INITIATIVE FOR
Climate Action
Transparency

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Renewable Energy Guidance

Guidance for assessing the greenhouse gas impacts of renewable energy policies

May 2018

PART I: INTRODUCTION, OBJECTIVES, STEPS AND OVERVIEW OF RENEWABLE ENERGY POLICIES

1. INTRODUCTION

With the adoption of the Paris Agreement in 2015, governments around the world are increasingly focused on implementing policies and actions that achieve greenhouse gas (GHG) mitigation objectives. Electricity generation accounts for approximately 40% of global GHG emissions[1] and countries are increasingly implementing renewable energy policies to accelerate the move from fossil fuel to renewable sources of electricity generation. In this context, there is an increasing need to assess and communicate the impacts of renewable energy policies and actions to ensure they are effective in delivering GHG mitigation and helping countries meet their sectoral targets and commitments.

Purpose of the guidance

This document provides methodological guidance for assessing the GHG impacts of renewable energy (RE) policies. The guidance provides a stepwise approach for estimating the effects of policy design characteristics, economic and financial factors, and other barriers on the potential for RE policies to achieve their maximum implementation potential. Guidance is provided to convert this impact (expressed in terms of newly installed renewable energy capacity or generated electricity) into GHG emission reductions.

This guidance is part of the Initiative for Climate Action Transparency (ICAT) series of guidance for assessing the impacts of policies and actions. It is intended to be used in combination with any other ICAT guidance documents that users choose to apply. The series of guidance is intended to enable users that choose to assess GHG impacts, sustainable development impacts and transformational impacts of a policy to do so in an integrated and consistent way within a single impact assessment process. Refer to the ICAT *Introductory Guide* for more information about the ICAT guidance documents and how to apply them in combination.

Intended users

This guidance is intended for use by policymakers and practitioners seeking to estimate GHG mitigation impacts in the context of Nationally Determined Contribution (NDC) development and implementation, national low carbon strategies, and Nationally Appropriate Mitigation Actions (NAMAs) and other mechanisms. The primary intended users are developing country governments and their partners who are implementing and assessing RE policies. Throughout the guidance, the term “user” refers to the entity implementing the guidance.

The main emphasis of the guidance is on the assessment of GHG impacts. Impact assessment can also inform and improve the design and implementation of policies. Thus, the intended users include any

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[1] IEA 2015. Available at: https://www.iea.org/publications/freepublications/publication/WEO2015SpecialReportonEnergyandClimateChange.pdf.

stakeholders involved in the design and implementation of national renewable energy policies, strategies, NDCs or NAMAs, including research institutions, businesses and non-governmental organisations.

Scope and applicability of the guidance

This guidance provides general principles, concepts and a stepwise method for estimating the GHG impacts of three types of RE policies[2]:

- **Feed-in tariff policies (including feed-in premiums)**: Policies that aim to promote RE deployment by offering long-term purchase agreements with power producers at a specified price per kilowatt-hour (kWh)
- **Auction policies (including tender policies)**: Competitive bidding procurement processes for renewable electricity in the form of either capacity (MW) or electricity generated (MWh)
- **Tax incentive policies**: Policies under which authorities at the national, subnational or municipal level offer tax incentives for the installation and operation of RE installations

These types of RE policies form the core of many policy packages that countries are using to promote RE and are further discussed in Chapter 3. RE can also be promoted via economic instruments (such as emission trading programs or carbon taxes), actions to change the regulatory environment (such as grid access), priority dispatch and wheeling, and capacity building programmes (such as energy service company development initiatives). However, the focus of this guidance is on policies that specifically target RE deployment, and these other types of instruments and actions are only discussed peripherally in this guidance. Appendix F: Selecting the Scope of the Guidance lists the full criteria used to choose the scope of the guidance.

This guidance details a process for users to follow when conducting a GHG assessment of RE policies. It provides guidance on defining the assessment, an approach to GHG assessment including ex-ante (forward-looking) assessments and ex-post (backward-looking) assessments, and monitoring and reporting. Throughout the document, examples and case studies [*to be developed*] are provided to illustrate how to apply the guidance.

The guidance is applicable to policies:

- At any level of government (national, subnational, municipal) in all countries and regions
- That are planned, adopted or implemented
- That are new policies or actions, or extensions, modifications or eliminations of existing policies or actions

The guidance does not provide exhaustive accounting guidance for all renewable energy technologies. For example, the GHG impact of electricity generation from biomass depends on the emissions associated with growing the biomass and any land-use change. In such cases, the guidance highlights technology-specific considerations and provides references to other resources where possible, but does not provide detailed accounting guidance.

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[2] Throughout this guidance, where the word “policy” is used without “action,” it is used as shorthand to refer to both policies and actions. See Glossary for definition of “policies or actions”.

When to use the guidance

The guidance can be used at multiple points in time throughout the policy design and implementation process, including:

- **Before policy implementation**: To assess the expected future impacts of a policy (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
- **After policy implementation**: To assess what impacts have occurred as a result of a policy (through ex-post assessment)

Depending on individual objectives and when the guidance is applied, users can implement the steps related to ex-ante assessment, ex-post assessment or both. The most comprehensive approach is to apply the guidance first before implementation, regularly during policy implementation and again after implementation. Users carrying out an ex-post assessment only skip Chapters 7 and 8. Users carrying out an ex-ante assessment only skip Chapter 9.

Key recommendations

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

Relationship to other guidance and resources

This guidance uses and builds on existing resources mentioned throughout the document. This includes Clean Development Mechanism (CDM) large-scale consolidated methodology *ACM0002: Grid-connected electricity generation from renewable sources*, and CDM *Tool to calculate the emission factor for an electricity system.*

The guidance builds upon the Greenhouse Gas Protocol *Policy and Action Standard*[3] and the *Draft Policy and Action Standard – Energy Supply Sector guidance*[4] (both of which provide guidance on estimating the greenhouse gas impacts of policies and actions, and discussion on many of the accounting concepts in this document such as baseline and policy scenarios), to provide a detailed method for specific

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[3] WRI 2014. Available at: http://www.ghgprotocol.org/policy-and-action-standard.

[4] Available at: http://www.ghgprotocol.org/sites/default/files/ghgp/standards_supporting/Energy%20Supply%20-%20Additional%20Guidance.pdf.

renewable energy policies. As such, this guidance adapts the structure and some of the tables, figures and text from the *Policy and Action Standard* where relevant. Figures and tables adapted from the *Policy and Action Standard* are cited, but for readability not all text taken directly or adapted from the standard is cited.

A full list of references is provided at the end of this document.

Process for developing the guidance

This guidance has been developed through an inclusive, multi-stakeholder process convened by the Initiative for Climate Action Transparency. The development is led by the NewClimate Institute (technical lead) and Verra (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 (TWG) and the Secretariat. The TWG consists of experts and stakeholders from a range of countries identified through a public call for expressions of interest. The TWG contributed to the development of the technical content for the guidance through participation in regular meetings and written comments. The energy sector TWG contributed to both the ICAT *Renewable Energy Guidance* and the *Buildings Efficiency Guidance.* A Review Group provided written feedback on the first draft of guidance.

This version of guidance will be applied with ICAT participating countries and other interested countries to ensure that it can be practically implemented, gather feedback for its improvement and provide case studies.

ICAT's Advisory Committee provides strategic advice to the initiative. More information about the guidance 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 the GHG Impacts of RE Policies

This chapter provides an overview of objectives users may have in assessing the GHG impacts of renewable energy policies. Determining the assessment objectives is an important first step, since decisions made in later chapters are often 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 GHG impacts of RE policies is a key step towards identifying opportunities and gaps in effective GHG mitigation strategies. Impact assessment supports evidence-based decision making by enabling policymakers and stakeholders to understand the relationship between policies and expected GHG impacts. It is *key recommendation* to determine the objectives of the assessment at the beginning of the impact assessment process.

Examples of objectives for assessing the GHG impacts of a policy are listed below. The ICAT *Sustainable Development Guidance* can be used to assess the broader sustainable development impacts of RE policies and users should refer to that guidance for objectives for assessing such impacts.

General objectives

- **Estimate the GHG impacts of policies to determine whether they are on track to help meet goals** such as NDCs or RE targets
- **Maximise positive impacts** of policies, such as increased GHG emission reductions, RE capacity addition, and RE electricity generation
- **Ensure that policies are cost-effective** and that limited resources are invested efficiently

Objectives of assessing impacts before policy implementation

- **Improve policy design and implementation** by understanding the impacts of different design and implementation choices
- **Inform goal setting** by assessing the potential contribution of policies to national goals and targets, such as NDCs
- **Access financing** for policies by estimating potential GHG emission reductions, or by estimating the RE capacity addition and RE electricity generation

Objectives of assessing impacts during or after policy implementation

- **Assess policy effectiveness** by determining whether RE policies are delivering the intended results
- **Improve policy implementation** by determining whether RE policies are being implemented as planned
- **Inform future policy design** and decisions on whether to continue current actions, enhance current actions, or implement additional actions

- **Learn from experience and share best practices** about policy impacts
- **Track progress toward national goals and targets** such as NDCs and understand the contribution of policies toward achieving them
- **Report**, domestically or internationally, including under the Paris Agreement's enhanced transparency framework, on the impacts of policies achieved to date
- **Meet funder requirements** to report on GHG emissions reductions or RE capacity addition, RE electricity generation

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 Guidance* (Chapter 5).

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 GHG assessment boundary and which methods and data sources to use. The appropriate level of accuracy and completeness is likely to vary by objective. Users should assess the impacts of their policies with a sufficient level of accuracy and completeness to meet the stated objectives of the assessment.

3. Overview of Renewable Energy Policies

Historically energy markets alone have not been able to deliver the desired level of renewable deployment in many countries. National-, subnational- and municipal-level support policies have been implemented to help to overcome market failures and to spur increased investment in RE. These policies help to reduce the cost of production, increase the price at which RE is sold, or increase the volume of RE purchased. This chapter provides an overview of the three types of renewable energy policy covered by the guidance.

3.1 Types of renewable energy policy

RE policies may be designed to overcome barriers to RE technological development and implementation, or to actively incentivise technological innovation and speed and ease of implementation. Several types of RE policies exist, shown in Table 3.1.

Table 3.1: Overview of policy instruments in the energy supply sector

Type of policy instrument ***(Policies in bold are those covered** by **the guidance)***	**Number of countries**	**Share of countries**
Reduction in sales, energy, value-added or other taxes	98	52%
Public investment, loans or grants	82	43%
Feed-in tariff and feed-in premium policies	81	43%
Biofuels obligations and mandates	66	35%
Auctions and tenders	64	34%
Capital subsidy, grant or rebate	58	31%
Net metering	52	27%
Investment or production tax credits	45	24%
Electric utility quota obligation and renewable portfolio standards	29	15%
Tradable renewable energy credits	29	15%
Energy production payment[5]	25	13%
Heat obligations and mandates	21	11%

Source: REN21 2016.

[5] The REN21 glossary defines an energy production payment as a “direct payment of the government per unit of renewable energy produced”, whereas a feed-in tariff is defined as a “policy that sets a price that is guaranteed over a certain period of time at which power producers can sell renewably generated electricity into the grid” (REN21, 2016). A feed-in tariff in that sense is a particular type of the energy production payment. Feed-in tariff policies can therefore be seen as the most prevalent policy type.

Depending on the country circumstances, regulatory agencies and public utilities may have the responsibility of designing and implementing RE policies, but non-governmental and private actors may also have a large role to play.

Some key elements of RE policies include[6]:

- Contributing to a rate of return that allows recovery of costs at a rate appropriate to the risk of investment
- Guaranteeing access to networks and markets
- Implementing long-term contracts to reduce risk
- Using contract provisions that account for diversity of technologies and applications
- Using incentives that decline predictably over time as technologies and/or markets mature
- Ensuring broad inclusiveness with potential for participation

3.2 Types of RE policies covered by the guidance

Feed-in tariff policies are price-based instruments that provide a fixed guaranteed electricity price or a fixed or fluctuating price premium. Auctions and tender policies are quantity-based instruments that set the fixed amount of electricity generation from renewable sources to be achieved, where the market determines the price. Tax incentive policies use the tax system to improve the financial viability of RE investments.

These policies can be technology-neutral or technology-specific. For example, an auction policy can include all renewable technologies, or can use eligibility criteria to include only specific technologies such as on- and off-shore wind, solar or biomass.

Feed-in tariff policies (including feed-in premiums)

Feed-in tariff policies aim to promote RE deployment by offering long-term purchase agreements with power producers at a specified price per kilowatt-hour.

In this guidance feed-in tariff policies also include feed-in premiums, which provide power producers a premium on top of the market price of their electricity production. Premiums can either be fixed at a constant level independent of market prices or sliding with variable levels that depend on market prices. They provide market certainty for power producers by guaranteeing payments that are usually awarded as long-term contracts for a period of 15 to 20 years.

Feed-in tariffs and feed-in premiums have been globally successful in promoting most renewable technologies including wind, solar photovoltaic, solar thermal, geothermal, biogas and biomass. Successful feed-in tariffs and feed-in premiums tend to encourage a diverse array of technologies and have been used for projects of varying sizes. They have been widely successful due to the inclusion of many of the following elements[7]:

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[6] Adapted from IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, 2012.

[7] Edenhofer et al. 2011.

- Tariffs for all potential power producers, including utilities
- Tariffs guaranteed for a long enough time period to ensure an adequate rate of return
- Tariff payment levels with carefully calculated starting values based on cost of generation and differentiated by technology type and project size
- Property access and dispatch
- Utility purchase obligation
- Regular long-term design evaluations and short-term payment level adjustments

Auction policies (including tender policies)

Auction policies for RE generation contracts create a competitive environment to procure renewable electricity through a defined selection process. In this guidance, "auction policies" refers to both auction and tender policies.

Under these policies (as applicable in this guidance), governments issue a request for bids for the total investment cost of a project or for the cost per unit of electricity. An auction process will generally involve an open bidding process, whereas with tenders the bidding is done in confidence. They are usually designed with a total capacity of projects that will be funded. The government then selects multiple winning bids until the total capacity reaches the auction capacity goals.

There are several trade-offs pertaining to specific design elements of auction and tender policies:

- Demand: Trade-off between ambition for an increasing share of renewables and cost-effectiveness may be manifested through the decision to introduce a technology-specific auction to develop a specific technology, or a technology-neutral auction to allow competition, which favours more cost-competitive technologies
- Qualification requirement: Trade-off between reducing entry barriers to encourage competition and discouraging underbidding
- Winner selection process: Trade-off between keeping the process simple and transparent and ensuring that the objectives are achieved by the auction
- Sellers' liabilities: Weighing the allocation of risks between the power producer and the auctioneer, and exercising caution on the over allocation of risks to producers

Price competition in auctions and tenders may favour larger and more established players such as utilities or public companies to the detriment of smaller players. Due to high administrative or financial qualification requirements, there may be too few bidders, which may impede the realisation of the true low-cost potential.

Policymakers might consider using technology-specific tenders to enable a diverse supply, or they may consider adding local content rules, which require the use of a certain percentage of local equipment or local ownership of the project. In return, there may be an offer of lower interest rates, local tax benefits or even bonus payments for local power producers, which can benefit communities and prevent excess imports of the cheapest technologies.

Tax incentive policies

Various types of tax incentive policies are available for the development and deployment of RE technologies. Many governments use tax policies to promote RE sources for electricity generation. There are a wide variety of tax incentives types, including:

- Value added tax (VAT) exemption
- Income tax exemption
- Import or export fiscal benefit
- Sales tax exemptions
- Accelerated depreciation
- Property tax incentives
- Tax credits
- Exemptions from local taxes
- RE-specific taxes such as a geothermal vapour tax or geothermal surface tax
- Other fiscal benefits

Tax incentives usually apply to services and equipment, and pre-investment expenses are related to RE projects, as well as income from the sale of electricity or other ancillary income. Policymakers can further opt for fiscal stability incentives, whereby eligible RE technologies are shielded from potential future changes in their fiscal regime or any additional fees. Tax incentive policies can be effective when linked to the generation of electricity and not just the installation of capacity.

Different levels of government (national, subnational or municipal) may implement various tax incentive policies simultaneously.

3.3 Policy caps

Some RE policies may be subject to a cap. For example:

- It is an increasingly common practice to set a cap as part of a feed-in tariff policy either at a maximum per year or over the lifetime of the policy.
- Policy caps are implicit in the design of auctions and tender policies. Under these policies, a certain quantity is auctioned/tendered, serving as the cap on either the number of installations, MW installed, or electricity generated.
- The country has a target which the RE policy aims to contribute towards.

Table 3.2 explains how the guidance is applicable to these different RE policies.

Table 3.2: Overview of caps for RE policies

RE policy	Applicability of guidance	RE policies to which guidance is applicable
The cap is part of the policy design (e.g., capped feed-in tariff or auction)	Guidance helps users assess whether there are any factors preventing the policy from reaching its cap (e.g., whether the scope is too limited or barriers exist that hinder the policy's impact)	• Auction policies • Feed-in tariff policies with a cap
A separate target exists in the country which the policy aims to contribute towards (e.g., a RE target such as 25% RE by 2025)	Guidance helps users assess whether the policy is sufficiently ambitious to achieve the target, or whether there are factors that may reduce the effectiveness of the policy	• Feed-in tariff policies with national RE target in place • Tax incentive policies with national RE target in place
No target exists; nor does the policy provide an indication of the impact that should be achieved	Guidance helps users assess the impact of the policy based on its design and other factors	• Standalone feed-in tariff policies • Standalone tax incentive policies

4. Using the Guidance

This chapter provides an overview of the steps involved in assessing the GHG impacts of RE policies, and outlines assessment principles to help guide the assessment.

Checklist of key recommendations

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

4.1 Overview of steps

This guidance is organised according to the steps a user follows to assess the GHG impacts of a RE policy (see Figure 4.1). Depending on when the guidance is applied, certain chapters are skipped. For example, for ex-post assessments users can skip Chapters 7 and 8.

Figure 4.1: Overview of steps

Part I: Introduction, objectives, steps and overview of renewable energy policies

Understand the purpose and applicability of the guidance (Chapter 1)
Determine the objectives of the assessment (Chapter 2)
Understand renewable energy policies (Chapter 3)
Understand assessment steps and principles (Chapter 4)

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Part II: Defining the assessment

Clearly describe the policy to be assessed (Chapter 5)
Identify GHG impacts, define the GHG assessment boundary and assessment period (Chapter 6)

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Part III: Assessing impacts

Estimate RE addition of the policy ex-ante (Chapter 7)
Estimate GHG impacts of the policy ex-ante (Chapter 8)
Estimate GHG impacts of the policy ex-post (Chapter 9)

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Part IV: Monitoring and reporting

Identify key performance indicators and parameters to monitor and develop a monitoring plan (Chapter 10)
Report the results and methodology used (Chapter 11)

4.2 Planning the assessment

Users should review this guidance, the *Introductory Guide* and other relevant guidance documents, and plan the steps, responsibilities and resources needed to meet their objectives for the assessment in advance. Identify in advance the expertise and data needed for each step, plan the roles and responsibilities of different actors, and secure the budget and other resources needed. Any interdependencies between steps should be identified, for example where outputs from one step feed into another, and timing should be planned accordingly.

The time and human resources required to implement the guidance and carry out an impact assessment depend on a variety of factors, such as the complexity of the policy being assessed, the extent of data collection needed and whether relevant data has already been collected, and the desired level of accuracy and completeness needed to meet the stated objectives of the assessment.

4.2.1 Choosing a desired level of accuracy based on objectives

There are a range of options for assessing GHG impacts that 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 objectives. Some objectives require more detailed assessments that yield more accurate results (to demonstrate that a specific reduction in GHG emissions is attributed to a specific policy, with a higher level of certainty), while other objectives may be achieved with simplified assessments that yield less accurate results (to show that a policy contributes to reducing GHG impacts, but with less certainty around the magnitude of the impact).

Users should choose approaches and methods that are sufficient to accurately meet the stated objectives of the assessment and ensure that the resulting claims are appropriate. For example, whether a policy contributes to achieving GHG emission reductions or whether emission reductions can be attributed to the policy. Users should also consider the resources needed to obtain the data needed to meet the stated objectives of the assessment.

4.2.2 Approaches for GHG impact assessment

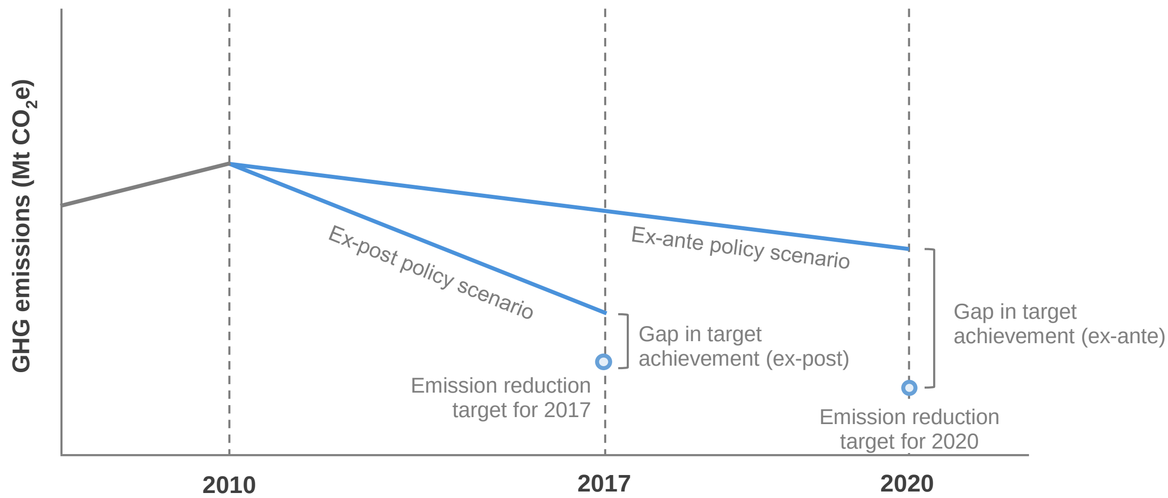
The guidance can be used to estimate either a GHG *emission level* or GHG *emission reductions* (either can be done ex-ante or ex-post). The choice is guided by the user's objectives in undertaking the impact assessment.

Estimating a GHG emission level

The objective of estimating an emission level is to evaluate policy performance in achieving NDCs. These NDCs may have established emissions targets relative to a specific base year, or RE deployment or sectoral emission levels. In such cases, users do not need to develop a baseline scenario or estimate baseline emissions.

Estimating an emission level, either ex-ante or ex-post, allows comparison against a target, as shown in Figure 4.2. Here, an ex-ante estimate of emission levels out to 2020 shows that there is a gap and expected emission reductions in the sector are not on track to be met. The figure also shows an ex-post estimate of emission levels, estimated in 2017. Here, the emission level is higher than the target – in other words, the anticipated emission reductions have not been achieved.

Figure 4.2: Use of GHG emission level in ex-ante and ex-post impact assessment

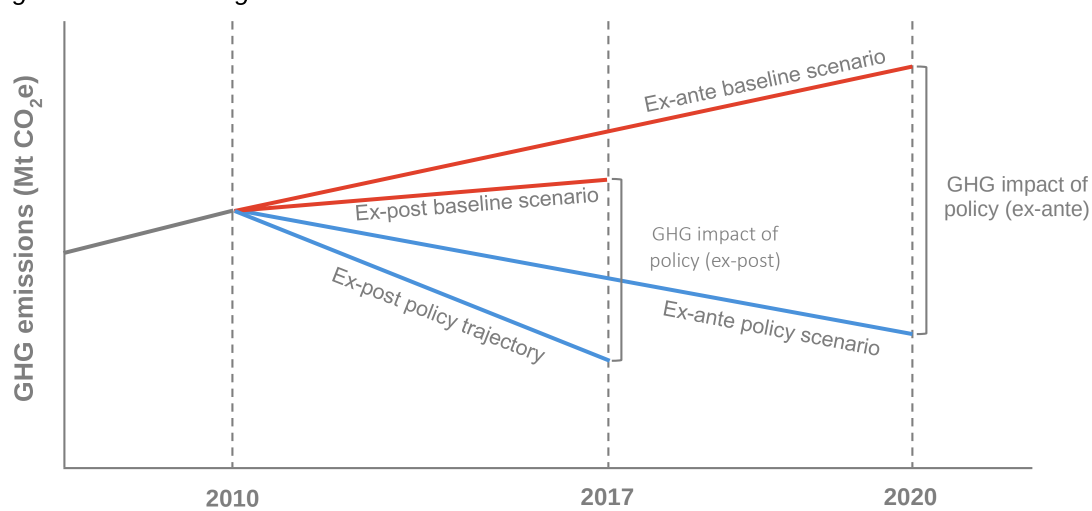


Estimating GHG emission reductions

Estimating emission reductions is relevant where the objective is to evaluate the GHG impact of a specific policy. This requires comparing policy scenario emissions to baseline scenario emissions. Figure 4.3 illustrates the estimation of GHG emission reductions ex-ante and ex-post. The reductions are calculated by subtracting the ex-ante (or ex-post) policy scenario emissions from the ex-ante (or ex-post) baseline emissions. To estimate the ex-ante emission reductions, both the policy scenario emissions and baseline emissions are forecasted. To estimate the ex-post emission reductions, baseline emissions are estimated according to the most likely baseline scenario, while the policy scenario emissions are estimated based on observed data.

Note that a RE policy may lead to GHG emission reductions in situations where the *absolute* level of GHG emissions is rising (i.e., the guidance estimates reductions based on the difference between baseline and policy scenario emissions, both of which may be rising.

Figure 4.3: Estimating GHG emission reductions with a baseline scenario



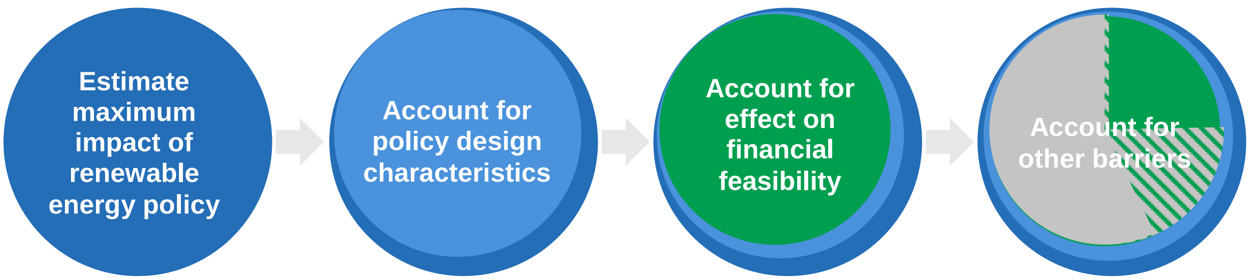
Ex-ante and ex-post assessment steps

Estimating GHG impacts ex-ante is divided into two parts. First, the RE addition of the policy is estimated (Chapter 7). RE addition is the additional installation of renewable energy capacity or electricity generation from renewable sources realised via the policy, expressed in megawatts (MW) or megawatt-hours (MWh) respectively. Second, the GHG impacts from this RE addition are estimated (Chapter 8).

RE addition is estimated through a process of estimating the maximum implementation potential of the policy (the maximum resource potential of for the technology or the policy cap) and then following stepwise guidance to evaluate the policy design characteristics and other factors that affect the likelihood that the policy will achieve this maximum implementation policy (illustrated in Figure 4.4). The result is the actual RE addition the policy is expected to achieve. Once the RE addition has been estimated, it can then be translated into a GHG emission level or GHG emissions reductions.

Estimating GHG impacts ex-post is also divided into two parts. First, data is collected from relevant agencies to determine the RE addition. Second, the GHG impacts (emission level or emission reductions) are estimated.

Figure 4.4: Guidance steps for estimating RE addition of the policy ex-ante



4.2.3 Methods for obtaining or estimating data

It is recommended that users use country-specific data. Potential data sources include the ministry of energy, national energy research institutes, and international agencies such as IEA. Where country-specific data are not available, users may use regional data or make estimates with input from experts. Section 8.2.2 provides further guidance for cases where data availability is limited.

4.2.4 Expert judgment

It is likely that expert judgment and assumptions will be needed in order to complete an assessment where information is not available or requires interpretation. Expert judgment is defined by the IPCC as 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.[8] The goal is to be as representative as possible in order to reduce bias and increase accuracy. The user can apply their own expert judgment or consult experts.

When relying on expert judgment, information can be obtained through methods that help to avoid bias known as expert elicitation. The 2006 IPCC Guidelines for National Greenhouse Gas Inventories provides

[8] IPCC 2000. Available at: http://www.ipcc-nggip.iges.or.jp/public/gp/english

a procedure for expert elicitation, including a process for helping experts understand the elicitation process, avoiding biases, and producing independent and reliable judgments.[9]

Expert judgment can be associated with a high level of uncertainty. As such, experts can be consulted to provide a range of possible values and the related uncertainty range or they can be consulted to help select suitable values from a range of values. Expert judgment can be informed or supported through broader consultations with stakeholders.

It is important to document the reason that no data sources are available and the rationale for the value chosen. Expert judgment can include applying proxy data, interpolating information, estimating a cap or maximum implementation potential, evaluating a barrier to RE deployment, or other types of assumptions or judgment.

4.2.5 Planning stakeholder participation

Stakeholder participation is recommended in many steps throughout the guidance. It can strengthen the impact assessment and the contribution of policies to GHG emission reduction goals in many ways, including by:

- Establishing a mechanism through which people who may be affected by or can influence a policy have an opportunity to raise issues and have these issues considered before, during and after 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 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 financing by strengthening the effectiveness of policies and credibility of reporting

Various sections throughout this guidance explain where stakeholder participation is recommended—for example, in identifying a complete list of GHG impacts (Chapter 6), identifying barriers to RE deployment (Chapter 7), monitoring performance over time (Chapter 10), reporting (Chapter 11).

Before beginning the assessment process, consider how stakeholder participation can support the objectives and include relevant activities and associated resources in their assessment plans. It may be helpful to combine stakeholder participation for impact assessment with other participatory processes

[9] IPCC 2006. Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

involving similar stakeholders for the same or related policies, such as those being conducted for assessment of sustainable development and transformational impacts, and for technical review.

It is important to ensure conformity with national legal requirements and norms for stakeholder participation in public policies, 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 Organization Convention 169).

During the planning phase, it is recommended to identify stakeholder groups that may be affected by or may influence the policy. Appropriate approaches should be identified to engage with the identified stakeholder groups, including through their legitimate representatives. To facilitate effective stakeholder participation, 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.

Refer to the ICAT *Stakeholder Participation Guidance* for more information, such as how to plan effective stakeholder participation (Chapter 4), identify and analyse 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 E summarises the steps in this guidance where stakeholder participation is recommended along with specific references to relevant guidance in the *Stakeholder Participation Guidance*.

4.2.6 Planning technical review (if relevant)

Before beginning the assessment process, 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 have been estimated and reported according to ICAT key recommendations. Refer to the ICAT *Technical Review Guidance* for more information on the technical review process.

4.3 Assessment principles

Assessment principles are intended to underpin and guide the impact assessment process, especially where the guidance provides flexibility. It is a *key recommendation* to base the assessment on the principles of relevance, completeness, consistency, transparency and accuracy, as follows:[10]

- **Relevance:** Ensure the GHG assessment appropriately reflects the GHG impacts of the policy and serves the decision-making needs of users and stakeholders—both internal and external to the reporting entity. Users should apply the principle of relevance when selecting the desired level of accuracy and completeness among a range of methodological options. Applying the principle of relevance depends on the objectives of the assessment. Due to the varied nature of users' objectives, it may be more relevant to estimate and report an intermediary impact, such as the RE

[10] Adapted from WRI 2014

addition expressed as installed capacity (MW) or generated electricity (MWh) achieved by the policy, rather than the GHG emissions reductions.

- **Completeness:** Include all significant GHG impacts and sources in the GHG assessment boundary. Disclose and justify any specific exclusions.
- **Consistency:** Use consistent accounting approaches, data collection methods, and calculation methods to allow for meaningful performance tracking over time. Document any changes to the data, GHG assessment boundary, methods, or any other relevant factors in the time series.
- **Transparency***:* Provide clear and complete information for stakeholder to assess the credibility and reliability of the results. Disclose all relevant methods, data sources, calculations, assumptions, and uncertainties. Disclose the processes, procedures, and limitations of the GHG assessment in a clear, factual, neutral, and understandable manner through an audit trail with clear documentation. The information should be sufficient to enable a party external to the GHG assessment process to derive the same results if provided with the same source data. Chapter 11 provides a list of recommended information to report to ensure transparency.
- **Accuracy:** Ensure that the estimated change in GHG emissions and removals is 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. Accuracy should be pursued as far as possible, but once uncertainty can no longer be practically reduced, conservative estimates should be used. Box 4.1 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 GHG impacts or to aggregate the results of multiple impact assessments and compare the collective impacts to national goals (discussed further in *Box 4.2*).

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

Box 4.1: Conservativeness

Conservative values and assumptions are those more likely to overestimate negative impacts or underestimate positive impacts resulting from a policy. 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 prioritised 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 4.2: Applying the principle of comparability when comparing or aggregating results

Users may want to compare the estimated impacts of multiple policies, 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 GHG 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 organisation assesses and compares multiple policies using the same methodology.

Users may also want to aggregate the impacts of multiple policies, 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 5 provides more information on policy interactions.

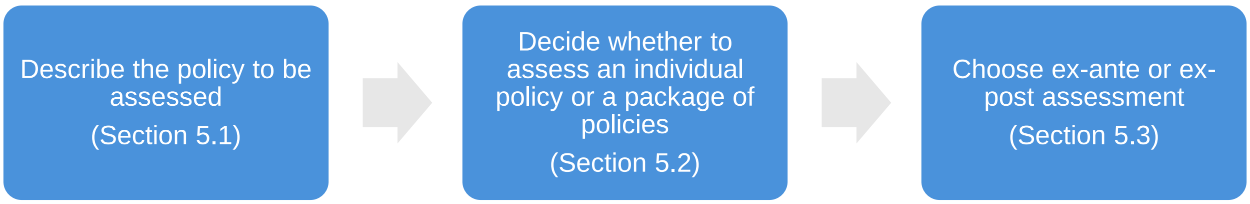
In practice, users may encounter trade-offs between principles when developing an assessment. For example, a user may find that achieving the most complete assessment requires using less accurate data for a portion of the assessment, which could compromise overall accuracy. Users should balance trade-offs 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

5. DESCRIBING THE POLICY

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

Figure 5.1: Overview of steps in the chapter



Checklist of key recommendations

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

5.1 Describe the policy to be assessed

In order to effectively carry out an impact assessment in subsequent chapters, it is necessary to have a detailed understanding of the policy being assessed. It is a *key recommendation* to clearly describe the policy, or package of policies, that is assessed. Table 5.1 provides a checklist of recommended information that should be included in a description to enable an effective assessment. Table 5.2 outlines additional information that may be relevant depending on the context.

If assessing a package of policies, these tables can be used to document either the package as a whole or each policy in the package separately. The first two steps in the chapter (Sections 5.1 and 5.2) can be done together or iteratively.

Users that are assessing the sustainable development and/or transformational impacts of the policy (using the ICAT *Sustainable Development Guidance* and/or *Transformational Change Guidance*) should describe the policy in the same way to ensure a consistent and integrated assessment.

Table 5.1: Checklist of recommended information to describe the policy being assessed

Information	**Description**	**Example**
Title of the policy or action	Policy name	Feed-in tariff without cap
Type of policy or action	The type of policy, such as those presented in Table 3.1	Feed-in tariff policy

Description of specific interventions	The specific intervention(s) carried out as part of the policy, such as the technologies, processes or practices implemented	Policy characteristics: Tariff differentiation: Higher tariffs for small-size projects and lower tariffs for large-scale projects (set to give rates of return between 5-8%) Eligibility: The only technology eligible under the feed-in tariff is solar photovoltaic (PV) Utility role: Government owned single buyer with guaranteed purchase up to the annual production quota Payment structure: Premium-price policies Contract and payment duration: Premium is offered over a project's entire lifetime Forecasting: No forecasting requirements Grid access: Grid priority for renewable energies Policy adjustments: Only inflation adjustments over lifetime of feed-in tariff
Status of policy	Whether the policy is planned, adopted or implemented	Implemented
Date of implementation	The date the policy comes into effect (not the date that any supporting legislation is enacted)	1 July 2016
Date of completion (if relevant)	If relevant, the date the policy ceases, such as the date a tax is no longer levied or the end date of an incentive policy with a limited duration (not the date that the policy no longer has an impact)	No end date has currently been set
Implementing entity or entities	The entity or entities that implement(s) the policy, including the role of various local, subnational, national, international or any other entities	Ministry of Energy/Energy Regulatory Commission
Objectives and intended impacts or benefits of the policy	The intended impact(s) or benefit(s) the policy intends to achieve (e.g., the purpose stated in the legislation or regulation)	To increase deployment of solar PV and increase energy security
Level of the policy	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 is implemented or	Small least developed country

	enforced, which may be more limited than all the jurisdictions where the policy has an impact	
Sectors, targeted	Which sectors or subsectors are targeted	Energy supply, grid-connected solar PV
Greenhouse gases targeted	Which GHG the policy aims to control, which may be more limited than the set of GHG that the policy affects	CO_2
Other related policies or actions	Other policies or actions that may interact with the policy assessed	Fossil fuel subsidies; tender policies; tax incentive policies

Table 5.2: Checklist of additional information that may be relevant to describe the policy being assessed

Information	Description	Example
Intended level of mitigation to be achieved and/or target level of other indicators	Target level of key indicators, if relevant	National Target: 15% share of PV or RE in electricity mix 20% sectoral emission reduction below base year Y Policy: The policy does not have a separate target but instead is designed in an open manner.
Title of establishing legislation, regulations, or other founding documents	The name(s) of legislation or regulations authorising or establishing the policy (or other founding documents if there is no legislative basis)	Energy Feed-in Law
Monitoring, reporting and verification procedures	References to any monitoring, reporting, and verification procedures associated with implementing the policy	A coordinating body will be formed to ensure continuous monitoring and create a monitoring plan. The power producer establishes QA and QC measures to control and manage data reading, recording, auditing and archiving all relevant data and documents. Monitoring data for net electricity generation at the plant level can be obtained from the periodic electricity meter records kept by the power producer and/or the electricity board or grid company. These may be cross-checked with invoices sent by power producers to the grid company.
Enforcement mechanisms	Any enforcement or compliance procedures, such as penalties for noncompliance	The feed-in tariff has enforcement mechanisms in place to ensure that the reported data (electricity generation) is correct.

Reference to relevant documents	Information to allow practitioners and other interested parties to access any guidance documents related to the policy (e.g., through websites)	Renewable Energy Sources Act
The broader context/significance of the policy	Broader context for understanding the policy	The policy will contribute to the national target of a 15% share of PV or RE in electricity mix, and the 20% sectoral emission reduction below base year 2005. The policy will reduce consumption of fossil fuels and contribute to energy security.
Outline of sustainable development impacts of the policy or action	Any anticipated sustainable development benefits other than GHG mitigation	Will lead to more construction jobs and greater energy security. Solar energy will also provide quick alternative power during severe climate changes that may occur (El Nino) Will lead to increased solar electricity generation in the country, contributing to energy security by displacing fossil energy source that require fuel imports.
Key stakeholders	Key stakeholder groups affected by the policy	• Departments or ministries of energy • Energy regulatory commissions • Energy planning offices • Power producers • Investors • Utilities • Consumers • Constituents impacted at installation sites
Other relevant information	Any other relevant information	

5.2 Decide whether to assess an individual policy or a package of policies

If multiple policies are being developed or implemented in the same timeframe, users can assess them either individually or as a package. When making this decision, users should consider the assessment objectives, feasibility of assessing impacts individually or as a package, scope and level of incentive, and the degree of interaction between the policies. Where interactions exist, there can be advantages and disadvantages to assessing policies individually or as a package.

5.2.1 Types of policy interactions

Policies interact if their total impact, when implemented together, differs from the sum of their individual impacts had been implemented separately. Table 5.3 provides an overview of the four possible relationships and further information is available in the *Policy and Action Standard*.

Table 5.3: Types of relationships between RE policies

Type	Description
Independent	Multiple policies do not interact with each other. The combined impact of implementing the policies together is equal to the sum of their individual impacts of implementing them separately.
Overlapping	Multiple policies interact, and their combined impact is less than the sum of their individual impacts. This category includes policies that have identical or complementary goals as well as policies that have different or opposing goals.
Reinforcing	Multiple policies interact, and their combined impact is greater than the sum of their individual impacts of implementing them separately.
Overlapping and reinforcing	Multiple policies interact, and have both overlapping and reinforcing interactions. The combined impacts may be greater or less than the sum of the individual impacts of implementing them separately.

Source: Adapted from WRI 2014

Policy interactions should be considered within the context of other RE policies as well as broader energy policy. Some RE policies may be implemented as part of a suite of measures to meet broad energy policy objectives in integrated policy planning, which is periodically reviewed (e.g., decommissioning of fossil fuel plants coupled with phasing-out of nuclear and deployment of RE as an integrated policy). Where this is the case, the RE component may be implemented using, for example, a tender process with many periodic windows that set the cap based on how well the other elements of the integrated energy policy are performing (i.e., whether the decommissioning of fossil fuel plants is on schedule, or whether a nuclear phase-out programme is delayed or has altered its ambition due to pressure from environmental activists). These considerations affect the potential for RE deployment over time.

5.2.2 Identification of interaction between policies

Where related policies exist, users should first consider their specific objectives and circumstances when deciding whether to assess an individual policy or a package of interacting policies. An approach is set out below to help with this decision.

Step 1: Characterise the type and degree of interactions between policies

Assess the relationship between the policies and the degree of interaction (minor, moderate or major) based on published studies of similar combinations of policies or on expert judgment. The assessment will be qualitative since a quantitative assessment would require many of the steps needed for a full assessment.

Consider whether the same types of RE installations or technologies are eligible under the policy being assessed and other policies identified. Table 5.4 provides an example of relationship characteristics of policies that target the same GHG emissions sources; a feed-in tariff for biomass installations interacts with two other policies that target the same emissions source.

Table 5.4: Example of mapping policies that target the same emissions sources

Policy being assessed	**Other policies targeting the same sources**	**Type of interaction** ***(independent, overlapping, reinforcing, overlapping and reinforcing)***	**Degree of interaction** ***(minor, moderate, major)***
Feed-in-tariff policy, biomass installations eligible	Tender policy, offshore wind energy installations eligible	Independent	Minor
	Tax incentive policies for solar and biomass installations	Overlapping (and potentially reinforcing)	Moderate

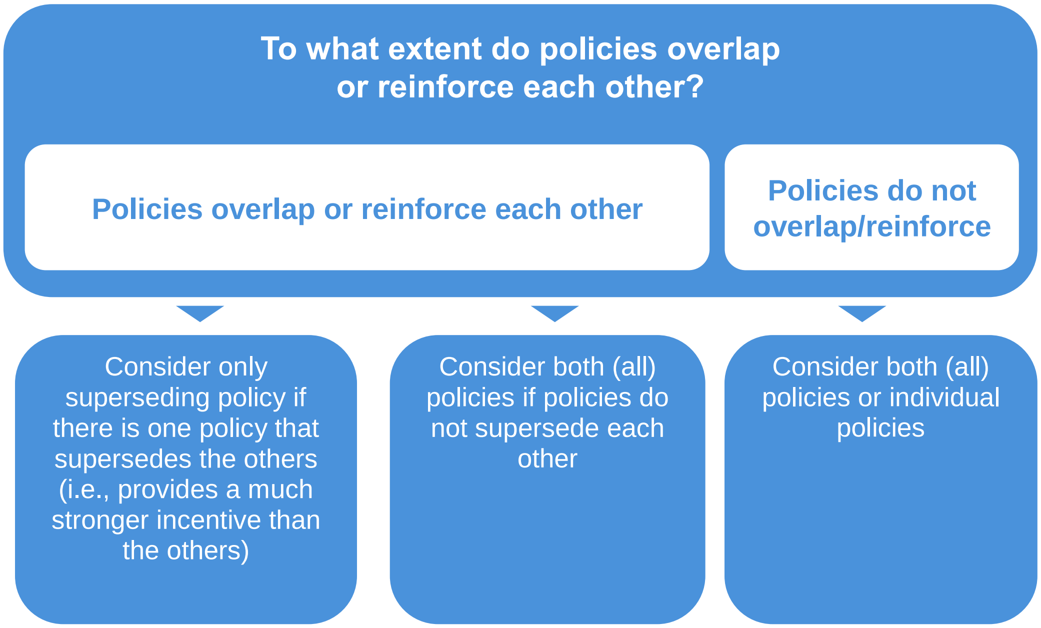
Step 2: Undertake preliminary analysis to understand nature of interactions and determine whether to assess an individual policy or a package of policies

This analysis is high-level and qualitative, since detailed analysis of interactions is taken up in subsequent chapters. The criteria and questions in Table 5.5 can help users decide whether to assess an individual policy or a package of policies.

Table 5.5: Criteria for determining whether to assess an individual policy or a package of policies

Criteria	**Questions**	**Guidance**
Objectives and use of results	Do the end-users of the assessment results want to know the impact of individual policies?	If "Yes", undertake an individual assessment
Significant interactions	Are there significant (major or moderate) interactions between the identified policies, either overlapping or reinforcing, which will be missed if policies are assessed individually?	If "Yes", consider assessing a package of policies
Scope and level of incentive	Does one policy clearly provide a stronger incentive than the others? Do the other policies spur additional emission reductions not already covered by the policies with stronger incentives? See the decision tree in Figure 5.2 to assess overlap in incentives provided by different policies.	If "Yes", consider focusing on the policy superseding the others in an individual assessment
Feasibility	Will the assessment be manageable if a package of policies is assessed? Is data available for assessing the package of policies? Are the policies implemented by a single entity?	If "No", consider undertaking an individual assessment
	For ex-post assessments, is it possible to disaggregate the observed GHG impacts of interacting policies?	If "No", consider assessing a package of policies

Figure 5.2: Overlap and reinforcement in incentives provided by different policies



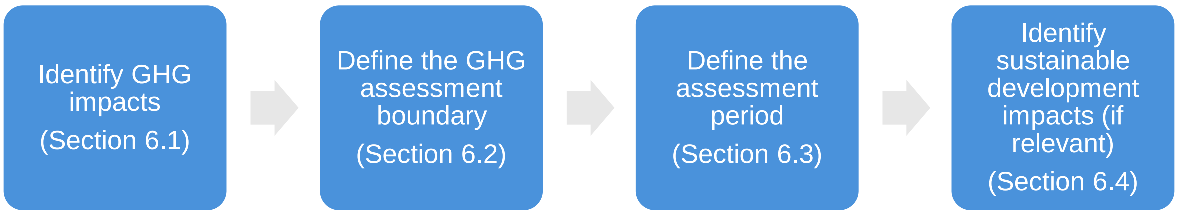
5.3 Choose ex-ante or ex-post assessment

Choose whether to carry out an ex-ante assessment, an ex-post 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. Where the policy is planned or adopted, but not yet implemented, the assessment will be ex-ante by definition. Alternatively, where the policy has been implemented, the assessment can be ex-ante, ex-post, or a combination of ex-ante and ex-post. The assessment is an ex-post assessment if the objective is to estimate the impacts of the policy to date; an ex-ante assessment if the objective is to estimate the expected impacts in the future; or a combined ex-ante and ex-post assessment to estimate both the past and future impacts. An ex-ante assessment can include historical data if the policy is already implemented, but it is still an ex-ante assessment (rather than an ex-post) if the objective is to estimate future effects of the policy.

6. Identifying Impacts: How RE Policies Reduce GHG Emissions

This chapter provides a process for identifying the most common GHG impacts of RE policies, and guidance for users to identify any additional impacts their policies may have. A subset of impacts that are considered significant is then taken from this list and included in the GHG assessment boundary. Guidance is also provided on defining the assessment period. The steps in this chapter are closely interrelated. Users can carry out the steps in sequence or in parallel, and the process may be iterative.

Figure 6.1: Overview of steps in the chapter



Checklist of key recommendations

- Identify all potential GHG impacts of the policy and associated GHG source categories
- Develop a causal chain
- Include all significant GHG impacts in the GHG assessment boundary
- Define the assessment period

6.1 Identify GHG impacts

GHG impacts are the changes in GHG emissions that result from the policy. For most RE policies being assessed using this guidance, the sole relevant GHG impact is likely to be reduced emissions from existing fossil fuel power plants and/or avoided emissions from new fossil fuel power plants that would have been built. For these policies, users may want to skip this section. For policies which may have other GHG impacts, such as emissions of CH_4 and CO_2 from water reservoirs, users should follow the guidance in Section 6.1 to ascertain the policy's GHG impacts.

6.1.1 Identify intermediate effects

In order to identify the GHG impacts of the policy, it is useful to first consider how the policy is implemented by identifying the relevant inputs and activities associated with implementing the policy. Inputs are resources that go into implementing the policy, while activities are administrative activities involved in implementing the policy. These inputs and activities lead to intermediate effects, which are changes in behaviour, technology, processes or practices that result from the policy. These intermediate effects then lead to policy's GHG impacts (the reduction in emissions).

The identification of intermediate effects enables a complete and accurate assessment, and is necessary to identify the potential GHG impacts of the policy and develop a causal chain. In order to identify the intermediate effects, users should identify the stakeholders, and the inputs and activities that are needed to implement the policy.

6.1.2 Identify potential GHG impacts

It is a *key recommendation* to identify all potential GHG impacts of the policy and associated GHG source categories. Guidance for this is provided below, and further discussion on the process is available in the *Policy and Action Standard*. There are several types of GHG impacts to consider, such as those described in Table 6.1.

Table 6.1: Types of GHG impacts

Type of GHG impact	Description	Example of GHG impact
Positive impact vs. negative impact	Impacts that cause decrease or increase in GHG emissions	*Positive*: Reduced GHG emissions from existing and new fossil fuel power plants *Negative*: Increased emissions from the manufacturing of RE based systems/equipment
Intended impact vs. unintended impact	Impacts that are both intentional and unintentional based on the original objectives of the policy	*Intended:* Reduced GHG emissions from fossil fuel power plants; reduced GHG emissions from national manufacturing of fossil fuel power plant equipment *Unintended:* Increased GHG emissions in other jurisdictions; increased GHG emissions from manufacturing of equipment for renewables
In-jurisdiction impact vs. out-of-jurisdiction impact	In-jurisdiction impacts are those that occur inside the geographic area over which the implementing entity has authority, such as a city boundary or national boundary. Out-of-jurisdiction impacts occur outside of the geopolitical boundary	*In-jurisdiction*: Increased GHG emissions from manufacturing of equipment for renewables *In-jurisdiction*: Reduced GHG emissions from local manufacturing of equipment for fossil fuel power plants *Out-of-jurisdiction*: Increased GHG emissions in other jurisdictions (e.g., from electricity generation)
Short-term impact vs. long-term impact	Impacts that are both nearer and more distant in time, based on the amount of time between implementation of the policy and the impact	*Short-term*: Reduced GHG emissions from operating fossil fuel power plants on the electricity grid *Long-term*: Reduced emissions from lower energy use due to increased cost of electricity

Users should consider impacts across the lifecycle of electricity generation. For example, biomass and large hydro energy installations may cause indirect land use change or material displacement impacts, and if RE policies support such installations these impacts need to be taken into consideration. CDM methodologies can help with the quantification of such impacts.[11] For example, CDM methodology

[11] Available at: https://cdm.unfccc.int/methodologies/index.html.

ACM0002 Grid-connected electricity generation from renewable sources includes a calculation method for quantifying CH_4 emissions from reservoirs.[12]

By separately identifying and categorising in-jurisdiction and out-of-jurisdiction impacts, users can more accurately link the GHG impacts to the relevant jurisdiction's inventory, targets and goals. This separate categorisation also creates transparency around any potential double counting of out-of-jurisdiction impacts between jurisdictions. In some cases, a single impact may affect both in and out-of-jurisdiction emissions, and separate tracking may not be feasible.

Stakeholder consultation can help to ensure the completeness of the list of GHG impacts. Refer to the ICAT *Stakeholder Participation Guidance* (Chapter 8) for information on designing and conducting consultations. Relevant stakeholder may include departments or ministries of energy, energy regulatory commissions, energy planning offices, power producers, investors, utilities, consumers, and those impacted at installation sites.

Users should identify all the GHG source categories associated with the GHG impacts of the policy. Example source categories are provided in Table 6.2. Source categories are the same for both RE projects and RE policies, so users with a project background should be familiar with all the main sources.

Table 6.2: Example GHG sources for RE policies

Source category	Description	Emitting entity or equipment	Relevant GHGs
Grid-connected electricity generation	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	Grid-connected power plants	CO_2
Water reservoirs of hydro power plants	CH_4 and CO_2 emissions from reservoirs	Decaying organic matter in reservoirs	CH_4, CO_2
Fugitive emissions of geothermal power plants	Fugitive emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam	Steam from power plant	CH_4, CO_2

6.1.3 Develop a causal chain

It is a *key recommendation* to develop a causal chain. A causal chain is a conceptual diagram tracing the process by which the policy leads to GHG impacts through a series of interlinked and sequential stages of cause-and-effect relationships. Developing a causal chain can help identify intermediate effects and GHG impacts not previously identified, and allows users to understand visually how policies lead to changes in emissions.

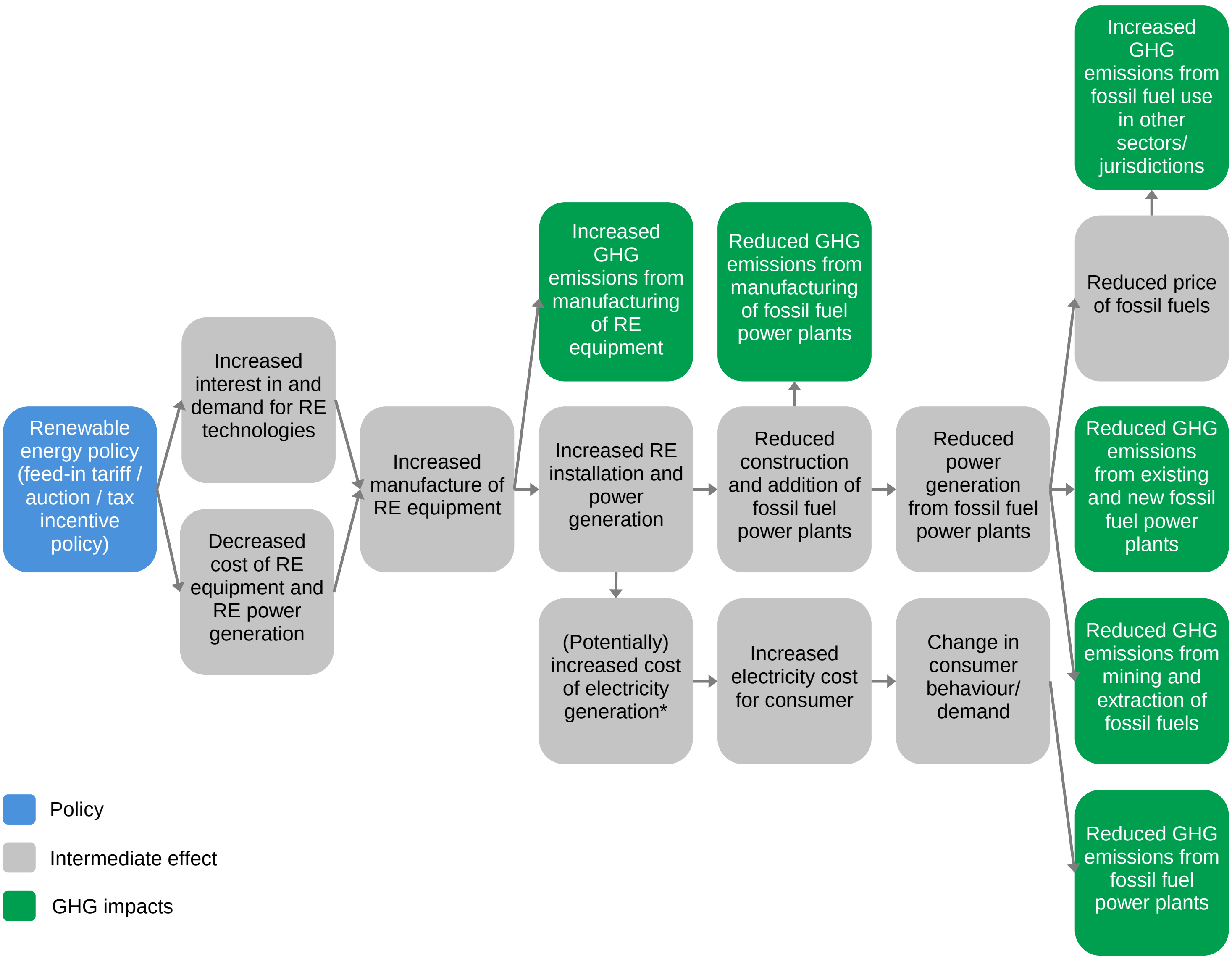
Figure 6.2 shows a high-level, illustrative example of a causal chain. Causal chains will vary from policy to policy, as will the strength of the links in the causal chain. Users should create their own causal chains, most likely with more (and different) detail from that shown in Figure 6.2.

[12] Available at: https://cdm.unfccc.int/methodologies/DB/8W400U6E7LFHHYH2C4JR1RJWWO4PVN.

Start by making a box for the policy, then build from there by adding linkages from the policy to the identified intermediate effects and GHG impacts. The causal chain represents the flow of changes expected to occur as a result of the policy. Causal chains can also include inputs and activities. The *Policy and Action Standard* provides more information about developing causal chains.

Where users are also applying the ICAT *Sustainable Development Guidance*, the causal chain can be used as a starting point for a causal chain mapping exercise that includes sustainable development impacts as well as GHG impacts.

Figure 6.2: Example causal chain for RE policies



6.2 Define the GHG assessment boundary

The GHG assessment boundary defines the scope of the assessment in terms of the range of GHG impacts. It is a *key recommendation* to include all significant GHG impacts in the GHG assessment boundary. The identified GHG impacts and the associated GHG source categories should be categorised for magnitude and likelihood, and included in the GHG assessment boundary if categorised as moderate or major in magnitude and very likely, likely or possible in likelihood (i.e., deemed significant). The *Policy and Action Standard* provides further information about categorising GHG impacts.

For most RE policies only one GHG impact is likely to be significant – *reduced GHG emissions from existing and new fossil fuel power plants*. This is because for most RE policies it is the only GHG impact that is categorised as both *very likely* and of *major* magnitude.

Table 6.3 lists other GHG impacts and source categories. Users should check the list to ensure that each of the GHG impacts is categorised appropriately for the given policy and therefore does not need to be included in the GHG assessment boundary. Any GHG impacts that are categorised as moderate or major in magnitude and very likely, likely or possible in likelihood should be included in the GHG assessment boundary.

Table 6.3: Example GHG impacts and source categories included/excluded in the GHG assessment boundary

GHG impact	GHG	Likelihood	Relative magnitude	Included?	Explanation
Reduced GHG emissions from existing and new fossil fuel power plants	CO_2	Very Likely	Major	Included	The main GHG impact of RE policies
Reduced emissions from mining of fossil fuels	CH_4	Possible	Minor	Excluded	Considered insignificant for most RE policies, and is conservative to exclude
Increased emissions from the manufacturing of RE equipment	CO_2, CH_4, N_2O	Possible	Minor	Excluded	Considered insignificant for most RE policies and is offset by decreased emissions from construction of fossil fuel power plants
Reduced emissions from construction of fossil fuel power plants	CO_2, CH_4, N_2O	Possible	Minor	Excluded	Considered insignificant for most RE policies, and is offset by increased emissions from construction of RE power plants
Leakage emissions to other jurisdictions	CO_2, CH_4, N_2O	Possible	Minor	Excluded	Considered insignificant for most RE policies
Reduced emissions from lower energy use due to increased cost of electricity	CO_2, CH_4, N_2O	Possible	Minor	Excluded	Considered insignificant for most RE policies

For geothermal power plants, fugitive emissions of CH_4 and CO_2	CH_4, CO_2	Possible	Moderate	Policy dependent	Significant for RE policies involving geothermal power
For hydro power plants, emissions of CH_4 and CO_2 from water reservoirs	CH_4, CO_2	Possible	Moderate	Policy dependent	Significant for RE policies involving hydro power plants with reservoirs
For biomass power plants, emissions associated with agriculture and land-use change	CO_2, CH_4, N_2O	Very likely	Minor-Major	Included	Significant for most biomass power plants

6.3 Define the assessment period

The assessment period is the time period over which GHG impacts resulting from the policy are assessed. It is *key recommendation* to define the assessment period.

For ex-ante assessments, the assessment period is usually determined by the longest-term impact included in the GHG assessment boundary. The assessment period can be longer than the policy implementation period, and should be as long as possible to capture the full range of significant impacts based on when they are expected to occur.

For an ex-post assessment, the assessment period can be the period between the date the policy 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 can separately estimate and report impacts over the periods 2020–2030, 2031–2040, and 2020–2040.

Where possible, users should align the assessment period with other assessments being conducted using ICAT guidance. For example, where users are assessing the RE policy's sustainable development impacts using the ICAT *Sustainable Development Guidance* in addition to assessing GHG impacts, the assessment period should be the same for both the sustainable development and GHG impact assessment.

6.4 Identify sustainable development impacts (if relevant)

RE policies have other sustainable development impacts in addition to their GHG impacts. Sustainable development impacts are 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 security. Table 6.4 identifies examples of sustainable development impacts associated with RE policies. Users can refer to the ICAT *Sustainable Development Guidance* if they want to conduct a full assessment of sustainable development impacts of their policy. This guidance in turn uses the ICAT *Stakeholder Participation Guidance*, since involving stakeholders is a recommended way of identifying sustainable development impacts.

Table 6.4: Example sustainable development impacts of RE policies

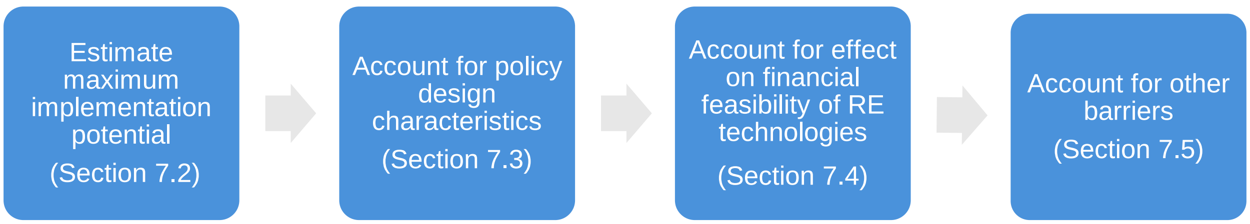
Dimension	Impact category	Examples of specific impacts
Environmental	Air quality / human health impacts of air pollution	Reduced particulate emissions from fossil fuel generation
Social	Access to clean, affordable, and reliable energy	Increased access to electricity due to cheaper RE power for self-consumption, especially for remote areas
	Capacity, skills, and knowledge development	Increased training for skilled workers in RE sectors
Economic	Jobs	Increased jobs for RE installation, operations maintenance sectors
	New business opportunities	Increased business opportunities for RE manufacturing, mining, transportation, solar power plants and grid associated technologies
	Energy security	Increased energy security from less import of fossil fuel (e.g., oil and gas)

Part III: Assessing Impacts

7. Estimating RE Addition of the Policy Ex-Ante

This chapter provides guidance for the first step of ex-ante impact assessment - estimating the RE addition that the policy can be expected to achieve. RE addition refers to the additional installation of renewable energy capacity or electricity generation from renewable sources realised via the policy, expressed in megawatts (MW) or megawatt-hours (MWh) respectively. The expected RE addition depends on a number of factors, which are accounted for in this chapter.

Figure 7.1: Overview of steps in the chapter



Checklist of key recommendations

- Estimate the maximum implementation potential of the policy
- Identify policy design characteristics and account for their effect on the maximum implementation potential of the policy
- Identify factors that affect the financial feasibility of RE technologies and account for their effect on the implementation potential of the policy
- Identify other barriers not addressed by the policy, and to account for their effect on the implementation potential of the policy

7.1 Introduction to estimating RE addition

The first step of estimating the RE addition of the policy is to estimate the maximum implementation potential of the policy. In the second step, users account for policy design characteristics that influence the maximum implementation potential, such as the scope of eligibility, differentiation between technologies, payment structure, longevity of financial support, and complexity of regulatory and legal procedures. The third step asks users to identify factors that affect the financial feasibility of RE technologies, account for their effect on the implementation potential (including accounting for alternative cost considerations, other policies in the sector and sector trends). Lastly, users identify other barriers that are not addressed by the policy and account for their effect on the implementation potential.

Once these four steps are complete users may wish to conduct a plausibility check by undertaking a benchmarking exercise. Because similar policies in similar countries often yield similar results, countries can compare their RE addition estimates with results from similar countries to ascertain whether the estimated RE addition seems reasonable. Users can refer to reports such as the REN21 Renewables

Global Status Reports[13] for an overview of countries that have implemented similar policies. Where this benchmarking exercise shows significant discrepancies (between the estimated RE addition and results from other countries and policies) that cannot be easily explained, users should revisit the inputs and method used to estimate the RE addition in an effort to refine the estimated RE addition. Appendix C: Example RE Policies provides country examples for each of the three types of policies covered by this guidance. These are examples only and users should use other peer country case studies that serve as appropriate benchmarks for their country context and specific policies.

7.2 Estimate maximum implementation potential

For the three policies described in this guidance, maximum implementation potential can be described as the maximum achievable RE addition. It is a *key recommendation* to estimate the maximum implementation potential of the policy.

The maximum implementation potential can be a policy cap inherent in the policy itself, or a RE target that is separate from the policy such as a target set at the national level. Where there is no such cap or target, users estimate the maximum implementation potential using available studies or data on RE resource potential.

7.2.1 Estimating maximum implementation potential where there is a policy cap

A policy cap is the maximum quantity of installed capacity or electricity generation supported by the policy. For feed-in tariff policies, it is an increasingly common practice to set a cap, either at a maximum per year or over the lifetime of the policy. Policy caps are implicit in the design of auctions and tenders, as a certain quantity is tendered which serves as the cap on either the number of installations, MW installed or electricity generated.

The policy cap should be taken as the maximum implementation potential. However, the following cases should be evaluated:

- The policy cap is indicative and non-binding, in which case it would serve the same purpose as a RE target.
- The policy cap is binding, but the policy still runs the risk of exceeding its objective if the government decides to revise it. For example, a government may decide to set an artificially low cap in the beginning when experience with the technology is lacking or where the government has decided against further deployment. As the technology penetration grows, acceptance and trust may increase, leading the government to revise the policy cap upwards.
- The timeframe associated with the policy cap does not match the assessment period. For example, a cap may only cover the first 5 years while the assessment considers impacts over a 15-year timeframe.

If the policy cap does not serve as a reliable estimate, users should follow the approach for policies without caps described in Section 7.2.2.

[13] Available at: www.ren21.net/status-of-renewables/global-status-report/

Where the timeframe of the cap does not match the timeframe of the impact assessment, it may be necessary for users to make assumptions about the deployment of the technology after the last cap year. Three approaches are available:

- Assume that the RE addition does not change after the last year of the cap. Users should assume the policy will be discontinued and that there are no other trends driving the deployment of the technology in the country.
- Assume that the RE addition continues to increase at the same rate as it did during the timeframe of the cap. Users should assume that the policy will be continued at the same level.
- Assume that the rate of RE addition accelerates after the end of the cap.

The example in Box 7.1 shows how the maximum implementation potential is estimated for a tender policy with three different rounds of scheduled tenders.

Box 7.1: Estimating maximum implementation potential for an example tender policy with a policy cap

The tender policy is administered by a public authority that has set up three different rounds of tenders for increasing quantities of installed capacity, which will be implemented in three consecutive years. Power producers will submit bids for these three tenders, and a number of winners will be selected to construct the total amount of installed capacity tendered for that year.

The following quantities of RE are scheduled to be tendered:

- 2017: 40 MW
- 2018: 100 MW
- 2019: 500 MW

The assessment period is 2017 to 2025. The quantities above may therefore be used as the maximum implementation potential up to 2019. The user assumes that 640 MW will be installed by then. The user may choose to assume that the tender policy is discontinued after 2019, since there is not a strong history of continuity in policymaking. There is no evidence of other trends driving the development of the technology in the country, and there is political opposition to RE deployment. Therefore, 640 MW is estimated to be the maximum implementation potential.

7.2.2 Estimating maximum implementation potential where there is no policy cap

Where no policy cap is specified, the maximum implementation potential should be estimated using available studies or data on RE resource potential. Maximum implementation potential could be based on a study that estimates the deployment potential for a particular technology in a region or country during a specific timeframe, or based on a similar policy with a policy cap.

Begin with the following prioritised list of studies. Preference should be given to the quality of the study over its relevance to national circumstances:

- National and technology-specific studies on RE resource potential
  - Example resource: International Renewable Energy Agency (IRENA) *Studies on Renewable Energy Potential*[14], which provides an overview of studies available by country or technology
- Global studies and databases on RE resource potential
  - Example resource: *IRENA Global Atlas for Renewable Energy*[15], which is an initiative coordinated by IRENA to close the gap between nations with and without access to necessary datasets, expertise and financial support to evaluate their national renewable energy potentials
- Expert judgment-based assessments
  - Example: Experts with ample experience in the national energy sector (e.g., in-house experts in ministries, research groups at national universities or other research organisations, or local consultants) might have a good understanding of the maximum renewable energy potential in the country. Such expert judgments might be based on country-specific models used by the experts' previous analysis and other projects or studies, or might just be informed by their long standing experience of working in the sector in the country.

Users should account for the following factors when estimating the maximum implementation potential, prioritising them from top to bottom and working with experts (e.g., national universities or local consultants) if necessary:

- **Resource factors** related to the availability of natural resources available for RE extraction, including the following:
  - Physical constraints: Physical characteristics that determine or constrain the overall potential for RE extraction, such as total sun hours in a country or region
  - Energy content of resource: Energy content that can theoretically be converted into electricity, such as wind intensity profile or solar radiation intensity
  - Theoretical physical potential: Maximum potential of RE extraction depending on the physical characteristics and energy content of the resource
- **Technical factors** relate to the geographical location of potential RE extraction, the energy system, the grid load location, and land use constraints that may impact the installation of RE equipment, permitting, stakeholder acceptance or available land area, including the following:
  - System and topographic constraints: Constraints that affect the realisation of RE extraction due to the topography (e.g., high mountains that inhibit the construction of

[14] Available at: http://www.irena.org/potential_studies/index.aspx.

[15] Available at: http://irena.masdar.ac.ae/.

solar or wind installations, or proximity to coast lines likely indicating a larger resource potential for wind installations)

- Land-use constraints: Constraints that affect the realisation of RE extraction due to land requirements for agriculture, housing and other infrastructure
- System performance constraints: Constraints that affect the realisation of RE extraction due to structural limitations of the energy system (e.g., non-existence or weak grid infrastructure in a certain region may limit what can be done in the region in a short to medium time frame or after the infrastructure has been built)

Construction of RE capacity, and therefore realisation of RE resource potential, takes time. Users should estimate maximum implementation potential accounting for the time it takes to install RE capacity and how much capacity it is practical to install within the relevant timeframe. “Practical to install” here means the RE capacity that could be constructed assuming no constraints imposed by policy design characteristic, economic and financial factors, and other barrier. The impact of these is addressed following the subsequent steps.

Box 7.2: Example of estimating maximum implementation potential for a feed-in tariff policy without a policy cap

The country has no available studies citing capped feed-in tariff policies that can be used, and global assessments do not contain sufficient detail to allow the estimation of the maximum implementation potential. However, a national university with expertise and a progressive energy department previously produced estimates for the maximum RE resource potential in the country which they have been updating on a yearly basis for their own research purposes. The insights gained through this analysis provide a good understanding of the country’s resource potential, based on resource and technical factors. For this reason, the university experts’ knowledge is deemed sufficiently good to be used as a basis for the estimation of the maximum implementation potential of the feed-in tariff policy.

In a workshop session, the university experts transparently explain their estimates on the RE resource potential and underlying assumptions on all resource and technical factors to ministry representatives and both groups jointly arrive at a conclusion. The maximum implementation potential of the feed-in tariff policy is as follows:

- Solar energy: 1,500 MW
- Wind energy: 800 MW

The experts further analyse capacity and, given the trajectory of RE implementation, determine that it is practical to install the following by 2030 (the target year for the country’s NDC):

- Solar energy: 900 MW
- Wind Energy: 400 MW

Therefore, the feed-in tariff policy’s maximum implementation potential (by 2030) is determined to be 1,300 MW.

7.3 Account for policy design characteristics

There are several design characteristics common to RE policies that influence their impact, such as the scope of eligibility, differentiation between technologies, payment structure, longevity of financial support, and complexity of regulatory and legal procedures. It is *a key recommendation* to identify policy design characteristics and account for their effect on the maximum implementation potential of the policy.

Table 7.1, Table 7.2 and Table 7.3 in the sections below list the main design characteristics for the different types of RE policies and describe how each influences the maximum implementation potential. Each section also provides a box with an illustrative example of how these policy design characteristics are used to refine the implementation potential of the policy.

Users should use these tables to:

- Identify design characteristics that are likely to influence maximum implementation in their country context;
- Describe how the identified policy design characteristics are expected to influence RE deployment; and
- Estimate the overall influence of these characteristics on the maximum implementation potential of the policy.

7.3.1 Design characteristics of feed-in tariff policies

Table 7.1: Feed-in tariff policies - Influence of policy design characteristics on maximum implementation potential

Design characteristic	Description	Influence on maximum implementation potential
Eligibility	• Project owner • Technology • Size • Location	• The narrower the eligibility conditions of the feed-in tariff policy, the lower the probability that the policy achieves its maximum implementation potential
Tariff Differentiation	• RE type • Project size • Resource quality • Technology application • Ownership type • Geography • Local content	• Differentiated tariffs are able to tap into a larger share of the GHG emission reduction potential; lower tariffs for less expensive RE technologies may lower the probability that the policy achieves its maximum implementation potential
Payment structure	• Fixed-price or premium-price policies	• For both types of payment structures, if the resulting end price is above the levelised cost of electricity or other feasibility calculations done by power producers, this should not reduce the probability

		that the policy achieves its maximum implementation potential
Utility's role	• Purchase obligation • Guaranteed grid connection	• The lack of purchase obligation or guaranteed grid connection may lower the probability that the policy achieves its maximum implementation potential due to decreased security and certainty for investors
Contract and payment duration	• Contract periods (short-term, medium-term, long-term)	A short contract periods in combination with relatively a low feed-in tariff might lower the probability that the policy achieves its maximum implementation potential due to a lack of certainty for power producers and their investors. Conversely, a short contract period with a relatively high feed-in tariff might be attractive, since it allows the initial investment to be recouped relatively quickly. Longer contract periods mean higher risks for power producers; they may lack confidence in the government's ability or will to sustain the feed-in tariff over time; and their own costs are more difficult to forecast further out. Longer contract periods might therefore lower the policy's maximum implementation potential.
Opt-out options	• Contractual opt-out options for power producers to sell energy on free market	Power producers gain contractual flexibility, after a certain time, to sell their electricity on the free market instead of receiving the feed-in tariff. This can increase investment interest in country contexts where RE technologies might achieve cost parity in the near- to mid-term future.
Forecasting	• Forecast obligation	Forecasting obligations require power producers to provide hourly predictions of power production in order to participate in the market, for which the actual production under the estimated forecast is charged the highest price on the market for the non-produced amount of energy. This presumably has a small effect on the likelihood that the policy achieves its maximum implementation potential, but may slightly increase project costs.
Grid access	• Transmission • Interconnection	A lack of grid priority for RE electricity presumably lowers the probability that the policy achieves its maximum implementation potential due to decreased security and certainty for investors
Policy adjustments	• Payment adjustments (fixed adjustments, regular adjustments, inflation adjustments) • Programme adjustments	Downward adjustment of feed-in tariff prices or premiums may decrease the probability that the policy achieves its maximum implementation potential if done ineffectively, and may also lead to resistance

Source: Adapted from (NREL, 2009; Couture, Cory and Williams, 2010; UNEP, 2012; UNESCAP, 2012).

Box 7.3: Feed-in tariff policy - Example of using policy design characteristics to refine maximum implementation potential

The design characteristics for the feed-in tariff are as follows:

- **Eligibility**: The only technology eligible under the feed-in tariff is solar PV
- **Tariff differentiation**: Higher tariffs for small-size projects and lower tariffs for large-scale projects (set to give rates of return between 5-8%)
- **Payment structure**: Premium-price policies
- **Utility role:** Government-owned single buyer with guaranteed purchase
- **Contract and payment duration**: Premium is offered over period of 15 years
- **Forecasting**: No forecasting requirements
- **Grid access**: Grid priority transmission and dispatch for renewable energies
- **Policy adjustments**: Only inflation adjustments over lifetime of feed-in tariff

Due to a lack of specific quantification methods, a qualitative approach is used to estimate the influence of each of design characteristics above on the maximum implementation potential of the policy.

The analysis reveals that the policy design characteristics reduce the maximum implementation potential as follows:

1. The **scope of eligibility** is expected to directly reduce the maximum implementation potential since only solar PV installations are eligible. The maximum implementation potential is reduced from 1,300 MW to 900 MW, thus excluding all potential identified for wind energy.
2. The **premium-price policy** is expected to reduce the maximum implementation potential as the partial dependence on the electricity market price introduces a level of uncertainty that would not be there if the entire feed-in price was fixed. Based on a representative survey conducted by a local consultancy among potential power producers and investors (both small- and large-scale) on how this uncertainty might affect future RE deployment, the local consultants estimate that this reduces the maximum implementation potential by only about 60 MW (conservative estimate) as most power producers have found ways to deal with this uncertainty (e.g., through integrating them into the rest of their portfolio). This reduces the maximum implementation potential to 840 MW.
3. The **contract and payment duration** of 15 years is expected to be too short for several of the large-scale solar PV projects, because with the expected interest rate power producers would require contracts with payment duration of 20 to 25 years. A consultation with two local experts on renewable energy investments that includes a look at the projects currently in the pipeline in the country reveals that, under these conditions, about 6% of the projects in the pipeline would not be built (3 projects in total). This means that the maximum implementation potential would be further reduced by another 40 MW (conservative estimate) to 800 MW.

After accounting for all policy design characteristics, the refined implementation potential is expected to be **800 MW** (compared to 1,300 MW before).

7.3.2 Design characteristics of auction policies

Table 7.2: Auction policies - Influence of policy design characteristics on maximum implementation potential

Design characteristic	Description	Influence on maximum implementation potential
Auction demand and auction design	• Choice of the volume auctioned and differentiation between different technologies and project sizes (technology-neutral auctions or technology-specific auctions and standalone or systematic auctioning policies)	• The size of the volume auctioned directly affects the size of the maximum implementation potential • Sub-optimal auction design and/or incomplete pre-analysis on conditions for successful tendering may affect auction’s effectiveness and decrease the likelihood that the policy will achieve its maximum implementation potential
Longevity of the power purchase agreement (PPA)	• PPA signed with the preferred bidder • Contract provides the power producers with a fixed price for certain number of years and guaranteed purchase for all generation	• Without the provision of longevity annuities, which safeguard against risks for power producers and investors and lower the costs of financing, there is a reduced likelihood that the maximum implementation potential will be achieved
Qualification requirements	• Power producers eligible to participate in the auction and requirements related to reputation • Equipment and production site selection • Securing grid access • Instruments to promote local socio-economic development	• A lack of qualification criteria for bidders may decrease the likelihood that expected capacity is successfully installed and that the maximum implementation potential is achieved • High and costly qualification requirements may exclude small-scale or new power producers since such potential bidders may lack required resources; this may decrease the likelihood that the maximum implementation potential is achieved • Identification of sites that lack ideal resources and secured grid connection potentially increases risks to investors, thus decreasing the likelihood that maximum implementation potential is achieved
Winner selection process	• Bidding procedure • Requirements of minimal competition • Winner selection criteria • Clearing mechanism and marginal bids • Payment to the auction winner	• Competitive bidding (in seal-bid or descending clock auction) can lead to underbidding due to incentive for bidders to bid as low as possible in order to increase chances of securing a contract, which may decrease the likelihood that the maximum implementation potential is achieved • Experience suggests that underbidding is widespread and contract failure rates remain high, leading to slower growth

Sellers' contractual liability requirements	• Commitments to contract signing • Contract schedule • Remuneration profile and financial risks • Nature of the quantity liabilities • Settlement rules and underperformance penalties • Delay and underbuilding penalties	• High overall liabilities requirements may deter potential bidders, possibly decreasing the likelihood that the maximum implementation potential is achieved • The less predictable and stable the institutional and regulatory framework, the higher the bidders' perceived risk in the auctioning process and the lower the probability that the maximum implementation potential is achieved • The lack of sellers' liabilities requirements provides an incentive for drastic underbidding, lowering the probability that the maximum implementation potential is achieved

Source: Adapted from (IRENA, 2013, 2015a; Agora Energiewende, 2014).

Box 7.4: Auction policy - Example of using policy design characteristics to refine maximum implementation potential

The design characteristics for the auction policy are:

- **Auction demand/auction design**: Technology-specific standalone auctions
  - 2017: 20 MW of solar, 20 MW of wind
  - 2018: 50 MW of solar, 30 MW of wind, 20 MW of biomass
  - 2019: 200 MW of solar, 250 MW of wind, 50 MW of biomass
- **Longevity of the PPA**: Duration of tariff is 25 years for solar, 20 years for wind and 20 years for biomass
- **Qualification requirements**: Pre-qualification phase with requirements to display experience, as well as financial and technical capacity to implement projects
- **Winner selection process**: One-round winner selection based on price and quota of energy (with no celling price) with several bidders being selected
- **Sellers' liabilities requirements**: Penalties for delay and underperformance determined in PPA, guarantee paid at signature of PPA, termination of PPA as last resort

Due to a lack of specific quantification methods, a qualitative approach is used to estimate the influence of each of policy design characteristics above on the maximum implementation potential of the policy.

The analysis reveals that the policy design characteristics reduce the maximum implementation potential as follows:

1. The **pre-defined qualification requirements** are likely to directly reduce the maximum implementation potential. A consultation with the above-mentioned industry experts in the country reveals that there are a limited number of companies that have sufficient financial and technical capacity to implement projects. These qualification requirements were introduced to ensure the successful implementation of the auctioned capacity. Accounting for the fact that the industry needs a few years to develop the capacity, the maximum implementation potential

for the period analysed is reduced by 60 MW from 640 MW (the maximum implementation potential determined in the previous step) to 580 MW.

2. The **sellers' liability requirements** are likely to reduce the maximum implementation potential as a number of potential power producers cannot provide the guarantee at the signature of the PPA. These liability requirements were introduced to ensure the successful implementation of the auctioned capacity. After consulting with the two industry experts and a look at the current project pipeline in the country, it is estimated that this reduced the maximum achievable impact further by 30 MW from 580 MW to 550 MW.
3. After conducting analysis on whether the specifications of the **longevity of the PPA** might reduce the maximum achievable impact, no further downward adjustments have been made as the duration has been set after consultation with power producers to ensure a sufficiently long PPA duration.

After accounting for all policy design characteristics, the refined implementation potential is expected to be **550 MW** (compared to 640 MW before).

7.3.3 Design characteristics of tax incentive policies

Table 7.3: Tax incentive policies - Influence of policy design characteristics on maximum implementation potential

Design characteristics	Description	Influence on maximum implementation potential
Type of tax incentive	• Reduced or complete tax exemption or refunds • Deductibles • Tax credits • Different payment schedules • Fiscal stability incentives	• Tax incentives that are too low provide insufficient incentives for eligible entities to install additional RE capacity, thus lowering the probability that the maximum implementation potential is achieved • Incentive policies incentivise RE in different ways: tax credits reducing the tax liability for (a portion of) the cost of purchasing and installing RE capacity is incentivised through direct cost saving; fiscal stability incentives that shield certain RE technologies from potential future changes in fiscal regime or from additional fees are mainly incentivised by creating a stable investment environment; decreased stability and low level of incentives lower the probability that the maximum implementation potential is achieved
Scope of application	• Pre-investment expenses related to RE projects • Sale of electricity • Carbon credits and other ancillary income • RE-specific taxes or concession fees • Services and equipment	• A narrow scope of tax incentive (potentially) decreases the incentive for eligible entities to install additional RE capacity, lowering the probability that the maximum implementation potential is achieved • Restricted eligibility that is limited to few RE technologies may lower the probability that the maximum implementation potential is achieved, as eligible entities have less flexibility to choose the most appropriate technology

	• Civil works	

Source: Adapted from IRENA 2015b; North Carolina Solar Center 2012; OECD 2011.

Box 7.5: Tax incentive policy - Example of using policy design characteristics to refine maximum implementation potential

[placeholder]

7.4 Account for effect on financial feasibility of RE technologies

RE policies provide incentives, thus directly influence the financial feasibility of RE technologies and in turn the implementation potential of the policy. It is *a key recommendation* to identify factors that affect the financial feasibility of RE technologies and account for their effect on the refined implementation potential of the policy. Existing cost-benefit analyses (e.g., conducted in the policy design phase) should be used as a basis here and should updated as needed.

In this step, users make an initial estimate of the effect of the policy on the financial feasibility of RE technologies (section 7.4.1). Users should then account for alternative cost considerations, other policies in the sector, and sector trends (covered in Sections 0, 0, 0 respectively). The effect of financial barriers on the implementation potential of the policy is considered separately in the barrier analysis (Section 7.5).

7.4.1 Identify factors that affect the financial feasibility of RE technologies

Users should identify the level of incentive provided by the policy and ascertain its effect on the financial feasibility of RE technologies. Where possible build upon existing cost-benefit analyses, and update these to reflect recent developments and confirm continued applicability and completeness.

There are a number of factors to consider. First, there are factors that are directly related to RE deployment, including:

- **Cost of the technology in the local market**: This includes capital costs, operations and maintenance costs, and fuel (e.g., biomass) costs. There may be mark-ups in local markets that may arise due to inexperience with a given technology in the country, such as a shortage of engineers that necessitates bringing in outside expertise. Technology costs in local markets can also be driven by advances in knowledge, which reduces technology costs over time.
- **Technical characteristics of the technology applied in the local market**: For example, capacity of the technology, load characteristics and operational lifetime of the technology.
- **Project financing**: This includes financing sources and their conditions, such as interest rates and duration of loans. Project finance generally comes in three different forms: equity, private debt and public debt financing. These can be captured in the weighted average cost of capital (WACC). WACC is the rate a company is expected to pay on average to compensate all of its investors. The WACC calculation formula for RE sources is provided in Appendix B: Overview of the Weighted Average Costs of Capital.

Second, there are a number of factors related to the electricity market, including:

- **Cost and technical characteristics of alternative technologies**: This includes, for example, capital costs, operations and maintenance costs, and fuel costs.

- **Electricity price in the local market**: The wholesale market price is the price power producers receive for selling electricity to the grid. The price depends on the type of market and the point in time the electricity will feed into the grid.[16] It can also be a price that is agreed directly between two parties independent of an exchange body supervising the trade (Over-the-counter, or OTC).
- **Variations in resource potential**: Resource potential vary widely across regions and different locations. For example, wind resource may be higher in some parts of the country than others, which directly influences wind turbine load capacity and therefore financial feasibility.

The combination of these factors determines how financially feasible RE technologies are in a given country context. The following data sources, prioritised from top to bottom, may be useful in informing the financial feasibility evaluation of RE technologies:

- Calculations made during policy set-up
- National cost studies (e.g., from low emissions development strategies (LEDS))
- Global cost estimates (e.g., from International Energy Agency (IEA World Energy Outlook database,[17] or IRENA RE technology costs with a country-specific resolution[18])

7.4.2 Evaluate financial feasibility of RE technologies

This section presents a commonly used method to analyse the factors that influence the financial feasibility of RE technologies: *levelised cost of electricity (LCOE)* analysis. Other methods used by public/private investors and policymakers, such as *annuity method of depreciation* and *return on investment (ROI),* can also be used in this context.

The levelised cost of electricity is the unique cost of an energy project representing the present value of the costs over the lifetime of the project. Users can refer to publicly-available LCOE quantification tools (e.g., the Excel spreadsheet tool provided by Agora Energiewende[19]) to conduct calculations, or development tools tailored to country-specific circumstances. In some country contexts, users might be further interested to use more sophisticated LCOE tools, which for example allow for the assessment of financial de-risking policy options such as the UNDP's De-risking Renewable Energy Investment (DREI) methodology.[20]

Step 1: Calculate the levelised cost of electricity for different RE technologies

The levelised cost of electricity represents a common metric for comparing costs across different power-generating technologies and analyses financial viability of technologies by comparing their cost structures over project lifetimes.

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[16] Next Kraftwerke 2016.

[17] Available at: http://www.worldenergyoutlook.org/aboutweo/.

[18] See "References" section.

[19] Available at: https://www.agora-energiewende.de/fileadmin/Projekte/2013/EEG-20/Calculator_Levelized_Cost_of_Electricity_And_FIT_Comparison__V1.0.xlsx

[20] Available at: http://www.undp.org/content/undp/en/home/librarypage/environment-energy/low_emission_climateresilientdevelopment/derisking-renewable-energy-investment.html

LCOE is often taken as a proxy for the average price that an energy project must receive in a market to break even over its lifetime. See Appendix A: Overview of LCOE Method for RE Sources for guidance on calculating LCOE for RE technologies, including the equation and the explanation of input parameters.

The financial feasibility of technologies can be estimated by comparing the LCOE for the given RE technology with either the policy's tariff rate (for feed-in tariffs policies and auction policies)[1] or the generation costs of technologies that will be displaced by the RE technology (for tax incentive policies). These can be:

- The costs for existing plants, if it is clear which fossil fuel plants will be displaced as a result of the policy;
- The average electricity generation costs across the electricity grid; or
- The costs for power plants that would have been built in the absence of the policy.

LCOE should be calculated separately for each RE technology. Since the LCOE of RE power plants might vary widely depending on geographical conditions such as wind and solar resource, a location differentiation should also be considered.

For example, users might conduct separate calculations for solar PV installations in different regions of the country if the solar potential can be divided into different geographic areas (see example in Box 7.5 in Section 7.4.3). Similarly, this can be done for other RE technologies such as onshore wind. Where regional data availability is scarce, users can make estimates based on available project information, such as CDM project design documents or surveys among power producers. The calculations and data taken from these documents should be updated as appropriate. Global data figures are readily available from sources such as the IPCC Working Group III Contribution to the Fifth Assessment Report, Mitigation of Climate Change, Chapter 7, Energy Systems[1], though these might not reflect country-specific circumstance well enough to make reasonable estimates.

Users should use current data and consider future cost decreases achieved through technology learning (local and global) and economies of scale. This might occur over short time horizons (even 2-3 years) in some cases. Users can use technology learning curves or consult experts on the cost trajectory for RE technologies. Technologies are likely to become cheaper if they become widely diffused, even though cost spikes may still occur due to reasons such as increased demand or changes in the prices of raw materials (e.g., increased steel prices in the case of wind energy).

Besides technology costs, there are other drivers of future electricity generation costs. First, electricity generation options that were historically available may not be available in the future due to resource or political constraints, which can be the case for hydro or nuclear power. Second, stricter environmental regulations may increase the cost of electricity generation from certain sources, such as stricter air pollution requirements that may require retrofits to existing plants (which can reduce power plant efficiency).

Where users have sufficient information about financing sources (i.e., equity, private debt financing and public debt financing), they can calculate the LCOE based on assumptions about the role of each finance source. For instance, there may only be a limited amount of public low-cost financing available and/or a guarantee fund may exist with limited capitalisation. In these cases, users can calculate LCOE separately for the amount of financing available. The WACC calculation formula for RE sources is provided in

Appendix B: Overview of the Weighted Average Costs of Capital and constitutes a direct input into the LCOE calculations.

Step 2: Comparing the LCOE to financial incentives provided by RE policies

The comparison of the LCOE for a given technology and location with the financial incentive level provided by the RE policy allows users to evaluate whether the policy makes investment in RE technologies financially feasible.

In absence of a RE policy, users would normally compare the LCOE to the price they could negotiate in an OTC contract or the (average) wholesale market price of electricity in the market they would sell into. The term *wholesale market price* is used here to represent a more complex situation. In reality, the wholesale market price depends on the particular situation in the country that dictates specific market prices with which RE technologies have to compete. The price depends on the type of market, but also on the point in time the electricity will feed into the grid.[21] In many countries, the technology will have to compete with several different prices, depending on the point in time that the electricity is fed into the grid and how far in advance the price will be set, among other things. A wholesale market price that represents an average price should be chosen.

When evaluating the impact of a RE policy on the financial feasibility of RE technologies, users should compare the LCOE to the financial incentive provided by the policy rather than the wholesale market price (or a combination thereof in case of premium policies). Possible conclusions that can be drawn from this step of the assessment include:

- **LCOE > tariff or wholesale market price**: Where a given RE technology has higher costs on average than the tariff or wholesale market price chosen, or financial incentives provided by the policy, the technology is likely to diffuse only in niches. If no such niches exist, the technology is not likely to diffuse at all.
- **LCOE < tariff or wholesale market price**: Where a given technology has lower costs on average than the costs of current technologies or financial incentives provided by the RE policy, the technology is likely to diffuse. For these calculations, users can assume that the financial analysis does not further restrict the implementation potential of the policy.
- **LCOE < tariff or wholesale market price for certain financing options, or a limited number of projects only**: The technology may only be feasible for a limited number of cases (e.g., only for wind sites with a wind speed higher than a certain threshold).

Informed by this evaluation, users can estimate how, from a financial feasibility perspective, RE technologies will diffuse under a given RE policy.

Step 3: Account for other cost considerations in a national context (if relevant)

As discussed in the previous steps, the electricity generated by renewable energy technologies will be fed directly into the grid in most cases. Therefore, the LCOE is compared to the electricity market wholesale price to identify the financial feasibility of such technology in a competitive market setting or the financial incentive provides by a RE policy.

[21] Next Kraftwerke 2016.

In some country contexts, however, there are certain alternative cost considerations that need to be accounted for when analysing the financial feasibility of certain renewable technologies from the perspective of the investor. This crucially depends on the country context and the policy design characteristics.

For example, if a tax incentive policy is eligible regardless of whether the electricity is fed into the grid or consumed by the investor directly without ever being fed into the grid, households or industrial entities (as the investors in solar PV installations) might install additional RE capacity even if the LCOE is above the electricity wholesale market price. This is due to the fact that in such a context, the investors (i.e., households and/or industrial entities) compare the location-specific electricity production costs plus the granted financial support to the end-consumer prices they pay for the consumption of electricity from the grid.

These end-consumer prices are well above the electricity wholesale market price as they take account of transmission and distribution as well as system costs. In such cases, users should replace what is referred to as wholesale market price in Step 2 with the cost of the alternative (i.e., the end consumer price):

- **Residential customer's own consumption** (ideally with net metering in place): Comparison of production costs plus financial support to end-consumer prices
- **Industrial generation for own consumption**:
  - Separate analysis should be done for all RE technologies considered
  - Calculations provide users with an indication of whether there will be any capacity extension; if so, analysis will provide specific technologies (and possibly which areas)
  - Comparison of end-consumer prices for industrial entities and RE production prices (with or without feed-in tariff or tax incentive)
  - Feasibility of analysis depends on regulations in the jurisdiction (e.g., whether "off-site" generation is allowed and, if so, whether policies on transmission exist)

If industrial entities and/or households install RE capacity for the purpose of own consumption under a given policy (under which the financial support is granted regardless of whether the electricity is fed into the grid), this might result in higher overall RE capacity deployment as the comparison of LCOEs with wholesale market price would result in. Again, users might need to account for regional differences and conduct separate analyses for different regions.

Users should critically reflect whether such additional analysis is necessary given the country context and policy design characteristics of the respective policy.

Step 4: Consider effect of other policies in the sector (if relevant)

Other policies in the sector may affect the financial feasibility of RE technologies. They may also enable or impede the implementation of the policy, and may continue into the future or be discontinued. Policies that may interact with the financial feasibility of policies include:

- Emissions trading programs, which may provide an additional incentive for RE technologies by increasing the cost of alternative technologies

- Taxes, such as energy or carbon taxes
- Energy regulations, such as mandatory closing of inefficient plants and quotas for fuels
- Subsidies, such as fossil fuel subsidies, or direct and indirect electricity subsidies

The guidance provided in Section 5.2.2 may also be helpful in determining the effects of other policies.

Step 5: Consider effect of sectoral trends (if relevant)

Sectoral trends can reinforce or counteract RE policies and the financial feasibility of RE technologies. Sectoral trends include:

- Changes in fossil fuel prices that can cause shifts between fossil fuels (e.g., shift from coal to natural gas due to lower costs of natural gas), or alter the financial feasibility of RE power plants
- Public support or opposition to certain technologies, such as onshore wind turbines
- Global trends in technology costs, such as the falling costs of solar PV panels in recent years
- Shifts in consumer behaviour, such as increasing demand for renewable electricity

To identify relevant trends, users can refer to sectoral studies on national or global developments in the sector or consult with national experts and relevant stakeholders from universities, ministries, the private sector, or the public. For example, users could refer to recent studies on global and local price development for fossil fuels to evaluate whether the projected trends significantly affect the overall financial feasibility of RE technologies in comparison with traditional fossil fuel technologies (e.g. cost reductions of natural gas due to accelerated fracking exploration).

The occurrence and impact of sectoral trends is highly dependent on national sectoral circumstances and, if accounted for, require careful evaluation of how and to what extent such trends affect the financial feasibility of renewables.

7.4.3 Examples of using financial factors to refine implementation potential

Box 7.6: Feed-in tariff policy - Example of using financial factors to refine implementation potential

The LCOE calculations for the country revealed costs between 10 cents/kWh and 17 cents/kWh for various locations. Since the solar potential can be roughly divided into four geographic areas, four different representative full load hour estimates were used to estimate these location-specific LCOE costs. The feed-in tariff rate is fixed at 13 cents/kWh. Solar PV will likely be developed in only two of the four geographic areas in which the LCOE is above the wholesale electricity price (i.e., the feed-in tariff rate). As the two regions in which no solar PV will be developed have a total maximum capacity of 100 MW (relatively low due to low solar radiation and relatively swampy regions where only limited capacity could be installed), this reduces the implementation potential of the policy from **800 MW** to **700 MW**.

Since both stand-alone and rooftop installations are eligible under the feed-in tariff, this should not further reduce the implementation potential in the two geographic areas with higher solar potential, as both areas have meaningful electricity loads and ample space available to build the plants.

The feed-in tariff provides a large degree of certainty to the investor, thereby attracting financing even from risk-averse sources. However, access to finance in general is limited in the country. Even with the guarantee provided by the feed-in tariff, the number of investors will be small. Therefore, after consultation with financial experts in the country, the implementation potential is further refined from **700 MW to 600 MW**.

Box 7.7: Auction policy – Example of using financial factors to refine implementation potential

Since the auction policy provides separate auctions by technology and there is no ceiling price for the auction, the financial feasibility assessment does not result in a downward revision of the implementation potential. However, access to financing in the country is very limited and only a small number of private investors are willing to invest in RE. This limits the number of plants that can be constructed. A simple comparison of the investment finance needed with the financing available shows that the overall achievable RE addition with the existing financing is between 400 MW and 500 MW. To be conservative, the implementation potential is refined to **450 MW**.

7.5 Account for other barriers

There are several barriers that can hinder RE deployment, including technical, regulatory, institutional, market, financial, infrastructure, awareness and public acceptance barriers. It is a *key recommendation* to identify other barriers not addressed by the policy and account for their effect on the implementation potential of the policy. The barrier analysis focuses only on those barriers not directly addressed by the policy being assessed.

Users should follow the steps below to identify barriers and account for their effect on the implementation potential of the policy. Table 7.4 provides a template table, which can be modified as needed, to assist users in accounting for other barriers.

Table 7.4: Sample template for barrier analysis

Step 1		**Step 2**	**Step 3**	**Step 4**		
Barrier category	**Barrier description**	**Severity of barrier**	**Other policies addressing barrier**	**Impact factor**	**General level/ Technology level**	**Overlap with other barrier(s)**
Specify the overarching barrier category	*Describe the specific barrier and explain how the barrier may affect the policy*	*Provide severity of the barrier on a scale from 1 to 5.*	*Provide analysis on whether other existing policies may help to overcome this barrier*	*Provide the effect of the barrier on the implementation potential of the policy. The implementation potential can also be provided with an uncertainty range.*	*Specify whether the impact factor applies on a general level or a technology-specific level*	*Provide analysis on whether and to what extent the barrier overlaps with other existing barriers*

Where users choose not to use the approach below, they can use country-specific studies that identify barriers and account for their effect, or use expert judgment to assist them in their assessment. Other tools are also available, such as the GIZ *Barriers-to-objectives weighting method*,[22] which provides a quantitative method for evaluating barriers on a project level. Such tools could be used to account for other barriers or in in support of the steps outlined below.

7.5.1 Step 1: Identify barriers

Table 7.5 lists barrier categories, and provides descriptions and examples for each. Use this categorisation to identify and describe barriers to RE deployment in the geographic area of the policy, note if no barriers are identified for a given barrier category.

Table 7.5: Barrier categories

Barrier category	Description	Examples
Technical	• Technical standards (e.g., uniform engineering or technical criteria, methods, processes and practices) are lacking for some RE technologies • Lack of sufficient technology providers • Insufficient transmission and distribution infrastructure to connect new RE capacity to the grid, especially where RE resource potential is highest	• No technical standard exists for a biomass technology that is eligible under the policy • There is a limited number of technology providers for a certain technology that is eligible under the policy • Outdated transmission and distribution infrastructure prevents grid connection of newly installed capacity (e.g., no transmission lines exist to connect wind generation in remote areas)
Regulatory and policy uncertainty	• Insufficient clarity and transparency in existing regulations or in the development of new policies	• Lack of transparency in policy set-up of feed-in tariff policy and history of ad-hoc changes in regulation increase uncertainty, which discourages market actors from participating in the policy
Institutional and administrative	• Lack of strong and dedicated institutions to carry out policies • Permits for new RE plants are difficult to obtain, approval procedures are lengthy and cumbersome, or there is a lack of spatial planning for RE • Unclear procedures and responsibilities and/or complex interactions and lack of coordination between the various authorities involved • Other barriers in the energy system, such as existing industry, infrastructure and energy market regulation, intellectual property rights, tariffs on	• Several institutions claim responsibility for implementation of the policy • Unclear procedures on how to participate in or receive assistance from policy, which discourages market actors

[22] Available at: https://www.transparency-partnership.net/giz-2011-climate-results-giz-sourcebook-climate-specific-monitoring-context-international-cooperatio.

	international trade, and allocation of government financial support	
Market	• Inconsistent pricing structures that put renewables at a disadvantage • Asymmetrical information between market actors • Market power and subsidies for fossil fuels • Blockage of incumbent actors and limited access of new actors to the market • Import tariffs and technical barriers that impede trade in renewables • Access to market	• Existing fossil fuel subsidies (direct or indirect) prevent large-scale RE deployment through the policy • Incumbent market actors possess information advantage and have direct or indirect influence on policy design process that limits access for new market actors • High import tariffs or domestic content requirements hinder deployment of technologies
Financial	• Absence of adequate funding opportunities and financing products for RE • Financing is unreasonably costly for RE technologies • Concerns about possible devaluation of asset value • Disproportionately high transaction costs in relative terms	• Insufficient funding available in domestic context due to high up-front costs of RE investments • Substantial concerns about financial solvency of state-owned utilities that discourage market actors to use policy
Infrastructure	• Lack of flexibility of the energy system (i.e., of the electricity grid to integrate or absorb RE) • Energy markets are not prepared for RE (i.e., integration of intermittent energy sources, grid connection and access is not fairly provided) • Higher grid connection costs for RE	• History of technical problems with grid infrastructure preventing decentralised access of RE to grid
Lack of awareness of RE and skilled personnel	• Insufficient knowledge about availability, benefits and performance of renewables • Insufficient numbers of skilled workers and lack of training and education • Lack of general information and access to data relevant to RE deployment (i.e., deficient data about natural resources) • Lack of experience and expertise among the relevant stakeholders, including project sponsors and power producers, investors and financiers, and regulators and authorities	• Deficient number of skilled workers for the installation of wind turbines
Public acceptance and environmental	• Linked to experience with planning regulations and public acceptance of RE • Lack of research into the more complex interactions between RE technologies and the environment • Competition with other interests in the geographic area, such as fishing, shipping and aviation, recreational use of land, archaeological and historical heritage interests, civil and military airport interests	• Lack of public acceptance of policy due to perceived high economic and social costs, and a lack of understanding and misleading information • Environmental concerns due to major investments in new infrastructure, in particular overland transmission lines

7.5.2 Step 2: Evaluate severity of barriers

Evaluate the severity of barriers using a predefined scale, such as a scale from 1 to 5, with 1 indicating low impact and 5 indicating very severe impact. Barriers that are considered to be very severe are ones that entirely inhibit the policy from having any impact. Barriers will most likely inhibit a given aspect of the policy and not the entire policy.

Identify the way in which the barrier affects the implementation potential of the policy. Further guidance on how to account for barriers on the implementation potential is provided in in Section 7.5.4.

The evaluation can involve expert judgment, desk reviews and stakeholder consultations. Refer to the ICAT *Stakeholder Participation Guidance* (Chapter 8) for information on designing and conducting consultations.

7.5.3 Step 3: Identify other policies that may help overcome barriers

For each barrier identified, identify other policies or actions in the country that may help overcome or increase the barrier, and provide a description of how and to what extent such policies/actions may help overcome the barrier. Adjust the evaluation of the effect of the barrier accordingly.

7.5.4 Step 4: Determine effect of barriers on implementation potential

Determine how the barriers effect implementation potential as follows:

1. Determine the effect of each barrier on the implementation potential of the policy: For example, the outcome of the barrier analysis might indicate that a barrier reduces the implementation potential of the policy by x%. The reduction can take place on two different levels depending on the design of the policy as follows:

    a. General level: The barrier affects the entire policy (e.g., barriers that hinder the deployment of all RE technologies). In this case, the effect of the barrier on implementation potential applies to the entire policy's impact.

    b. Technology level: The barrier only affects one specific RE technology supported by the policy (e.g., specific barriers that hinder the deployment of solar PV installations). In this case, the effect of the barrier on implementation potential only applies to the policy's implementation potential on this specific technology.

    For barriers that are categorised as very severe, identify the precise aspect of the implementation potential or RE resource potential to which the barrier relates (e.g., wind energy in a particular region). Reduce the impact of the policy to zero for this aspect of the implementation potential or RE resource potential.

2. Determine overlaps between the barriers: Identify whether and to what degree the barriers' impacts overlap, and account for this overlapping effect.

3. Account for the effect of all barriers on the implementation potential: Calculate the potential impact of all barriers while accounting for the potential overlap. This outcome may be supported with an uncertainty range to account for uncertainty about the likelihood and magnitude of one or multiple barriers (whereby the refined implementation potential is expressed as a range of, for example, MWs, as illustrated in Box 7.7).

7.5.5 Examples of accounting for other barriers

The two boxes below provide examples of accounting for other barriers for a feed-in tariff policy and auction policy, respectively.

Box 7.8: Feed-in tariff policy – Example of accounting for other barriers to refine implementation potential

In **Step 1**, the main barriers for the feed-in tariff are identified using the list of barrier categories:

- **Technical**: No technical standard for rooftop solar PV installations; no domestic technology providers for rooftop solar PV installations
- **Regulatory and policy uncertainty**: History of numerous ad-hoc policy changes and adjustments, leading to a general lack of transparency and uncertainty for market actors
- **Institutional and administrative**: Permits for new RE plants are difficult to obtain as approval procedure is lengthy, non-transparent and cumbersome
- **Market**: Existing fossil fuel subsidies for low- and medium-income households
- **Financial**: Concerns about financial solvency of only state-owned utilities with history of defaults
- **Infrastructure**: None
- **Lack of awareness of RE and skilled personnel**: Lack of skilled personnel to install solar PV panels
- **Public acceptance and environmental**: None

In **Step 2**, the severity of each identified barrier is evaluated and rated on a scale of 1 to 5, with 5 indicating very severe.

- No technical standard and no domestic technology providers for rooftop PV installations: 5
- Policy uncertainty due to history of ad-hoc policy changes and adjustments: 2
- Slow and non-transparent permit approval process: 3
- Existing fossil fuel subsidies for low- and medium-income households: 1
- Concerns about financial solvency of only state-owned utilities with history of defaults: 3
- Lack of skilled personnel to install solar energy panels: 2

In **Step 3**, other policies are identified that may help the feed-in tariff policy overcome barriers to RE deployment. A separate policy enacted to fix the slow and non-transparent permit approval process addresses this barrier. The Ministry of Energy is currently carrying out a comprehensive reform of its entire approval processes due to new anti-corruption legislation. Thus, the permit approval process will be entirely redesigned to promote a faster and more transparent process. Even though the reform process may require a transitional phase, it is deemed sufficient to overcome the barrier.

In **Step 4**, the effect of barriers on the implementation potential is estimated. The extent of this effect is based on expert judgment:

- **No technical standard and no domestic technology providers for rooftop solar PV panels**: Barriers are categorised as very severe (in Step 2), indicating that no installations can be expected for rooftop solar PV installations under the feed-in tariff policy. A national university had estimated that 50 MW of the 800 MW implementation potential of the policy directly links to rooftop installation. These 50 MW are subtracted from the policy's impact of 600 MW, resulting in 550 MW
- **Policy uncertainty due to history of ad-hoc policy changes and adjustments**: 5% to 8% (general level) based on the assessment on how policy uncertainty affects investor behaviour using survey data with a small representative sample of investors
- **Slow and non-transparent permit approval process**: Barrier is overcome by other policy intervention to reform permit approval process (discussed under Step 3).
- **Existing fossil fuel subsidies for low- and medium-income households**: 3% to 4% (general level) based on experience with household behaviour in the past
- **Concerns about financial solvency of only state-owned utilities with history of defaults**: Minus 20% to 30% (general level) based on the assessment on how policy uncertainty affects investor behaviour using survey data with a small representative sample of investors
- **Not enough skilled personnel to install solar energy panels**: 20% (technology level) based on market assessment on the number of skilled personal to install solar energy panels

As the impact of the *lack of skilled personnel to install solar PV panels* partially overlaps with the impact of *no domestic technology providers for rooftop PV* installations, the barrier-specific impact cannot be aggregated. As the overlap accounts for about 5%, the total effect of the barriers is between 43% to 57%.

The result of the barrier analysis is an estimated effect of feed-in tariff policy of between 237 MW and 314 MW. The range represents the uncertainty associated with the identified barriers.

Box 7.9: Auction policy - Example of accounting for other barriers to refine implementation potential

In **Step** 1, the main barriers for the auction policy are identified using the list of barrier categories:

- **Technical**: None
- **Regulatory and policy uncertainty**: None
- **Institutional and administrative**: None
- **Market**: High domestic fossil fuel subsidies
- **Financial**: Financing costs relatively high for power producers
- **Infrastructure**: Grid infrastructure is not flexible enough to be linked to numerous RE installations

- **Lack of awareness of RE and skilled personnel**: None
- **Public acceptance and environmental**: None

In **Step 2**, the severity of each identified barrier is evaluated using expert judgment, and rated. None are rated as *very severe*.

- High domestic fossil fuel subsidies: 1
- Financing costs relatively high for power producers: 2
- Problems with flexibility of grid infrastructure: 3

No other policies help overcome the barriers in **Step 3**.

In ***S*tep 4**, the overall impact factor applied to the auction policy is estimated using the barrier analysis. The identification of barrier-specific impact factors is based on expert judgment:

- **High domestic fossil fuel subsidies**: Minus 2% to 5% (general level) based on experience with fossil fuel subsidies in the past
- **Financing costs relatively high for power producers**: Minus 5% to 10% (general level) based on market analysis of how available financing options for investors affect RE deployment and a survey with a representative sample of investors
- **Problems with flexibility of grid infrastructure**: Minus 10% (general level) based on analysis of current status of grid infrastructure and planned improvements over the course of assessment period

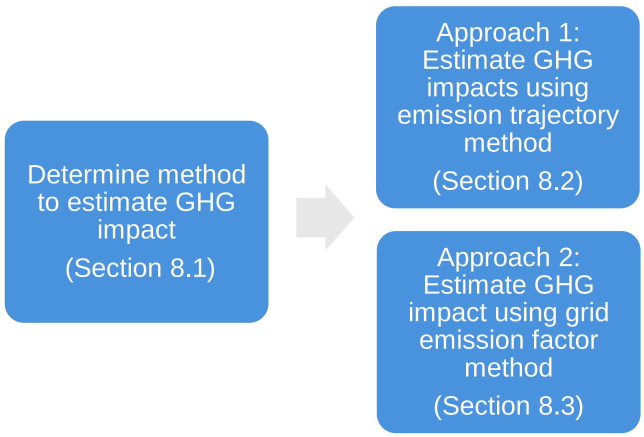
The identified barriers do not overlap, thus the barrier-specific impacts can be aggregated. The overall impact factor is determined to be 17% to 25%, accounting for the uncertainty range for the overall impact of the identified barriers.

As a result of the barrier analysis, the auction policy's impact is estimated to be between 338 and 374 MW, displaying the range of uncertainty for the specific impact of the identified barriers.

8. Estimating GHG Impacts of the Policy Ex-Ante

This chapter provides guidance for the second step of ex-ante impact assessment - translating estimated RE addition in the policy scenario into GHG impacts. The GHG impacts can either be expressed as a GHG emission level or as GHG emission reductions achieved by the policy.

Figure 8.1: Overview of steps in the chapter



Checklist of key recommendations

- Choose the method for estimating GHG impacts based on the objectives of the assessment, and the policy's expected impact and timeframe
- Estimate the emission trajectory using energy models where feasible, and otherwise using the method for limited data availability
- Estimate the GHG impact using a grid emission factor calculated using the CDM combined margin emission factor approach or emission factor modelling

8.1 Determine method to estimate GHG impacts from RE addition

Users should choose between two methods for translating estimated RE addition into GHG impacts: the emission trajectory method and the grid emission factor method.

The emission trajectory method develops a trajectory for future emissions from the electricity grid based upon the expected future mix of generating technologies. The method involves making assumptions about the future electricity mix, and can be done using limited data or more complex models that model the energy sector development in detail. The resulting emission trajectory can either be used as a stand-alone assessment to determine whether the trajectory is on track to meet a target, or in combination with a baseline scenario to determine the emission reductions.

The grid emission factor method assumes that the RE addition displaces grid electricity and calculates the GHG impacts of the policy based upon the emission factor of the current and expected future electricity grid. This method is appropriate for policies with a limited impact on the grid since it uses simple assumptions about the future development of the entire energy sector. Users assume that the generated electricity resulting from the policy will displace carbon-intensive electricity generation and, to a certain extent, replace future carbon-intensive capacity additions. The grid emission factor reflects the emission intensity of carbon-intensive electricity generation being displaced by the RE addition. For installations that feed into the electricity grid, this is equal to the grid emission factor, which serves as the baseline emission factor.

Table 8.1 provides further information about the two methods.

Table 8.1: Overview of emission trajectory and grid emission factor methods

Method	Approach	Objective	Advantages	Disadvantages
Emission trajectory method	Modelling of sectoral emissions development	• To estimate sectoral GHG emission levels achieved after an intervention • To estimate GHG emission reductions from interventions (by comparing baseline GHG emissions to policy GHG emissions) • *Especially suitable for larger scale interventions*	• Dynamic; accounts for interactions between the RE technologies incentivised by the policy and the electricity mix over time • Emission level calculations; not necessary to develop a baseline scenario	• Low level of standardisation; many commonly used models exist (e.g., LEAP), though there is no standardised approach for developing emission trajectories
Grid emission factor method	Emission factors reflect emissions intensity of displaced technology	• To estimate GHG emission reductions from interventions • *Especially suitable for single projects or other smaller scale interventions*	• High level of calibration; methodologies have been developed for a wide range of GHG emissions reduction interventions under the CDM and revised and improved over time • Methods are widely accepted and used for project-level analysis, including through harmonisation efforts of bilateral and multilateral funds • Energy sector model not needed; may be easier to use than emission trajectory method	• Relatively static; methods account for future development (e.g., operating margin method) but only to a limited extent • Assumptions about the baseline scenario may be contested • More challenging to estimate GHG impacts over longer timeframes

It is a *key recommendation* to choose the method for estimating GHG impacts based on the objectives of the assessment, and the policy's expected impact and timeframe.

Users should choose between the emission trajectory method and grid emission factor method considering the following two interrelated factors:

- **Impact on the energy system**: The policy may have a smaller impact on the energy system or may be a larger intervention with more impact on the energy mix in the sector. The degree of impact of the energy mix further depends on two factors: the size of the energy system and the size of the intervention. In small energy systems, small interventions (e.g., single projects or small-scale policies) can also substantially alter the energy mix in the sector. In general, the emission trajectory method is more appropriate for policies with larger impacts on the energy system, and the grid emission factor method is more appropriate for those with small impacts.

- **Timeframe of the intervention**: Interventions with shorter timeframes (e.g., single projects or policies with shorter timeframes) will have less impact on the energy system, whereas interventions with longer time frames will have a larger impact.

Users should also choose whether they want to estimate a GHG *emission level*, or GHG *emission reductions* achieved by the policy, based on the objectives of the assessment:

- **GHG emission level**: Appropriate in particular for determining whether policies are on track to meet goals such as NDCs or RE targets and to inform goal setting. The emission trajectory method should be used for meeting these objectives (the grid emission factor method is not designed for these objectives).
- **GHG emission reductions**: Appropriate in particular for assessing the effectiveness of policies and improving their design and implementation. Either the emission trajectory method or grid emission factor method can be used to meet these objectives.

8.2 Approach 1: Estimate GHG impacts using emission trajectory method

An emission trajectory is used either on its own (to determine whether the trajectory is on track to meet a RE target) or in combination with a baseline scenario (to determine the GHG emission reductions the policy is estimated to achieve). The steps below are followed for estimating emission trajectories for both policy scenarios and baseline scenarios.

It is a *key recommendation* to estimate the emission trajectory using energy models where feasible, and otherwise using the method for limited data availability. If the user is determining a baseline scenario, the same approach should be used for both the baseline scenario and policy scenario.

8.2.1 Estimate emission trajectory using an energy model

Several institutions have developed global models for countries to analyse energy policy and to forecast GHG emissions under different scenarios. Table 8.2 provides an overview of the most commonly used models. Users can use these and other suitable models to estimate the emission trajectory. The RE addition calculated in Chapter 7 should be used as an input for these models, such that the resulting emission trajectory is based on the additional RE deployment that the policy is expected to achieve.

Table 8.2: Overview of commonly-used energy models

Model	Institution	Description	Link
LEAP	Stockholm Environment Institute (SEI)	Software tool for energy policy analysis and climate change mitigation assessment. The LEAP model has been used in 190 countries worldwide undertaking integrated resource planning, GHG mitigation assessments, and development of LEDS. LEAP is an integrated, scenario-based modelling tool that can be used to track energy consumption, production and resource extraction in all sectors of an economy. It can be used to account for both energy sector and non-energy sector GHG emission sources and sinks. **Level of expertise required**: Level of expertise required is relatively modest and the tool is very self-explanatory, but introductory training is generally advised **Data and resource requirements**: Data and resource requirements relatively modest with limited complexity of modelling and simplification of processes **Cost and availability of model**: Relatively easy to access, use and acquire with different tool licences and cost structures available depending on type of institution acquiring model	SEI LEAP: http://sei-us.org/software/leap
MARKAL-TIMES	International Energy Agency	MARKAL-TIMES is a software tool that generates technical-economic models of global, regional, national and local energy systems. Based upon the characterisation of different energy technologies and demand devices, MARKAL-TIMES calculates the optimal mix of technologies and commodities. These models allow for the evaluation of energy plans, environmental policies, climate mitigation scenarios and new technologies in trade-off modes. The tool also allows for the projection of scenario dependent energy balances and GHG emissions inventories. **Level of expertise required**: Complex to implement and develop, but once built flexible and easy to use. **Data requirements**: Relatively high data and resource requirements **Cost and availability of model**: Free of charge (after registration and Letter of Agreement). However, to use the tool users need to install additional third-party software (which needs to be purchased).	TIMES model generator: http://iea-etsap.org/index.php/etsap-tools/model-generators/times

EFFECT	World Bank	EFFECT is an open and transparent modelling tool used to forecast GHG emissions from a range of development scenarios. It focuses on sectors that contribute to and are expected to experience a rapid growth in emissions. EFFECT has been used in eleven countries as of this writing, including Brazil, Georgia, Macedonia, Nigeria, Poland and Vietnam. **Level of expertise required**: Level of expertise required is relatively low as tool is Excel-based, but introductory training is generally advised **Data requirements**: Data and resource requirements relatively modest **Cost and applicability of model**: Open-source Excel tool, used in 11 countries as of January 2018	World Bank ESMAP: https://www.esmap.org/ World Bank EFFECT: https://esmap.org/EFFECT

The **Climate Smart Planning** (www.climatesmartplanning.org) resource provides an in-depth overview of a wide array of analytical models, tools, methods, procedures and guides for assessment of policy and investment implementation User can retrieve further overview on tool available to inform their choice.

Where users have expertise in using econometric models or Excel Including experience with macros) to do emission trajectory forecasting, such software can be used as well. Users can also consider using a book-keeping model such as the PROSPECTS model, which contains data for all sectors, enabling the estimation of economy-wide emission trajectories through the aggregation of electricity demand in individual sectors. Box 8.1 provides more information on the PROSPECTS model.

Box 8.1: Use of the PROSPECTS model as a book-keeping tool

The PROSPECTS model (*Policy-Related Overall and Sectoral Projections of Emission Curves and Time Series*) is a sector-level, bottom-up Excel tool which can track and predict overall and sectoral GHG emissions trends of a country, based on the historic and future development of relevant indicators for decarbonisation. This tool allows for projections of future GHG emissions responding to policy and technology shifts.

The PROSPECTS model has been developed under an indicator-led methodology, which measures key indicators that shape emission trends on sectoral level for each country (e.g., emission intensity of electricity generation for the power sector or passenger km travelled per person for the transport sector). By breaking down macro-level emissions into sectoral-level indicators, the approach increases transparency on decarbonisation in each sector and allows comparisons among regions and over time at multiple levels of the economy. An aggregation of all sectoral trends in the model then leads to an overall emissions profile of a country.

The tool covers all emissions-generating sectors: power and heat, buildings, transport, various industrial sectors, waste, agriculture and forestry. Power and heat sectors are *supply-side* sectors since they provide electricity and heat, respectively, to other sectors. Other sectors are *demand-side* sectors.

The tool covers the time period from 1990 to 2050. Through adjusting driver metrics at the (sub) sector level, the GHG impacts of policies can be estimated on the sectoral as well as the economy wide level. Linkages between the sectors as well as linkages with other drivers are integral to the model. In that way, the model serves as a book-keeping model and allows for estimating the aggregated emission effect of policies.

Emissions are calculated as a function of **activity** and **intensity** metrics.

Activity metrics refer to the behaviours that drive emissions. Examples include population, number of households, and households' demands for goods, services and energy. When an increase in activity increases demand for energy use, and depending on the fuel mix, annual emissions increases result.

Intensity metrics refer to both measures of energy and emissions resulting from a unit of activity. The emissions intensity is informed by the production method, which includes process emissions, and the fuel mix of energy.

8.2.2 Determine emission trajectory using method for limited data availability

Where data availability is limited, users should follow the three steps set out below.

Step 1: Estimate the development of electricity demand in the future

The starting point for any energy supply emission trajectory is to understand how electricity demand develops over time. Choose between the following approaches, or combination thereof:

1. **Use existing country-specific electricity market forecasts**: Potential data sources include ministry of energy, national energy research institutes, and international agencies such as IEA. Where possible, users should use national data sources that are widely accepted among policymakers, and developed or otherwise endorsed by the government.

2. **Where country-specific data and resources are not available, users may scale down data from regional scenarios**: The easiest approach is to apply growth rates from the regional scenarios to the historic data available for the country. However, users should consider how representative the regional development is of national development. For example, the IEA World Energy Outlook database includes Canada, USA and Mexico in the North American region. Applying the growth rate for North America to historical data for Mexico would underestimate the growth in the sector, as Mexico's current levels of renewables are much lower than those of the USA and Canada.
3. **Estimate the future electricity demand**: Where no electricity demand forecast for the country or region is available, users can make simple assumptions to estimate the electricity growth in the sector, including:
    a. Extrapolate historic growth rates: Extrapolate historic data on electricity demand using linear or other trends that align with historic development.
    b. Link electricity growth to GDP growth: This assumes that electricity growth and GDP growth are coupled. Users should bear in mind that certain processes have led to their decoupling, and they should make additional assumptions about autonomous energy efficiency improvements occurring in the economy.
4. **Obtain input from sectoral experts**: Consult national experts for estimates of growth and seek views on compound annual growth rates for electricity demand.

Step 2: Estimate the development of technologies in the electricity mix

Users should use the electricity demand (estimated in Step 1) and the RE addition (expressed in GWh/year and estimated in Chapter 7) to calculate the remaining electricity mix.

Calculate the difference between the electricity demand and the proportion of this demand that will be met by the net renewable electricity supplied to end-users. The net renewable electricity delivered to end-users can be calculated by subtracting the transmission and distribution losses and consumption by power plants from the gross RE generated. The remainder of the demand is met by conventional technologies.

Considering the policy interactions within a country is important when developing the emission trajectory. Where the policy is embedded in an integrated energy policy and/or other polices are in place that influence the generation mix, users should consider the effect these interactions have on the calculation of the remaining electricity generation. For example, a sectoral policy to phase out coal-fired power plants should be accounted for in the emission trajectory.

Having determined the remaining electricity generation based on the estimated RE addition, the split across different fuel and technology types should be determined for the remaining electricity supply. Users should choose between the following approaches, or combination thereof, to achieve this:

1. **Assume that the share of different technologies in the electricity mix remains as is**. Use data on share of different technologies from the most recent year for which data is available and increase (or decrease if electricity demand is falling) all of them in proportion to their current mix. This can be the best assumption where the future energy mix development is unknown.

2. **Continue historical trends for the share of different technologies in the electricity mix.** Carry past sectoral trends into the future. This approach can lead to unreasonable results for longer timeframes where certain shares have experienced high growth rates in the past but are unlikely to do so in the future. Users should apply individual adjustment to account for such factors.

3. **Assume that certain technologies decrease more (or less) than others**. This approach is realistic under the following conditions:

   a. There is evidence that a certain technology will be more relevant in the future energy system than in an alternative system. For example, a national study may forecast the development of the future energy mix showing trends such as the replacement of certain technologies by natural gas.

   b. A country's climate strategy is leading toward the decarbonisation of the power sector. In such a case, the bridge technology (such as natural gas), may be preferred over coal.

   c. System characteristics changes are now favouring certain technologies over others. For example, as shares of intermittent RE sources such as wind and solar become increasingly significant, the energy mix shifts from being baseload-focused towards a more flexible market regime, which may in turn favour certain technologies, such as natural gas, over others.

Step 3: Calculate emission levels based on technology-specific emission factors

Users should apply technology-specific emission factors to the electricity generation mix to estimate the emission level, using one following approaches:

1. Use future technology-specific emission factors available in national studies or other sources. Unlike the emission factors described in Section 8.3, these do not change significantly in response to changes in the electricity mix, so results from existing sectoral modelling exercises can be used.

2. Calculate technology-specific emission factors using historic emission factors. Users can calculate these emission factors using historical technology-specific emissions (tCO_2/MWh), which are readily available from the IEA CO_2 Emissions from Fuel Combustion database[23] or can be calculated from national statistics. Future specific emissions can be derived using the following approaches:

   a. Assume that they remain constant, indicating that there is no improvement in the energy efficiency of technologies and that the fuel composition stays the same.

   b. Assume that they improve over the years, indicating that there are energy efficiency improvements for the technology. However, this is only realistic where current plants will be retrofitted or where the construction of more efficient plants is planned, so it is important to carefully consider how probable this is.

[23] Available at: http://www.iea.org/statistics/topics/CO2emissions/.

Users should then apply technology-specific emission factors to each technology in the electricity generation mix to calculate the emission trajectory. The emission trajectory is expressed in terms of tCO_2e emitted in a given year, stated for each of the years for which the trajectory is being developed.

8.2.3 Calculate GHG emission reductions (if relevant)

Where the objective is to estimate the GHG emission reductions of the policy, users should determine a baseline scenario and estimate the associated emission trajectory. GHG emission reductions achieved by the policy are the difference between the policy scenario emission trajectory and the baseline scenario emission trajectory.

The baseline scenario emission trajectory should be estimated by following the same steps used for estimating the policy scenario emission trajectory (set out in Sections 8.2.1 and 8.2.2). The same approach used for the policy scenario (energy model versus method for limited data availability) should be used for the baseline scenario.

The following should be considered when determining the baseline scenario:

- Which policies should be included and what timeframes do they have?
- Which non-policy drivers and/or sectoral trends should be included?
- How would the sector have developed without the policy? What assumptions should be made regarding technologies that would have been implemented in the absence of the policy?

The policies covered by this guidance and/or other policies can be included in the baseline scenario. The sources of data for developing assumptions on such policies may include government policies, regulations and plans; forecasting models; expert interviews; and market assessment studies for supply and demand projections.

Users should also develop assumptions on non-policy drivers and sectoral trends, including load forecasts, fuel prices, grid storage capacity, renewable technology prices, population and GDP.

Users could consider developing multiple baselines rather than just one, each based on different assumptions. This approach produces a range of possible emission reductions scenarios. Box 8.2 describes some further considerations for the development of baseline scenarios.

Box 8.2: Considerations for the development of baseline scenarios

Users should exercise caution when developing baseline scenarios. The development of baseline scenarios requires assumptions about future sectoral, economic, social and political developments, as well as assumptions about national policies. These can be difficult to predict.

It is important to note that there is an additional element of uncertainty in the development of a baseline scenario compared to the development of the policy scenario. Historically, there has been some controversy surrounding the development of baseline scenarios and the existence of incentives to overstate baseline emissions.

Conservativeness is important for baseline scenarios, since a range of possible values and probabilities exist in the development of baseline scenarios. Users may want to develop a range of possible baseline scenarios and, where necessary, use the lower end of this range.

The last step is to calculate the GHG emission reductions achieved by the policy. This is calculated by subtracting, for the given year, the emissions level associated with the policy scenario emission trajectory from the emissions level associated with the baseline scenario emission trajectory.

8.2.4 Example of calculating GHG impacts using emission trajectory method

Box 8.3: Example of calculating GHG impacts for a feed-in tariff policy

The country's current electricity mix is largely composed of coal-based power (4,500 GWh/year) and some natural gas (500 GWh/year). There is a large potential for solar power and moderate potential for wind power. The country has decided to focus on its solar potential to transition to a low-carbon power sector by 2030. To this end, an uncapped feed-in tariff policy for solar power has been implemented to promote uptake of solar power.

In a first step, users estimate the implementation potential of the policy as 1,200 MW (total renewable energy potential, of which 800 MW is solar power). Assessment of the policy design characteristics therefore reduces this potential to 800 MW (the solar portion). Financial factors and the barrier analysis further reduce the policy's impact to between 237 and 314 MW. This translates to the generation of between 469 and 622 GWh power in 2030, assuming annual average operation of 330 days per year at an average annual capacity factor of 25% for solar and wind in the country[24], using the formula:

Annual electricity generation (GWh) =

*(Capacity (MW) * annual operating hours (h) * capacity factor of technology (%)) / 1,000*

Officials from the Ministry of Energy are keen to understand how this RE addition affects the emission trajectory of the energy sector in the target year.

The future electricity demand in the country is estimated. Previous estimates of growth in energy demand are extrapolated to provide an estimate of future demand. Energy sector experts from national universities are consulted, and the consensus is that energy demand is expected to grow at 2% per year. At this rate, the electricity demand is expected to be close to 6,700 GWh in 2030. Of this, 546 GWh are expected to be provided by the new solar installations (average of the range resulting from the RE addition estimation: (469 + 622) / 2). After consulting the country's energy development plans and relevant country experts, the remaining energy mix expected in 2030 is estimated to be 5,154 GWh from coal and 1,000 GWh from gas.

Next, sectoral emissions from the estimated generation mix are calculated using technology-specific emission factors from the IEA CO_2 Emissions from Fuel Combustion database (coal = 955 tCO_2e/GWh, gas = 530 tCO_2e/GWh). Assumptions on operating hours and capacity factor are the same as above. **The resulting policy scenario emissions in 2030 are expected to be 5,452 $MtCO_2e$**.

[24] Users might refer to national databases on capacity factors or capacity factors of a relevant benchmark country (see for example the overview of annual capacity factors for different technologies provided by the U.S. Energy Information Administration under https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b)

Another request from the minister is to estimate the resulting GHG emission reductions. For this, two baseline scenarios are developed. It is assumed that the existing cohort of power plants would remain operational in 2030.

- In baseline scenario 1, preference is given to natural gas over coal. Hence, the majority of the new capacity addition is natural gas, feeding 1,900 GWh of power to the end-users. Of the remaining demand, 300 GWh comes from new coal power plants and 4,500 GWh from existing coal power plants.
- In baseline scenario 2, most of the needed new capacity addition comes from coal and generates 6,000 GWh for end-users. The remaining 700 GWh comes from existing natural gas plants and new natural gas capacity additions.

The resulting baseline emissions are estimated to be between **5,591 MtCO_2e** (baseline scenario 1) and **6,101 MtCO_2e** (baseline scenario 2). The GHG emissions reductions achieved by the policy are calculated by subtracting the policy scenario emissions from the baseline emissions. This produces a result of **139 MtCO_2e** (baseline scenario 1) to **510 MtCO_2e** (baseline scenario 2).

8.3 Approach 2: Estimate GHG impacts using grid emission factor method

The grid emission factor method uses simple assumptions about the development of the electricity sector and can be useful for policies with a limited impact on the grid. Many RE technologies do not result in any direct emissions; their grid emission factor is zero.[25] For others such as biomass, there are associated emissions that need to be accounted for.

It is assumed that the generated electricity resulting from the policy will displace carbon-intensive electricity generation and, to a certain extent, replace future carbon-intensive capacity additions. The grid emission factor reflects the emission intensity of the carbon-intensive electricity generation being displaced by the RE addition (expressed in tCO_2e/MWh).

It is a *key recommendation* to estimate the GHG impact using a grid emission factor calculated using the CDM combined margin emission factor approach or emission factor modelling. The two approaches for calculating the grid emission factor are discussed in Section 8.3.1. The GHG impact of the policy is then calculated by multiplying the grid emission factor with the estimated RE addition (Section 8.3.2).

8.3.1 Calculate grid emission factor

CDM combined margin approach

Grid emission factors have been used to assess the emission impacts of projects under the CDM and for bi- and multi-laterally funded projects. The combined margin emission factor looks at the emissions impact of an addition of RE capacity to an electricity grid on the operation of existing plants (the operating margin) and future capacity additions (the build margin). A range of guidance and tools are available to

[25] The lifetime GHG emissions caused by the construction and operation of RE installations can reasonably be excluded, as they are roughly equivalent to emissions that would be caused by the construction and operation of fossil fuel power plants.

assist users in calculating the emission factors of their grids. Table 8.3 provides an overview of key relevant resources.

Table 8.3: Resources available for estimating emission factors based on the combined margin approach

Resources	Description	Source
CDM Tool to calculate emission factor for an electricity system	• Detailed guidance providing calculation methodology • Country users use country-level data to calculate grid emission factors • Developed by UNFCCC secretariat	Tool to calculate emission factor for an electricity system: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf/history_view
IGES List of Grid Emission Factors	• Database of country-specific grid emission factors • Collated from information provided in project design documents • Developed by IGES and regularly updated	List of Grid Emission Factors: https://pub.iges.or.jp/pub/list-grid-emission-factor
IGES CDM Grid Emission Factor Calculation Sheet	• Excel-based calculation sheet based on the CDM tool • Uses country level emission factor data collated from project design documents • Developed by IGES	Grid Emission Factor Calculation Sheet: https://pub.iges.or.jp/pub/iges-cdm-grid-emission-factor-calculation
International Financial Institutions' (IFI) Approach to GHG Accounting for Renewable Energy Projects	• Guidelines for renewable energy projects	IFI Approach to GHG Accounting for RE Projects: http://www.nib.int/filebank/a/1449216433/c78bcf00c64ba92b3a73673a2217be4d/5023-Joint_GHG_RE.pdf

The CDM *Tool to calculate the emission factor for an electricity system* listed in Table 8.3 outlines a method to calculate a combined margin emission factor. The combined margin is a blended emissions factor that is based on emissions factors of existing power plants (operating margin) and on future capacity additions (build margin). Appendix D: Overview of CDM Combined Margin Approach provides information about using the CDM *Tool to calculate the emission factor for an electricity system*, along with related guidance and resources for country-specific emission factors.

Emission factor modelling

Emission factor modelling can be used to capture changes in the electricity grid's structure over time while capturing the impact of policies on the load characteristics of the grid.

Emission factor models use historical performance data from power plants and calculate emission factors by developing statistical models with respect to variables that impact the emission intensity of the grid. These variables include electricity export and import, trading and, to a limited extent, changes in power supply and demand. The US EPA AVERT (Avoided Emissions and Generation Tool) is an example of such a statistical model.[26] AVERT uses hourly and unit-level historical generation data and models avoided emissions through implementation of energy efficiency or renewable energy.

Emission factor models are useful since they reflect variations in load and frequent changes in emissions (e.g., hourly differences) based on power plants supplying to the grid. They are especially beneficial for countries with significant power imports, as they accurately capture the emission intensity of the grid. In spite of these advantages, note that data used in these statistical models reflect historical emissions performance and do not adequately capture future changes in grid composition, infrastructure, and policy and pricing changes. Where users intend to capture these trends, projection-based energy modelling approaches, discussed in Section 8.2.1, may be more useful.

8.3.2 Calculate GHG emission reductions

The GHG emission reductions achieved by the policy are calculated by multiplying the grid emission factor with estimated RE addition estimated in Chapter 7. This is the GHG impact of the policy.

Where the policy involves hydro or biomass power plants, additional emissions may have to be subtracted to take account of CH_4 emissions associated with reservoirs and emissions associated with growing energy crops, respectively. CDM methodologies provide guidance for estimating such emissions (e.g., see UNFCCC 2016).

8.3.3 Example of calculating GHG impacts using grid emission factor method

Box 8.4: Example of calculating GHG impacts for a tender policy

The country generates 500,000 GWh/year of electricity and its generation mix is comprised of 50% coal (250,000 GWh/year), 40% gas (200,000 GWh/year) and 10% hydro (50,000 GWh/year).

A tender policy for renewables is introduced which consists of three rounds of tenders with the following breakdown: 40 MW in 2017; 100 MW in 2018; 500 MW in 2019 (total 640 MW).

The tender policy is expected to contribute to a national target of 1,000 MW of RE capacity by 2025.

The implementation potential of the tender policy (640 MW) is reduced by 14% after the assessment of its design characteristics. Thus, the tender policy is expected to lead to 550 MW of RE deployment by 2025. This is further reduced to 450 MW after the assessment of factors that affect financial viability.

A series of barriers are subsequently identified that further reduce the impact of the tender policy by 17% to 25%. Thus, the RE addition of the tender policy is estimated to be between 338 and 374 MW (42-47% lower than the maximum implementation potential).

This estimate translates to a generation potential of between 3,875 and 4,336 GWh power between 2017 and 2025, assuming 24 hours and 330 days of annual operation with a 25% capacity factor (considered appropriate to the country context), while accounting for the yearly capacity addition.

This exercise highlights the limitations of the tender policy to achieve the RE target.

The government wants to estimate the GHG emissions reductions associated with the RE addition and chooses to use the grid emission factor approach.

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[26] Available at: https://www.epa.gov/statelocalclimate/avoided-emissions-and-generation-tool-avert.

The Ministry of Energy consults the regulatory commissions and utilities to define the spatial boundary of the grid. They decide to include both utilities and independent power producers in the spatial boundary of the grid. Power imports and exports are also included in the assessment. The operating margin and build margin of the grid are calculated. Using simple operating margin and build margin, and typical weightings used under the CDM for solar and wind (w_{OM}:w_{BM} = 0.75:0.25), the combined margin emission factor is calculated using the equation:

$$\boldsymbol{EF_{\{grid,CM,y\}} = EF_{\{grid,OM,y\}} * w_{\{OM,y\}} + EF_{\{grid,BM,y\}} * w_{\{BM,y\}}}$$

$$EF_{\{grid,CM,y\}} = 0.82\ tCO_2e/MWh$$

The generation potential due to the RE addition is:

$$\sum EG_y = 3{,}875 - 4{,}336\ GWh$$

The estimated GHG emission reductions of the RE tender policy between 2017 and 2025 is:

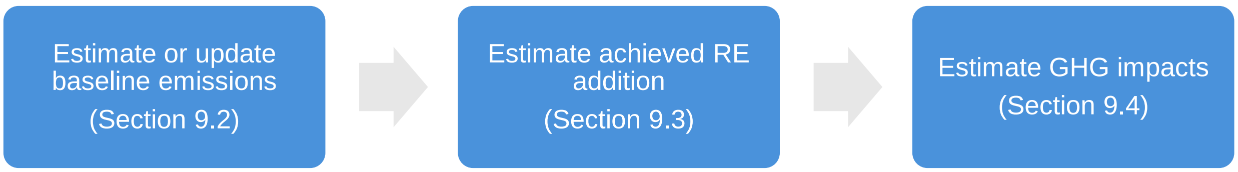
$$\left[EF_{\{grid,CM,y\}} * \sum EG_y\right] = \mathbf{3,177,297 - 3,555,546}\ \boldsymbol{tCO_2e}$$

$$= \mathbf{3.18 - 3.56}\ \boldsymbol{MtCO_2e}$$

9. Estimating GHG Impacts Ex-Post

Ex-post impact assessment is a backward-looking assessment of the GHG impacts achieved by a policy to date. The GHG impacts can be assessed during the policy implementation period or in the years after implementation. Ex-post assessment involves estimating achieved RE addition and estimating the consequential GHG impacts. In contrast to ex-ante estimates of GHG emissions, which are based on assumptions about future RE deployment, ex-post estimates of emissions are based on observed (monitored) data collected during the policy implementation period. Users that are estimating ex-ante GHG impacts only can skip this chapter.

Figure 9.1: Overview of steps in the chapter



Checklist of key recommendations

- Estimate achieved RE addition using monitored values for the parameters described in the monitoring plan
- Estimate the GHG impacts of the policy over the assessment period, for each GHG source included in the GHG assessment boundary

9.1 Introduction to estimating GHG impacts ex-post

There are three main objectives to estimating GHG impacts ex-post. These are described below along with the sections of this chapter that are relevant to each.

Objective 1: Compare achieved RE addition with a policy cap, RE addition with a RE target, or GHG emission level to a sectoral emissions target

Users may want to compare achieved RE addition with a policy cap. A policy cap generally reflects the ambition or the expected amount of RE addition the policymaker is aiming to achieve. Users might also want to assess the extent to which a policy has contributed to a separate target, such as a national RE target. Lastly, users may want to compare the ex-post estimated policy scenario emissions with a sectoral target for emissions in the energy sector.

To meet these objectives, it is not necessary to develop a baseline scenario and users follow the guidance in Section 9.3.

Objective 2: Compare achieved RE addition or GHG emission reductions with a baseline scenario

Users may want to compare the achieved RE addition with what would have happened in the absence of the policy. This requires the determination of a baseline scenario, which also serves as the basis for calculating baseline emissions and GHG emission reductions.

Users develop a baseline scenario under which an equivalent amount of electricity is generated as in the policy scenario, but from business-as-usual sources rather than via the RE addition that results from the policy. All other variables (such as economic trends) are kept the same as in the policy scenario. The baseline scenario is used to estimate either the GHG emission trajectory or the GHG emissions reductions.

To meet these objectives, follow the guidance in Sections 9.2, 9.3 and 9.4.

Objective 3: Compare achieved RE addition or GHG emission reductions with an ex-ante assessment

Users may want to compare an ex-ante (expected) RE addition with achieved RE addition, to ascertain whether a policy is performing in line with expectation. Likewise, they may want to compare the GHG emission reductions achieved by a policy with the reductions estimated in an ex-ante assessment.

This can provide an indication of the impact of policy design characteristics and other factors on the RE addition (i.e., the factors set out in Chapter 7). For example, if the achieved RE addition is greater than the expected RE addition, this could be an indication that other policies are interacting with, or adding further incentive to, the policy (e.g., where a renewable portfolio standard is achieved using a feed-in tariff policy). Alternatively, if the achieved RE addition is lower than the expected RE addition, it could be that other policies have counteracted the policy's intended impact or the policy may not have been as effective as originally predicted.

This exercise can help users avoid double-counting through the aggregation of emission reductions from interacting policies. It can also be used to check whether all the assumptions that were made during the ex-ante assessment were correct. Lastly, comparisons between ex-ante and ex-post assessments can inform subsequent improvements of ex-ante assessments. These comparisons may become part of an ongoing process to refine future assessments.

To meet these objectives, follow the guidance below in Sections 9.3 and 9.4.

Considerations for the desired level of accuracy

When selecting methods to estimate ex-post GHG impacts, users should consider objectives, the level of accuracy needed to meet stated objectives, the availability and quality of relevant data, the accessibility of methods, and capacity and resources for the assessment.

Users can follow a low accuracy approach for their assessment, which may entail collecting aggregate data on energy generation from government agencies and/or using auxiliary electricity consumption emission factors based on the most common source of auxiliary generation for the country. An intermediate accuracy approach may involve using clustered data on energy generation from electricity purchasers or distribution companies, and/or using auxiliary electricity consumption emission factors based on the most common source of auxiliary generation within the regions where the clusters are located. A high accuracy approach can involve using disaggregated metered data on electricity imports and exports, and disaggregated fuel consumption data for auxiliary generation.

9.2 Estimate or update baseline emissions (if relevant)

To estimate the GHG emission reductions achieved by the policy, baseline emissions need to be estimated. Baseline emissions should be recalculated each time an ex-post assessment is undertaken. If using the emission trajectory method, update the baseline emissions by following the steps in Section 8.2.3. If using the grid emission factor, skip this step (emission reductions are estimated based upon the RE addition and updated grid emission factor, in Section 9.4).

9.3 Estimate achieved RE addition

It is a *key recommendation* to estimate achieved RE addition using monitored values for the parameters described in the monitoring plan. This achieved RE addition can be estimated in terms of RE capacity addition or RE electricity generation addition. Two main parameters to monitor are, respectively, *installed RE capacity* and ne*t electricity supplied to the electricity grid from RE*. Further guidance on indicators, parameters and monitoring plans is provided in Chapter 10.

Where users have no, or limited, monitored data for the policy, the achieved RE addition may have to be estimated using the best data available. See the considerations for the desired level of accuracy in Section 9.1 for further guidance on choosing an approach.

9.4 Estimate GHG impacts

The achieved RE addition should be translated into GHG impacts by following the guidance set out in Chapter 8, using monitored (rather than projected) data. Chapter 10 lists all the relevant indicators and parameters for which data should be gathered to translate achieved RE addition into ex-post GHG impacts.

It is a *key recommendation* to estimate the GHG impacts of the policy over the assessment period, for each GHG source included in the GHG assessment boundary. For the emission trajectory method, calculate the GHG impacts of the policy by subtracting baseline emissions (estimated in Section 9.2) from the ex-post policy scenario emissions for each source category included in the GHG assessment boundary.

For the grid emission factor method, calculate the GHG impacts of the policy by multiplying the updated grid emission factor by the RE addition (expressed in terms of GWh).

PART IV: MONITORING AND REPORTING

10. MONITORING PERFORMANCE OVER TIME

Monitoring serves two objectives – evaluation of the policy's performance (monitor trends in performance parameters to understand whether the policy is on track and being implemented as planned) and estimation of the policy's GHG impacts. This chapter provides guidance on monitoring the performance of policies during the implementation period and collecting data for estimating RE addition and GHG impacts ex-post. Users estimating GHG impacts ex-ante without monitoring performance can skip this chapter.

Figure 10.1: Overview of steps in the chapter

Checklist of key recommendations

- Identify the key performance indicators that will be used to track performance of the policy over time and define the parameters necessary to estimate GHG emissions ex-post
- Create a plan for monitoring key performance indicators and parameters
- Monitor each of the indicators and parameters over time, in accordance with the monitoring plan

10.1 Identify key performance indicators and parameters

To estimate RE addition and GHG impacts ex-post, users collect data on a broader range of indicators and parameters to be monitored during the implementation period. A key performance indicator is a metric that helps track the performance of the policy. A parameter is a variable such as activity data or an emission factor that is needed to estimate emissions.

It is a *key recommendation* to identify the key performance indicators that will be used to track performance of the policy over time and define the parameters necessary to estimate GHG emissions ex-post. The selection of indicators and parameters should be tailored to the policy, the needs of stakeholders, the availability of existing data and the cost of collecting data. Table 10.1 provides example key performance indicators for the types of policies covered by this guidance, while Table 10.2 provides example parameters. Users should adapt the indicators and parameters as needed for the specific polices being assessed.

Table 10.1: Example key performance indicators for RE policies

Key performance indicators	Definition	Example key performance indicators
Inputs	Resources that go into implementing a policy	• Financial resources for implementing and administering the policy
Activities intermediate effects	Activity: Administrative activities involved in implementing the policy Intermediate effects: Changes in behaviour, technology, processes or practices	• Level of tariff or premium by technology or installation, etc. *(feed-in tariff policy, auction policy)* • Sum of tariff or premium payments *(feed-in tariff policy, auction policy)* • Amount capacity auctioned vs. installed *(auctions)* • Sum of tax deductions given to end user *(tax incentive policy)* • Share of installations that achieve tax breaks *(tax incentive policy)* • Funds collected *(tax incentive policy)* • Capacity utilisation factor of RE installations *(all policies)* • Share of RE plants by stage: planned, under construction, operational *(all policies)*
Sustainable development impacts	Changes in relevant environmental, social or economic conditions that result from the policy	• Cost savings achieved *(all policies)* • Employment generated *(all policies)* • Number of households with reduced energy costs *(all policies)* • Number of new business and/or investment opportunities *(all policies)* • Air quality *(all policies)*

Table 10.2: Example parameters for estimating the GHG impacts of RE policies

Parameter and unit	Potential sources of data	Parameter type	Suggested monitoring frequency
General			
Installed RE capacity (MW)	Monitoring reports and surveys; installation registers by federal energy agencies	Measured	Monthly/annual

Net electricity supplied to the electricity grid from RE (GWh)	Meter readings taken jointly by grid utility and power producer representatives	Calculated as the difference of quantity of electricity exported to the grid and the quantity of electricity imported from the grid as measured by electronic energy meters at the grid delivery point	Continuous measurement; monthly recording
Emission trajectory method			
Electricity mix (GWh per technology)	Monitoring reports and surveys; installation registers by federal energy agencies; electricity market regulator	Measured	Monthly/annual
Technology-specific emissions factors	National studies or other relevant sources	Calculated for each fuel source and/or type of technology	Annual
Grid emission factor method			
Grid emission factor (tCO_2e/MWh)	National statistics for grid connected power plants	Calculated as the combination of operating and build margin by applying suitable weights	Most recent three years of data is used to recalculate operating margin every year
Operating Margin (tCO_2e/MWh)	National statistics for grid connected power plants	Calculated using methods specified in tools such as the CDM *Tool to calculate the emission factor for an electricity system*	Most recent three years of data is used to recalculate operating margin every year
Build Margin (tCO_2e/MWh)	National energy strategies, national energy modelling, utility investment plans/permitting documents	Calculated using methods specified in tools such as the CDM *Tool to calculate the emission factor for an electricity system*	Most recent year data is used to recalculate build margin every year

10.2 Create a monitoring plan

A monitoring plan is important to ensure that the necessary data are collected and analysed. It is a *key recommendation* to create a plan for monitoring key performance indicators and parameters. A monitoring plan is the system for obtaining, recording, compiling and analysing data and information important for tracking performance and estimating GHG impacts. Where feasible, users should develop the monitoring plan during the policy design phase (before implementation) rather than after the policy has been designed and implemented.

Monitoring period

The policy implementation period is the time period during which the policy is in effect. The assessment period is the time period over which the GHG impacts resulting from the policy are assessed. The monitoring period is the time period over which the policy is monitored. There can be multiple monitoring periods within the assessment period.

At minimum, the monitoring period should include the policy implementation period, but it is also useful if the period covers pre-policy monitoring of relevant activities prior to the implementation of the policy and post-policy monitoring of relevant activities after the implementation period. Depending on the indicators being monitored, it may be necessary to monitor some indicators over different time periods than others.

Users should strive to align the monitoring period with those of other assessments being conducted using other ICAT guidance documents. For example, if assessing sustainable development impacts using the ICAT *Sustainable Development Guidance* in addition to assessing GHG impacts, the monitoring periods should be the same.

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 monitoring, reporting and verification (MRV) processes in which responsibilities have been delegated to different institutions. Since data 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.[27]

Considerations for a robust monitoring plan

To ensure that the monitoring plan is robust, consider including the following elements in the plan.

- **Roles and responsibilities**: Identify the entity or person that is responsible for monitoring key performance indicators and parameters, and clarify the roles and responsibilities of the personnel conducting the monitoring.

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

- **Competencies**: Include information about any required competencies and any training needed to ensure that personnel have necessary skills.
- **Methods**: Explain the methods for generating, storing, collating and reporting data on monitored parameters.
- **Frequency**: Key performance indicators and parameters can be monitored at various frequencies, such as monthly, quarterly or annually. Determine the appropriate frequency of monitoring based on the needs of decision makers and stakeholders, cost and data availability. In general, the more frequent that data is collected, the more robust the assessment will be. Frequency of monitoring can be consistent with measurement conducted under the national MRV system.
- **Collecting and managing data**: Identify the databases, tools or software systems that are used for collecting and managing data and information.
- **Quality assurance and quality control (QA/QC)**: Define the methods for QA/QC to ensure the quality of data enhance the confidence of the assessment results. Quality assurance is a planned review process conducted by personnel who are not directly involved in the data collection and processing. Quality control is a procedure or routine set of steps that are performed by the personnel compiling the data to ensure the quality of the data.
- **Record keeping and internal documentation**: Define procedures for clearly documenting the procedures and approaches for data collection as well as the data and information collected. This information is beneficial for improving the availability of information for subsequent monitoring events, documenting improvements over time and creating a robust historical record for archiving.
- **Continual improvement**: Include a process for improving the methods for collecting data, taking measurements, running surveys, monitoring impacts, and modelling or analysing data. Continual improvement of monitoring can help reduce uncertainty in GHG estimates over time.
- **Financial resources**: Identify the cost of monitoring and sources of funds.

10.3 Monitor indicators and parameters over time

It is a *key recommendation* to monitor each of the indicators and parameters over time, in accordance with the monitoring plan. The frequency of monitoring is dependent on stakeholder resources, data availability, feasibility, and the uncertainty requirement of reporting or estimation needs. The monitoring plan should include an iterative process for balancing these dependencies. Where monitoring indicates that the assumptions used in the ex-ante assessment are no longer valid, users should document the difference and account for the monitored results when updating ex-ante estimates or when estimating ex-post GHG impacts.

11. Reporting

Reporting the results, methodology 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 provides a list of information that is recommended for inclusion in an assessment report.

Checklist of key recommendations

- Report information about the assessment process and the GHG impacts resulting from the policy (including the information listed in Section 11.1)

11.1 Recommended information to report

It is a *key recommendation* to report information about the assessment process and the GHG impacts resulting from the policy (including the information listed below[28]). For guidance on providing information to stakeholders, refer to the *ICAT Stakeholder Participation Guidance* (Chapter 7).

General information

- The name of the policy assessed
- The person(s)/organisation(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 of Assessing the GHG Impacts of RE Policies

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

Chapter 3: Steps and Assessment Principles

- Opportunities for stakeholders to participate in the assessment

Chapter 5: Describing the RE Policy

- A description of the policy, including the recommended information in Table 5.1. Whether the assessment applies to an individual policy or a package of related policies, and if a package is assessed, which policies are included in the package.
- Whether the assessment is ex-ante, ex-post, or a combination of ex-ante and ex-post

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[28] The list does not cover all chapters in this document because some chapters provide information or guidance not relevant to reporting.

Chapter 6: Identifying Impacts: How RE Policies Reduce GHG Emissions

- If identifying GHG impacts (Section 6.1), a list of all GHG sources of the policy identified, using a causal chain, showing which impacts are included in the GHG assessment boundary
- A list of potential GHG impacts that are excluded from the GHG assessment boundary with justification for their exclusion
- The assessment period

Chapter 7: Estimating RE Addition of the Policy Ex-Ante

- An estimate of the maximum implementation potential that the policy is expected to achieve
- A refined estimate after accounting for policy design characteristics
- A refined estimate after accounting for factors that affect the financial feasibility of RE technologies
- A refined estimate after accounting for other barriers (Table 7.4provides a sample template for this barrier analysis)
- The estimated RE addition of the policy upon completion of the steps in Sections 7.1 to 7.5
- The method or approach used to assess uncertainty
- An estimate or description of the uncertainty and/or sensitivity of the results in order to help users of the information properly interpret the results

Chapter 8: Estimating the GHG Impacts of the RE Policy Ex-Ante

- The method chosen, Approach 1 or Approach 2, for estimating GHG impacts based on the objectives of the assessment, and the policy's expected impact and timeframe
- Where using Approach 1
  - An estimate of the emission trajectory using an energy model, or determined using the method for limited data availability
  - The calculated GHG emissions reductions (if relevant)
- Where using Approach 2:
  - An estimate of the grid emission factor using the Combined Margin approach or using emission factor modelling
  - The calculated GHG emission reductions
- Any methodologies and assumptions used to estimate GHG emissions reductions, including any models used
- All sources of data used to estimate GHG emissions reductions, including activity data, emission factors and assumptions
- The method or approach used to assess uncertainty

- An estimate or description of the uncertainty and/or sensitivity of the results in order to help users of the information properly interpret the results

Chapter 9: Estimating GHG Impacts Ex-Post

- An estimate of the achieved RE addition using monitored values for the indicators and parameters described in the monitoring plan
- Total annual and cumulative policy scenario emissions and removals over the GHG assessment period
- The methodology and assumptions used to estimate policy scenario emissions, including the emissions estimation methods (including any models) used
- The ex-post GHG impact estimate calculated using the emission trajectory method or the grid emission factor method
- The method or approach used to assess uncertainty
- An estimate or description of the uncertainty and/or sensitivity of the results in order to help users of the information properly interpret the results

Chapter 10: Monitoring Performance over Time

- A list of the key performance indicators used to track performance over time and the rationale for their selection
- Sources of key performance indicator data and monitoring frequency

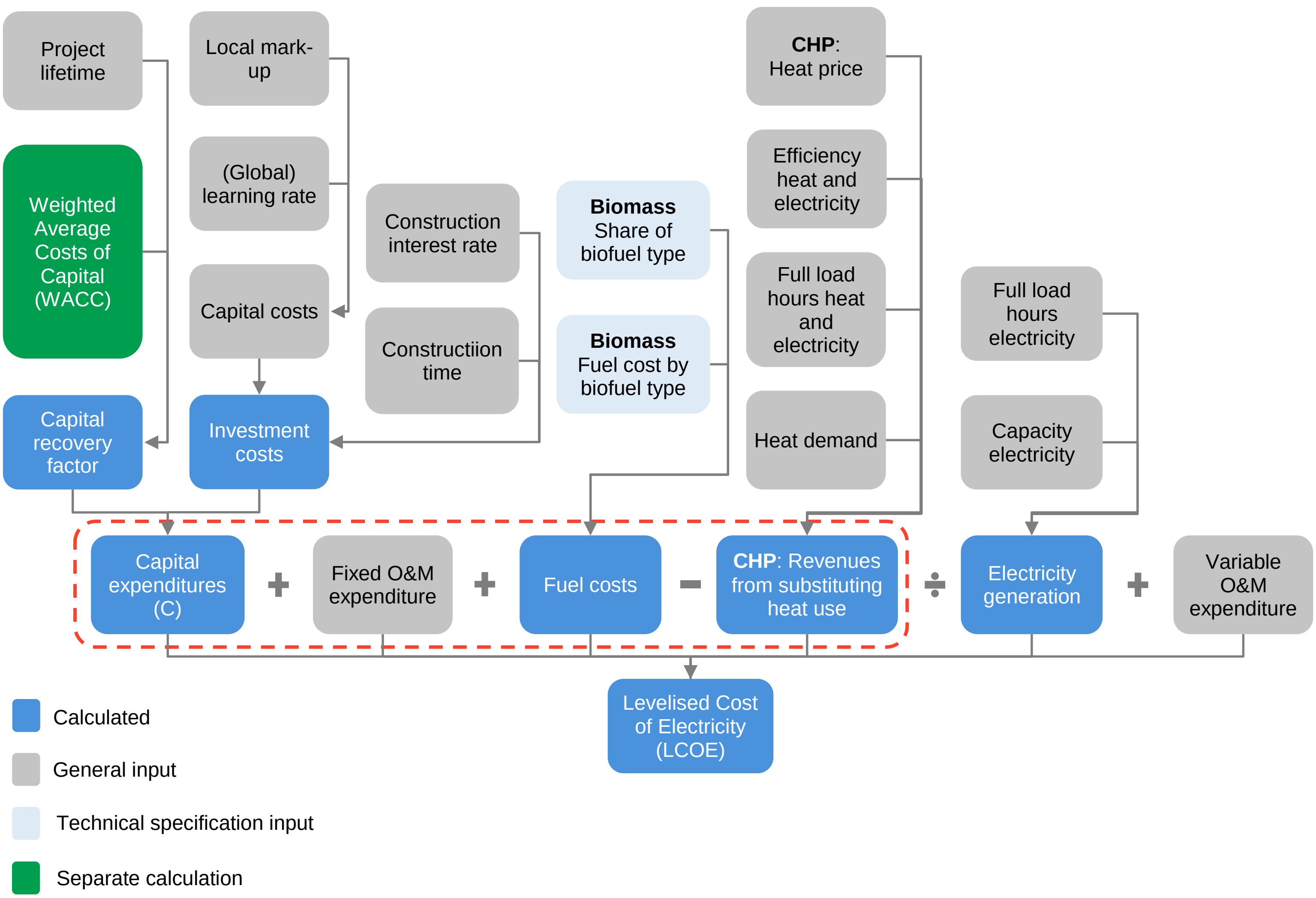
Additional information to report (if relevant)

- The type of technical review undertaken (first-, second-, or third-party), the qualifications of the reviewers and the review conclusions. More guidance on reporting information related to technical review is provided in Chapter 9 of the *Technical Review Guidance*.

Appendix A: Overview of LCOE Method for RE Sources

The levelised cost of electricity is the unique cost of an energy project representing the present value of the costs over the lifetime of the project. Figure A.1 illustrates calculation of LCOE for RE sources for a biomass combined heat and power (CHP) technology.

Figure A.1: Calculation for LCOE for RE sources for a biomass CHP



Source: *Adapted from Röser and Hagemann 2015.*

Equation A.1 provides the equation for LCOE for renewable energy sources. Table A.1 provides the input parameters and units for the calculation of the project LCOE. The input parameters for the LCOE calculation below are specified for the biomass CHP technology example provided in Figure 7.1 in

Section 0. For some technologies users might want to include variability and integration costs, referring specific literature.[29]

Equation A.1: LCOE for renewable energy sources

$$LCOE = \frac{\alpha * I_t + FOM + F_T}{E_{El}} + VOM - REV$$

Where:

- $\alpha = \frac{WACC}{1-(1+WACC)^{-L_P}}$
- $I_t = \frac{C_t}{L_C}\sum_{t=1}^{L_C}(1+i_C)^t$
- $C_t = C_0 * X^{-E}$
- $F_T = (\sum_{n=1}^{\#fuels}(\%_n * F_n))$
- $E_{El} = FLH_{El} * P_{El}$

Only applicable to biomass CHP

- $REV = HP * \frac{\eta_H}{\eta_E}$
- $H = P_{El} * \frac{\eta_H}{\eta_E} * FLH_{El}$
- $F_T = (\sum_{n=1}^{\#fuels}(\%_n * F_n)) * \frac{E_{El}+H}{\eta_E+\eta_H}$

Table A.1: Input parameters and description for the calculation of the project LCOE

Input parameter	Description	Unit
I_t	Investment cost at point t in time	USD
α	Capital recovery factor	1/a
FOM	Fixed Operational and Maintenance costs	USD/a
VOM	Variable Operational and Maintenance costs	USD/kWh
WACC	Weighted average cost of capital	%
$\%_n$	Share of fuel n in total fuel feed stock	%
F_n	Fuel costs of fuel n	USD/a
F_T	Total fuel costs	USD/a
REV	Revenue generated through heat production	USD/a

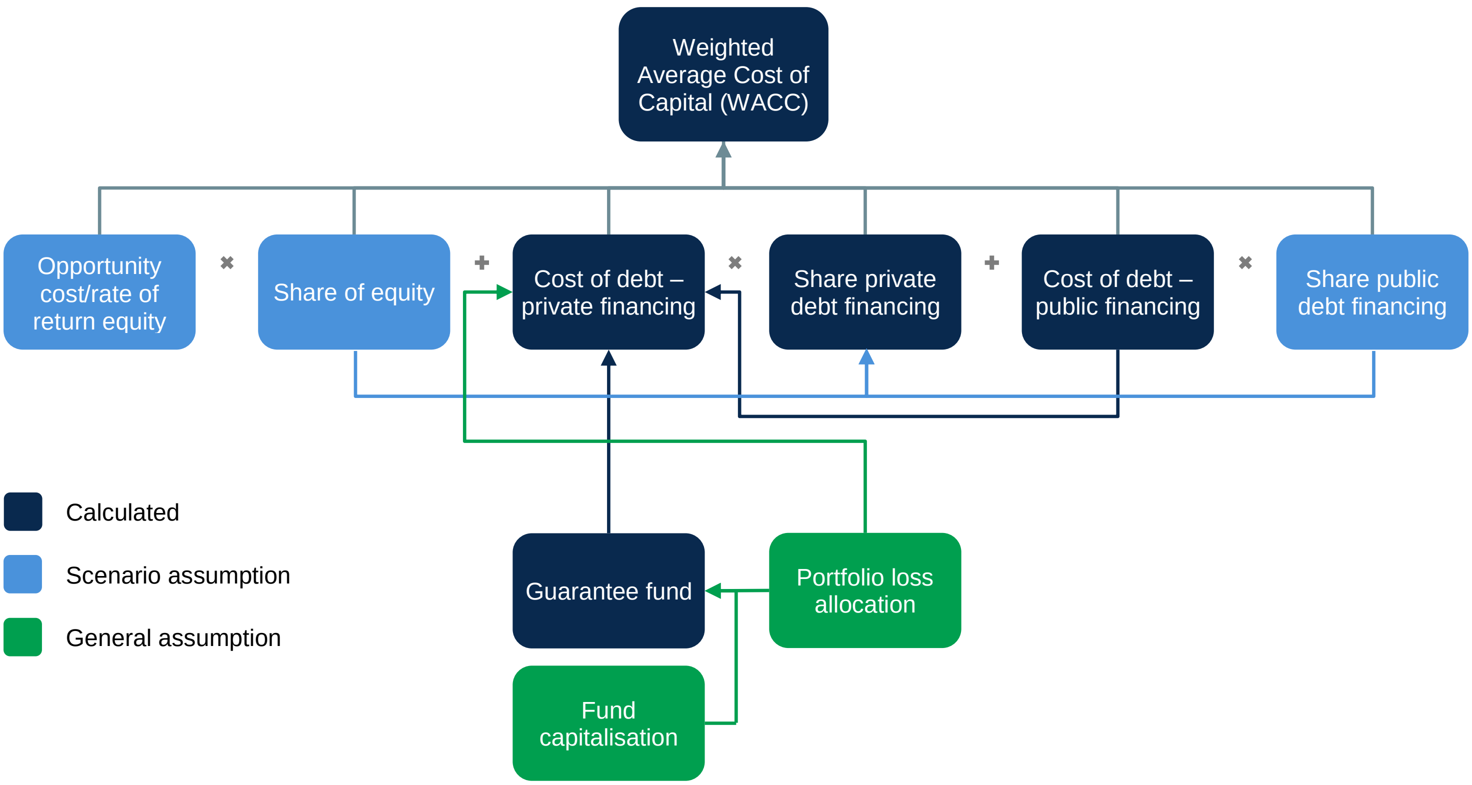
[29] For example https://www.pik-potsdam.de/members/edenh/publications-1/SystemLCOE.pdf

LP	Project lifetime	A
Ct	Capital “overnight” costs at point t in time	USD
LC	Construction time	A
E	Experience parameter	-
C0	Capital “overnight” costs in year 0	USD
X	Cumulative capacity installed in year t	MW

APPENDIX B: OVERVIEW OF THE WEIGHTED AVERAGE COSTS OF CAPITAL FOR RE SOURCES

Financing is an important part of the electricity generation cost. Project finance generally comes in three different forms: equity, private debt financing and public debt financing. In the calculations, these are captured in the weighted average cost of capital (WACC). WACC is the rate a company is expected to pay on average to compensate all of its investors. Figure B.1 illustrates the WACC composition and assumptions. The complete calculation formula for the WACC for RE sources is provided in Appendix B: Overview of the Weighted Average Costs of Capital

Figure B.1: WACC composition and important assumptions



Source: Adapted from Röser and Hagemann 2015.

The WACC is the rate a company is expected to pay on average to compensate all of its investors. This calculation captures three different forms of project finance for RE projects: equity, private debt financing and public debt financing. Section 7.4.1 addresses use of the WACC in financial feasibility calculations. The equation for the WACC is provided in Equation B.1. Table B.1 provides the input parameters and assumptions to calculate the WACC.

Equation B.1: WACC

$$ACC = \%_{equity} * o_{equity} + \%_{private} * i_{private} + \%_{public} * i_{public}$$

$$i_{private} = \frac{C_{private}}{(R_{Gross,private} - L_{ann,private})}$$

$$R_{Gross,private} = R_{Gross\ ,total} - R_{Gross\ ,public}$$

$$R_{Gross\ ,total} = IRR * C_{Total}$$

$$R_{Gross\ ,public} = i_{public} * C_{public}$$

$$L_{ann,private} = \frac{\%_{loan\ lost}}{T_{Loan}} * C_{Total} * \%_{loss,private}$$

$$C_{Total} = C_{public} + C_{private}$$

Table B.1: Assumptions in the calculation of the weighted average cost of capital (WACC)

Input parameter	Description	Unit
$\%_{equity}$	Share of equity financing of total	%
o_{equity}	Opportunity costs/required return equity financing	%
$\%_{private}$	Share of private debt financing	%
$i_{private}$	Rate of return / interest rate private debt finance	%
$\%_{public}$	Share of private debt financing	%
i_{public}	Rate of return / interest rate public debt financing	%
$C_{private}$	Contribution by private banks	USD
C_{public}	Contribution by public banks	USD
C_{Total}	Total debt financing contribution	USD
$L_{ann,private}$	Annualised losses for private debt	USD
$R_{Gross,private}$	Gross revenue private debt financing	USD
$R_{Gross\ ,total}$	Gross revenue debt financing	USD
$R_{Gross\ ,public}$	Gross revenue public financing	USD
IRR	Internal Rate of Return	%
$\%_{loan\ lost}$	Rate of loans lost	%
T_{Loan}	Tenor of the loan	Years
$\%_{loss,private}$	Share of loan lost allocated to the private debt	%

APPENDIX C: EXAMPLE RE POLICIES

This appendix provides example of RE policies from a number of countries, and case studies of RE policies from the literature. This information is provided particularly in support of the benchmarking exercise users can choose to undertake after calculating RE addition.

Table C.1: Example feed-in tariff policies

Country	Main design characteristics	Main barriers and challenges	Achieved impact
United Kingdom (UK Department of Energy and Climate Change, 2015) FiT introduced in 2010.	• Technologies eligible are solar PV, onshore wind, hydropower, anaerobic digestion (AD) and micro combined heat and power (micro CHP) • Tariff differentiation with higher tariffs for less mature technologies and small-scale installations • Tariffs were set to give rates of return between 5-8%	• **Regulatory and policy uncertainty barrier:** Policy risk and uncertainty, result from changing policies and financial support policies (RE Association 2015, p.64). Some of these changes include large digressions in the FiT and impending solar FiT review (European Forum for RE Sources 2015). • **Lack of awareness and skilled personnel:** Deficient number of skilled workers for the installation of microgeneration technologies (Aaskov and Tallat-Kelpšaitė, 2015) • **Institutional and administrative barrier:** The objectives of Ofgem (UK's independent national energy regulator) are not aligned with national and European RE and green economic objectives (Aaskov and Tallat-Kelpšaitė, 2015) • **Policy design challenge:** Problems with FiT cost control mechanism for small scale anaerobic digestion exist • **Policy design challenge:** The financial support for FiT technologies is unbalanced. While there is adequate support for PV, other technologies do not receive enough support to encourage similar investments (Aaskov and Tallat-Kelpšaitė, 2015)	• 3,567.40 MW of installed RE capacity over period of operation from 04/2010 until 03/2015 with total of 682,511 installations • PV accounts for 83.46% of all installed capacity and wind accounts for 11.47% of all installed capacity
Algeria (Nganga, Wohlert and Woods, 2013) FiT introduced in 2004 (Meyer-Renschhausen, 2013); 2014 for PV (PwC and Eversheds, 2016)	• All RE technologies eligible • Tariff differentiation with tariff premiums ranging between 80% to 300% • Government-owned single buyer with guaranteed purchase up to the annual production quota	• **Market barrier:** Significant subsidies available for conventional energy sources that reduce the price for all consumers • **Regulatory and policy uncertainty barrier**: Regulatory obstacles • **Financial barrier:** Lack of available capital (BETTER, 2013) • **Institutional and administrative barrier:** Regulatory and bureaucratic uncertainty and inefficiency (BETTER, 2013)	• No single project has become operational as of 02/2013

	• FITs are offered over a project's lifetime	• **Policy design challenge:** Insufficient level and variability of tariffs	
Tanzania (Nganga, Wohlert and Woods, 2013) FiT introduced in 2009 (Bank and Weischer, 2012)	• Eligible projects are restricted to be at least 100 kW and export no more than 10MW • No differentiation based on technology, size, fuel type, or application, but depending on whether the SPP is grid-connected or mini-grid • Payment duration of 15 years • 100% of energy purchased by utility and IPPs	• **Financial barrier:** Solvency of state-owned utility TANESCO • **Infrastructure barrier:** Under-developed grid and problems with grid stability • **Financial barrier:** Low-interest financing as key challenge for SPP developers (with interest rates in the range of 12-15% and payback periods of only 7-10 years as of 02/2013) • **Regulatory and policy uncertainty barrier:** Complicated regulatory requirements coordinated by several agencies (Bank and Weischer, 2012) • **Lack of awareness and skilled personnel:** Lack of experience in RE projects. Lack of confidence among stakeholders due to inexperience. • **Public acceptance and environmental barrier:** Conflicts over land ownership and water rights (Bank and Weischer, 2012)	• 24.4 MW of newly developed capacity as of 02/2013 • Additional 60 projects of a combined 130 MW in the pipeline as of 02/2013
Thailand (Beerepoot *et al.*, 2013; ADB, 2015) Feed-in Premium introduced in 2007, revised in 2009; Solar FiT in 2013 (Tongsopit, 2014)	• Technologies eligible are biomass, biogas, municipal solid waste, wind, mini- and micro-hydropower, and solar, however, suspended the purchase of solar energy through the adder program • Adder rates for RE are differentiated by technology capacity, location, and use as diesel replacement and installed capacity • 100% energy purchased by Thai power utilities (EGAT, PEA and MEA) • Projects are eligible for support for 7 to 10 years	• **Regulatory and policy uncertainty barrier:** Weak regulation and lack of transparency (Tongsopit and Greacen, 2012; Pacudan, 2014). Conflicting laws (Chaianong and Pharino, 2015). Uncertainty over future policy (Tongsopit, 2014). • **Techno-economic barrier:** Technical barriers including severe energy shortages (Chaianong and Pharino, 2015) • **Public acceptance and environmental barrier:** Lack of public discourse (Tongsopit and Greacen, 2012) • **Lack of awareness and skilled personnel**: Limited number of skilled workforce in various technologies (Sawangphol and Pharino, 2011). Lack of domestic production of PV and wind (Chaianong and Pharino, 2015) • **Market barrier:** High capital investment, especially for PV (break-even point of 7-9 years). Fluctuation of fossil fuel price (Sawangphol and Pharino, 2011). • **Institutional and administrative barrier:** Lack of coordination among implementing bodies (Pacudan, 2014). Complex permitting process (Tongsopit, 2014)	• 215.66 MW of installed capacity for rooftop solar PV as of 2012 (Chaianong and Pharino, 2015)

	• FiT programme for solar (Tongsopit, 2014))	• **Policy design challenge:** Planning barriers (Tongsopit and Greacen, 2012) • **Market barrier:** Absence of consumer's demand (Tongsopit and Greacen, 2012)	
Uruguay (IRENA, 2015e) ***Only feed-in tariff policy for biomass in 2010 reviewed in this overview***, however, not hybrid FiT/net metering policy for microgeneration in 2010 and hybrid policy of feed-in tariff and auction for PV in 2013 (Glemarec, Rickerson and Waissbein, 2012).	• Only eligible technology is biomass • Production capacity up to 20MW (Government of Uruguay, 2010) • Payment duration of up to 20 years	• **Institutional and administrative barriers:** Significant barriers in licencing process for wind (Glemarec, Rickerson and Waissbein, 2012). Lack of experience in issuing permits for micro hydro (Terra and Schenzer, 2014). Absence of a regulated tariff for cogeneration as of 2012 (Garmendia, 2012).	• While the initial proposals received under the feed-in tariff totalled 354MW of capacity, as of late 2014 there were only 0.6MW installed with 43MW in the pipeline (IRENA, 2015e)

Table C.2: Example auctions and tender policies

Country	Main design characteristics	Main barriers and challenges	Achieved impact
Brazil (IRENA, 2013, 2015d) Laws adopted in 2004.	• Auctions for wind, solar, small-scale hydro, large-scale hydro as well as conventional power sources • Projects contracted in auction required to start delivery after 3-5 years • PPAs are typically secured for 30 years for hydro and 20 years for wind and biomass • 100% of the energy is bought in competitive bids with guaranteed revenue for power producers • Several pre-requisites for bidders to participate in bidding process	• **Institutional and administrative barrier:** Difficulty in financing and problems getting environmental permits approved • **Infrastructure barrier:** Problems accessing the grid that lead to delays (Förster and Amazo, 2015) • **Policy design challenge:** The hybrid system of auctioning may allow for the 'winner's phenomenon' where bidders underbid to win the auction and ultimately undergo economic loses (Ferroukhi *et al.*, 2015) • **Policy design challenge:** The auctioning process may last too long (Ferroukhi *et al.*, 2015)	• Total of 62 GW have been contracted through 25 auctions for new capacity including 9 GW RE-based electricity generation auctions between 2005-2013 • 443 new generation projects for all technologies including conventional power with 60% renewables (40% large scale hydro and 20% other RE)

	• Bidders have to deposit several guarantees incl. a bid bond of 1% of project's investment cost and a project completion bond of 5% of project's investment cost • Additional reserve energy auctions		
China (IRENA, 2013) Auctions between 2003 and 2007 (IRENA, 2013)	• Auctions for wind onshore and offshore, solar PV and CSP • Selection in one stage based on price (following the 'lowest price wins' criterion) or weighted score from price and local content • Duration of tariff is 25 years for onshore wind and 30 years for offshore wind (including 4 years construction period) • No specific compliance rules nor clear penalties for non-compliance	• **Market barrier:** Information errors during the first and second bidding rounds that presented risks for bidders (Förster and Wigand, 2016) • **Lack of awareness and skilled personnel:** Lack of experience by bidders (Förster and Wigand, 2016). Lack of sufficiently stringent procedures to qualify bidders (Azuela *et al.*, 2014) • **Regulatory and policy uncertainty barrier**: Conflicting policies and absence of penalties (Förster and Wigand, 2016). Lack of clear compliance rules such as ex-post change of location and Investment uncertainty (Held *et al.*, 2014). • **Institutional and administrative barrier**: Lack of coordination between the auction organiser and the State Oceanic Administration (responsible for management of sea areas) (Azuela *et al.*, 2014)	• Total of 8.64 GW of capacity contracted between 2003 and 2011 (7.3 GW of onshore wind; 10 MW of solar PV; 280 MW of CSP; 1.0 GW of offshore wind) (IRENA, 2013)
Morocco (IRENA, 2013) Tendering of hydro projects since 1960, legislation revised in 2010. Wind projects tendered since 1998 (Ecofys, 2013).	• Technology-specific auctions for wind onshore, hydro and solar CSP in designated locations and for maximum capacity installed • Selection process with pre-qualification phase (experience, financial, technical capacity) and evaluation phase (technical specifications, financial aspects, industrial integration) • Duration of tariff is 20 years for wind and 25 years for solar • Penalties for delay and	• **Institutional and administrative barriers:** Complex tendering system that includes the involvement of five international financing institutions with different sets of procurement rules and processes (Ecofys, 2013). The tendering process is long and the implementation of the requirements is still unclear (Ecofys, 2013). • **Regulatory and policy uncertainty barriers:** Details for contracting projects are not transparent to the public (Ecofys, 2013) • **Infrastructure barriers:** Issues with integrating renewable power on to the transmission grid system (Currie, Lapierre and Malek, 2016) • **Overcoming potential barrier:** Stable political and regulatory environment and Morocco's experience with IPPs essential in attracting investors	• Total of 310 MW of RE capacity contracted between 2011 and 2012 (150 MW of wind; 160 MW of solar) • In March 2016, Morocco tendered a total of 850MW of wind energy capacity to be installed on five wind farms (Reuters, 2016)

	underperformance determined in PPA, guarantee paid at signature of PPA and termination of PPA as last resort	• **Overcoming potential barrier:** Establishment of governing agency for solar energy (MASEN) was instrumental in the successful management of CSP solar auction • **Overcoming potential barrier:** Adoption of the PPP model was crucial in de-risking the large-scale projects	
Peru (IRENA, 2013) Start of auctioning scheme in 2009 (IRENA, 2015a).	• Technology-specific auctions targeting solar, biomass and waste, wind, small hydro and geothermal • Selection in one round without a prequalification phase based on price and quota of energy (with celling price) • Duration of tariff for 20 years (in form of a PPA) • Use of performance bonds deposited by the power producers in order to secure completion of projects • Compliance with volume of energy generation contracted is ensured by penalising shortages • Almost no administrative barriers due to high bidding guarantees pre-qualification requirements (GIZ, 2015)	• **Market barrier:** Gas powered plants have preference over hydropower plants through tax incentives (IRENA, 2012). • **Institutional and administrative barrier:** Environmental Impact Assessment for hydro can be a hurdle (IRENA, 2012). Problems with environmental permits and agreement with local people exist. The low level of technical barriers to participate in the auctions increases the risk of delays and non-execution (Ecofys, 2013). • **Lack of awareness and skilled personnel:** Feasibility studies, technical knowledge and a comprehensive legal framework are missing for geothermal (IRENA, 2012) • **Regulatory and policy uncertainty barrier:** Access to finance for RE projects is unregulated (Ecofys, 2013)	• Total of 639 MW of RE capacity contracted between 2009-2011 across 36 projects (142 MW in wind, 80 MW in solar; 23 MW in biomass, 4 MW in biomass and 180 MW small-hydro) • 236 MW of capacity operated as of 12/2012 (GIZ, 2015) • Cumulative capacity for solar 184.5MW as of 07/2016 (SolarPower Europe, 2016)
South Africa (IRENA, 2013) The RE Independent Power Producer Procurement, REIPPP, was introduced in 08/2011, last round in 2014 and planned auctions for 2016.	• Technology-specific volume targeted across 5 auctions • Selection process with 1st phase (bidders have to meet minimum criteria related to legal, financial, technical and environmental requirements) and 2nd phase (price 70%, economic development including local content 30%)	• **Institutional and administrative barrier:** Auction process complex and not automatised. External transaction advisers are needed (Eberhard, Kolker and Leigland, 2014). Administrative hurdles (IRENA, 2013). • **Lack of awareness and skilled personnel**: Little provision of local capacity building and knowledge transfer (IRENA, 2013) • **Financial barrier:** High transaction costs for both the government and bidders (Eberhard, Kolker and Leigland, 2014)	• Total of 2.46 GW of RE capacity contracted between 2011-2013 of 5.93 GW auctioned over the same period (1.2 GW of onshore wind, 200 MW of CSP, 1.05 GW of solar PV, 14.3 of small hydro) • Cumulative capacity of solar 1,048MW as of 07/2016

	• Duration of tariff is 20 years • Contracts terminated for bidders who fail to meet their commitment under the PPA • Current technologies considered within the PPA program are onshore wind, CSP, solar PV, small hydro, biomass, biogas, landfill gas and co-generation from agricultural waste of by-products (del Río, 2015)	• **Financial barrier:** Eskom is the grid operator and single buyer which makes power producers vulnerable to its responses (Ecofys, 2013) • **Policy design challenge:** As of 08/2012 there were no successful bids for biomass, biogas and landfill gas technologies possibly attributed to low price ceilings (IRENA, 2013) • **Policy design challenge:** Short time spans between auctions may negatively affect competition (del Río, 2015)	(SolarPower Europe, 2016) • By end of 06/2015, 1,860 MW of procured capacity had already started operations (960MW solar PV, 790 MW onshore wind, 100Mw CSP and 10MW hydro) (del Río, 2015)

Table C.3: Example tax incentive policies

Country	Main design characteristics	Main barriers and challenges	Achieved impact
Argentina (IRENA, 2015c) Law 25.019 Art. 3 enacted 09/1998 for solar and wind (Government of Argentina, 1998); Law 26.190 art 9 enacted 12/2006 (Argentina, 2006) incl. decree 562/2009 (incl. wind, solar, geothermal, tidal, hydraulic, biomass, landfill gas, purification gas and biogas); Law 27.191 Arts 3&4 10/2015 (amendment to law 26.190) (Government of Argentina, 2015) Law 26.334 01/2008 for biofuels	• Available technologies are wind, solar geothermal, tidal, mall hydro, biomass, landfill gas, purification gas and biogas (Climatescope, 2015a) • At national level: • **Accelerated income tax depreciation** • **Value-added tax (VAT) rebate:** 15-year VAT deferral from capital investments in wind and solar equipment (from enactment of law 25.019) • At provincial/local level (KPMG, 2012; IRENA, 2015c): • **Real estate tax exemption** • **Stamp tax exemption** • **Turnover tax exemption/deferral** • **Tax stability**	• **Market barrier:** Subsidies to consumption of fossil fuels. Tax breaks for companies investing in oil and gas. Tax incentives to promote exploration (ODI, 2015) • **Institutional and administrative barrier:** Public investment in fossil fuel power stations (ODI, 2015) • **Market barrier:** The availability of substantial amounts of natural gas and hydropower makes other sources uncompetitive (UNEP, 2011) • **Financial barrier:** Lack of support from financial institutions (EY, 2016)	• *No ex-post impact study available*
Colombia Law 1715 (Government of Colombia, 2014) and its decree	• Four explicit fiscal incentives described in Laws 1716 and 1715 (Decree 2143):	• **Market barrier:** Subsidies for fossil fuels, although less, are still present (UPME, 2015b) • **Techno-economic barrier:** Lack of technical requirements to connect	• *No ex-post impact study available*

2143 (Government of Colombia, 2015) published 11/2015 and effective 02/2016 Law 1716 (2014) Art. 11 to 14	• 50% **tax break on investmen**t over five years • **VAT exemption** for equipment and machinery (local or foreign) associated with the project • **Accelerated depreciation of assets** • Exemption from **import duty** • Tax exemptions for biofuels: some biofuel plants are labelled tax-free zones (IRENA, 2015b)	and operate wind parks and small solar PV projects (UPME, 2015a) • **Market barrier:** Oligopolies for conventional energy production (UPME, 2015a) • **Market barrier:** Slightly higher investment costs for renewable technology in comparison to conventional • **Infrastructure barrier:** Lack of transmission lines in areas with the greatest potential for wind energy generation • **Public acceptance and environmental barrier:** Competition with historical heritage interests in the area • **Lack of awareness and skilled personnel**: Insufficient numbers of skilled workers and lack of training and education	
Panama For all renewables: Law 45 (2004) Art. 9 and 10. For wind installations: Law 44 (2011) Art. 22. For wind installations: Law 37 (2013) Art. 20 and its reform (2016)) (Government of Panama, 2013; Panama, 2016)	• Available technologies: solar, wind, hydro, small hydro and geothermal • Incentives for the construction, operation and maintenance valid for a period of up to 20 years for solar and 10 years for other renewable energies. • For projects up to 0.5 MW (Climatescope, 2015b): • **Import tax exemptions** • **VAT exemptions** • **Income tax credit** equivalent to up to 100% of direct investment for ten years. • For projects up to 10 MW (Climatescope, 2015b): • Exemption from **import, transmission** and **distribution taxes** • **Income tax credit** equivalent to up to 50% of direct investment. • For projects up to 20 MW: • Exemption of transmission taxes (on the first 10 MW for 10 years)	• **Infrastructure barrier:** Lack of transmission lines in areas with the greatest potential for wind energy generation (Extenda, 2014) • **Financial barrier**: Absence of adequate funding opportunities and financing products for RE • **Market barrier:** price structure that disadvantage renewables • **Lack of awareness and skilled personnel**: Insufficient numbers of skilled workers and lack of training and education • **Public acceptance and environmental barrier:** Competition with protected status in some potential areas	• *No ex-post impact study available.*

California (USA) 26 USC § 25D and § 48 established in 2005 (for solar), extended in 2008 and in 2015 (California Energy Commission, 2015) 26 USC § 45 established in 1992 and subsequently amended numerous times (N.C. Clean Energy Technology Center, 2016b) 26 USC § 136 (1992) Cal Rev & Tax Code § 73 (2012) (N.C. Clean Energy Technology Center, 2016a)	• **Federal investment tax credit (ITC)** • 30% for solar, fuels cells and small wind • 10% for geothermal, microturbines and CHP: • **Federal renewable electricity production tax credit (PTC):** • Available technologies include geothermal, wind, biomass, hydroelectric, municipal solid waste, landfill gas, tidal, wave, and ocean thermal • **Non-taxable energy conservation subsidies:** Applicable to residential solar-thermal and PV systems • Section 73 of the California Revenue and Taxation code: **property tax exclusion** of certain solar energy systems installed between 01/99 and 12/16	• **Institutional and administrative barrier:** State incentive programs can have complex eligibility requirements (California Energy Commission, 2015) • **Regulatory and policy uncertainty barrier:** Financial incentive legislation for renewable energy has been volatile. Typically, extensions for tax credits are only given for a period between one to three years. • **Regulatory and policy uncertainty barrier:** Barriers in environmental permitting due to strict requirements for large-scale renewable energy technologies (US EPA, 2016) • **Infrastructure barrier:** Constraints in existing transmission infrastructure (Department of the Navy, 2012).	• Residential and commercial solar ITC has helped annual solar installation grow by over 1,600% since 2006 - a compound annual growth rate of 76% (SEIA, 2016) • In years following PTC expiration, wind installations drop by approx. 80% (Spengler, 2011)
Indonesia Implemented by Government Regulation No. 1/2007 (amended by GR No. 62/2008 and GR No. 52/2011), MoF Regulation No. 21/2010, and MoF Regulation No. 130/2011 (Damuri and Atje, 2012; PwC, 2013)	• **Import duty and VAT exemption**: import duty exemption on machinery and capital for development of power plants. Exemption from VAT on importation of taxable goods. • **Income tax reduction**: Reduction and various facilities for income tax on energy development projects, including net income reduction, accelerated depreciation, dividends reduced for foreign investors and compensation for losses • **Accelerated depreciation and amortisation**: This allows investments to be depreciated within 2–10 years, depending on type of asset. This incentive would reduce the income tax paid by the investors and is expected to encourage expansion of	• **Market barrier:** The tariff for electricity set by the government is lower that the costs of production (indirect subsidy on conventional energy production) • **Market barrier:** Unequal tax burdens between conventional and renewable energy sources (WWF, 2014) • **Institutional and administrative barrier:** Multilayer government approval procedures (IEA, 2015) • **Institutional and administrative barrier:** Difficult licensing acquisition • **Regulatory and policy uncertainty barrier:** Unclear regulations	• No company in the renewable energy sector has qualified as a pioneer to receive additional tax exemptions (tax holidays of 5-10 years) as of 04/2015 (Ministry of Finance Indonesia, 2015) • No further ex-post impact study found

	investment (Government Regulation No. 1/2007). • **An income tax reduction for foreign investors** allows them to pay a rate of only 10 per cent on dividends they receive • Income Tax holidays/reductions under "Pioneer Industries Facility": **Corporate Income Tax (CIT) exemption** for 5-10 years, 50% reduction of CIT for two years after end of exemption period		

Table C.4: Case studies of RE policies in the literature

Study	Author, Year	Case study countries	Type of policy	Link
Renewable Energy Auctions in Developing Countries	IRENA, 2013	Brazil, China, Morocco, Peru, South Africa	In-depth description of country case studies, including design characteristics and achieved auction outcomes for all case studies	https://www.irena.org/DocumentDownloads/Publications/IRENA_Renewable_energy_auctions_in_developing_countries.pdf
Taxes and incentives for renewable energy	KPMG, 2014	31 countries	Country profiles on all promotion policies; no information on achieved outputs linked to specific policies	https://www.kpmg.com/PE/es/IssuesAndInsights/ArticlesPublications/Documents/taxes-incentives-renewable-energy-14.pdf
Taxes and incentives for renewable energy	KPMG, 2015	31 countries	Country profiles on all promotion policies; no information on achieved outputs linked to specific policies	https://assets.kpmg.com/content/dam/kpmg/pdf/2015/09/taxes-and-incentives-2015-web-v2.pdf
Renewable Energy in Latin America 2015: An Overview of Policies	IRENA. 2015	20 countries in Central and South America	Overview of all implemented policies in the field of national policy, fiscal incentives and grid access, especially Table 1 (plus IRENA in-depth country profiles); No/limited information on achieved outputs linked to specific policies	http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Latin_America_Policies_2015.pdf
Powering Africa through Feed-in-Tariffs	World Future Council (WFC) & Heinrich Böll Stiftung	13 countries in Africa ("Pioneers" and "Late movers"	Country profiles for each country with design characteristics and (short) impact assessment	https://ke.boell.org/sites/default/files/2013-03-powering-africa_through-feed-in-tariffs.pdf

	(HBS), 2013			
Evaluation of feed-in tariff-schemes in African countries	Journal of Energy in Southern Africa, 2013	4 countries in Africa	Overview of FiT design choices; no information on achieved outputs/impacts	http://www.erc.uct.ac.za/sites/default/files/image_tool/images/119/jesa/24-1jesa-meyer.pdf
Performance and Impact of the Feed-in-Tariff Scheme: Review of Evidence	U.K. Department of Energy and Climate Finance, 2015	Country case study for the UK	In-depth description of feed-in-tariff policy and impact/output assessment	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/456181/FIT_Evidence_Review.pdf
Comparison of Feed-in Tariffs and Tenders to Remunerate Solar Power Generation	DIW Berlin, 2015	Country case studies for Germany and France	Overview of FiT and tender policies in both countries	https://www.diw.de/documents/publikationen/73/diw_01.c.437464.de/dp1363.pdf
Ontario's Feed-in Tariff Program: Two-Year Review Report	Government of Ontario, 2012	Case study for Ontario (province in Canada)	Overview of FiT design and impact plus policy recommendation	http://www.energy.gov.on.ca/en/files/2011/10/FIT-Review-Report-en.pdf
A Policymaker's Guide to Feed-in Tariff Policy Design	NREL	Information overview for 5 countries	Information on FiT tariff payment levels for Germany, Spain, Ontario, Switzerland, Minnesota	http://www.nrel.gov/docs/fy10osti/44849.pdf

APPENDIX D: OVERVIEW OF CDM COMBINED MARGIN APPROACH

The combined margin approach used in the CDM has gained wide technical and political acceptance over the years. The combined margin is calculated in the CDM *Tool to calculate emission factor for an electricity system* using the following formula:

$$EF_{[grid,CM,y]} = EF_{[grid,OM,y]} * W_{[OM,y]} + EF_{[grid,BM,y]} * W_{[BM,y]}$$

Where:

$EF_{grid, CM, y}$ = Combined margin emission factor for a defined timeframe y (tCO_2e/MWh)

$EF_{grid, OM, y}$ = Operating margin emission factor for a defined timeframe y (tCO_2e/MWh)

$EF_{grid, BM, y}$ = Build margin emission factor for a defined timeframe y (tCO_2e/MWh)

$w_{OM,y}$ = Weighting of operating margin emission factor (%)

$w_{BM,y}$ = Weighting of build margin emission factor (%)

The main steps of the CDM Tool are summarised as follows:

Step 1: Determine the operating margin ($EF_{grid, OM, y}$**).** Operating margin provides the GHG impact due to displacement of power generated from existing grid-connected power plants by the introduction of new capacity. The CDM Tool provides four calculation approaches for estimating the operating margin, outlined in Table D.2. The appropriate approach should be selected based on the composition of the generation mix, particularly on the extent of use of low cost/must run plants in the grid.[30]

Table D.2: Overview of options for calculating operating margin

Options	Description
Simple operating margin	The emission factor is calculated as the power generation-weighted average of all power units supplying to the grid, except for low-cost/must-run plants.
Simple adjusted operating margin	If low-cost/must-run power plants generate a significant share of electricity (>50%) and daily load (average load > average lowest recorded hourly load over a year), these must be included in the simple operating margin calculation. In such cases, first the generation-weighted average emission rate is estimated separately for power plants that fall in the low-cost/must-run category and for the rest. Next, these two are weighted based on the number of hours when low-cost/must-run power units are on the margin in a year.
Average operating margin	The average operating margin emission factor is a simple average of all power plants that contribute to the grid, including low cost/must run plants.
Dispatch data analysis operating margin	The operating margin is calculated using the electricity displaced hourly by the project and the emission factor of the grid power units that are at the top of the dispatch order in that hour (whose power is replaced by the project).

[30] Low-cost/must-run resources are power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid (e.g., hydro, geothermal, wind, low-cost biomass, nuclear and solar generation) (UNFCCC, 2015).

	The dispatch order data is to be gathered from relevant authorities. The number of power plants at the top of the dispatch is calculated based on merit order. The approach requires annual monitoring.

Source: (UNFCCC, 2015).

Step 2: Calculate the build margin ($EF_{grid, BM, y}$**).** Build margin refers to the GHG impacts of future capacity expansion. The CDM recommends using historical data from most recently built power plants as a proxy for determining the make-up of future power units in the energy system.

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \text{ X } EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$ = Build margin emission factor (tCO_2e/MWh)

$EG_{m,y}$ = Electricity generated and delivered to the grid in a defined timeframe y (MWh)

$EF_{EL,m,y}$ = CO_2 emission factor for power plants m in a defined timeframe y (tCO_2e/MWh)

m = All power plants serving the grid in defined timeframe y except low-cost/must-run power units

y = defined timeframe (most recent historical year for which electricity data is available)

Step 3: Determine combined margin emission factor. The combined margin is calculated as a weighted average of the operating margin and build margin:

- The sum of the weighing factors for operating margin ($w_{OM,y}$) and build margin ($w_{BM,y}$) must be equal to 1.
- They must reflect the age of currently operational plants and expected future capacity additions.
- Common default values used in the CDM, are as follows:
  - Wind and solar: Operating margin, 0.75; build margin, 0.25
  - Other RE technologies: Operating margin, 0.5; build margin, 0.5

Selecting alternative weights for operating and build margin

The CDM Tool provides for some adjustments to the default weighting of operating and build margin. Users should consider the technology focus of the policy, the national electricity generation mix and load characteristics when determining whether the weightings should be adjusted. The CDM Tool provides further guidance on adjusting weights.

APPENDIX E: STAKEHOLDER PARTICIPATION DURING THE ASSESSMENT PROCESS

This appendix provides an overview of the ways that stakeholder participation can enhance the process for assessment of GHG impacts of renewable energy policies. Table E.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 Guidance*.

Table E.1 List of steps where stakeholder participation is recommended in the impact assessment

Chapter/step in this guidance document	Why stakeholder participation is important at this step	Relevant chapters in *Stakeholder Participation Guidance*
Chapter 2 – Objectives of assessing GHG impacts of RE policies	Ensure that the objectives of the assessment respond to the needs and interests of stakeholders	Chapter 5 – Identifying and understanding stakeholders
Chapter 4 – Using the guidance Section 4.2.5 Planning stakeholder participation	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 understanding stakeholders Chapter 6 – Establishing multi-stakeholder bodies Chapter 9 – Establishing grievance redress mechanisms
Chapter 6 – Identifying impacts: How RE policies reduce GHG emissions	Enhance completeness of the list of GHG impacts with stakeholder insights Improve and validate causal chain with stakeholder insights on cause-effect relationships between the policy, behaviour change and expected impacts	Chapter 5 – Identifying and understanding stakeholders Chapter 8 – Designing and conducting consultations
Chapter 7 – Estimating RE addition of the policy	Improve identification of barriers and evaluation of their severity with stakeholder insights	Chapter 8 – Designing and conducting consultations
Chapter 10 – Monitoring performance over time	Ensure monitoring frequency addresses the needs of decision makers and other stakeholders	Chapter 8 – Designing and conducting consultations
Chapter 11- Reporting	Raise awareness of benefits and other impacts to build support for the policy or action Inform decision makers and other stakeholders about impacts to facilitate adaptive management Increase accountability and transparency and thereby credibility and acceptance of the assessment	Chapter 7 – Providing information to stakeholders

APPENDIX F: SELECTING THE SCOPE OF THE GUIDANCE

The scope of this guidance was selected using a set of criteria developed with the Technical Working Group:

- Role of the subsector in countries' NDCs
- GHG emission reductions potential
- Extent to which policies for the subsector exist in countries and are being implemented to directly promote renewable electricity generation
- Current and future emissions levels/share of subsector emissions
- Potential lock-in/transformation
- Gaps in available guidance
- Investment needs under a 1.5-2 °C temperature goal

Abbreviations and Acronyms

CDM	Clean Development Mechanism
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
tCO_2e	tonnes of carbon dioxide equivalent
MCO_2e	million tonnes of carbon dioxide equivalent
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GWh	Gigawatt-hours
ICAT	Initiative for Climate Action Transparency
IPCC	Intergovernmental Panel on Climate Change
LCOE	Levelised cost of electricity
NDC	Nationally Determined Contribution
MRV	Monitoring, Reporting and Verification
MW	Megawatts
MWh	Megawatt-hours
NAMA	Nationally Appropriate Mitigation Action
UNFCCC	United Nations Framework Convention on Climate Change
WACC	Weighted average cost of capital
WRI	World Resources Institute

GLOSSARY

Activities	The administrative activities involved in implementing the policy (undertaken by the authority or entity that implements the policy), such as permitting, licensing, procurement, or compliance and enforcement
Assessment period	The time period over which GHG impacts resulting from a policy are assessed
Assessment report	A report, completed by the user, that documents the assessment process and the GHG, sustainable development and/or transformational impacts of the policy
Barrier	Any obstacle to developing and deploying a renewable energy (RE) potential that can be overcome or attenuated by a policy, programme or measure
Baseline scenario	A reference case that represents the events or conditions most likely to occur in the absence of a policy (or package of policies) being assessed
Causal chain	A conceptual diagram tracing the process by which the policy leads to impacts through a series of interlinked logical and sequential stages of cause-and-effect relationships
Emission factor	A factor that converts activity data into GHG emissions data
Ex-ante assessment	The process of estimating expected future GHG impacts of a policy (i.e., a forward-looking assessment)
Ex-post assessment	The process of estimating historical GHG impacts of a policy (i.e., a backward-looking assessment)
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)
Feed-in tariff	The price per unit of electricity that a utility or power supplier has to pay for distributed or renewable electricity fed into the grid by non-utility power producers
GHG assessment boundary	The scope of the assessment in terms of the range of GHG impacts that is included in the assessment
GHG impacts	Changes in GHG emissions by sources that result from a policy
Electricity grid (grid)	A network consisting of wires, switches and transformers to transmit electricity from power sources to power users. A large network is layered from low-voltage (110-240 V) distribution, over intermediate voltage (1-50 kV) to high-voltage (above 50 kV to MV) transport subsystems. Interconnected grids cover large areas up to

	continents. The grid is a power exchange platform enhancing supply reliability and economies of scale.
Grid access	Refers to the acceptance of power producers to deliver to the electricity grid
Impact assessment	The estimation of changes in GHG emissions or removals resulting from a policy, either ex-ante or ex-post
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
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
Inputs	Resources that go into implementing the policy, such as financing
Intended impacts	Impacts that are intentional based on the original objectives of the policy. 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 effects	Changes in behaviour, technology, processes, or practices that result from the policy, which lead to GHG impacts
Jurisdiction	The geographic area within which an entity's (such as a government's) authority is exercised
Key performance indicator (indicator)	A metric that indicates the performance of a policy
Levelised Cost of Electricity (LCOE)	The unique cost price of the outputs (US cent/kWh or USD/GJ) of a project that makes the present value of the revenues (benefits) equal to the present value of the costs over the lifetime of the project
Long-term impacts	Impacts that are more distant in time, based on the amount of time between implementation of the policy and the impact
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
Negative impacts	Impacts that are perceived as unfavourable from the perspectives of decision makers and stakeholders
Net metering	The practice of using a single meter to measure consumption and generation of electricity by a small generation facility (such as a house with a wind or solar photovoltaic system). The net energy

	produced or consumed is purchased from or sold to the power producer, respectively.
Non-policy drivers	Conditions other than RE policies, such as socioeconomic factors and market forces, that are expected to affect the emissions sources included in the GHG 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 such as activity data or emission factors that are needed to estimate GHG impacts
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 is in effect
Policy scenario	A scenario that represents the events or conditions most likely to occur in the presence of the policy (or package of RE policies) being assessed. The policy scenario is the same as the baseline scenario except that it includes the policy (or package of policies) being assessed.
Positive impacts	Impacts that are perceived as favourable from the perspectives of decision makers and stakeholders
Power purchase agreement (PPA)	A contract between an electricity (power) producer and an electricity consumer (or distributor). Historically, PPAs have been frequently signed between utilities and independent power producers as a way for the utility to procure additional generation. In recent years, PPAs have been used as a way for power

	consumers to purchase electricity, often from solar systems, from a third-party power producer (NREL).[31]
RE addition	The additional installation of renewable energy capacity or electricity generation from renewable sources realised via the policy, expressed in megawatts (MW) or megawatt-hours (MWh) respectively
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
Renewable energy	Any form of energy from solar, geophysical or biological sources that is replenished by natural processes at a rate that equals or exceeds its rate of use. Renewable energy is obtained from the continuing or repetitive flows of energy occurring in the natural environment and includes low-carbon technologies such as solar energy, hydropower, wind, tide and waves and ocean thermal energy, as well as renewable fuels such as biomass.
Renewable portfolio standard	A legal mandate that require utilities to procure a certain percentage or flat amount of renewable electricity or power based on their total generation. Utilities can procure the renewable energy via direct ownership or the purchase of renewable energy credits (NREL).[32]
Short-term impacts	Impacts that are nearer in time, based on the amount of time between implementation of the policy and the impact
Solar energy	Energy from the sun that is captured either as heat, as light that is converted into chemical energy by natural or artificial photosynthesis, or by photovoltaic panels and converted directly into electricity
Stakeholders	People, organisations, communities or individuals who are affected by and/or who have influence or power over the policy
Sustainable development impacts	Changes in environmental, social, or economic conditions that result from a policy, such as changes in economic activity, employment, public health, air quality, and energy security
Transmission and distribution	The network that transmits electricity through wires from where it is generated to where it is used. The distribution system refers to the lower-voltage system that delivers the electricity to the end consumer.

[31] Available at: https://financere.nrel.gov/finance/content/glossary.

[32] Available at: https://financere.nrel.gov/finance/content/glossary.

Uncertainty	1. Quantitative definition: Measurement that characterises 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. In some contexts, these are referred to as secondary impacts.
Utility	An entity in the electric power industry that engages in electricity generation and distribution of electricity for sale, generally in a regulated market
Weighted average cost of capital (WACC)	The rate that a company is expected to pay on average to all its security holders to finance its assets, including the fraction of each financing source in the company's capital structure

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