estimates that quantity is approximately 50,000 kg/year. Next, the user compares the approximate magnitude of each impact in relation to the reference point. In this case, the relative magnitude of “reduced SO_2 emissions from fossil fuel combustion” is 10% (5,000 divided by 50,000), the relative magnitude of “increased SO_2 emissions from extraction and transportation of fossil fuels” is 4% (2,000 divided by 50,000), and the relative magnitude of “increased SO_2 emissions from extraction and transportation of materials associated with solar panels” is 0.4% (200 divided by 50,000). Based on this estimation, one impact is considered major, one impact is considered moderate, and one impact is considered minor.

7.3.3 Step 3: Determine the significance of sustainable development impacts

Once the likelihood and magnitude of each impact has been determined, users should combine the scores on likelihood and magnitude to determine whether each impact is significant. In general, users should consider impacts to be significant unless they are either minor in size or unlikely or very unlikely to occur (see Figure 7.2). Depending on the context and assessment objectives, users can adopt other approaches to determining the significance of impacts, such as considering unlikely impacts that are major or moderate to be significant. Users should use a consistent approach to determining significance across all impacts. Both positive and negative impacts should be considered equally significant based on the same likelihood and magnitude criteria in order to avoid a bias toward either positive or negative impacts. Users can separately assess positive impacts and negative impacts.

Figure 7.2: Recommended approach for determining significance based on likelihood and magnitude

<table>
<tr><th rowspan="2">Likelihood</th><th colspan="3">Magnitude</th></tr>
<tr><th>Minor</th><th>Moderate</th><th>Major</th></tr>
<tr><td>Very likely</td><td rowspan="5">Insignificant</td><td colspan="2" rowspan="3">Significant</td></tr>
<tr><td>Likely</td></tr>
<tr><td>Possible</td></tr>
<tr><td>Unlikely</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Very unlikely</td></tr>
</table>

Source: Adapted from WRI 2014

7.3.4 Step 4: Determine the nature of the change

Users should characterize each sustainable development impact identified in Chapter 6 as positive, negative or neutral. For example, an increase in available habitat area for a key species would be classified as positive, whereas habitat loss would be considered negative. The determination should be based on the perspectives of the user, policymakers and affected stakeholders. If it is not possible to determine whether the net impact is positive or negative, users should classify the impact as “unknown” or “cannot be determined.”

Box 7.2 provides a case study of consulting stakeholders during the qualitative assessment process.

Box 7.2: Using stakeholder consultation to qualitatively assess impacts in Malawi

The Initiative for Climate Action and Development in Malawi applied the ICAT *Sustainable Development Methodology* to assess the impacts of the Farmer Field Schools Approach, an element of the Malawi National Climate Change Management Policy. The project was an ex-post assessment of the environmental, social and economic impacts of a group of initiatives addressing pesticide risk reduction, poverty alleviation, the mainstreaming of climate change impacts in the irrigation sector, agricultural productivity and diversification, value chain and business development, and governance.

The objective was to assess policy effectiveness by determining whether actions are being implemented as planned and delivering intended results across multiple impact categories and across different groups in society. The findings will be used to improve policy design and implementation.

The impact categories, specific impacts and indicators assessed were drawn from the National Climate Change Management Policy, the objectives of programme donors, and selected indicators from the SDGs. Due to a lack of quantitative data, the project team carried out a qualitative assessment, using a mixed methods approach of literature review, case studies, and stakeholder consultation.

The project team developed assessment questionnaires that included all the identified impact categories, specific impacts and indicators. Respondents were asked to qualitatively assess the impacts for each indicator in terms of likelihood, magnitude, positive or negative impact, and whether the impact was significant. Interviews and focus groups of identified stakeholders were carried out by enumerators that had completed training specifically for this project.

Target groups of stakeholders for the interviews were: (1) district government officials, (2) non-governmental/civil society organization representatives, and (3) community stakeholders, which were primarily the participants in the Farmers Field Schools. Care was taken to ensure marginalized groups were included in the consultation process. To identify community stakeholders, the project leads consulted the National Youth Network on Climate Change, Coalition of Women Farmers, and Federation of Disability Organization in Malawi. 401 people were engaged, of which 203 responded, evenly distributed across regions and groups of stakeholders.

Table 7.4 provides examples of qualitative assessment results from the stakeholder respondents.

Table 7.4: Examples of stakeholder responses for one of the programmes

Dimension	Summary of stakeholder responses
Environmental impacts	• Water, land, and waste impacts were considered likely, major magnitude, positive, and significant. • The possibility for water acidification was considered to be very likely, major magnitude, significant, and negative.
Social impacts	• Health and wellbeing, education and culture, and welfare and equality indicators were considered to be likely, major magnitude, positive impact, and significant. • Institutions and laws, indicators of public participation in policy making, and access to administrative and judicial remedies were agreed as likely and positive but of only moderate impact. • Labour rights and youth labour conditions were considered unlikely and not significant. • Quality of jobs and fairness of wages were considered not applicable by the respondents.
Economic impacts	• Jobs, wages, and worker productivity indicators were marked as not applicable by respondents. • Business and technology, growth in new sustainable industries, and innovation were agreed as very likely, major magnitude, positive impact, and significant.

The results included a recommendation to introduce a quantitative aspect to performance measurement in the future which can be used in defining objectives, measuring baseline data, and tracking performance through a database.

7.3.5 Step 5: Report the results

Users should report the outcomes of the qualitative assessment for each specific impact—including the likelihood, relative magnitude, nature of the change, and whether each impact is significant—and the methods and sources used. Table 7.5 provides a reporting template that can be used.

7.4 Summarize the qualitative assessment results for each impact category

As the last step of the qualitative assessment, it is a *key recommendation* to summarize the qualitative assessment results for each impact category, taking into account all significant impacts. This involves summarizing the net impact of the policy or action on each impact category in descriptive terms based on the qualitative assessment of specific impacts.

Users should comprehensively consider all significant impacts within each impact category, considering the magnitude and likelihood of both positive and negative impacts, and provide a succinct summary of the qualitative results for each impact category. Users should conclude that the policy or action has an overall positive or negative impact on a given impact category if the assessment of each significant impact is either positive or negative. If the results are mixed and the conclusion is not clear for a given impact category, users should provide a balanced summary including both positive and negative impacts. See Table 7.5 for an illustrative example of summarizing the qualitative assessment results.

It is a *key recommendation* to separately assess the impacts of the policy or action on different groups in society where relevant. If relevant and feasible, user should separately summarize the conclusions for in-jurisdiction and out-of-jurisdiction impacts. Users should consult stakeholders when summarizing the assessment results to ensure the qualitative summary properly characterizes the impact for each impact category. Stakeholders should be informed about the methods and sources used to determine the likelihood and magnitude of impacts. If insignificant impacts are deemed important by stakeholders, users should acknowledge the existence of such impacts in the summary.

Table 7.5: Reporting the qualitative assessment results for a solar PV incentive policy

Chapter 5	**Chapter 6 (Identify specific impacts)**			**Chapter 7 (Qualitatively assessing impacts)**						**Chapter 8 (Defining the quantitative assessment boundary)**		
Impact categories included in the assessment	Specific impacts identified	In- or out-of-jurisdiction	Type of impacts (optional)	Likelihood	Magnitude	Positive or negative impact	Significant?	Summary of qualitative assessment results for each impact category	Methods/sources used	Feasible to quantify?	Included in the quantitative assessment boundary?	Justification for exclusions or other comments
Climate change mitigation	Reduced GHG emissions from grid-connected fossil fuel-based power plants	In		Very Likely	Major	Positive	Yes	Major positive impact from displacing fossil fuel electricity with solar electricity. While negative impacts do exist, they are insignificant.	Stakeholder consultation	Yes	Yes	Included
	Reduced GHG emissions from distributed fossil fuel generation	In		Unlikely	Moderate	Positive	No		https://india.blogs.nytimes.com/2012/07/31/the-diesel-generator-indias-trusty-power-source/)	No	No	Impact is not significant
	Reduced GHG emissions associated manufacturing of new fossil fuel generation plants	In		Unlikely	Minor	Positive	No		Stakeholder consultation	N/A	No	Impact is not significant
	Reduced GHG emissions from fossil fuel extraction and transportation	Both		Possible	Moderate	Positive	Yes		http://www.catf.us/resources/publications/files/Cradle_to_Grave.pdf	No	No	No reliable data/methods available
	Increased GHG emissions from solar production, transportation and installation	Both		Likely	Minor	Negative	No		http://spectrum.ieee.org/green-tech/solar/solar-energy-isnt-always-as-green-as-you-think	N/A	No	Impact is not significant
	Increased GHG emissions from increased production of goods and services due to increased income	In		Likely	Minor	Negative	No		Household energy consumption in the UK: a highly geographically and socioeconomically disaggregated model." Energy Policy 36(8): 3167– 3182.	N/A	No	Impact is not significant
Air quality / health impacts of air pollution	Reduced air pollution from grid-connected fossil fuel-based power plants	In		Very Likely	Major	Positive	Yes	Major positive impact from displacing fossil fuel electricity with solar electricity. While negative impacts do exist, they are insignificant.	Stakeholder consultation	Yes	Yes	Included
	Reduced air pollution from distributed fossil fuel generation	In		Unlikely	Major	Positive	No		Stakeholder consultation	No	No	Impact is not significant
	Reduced indoor air pollution from traditional use of biomass	In		Very Likely	Major	Positive	Yes		https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2568866/	No	No	No reliable data/methods available
	Reduced air pollution from manufacturing of new fossil fuel generation plants	In		Likely	Minor	Positive	No		Expert judgment	No	No	Impact is not significant
	Reduced air pollution from fossil fuel extraction and transportation	Both		Possible	Moderate	Positive	Yes		http://www.catf.us/resources/publications/files/Cradle_to_Grave.pdf	No	No	No reliable data/methods available
	Increased air pollution from solar production, transportation and installation	Both		Likely	Minor	Negative	No		http://spectrum.ieee.org/green-tech/solar/solar-energy-isnt-always-as-green-as-you-think	N/A	No	Impact is not significant

	Increased air pollution from increased production of goods and services due to increased income	In		Likely	Minor	Negative	No		Household energy consumption in the UK: a highly geographically and socioeconomically disaggregated model." Energy Policy 36(8): 3167– 3182.	N/A	No	Impact is not significant
Waste generation and disposal	Decreased waste generation and disposal from less fossil fuel generation (e.g., coal ash)	In		Very likely	Moderate	Positive	Yes	Major positive impacts from reducing fossil fuel extraction, transportation and consumption outweigh moderate or insignificant negative impacts from solar related mining and solar panel disposal.	http://www.catf.us/resources/publications/files/Cradle_to_Grave.pdf	No	No	No reliable data/methods available
	Decreased waste generation and disposal from less fossil fuel production and transportation	Both		Very likely	Major	Positive	Yes		http://www.catf.us/resources/publications/files/Cradle_to_Grave.pdf	No	No	No reliable data/methods available
	Increased waste generation and disposal from more solar production (e.g., silicon tetrachloride waste)	Both		Likely	Moderate	Negative	Yes		http://spectrum.ieee.org/green-tech/solar/solar-energy-isnt-always-as-green-as-you-think	No	No	No reliable data/methods available
	Increased waste generation and disposal from discarded solar panels (e.g., cadmium and tellurium)	In		Possible	Minor	Positive	No		http://spectrum.ieee.org/green-tech/solar/solar-energy-isnt-always-as-green-as-you-think	No	No	Impact is not significant
Energy	Increased renewable energy generation from more solar generation	In		Very likely	Major	Positive	Yes	Major positive impact from increase solar electricity	Stakeholder consultation	Yes	Yes	Included
Access to clean, affordable, and reliable energy	Increased access to clean, affordable and reliable electricity	In		Very likely	Major	Positive	Yes	Major positive impact from increased solar electricity outweighs unlikely, insignificant negative impact.	Stakeholder consultation	Yes	Yes	Included
	Decreased access to electricity due to fewer new coal power plants	In		Unlikely	Minor	Negative	No		Stakeholder consultation	N/A	No	Impact is not significant
Capacity, skills, and knowledge development	Increase in training for skilled workers in solar relevant sectors	Both		Likely	Major	Positive	Yes	Major positive impact from solar sectors. While a negative impact exists, it is insignificant.	Stakeholder consultation	Yes	Yes	Included
	Decrease in training for skilled workers in fossil fuel sectors	Both		Possible	Minor	Negative	No		Stakeholder consultation	N/A	No	Impact is not significant
Quality and safety of working conditions	Increased safety and working conditions due to more jobs from the solar installation sector, where workers have better working conditions	Both		Very Likely	Major	Positive	Yes	Major positive impact from solar sectors. While negative impacts exist, they are insignificant.	Stakeholder consultation	No	No	No reliable data/methods available
	Increased safety and working conditions due to fewer jobs in coal sector, where workers have worse working condition	Both		Likely	Moderate	Positive	Yes		http://www.catf.us/resources/publications/files/Cradle_to_Grave.pdf	No	No	No reliable data/methods available
	Decreased safety and working conditions due to more jobs from silica mining and solar cell manufacturing, where workers have worse working condition (e.g., the lung disease silicosis,	Both		Unlikely	Moderate	Negative	No		Reference: https://qz.com/760079/indias-solar-dreams-too-are-made-in-china/	N/A	No	Impact is not significant

	exposure to Hydrofluoric acid and cadmium)											
Jobs	Increased jobs in the solar installation, operations maintenance sectors	In		Very likely	Major	Positive	Yes	Major positive impacts from solar power plants and solar panel sectors outweigh moderate negative impact on coal extraction, transportation and import/export sectors.	http://www.thesolarfoundation.org/wp-content/uploads/2016/10/TSF-2015-National-Solar-Jobs-Census.pdf	Yes	Yes	Included
	Increased jobs in the solar panel manufacturing sector	Both		Very likely	Major	Positive	Yes		http://www.thesolarfoundation.org/wp-content/uploads/2016/10/TSF-2015-National-Solar-Jobs-Census.pdf	Yes	Yes	Included
	Increased jobs for solar and grid technology sectors, and mining of rare earth for solar cells	Both		Possible	Minor	Positive	No		Stakeholders consultation	N/A	No	Impact is not significant
	Decreased jobs in the fossil fuel power operations and maintenance sectors	In		Likely	Minor	Negative	No		Stakeholder consultation	N/A	No	Impact is not significant
	Decreased jobs in fossil fuel sectors	Both		Likely	Moderate	Negative	Yes		Stakeholder consultation	Yes	Yes	Included
	Decreased jobs in the fossil fuel generation technology sectors (e.g., super critical and ultra-super critical generation)	Both		Unlikely	Moderate	Negative	No		Stakeholder consultation	N/A	No	Impact is not significant
Income	Increased income for households, institutions and other organizations due to reduction in energy costs	In		Very likely	Major	Positive	Yes	Major positive impact from saving from energy spending.	Stakeholder consultation	Yes	Yes	Included
New business opportunities	Increased business opportunities for solar manufacturing, mining, transportation, solar power plants and grid associated technologies	Both		Very likely	Major	Positive	Yes	Major positive impact from solar sectors. While a negative impact exists, it is insignificant.	https://connectamericas.com/content/opportunities-renewable-energy-value-chain	No	No	No reliable data/methods available
	Decreased business opportunities for fossil fuel extraction, transportation, fossil fuel power plants, and fossil fuel generated associated technologies	Both		Likely	Minor	Negative	No		Stakeholder consultation	No	No	Impact is not significant
Energy Independence	Increased energy independence from reduced imports of fossil fuels	In		Very likely	Major	Positive	Yes	Major positive impact from decrease fossil fuel import. While a negative impact exists, it is insignificant.	Stakeholder consultation	Yes	Yes	Included
	Decreased energy independence from foreign control over scarce resources needed to manufacture solar panels	In		Possible	Minor	Negative	No		Reference: http://foreignpolicy.com/2016/07/12/decoder-rare-earth-market-tech-defense-clean-energy-china-trade/	N/A	No	Impact is not significant

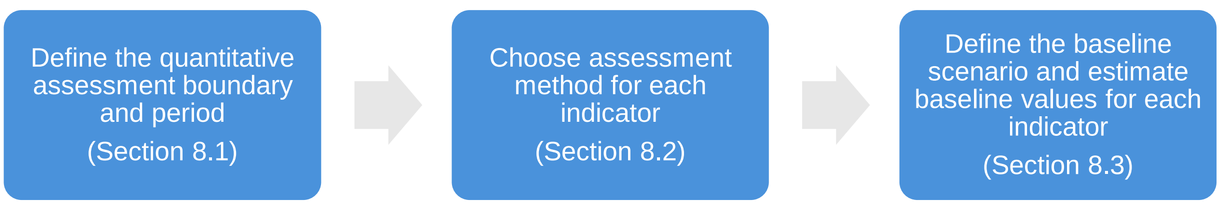
PART IV: QUANTITATIVE APPROACH TO IMPACT ASSESSMENT

8. ESTIMATING THE BASELINE

This chapter is relevant for users following the quantitative approach to impact assessment. Quantifying impacts by defining changes relative to a baseline scenario may not always be necessary to meet the stated objectives of the assessment. Users can assess impacts qualitatively (in Chapter 7) or track trends in key indicators over time (in Chapter 12). Attributing impacts to specific policies and actions relative to a baseline scenario is valuable since it enables an understanding of how effective policies are, relative to what would have happened otherwise. This information enables a wider range of objectives outlined in Chapter 2, such as improving policy design, selection, implementation and determining whether policies have been effective.

Quantifying the sustainable development impacts of a policy or action requires a reference case, or baseline scenario, against which impacts are estimated. The baseline scenario represents the events or conditions that would most likely occur in the absence of the policy or action being assessed. Properly estimating baseline values is a critical step, since it has a direct effect on the estimated impacts of the policy or action. In this chapter, users estimate baseline values for each indicator included in the quantitative assessment boundary. This chapter is relevant to both ex-ante and ex-post assessment and provides guidance on estimating ex-ante and ex-post baseline scenarios.

Figure 8.1: Overview of steps in the chapter



Checklist of key recommendations

- 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

8.1 Define the quantitative assessment boundary and period

The quantitative assessment boundary defines the scope of the quantitative assessment in terms of the range of dimensions, impact categories, specific impacts and indicators that are included in the quantitative assessment and estimated. Not all specific impacts identified in Chapter 6 need to be estimated. It is a *key recommendation* to include all significant impacts in the quantitative assessment boundary, where feasible.

Choose which specific impacts to quantify

Users should determine which specific impacts to include in the quantitative assessment boundary and estimate based on:

- The significance of each impact, as determined in Section 7.3 based on a combination of likelihood and magnitude
- The feasibility to estimate each impact

Feasibility may depend on data availability, technical capacity and resources available to estimate impacts, or other factors. If it is not feasible to estimate certain impacts, the decision to exclude them from the quantitative assessment boundary should be explained and justified. Table 7.5 provides a template that can be used to report whether it is feasible to quantify each significant impact, whether the impact is included in the quantitative assessment boundary, and if it is not included, a justification for exclusion. The example in Table 7.5 shows that out of many identified impacts, 10 specific impacts are included in the quantitative assessment boundary. This short list of specific impacts is presented in Table 8.1.

In general, users should not exclude any impacts from the quantitative assessment boundary that would compromise the relevance of the overall assessment. Users should ensure that the assessment appropriately reflects the impacts resulting from the policy or action and that it serves the decision-making needs of users of the assessment report. Exclusions may lead to misleading and biased results and not accurately represent the impacts of the policy or action. Where possible, instead of excluding significant impacts, users should use simplified or less rigorous estimation methods to approximate each impact or use proxy data to fill data gaps. Any significant impacts that are not quantified should be described qualitatively.

Choose which indicators to quantify

It is a *key recommendation* to define one or more appropriate indicators for each impact category included in the quantitative assessment boundary. This indicator will be quantified in the baseline scenario and policy scenario to estimate the impact of the policy or action. Each indicator will generally require a different assessment method.

Section 5.2 introduces indicators and provides examples in Table 5.5. The initial indicators chosen in Chapter 5 may need to be revisited based on the outcomes of Chapters 6 and 7, since the choice of indicators should be informed by which specific impacts are significant and included in the quantitative assessment boundary.

Users can define one or more indicators for each impact category. For example, within the impact category of air quality, a user may estimate the impact of a policy on multiple indicators, such as $PM_{2.5}$, PM_{10}, SO_2 and NO_x.

Some indicators for a given impact category are likely to be more feasible to quantify than others. Users should choose indicators for which it is possible to collect data and quantify impacts. If it is not possible to quantify a particular indicator, users should either select a different indicator for the same impact category or qualitatively assess any indicators and specific impacts that cannot be quantified.

The indicators selected in this step will be estimated in the baseline and policy scenario (in Chapters 8-10) and monitored over time (Chapter 12). Table 8.1 presents indicators selected for a solar PV incentive policy.

Table 8.1: Example of defining the quantitative assessment boundary for a solar PV incentive policy (i.e., the set of impact categories, specific impacts and indicators to be quantified)

Chapter 5	**Chapter 6 (Identify specific impacts)**	**Chapter 8 (Defining the quantitative assessment boundary)**		
Impact categories included in the assessment	**Specific impacts included in the quantitative assessment boundary**	**Indicator(s) 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 (tCO_2e/year)	Yes	Yes
Air quality / health impacts of air pollution	Reduced air pollution from grid-connected fossil fuel-based power plants	Emissions of $PM_{2.5}$, PM_{10}, SO_2, 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 jobs reduced 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

Define the assessment period

It is a *key recommendation* to define the assessment period for the quantitative assessment. In general, the assessment period for a quantitative assessment should be the same as the period defined in Section 7.2 for the qualitative assessment. In some cases, users may want to choose a different assessment period for the quantitative assessment, based on objectives, data availability, or other reasons.

Box 8.1 provides an example from an assessment in Mexico of how the choice of assessment period can have a significant impact on the overall assessment results.

Box 8.1: Selection of assessment periods and how assessment results vary over different time periods for a policy in Mexico

A researcher at Aalto University assessed 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. The net impacts of the policy may not be linear, and the nature of impacts could change from negative to positive or vice versa under different assessment periods. In such cases, it is important to assess and report both short- and long-term impacts.

Selected results of the assessment are shown in Table 8.2, while Figure 8.2 illustrates the trends in the policy's net impact over time for three selected impact categories. The assessment found that the nature and scale of impacts across short- and long-term time horizons, measured by the percentage of cumulative net impact compared to the baseline scenario, remain stable for some impact categories (GHG emissions, depletion of fossil resources, and air quality). For others (mineral resources depletion), the scale of the impact changed dramatically over time. For impact categories such as land use, human toxicity and water ecotoxicity, the net impact changed from negative to positive when expanding the assessment period from five years to 17 years. The policy had nearly all positive environmental impacts using a longer assessment period, compared to mixed results using a short assessment period.

Table 8.2: Summary of environmental impacts resulting from LED lamp replacement policy over 5- and 17-year assessment periods

		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	t CO_2 eq	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%**
Land use	m^2a crop eq	443	690	**Increase of 247**	**-56%**	4,888	2,900	**Reduction of 1,988**	**41%**
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%**

Note: Positive (good) results are shown in black and negative (bad) results are shown in red.

Figure 8.2: Cumulative impact of the policy on depletion of fossil resources, freshwater consumption, and human toxicity over time

1

8.2 Choose assessment method for each indicator

Estimating the impacts of a policy or action involves a comparison of the outcome of the policy or action against an estimate of what would most likely have happened in the absence of that policy or action.

Quantifying the impact of a policy or action relative to a baseline scenario can be done in two ways:

- **Scenario method**: A comparison of a baseline scenario with a policy scenario for the same group or region, where separate baseline and policy scenarios are defined and estimated
- **Deemed estimates method**: A simplified approach to the scenario method, where the change resulting from a policy or action is estimated directly without separately defining and estimating baseline and policy scenarios
- **Comparison group method**: A comparison of one group or region affected by the policy or action with an equivalent group or region not affected by the policy or action.

Ex-ante assessments can only use the scenario method or deemed estimates method. Ex-post assessments can use any method. Users can use a different assessment method for each indicator included in the assessment boundary, if determined to be most appropriate for a given assessment.

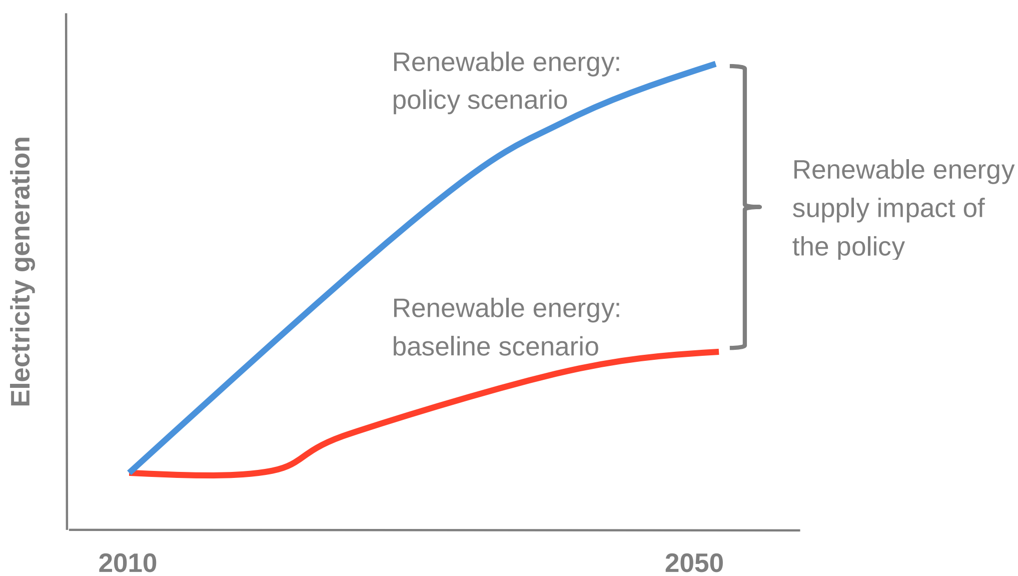
Scenario method

Using the scenario method, users quantify the impact of a policy or action by comparing two scenarios:

- The *baseline scenario*, which represents the events or conditions most likely to occur in the absence of the policy or action (or package of policies and actions) being assessed; and
- The *policy scenario*, which represents the events or conditions most likely to occur in the presence of the policy or action (or package of policies and actions) being assessed.

Figure 8.3 illustrates using scenario method to quantify the impact of a renewable energy policy on renewable electricity generation.

Figure 8.3: Example of a scenario method



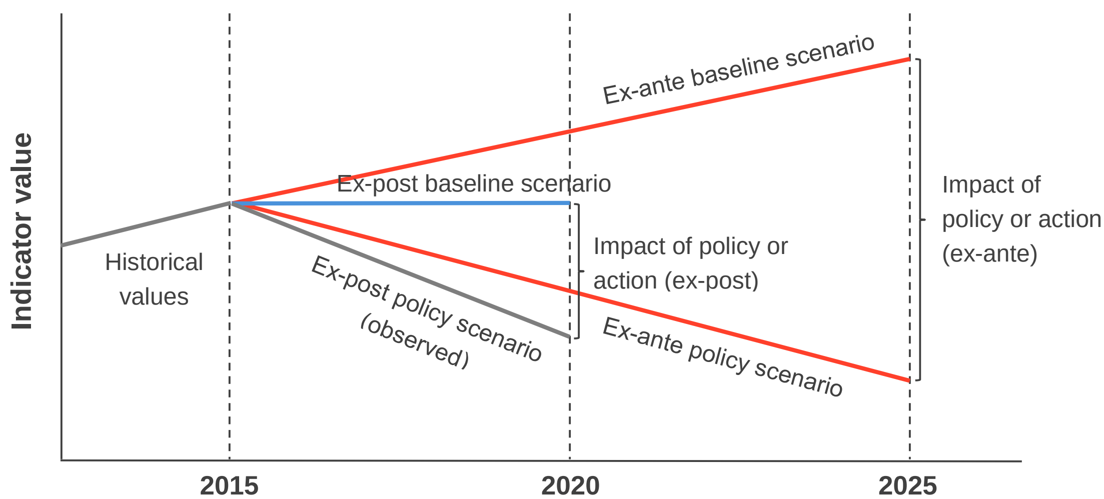
In the scenario method, the baseline scenario depends on assumptions related to key impact drivers over the assessment period. Drivers include other policies or actions that have been implemented or adopted, as well as non-policy drivers, such as economic conditions, energy prices and technological development.

Baseline scenarios can be determined ex-ante or ex-post. An *ex-ante baseline scenario* is a forward-looking baseline scenario, typically established prior to implementation of the policy or action, which is based on forecasts of drivers (such as projected changes in population, economic activity or other drivers that affect the impact category), in addition to historical data. Ex-ante baseline scenarios are used for ex-ante assessment in Chapter 9.

An *ex-post baseline scenario* is a backward-looking baseline scenario established during or after implementation of the policy or action. Ex-post baseline scenarios should include updates to the ex-ante forecasts of drivers, if an ex-ante assessment was first undertaken. Ex-post baseline scenarios are used for ex-post assessment in Chapter 10.

The methods described in this chapter apply to both ex-ante and ex-post baseline scenarios. See Figure 8.4 for a diagram illustrating both types of baseline scenarios. Box 8.2 provides an example of applying the scenario method. Appendix A also includes examples of using the scenario method for a solar PV incentive policy.

Figure 8.4: Ex-ante and ex-post baseline scenarios



Source: Adapted from WRI 2014.

Box 8.2: Scenario method example - Waste policy in Brazil

To quantify a range of socioeconomic benefits from of an integrated solid waste management policy in Brazil, a baseline scenario is compared to four policy scenarios. The baseline scenario assumes that without the policy, 58% of solid waste would go to sanitary landfills, most of which flare the methane produced. The remaining waste goes to open dumps where methane vents to the atmosphere.

Four policy scenarios were defined: (1) all waste is sent to a sanitary landfill with 50% of landfill gas (LFG) collected and flared; (2) same as scenario 1 but the LFG is used to generate electricity that displaces natural gas from the power grid; (3) anaerobic digestion of organic waste with electricity generation; and (4) Composting of organic waste.

The calculated impacts of implementing all four policy scenarios together, relative to the baseline scenario, are:

- 44,000-110,000 jobs created
- 0.5-1.1% of Brazil's electricity demand is saved
- $13.3-$35.2 billion increase in Brazil's GDP between 2012 and 2032
- 158-315 $MtCO_2e$ reduced
- 2,500 – 4,900 premature deaths from air pollution avoided, with a monetized value of $5.5-$10.6 billion
- 550,000 – 1.1 million tonnes of crops saved, worth $61-$120 million
- Total net present value (NPV) of development objectives exceed $100 billion

Source: ClimateWorks Foundation and World Bank Group, 2014.

Deemed estimates method

The deemed estimates method (sometimes called a "deemed savings" or "unit savings" approach) is a simplified variation of the scenario method. This method involves calculating the impact of a policy or action without separately defining and estimating baseline and policy scenarios and comparing the two. This method may be appropriate for certain common or homogeneous policies and actions where deemed estimate values are reliable or in cases where the scenario method is not practical.

To carry out the approach, users estimate the impact by multiplying the number of projects or measures taken as a result of the policy (such as the number of solar PV systems installed) by deemed estimate values that represent the change per project or measure taken (such as the change in jobs or reduction in air pollution per MW of solar installed). For example, to estimate the energy savings from a policy to replace inefficient lightbulbs with energy efficient lightbulbs, a user can multiply the number of lightbulbs replaced by the difference in energy use between a typical inefficient bulb and a typical replacement bulb.

Such approaches simplify the calculation and data collection required to quantify the impact of the policy. However, the calculation risks being oversimplified and inaccurate. The deemed estimates method typically holds constant many factors that could influence the indicator. The estimated impact value (or "deemed estimate") is an implicit representation of the difference between a baseline and a policy scenario value, which may not use accurate or representative baseline or policy scenario assumptions. The deemed estimate value may assume that the maximum impact (such as energy savings) will be attained, if the estimate does not take into account the specific conditions under which the policy or action is implemented. For example, using the lightbulb example, the number of hours each lightbulb is in use in the implementing country may differ from the assumptions taken from impacts in another country. These factors should be taken into consideration when calculating impacts to ensure estimates are realistic, for example by adjusting the number of hours of operation to represent the local context, or conservative in cases where there is uncertainty. The deemed estimate values can be customized to local circumstances or calculated based on local data, rather than using default factors.

Users can apply a different method for each indicator being assessed. For example, users can use the deemed estimates method for one indicator and the scenario method for other indicators. Box 8.3 provides an example of using the deemed estimates method. Appendix A also includes examples of using the deemed estimates method for a solar PV incentive policy.

Box 8.3: Example of deemed estimates method

A Gold Standard (GS) study used a deemed estimates method to capture and monetize the environmental and socioeconomic net benefits associated with GS carbon projects. To quantify the improvements in health from a cookstoves project, the mortality rate was applied to the number of households with cookstoves to determine the reduction in mortality. First, the indicator was identified as the difference in indoor $PM_{2.5}$. Next, the study created an index based on the linear relationship between indoor air quality and mortality. The percentage reduction in mortality was calculated by applying $PM_{2.5}$ changes to the index. The mortality rate was then applied to the number of households with cookstoves to determine the reduction in mortality.

Source: The Gold Standard, 2014.

Comparison group method

The comparison group method can only be used for ex-post assessments and if an equivalent comparison group exists. To reliably and credibly implement a comparison group method, actors affected by the policy (the policy group) and actors not affected by the policy (the comparison group or control group) must be otherwise equivalent. Under ideal experimental conditions, the two groups would be randomly assigned to ensure that any differences between the groups are a result of the policy, rather than any underlying systematic differences or biases. If random assignment is not possible, other methods can be used to control for external factors, avoid "selection bias," and ensure valid comparisons (described further in Chapter 10).[10]

If an appropriate comparison group is not available, the scenario method or deemed estimates method should be used. In some cases, data obtained from a comparison group can also be used to update, calibrate or validate assumptions and data used in the scenario method or deemed estimates method. Box 8.4 provides an example of the approach.

[10] For more information on the applicability of the comparison group method, see Coalition for Evidence-Based Policy, 2014, "*Which Comparison-Group ("Quasi-Experimental") Study Designs Are Most Likely to Produce Valid Estimates of a Program's Impact?*" Available at: http://coalition4evidence.org/wp-content/uploads/2014/01/Validity-of-comparison-group-designs-updated-January-2014.pdf.

Box 8.4: Comparison group example from the United Kingdom Government Guidance for Conducting Evaluations

The UK government provides analysts and policymakers at all levels of government with guidance on how to assess and review policies and projects to ensure that public funds are well spent. It views evaluation as essential to determining whether policies are effective.

The guidance, provided in the Magenta Book, includes approaches for using a control group to establish a baseline (i.e., counterfactual) scenario. It suggests that controlling policy allocation (i.e., which individuals or areas receive policy interventions, and when) can play a key role in successful impact evaluation by affecting whether there is a meaningful comparison group. The guidance offers several examples of how to do this:

- **Pilots**: Allow the policy to be tried and information collected before committing full-scale resources. Not every potential subject is exposed to the policy and can thus act as a control group.
- **Randomization and randomised control trials** (RCT): Allocate by lottery or other purely random mechanism which individuals, groups, or local areas receive the policy or action. Carefully conducted, an RCT provides the clearest evidence of whether a policy or action has had an impact.
- **Phased introduction**: Implement the policy or action sequentially over a period of time. The periods when some participants have received the intervention and others have not can then serve to generate a comparison group.

Source: HM Treasury, United Kingdom. Magenta Book: Guidance for Evaluation.

The remainder of this chapter focuses on steps involved in applying the scenario method. Guidance on the comparison group method is provided in Chapter 10.

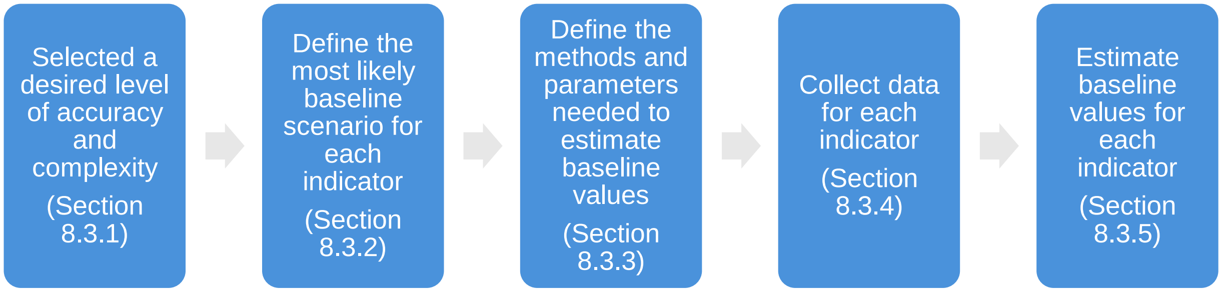
8.3 Define the baseline scenario and estimate baseline values for each indicator

This section provides guidance on estimating baseline scenario and values using the scenario method. It is applicable to all ex-ante assessments and to ex-post assessments that use the scenario method.

Figure 8.5 outlines the steps in this section. Users may find it most useful to follow the steps in this section separately for each impact category being estimated, since the choices made regarding methods and data are likely to be different for each impact category being assessed. In this case, users should complete the steps for one impact category at a time, then repeat the process for each impact category included in the assessment. Involving stakeholders in the selection and estimation of baseline scenarios is important to ensure credible assumptions and valid results.

Appendix A provides an example of carrying out the steps in this section for a solar PV incentive policy.

Figure 8.5: Overview of steps in defining and estimating the baseline scenario and values



8.3.1 Select a desired level of accuracy and complexity

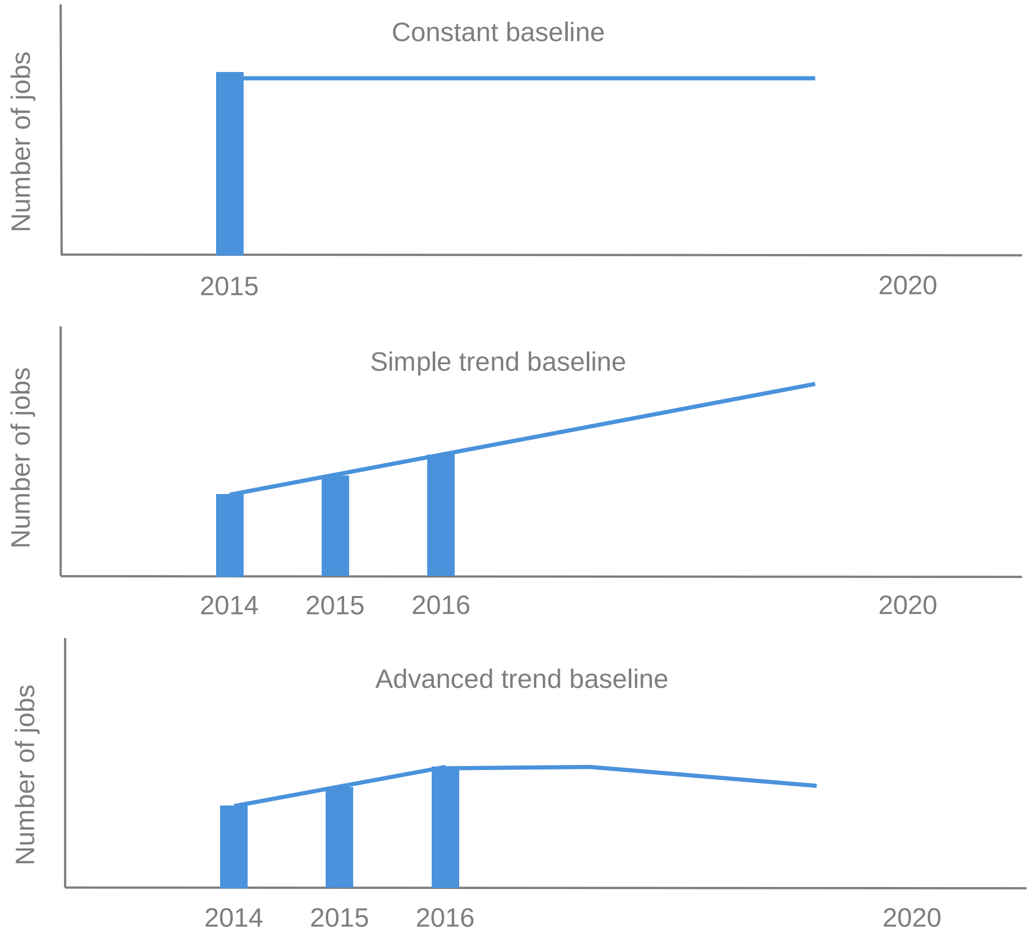
A range of methods and data can be used to estimate the baseline scenario. Users should achieve a sufficient level of accuracy to meet the stated objectives of the assessment, while considering the availability and quality of relevant data, the accessibility of methods, and capacity and resources available for the assessment. In general, users should follow the most accurate approach that is feasible in the context of the assessment objectives, capacity and resources. Because a wide variety of methods and data can be used, it is important to report the methods, assumptions and data used to estimate the baseline scenario.

Users can choose a different level of accuracy for various impact categories included in the assessment. Users should consider the relative resources available for each impact category being assessed and focus efforts on achieving higher levels of accuracy for impact categories determined to be the most relevant and significant. Data availability, the availability of methods and models, or resources may constrain the level of accuracy even for high priority impacts. Users should clearly document the uncertainty, either qualitatively or quantitatively, associated with the results and explain how the methods chosen for the assessment represent an acceptable level of accuracy.

Estimation of the baseline scenario can range from simple to complex, as explained below and illustrated in Figure 8.6:

- **Constant baseline**: A constant baseline uses historical or current values as the baseline scenario. This assumes there will be no change in the impact category in the future in the absence of the policy or action. This is a simple “before” and “after” comparison to indicate the impacts of the policy or action.
- **Simple trend baseline**: A simple trend baseline uses historical trends as the basis for the baseline scenario, and assumes that the historical trend will remain the same into the future in the absence of the policy or action. This can take the form of a simple linear extrapolation, exponential extrapolation or other forms.
- **Advanced baseline**: An advanced baseline is a more complex approach that models the impact of many interacting elements, such as the impacts of non-policy drivers (such as macroeconomic conditions) and other policies in terms of how they are likely to change conditions in the future.

Figure 8.6: Examples of constant, simple trend and advanced baselines



The choice of baseline scenario depends on which is most appropriate for a given impact category and situation as well as users' resources, capacity, access to data, and availability of appropriate models and methods. Users should choose methods and data that yield the most accurate results within a given context, based on the methodological and data options available.

A constant baseline is the simplest option and may be appropriate when indicators are considered likely to remain stable over time. A simple trend baseline is most appropriate if the change in indicator values (rather than actual indicator values) is expected to remain stable over time. In general, more advanced baselines are likely to be more accurate since they take into account various drivers that affect conditions over time. However, more advanced baselines will only be more accurate if the data and methods available to integrate the impacts of multiple drivers are robust. Users should weigh the priority of each impact category and allocate resources accordingly when determining the complexity of the baseline scenario.

8.3.2 Define the most likely baseline scenario for each indicator

A critical step in applying the scenario method is to define the baseline scenario. It is a *key recommendation* to 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.

The most likely baseline scenario depends on drivers that would affect the impact in the absence of the policy or action being assessed. Identifying key drivers for each significant impact being assessed and determining reasonable assumptions about their most likely values in the absence of the policy or action being assessed have a significant impact on the baseline scenario, and consequently on the eventual estimate of the impact of the policy or action.

Drivers that affect baseline values are divided into two types:

- **Other policies or actions**: Policies, actions and projects—other than the policy or action being assessed—that are expected to affect the impacts included in the assessment boundary
- **Non-policy drivers**: Other conditions such as socioeconomic factors and market forces that are expected to affect the impacts included in the assessment boundary

Users should ensure that baseline scenarios defined for each impact category are consistent. That is, where common drivers or assumptions exist across impact categories, the same values should be used for each baseline scenario developed for the policy or action. For example, if GDP is a common driver needed for assessing both the job impacts and economic developments impacts of a solar PV incentive policy, users should use the same assumed value for GDP over time for both impact categories.

Users should identify plausible baseline options and then choose the option that is considered to be the most likely to occur in the absence of the policy or action. The choice should be made in consultation with stakeholders and experts. Possible options include:

- The continuation of current technologies, practices or conditions
- Discrete baseline alternatives, practices, technologies or scenarios (such as the least-cost alternative practice or technology), identified using environmental, financial, economic, or behavioural analysis or modelling
- A performance standard or benchmark indicative of baseline trends

Users should create a baseline scenario for each significant impact to be quantitatively assessed, where feasible. The baseline scenarios may be developed separately for each impact of interest. Users should ensure that the set of baseline scenarios developed to assess multiple impact categories of a policy or action applies consistent data and assumptions where common drivers exist (such as population growth or GDP growth).

Including other policies or actions

In addition to the policy or action being assessed, there are likely to be other policies, actions or projects that affect the indicator being estimated. These may include regulations and standards, taxes and charges, subsidies and incentives, voluntary agreements, information instruments, or other types of policies and actions.

In the case of a national solar PV incentive policy, other policies may be in place that also affect the amount of solar PV installed by households and businesses in the baseline scenario, such as national regulations that facilitate connection of distributed generation to the electric grid (other national policies), municipal incentives to promote renewable energy at the local level (subnational policies), and utility incentives for solar PV installation (private sector actions). These other policies affect conditions in the baseline scenario and should be considered to determine what the incremental impact of the national solar PV policy is relative to what would have happened otherwise. Appendix A provides an example of including other policies in the baseline scenario.

To identify other policies and actions to consider in the baseline scenario, users should identify key parameters in the assessment—such as the amount of solar PV installed—and identify other policies and actions that affect the same parameters.

Users should include all other policies, actions and projects in each baseline scenario that:

- Have a significant effect on the impacts included in the assessment boundary; and
- Are implemented or adopted at the time the assessment is carried out (for ex-ante assessment) or are implemented during the assessment period (for ex-post assessment).

Published baseline values may already include the impact of existing policies and actions in the baseline scenario. If it is not possible to include a relevant policy or action in the baseline scenario, users should document and justify its exclusion.

See Table 8.3 for definitions of implemented, adopted and planned policies and actions. For ex-ante assessment, adopted policies should be included in the baseline scenario if they are likely to be implemented and if there is enough information to estimate the impacts of the policy. In some cases, users can may want to include planned policies in the baseline scenario for ex-ante assessment, for example if the objective is to assess the impact of one planned policy relative to other planned policies.

Table 8.3: Definitions of implemented, adopted, and planned policies and actions

Policy or action status	Definition
Implemented	Policies and actions that are currently in effect, as evidenced by one or more of the following: (a) relevant legislation or regulation is in force; (b) one or more voluntary agreements have been established and are in force; (c) financial resources have been allocated; (d) human resources have been mobilized.
Adopted	Policies and actions for which an official government decision has been made and there is a clear commitment to proceed with implementation, but that have not yet begun to be implemented (e.g., a law has been passed, but regulations to implement the law have not yet been established or are not being enforced).
Planned	Policy/action options that are under discussion and have a realistic chance of being adopted and implemented in the future, but that have not yet been adopted.

Source: WRI 2014

Users can establish a significance threshold or other criteria to determine which policies, actions and projects are significant and should be included. For other policies or actions that are included, users should determine whether they are designed to operate indefinitely or are limited in duration. Users should assume that policies or actions will operate indefinitely unless an end date is explicitly stated.

Including non-policy drivers

Non-policy drivers include a wide range of exogenous factors such as socioeconomic factors and market forces that may cause changes in the impact category but are not a result of the policy or action assessed. Users should identify non-policy drivers based on literature reviews of similar assessments and policies, consultations with relevant experts and stakeholders, expert judgment, modelling results, or other methods.

In the case of a solar PV incentive policy, non-policy drivers that affect the amount of solar PV installed by households and businesses in the baseline scenario may include the price of solar PV systems (the less expensive they are, the more households and businesses will install them) and the price of electricity (the more expensive electricity from the grid is, the greater the incentive for households and businesses to install solar PV systems). These factors affect conditions in the baseline scenario and should be considered to determine the impact of the solar PV incentive policy relative to what would have happened otherwise.

Users should include all non-policy drivers in the baseline scenario that are not caused by the policy or action being assessed (i.e., that are exogenous to the assessment), and that are expected to result in a significant change in calculated impacts between the baseline scenario and policy scenario. In ex-ante assessments, users do not need to include drivers that are expected to remain the same under both the policy scenario and baseline scenario. Users can establish a significance threshold or other criteria to determine which non-policy drivers are significant.

To identify non-policy drivers that should be considered in the baseline scenario, users should identify key parameters in the assessment—such as the amount of solar PV installed—and identify other policies and actions that affect the same parameters.

Published baseline values may already include the impact of non-policy drivers in the baseline scenario. If it is not possible to include a relevant non-policy driver in the baseline scenario, users should document and justify its exclusion.

Defining a range of baseline scenario options

If possible, users should identify the single baseline scenario that is considered most likely for each impact being assessed. In certain cases, multiple baseline options may seem equally likely. In such cases, users should consider estimating and reporting a range of results based on multiple alternative baseline scenarios. Users should conduct sensitivity analysis to see how the results vary depending on the selection of baseline options. Sensitivity analysis involves varying the parameters, or combinations of parameters, to understand the sensitivity of the overall results to changes in those parameters. It is a useful tool for understanding differences resulting from methodological choices and assumptions and exploring model sensitivities to inputs. Sensitivity analysis is further described in Chapter 11.

Use of assumptions and expert judgment

Assumptions or expert judgment will likely be required in cases where information is not available to make a reasonable assumption about the value of a parameter. Users may need to use proxy data, interpolate information, estimate a rate of growth, or use other types of assumptions or judgment. Users can apply their own expert judgment or consult experts. When doing so, it is important to document the reason no data sources are otherwise available and the reason for the value chosen.

8.3.3 Define the estimation methods and parameters needed to estimate baseline values

For each indicator to be assessed, users should first identify a method (such as an equation, algorithm or model) for estimating the baseline scenario, then identify the data requirements needed to quantify the baseline value using the chosen method. When selecting the baseline scenario method, consideration should be given to the data needs and data availability under the baseline scenario and the policy scenario, since the same method or model should be used for both scenarios.

Multiple types of data can be used to estimate the impacts of policies and actions, including both bottom-up and top-down data. See Table 8.4.

Table 8.4: Overview of bottom-up and top-down data

Type of data	Description
Bottom-up data	Bottom-up data are measured, monitored or collected at the facility, entity or project level. Examples include energy used at a facility (e.g., using a measuring device such as a fuel meter) and production output.
Top-down data	Top-down data are macro-level data or 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.

Source: Adapted from WRI 2014

Both bottom-up and top-down data may be appropriate in different contexts and are valuable for different purposes. For example, top-down data may be most appropriate for national policies and actions while bottom-up data may be better suited to smaller scale policies and actions. The choice of bottom-up versus top-down approaches depends on data availability and the needs of the assessment.

A wide range of tools and models can be used to quantify different social, environmental, and economic impacts. Methods may range from simple equations (such as simple extrapolation) to complex models (such as simulation models, computable general equilibrium models, or integrated assessment models). Simple equations may not be sufficient to represent the complexity necessary to accurately estimate baseline or policy scenarios or to capture the difference between them. Detailed models may be needed to estimate the impacts of certain policies or actions. Detailed models may also be appropriate when the chosen impact category includes multiple interacting parameters.

A variety of methods can be used depending on what type of data is available and the level of accuracy desired. Some methods (such as engineering models) calculate or model the impact of a policy or action for each facility, project or entity affected by the policy or action, then aggregate across all facilities, projects or entities to determine the total impact of the policy or action. Other methods may include regression analysis or other statistical methods, simulation models, computable general equilibrium models or other models.

For example, a user assessing the impact of a solar PV incentive policy on jobs could use a bottom-up approach by multiplying the estimated number of buildings that install PV systems by the estimated number of workers needed to install and maintain solar PV systems per building, where data may be provided by individual companies. Alternatively, a user could use a top-down approach by using economic models based on national employment statistics on the number of people employed in the solar energy industry and other relevant variables. Hybrid approaches that combine elements of both bottom-up and top-down approaches may also be used.

The ICAT website[11] provides examples of tools and models to support impact quantification. Users can use existing methods or models or develop new methods or models (if no relevant and appropriate methods or models exist). Users should select a tool that achieves sufficiently accurate results in the context of objectives, data availability and resource constraints. Objectives may range from theoretical explorations of policy questions, to practical applications of the results in a governmental regulatory or programmatic context, to forecasting for planning purposes. These needs will determine the ranges of sectors that must be included in the tool, the geographic scales and time frames. For example, some users may choose simple scenarios to support their analyses, while others may want additional variables, longer time scales or more detailed time steps, or the flexibility to incorporate changing policies or patterns and develop conditional futures. Likewise, some may be interested in assessing a small geographic region, a single sector, or even a single project, while others may want multi-scale futures or integrated approaches (USGCRP 2016).[12]

Based on users' specific needs, a suite of models may be available to help. Each will require varying levels of data inputs, user knowledge/expertise, and cost. Thus, selecting the most appropriate tool will depend on users' time and financial resources available, as well as their team expertise. These considerations are illustrated in Table 8.5.

Table 8.5: Considerations for selecting tools to assess social, economic, or environmental impacts

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

Note: [a] The level of accuracy varies in general with the various attributes presented here. In reality, a complex, advanced model that has a high cost and requires extensive data inputs will only be as accurate as the quality of the data that goes into it.

[11] http://www.climateactiontransparency.org/methodological-framework/sustainable-development/

[12] U.S. Global Change Research Program (USGCRP). *Multi-Scale Economic Methodologies and Scenarios Workshop. Prepared by ICF International*. August 2016. Available at: http://www.globalchange.gov/sites/globalchange/files/reports_files/Multi-Scale%20Economic%20Medthodologies%20%26%20Scenarios%20Workshop%20Report_Final_0.pdf.

Table 8.6 provides an overview of types of economic models for quantifying economic impacts. Box 8.5 provides an explanation of one model for quantifying job and economic impacts of constructing and operating power plants, such as wind farms. Box 8.6 provides an example of a model for estimating the health and economic effects of air pollution.

Table 8.6: Overview of Modelling Approaches and Tools for Economic Analysis

Method	Advantages	Disadvantages
Input-Output model (also called multiplier analysis)	• Quantifies the total economic effects of a change in the demand for a given product or service • Can be inexpensive	• Static; multipliers represent only a snapshot of the economy at a given point in time • Generally assumes fixed prices • Typically does not account for substitution effects, supply constraints, and changes in competitiveness or other demographic factors
Econometric models	• Usually dynamic, can estimate and/or track changes in policy impacts over time • Coefficients are based on historical data and relationships, and statistical methods can be used to assess model credibility	• Historical patterns may not be best indicator or predictor of future relationships • Some econometric models do not allow foresight
Computable General Equilibrium (CGE) models	• Accounts for substitution effects, supply constraints and price adjustments	• Not available for all regions
Hybrid models	• Most sophisticated, combining aspects of all the above • Dynamic, can be used to analyze both short- and long-term impacts • Can be used to model regional interactions	• Can be expensive

Source: US EPA, available at: https://19january2017snapshot.epa.gov/sites/production/files/2016-03/documents/overview_modeling_approaches.pdf.

Box 8.5: JEDI model for estimating job and economic impacts from power plants

NREL's Jobs and Economic Development Impact (JEDI) model is an Excel-based model that estimates the number of jobs and economic impacts to a local area of constructing and operating power plants, fuel production facilities, and other projects at the local level. For example, JEDI estimates the number of construction jobs from a new wind farm. JEDI models are used by decision makers, public utility commissions, potential project owners, developers, and others.

The model estimates the project costs and the economic impacts in terms of jobs, earnings (i.e., wages and salary), and output (i.e., value of production) resulting from the project. Jobs, earnings and output are distributed across three categories: project development and onsite labour impacts, local revenue and supply chain impacts, and induced impacts. To the extent a user has and can incorporate project-specific data as well as the share of spending expected to occur locally, the results are more likely to better reflect the actual impacts from the specific project. Project-specific data include a bill of goods (costs associated with actual construction of the facility, roads, etc., as well as equipment costs, other services and fees required), annual operating and maintenance costs, the portion of expenditures to be spent locally, financing terms and local tax rates. The analysis is not designed to provide a precise forecast, but rather an estimate of overall economic impacts from specific scenarios.

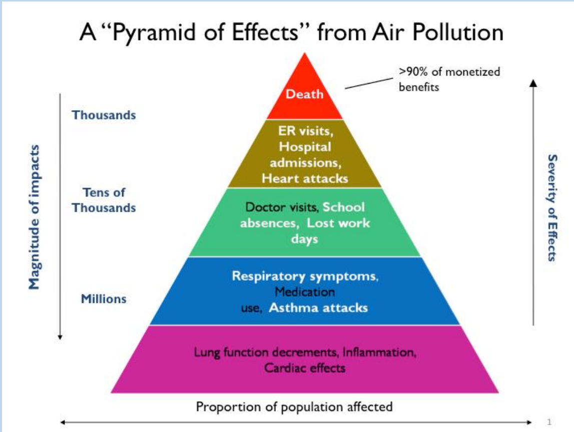
The JEDI model uses an input-output methodology. It uses economic data (multipliers and consumption patterns) to estimate the local economic activity and the resulting impact from new energy generation plants. This involves aggregating national and regional economic and demographic data to calculate inter-industry linkages and the relationships between changes in demand for goods and services, and the associated economic activity at the local and regional levels. Local spending results from using: local labour (e.g., concrete pouring jobs), services (e.g., engineering, design, legal), materials (e.g., wind turbine blades) or other components (e.g., nuts and bolts).

Source: NREL, available at: http://www.nrel.gov/analysis/jedi/

Box 8.6: The Benefits Mapping and Analysis Program (BenMAP) Model for Estimating the Health and Economic Effects of Air Pollution

U.S. EPA's BenMAP-Community Edition (CE) tool estimates the economic value of health impacts resulting from changes in air quality—specifically, ground-level ozone and fine particles. BenMAP-CE is an open-source computer programme that calculates the number and economic value of air pollution-related deaths and illnesses. The software incorporates a database that includes many of the concentration-response relationships, population files, and health and economic data needed to quantify these impacts.

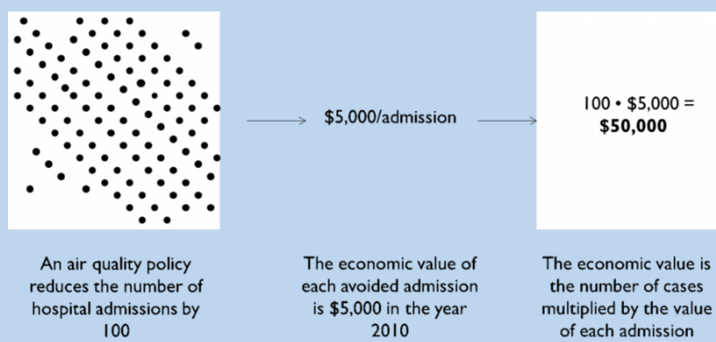
Air pollution affects health through fine particles that enter deep into the lungs and enter the blood stream. Health impacts from particles include premature death, non-fatal heart attacks, and aggravated asthma. Ground-level ozone is an oxidant that can irritate airways in the lungs. Health impacts form ozone include premature death, aggravated asthma and lost days of school.



The pyramid describes how the incidence and severity of fine particle and ozone-related health impacts are related. Health outcomes toward the bottom of the pyramid like asthma attacks and cardiac effects are less severe, and affect a larger proportion of the population. Impacts toward the tip of the pyramid like hospital admissions and heart attacks are more severe and affect a smaller proportion of the population. BenMAP-CE quantifies those impacts shown in white.

BenMAP-CE estimates health impacts through a health impact function that incorporates four key sources of data from the published epidemiology literature: 1) modeled or monitored air quality changes, 2) population, 3) baseline incidence rates, and 4) an effect estimate. The figure below describes the data BenMAP-CE uses to calculate health impacts.

BenMAP-CE calculates the economic value of air quality change using both "Cost of Illness" and "Willingness to Pay" metrics. The Cost of Illness metric summarizes the expenses that an individual must bear for air pollution-related hospital admissions, visits to the emergency department and other outcomes; this metric includes the value of medical expenses and lost work, but not the value that individuals place on pain and suffering associated with the event. By contrast, Willingness to Pay metrics are understood to account for the direct costs noted above as well as the value that individuals place on pain and suffering, loss of satisfaction and leisure time. This simple example summarizes the procedure for calculating economic values using these two metrics in BenMAP-CE.



Source: U.S. EPA, Benefits Mapping and Analysis Program (BenMAP), available at: https://19january2017snapshot.epa.gov/benmap/how-benmap-ce-estimates-health-and-economic-effects-air-pollution_.html.

8.3.4 Collect data for each indicator

The next step is to collect data for each indicator (and parameter, if applicable) in each baseline scenario. To estimate baseline values for each indicator, users should first decide whether to estimate new baseline values or use baseline values from published data sources. For some indicators, published values may not be available. In this case, users should estimate new values.

Users should collect data separately for different groups in society where relevant, such as men and women, people of different income groups, people of different racial or ethnic groups, people of different education levels, people from various geographic regions, people in urban versus rural locations, among others.

When using either published values or estimating new values, users should report the baseline values for each indicator being estimated over defined time periods, such as annually over the assessment period, if feasible. It is important to report the methods, assumptions and data sources used. Users should also justify the choice of whether to estimate new baseline values and assumptions or to use published baseline values and assumptions. If no data source is cited, users should provide sufficient information such that stakeholders and those tracking the impact over time can know where to look for updates to the data.

When collecting data from various data sources, users should consider whether the data source is readily available, whether data sources will be available to track indicator values over time, and how expensive or labour intensive it will be to collect over time. Users should use conservative assumptions to define baseline values when uncertainty is high, or a range of possible values exist. Conservative values and assumptions are those more likely to overestimate negative impacts or underestimate positive impacts resulting from a policy or action.

Parameters whose values will not change between the baseline and policy scenario may "cancel out" when the baseline and policy values are subtracted. Where that is the case, the value chosen for the parameter will not influence the final result and fewer resources should be expended to gather the data for the parameter. Ideally, where such parameters will net out in the final comparison, the method should be simplified, and its description narrowed to remove those parameters that are not relevant.

Option 1: Using baseline values from published data sources

In some cases, existing data sources of sufficient quality may be available to determine baseline values for indicators. Potential data sources of historical or projected data include 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 the IEA, IPCC, World Bank and FAO), and economic and engineering analyses and models.

Users should use high-quality, up-to-date, and peer-reviewed data from recognized, publicly available, credible sources if available. When selecting data sources, users should apply the data quality indicators in Table 8.7 as a guide to obtaining the highest quality data available. Users should select data that is the most representative in terms of technologies and practices, time and geography; most complete; and most reliable.

Table 8.7: Data quality indicators

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 (such as the country, city or 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.

Source: WRI 2014, based on Weidema and Wesnaes 1996.

In some cases, the baseline scenario itself may be the subject of published research and available for use. As above, the information should be high quality and credible. In addition, the method used should be sufficiently clear that users can generate a comparable policy scenario, with consistent methods, assumptions and data sources.

For published values, a range of data may be available, such as:

- International default values
- National average values
- Jurisdiction- or activity-specific data

In general, users should use the most accurate and representative data available.

Option 2: Estimating new baseline values

In some cases, no published baseline data and assumptions will be available for historical or projected data, or the existing data may be incomplete, of poor quality, or in need of supplementation or further disaggregation. Users should estimate new baseline values when no relevant data are available that supports the level of accuracy needed to meet the stated objectives.

To estimate new baseline values for a given indicator, users should:

1. Collect historical data for the indicator
2. Identify other policies/actions 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

8.3.5 Estimate baseline values for each indicator

The final step in developing the baseline is to apply the method using the data collected to estimate baseline values for each indicator.

It is a *key recommendation* to estimate baseline values over the assessment period for each indicator included in the assessment boundary. Any impact in the assessment boundary that cannot be estimated should be assessed qualitatively (as described in Chapter 7). It is a *key recommendation* to separately estimate baseline values for different groups in society where relevant.

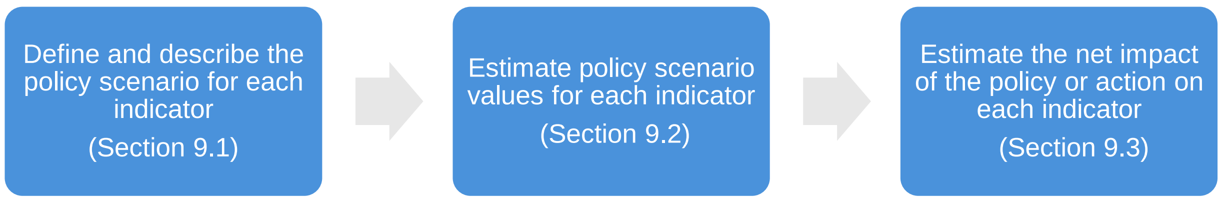
See Appendix A for an example of estimating the impact of a solar PV incentive policy, including estimating the baseline. The ICAT website[13] provides examples of tools and models to support impact quantification.

[13] http://www.climateactiontransparency.org/methodological-framework/sustainable-development/

9. ESTIMATING IMPACTS EX-ANTE

This chapter describes how to estimate the expected future impacts of the policy or action (ex-ante assessment). In this chapter, users estimate policy scenario values for the indicators included in the assessment boundary. The impacts of the policy or action are estimated by subtracting baseline values (as determined in Chapter 8) from policy scenario values (as determined in this chapter). Users not quantitatively assessing impacts ex-ante can skip this chapter.

Figure 9.1: Overview of steps in the chapter



Checklist of key recommendations

- 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

9.1 Define and describe the policy scenario for each indicator

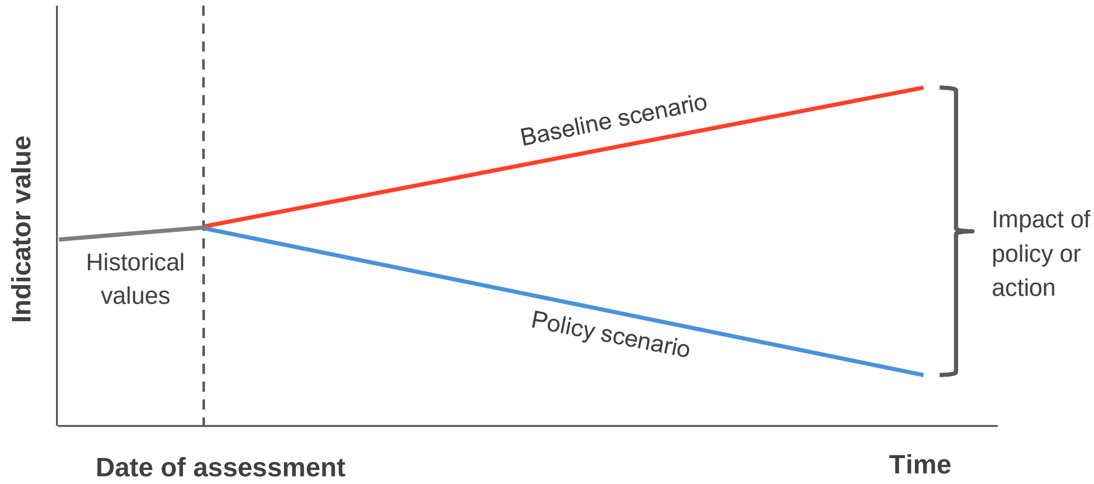
In Chapter 8, users defined an indicator for each impact category included in the assessment boundary. For examples of indicators, see Table 5.5. This indicator will be estimated in the baseline and policy scenario to estimate the impact of the policy or action. Each indicator will generally require a different assessment method. The same general assessment method(s) used to estimate baseline values (in Chapter 8) should also be used to estimate the policy scenario for each indicator to ensure methodological consistency between the baseline and policy scenario estimation. Consistency ensures that the estimated impact reflects underlying differences between the two scenarios, rather than differences in methods. If it is not feasible or appropriate to use the same method, users should justify why different methods have been used. The ICAT website[14] provides examples of tools and models to support impact quantification.

For each indicator being estimated, it is a *key recommendation* to define a policy scenario that represents the conditions most likely to occur in the presence of the policy or action over time. The policy scenario represents the events or conditions most likely to occur in the presence of the policy or action (or package of policies or actions) being assessed. The only difference between the baseline scenario and the policy

[14] http://www.climateactiontransparency.org/methodological-framework/sustainable-development/

scenario is that the policy scenario includes the changes caused by the policy or action (or package of policies/actions) being assessed. See Figure 9.2 for an illustration of estimating impacts ex-ante. Users can estimate policy scenario values either before or after estimating baseline values.

Figure 9.2: Illustration of estimating impacts ex-ante



Users should identify various policy scenario options and then choose the one considered to be the most likely to occur in the presence of the policy or action. It is important to consult stakeholders during the selection and estimation of the policy scenario to ensure credibility. Users should report a description of the policy scenario for each indicator being estimated.

9.2 Estimate policy scenario values for each indicator

The policy scenario values for some indicators may be able to be estimated directly without the need for additional parameters. Other assessment methods may require multiple parameters in order to estimate policy scenario values for a given indicator. For example, estimating household cost savings from an energy efficiency policy requires the electricity price and the quantity of energy consumed in the baseline scenario and policy scenario. In this example, *household cost savings* is the indicator (measured in dollars or other currency) while *electricity price* and *quantity of energy consumed* are parameters. These two parameters are not themselves indicators of interest, but are necessary in order to calculate the impact on the indicator of interest (i.e., *household cost savings*). Calculating the impact on each indicator therefore requires estimating policy scenario values for each parameter in the assessment method(s).

To estimate policy scenario values for each parameter, users should first identify which parameters are affected by the policy or action. In the example above, *quantity of energy consumed* is affected by the policy, since it is designed to save energy, while *electricity price* is not affected by the energy efficiency policy.

Parameters that are affected by the policy or action (such as *quantity of energy consumed*) need to be estimated in the policy scenario. These parameter values are expected to differ between the policy scenario and baseline scenario. Users should follow the same general steps described in Section 8.3 for estimating baseline values but should instead estimate the policy scenario value for each parameter. This requires developing assumptions about how the policy or action is expected to affect each parameter over the assessment period.

Parameters that are not affected by the policy or action (such as *electricity price*) do not need to be estimated again, since the parameter value is not expected to differ between the policy scenario and baseline scenario. The baseline value for that parameter (estimated in Chapter 8) should also be used as the policy scenario value for that parameter (in this chapter). All drivers and assumptions estimated in the baseline scenario should be the same in the policy scenario except for those drivers and assumptions that are affected by the policy or action being assessed.

Users should report the policy scenario values for each indicator being estimated and the methods, assumptions, and data sources used to calculate policy scenario values.

9.2.1 Guidance for estimating policy scenario values

Users can either:

- Use policy scenario values from published data sources (Option 1), or
- Estimate new policy scenario values (Option 2)

Option 1: Using policy scenario values from published data sources

In some cases, existing data sources of sufficient quality may be available to determine policy scenario values. Potential data sources of historical or projected data include 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.

Users should use high-quality, up-to-date, and peer-reviewed data from recognized, publicly available, credible sources if available. When selecting data sources, users should apply the data quality indicators in Table 8.7 as a guide to obtaining the highest quality data available. Users should select data that is the most representative in terms of technologies and practices, time and geography; most complete.

For published values, a range of data may be available, such as:

- International default values
- National average values
- Jurisdiction- or activity-specific data

In general, users should use the most accurate data available.

Option 2: Estimating new policy scenario values

In some cases, no relevant published data and assumptions will be available for policy scenario values, or the existing data may be incomplete, of poor quality, or in need of supplementation or further disaggregation. Users should estimate new policy scenario values and assumptions when no relevant data is available that supports the level of accuracy needed to meet the stated objectives.

Users can use a range of methods and data to estimate policy scenario values, ranging from simpler to more complex. For example, a simple method may involve an assumption that parameters will remain static (fixed) over the assessment period or involve a linear extrapolations of historical trends, while a more complex approach involves an assumption that parameters are dynamic (changing) over the assessment period and estimated based on detailed modelling or equations.

Users should estimate the change in the indicator over time based on what is considered to be the most likely scenario for each indicator, based on evidence, such as peer-reviewed literature, modelling or simulation exercises, government statistics, or expert judgment. Existing literature or methods may not be similar enough to use directly. Users may need to make adjustments to results found in literature to adapt to the assumptions made in the baseline scenario and other elements of the assessment. Users may need to apply new methods, models and assumptions not previously used in the baseline method to estimate the expected change in each indicator as a result of the impacts of the policy or action. However, new methods should not be used to estimate total impacts of the policy or action, since the same general methods used to estimate baseline values should be used to estimate policy scenario values to ensure consistency.

Each indicator may be assumed to be static or dynamic over the assessment period, and dynamic indicators can change at a linear or nonlinear rate. In many cases, dynamic models that allow for conditions to change throughout the assessment period are expected to be the most accurate, so they should be used where relevant and feasible.

To estimate policy scenario values for each indicator affected by the policy or action, users should consider a variety of factors (described in more detail below), such as:

- Historical trends and expected values in the baseline scenario
- Timing of impacts
- Barriers to policy implementation or effectiveness
- Policy interactions
- Sensitivity of parameters to assumptions

To the extent relevant, users should also consider the following additional factors:

- Non-policy drivers included in the baseline scenario (see Chapter 8), which should be the same between the policy scenario and baseline scenario if they are not affected by the policy assessed, but should be different between the two scenarios if they are affected by the policy
- Learning curves (economic patterns that can accelerate or slow new product development and deployment)
- Economies of scale
- Technology penetration or adoption rates (the pace of adoption by targeted actors, which may be slow initially then accelerate as products become more socially accepted)

Depending on the assessment, users may not need to consider each of these factors. In practice, users may also be limited by the following considerations:

- Type of policy or action (which may require consideration of certain factors but not others)
- Assessment method (for example, simplified approaches may be limited to linear approximations)
- Data availability (which may limit the number of factors that can be considered)
- Objectives of the assessment (which may require a more or less complete and accurate assessment)

- Available resources to conduct the assessment

In general, users should follow the most accurate approach that is feasible and focus on achieving higher levels of accuracy for the most significant impact categories and specific impacts included in the assessment boundary.

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. Understanding the historical values of the indicator as well as the expected values in the baseline scenario are both useful when estimating policy scenario values.

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. Users should assume that a policy or action will operate indefinitely unless an end date is explicitly embedded in the design of the policy or action, despite inherent uncertainty over whether it will eventually be discontinued. If the policy or action is limited in duration, the assessment period may include some impacts that occur during the policy implementation period and some impacts that occur after the policy implementation period.

Users should also consider whether and how the implementation of the policy or action is expected to change over the assessment period. Examples include tax instruments where the tax rate increases over time, performance standards where the level of stringency increases over time, or regulations with multiple distinct phases.

In addition to estimating and reporting the full impacts of the policy or action over the assessment period, users can separately estimate and report impacts over any other time periods that are relevant. For example, if the assessment period is 2020–2030, users can separately estimate and report impacts over the periods 2020–2025, 2025–2030 and 2020–2030.

Barriers to policy implementation, enforcement, or effectiveness

The policy scenario values should represent the values most likely to occur in the presence of the policy or action, which depend on assumptions related to policy implementation, enforcement, and 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. For example, a policy or action may not achieve its full potential due to governance challenges, such as a lack of capacity, interagency coordination, public participation or accountability. 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). For example, a new municipal solar PV incentive policy may overlap with an existing national renewable energy mandate and a local energy efficiency policy. Because both existing policies are included in the baseline scenario, they have the effect of reducing the energy savings achieved through the new solar policy.

If there are no interactions with other policies or actions included in the baseline scenario, the policy or action assessed will have the full range of impacts expected. If the policy or action assessed has a reinforcing impact with policies in the baseline scenario, the policy or action assessed will have a greater range of positive impacts than expected.

However, if the policy or action overlaps with policies in the baseline scenario, the positive impact of the policy or action will be reduced. In an extreme case where the policy or action assessed overlaps completely with policies included in the baseline scenario, the policy or action would have no impacts relative to the baseline scenario.

If interactions with policies included in the baseline scenario exist, users should estimate the magnitude of the policy interactions when estimating policy scenario values. This enables users to estimate the incremental impact of the policy or action being assessed relative to existing policies and actions included in the baseline scenario.[15]

Sensitivity of indicator values 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.

9.3 Estimate the net impact of the policy or action on each indicator

After estimating policy scenario values, the last step is to estimate the net impact of the policy or action on each indicator. It is a *key recommendation* to 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 (see Equation 9.1). This involves estimating each specific impact within an impact category, then aggregating across all of the specific impacts to determine the net impact of the policy or action on each impact category, where feasible.

[15] An example of assessing policy interactions is available at: http://www.res-policy-beyond2020.eu/pdffinal/Interactions%20between%20EU%20GHG%20and%20Renewable%20Energy%20Policies%20%E2%80%93%20how%20can%20they%20be%20coordinated%20(beyond2020%20-%20D6-1b).pdf

To do so, users should follow these steps for each indicator being estimated:

1. Estimate baseline values related to each specific impact in the quantitative assessment boundary (as described in Chapter 8)
2. Estimate policy scenario values related to each specific impact in the quantitative assessment boundary
3. Subtract baseline values from policy scenario values to estimate the impact of the policy or action for each specific impact
4. Aggregate across all specific impacts to estimate the total net impact of the policy or action on a given indicator, which represents the change in the impact category, where feasible
5. Repeat the process for each indicator in the assessment boundary

When aggregating across impacts, users should address any possible overlaps or interactions between impacts to avoid over-or underestimation of the total net impact of the policy or action.

Users should calculate baseline values, policy scenario values, and the net impact of the policy or action over defined time periods, such as annually and cumulatively over the quantitative assessment period.

Equation 9.1: Estimating the impact of the policy or action on a given indicator

For a specific impact: Estimated change due to the policy or action = Policy scenario value for the chosen indicator – Baseline value for the chosen indicator

Net impact of a policy or action on the chosen indicator = ∑ Estimated change for each specific impact included in the assessment boundary

Note: “Net” refers to the aggregation of all specific impacts included in the assessment boundary, including both positive and negative impacts.

It is a *key recommendation* to separately assess the impacts of the policy or action on different groups in society where relevant, such as men and women, people of different income groups, people of different racial or ethnic groups, people of different education levels, people from various geographic regions, people in urban versus rural locations, among others. This allows users to understand distributional impacts on different groups and manage tradeoffs in cases where policies or actions have positive impacts on some groups and negative impacts on other groups.

Equation 9.1 results in a neutral estimate of impact, which may either be an increase (positive value) or a decrease (negative value). For example, if estimating the impact of a policy on air pollution, the equation will yield a positive value if the policy increases air pollution and a negative value if the policy reduces air pollution. If a policy creates jobs, the equation will yield a positive value, whereas if a policy reduces jobs, the equation will yield a negative value. Policy scenario values may either be higher or lower than baseline scenario values, depending on the impact being estimated. Users may interpret and communicate the result as either positive or negative or an increase or decrease depending on the impact category and the context.

If any impacts in the quantitative assessment boundary have not been estimated, users should document and justify the exclusion and describe the impact qualitatively (as explained in Chapter 7).

See Appendix A for an example of estimating the impact of a solar PV incentive policy. Table 9.1 summarizes the ex-ante quantification results for the solar PV incentive policy across all impact categories included in the assessment.

Table 9.1: Estimated impact of the solar PV incentive policy on all impact categories included in the assessment

Impact category	Indicator quantified	Estimated impact (Cumulative impact from 2016 – 2025)
Climate change mitigation	GHG emissions ($MtCO_2e$) from the electric grid	Reduction of 307 Mt CO_2e
Air quality / health impacts of air pollution	$PM_{2.5}$ emissions (t) from the electric grid	Reduction of 1,177,996 t $PM_{2.5}$
	PM_{10} emissions (t) from the electric grid	Reduction of 2,437,234 t PM_{10}
	SO_2 emissions (t) from the electric grid	Reduction of 4,265,161 t SO_2
	NOx emissions (t) from the electric grid	Reduction of 4,062,057 t NOx
	Number of premature deaths per year in India resulting from air pollution from coal plants	Reduction of 32,304 premature deaths
Energy	Renewable energy installed capacity (MW)	Increase of 40,000 MW of renewable energy capacity
Access to clean, affordable, and reliable energy	Increase in number of houses/buildings/facilities with access to clean energy resulting from the policy	Increase of 5,741,889 houses/buildings/facilities with access to clean energy
Capacity, skills, and knowledge development	Number of new skilled trainees and workers on the ground because of the policy	Increase of 40,060 new skilled trainees and workers
Jobs	Change in jobs resulting from the policy (number of jobs)	Net increase of 821,102 jobs
Income	Savings in annual electric bill for households and businesses (USD)	Savings of 27,855 million USD
Energy independence	Reduction in coal imports (t)	Reduction of 57,770,140 tons of coal

Users should estimate the total in-jurisdiction impact (the total net change that occurs within the implementing jurisdiction's geopolitical boundary), separately from total out-of-jurisdiction impacts (the net change that occurs outside of the jurisdiction's geopolitical boundary) for each indicator, if relevant and feasible.

Users should separately estimate and report the change resulting from each specific impact included in the assessment boundary, where relevant and feasible. Users can also separately report by type of impact.

Users should report the net impact of the policy or action on a given indicator as a range of likely values, rather than as a single estimate, when uncertainty is high (e.g., because of uncertain baseline assumptions). Chapter 11 provides guidance on uncertainty and sensitivity analysis.

Separate reporting based on likelihood and probability, if relevant

Each impact of the policy or action included in the assessment may vary in the likelihood that it will actually occur. In Chapter 7, users categorize potential impacts based on whether they are very likely, likely, possible, unlikely or very unlikely to occur. If unlikely or very unlikely effects are included in the assessment, users should consider reporting those impacts separately from the results based on very likely, likely and possible impacts. Users can also separately report impacts by each likelihood category (e.g., very likely, likely, possible) if relevant and feasible.

Where likelihood is difficult to estimate, users can report a range of values for a given impact based on sensitivity analysis around key parameters (further described in Chapter 11). Users can additionally incorporate probability into the estimation of ex-ante policy scenario values by weighting each impact by its expected probability (such as 100%, 75%, 50%, 25% or 0%).

Box 9.1: Quantitative ex-ante impact assessment in South Africa

A landfill in Garden Route District Municipality in South Africa was recently closed due to capacity constraints and will be replaced by a new regional waste management and landfill facility. The new landfill will not accept organic waste materials. To inform the municipality's new organic waste management plan, the South Africa Low Emission Development (SA-LED) program supported the municipality in conducting an ex-ante assessment of the sustainable development impacts of different organic waste management options. The assessment focused on different approaches to managing abattoir waste, which is a major component of organic waste in the district. The findings are expected to inform broader organic waste management policy in the region.

<u>Defining the baseline and policy scenarios</u>: The baseline scenario assumed that the new regional landfill would be built without an abattoir waste management facility and the abattoir waste would go to other regional landfills or be discarded at the community or household level. The policy scenario assumed the new waste management facility includes an abattoir waste management facility that uses anaerobic digestion. The study quantified the impact of building the facility with an abattoir waste facility compared to the baseline scenario.

<u>Determining impact categories and indicators to assess</u>: Table 9.2 provides examples of impact categories and indicators that were assessed.

Table 9.2. Examples of assessed impact categories and indicators

Impact category	**Indicator**
Climate change mitigation	Amount of CO_2e avoided (t/year)
Economic development	Earnings gained from the project (ZAR/year) GDP gained from the project (ZAR/year)
Jobs	Number of short-term jobs created, disaggregated by direct (on-site) and indirect (supply chain) jobs

	Number of long-term operations and maintenance (O&M) jobs created, disaggregated by direct and indirect jobs
Water saving	Amount of water saved (t/year)
Waste generation	Change in amount of waste sent to the landfill (t/year)
Women employment	Number of full-time, trained women employees
Youth employment	Number of full-time, trained employees under 35 years old
Land use	Years of landfill life saved (year)

Identifying and assessing specific impacts: Based on the included impact categories, the study identified specific impacts of the abattoir waste management facility. Each specific impact was qualitatively assessed, including its likelihood and magnitude, to determine whether each was significant. With the exception of water savings, all impacts in Table 9.2 were found to be significant. Due to data limitations, impacts on women employment and youth employment were assessed qualitatively rather than quantified.

To quantify the baseline scenario, policy scenario, and net impacts, the assessment used recent studies including a municipal waste characterization study performed by SA-LED and tools such as the International Jobs and Economic Development Impacts (I-JEDI) tool and the US EPA Waste Reduction Model (WARM) tool. The quantitative results are shown in Table 9.3.

Table 9.3. Selected quantitative results of the waste management policy

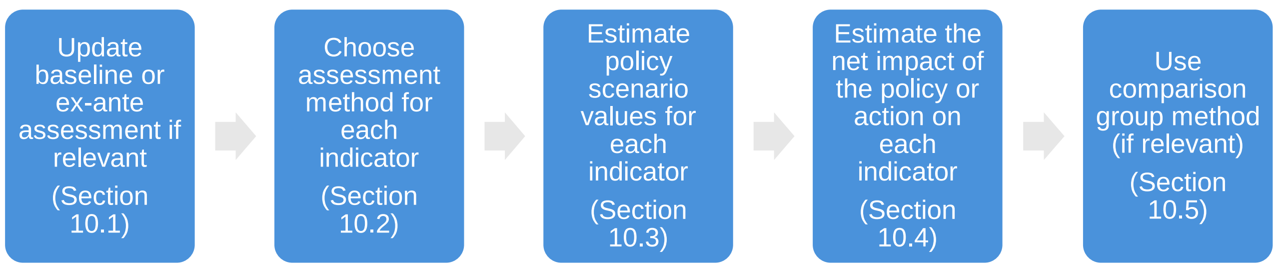
Indicator	Change
Change in GHG emissions from diverting waste into anaerobic digester	Reduction of 5,718 t CO_2e/yr
Change in number of earnings gained from diverting waste into biopower	Increase of 2,284,016 ZAR/yr
Change in GDP gained from diverting waste into biopower	Increase of 3,907,917 ZAR/yr
Number of direct one-time construction jobs created in a single year	Increase of 31 jobs
Number of indirect one-time construction jobs created in a single year	Increase of 22 jobs
Number of direct long-term O&M jobs created from diverting waste to biopower	Increase of 1 job
Number of indirect long-term O&M jobs created from diverting waste to biopower	Increase of 1 job
Change in tonnes of waste sent to the landfill	Reduction of 9,697 t/yr
Change in lifespan of new regional landfill site	Increase of 3 years

1

10. Estimating Impacts Ex-Post

Ex-post assessment is the process of estimating historical impacts of policies and actions. It is a backward-looking assessment of impacts achieved to date. In this chapter, users estimate the impact of the policy or action by comparing observed policy scenario values of an indicator (based on monitored data) to ex-post baseline values (described in Chapter 8). Unlike ex-ante assessment which involves forecasted values, ex-post assessment involves monitored or observed values. The impact of the policy or action (ex-post) is estimated by subtracting baseline values from policy scenario values. Users that are not quantitatively assessing impacts ex-post can skip this chapter. Sections 10.1-10.4 apply to users following the scenario method, while Section 10.5 applies to users following the comparison group method.

Figure 10.1: Overview of steps in the chapter



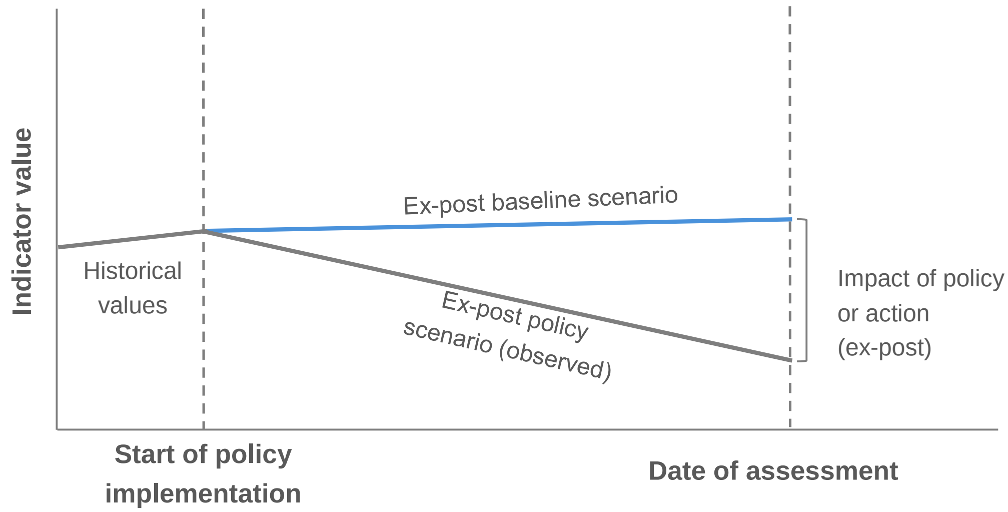
Checklist of key recommendations

- Recalculate baseline values (as described in Chapter 8) every time an ex-post assessment is undertaken
- Estimate the net impact of the policy or action 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 or action 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

10.1 Update baseline values or ex-ante assessment (if relevant)

Figure 10.2 provides an illustration of estimating impacts ex-post. In contrast to ex-ante policy scenario values, which are forecasted based on assumptions, ex-post policy scenario values are observed based on data collected during the time the policy or action was implemented. Users carrying out an ex-post assessment may either estimate ex-post policy scenario values before or after estimating ex-post baseline values.

Figure 10.2: Illustration of estimating impacts ex-post



Source: Adapted from WRI 2014.

It is a *key recommendation* to recalculate baseline values (following the guidance in Chapter 8) every time an ex-post assessment is undertaken. The ex-post baseline scenario should include all other policies or actions with significant impacts that were implemented both (1) prior to the implementation of the policy or action being assessed and (2) after the implementation of the policy or action being assessed but prior to the ex-post assessment.

The baseline scenario should also be recalculated to include updates to all non-policy drivers based on their observed values over the assessment period. Non-policy drivers should be considered in the baseline scenario if they are exogenous to the assessment—that is, if they are not affected by the policy or action being assessed.

If an ex-ante assessment for the policy or action was previously carried out, the same method can be used by replacing the forecasted indicator values (ex-ante) with observed indicator values (ex-post) in the ex-post estimation. Alternatively, users can apply a different method than was used in the ex-ante assessment to estimate policy scenario values. Users should choose the method that yields the most accurate results. If both an ex-ante and ex-post assessment are carried out for the same policy or action at different points in time, each assessment will likely yield different estimates of the impacts of the policy, since the observed (ex-post) indicator values will likely differ from assumptions forecasted in the ex-ante scenario.

10.2 Choose assessment method for each indicator

This section provides a list of ex-post assessment methods that users can use to estimate the impacts of a policy or action (see Table 10.1). The list is not exhaustive, and users can classify methods differently depending on the individual context. Users can also use a combination of approaches listed in Table 10.1. The ICAT website[16] provides specific examples of tools and models to support impact quantification.

[16] http://www.climateactiontransparency.org/methodological-framework/sustainable-development/

Users should select either methods based on a combination of factors, such as data availability, the type of policy and sector, the number of actors influenced by the policy, the number of interacting policies and actions, and capacity, resources, and level of expertise available to carry out the methods.

Users should ensure consistency in the methods used to estimate baseline values and policy scenario values for each indicator to ensure that the estimated impact reflects underlying differences between the two scenarios, rather than differences in method. If it is not feasible or appropriate to use the same method in a given situation, users should justify why different methods have been used.

When selecting methods to estimate impacts ex-post, users should determine the desired level of accuracy to be achieved. Users should achieve a sufficient level of accuracy to meet the stated objectives of the assessment, while considering the availability and quality of relevant data, the accessibility of methods, and capacity and resources available for the assessment. In general, users should follow the most accurate approach that is feasible.

Table 10.1: 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 through data collected from affected participants, facilities or other affected actors. Data collection methods may include monitoring of parameters (such as metering of energy consumption), collecting expenditure or billing data (such as 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 or actions. This involves collecting data on the number of actions taken (such as the number of buildings that install rooftop solar PV) and applying default values for the estimated impact or other relevant parameter per action taken (such as the 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 or actions that are homogenous across policy contexts, such that deemed estimates from other contexts are representative of the policy or action being assessed. Deemed estimates can be complemented by sampling the affected participants or sources to determine whether the deemed 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/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 (such as transportation or buildings) or subsector (such as space heating in buildings). Policy scenario indicator values should be compared to 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 when 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, such as prices, price elasticities of fuels, economic activity, and population. By doing so, models can control for various factors that affect the impact category other than the policy or action being assessed.

Source: Adapted from WRI 2014

10.3 Estimate policy scenario values for each indicator

Ex-post policy scenario values are observed based on data collected during the time the policy or action is implemented. Users should first assess whether the specific impacts identified in Chapter 6 actually occurred. This may include assessing the degree of policy implementation to ensure that the policy or action was implemented as planned, including assessing the extent of enforcement and noncompliance, if relevant and feasible.

Users should then update the impacts identified based on observed data before estimating each impact. To estimate certain impacts, users may find it useful to conduct surveys with consumers or businesses affected by the policy or action, or use results from similar policy assessments, if the conditions are similar enough for valid comparisons.

Users should report the policy scenario values for each indicator being estimated and the methods, assumptions, and data sources used to calculate policy scenario values.

10.4 Estimate the net impact of the policy or action for each indicator

The last step is to estimate the net impact of the policy or action. It is a *key recommendation* to 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 (see Equation 10.1). This involves estimating each specific impact within an impact category, then aggregating across all of the specific impacts to determine the net impact of the policy or action on each impact category, where feasible.

To do so, users should follow these steps for each indicator being estimated:

1. Estimate baseline values related to each specific impact in the quantitative assessment boundary (as described in Chapter 8)
2. Determine policy scenario values related to each specific impact in the quantitative assessment boundary
3. Subtract baseline values from policy scenario values to estimate the impact of the policy or action for each specific impact
4. Aggregate across all specific impacts to estimate the total net impact of the policy or action on a given indicator, which represents the change in the impact category, where feasible
5. Repeat the process for each indicator in the assessment boundary

When aggregating across impacts, users should address any possible overlaps or interactions between impacts to avoid over-or underestimation of the total net impact of the policy or action.

Users should calculate baseline values, policy scenario values and the net impact of the policy or action over defined time periods, such as annually and cumulatively over the quantitative assessment period.

Equation 10.1: Estimating the impact of the policy or action on a given indicator

For a specific impact: Estimated change due to the policy or action = Policy scenario value for the chosen indicator – Baseline value for the chosen indicator

Net impact of a policy or action on the chosen indicator = ∑ Estimated change for each specific impact included in the assessment boundary

Note: "Net" refers to the aggregation of all specific impacts included in the assessment boundary, including both positive and negative impacts.

It is a *key recommendation* to separately assess the impacts of the policy or action on different groups in society where relevant, such as men and women, people of different income groups, people of different racial or ethnic groups, people of different education levels, people from various geographic regions, people in urban versus rural locations, among others. This allows users to understand distributional impacts on different groups and manage tradeoffs in cases where policies or actions have positive impacts on some groups and negative impacts on other groups.

Equation 10.1 results in a neutral estimate of impact, which may either be an increase (positive value) or a decrease (negative value). Policy scenario values may either be higher or lower than baseline scenario values, depending on the impact being estimated and the nature of the policy or action. Users may interpret and communicate the result as either positive or negative or an increase or decrease depending on the impact category and the context.

If any impacts in the assessment boundary have not been estimated, users should document and justify the exclusion and describe the impact qualitatively (as described in Chapter 7).

See Appendix A for an example of estimating the impact of a solar PV incentive policy.

Users should estimate the total in-jurisdiction impact (the total net change that occurs within the implementing jurisdiction's geopolitical boundary), separately from total out-of-jurisdiction impacts (the net change that occurs outside of the jurisdiction's geopolitical boundary) for each indicator, if relevant and feasible.

Users should separately estimate and report the change resulting from each individual impact included in the assessment boundary, where relevant and feasible. Users can also separately report by type of impact.

Users should report the net impact of the policy or action on a given indicator as a range of likely values, rather than as a single estimate, when uncertainty is high (e.g., because of uncertain baseline assumptions). See Chapter 11 for guidance on uncertainty and sensitivity analysis.

Combining ex-ante and ex-post assessments

Ex-ante and ex-post assessment may be combined in a "rolling monitoring" approach. Under this approach, the forecast provided by the ex-ante assessment is continually overwritten with the results from ex-post assessment, which allows for a comparison of the original expectations and the final results. By combining ex-ante and ex-post data, rolling monitoring can demonstrate the impacts that have been initiated up to a certain date (through ex-ante assessment); the impacts that have been achieved up to a certain date (through ex-post assessment); and the impact that have been achieved (ex-post) compared to the ex-ante estimates.

10.5 Using the comparison group method to estimate impacts (if relevant)

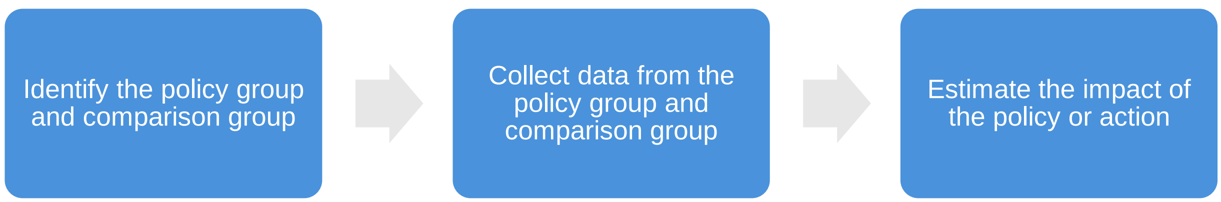
This section provides guidance on using the comparison group method to estimate the impact of a policy or action on various indicators.

As outlined in Chapter 8, users can use the comparison group method to define the baseline scenario when carrying out an ex-post assessment. The comparison group method cannot be used for ex-ante assessments, since comparative data for the comparison group and policy group during policy implementation cannot be observed prior to policy implementation.

The comparison group method involves comparing one group or region affected by a policy or action with an equivalent group or region that is not affected by that policy or action. For users following the comparison group method, is it a *key recommendation* to (1) identify an equivalent comparison group for each impact category in the assessment boundary, and (2) collect data from the comparison group and the policy group over the assessment period for each indicator included in the assessment boundary. Any impacts in the assessment boundary that have not been estimated should be documented and justified and described qualitatively.

Figure 10.3 provides an overview of key steps.

Figure 10.3: Overview of steps for using the comparison group method



Identify the policy group and comparison group

The first step is to identify the policy group (the group or region affected by the policy) and the comparison group or control group (an equivalent group or region not affected by the policy). The policy groups and comparison groups may be groups of people, facilities, companies, jurisdictions, sectors or other relevant groups.

The policy group and the comparison group should be equivalent in all respects except for the existence of the policy for the policy group and absence of the policy for the comparison group. The most robust way to ensure two groups are equivalent is to implement a randomized experiment—for example, by randomly assigning one subset of entities to participate in a programme and randomly assigning the other subset to not participate in the programme.

To be equivalent means the comparison group should be the same or similar to the policy group in terms of:[17]

- **Geography**: for example, facilities in the same city, subnational region or country
- **Time**: for example, facilities built within the same time period
- **Technology**: for example, facilities using the same technology
- **Other policies or actions**: for example, facilities subject to the same set of policies and regulations, except for the policy or action being assessed

[17] Adapted from WRI 2014

- **Non-policy drivers**: for example, facilities subject to the same external trends, such as the same changes in economic activity, population and energy prices

When identifying a potential comparison group, users should collect data from both the policy group and the comparison group before the policy or action is implemented to determine whether the groups are equivalent. Users should ensure that the entities in the comparison group are not directly or indirectly affected by the policy.

If the groups are similar but not equivalent, statistical methods can be used to control for certain factors that differ between the groups (for examples, see Box 10.1). If the groups are not sufficiently equivalent, the comparison group method will yield misleading results, so users should follow the scenario method instead (described in Chapter 8).

Collect data from the policy group and comparison group

Users should collect data from both the policy group and the comparison group for all each indicator included in the assessment method(s).

Users should collect data from both groups at multiple points in time to account for changes that occur over time. At a minimum, users should collect data from both groups before and after the policy or action is implemented (in the policy group), so that the two groups can be compared during both the pre-policy period and the policy implementation period.

Either top-down or bottom-up data may be used. To collect bottom-up data, representative sampling may be used to collect data from a large number of individual entities or facilities. If so, appropriate statistical sampling procedures should be used, and the sample size should be large enough to draw valid statistical conclusions.

Estimate the impact of the policy or action

After data are collected, users should determine baseline values (from the comparison group) and policy scenario values (from the policy group). In rare cases where the policy group and comparison group are equivalent, the outcomes of each group can be compared directly. A statistical test (such as a t-test) should be employed to ensure that the difference in values cannot be attributed to chance. If the difference between the two groups is statistically significant, the difference can be attributed to the existence of the policy, rather than to other factors.

In most cases, differences are expected to exist between the groups. If material differences exist that may affect the outcome, users should use statistical methods to control for variables other than the policy that differ between the non-equivalent groups. Such methods are intended to help address the “selection bias” and isolate the impact of the policy being assessed. See for examples of methods that may be used.

Box 10.1: Examples of statistical methods for estimating impacts and controlling for factors that differ between groups

Multiple regression analysis involves including data for each relevant driver that may differ between the groups (such as economic activity, population and energy prices) as explanatory variables in a regression model, as well as proxies for other relevant policies that may differ between the two groups (other than the policy being assessed). If the expanded regression model shows a statistically significant effect of the policy being assessed, the policy can be assumed to have an effect on the policy group, relative to the comparison group. Statistical significance refers to the certainty that the differences between two outcomes is unlikely to be a result of random chance.

Difference-in-difference methods compare two groups over two periods of time: a first period in which neither the policy group nor the comparison group implements a given policy and a second period in which the policy group implements the policy and the comparison group does not. This method estimates the difference between the groups prior to policy implementation (A1 - B1 = X); the difference between the two groups after policy implementation (A2 - B2 = Y); and the difference between the two differences (Y - X) as a measure of the change attributable to the policy.

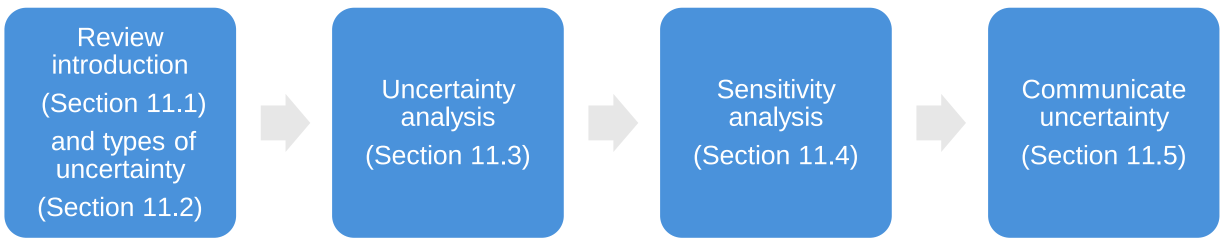
Matching methods are statistical approaches for making two groups (a policy group and a comparison group) more equivalent, when random assignment is not possible.

Source: Adapted from WRI 2014

11. Assessing Uncertainty

This chapter provides an overview of concepts and procedures for understanding and evaluating the uncertainty of the assessment. Uncertainty can be assessed either qualitatively or quantitatively. This chapter is relevant to both qualitative and quantitative assessment of impacts.

Figure 11.1: Overview of steps in the chapter



Checklist of key recommendations

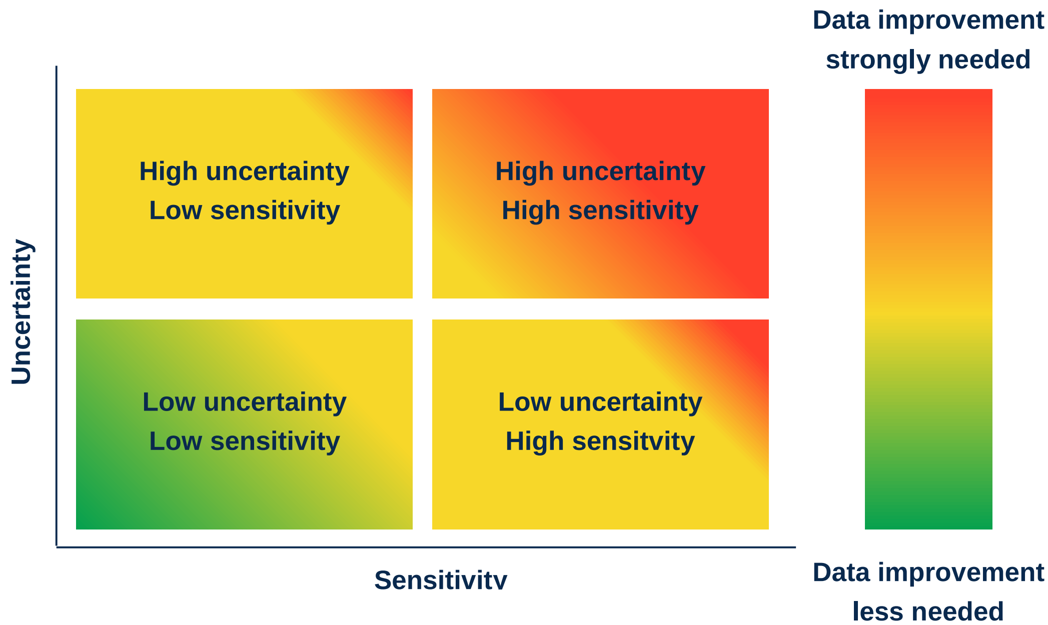
- Assess the uncertainty of the assessment results, either qualitatively or quantitatively
- For quantitative assessments: Conduct a sensitivity analysis for key parameters and assumptions in the assessment

11.1 Introduction to uncertainty analysis and sensitivity analysis

Understanding uncertainty is important for properly interpreting and communicating the results of the assessment. Uncertainty analysis refers to a systematic procedure to quantify and/or qualify the uncertainty associated with the impact assessment results. Identifying, documenting and assessing uncertainty can help users understand the level of confidence in the results and identify the areas of the assessment that contribute most to uncertainty. Users should identify and track key uncertainty sources throughout the assessment process. Identifying, assessing and managing uncertainty is most effective when done during, rather than after, the assessment process.

Sensitivity analysis is a useful method to test the robustness of the assessment results. It involves varying the value of key parameters (or combinations of parameters) to determine the impact of such variations on the overall results. Key parameters are those that are highly variable, highly uncertain or most likely to significantly impact assessment results. Sensitivity analysis can be conducted in combination with uncertainty analysis to prioritize efforts for improving data. If one parameter is determined to be highly uncertainty and sensitive, better data are thus highly desired for further improvement for that parameter. If one parameter is certain and insensitive, there is less need for data improvement. Figure 11.2 illustrates how to prioritize data improvement based on uncertainty and sensitivity.

Figure 11.2: Identifying where data improvement is needed in relation to uncertainty and sensitivity



Understanding uncertainty can help users understand whether to apply conservative assumptions. As explained in Chapter 3, accuracy should be pursued as far as possible, but once uncertainty cannot be reduced to an acceptable level, conservative estimates should be used.

11.2 Types of uncertainty

This chapter classifies uncertainty into three categories according to the source of uncertainty: parameter uncertainty, scenario uncertainty and model uncertainty. The categories are not mutually exclusive, but they can be evaluated and reported in different ways. Table 11.1 summarizes each type of uncertainty.

Table 11.1: Types of uncertainty

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

Source: Adapted from WRI 2014

Parameter uncertainty

Parameter uncertainty represents the imperfect knowledge of true parameters values in an assessment method or model. It may arise from insufficient data, measurement errors, inaccurate approximation, or geographical and temporal variability. For example, wind speed may be used as an input parameter to model the dispersion and concentration of $PM_{2.5}$. The test equipment will deliver wind speeds with a certain range of uncertainty. Meanwhile, wind speed may vary every second, but only limited numbers of values (e.g., one value per hour) will be used to model the dispersion of $PM_{2.5}$. If parameter uncertainty can be determined, it can typically be represented as a probability distribution of possible values that include the chosen value used in the assessment. Individual parameter uncertainties can be propagated to provide a quantitative measure of the uncertainty of the assessment results, which may be represented in the form of a probability distribution.

Scenario uncertainty

Ex-ante assessments involve baseline scenarios and policy scenarios that describe how conditions are expected to develop in the future, while ex-post assessments involve baseline scenarios that describe how conditions would have developed in the past if a policy or action were not implemented. These scenarios are based on a set of uncertain assumptions which creates scenario uncertainty. To identify the influence of these assumptions on the results, users should undertake a sensitivity analysis for key parameters in those assumptions (described in Section 11.4).

Model uncertainty

Simplifying the real world into a numeric model introduces inaccuracies and different models are likely to yield different results. For example, various life cycle impact assessment models can be used to assess the environmental impacts associated with producing solar PV panels. Each model is likely to yield different results, leading to model uncertainty. The extent of uncertainty can be estimated by comparing the results of different models. Users should acknowledge model uncertainties and report model limitations qualitatively.

11.3 Uncertainty analysis

Two primary approaches to assess uncertainty are:

- Qualitative uncertainty analysis
- Quantitative uncertainty analysis

It is a *key recommendation* to assess the uncertainty of the results of the assessment, either quantitatively or qualitatively. Only qualitative uncertainty analysis is relevant to assessing the uncertainty of a qualitative impact assessment. Either approach can be used to assess the uncertainty of a quantitative impact assessment. Quantitative uncertainty analysis can provide more robust results than qualitative assessment. Reporting quantitative uncertainty estimates also gives greater clarity and transparency to stakeholders.

Users should select an approach based on the objectives of the assessment, the level of accuracy needed to meet stated objectives, data availability, and capacity and resources. Depending on the methods used and data availability, users may not be able to assess the uncertainty of all parameters in the assessment method(s). Users should assess the uncertainty for all parameters for which it is feasible. For cases where quantitative uncertainty is not possible or appropriate to calculate, uncertainty should be assessed and described qualitatively.

11.3.1 Qualitative uncertainty analysis[18]

Qualitative uncertainty analysis can be done in a variety of ways. This section outlines a structured approach, which involves characterizing the level of confidence of the results based on:

- The quantity and quality of evidence (robust, medium, or limited), and
- The degree of agreement of the evidence (high, medium, or low)

The level of confidence is a metric that can be expressed qualitatively to express certainty in the validity of a parameter value or result. (The qualitative confidence level described in this section is distinct from statistical confidence and should not be interpreted in statistical terms.)

When characterizing parameter uncertainty, evidence refers to the sources available for determining a parameter value. Evidence should be assessed with regard to both the quantity and quality of evidence and can be defined in overall terms of being robust, medium, or limited. Evidence should be considered robust when there is a large quantity of high-quality evidence. Evidence should be considered medium when there is a medium quantity of medium-quality evidence. Evidence should be considered limited when there is a small quantity of low-quality evidence. High-quality evidence adheres to principles of research quality. Low-quality evidence shows deficiencies in adhering to principles of research quality. Medium-quality evidence is a mix of high-quality and low-quality evidence.[19]

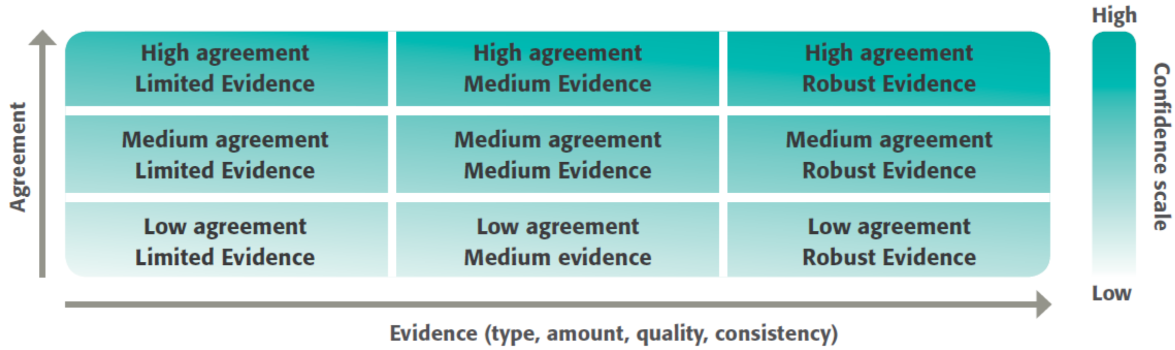
The degree of agreement is a measure of the consensus or consistency across available sources for a parameter value or result. The degree of agreement can be defined in terms of high, medium or low. As a rule of thumb, high agreement means that all sources had the same conclusion; medium agreement means that some sources had the same conclusion; and low agreement means that most of the sources had different conclusions. This step is not applicable if there is only one source available.

A level of confidence provides a qualitative synthesis of the user's judgment about the result, integrating both the evaluation of evidence and the degree of agreement in one metric. Figure 11.3 depicts summary statements for evidence and agreement and their relationship with confidence, where confidence increases as evidence and agreement increase. The level of confidence can be considered very high, high, medium, low and very low. In the best case (very high confidence), the evidence found should be sourced from multiple credible, independent institutions. Presentation of findings with "low" and "very low" confidence should be reserved for areas of major concern, and the reasons for their presentation should be explained. The confidence level of individual parameters, models, and scenarios should be aggregated to provide a level of confidence for the overall assessment, if feasible.

[18] This section is adapted from IPCC 2010.

[19] Adapted from DFID 2014.

Figure 11.3: Summary statements for evidence and agreement and their relationship with confidence



Source: WRI 2014, adapted from IPCC 2010.

11.3.2 Quantitative uncertainty analysis

If feasible, users should carry out a quantitative uncertainty analysis to characterize the uncertainty of key parameters. This involves estimating the uncertainty of individual parameters (single parameter uncertainty), then aggregating for a given indicator as a whole (propagated parameter uncertainty). Propagated parameter uncertainty is the combined effect of each parameter's uncertainty on the total result.

Users should estimate uncertainty at a specified confidence level, preferably 95%. Users should use the best available estimates using a variety of methods and approaches, such as a combination of measured data, published information, model outputs, and expert judgment.

Approaches of quantifying the uncertainty of individual parameters include the following:

- Default uncertainty estimates for parameters reported in literature
- Probability distributions and standard deviations
    - This method is 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 related with 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 (based on qualitative data quality indicators in Table 8.7)

This method provides a way to quantify the 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. For more information, see Weidema and Wesnaes (1996).

- Survey of experts to generate upper- and lower-bound estimates
- The user's expert judgment (based on as much data as available) or other approaches

Once the uncertainties of individual parameters have been estimated, they may be aggregated to provide uncertainty estimates for the entire assessment for an indicator. Approaches to combining uncertainties include but are not limited to the following:

- Error propagation equations: An analytical method used to combine the uncertainty associated with individual parameters from a single scenario. Equations involve estimates of the mean and standard deviation of each input.
- Monte Carlo simulation: A form of random sampling used for uncertainty analysis that shows the range of likely results based on the range of values for each parameter and probabilities associated with each value. In order to perform Monte Carlo simulation, input parameters must be specified with probability distributions. The input parameters are varied at random but restricted by the given probability distribution for each parameter. Repeated calculations produce a probability distribution of the predicted output values, reflecting the propagated uncertainty of the various parameters. This method gives comprehensive results, but is more resource and time intensive. Simple Monte Carlo simulations can be done using the Crystal Ball tool in Microsoft Excel.

Further references on quantitative uncertainty analysis

For more detailed guidance on the methods outlined in this section, see the references below.

- Ecoinvent. 2013. Chap. 10, *Uncertainty*. In Overview and Methodology: Data Quality Guideline for the Ecoinvent Database, Version 3. Available at http://www.ecoinvent.org/support/documents-and-files
- IPCC. 2000. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. Available at http://www.ipcc-nggip.iges.or.jp/public/gp/english.
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11.4 Sensitivity analysis

A sensitivity analysis involves varying the value of key parameters (or combinations of parameters) to determine the impact of such variations on the overall results. Sensitivity analysis is a useful tool to understand differences resulting from methodological choices and assumptions and to explore model sensitivities to input parameters.

For quantitative impact assessments, it is a *key recommendation* to conduct a sensitivity analysis for key parameters and assumptions in the assessment. Sensitivity analysis is expected to be most relevant for quantitative impact assessments, but may also be useful for certain qualitative impact assessments.

To conduct a sensitivity analysis, users should adjust the value of key parameters to determine the impact of such variations on the overall results. Since an assessment may include many impact categories and involve many parameters, users should only conduct sensitivity analysis on key parameters.

Users should consider reasonable variations in parameter values. Not all parameters need to be subjected to both negative and positive variations of the same magnitude, but they should be varied based on what is considered reasonable. Past trends may be a guide to determine the reasonable range. As a general rule, variations in the sensitivity analysis should at least cover a range of +10% and -10% (unless this range is not deemed reasonable under the specific circumstances).

Sensitivity analysis can be assessed in several ways. One simple method is to assess the relative sensitivity for one parameter at a time according to Equation 11.1.

Equation 11.1: Assessing the sensitivity of a parameter

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

In the equation, S represents the relative sensitivity of the assessment output to the specific input parameter. Input and output represent the original values. Δinput is the marginal change of the input parameter, which should represent a reasonable expected change. Δoutput is the corresponding marginal changes of the output. Using this equation, users can compare the sensitivity of the output in response to different input parameters.

See Box 11.1 for an example of applying Equation 11.1 to assess the sensitivity of various parameters to determine which is most sensitive.

Box 11.1: Example of sensitivity analysis

Table 11.2 illustrates a sensitivity analysis of three key parameters for a solar PV incentive policy. It is assumed that there are 186,306,371 grid-connected households in India, with an annual consumption of 900 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 90% (810 kWh) is supplied by the grid and 10% (90 kWh) is supplied by a diesel-fueled power generator when blackouts occur.

The three chosen parameters for sensitivity analysis are annual electricity consumption per household, the percentage of households that will adopt solar PV, and the percentage of electricity supplied by grid for the households that use combined electricity supply, assuming that the remaining electricity demand is met by diesel fueled power generator. Table 11.2 illustrates a scenario where each parameter value is set to a reasonable assumption. The table also shows the calculation of the output, in this case changes of emissions for each scenario. This example specifically focuses on PM_{10}. Combined, this information provides the information to calculate the relative sensitivity. The input, output, and sensitivity analysis results are presented below.

Table 11.2: Sensitivity analysis of estimated PM_{10} emissions

Parameter	**Annual electricity consumption**	**Percentage of households that adopt solar PV**	**Percentage of electricity supplied by grid**
Input data			
Original value	900	10%	90%
Scenario value	1800	80%	50%
Δinput/input	100%	700%	-44%
Output: emission reduction (t PM_{10})			
Original value	300,817	300,817	300,817
Scenario value	601,635	71,886	171,695
Δoutput/output	100%	-76%	-43%
Sensitivity analysis result			
Relative sensitivity	100%	-11%	97%

This sensitivity results show that of the three parameters, PM_{10} emissions are more sensitive to annual electricity consumption and percentage of electricity supplied by grid and less sensitive to percentage of households that adopt solar PV. This information can be used to prioritize future data collection efforts.

11.5 Communicating uncertainty and sensitivity

Reporting information about uncertainty helps users and stakeholders assess the accuracy and uncertainty of the reported results, to inform how the information should be used. It is important to properly communicate the results, since the estimate of policy impact may not be very accurate, depending on what methods, assumptions, and data sources were used to assess the impacts.

Users should report a quantitative estimate or qualitative description of the uncertainty of the results in order to help users of the information properly interpret the results. Users should also report the range of results from sensitivity analysis for key parameters and assumptions.

Users should report the range of possible outcomes based on different parameter values (representing upper- and lower-bounds of plausible values) to indicate the level of uncertainty. When uncertainty is high, users should consider reporting a range of values around the average or most likely value, rather than only a single value. Users should transparently report the full range of likely values, rather than reporting only upper-bound or lower-bound values.

Users should also use an appropriate number of significant figures depending on the uncertainty of the results, to avoid overstating the precision of the results.

Users should make a thorough yet practical effort to communicate key sources of uncertainty in the results including key parameters and assumptions that have high uncertainty. If feasible, users should present both qualitative and quantitative uncertainty information in the report. Users should also describe their efforts to reduce uncertainty in future revisions of the assessment, if applicable.

Uncertainty can be reported in many ways, including qualitative descriptions of uncertainty sources and quantitative representations, such as error bars, histograms and probability density functions. Users should provide as complete a disclosure of uncertainty information as possible.

Part V: Monitoring and Reporting

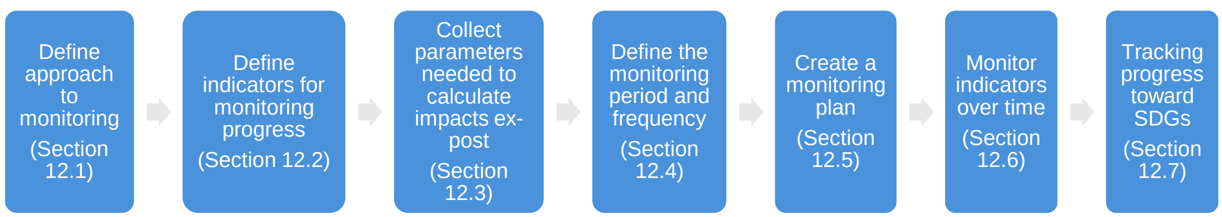
12. Monitoring Performance Over Time

Monitoring helps users assess whether a policy or action is on track and being implemented as planned. This chapter provides guidance on how to (1) monitor the performance of a policy or action over time by tracking the progress of key indicators, (2) collect data needed for ex-post assessment, and (3) prepare a monitoring plan.

This chapter is relevant to users that want to:

- Determine whether policies or actions are being implemented as planned and having the desired effects across the identified impact categories, in order to improve implementation and inform future policy design
- Assess progress towards achieving SDGs, in order to adjust current efforts and inform future goal setting
- Collect data needed for ex-post assessment of impacts

Figure 12.1: Overview of steps in the chapter



Checklist of key recommendations

- Define indicators that will be used to track performance of the policy or action over time for each impact category included in the assessment
- If estimating impacts ex-post: Collect data needed for ex-post assessment
- Create a plan for monitoring indicators
- Monitor each of the indicators over time, in accordance with the monitoring plan
- Separately monitor indicators for different groups in society where relevant

12.1 Define approach to monitoring

Monitoring during policy implementation serves two distinct objectives:

- Monitor performance of the policy or action: Track key indicators over time in relation to historical values, goal values and values at the start of policy implementation to understand whether the policy or action is on track and being implemented as planned
- Ex-post assessment of impacts: Collect data on the indicators and parameters (if applicable) needed for ex-post assessment of impacts

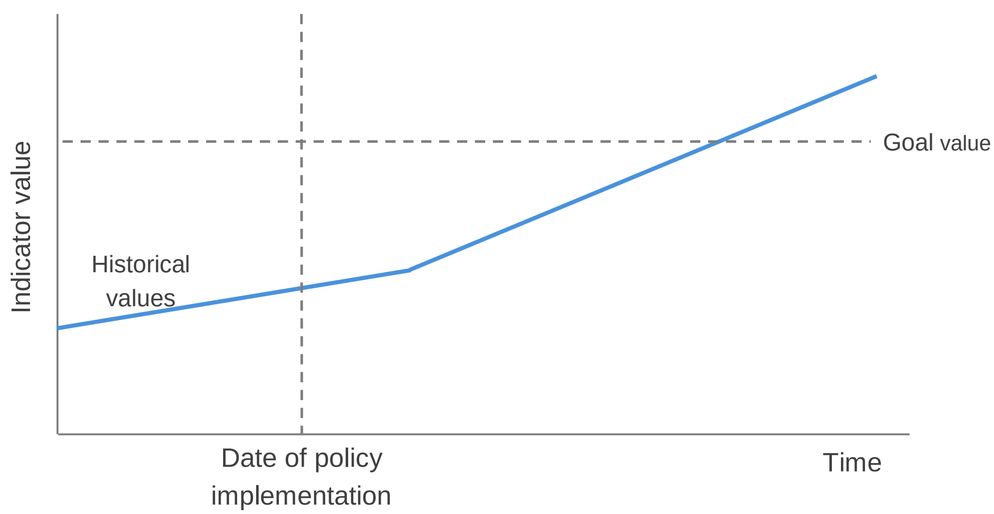
Users can collect data to fulfill one or both objectives. The first objective requires the tracking of *indicators* only, while the second objective may require collecting a broader set of *parameters*. *Indicators* are metrics that can be monitored over time to enable tracking of changes toward targeted outcomes. *Parameters* are additional data needed under certain circumstances to calculate the impact of a policy or action on indicators that cannot be directly monitored.

Monitoring key indicators is useful for understanding progress over time, understanding whether indicators of interest are moving in the right direction, and tracking progress toward meeting goals, such as sustainable development goals at the international, national or local levels. Monitoring key indicators over time is generally simpler and less onerous than estimating impacts and can provide a low-cost way of understanding policy effectiveness by tracking trends in key indicators. If progress of key indicators is not on track in relation to goal values, monitoring can inform corrective action.

Key indicators can be monitored over time relative to historical values, goal values and/or values at the start of policy implementation. Each is described below and illustrated in Figure 12.2.

- Relative to historical values: Monitor the trend in a given indicator over time to see whether it's moving in the right direction in relation to past values
- Relative to goal values: Monitor the trend in a given indicator in relation to goal level values (defined ex-ante) to see if goals for that indicator are being achieved[20]
- Relative to values at the start of policy implementation: Monitor the trend in a given indicator before and after a policy is implemented to infer whether the policy is having the desired effect

Figure 12.2: Monitoring indicators relative to historical values, goal values and the date of policy implementation



However, monitoring indicators is not sufficient to estimate the impact of a policy. Monitoring trends in indicators can show a correlation between desired outcomes and the implementation of the policy or

[20] Tracking of indicators over time may still be useful even if there are no defined goal values for the selected indicator.

action but does not demonstrate causation or attribute changes in indicators to policies or actions. Changes in indicators could be a result of factors that affect the indicators other than the policy or action being assessed. Attributing impacts to specific policies or actions requires a baseline scenario as discussed in Chapters 8-10. Depending on how indicators are defined, it may be possible to infer causation. For example, a user can monitor the number of new jobs created from discrete projects resulting from a policy to demonstrate the additional jobs created.

Users that are estimating the impacts of a policy or action ex-post should collect data on a broader range of parameters needed to calculate the ex-post policy scenario and ex-post baseline scenario. The types of parameters that need to be collected should be informed by the ex-post estimation method that will be used. To ensure an accurate assessment, data collection should begin before or at the beginning of the policy implementation period and continue throughout the policy implementation period.

12.2 Define indicators for monitoring progress of a policy or action

It is a *key recommendation* to define indicators that will be used to track performance of the policy or action over time for each impact category included in the assessment (as defined in Chapter 5). Examples of indicators are provided in Table 5.5.

When selecting indicators, users should consider the intended objectives of monitoring, the nature of the policy or action, the impact categories being assessed and any related goals, stakeholder priorities, and data availability. All relevant indicators should be clearly described. The selected indicators should be monitored in accordance with the monitoring plan over time and in relation to historical values and/or goal level values and to values at the start of policy implementation. The selected indicators from each impact category should be discussed in an inclusive stakeholder consultation process to get more perspectives and enhance the completeness of the assessment. Chapter 8 of the ICAT *Stakeholder Participation Guide* provides more information on how to conduct consultations.

Users tracking progress toward SDGs may reference the relevant SDG goal and if applicable the relevant SDG target(s) for each selected indicator (as described in Section 12.7).

Table 12.1 provides an overview of possible impact categories and referenced SDGs, indicators and a brief explanation of the selected indicator for a solar PV incentive policy.

Table 12.1: Example of selected indicators and referenced SDGs for a solar PV incentive policy and explanation of chosen indicator

Impact category	Indicator	Explanation of chosen indicator
Energy (SDG 7)	Solar capacity installed (MW) Electricity delivered from solar PV installations (MWh)	These indicators will track the quantity of renewable energy installed and generated from the solar PV incentive policy.
Health (SDG 13)	Emissions of $PM_{2.5}$, PM_{10}, SO_2 and NO_X Number of premature deaths due to air pollution	The policy will improve health of people by avoiding burning of kerosene/paraffin, which causes severe indoor air pollution by emitting noxious fumes and soot. Kerosene lighting is hazardous and is responsible for many burns and deaths. It will also improve healthcare conditions by providing lighting and refrigeration for health clinics.

	Number of health clinics electrified	
Quality of life (SDG 1, 2, 16)	Number of households having access to clean, reliable and affordable electricity	The policy will provide more reliable lighting conditions allowing children to study at home, which has a significant impact on improving child education in rural families and future employability. With a more reliable light source, adults can pursue productive activities in the house after nightfall.
Access to clean energy/energy security (SDG 7)	Share of people having access to reliable electricity services	In the absence of reliable grid electricity, people depend mostly on diesel generators and kerosene/paraffin lamps for lighting. The policy will make people less dependent on expensive fuels and reduce the need to purchase fuel. The policy will enable use of local energy sources, independent of geopolitical uncertainty.
Empowerment of women (SDG 5)	Share of female entrepreneurs	The policy will create opportunities for new income-generating activities for women and women associations.
Employment/job creation and income generation (SDG 8)	Number of people (men/women) in jobs Household income	The policy will encourage new job-creating and income-generating activities related to renewable energy supply and installation, mini-grid operation, awareness raising, marketing and accounting, thereby creating many new jobs. The generation of income will enhance economic growth and provide the means to afford electricity.
Economic productivity (SDG 8)	Number of households with improved economic productivity	The policy will foster productivity, increase production efficiency and production time, and enable added-value activities.
Food security (SDG 2)	Number of households with improved food security	The policy will reduce food waste by improving refrigeration. It will also promote better food processing, adding value to agricultural products.
Safety (SDG 3)	Number of people affected by hazardous conditions	Kerosene/paraffin lighting is hazardous and is responsible for loss of property through fire, as well as burns and death. The policy will foster the implementation of safety measures such as street lighting, security lighting, remote alarm systems, electric fences and road signs.

12.3 Collect parameters needed to calculate impacts ex-post (if relevant)

For ex-post quantitative impact assessments, it is necessary to identify and collect parameters needed to calculate impacts of the policy or action on each indicator being quantified. If estimating impacts ex-post, it is a *key recommendation* to collect data needed for ex-post assessment. Parameters should be collected, as needed, for each impact category included in the assessment boundary and selected indicator (as described in Chapter 5).

Parameters are additional data needed under certain circumstances to calculate the impact of a policy or action on indicators that cannot be directly monitored. For example, to estimate the impact category of cost savings from a solar PV incentive policy that replaces kerosene use in the baseline with solar electricity, the indicator could be household savings (money). Money saved is not monitored directly. Instead, the parameters needed to calculate the amount of money saved include the cost for kerosene as well as amount of kerosene savings. The cost of kerosene and the amount of kerosene savings are parameters needed to calculate the impact on the selected indicator (money saved) but not the indicator itself. Parameters can be collected from various sources, such as statistics collected at the jurisdiction level or surveys.

12.4 Define the monitoring period and frequency

Next, users should define the monitoring period and monitoring frequency.

12.4.1 Monitoring period

The monitoring period is the time period over which the policy or action is monitored. At a minimum, the monitoring period should include the policy implementation period, but where possible it should also include pre-policy monitoring of relevant activities prior to the implementation of the policy and post-policy monitoring of relevant activities after the policy implementation period. For example, a solar PV incentive policy that has a policy implementation period of 2010-2020 may have a monitoring period of 2008-2022. Depending on the impact categories and indicators being monitored, it may be necessary to monitor some indicators over different time periods than for others. In general, the longer the time series of data that is collected, the more robust the assessment will be.

12.4.2 Monitoring frequency

Users can monitor indicators at various frequencies, such as monthly, quarterly or annually. In general, users should collect data with as high a frequency as is feasible and appropriate in the context of objectives. The appropriate frequency of monitoring should be determined based on the needs of decision makers and stakeholders, the type of impact categories and indicators being monitored, cost, and data availability. In general, the more frequent that data is collected, the more robust the assessment will be. The monitoring frequency should in general be fixed ex-ante for the duration of the monitoring period.

12.5 Create a monitoring plan

A monitoring plan is important to consistently track progress of indicators over time in relation to goals. It is a *key recommendation* to create a plan for monitoring indicators.

A monitoring plan should include the following key elements:

- Brief description of each indicator
- Source of data for each indicator and parameter (if applicable)
- Monitoring period
- Monitoring frequency (fixed ex-ante during the monitoring period)
- Measurement or data collection methods (such as survey or census)
- Historical value (baseline value)
- Goal value
- Entity(ies) or institution(s) responsible for monitoring the respective indicator and collection of parameter(s), if applicable

Additional information may include:

- Methods for generating, storing, collating and reporting data
- Level of uncertainty of data and how this uncertainty will be accounted for
- Databases, tools or software systems to be used for collecting and managing
- Procedures for internal auditing, quality assurance (QA) and quality control (QC), including record keeping and internal documentation procedures and length of time data will be archived
- Whether data are verified, and if so, verification procedures used
- Roles and responsibilities of relevant personnel involved in monitoring
- Competencies required and any training needed to ensure personnel have necessary skills

Before monitoring begins, users should identify the entity or institution responsible for collecting data during the monitoring period. The responsible entity should establish a database based on the monitoring plan. See Box 12.1 for more information on institutional arrangements for monitoring.

Box 12.1: Institutional arrangements for coordinated monitoring

Information on key performance indicators and parameters can be dispersed among a number of different institutions. Given the wide variety of data needed for impact assessment and a range of different stakeholders involved, strong institutional arrangements serve an important function. They play a central role in coordinating monitoring. A technical coordinator, coordinating team, or body is often assigned to lead MRV processes in which responsibilities have been delegated to different institutions. Since data is can be widely dispersed between institutions, the coordinating body oversees the procedures for data collection, management and reporting.

Countries may already have institutions in place as part of the national MRV system. Where this is the case, users can consider expanding the national MRV system to also monitor the impact of the policy. Where strong institutional arrangements do not yet exist, countries can determine the governmental body with the adequate capacity and authority to be responsible for the MRV system and to establish the necessary legal arrangements. Institutional mandates help to strengthen the procedures and the system and may also help secure funding from the government to ensure the continuity of the process. Users can refer to the UNFCCC *Toolkit on Establishing Institutional Arrangements for National Communications and Biennial Update Reports*, as well as other sources, for support on establishing or improving the institutional arrangements for a robust MRV system.[21]

Table 12.2 provides an example of a template that can be used. The table includes goal values and historical values for each previously identified indicator for a solar PV incentive policy. Historical values were determined through interviews with the communities that will benefit from the policy. Goal values should be estimated through inclusive consultations with a wide variety of different stakeholder groups,

[21] Available at: http://unfccc.int/files/national_reports/non-annex_i_natcom/training_material/methodological_documents/application/pdf/unfccc_mda-toolkit_131108_ly.pdf.

such as beneficiaries, government representatives, technical experts, businesses, NGOs and local representations of international organizations.

Box 12.2 presents an example of a monitoring plan in South Africa.

Table 12.2: Example of a monitoring template for the selected indicators and parameters for a solar PV incentive policy

Indicator	Source of data	Monitoring frequency	Measurement method	Responsible entity or institution	Historical value in 2015	Goal value for 2022
Rooftop solar capacity installed	Government statistics	Monthly	Name plate installed capacity; ground verification on a random sample basis	Ministry of Energy		
Electricity delivered from solar PV installations	Government statistics	Monthly	Electric meters; Ground verification on a random sample basis	Ministry of Energy		
Number of health clinics electrified	Survey	Annual	Community-level assessment	Health Ministry		
Number of households having access to clean electricity	Survey	Annual	Community-level assessment	Ministry of Energy		
Number of people having access to electricity services	Survey	Annual	Community-level assessment	Ministry of Energy		
Number of female entrepreneurs	Survey	Annual	Community-level assessment	Minister of Social Affairs		
Number of people in jobs, disaggregated by gender	Government statistics	Monthly	Community-level assessment	Minister of Social Affairs		
Money saved through replacement of kerosene by solar energy (which requires further parameters to calculate: 1) cost of kerosene, and 2) amount of kerosene saved	Statistics and/or survey	Biennial	Sector level (cost of kerosene) community level assessment (amount of kerosene saved)	Ministry of Energy		

1 *Box 12.2: Defining indicators and a monitoring plan in South Africa*

The White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (Draft) is a strategy to address biodiversity protection and sustainable utilization in South Africa. The white paper identifies six goals that covers environmental, social and economic impacts and lists 175 policy interventions to achieve these goals. The policy interventions range from controls on conservation and sustainable use of biodiversity, improving knowledge, direct biodiversity conservation or rehabilitation activities, coordination and cooperation processes, relationship building and conflict resolution, capacity building, and monitoring. The Energy Research Centre at the University of Cape Town conducted an ex-ante qualitative assessment of the strategy, and as part of the assessment, provided examples of indicators that can be tracked as part of a monitoring plan (Table 12.3).

Table 12.3: Example of a monitoring template for a biodiversity policy in South Africa

Indicator	Source of data	Monitoring frequency	Measurement method	Responsible entity or institution	Goal value for year Y
Areas protected (ha, km, km^2)	Provincial conservation authorities and South Africa's Scientific Authority	National Biodiversity Assessments are updated every 7 years	Land survey	SANBI, with support of DEA and the Centre for Scientific and Industrial Research (CSIR)	By 2028, in protected areas: 10.8m land-based hectares, 353km inshore, 210 000km2 marine offshore in SA's EEZ plus 93 300 km^2 marine offshore in Prince Edward Islands EEZ.
Percentage of threatened species conserved ex situ	Provincial conservation authorities and South Africa's Scientific Authority	Every 4 years (Monitoring processes being developed by 2020.)	Counts of Threatened species (IUCN Red List)	SANBI and Botanical Society of South Africa (BotSoc)	60% of threatened plant species by 2020
Percentage of species with ex situ collections active in restoration programmes	SANBI	Every 4 years	Reported	DEA with support from SANBI's zoological and biological gardens	1% of plant species by 2020
Threat status of ecosystems	Provincial conservation authorities, DEA, DAFF, CSIR, research institutions	National Biodiversity Assessments are updated every 7 years	Four datasets (ecosystem types, ecological conditions, protected areas, biodiversity targets), local datasets where possible, otherwise global with some ground truthing	SANBI	Minimum 60% of each ecosystem type is in good ecological condition
Protection level of ecosystems	Provincial conservation authorities and South Africa's Scientific Authority	National Biodiversity Assessments are updated every 7 years	As above	SANBI	Minimum 20% of each ecosystem
Benefit-sharing: patents that exist for products made from local biodiversity or that use local or	International patent registry, agreements registered under South Africa's Bioprospecting,	Annual	Desktop review	DEA	By 2025, benefit-sharing agreements exist for patents that are commercialized. Benefit-sharing

indigenous knowledge, and that have benefit sharing agreements	Access and Benefit-Sharing Regulatory Framework				agreements have been reviewed.
Percentage of spatial development frameworks (SDFs), integrated development plans, and land-use schemes that include biodiversity considerations	All national, provincial and municipal departments responsible for development planning and monitoring; Department of Rural Development and Land Reform	Every 5 years	Reporting progress on the Mid Term Strategic Framework (MTSF)	Presidency	By 2020, 100% of SDFs include maps for critical biodiversity areas and controls development
Increase in average annualized GDP growth rate of the SA bioprospecting and wildlife sectors	StatsSA	Every year	NBES	DEA	By 2030, 10% increase compared with 2020

If surveys are used and/or sampling procedures are applied, users should develop a statistically sound sampling plan as part of the monitoring plan. Users should follow internationally recognized standards for sampling. Before including the sampling plan in the monitoring plan, users should familiarize themselves with different standards and required sampling sizes in order to achieve statistically sound results.

12.6 Monitor indicators over time

Once indicators and parameters have been defined, it is a *key recommendation* to monitor each of the indicators over time in accordance with the monitoring plan. Indicators should be monitored in relation to historical values, goal values, and to values at the start of policy implementation to understand the performance of the policy or action over time.

It is a *key recommendation* to separately monitor indicators for different groups in society where relevant, such as men and women, people of different income, racial or ethnic groups, people of different education levels, people from various geographic regions, people in urban versus rural locations, among others. This allows users to understand distributional impacts on different groups and manage tradeoffs in cases where policies or actions have positive impacts on some groups and negative impacts on other groups. Users should report distributional impacts on different groups to identify and manage potential tradeoffs.

If monitoring indicates that the assumptions used in the ex-ante assessment are no longer valid, users should document the differences and take the monitoring results into account when updating the ex-ante estimates or when estimating impacts ex-post. Users should also determine whether the assumptions on key indicators within the ex-ante assessment (from Chapters 8 and 9) remain valid.

12.7 Tracking progress toward SDGs

In addition to monitoring progress of individual policies and actions (described in previous sections), users may also want to track overall progress toward SDGs and/or related national or subnational sustainable development goals, independent of the individual policies or actions taken to achieve the SDGs. Tracking national progress, for example, involves defining national indicators for each goal and tracking progress of those indicators over time by comparing historical values (if data are available) to desired goal values in a future year.

Many countries are developing their own national implementation plans, and in the process selecting targets, indicators, and methodologies of their choice. In principle, tracking progress towards SDGs should be aligned with existing and emerging national frameworks, targets and indicators. Those used to track progress toward SDGs should also be aligned to the extent possible with those used for NDCs. Table 12.4 provides illustrative examples of selecting national indicators for tracking progress. Box 12.3 shows an example of developing a plan to monitor progress toward SDGs by cities in Bolivia.

For further guidance and examples of indicators that can be used, see:

- The UN Sustainable Development Goals website (https://sustainabledevelopment.un.org/sdgs)
- UN SDG indicators website (http://unstats.un.org/sdgs/), including the global SDG indicators database (http://unstats.un.org/sdgs/indicators/database/) and list of indicators (http://unstats.un.org/sdgs/indicators/indicators-list/)
- The UN Commission on Sustainable Development Indicators of Sustainable Development: Guidelines and Methodologies (https://sustainabledevelopment.un.org/content/documents/guidelines.pdf)

Across the 169 targets defined for the 17 SDGs, there are a mix of quantitative targets (e.g., Goal 3, Target 3.1: “By 2030 reduce the global maternal mortality ratio to less than 70 per 100,000 live births”) and qualitative targets (e.g., Goal 15, Target 15.9: “By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes”). Therefore, indicators should be defined either quantitatively or qualitatively depending on the goal.

While top-down national statistics and indicators are useful to monitor overall country progress towards SDGs, progress toward achieving the SDGs is made by implementing policies and actions on the ground. To ensure these policies are effective, a national measurement, reporting and verification (MRV) system should be established to collect data related to individual policies and actions and their impact and effectiveness should be assessed using the previous sections in this methodology.

Box 12.4 shows an example of identifying SDG targets and indicators that are relevant to a policy assessed in Kenya, which can help link the results of a policy assessment with monitoring progress toward SDGs.

Table 12.4: Examples of indicators that may be used by a country to track progress toward SDGs

Examples of goals	Examples of corresponding targets	Indicator	Source of data	Monitoring frequency	Measurement method	Responsible entity or institution	Historical value	Goal value
Examples of SDGs related to the solar PV incentive policy used in previous examples								
SDG 3: Ensure healthy lives and promote wellbeing for all at all ages	Target 3.8: Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	Number of health clinics electrified	Survey	Annual	Community-level assessment	Health Ministry	75	250
SDG 5. Achieve gender equality and empower all women and girls	Target 5.5: Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision making in political, economic and public life	Share of female entrepreneurs (%)	Survey	Annual	Community-level assessment	Minister of Social Affairs	10	30
SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all	Target 7.1: By 2030, ensure universal access to affordable, reliable and modern energy services	Share of people having access to electricity services (%)	Survey	Annual	Community-level assessment	Ministry of Energy	58	85
SDG 8: Promote sustained, inclusive and sustainable economic growth,	Target 8.5: By 2030, achieve full and productive employment and decent work for all women and men,	Share of people (men/women) in jobs	Survey	Monthly	Community-level assessment	Minister of Social Affairs	65	85

full and productive employment and decent work for all	including for young people and persons with disabilities, and equal pay for work of equal value.							
Examples of other SDGs in a country								
SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Target 2.3: By 2030, double the agricultural productivity and the incomes of small-scale food producers	Rice yield growth (Y - kg/ha)	National rice information system	Annual	Combined remote sensing/crop modelling approaches	Ministry of Agriculture	2125 kg/ha in 2010	2700 by 2020
SDG 3: Ensure healthy lives and promote wellbeing for all at all ages	Target 3.1: By 2030 reduce the global maternal mortality ratio to less than 70 per 100,000 live births	Reduction of the national maternal mortality rate	Survey; Civil registration systems	Annual	Large population-based surveys; Counting	Health Ministry	300 in 2010	50 by 2030
SDG 6: Ensure availability and sustainable management of water and sanitation for all	Target 6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all	Proportion of population that has access to a sustainable safe water supply and hygienic sanitation in the household	Survey	Annual	Large population-based surveys;	Health Ministry	75% in 2015	100% by 2030
SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all	Target 7.2: By 2030, increase substantially the share of renewable energy in the global energy mix	Share of renewable energy in the national energy mix	National energy information system	Annual	Calculation based on MW RE installed	Ministry of Energy	65% in 2016	85% by 2027
SDG 9: Build resilient infrastructure, promote inclusive	Target 9.1: Develop quality, reliable, sustainable and resilient infrastructure, including	The National Construction Code for buildings	National Construction Code	Once (in 2018)	Presence/absence of features on extreme wind	Ministry of Construction	In 2014, the National Construction Code for	By 2018, the National Construction Code for

and sustainable industrialization and foster innovation	regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	takes into account extreme wind events			events in the National Construction Code for buildings		buildings does not take into account extreme wind events	buildings includes features on extreme wind events
SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Target 15.2: By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	Reduction of the deforestation rate	National environment statistics	Annual	Remote sensing modelling approaches	Ministry of Agriculture/Ministry of Environment	Deforestation rate of 1.29% in 2015	Deforestation rate of 0 by 2030

Box 12.3: Monitoring progress toward SDGs by cities in Bolivia

Cities and local governments, in addition to other non-government stakeholders, are recognized as key implementers of the SDGs as the core of the 2030 Agenda for Sustainable Development. The Cities Footprint Project in Bolivia has the goal of promoting low-carbon and climate-resilient development in Latin American cities. In an assessment using the ICAT *Sustainable Development Methodology*, Servicios Ambientales S.A. developed a monitoring plan for the Bolivian cities of La Paz, Cochabamba, Santa Cruz, El Alto, and Tarija to help initiate monitoring and reporting processes towards the SDGs, which will inform the cities' development efforts to achieve the SDGs. Table 12.5 provides an example of the monitoring plan for one selected SDG goal, Goal 6, while the complete SDG monitoring plan includes many different SDG goals, targets, and indicators. In Table 12.5, goal values are still to be established by the Municipal Governments, and the monitoring frequency is monthly.

Table 12.5: Example of SDG monitoring plan for cities in Bolivia for an SDG goal

SDGs or other goals	Corresponding targets	Indicator	Level of data collection	Source of data	Responsible entity or institution	Measurement method
Goal 6. Ensure availability and sustainable management of water and sanitation for all	6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	6.4.1 Change in water-use efficiency over time	General Sources	National Statistical Office (INE), particularly for economic data. Administrative data collected at country level by the relevant institutions, either technical (for water and irrigation) or economic (for value added). Those data are then compiled by FAO, World Bank, UNSD and other international institutions, harmonized and published in sectoral databases such FAO's AQUASTAT, WB's Databank and UNSD's UNdata.	WHO UNICEF AAPS Vice-Ministry of Water and Irrigation	Water Use Efficiency (WUE) is defined as the volume of water used divided by the value added of a given major sector The unit of the indicator is expressed in Value/Volume, commonly USD/m^3 Services water supply efficiency is calculated as the service sector value added (ISIC 36-39 and ISIC 45-98) divided by water used for distribution by the water collection, treatment and supply industry (ISIC 36), expressed in USD/m^3
			City of La Paz	Report from Public Social Enterprise of Water and Sanitation of La Paz (EPSAS)	Municipal Government Water and Sanitation Directorate (EPSAS)	
			City of Cochabamba	Report from Cochabamba Municipal service of drinking water and sanitation (SEMAPA)	Municipal Government Water and Sanitation Directorate (SEMAPA)	
			City of Santa Cruz	Report from Drinking Water and Sanitary Sewer Service (SAGUAPAC)	Municipal Government Water and Sanitation Directorate (SAGUAPAC)	
			City of El Alto	Report from Public Social Enterprise of Water and Sanitation of El Alto (EPSAS)	Municipal Government Water and Sanitation Directorate (EPSAS)	

			City of Tarija	Report from Co-op for water services and sanitation Tarija (COSSALT)	Municipal Government Water and Sanitation Directorate (COSSALT)	

1

2 *Box 12.4: Identifying SDG targets and indicators relevant to a policy assessed in Kenya*

UNEP DTU Partnership conducted an ex-ante assessment of the sustainable development impacts of a policy to promote solar PV mini-grids in Kenya. Ten impact categories were assessed qualitatively, ranging from accessibility and quality of health care to gender equality and empowerment of women, while four impact categories were assessed quantitatively: climate change mitigation, air pollution, human toxicity, and resources depletion. To identify SDG indicators that are relevant to the solar PV mini-grid policy, the study first identified SDG targets that are directly connected with the impact categories and specific impacts analyzed in the assessment. The study explains the reason why the assessed impact categories are connected with specific SDG targets (Table 12.6).

Table 12.6: Examples of linkages between impact categories and SDGs targets for the solar PV mini-grid policy in Kenya

Impact category assessed	SDGs target	Rationale
Climate change mitigation	**9.4** By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities **13.2** Integrate climate change measures into national policies, strategies and planning	**9.4** The impact on climate change mitigation of the policy increases resource-use efficiency and consists in an adoption of clean and environmentally sound technology **13.2** The policy is a climate change measure
Accessibility and quality of health care	**3.8** Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	**3.8** The specific impacts of "Improved access to healthcare due better service in health centres and longer working hours" and "Improved access to healthcare due to the possibility of storing vaccines" are connected with accessing quality essential health-care services and vaccines for all
Gender equality and empowerment of women	**5.6** Ensure universal access to sexual and reproductive health and reproductive rights as agreed in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences **11.7** By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities	**5.6** Through the specific impact "Knowledge on health and family planning" the action will support access to sexual and reproductive health **11.7** By increasing "Mobility at dark hours" the action will provide access to safer public spaces, in particular for women and children

Based on the identified SDG targets, a list of relevant indicators for each target can be found in the UN Global SDG Indicators Database as well as Kenya's National SDG Indicator Framework (a nationally defined subset of indicators agreed to be tracked in the country). The UN SDG Indicators database also provides historical values for these indicators in Kenya. Using these indicators, progress can be tracked toward specific SDG targets.

3

13. REPORTING

Reporting the results, methods and assumptions used is important to ensure the impact assessment is transparent and gives decision-makers and stakeholders the information they need to properly interpret the results. This chapter presents a list of information that is recommended to be reported.

Checklist of key recommendations

- Report information about the assessment process and the sustainable development impacts resulting from the policy (including the information listed in Section 13.1)

13.1 Recommended information to report

It is a *key recommendation* to report information about the assessment process and the sustainable development impacts resulting from the policy or action (including the information listed below). For guidance on providing information to stakeholders, refer to the *ICAT Stakeholder Participation Guide* (Chapter 7).

General information

- The name of the policy/action assessed
- The person(s)/organization(s) that did the assessment
- The date of the assessment
- Whether the assessment is an update of a previous assessment, and if so, links to any previous assessments

Chapter 2: Objectives

- The objective(s) and intended audience(s) of the assessment

Chapter 3: Overview of key concepts and steps

- Whether the assessment consists of a qualitative impact assessment, quantitative impact assessment and/or tracking progress of indicators over time
- Opportunities for stakeholders to participate in the assessment

Chapter 4: Describing the policy or action

- A description of the policy or action including the recommended information in Table 4.1
- Whether the assessment applies to an individual policy/action or a package of related policies/ actions, and if a package is assessed, which policies and actions are included in the package
- Whether the assessment is ex-ante, ex-post, or a combination of ex-ante and ex-post

Chapter 5: Choosing which impact categories and indicators to assess

- A list of impact categories included and excluded from the assessment boundary, with justification for exclusions of impact categories that may be relevant, significant or identified by stakeholders

- Indicator(s) selected for each impact category included in the assessment boundary

Chapter 6: Identifying specific impacts within each impact category

- A list of all sustainable development impacts identified, using a causal chain and table format

Chapter 7: Qualitatively assessing impacts

- The assessment period
- A description of each specific impact
- The outcomes of the qualitative assessment for each impact (including likelihood, magnitude and whether it is positive or negative), including which identified impacts are significant and the methods and sources used
- A summary of the qualitative assessment results for each impact category

Chapter 8: Estimating the baseline

- For users following a quantitative approach:
    - A list of impacts and indicators included in the quantitative assessment boundary and a list of any impacts that are not quantified, with justification
    - A description of the baseline scenario for each indicator being estimated and a justification for why it is considered to be the most likely scenario
    - The methods, assumptions and data used to estimate the baseline scenario for each indicator being estimated, including the source of the baseline scenario if adapted from a previous analysis
    - The baseline values for each indicator being estimated over defined time periods, such as annually over the assessment period, if feasible
    - The methods, assumptions and data sources used to calculate baseline values
    - A list of policies, actions and projects included in the baseline scenario, with justification for any implemented or adopted policies, actions or projects with a potentially significant impact that are excluded from a baseline scenario
    - A list of non-policy drivers included in each baseline scenario, with justification for any relevant non-policy drivers excluded from a baseline scenario
    - Which planned policies are included in the baseline scenario, if any
    - Justification for the choice of whether to estimate new baseline values and assumptions or to use published baseline values and assumptions
    - If it is not possible to report a data source, justification for why a source is not reported

Chapter 9: Estimating impacts ex-ante

- For users estimating impacts ex-ante:
    - The estimated net impact of the policy or action, for each indicator, over defined time periods, such as annually and cumulatively over the assessment period, if feasible
    - The total in-jurisdiction impact, separately from total out-of-jurisdiction impact, for each indicator, if relevant and feasible
    - Justification for why any impacts in the assessment boundary have not been estimated, with a qualitative description of the impacts
    - The assessment methods used
    - A description of the policy scenario for each indicator being estimated
    - The policy scenario values for each indicator being estimated and the methods, assumptions and data sources used to calculate policy scenario values
    - Distributional impacts on different groups in society

Chapter 10: Estimating impacts ex-post

- For users estimating impacts ex-post:
    - The estimated net impact of the policy or action, for each indicator, over defined time periods, such as annually and cumulatively over the assessment period, if feasible
    - The total in-jurisdiction impact, separately from total out-of-jurisdiction impact, for each indicator, if relevant and feasible
    - Justification for why any impacts in the assessment boundary have not been estimated, with a qualitative description of the impacts
    - The assessment methods used
    - The policy scenario values for each indicator being estimated and the methods, assumptions and data sources used to calculate policy scenario values
    - Distributional impacts on different groups in society

Chapter 11: Assessing uncertainty

- The method or approach used to assess uncertainty.
- A quantitative estimate or qualitative description of the uncertainty and sensitivity of the results in order to help users of the information properly interpret the results.

Chapter 12: Monitoring performance over time

- A list of indicators used to track progress over time and the rationale for their selection
- Sources of indicator data and monitoring frequency
- The performance of the policy or action over time, as measured by the indicators, and whether the performance of the policy or action is on track relative to expectations

- Whether the assumptions on key indicators within the ex-ante assessment remain valid, if applicable
- Trends in indicators for different groups in society

13.2 Additional information to report (if relevant)

- The impact of the policy or action on different groups in society, such as men and women, people of different income groups, people of different racial or ethnic groups, people of different education levels, people from various geographic regions, people in urban versus rural locations, among others
- A range of likely values for the net change in each indicator, rather than a single estimate, when uncertainty is high
- Historical values for the indicators included in the assessment
- Sustainable development goals of the implementing jurisdiction
- The contribution of the assessed policy or action toward the jurisdiction's sustainable development goals
- How the policy is modifying longer-term trends
- Any potential overlaps with other policies and actions
- Any limitations in the assessment not described elsewhere
- The type of technical review undertaken (first-, second-, or third-party), the qualifications of the reviewers and the review conclusions (further guidance on reporting information related to technical review is provided in Chapter 9 of the ICAT *Technical Review Guide*)
- Other relevant information

Box 13.1 provides an example of how the assessment results can used to report progress made in achieving SDGs for a country.

1 *Box 13.1: Using the assessment results to report progress toward SDGs in Kenya*

UNEP DTU Partnership conducted an ex-ante assessment of the sustainable development impacts of a policy to promote solar PV mini-grids in Kenya. Ten impact categories were assessed qualitatively, ranging from accessibility and quality of health care to gender equality and empowerment of women, while four impact categories were assessed quantitatively: climate change mitigation, air pollution, human toxicity, and resources depletion.

One objective of the study was to link the policy's impacts to progress in achieving the SDGs. Similar to the case study shown in Box 12.4, the first step was to link specific impacts identified in the assessment with SDG targets. The study then used two different approaches, one for qualitatively assessed impacts and one for quantitatively assessed impacts.

For qualitatively assessed impacts, the study used the colour coding in Figure 13.1 classify each impact as having a very negative, negative, uncertain/insignificant, positive, or very positive impact on each SDG target.

Figure 13.1: Colour coding scheme for qualitative impacts

		Magnitude (Negative)			**Magnitude (Positive)**		
	Score	Major	Moderate	Minor	Minor	Moderate	Major
Likelihood	Very likely	Red	Orange	Yellow	Yellow	Light green	Green
	Likely	Red	Orange	Yellow	Yellow	Light green	Green
	Possible	Orange	Yellow	Yellow	Yellow	Yellow	Light green
	Unlikely	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
	Very unlikely	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

● Very negative impact ● Negative impact ● Uncertain/insignificant impact ● Positive impact ● Very positive impact

For quantitatively assessed impacts, the study calculated the relative improvement for each impact category by using either Equation 13.1 or Equation 13.2, depending on the impact category. For each impact category, an indicator was defined, such as $PM_{2.5}$ (tons/year) for air pollution and CO_2e (kg/year) for climate change mitigation. The study then used Figure 13.2 to classify each impact as having a very negative, negative, uncertain/insignificant, positive, or very positive impact on each SDG target based on the results of the equation.

Equation 13.1: For impact categories where the goal is to increase the indicator value (e.g., jobs)

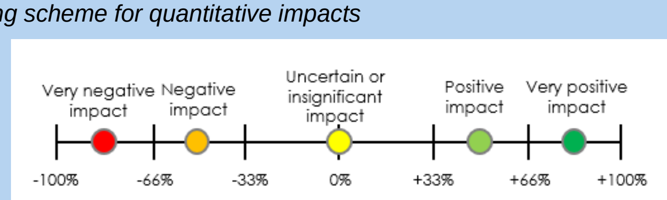
$$\text{Relative improvement (\%)} = \frac{\text{Policy scenario impact} - \text{Baseline scenario impact}}{\text{Baseline scenario impact}}$$

Equation 13.2: For impact categories where the goal is to decrease the indicator value (e.g., air pollution)

$$\text{Relative improvement (\%)} = \frac{\text{Baseline scenario impact} - \text{Policy scenario impact}}{\text{Baseline scenario impact}}$$

Note: The equations can be applied either annually or cumulatively over the assessment period.

Figure 13:2. Colour coding scheme for quantitative impacts

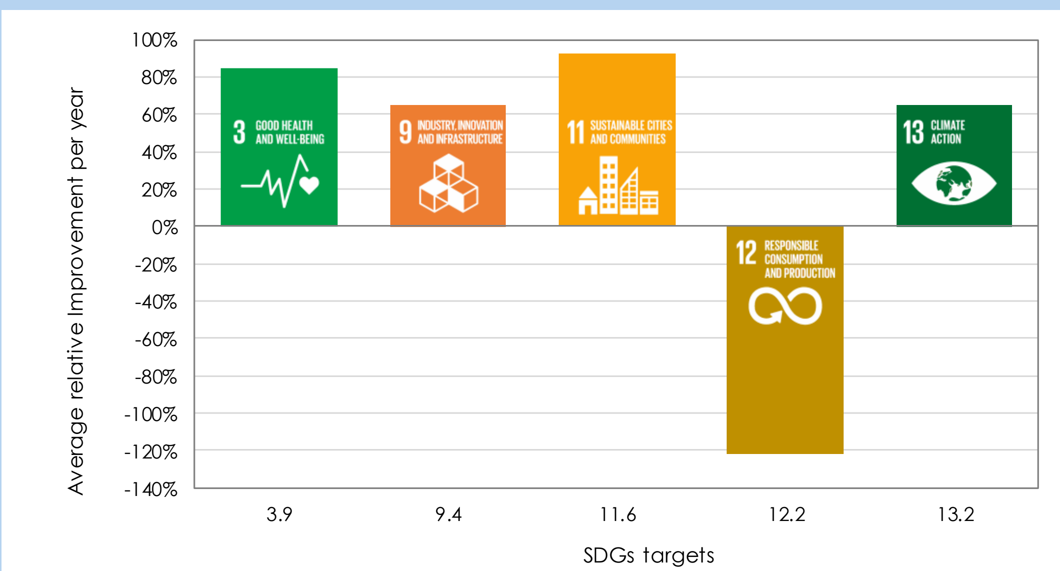


The study then used Figure 13.3 to present a visual representation of the policy's impacts on the various SDG targets, combining both the qualitative and quantitative results. The figure shows where the policy has a positive, negative, or uncertain impact on the various SDGs targets. The individual circles in the SDGs boxes represent the 169 SDG targets.

Figure 13.3: Impacts of the policy on the SDG targets

Additionally, the study used Figure 13.4 to report the quantitative results as relative improvements in each SDG target, based on the results of Equations 13.1 and 13.2.

Figure 13.4. The policy's quantified impacts on SDG targets



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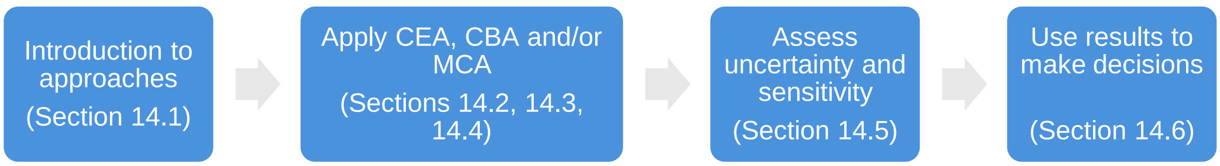
PART VI: DECISION MAKING AND USING RESULTS

14. EVALUATING SYNERGIES AND TRADEOFFS AND USING RESULTS

This chapter provides an overview of approaches for understanding and evaluating the results and possible tradeoffs across multiple impact categories included in the assessment, and making decisions based on the results. This chapter is applicable to qualitative and quantitative assessments, either ex-ante or ex-post.

Figure 14.1: Overview of steps in the chapter



14.1 Introduction to approaches

After assessing the impacts of a policy or action on the various impact categories, the final step is to evaluate the results across all the impact categories and draw conclusions in order to make decisions about policy selection, design and implementation. In many cases, users will need to evaluate trade-offs, since the policy or action is likely to achieve positive benefits in some impact categories and negative impacts in others.

Policies can be evaluated based on the following criteria to determine which to implement or prioritize:[22]

- **Effectiveness**: Which policy option maximizes positive impacts and achieved desired outcomes across multiple impact categories and best contributes to broader goals such as SDGs?
- **Efficiency or cost-effectiveness**: Which policy option generates the greatest positive impacts for a given level of resources?
- **Coherence**: Which policy option is most likely to avoid negative impacts, limit trade-offs and achieve net benefits across the various impact categories that are relevant to policy objectives?

The same questions can be asked of different policy design or implementation choices within a single policy option in order to optimize policy design and implementation. During or after policy implementation, the same questions can also be asked to determine how effective policies or actions have been to inform any adjustments to policy design or implementation and decide whether to continue current actions, enhance current actions or implement additional actions.

Multiple methods are available to address these questions. This chapter focuses on three such methods (summarized in Table 14.1), including:

- Cost-effectiveness analysis (CEA)

[22] European Commission. 2009. *Impact Assessment Guidelines: Chapter 9*; Available at: http://ec.europa.eu/smart-regulation/impact/commission_guidelines/docs/iag_2009_en.pdf.

- Cost-benefit analysis (CBA)
- Multi-criteria analysis (MCA)

Table 14.1: Summary of methods

Method	Description	Advantages	Disadvantages
Cost-effectiveness analysis (CEA)	• Determines the ratio of costs to effectiveness for a given impact category • Can be used to compare policy options to determine which is most effective in achieving a given objective for the least cost	Simple approach; does not require that non-monetary benefits be quantified in monetary terms; fewer subjective elements	Results in multiple indicators when assessing more than one impact categories; requires discount rates
Cost-benefit analysis (CBA)	• Determines the net benefits to society (the difference between total social benefits and total social costs) of policy options • Can be used to compare policy options to determine which has the greatest net benefit to society or to analyze a single policy or action to determine whether its total benefits to society exceed its costs	Assesses aggregated benefits (across the environmental, social and economic dimensions) of policy options with one single indicator	Complex approach that requires monetizing non-monetary costs and benefits and requires discount rates; can underestimate non-monetary benefits
Multi-criteria analysis (MCA)	• Compares the favourability of policy options based on multiple criteria • Can be used to determine the most preferred policy option	Assesses aggregated benefits (across the environmental, social and economic dimensions) of policy options with one single indicator; does not require that non-monetary benefits be quantified in monetary terms; does not require discount rate	Has significant subjective elements

Users should select one or more methods based on the objectives and circumstances. Cost-effectiveness analysis and cost-benefit analysis are relevant to quantitative impact assessments, since they both require estimates of policy impact, while multi-criteria analysis can be applied to either qualitative or quantitative impact assessment. CBA and MCA are best suited to assessing multiple impact categories, whereas CEA focuses on a single measure of effectiveness. CEA and MCA are easier to conduct compared with CBA, which requires more complex techniques such as monetizing impacts. Other approaches beyond CEA, CBA, and MCA include life-cycle cost assessment and economic rate of return.

Valuing or monetizing impacts is not always necessary when assessing the impacts of a policy or action. The method outlined in Parts II, III, and IV explain how to quantify the impacts of policies or actions in physical terms, such as tonnes of air pollution reduced, number of jobs created, or number of people with increased access to energy. Expressing these impacts in monetary terms is useful to carry out a CBA, but is not always necessary to understand the benefits and costs arising from a policy or action and make decisions about which policies or actions to implement.

Each of the three approaches is described in the following sections.

14.2 Cost-effectiveness analysis

Cost-effectiveness analysis (CEA) involves comparing different policy options based on their cost in achieving a single desired objective. The output of a cost-effectiveness analysis is a ratio of costs to effectiveness for a given policy option, such as cost per job created or cost per tonne of air pollution reduced. This ratio can be compared across policy options to determine which is most cost-effective. Cost-effectiveness can also be calculated for different groups of society to assess distributional impacts.

CEA is a simple method to compare policy cost-effectiveness, since it only requires a single measure of effectiveness and a single measure of costs. It can work well if the policy has one primary objective and one primary measure of effectiveness. Users that do not calculate a cost-effectiveness ratio for each impact category included in the assessment should mitigate any possible negative impacts that have been identified for any relevant impact categories not calculated.

In general, a CEA consists of three steps:

1. Estimate the cost of each policy option
2. Estimate the effectiveness of each policy for relevant impact categories
3. Calculate the cost effectiveness of each policy for relevant impact categories

Step 1: Estimate the cost of each policy option

In CEA, cost refers to momentary costs. The cost of policy options could include direct costs to the government to implement the policy such as budget expenditure and administrative costs, direct costs to members of society such as taxes and other compliance costs, and indirect costs to members of society such as higher fuel prices. Users should include direct government costs in all cases. Depending on the purpose of the analysis, users can include other monetary costs when conducting the CEA. There may also be negative costs that should be taken into account—that is, costs reduced or money saved because of the policy, such as reduced energy costs or reduced subsidies for fossil fuel.

Users should compare costs of different policy options based on the present value of costs. Costs that are incurred over time can be covered to present value by applying a discount rate. Equation 14.1 provides equations for calculating the present value of costs. Box 14.1 provides more information on discount rates. Table 14.2 provides an example of calculating costs for two illustrative policies over a ten-year period.

Equation 14.1: Calculating present value of costs

$$PV_C = \sum_{t=0}^{n} C_t / (1+r)^t$$

$PV_C = \sum_{t=0}^{n} C_t / (1+r)^t$

Where PV_C = present value of costs, C_t = Costs in a particular year, r = discount rate, t =number of years from present, and n = number of years

Box 14.1: Discount rates

Costs and benefits are likely to arise over multiple time periods. In economic theory, monetary impacts in the future are worth less to individuals than resources available today, since individuals can earn a return on investment on money they possess today which they forego when receiving the same amount of money in the future. Both CEA and CBA typically convert monetary values to their present value by using a discount rate.

For sustainable development impacts, social discount rates are most appropriate, since they reflect a society's relative valuation of today's well-being versus well-being in the future. Social discount rates can vary widely, for example, from 0% to over 10%, depending on how they address equity concerns with respect to future generations, among other considerations not accounted for in national interest rates or typical discount rates. The World Bank has recommended using social discount rates of 6% for low- and middle-income countries and 4% for high-income countries (World Bank and IHME 2016). The European Commission *Impact Assessment Guidelines* recommends a discount rate of 4% (European Commission 2009).

The following discussion offers further perspectives on the choice of a discount rate: "A high discount rate suggests those alive today are worth more than future generations. A third approach to discounting, based on ethics, says this is wrong, and argues for a very low or even zero rate. This is why the Stern Review on the economics of climate change published in 2006 adopted a rate of 1.4%. US government guidance is to use discount rates of both 3% and 7% for valuing costs and benefits within a single generation of, say, 30 years. It suggests using a lower rate, for time horizons that cross generations. UK government guidance from HM Treasury is to use a 3.5% rate. However, it says: "The received view is that a lower discount rate for the longer term (beyond 30 years) should be used." It sets out a sliding scale falling to 1% for time periods greater than 300 years. In a major survey of 197 economists, the average long-term discount rate was 2.25%. The survey found almost all were happy with a rate of between 1 and 3%, whereas only a few favoured higher figures." (Carbon Brief, Q&A: The Social Cost of Carbon, available at: https://www.carbonbrief.org/qa-social-cost-carbon). Users should consider a range of discount rates and conduct sensitivity analysis to see how the choice affects the overall results.

Table 14.2: Example of calculating costs (present value) of two policies over a ten-year period (illustrative results only)

Policy options	Discount Rate	Costs in each year (million USD)					Discounted costs (million USD)					Present value (million USD)
		Year 1	Year 2	…	Year 9	Year 10	Year 1	Year 2	…	Year 9	Year 10	
Solar PV incentive policy	3%	1	1	…	1	1	0.97	0.94	…	0.77	0.74	8.53
Energy efficiency policy		0.4	0.4	…	0.4	0.4	0.78	0.75	…	0.61	0.6	3.41

Step 2: Estimate the effectiveness of each policy for relevant impact categories

Users should use the quantitative assessment results from previous chapters for all relevant impact categories as the measure for effectiveness of each policy option, representing the change in indicator value attributed to the policy or action. Table 14.3 provides an illustrative example of the effectiveness of each policy option.

Table 14.3: Effectiveness of two policies across three impact categories (illustrative results only)

Policy options	GHG reduction	Air pollution reduction	Job creation
Solar PV incentive policy	50,000 t CO_2e per year for 10 years	1,000 t $PM_{2.5}$ per year for 10 years	200 jobs created in the first year which last for 10 years
Energy efficiency policy	30,000 t CO_2e per year for 10 years	600 t $PM_{2.5}$ per year for 10 years	50 jobs created in the first year which last for 10 years

Step 3: Calculate the cost effectiveness of each policy for relevant impact categories

Equation 14.2 provides the equation for calculating cost effectiveness. Cost effectiveness can only be calculated for one impact category at a time. Users can apply the method individually to each impact category of interest to calculate different cost-effectiveness ratios for each impact category, such as cost per job created or cost per tonne of air pollution reduced.

Equation 14.2: Calculating cost effectiveness for a policy

$$\text{Cost-effectiveness} = \frac{PVc}{effectiveness}$$

Where PV_C = present value of costs, effectiveness = a measure of effectiveness for a specific impact category

Table 14.4 shows the cost-effectiveness results for both policy options for each of three impact categories: GHG reduction, air pollution reduction and job creation. In this illustrative example, the energy efficiency policy is more cost-effective in reducing GHG emissions and air pollution, but less cost-effective in creating jobs.

Table 14.4: Calculating cost-effectiveness for a solar PV incentive policy (illustrative results only)

Policy option	GHG reduction	Air pollution reduction	Job creation
Solar PV incentive policy	\$17 per tCO_2e reduced	\$853 per t $PM_{2.5}$ reduced	\$42,650 per job created
Energy efficiency policy	\$11 per tCO_2e reduced	\$568 per t $PM_{2.5}$ reduced	\$68,200 per job created

Note: Results are over the ten-year assessment period.

From the point of view of cost-effectiveness, users should balance the tradeoffs and choose which policy option to implement based on which impact categories are most important and the relative cost-effectiveness of the results. CBA and MCA offer further approaches to help decide which policy option to implement.

14.3 Cost-benefit analysis

Unlike CEA, cost-benefit analysis (CBA) takes into account a wide variety of costs and benefits of a policy or action in an aggregated manner. CBA involves quantifying the various benefits and costs of a policy and using valuation methods to express those impacts in monetary terms as a proxy to represent social and environmental impacts that may not have an explicit economic or monetary value.

The result of CBA can be used to determine whether the net benefits of a single policy exceed its net costs and therefore whether the policy should be implemented (in the case of ex-ante assessment) or continued (in the case of ex-post assessment). It can also be used to compare multiple policy options to determine which policy should be implemented based on which has the greatest net benefits to society.

Three overarching steps to conducting a CBA are:

1. Quantify all relevant costs and benefits of the policy or action
2. Express non-monetary costs and benefits in monetary terms
3. Calculate the present value of all cost and benefits, and calculate the net present value for each policy option

Step 1: Quantify all relevant costs and benefits of the policy or action

In CBA, benefits refer to positive impacts and costs refer to negative impacts. Benefits also include avoided negative impacts. Unlike CEA, where only monetary costs are accounted for, CBA includes all relevant social, economic and environmental costs and benefits, including both monetary and non-monetary costs and benefits. Costs should be calculated as described for CEA, while the broader impacts should be quantified in physical terms (rather than monetary terms) as described in Parts II, III, and IV. Table 14.5 provides an example of costs and benefits for two policy options.

Table 14.5: Costs and benefits of two policy options (illustrative results only)

Policy option	Costs	Benefits		
		GHG reduction	Air pollution reduction	Job creation
Solar PV incentive policy	$1,000,000 each year for 10 years	50,000 t CO_2e per year for 10 years	1,000 t $PM_{2.5}$ per year for 10 years	200 jobs created in the first year which last for 10 years
Energy efficiency policy	$400,000 each year for 10 years	30,000 t CO_2e per year for 10 years	600 t $PM_{2.5}$ per year for 10 years	50 jobs created in the first year which last for 10 years

Step 2: Express non-monetary costs and benefits in monetary terms

CBA involves representing noneconomic impacts in monetary terms through valuation methods. Economists estimate monetary values of non-monetary costs and benefits by linking them to market prices or quantifying their impact on utility such as the satisfaction a person derives from consuming a particular good or their change in well-being.[23]

A downside of CBA is that many environmental and social benefits are intangible, uncertain, subjective, or controversial to monetize. If all costs and benefits cannot be properly quantified in monetary terms, a

[23] European Commission. *Better Regulation "Toolbox"*. Chapter 8: Methods, models, costs, and benefits. Available at: http://ec.europa.eu/smart-regulation/guidelines/docs/br_toolbox_en.pdf.

partial CBA can be carried out that includes the subset of costs and benefits that are quantified and monetized. Alternatively, users can apply multi-criteria analysis which does not monetize benefits.

Users should avoid double counting monetary values for multiple impacts. For example, health benefits of CO_2e reduction may be included in the health benefits from reduced air pollution.

As an example, in the case of the illustrative solar PV incentive policy, the monetary value for health benefits of carbon reduction is valued at $50 per t CO_2e based on literature.[24]

Step 3: Calculate the present value of all cost and benefits, and calculate the net present value for each policy option

The output of a CBA is a calculated value representing the present value of net benefits of the policy or action to society. Users should discount the future costs and benefits to calculate the present value of costs and benefits, and calculate the net present value for each policy option. This step is similar to Step 1 for CEA. Users should use Equation 14.3 to calculate the result, which is an aggregated value representing the net present value of the net benefits of the policy or action to society.

The results can be used, for example, to determine whether the policy or action has a positive net benefit to society and therefore should be implemented, or to compare two policy options and implement the policy option with the greatest net benefits.

CBA typically considers net benefits in aggregate rather than addressing distributional impacts among different groups in society. However, the various costs and benefits in a CBA can be disaggregated among different stakeholder groups to assess distributional impacts. Alternatively, if distributional impacts are significant, multi-criteria analysis may be preferable.

Equation 14.3: Calculating the net benefit of a policy or action

$$PV_C = \sum_{t=0}^{n} C_t / (1+r)^t$$

Where PV_C = present value of costs, C_t = Costs in a particular year, r = discount rate, t =number of years from present, and n = number of years

$$PV_B = \sum_{t=0}^{n} B_t / (1+r)^t$$

Where PV_B = present value of benefits, B_t = Benefits in a particular year, r = discount rate, t =number of years from present, and n = number of years

$$NPV = PV_B – PV_C$$

Where NPV = net present value representing the net benefits of the policy or action

Table 14.6 shows the calculation of net benefits of policy option for the illustrative solar incentive policy, focused on the monetized value of greenhouse gas reductions on health ($50 per t CO_2e). In the example, the solar PV incentive policy has greater net benefits than the energy efficiency policy so is the preferred policy option.

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[24] West, J. et al. (2013), *Co-Benefits of Mitigating Global Greenhouse Gas Emissions for Future Air Quality and Human Health*, Nature Climate Change 3.

Table 14.6: Calculation of net benefits (NPV) for two policy options (illustrative results only)

Policy option		Annual costs/benefits	Discount rate	Duration	Present value of costs/benefits
Solar PV incentive policy	Costs	$1,000,000	3%	10 years	$\sum_{t=1}^{10} \$1{,}000{,}000 / (1+0.03)^{t}$ = $8,530,202
	Benefits	50,000 x $50 = $2,500,000			$\sum_{t=1}^{10} \$2{,}500{,}000 / (1+0.03)^{t}$ = $21,325,507
	Net Benefits	**$1,500,000**			$21,325,507 - $8,530,202 = **$12,795,304**
Energy efficiency policy	Costs	$400,000	3%	10 years	$\sum_{t=1}^{10} \$400{,}000 / (1+0.03)^{t}$ = $3,412,081
	Benefits	30,000 x $50 = $1,500,000			$\sum_{t=1}^{10} \$1{,}500{,}000 / (1+0.03)^{t}$ = $12,795,304
	Net Benefits	**$1,100,000**			$12.795,304 - $3,412,081 = **$9,383,223**

14.4 Multi-criteria analysis

Multi-criteria analysis (MCA) or multi-criteria decision analysis (MCDA) allows stakeholders to determine the overall preference among alternative options, where the options accomplish multiple goals. It uses normalization and weighting to aggregate results into one metric.[25,26] Indicators used to measure each criterion can be qualitative or quantitative.[27] There are multiple ways to construct and apply an MCA. For example, there are different scales the user can use to assign performance score, as well as how to determine criteria weight factors. This section provides simplified guidance based on the MCDA approach described in the UK government's *Multi-criteria Analysis: A Manual*.[28] Additional references are listed at the end of chapter for further guidance on this and other MCA approaches.

MCA can be summarized into three general steps:

1. Identify the decision context, policy options, assessment objectives and criteria
2. Score each policy option's performance for each criterion
3. Assign a weight for each criterion and calculate an overall score and/or cost-benefit score ratio for each option

Step 1: Identify decision context, policy options, assessment objectives and criteria

In the first step, the user should answer the following questions:[29]

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[25] Department for Communities and Local Government, United Kingdom (2009).

[26] Multi-Metric Sustainability Analysis, The Joint Institute for Strategic Energy Analysis, Dec 2014

[27] *Policy and Action Standard* (WRI, 2014).

[28] Department for Communities and Local Government, United Kingdom. 2009. *Multi-criteria Analysis: A Manual.* Chapter 6. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7612/1132618.pdf.https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7612/1132618.pdf.

[29] USAID, 2014. "Application of MCA Methods: A seven step process"

- What are the overall reasons or objectives for the analysis and who are the stakeholders for the decision?
- What are the options to be assessed?
- What is the decision that needs to be made?
- What are the economic, social and political factors that should be considered for the decision?

Most issues in Step 1 should be largely defined in the assessment steps detailed in Chapters 2, 4 and 5. Users should review those choices and determine if they are appropriate for the MCA. Users should also review whether the policy being assessed creates appropriate options for the MCA, since an MCA requires multiple policy options. If only a single policy's sustainable development impacts are being assessed, users should decide whether to conduct additional impact assessments for additional policy options and/or use "no action" as an option.

For example, in the case of a solar PV incentive policy, the reason for the assessment is to support the government's efforts to pursue multiple policy objectives such as addressing climate change, improving health from improved air quality, creating jobs, improving energy independence, and reducing budget deficits. Within that context, three policy options are identified: enact a solar PV incentive policy, enact an energy efficiency policy, or take no action. These policy objectives translate into five criteria for the MCA: GHG reduction, air pollution reduction, job creation, energy independency and direct costs.

Step 2: Score each policy option's performance for each criterion

This step involves charactering, either quantitatively or qualitatively, the performance of each option against each criterion, then normalizing the performance to scores.[30]

A performance matrix can be used to summarize and present the performance of options. For criteria that are assessed quantitatively, the value should be used directly. For criteria that are assessed qualitatively, the user should provide a succinct description of the result.

In the example of the solar PV incentive policy, four criteria were quantified and one criterion (energy independence) was assessed qualitatively. The results are shown in Table 14.7.

The performance of each option should be assessed relative to a baseline scenario (as described in Chapter 8). When scoring the "no action" option, users should be aware that taking no action often also has costs. For example, not acting on climate change has significant monetary, social, economic and environmental costs. In this assessment, "no action" means no impact relative to the baseline scenario, but the "no action" option may impose costs in absolute terms.

Table 14.7: Performance matrix for an illustrative MCA (illustrative results only)

Policy option	GHG reduction	Air pollution reduction	Job creation	Energy independence	Monetary costs
Solar PV incentive policy	500,000 t CO_2e	10,000 t $PM_{2.5}$	200	Major positive impact	$8,530,202

[30] Department for Communities and Local Government, United Kingdom (2009).

Energy efficiency policy	300,000 t CO_2e	6,000 t $PM_{2.5}$	50	Moderate positive impact	$3,410,000
No action	0	0	0	No impact	$0

After producing the performance matrix, users should rank the performance for each criterion. For criteria that are quantitatively assessed, the user should assign 100 to the best option and 0 to the worst option. All others should be scaled between those limits in proportion to their quantitative impacts.

For criteria that are assessed qualitatively, users can directly assign scores to each option's performance for each criterion, giving the best performance a score of 100 and the worst performance a score of zero, and score everything else in between. This may require making difficult judgments on the degree of difference between each option's qualitative performance. However, such judgments are required to conduct an MCA for qualitative assessed criteria.[31]

Table 14.8 illustrates the performance scores for the solar PV incentive policy.

Table 14.8: Performance scores for an illustrative MCA (illustrative results only)

Policy option	GHG reduction	Air pollution reduction	Job creation	Energy independence	Direct monetary costs
Solar PV incentive policy	100	100	100	100	0
Energy efficiency policy	60	60	40	50	60
No action	0	0	0	0	100

Step 3: Assign a weight for each criterion and calculate an overall score and/or cost benefit score ratio for each option

In this step, users should determine how important each criterion is to the decision. The process of deriving weights is fundamental to the effectiveness of MCA.[32] It should reflect value assumptions and policy priorities. Since it is subjective, the weighting should be developed in consultation with stakeholders, such as policymakers, businesses, civil society and other experts and affected stakeholders. The weighting should be guided by the objectives of the assessment and the local policy objectives and context and should be transparently documented and justified.

The user may allocate a total of 100 points among all criteria, with more points meaning the criterion is more important. When allocating the points, users should take into account how important the particular criterion is, and how much the difference between the least and most preferred options for the criteria matters. For example, the user may determine job creation is important, but in the illustrative case of the solar PV incentive and energy efficiency policies, the difference between the best and worst performing options is only 100 jobs, which is insignificant in the broader context of total jobs in a country. That

[31] Department for Communities and Local Government, United Kingdom (2009).

[32] Department for Communities and Local Government, United Kingdom (2009).

criterion should receive a low weight because the difference between the highest and lowest options is small.[33]

Once the weights are determined, the user should calculate an overall score for each option by calculating the weighted average of its scores on all the criteria.[34] Equation 14.4 shows how to calculate the result.

Equation 14.4: Calculating an overall score for each option

$$S_i = \frac{\sum_{j=1}^{n} w_j s_{ij}}{100}$$

Where S_i = overall score for option i, Wj = weight for criteria j, S_{ij} = performance score of option i for

Table 14.9 shows the overall scores for each option in an illustrative MCA. In this example, the solar PV incentive policy has the highest score, so is the most preferred policy option.

Table 14.9: Calculating overall scores for an illustrative MCA (illustrative results only)

Scenario	GHG reduction	Air pollution reduction	Job creation	Energy independence	Direct monetary costs	Overall score
Criteria weights	30	30	5	5	30	N/A
Solar PV incentive policy	100	100	100	100	0	70
Energy efficiency policy	60	60	40	50	60	58.5
No action	0	0	0	0	100	30

Another useful way is to calculate the benefits score without including monetary costs. To do so, users should classify all criteria into two categories, costs and benefits, assign weights to criteria in the benefit category only, and then calculate the weighted-average benefit scores for each option. By separating benefit scores and costs, users can calculate the cost-benefit score ratio for each option. Table 14.10 demonstrates how to calculate benefit scores and cost-benefit ratios. In this example, the solar PV incentive policy has a higher cost-benefit ratio than the energy efficiency policy. If policymakers are concerned with maximizing benefits or effectiveness, the solar PV incentive policy is preferred, as shown in Table 14.9. If policymakers are concerned with maximizing benefits per unit of cost, the energy efficiency policy is preferred.

Table 14.10: Calculating benefit scores for an illustrative MCA (illustrative results only)

	GHG reduction score	Air pollution reduction score	Job creation score	Energy independence score	Overall benefit score	Direct monetary costs (million USD)	Cost benefit ratio (USD per unit of benefit score)

[33] Department for Communities and Local Government, United Kingdom (2009).

[34] Department for Communities and Local Government, United Kingdom (2009).

Criteria weights	42	42	8	8	N/A	N/A	N/A
Solar PV incentive policy	100	100	100	100	100	$8,530,202	$85,302
Energy efficiency policy	60	60	40	50	57.6	$3,410,000	$59,201
No action	0	0	0	0	0	0	N/A

14.5 Assess uncertainty and sensitivity

All tradeoff evaluation approaches (CEA, CBA, and MCA) involve a certain level of complexity and subjectivity. Therefore, it can be useful to conduct uncertainty and sensitivity analysis to examine the extent to which key assumptions or different views among stakeholders affect the results. Users should follow the guidance in Chapter 11 to assess the uncertainty and sensitivity of the results.

Table 14.11 provides examples of key parameters for sensitivity analysis pertaining to CEA, CBA and MCA. Users should consider whether differences in values advocate by different stakeholders yield significantly different results. If so, the assumptions and values should be investigated and discussed further. If not, the results can be considered more robust for purposes of choosing between policy options.

Table 14.11: Key parameters for sensitivity analysis

Type of analysis	**Key parameter for sensitivity analysis**
Cost Effectiveness Analysis	Discount rate
Cost Benefit Analysis	Discount rate; monetary value of non-monetary costs and benefits
Multi-Criteria Analysis	Criteria weights; performance scores for qualitatively assessed criteria

Table 14.12 shows how the values of key parameters can be varied as part of a sensitivity analysis. Table 14.13 shows the sensitivity analysis results based on those variations in values.

Table 14.12: Sensitivity analysis - parameters considered (illustrative results only)

Sensitivity scenarios	**Cost Effectiveness Analysis**	**Cost Benefit Analysis**		**Multi-Criteria Analysis**	
	Discount rate	**Discount rate**	**Monetary value of CO_2 emission reduction**	**Criteria weights** (GHG reduction: Air pollution reduction: Job creation: Energy independence: Monetary costs)	**Performance scores for energy independence** (Solar PV policy: Energy efficiency policy)
Primary scenario	3%	3%	$50	30:30:5:5:30	100:50

Alternative scenario 1	1.4%	1.4%	$30	10:40:5:5:40	100:20
Alternative scenario 2	6%	6%	$70	20:20:15:15:30	100:80

Table 14.13: Sensitivity analysis: tradeoff analysis results (illustrative results only)

Sensitivity scenarios	**Cost Effectiveness Analysis**	**Cost Benefit Analysis**		**Multi-Criteria Analysis**	
	Discount rate	**Discount rate**	**Monetary value of CO_2 emission reduction**	**Criteria weights** (GHG reduction: Air pollution reduction: Job creation: Energy independence: Monetary costs)	**Performance scores for energy independence** (Solar PV policy: Energy efficiency policy)
Primary scenario	Solar PV incentive policy: $17 per tCO_2e; $853 per t $PM_{2.5}$; $42,650 per job Energy efficiency policy: $11 per t CO_2e; $568 per t PM 2.5$68,200 per job	Solar PV incentive policy Net Benefit: $12,795,304 Energy efficiency policy Net Benefit: $9,383,223	Solar PV incentive policy Net Benefit: $12,795,304 Energy efficiency policy Net Benefit: $9,383,223	Solar PV incentive policy Overall Score/Cost Benefit Score Ratio:70; $85,302 per benefit score Energy efficiency policy Overall Score/Cost Benefit Score Ratio: 58.5; $59,201 per benefit score No Action Overall Score/Cost Benefit Score Ratio: 30; N/A	Solar PV incentive policy Overall Score/Cost Benefit Score Ratio: 70; $85,302 per benefit score Energy efficiency policy Overall Score/Cost Benefit Score Ratio: 58.5; $59,201 per benefit score No Action Overall Score/Cost Benefit Score Ratio: 30; N/A
Alternative scenario 1	Solar PV incentive policy: $19 per t CO_2e; $927 per t $PM_{2.5}$; $46,650 per job Energy efficiency policy: $12 per tCO_2e; $618 per t $PM_{2.5}$; $74,170 per job	Solar PV incentive policy Net Benefit: $12,054,274 Energy efficiency policy Net Benefit: $9,086,811	Solar PV incentive policy Net Benefit: $4,265,101 Energy efficiency policy Net Benefit: $4,265,101	Solar PV incentive policy Overall Score/Cost Benefit Score Ratio:60; $85,302 per benefit score Energy efficiency policy Overall Score/Cost Benefit Score Ratio: 58.5; $59,304 per benefit score No Action Overall Score/Cost Benefit Score Ratio: 40/ N/A	Solar PV incentive policy Overall Score/Cost Benefit Score Ratio: 70; $85, 302 per benefit score Energy efficiency policy Overall Score/Cost Benefit Score Ratio: 57/$61,775 per benefit score No Action Overall Score/Cost Benefit Score Ratio: 30; N/A
Alternative scenario 2	Solar PV incentive policy: $15 per t CO_2e; $736 per t $PM_{2.5}$; $36,800 per job Energy efficiency policy: $10 per t CO_2e; $490 per t $PM_{2.5}$; $58,880 per job	Solar PV incentive policy Net Benefit: $13,965,420 Energy Efficiency Program Net Benefit: $9,851,269	Solar PV incentive policy Net Benefit: $21,325,507 Energy efficiency policy Net Benefit: $14,501,345	Solar PV incentive policy Overall Score/Cost Benefit Score Ratio: 70/ $85,302 per benefit score Energy efficiency policy Overall Score/Cost Benefit Score Ratio: 55.5/$63,653 per benefit score	Solar PV incentive policy Overall Score/Cost Benefit Score Ratio: 70; $85, 302 per benefit score Energy efficiency policy Overall Score/Cost Benefit Score Ratio:60/$56,833 per benefit score

				No Action Overall Score/Cost Benefit Score Ratio: 30/ N/A	No Action Overall Score/Cost Benefit Score Ratio: 30; N/A

14.6 Using results to make decisions

Depending on the assessment objectives, different decisions need to be made. For ex-ante assessments, decisions may include whether or not to implement a specific policy, whether to implement multiple policies, or how to improve a policy before implementation. For ex-post assessments, decisions may include whether to continue or discontinue a policy that is in effect, whether to revive a policy that is no longer in effect, or how to improve a policy during implementation.

Choosing a policy option

CEA, CBA and MCA provide useful insights on the effectiveness, efficiency and coherence of policy options, but before decisions are taken based on the results, it is important to gather further inputs and perspectives on the best course of action since each analytical approach has limitations and involves subjective judgments.

In general, policy options that do not have positive net benefits should be eliminated. The same is true for policy options that are inferior to others under every criterion. To assist with decision making, users can develop a performance matrix of policy options (including no action), following the guidance provided in Section 14.4, using effectiveness, efficiency and coherence as criteria, as illustrated in Table 14.14. The example shows that each policy option is preferred based on certain criteria but not others, so it is difficult to come to an overall conclusion based on the results alone. If needed, users can conduct an MCA by assigning weights to the three criteria as a means of choosing the preferred policy option.

Table 14.14: Illustrative performance matrix for policy options (illustrative results only)

Policy option	Effectiveness	Efficiency	Coherence
Solar PV incentive policy	Reduces 500, 000 t CO_2e and 10,000 t $PM_{2.5}$; Creates 200 jobs; Major positive impact on energy independency Overall benefit score 100	\$17 per t CO_2e \$853 per t $PM_{2.5}$; \$42,650 per job Cost \$85,302 per unit of benefit score	Good balance of climate, air, energy independency and job impacts; Tradeoff exists with monetary costs but with net benefits of \$12.8 million
Energy efficiency policy	Reduces 300,000 t CO_2e and 6,000 t $PM_{2.5}$; Creates 50 jobs; Moderate positive impact on energy independency Overall benefit score 57.6	\$11 per t CO_2e; \$568 per t $PM_{2.5}$; \$68,200 per job Cost \$59,201 per unit of benefit score	Good balance of climate, air, energy independency and job impacts; Tradeoff exists with monetary costs but with net benefits of \$9.4 million
No action	No positive impacts	No costs (or benefits)	No trade off (because there are no benefits)

Source: Adapted from European Commission. 2009. *Impact Assessment Guidelines.*

In some circumstances, rather than taking a neutral approach to maximizing net benefits across all impact categories, users may want to instead focus on minimizing negative impacts in certain key impact categories or ensuring zero negative impacts across all impact categories. User should consider the following factors when making decisions regarding trade-offs:

- Minimum requirements: There may be minimum thresholds for a given impact category below which a policy should not be implemented, for example related to human rights violations. Minimum requirements are not negotiable, meaning the negative impact cannot be offset by positive impacts in other impact categories. Minimum thresholds could be set by statutes, science or socio-political expectations. In such cases, users should either improve the policy design to mitigate the negative impacts or discontinue the policy option.
- Irreversibility: Policies may have negative impacts that are irreversible, such as loss of species, that are deemed unacceptable and cannot be offset with positive impacts in other impact categories. In such cases, users should improve the policy design to avoid irreversible negative impacts or discontinue the policy option.
- Precaution: Policies may present major risks that are highly uncertain but could be catastrophic. Users should adopt the precautionary principle by taking precautionary protection against potentially hazardous impacts, and in such cases give more weight to avoiding negative impacts than achieving positive impacts.[35]

If multiple policy options are being considered for implementation, users should also be aware that if policy A is better than policy B, it does not imply that policy A + C is better than policy B + C, as a result of possible interactions that may exist between the policies (described in Chapter 4). In such a case, users should consider evaluating the impact of each combination of policies separately to determine which combination is best.

Improving policy design

Users should also consider improving policy design based on the assessment results. In some cases, the assessment findings may warrant completely redeveloping a policy option. To improve policy design, users can explore how different policy implementation specifications can mitigate any negative impacts. For example, if a solar PV incentive policy is found to have negative impacts on the national budget, policymakers can optimize the policy by choosing a financing model that would lead to lower costs.

Users should also consider establishing safeguards as part of the policy design (e.g., environmental standards for solar manufacturing) to minimize the likelihood of negative impacts, or developing measures to offset any negative impacts (e.g., job retraining programmes for job losses in the coal mining sector). The effectiveness of safeguards and offset measures should be evaluated and closely monitored during the policy implementation period to ensure they are working as planned.[36]

Further references on CEA, CBA and MCA

Reference	Topics	Link
Asian Development Bank. 2007. *Theory and Practice in the Choice of Social Discount Rate for Cost-Benefit Analysis*: A Survey. Economics and Research Department Working Paper, Series No. 94.	Discount rates	http://www.adb.org/sites/default/files/pub/2007/WP094.pdf

[35] Federal Office for Spatial Development, Switzerland (2004)

[36] Federal Office for Spatial Development, Switzerland (2004)

Bakhtiari, F. 2016. *Valuation of Climate Change Mitigation Co-Benefits.* UNEP DTU Partnership. Copenhagen, Denmark.	Valuation methods	http://www.unepdtu.org/-/media/Sites/Uneprisoe/Publications%20(Pdfs)/valuation_Climate-Change-Mitigation.ashx?la=da.
Boardman, A., et al. 2006. *Cost-benefit analysis: concepts and practice*. Prentice Hall.	CBA	
Centre for European Policy Studies and Economisti Associati. 2013. *Assessing the Costs and Benefits of Regulation*. Study for the European Commission, Secretariat General	CBA, discount rates, valuation methods	http://ec.europa.eu/smart-regulation/impact/commission_guidelines/docs/131210_cba_study_sg_final.pdf
Council of Economic Advisers. 2017. *Discounting for Public Policy: Theory and Recent Evidence on the Merits of Updating the Discount Rate*	Discount rates	https://obamawhitehouse.archives.gov/sites/default/files/page/files/201701_cea_discounting_issue_brief.pdf
Department for Communities and Local Government, United Kingdom. 2009. *Multi-criteria Analysis: A Manual*.	MCA	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7612/1132618.pdf.https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7612/1132618.pdf.
Department for Environment, Food, and Rural Affairs, United Kingdom. 2003. *Use of Multi-criteria Analysis in Air Quality Policy: A Report*.	MCA	http://www.defra.gov.uk/environment/airquality/mcda/index.htm
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European Commission. 2009. *Impact Assessment Guidelines.*	CEA, CBA, MCA, discount rates	http://ec.europa.eu/smart-regulation/impact/commission_guidelines/docs/iag_2009_en.pdf
European Commission. 2009. *Impact Assessment Guidelines – Technical Annex.*	CEA, CBA, MCA, discount rates	http://ec.europa.eu/smart-regulation/impact/commission_guidelines/docs/iag_2009_annex_en.pdf
European Commission. 2014. *Guide to Cost-Benefit Analysis of Investment Projects.*	CBA	http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf
European Commission. *Better Regulation "Toolbox"*. Chapter 8: Methods, models, costs, and benefits.	CEA, CBA, MCA, discount rates	http://ec.europa.eu/smart-regulation/guidelines/docs/br_toolbox_en.pdf
Interagency Working Group on Social Cost of Carbon, United States. 2010. *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866*.	Social cost of carbon	http://www.epa.gov/oms/climate/regulations/scc-tsd.pdf.
Jeuland, Marc and Jie-Sheng Tan Soo. 2016. *Analyzing the costs and benefits of clean and improved cooking solutions*.	CBA	https://cleancookstoves.org/binary-data/RESOURCE/file/000/000/459-1.pdf
Lawrence, Robert S., Lisa A. Robinson, and Wilhelmine Miller, eds. *Valuing health for regulatory cost-effectiveness analysis*. Chapter 5: Recommendations for Regulatory Cost-Effectiveness Analysis. National Academies Press, 2006.	CEA	https://www.nap.edu/read/11534/chapter/7#167
National Academies of Sciences, Engineering, and Medicine, United States. 2017. *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide.*	Social cost of carbon	https://www.nap.edu/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of

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United Nations Economic Commission for Europe. 2017. *Sustainable Development Briefs No.2*: *The co-benefits of climate change mitigation.*	CBA	http://www.unece.org/fileadmin/DAM/Sustainable_Development_No._2__Final__Draft_OK_2.pdf
World Bank, Independent Evaluation Group. 2007. *Sourcebook for Evaluating Global and Regional Partnership Programs: Indicative Principles and Standards Indicative Principles and Standards.*	CEA, CBA, MCA	http://siteresources.worldbank.org/EXTGLOREGPARPROG/Resources/sourcebook.pdf.
World Bank. 2008. Social Discount Rates for Nine Latin American Countries. Washington, DC: World Bank.	Discount rates	http://elibrary.worldbank.org/content/workingpaper/10.1596/1813–9450–4639.
World Bank and ClimateWorks Foundation. *Climate Smart Development: Adding up the benefits of actions that help build prosperity, end poverty and combat climate change*	CBA, valuation methods, discount rates	http://documents.worldbank.org/curated/en/794281468155721244/Main-report
World Bank and Institute for Health Metrics and Evaluation, University of Washington (IHME). 2016. *The Cost of Air Pollution: Strengthening the Economic Case for Action*.	CBA	http://documents.worldbank.org/curated/en/781521473177013155/The-cost-of-air-pollution-strengthening-the-economic-case-for-action.
World Health Organization. WHO Guide to Cost-Effectiveness Analysis.	CEA	http://www.who.int/choice/publications/p_2003_generalised_cea.pdf
USAID, 2014. *Application of MCA Methods: A Seven Step Process*.	MCA	
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Scrieciu, S. Ş., et al. (2014). *Advancing methodological thinking and practice for development-compatible climate policy planning. Mitigation and adaptation strategies for global change*, 19(3), 261-288.	MCA	

APPENDIX A: EXAMPLE OF QUANTIFYING THE IMPACT OF A SOLAR PV INCENTIVE POLICY

This appendix provides an example of quantifying the impact of a grid-connected rooftop solar PV incentive policy. The example shows how to carry out an ex-ante assessment following the steps outlined in both Chapter 8 and Chapter 9 by developing an ex-ante baseline and policy scenario and estimating the various sustainable development impacts of the policy.

The Government of India has a target to achieve 100 GW solar capacity by 2022. The 100 GW solar power target is divided into large-scale centralized power plants (50 GW) and distributed smaller-scale projects including 40 GW of rooftop solar mainly used by industrial, commercial and residential consumers and 10 GW of grid-connected tail-end plants. This example only focuses on grid-connected solar rooftop programmes that supports 40 GW installation by 2022.

For previous steps related to the same example, see Table 4.1 and Table 4.2, Table 5.2, Table 6.3: Example of reporting impacts through reporting template for a solar PV incentive policy, Table 7.5, and Table 8.1.

Chapter 8, Section 8.1 – Define the quantitative assessment boundary and period

Table A.1 shows the set of impact categories, specific impacts, and indicators included in the quantitative assessment boundary. The assessment period is 2016–2025.

Table A.1: Impact categories, specific impacts, and indicators included in the quantitative assessment boundary

Impact categories included in the assessment	Specific impacts included in the quantitative assessment boundary	Indicator to quantify
Climate change mitigation	Reduced GHG emissions from grid-connected fossil fuel-based power plants	GHG emissions (tCO_2e/year)
Air quality / health impacts of air pollution	Reduced air pollution from grid-connected fossil fuel-based power plants	Emissions of $PM_{2.5}$, PM_{10}, SO_2, and NOx (t/year); number of deaths due to air pollution
Energy	Increased electricity generation from solar PV	Solar installed capacity (MW); % solar of total installed capacity; % solar of total installed capacity of renewable energy sources
Access to clean, affordable and reliable energy	Increased access to clean, affordable, and reliable energy	Number of houses/buildings/facilities with access to clean energy resulting from the policy
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
Jobs	Increased jobs in the solar installation, operations maintenance sectors	Number of new jobs resulting from the policy
	Increased jobs for solar panel manufacturing sector	Number of new jobs resulting from the policy

	Decreased jobs in fossil fuel sectors	Number of jobs reduced resulting from the policy
Income	Increased income for households, institutions and other organizations due to reduction in energy costs	Savings in annual electric bill for households and businesses (USD/year)
Energy Independence	Increased energy independence from reduced imports of fossil fuel	Reduction in coal imports resulting from the policy (t/year)

Chapter 8, Section 8.2 – Choose assessment method for each indicator

The first step is to choose an assessment method for each indicator—the scenario method, comparison group method, or deemed estimates method, which is a subset of the scenario method (outlined in Section 8.2). In this example, the scenario method is used for certain indicators and the deemed estimates method is used for others. To apply the scenario method, baseline values and policy scenario values are needed for each indicator over the assessment period. To apply the deemed estimates method, only the estimated change from the policy is quantified, without separately estimating baseline and policy scenario values.

Chapter 8, Section 8.3 – Define the baseline scenario and estimate baseline values for each indicator

Section 8.3.1: Select a desired level of accuracy and complexity

This example uses a combination of constant baseline scenarios and simple trend baseline scenarios for different indicators. Where the deemed estimates method is used, no baseline values are presented.

A lower level of accuracy, commensurate with IPCC Tier 1 methods, was determined to be appropriate. For example, national level data such as the national average grid emission factor, country-wide rates of solar PV as a percentage of total installed capacity, and national air pollution data can be considered as representative within the impact category assessment boundaries.

Section 8.3.2: Define the most likely baseline scenario for each indicator

A key assumption about what is most likely to occur in the absence of the solar PV policy is that the households installing the solar PV systems would have used grid-connected electricity in the absence of the solar PV policy.

Other policies/actions

The baseline scenario takes into account India's National Solar Mission, which calls for 100,000 MW of new solar capacity. Of the 100,000 MW of solar power to be achieved by 2022, 40,000 MW is to be met by grid-connected rooftop solar systems (included in the policy scenario), whereas the remaining 60,000 MW are to be met through from ground-based solar systems (included in the baseline scenario).

No other policies or subsidies are assumed to exist for rooftop grid-connected solar PV systems. No other financial incentives, such as soft loans or capital grants for solar PV panels/systems are assumed to be available.

The Government of India is also implementing the "Off-Grid and Decentralized Solar Applications" scheme to promote solar home lights, solar street lights, power plants, solar pumps and mini and micro grids in rural areas of the country, where a significant amount of the population remains without access to electricity. The programme also has an emphasis on Concentrating Solar Thermal (CST) technology. The objective and target user group under off-grid policy is different from the solar PV incentive policy. Therefore, the off-grid incentive policy has not been considered for assessment.

Non-policy drivers

Table A.2 lists key drivers for each impact category being assessed included in the baseline scenario.

Table A.2: Drivers and assumptions for the solar PV incentive policy

Impact categories	Drivers and assumptions in the baseline scenario
Climate change mitigation	No change in emissions limits from power plants and vehicles or compliance rates
Health impacts of air pollution	No change in particulate matter limits from power plants, power generators, or vehicles, and no change in compliance rates
Air pollution	No change in air emissions limits from power plants, power generators, or vehicles, and no change in compliance rates
Renewable energy generation	No change in renewable energy targets, including the proportion of the target to be met by solar
Access to clean, reliable and affordable energy	No significant change in household income, production cost of solar systems, or number of solar companies; No change in awareness of and ability of homeowners to invest in solar PV systems
Skilled labour and worker training	No change in access to or awareness of opportunities for solar PV industry training
Job creation	No change in employment rate for skilled or unskilled labour
Income	No significant change in average household income or inflation rate
Energy independence	No change in the cost of fossil fuels or economic incentives for renewable energy

Section: 8.3.3: Define the methods and parameters needed to estimate baseline values

Each indicator has its own estimation method and list of parameters. These are included in Table A.6.

Selected parameters included are listed in the Table A.3.

Table A.3: Parameters needed to estimate baseline values and data to be collected

Impact category	Parameters needed to estimate baseline values; data to be collected
Climate change mitigation	Grid electricity emission factor in India Installed capacity of solar rooftop systems due solar PV incentive policy
Air quality / health impacts of air pollution	Emissions of $PM_{2.5}$ and PM_{10} from stationary power plants as reported by the Central Pollution Control Board, state pollution control boards, and/or the National Environmental Engineering Research Institute Or Reported levels of $PM_{2.5}$ and PM_{10} in India (micrograms per cubic meter of air (µg/m3)) $PM_{2.5}$ and PM_{10} that is attributable to power generation (%)

	Emissions of sulphur dioxide and nitric oxide from stationary power plants as reported by the Central Pollution Control Board, state pollution control boards, and/or the National Environmental Engineering Research Institute Or Reported levels of SO_2 and NOx in India SO_2 and NOx that is attributable to power generation (%)
Energy	Total installed capacity of solar systems prior to the implementation of the policy (MW)
Access to clean, reliable, and affordable energy	Within the assessment boundary, the households that are assumed to adopt the policy already have access to energy and are simply replacing fossil sources with solar PV, therefore baseline values are not separately calculated
Capacity, skills, and knowledge development	Within the assessment boundary, only the incremental increase in skilled labour associated with adoption of the policy is assessed, therefore baseline values are not separately calculated
Jobs	Within the assessment boundary, only the incremental increase in job creation associated with adoption of the policy is being assessed, therefore baseline values are not separately calculated
Income	Average expenditure on grid electricity Or Average cost of grid-connected electricity consumed for residential and institutional use (Rs.)
Energy independence	Within the assessment boundary, only the incremental change in energy independence due to the policy is evaluated, so baseline values are not separately calculated

Section 8.3.4: Collect data for each indicator

Data is collected for each parameter required for calculations. These are included in Table A.6.

Section 8.3.5: Estimate baseline values for each indicator

Baseline values are calculated over the assessment period. These are included in Table A.6.

Chapter 9, Section 9.1 – Define and describe the policy scenario for each indicator

The following assumptions describe the policy scenario:

- The policy is implemented in India and implemented over the period is 2016-2022.
- The policy aims to install 40,000 MW of rooftop solar PV by 2022. Table A.4 shows the annual and cumulative projected installed capacity of solar PV systems in each year. The table also provides corresponding electricity generated in each year from the solar PV. Each MW of installed solar PV generates 1327 MWh of electricity per year.

Table A.4: The policy's intended electricity generation over the assessment period

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Installed Rooftop Solar PV capacity (MW)	200	4,800	5,000	6,000	7,000	8,000	9,000	0	0	0
Cumulative Installed Rooftop Solar PV capacity (MW)	200	5,000	10,000	16,000	23,000	31,000	40,000	40,000	40,000	40,000
Electricity generation from Rooftop Solar PV (1000 MWh/year)	265.320	6,633	13,266	21,225.6	30,511.8	41,124.6	53,064	53,064	53,064	53,064

Chapter 9, Section 9.2 – Estimate policy scenario values for each indicator

Policy scenario values are calculated over the assessment period. These are included in Table A.6.

Chapter 9, Section 9.3 – Estimate the net impact of the policy or action on each indicator

The net impact of the policy or action is calculated for each indicator over the assessment period. These are included in Table A.6.

Table A.5 presents a summary of the net impact of the policy across all impact categories included in the quantitative assessment.

Table A.5: Summary of quantitative results – the impact of the solar PV incentive policy on all impact categories included in the assessment

Impact category	Indicator quantified	Estimated impact (Cumulative impact from 2016 – 2025)
Climate change mitigation	GHG emissions ($MtCO_2e$) from the electric grid	Reduction of 307 Mt CO_2e
Air quality / health impacts of air pollution	$PM_{2.5}$ emissions (t) from the electric grid	Reduction of 1,177,996 t $PM_{2.5}$
	PM_{10} emissions (t) from the electric grid	Reduction of 2,437,234 t PM_{10}
	SO_2 emissions (t) from the electric grid	Reduction of 4,265,161 t SO_2
	NOx emissions (t) from the electric grid	Reduction of 4,062,057 t NOx
	Number of premature deaths per year in India resulting from air pollution from coal plants	Reduction of 32,304 premature deaths
Energy	Renewable energy installed capacity (MW)	Increase of 40,000 MW of renewable energy capacity
Access to clean, affordable, and reliable energy	Increase in number of houses/buildings/facilities with access to clean energy resulting from the policy	Increase of 5,741,889 houses/buildings/facilities with access to clean energy
Capacity, skills, and knowledge development	Number of new skilled trainees and workers on the ground because of the policy	Increase of 40,060 new skilled trainees and workers
Jobs	Change in jobs resulting from the policy (number of jobs)	Net increase of 821,102 jobs
Income	Savings in annual electric bill for households and businesses (USD)	Savings of 27,855 million USD
Energy independence	Reduction in coal imports (t)	Reduction of 57,770,140 tons of coal

Table A.6: Calculations of baseline values, policy scenario values, and the net impact of the policy or action on the indicators included in the assessment

Impact category #1	**Climate change mitigation**										
Indicator	GHG emissions ($MtCO_2e$/year) from the electric grid										
Specific impact	Reduced GHG emissions from grid-connected fossil fuel-based power plants										
Assessment method	Deemed estimates method										
Equation	GHG emission reduced from the solar PV ($MtCO_2e$/year) = Electricity generated from rooftop solar PV (MWh) x Coal generation emission factor (tCO_2e/MWh) / 1,000,000										
Parameters needed	Electricity generated from new solar PV (MWh) = see Table A.4 Coal generation emission factor = 0.945 tCO_2e/MWh (for new coal power plants; emission factor assumed to stay constant over the assessment period)										
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Reduction in GHG emissions ($MtCO_2e$/year) from the policy	0.25	6.27	12.54	20.06	28.83	38.86	50.15	50.15	50.15	50.15	307

Impact category #2	**Air quality / health impacts of air pollution**
Indicator #1	$PM_{2.5}$ emissions (t/year) from the electric grid
Specific impact	Reduced $PM_{2.5}$ emissions from grid-connected fossil fuel-based power plants
Assessment method	Scenario method
Equation	Reduction in $PM_{2.5}$ emissions = Baseline $PM_{2.5}$ emissions – Policy scenario $PM_{2.5}$ emissions Where Baseline $PM_{2.5}$ emissions = Total fossil fuel based installed capacity of the grid (MW) in baseline scenario * $PM_{2.5}$ emission factor (ton/MW) Policy scenario $PM_{2.5}$ emissions = Total fossil fuel based installed capacity of the grid (MW) in the policy scenario * $PM_{2.5}$ emission factor (ton/MW)
Parameters needed	Installed capacity (MW) [see below] and $PM_{2.5}$ emission factor = 4.8 ton/MW per year
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario.

Assessment period	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Cumulative impact
Baseline values – Installed capacity of coal-based power plant (MW)	184274	197976	211677	225379	239081	252783	266485	260571	247422	250106	N/A
Policy scenario values – Installed capacity of coal-based power plant (MW)	184074	192976	201677	209379	216081	221783	226485	220571	207422	210106	N/A
Baseline values – $PM_{2.5}$ emissions (t/year)	885,293	951,120	1,016,947	1,082,774	1,148,600	1,214,427	1,280,254	1,251,841	1,188,671	1,201,568	N/A
Policy scenario values – $PM_{2.5}$ emissions (t/year)	884,332	927,099	968,904	1,005,906	1,038,103	1,065,496	1,088,085	1,059,672	996,502	1,009,399	N/A
Reduction in $PM_{2.5}$ emissions (t/year) from the policy	961	24,021	48,042	76,868	110,497	148,931	192,169	192,169	192,169	192,169	1,177,996

Impact category #2	Air quality / health impacts of air pollution
Indicator #2	PM_{10} emissions (t/year) from the electric grid
Specific impact	Reduced PM_{10} emissions from grid-connected fossil fuel-based power plants
Assessment method	Scenario method
Equation	Reduction in PM_{10} emissions = Baseline PM_{10} emissions – Policy scenario PM_{10} emissions Where: Baseline PM_{10} emissions = Total fossil fuel based installed capacity of the grid (MW) in baseline scenario * PM_{10} emission factor (ton/MW) Policy scenario PM_{10} emissions = Total fossil fuel based installed capacity of the grid (MW) in the policy scenario * PM_{10} emission factor (ton/MW)
Parameters needed	Installed capacity (MW) [see below] and PM_{10} emission factor = 9.9 ton/MW per year
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario.

Assessment period	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Cumulative impact
Baseline values	1,831,640	1,967,834	2,104,027	2,240,221	2,376,415	2,512,608	2,648,802	2,590,016	2,459,319	2,486,003	N/A
Policy scenario values	1,829,652	1,918,135	2,004,630	2,081,185	2,147,800	2,204,475	2,251,211	2,192,425	2,061,728	2,088,412	N/A
Reduction in PM_{10} emissions (t/year) from the policy	1,988	49,699	99,398	159,037	228,615	308,133	397,591	397,591	397,591	397,591	2,437,234

Impact category #2	**Air quality / health impacts of air pollution**
Indicator #3	SO_2 emissions (t/year) from the electric grid
Specific impact	Reduced SO_2 emissions from grid-connected fossil fuel-based power plants
Assessment method	Scenario method
Equation	Reduction in SO_2 emissions = Baseline SO_2 emissions – Policy scenario SO_2 emissions Where Baseline SO_2 emissions = Total fossil fuel based installed capacity of the grid (MW) in baseline scenario * SO_2 emission factor (ton/MW) Project SO_2 emissions = Total fossil fuel based installed capacity of the grid (MW) in the policy scenario * SO_2 emission factor (ton/MW)
Parameters needed	Installed capacity (MW) [see below] and SO_2 emission factor = 17.4 ton/MW per year
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario.

Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Baseline values	3,205,370	3,443,709	3,682,048	3,920,387	4,158,726	4,397,065	4,635,403	4,532,528	4,303,808	4,350,506	N/A
Policy scenario values	3,201,891	3,356,736	3,508,102	3,642,073	3,758,649	3,857,831	3,939,619	3,836,743	3,608,023	3,654,721	N/A
Reduction in SO_2 emissions (t/year) from the policy	3,479	86,973	173,946	278,314	400,076	539,233	695,785	695,785	695,785	695,785	4,265,161

Impact category #2	**Air quality / health impacts of air pollution**										
Indicator #4	NOx emissions (t/year) from the electric grid										
Specific impact	Reduced NOx emissions from grid-connected fossil fuel-based power plants										
Assessment method	Scenario method										
Equation	Reduction in NOx emissions = Baseline NOx emissions – Policy scenario NOx emissions Where Baseline NOx emissions = Total fossil fuel based installed capacity of the grid (MW) in baseline scenario * NOx emission factor (ton/MW) Policy scenario NOx emissions = Total fossil fuel based installed capacity of the grid (MW) in the policy scenario * NOx emission factor (ton/MW)										
Parameters needed	Installed capacity (MW) [see below] and NOx emission factor = 16.6 ton/MW per year										
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Baseline values	3,052,734	3,279,723	3,506,712	3,733,702	3,960,691	4,187,681	4,414,670	4,316,693	4,098,865	4,143,339	N/A
Policy scenario values	3,049,420	3,196,891	3,341,049	3,468,641	3,579,666	3,674,125	3,752,018	3,654,041	3,436,213	3,480,687	N/A
Reduction in NOx emissions (t/year) from the policy	3,313	82,832	165,663	265,061	381,025	513,555	662,652	662,652	662,652	662,652	4,062,057

Impact category #2	**Air quality / health impacts of air pollution**
Indicator #5	Number of premature deaths per year in India resulting from air pollution from coal plants
Specific impact	Reduction in premature mortality in India from reduced fossil fuel electricity generation
Assessment method	Scenario method
Equation	Reduction in premature deaths per year = Expected premature deaths in baseline scenario – Expected premature deaths in policy scenario
Parameters needed	Installed capacity (MW) [see below] and Premature deaths = 0.81/MW installed capacity per year

Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario. The total health risk for mortality is quantified using the relative risk functions and exposure level of $PM_{2.5}$. The premature deaths per MW applied for this example are based on previously published literature and are extrapolated for simplification.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Baseline values (Cumulative)	148,821	159,886	170,952	182,018	193,084	204,149	215,215	210,439	199,820	201,988	N/A
Policy scenario values (Cumulative)	148,659	155,848	162,876	169,096	174,509	179,114	182,911	178,135	167,515	169,683	N/A
Reduction in premature deaths (Cumulative)	162	4,038	8,076	12,922	18,575	25,036	32,304	32,304	32,304	32,304	32,304

Impact category #3	**Energy**										
Indicator	Renewable energy installed capacity (MW)										
Specific impact	Increased renewable energy generation from more solar generation										
Assessment method	Scenario method										
Equation	Total renewable energy installed capacity (MW) = Renewable energy capacity in baseline scenario - Renewable energy capacity in policy scenario										
Parameters needed	Baseline values of total renewable energy without the policy (MW) Policy scenario values of total renewable energy with the policy (MW) per year										
Assumptions	See Table A.4										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Baseline values (Total renewable energy without the policy) (Cumulative)	42,649	54,674	72,739	89,804	105,870	120,935	135,000	139,613	144,226	148,839	N/A
Policy scenario values (Total renewable energy with the policy) (Cumulative)	42,849	59,674	82,739	105,804	128,870	151,935	175,000	179,613	184,226	188,839	N/A
Increase in renewable energy capacity (MW) (Cumulative)	200	5,000	10,000	16,000	23,000	31,000	40,000	40,000	40,000	40,000	40,000
Percent increase in in renewable energy capacity (MW)	0%	9%	14%	18%	22%	26%	30%	29%	28%	27%	N/A

Impact category #4	**Access to clean, affordable, and reliable energy**									
Indicator	Increase in number of houses/buildings/facilities with access to clean energy resulting from the policy									
Specific impact	Increased access to clean electricity									
Assessment method	Deemed estimates method									
Equation	Number of installation = Total installed capacity target in eligible sector i.e., residential, institutional, industrial, commercial and government / standard solar rooftop installation size for each type of installation/1000									
Parameters needed	Standard solar rooftop system size for each type of installation (kW) Total installed capacity target in eligible sector i.e., residential, institutional, industrial, commercial and government (MW)									
Assumptions	The solar PV incentive policy sets target for eligible sectors. Total new installations are estimated using a standard size and target of the eligible category.									
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Residential (number of households)	24,000	576,000	600,000	720,000	840,000	960,000	1,080,000	0	0	0	4,800,000
Institutional (number of buildings)	240	5,760	6,000	7,200	8,400	9,600	10,800	0	0	0	48,000
Industrial (number of facilities)	3,375	81,000	84,375	101,250	118,125	135,000	151,875	0	0	0	675,000
Commercial (number of buildings)	1,050	25,200	26,250	31,500	36,750	42,000	47,250	0	0	0	210,000
Government (number of buildings)	44	1,067	1,111	1,333	1,556	1,778	2,000	0	0	0	8,889
Increase in number of houses/buildings/facilities with access to clean energy resulting from the policy (houses/buildings)	28,709	689,027	717,736	861,283	1,004,831	1,148,378	1,291,925	0	0	0	5,741,889

Impact category #5	**Capacity, skills, and knowledge development**
Indicator	Number of new skilled trainees and workers on the ground because of the policy per year
Specific impact	Increase in training for skilled workers in solar relevant sectors
Assessment method	Deemed estimates method
Equation	Target for new skilled trainees and workers on the ground per year
Parameters needed	Target for new skilled trainees and workers on the ground per year

Assumptions	The solar PV incentive policy includes targets to train new workers to support the policy goals.									
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Number of new skilled trainees and workers on the ground because of the policy per year	460	5200	6000	8400	8000	8000	4000	0	0	0	40,060

Impact category #6	**Jobs**									
Indicator	Change in jobs resulting from the policy (jobs/year)									
Specific impacts	Increased jobs in the solar panel manufacturing, construction and installation, and operation and maintenance sectors Reduced jobs in fossil fuel sectors									
Assessment method	Deemed estimates method									
Equation	Total jobs = Total capacity (MW) * Jobs per MW									
Parameters needed	Jobs per MW = Manufacturing (11 jobs/MW, out of which 40% are domestic; Installation (13 jobs/MW); O&M (3.5 jobs/MW), Job in fossil industry (1 job/MW) Installed capacity (MW)									
Assumptions	It is assumed that 70% of planned capacity will likely come from new fossil-based power plants.									
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Solar panel manufacturing	879	21,097	21,976	26,371	30,766	35,162	39,557	0	0	0	175,808
Construction and installation	2,640	63,360	66,000	79,200	92,400	105,600	118,800	0	0	0	528,000
Operation and maintenance	702	16,848	17,550	21,060	24,570	28,080	31,590	0	0	0	140,400
Fossil fuel sector	-139	-3,143	-3,103	-3,555	-3,984	-4,393	-4,789	0	0	0	-23,106
Net change in jobs (jobs/year)	4,082	98,162	102,423	123,076	143,753	164,448	185,158	0	0	0	821,102

Impact category #7	**Income**
Indicator	Savings in annual electric bill for households and businesses (USD/year)
Specific impact	Increased income households, institutions and other organizations due to reduction in energy costs

Assessment method	Deemed estimates method										
Equation	Savings on electricity bill = Total electricity generated from solar rooftop by sector (kWh) * Tariff by sector (USD/kWh)										
Parameters needed	Total units generated (kWh) (see Table A.4) Tariff: household and institutional (USD 0.08/kWh); commercial (USD 0.12/kWh)										
Assumptions	The annual escalation in tariff is assumed to be 4%										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
National reduction in electric bills (million USD/year)	27	566	1178	1960	2930	4107	5512	4586	3815	3174	27,855

Impact category #8	**Energy independence**										
Indicator #1	Reduction in coal imports (t/year)										
Specific impact	Increased energy independence from reduced imports of coal										
Assessment method	Deemed estimates method										
Equation	Reduction in coal imports = Electricity generated from new solar PV (MWh) * coal consumption per unit of electricity (t/MWh) * coal import ratio (%)										
Parameters needed	Electricity generated from new solar PV (MWh/year) (see Table A.4 Coal consumption per unit of electricity (t/MWh) – (0.74 t/MWh) Coal import ratio (%) – 24%										
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. It is also assumed the coal reduction will have a proportional impact on import and domestic coal. It is further assumed coal efficiency and coal import ratio will stay the same for the next ten years.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Reduction in coal imports from the policy (t/year)	47,121	1,178,021	2,356,042	3,769,667	5,418,896	7,303,729	9,424,166	9,424,166	9,424,166	9,424,166	57,770,140

APPENDIX B: STAKEHOLDER PARTICIPATION DURING THE ASSESSMENT PROCESS

This appendix provides an overview of the ways that stakeholder participation can enhance the sustainable development impact assessment process and the contribution of policies and actions to sustainable development. Table B.1 provides a summary of the steps in the assessment process where stakeholder participation is recommended and why it is important, explaining where relevant guidance can be found in the ICAT *Stakeholder Participation Guide*.

Table B.1: List of steps where stakeholder participation is recommended in the impact assessment

Step of sustainable development impact assessment	**Why stakeholder participation is important at this step**	**Relevant chapters in *Stakeholder Participation Guide***
Chapter 2 – Objectives of assessing sustainable development impacts	Ensure that the objectives of the assessment respond to the needs and interests of the stakeholders	Chapter 5 – Identifying and analyzing stakeholders
Chapter 3 – Key concepts, steps and assessment principles 3.4 Planning the assessment	Build understanding, participation and support for the policy or action among stakeholders Ensure conformity with national and international laws and norms, as well as donor requirements related to stakeholder participation Identify and plan how to engage stakeholder groups who may be affected or may influence the policy or action Coordinate participation at multiple steps for this assessment with participation in other stages of the policy design and implementation cycle and other assessments	Chapter 4 – Planning effective stakeholder participation Chapter 5 – Identifying and analyzing stakeholders Chapter 6 – Establishing multi-stakeholder bodies/structures Chapter 9 – Establishing grievance redress mechanisms
Chapter 5 - Choosing which impact categories and indicators to assess	Enhance completeness by including impact categories that are relevant and significant for the priorities and concerns of diverse stakeholder groups Identify and address possible unintended or negative impacts early on Identify credible sources of information for selected indicators	Chapter 5 – Identifying and analyzing stakeholders Chapter 7 – Providing information Chapter 8 – Designing and conducting consultations
Chapter 6 – Identifying specific impacts within each impact category	Strengthen identification and assessment of sustainable development impacts Enhance completeness by identifying impacts for different stakeholder groups Integrate stakeholder insights about cause-effect relationships between the policy or action and impacts	Chapter 8 – Designing and conducting consultations

	Identify and address possible unintended or negative impacts	
Chapter 7 – Qualitatively assessing impacts	Ensure the assessment period responds to stakeholders' needs Gain insights into a policy's specific local context and impacts Strengthen evidence-base of the assessment Integrate stakeholder insights on likelihood and magnitude of impacts, and their nature of change	Chapter 8 – Designing and conducting consultations
Chapter 12 – Monitoring performance over time	Ensure relevance and completeness of indicators to be monitored Ensure monitoring frequency addresses the needs of decision makers and other stakeholders Assess impacts on different stakeholder groups to identify and manage tradeoffs	Chapter 8 – Designing and conducting consultations
Chapter 13 – Reporting	Raise awareness of benefits and other impacts to build support for the policy or action Ensure reports and summaries properly characterizes the impacts for each category Inform decision makers and other stakeholders about impacts, including differentiated impacts on different stakeholder groups to allow adaptive management to reduce negative and enhance positive impacts Increase accountability and transparency and thereby credibility and acceptance of the assessment	Chapter 7 – Providing information
Chapter 14 – Evaluating tradeoffs and using results	Ensure diverse perspectives are considered when doing a cost effectiveness analysis, cost-benefit analysis, or multi-criteria analysis, especially regarding subjective elements such as valuation of social and environmental benefits and weighting the importance of different impacts Ensure diverse perspectives are considered, especially those of affected communities, when making decision about whether to continue or discontinue policies, make changes to policies, or implement new policies	Chapter 7 – Providing information Chapter 8 – Designing and conducting consultations

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APPENDIX C: QUALITATIVE RESEARCH METHODS

Qualitative methods can be flexible and may involve several methods and approaches such as stakeholder interviews, surveys, focus groups, case studies, literature review and direct observations, using narrative descriptions.

Interviews and case studies are useful to gain insights into a policy's specific local context and impacts as well as the attitudes, experiences, and perspectives of affected stakeholders and participants. On the other hand, they tend to be limited in coverage therefore non-representative of broader conditions or impacts, which can produce less reliable results with less ability to generalize and quantify impacts. Therefore, it can be helpful to use a combination of qualitative and quantitative data and approaches.

Quantitative approaches should be used if a user wants to conduct numerical or statistical analysis, wants to be precise, knows what can be measured, or wants to cover a large group. On the other hand, qualitative approaches should be used if a user wants narrative or in-depth information, is not sure what can be measured, or does not need to quantify the results (Imas and Rist 2009).

Qualitative methods are used specifically to consider the "why" questions that quantitative methods typically cannot answer:

- Why does the policy or action work (or not work)?
- How does the policy or action achieve its goals?
- Why does it work for some policies or actions (or in some situations) and not others?
- What are/were the needs of the population that were not anticipated?
- What were the additional unintended and/or unexpected positive or negative consequences?

Qualitative methods (especially story-based approaches) can yield powerful stories which can be useful for media reports and are often preferred by policymakers and politicians. Hard data is not always the most convincing evidence for all audiences.

The approach used will depend on the goals of the assessments. To determine which type of data to collect, users need to determine what is most important to the policy or action under assessment. Is the goal to collect numerical data on the use of solar PV or provide a more in-depth understanding of the situation in the poorest urban areas? Sometimes both approaches are important, but resource availability requires that one must be given priority.

Forms of data collection

Data collection approaches can be considered structured or semi-structured. A structured data collection approach requires that all data be collected in exactly the same way. Structured data collection allows users to compare findings at different sites in order to draw conclusions about what is working where. A structured approach is also important when comparing alternative interventions to determine which is most cost-effective. Structured data collection approach is mostly used to collect quantitative data when the user has a large sample or population, knows what needs to be measured, needs to show results numerically, or needs to make comparisons across different sites or interventions.

A semi-structured data collection approach may be systematic and follow general procedures, but data are not collected in the same way every time. Semi-structured interviews, for example, are often based on a predetermined set of broad questions, but the order of presenting them may depend on circumstances. Moreover, some responses provided can be probed with additional questions developed during the interview. This approach is more open and fluid than the structured approach. The semi-structured approach allows respondents to tell users what they want to know in their own way.

Semi-structured data collection methods are generally qualitative. They are used when a user is conducting exploratory work in a new development area, seeks to understand themes or issues, or wants participant narratives or in-depth information. They can also be used to understand results of structured data collection that are unexpected and not well understood or to give nuanced examples to supplement the findings from a structured data collection effort.

For example, in an evaluation of a community-driven development project, evaluators might choose a semi-structured approach to data collection. Because such programmes give control of planning decisions to local groups, it is appropriate for the evaluator to use a semi-structured approach to learn more about how decisions are made as well as to solicit community members' views of the process and project outcomes.

Data can also be collected obtrusively or unobtrusively. Obtrusive methods are observations made with the participants' knowledge. Such methods are used to measure perceptions, opinions, and attitudes through interviews, surveys and focus groups. Observations made with the knowledge of those being observed are also obtrusive. Unobtrusive methods are observations made without the knowledge of the participant. Examples of unobtrusive methods include using data from documents or archives and observing participants without their knowledge.

Data collection usually includes both quantitative and qualitative data, but one approach may be dominant. The two approaches can be characterized in the following ways.

Table C.1: Summary of quantitative and qualitative approaches

A quantitative approach	A qualitative approach
is more structured emphasises reliability is harder to develop is easier to analyze	is less structured is easier to develop can provide nuanced data (idiosyncratic data on each unit being studied) more labour intensive to collect and analyze data emphasises validity

Source: Imas and Rist (2009)

Box C.1 provides a checklist to help decide which data collection approaches are most appropriate.

Box C.1: 20-question qualitative checklist

1. Does the programme emphasize individual outcomes—that is, are different participants expected to be affected in qualitatively different ways? Is there a need or desire to describe and evaluate these individualised client outcomes?
2. Are decision makers interested in elucidating and understanding the internal dynamics of programmes—programme strengths, programme weaknesses and overall programme processes?
3. Is detailed, in-depth information needed about certain client cases or programme sites (e.g., particularly successful cases, unusual failures or critically important cases) for programmatic, financial or political reasons?

4. Is there interest in focusing on the diversity among, idiosyncrasies of, and unique qualities exhibited by individual clients and programmes (as opposed to comparing all clients or programmes on standardised, uniform measures)?
5. Is information needed about the details of programme implementation: What do clients in the programme experience? What services are provided to clients? How is the programme organized? What do staff members do? Do decision makers need to know what is going on in the programme and how it has developed?
6. Are the programme staff and other stakeholders interested in collection of detailed, descriptive information about the programme for the purpose of improving the programme (i.e., is there interest in formative evaluation)?
7. Is there a need for information about the nuances of programme quality— descriptive information about the quality of programme activities and outcomes, not just levels, amounts or quantities of programme activity and outcomes?
8. Does the programme need a case-specific quality assurance system?
9. Are legislators or other decision makers or funders interested in having evaluators conduct programme site visits so that the evaluations can be the surrogate eyes and ears for decision makers who are too busy to make such site visits themselves and who lack the observing and listening skills of trained evaluators? Is legislative monitoring needed on a case-by-case basis?
10. Is the obtrusiveness of evaluation a concern? Will the administration of standardised measuring instruments (questionnaires and tests) be overly obtrusive in contrast to data-gathering through natural observations and open-ended interviews? Will the collection of qualitative data generate less reactivity among participants than the collection of quantitative data? Is there a need for unobtrusive observations?
11. Is there a need and desire to personalize the evaluation process by using research methods that emphasize personal, face-to-face contact with the programme—methods that may be perceived as “humanistic” and personal because they do not label and number the participants, and they feel natural, informal and understandable to participants?
12. Is a responsive evaluation approach appropriate—that is, an approach that is especially sensitive to collecting descriptive data and reporting information in terms of differing stakeholder perspectives based on direct, personal contact with those different stakeholders?
13. Are the goals of the programme vague, general and nonspecific, indicating the possible advantage of a goal-free evaluation approach that would gather information about what effects the programme is actually having rather than measure goal attainment?
14. Is there a possibility that the programme may be affecting clients or participants in unanticipated ways and/or having unexpected side effects, indicating the need for a method of inquiry that can discover effects beyond those formally stated as desirable by programme staff (again, an indication of the need for some form of goal-free evaluation)?
15. Is there a lack of proven quantitative instrumentation for important programme outcomes? Is the state of measurement science such that no valid, reliable, and believable standardised instrument is available or readily capable of being developed to measure quantitatively the particular programme outcomes for which data are needed?
16. Is the evaluation exploratory? Is the programme at a pre-evaluation stage, where goals and programme content are still being developed?
17. Is an evaluability assessment needed to determine a summative evaluation design?
18. Is there a need to add depth, detail, and meaning to statistical findings or survey generalizations?
19. Has the collection of quantitative evaluation data become so routine that no one pays much attention to the results anymore, suggesting a possible need to break the old routine and use new methods to generate new insights about the programme?
20. Is there a need to develop a programme theory grounded in observations of programme activities and impacts, and the relationship between treatment and outcomes?

1 *Source:* Patton 1987

In order to collect data on a policy or action, it is important to apply rules in the data collection process. Some of the data collection rules are in Box C.2.

Box C.2: Rules for collecting data

Evaluators should apply the following rules in collecting data:

- Use multiple data collection methods when possible.
- Use available data if possible (doing so is faster, less expensive, and easier than generating new data).
- If using available data, find out how earlier evaluators collected the data, defined the variables, and ensured accuracy of the data. Check the extent of missing data.
- If original data must be collected, establish procedures and follow them (protocol); maintain accurate records of definitions and coding; pretest; and verify the accuracy of coding and data input.
- Collect data in a disaggregated manner, to understand if there are differences in views, impacts, and economic opportunities between women/men, ethnicities, and other groups

Source: Adapted from Imas and Rist (2009)

Sampling in qualitative impact assessment

Qualitative impact assessment involves engaging with people and talking to them. This can be time consuming and generate a large amount of data to analyze. For example, policies and actions are likely to affect thousands of people and setting up interviews and analysing transcripts for each of them will be expensive and may divert user from other tasks. Sampling systematically enables the user to select a representative smaller group of participants from the overall population who can give a reliable account of the bigger picture.

The way users select the sample has implications for the conclusions users can draw. Sampling for qualitative impact assessment has a slightly different aim to sampling in quantitative impact assessment. In quantitative impact assessment, the goal is to draw a sample which is mathematically representative of the whole, so can be used to draw firm conclusions about the population. In qualitative impact assessment, precise or definitive conclusions are less important so sample sizes can be smaller—the goal is to learn about the range of experiences.

Although samples can be smaller, it is still vital to ensure the sample resembles the whole group as closely as possible. Therefore, users should:

- Have a clear idea of the characteristics of the group they are assessing.
- Create a sample that attempts to reflect the range of different people in the group— for example if the policy or action impacts equal numbers of women and men, the qualitative sample should contain equal numbers of women and men.

A particularly important goal of sampling in qualitative impact assessment is involving people who have been less engaged in the policy or action and those who do not volunteer themselves to be consulted. This is important because if the user only collects information from those who have been affected by the policy or action or are the first to volunteer, then the sampling will not be representative of the population as a whole and the assessment will not be credible.

Longitudinal impact assessment

To show change over time, it is useful to speak to the same people at multiple points in time to see how their experiences have changed, rather than collecting information only once. Longitudinal qualitative impact assessment provides nuanced information on people's perspectives and how and why they have changed over time, which can give a fuller assessment of policy impact.

Avoiding bias

The data collection technique chosen will depend on the situation. No matter which method is chosen to gather data from people, all the information gathered is potentially subject to bias**.** Bias means that when asked to provide information about themselves or others, respondents may or may not tell the whole truth, unintentionally or intentionally. They may distort the truth because they do not remember accurately or fear the consequences of providing a truthful answer. They may also be embarrassed or uncomfortable about admitting things they feel will not be socially acceptable. All self-reported data are vulnerable to this problem.

Selection bias—the fact that the people who choose to participate in the survey may be different from those who choose not to participate—may also exist. This is often a challenge in surveys, interviews and focus groups. Those who volunteer to participate may be systematically different from those who do not.

Tools for collecting data

Typically, more than one data collection approach is used to answer different impact assessment questions or provide multiple sources of data in response to a single impact assessment question. Users may, for example, collect available data for solar PV installation records, interview buyers on the use of solar PV, and survey users. Sometimes investigators use focus groups or conduct case studies to help develop themes for a questionnaire or to make sense of survey results.

Collecting the same information using different methods in order to increase the accuracy of the data is called a triangulation of methods*.* Evaluators use triangulation to strengthen findings. The more information gathered using different methods that support a finding, the stronger the evidence is.

The following data collection tools can be used depending on which are most appropriate for a given situation:

- Tool 1: Surveys
- Tool 2: Interviews
- Tool 3: Focus groups
- Tool 4: Participatory methods
- Tool 5: Ethnography
- Tool 6: Documents and other sources
- Tool 7: Case study approaches

Each is described further below.

1. Surveys

Surveys can be excellent tools for collecting data about people's perceptions, opinions and ideas. They are less useful in measuring behaviour, because what people say they do may not reflect what they actually do. Surveys can be structured or semi-structured, administered in person or by telephone, or self-administered by having people respond to a mailed or web form. Surveys can poll a sample of the population or all of the population. There are two types of surveys: structured and semi-structured surveys.

- **Structured surveys** are surveys that include a range of response choices, one or more of which respondents select. All respondents are asked exactly the same questions in exactly the same way and given exactly the same choices to answer the questions.
- **Semi-structured surveys** are surveys that ask predominantly open-ended questions. They are especially useful when the user wants to gain a deeper understanding of reactions to experiences or to understand the reasons why respondents hold particular attitudes. Semi-structured surveys should have a clearly defined purpose. It is often more practical to interview people about the steps in a process, the roles and responsibilities of various members of a community or team, or a description of how a programme works than to attempt to develop a written survey that captures all possible variations.

Box C.3 highlights the advantages of structured and semi-structured surveys.

Box C.3: Structured and semi-structured survey questions

Examples of structured questions include the following:

1. Has this workshop been useful in helping you to learn how to evaluate your programme?
   - Little or no extent
   - Some extent
   - Moderate extent
   - Great extent
   - Very great extent
   - No opinion
   - Not applicable
2. Do all people in the village have a source of clean water within 500 metres of their homes?
   - Yes
   - No
   - Examples of semi-structured questions include the following:
   - What have you learned from the programme evaluation workshop that you have used on the job?
   - Where are the sources for clean water for the villagers?

Source: Imas and Rist 2009

When conducting surveys, it is important to ensure representative samples to draw meaningful conclusions about the broader population of interest and avoid selection bias. Obtaining a credible and representative response from the population of interest can sometimes be time consuming and expensive.

2. Interviews

One of the most common methods of collecting qualitative data is interviewing people—that is, talking to them one-to-one. Interviews can be undertaken in person, by phone or over the internet, for example through Skype. Table C.2 describes three different approaches to interviewing.

Table C.2: Interview approaches

	Structured	Semi-structured	Unstructured
Description	Questions are agreed in advance; interviewers stick rigidly to a script.	The main questions are fixed, but follow-up questions can be improvised.	Interviewer may have a list of broad topics, but no set questions.
When to Use	Useful for collecting standardized, survey-style information.	Most common in qualitative work; allows expanded opinions on the topics of the interview.	More appropriate for very exploratory research questions or academic research; direction is set by the interviewee, rather than the interviewer, so topics vary.
Sampling	Sample sizes can be large and commitment/time is minimal. Random sampling is recommended for maximum rigour.	Longer interviews require greater commitment/time, so more it is suited to smaller samples targeting particular participants.	Longer interviews require greater commitment, so it is more suited to smaller samples targeting particular participants.
Transcribing	Easy because all responses are on the same template.	Mixed	Time consuming, full transcription or detailed notes and recording may be needed.
Data analysis	Easy to compare and analyze, but detail and nuance limited.	Mixed	Difficult to analyze, but detailed and nuanced data.

Source: Adapted from Arksey and Knight (1999)

Of the options in Table C.2, semi-structured interviewing is often the most promising approach for carrying out qualitative impact assessment. The approach allows the user to guide the direction and themes of the interview, while still allowing the respondent to articulate their experiences in detail.

Another valuable approach is to combine structured ‘tick box’ type questions with more open-ended questions within the same interview. This will provide both numerical impact results alongside more nuanced qualitative information.

In qualitative assessment impact, interview questions should be:

- **Open ended** to encourage full responses. Minimize yes/no questions and instead try to start questions beginning with how, what, why and where to encourage interviewees to explore their answers.
- **Clear and in plain English**. Avoid long or complex questions. Instead of asking ‘What was the impact of…’ try ‘Did anything change after…’.
- **Framing rather than leading.** Do not point interviewees towards a particular response. Instead of ‘Did you feel better after…’, ask ‘How did you feel after…’
- **Neutral.** Using emotive language or asking in a way that sounds accusatory may close down people’s responses. Instead of ‘Did you do...’, ask ‘How many times have you done…’ to imply that others also do so.

Source: Imas and Rist 2009

3. Focus groups

Focus groups are interviews with small groups of people. Numbers should be restricted to around six to eight participants in order to prevent sub-groups emerging and to make transcribing easier. In some cases, mini-groups of three or four may be most suitable.

Focus groups may be useful:

- Where time is too limited to conduct individual interviews
- For a collective discussion amongst a similar or differing group, since the group dynamics can encourage more lively and interesting discussions
- Where participants do not feel confident about taking part in individual interviews

Group interviews provide group data, since participants play off against each other. This can be positive, allowing ideas to develop and be discussed in detail. However, it is important for the user to note that an individual’s response in a focus group cannot be considered in the same way as an individual interview. Participants influence each other, and responses should be seen in that context. When analysing focus group data, avoid talking about magnitude. For example, three out of six participants making a statement does not necessarily mean that 50% of participants agree with it, particularly as they can be influenced by each other.

Focus groups can have disadvantages, however. They can be hard to set-up and organize and difficult to moderate. They are not good for discussing sensitive or personal topics. Unless the user has the skills at drawing out quieter members of the group, the views can be strongly influenced by the most vocal or dominant participants of the group.

4. Participatory methods

Impact assessment is participatory when the population under study is actively involved in designing the assessment or collecting data. For example, participatory methods have been used in international development projects to give local people a say in how projects are run, and to use local knowledge to better tailor the project and its measurement to specific contexts.

Participatory methods can be used to collect qualitative evidence of impact. Project participants gather data using methods like photography or video, giving a highly personal account of their own lives and experiences. Other participatory methods include creating diaries or “route-maps” with users, in which they plot events on a timeline. These methods can help to highlight the link between certain life events and levels of engagement with a project, giving a sense of external influences.

Participatory methods can give nuanced information on the effects of the policy or action, but are resource intensive and lack objectivity or any method of comparing impacts on different individuals.

5. Ethnography

Ethnography involves observing things from the point of view of those being studied. Rather than talking to people about their experiences, the ethnographer joins in and sees it first-hand. For example, it may apply to understand community services to help understand how people are engaging with staff.

6. Documents and other sources

Though qualitative data collected face-to-face is ideal, in some cases users may not need to collect data directly. Instead, the required information may be found in existing documents. For example, some qualitative data may be available from open-ended questions within a quantitative survey or from key workers' case notes. Similarly, media articles about a particular topic can be useful, or users may want to analyze local strategy documents to show variation in attitudes or services.

Although this data is already available, collecting and analysing it systematically is still important. It will help to show that users have included data from all participants or a systematically selected sample or that users have completed a thorough search for publicly available material.

7. Case study approaches

Case studies are widely used in impact assessment. They are not a method of data collection in themselves, but rather an approach that focusses on gathering a range of evidence about a small number of cases. It shows the policy or action impact in a balanced way through case studies. Case studies should be chosen systematically, as would be done for a sample for interviews or surveys. In particular, it is important to capture a wide spectrum of experiences of the policy or action, not just the cases in which the project worked best.

To create credible case studies, users should choose a small sample of cases randomly or based on certain criteria. Users can use the methods described above to gather more information about each selected case (e.g., interviews, focus groups, observation and quantitative data alongside any documents relating to the case). The aim is to create a nuanced description of how a policy or action has (or has not) affected the individuals and the reasons for change, as well as any other factors that are important.

Using multiple methods

In general, many of the above techniques for collecting data can be utilized. In qualitative assessments, partly as a quality-control mechanism, the use of multiple methods (also called "mixed methods" especially when in conjunction with quantitative methods) is common. It also yields more robust results on the basis of "triangulation"—that different methods should be used, with different sources of data, and from different perspectives to gain the best understanding and produce the most credible results.

ABBREVIATIONS AND ACRONYMS

ADALY	Averted disability-adjusted life year
BAU	business as usual
Btu	British thermal unit
CBA	cost-benefit analysis
CDM	Clean Development Mechanism
CEA	cost-effectiveness analysis
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
DALY	Disability-adjusted life year
dB	decibel
dv	deciview
FAO	Food and Agriculture Organization of the United Nations
g	grams
GDP	gross domestic product
GHG	greenhouse gas
GNH	gross national happiness
GNI	gross national income
GS	Gold Standard
GW	gigawatt
GWP	global warming potential
ha	hectare
HCFC	hydrochlorofluorocarbon
HFC	hydrofluorocarbon
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
km	kilometre
kWh	kilowatt-hour
kWp	kilowatt-peak
LCA	life cycle assessment
m^3	cubic metre

MSY	maximum sustainable yield
MCA	multicriteria analysis
Mt	million tonnes
$MtCO_2e$	million tonnes of carbon dioxide equivalent
MWp	megawatt-peak
NAMA	nationally appropriate mitigation action
NF_3	nitrogen trifluoride
NGO	non-governmental organization
NH_3	ammonia
NMVOC	non-methane volatile organic compound
NO_X	nitrogen oxide
N_2O	nitrous oxide
O&M	operations and maintenance
OECD	Organisation for Economic Co-operation and Development
PAH	polycyclic aromatic hydrocarbons
PFC	perfluorocarbon
pH	potential of hydrogen
PM	particulate matter
POP	Persistent organic pollutants
PPP	purchasing power parity
PV	photovoltaic
QA	quality assurance
QALY	Quality-adjusted life year
QC	quality control
R	Indian rupees
RCT	randomized control trials
SDG	Sustainable Development Goal
SF_6	sulphur hexafluoride
SLCP	short-lived climate pollutant
SO_2	sulfur dioxide
t	tonne (metric ton)
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollars
WRI	World Resources Institute

GLOSSARY

Absolute value	The non-negative value of a number without regard to its sign. For example, the absolute value of 5 is 5, and the absolute value of -5 is also 5.
Adopted policies and actions	Policies and actions for which an official government decision has been made and there is a clear commitment to proceed with implementation but that have not yet been implemented
Assessment boundary	The scope of the assessment in terms of the range of dimensions, impact categories and specific impacts that are included in the assessment
Assessment period	The time period over which impacts resulting from the policy or action are assessed
Assessment report	A report, completed by the user, that documents the assessment process and the greenhouse gas, sustainable development and/or transformational impacts of the policy or action
Baseline scenario	A reference case that represents the events or conditions most likely to occur in the absence of the policy or action (or package of policies or actions) being assessed
Baseline value	The value of a parameter in the baseline scenario
Bottom-up data	Data that are measured monitored, or collected at the facility, entity, or project level
Causal chain	A conceptual diagram tracing the process by which the policy or action leads to impacts through a series of interlinked logical and sequential stages of cause-and-effect relationships
Dimension	An overarching category of sustainable development impacts. There are three dimensions: environmental, social, and economic.
Drivers	Socioeconomic or other conditions or other policies and actions that affect an impact category. For example, economic growth is a driver of increased energy consumption. Drivers are divided into two types: other policies or actions and non-policy drivers.
Dynamic	A descriptor for a parameter that changes over time.
Ex-ante assessment	The process of assessing expected future impacts of policies and actions (i.e., a forward-looking assessment)
Ex-ante baseline scenario	A forward-looking baseline scenario, based on forecasts of external drivers (such as projected changes in population, economic activity or other drivers that affect emissions), in addition to historical data
Expert judgment	A carefully considered, well-documented qualitative or quantitative judgment made in the absence of unequivocal observational evidence by a person or persons who have a demonstrable expertise in the given field (IPCC 2006). The user can apply their own expert judgment or

consult experts. Expert judgment can be strengthened through expert elicitation methods to avoid bias.

Ex-post assessment The process of assessing historical impacts of policies and actions (i.e., a backward-looing assessment)

Ex-post baseline scenario A backward-looking baseline scenario that is established during or after implementation of the policy or action

Impact assessment The qualitative or quantitative assessment of impacts resulting from a policy or action, either ex-ante or ex-post

Impact category A type of sustainable development impact (environmental, social or economic) affected by a policy or action

Implemented policies Policies and actions that are currently in effect, as evidenced by one or more of the and actions following: (a) relevant legislation or regulation is in force, (b) one or more voluntary agreements have been established and are in force, (c) financial resources have been allocated, or (d) human resources have been mobilized

Independent policies Policies that do not interact with each other, such that the combined effect of implementing the policies together is equal to the sum of the individual effects of implementing them separately

Indicator For quantitative impact assessment: A metric that can be estimated to indicate the impact of a policy or action on a given impact category. For monitoring performance over time: A metric that can be monitored over time to enable tracking of changes toward targeted outcomes.

Indicator value The value of an indicator. For example, 500 is an indicator value for the indicator “number of jobs created.”

In-jurisdiction impacts Impacts that occur inside the geopolitical boundary over which the implementing entity has authority, such as a city boundary or national boundary

Intended impacts Impacts that are intentional based on the original objectives of the policy or action. In some contexts, these are referred to as primary impacts.

Interacting policies Policies that produce total effects, when implemented together, that differ from the sum of the individual effects had they been implemented separately

Intermediate impacts Changes in behaviour, technology, processes, or practices that result from the policy or action, which lead to sustainable development impacts

Jurisdiction The geographic area within which an entity’s (such as a government’s) authority is exercised

Life-cycle impacts Changes in upstream and downstream activities, such as extraction and production of energy and materials, or effects in sectors not targeted by the policy, resulting from the policy or action

Long-term impacts	Impacts that are more distant in time, based on the amount of time between implementation of the policy and the impact
Macroeconomic impacts	Changes in macroeconomic conditions—such as GDP, income, employment or structural changes in economic sectors—resulting from the policy or action
Market impacts	Changes in supply and demand, prices, market structure or market share resulting from the policy or action.
Model uncertainty	Uncertainty resulting from limitations in the ability of modelling approaches, equations or algorithms to reflect the real world.
Monitoring period	The time over which the policy is monitored, which may include pre-policy monitoring and post-policy monitoring in addition to the policy implementation period
Net impact	The aggregation of all impacts, including positive impacts and negative impacts, within a given impact category
Negative impacts	Impacts that are perceived as unfavourable from the perspectives of decision makers and stakeholders
Non-policy drivers	Conditions other than policies and actions, such as socioeconomic factors and market forces, that are expected to affect the impact categories included in the assessment boundary. For example, energy prices and weather are non-policy drivers that affect demand for heating.
Other policies or actions	Policies, actions and projects—other than the policy or action being assessed—that are expected to affect the impact categories included in the assessment boundary
Out-of-jurisdiction impacts	Impacts that occur outside the geopolitical boundary over which the implementing entity has authority, such as a city boundary or national boundary
Overlapping policies	Policies that interact with each other and that, when implemented together, have a combined effect less than the sum of their individual effects when implemented separately. This includes both policies that have the same or complementary goals (such as national and subnational energy efficiency standards for appliances), as well as counteracting or countervailing policies that have different or opposing goals (such as a fuel tax and a fuel subsidy).
Parameter	A variable or other type of data needed to calculate the value of an indicator, in cases where the indicator value cannot be directly measured.
Parameter uncertainty	Uncertainty regarding whether a parameter value used in the assessment accurately represents the true value of a parameter
Parameter value	The value of a parameter. For example, 5 is a parameter value for the parameter "tonnes of SO_2 emitted per kWh of electricity."

Peer-reviewed	Literature (such as articles, studies or evaluations) that has been subject to independent evaluation by experts in the same field prior to publication
Planned policies and actions	Policy or action options that are under discussion and have a realistic chance of being adopted and implemented in the future but that have not yet been adopted or implemented
Policy or action	An intervention taken or mandated by a government, institution or other entity, which may include laws, regulations and standards; taxes, charges, subsidies and incentives; information instruments; voluntary agreements; implementation of new technologies, processes or practices; and public or private sector financing and investment, among others
Policy implementation period	The time period during which the policy or action is in effect
Policy scenario	A scenario that represents the events or conditions most likely to occur in the presence of the policy or action (or package of policies or actions) being assessed. The policy scenario is the same as the baseline scenario except that it includes the policy or action (or package of policies/actions) being assessed.
Positive impacts	Impacts that are perceived as favourable from the perspectives of decision makers and stakeholders
Propagated parameter uncertainty	The combined effect of each parameter's uncertainty on the total result
Proxy data	Data from a similar process or activity that are used as a stand-in for the given process or activity
Qualitative assessment	An approach to impact assessment that involves describing the impacts of a policy or action on selected impact categories in numerical terms
Qualitative assessment boundary	The scope of the qualitative assessment in terms of the range of dimensions, impact categories and specific impacts that are included in the qualitative assessment
Quantitative assessment	An approach to impact assessment that involves estimating the impacts of a policy or action on selected impact categories in quantitative terms
Quantitative assessment boundary	The scope of the quantitative assessment in terms of the range of dimensions, impact categories, specific impacts and indicators that are included in the quantitative assessment and estimated.
Regression analysis	A statistical method for estimating the relationships among variables (in particular, the relationship between a dependent variable and one or more independent variables.
Reinforcing policies	Policies that interact with each other and that, when implemented together, have a combined effect greater than the sum of their individual effects when implemented separately

Scenario uncertainty	Variation in calculated emissions resulting from methodological choices, such as selection of baseline scenarios
Sensitivity analysis	A method to understand differences resulting from methodological choices and assumptions and to explore model sensitivities to inputs. The method involves varying the parameters to understand the sensitivity of the overall results to changes in those parameters.
Short-term impacts	Impacts that are nearer in time, based on the amount of time between implementation of the policy and the impact
Specific impact	A specific change that results from a policy or action (within a given impact category)
Stakeholders	People, organizations, communities or individuals who are affected by and/or who have influence or power over the policy
Static	A descriptor for a parameter that does not change over time
Sustainable development impacts	Changes in environmental, social or economic conditions that result from a policy or action, such as changes in economic activity, employment, public health, air quality and energy independence
Technology impacts	Changes in technology such as design or deployment of new technologies resulting from the policy or action
Top-down data	Macro-level statistics collected at the jurisdiction or sector level, such as energy use, population, GDP or fuel prices
Trade impacts	Changes in imports and exports resulting from the policy or action
Uncertainty	1. Quantitative definition: Measurement that characterizes the dispersion of values that could reasonably be attributed to a parameter. 2. Qualitative definition: A general term that refers to the lack of certainty in data and methodological choices, such as the application of non-representative factors or methods, incomplete data, or lack of transparency.
Unintended impacts	Impacts that are unintentional based on the original objectives of the policy or action. In some contexts, these are referred to as secondary impacts.

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