Policy and Action Standard

Energy Supply Sector Guidance

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Introduction

This document provides sector-specific guidance to help users implement the GHG Protocol *Policy and Action Standard* in the energy supply sector. The energy supply sector represents supply of electrical or thermal energy from renewable or fossil fuel based sources. Supply of energy involves a sequence of processes including extracting energy resources, converting them into more desirable and suitable forms of energy, and delivering energy to consumers. GHG emissions related to energy supply can be reduced through measures such as switching to renewable sources of energy, switching to low-carbon fossil fuels, more efficient conversion of fossil fuels to energy, decarbonization of flue gases and fuels, carbon capture and storage, and enhancing efficiency of electricity distribution systems. Demand-side energy efficiency also plays a critical role in reducing emissions from energy supply.

Users should follow the requirements and guidance provided in the *Policy and Action Standard* when using this document. The chapters in this document correspond to the respective chapters in the *Policy and Action Standard*. This document refers to Chapters 5–11 of the *Policy and Action Standard* to provide specific guidance for the energy supply sector. The other chapters have not been included as they are not sector-specific, and can be applied to the energy supply sector without additional guidance. Chapters 1 – 4 of the *Policy and Action Standard* introduce the standard, discuss objectives and principles, and provide an overview of steps, concepts, and requirements. Chapters 12–14 of the *Policy and Action Standard* address uncertainty, verification, and reporting. The table, figure, and box numbers in this document correspond to the table, figure, and box numbers in the standard.

To illustrate the various steps in the standard, this guidance document uses a running example of a hypothetical preferential tariff policy for renewable power.

We welcome any feedback on this document. Please email your suggestions and comments to David Rich at drich@wri.org.

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Chapter 5: Defining the policy or action

In this chapter, users are required to clearly define the policy or action that will be assessed, decide whether to assess an individual policy or action or a package of related policies or actions, and choose whether to carry out an ex-ante or ex-post assessment. Table 5.1 provides examples of policies and actions in the sector by policy/action type.

5.1 Select the policy or action to be assessed

Table 5.1 provides a non-exhaustive list of policies and actions in the sector for which this guidance document may be useful.

Table 5.1 Examples of policies/actions in the sector by policy/action type

Type of policy or action	Examples
Regulations and standards	• Renewable portfolio standard • Renewable quota obligation on production • Renewable quota obligation on consumption
Taxes and charges	• Tax on fossil fuel use • Tax advantage for renewable energy investments (for example, attractive depreciation schemes) • Tax advantage on loans for renewable energy investments • Tax advantage on the income generated by renewable energy • Tax advantage on the consumption of renewable energy • Proposals for lower VAT rates • Tax exemption for green funds
Subsidies and incentives	• Preferential tariff or feed-in tariff • Power purchase agreements • Fixed government investment subsidy • Bidding system for availing investment subsidy/grant • Subsidy on switching to renewable energy production or on the replacement of old renewable energy installations • Zero (or low) interest loans
Tradable permits	• Green certificates • Energy saving certificates • Cap-and-trade program that includes energy sector
Voluntary agreements	• Corporate goals • Negotiated agreements
Information instruments	• Emissions intensity labeling of equipment • Workshops/seminars for energy sector companies • Renewable energy courses in universities
Research and development (R&D)	• Renewable energy development grants to universities • Fixed government RD&D subsidies • Grants for demonstration, development, test facilities, etc.
Public procurement policies	• Quota obligation on consumption or purchase of renewable energy
Infrastructure programs	• Smart grid enhancement • Enhancement of distribution infrastructure
Implementation of new technologies, processes, or practices	• Demonstration projects • Subsidized introduction of technologies

Financing and investment	• Zero (or low) interest loans • Renewable energy regulatory fund

5.2 Clearly define the policy or action to be assessed

A key step in Chapter 5 is to clearly define the policy or action. Chapter 5 in the standard provides a checklist of information users should report. Table 5.2 shows the completed checklist for a hypothetical preferential tariff policy for wind power in a country. The preferential tariff example will be used throughout the guidance document to illustrate the individual steps of the standard.

Table 5.2 Checklist of information to describe the preferential tariff policy

Information	Example
The title of the policy or action	Preferential tariff for wind based power generation
Type of policy or action	Subsidies and incentives
Description of the specific interventions included in the policy or action	The scheme applies to newly installed wind power projects that supply power to the national grid. The tariff is paid to eligible installations for net electricity supplied to the grid. It is guaranteed for a minimum period of 13 years, starting from the date of commercial operation of the wind power installations. The tariff for the wind power installations is a single part tariff consisting of the following cost components: (a) Return on equity; (b) Interest on loan capital; (c) Depreciation; (d) Interest on working capital; (e) Operation and maintenance expenses; and (f) Any other subsidies availed Assumptions are described in the policy to work out the generic tariff determined on levelized basis for the tariff period. The normative return on equity set for wind power projects is: a) 20% per year for the first 10 years b) 24% per year 11th year onwards
The status of the policy or action	Implemented
Date of implementation	Came into force in February 2012
Date of completion (if applicable)	N/A
Implementing entity or entities	Ministry of Energy
Objective(s) of the policy or action	To increase energy security and reduce local air pollution through increased wind power generation in the country
Geographical coverage	National
Primary sectors, subsectors, and emission sources or sinks targeted	Energy supply, grid connected wind power plants
Greenhouse gases targeted	CO_2, CH_4, N_2O
Other related policies or actions	*Subsidy on power plant equipment parts* To ensure electricity prices are affordable, a subsidy scheme for power plant equipment was launched in 2008. The subsidy is applicable to high efficiency

	equipment. Exact criteria have been defined to determine efficiency and apply thresholds for different types of equipment. Some of the eligible equipment types, such as current transformers, are also used in wind power projects. *Accelerated depreciation benefits* The domestic tax law allows renewable energy projects an accelerated depreciation at 60%. However, projects can only participate in one government support scheme, so they need to select either accelerated depreciation or other support schemes, such as the preferential tariff scheme. *Excise duty exemption of power plant equipment parts* Equipment for the generation of renewable energy is fully exempt from excise duty.
Optional information	
Key performance indicators	Wind power capacity installed Electricity delivered to the grid from eligible wind power installations Amount of preferential tariff paid
Intended level of mitigation to be achieved and/or target level of other indicators	N/A
Title of establishing legislation, regulations, or other founding documents	Terms and Conditions for Tariff Determination from Renewable Energy Sources
Monitoring, reporting, and verification procedures	The critical parameter to be monitored is the net wind based electricity delivered to the national/regional grid due to the policy. This will be an aggregation of the net electricity delivered to the grid by all the projects, plants, or electricity production units benefitting from the policy. MRV will be carried out at two levels: Meter readings will be taken by the representative of the state electricity board or grid company on a monthly basis; and by the power producers at the unit level on a daily basis. The responsibility of project management as well as monitoring, measurement and reporting at the unit level will rest with the individual power producer benefitting from the policy. A project team will need to be formed to ensure proper and continuous monitoring of the performance of the power plant. A monitoring plan will need to be prepared to ensure that reliable data is used to measure the net electricity delivered to the national/regional grid by the unit. The power producer will need to establish Quality Assurance and Quality Control (QA and QC) measures to effectively control and manage data reading, recording, auditing as well as to archive all relevant data and documents. For monitoring net electricity generation at the plant level, meters will be installed at the grid inter-connection point. The meters will be bi-directional with a minimum specified accuracy class. The monitoring data can be obtained from the periodic electricity meter records kept by the power producer and/or the state electricity board/ grid company, which can be cross-checked with actual invoices sent by the power producers to the grid company.

	The power producer will need to implement QA/QC measures to calibrate and guarantee the accuracy of metering and safety of the project operation. The metering devices will be calibrated and inspected properly and periodically as per standard industry norms or national or state electricity grid codes.
Enforcement mechanisms	No enforcement is required to ensure renewable energy generation. If the beneficiary does not generate electricity from wind power, it will not be eligible to receive preferential tariff from the government. However, regular checks will be carried out to ensure that all requisite stipulations of the regulation are being followed.
Reference to relevant guidance documents	-
The broader context/significance of the policy or action	Will lead to increased wind generation in the country, contributing to energy security
Outline of non-GHG effects or co-benefits of the policy or action	Will contribute towards development, energy security and increased employment in economically depressed areas. Will also reduce air pollution due to particulate matter and harmful gases emitted by fossil fuel based power plants.
Other relevant information	-

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

Chapter 5 also provides a description of the advantages and disadvantages of assessing an individual policy/action or a package of policy actions. Steps to guide the user in making this decision based on specific objectives and circumstances include identifying other related policies/actions that interact with the initial policy/action.

As a first step, a policy mapping exercise is undertaken to inform whether to assess an individual policy/action or a package of policies/actions for the hypothetical preferential tariff policy example.

For the purposes of this guidance document, three example policies have been identified that target the same emission sources as the preferential tariff policy (Table 5.5). The user will need to undertake a preliminary analysis to understand the nature of these interactions and then determine whether to assess an individual policy/action or a package of policy actions. This analysis can be brief and qualitative, since detailed analysis of interactions would be taken up in subsequent chapters. An illustrative example for the preferential tariff policy is provided below.

Table 5.5 Mapping policies/actions that target the same emission source(s)

Policy assessed	Targeted emission source(s)	Other policies/actions targeting the same source(s)	Type of interaction	Degree of interaction
Preferential tariff for wind based power generation	Fossil fuel combustion in Grid connected power plants	Subsidy on power plant equipment parts	Overlapping	Moderate
		Accelerated Depreciation benefits	Overlapping	Major
		Excise duty exemption of power plant equipment parts	Overlapping	Minor

Preferential tariff policy

The preferential tariff in this specific case is computed taking into account any subsidies, incentives, or depreciation benefits availed by a power producer (the tariff is calculated based on a normative return on equity, taking into account all financial benefits). Therefore, power producers cannot increase their revenue or profitability beyond the preferential tariff incentive. Those who take advantage of the preferential tariff incentive are choosing not to take advantage of the other incentives, assuming that the incentive offered by preferential tariff is more than the combination of all the other incentives that they would have eligible for. Despite overlapping policies, the power producer can take advantage of one kind of policy only. This allows for clear categorization of interaction between policies as overlapping and also makes it easier to calculate these non-overlapping interactions.

Table 5.6 Criteria to consider for determining whether to assess an individual policy/action or a package of policies/actions

Criteria	Questions	Guidance	Preferential tariff example
Use of results	Do the end-users of the assessment results want to know the impact of individual policies/actions, for example to inform choices regarding which individual policies/actions to implement or continue supporting?	If "Yes" then undertake an individual assessment	Yes
Significant interactions	Are there significant (major or moderate) interactions between the identified policies/actions, either overlapping or reinforcing, which will be missed if policies/actions are assessed individually?	If "Yes" then consider assessing a package of policies/actions	No. It would be possible to separately determine the impact of interactions
Feasibility	Will the assessment be manageable if a package of policies/actions is assessed? Is data available for assessing the package of policies/actions? Are policies implemented by a single entity?	If "No" then undertake an individual assessment	Yes
	For ex-post assessments, is it possible to disaggregate the observed impacts of interacting policies/actions?	If "No" then consider assessing a package of policies/actions	Yes

Chapter 6: Identifying effects and mapping the causal chain

In this chapter, users are expected to identify all potential GHG effects of the policy or action and include them in a map of the causal chain.

For this chapter, there are a number of sector-specific resources such as guidance documents, tools, databases of projects, and other resources that can be referred to while brainstorming possible effects of policies in the sector, however the extent of available literature and resources varies by policy type and geography. Some examples of these resources are provided in the methods and tools database on the GHG Protocol website, which can be filtered by sector. Most of these resources will not be applicable in their entirety, however select sections of these resources could provide a preliminary basis for further brainstorming and analysis.

6.1 Identify potential GHG effects of the policy or action

Using reliable literature resources (such as those mentioned in Box A below), combined with professional judgment or expert opinion and consultations, users can develop a list of all potential GHG effects of the policy or action and group them into two categories: in-jurisdiction effects and out-of-jurisdiction effects. In order to do this, users may find it useful to first understand how the policy or action is implemented by identifying the relevant inputs and activities associated with the policy or action. For the preferential tariff policy example, an illustrative list of indicators and possible effects for the policy (by type) is provided below.

Table 6.1 Summary of inputs, activities, and effects for the preferential tariff policy

Indicator types	Examples for preferential tariff policy
Inputs	Infrastructure investment generated Amount of tariff payments
Activities	Total number of wind power installations under the policy Total capacity of wind power installations under the policy Plant Load Factor or Capacity Utilization Factor of wind installations under the policy
Intermediate effects	Total energy generation from wind installations under the policy Local employment generated due to the installation of windfarms
GHG effects	Absolute reduction in GHG emissions due to fossil fuel displacement in the grid by wind energy installations under the policy Reduction in GHGs per unit of wind capacity installation
Non-GHG effects	Enhancement of energy security Employment generation for local population Reduction / prevented increase in air pollution

Quantitative information may not be available for all elements identified in the table at the point of assessment and not all elements are relevant for the determination of the causal chain. However, creating a comprehensive list will help in robust performance monitoring (see Chapter 11) in addition to identifying effects at this stage.

The next step is to create a comprehensive list of expected effects, based on the understanding of the design of the policy (see Table 6.2).

Table 6.2 Illustrative example of various effects for the preferential tariff policy

Type of effect	Effect
Intended effect	• Reduced GHG emissions from operating fossil fuel fired plants in the grid • Reduced GHG emissions from national manufacturing of fossil fuel fired plant equipment
Unintended effect	• Leakage of GHG emissions to other jurisdictions (further explained below) • Increased emissions from national wind turbine manufacturing
In-jurisdiction effect	• Increased emissions from national wind turbine manufacturing • Reduced/limited growth of GHG emissions from local mining of fossil fuels* • Reduced emissions from local manufacturing of fossil fuel fired plant equipment

Out-of-jurisdiction effect	• Leakage of GHG emissions to other jurisdictions
	  ○ Increased GHG emissions from manufacturing of imported turbines
	  ○ Increased GHG emissions in other jurisdictions from fossil fuel exports*
	• Spillover effects in other jurisdictions
	  ○ Reduced GHG emissions in other jurisdictions from reduced fossil fuel imports*
	  ○ Reduced GHG emissions from manufacturing of imported fossil fuel fired plant equipment

Short-term effect	• Reduced GHG emissions from operating fossil fuel fired plants in the grid
Long-term effect	• Reduced emissions from lower energy use due to increased cost of power

Note: The effects marked with * depend on the structure of the energy system of a country. If the country is largely importing fossil fuels, then effects on local mining emissions will be unlikely and there will be no leakage effect from the selling of excess fossil fuels. If the country is largely self-reliant or a net exporter, then the effects will depend on whether the local mining activity will be reduced or if the reduced domestic demand will be compensated by additional exports, leading to leakage effects.

6.2 Identify source/sink categories and greenhouse gases associated with the GHG effects

Users are also expected to identify and report the list of source/sink categories and greenhouse gases affected by the policy or action.

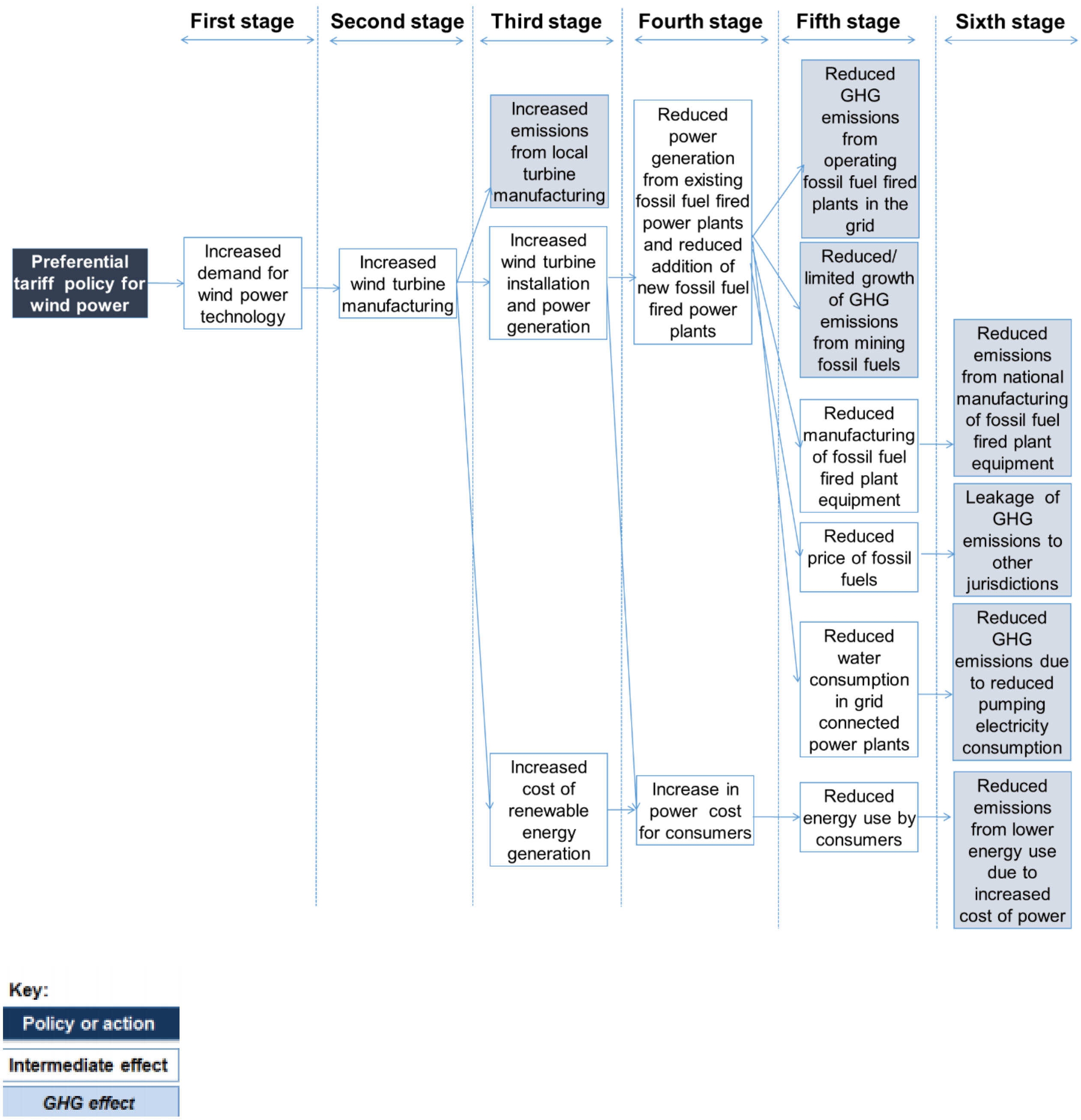
Table 6.3 Sources/sinks and greenhouse gases affected by the preferential tariff policy

Source category	Description	Examples of emitting equipment or entity	Relevant greenhouse gases
Grid-connected electricity generation	Combustion of fuels to generate grid-connected electricity	Grid-connected power plants	CO_2, CH_4, N_2O
Fossil fuel mining	Processes involved in mining of fossil fuels	Industrial facilities, mining equipment	CO_2, CH_4

6.3 Map the causal chain

Once effects have been identified, developing a map of the causal chain allows the user and relevant stakeholders to understand in visual terms how the policy or action leads to changes in emissions. Figure 6.3 presents a causal chain for the preferential tariff policy based on the effects identified above.

Figure 6.3 Mapping GHG effects by stage for a preferential tariff policy



Chapter 7: Defining the GHG assessment boundary

The standard requires users to include all significant effects in the GHG assessment boundary. In this chapter, users determine which GHG effects are significant and therefore need to be included. The standard recommends that users estimate the likelihood and relative magnitude of effects to determine which are significant. Users may define significance based on the context and objectives of the assessment. The standard recommends that users consider all GHG effects to be significant (and therefore included in the GHG assessment boundary) unless they are estimated to be either minor in size or expected to be unlikely or very unlikely to occur.

7.1 Assess the significance of potential GHG effects

Effects that may be significant for policies in the sector include:

- Decrease in emissions due to displacement of fossil fuel based electricity generation
- Decrease in emissions from mining of fossil fuels
- Increase in upstream and downstream emissions (e.g., manufacture of renewable energy based systems, hydro reservoir methane generation etc.)
- Changes in emissions due to changes in consumer behavior
- Change in emissions due to change in utilization of other natural resources like water
- Changes in electricity consumption and emissions due to instability of grid
- Leakage of emissions to other jurisdictions (transfer of equipment, fuel etc.)

For the preferential tariff example, an illustrative assessment boundary is described below. The example assumes:

- The country is a net importer of fossil fuels, hence leakage effects of export of excess fossil fuels from the country are considered very unlikely. The policy aims to switch 10% of the total electricity generation by fossil fuels to wind power. The majority of the fossil fuel consumed in the country is imported. In this scenario, this effect will not have a significant leakage GHG impact, since fossil fuels will not be exported in any case, however imports to the country may reduce.
- Manufacturing and installation of wind turbines has a negligible contribution to GHG emissions when compared to the reductions attributable to it over the life of the plant. Some studies suggest that the “energy payback time” (a measure of how long a power plant must operate to generate – “payback” – the amount of electricity required for its manufacture and construction) of a wind plant is only a few months, compared to the lifetime of the plant of over 25 years. However, this may vary from country to country and must be evaluated from a country standpoint.
- Reduction in emissions from manufacturing and installation of fossil fuel fired plants although is very likely effect, similar to the argument above, its impact is negligible compared to the emissions from the operation of the power plant over its lifetime. Further, both wind power plants and fossil fuel fired plants need to be manufactured and installed, and thus cancel each other’s impact to a degree, making the net impact even smaller.

Table 7.3 Example of assessing each GHG effect separately by gas to determine which GHG effects and greenhouse gases to include in the GHG assessment boundary for the example policy

GHG effect	Likelihood	Relative magnitude	Included?
Reduced GHG emissions from operating fossil fuel fired plants in the grid			
CO_2	Very likely	Major	**Included**
CH_4	Very likely	Minor	Excluded
N_2O	Very likely	Minor	Excluded
Reduced GHG emissions from local mining of fossil fuels			
CO_2	Very likely	Major	**Included**
CH_4	Very likely	Minor	Excluded
N_2O	Very likely	Minor	Excluded
Reduced emissions from local manufacturing of fossil fuel fired plant equipment			
CO_2	Very likely	Minor	Excluded
CH_4	Very likely	Minor	Excluded
N_2O	Very likely	Minor	Excluded
Increased emissions from national wind turbine manufacturing			
CO_2	Very likely	Minor	Excluded
CH_4	Very likely	Minor	Excluded
N_2O	Very likely	Minor	Excluded
Leakage of GHG emissions to other jurisdictions			
CO_2	Very Unlikely	Moderate	Excluded
CH_4	Very Unlikely	Minor	Excluded
N_2O	Very Unlikely	Minor	Excluded
Reduced emissions from lower energy use due to increased cost of power			
CO_2	Possible	Moderate	**Included**
CH_4	Possible	Minor	Excluded
N_2O	Possible	Minor	Excluded
Reduction in GHG emissions due to reduced water consumption in fossil fuel fired plants			
CO_2	Very likely	Minor	Excluded
CH_4	Very likely	Minor	Excluded
N_2O	Very likely	Minor	Excluded

7.2 Determine which GHG effects, source/sink categories, and greenhouse gases are included in the GHG assessment boundary

Figure 7.3 Assessing each GHG effect to determine which GHG effects to include in the GHG assessment boundary for the example policy

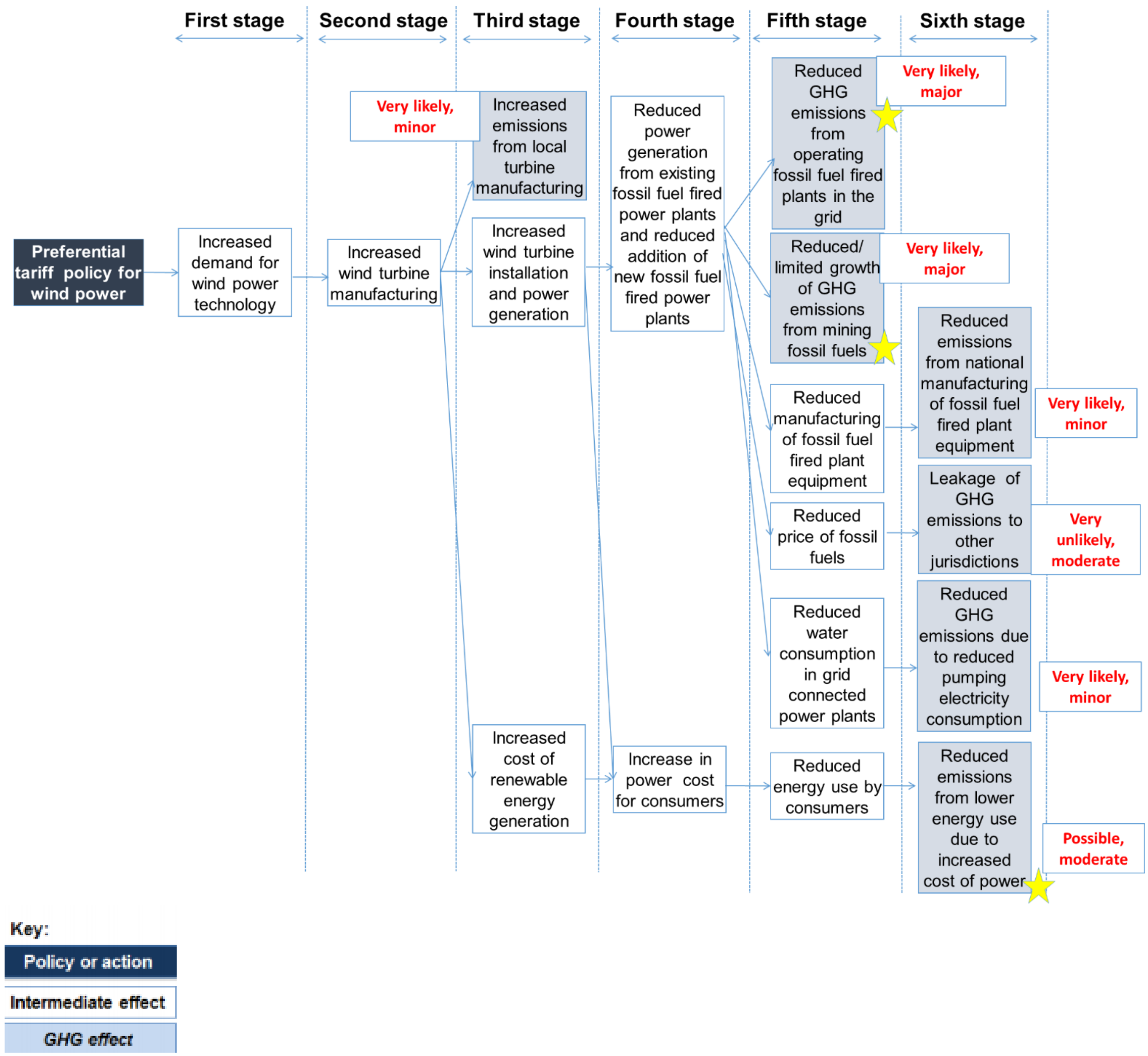


Table 7.4 List of GHG effects, sources/sink category, and greenhouse gases included in the GHG assessment boundary for a preferential tariff policy

GHG effect	GHG sources	GHG sinks	Greenhouse gases
1 Reduced GHG emissions from operating fossil fuel fired plants in the grid	Fossil fuel combustion in Grid-connected power plants	N/A	CO_2
2 Reduced GHG emissions from local mining of fossil fuels	Mining processes	N/A	CO_2
3 Reduced emissions from lower energy use due to increased cost of power	Fossil fuel combustion in Grid-connected power plants	N/A	CO_2

Chapter 8: Estimating baseline emissions

In this chapter, users are expected to estimate baseline emissions over the GHG assessment period from all sources and sinks included in the GHG assessment boundary. Users need to define emissions estimation method(s), parameter(s), driver(s), and assumption(s) needed to estimate baseline emissions for each set of sources and sinks.

8.3 Choose type of baseline comparison

Of the two methods described in this chapter, the scenario approach is expected to be common for the energy supply sector since it can be difficult to identify a suitable control group considering most jurisdictions are distinct from the others in terms of energy potential, consumption patterns, and distribution infrastructure.

However, depending on the type of policy or action, the comparison group approach can be adopted in situations where an appropriate control group is available. For example, in the case of a renewable energy based lighting scheme, the effects in the jurisdiction where the policy has been implemented can be compared with those in a similar jurisdiction that did not implement the scheme (i.e., the control group).

8.4 Estimating baseline emissions using the scenario method

For estimating baseline emissions, the first step is to define an emissions estimation method (e.g., equation, algorithm, or model). This is followed by identifying the parameters (i.e., activity data and emission factors) needed to estimate emissions, and finally, determining the baseline values of these parameters.

8.4.1 Define the most likely baseline scenario

Data needs for baseline assessment vary with the type of policy/action being implemented, however some of the common data needs in the energy sector are:

- **Activity data**: This can include data such as estimated electricity generation from RE technology; estimated electricity generation from non-RE technologies; estimated fuel consumption in manufacturing of RE equipment; estimated fuel consumption in manufacturing of non-RE equipment; estimated displacement of fossil fuel mining, extraction, supply, transport, operation or waste disposal; and, estimated energy demand.
- **Emission factor**: These may be fuel emission factors, grid emission factor, or power plant/unit-specific emission factors.

Users may either use baseline values from published data sources or develop new baseline values. In the latter case, users should identify other policies and non-policy drivers that affect emissions in the absence of the policy or action. Examples of other policies and non-policy drivers are provided in Table 8.3 and Table 8.4.

Table 8.2 Examples of other policies or actions that may be included in a baseline scenario

Other policies	Sources of data for developing assumptions
Production tax credits or renewable incentives	Government policies/regulations/action plans, forecasting models, expert interviews, interviews with power producers
REC markets	Market assessment studies for demand and supply projections
Utility regulations and interconnect fees	Government policies/regulations/action plans, expert interviews
Regulations on electricity rate structures	Government policies/regulations/action plans, expert interviews

Table 8.4 Examples of non-policy drivers that may be included in a baseline scenario

Non-policy drivers	Sources of data for developing assumptions
Load forecast	Energy forecasting models, government action plans, reports published by international institutions (e.g., IEA, IPCC, World Bank, UN FAO)
Fuel prices by fuel type	Energy forecasting models, government action plans, reports published by international institutions (e.g., IEA, IPCC, World Bank, UN FAO)
Renewable technology prices	Energy forecasting models, government action plans, reports published by international institutions (e.g., IEA, IPCC, World Bank, UN FAO)
Transmission and distribution accessibility	Government action plans
Grid storage capacity	Government action plans related to the energy sector
Biomass supply	Forecasting models
Population	National statistics and forecasting reports, energy forecasting models, reports published by international institutions (e.g., IEA, IPCC, World Bank, UN FAO)
GDP	National economic statistics and forecasting reports, energy forecasting models, reports published by international institutions (e.g., IEA, IPCC, World Bank, UN FAO), expert interviews

8.4.2 Select a desired level of accuracy

There are different methodological choices related to the level of accuracy of an assessment. Users can employ simplified methods, such as IPCC Tier 1 methods, or more complex methods, such as IPCC Tier 3. The level of accuracy is determined by the methods used to derive parameter values and data sources used. For example, the lower tier methods utilize internationally applicable default values while jurisdiction/source-specific data is used in higher tier methods to reflect changes in grid composition and operation.

The discussion below presents examples of different levels of accuracy for determining parameter values for the preferential tariff policy.

Low accuracy
Simplified methods could be used to approximate activities in a complex grid system, or default values for emission factor could be applied. Default values can be obtained from reliable sources such as IGES database of grid emission factors, US EPA, and EBRD. Grid emission factors related to offset projects are provided by the CDM, but these are typically much smaller in scale compared to the gross capacity of projects that could potentially fall under a preferential tariff policy. Hence, although grid emission factors

may have been derived by applying rigorous and complex methods, they are considered low accuracy methods unless their accuracy with respect to the policy being assessed has been demonstrated.

Intermediate accuracy
Default values can be used or more detailed methods could be selected based on credible sources, taking into consideration context-specific factors. For example, determining the share of each type of emission factor (*w* in equation 1 in section 8.4.3) could be carried out more accurately. The main determinant of the relative effect of new wind capacity on BM or OM emissions is the extent to which it meets demand for new capacity, and therefore displaces new capacity at the BM. Thus, it needs to be determined whether demand for new capacity exists on the grid where the wind installations are to be located. If the grid has more than enough capacity to meet foreseeable power demands, then generation from the wind installations will not displace new capacity, but will only affect the OM.

High accuracy
Computer models that examine the effect of new installations on grid operation and future capacity additions could be employed. More complex methods could be used to calculate the individual parameter values. Many sector-specific emissions estimation algorithms, equations, models, tools, and methodologies are available for estimating baseline emissions for the sector. Source documentation should be reviewed for transparency, completeness, and applicability to the standard. Users should refer to the corresponding websites to review source documentation and additional information.

8.4.3 Define the emissions estimation method(s) and parameters needed to calculate baseline emissions

For the preferential tariff example, two effects that were included during boundary setting are explained further for demonstration:

1. Reduced GHG emissions from operating fossil fuel fired plants in the grid
2. Reduced GHG emissions due to increased cost of power for consumer

Both impact the same emission sources (grid connected power plants).

Electricity generation from new wind power plants would normally first displace the implementation and operation of new fossil fuel based power plants planned in the future. Depending on the amount of electricity provided and the expected growth in electricity demand over the assessment period, it could also partly displace fossil fuel based electricity generation from a group of existing power plants. These effects are distinguished and separately demarcated in the fourth stage of the causal chain. For the calculations, however, they can be combined to determine an overall baseline grid emission factor.

If Effect 2 is ignored, it can be assumed that electricity demand is driven by factors such as population and GDP growth. This means that the net electricity generated (ex-post assessment) or expected to be generated (ex-ante assessment) by the wind power plants is equivalent to the net electricity displaced in the baseline scenario. One option to determine baseline emissions is to multiply the expected net electricity generated by the wind power plants (EG_y) with the baseline grid emission factor ($EF_{baseline}$), i.e. the expected emission factor without the additional wind capacity expected from the policy.

Assuming that preferential tariffs are available for wind power generation because it is less profitable than conventional power generation, the price of power can be expected to increase due to the introduction of the policy. Thus, consumers can be expected to reduce energy consumption in the policy scenario compared to the baseline scenario.

In order to simplify the methodology and depending on the availability of data and the magnitude of the price elasticity, a conservative step would be to ignore the impact of increasing power cost attributable to the policy.

The following example calculations will thus concentrate on Effect 1. The basic equation for the calculation is:

Equation 1 Estimating baseline emissions for grid electricity generation

$$Baseline\ emissions_y = EG_y \times [wBM + (1-w)OM]_y$$

Where:
EG = Electricity generated
BM = Build margin
OM = Operating margin
w = Share of electricity generation
y = year

The baseline emission factor can be seen as a combination of the operating margin (OM) and build margin (BM) as shown in the emissions estimation method below. Operating margin (OM) is the emission factor that refers to the group of existing power plants (tCO_2e/MWh). Build margin (BM) is the emission factor that refers to the group of prospective power plants in the absence of the policy, i.e., in the absence of additional new wind power installations (tCO_2e/MWh). Examples of published data sources for obtaining baseline values of these parameters are provided in Table A.

Table A[1] Examples of determining baseline values from published data sources

Parameter	Sources of published data for baseline values
Emission factor of the grid (if sourced directly)	IGES grid emission factor database
Operating margin	Can be derived from country electricity statistics
Build margin	National energy strategy/planning documents, national energy modeling, utility investment plans/permitting documents
Share of electricity production (w)	Defaults provided in CDM Tool to calculate the emission factor for an electricity system
Electricity generated	National energy strategy/planning documents, national energy modeling, utility forecasts, studies from energy institutes/experts

[1] Table numbering differs, as there is no corresponding table included in the standard. The table is adapted from table 8.7 in the standard.

8.4.4 Estimate baseline values for each parameter

The following table provides an overview of the example parameter values used for the baseline calculation.

Table 8.7 Example of reporting parameter values and assumptions used to estimate baseline emissions for the policy

	Baseline value(s) applied over the GHG assessment period	Methodology and assumptions to estimate value(s)	Data sources
Operating margin	1.0 t CO_2e/MWh	Derived using generation-weighted grid emission rate method	Calculated using national electricity statistics
Build Margin	0.9 t CO_2e/MWh	Derived using blended emission factor of recently added group of power plants in the grid method	Calculated using national electricity statistics
Share of electricity production (w)	0.25	Default value	CDM Tool
Electricity generated	200,000 MWh	Estimated using projection studies	Research studies

8.4.5 Estimate baseline emissions for each source/sink category

The final step is to estimate baseline emissions by using the emissions estimation method identified in Section 8.4.3 and the baseline values for each parameter identified in Section 8.4.4.

Baseline emissions = 200,000 x (0.25 x 0.9 + (1-0.25) x 1.0) = 195,000 t CO_2e

8.6 Aggregate baseline emissions across all source/sink categories

Table 8.9 provides an illustrative example of the results of the analysis for all effects included in the assessment boundary. It assumes that the calculation steps outlined in section 8.4, which were illustrated with Effect 1, were carried out for each of the effects.

Table 8.9 Example of aggregating baseline emissions for the policy

GHG effect included in the GHG assessment boundary	Affected sources	Baseline emissions
1 Reduced GHG emissions from operating fossil fuel fired plants in the grid	Fossil fuel combustion in grid-connected power plants	195,000 t CO_2e
2 Reduced GHG emissions from local mining of fossil fuels	Mining processes	50,000 t CO_2e

3 Reduced emissions from lower energy use due to increased cost of power	Fossil fuel combustion in Grid-connected power plants	10,000 t CO_2e
Total baseline emissions		**255,000 t CO_2e**

Box B. Levels of accuracy for determining individual parameters

Intermediate accuracy

Operating Margin can be calculated using a variety of methods, including simple average grid emission rate, generation weighted grid emission rate, average annual emissions of load following plants, load duration curves to determine marginal plants etc. One example is described below, assuming that low-cost/must-run resources constitute less than 50 per cent of total grid generation:

Method**:** Generation-weighted average CO_2 emissions per unit of net electricity generation (tCO_2e/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units Within this method, OM can be calculated following two options, one of which is described below.

Sub-method: based on the net electricity generation and a CO_2 emission factor of each power unit in the grid

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:
$EF_{grid,OMsimple,y}$ = Simple operating margin CO_2 emission factor in year y (tCO_2e/MWh)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$ = CO_2 emission factor of power unit m in year y (t CO_2/MWh)
m = All power units serving the grid in year y except low-cost/must-run power units
y = The relevant year as per the data vintage chosen

Within this method, $EG_{m,y}$ and $EF_{EL,m,y}$ can further be calculated using various methods.

Build Margin could be calculated using a variety of methods including blended emission factor of recently added group of power plants in the grid, emissions from an identified type of power plant which has lowest barriers or greatest net benefits, the lowest emitting of fossil fuel based plants in the grid capable of providing similar service to the grid, among others. One example is described below.

Method: Generation-weighted average emission factor (tCO_2e/MWh) of all power units, *m*, (sub-set of power plants in the grid which are recent additions chosen as per set criteria) during the most recent year y for which electricity generation data is available, calculated as follows:

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

Where:
$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (t CO_2/MWh)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$ = CO_2 emission factor of power unit m in year y (t CO_2/MWh)
m = Power units included in the build margin
y = Most recent historical year for which electricity generation data is available

High accuracy

For determining the value of *w* where wind installations are able to meet demand for new capacity, it is to be noted that the wind installations will affect BM capacity additions in proportion to their capacity value. The appropriate value of *w* can be taken either as 1, or the ratio of the project's capacity value to its average utilization in megawatts, whichever is less:

$$w = min\left(1 - \frac{CAP_{value}}{CAP_{rated} \times CF}\right)$$

Where:

w is the weight assigned to the BM

CAP_{value} is the project activity's capacity value (MW)

CAP_{rated} is the rated capacity for the project activity i.e., the power it is physically capable of delivering (MW)

CF is the expected capacity factor (i.e., percentage average utilization) for the project activity (or its average level of demand reduction as a percent of CAP_{rated})

Chapter 9: Estimating GHG effects ex-ante

In this chapter, users are expected to estimate policy scenario emissions for the set of GHG sources and sinks included in the GHG assessment boundary based on the set of GHG effects included in the GHG assessment boundary. Policy scenario emissions are to be estimated for all sources and sinks using the same emissions estimation method(s), parameters, parameter values, GWP values, drivers, and assumptions used to estimate baseline emissions, except where conditions differ between the baseline scenario and the policy scenario, for example, changes in activity data and emission factors.

9.2 Identify parameters to be estimated

Table A in chapter 8 forms the basis for determining which parameters are affected by the policy. In case the determination of affected parameters is not straight forward, the methodology to determine significance outline in chapter 7 can be used.

For the preferential tariff example, it can be assumed that wind power generation replaces the equivalent quantum of electricity produced by the grid in the baseline scenario, as described above. Hence, emissions from the source, i.e., fossil fuel combustion in the grid, would be affected. While the emission factor could vary by a minor quantum, equivalent quantum of electricity to be generated from the grid would be eliminated.

Table 9.1 Example of identifying affected parameters to estimate policy scenario values for Effect 1 of example policy

Parameter	Likelihood	Relative magnitude
Operating margin	Likely	Minor
Build Margin	Likely	Minor
Electricity generated	Very likely	Major

9.4 Estimate policy scenario values for parameters

Once the affected parameters are determined the parameter values for the policy scenario can be determined. All other parameters remain as in the baseline scenario. Table 9.2 provides an example.

Table 9.2 Example of reporting parameter values and assumptions used to estimate ex-ante policy scenario emissions for the example policy

Parameter	Baseline value(s) applied over the GHG assessment period	Policy scenario value(s) applied over the GHG assessment period	Methodology and assumptions to estimate value(s)	Data source(s)
Operating margin	1.0 t CO_2e/MWh	1.0 t CO_2e/MWh	Derived using Generation-weighted grid emission rate method	Calculated using national electricity statistics
Build Margin	0.9 t CO_2e/MWh	0.9 t CO_2e/MWh	Derived using blended emission factor of recently added group of power plants in the grid method	Calculated using national electricity

				statistics
Share of electricity production (w)	0.25	0.25	Default value	CDM Tool
Electricity generated	200,000 MWh	0	Estimated using projection studies	-

9.5 Estimate policy scenario emissions

Once parameter values have been determined, the same equations as used for the calculation of baseline values can be used to derive the policy scenario values:

Policy scenario emissions = 0 x (0.25 x 0.9 + (1-0.25) x 1.0) = 0 tCO_2e

9.6 Estimate the GHG effect of the policy or action (ex-ante)

After determining the GHG emissions for the policy scenario for each source category, the change resulting from the policy can be determined. Table 9.3 provides an overview of the results.

Table 9.3 Example of estimating the GHG effect of the building code[2]

GHG effect included	Affected sources	Policy scenario emissions	Baseline emissions	Change
1 Reduced GHG emissions from operating fossil fuel fired plants in the grid	Fossil fuel combustion in Grid-connected power plants	0 t CO_2e	195,000 t CO_2e	-195,000 t CO_2e
2 Reduced GHG emissions from local mining of fossil fuels	Mining processes	0 t CO_2e	50,000 t CO_2e	-50,000 t CO_2e
3 Reduced emissions from lower energy use due to increased cost of power	Fossil fuel combustion in Grid-connected power plants	0 t CO_2e	10,000 t CO_2e	-10,000 t CO_2e
Total emissions / Total change in emissions		**0 t CO_2e**	**255,000 t CO_2e**	**-255,000 t CO_2e**

Box B.1 Addressing policy interactions

Assume that the policies implement in the baseline are:

- Subsidy on renewable power plant equipment parts
- Accelerated depreciation on renewable investment
- Excise duty exemption on renewable power plant equipment parts

As explained, there is an overlapping effect between the policy being assessed and the baseline policies. While carrying out the ex-ante assessment, it should be ensured that any wind installations that would have been built due to the existence of the baseline policies are considered in the baseline scenario.

[2] Numbers for effects 2 and 3 are illustrative.

An example policy interaction matrix is provided in Figure B.1.

Figure B.1 Example policy interaction matrix

	Parameter- EG			
	Preferential tariff	**Equipment subsidy**	**Accelerated Depreciation**	**Excise duty exemption**
Preferential tariff	**N/A**			
Equipment subsidy	**- -**	**N/A**		
Accelerated depreciation	**0**	**+++**	**N/A**	
Excise duty exemption	**-**	**+**	**+**	**N/A**

Key:

- Independent: 0
- Overlapping: - - - major/- - moderate/ - minor interaction
- Reinforcing: +++ major/++ moderate/+ minor interaction
- Uncertain: U

Chapter 10: Monitoring performance over time

In this chapter, users are required to define the key performance indicators that will be used to track the performance of the policy or action over time. Where relevant, users need to define indicators in terms of the relevant inputs, activities, intermediate effects and GHG effects associated with the policy or action.

10.1 Define key performance indicators

Some typical indicators for common policies in the sector are shown in the table below.

Table 10.1 Examples of indicators

	Feed-in tariff or preferential tariff	Renewable portfolio standard	Fossil fuel tax	Absolute RE installation target
Input indicators	• Money spent to implement the program	• Money spent to implement the program	• Money spent to implement the program	• Money spent to implement the program
Activity indicators	• Infrastructure investment generated • Amount of tariff payments • Number of RE (renewable energy) plants installed under the policy • Capacity of RE installed under the policy • Capacity utilization factor of RE installations	• Number of renewable energy certificates (RECs) traded • Number of power producers availing benefits	• Funds collected under scheme	• Number of installations of each type of RE • Capacity of installations of each type of RE
Intermediate effect indicators	• Energy generation from RE installations availing benefits	• Number and capacity of installations of each type of RE • Amount of generation from RE installations availing benefits	• Changes in total energy demand • Changes in energy intensity • Changes in per capita energy demand	• Amount of generation from RE installations
GHG effects	• GHG reduction per RE installation	• GHG reduction per RE installation	• GHG reduction per unit tax	• GHG reductions achieved
Non-GHG effects	• Cost savings achieved • Local employment generated	• Employment generated	• Depends on use of revenue	• Employment generated

10.4 Create a monitoring plan

An illustrative example of a monitoring plan for the preferential tariff policy is provided below, assuming a high accuracy ex-post GHG assessment.

Table 10.5 Example of information to be contained in the monitoring plan

Indicator or parameter (and unit)	Source of data	Monitoring frequency	Measured/modelled/ calculated/estimated (and uncertainty)	Responsible entity
Quantity of net electricity supplied to the grid (EG)	Meter readings of electronic energy meters at the grid delivery point taken jointly by grid utility and power producers representatives Cross-check: Records for net electricity sold to grid utility in invoices	Continuous measurement and at least monthly recording	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	Power producers and grid utilities
Grid emission factor ($EF_{baseline,grid}$)	National statistics on operations of grid connected power plants	Most recent three years data would be used to recalculate operating margin (OM) every year	Calculated as the combination of OM and build margin (BM) by applying suitable weights	Based on data collected by grid utilities and consolidated by electricity boards
Operating Margin (OM)	National statistics on operations of grid connected power plants	Most recent three years data would be used to recalculate OM every year	Calculated using methods specified in tools such as the CDM “Tool to calculate the emission factor for an electricity system” or the Greenhouse Gas Protocol “Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects”	Based on data collected by grid utilities and consolidated by electricity boards
Build Margin (BM)	National energy strategies/planning documents, national energy modeling, utility investment plans/ permitting documents	Most recent year data would be used to recalculate BM every year		Based on data collected by grid utilities and consolidated by electricity boards

Chapter 11: Estimating GHG effects ex-post

A number of ex-post assessment methods have been described in this chapter, which can be classified into bottom-up and top-down methods. For the energy supply sector, the applicability of top-down or bottom-up methods depends on the type of policy or action and the objectives of the assessment.

11.2 Select an ex-post assessment method

Examples of bottom-up energy models in the energy sector include:[3]

- Optimization models, e.g., MARKAL
- Iterative equilibrium/simulation models, e.g., ENPEP
- Hybrid models, e.g., MARKAL-MACRO
- Accounting frameworks, e.g., LEAP

Examples of top-down approaches for the energy sector include:

- Simplified macroeconomic assessment
- Input-output models
- Computable general equilibrium (CGE) models

Users should consult individual models to learn more about the relevance of these models to their assessment.

The applicability of individual ex-post quantification methods for the sector and illustrative sources of data are discussed in Table 11.1.

Table 11.1 Applicability of ex-post assessment methods

Bottom up methods	Applicability
Collection of data from affected participants/sources/other affected actors	• Continuous Emissions Monitoring Systems for CO_2 emissions from power plant operations • Electricity generation using energy meters • Fuel consumption measurements using online metering systems at feeding point (like load cells) • Electricity sale records for estimating net electricity export • Fuel purchase records for estimating fuel consumption
Engineering estimates	• Emissions from operation of power plant/unit using plant-specific emission factor • Estimation of fuel consumption from pre-determined value of Specific Fuel Consumption (SFC) of power plant / unit
Deemed estimate	• Emissions from mining activities (such as coal mining and post-mining) estimated as m^3 CH_4 or Gg per unit of fuel
Methods that can be bottom-up or top-down depending on the context	**Applicability**
Stock modeling	• Penetration of technology

[3] For more information, see http://unfccc.int/resource/cd_roms/na1/mitigation/Module_5/Module_5_1/a_Mitigation_assessment_tools_energy/Module5_1.ppt.

	• Estimation/projection of installed capacities
Diffusion indicators	• Percentage of renewable energy based off-grid installations
Top down methods	**Applicability**
Monitoring of indicators	• Monitoring of electricity demand/load • Demand for fossil fuels of each type
Economic modeling	• Estimation of electricity demand and electricity prices

11.3 Select a desired level of accuracy

Examples of how to implement ex-post quantification methods using low to high accuracy level approaches for the policy example are described below:

Low accuracy

- Collecting aggregate data on energy generation from annual update reports of government agencies.
- Using auxiliary electricity consumption emission factors based on the most common source of auxiliary generation in wind installations in the country
- Assuming auxiliary electricity consumption based on default values (for example, 1% of gross generation).

Intermediate accuracy

- Using clustered data on energy generation from electricity purchasers/ distribution companies.
- Using auxiliary electricity consumption emission factors based on the most common source of auxiliary generation in wind installations within the clusters/ within the regions where the clusters are located.
- Assuming auxiliary electricity consumption based on manufacturers' estimates of the most common wind turbines installed in the cluster.

High accuracy

- Using disaggregated metered data on electricity exported and imported to grid from wind installations to determine energy generation.
- Using disaggregated fuel consumption data for auxiliary generation from wind installations (fuel consumption can directly be multiplied with calorific value (NCV_{FF}) and emission factor of the fuel (EF_{FF}) to arrive at GHG emissions from auxiliary consumption)