The Greenhouse Gas Protocol

Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects

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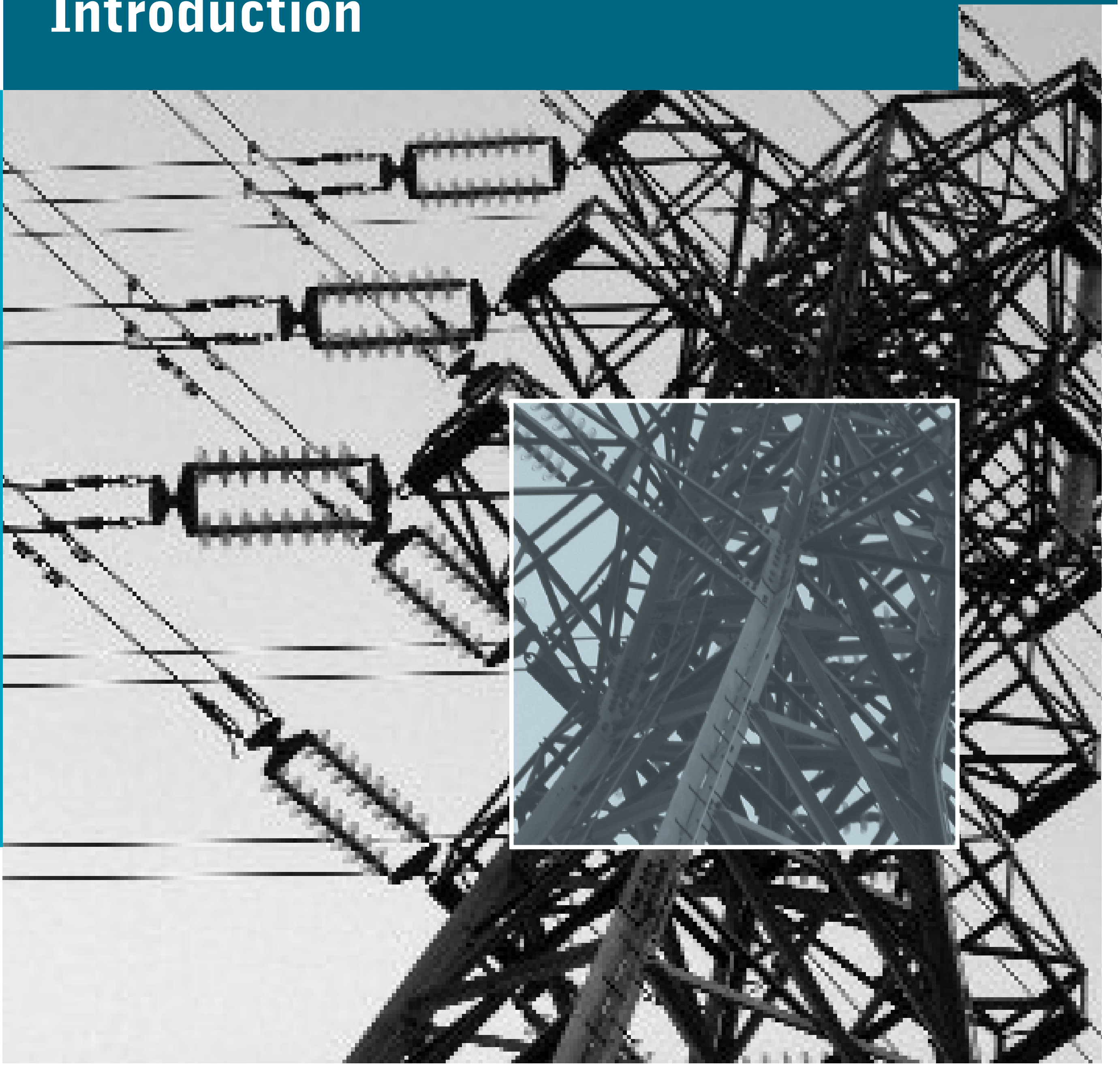
PART I:
BACKGROUND AND KEY CONCEPTS

These guidelines were developed to supplement the *Greenhouse Gas Protocol for Project Accounting,* published in December 2005 by the World Resources Institute and the World Business Council for Sustainable Development. The chapters in Part I contain background information related to the GHG accounting and quantification procedures described in Part II. Chapter 1 provides an introduction and overview of how these guidelines can be used. Chapter 2 contains information on key concepts necessary to understand and perform the GHG accounting procedures. Chapter 3 provides guidance on special considerations related to project activities that reduce consumption of grid electricity (i.e., energy efficiency and similar project activities).

1 Introduction



These guidelines explain how to quantify reductions in greenhouse gas emissions (referred to as “GHG reductions”) resulting from projects that either generate or reduce the consumption of electricity transmitted over power grids. They are designed as a supplement to the *Greenhouse Gas Protocol for Project Accounting (“Project Protocol”),* and as such are focused on practical and simplified methods for estimating GHG reductions. They do not describe how to model the effects of a project on grid operations and development. Although modeling may be the most accurate method for estimating GHG reductions on systems as complex as electricity grids, these guidelines are intended for use in situations where extensive modeling would be too costly or insufficiently transparent.

1.1 About the Greenhouse Gas Protocol Initiative

The Greenhouse Gas Protocol Initiative is a multi-stakeholder partnership of businesses, non-governmental organizations, governments, academics, and others convened by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI). Launched in 1998, the Initiative's mission is to develop internationally accepted GHG accounting and reporting standards and protocols, and to promote their broad adoption. The GHG Protocol is comprised of two separate modules:

- The GHG Protocol Corporate Accounting and Reporting Standard *(Corporate Standard)*, revised edition, published in March 2004.
- The GHG Protocol for Project Accounting (*Project Protocol*), published in December 2005.

1.2 About the GHG Protocol for Project Accounting

The *Project Protocol* is the most comprehensive, policy-neutral accounting tool for quantifying the greenhouse gas benefits of climate change mitigation projects (referred to as "GHG projects"). It is the culmination of a unique four-year dialogue among business, environmental, and government experts led by WRI and WBCSD. The *Project Protocol* provides the cornerstone for efforts led by WRI and others to develop globally compatible standards for a robust and thriving greenhouse gas market.

The *Project Protocol*:

- Provides a credible and transparent approach to quantifying and reporting GHG emission reductions.
- Enhances the credibility of GHG project accounting by means of common accounting concepts, procedures, and principles.
- Provides a platform for harmonizing different project-based GHG initiatives and programs.

Although the *Project Protocol* contains extensive requirements, it is flexible with regard to how they are met. This flexibility arises largely because key elements of GHG project accounting relate to policy questions related to the design of project-based GHG programs and trading systems, including questions about environmental integrity, cost, and administrative burdens. Because the *Project Protocol* is intended to be policy neutral, decisions related to program and policy design are left to the discretion of its users.

1.3 About the Guidelines for Grid-Connected Electricity Projects

These guidelines are designed to facilitate the use of the *Project Protocol* for projects that affect grid electricity generation (referred in these guidelines as "grid-connected project activities"). The guidelines are applicable to two general types of project activities:

1. **Project activities that supply electricity to the grid.** These project activities generate electricity and deliver it into the power grid, in effect displacing electricity from other sources. An example would be a wind turbine that provides electricity to the grid.
2. **Project activities that reduce consumption of grid electricity.** These types of project activities reduce the need for grid-based electricity by either (1) improving the efficiency with which grid electricity is used for a partic-

ular application; or (2) generating electricity onsite so that supply from the grid is unnecessary. An example would be a project to install energy efficient lighting in a building that uses grid electricity.

Special considerations related to electricity reduction project activities are covered in Chapter 3. However, the general guidance for estimating baseline emissions and quantifying GHG reductions (Part II of these guidelines), is the same for both types of project activities.

1.4 Who Should Use These Guidelines?

These guidelines should be of interest to anyone seeking credible techniques to account for GHG reductions from projects that affect the production or consumption of grid electricity. There are two primary audiences envisioned for these guidelines:

1. **Project developers seeking to quantify GHG reductions outside the context of a particular GHG offset program or regulatory system.** For these users, the guidelines provide a rigorous, comprehensive, and credible set of procedures to account for GHG reductions resulting from an individual project activity. The guidelines are designed to be program- and policy-neutral and therefore afford considerable flexibility in the choice of procedures and calculation methods. Partly because of this, however, they also prescribe a substantial amount of detailed analysis, documentation, and reporting on the part of project developers. The guidelines are generally more detailed than what may be prescribed under a typical GHG offset program or trading system.
2. **Designers of initiatives, systems, and programs that incorporate grid-connected GHG projects.** These users will find a comprehensive set of guidelines for deriving marginal grid emission factors, to be used in determining the GHG emissions displaced or avoided by different types of project activities. Deriving standard emission rates is done by following the same basic procedures used to estimate the baseline emissions of individual projects.

1.5 How to Use These Guidelines

How these guidelines are used depends on whether they are used for: (1) quantifying GHG reductions for a specific project activity; or (2) developing a standard baseline emission rate that can be applied to multiple project activities.

QUANTIFYING GHG REDUCTIONS FOR A SPECIFIC PROJECT ACTIVITY

To quantify the GHG reductions for a specific project activity, users of these guidelines should follow all the basic requirements and procedures of the *Project Protocol*. This means:

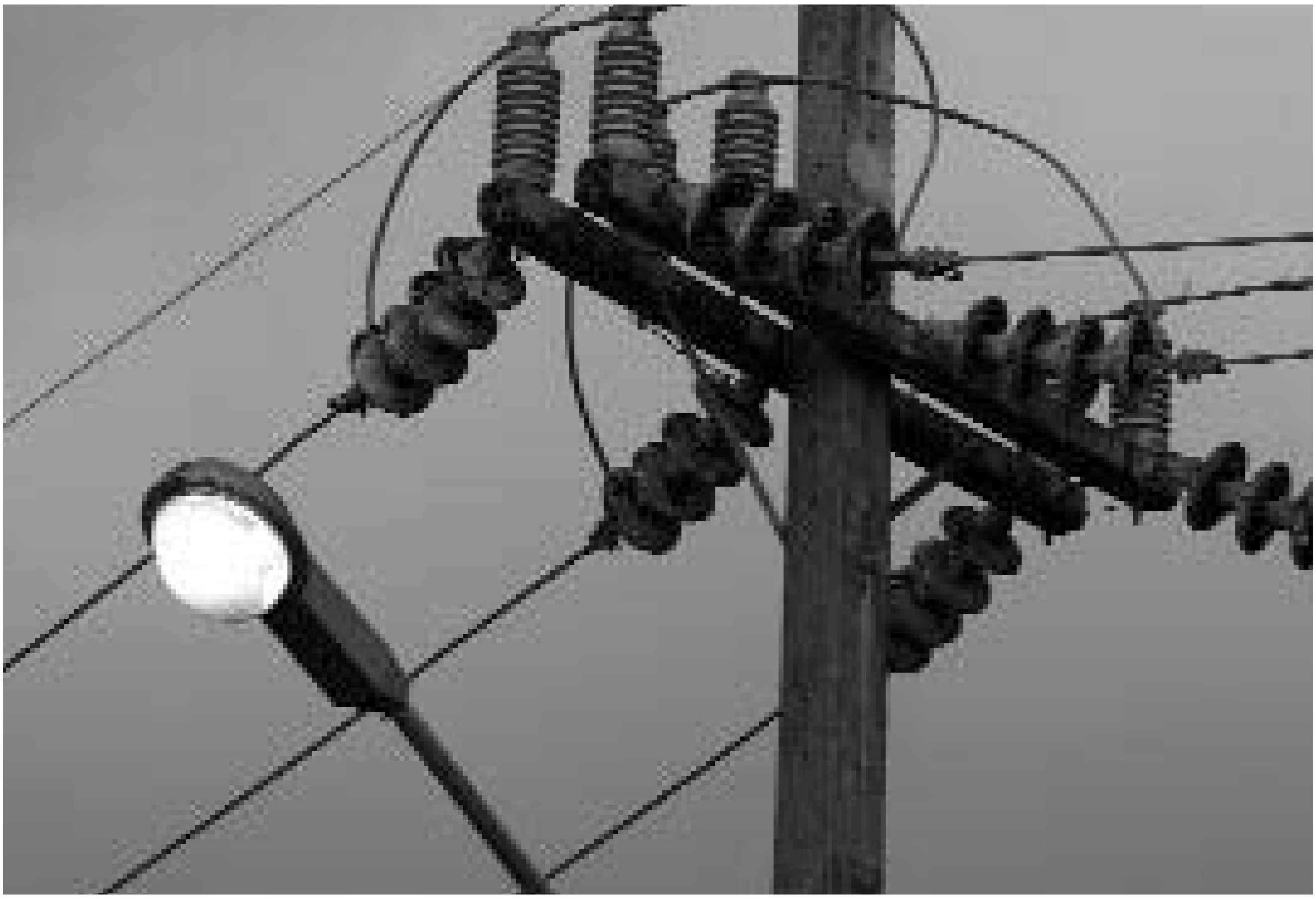
- *Fully accounting for both the intended and unintended changes in GHG emissions caused by a project activity.* In *Project Protocol* terminology, these are the project activity's "primary" and "secondary" effects (see Section 2.4 of the *Project Protocol*). Guidance related to secondary effects for grid-connected project activities is presented in Chapter 4 of these guidelines.
- *Estimating baseline emissions.* Quantifying GHG reductions involves comparing actual GHG emissions after a project activity is implemented to an estimate of what emissions would have been under its baseline scenario. The most critical part of GHG project accounting is deriving a reasonable and accurate estimate of baseline emissions.[1] Chapters 5 through 11 of these guidelines explain how to estimate baseline emissions for grid-connected project activities. Chapter 8 contains procedures for justifying the baseline scenario, which also serve to demonstrate an individual project activity's "additionality."[2]
- *Monitoring project performance.* Accurately quantifying GHG reductions requires monitoring both a project's performance and any parameters related to estimates of its baseline emissions. Chapter 12 of these guidelines provides guidance on monitoring grid-connected project activities and quantifying their GHG reductions.
- *Reporting GHG reductions.* Accurate and comprehensive reporting about a project is necessary to assure stakeholders that GHG reductions have been credibly quantified. Chapter 13 of the guidelines presents basic reporting requirements for grid-connected project activities.

DEVELOPING A STANDARD BASELINE EMISSION RATE

To develop a standard baseline emission rate for multiple project activities, users of these guidelines only need to consult guidance related to estimating baseline emissions. Because developing a standard baseline emission rate does not involve assessment of an individual project activity, it is not necessary to justify a baseline scenario (Chapter 8). Thus, only the procedures and guidance contained in Chapters 5-7 and 9-11 need to be followed.

Developing standard baseline emission rates is usually done in conjunction with programs or trading systems that incorporate project-based GHG reductions. The design of such programs is beyond the scope of these guidelines. However, the following issues should be considered in developing and using standard baseline emission rates.

First, any individual GHG projects that use a standard baseline emission rate to quantify their GHG reductions



should also follow procedures for quantifying secondary effects, monitoring project performance, and reporting project information. These procedures are necessary to fully and credibly account for GHG reductions from individual projects. GHG programs that employ standard baseline emission rates should therefore specify rules for secondary effect accounting, monitoring, and reporting.

Second, many grid-connected project activities involve zero-emission technologies (e.g., wind or solar power) that will by definition have lower emissions than a standard baseline emission rate. The practical implication is that any zero-emission project activity would automatically be credited with GHG reductions, even if it is not "additional."[3] Developers of standard baseline emission rates are therefore encouraged to adopt specific tests or criteria for establishing the additionality of individual projects. Such tests are beyond the scope of these guidelines, but a general discussion of additionality and additionality tests may be found in Chapter 3 of the *Project Protocol*.

Finally, because different types of project activities will have different impacts on the grid, it will rarely make sense to try to derive a general, "all-in-one" baseline emission rate for all types of projects. Rather, standard baseline emission rates should be specified for types of project activities that share the same operating characteristics, and therefore have approximately the same effects on grid emissions. For example, wind energy, biomass energy, and industrial energy efficiency projects should generally use different baseline emission rates, even on the same grid.

1.6 Guideline Overview

These guidelines contain four parts. Part I provides background information, descriptions of key concepts, and an overview of special considerations for project activities that reduce consumption of grid electricity. Part II offers full guidance on accounting for GHG reductions from individual grid-connected electricity projects. Part III presents examples of how these guidelines can be applied to estimate baseline emissions for three different grid-connected electricity projects. Part IV contains supplementary information.

PART I: BACKGROUND AND KEY CONCEPTS

- **Chapter 1: Introduction**
  This chapter introduces the GHG Protocol Initiative, the *Project Protocol*, and the guidelines for grid-connected electricity projects. It outlines the uses and limitations of the guidance and provides an overview of what the guidelines contain.

- **Chapter 2: Key Concepts**
  This chapter presents the basic concepts and assumptions necessary to estimate baseline emissions and account for the GHG reductions from grid-connected project activities. It also explains how general accounting concepts and terminology from the *Project Protocol* are applied to grid-connected project activities.

- **Chapter 3: Electricity Reduction Project Activities**
  This chapter covers special considerations for estimating GHG reductions from project activities that reduce consumption of grid electricity. For these project activities, quantifying GHG reductions first requires quantifying the amount by which they reduce (or "avoid") generation from grid-connected power plants. This chapter provides a brief overview of methods for estimating avoided generation and highlights GHG accounting questions unique to these types of projects. It is not, however, a comprehensive guide to baseline estimation for these projects (see Section 1.7, below).

PART II: ACCOUNTING GUIDELINES

- **Chapter 4: Defining the GHG Assessment Boundary**
  This chapter describes how to define the "GHG assessment boundary"[4] for grid-connected project activities, including how to identify common secondary effects.

- **Chapter 5: Determining Build Margin and Operating Margin Effects**
  This chapter contains special guidance related to estimating baseline emissions for grid-connected project activities. Specifically, it describes how to estimate the relative effects a project activity will have on the "build margin" (BM), or new power plant construction, and the "operating margin" (OM), or electricity from existing power plants.

- **Chapter 6: Selecting a Method to Estimate Build Margin Emissions**
  The chapter covers how to choose a method to estimate GHG emissions associated with the build margin.

- **Chapter 7: Identifying the Baseline Candidates**
  For grid-connected project activities, baseline candidates are alternative types of power plants used to represent the build margin.[5] This chapter describes how to identify baseline candidates, usually from recent capacity additions on the local power grid.

- **Chapter 8: Justifying the Baseline Scenario and Characterizing the Build Margin**
  This chapter explains how to establish a baseline scenario for grid-connected project activities using the project-specific procedure described in the *Project Protocol*. It also explains how to use this procedure to identify a single "baseline candidate" (power plant) to represent the build margin.

- **Chapter 9: Estimating the Build Margin Emission Factor**
  This chapter describes how to determine an emission factor for the build margin, derived either from a particular type of power plant identified in Chapter 8, or using the performance standard procedure from the *Project Protocol*.

- **Chapter 10: Estimating the Operating Margin Emission Factor**
  This chapter provides guidance on applying four different types of methods for estimating operating margin emissions (i.e., emissions from existing power plants whose operation is curtailed in response to the project activity). For some methods, detailed steps are described. For others, the methods are outlined and details of their application must be determined by their users.

- **Chapter 11: Estimating Baseline Emissions**
  This chapter describes how to calculate a baseline emission rate using the "Build Margin" and "Operating Margin" emission factors derived in Chapters 9 and 10. It also describes how to calculate overall baseline emissions using the baseline emission rate.

- **Chapter 12: Monitoring and Quantifying GHG Reductions**
  This chapter describes the essential elements of a monitoring plan for grid-connected project activities. It also provides guidance on quantifying GHG reductions from grid-connected project activities.

- **Chapter 13: Reporting GHG Reductions**
  This chapter lists unique items of information that should be reported when reporting the GHG reductions for grid-connected project activities.

PART III: WORKED EXAMPLES OF BASELINE EMISSION RATE CALCULATIONS

Part III presents examples of how these guidelines can be applied to estimate baseline emissions for three different grid-connected electricity projects: a biomass energy project, a wind project, and a small-scale energy efficiency project. Each project involves unique considerations and uses different methods for calculating build margin and operating margin emissions.

PART IV: SUPPLEMENTARY INFORMATION

Part IV contains supplementary annexes, a glossary, references, and acknowledgements.

1.7 Issues Not Addressed in These Guidelines

Like the *Project Protocol*, these guidelines do not address every issue related to the development of GHG projects, or the "crediting," recognition, and sale of their GHG reductions. Specifically, aspects of GHG projects related to sustainable development, stakeholder consultation, confidentiality, verification, and uncertainty are not addressed. For grid-connected project activities, the following important issues are also not addressed:

- **Estimating electricity savings for energy efficiency projects, and other projects that reduce consumption of grid electricity.** While these guidelines are intended to apply equally well to projects that generate electricity or reduce its consumption, they do not cover important aspects of baseline estimation for the latter. GHG reductions associated with electricity reduction projects depend on how much electricity they save, which requires a separate baseline analysis unrelated to GHG emissions. Chapter 3 of these guidelines presents a brief overview of methods for determining electricity savings, but refers readers to other sources for detailed guidance. Once electricity savings are determined, these guidelines can be used to quantify their associated GHG reductions. Unique GHG quantification issues for electricity reduction project activities are noted in Section 3.4, and in relevant areas throughout the guidelines.

- **Ownership of GHG reductions.** Project developers seeking to turn GHG reductions into a saleable commodity (e.g., an emission reduction credit) should establish clear legal or contractual claims to the GHG reductions. This is a particular concern for grid-connected project activities, since in many cases GHG reductions will occur at power plants not owned by the project developers. Whether this is a significant issue depends largely on whether the power plant owners have an interest in claiming or reporting the GHG reductions themselves. Generally, instances where potential double-counting or double-claiming of GHG reductions occur must be resolved through legal or policy measures. The specific means for doing so are beyond the scope of these guidelines.

- **Modeling of displaced grid emissions.** These guidelines are designed to help quantify GHG reductions from grid-connected project activities following the general procedures of the *Project Protocol*. It assumes that project developers generally do not have access to sophisticated models of electricity grid operation and development. The procedures presented in the guidance for estimating "Build Margin" and "Operating Margin" GHG emissions are essentially simplified methods for approximating activities on highly complex systems. Computer models exist that can examine in an integrated fashion the effect of a new project on current grid operations and future capacity additions. In theory, these models are a very suitable means for quantifying the GHG reductions expected from implementing a grid-connected project activity. The use of such models is not discouraged, but how to use them is beyond the scope of these guidelines. If they are used to quantify project-based GHG reductions for the purpose of emissions trading, they should generally be combined with project-based additionality tests, which are also not addressed here.

- **Additionality.** Under the *Project Protocol*, additionality is addressed through the application of baseline procedures.[6] A project activity is presumed to be "additional" if it can be shown that either: (1) the project activity and its baseline scenario involve different technologies or practices (project-specific baseline procedure); or (2) the project activity's emissions are lower than the baseline emission rate (performance standard baseline procedure). No additionality tests are prescribed. Where these guidelines are used to quantify GHG reductions from an individual project activity, additionality is established by using the project-specific procedure. Developing a standard baseline emission rate for multiple project activities, however, is analogous to following the performance standard procedure. As noted above, many grid-connected project activities involve zero-emission technologies that will by definition have lower emissions than a standard baseline emission rate. While it may be tenable in some policy contexts to treat these technologies as automatically additional, users of these guidelines are strongly encouraged to develop credible screening tests for additionality in conjunction with developing standard baseline emission rates. Appropriate tests will be context-specific and policy-driven, and are not defined in these guidelines. See Chapter 3, Section 3.1 of the *Project Protocol* for further discussion.

NOTES

[1] See Sections 2.8 and 2.9 of the *Project Protocol* for explanations of the terms "baseline scenario" and "baseline emissions."

[2] For a full explanation of additionality and how it is addressed under the *Project Protocol*, see Section 2.14 of the *Project Protocol*.

[3] For further discussion of additionality and "performance standard" baseline emission rates, see Section 2.14 and Chapter 9, Box 9.2 of the *Project Protocol*.

[4] See the *Project Protocol*, Section 2.5.

[5] See Section 2.7 of the *Project Protocol* for a general definition of baseline candidates.

[6] See the *Project Protocol*, Section 2.14.

2 Key Concepts

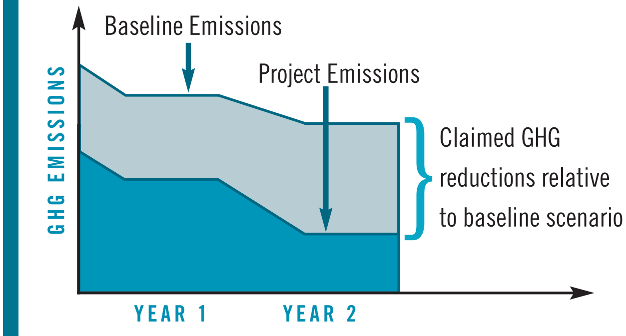
These guidelines explain how to account for GHG reductions that result from projects that displace or avoid power generation on electricity grids. The complex nature of power grid operations can make this task challenging, and to make it manageable these guidelines employ a number of simplifying assumptions and concepts. This chapter presents the basic concepts and assumptions that – together with the procedures of the *Project Protocol* – are used to account for the GHG reductions that result from grid-connected project activities.

Additional background related to the functioning of grids and power plants is provided in Part IV (Annexes A and B).

2.1 Quantifying GHG Reductions from Projects

Quantifying a project's GHG emission reductions is done by subtracting actual GHG emissions associated with the project's implementation from an estimate of GHG emissions under its "baseline scenario" (referred to as "baseline emissions"). See Figure 2.1.

FIGURE 2.1 Quantifying GHG Reductions from Projects



The *Project Protocol* refers to changes between baseline and actual emissions as "GHG effects." Fully accounting for GHG reductions requires assessing both the intended change caused by a project activity (i.e., its "primary effect") and any unintended changes (i.e., "secondary effects").[1] The primary effect for all grid-connected project activities is the reduction of combustion emissions from grid-connected power plants.[2] Most of the guidance in Part II of these guidelines pertains to estimating the baseline emissions for this primary effect. Chapter 4 covers the identification and quantification of common secondary effects.

2.2 Grid-Connected Project Activities

In the context of these guidelines, a grid-connected project activity is any kind of activity that displaces or avoids the generation of electricity distributed over power grids. Broadly, there are two types of grid-connected project activities:

1. **Project activities that supply electricity to the grid.** These project activities generate electricity and deliver it into the power grid, in effect displacing electricity from other sources. GHG reductions occur where the emission rate of the project activity is lower than that of displaced sources. Throughout these guidelines, these kinds of project activities are referred to as *electricity generation project activities.*
2. **Project activities that reduce consumption of grid electricity.** These types of project activities reduce the need for grid-based electricity by either (1) improving the efficiency with which grid electricity is used for a particular application; or (2) generating electricity onsite so that supply from the grid is unnecessary. GHG reductions occur to the extent that combustion emissions on the grid are avoided (and, where onsite generation is involved, project activity GHG emissions are lower than emissions from grid sources). Throughout these guidelines, these kinds of project activities are referred to as *electricity reduction project activities.* Special considerations for electricity reduction project activities are presented in Chapter 3.[3]

These guidelines focus exclusively on GHG accounting for grid-connected project activities, and are not relevant for projects whose primary effect does not involve a change in grid-wide GHG emissions. Some electricity sector GHG projects may involve a combination of grid-connected and "off-grid" project activities. A combined heat-and-power project, for example, will consist of two project activities: (1) generation of heat energy that displaces combustion emissions from thermal generation; and (2) generation of electricity that displaces combustion emissions from grid-connected power plants. The GHG reductions from the first (off-grid) project activity should be accounted for using the general procedures of the *Project Protocol.* GHG reductions from the second project activity should be accounted for using these guidelines. Table 2.1 provides some examples of electricity sector GHG projects, their associated project activities and primary effects, and whether these guidelines address them.

2.3 Baseline Emissions for Grid-Connected Project Activities

The baseline emissions for a grid-connected project activity are estimated by determining the GHG emissions of the sources of electricity that the project activity displaces or avoids. A key assumption of these guidelines is that a project activity can displace or avoid the operation of existing grid-connected power plants and/or the construction and operation of new power plants. Further, it is assumed that these effects can be distinguished and separately assessed. Generation displaced from existing power plants is referred to as the "operating margin" (OM). Generation from potential new capacity, whose construction is avoided due to the project activity, is referred to as the "build margin" (BM). Both these concepts are further described below (Sections 2.4 and 2.5). Projects that provide firm power will usually affect only the BM. However, many types of projects will affect both the OM and BM, and some may affect the OM exclusively.

TABLE 2.1 Examples of Electricity Sector GHG Projects and Grid-Connected Project Activities

GHG PROJECT	PROJECT ACTIVITY	PRIMARY EFFECT	GRID-CONNECTED?	ADDRESSED BY THESE GUIDELINES?
Install and operate grid-connected wind turbine facility	Generate zero-emission electricity from wind energy	Reduce combustion GHG emissions from grid-connected power plants	Yes	Yes
Install and operate grid-connected natural gas combined-cycle power plant	Generate low-emission electricity from high-efficiency natural gas plant	Reduce combustion GHG emissions from (higher emitting) grid-connected power plants	Yes	Yes
Install and operate combined heat-and-power generation equipment at an electric grid-connected building	1. Generate electricity for onsite consumption, avoiding the need for grid electricity	Reduce combustion GHG emissions from grid-connected power plants	Yes	Yes. See Chapter 3.
	2. Generate heat for onsite consumption, avoiding the need for a separate boiler	Reduce combustion GHG emissions from generating (onsite) energy	No	No. Account for GHG reductions using *Project Protocol* general procedures.
Retrofit an existing grid-connected coal-fired power plant to improve its generation efficiency and capacity	1. Generate current levels of electricity output more fuel-efficiently	Reduce combustion GHG emissions from "off-grid" electricity generation*	No*	No. Account for GHG reductions using *Project Protocol* general procedures.
	2. Generate more grid electricity, due to greater capacity and utilization	Reduce combustion GHG emissions from grid-connected power plants	Yes	Yes
Install compact fluorescent light bulbs in an existing building	Reduce consumption of grid electricity	Reduce combustion GHG emissions from grid-connected power plants	Yes	Yes. See Chapter 3.
Retrofit an off-grid diesel generator to improve its generation efficiency	Generate electricity more efficiently	Reduce combustion GHG emissions from off-grid electricity generation	No	No. Account for GHG reductions using *Project Protocol* general procedures.

* Although the electricity from this project activity is still delivered to the grid, the GHG reductions the project activity causes occur at the coal-fired power plant itself (because of its enhanced fuel efficiency) and not at other grid-connected power plants. The project activity is therefore not considered a "grid-connected" project activity for the purposes of these guidelines.

In general terms, baseline emissions are estimated by (1) determining the extent to which the project activity affects the BM and OM (covered in Chapter 5); (2) determining appropriate emission factors for the BM and OM (covered in Chapters 6 through 10); and (3) calculating an overall baseline emission rate (covered in Chapter 11). The general formula for the baseline emission rate of grid-connected project activities is:

$$ER_{baseline} = wBM + (1\text{-}w)OM \qquad (1)$$

Where:

- $ER_{baseline}$ is the baseline emission rate with respect to generation (e.g., tons CO_2-equivalent / MWh);
- BM is the build margin emission factor (t CO_2-e / MWh);[4]
- OM is the operating margin emission factor (t CO_2-e / MWh);
- w is the weight (between 0 and 1) assigned to the build margin.

In this formula, w indicates where the generation produced (or reduced) by the project activity would have come from in the baseline scenario, i.e., if the project activity had not been implemented. A weight of 1 means that all generation produced or saved by the project activity would have come from an alternative type of new capacity built in place of the project activity (the BM). A weight between 0 and 1 means that some of the generation would have come from new capacity (BM) and the remainder from existing capacity (the OM). A weight of 0 means that all of the generation would have been provided by existing power plants, and no new capacity would have been built in place of the project activity. Section 2.6, below, describes some basic concepts behind how to assign a value to w. Full guidance for assigning this weight is provided in Chapter 5.

As described in Section 2.1, GHG reductions are determined by subtracting total project activity emissions from total baseline emissions. Total baseline emissions for a given time period are estimated by multiplying the baseline emission rate ($ER_{baseline}$) times the total electricity generated or avoided by the project activity over that time period (see Chapter 11).

2.4 The Build Margin (BM)

Many grid-connected project activities are able to help satisfy a grid's need for new power plant capacity.[5] In these cases, another potential power plant either does not need to be built or can be reduced in size. In other words, the project activity will constitute an alternative choice for meeting the grid's demand for new capacity. The incremental new capacity displaced by a project activity, and its associated generation, are referred to as the *build margin*. Build margin emissions are estimated from the GHG emission rates of recent capacity additions, or in some cases, planned and under-construction capacity (see Chapter 7).

2.5 The Operating Margin (OM)

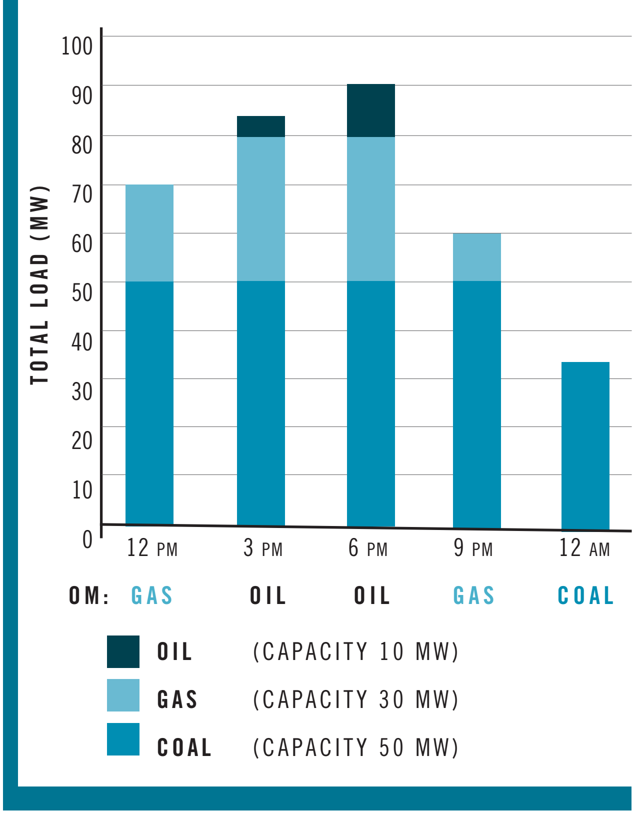
The *operating margin* refers to electricity generation from existing power plants whose output is reduced in response to a project activity. OM emissions are estimated using methods that attempt to approximate the emissions from the specific power plants whose operation is displaced. In theory, this estimation requires identifying which power plants are providing electricity at the margin (i.e., the last to be switched on-line or first to be switched off-line) during times when the project activity is operating. OM emissions can vary considerably over time depending on load levels, the types of power plants on the grid, and the order in which they are dispatched to meet load. Figure 2.2 presents a simplified example involving a grid with three different power plants: a 50 MW coal plant (dispatched first); a 30 MW natural gas plant (dispatched second); and a 10 MW oil-fired plant (dispatched only to meet peak loads). The last resource to be dispatched in each hour is at the OM, as indicated at the bottom of the figure. Generation provided or avoided by the project activity may therefore affect a different marginal resource in each hour.

In theory, estimating OM emissions can be a complex and data intensive task, matching a project activity's output to the marginal generating sources in each hour. In practice, a diversity of estimation methods can be used that vary in their complexity and accuracy. The major types of OM emission estimation methods, along with guidance for choosing an appropriate method, are presented in Chapter 10 of these guidelines.

2.6 Determining Relative Build Margin and Operating Margin Effects

As described in Section 2.3, grid-connected project activities can affect the build margin, the operating margin, or both. A critical step in estimating baseline emissions involves assigning appropriate weights to both of these possible

FIGURE 2.2 Simplified Example of Changes in the Operating Margin Over a Typical Day



effects. Per Equation 1 in Section 2.3, this means assigning a value to w for the BM, and (1-w) for the OM. This step is performed in Chapter 5 of these guidelines, as a prelude to applying the *Project Protocol's* baseline procedures.

The main determinant of a project activity's relative effect on BM or OM emissions is the extent to which it meets demand for new capacity, and therefore displaces new capacity at the BM. Generally, projects that provide firm power will only affect the BM. There are three questions to consider, however, in determining an appropriate value for w:

1. *Does demand for new capacity exist?* A first order question is whether there is in fact demand for new capacity on the grid where the project activity is located. If the grid has more than enough capacity to meet foreseeable power demands, then the project activity may not actually displace any new capacity because no new builds are otherwise occurring. In these cases, the appropriate value for w is zero. This will be a rare circumstance for project activities that generate electricity, however, since most are strongly influenced by the same economic conditions that drive the timing of other new generation resources.

2. *Is the project activity considered as a source of new capacity?* Some project activities may be implemented for reasons having nothing to do with the grid's need for new capacity. These can include electricity-reduction project activities (see Chapter 3) whose primary purpose is to avoid the need for grid-based power at a particular site. If grid operators give no consideration to the project activity in determining their capacity requirements, then the project activity may not displace new capacity. Once again, the appropriate value for w would be zero. In some cases, project activities involving certain types of "small" power plants may fall into this category, although the possible cumulative effects of small plants on capacity demand should still be considered.

3. *What is the project activity's capacity value?* All else being equal, the project activity's capacity value will be the primary indicator of its relative effect on the BM see Annex B for an explanation of capacity value). A high capacity value means that the project activity will have a greater impact on new capacity (the BM), and less of an impact on the OM. Project activities that provide firm power – and therefore have a capacity value roughly equivalent to their rated capacity – will generally affect only the BM ($w = 1$). Box 2.1 explains how a project's capacity value is used to derive a value for w for the purpose of estimating baseline emissions.

2.7 Applying the *Project Protocol* to Grid-Connected Project Activities

The baseline estimation and GHG accounting methods described in Part II of these guidelines are based on the general procedures of the *Project Protocol*. There are, however, some important differences and unique considerations that arise when applying the *Project Protocol* to grid-connected project activities.

As explained in previous sections, grid-connected project activities differ from other types of projects in that their "baseline scenarios" can simultaneously involve GHG emissions from both the BM and OM. In *Project Protocol* terminology, this means the baseline scenario can involve both "implementation of a baseline candidate" (the BM) and the "continuation of current activities" (the OM). See Box 2.2 for explanations of these terms.[6]

The *Project Protocol* itself does not address the possibility of simultaneous effects on both the BM and OM. Determining the relative extent of these effects is done through a unique assessment described in Chapter 5 of these guidelines (and outlined above in Section 2.6).

2.7.1 ESTIMATING BM EMISSIONS

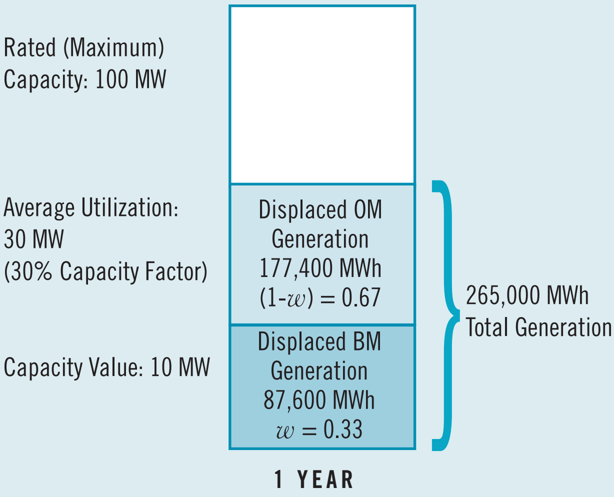
The *Project Protocol* contains two procedures for estimating baseline emissions: the *project-specific* procedure and the *performance standard* procedure. Both these procedures can be applied to estimate BM emissions for grid-connected project activities. Table 2.2 presents the basic options for

BOX 2.1 Using Capacity Value to Determine Displaced BM Generation

For the purpose of estimating baseline emissions, generation is what matters, not capacity – baseline emissions are determined by the amount of generation a project activity displaces or avoids. The weight assigned to the BM represents the proportion of a project activity's generation that would have been provided by new capacity in the baseline scenario. If a project activity is able to fulfill demand for new capacity, then its capacity value is used to determine the maximum level of firm generation it can provide, and therefore the level of displaced BM generation.

For any given time period, displaced BM generation is calculated by multiplying the project activity's capacity value by the number of hours in that time period. For example, a project activity with a capacity value of 10 MW would displace 87,600 MWh of BM generation over one year (10 MW x 8,760 hours/year). The appropriate value for w (i.e., the weight assigned to the BM) is determined by comparing this level of generation to the project activity's total expected generation over the same time period. Total expected generation is determined from the project activity's expected capacity factor, or average utilization. A 100 MW wind farm with a capacity factor of 30 percent, for example, would have an average utilization of 30 MW and would produce a total of 265,000 MWh per year. If it had a capacity value of 10 MW, the appropriate value for w would be (10 MW / 30 MW) = 0.33. Any generation that does not affect the BM will affect the OM (see Figure 2.5).

FIGURE 2.3 **BM and OM Displacement for a Hypothetical 100 MW Wind Farm**



A couple of caveats apply to this approach. First, capacity value is generally determined according to a project's statistically reliable output during times of peak load, which is not necessarily the same as its continuously reliable output over a year. If a project's reliable output is higher (or lower) during times of peak demand than at other times, its designated capacity value may be too high (or too low) for the purpose of determining displaced BM capacity. Second, using this approach requires a reasonably good estimate of the project's expected capacity factor. The expected capacity factor should be based on the same set of assumptions about its operation that is used to determine its capacity value.

BOX 2.2 "Baseline Candidates" and the "Continuation of Current Activities"

A *baseline candidate* is an alternative technology or practice that could provide the same product or service as the project activity. For grid-connected project activities, baseline candidates will consist of different types of power plants that could have been built in place of the project activity. In other words, they will be BM alternatives. Baseline candidates for the BM are identified by following the requirements of the *Project Protocol,* using the guidance in Chapter 7 of these guidelines.

A baseline scenario involving the *continuation of current activities* can mean different things depending on the type of project activity (see Chapter 8 of the *Project Protocol,* including Box 8.7). For grid-connected project activities, the continuation of current activities means that existing power plants would have provided the generation produced or avoided by the project activity. The continuation of current activities thus equates to generation at the OM.

estimating BM emission factors, along with the relevant baseline procedure associated with these options.

Where these guidelines are used to develop a standard baseline emission rate unrelated to a specific project activity (see Section 1.5), using the project-specific procedure to estimate BM emissions is not feasible. Instead, BM emissions can be estimated using the performance standard procedure, or by simply identifying the most conservative (lowest emitting) capacity alternative.

2.7.2 ESTIMATING OM EMISSIONS

In contrast to the BM, OM emissions are estimated using separate methods unrelated to the project-specific or performance standard procedures. These methods are described in Chapter 10 of these guidelines.

2.7.3 JUSTIFYING THE BASELINE SCENARIO FOR INDIVIDUAL PROJECT ACTIVITIES

When quantifying GHG reductions for a specific project activity, users of these guidelines are advised to justify the basic presumption that the project activity's baseline scenario involves BM and/or OM generation.[7] This is done by using the project-specific procedure to show that the project activity faces higher barriers and/or lower net benefits (excluding GHG reduction benefits) than at least one of its alternatives. As described in Section 2.14 of the *Project Protocol*, this is equivalent to establishing the project activity's "additionality." Guidance for applying the project-specific procedure to grid-connected project activities is provided in Chapter 8 of these guidelines.

TABLE 2.2 Options for Estimating Build Margin Emissions

BM IS REPRESENTED BY...	BASELINE PROCEDURE	EXPLANATION
The "most likely" capacity alternative	Project-specific	The project-specific procedure is used to identify the capacity alternative (i.e., "baseline candidate"), with the least barriers or greatest net benefits (excluding GHG reduction benefits). This alternative is used to represent the BM and calculate BM emissions.
The most "conservative" (least emitting) capacity alternative	Project-specific	The project-specific procedure is used, but the most conservative viable alternative is chosen rather than the alternative with the least barriers/greatest benefits. BM emissions are calculated from this lowest-emitting alternative.*
A weighted blend of capacity alternatives	Performance standard	The performance standard procedure is used to calculate a BM emission rate. The BM emission rate will reflect a weighted average (or weighted percentile) of the emission rates of different capacity alternatives.

* The lowest-emitting alternative is sometimes called a "proxy plant" for the BM, because it is used as a conservative stand-in for the "actual" BM.

2.8 Grid Boundaries

Accurately calculating both BM and OM emissions requires defining the boundaries within which electricity generation is displaced or avoided. Although it is often possible to obtain data on GHG emissions and power generation within legal or political boundaries (e.g., by country, state, or province), these data may not correspond to the sources of GHG emissions affected by a project activity. Grid-connected project activities will generally only affect power generation and GHG emissions on the same grid. Where a power grid is connected to other grids, the project activity may also affect generation on neighboring grids. In any case, the geographic area within which to evaluate baseline emissions will be determined by grid boundaries, not legal or political boundaries.

The boundaries of a power grid will be determined by technical, economic, and regulatory-jurisdictional factors. Regardless of these factors, generation on a grid must be coordinated in order for it to function properly, so a central *grid operator* is required to dispatch power plants in accordance with engineering and economic constraints. The precise institutional nature of the grid operator will differ from system to system.[8] Nevertheless, the simplest way to define grid boundaries is according to the set of power plants and transmission lines under the control of a single grid operator.

In the context of the *Project Protocol,* grid boundaries determine the geographic area within which "baseline candidates" are identified (see Chapter 7 of the *Project Protocol*). The grid boundary should not be confused with the "GHG Assessment Boundary" (Chapter 5 of the *Project Protocol*), which defines and encompasses all GHG emission sources affected by a project activity – including those that are unrelated to BM and OM displacement. For grid-connected project activities, the GHG assessment boundary can encompass unintended changes in emissions from sources that are not connected to the grid, that are unrelated to fossil fuel combustion, or that may be located in other regions (e.g., where fuel extraction occurs). See Chapter 4 for further guidance.

Section 7.3 of these guidelines provides further guidance on how to define grid boundaries. The grid boundary will be the same for calculating both BM and OM emissions for a given project activity.

2.9 GHG Accounting Principles

The GHG accounting principles outlined in Chapter 4 of the *Project Protocol* should always guide decisions about GHG accounting for grid-connected project activities. The principles are:

- Relevance
- Completeness
- Consistency
- Transparency
- Accuracy
- Conservativeness

Full descriptions of these principles are provided in the *Project Protocol*. Where appropriate, their application is also discussed in these guidelines. In some cases, it is necessary to strike a balance between competing principles. For example, in estimating grid emission factors it may be necessary to sacrifice accuracy for conservativeness where accuracy is difficult or costly to achieve.

NOTES

[1] For full descriptions of these concepts, see Chapter 2 of the *Project Protocol*.

[2] In the *Project Protocol's* typology of GHG sources and sinks (Section 2.3 of the *Project Protocol*), the category of GHG emissions addressed by these guidelines is referred to as "combustion emissions from grid-connected electricity."

[3] These guidelines do not directly address projects that upgrade or improve the efficiency of power grid transmission and distribution lines. Although these projects share many characteristics with improvements to end-use efficiency, they usually involve grid-specific engineering interventions whose effects should be modeled to accurately estimate any associated GHG reductions. Such modeling is beyond the scope of these guidelines.

[4] Throughout these guidelines, BM and OM emission rates are referred to as "emission factors" because they are components (factors) of the overall baseline emission rate.

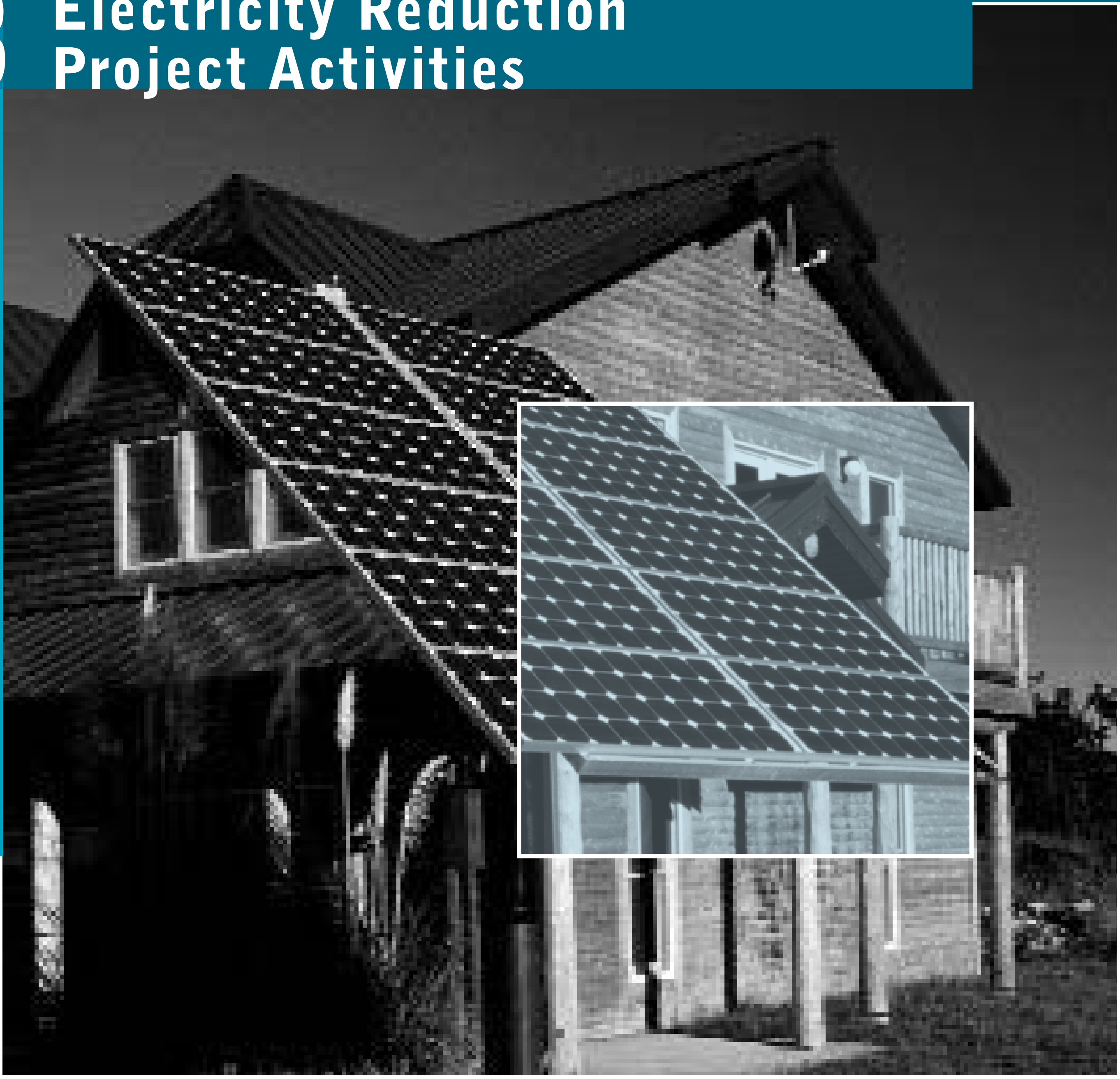
[5] This will generally be true if the project activity has a positive "capacity value" and can be relied on to help meet the grid's peak load requirements. See Annex B for further explanation of these concepts.

[6] For further reference, see the *Project Protocol* Sections 2.7 and 2.8, and Chapter 8. In particular, see Box 8.7 regarding estimation of baseline emissions from the "continuation of current activities."

[7] See Section 2.8 and Chapter 8 of the *Project Protocol.*

[8] Depending on the system, the grid operator may alternately be referred to as a "system dispatcher," "control area operator," "independent system operator," "regional transmission organization," etc.

3 Electricity Reduction Project Activities



Electricity reduction project activities reduce GHG emissions by avoiding grid-based generation. These project activities involve either: (1) improving the efficiency with which grid electricity is used for a particular application; or (2) generating electricity onsite so that supply from the grid is unnecessary. (These guidelines do not directly address projects that upgrade or improve the efficiency of power grid transmission and distribution systems.)

In terms of accounting for GHG reductions, electricity reduction and generation project activities can be treated analogously. The difference is that the amount of *avoided* generation is used to determine baseline emissions instead of the amount of generation. Whereas project activity generation can be metered and measured, avoided generation must be inferred from an estimate of the project activity's electricity savings. Electricity savings can be determined using the same methods prescribed in the *Project Protocol* for determining GHG reductions, or by using commonly accepted methods developed by energy efficiency experts. In this chapter:

- Section 3.1 explains the two broad types of electricity reduction project activities (individual activities and programs);
- Section 3.2 provides a general overview of appropriate methods for estimating electricity savings;
- Section 3.3 describes how to calculate avoided grid generation from estimated electricity savings;
- Section 3.4 discusses how to estimate baseline emissions and quantify GHG reductions from electricity reduction project activities, using estimates of avoided grid generation.

This chapter is not intended to be a guide to determining electricity savings associated with different types of electricity reduction projects. Rather, it provides a general overview that should be supplemented with other guidance and materials. Once electricity savings are determined for a project activity, they can be used in conjunction with the rest of these guidelines to estimate baseline emissions and quantify GHG reductions (as described in Section 3.4).

3.1 Types of Electricity Reduction Project Activities

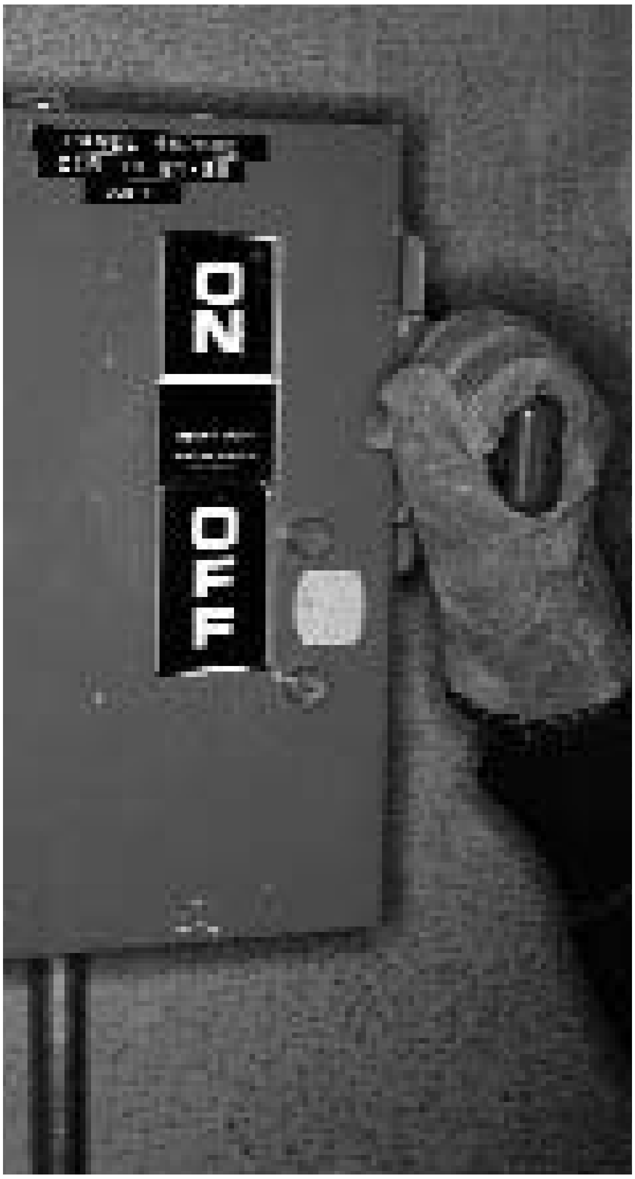
Electricity reduction project activities can be broadly grouped into two categories:

- **Individual end-user activities.** An individual end-user activity is a specific energy-saving measure implemented and managed by an electricity consumer, often at a single facility.
- **Wide-area programs.** Wide-area programs involve coordinated activities to help a large number of consumers reduce grid electricity consumption. They are typically implemented by utilities, grid operators, non-governmental organizations, or governments, and may involve information and educational campaigns; working with manufacturers and vendors to increase the supply and distribution of energy efficient equipment; and/or financial or other incentives for electricity users to install specific technologies or change their operations in a manner that reduces electricity consumption.

Within these categories, many types of projects are possible. Specific methods for determining electricity savings (and associated GHG reductions) can differ depending on whether projects involve new construction or retrofits; whether they involve energy conservation, efficiency improvements, distributed generation, or demand response programs; and whether they involve individual pieces of equipment or entire energy systems (such as "green" buildings). Detailed guidance related to these different project possibilities is beyond the scope of the guidelines. The following section provides a general overview of methods to determine electricity savings.

3.2 Determining Electricity Savings

Just as GHG reductions involve the absence of emissions, electricity savings involve the absence of electricity use. Like GHG reductions, electricity savings cannot be directly



measured. Instead they are determined by comparing actual electricity consumption with estimates of baseline consumption derived from an appropriate analysis. This chapter briefly describes methods for determining electricity savings that may be used in conjunction with the *GHG Protocol for Project Accounting.* A full discussion of techniques for determining electricity savings for different types of projects and programs, however, is beyond the scope of these guidelines. References to external standards and documents are provided where appropriate.

The term a*djusted consumption baseline* is commonly used to describe the amount of grid electricity that would have been consumed without the project activity. The avoided site electricity usage, or *electricity savings,* is then determined by subtracting actual electricity consumption during the project activity's operation from the adjusted consumption baseline.

The term "adjusted consumption baseline" is used because estimates of baseline electricity consumption must often be adjusted to account for changes in usage unrelated to the project activity. For example, if a manufacturing plant's production level drops, the associated reduction of energy should not be confused with any reduction caused by an efficiency-enhancing project activity. Thus, baseline estimates of electricity consumption generally must be re-stated using actual measurements of project activity conditions. Without such adjustment, a portion of the difference between baseline estimates and project activity usage may be attributed to events unrelated to the project activity.

The adjusted consumption baseline may be identified and justified by following the procedures of the *Project Protocol,* or by using a recognized international standard for evaluating end-user efficiency projects.

3.2.1 DETERMINING THE ADJUSTED CONSUMPTION BASELINE USING THE *PROJECT PROTOCOL*

The *Project Protocol's* methods for estimating baseline emissions can also be used to determine an adjusted consumption baseline. The full application of the *Project Protocol* for this purpose is not presented here. Key *Project Protocol* chapters to consult include the following:

- *Chapter 5: The GHG Assessment Boundary.* Electricity reduction projects may have both intended and unintended effects on electricity consumption and energy usage, analogous to "primary" and "secondary" effects on GHG emissions. These effects should be considered in determining overall electricity savings and GHG reductions. Guidance from existing energy efficiency project evaluation standards (see next section) can be used to help identify these effects.

- *Chapter 7: Identifying the Baseline Candidates.* For the adjusted consumption baseline, "baseline candidates" will represent alternative technologies or practices capable of delivering the same end-use service as the project activity. For example, depending on the nature of the project activity, the baseline candidates could be alternative light bulbs that would provide the same amount of illumination; alternative electric motors that would provide the same amount of work; or alternative onsite power generation technologies that would provide the same amount of electricity.

- *Chapter 8: Project-Specific Procedure.* The project-specific baseline procedure can be used to assess the baseline candidates and identify the most likely baseline scenario alternative. In many cases, especially where the project activity involves an addition or retrofit to existing facilities, the most likely alternative may be the "continuation of current activities."[1] In these cases, the adjusted consumption baseline can be determined from historical grid electricity usage rates.[2] Adjustments should be made to re-state this historical usage to what it would be under the actual conditions of the project activity's operation.

BOX 3.1 Using Historical Data to Determine the Adjusted Consumption Baseline for GHG Projects

Standard methods for determining an adjusted consumption baseline (such as those described in the IPMVP Volume I) often rely on historical measurements of electricity usage prior to the implementation of a project activity. Using historical information to characterize the baseline implies that the project activity's baseline scenario involves the "continuation of current activities" (see the *Project Protocol,* Section 2.8 and Chapter 8). As noted in Section 3.1.1, this may be reasonable for many electricity reduction project activities. For the purpose of GHG reduction accounting, however, a full analysis should be conducted to demonstrate that the baseline scenario would not involve an alternative new technology or practice, and would not involve the project activity itself (in which case the project activity would not be additional; see the *Project Protocol*, Section 2.14).

For example, some project activities may replace obsolete equipment with a currently available, standard equivalent. Since technology tends to improve over time, the standard replacement is likely to reduce electricity usage relative to historical levels. At the same time, the replacement would be likely to occur regardless of any considerations about GHG reductions and climate change. Because of this, the projected baseline scenario would involve the same replacement, so no GHG reductions would occur relative to baseline emissions. For the project activity to produce quantifiable GHG reductions, it would have to involve a more energy efficient model than current "standard" equipment.

Where historical measurements are used to determine the adjusted consumption baseline, the methods described under the *Project Protocol's* project-specific baseline procedure (Chapter 8) should be used to confirm that the baseline scenario involves the "continuation of current activities."

- *Chapter 9: Performance Standard Procedure.* The performance standard procedure can in some cases be used to estimate the adjusted consumption baseline for energy efficiency project activities. In this case, the performance metric specified (see *Project Protocol* Section 9.1) should reflect marginal watt-hours of electricity required per unit of service provided (e.g., marginal kWh per unit of production). The baseline candidates are then assessed using this performance metric. The performance standard will determine the adjusted consumption baseline. In most cases, this should be a better-than-average usage rate (see *Project Protocol* Section 9.4).

3.2.2 DETERMINING THE ADJUSTED CONSUMPTION BASELINE USING OTHER METHODS

Well-developed standards exist for determining the adjusted consumption baseline for individual end-user activities. The Efficiency Valuation Organization's *International Performance Measurement and Verification Protocol (IPMVP),* for example, contains extensive guidance for this purpose, including detailed descriptions of computation methodologies and monitoring methods.[3] Another industry guideline is the American Society of Heating, Refrigerating, and Air-Conditioning Engineers' (ASHRAE) *Guideline 14-2002.*[4]

For wide-area programs, a number of guidelines have been developed to facilitate estimation of electricity savings, and an extensive body of relevant research is available online. Until recently, these methods have focused on energy savings and or avoided costs of generation from energy efficiency, rather than reductions in GHG emissions *per se.*[5] GHG reductions can be calculated as a function of electricity savings following the guidelines presented in this document. However, due to the frequent involvement of institutional actors, unique considerations may arise in justifying the baseline scenario for wide-area programs (e.g., in the assessment of their barriers and benefits relative to "standard" grid capacity alternatives, following the guidance in Chapter 8 of these guidelines). A full discussion of these considerations and related policy questions is outside the scope of these guidelines.

3.3 Determining Avoided Grid Generation

When electrical energy is transmitted and distributed over power lines, a portion of it is lost due to resistance and other forms of dissipation. The amount of electricity delivered to consumers is therefore less than the amount generated at power plants, usually by around 7 to 10 percent. For a project activity that generates electricity, the energy lost over transmission and distribution (T&D) systems before reaching consumers may be assumed to be roughly the same as for the sources of generation the project activity displaces. Thus, a project activity that generates 1 MWh of electricity is assumed to displace 1 MWh of electricity from other sources, even though they may be located elsewhere on the grid.

Analogously, 1 MWh of electricity savings means that more than 1 MWh of electricity no longer needs to be generated by power plants. Thus, in order to estimate grid GHG reductions, electricity savings must be converted to a corresponding amount of avoided grid generation. Avoided grid generation should be calculated as follows:

$$GEN_{proj,t} = \frac{S_t}{1\text{-}L} \quad (2)$$

Where:

- $GEN_{proj,t}$ is total grid generation avoided by the project activity for time period t.

- S_t is total electricity savings for time period t, derived using an appropriate method as described in Section 3.2.

- L is the average fraction of generated power that is lost within the grid where the project activity is located. This fraction can generally be obtained from local grid operators. In some cases, utility companies are also required to report this fraction to their regulator. Where theft or unmetered customers are present, their estimated total consumption should be removed before deriving L.

The magnitude of line losses can change over time as a grid develops. Thus, the quantity used for L may be monitored and updated over time as appropriate (see Chapter 12).

3.4 Estimating Baseline Emissions and Quantifying GHG Reductions

Estimating baseline emissions for electricity reduction project activities is done by multiplying avoided generation ($GEN_{proj,t}$ in Equation 2) by an appropriate baseline emission rate, determined using the procedures in Chapters 5 through 11 of these guidelines. For the general baseline emissions formula, see Equation 20 in Chapter 11.

In deriving a baseline emission rate, the same types of considerations that apply to generation project activities also apply to electricity reduction project activities. The baseline emission rate can have both a BM and OM component, and the same methods can be used to estimate BM and OM emission factors. The following specific considerations, however, will arise for electricity reduction projects:

Chapter 5: Determining the Extent of BM and OM Effects

- Many individual end-user project activities are small in scale, and are often implemented for reasons wholly unrelated to grid capacity requirements. These types of project activities will have little or no effect on the BM (see Section 5.2).

- For larger end-user project activities and for wide-area programs, a key consideration will be quantifying their effects on grid electricity consumption and translating these effects into estimates of their "capacity value" and "rated capacity." Box 5.2 presents some general guidance on this, but detailed methods for determining the capacity effects of electricity reduction projects are beyond the scope of these guidelines.

Chapter 7: Identifying Baseline Candidates

- For project activities that do affect the BM, a key consideration is what types of new capacity they displace (the different possible types of BM capacity are referred to as "baseline candidates"). In these guidelines, the most important distinction is between "baseload" and "load-following" capacity (see Section 7.1). Load-following project activities will displace only load-following capacity. Thus, for electricity reduction project activities, an assessment is required to determine whether their effects on electricity consumption are best characterized as "baseload" or "load-following." Box 7.2 presents some general guidance on this topic.

Chapter 8: Justifying the Baseline Scenario and Characterizing the Build Margin

- Where these guidelines are used to quantify GHG reductions for a specific project activity, the guidance in Chapter 8 should be followed to justify the project activity's baseline scenario. This generally requires comparing the barriers faced by the project activity to barriers faced by other alternatives, including new capacity alternatives. Section 8.1 presents general guidance on performing a comparative assessment of barriers, but specific considerations about how electricity reduction measures might be compared to generation capacity alternatives in different market and regulatory contexts are not discussed.

Chapter 10: Estimating the Operating Margin Emission Factor

- Any of the methods described in Chapter 10 for estimating OM emissions can be applied to electricity reduction project activities. Project activities whose effects on electricity usage vary significantly by time period, however, should use a method that accurately captures differences in marginal emissions by time period (see Table 10.1).

Finally, quantifying GHG reductions for electricity reduction project activities is done in the same manner as for generation project activities, i.e., by comparing baseline emissions to project emissions (see Section 12.2). A project activity that improves the efficiency with which electricity is used will have zero project emissions for the purposes of quantifying its "primary effect" (Section 12.2.2).

NOTES

[1] If the project activity involves onsite generation, then the "continuation of current activities" can be equated with purchasing electricity from the grid. The adjusted consumption baseline would then be equivalent to the amount of generation provided by the project activity.

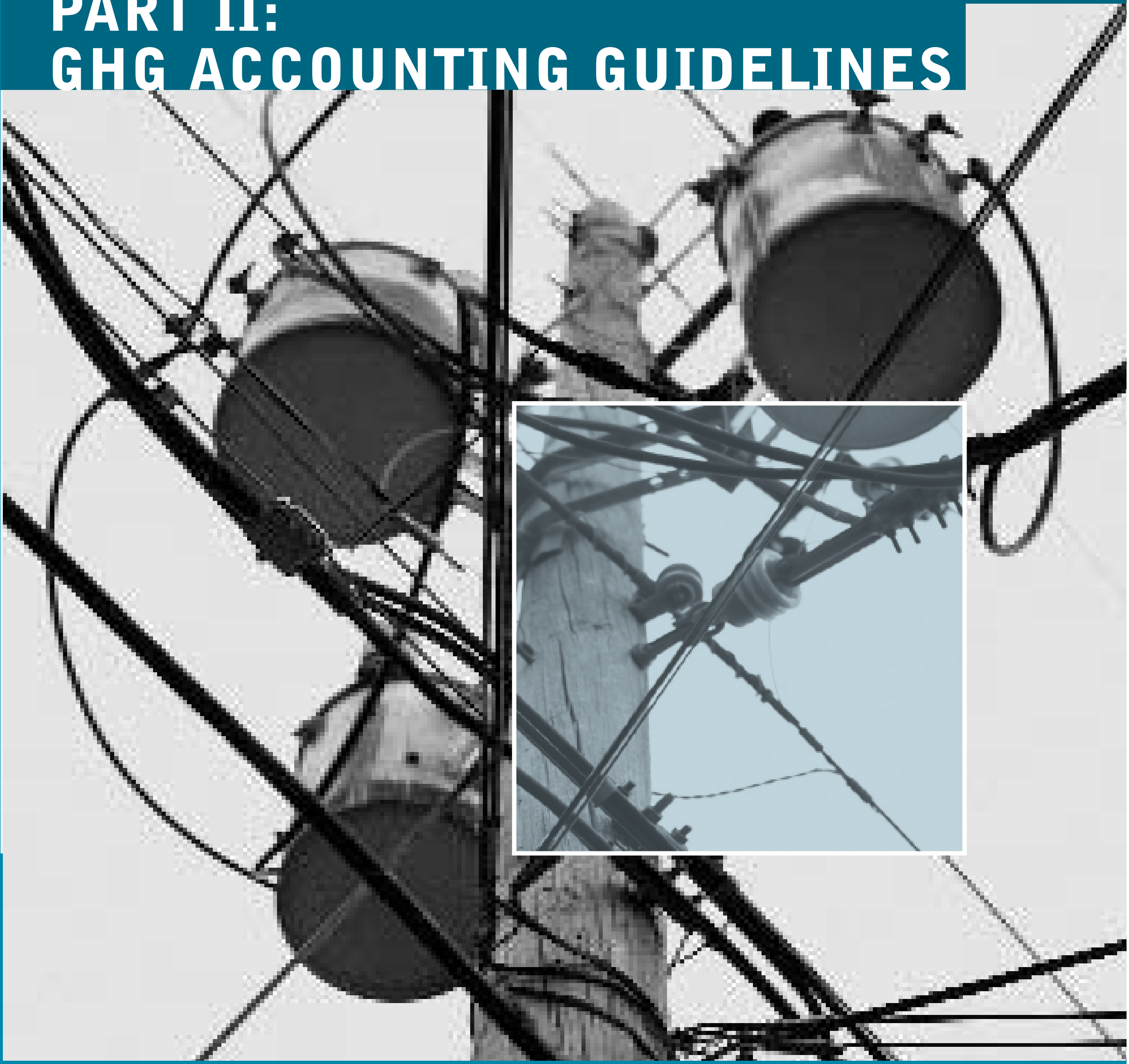
[2] If an energy efficiency project activity is implemented at a new facility with no historical usage data, then the "continuation of current activities" may not be a viable baseline scenario alternative.

[3] Efficiency Valuation Organization, 2007. *International Performance Measurement and Verification Protocol (IPMVP), Volumes I and III.* San Francisco, USA. Volume I covers concepts and methodological options for determining electricity savings from retrofits to existing facilities. Volume III covers concepts and options for determining energy savings in new construction, as well as special considerations for electricity generation projects installed on the end-user side of the utility meter. Both volumes are available online at http://www.evo-world.org.

[4] Available at http://resourcecenter.ashrae.org/store/ashrae/.

[5] Some useful further reading on this topic can be found at www.calmac.org, www.aceee.org, and www.cee.org. Relevant publications include: *California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals* (2006); *The California Evaluation Framework* (2004); *A Framework for Planning and Assessing Publicly-Funded Energy Efficiency* (2001); *Protocols and Procedures for the Verification of Costs, Benefits and Shareholder Earnings from Demand-Side Management Programs* (1998); *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects* (2001) – all available at www.calmac.org.

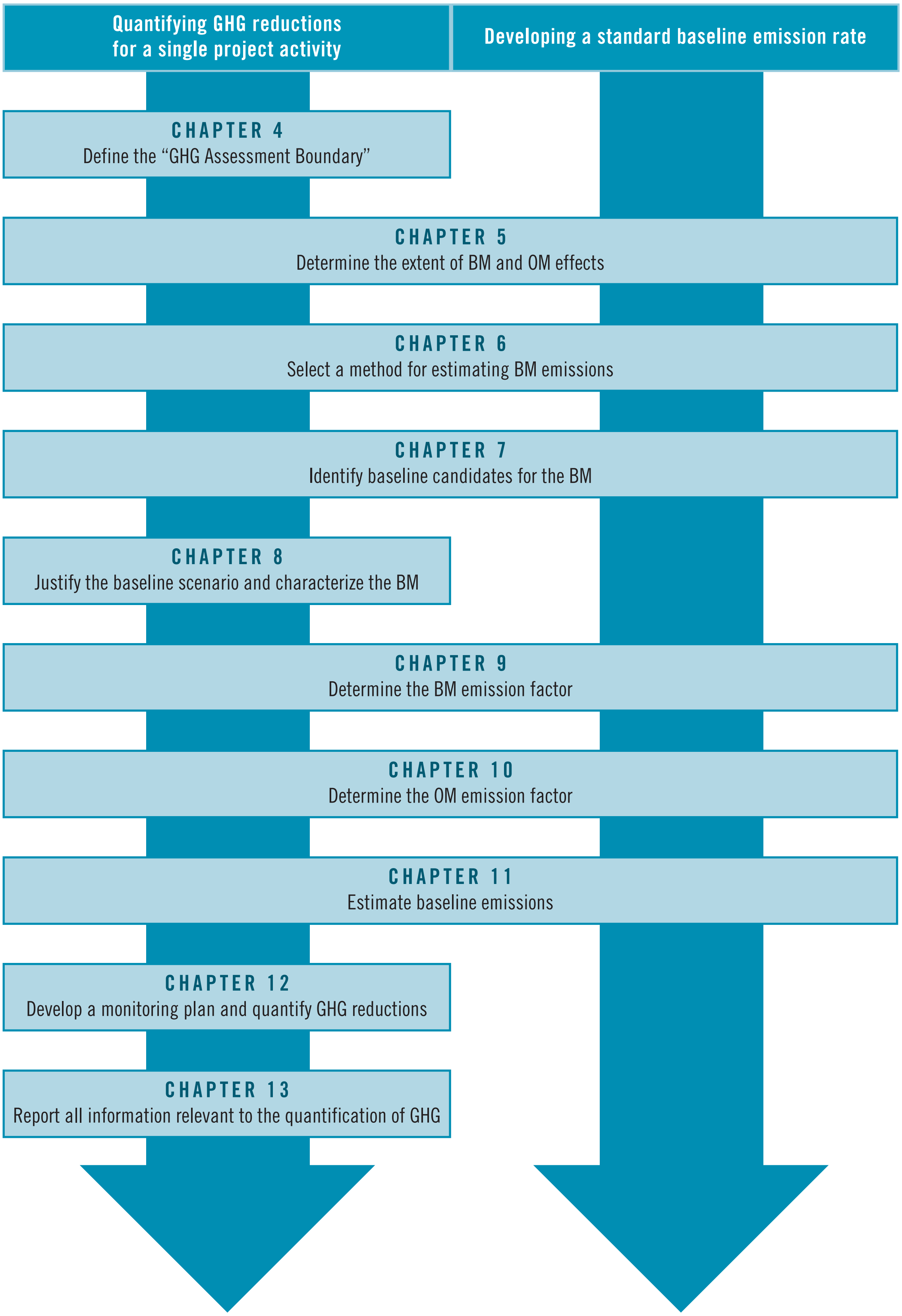
PART II: GHG ACCOUNTING GUIDELINES



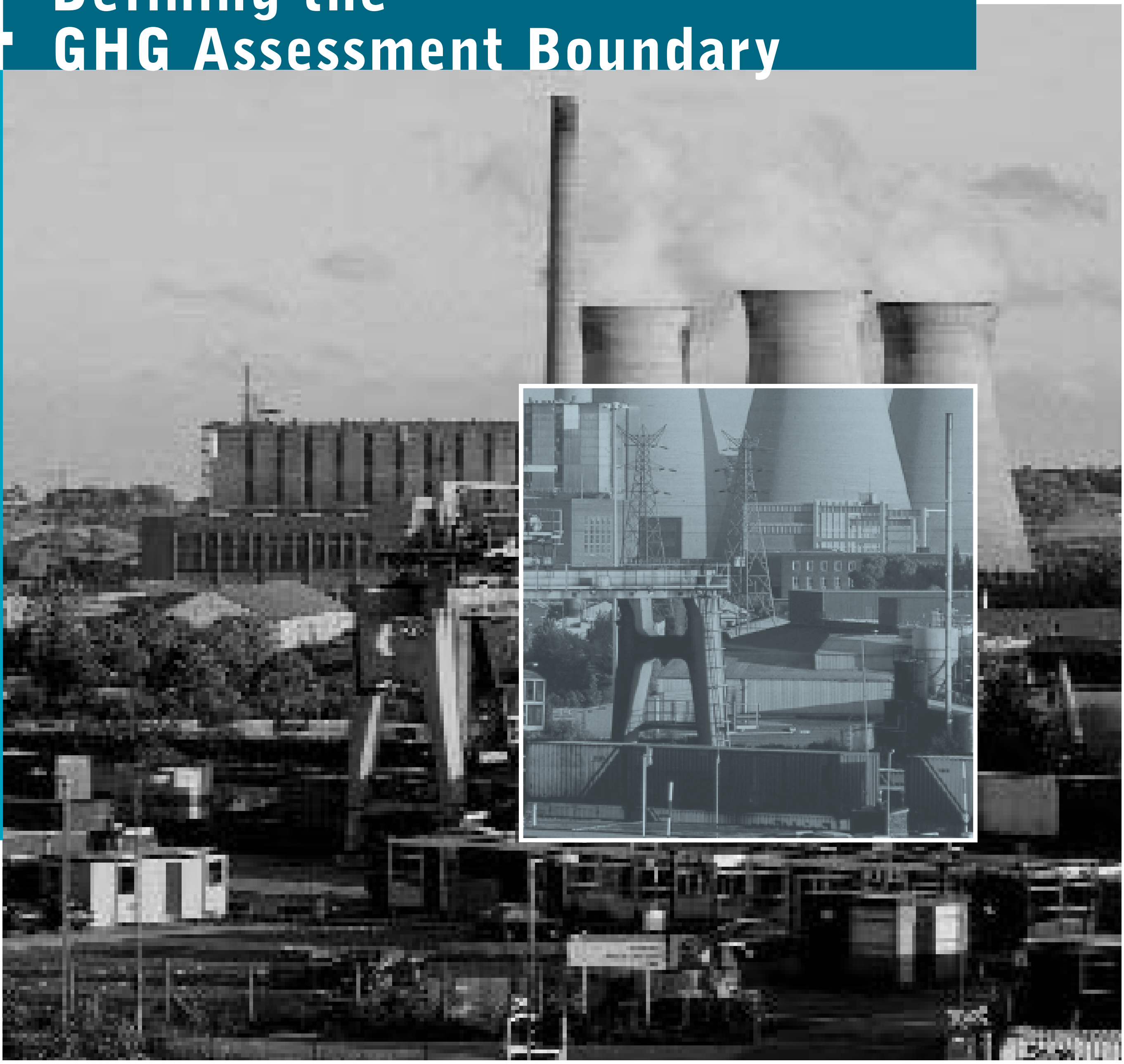
Chapters 5 through 13 of these guidelines explain in detail how to apply the accounting and reporting requirements of the *Project Protocol* to grid-connected project activities. There are two ways these guidelines can be used. The first is to fully account for, monitor, and report the GHG reductions resulting from an individual project activity. The second is to develop a *standard baseline emission rate* that can be applied to multiple project activities of the same type. The following diagram indicates which chapters to consult depending on the intended use.

These guidelines are written primarily from the perspective of accounting for the GHG reductions of an individual project activity. Thus, some discretion may be required in interpreting the guidelines when developing a standard baseline emission rate. For example, where the guidelines refer to an individual project activity, they should be interpreted with regard to the general type of project activity being considered for the standard.

Accounting Steps for Grid-Connected Project Activities



4 Defining the GHG Assessment Boundary



Defining the GHG assessment boundary is necessary to fully quantify the GHG reductions from an individual project activity. As explained in Chapter 5 of the *Project Protocol,* the GHG assessment boundary encompasses all the *primary effects* and significant *secondary effects* associated with a GHG project, and therefore all the changes in GHG emissions that must be accounted for in order to quantify the project's GHG reductions. A primary effect is the intended change caused by a project activity in GHG emissions from a particular GHG source. For grid-connected project activities, the primary effect will consist of reducing combustion emissions from grid-connected power plants.

A secondary effect is an unintended change caused by a project activity in GHG emissions from a particular GHG source. Only significant secondary effects are included in the GHG assessment boundary, and many grid-connected project activities will not have significant secondary effects. Various types of secondary effects to consider, however, are described below.

4.1 Identifying Project Activities

An overview of different types of grid-connected project activities is provided in Section 2.2. As indicated in Table 2.1, some grid-connected project activities may be part of a GHG project involving multiple project activities. Follow the general requirements of Chapter 5 of the *Project Protocol* to define the GHG project and its component project activity or activities.

The key distinction for grid-connected project activities is whether they involve electricity generation or demand reductions. Some GHG projects may involve both kinds of activities. For example, an onsite generation project may produce electricity to meet site-specific needs, and provide any excess electricity it generates to the grid. This type of project should be treated as a single GHG project involving two grid-connected project activities. The first is an electricity-reduction project activity that avoids consumption of grid electricity. The second is a generation project activity that displaces grid electricity. Baseline emissions would therefore be estimated separately for generation that is consumed onsite and generation that is delivered to the grid.

4.2 Identifying Primary Effects

As noted above, the primary effect for grid-connected project activities will be reducing combustion emissions from grid-connected power plants. See Section 2.4 of the *Project Protocol* for further information.

4.3 Considering All Secondary Effects

Many grid-connected project activities will not have significant secondary effects. There are some important exceptions, however. Below are some types of secondary effects to consider for different types of grid-connected project activities. The guidance in Section 5.3 of the *Project Protocol* should also be consulted in identifying secondary effects.

4.3.1 ONE-TIME EFFECTS

One-time effects are secondary effects related to GHG emissions that occur during the construction, installation, and establishment, or the decommissioning and termination of a project activity. Most grid-connected project activities involving the installation of power generation technologies will produce GHG emissions associated with construction and decommissioning. However, if a project activity displaces construction of another power plant – in other words, if it affects the build margin – then similar GHG emissions would also occur in the baseline scenario. Thus, in many cases one-time effects will not be significant, because one-time emissions will be roughly the same for both the project activity and the power capacity it displaces. One-time effects may be significant, however, for project activities that largely affect the operating margin. Consult Section 4.4.1, below, for guidance on estimating the magnitude of one-time effects.

4.3.2 UPSTREAM AND DOWNSTREAM EFFECTS

Upstream and downstream effects are recurring secondary effects associated with the operating phase of a project activity. For grid-connected project activities these could include many things, including changes in GHG emissions associated with upstream extraction and transportation of fuels, or with downstream electricity consumption patterns. It is not necessary to conduct a full life-cycle analysis of a project activity's net impacts on GHG emissions. However, any changes in GHG emissions from upstream and downstream GHG sources should be considered if they are potentially significant. Some categories of GHG emissions to look at include the following:

- **Fuel extraction and transportation GHG emissions.** Most grid-connected project activities will either reduce or cause no increase in fuel extraction and transportation GHG emissions, so changes in these emissions can often be ignored as secondary effects. Possible exceptions include project activities that use biofuels, where GHG emissions from fuel extraction, refining, and transportation could be significantly higher for the project activity than for the baseline scenario.

- **Hydro reservoir methane emissions.** One type of "upstream" effect that will generally be significant for reservoir hydroelectric project activities involves methane emissions from organic decomposition on land areas flooded by the reservoir. Estimating such emissions can be difficult and subject to uncertainty.[1]

4.4 Estimating the Magnitude of All Secondary Effects

Appropriate methods for estimating the magnitude of secondary effects will depend on the specific GHG sources being examined. For general guidance, consult Section 5.4 of the *Project Protocol*. Considerations for grid-connected project activities are described below.

4.4.1 ONE-TIME EFFECTS

One-time effects will be greatest for project activities that affect the operating margin. If a project activity only partially affects the build margin, then it will also have a partial effect on the construction and decommissioning GHG emissions for the capacity it displaces. The construction and decommissioning emissions for displaced BM capacity should be discounted by the same weighting factor, w, used

in estimating baseline emissions (see Section 2.3 and Chapter 5). Use the following formula to estimate the magnitude of one-time effects:

$$OT = w(CAP_{proj})(CD_{BM}) - (CAP_{proj})(CD_{proj}) \tag{3}$$

Where:

- OT is the size of the one-time effect, in tons of CO_2-equivalent. Note that the sign of the effect will often be negative, indicating an increase in GHG emissions. Emission increases are expressed as negative GHG reductions to be consistent with the accounting for primary effects.
- w is the weight (between 0 and 1) assigned to the build margin (see Section 2.3 as well as Chapter 5).
- CAP_{proj} is the rated capacity of the project activity, in MW (see Annex B for an explanation of capacity).
- CD_{BM} is the average GHG emissions associated with construction and decommissioning of 1 MW of BM power plants. To determine these emissions, the BM must first be characterized using the methods described in Chapters 6 through 9. If BM emissions are estimated using a performance standard, use an average of the construction and decommissioning emissions for each baseline candidate identified in Chapter 7.
- CD_{proj} is the average GHG emissions associated with construction and decommissioning for 1 MW of the project activity capacity. For example, if the project activity has a 50 MW capacity, divide total construction and decommissioning GHG emissions by 50.

Estimates may be used for construction and decommissioning GHG emissions. Default data on GHG emissions associated with the construction and decommissioning of different types of power plants can be obtained from a number of sources; a list of possible sources may also be available from the *GHG Protocol* website (http://www.ghgprotocol.org).

4.4.2 UPSTREAM AND DOWNSTREAM EFFECTS

Consult geographically relevant sources for data and information related to upstream and downstream effects for specific types of grid-connected project activities. Appropriate data sources may also be available on the *GHG Protocol* website (http://www.ghgprotocol.org).

4.5 Assessing the Significance of Secondary Effects

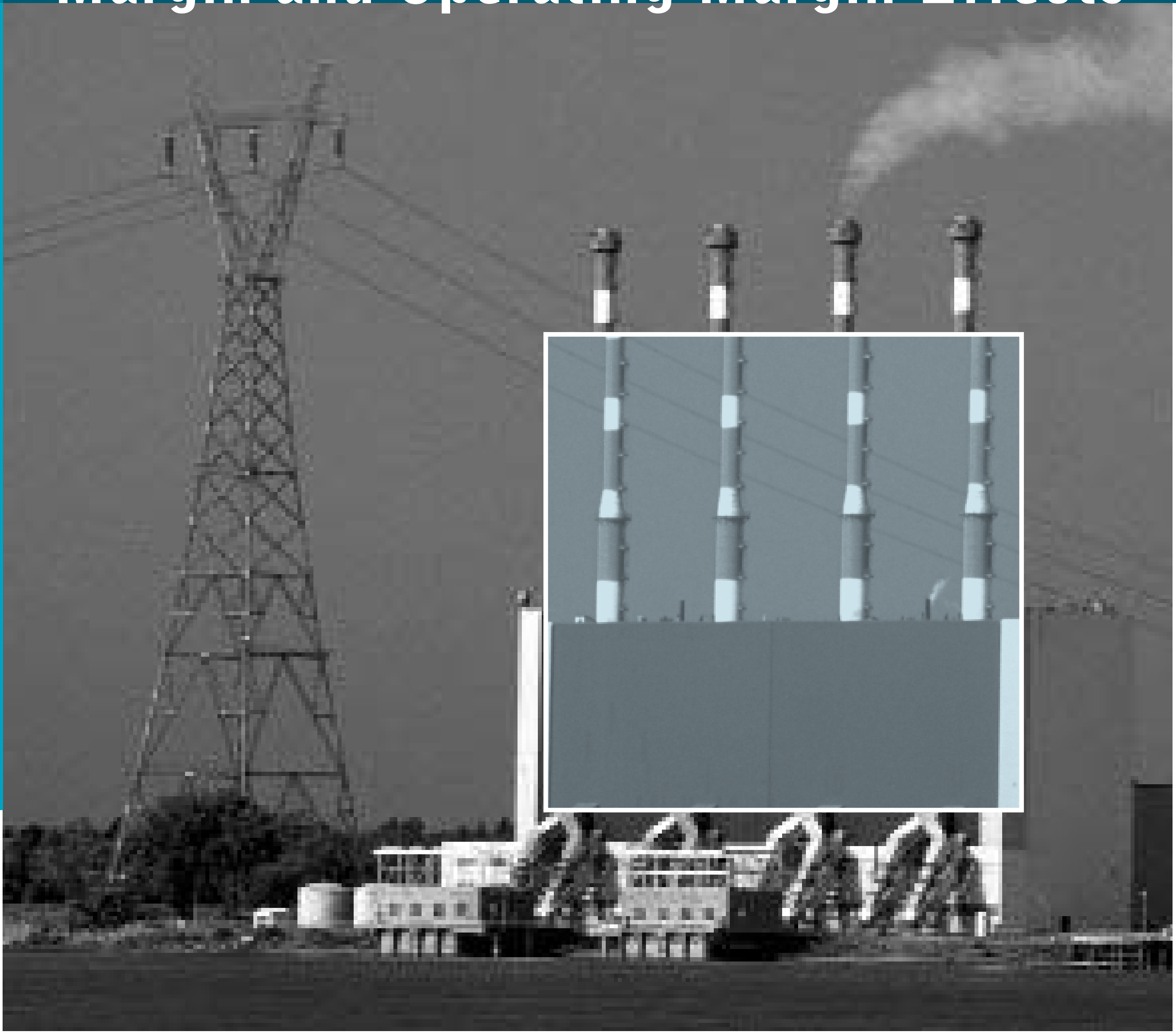
The significance of secondary effects will depend on their magnitude relative to the project activity's primary effect. Secondary effects may be excluded from the GHG assessment boundary if they involve a reduction, not an increase, in GHG emissions (e.g., a reduction in fuel extraction and transportation emissions). Otherwise, if their magnitude is more than a few percent[2] of the expected primary effect GHG reductions, they should be included in the GHG assessment boundary. Consult Section 3.3 and Section 5.5 of the *Project Protocol* for further guidance on assessing the significance of secondary effects.

NOTES

[1] For example, see Rosa, L., and M. dos Santos, 2000. *Certainty and Uncertainty in the Science of Greenhouse Gas Emissions from Hydroelectric Reservoirs.* World Commission on Dams, Cape Town, South Africa. Draft available at http://www.dams.org/docs/kbase/-thematic/drafts/tr22_part2_finaldraft.pdf.

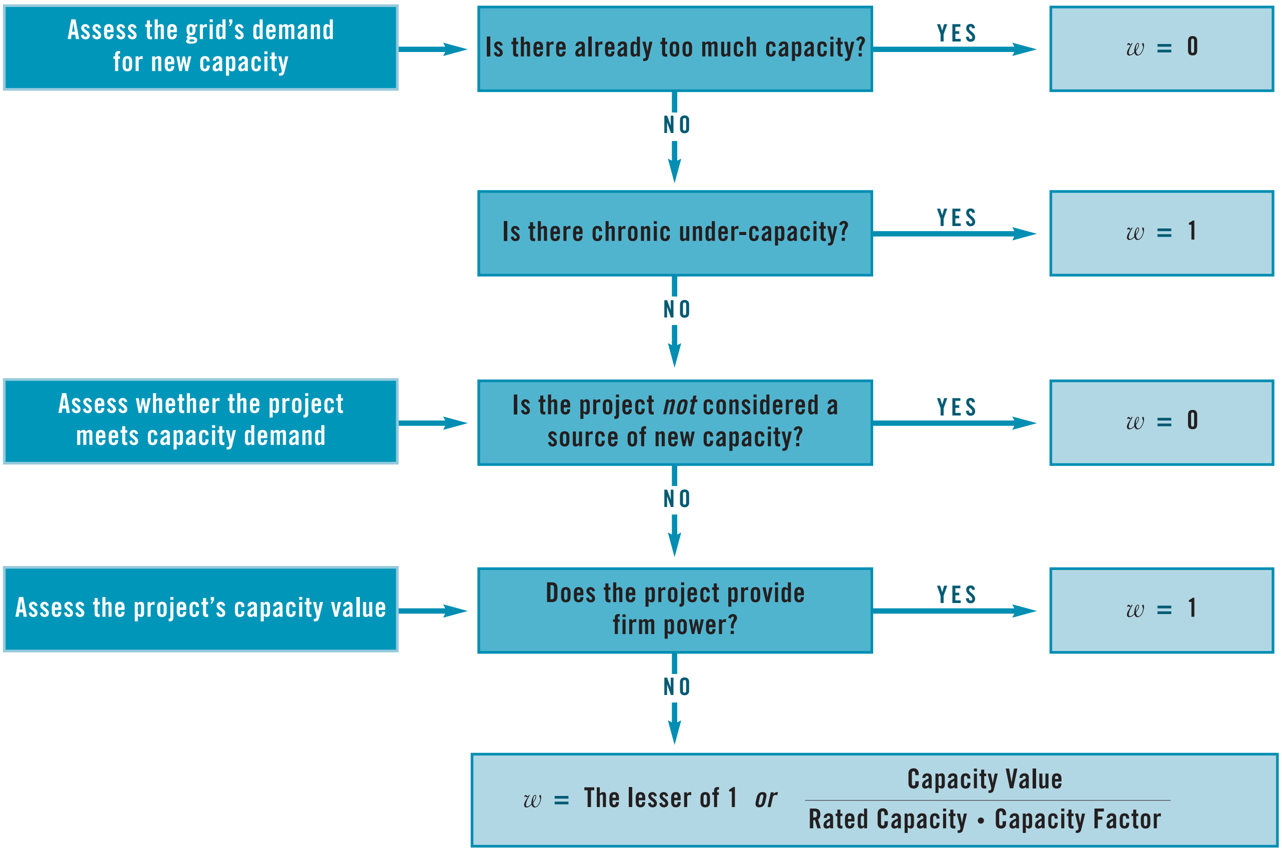
[2] The precise magnitude of "significant" secondary effects depends on the context of the GHG project and related policy questions; see Section 3.3 of the *Project Protocol*.

5 Determining the Extent of Build Margin and Operating Margin Effects



As described in Section 2.3, baseline emissions are calculated using a weighted average of BM and OM emission factors (Section 2.3, Equation 1). Section 2.6 describes the general concepts behind assigning weights to the BM and OM components of baseline emissions. This chapter provides specific guidance on determining those weights, and in particular assigning a value to w, the weight assigned to the BM. Figure 5.1 provides an overview of major considerations behind assigning an appropriate weight to w.

FIGURE 5.1 Guide to Assigning an Appropriate Weight to the Build Margin



5.1 Assessing Grid Capacity Demand

As described in Section 2.6, the main determinant of a project activity's relative effect 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, the first step in deciding a weight for w is determining whether demand for new capacity exists on the grid where the project activity is located. If the grid has more than enough capacity to meet foreseeable power demands (i.e., there is "overcapacity") then there may be no demand. The project activity may not actually displace any new capacity, and will only affect the OM. In these cases, assigning a value of zero to w is appropriate. The extent and expected duration of grid overcapacity should be documented.

Note that for project activities that generate electricity, the presumption should generally be that demand for new capacity does exist, since these project activities will be strongly influenced by the same economic conditions that drive the timing of other capacity additions. In other words, the same factors enabling the project activity would have enabled an alternative form of capacity in its absence, considerations about overcapacity notwithstanding. Finally, even where overcapacity exists, the project activity could still affect the BM in the future, once demand catches up to installed capacity. See Box 8.3 in Chapter 8 for guidance on how to estimate baseline emissions where the displacement of the BM is effectively delayed due to current lack of capacity demand.

Some grids may face the opposite situation, i.e., a capacity shortage characterized by insufficient power to meet demand during certain time periods. During these periods, a project activity that otherwise displaces the OM may not actually cause any existing plants to curtail their generation because all spare capacity is dispatched to try to meet demand. Where capacity shortages occur only during limited times of seasonal or annual peak demand, it can be assumed for GHG accounting purposes that OM displacement still occurs. However, where a capacity shortage is persistent and chronic over extended time periods, a better assumption is that the project activity will only displace at the BM ($w = 1$), notwithstanding other considerations (e.g., see Chapter 8, Section 8.1.2).

5.2 Assessing Whether the Project Activity Meets Capacity Demand

As noted in Section 2.6, some grid-connected project activities are not implemented in response to demand for new capacity, and may have little influence on it. If grid operators, power utilities, or power plant developers give no consideration to the project activity's capacity in assessing grid capacity requirements, then the project activity may not displace the BM. In these cases, an appropriate weight for w is zero; generation provided (or avoided) by the project activity will entirely affect the operating margin.

Many electricity reduction project activities are built without regard to overall demand for new capacity and will fall into this category. Electricity reduction project developers should explain, however, whether or not grid operators are likely to consider the project in determining capacity requirements, and whether the project is considered as an explicit alternative for meeting capacity demand. Where the project activity would qualify as a measure for mitigating load growth, for example, it should be assumed to displace new capacity (see Box 5.1).

In addition, certain kinds of "small" generation project activities, i.e., those with very low power output or savings, may have little or no influence on demand for new capacity. What constitutes a "small" project activity depends on the grid and is primarily a matter of situational judgment. Most small projects will have a capacity of 1 MW or less. Note that even small project activities can still affect grid capacity requirements, however, especially in conjunction with many similar installations that have a cumulative impact. Any determination that a project activity will not contribute to meeting grid capacity requirements should therefore be justified in consultation with grid operators or regulators, and should consider possible cumulative effects.

BOX 5.1 Capacity Demand and Electricity Reduction Project Activities

As described in Chapter 3, electricity reduction project activities can consist of "individual end-user" activities and "wide area programs." Many, if not most, individual end-user activities (those pursued outside any coordinated, supporting program) are pursued for reasons unrelated to capacity demand or grid capacity requirements, and therefore will arguably have little or no build margin effect (i.e., $w = 0$). On the other hand, wide-area programs (and some large end-user project activities) are often explicitly considered as alternatives to new capacity, and should therefore have an effect on the BM ($w > 0$).

5.3 Assessing the Project Activity's Capacity Value

Where a project activity is able to meet demand for new capacity, it will affect BM capacity additions in proportion to its capacity value. More specifically, the appropriate weight for w will either be 1, or the ratio of the project's capacity value to its average utilization in megawatts, whichever is less:

$$w = \min\left(1, \frac{CAP_{value}}{CAP_{rated} \cdot CF}\right) \quad (4)$$

Where:

- w is the weight assigned to the BM (see Equation 1, Section 2.3)
- CAP_{value} is the project activity's capacity value (or minimum level of demand reduction) in megawatts
- CAP_{rated} is the rated capacity for the project activity – i.e., the power it is physically capable of delivering, also called the "nameplate" capacity – or its maximum demand reduction capability, in megawatts
- 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})

Generally, project activities that can provide firm power at all times will fully displace the BM (i.e., $w = 1$). Non-firm projects, however, will have a capacity value lower than their average utilization, and only some of the electricity they produce or avoid will displace generation at the BM. The remainder will displace generation at the OM. If a project activity has no capacity value, then all of its output will affect the OM.

Capacity value is largely determined by the extent to which the project activity provides firm power, but also by the timing of its generation. Deriving a precise capacity value often requires detailed modeling of grid operations and other capacity additions. In some cases, it may be possible to consult grid operators or relevant analytical studies to obtain an approximate capacity value for the project activity.[1] See Box 5.2 for general guidance on determining capacity value for electricity reduction project activities.

In all cases, make sure that the capacity value assigned to the project activity is appropriate for estimating firm generation levels. Projects that reliably provide greater or lesser power during times of peak demand, for example, may have capacity values higher or lower than their level of continuously reliable generation. Where a precise capacity value is assigned to the project activity, its derivation or source should be explained.

BOX 5.2 Assessing Capacity Value for Electricity Reduction Project Activities

The capacity value of electricity reduction project activities can be determined in an analogous fashion to electricity generation project activities, by considering whether their operation is predictable or unpredictable. Capacity value will be largely determined by the minimum predictable load reduction caused by the project activity. For example, suppose a utility demand side management program affects electricity demand in a way that varies from hour to hour from 5 to 20 MW, with an average reduction of 10 MW. The "rated capacity" of the program would be equivalent to 20 MW, but the program's capacity value would be the minimum predictable level of reduction, i.e., 5 MW. Analogously, its "capacity factor" would be 50 percent (10 MW / 20 MW). The appropriate value for w would therefore be [5 MW / (20 MW x 0.5)] = 0.5.

Where precise values for predictable and variable load reductions are difficult to determine, estimate capacity value by assessing the timing of the project's operation and its firm and non-firm characteristics (per Table 5.1). In general terms, an electricity reduction project activity whose effects are predictable can be treated as if it provides firm power. A project activity whose effects are unpredictable can be treated as if it provides non-firm power. Assessing predictability requires careful analysis of the design and operation of the project activity and any affected systems. Predictable effects arise where the project activity has a known or constant impact. For example, the replacement of an electric motor with a more efficient model will always have the same effect on electricity consumption if the motor is always operated under the same load, or if the load varies in a predictable fashion. Unpredictable effects arise when a system is retrofitted to tailor its power use to variable and unpredictable demand. For example, a sensor installation that turns off lights when offices are unoccupied creates unpredictable results if the occupants do not have regular work schedules.

Many (if not most) electricity reduction project activities will involve elements of predictability and unpredictability, analogous to both firm and non-firm power generation. Furthermore, even predictable electricity reduction project activities do not generally provide dispatchable reductions in load. From the perspective of grid operators, therefore, a predictable electricity reduction project activity may not be fully equivalent to a firm generation project activity. Because many electricity reduction project activities will have non-firm characteristics, it may be appropriate to use a smaller value for w than the default values listed in Table 5.1. Where a smaller weight is used, this should be explained and justified with respect to the project activity's likely impact on grid capacity demand.

The capacity factor (CF) assigned to a project activity can be approximate and should be based on its expected average level of output over any given year. Any assumptions used to estimate the capacity factor should match those used in determining the project activity's capacity value.

In cases where determining a precise capacity value and/or expected capacity factor is not practical, Table 5.1 can be used to assign default value for w. Once a value of w is determined, it does not need to be updated. The same value can be used for the entire period over which baseline emissions are estimated.[2]

TABLE 5.1 Default BM/OM Weights Based on Project Capacity Value

PROJECT ACTIVITY PROVIDES	FIRM POWER	NON-FIRM POWER
On-peak, baseload, or intermittent generation	Capacity Value: High **100% BM** $w = 1$	Capacity Value: Low **50% BM + 50% OM** $w = 0.5$
Exclusively off-peak generation	Capacity Value: Low **50% BM + 50% OM** $w = 0.5$	Capacity Value: Zero **100% OM** $w = 0$

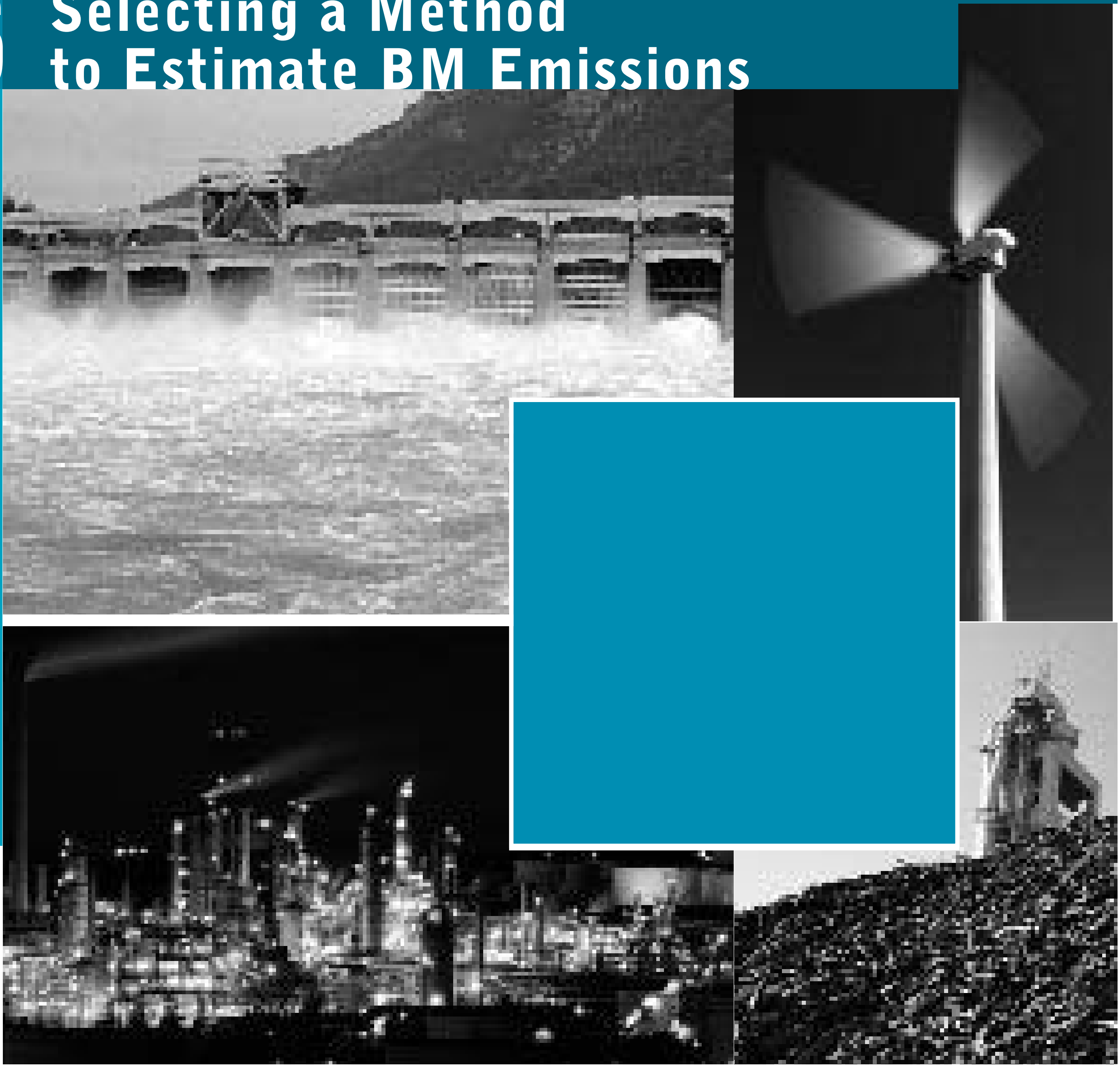
NOTES

[1] A good overview of methods for determining capacity value of wind projects, for example, can be found in Milligan, M. and K. Porter, 2005. *Determining the Capacity Value of Wind: A Survey of Methods and Implementation.* National Renewable Energy Laboratory, Boulder, Colorado, May 2005. This report surveys the results of capacity value studies in the United States.

[2] Not updating w is recommended for practical reasons, despite the fact that actual levels of project generation may fluctuate from year to year, leading to variable levels of OM displacement. If the project activity's generation is significantly and persistently higher or lower over time than was predicted at its outset, the value for w should be adjusted accordingly (i.e., using the project activity's actual capacity factor).

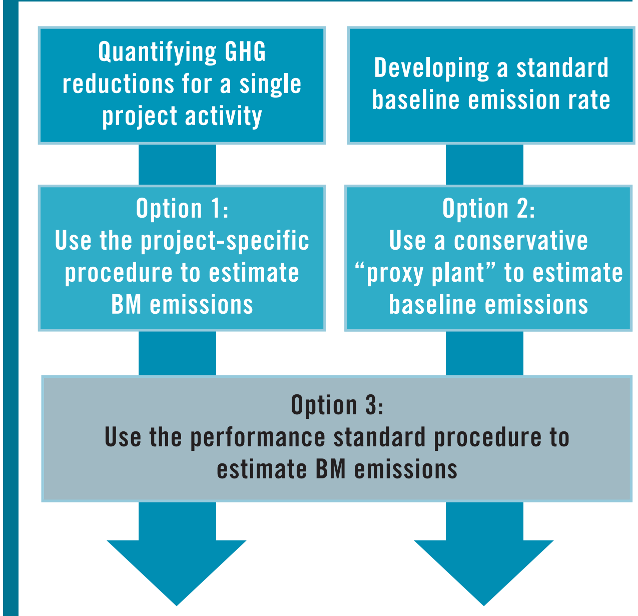
6

Selecting a Method to Estimate BM Emissions



Appropriate methods for estimating BM emissions will depend on whether these guidelines are used to quantify GHG reductions for an individual project activity, or to develop a standard baseline emission rate. See Figure 6.1.

FIGURE 6.1 Options for Estimating BM Emissions



Option #1
USE THE PROJECT-SPECIFIC PROCEDURE TO ESTIMATE BM EMISSIONS

Where GHG reductions are being quantified for an individual project activity, the project-specific procedure can be used to identify a single type of power plant to represent the BM. This type of power plant will be either: (1) the baseline candidate with the lowest barriers or greatest net benefits (excluding benefits from GHG reductions); or (2) the most conservative, lowest-emitting baseline candidate. Guidance for using the project-specific procedure is presented in Chapter 8.

Option #2
USE A CONSERVATIVE "PROXY PLANT" TO ESTIMATE BM EMISSIONS

When developing a standard baseline emission rate, BM emissions can be determined by the least-emitting baseline candidate identified in Chapter 7. Note that in some cases, this baseline candidate may have a GHG emission rate of zero.

Option #3.
USE THE PERFORMANCE STANDARD PROCEDURE TO ESTIMATE BM EMISSIONS

Under this option, the BM emission factor is determined using the performance standard procedure, and will reflect a blended emission rate of identified baseline candidates. This approach can be used for both individual project activities and for developing a standard baseline emission rate.

The best option to use will depend on circumstances and can be determined based on GHG accounting principles (Section 2.9):

- **Relevance.** Choose an option that is appropriate for the context in which the BM estimate will be used. For example, consider whether users will prefer greater rigor, greater transparency, or greater ease-of-use.
- **Consistency.** Choose an option that can be consistently applied and reproduced for similar types of GHG projects.
- **Transparency.** All else being equal, choose an option that will be transparent for relevant reviewers and for which data supporting any assessments and calculations can be easily obtained.
- **Accuracy.** There will always be a degree of uncertainty associated with BM estimates, so accuracy may be hard to gauge. However, on grids with diverse types of capacity the BM is often best represented as a blend of different resources. This can be done using the performance standard procedure (Option #3).
- **Conservativeness.** As a practical matter, it will often be easiest to conservatively estimate the BM emission rate by simply identifying the lowest-emitting viable baseline candidate (Options #1 or #2). This may be the best approach if there are significant uncertainties about the barriers and benefits facing identified baseline candidates, or about likely future capacity additions in general.

BOX 6.1 Project Activities that Only Affect the OM

Where a project activity affects only the OM ($w = 0$), it is not necessary to estimate BM emissions. OM emissions are estimated separately from the BM, using methods described in Chapter 10. When quantifying GHG reductions for an individual project activity, however, Chapter 8 should still be consulted in order to justify the baseline scenario. For electricity generation project activities, this may require identifying baseline candidates – using the guidance in Chapter 7 – in order to demonstrate that the project activity is not "common practice." See the introduction to Chapter 7 and Section 8.2.3.

7 Identifying the Baseline Candidates

The build margin for a grid-connected project activity is characterized using baseline candidates. As described in Chapter 7 of the Project Protocol, baseline candidates are alternative technologies or practices that could provide the same product or service as the project activity. They represent discrete alternatives found within a particular geographic area and commenced within a specific time period or "temporal range." For grid-connected project activities, baseline candidates represent the types of new capacity that might have been built in place of the project activity to provide the same generation. They are identified from recent capacity additions, or in some cases from under-construction or planned new capacity additions. Basic data requirements for identifying baseline candidates are presented in Box 7.1.

Where an electricity generation project activity only affects the OM, as determined in Chapter 5, identifying baseline candidates may still be necessary when quantifying GHG reductions for an individual project activity. This is because justifying the baseline scenario (Chapter 8) may involve comparison of the project activity against "common practice" alternatives. "Common practice" is defined using identified baseline candidates (see Sections 7.4 and 7.6, below). If the technology used by the project activity is common practice, then additional justification may be necessary to establish that the baseline scenario would not involve the project activity (see Section 8.2.3).

For electricity reduction project activities that only affect the OM, it is not necessary to identify baseline candidates; this chapter may be skipped.

BOX 7.1 Baseline Candidate Data Requirements

To identify a full list of baseline candidates using the guidance in this chapter, the following information and data will be necessary:

- Information on the extent of grid boundaries where the project activity is located;
- A list of power plants and/or generation units that serve the grid within these boundaries, along with their dates of initial operation;
- Information about the capacity factors or operating characteristics (e.g., baseload or load-following) of these power plant and generation units;
- Data on total power imports and exports from/to neighboring grids;
- Information about any persistent transmission constraints or areas of congestion on the grid;
- Information on any laws, regulations, or policies that could affect future capacity additions on the grid;
- Information on any unique or extenuating circumstances associated with recent capacity additions (e.g., siting exemptions).

In some cases, the following additional information may also be required:

- Where there are significant power imports, information on the power plants/generation units on neighboring grids, including their inception dates;
- Where there are few recent capacity additions, information on planned and/or under construction power plants (on local or neighboring grids, as relevant).

Finally, once the final list of baseline candidates is compiled, data on their generation and fuel consumption will be required. These data are used in Chapter 9 to calculate BM emissions.

7.1 Defining the Product or Service Provided by the Project Activity

For the purpose of identifying baseline candidates, the basic service provided by any grid-connected project activity is electrical energy, measured in watt-hours (see Annex B). However, some types of project activities generate electricity only during certain time periods (e.g., load-following or peaking power plants), and this may constrain the types of power plants that they displace. For these project activities, the timing of electricity generation is also part of the defined "service" they provide.

In general, a "baseload" power plant can displace all types of generators, including plants that are load-following. The reverse, however, is not true; load-following power plants will generally not displace baseload power. For the purposes of identifying baseline candidates, therefore, load-following project activities should be distinguished from baseload. Load-following project activities will displace only load-following baseline candidates (see Table 7.1).

TABLE 7.1 Defining Baseline Candidates Relative to the Timing of Generation

IF THE PROJECT ACTIVITY IS:	BASELINE CANDIDATES CAN BE:
Baseload/Intermittent*	• Baseload power plants; and • Load-following power plants
Load-following	• Load-following power plants only

* As noted in Section 2.3, the "baseload" category as used in these guidelines includes baseload, must-run, and intermittent power plants.

Project developers should justify how they classify both the project activity and any identified baseline candidates. While there are no hard-and-fast rules for what separates baseload from load-following power plants, the rules of thumb in Table 7.2 can be used. In general, power plants that have lower capacity factors and are dispatchable will be load-following. Most other types of generators should be considered "baseload." Box 7.2 provides guidance on how to classify electricity reduction project activities.

7.2 Identifying Possible Types of Baseline Candidates

Baseline candidates will consist of electricity generation technologies that can provide the same type – baseload or load-following – and quantity of electricity as that provided (or avoided) by the project activity. Baseline candidates will include any appropriate power plants or generation facilities identified within the geographic area and temporal range

TABLE 7.2. Classifying Power Plants as Baseload or Load-Following

ATTRIBUTE	RULE-OF-THUMB	EXPLANATION
High capacity factor	High capacity factor = baseload	Power plants with greater than an 80 percent capacity factor (i.e., they operate at or near full capacity for most of the year) may be considered baseload.[†] The reverse is not necessarily true; some plants with lower capacity factors may still operate as "baseload" generation and would not be considered load-following.
Must-run	Needed for grid reliability = baseload*	Power plants whose operation is required to ensure the reliable transmission and delivery of grid electricity are "must-run" and should be treated as "baseload" plants for the purposes of these guidelines.
Non-firm	Non-firm / intermittent = baseload*	Some plants – due to the nature of their technology or contractual provisions – provide non-firm power that is available only intermittently and cannot be dispatched. Although these generators may have low capacity factors, they should generally be treated as "baseload" for the purposes of these guidelines. The exception would be plants whose output regularly coincides with peak load requirements (see below).
Dispatchable	Dispatchable = load-following	If the power plant has controls that allow it to be dispatched (i.e., ramped up and down in response to real-time fluctuations in demand for electricity), it should generally be classified as load-following. However, some baseload plants have these controls as well.
Operates during peak load	Timed to load = load-following	Some intermittent sources of generation (e.g., some wind turbines or solar panels) may predictably provide power during times of peak load, and will therefore operate similarly to "firm" load-following power plants. These sources should be classified as load-following.

* As noted in Section 2.3, the "baseload" category as used in these guidelines includes baseload, must-run, and intermittent power plants. The rationale is that must-run and intermittent power plants, because of how they operate, can displace generation from both baseload and load-following power plants, and therefore are functionally equivalent to baseload plants in terms of their potential effect on GHG emissions.

[†] The 80 percent threshold for treating power plants as "baseload" is a rule of thumb, not an exact definition. Some baseload plants may have lower capacity factors, e.g., if they are frequently down for maintenance.

BOX 7.2 Classifying Electricity Reduction Project Activities

Electricity reduction project activities can affect the timing and need for grid electricity in diverse ways. They may improve equipment efficiency, reduce equipment operating periods, or reduce loads. Their operation may be continuous or intermittent, with constant or variable power usage. Avoided grid generation profiles may or may not clearly coincide with their particular grid's demand profile. Therefore, judgment is required in establishing whether a project should be treated as "baseload" or "load-following." For example, many efficiency projects shut off unnecessary equipment during facility quiet periods. If these periods coincide with the grid's off-peak period the savings from this shutoff activity would be treated as baseload. If the shutoff occurred during grid peak periods they would be classified as load-following.

The following table can be used to translate an electricity reduction project activity's general operation to a classification of "baseload" or "load-following."

PROJECT ACTIVITY OPERATION	CLASSIFICATION FOR IDENTIFYING BASELINE CANDIDATES
Constant reduction to a load operating at all hours	Baseload
Constant reduction during all grid-defined peak periods	Load-following
Irregular (intermittent or variable) reductions at all hours, or during grid-defined off peak periods	Baseload
Irregular (intermittent or variable) reductions during grid-defined peak periods	Load-following

defined below (Section 7.3), regardless of the technologies or fuels involved.

Some individual project activities may be premised on improving the efficiency of generation using a specific type of fuel, with the primary effect resulting from a reduction in fuel use. For example, a project developer may propose to build a high-efficiency combined-cycle coal plant, on the assumption that a less efficient, single-cycle plant would have been built otherwise. However, this assumption should not be grounds for excluding baseline candidates of other fuel types. If baseline candidates using other fuels (e.g., natural gas) are identified within the defined geographic area and temporal range, then they should be included in the analysis used to estimate BM emissions (Chapters 8 and 9). The project developer should demonstrate through this analysis that baseline emissions would in fact be equivalent (or approximate) to that of a less efficient coal plant.

Demand-side energy-saving measures do not need to be considered as baseline candidates. These measures may include end-use energy efficiency improvements, as well as installation of small-scale, site-specific or distributed energy generation systems that reduce the need for grid electricity. Although measures that reduce energy consumption from the grid can, in effect, provide the same type and quantity of service as new generation capacity, on most grids these measures are unlikely to be displaced by alternative electricity generation or reduction project activities.[1] For the purposes of these guidelines, it is therefore acceptable to exclude such measures from the baseline analysis.

7.3 Defining the Geographic Area and Temporal Range

7.3.1 DEFINING THE GEOGRAPHIC AREA

In most cases, the geographic area for identifying baseline candidates should be defined by the extent of the electrical transmission and distribution (T&D) grid where the project activity will be operating. The local grid is usually the most appropriate area for identifying the types of new capacity that might be displaced by the project activity.

Generally, a grid can be defined by the set of generating stations and T&D lines under the control of a single coordinating entity or "grid operator." The grid operator is the entity responsible for implementing procedures to dispatch power plants in a given area to meet demand for electricity in real time. The precise institutional nature of the grid operator can differ from system to system. **As a default, project developers should define the geographic area for identifying baseline candidates according to the local grid boundaries, i.e., the specific set of power plants and T&D lines over which the grid operator has dispatch control.**

There are some instances where expanding or restricting the geographic area from the local grid boundaries may be appropriate. Expanding the geographic area to include neighboring grids, for example, may be warranted under two different circumstances:

- **Where there are significant interconnections with neighboring grids.** Interconnections and coordinated dispatch are possible between grids on an international, national, or sub-national scale. Where such interconnections exist, it is possible the project activity could displace new capacity on neighboring grids. As a rule of thumb, capacity additions on neighboring grids should be considered as baseline candidates where:
    - Power imports or exports constitute more than 20 percent of total native generation on the local grid – or where planned new transmission lines could increase power imports/exports to this level in the near future;[2] and
    - Transmission between the grids is unconstrained and could be increased in the future.
- **Where there are few recent capacity additions from which to identify baseline candidates on the local grid.** It may also be appropriate to consider capacity additions on nearby grids when there have been very few local grid capacity additions within the identified temporal range (see Section 7.3.2). This should only be done if nearby grids have a similar resource mix and face comparable economic conditions. Furthermore, it should be justified why the local grid cannot serve as a sufficient geographic area for identifying baseline candidates.

Restricting the geographic area to an area smaller than local grid boundaries may also be appropriate in some circumstances. This would primarily be the case if transmission or regulatory constraints would prevent displacement of capacity on adjacent sections within the same grid control area. For example:

- Persistent transmission constraints can sometimes occur between different areas of the same grid (controlled by the same grid operator). Thus, a power plant built in one area may not be able to meet demand for electricity in a neighboring area because of chronically insufficient transmission capacity. In these cases, it would make sense to limit the geographic area to the sub-region of the grid where the project activity is located and where transmission is unconstrained. The exception would be where new transmission capacity is planned in the near future to alleviate the constraint.
- It is possible that certain jurisdictions within a grid control area could impose regulatory constraints on the type or quantity of power that can be transmitted from neighboring areas. If the project activity is located in a neighboring sub-region and the project activity would violate these regulatory constraints, then it may make sense to limit the geographic area to the sub-region of the grid where the project activity is located. See Section 7.4, below, for more guidance on these and other types of legal requirements.

Project developers should always justify the criteria and methods used to define the geographic area. The justification should explain why the chosen geographic area is appropriate for identifying baseline candidates that would accurately represent displaced BM emissions for the project activity.

7.3.2 DEFINING THE TEMPORAL RANGE

The temporal range is used to restrict the list of baseline candidates to recently built, planned, or under construction generation resources providing the same type of power as the project activity. Recently built resources are preferred, since these will have existing data on electricity generation and GHG emissions that can be used to calculate a BM emission factor. For planned and under-construction facilities, such data can only be estimated.

Defining "recently built" is somewhat arbitrary and may vary according to country or grid-specific conditions. Different types of capacity additions may occur cyclically according to overall load growth and varying needs for baseload, intermediate, and peaking power. **To ensure a sufficiently representative sample, the temporal range should be inclusive of the most recent 20 percent of capacity additions, as measured against total grid capacity.**[3] Nevertheless, the temporal range should generally not extend beyond the most recent 5 to 7 years. Depending on the grid, power plants older than seven years will tend to be unrepresentative of the types of capacity additions the project activity might actually displace. If fewer than 20 percent of recent capacity additions fall within the last seven years (determined with respect to when plants started operation), the temporal range should be shifted or expanded to include planned and under-construction capacity.

A temporal range of less than 5 to 7 years may be appropriate in situations where grid conditions, such as fuel mix, are rapidly changing. In some cases, it may even make sense to look exclusively at planned or under-construction capacity. For example, if a natural gas pipeline is being built or is planned in a region where gas was not previously available, then identifying baseline candidates from even very recently built plants may not be a good indicator of future additions.

Always explain how the temporal range is defined, regardless of the time period used. The explanation should cover why the chosen temporal range is appropriate for identifying baseline candidates that could credibly represent the build margin.[4] As a final check, if a historical temporal range is used, compare the identified baseline candidates to planned

and under-construction facilities to rule out any major shifts or discrepancies between recent and projected additions.

Finally, per Section 7.1, if the project activity provides load-following power, only load-following plants that fall within the temporal range should be identified as baseline candidates. However, both baseload and load-following plants should be considered when defining the temporal range (e.g., in determining the most recent 20 percent of capacity additions).

7.4 Defining Other Criteria Used to Identify Baseline Candidates

7.4.1 LEGAL REQUIREMENTS

Electricity grids can be subject to many types of legal requirements that could in principle constrain the list of baseline candidates identified for a project activity. In many cases, legal requirements will influence how either the geographic area or temporal range is defined. The precise nature of legal requirements will vary from country to country, and even region to region within countries. The following list is therefore not exhaustive, but provides guidance on how to consider some general types of legal requirements.

- **Laws that affect emissions performance.** Some legal requirements may affect the GHG emission rates of new power plants. These requirements do not have to be directly targeted at GHG emissions. If a law requiring reductions in pollutant emissions causes improvements in the combustion efficiency of new power plants, for example, then it may still be relevant to estimating GHG emissions. Generally, these types of requirements will effectively limit the temporal range for identifying baseline candidates. For example, if an emissions performance mandate went into effect three years ago, the temporal range should in most cases be limited to the most recent three years, in order to exclude power plants not subject to the mandate. Conversely, if a law has been enforced for many years it may not be a limiting factor, unless it calls for discrete emissions improvements on a specific timetable.

- **Laws that affect the siting or construction of particular types of power plants.** Some legal requirements, such as environmental or siting regulations, can have direct or indirect effects on the type, location, and size of new power plants. For example, siting regulations in the state of California, United States make it very difficult to build new coal-fired power plants within the state. If siting or other legal requirements have been instituted that would prevent particular types of power plants from being built in the future, then these types should be excluded from the final list of baseline candidates.

- **Portfolio standards or other resource promotion policies.** In some jurisdictions, portfolio standards or other regulatory standards may explicitly promote the development of a certain type of generation resource (e.g., renewables or nuclear power). In these cases, such resources should generally be excluded from the final list of baseline candidates because they are unlikely to be displaced or deferred. The exception would be where the project activity itself involves the type of resource being promoted; in these cases, baseline candidates involving the promoted resource should not be excluded.

- **Power import or purchasing restrictions.** In theory, it is possible for grids to have legal restrictions that affect the quantity of generation that can be imported from neighboring grids, or that restrict the sources of generation for purchased power. Quantity restrictions would function just like physical transmission constraints, i.e., they would limit the geographic area used to identify baseline candidates. Restrictions on sources of power (such as caps on emissions associated with purchased power) may limit the types of capacity additions expected in the future, and so may limit the final pool of baseline candidates (e.g., by constraining the temporal range to the period after the restrictions were enacted).

In many instances, it is possible for legal jurisdictions to not coincide with grid boundaries. This may mean that certain types of baseline candidates will be excluded for particular sub-regions on the grid – corresponding with specific legal jurisdictions – even though they should not be excluded for other parts of the grid. For example, power plants on a nationally integrated grid may face unique siting and environmental requirements in individual provinces. If provincial legal requirements affect the appropriate temporal range for identifying baseline candidates (e.g., because they were enacted within the past three years), then different temporal ranges may be used for different parts of the grid.

7.4.2 COMMON PRACTICE

In general, any type of recently constructed power plant identified within the appropriate geographic area and temporal range should be considered "common practice." Exceptions would include power plants constructed under special, one-time regulatory exemptions or extraordinary circumstances. Power plants which are clearly *not* common practice because of extenuating circumstances surrounding their construction may be excluded from the final list of baseline candidates. Project developers should justify any such exclusion and explain why the project activity would not be expected to displace this type of power plant.

Examples:

- A large nuclear power plant has been recently constructed in the geographic area because of a one-time regulatory exemption. Because similar nuclear plants will not be built in the same area over the lifetime of the project activity, this nuclear plant may be excluded from the list of baseline candidates.

- A geothermal plant has been recently constructed in the geographic area. Because the plant had special permitting requirements and there are no other sites within the geographic area physically suited for geothermal power, a similar plant is unlikely to be built in the future. It may therefore be excluded from the final list of baseline candidates.
- Geographic constraints and environmental regulations limit the construction of large-scale hydroelectric power. A recently constructed large hydro plant (exempt from regulation or built under unique circumstances) could therefore be excluded from the list of baseline candidates.
- One of the recently built plants on the grid was constructed for research and demonstration purposes. Since it involves an experimental technology and is clearly not common practice, it may be excluded from the final list of baseline candidates.

7.5 Identifying the Final List of Baseline Candidates

The final list of baseline candidates should include all power plants identified within the appropriate geographic area and temporal range. They should reflect the types of generation capacity that are likely to be built in the near future, and which could be displaced by the project activity.

Completing the final list of baseline candidates requires determining their associated GHG emissions and total generation. Preferably, the identified plants will have been operational for at least one year and have a complete annual GHG emissions and generation data set. Where simple GHG emissions data are unavailable, they should be estimated using either: (1) data on fuel consumption; or (2) data on fuel mix and operating efficiencies. Where generation data are unavailable, they can be estimated using default capacity factors by plant type.

In most cases, the number of identified baseline candidates will not be unmanageably large. However, if the project-specific procedure is used to estimate build margin emissions (Chapter 6, Option #1), it may be helpful to define some baseline candidates as representative types of power plants (see the *Project Protocol*, pp. 46-47 and Figure 7.3). Representative types should only be defined for power plants in the geographic area and temporal range that have very similar characteristics. A representative type of baseline candidate can be defined using the average efficiencies and operating characteristics of similar plants (see Box 7.3 for an example).[5]

7.6 Identifying the Baseline Candidates that Represent Common Practice

Any power plant in the final list of baseline candidates (and not excluded per the guidance in Section 7.4) should be considered "common practice."

BOX 7.3 Example of When to Define a "Representative" Baseline Candidate

Quality Wind Turbines will use the project-specific procedure to estimate BM emissions for their wind project and has identified the following list of baseline candidates:

TYPE OF PLANT	CAPACITY	FUNCTION	DATE OF OPERATION	EMISSIONS RATE (T CO_2 / MWH)
Coal-fired generating station	1,500 MW	Baseload*	2003	0.75
Coal-fired peaker	50 MW	Load-following	2000	1.00
Gas-fired combustion turbine	50 MW	Load-following	2004	0.44
Gas-fired combustion turbine	70 MW	Load-following	2004	0.39
Gas-fired combustion turbine	65 MW	Load-following	2004	0.40
Gas-fired combustion turbine	50 MW	Load-following	2004	0.42

* Because wind turbines provide intermittent power, they can be treated under these guidelines as "baseload" (see Section 2.3 and Table 7.2, above) and can therefore displace both baseload and load-following power plants. The size of the baseline candidates is not material, since they are only used to indicate the types of new capacity that could be displaced by the project activity.

For the purpose of assessing barriers and benefits (using the project-specific procedure), Quality Wind Turbines chooses to define a representative type of baseline candidate for the gas-fired combustion turbines. They do this by determining an average emission rate of the four plants identified and assigning this rate to a single, representative baseline candidate used in their analysis. They should also broadly characterize the costs, operating characteristics, siting requirements, fuel availability, and other characteristics of these plants in order to assess the barriers and benefits associated with building a new, representative gas combustion turbine.

The two coal plants, on the other hand, are treated as distinct, individual baseline candidates since they have different functions and characteristics, and they should not be combined into a single representative type. The representative baseline candidates will therefore be:

TYPE OF PLANT	CAPACITY	FUNCTION	DATE OF OPERATION	EMISSIONS RATE (T CO_2 / MWH)
Coal-fired generating station	1,500 MW	Baseload*	2003	0.75
Coal-fired peaker	50 MW	Load-following	2000	1.00
Gas-fired combustion turbine (representative)	60 MW	Load-following	2004	0.41 (average)

NOTES

[1] In practice, many electric utilities will consider "demand-side management" measures as a discrete resource and an alternative to new capacity additions. However, these measures are often driven by policy or programmatic imperatives that make it unlikely for them to be displaced or deferred. For this and other practical considerations, GHG Protocol stakeholders concluded that such alternatives may be ignored for the purpose of estimating BM emissions.

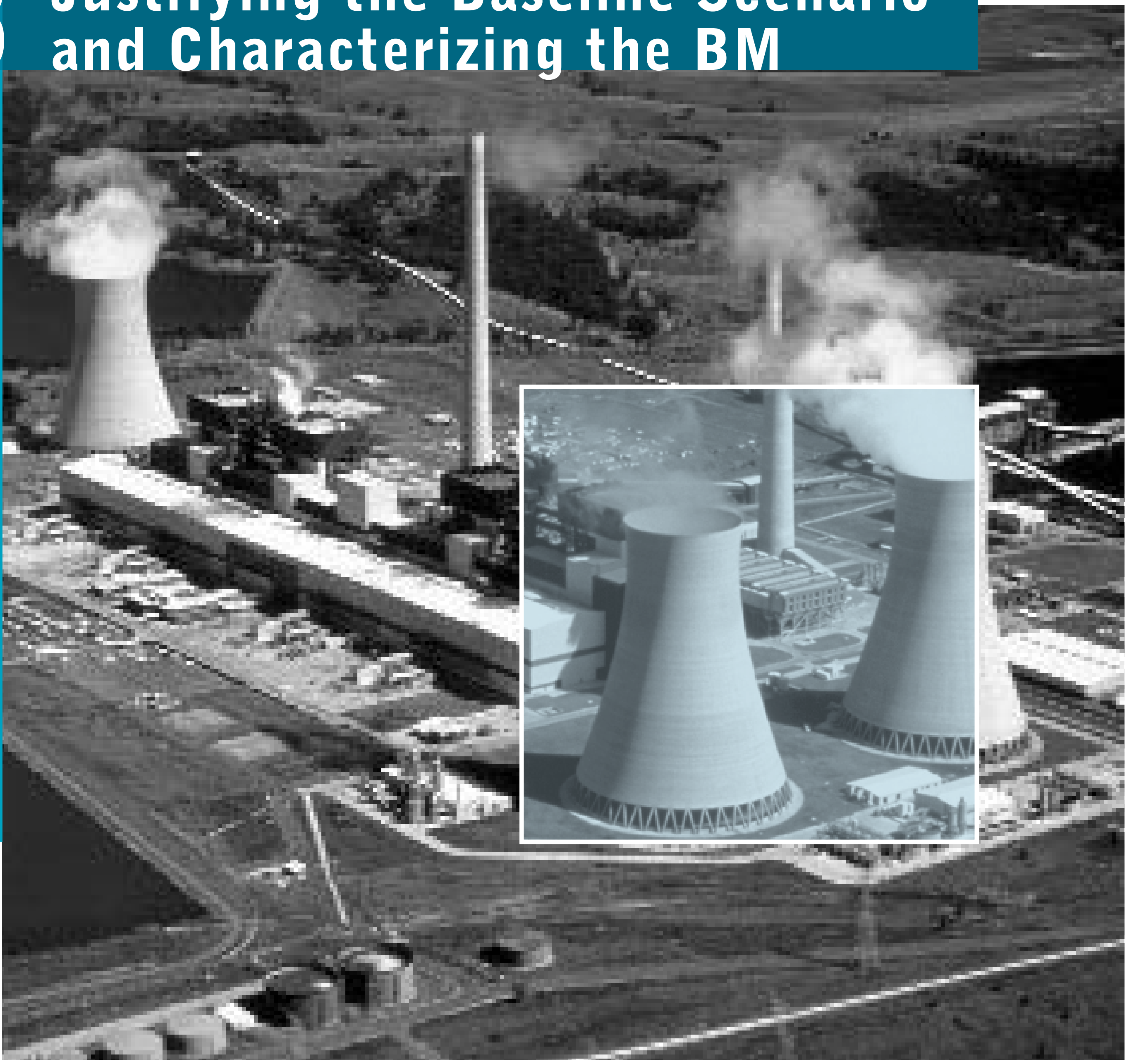
[2] The 20 percent threshold for imports/exports is recommended based on the expert opinion of the GHG Protocol stakeholders who reviewed these guidelines. It is not a "scientific" number. In all cases, users of these guidelines are advised to fully consider grid usage patterns (including what percentage of imports/exports are effectively baseload or load-following) and set the geographic area for baseline candidates accordingly.

[3] Again, the "most recent 20 percent" capacity threshold is based on the expert opinion of GHG Protocol stakeholders who reviewed these guidelines. Users of these guidelines should apply discretion where identification of the most recent 20 percent of capacity would be impractical.

[4] For more information and further guidance on determining an appropriate temporal range, see Murtishaw S, Sathaye J, and LeFranc M, 2006. "Spatial boundaries and temporal periods for setting GHG Performance Standards," *Energy Policy* 34 (12): 1378-1388.

[5] Defining a "representative type" of power plant is not the same as calculating an emissions performance standard. Rather, the objective is to identify a manageable number of BM power plant categories for evaluation using the barriers and benefits assessments of the project-specific procedure. For the purpose of estimating BM emissions, an average emission rate specific to a particular type of plant is acceptable.

8 Justifying the Baseline Scenario and Characterizing the BM



This chapter describes how to use the project-specific procedure (Chapter 8 of the *Project Protocol*) to justify the baseline scenario and characterize the BM for an individual grid-connected project activity. Basic data requirements for using the project-specific procedure are presented in Box 8.1.

As described in the *Project Protocol*, the project-specific procedure is generally used to identify the baseline scenario for a project activity (see Section 8.2 of the *Project Protocol*). For grid-connected project activities, however, it is presumed that the baseline scenario will involve generation from new power plants (the BM), generation from existing power plants (the OM), or both. The relative proportions of BM and OM generation are determined in Chapter 5. The project-specific procedure is therefore used to justify this presumption and to demonstrate that the baseline scenario would not involve the project activity itself. In effect, this means the project-specific procedure is used to establish the project activity's "additionality" (see Section 2.14 of the *Project Protocol*).

As an option, the project-specific procedure can also be used to identify a specific baseline candidate to represent the BM. The application of the project-specific procedure thus depends how BM emissions will be estimated (and whether the BM is affected):

- Where the project-specific procedure is used to estimate BM emissions (Chapter 6, Option #1), this chapter is used to justify the baseline scenario and to identify a single baseline candidate to represent the BM.
- Where the performance standard procedure is chosen to estimate BM emissions (Chapter 6, Option #3), this chapter is used only to justify the baseline scenario.
- Where the project activity will only affect the OM, this chapter is used to justify a baseline scenario consisting solely of OM generation.

Figure 8.1 provides an overview of what steps to follow depending on how (and whether) BM emissions will be estimated.

BOX 8.1 Data Requirements for Applying the Project-Specific Procedurets

Information required to perform a comparative assessment of barriers and justify the baseline scenario may include (but is not necessarily limited to) the following:

- For the project activity, and for each baseline candidate identified in Chapter 7:
  - Documentation related to any relevant barriers of the types listed in Table 8.1;
  - Where necessary, information on expected revenues, cost savings, or other potential benefits.

Information can be derived from actual baseline candidate and project data, or approximated using general sources including: general technology studies; industry studies or corporate documents; regulatory proceedings; resource planning studies; fuel price forecasts; market analyses; local advisors or experts familiar with grid conditions; and other sources.

FIGURE 8.1 How to Apply the Project-Specific Procedure to Grid-Connected Project Activities

PROJECT-SPECIFIC PROCEDURE REQUIREMENTS*	WHERE BM EMISSIONS ARE DETERMINED USING THE *PROJECT-SPECIFIC PROCEDURE*	WHERE BM EMISSIONS ARE DETERMINED USING THE *PERFORMANCE STANDARD PROCEDURE*	WHERE THE PROJECT ACTIVITY ONLY AFFECTS THE OM ($w = 0$)
8.1 PERFORM A COMPARATIVE ASSESSMENT OF BARRIERS			
8.1.1	Identify barriers to the project activity and any baseline candidates		Identify barriers to the project activity
8.1.2	Identify barriers to the continuation of current activities Where a barrier is identified, start over assuming 100% BM displacement ($w = 1$)		
8.1.3	Assess the relative importance of identified barriers for the project activity and each baseline candidate		N/A
8.2 JUSTIFY THE BASELINE SCENARIO			
8.2.1	Explain barriers to the project activity and how these barriers will be overcome		
8.2.2	Identify a baseline candidate to represent the BM. This will be either: (a) the most conservative, lowest-emitting baseline candidate; or (b) the baseline candidate with the fewest barriers or greatest net benefits (excluding GHG reduction benefits).	N/A	N/A
8.2.3	Demonstrate that the project activity faces greater barriers, or has fewer net benefits (excluding GHG reduction benefits), than the identified BM baseline candidate.	Demonstrate that the project activity faces greater barriers, or has fewer net benefits (excluding GHG reduction benefits), than at least one of the baseline candidates.	Demonstrate that the project activity faces greater barriers, or has fewer net benefits (excluding GHG reduction benefits), than the continuation of current activities.

* The numbering of these requirements parallels the structure of the project-specific procedure, as presented in Chapter 8 of the *Project Protocol*.

8.1 Performing a Comparative Assessment of Barriers

The comparative assessment of barriers determines to what extent the project activity and each baseline candidate are affected by barriers to their implementation (Section 8.1.1), and whether there are barriers to the continuation of current activities (Section 8.1.2).

The results of the comparative assessment of barriers are used in Section 8.2 for two purposes:

1. To demonstrate that the project activity faces more significant barriers than other BM alternatives and is therefore not the baseline scenario.
2. Where the project-specific procedure is used to estimate BM emissions, to identify a specific baseline candidate to represent the BM.

8.1.1 IDENTIFYING ALL BARRIERS THAT WOULD AFFECT DECISIONS TO IMPLEMENT THE PROJECT ACTIVITY OR ANY OF THE BASELINE CANDIDATES

This step is necessary for all project activities, regardless of how BM emissions will be estimated. If the project activity does not affect the BM, then only barriers to the project activity need to be identified.

Identified barriers should include anything that would discourage a decision to implement the project activity or any baseline candidates. See Table 8.1 on page 51 of the *Project Protocol* for some major categories of possible barriers. Specific types of barriers that may affect grid capacity alternatives (i.e., power plants or demand reduction measures) are listed in Table 8.1 below. This list should not be considered exhaustive.

BOX 8.2 Performing a Comparative Assessment of Barriers for Electricity Reduction Project Activities

For electricity reduction project activities, an assessment of the project activity's barriers relative to other end-use alternatives is (implicitly or explicitly) conducted in determining the "adjusted consumption baseline" and estimating electricity savings (see Chapter 3). However, if the project activity will affect the BM (as determined in Chapter 5), barriers to the project activity should also be compared to the barriers faced by possible sources of new generation capacity. This comparative assessment may be substantively and qualitatively different from the assessment used to determine electricity savings. This chapter focuses exclusively on comparing barriers (and, where necessary, net benefits) faced by the project activity and different BM capacity alternatives.

Cost data for baseline candidates can be actual or approximate. To assess financial and budgetary barriers, it may be useful to consult Appendix C of the *Project Protocol*, in particular Section C.1 on conducting an "Expected Cost Comparison." The guidance in Section C.1 can be used to generate a comparison of the cost-effectiveness of the project activity and baseline candidates for generating electricity (or reducing electricity consumption). Alternatively, it may be possible to obtain publicly available information on the cost

TABLE 8.1 . Examples of Barriers That Affect Grid Capacity Alternatives

BARRIER TYPE	BARRIER EXAMPLES
Financial and Budgetary	• Upfront capital costs • Cost of delivered electricity (e.g., levelized $/kWh) • Cost of fuel • Cost of materials (e.g., for construction or maintenance) • Power plant decommissioning or disposal costs
Technology Operation and Maintenance	• New or unproven technology • Technology with demanding technical or operational requirements
Infrastructure	• Physical siting requirements • Availability of fuel • Availability of materials • Availability of waste disposal infrastructure (e.g., for nuclear) • Lack of manufacturing or delivery capacity for relevant technologies
Market Structure	• Lack of capacity demand (e.g., excess power capacity or a capacity "overbuild") – See Box 8.3 • Regulatory conditions or market constraints that disfavor capital investments for a particular technology • Perceptional or informational market barriers (e.g., consumer failure to understand the benefits of energy savings)
Institutional / Social / Cultural / Political	• Permitting and other regulatory requirements • Public perception and acceptance

BOX 8.3 Lack of Capacity Demand and its Effect on the Baseline Scenario

A grid with excess power capacity – i.e., more than sufficient capacity to meet peak load requirements over a multi-year period – presents a unique type of "market structure" barrier (see Table 8.1). Periods of true overcapacity will be rare, but they can constitute a real barrier to new power generation projects – including, in most cases, the project activity itself (if it involves electricity generation). Under these circumstances, new power plant additions are likely to be uneconomical and therefore unlikely to occur until electricity demand grows. A project activity implemented under these conditions may not immediately displace generation at the BM (see Section 5.1). However, any capacity provided by the project activity could still avoid the need for new capacity in the future, once demand grows and market conditions change. This means that the baseline scenario may involve 100% OM displacement for a number of years, followed by BM displacement (or a combination of BM and OM displacement) once new capacity is needed. The baseline scenario should be characterized as follows:

- Assume the project activity will displace only the OM ($w = 0$) for the first time period, and justify this baseline scenario for the time period accordingly (following the guidance in this chapter).
- Determine a separate weight, w, for the second time period using the guidance in Chapter 5, assuming there is no longer excess capacity on the grid.

The length of the first time period should be estimated transparently using publicly available data. The length of this time period will depend upon the magnitude of excess capacity, and assumptions about load growth and capacity requirements. All data and assumptions used for this estimate should be reported and explained. For further guidance, consult Section 8.2.3, Box 8.6, and Box 8.8 of the *Project Protocol*.

of generating electricity for different technologies. Make sure, however, that the cost assumptions used in any publicly available studies are valid for the grid where the project activity is located.

8.1.2 IDENTIFYING BARRIERS TO THE CONTINUATION OF CURRENT ACTIVITIES

This step is only necessary if the project activity affects the OM (i.e., $w < 1$*).*

For grid-connected project activities, the "continuation of current activities" corresponds to OM electricity generation. A barrier may exist to the continuation of current activities when the grid where the project activity is located faces a significant capacity shortage, characterized by a chronic and persistent undersupply of power over extended time periods. This means that in the baseline scenario, existing OM power plants would not be able to serve the demand for generation met by the project activity. In these circumstances, notwithstanding the project activity's capacity value, the project activity should be assumed to affect only the BM. If these circumstances were not fully considered in Chapter 5, then begin a new analysis to identify the baseline scenario assuming 100% BM displacement.

8.1.3 ASSESSING THE RELATIVE IMPORTANCE OF THE IDENTIFIED BARRIERS

This step is only necessary if the project activity affects the BM (i.e., $w > 0$*).*

Following the guidance in Section 8.1.3 of the *Project Protocol*, assess the relative importance of barriers facing the project activity and the baseline candidates. Assess and rank the barriers for each baseline scenario alternative. Table 8.2 provides a generic example for how this can be done. This assessment should be done regardless of whether the project-specific or performance standard procedure will be used to estimate BM emissions.

As indicated in Table 8.2, the capacity of the project and its baseline candidates may differ markedly. The barriers for each baseline candidate, however, should be assessed according to the baseline candidate's size as it was identified in Chapter 7, not as if the baseline candidates were the same size as the project activity.

8.2 Justifying the Baseline Scenario

8.2.1 EXPLAINING THE SIGNIFICANCE OF ANY BARRIERS THAT AFFECT THE PROJECT ACTIVITY AND HOW THESE BARRIERS WILL BE OVERCOME

This step is necessary for all project activities.

Regardless of the method used to determine BM emissions, it is important to demonstrate that the baseline scenario does not involve the project activity itself. This can be done by establishing that the project activity faces greater barriers than other alternatives. Explaining how barriers to the project activity will be overcome adds credibility to the assessment of their significance and relative impact. Consult the guidance under Sections 8.2.1 and 8.2.2 of the *Project Protocol*. If the project activity faces few or no barriers, it may still be shown that the baseline scenario would involve another alternative by demonstrating that other alternatives provide greater net benefits, excluding any benefits related to GHG reductions.[1] Follow the guidance below and under Section 8.2.2, part (b) of the *Project Protocol*.

TABLE 8.2 Generic Example of Assessing and Ranking Barriers for the Project Activity and Different Baseline Candidates

	FINANCIAL & BUDGETARY	TECHNOLOGY O&M	INFRA-STRUCTURE	MARKET STRUCTURE	INSTITUTIONAL/ CULTURAL/SOCIAL/ POLITICAL	RANK BY CUMULATIVE IMPACT
10 MW Project Activity	High	Medium	High	None	Low	(4) High Barriers
50 MW Natural Gas CCCT*	Medium	Low	Low	None	Medium	(2) Second Lowest Barriers
500 MW Standard Coal Plant	Low	None	None	None	Medium	(1) Lowest Barriers
500 MW Coal IGCC**	High	Medium	None	Medium	Medium	(3) Medium Barriers
30 MW Hydro Plant	High	None	High	Low	Medium/High	(5) Highest Barriers

This table presents a possible matrix for ranking the project activity and baseline candidates by the barriers they face. The types of baseline candidates listed here are purely illustrative; actual baseline candidates will depend on the specific project activity and should be identified using the guidance in Chapter 7. Not all types of barriers will necessarily have the same importance in terms of assessing their overall cumulative impact. Finally, barrier assessments should be made with as much supporting detail and explanation as possible; a table such as this should only be used to summarize the overall results of the assessment.

* Combined-cycle combustion turbine

** Integrated gasification combined-cycle

8.2.2 CHARACTERIZING THE BM USING THE COMPARATIVE ASSESSMENT OF BARRIERS

This step is necessary where the project-specific procedure is used to estimate BM emissions (Chapter 6, Option #1).

The comparative assessment of barriers conducted in Section 8.1 can be used to identify a single baseline candidate to represent the BM. Follow the guidance for Section 8.2.2 of the *Project Protocol*. If one of the baseline candidates clearly faces lower barriers than the project activity and any of the other baseline candidates, then it can be identified to represent the BM.

If it is not easy to clearly distinguish which baseline candidate faces the lowest barriers – or comparing barriers otherwise appears insufficient to identify a candidate for the BM – then there are two options:

1. **Identify the most conservative viable alternative.** This will be the alternative with the lowest GHG emission rate. This option is only valid if the project activity clearly faces higher barriers than any of the baseline candidates, and is therefore not a "viable" alternative; otherwise, the project activity itself will generally be the lowest emitting alternative.
2. **Identify the alternative with the greatest net benefits, excluding GHG reduction benefits.** Follow the guidance for Section 8.2.2 of the *Project Protocol* to conduct a net benefits assessment. If the only examined benefit for the alternatives is electricity revenue, this assessment will in principle yield the same results as the barriers assessment (since in general it should be assumed that the different alternatives will receive the same revenue per kWh of electricity generated or avoided). In some cases, however, it may make sense to consider broader benefits for the different alternatives than revenues alone.

If the net benefits assessment is also insufficient to clearly identify a baseline candidate for the BM, use the most conservative viable alternative, or estimate BM emissions using the performance standard procedure.

8.2.3 JUSTIFYING THE BASELINE SCENARIO

This step is necessary for all project activities. How this step is performed depends on whether the project activity affects the BM, and on which procedure is used to estimate BM emissions.

WHERE THE PROJECT-SPECIFIC PROCEDURE IS USED TO ESTIMATE BM EMISSIONS

Justifying the baseline scenario involves demonstrating that the project activity faces greater barriers, or has fewer net benefits (excluding GHG reduction benefits), than other capacity alternatives (even where some of the project activity's generation might affect the OM). This demonstration can be made using the analysis conducted in Section 8.2.2 to characterize the BM. Explain the analysis and use it to justify that the baseline scenario would involve another type of new capacity, i.e., the baseline candidate identified to represent the BM.

If the results of the analysis in Section 8.2.2 are ambiguous, then the baseline scenario cannot be justified. The project activity will not result in GHG reductions.

WHERE THE PERFORMANCE STANDARD PROCEDURE IS USED TO ESTIMATE BM EMISSIONS

Under this option (Chapter 6, Option #3), the BM is represented as a blend of different types of baseline candidates. The comparative assessment of barriers should be used to demonstrate that the baseline scenario does not involve the project activity itself. This can be done by demonstrating that at least one of the baseline candidates faces significantly lower barriers than the project activity.

If the project activity does not face significant barriers – or if it is difficult to clearly show that its barriers are greater than those facing any of the baseline candidates – then conduct a net benefits assessment following the guidance in Section 8.2.2 of the *Project Protocol*. Using the net benefits assessment, indicate whether any of the baseline candidates would have significantly greater benefits (without considering GHG reduction benefits). If this demonstration is not possible, then the baseline scenario cannot be justified. The project activity will not result in GHG reductions.

WHERE THE PROJECT ACTIVITY AFFECTS ONLY THE OM

If the project activity will have no effect on the BM, then the baseline scenario will presumably involve OM generation. However, any barriers affecting the project activity and the continuation of current activities should still be identified, assessed, and explained in order to justify this presumption. If the project activity faces no significant barriers, then the baseline scenario cannot be justified. The project activity will not result in GHG reductions.

FOR ALL ELECTRICITY GENERATION PROJECT ACTIVITIES

If a technology that is similar or identical to that of the project activity was identified as a baseline candidate, the project activity should be considered "common practice" (see Section 7.6). In this case, fully justifying the baseline scenario may require explaining why the project activity's barriers are unique compared to those facing other projects of the same type.

NOTES

[1] For an explanation of why benefits related to GHG reductions should be excluded, see Box 8.4 of the *Project Protocol*, p. 54.

9 Estimating the Build Margin Emission Factor

Follow the guidance in Section 9.1 if BM emissions will be estimated from a single baseline candidate (Options 1 and 2 in Chapter 6). Follow the guidance in Section 9.2 if BM emissions will be estimated using the performance standard procedure (Option 3 in Chapter 6).

9.1 Estimating BM Emissions Using a Single Baseline Candidate

DATA REQUIREMENTS

For the single baseline candidate identified:

- Data on total generation for a specific time period (preferably at least one year)
- Data on total GHG emissions over the same time period

See Section 7.5 for guidance on obtaining these data.

Under this option, the BM will be represented by either: (1) the baseline candidate with the lowest barriers or greatest net benefits, excluding GHG reduction benefits (as identified in Chapter 8); or (2) the most conservative, lowest-emitting baseline candidate (as identified in Chapter 8, or chosen in Chapter 6 under Option 2).

The BM emission factor should be derived from actual or estimated generation and emissions data associated with the identified baseline candidate. These data should be collected in the process of identifying the final list of possible baseline candidates, as described in Section 7.5. Calculate the BM emission factor as follows:

$$BM = \frac{EM_t}{GEN_t} \tag{5}$$

Where:

- BM is the build margin emission factor (e.g., expressed as tons CO_2-equivalent per MWh);
- EM_t is the total GHG emissions from the identified baseline candidate power plant over time period t. The time period should be at least one year.
- GEN_t is the total generation from the identified baseline candidate power plant over time period t. The time period should be at least one year.

In some cases, a predetermined emission factor for the baseline candidate will already be available, in which case a calculation is unnecessary. If no data for the baseline candidate are available – for example, where the baseline candidate is derived from a planned or under construction power plant – then an emission factor should be estimated from information about its expected fuel usage and generation efficiency. The source of any emission factor used (calculated or otherwise) should be transparently reported.

9.2 Estimating BM Emissions Using the Performance Standard Procedure

DATA REQUIREMENTS

For every baseline candidate identified in Chapter 7:

- Data on total generation for a specific time period (preferably at least one year)
- Data on total GHG emissions over the same time period

See Section 7.5 for guidance on obtaining these data.

Using the performance standard procedure, the BM emission factor is calculated as a blended emission rate of identified baseline candidates. A performance standard emissions rate can be calculated following the requirements of Chapter 9 of the *Project Protocol*. The performance standard emission rate for the BM will be "production based" (*Project Protocol* Table 9.1) and should be expressed in terms of kilograms or tons of CO_2-equivalent emissions per kWh or MWh of generation. The following section provides some general guidance on how to fulfill the requirements of the performance standard procedure in order to estimate a BM emission factor.

9.2.1 SPECIFYING APPROPRIATE "PERFORMANCE METRICS" FOR THE BASELINE CANDIDATES

The "performance metric" for each baseline candidate should indicate how much fuel is consumed per MWh of electricity generated. Some common units are presented in Table 9.1. If a particular "fuel" does not give rise to GHG emissions (e.g., wind, solar, nuclear, etc.), then a performance metric does not need to be specified; baseline candidates using this fuel will have a GHG emission rate of zero.

If GHG emission rates for each baseline candidate are already known and publicly available, then separately specifying "performance metrics" and calculating emission rates is not necessary. However, the baseline candidates should still be grouped by their associated fuel type (see Section 9.2.3, below).

TABLE 9.1 . Examples of GHG "Performance Metrics" for Power Plants

FUEL TYPE	PERFORMANCE METRIC
Coal	Tons of coal burned per MWh generated (t / MWh)
Natural Gas	Cubic meters of gas burned per MWh generated (m^3 / MWh)
Oil	Liters of oil burned per MWh generated (*l* / MWh)
Wind	N/A
Hydro	N/A

9.2.2 CALCULATING THE GHG EMISSION RATE FOR EACH BASELINE CANDIDATE

Use data on fuel consumption and generation (collected in Section 7.5) to calculate GHG emission rates for each baseline candidate. Alternatively, use predetermined GHG emissions rates for each baseline candidate if they have already been calculated and are publicly available.

Fuel data should be converted to GHG emissions using recognized emission factors appropriate to each type of fuel. Emission factors for common fuel types – obtained from the Intergovernmental Panel on Climate Change (IPCC) and other sources – can be found in the GHG Protocol's "stationary combustion tool," available for download at http://www.ghgprotocol.org.[1] Emission factors should be as specific as possible to the type(s) of fuel used by each baseline candidate. For example, separate emission factors should be used for lignite and bituminous coal where data on consumption of each type of coal are available.

9.2.3 CALCULATING THE GHG EMISSION RATE FOR DIFFERENT STRINGENCY LEVELS

The *Project Protocol* requires calculating GHG emission rates for a range of different "stringency levels." The performance standard emission rate is chosen from among these stringency levels. At a minimum, determine the emission rates associated with the following stringency levels:

- **Most stringent.** This will be the emission rate of the lowest-emitting baseline candidate. This could be zero if one of the baseline candidates does not produce GHG emissions (e.g., a wind, solar, or hydro plant).
- **Weighted mean.** This will be the average GHG emission rate of all baseline candidates, weighted by their generation. Use the following formula (from the *Project Protocol*, Section 9.3):

$$\text{(6)} \quad \textit{Weighted Mean} = \frac{\sum_{j=1}^{n} (ER_j \cdot Q_j)}{\sum_{j=1}^{n} (Q_j)}$$

  Where:

  - ER_j is the GHG emission rate of baseline candidate j.
  - Q_j is the generation in MWh produced by baseline candidate j over a certain time period. The time period should be at least one year, should be the same for all baseline candidates, and should coincide with the time period used to determine the emission rate, ER_j.
  - n is the total number of baseline candidates.
- **Median.** This will be the 50th percentile emission rate of the baseline candidates.

BOX 9.1 Calculating Emissions Percentiles Where There Are Multiple Fuel Types

When calculating emission percentiles, the *Project Protocol* specifies averaging emissions across different fuel types. This avoids having percentiles be largely a function of fuel type. Thus, if the identified baseline candidates use different types of fuel, the percentile emission rates should be calculated separately for each fuel type and then averaged by total generation. The following diagram presents a schematic overview of how to do this calculation.

CALCULATING EMISSION RATE PERCENTILES BY AVERAGING ACROSS FUEL TYPES

Coal Plants: Xth percentile emission rate	x total coal MWh	= total coal GHGs (Xth percentile)
Natural Gas Plants: Xth percentile emission rate	x total gas MWh	= total gas GHGs (Xth percentile)
Oil Plants: Xth percentile emission rate	x total oil MWh	= total oil GHGs (Xth percentile)
Renewables: Xth percentile emission rate (zero)	x total RE MWh	= total RE GHGs (Xth percentile)
Other: Xth percentile emission rate	x total other MWh	= total other GHGs (Xth percentile)

OVERALL Xth PERCENTILE EMISSION RATE:

$$= \frac{\sum \text{GHGs}}{\sum \text{MWh}}$$

When grouping baseline candidates by fuel type, it is not necessary to segregate them by fuel sub-types. Power plants using any type of coal, for example, can be grouped under "coal plants." Multi-fuel plants should be grouped in multiple categories according to the percentage of their generation derived from each type of fuel.

- **Two better-than-average GHG emission rates.** For example, the 25th and 10th percentile emission rates for the baseline candidates.

Emission percentiles can be calculated by following the guidance in the *Project Protocol* under Section 9.3. In addition, Box 9.1 of the *Project Protocol* presents an example of how to calculate a percentile emission rate for a set of five hypothetical power plants that use the same type of fuel. Where different baseline candidates use different types of fuels, percentile emission rates should be calculated by averaging fuel-specific percentiles – see Box 9.1.

9.2.4 SELECTING AN APPROPRIATE STRINGENCY LEVEL FOR THE PERFORMANCE STANDARD

Consult Section 9.4 of the *Project Protocol* for guidance on selecting and appropriate stringency level. For many grids, a stringency level based on the weighted average emission rate of the baseline candidates will be appropriate. This will especially be true where the baseline candidates are fairly homogeneous in their make-up and combustion efficiencies. However, where there is a diversity of combustion efficiencies, or where the efficiency of power plants is expected to improve significantly in the future, a low-percentile stringency level will be more appropriate.

Under the performance standard procedure, the BM emission factor is determined by the emission rate associated with the chosen stringency level.

(7) $$BM = ER_s$$

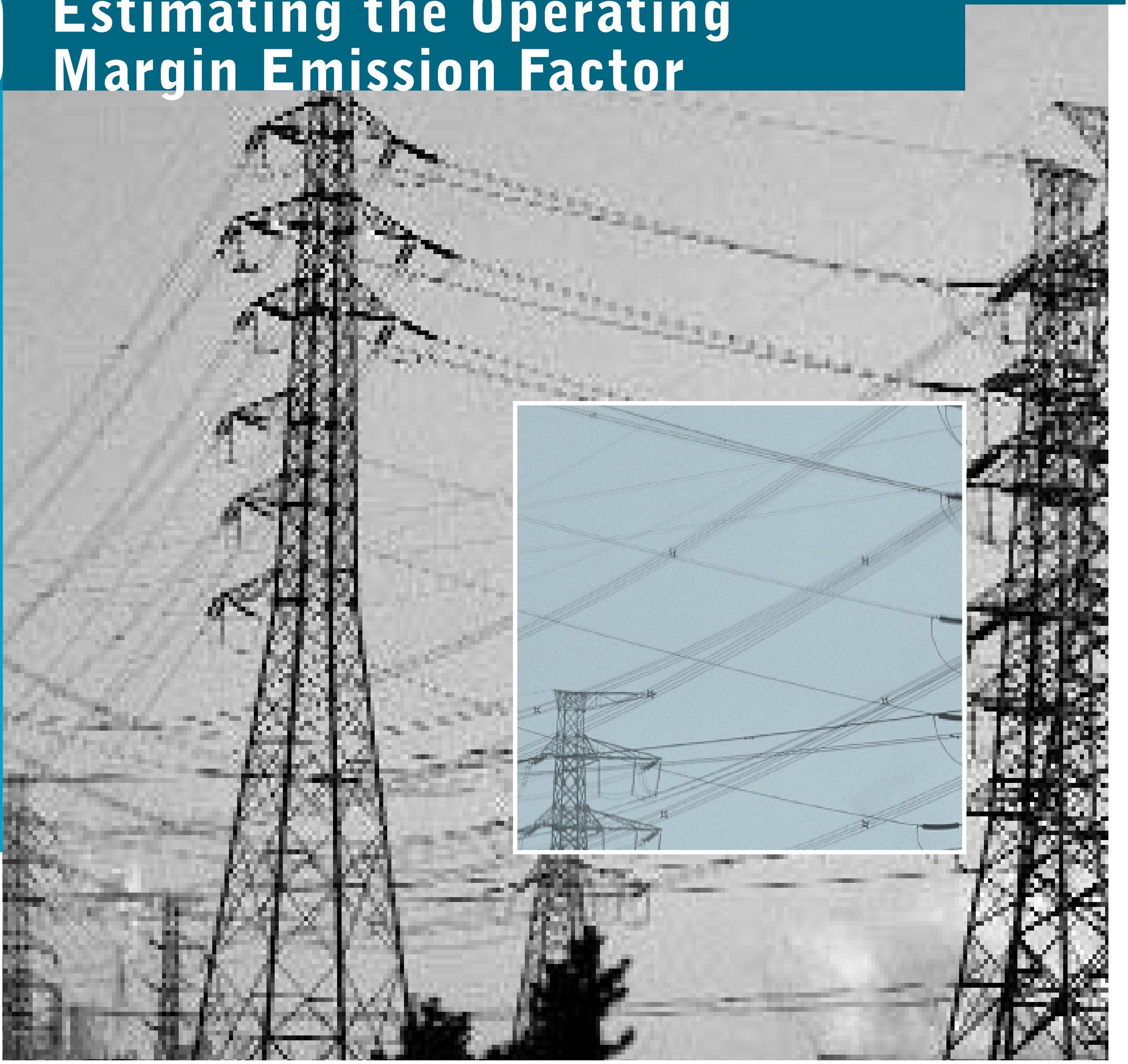
Where:

- BM is the build margin emission factor (e.g., expressed as tons CO_2-equivalent per MWh);
- ER_s is the emission rate associated with stringency level, s, as calculated in Section 9.2.3.

NOTES

[1] The complete title of the tool is the *Revised Tool for Direct Emissions from Stationary Combustion.*

10 Estimating the Operating Margin Emission Factor



The ideal method to estimate operating margin (OM) emissions would be to identify precisely which power plants on a grid are backed down in response to the project activity's operation. In practice, this is difficult if not impossible to do. Various methods can be used to approximate OM emissions, each with advantages and disadvantages concerning accuracy and ease of use.

This chapter provides guidance on applying four different types of methods. For some of these methods, detailed steps are described. For others, due to their complexity, the methods are outlined and details of their application must be elaborated by their users. In order of increasing rigor, the methods are:

1. **Average load-following.** Calculates the average annual emissions of load-following power plants.
2. **Average marginal.** Uses a load-duration curve analysis to calculate weighted average emissions of resource types that are on the margin for specific time periods.
3. **Marginal historic.** Uses an analysis of historical data (i.e., a dispatch decrement analysis) to determine a marginal emission rate for each hour the project activity operates.
4. **Marginal modeled.** Uses dispatch modeling to determine marginal emissions for each hour the project activity operates.

Another method, not presented here, is to calculate a simple average grid emission rate (e.g., total GHG emissions divided by total MWh of generation for a given time period). An average emission rate is easy to calculate, but it provides only a rough approximation of marginal displaced emissions. A simple average emission rate may be necessary in situations where data are not available to perform one of the marginal rate methods described in this chapter. Because calculating a simple average is significantly less precise than other methods, however, it should only be used where other methods are not practicable.

10.1 Choosing the Right Method

Choosing the right calculation method depends on a number of considerations. Refer to the *Project Protocol's* GHG accounting principles and keep the following considerations in mind:

- **Relevance.** Choose a method that is appropriate for the context in which the OM estimate will be used. For example, consider whether reviewers of the GHG project prefer greater rigor, greater transparency, or greater ease-of-use.
- **Completeness.** Choose a method for which it is possible to reliably meet all data requirements.
- **Consistency.** Choose a method that can be consistently applied and reproduced over time in the context where the project activity is operating. Also, consider whether the method is consistent with the method(s) used by other grid-based GHG projects in the same area.
- **Transparency.** All else being equal, choose a method that will be transparent for relevant reviewers and for which data can be easily obtained.
- **Accuracy.** Choose the most accurate method possible given data constraints, the need for consistency, the need for transparency, and relevance to the project activity's context. Generally, the more rigorous methods will be more accurate for any particular year. However, accuracy can also be improved through updating OM emission factors over time; see Section 10.2.
- **Conservativeness.** Where data and resources allow, calculate OM emissions using several methods and choose the most conservative (lowest) result. (Also, in deciding on the details for particular calculation methods, use conservative assumptions.)

In addition to these basic principles, the timing of a project's operation and the need to update emission factors over time may influence the choice of an appropriate method. See Table 10.1.

10.2 Ex Ante or Ex Post Emission Factors?

An OM emission factor can either be "static," i.e., calculated upfront and applied for the duration of the project activity's baseline scenario (also called an *ex ante* emission factor), or "dynamic," i.e., updated over time to reflect changes in grid composition and operation (also called an *ex post* emission factor). See Section 2.12 of the *Project Protocol* for further discussion of these approaches. To determine whether

TABLE 10.1 Additional Considerations for Choosing an OM Calculation Method

CONSIDERATION	EXPLANATION	APPROPRIATE METHODS
Variable timing of project output or operation	Where project output or operation is concentrated in certain time periods (e.g., by hour, month, or season), a method should be used that accurately reflects this timing.	• Methods 3 and 4 • Method 2, as long as the data used are appropriate to the timing of the project activity's operation
Need for updating	Where *ex post* emission factors are used (see Section 10.2), it may be preferable to use emission factors that are easier to update.	• Methods 1 or 2

ex ante or *ex post* emission factors are appropriate for a particular project activity, ask the following questions:

- *Are grid conditions changing significantly from year to year?* All else being equal, *ex post* emission factors should be used if marginal resources on the grid are likely to change significantly over time. This could be the case if new types of capacity are being added to the grid rapidly, or annual variations in weather or fuel availability are likely to cause significant differences in the dispatch of power plants.

- *How long are estimated baseline emissions assumed to be valid?* Estimates become more uncertain the further they are projected into the future. If the valid time length for the baseline scenario (see Section 2.11 of the *Project Protocol*) is more than five to seven years, *ex post* OM emission factors should be used.

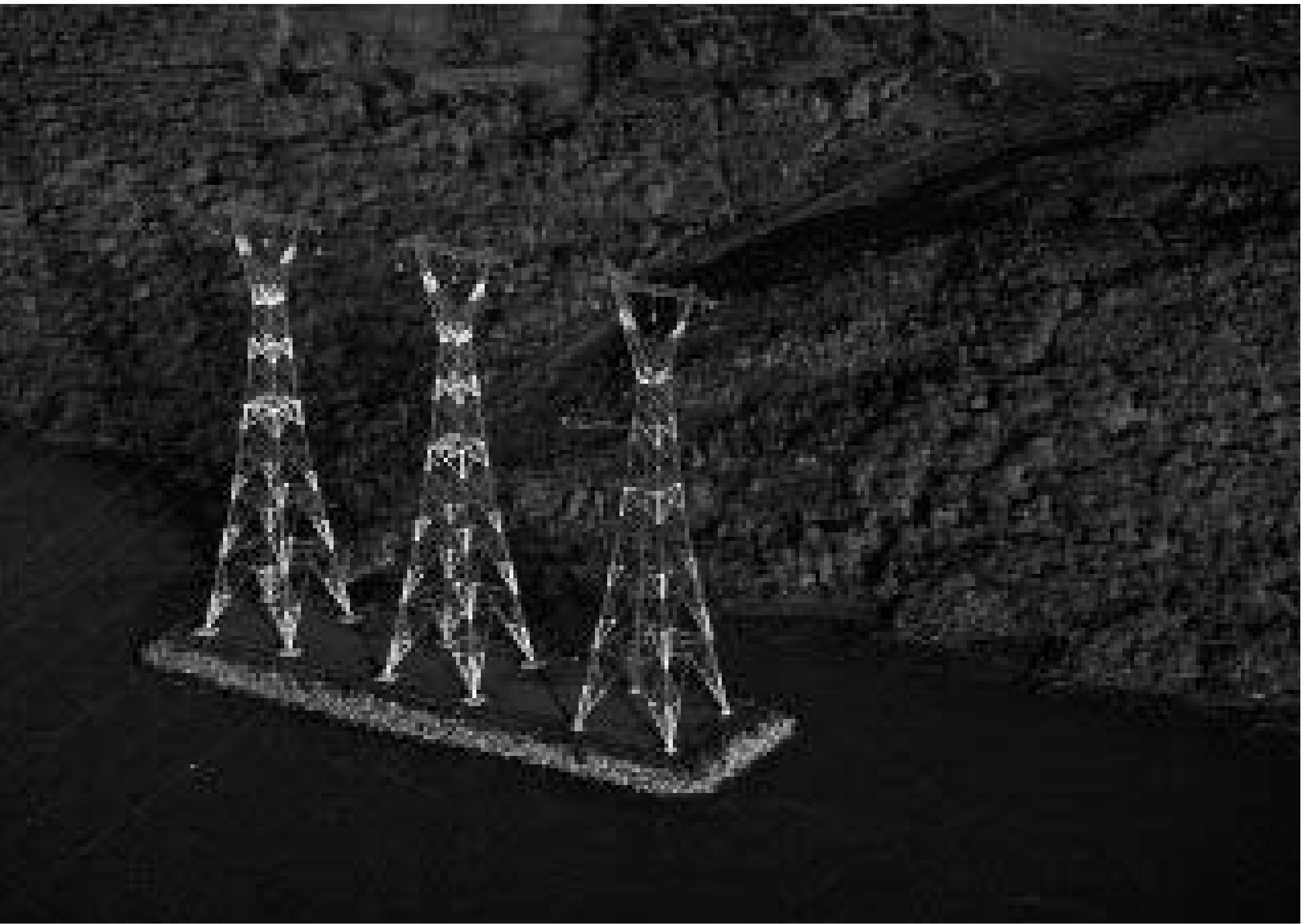
- *Are emissions data made available within a reasonable timeframe?* In some cases, grid operations and emissions data may not be available until several years after the fact. If there is a significant lag between the time that emissions occur and when the data are made available, *ex post* emission factors may be infeasible and an *ex ante* emission factor may be appropriate.

In general, *ex ante* emission factors are most appropriate where grid conditions are relatively static, or where baseline emissions are being projected only a few years into the future.[1] If an *ex ante* emission factor is used, choose the most accurate OM calculation method for which data and resources are available.

10.3 Calculating Annual Emission Factors

Baseline emissions will typically be estimated on an annual basis. This means that *ex post* OM emission factors will be calculated annually, using data for the relevant year. For *ex ante* emission factors, accuracy may sometimes be enhanced by calculating an annual average based on several years of data (historical, or projected if a dispatch model is used), to account for any year-to-year variability.

For several of the methods described in this chapter, it is necessary to calculate OM emission factors for time periods of less than a year. Using Methods 3 and 4, for example, separate OM emission factors are calculated for each hour of the year. Using the other methods, OM emission factors can in principle be calculated for each hour, day, week, month, or season wherever sufficient data are available. If emission factors are calculated for periods shorter than one year, they should be converted, or "normalized," into an annual OM emission factor specific to the project activity's output. This allows for easier quantification of GHG reductions, particularly where baseline emissions are estimated as a product of both OM and BM emission factors.



To calculate an annual OM emission factor, weight each sub-annual emission factor by the project activity's output during that time period. Use the following general formula:

$$OM_y = \frac{\sum_t (EG_{t,y} \cdot OM_{t,y})}{EG_y} \quad (8)$$

Where:

- OM_y is the OM emission factor specific to the project activity for year, y, in tonnes of CO_2-equivalent per megawatt-hour (t CO_2eq/MWh).
- $EG_{t,y}$ is the project activity's output in MWh over sub-annual time period, t (e.g., hour, day, week, month, or season) for year, y.
- $OM_{t,y}$ is the OM emission factor (expressed as t CO_2eq/MWh) calculated for sub-annual time period, t, in year, y, using one of the methods described in this chapter.
- EG_y is the project activity's total output in MWh over the year, y.

Where these guidelines are used to develop a standard baseline emission rate (rather than to estimate baseline emissions for an individual project activity) use typical estimates for $EG_{t,y}$ and EG_y appropriate to the class of projects for which the standard is being developed.

10.4 Descriptions of the OM Calculation Methods

The following section describes each type of method for calculating OM emission factors. Basic steps are prescribed for the simpler methods. The more rigorous methods will usually require consultation with grid operators or dispatch modeling professionals.

Data requirements for each method are listed at the beginning of each section. Where fuel data are needed, fuel amounts can be expressed in units of volume or mass, as appropriate. Emission coefficients for different fuel types (which generally include both CO_2 and residual non-CO_2 emissions) can be obtained from the GHG Protocol "stationary combustion tool," available for download at http://www.ghgprotocol.org.[2] Regardless of the method used, be as specific as possible with respect to different fuel types. For example, if different power plants use different types of coal with different carbon contents, these should be treated as separate fuels for the purpose of calculating the OM emission factor, assuming sufficient data are available.

10.4.1 DEFINING THE GRID BOUNDARY AND ACCOUNTING FOR POWER IMPORTS

Each calculation method requires a definition of the grid boundary where the project activity is located. The grid boundary will determine which power plants' emissions are factored into the calculation of the OM emission factor. To determine the appropriate grid boundary, follow the guidance in Section 7.3 for defining the *geographic area* used to identify baseline candidates. Make sure that any data used to calculate the OM emission factor are derived for the same grid boundary. In most cases, this should be straightforward since the data will be provided by the grid operator.

In addition to the electricity generated on the local grid, the project activity may sometimes displace electricity imported from neighboring grids. As a general rule, if power imports constitute 5 percent or more of the total generation consumed on the local grid, then these imports should be factored into the calculation of the OM emission factor.[3]

Specific procedures for factoring in power imports will depend on the type of method used to calculate the OM emission factor. However, there are two general steps for dealing with power imports:

1. **Determining an emission factor for imported power.** In principle, the emission factor for imported power can be determined using any of the same methods used to calculate the OM emission factor for the local grid. In practice, it may not make sense to expend the same level of effort. Generally, the greater the level of power imports, the more important it is to use more rigorous methods or err on the side of being conservative. In most cases, using the average load-following method will be appropriate. Alternatively, assume an emission factor of zero to be conservative.
2. **Determining what portion of imported power is on the margin.** As with local generation, imported power may serve baseload demand or respond to demand fluctuations. In theory, imported power should only be factored into the OM emission factor if in fact it is going to serve marginal demand. In practice, it may be difficult to determine whether imported power is "baseload" or "load-following." Generally, assume that all power imports are load-following unless these imports constitute more than 20 percent of total native generation on the local grid.[4] If power imports are more than 20 percent of total native generation, consult with grid operators to determine what portion of the imports can be considered "baseload" and therefore excluded from OM emission factor calculations.

Specific procedures to account for power imports are described in each section below.

10.4.2 OPERATING MARGIN METHOD #1: AVERAGE LOAD-FOLLOWING EMISSIONS

DATA REQUIREMENTS

METHOD 1A	METHOD 1B
Total generation, by power plant	Total generation, by fuel type
Total emissions or total fuel consumption, by power plant	Total installed capacity or average fuel cost, by fuel type
A list of identified baseload, must-run, and intermittent power plants	Total fuel consumption or GHG emissions, by fuel type

This type of method calculates the average annual emissions of power plants that are not baseload or must-run. The advantage of this method is that it is easy to perform and requires minimal amounts of data. However, the result is an average emission rate of load-following plants, which may or may not accurately reflect the emission rates of power plants that are actually on the margin.

There are two specific methods for calculating an "average load-following" emission factor. Method 1A is preferred; Method 1B should be used only if obtaining the data for Method 1A would be difficult.

METHOD 1A

Method 1A requires obtaining data on all power plants on the grid that do not provide baseload or must-run power. Baseload, must-run, and intermittent power plants are excluded from the calculations. Generally, it is necessary to consult with the grid operator to identify baseload, must-run, and intermittent plants for exclusion. If the grid operator does not have a list that explicitly identifies these plants, follow the guidance in Section 7.1 to identify them.[5]

Once baseload, must-run, and intermittent plants have been identified, obtain data on total generation and either total GHG emissions or fuel consumption for all remaining power plants. Calculate average emissions for load-following power plants as follows:

If directly measured GHG emissions data are available:

$$OM_t = \frac{\sum_j (EM_{j,t})}{\sum_j (GEN_{j,t})} \tag{9}$$

Where:

- OM_t is the OM emission factor for time period, t (usually one year).
- $EM_{j,t}$ is the total GHG emissions for load-following power plant, j, over time period, t.
- $GEN_{j,t}$ is the total power generation (e.g., in MWh) for load-following power plant, j, over time period, t.

If only **fuel consumption** data are available:

$$OM_t = \frac{\sum_{i,j} (F_{i,j,t} \cdot EC_i)}{\sum_j (GEN_{j,t})} \tag{10}$$

Where:

- OM_t is the OM emission factor for time period, t (usually one year).
- $F_{i,j,t}$ is the amount of fuel of type i, consumed by load-following power source, j, over time period, t. If a non-emitting (non-fossil) fuel is used, a zero value may be used for this amount.
- EC_i is the emission coefficient for fuel type, i.
- $GEN_{j,t}$ is the total power generation (e.g., in MWh) for load-following power source, j, over time period, t.

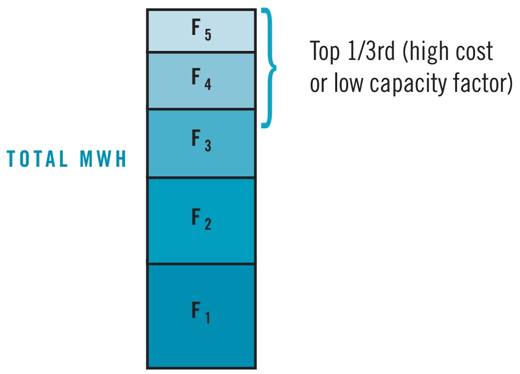
METHOD 1B

Method 1B requires aggregate information on power generation by fuel type and avoids the need for data on individual power plants. The basic approach is to rank megawatt-hours of generation by the average cost or capacity factor associated with each fuel type, and to calculate the average emissions of the top third (highest cost or lowest capacity factor). The OM emission factor is derived from the emission rate of the top third of ranked megawatt-hours. See Figure 10.1.

Ranking generation by the average fuel-based **capacity factor** is the preferred approach. Perform the following steps:

1. Identify the total generation (MWh) derived from each type of fuel used by power plants on the grid for a given time period (e.g., one year).
2. Identify total fuel consumption for each type of fossil fuel, for the same time period.
3. Identify the total installed capacity (MW) for the power plants using each type of fuel.
4. Calculate an average capacity factor for the power plants using each type of fuel:

FIGURE 10.1 Deriving the OM Emission Factor Using Method 1B



F1…F5 = different fuel types,* stacked by average capacity factor (highest to lowest)† or fuel cost (lowest to highest)

* Depending on the grid, there may be more or less than the five fuel types illustrated in this figure.

† All MWh derived from the same type of fuel will have the same associated average capacity factor.

$$CF_{i,t} = \frac{GEN_{i,t}}{CAP_{i,t} \cdot HRS_t} \tag{11}$$

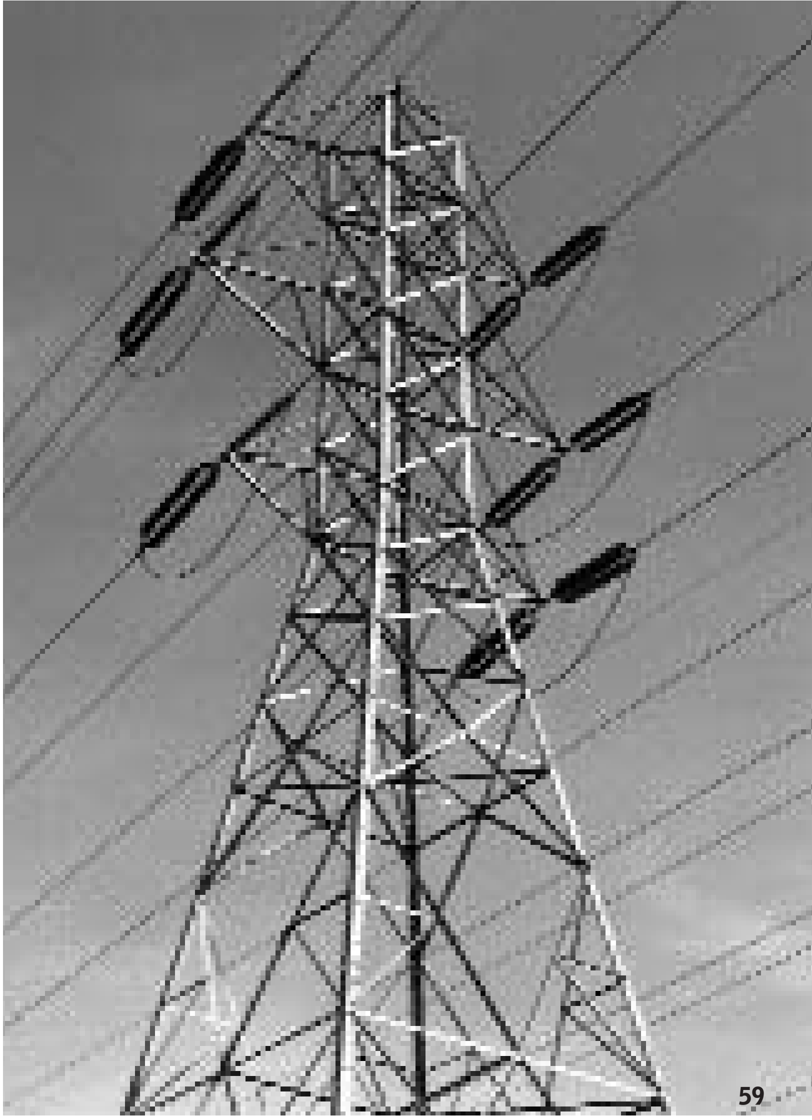
Where:

- $CF_{i,t}$ is the capacity factor for power plants using fuel type, i, over time period, t.
- $GEN_{i,t}$ is the total generation in MWh derived from fuel type, i, over time period, t.
- $CAP_{i,t}$ is the total installed capacity in MW of power plants using fuel type, i, during the time period, t.
- HRS_t is the number of hours in time period, t (e.g., for one year, 8,760 hours).

5. Rank each megawatt-hour of generation derived from each type of fuel by the average capacity factor for power plants using that type of fuel, from highest to lowest capacity factor (as illustrated in Figure 10.1). MWh at the bottom of the ranking will have the highest associated capacity factor; those at the top will have the lowest.

   Note: MWh from intermittent or non-firm power sources such as wind, hydro, or solar should be excluded from this ranking, since these sources will have low capacity factors but will not be displaced at the margin.

6. Calculate the average emissions rate of the top one third of MWh generated (i.e., the MWh with the lowest associated capacity factors):



$$OM_t = \frac{\sum_{i,j}(F_{i,t} \cdot EC_i \cdot k_i)}{m} \tag{12}$$

Where:

- OM_t is the OM emission factor for time period, t.
- i is the set of all fuels used by power plants on the grid.
- $F_{i,t}$ is the total amount of fuel of type, i, , that was consumed by all power plants on the grid over time period, t.
- EC_i is the emission coefficient for fuel type, i.
- k_i is the fraction of all MWh generated using fuel type, i, that falls into the top 1/3 of the ranking established in Step 5.
- m is the total number of MWh in the top 1/3 of the ranking established in Step 5.

If total GHG emissions are known by fuel type, then total emissions for fuel type, i, can be substituted for the expression $(F_{i,t} \cdot EC_i)$ in Equation 12.

If ranking generation by **fuel cost** (e.g., where data on installed capacity are not available), perform the following steps:

1. Identify the total generation (MWh) derived from each type of fuel used by power plants on the grid for a given time period (e.g., one year).
2. Identify total fuel consumption for each type of fossil fuel, for the same time period.
3. Identify the average unit cost for each type of fuel used by power plants on the grid (for some fuels, like wind, solar, or hydro, this may be zero).
4. Rank each megawatt-hour of generation derived from each type of fuel by the average unit cost for that fuel, from lowest to highest cost (as illustrated in Figure 10.1). MWh at the bottom of the ranking will have the lowest average unit cost; those at the top will have the highest.
5. Calculate the average emissions rate of the top one third of MWh generated (i.e., the MWh with the highest associated fuel costs):

$$OM_t = \frac{\sum_i (F_{i,t} \cdot EC_i \cdot k_i)}{m} \qquad (13)$$

Where:

- OM_t is the OM emission factor for time period, t.
- i is the set of all fuels used by power plants on the grid.
- $F_{i,t}$ is the total amount of fuel of type, i, , that was consumed by all power plants on the grid over time period, t.
- EC_i is the emission coefficient for fuel type, i.
- k_i is the fraction of all MWh generated using fuel type, i, that falls into the top 1/3 of the ranking established in Step 4.
- m is the total number of MWh in the top 1/3 of the ranking established in Step 4.

If total GHG emissions are known by fuel type, then total emissions for fuel type, i, can be substituted for the expression $(F_{i,t} \cdot EC_i)$ in Equation 13.

ACCOUNTING FOR POWER IMPORTS

First, determine the emission factor for imported power. This can be done by using Method 1A or 1B to calculate the OM emission factor for the exporting grid(s). Alternatively, assume an emission factor of zero to be conservative.

For Method 1A, treat imported load-following power as if it were generation from a single load-following power source. Calculate the *total emissions* for imported load-following power and factor this into the appropriate formula for calculating the average OM emission factor (Equation 9 or 10). If the fuel consumption formula is used (Equation 10), use total emissions for imported power in place of the fuel consumption and emission coefficient variables.

For Method 1B, treat imported load-following power as if it were generation from a distinct fuel type, and add this generation to the top third of generation from the local grid.[6] The OM emission factor should be calculated as the average emission factor for the entire top third plus the imported MWh. Equations 12 and 13, above, would thus be amended to:

$$OM_t = \frac{\sum_i (F_{i,t} \cdot EC_i \cdot k_i) + IM_t \cdot ER_{imp}}{m + IM_t} \qquad (14)$$

Where:

- OM_t is the OM emission factor for time period, t.
- i is the set of all fuels used by power plants on the grid.
- $F_{i,t}$ is the total amount of fuel of type, i, , that was consumed by all power plants on the grid over time period, t.
- EC_i is the emission coefficient for fuel type, i.
- k_i is the fraction of all MWh generated using fuel type, i, that falls into the top 1/3 of the ranking.
- m is the total number of MWh in the top 1/3 of the ranking.
- IM_t is the total number of MWh of load-following power imported over time period, t.
- ER_{imp} is the emission factor for the imported power (e.g., in tonnes of CO_2-equivalent per MWh).

10.4.3 OPERATING MARGIN METHOD #2: AVERAGE MARGINAL EMISSIONS

DATA REQUIREMENTS

- **Total system loads (power demand, in MW), by hour, for specific time periods**
- **Total generation, by fuel or resource type, for specific time periods**
- **Total emissions or total fuel consumption, by fuel or resource type, for specific time periods**
- **Optional: Fuel and/or operating costs, by fuel or resource type**

This type of method calculates an OM emission factor by averaging the emission rates of different types of power resources, weighted according to the length of time these resources actually provide power on the margin. The length of time on the margin is determined through a "load-duration curve" analysis, which reveals the types of resources that were required to meet peak system loads over a specific time period. The level of detail required for this analysis can vary, as can some of the specifics for determining marginal resources. Key variables include:

- **Time periods.** Load-duration curve analyses can be used to calculate an annual OM emission factor using an entire year's worth of data, or to calculate sub-annual OM emission factors using data for shorter time periods. Sub-annual OM emission factors will generally be more accurate, especially where marginal resources are expected to vary significantly over the year (e.g., by week, month, or season), or if project output is expected to be concentrated in certain time periods.
- **Distinctions between types of resources.** The simplest kind of analysis distinguishes between two types of resources (e.g., load-following and baseload) and determines the relative length of time on the margin for just these two types. Generally, however, accuracy will be improved by distinguishing multiple types of generation and their associated emission rates and times on the margin. Distinctions can be made by fuel and by function or type of power plant (e.g., peaking plants, single cycle, combustion turbines, etc.).
- **Resource ranking criteria.** With a load-duration curve analysis, different types of resources are assigned an overall dispatch priority rank in order to determine which resources are used to meet different load levels. Usually, resources should be ranked by average operating cost (i.e., fuel plus any operation and maintenance costs). However, where cost data are not available (or where other criteria play a significant role in dispatch priorities), other ranking criteria may be used. The description provided here assumes resources will be ranked by operating cost.

Perform the following steps to calculate the OM emission factor using average marginal emissions:

1. *Construct a load duration curve.* Over the time period being examined (e.g., one year), collect data on total grid electricity demand (load) for each hour. Plot MW of load against hours, in descending order (see Figure 10.2).
2. *Collect data on total generation by resource type.* For each resource type being considered, collect data on total generation (in MWh) over the time period being examined.
3. *Determine the average operating cost for each resource type.* The average operating cost should reflect fuel costs and any other variable costs associated with the resource type. (Use fuel costs if no other data are available.)

FIGURE 10.2 **Illustration of a Load-Duration Curve for One Year (8,760 hours)**

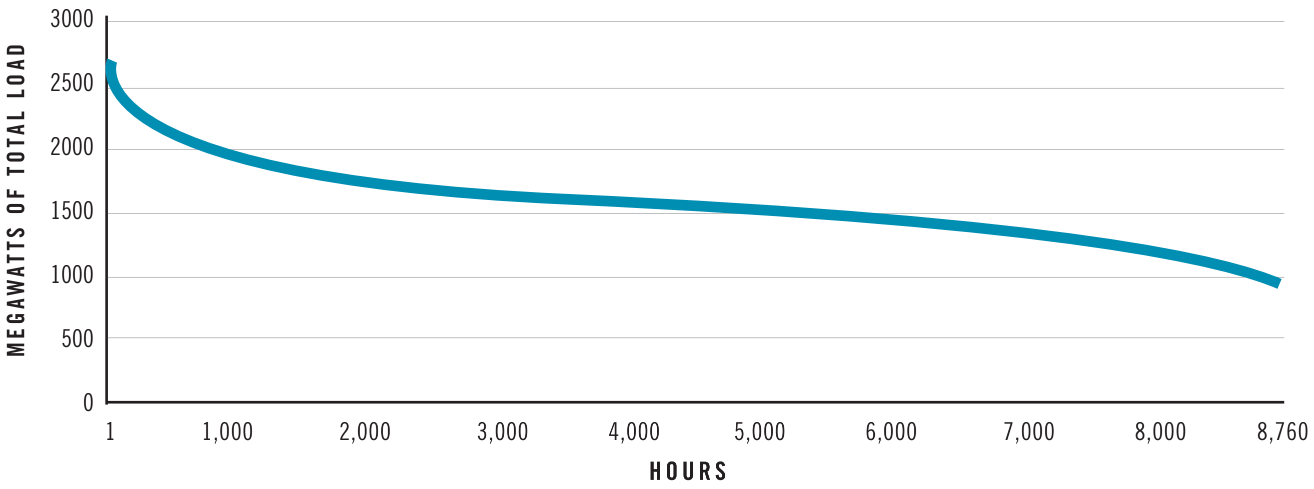
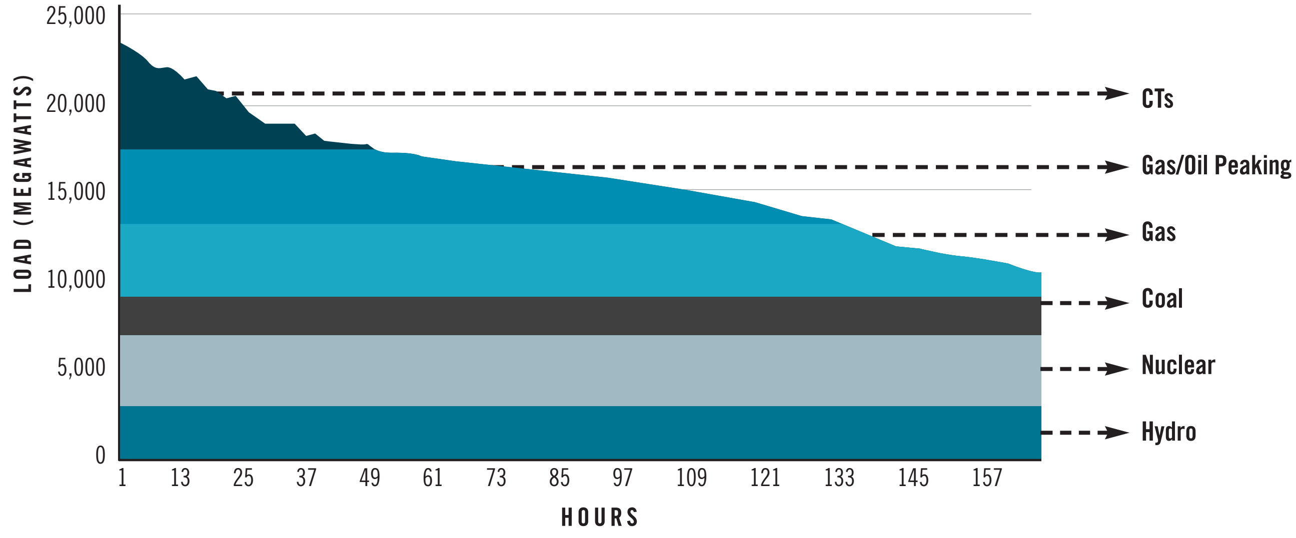


FIGURE 10.3 Single Week Load-Duration Curve "Filled" With Generation by Resource Type



Source: Synapse Energy Economics 2004

4. *Fill the load duration curve with generation from each resource type, ordered by average operating cost.* Starting with the lowest-cost resource and proceeding upward, fill the area under the load-duration curve with the total generation from each resource type.[7] The area should be filled from the bottom MW row upwards. For example, if the lowest-cost resource generated a total of 8,760 MWh, its generation would exactly fill the first MW row in Figure 10.2. Above the row corresponding to the lowest observed load level, generation will intersect the load-duration curve. See Figure 10.3, which distinguishes generation from six different resource types, with hydro the cheapest and gas combustion turbines (CTs) the most expensive in terms of average operating cost.

5. *For each resource type whose generation intersects the load-duration curve, determine the number of hours of intersection.* For each resource type, determine the highest and lowest numbered hour for which the associated generation intersects the load-duration curve. Calculate the difference; the difference represents the number of hours that the resource type is on the margin.

6. *For each resource type whose generation intersects the load-duration curve, calculate an average emission factor.* If total GHG emissions data are available by resource type, use the following formula:

$$EF_{r,t} = \frac{EM_{r,t}}{GEN_{r,t}} \tag{15}$$

Where:

- $EF_{r,t}$ is the average emission factor for resource type, r, for time period, t, which is the time period for which the load-duration curve was developed (e.g., one week in Figure 10.3).
- $EM_{r,t}$ is the total GHG emissions for resource type, r, over time period, t.
- $GEN_{r,t}$ is the total power generation (in MWh) for resource type, r, over time period, t.

Otherwise calculate emissions based on fuel consumption data:

$$EF_{r,t} = \frac{\sum_i (F_{i,r,t} \cdot EC_i)}{GEN_{r,t}} \tag{16}$$

Where:

- $EF_{r,t}$ is the average emission factor for resource type, r, for time period, t, which should correspond to the time period for the load-duration curve.
- $F_{i,r,t}$ is the amount of fuel of type i, consumed by resource type, r, over time period, t. If a non-emitting (non-fossil) fuel is used, a zero value may be used for this amount.
- EC_i is the emission coefficient for fuel type, i.
- $GEN_{r,t}$ is the total power generation (in MWh) for resource type, r, over time period, t.

7. *Calculate the OM emission factor as a time-weighted average of the emission rates for marginal resource types.* Use the following formula:

$$OM_t = \frac{\sum_r (TM_{r,t} \cdot EF_{r,t})}{HRS_t} \quad (17)$$

Where:

- OM_t is the OM emission factor for time period, t.
- $TM_{r,t}$ is the number of hours that resource type, r, was on the margin for time period, t, as determined in Step 5.
- $EF_{r,t}$ is the average emission factor for resource type, r, for time period, t, as determined in Step 6.
- HRS_t is the total number of hours in time period, t.

ACCOUNTING FOR POWER IMPORTS

First, determine the emission factor for imported power. This can be done by using the average load following or average marginal methods, described above, to calculate the OM emission factor for the exporting grid(s). Alternatively, assume an emission factor of zero to be conservative.

There are two ways that power imports can be incorporated in an *average marginal* OM analysis. The recommended approach is to treat imported power as a distinct resource type and include it in the load-duration curve analysis in the same way as other resource types. This approach requires assigning an average cost to imported power (or other appropriate metric for determining its dispatch rank relative to other resources).

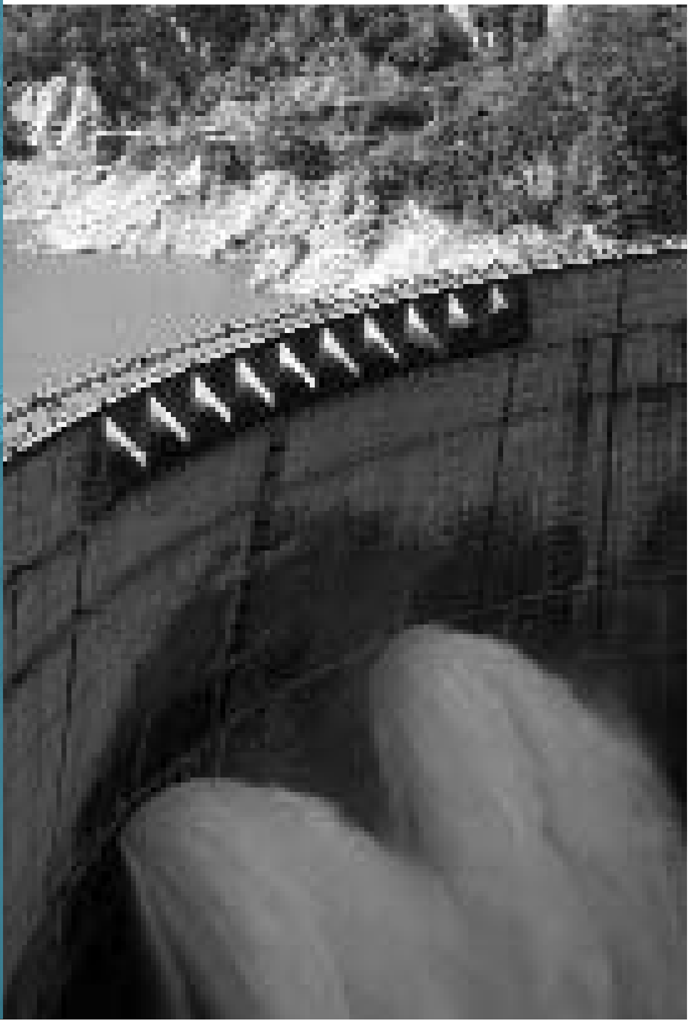
The alternative approach is to determine how much imported generation is load-following, and calculate a generation-weighted OM emission factor combining the emission factor for imported generation with the emission factor for the local grid.

10.4.4 OPERATING MARGIN METHOD #3: MARGINAL HISTORIC EMISSIONS

DATA REQUIREMENTS

- **Total generation from each power plant on the grid, by hour.**
- **GHG emissions or fuel consumption for each power plant on the grid, by hour.**
- **The system dispatch order of operation for each power plant on the grid.**

This type of method involves an analysis of historical data to determine which power plants were in the dispatch order for



the grid during each hour of a year.[8] The project activity's generation (or avoided consumption) can then be matched to the marginal generation mix in each hour to calculate an OM emissions rate. Ideally, this analysis is done with historical data derived from the same time period over which the project activity operates (*ex post*), although it can also be done using prior year data matched to project activity generation in the current year (*ex ante*).

Slightly different versions of this method are possible, depending on data availability and assumptions about how dispatch would be affected by the project activity's generation. The basic approach is described below.

1. *Determine the amount of generation (in MWh) from each power source on the grid, by hour (or for each hour in which the project activity operates).* These data must usually be obtained from the grid operator.

2. *Determine the associated GHG emissions for each power source on the grid, by hour.* If directly measured GHG emissions are not available, obtain data on fuel consumption by hour and calculate GHG emissions based on the fuel consumption.

3. *Determine the dispatch order for each power source on the grid.* Obtain from the grid operator specific information about the merit order of dispatch for each power source on the grid. Generally, merit order will be determined by cost of generation, although other factors may also come into play. The merit order of dispatch may change over time in response to changing conditions, so consult with grid operators about the best "generic" set of rules to use.

4. *Stack the generation from each power source in each hour according to the dispatch order.* Generation from each power source (determined in Step 1) should be ranked according to the dispatch order, from highest to least merit; the "top" of the stack will reflect generation from power sources that were the last to be dispatched. If the dispatch order changes over time according to regular rules (e.g., for summer versus winter), follow the dispatch order appropriate to the hour being examined.

5. *Calculate the marginal emission rate matched to the project activity's generation in each hour.* There are two basic methods for doing this:

   a. Match the amount of the project activity's generation in each hour to an equal amount of generation at the top of the dispatch order, as determined in Step 4, and calculate the weighted average emissions of this generation using the data derived in Steps 1 and 2.

   b. Calculate the average emission rate of power sources providing the top 10 percent of generation in each hour, as determined by the dispatch order in Step 4.[9] This method is generally preferred, since the apparent precision of method (a) can be somewhat illusory depending on the data used and variations in actual grid dispatch in response to the project activity. Using this method, the OM emission factor for each hour would be:

$$OM_h = \frac{\sum_n (EM_{n,h})}{\sum_n (GEN_{n,h})} \tag{18}$$

   Where:

   - OM_h is the OM emission factor for hour, h.
   - $EM_{n,h}$ is the total GHG emissions (derived in Step 2) for each power source, n, providing any amount of generation in the top 10 percent of the dispatch order in hour, h, as determined in Step 4.
   - $GEN_{n,h}$ is the total power generation for each power source, n, in hour, h.

The OM emission factor for each hour is then matched to the project activity's generation in each hour to determine an annual OM emission factor, following the guidance in Section 10.3.

RELATED METHODS

Other approaches to estimating marginal historic emissions are possible as well. One alternative is to use a regression analysis to model the relationship between overall system loads and overall grid GHG emissions for specific time periods. The slope of the resulting regression equation can be inferred to represent the marginal emission rate associated with different load levels (or, if the equation is linear, the average marginal emission rate over the time period examined). This method, however, requires access to hourly load and emissions data.[10]

ACCOUNTING FOR POWER IMPORTS

Treat imports as distinct power sources and incorporate them into the analysis on the same basis as local power sources. This requires identifying where power imports are placed in the dispatch order. Only power imports near the top of the dispatch order (e.g., in the top 10 percent for each hour) should be incorporated in the OM emission factor. The emission rate associated with power imports may be derived using any of the OM methods described in this chapter, assuming that detailed information on the source(s) of the imports is unavailable.

10.4.5 OPERATING MARGIN METHOD #4: MARGINAL MODELED EMISSIONS

DATA REQUIREMENTS

- **Depends on the model used.**

This type of method uses a model of the grid electricity system to simulate the dispatch of power sources under typical operating conditions. Globally, a number of models are available for this purpose and they can be used and applied in different ways. There are two basic approaches, however, to this type of dispatch modeling:

1. Use a "generic" modeling run for the grid to calculate a typical OM emission factor for each hour in which the project activity generates. This approach is analogous to the marginal historic method (Method #3), but relies on modeled rather than historical dispatch and emissions data. In principle, hourly marginal GHG emissions can be estimated and applied to the output from any project activity that displaces the OM.

2. Conduct separate modeling runs that simulate grid operation under identical circumstances with and without the project activity. OM emissions displaced by the project activity are estimated by comparing the results of the modeling runs. This approach requires more effort and produces project-specific results, so it generally makes sense only for large project activities.

Dispatch modeling can sometimes suffer from lack of transparency. Regardless of the approach, project developers should use a generally recognized, peer-reviewed model. Make sure that the model is appropriately calibrated to grid conditions during the period of the project activity's operation.

ACCOUNTING FOR POWER IMPORTS

Most dispatch models will include a component for modeling power imports. Follow the specific requirements of the model to determine an appropriate emission rate for imported power and to determine when imported power is on the margin.

NOTES

[1] Note, however, that GHG programs may also prescribe *ex ante* emission factors where the objective is to provide certainty about future baseline emissions to project developers and investors.

[2] The complete title of the tool is the *Revised Tool for Direct Emissions from Stationary Combustion.*

[3] The 5 percent threshold for considering imports is recommended based on the expert opinion of the GHG Protocol stakeholders who reviewed these guidelines. It is not a "scientific" number and should be used as a general rule of thumb. Users of these guidelines are advised to fully consider grid usage patterns and factor power imports into marginal emission calculations as appropriate.

[4] The 20 percent threshold for treating imports as "load following" is recommended based on the expert opinion of the *GHG Protocol* stakeholders who reviewed these guidelines.

[5] Generally, baseload and must-run plants will include hydro, geothermal, wind, nuclear and solar generation sources. However, baseload power plants will often include those using fossil fuels as well, such as coal. It is therefore recommended to explicitly identify power plants that are baseload or must-run, rather than simply excluding non-fossil fuel plants and calculating an "average fossil fuel" emission factor.

[6] Adding imported power into the top 1/3 of local grid generation may over-represent the contribution of imported power to the OM. This method is recommended, however, since it is generally not possible to determine where imported power falls in the dispatch order without additional data and information.

[7] It may help to develop a computer algorithm for this purpose.

[8] This type of analysis may be alternately referred to as a "dispatch data," "dispatch decrement" or "time-of-use marginal" analysis.

[9] The percentage of generation in each hour to include in the calculation is somewhat arbitrary. Using the top 10 percent is recommended as a rule of thumb.

[10] This method has been demonstrated in principle for grids in the United States. Contact Synapse Energy Economics (www.synapse-energy.com) for more information.

11 Estimating Baseline Emissions

Baseline emissions are estimated using a combined margin emission rate derived from a weighted average of the BM and OM emission factors.

The formula for the baseline emission rate is:

$$ER_{baseline,\ t} = w\ \ BM + (1 - w)\ OM_t \tag{19}$$

Where:

- $ER_{baseline,\ t}$ is the baseline emission rate (e.g., tons of CO_2-equivalent per MWh) for time period, t (e.g., one year);
- BM is the build margin emission factor estimated in Chapter 9. The BM emission factor is calculated only once and does not vary by time period;
- OM_t is the operating margin emission factor for time period, t, estimated in Chapter 10;
- w is the weight (between 0 and 1) assigned to the build margin, as determined in Chapter 5.

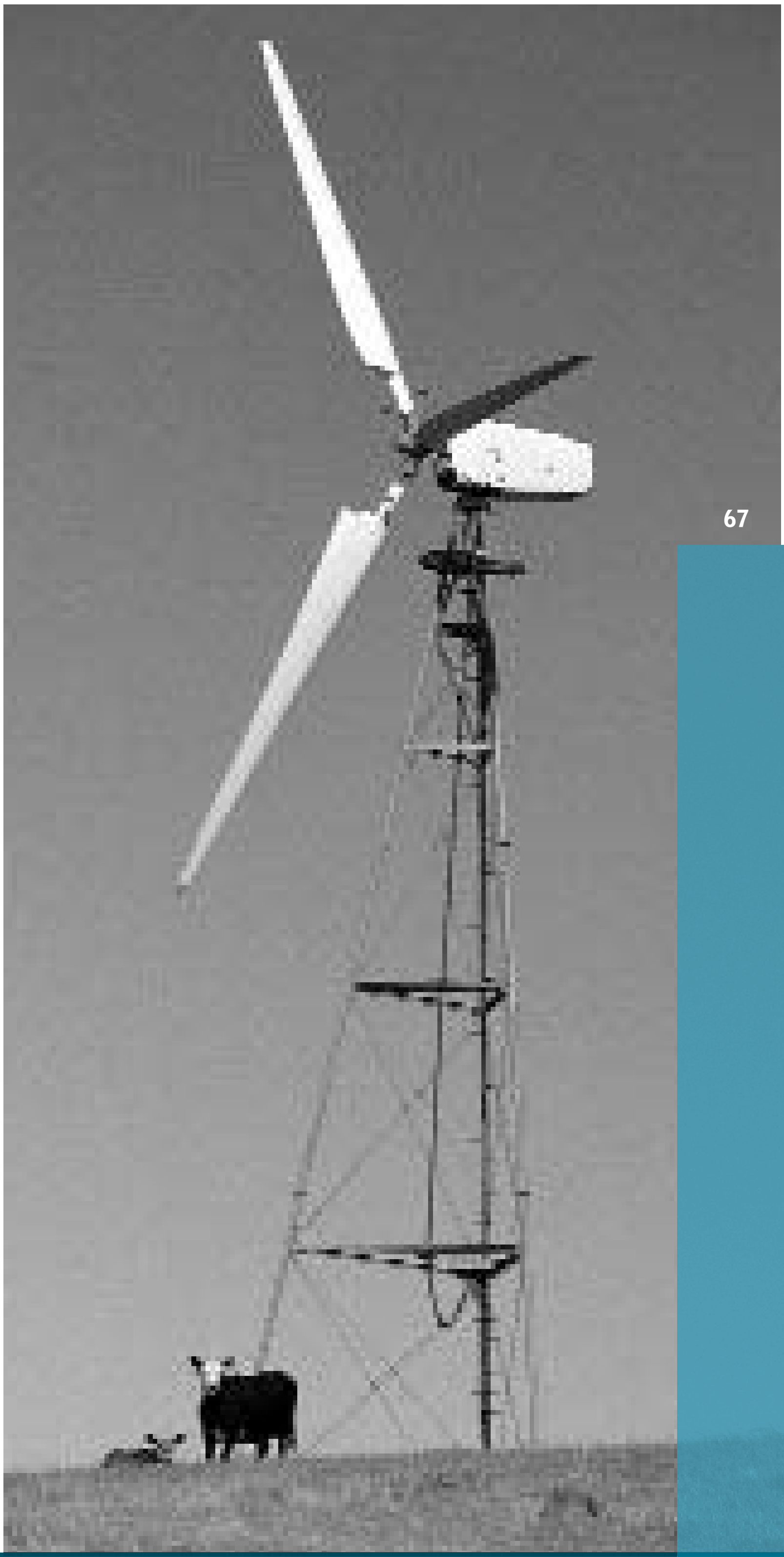
Total baseline emissions are estimated by multiplying the baseline emission rate times the total electricity generated or avoided by the project activity over the appropriate time period, t.

$$BE_t = ER_{baseline,\ t} \bullet GEN_{proj,t} \tag{20}$$

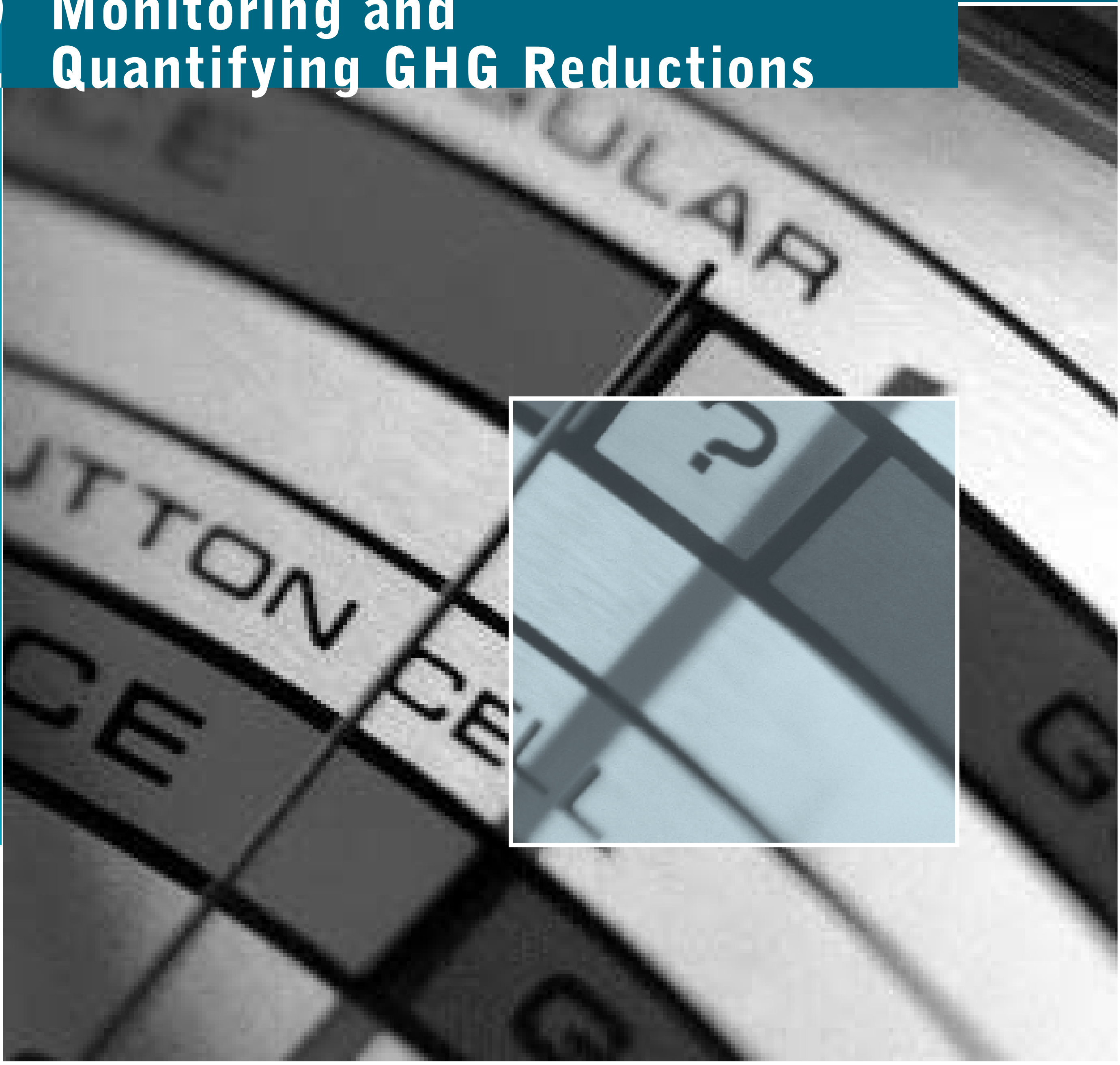
Where:

- BE_t is the total baseline emissions for time period t;
- $ER_{baseline,\ t}$ is the baseline emission rate for time period t;
- $GEN_{proj,t}$ is the electricity generated or avoided by the project activity over time period t.

As described in Chapter 3 (Section 3.3), the generation avoided by electricity-reduction project activities should be calculated using an appropriate adjustment for transmission and distribution line losses.



12 Monitoring and Quantifying GHG Reductions



Monitoring a project activity's performance is necessary to quantify its GHG reductions. The guidance in this chapter covers how to develop a monitoring plan for individual grid-connected project activities (Section 12.1). It also explains in detail how to quantify GHG reductions (Section 12.2).

12.1 Creating a Monitoring Plan

For all GHG projects, a monitoring plan is required to track project activity performance, verify and update baseline assumptions, and quantify GHG reductions. A monitoring plan is a working document that should specify how data will be collected, define responsibilities of any personnel involved in gathering the data, and describe how the data will be stored and archived.

Monitoring for electricity generation project activities is generally straightforward. Determining project activity performance consists primarily of monitoring and quantifying GHG emissions and electricity output associated with the project activity.

Monitoring the performance of electricity reduction project activities can be more complicated, in particular because of the need to adjust baseline estimates related to electricity savings (see Section 3.2). While some considerations for monitoring electricity reduction project activities are provided here, project developers are encouraged to consult resources developed by the energy efficiency industry for additional guidance. Chapter 5 of the *International Performance Measurement and Verification Protocol* (IPMVP), Volume 1 (2007), for example, provides commonly accepted guidance on developing monitoring plans for end-user project activities.

12.1.1 MONITORING PROJECT ACTIVITY EMISSIONS

Where applicable, the monitoring plan should specify how, and with what frequency, project activity emissions will be monitored. Many types of grid-connected project activities do not produce GHG emissions, e.g., renewable energy and electric efficiency projects. For project activities that do produce GHG emissions, they can be monitored in two ways:

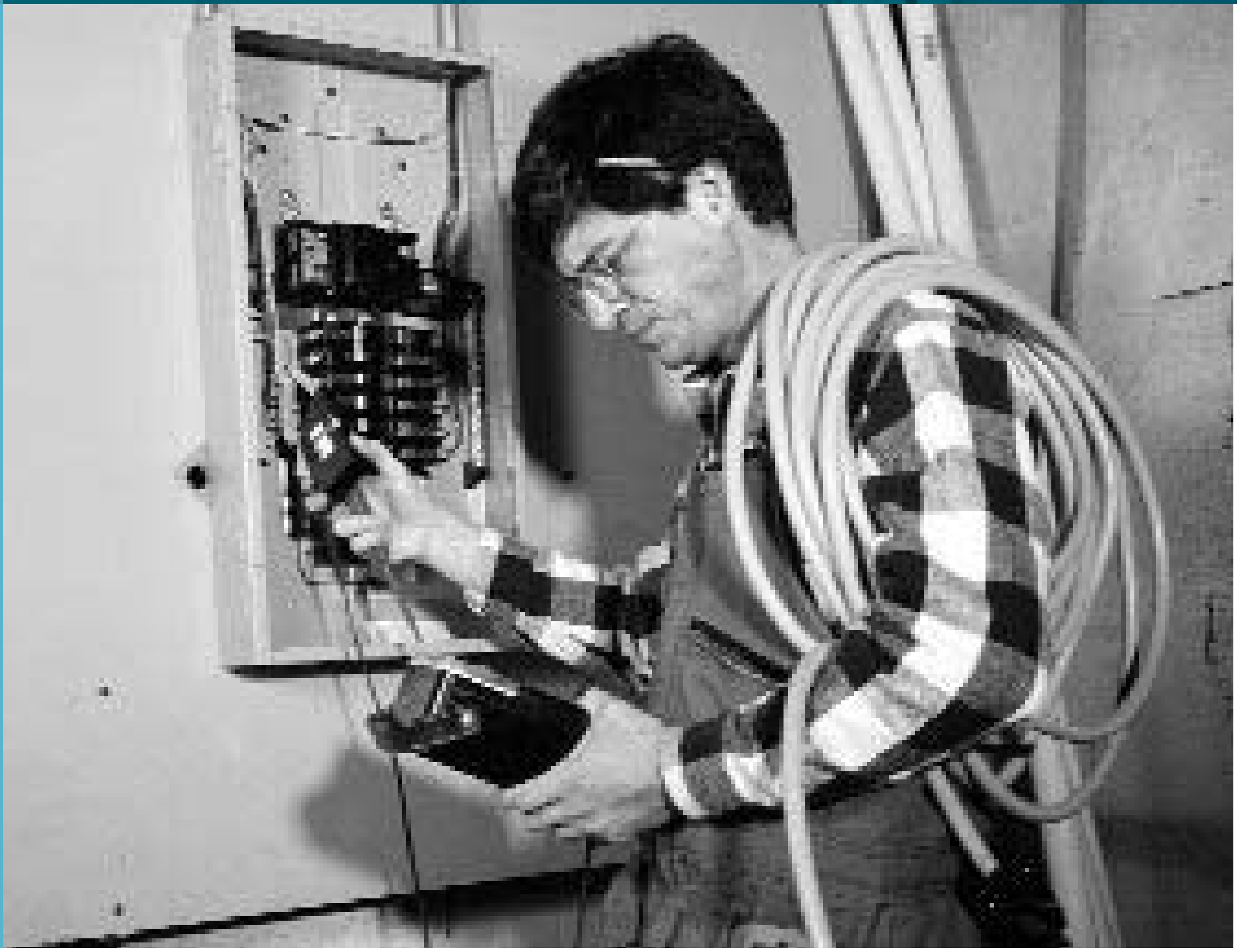
1. **Direct emissions monitoring**. Power plants can be equipped with devices that directly measure the quantity of GHGs emitted from the combustion of fossil fuels. Where such devices are installed, their data can be used to monitor project activity GHG emissions. Note, however, that these devices often track CO_2 emissions and not emissions of other GHGs resulting from incomplete combustion (e.g., CH_4 and N_2O). Following best practice (and the GHG Protocol completeness principle), these residual non-CO_2 emissions should still be estimated if they are not directly monitored.
2. **Calculation of emissions based on fuel consumption.** In many cases, the most practical way to monitor GHG emissions is by tracking the quantity of fuel(s) used by the project activity to produce electricity, and converting this quantity to total CO_2-equivalent GHG emissions using appropriate emission factors. The GHG Protocol "stationary combustion tool" contains widely used emission factors for all major fossil fuels used in energy production, obtained from the Intergovernmental Panel on Climate Change (IPCC) and other sources.[1]

If any significant secondary effects were identified in Chapter 4, emissions from the GHG sources associated with these effects should also be appropriately monitored. For grid-connected project activities, this may include monitoring emissions associated with project construction and decommissioning. In some cases, GHG emissions associated with secondary effects can be estimated rather than directly monitored; consult the guidance in the *Project Protocol* under Section 10.1.1.

12.1.2 MONITORING BASELINE PARAMETERS

The monitoring plan should specify which baseline parameters to monitor, how they will be monitored, and the frequency with which they will be monitored. Important baseline parameters for grid-connected project activities include:

1. *The quantity of electricity generated by the project activity.* Baseline emissions are estimated by multiplying project activity generation (usually in MWh) by the baseline emission rate determined in Chapter 11 (usually expressed in tons of CO_2-equivalent / MWh). For electricity generation project activities, monitoring generation is usually done by collecting metering data that indicate how much electricity was delivered to the grid. For electricity reduction project activities, more involved monitoring methods may be necessary to determine electricity savings and avoided generation.
2. *The project activity's capacity factor.* The expected capacity factor associated with a project activity will determine the weight, w, assigned to its effect on the BM (see Section 5.3). If the actual capacity factor differs significantly over time from what was originally expected, the weight assigned to the BM should be adjusted accordingly.
3. *The timing of project activity electricity generation.* The timing of project activity output and operation can also influence the weight assigned to the BM. Any *ex ante* assumptions about the timing of project output should therefore be monitored and verified in order to validate assumptions about the value for w.
4. *Operating margin emissions.* If *ex post* emission factors are used to estimate OM emissions (see Section 10.2), then data used to calculate OM emissions should be periodically monitored and updated.
5. *Grid capacity additions.* Build margin estimates will always be subject to some unavoidable uncertainty. These guidelines prescribe estimating BM emissions using recent or planned capacity additions as a basis. To validate the BM estimate, however, grid capacity additions should be monitored to ensure there are no major discrepancies



between actual new capacity and the "baseline candidates" identified in Chapter 7.

6. *Line loss factors.* For electricity reduction project activities, estimates of electricity savings must be converted to avoided grid generation in order to determine GHG reductions. This is done by taking into account T&D line losses (see Section 3.3). Line loss factors may change over time, so they should be monitored and updated as needed to ensure accuracy.

If any significant secondary effects were identified in Chapter 4, baseline parameters for the GHG sources associated with these effects should also be monitored, where applicable. The types of baseline parameters to monitor will depend on the effects identified but could include, for example, best estimates of one-time emissions for any BM capacity displaced by the project activity. Consult Chapter 4 and the general guidance in the *Project Protocol* under Section 10.1.2.

12.1.3 QUALITY ASSURANCE / QUALITY CONTROL MEASURES

The monitoring plan should describe the measures that will be used to ensure the consistency, accuracy, and completeness of all monitored data and calculations. Specific measures will depend on the type of data being monitored, and should be specific to the type of technology (e.g., meters or emissions monitors), data sources (e.g., published grid emissions data), or monitoring practices involved. At a minimum, the monitoring plan should cover the provisions listed in Section 10.1.3 of the *Project Protocol*.

12.1.4 FREQUENCY OF MONITORING

The appropriate frequency of monitoring efforts will depend on the types of parameters being monitored as well as the intended use of the resulting data. For grid-connected project activities, parameters such as electricity production or fuel consumption can be monitored on a continuous, or nearly continuous, basis using metering equipment. Other parameters such as OM emission factors, capacity additions, and line loss factors should be monitored on a less frequent basis, usually annually. However, the appropriate frequency will generally be dictated by verification regimes or the requirements of any GHG programs under which the project activity might qualify for crediting. Such requirements are beyond the scope of these guidelines.

12.2 Quantifying GHG Reductions

12.2.1 IDENTIFYING THE TIME PERIOD OVER WHICH GHG REDUCTIONS WILL BE QUANTIFIED

Grid-connected project activities may generate GHG reductions for a number of years. How many years is subject to uncertainty and will often be determined by policy considerations (see Chapter 3, Section 3.4 of the *Project Protocol*). Longer time periods may be justified for project activities whose OM emission estimates are updated over time to reflect changing circumstances (see Section 10.2). BM emission estimates, however, are generally not updated and the credibility of baseline emission estimates will tend to diminish the further they are projected into the future. Consult Section 10.2.1 of the *Project Protocol* for further guidance related to justifying a particular time period. As a default, choose a time period of 10 years.

12.2.2 USING MONITORED DATA TO QUANTIFY GHG REDUCTIONS

The "primary effect" of grid-connected project activities is to reduce combustion emissions from grid-connected power plants. To quantify GHG reductions associated with this primary effect, subtract monitored GHG emissions associated with the project activity from estimated baseline emissions.

$$\text{(21)} \quad \mathit{Primary\ Effect}_t = \mathit{Baseline\ Emissions}_{p,t} - \mathit{Project\ Activity\ Emissions}_{p,t}$$

Where:

- $\mathit{Primary\ Effect}_t$ is the quantity of GHG reductions associated with the project activity's primary effect over time period t.
- $\mathit{Baseline\ Emissions}_{p,t}$ is the quantity of baseline emissions estimated for time period t, as calculated in Chapter 11.
- $\mathit{Project\ Activity\ Emissions}_{p,t}$ is the quantity of monitored GHG emissions emitted by the project activity (where relevant) over time period t.

"Secondary effects" involve unintended changes (usually increases) in GHG emissions caused by a project activity. For significant secondary effects, any changes in GHG emissions should be calculated in a similar manner to the primary effect:

BOX 12.1 Quantifying GHG Reductions Where There are Multiple Project Activities

As indicated in Table 2.1, some grid-connected project activities may be part of a GHG project involving more than one project activity. A combined heat-and-power (CHP) project, for example, may displace both grid electricity generation and onsite energy production from a boiler. Baseline emissions for each of these effects should be estimated separately, as if they were separate project activities. In these cases, the monitored GHG emissions for the CHP project should be subtracted from the combined baseline emissions of both project activities. It is not necessary to assign a portion of the CHP project's GHG emissions to each project activity and calculate their GHG reductions separately.

$$\text{(22)} \quad \mathit{Secondary\ Effect}_{s,t} = \mathit{Baseline\ Emissions}_{s,t} - \mathit{Project\ Activity\ Emissions}_{s,t}$$

Where:

- $\mathit{Secondary\ Effect}_{s,t}$ is the quantity of GHG "reductions" – usually negative – associated with the secondary effect, s, over time period t.
- $\mathit{Baseline\ Emissions}_{s,t}$ is the estimated baseline quantity of GHG emissions from the source where the secondary effect, s, occurs over time period t.
- $\mathit{Project\ Activity\ Emissions}_{s,t}$ is the monitored or estimated quantity of actual GHG emissions from the source where the secondary effect, s, occurs over time period t.

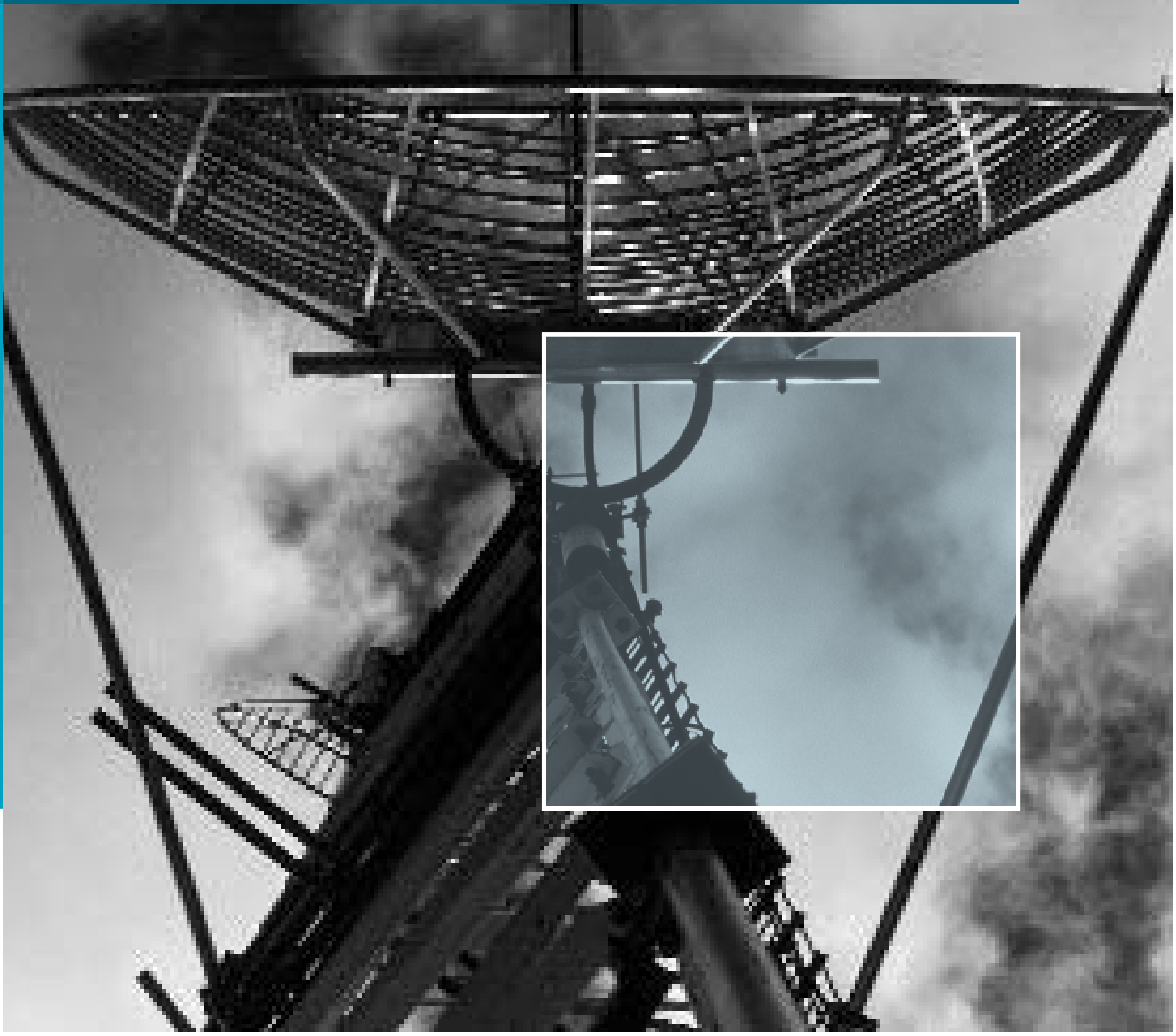
Total GHG reductions are quantified by summing primary and secondary effects:

$$\text{(23)} \quad \mathit{GHG\ Reduction}_t = \mathit{Primary\ Effect}_t + \sum_s (\mathit{Secondary\ Effect}_{s,t})$$

NOTES

[1] The complete title of the tool is the *Revised Tool for Direct Emissions from Stationary Combustion.* It is available for download free-of-charge at http://www.ghgprotocol.org.

13 Reporting GHG Reductions



Project developers who report GHG reductions for an individual project activity should adhere to all the requirements of Chapter 11 of the *Project Protocol*. This means that all information relevant to the quantification of GHG reductions should be reported.

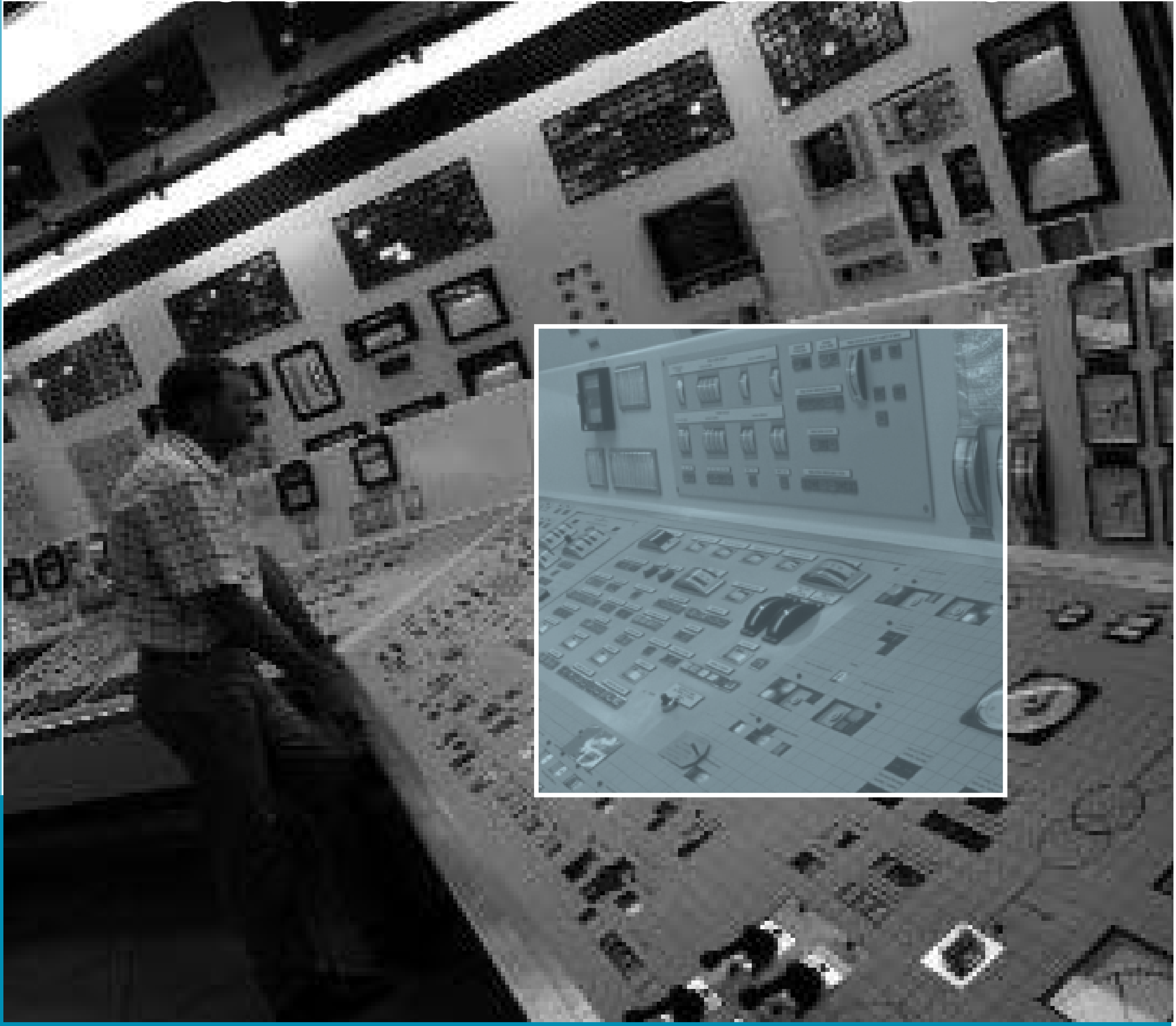
In addition to the general requirements of the *Project Protocol*, the following items should be reported for grid-connected project activities:

1. The weight, w, assigned to the BM and an accompanying justification, following the guidance in Chapter 5.
2. The choice of procedure used to estimate BM emissions and an accompanying explanation, following the guidance in Chapter 6.
3. The emission rate calculated for the BM along with accompanying documentation, following the guidance in Chapter 9.
    - 3a. Where the performance standard procedure is used to estimate BM emissions, a justification for the chosen stringency level, following the guidance in Chapter 9, Section 9.2.4.
4. The choice of method used to estimate OM emissions and an accompanying explanation, following the guidance in Chapter 10.
5. The emission rate calculated for the OM along with accompanying documentation, following the guidance in Chapter 10.
6. Whether the OM emission rate will be set *ex ante*, or updated *ex post* over the GHG project's reporting period, following the guidance in Chapter 10, Section 10.2.
7. The calculated baseline emission rate, following the guidance in Chapter 11.
8. A description of the monitoring plan, following the guidance in Chapter 12.

Finally, annual monitoring reports should be provided that present calculations of quantified GHG reductions based on monitored data, and report any updates to the OM emission factor and any other relevant baseline parameters. Annual monitoring reports should report data on all parameters described in the monitoring plan and include:

1. Actual project activity generation in MWh; or
2. Estimated electricity savings and avoided generation in MWh, following the guidance in Chapter 3.

PART III: EXAMPLES OF BASELINE EMISSION RATE CALCULATIONS



This section presents examples of applying the guidelines in Part II to estimate baseline emission rates for three hypothetical grid-connected electricity projects. The examples are intended to illustrate some of the different options for estimating baseline emissions, as well as how different types of project activities on the same grid may have different effects on BM and OM emissions.

The three hypothetical GHG projects are:

GHG PROJECT	PROJECT ACTIVITY
1. A 20 MW biomass-fueled, load-following power plant	**Generate zero-emission electricity from biomass combustion***
2. A 20 MW wind power installation	**Generate zero-emission electricity from wind energy**
3. An industrial-site electric efficiency upgrade with a minimum continuous load reduction of 500 kW	**Reduce consumption of grid electricity**

* *For this example, biomass fuel will be treated as having zero net GHG emissions.*

All three project activities are assumed to take place in India, in the state of Assam, and are assumed to be implemented at the beginning of 2007. This location was chosen because basic relevant data on power plants and their GHG emissions were easily accessible for the region from India's Central Electricity Authority.[1] The examples are not the product of extensive research or road-testing, and various assumptions used in the following analyses may or may not reflect actual conditions.

These examples are meant only to illustrate methods for estimating baseline emissions, and do not present a full accounting of GHG reductions. The examples therefore do not cover defining the GHG assessment boundary and identifying secondary effects (Chapter 4); monitoring and quantifying GHG reductions (Chapter 12); or reporting (Chapter 13). Since the examples involve individual project activities, however, the procedures in Chapter 8 for justifying the baseline scenario and (where appropriate) characterizing the BM are illustrated. (When developing standard baseline emission rates for general *types* of project activities, Chapter 8 can be skipped.) Finally, methods for determining electricity savings (Chapter 3) are also not addressed here.

To facilitate comparisons, the steps in Chapters 5 through 11 are presented below for all three examples concurrently.

CHAPTER 5:
Determining the Extent of BM and OM Effects

5.1 Assessing Grid Capacity Demand

India's electricity system is divided into five interconnected regional grids, each managed by a Regional Load Dispatch Centre (RLDC). The five grids are the Northern, Eastern, Western, Southern, and North-Eastern grids. The state of Assam, where our hypothetical projects are located, is covered by the North-Eastern grid.

The North-Eastern grid, like the other Indian grid regions, often does not have enough capacity to meet peak demand. For the purpose of these examples, we will assume that capacity shortages occur intermittently and only during certain times of the year. (Where capacity shortages are chronic, e.g., they occur daily or weekly, project activities should be assumed to affect only the BM; for these examples, we wish to illustrate both BM and OM estimations.)

5.2 Assessing Whether the Project Activity Meets Capacity Demand

1. **20 MW Biomass Plant.** This project, though not overly large, is nevertheless designed to help meet capacity demand and will be recognized by grid operators for that purpose.
2. **20 MW Wind Plant.** This project provides only intermittent power, but the project was intended to help meet grid generation needs and therefore will help to meet demand for capacity.
3. **500 kW electricity reduction project.** This project is primarily driven by site-specific considerations related to electricity consumption. Because of its small size and the fact that it is not a factor in any economic or planning decisions related to grid capacity needs, it will not displace new capacity. It therefore only affects the OM ($w = 0$).

5.3 Assessing the Project Activity's Capacity Value

1. **20 MW Biomass Plant.** This project provides firm power and is capable of operating at all hours. Its capacity value is roughly equal to its rated capacity of 20 MW, which is greater than its expected average utilization of 8 MW (it has an expected capacity factor of 40 percent). Per Equation 4, it will therefore displace generation exclusively at the BM ($w = 1$).
2. **20 MW Wind Plant.** This project provides non-firm, intermittent power. Its capacity value is low, although an exact number is not known. Since there is no reason to believe that the power will only be available during off-peak hours, one option is to use the default, $w = 0.5$. However, the project developer has commissioned a study suggesting the appropriate capacity value for wind projects of this type should be around 1 MW. The project's expected capacity factor is 25 percent. Therefore, the value assigned to w will be [1 MW / (20 MW x 0.25)] = 0.2.

3. **500 kW electricity reduction project.** Assessing this project's capacity value is not necessary because it was already determined that it will not displace any capacity, in Section 5.2.

SUMMARY

The baseline emission rate ($ER_{baseline}$) for each project activity will be determined accordingly:

1. *20 MW Biomass Plant.*
   $ER_{baseline} = BM$
2. *20 MW Wind Plant.*
   $ER_{baseline} = (0.2)BM + (0.8)OM$
3. *500 kW electricity reduction project.*
   $ER_{baseline} = OM$

Where BM and OM are the build margin and operating margin emission factors, respectively.

CHAPTER 6:

Selecting a Method to Estimate BM Emissions

The following methods will be used to estimate a BM emission factor for each project activity.

GHG PROJECT	SELECTED BM METHOD
1. 20 MW Biomass Plant	**Project-Specific Procedure (Chapter 8)**
2. 20 MW Wind Plant	**Performance Standard Procedure (Chapter 9)**
3. 500 kW electricity reduction project	**N/A (The project only affects the OM)**

CHAPTER 7:

Identifying the Baseline Candidates

7.1 Defining the product or service provided by the project activity

1. *20 MW Biomass Plant* – **Load-following.** This project will be dispatchable and designed to respond to fluctuations in grid load. It is likely to have a low overall capacity factor (40 percent) because it is not used for baseload power.

2. *20 MW Wind Plant* – **Baseload.** This project will have a low capacity factor, but only because it provides non-firm (intermittent) power. Because it is non-firm, it should be considered "baseload" for the purpose of identifying baseline candidates.

3. *500 kW electricity reduction project* – **N/A.** This project only affects the OM. Because it is an electricity reduction project activity that has no effect on the BM, baseline candidates do not need to be identified.

7.2 Identifying possible types of baseline candidates

The baseline candidates identified for project #1 will consist only of other load-following power plants found within the geographic area and temporal range defined below. The baseline candidates for project #2 will consist of both baseload and load-following plants.

TABLE 1 Identified Baseline Candidates with Generation Data

NO.	TYPE OF FUEL	CAPACITY	FUNCTION*	DATE OF OPERATION	EMISSION RATE(T CO_2 / MWH)
NORTH-EASTERN GRID					
1	Diesel	6 MW	LF	March 2002	0.60
2	Diesel	6 MW	LF	March 2002	0.60
3	Diesel	6 MW	LF	March 2002	0.60
4	Diesel	6 MW	LF	March 2002	0.60
5	Diesel	6 MW	LF	March 2002	0.60
6	Natural Gas	21 MW	BL	November 2002	0.91†
7	Natural Gas	21 MW	LF	July 2002	0.43
8	Hydro	25 MW	BL	December 2003	0.00
9	Hydro	135 MW	BL	January 2002	0.00
10	Hydro	135 MW	BL	January 2002	0.00
11	Hydro	135 MW	BL	March 2002	0.00
12	Hydro	8 MW	BL	April 2003	0.00
EASTERN GRID					
13	Coal	500 MW	BL	January 2003	1.00
14	Coal	500 MW	BL	October 2003	1.00
15	Coal	500 MW	LF	May 2004	1.00
16	Coal	210 MW	LF	October 2004	1.29
17	Coal	500 MW	LF	February 2005	1.00

* LF = Load-following; BL = baseload

† This is the plant's published emission rate, although it is anomalously high for a natural gas plant.

7.3 Defining the Geographic Area and Temporal Range

GEOGRAPHIC AREA

All three of the GHG projects discussed here are located on India's North-Eastern grid. Power generation on the North-Eastern grid is managed by a single RLDC. The grid has a significant interconnection with the Eastern grid, and is also connected to grids in Nepal and Bhutan. In fiscal year 2005, over 2,100 GWh were imported from the Eastern Grid, which was 27 percent of the native generation on the North-Eastern grid.[2] Because such a large volume of electricity was imported, the geographic area for identifying baseline candidates is expanded to include the Eastern grid.

TEMPORAL RANGE

For the North-Eastern grid, available data indicate there have been no capacity additions since 2003. However, more than 20 percent of total capacity on the North-Eastern grid was added in 2002 and 2003. For this example, the temporal range is therefore set at 5 years (on the assumption that there have not, in fact, been any capacity additions since 2003). The same temporal range will be applied to identify baseline candidates on the Eastern grid.

7.4 Other Criteria Used to Identify Baseline Candidates

There are no legal requirements that would restrict the final list of baseline candidates beyond the geographic area and temporal range already identified. The initial list of baseline candidates is presented in Table 1.

None of the plants identified were constructed under unique or extenuating circumstances, i.e., they can all be considered "common practice."[3]

TABLE 2 Final List of Representative Baseline Candidates for 20 MW Biomass Project

NO.	TYPE OF FUEL	CAPACITY	FUNCTION*	EMISSION RATE ($T\ CO_2$ / MWH)
NORTH-EASTERN GRID				
1	Diesel[†]	6 MW	LF	0.60
2	Natural Gas	21 MW	LF	0.43
EASTERN GRID				
3	Coal[††]	400 MW	LF	1.10

* LF = Load-following; BL = baseload

[†] Average of plants 1-6 in Table 1.

[††] Average of plants 15-17 in Table 1.

7.5 Identifying the Final List of Baseline Candidates

Emission rates for each potential baseline candidate were obtained from publicly available information sources (it was not necessary to calculate them from data on fuel usage and generation). The final list of baseline candidates is different for each project.

1. *20 MW Biomass Plant.* Because project #1 is a load-following power plant, the list of baseline candidates will include **only the load-following power plants identified in Table 1**. In addition, the project-specific procedure will be used to estimate BM emissions for project #1. To facilitate the assessment of barriers and benefits under the project-specific procedure, **representative types** of power plants are identified from the list of load-following plants. The representative types will be used for the final list of baseline candidates examined under the project-specific procedure. Table 2 presents this list.
2. *20 MW Wind Plant.* For project #2 the final list of baseline candidates includes **all plants identified in Table 1.** This is because the performance standard procedure will be used to estimate the emission factor for the BM (described below, under Chapter 9).

CHAPTER 8:
Justifying the Baseline Scenario and Characterizing the BM

The examples presented here are intended to illustrate different possible methods for estimating baseline emissions. The assessments presented in this section are therefore only indicative of what a full analysis might look like, and are not exhaustive. For a fully developed example of a barriers and benefits analysis using the project-specific procedure, please see Part III of the *Project Protocol*.

The general approach for each project will be as follows:

1. *20 MW Biomass Plant* – **Justify the baseline scenario and characterize the BM.** For this project activity, the project-specific procedure will be used to both justify the baseline scenario (100% BM generation, as determined in Chapter 5) and to characterize the BM (as decided in Chapter 6). The BM will be characterized by identifying the baseline candidate with the least barriers or greatest net benefits.
2. *20 MW Wind Plant* – **Justify the baseline scenario.** For this project activity, the project-specific procedure will be used only to justify the baseline scenario. This will be done by demonstrating that the project activity faces greater barriers, or has fewer net benefits, than at least one of the baseline candidates. The BM emission factor will be calculated using the performance standard procedure in Chapter 9.
3. *500 kW electricity reduction project* – **Justify the baseline scenario.** This electricity reduction project activity only affects the OM. The project-specific procedure will be used to justify this presumed baseline scenario. This will be done by demonstrating that there are no barriers to the continuation of current activities.

8.1 Performing a Comparative Assessment of Barriers

The assessments provided here are in summary form and are intended only to be illustrative. For all three projects, there are no barriers to the continuation of current activities (see discussion under Section 5.1, above).

1. *20 MW Biomass Plant.* Table 3 provides a summary of a possible comparative assessment of barriers. The specific steps and explanation behind this summary are not provided here, and may or may not reflect actual conditions in Assam.
2. *20 MW Wind Plant.* The comparative assessment of barriers can be conducted in an identical fashion to the assessment for the biomass project. For this example, we assume that a wind project will face barriers comparable to those of the biomass power plant. Although there are a greater number of baseline candidates for the wind project (see Table 1), it is not necessary to assess the barriers for all of them. Justifying the baseline scenario requires only a demonstration that at least one of the baseline candidates faces lower barriers than the project activity. From Table 3, it is clear that several baseline

TABLE 3 Summary of Comparative Assessment of Barriers for Project #1

BASELINE SCENARIO ALTERNATIVES	FINANCIAL & BUDGETARY	TECHNOLOGY O&M	INFRA-STRUCTURE	MARKET STRUCTURE	INSTITUTION / CULTURAL / SOCIAL / POLITICAL	RANK BY CUMULATIVE IMPACT
Project Activity - 20 MW Biomass Power Plant	High	Medium	High	None	Low	(4) High Barriers
6 MW Diesel Power Plant	Low	None	None	None	Medium	(1) Lowest Barriers
21 MW Natural Gas Power Plant	High	None	Low	None	Low	(3) Medium Barriers
400 MW Coal Power Plant	Medium	None	Low	None	Medium	(2) Medium Barriers

candidates common to both the biomass and wind projects face lower barriers.

3. *500 kW electricity reduction project.* Any barriers to this project should be assessed in determining its electricity savings; a separate assessment is not required here since the project does not need to be compared to any BM alternatives (it only affects the OM).

8.2 Justifying the Baseline Scenario

Fully justifying the baseline scenarios for these projects requires an explanation of how any barriers facing each project activity would be overcome (in accordance with Section 8.2.1). The following "justifications" are in summary form only.

1. *20 MW Biomass Plant.* Following the guidance in Section 8.2.2., the BM is characterized for this project activity using the comparative assessment of barriers. The diesel power plant clearly faces the lowest barriers and is therefore identified to represent the BM. The baseline scenario is justified as a result of this assessment. The project activity itself is not found among the baseline candidates and is not "common practice," so no further justification is necessary. (Note: The identified baseline candidate has a capacity of only 6 MW; the baseline scenario can be assumed to involve a sufficient number of these units to match the size of the 20 MW biomass project.)

2. *20 MW Wind Plant.* The baseline scenario is justified as a result of the comparative assessment of barriers, because at least one of the baseline candidates clearly faces lower barriers than the project activity. The project activity itself is not found among the baseline candidates and is not "common practice," so no further justification is necessary.

3. *500 kW electricity reduction project.* Since barriers do not need to be assessed for this project activity, and it does not affect the BM, the baseline scenario (i.e., 100% OM generation) is justified automatically because there are no barriers to the continuation of current activities.

CHAPTER 9:
Estimating the BM Emission Factor

Estimating the BM emissions factor is performed differently for each example:

1. *20 MW Biomass Plant.* The BM emission factor is estimated from a single baseline candidate, as identified in Chapter 8.
2. *20 MW Wind Plant* The BM emission factor is estimated using the performance standard procedure.
3. *500 kW electricity reduction project.* This project does not affect the BM, so the BM emission factor is not estimated.

9.1 Estimating BM Emissions Using a Single Baseline Candidate

For the 20 MW biomass plant the BM is represented by diesel capacity, since this was the baseline candidate identified using the comparative assessment of barriers in Chapter 8. The identified diesel plant has an emission rate of 0.60 t CO_2 / MWh, as specified in Table 2, above. Thus, the estimated BM emission factor for the 20 MW biomass plant is 0.60 t CO_2 / MWh.

9.2 Estimating BM Emissions Using the Performance Standard Procedure

The following analysis is used to estimate BM emissions for the 20 MW wind plant using the *Project Protocol's* performance standard procedure.

9.2.1 SPECIFYING APPROPRIATE & "PERFORMANCE METRICS" AND 9.2.2 CALCULATING GHG EMISSION RATES FOR EACH BASELINE CANDIDATE

Since we already have data on the CO_2 emission rates for each baseline candidate (Table 1), it is not necessary to specify performance metrics or separately calculate emission rates.

9.2.3 CALCULATING THE GHG EMISSION RATE FOR DIFFERENT STRINGENCY LEVELS

Following the requirements of the *Project Protocol*, it is necessary to calculate emission rates associated with five different stringency levels: (a) the most stringent; (b) the weighted average; (c) the median; (d) a lower-than-average percentile; and (e) a second lower-than-average percentile.

(a) *Most Stringent Emission Rate.* The most stringent emission rate is that associated with the lowest-emitting baseline candidate. From Table 1, this would be one of the hydro plants, with zero emissions. Thus, the most stringent performance standard would be **0.0 t CO_2 / MWh.**

(b) *Weighted Mean Emission Rate.* Table 4 shows the most recent annual generation numbers for each identified baseline candidate in Table 1. The weighted mean emission rate is calculated by weighting baseline candidate emission rates by total annual generation. A performance standard based on the weighted mean would thus be **0.82 t CO_2 / MWh** (for brevity, this calculation is not shown).

(c)– (e) *Median and Percentile Emission Rates.* Because there is very little variation, if any, in the emission rates for baseline candidates within each fuel type, the different percentile emission rates will be nearly identical. For purposes of comparison we therefore calculate just the median (50th percentile) emission rate. This is done by calculating the 50th percentile emission rate for each fuel type (Table 5), and then calculating a generation-weighted average of these fuel-type percentiles (following Box 9.1 in the guidelines; calculations not shown here). The median performance standard emission rate is therefore close to the weighted mean: **0.81 t CO_2 / MWh**. The emission rates associated with lower percentiles would be identical.

SELECTING A STRINGENCY LEVEL FOR THE PERFORMANCE STANDARD

In this case, the difference between the stringency levels is very slight, excluding the most stringent. Since the most stringent level (i.e., zero) would be unrepresentative of likely new capacity additions, the median stringency level is chosen (which, conservatively, is slightly less than the weighted average). **Thus, the estimated BM emission factor for the 20 MW wind plant is 0.81 t CO_2 / MWh.**

TABLE 4 Identified Baseline Candidates

NO.	TYPE OF FUEL	CAPACITY	ANNUAL GENERATION (MWH)	EMISSION RATE(T CO_2 / MWH)
NORTH-EASTERN GRID				
1	Diesel	6 MW	28,000	0.60
2	Diesel	6 MW	28,000	0.60
3	Diesel	6 MW	28,000	0.60
4	Diesel	6 MW	28,000	0.60
5	Diesel	6 MW	28,000	0.60
6	Natural Gas	21 MW	152,000	0.91
7	Natural Gas	21 MW	159,000	0.43
8	Hydro	25 MW	101,000	0.00
9	Hydro	135 MW	547,000	0.00
10	Hydro	135 MW	547,000	0.00
11	Hydro	135 MW	547,000	0.00
12	Hydro	8 MW	2,000	0.00
EASTERN GRID				
13	Coal	500 MW	3,009,000	1.00
14	Coal	500 MW	3,325,000	1.00
15	Coal	500 MW	1,684,000	1.00
16	Coal	210 MW	159,000	1.29
17	Coal	500 MW	3,000	1.00

TABLE 5 50th Percentile Emission Rates and Generation by Fuel Type

FUEL TYPE	50TH PERCENTILE EMISSION RATE (t CO_2 / MWh)	TOTAL ANNUAL GENERATION (MWh)
Diesel	0.60	142,000
Natural Gas	0.43	311,000
Hydro	0.00	1,744,000
Coal	1.00	8,180,000

CHAPTER 10

Estimating the OM Emission Factor

The following methods will be used to estimate the OM emission factor for the three examples:

1. *20 MW Biomass Plant.* Not applicable; this project does not affect the OM.
2. *20 MW Wind Plant.* The OM emission factor is calculated using the first "average load-following" method (Method 1A).
3. *500 kW electricity reduction project.* The OM emission factor is calculated using the second "average load-following" method (Method 1B).

OPERATING MARGIN METHOD 1A

For the 20 MW wind project, OM emissions are estimated by calculating an average emission rate, using annual data for 2004-2005 (the most recent reporting year), for all power plants on the North-Eastern grid except baseload, must-run, and intermittent plants. Power imports are also factored into this emission rate. Since power imports to the North-Eastern grid exceed 20 percent of the grid's native generation, grid operators are consulted to determine what percentage of imports may be considered load-following. On this basis, only 1,000 GWh (approximately 45 percent) of imports are factored into the OM emission rate.[4]

TABLE 6 Data for Power Plant Installations on the North-Eastern Grid + Imports

INSTALLATION	FUEL TYPE	FUNCTION*	ANNUAL GENERATION 2004-5 (MWh)	ANNUAL CO_2 EMISSIONS 2004-5 (t CO_2)
1	Gas	Load-following	428,660	287,658
2	Gas	Load-following	292,280	248,973
3	Diesel	Load-following	—	—
4	Gas	Load-following	1,566,696	911,367
5	Gas	Load-following	568,220	481,018
6	Gas	Load-following	152,210	138,339
7	Gas	Load-following	321,943	132,488
8	Gas	Load-following	139,210	94,588
9	Oil	Load-following	—	—
10	Coal	Load-following	—	—
11	Gas	Load-following	—	—
12	Hydro	Baseload	1,990	—
13	Hydro	Baseload	1,990	—
14	Hydro	Baseload	128,355	—
15	Hydro	Baseload	430,835	—
16	Hydro	Baseload	51,740	—
17	Hydro	Baseload	195,020	—
18	Hydro	Baseload	909,430	—
19	Hydro	Baseload	252,730	—
20	Hydro	Baseload	1,639,760	—
21	Hydro	Baseload	68,655	—
22	Hydro	Baseload	—	—
23	Hydro	Baseload	625,855	—
Imports	Mix	Load-following	1,000,000	1,203,744†

* Must-run and intermittent plants are listed as "baseload." The function is determined for the installation as a whole, although some units might operate independently according to different functions.

† The annual emissions for imports were calculated using the 2004-2005 OM emission factor for the Eastern grid (1.20 t CO_2/MWh), also calculated using Method 1A.

Table 6 presents a list of power plant installations on the North-Eastern grid,[5] along with their fuel type; function (baseload or load-following); total annual generation from 2004-2005 (in MWh); and total CO_2 emissions from 2004-2005 (tons of CO_2). Load-following power imports from the Eastern grid are also included as a separate "installation."

Only the highlighted plants in Table 6 are factored into the OM emission factor calculation. Based on these data, the weighted average emission rate of the load-following plants (plus imports) for 2004-2005 is **0.78 t CO_2 / MWh**. This is the OM emission factor used for the 20 MW wind project.

OPERATING MARGIN METHOD 1B

For the 500 kW electricity reduction project, OM emissions are estimated by ranking megawatt-hours of generation according to cost (lowest to highest) or average capacity factor (highest to lowest) associated with each fuel type, and then calculating the average emissions of the top 1/3 of ranked MWh. This method requires general data for each fuel type, rather than for individual power plant installations. For the 2004-2005 reporting year, this method can be performed fairly simply, since all generation came either from natural gas or hydro. Table 7 summarizes the necessary data.

TABLE 7 North-Eastern Grid Data by Fuel Type

FUEL TYPE	ANNUAL GENERATION 2004-5 (MWh)	INSTALLED CAPACITY (MW)	AVERAGE CAPACITY FACTOR	ANNUAL CO_2 EMISSIONS 2004-5 (t CO_2)
Gas	3,469,219	764	52%	2,294,431
Diesel	—	36	N/A	—
Oil	—	60	N/A	—
Coal	—	240	N/A	—
Hydro	4,306,360	1,089	Exclude	—

Ranking generation by fuel cost, gas is more expensive than hydro, which has an effective fuel cost of zero, so gas would be at the top of the stack. Ranked by capacity factor, gas is the only fuel type to be considered, since hydro is classified as intermittent. Thus, under both rankings, the results are the same: the top 1/3 of ranked MWh are all generated from natural gas. The OM emission factor for the North-Eastern grid is therefore equal to the average emission factor for natural gas power plants: 2,294,431 t CO_2 / 3,469,219 MWh = 0.66 t CO_2 / MWh.

Imports from the Eastern grid still need to be factored in to arrive at a final OM emission factor. Under Method 1B, emissions from imports are simply combined on a generation-weighted basis with the emissions of the top 1/3 of MWh. Annual emissions for imports are calculated using the 2004-2005 OM emission factor for the Eastern grid (1.20 t CO_2 / MWh), yielding total emissions of 1,203,744 tons CO_2 (as in the 20 MW wind project example). Thus the final OM emission factor using Method 1B is calculated as: (2,294,431 t CO_2 + 1,203,744 t CO_2) / (3,469,219 MWh + 1,000,000 MWh) = **0.78 t CO_2 / MWh.**

This is the same emission factor as calculated using Method 1A.

CHAPTER 11:
Estimating Baseline Emissions

The baseline emission rate for each project is calculated as follows:

1. 20 MW Biomass Plant

$$ER_{baseline,t} = (1)BM + (0)OM_t = \mathbf{0.60\ t\ CO_2 / MWh}$$

Using:

- BM emission factor from Section 9.1

2. 20 MW Wind Plant

$$ER_{baseline,t} = (0.2)BM + (0.8)OM_t$$

$$= (0.2)(0.82\ t\ CO_2 / MWh) + (0.8)(0.78\ t\ CO_2 / MWh)$$

$$= \mathbf{0.79\ t\ CO_2 / MWh}$$

Using:

- BM emission factor from Section 9.2
- OM emission factor from Chapter 10, Method 1A.

3. 500 kW electricity reduction project

$$ER_{baseline,t} = (0)BM + (1)OM_t = \mathbf{0.78\ t\ CO_2 / MWh}$$

Using:

- OM emission factor from Chapter 10, Method 1B.

Total baseline emissions would be calculated by multiplying these baseline emission rates times each project activity's total generation in MWh.

NOTES

[1] For further information, see http://www.cea.nic.in/.

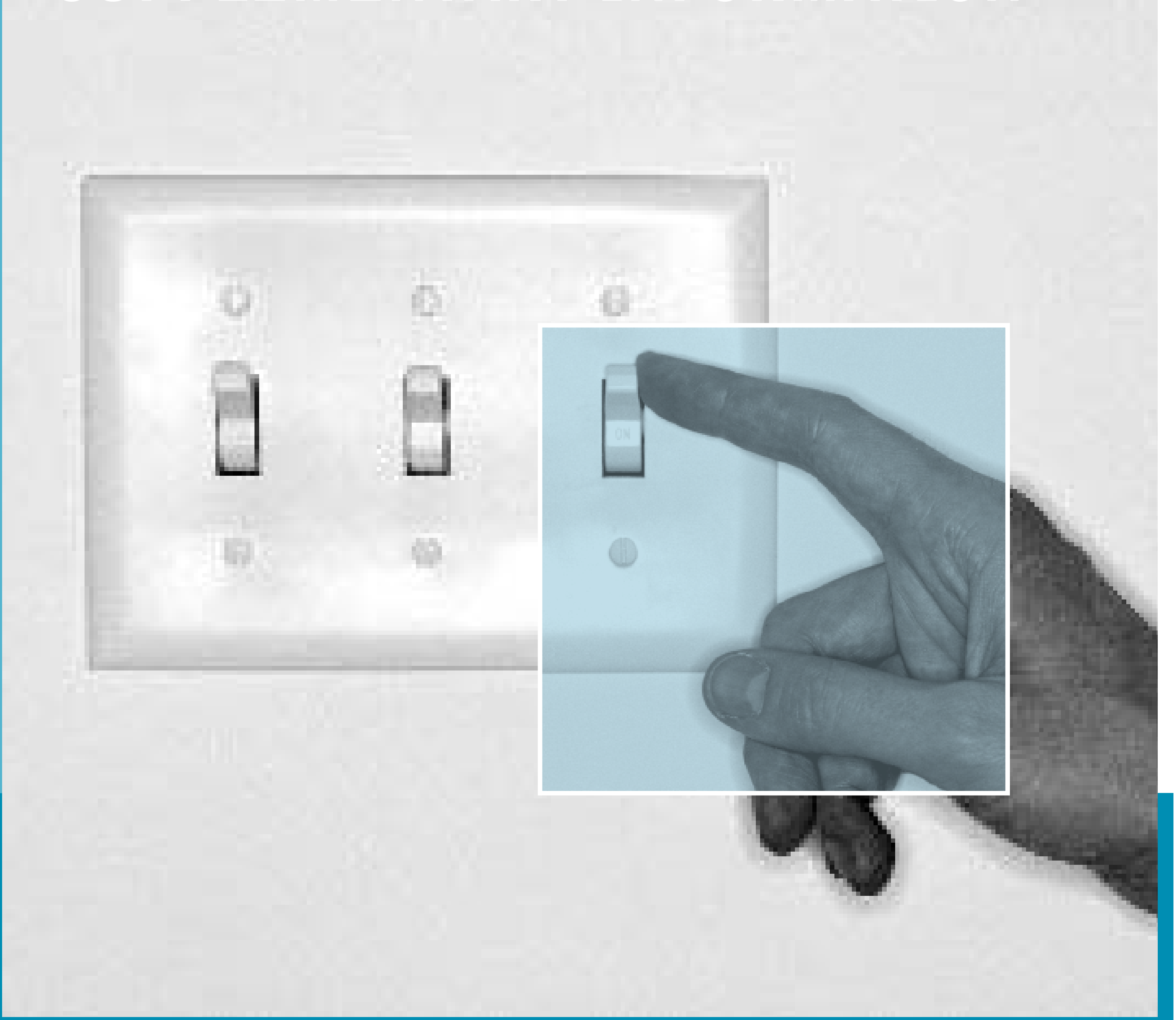
[2] According to data from the India Central Electricity Authority, this was a sudden change from previous years (2000-2004), when there were no imports. For the purpose of these examples, we use the 2004/2005 data as the basis for establishing the geographic area used to identify baseline candidates.

[3] The identified baseline candidates do not include, for example, any nuclear power plants. Even nuclear plants would be included in the list of baseline candidates, however, if such plants were indicative of likely future capacity additions.

[4] This percentage of imports was chosen arbitrarily for the sake of the example. It is not the product of an actual inquiry.

[5] In India, individual generation units tend to be clustered at specific sites or installations. In Table 6, the numbered installations all represent several individual generation units. These installations do not directly correspond to the baseline candidates – identified from specific units—listed in Table 1.

PART IV: SUPPLEMENTARY INFORMATION



This section presents supplementary information related to the functioning of grids and power plants, a glossary, references, and a list of other contributors.

Annex A

Functional Differences of Grid-Connected Power Plants

A.1 Baseload vs. Load-Following Power Plants

Since demand for electricity varies minute by minute, and since electricity cannot be stored, grids contain a mix of power plants that perform different functions according to the overall level of power demand (i.e., the "load" level). Baseload power plants are those that operate continuously (or nearly continuously) to meet base levels of power demand that can be expected regardless of the time of day or year (see Figure A.1). Baseload plants operate continuously either because of the physical nature of the generation technology (e.g., nuclear or other power plants whose output cannot easily respond to demand fluctuations) or the low cost of the energy source (e.g., a minemouth coal-fired power plant). They are the last to be curtailed in response to decreases in power demand.

Load-following power plants are those whose output varies as demand fluctuates above base levels, and which operate when further generation is needed during times of peak demand. Load-following plants are generally smaller power plants, often gas or oil-fired. Figure A.1 illustrates the respective levels of demand met by generation from baseload and load-following power plants over a typical one-week period.

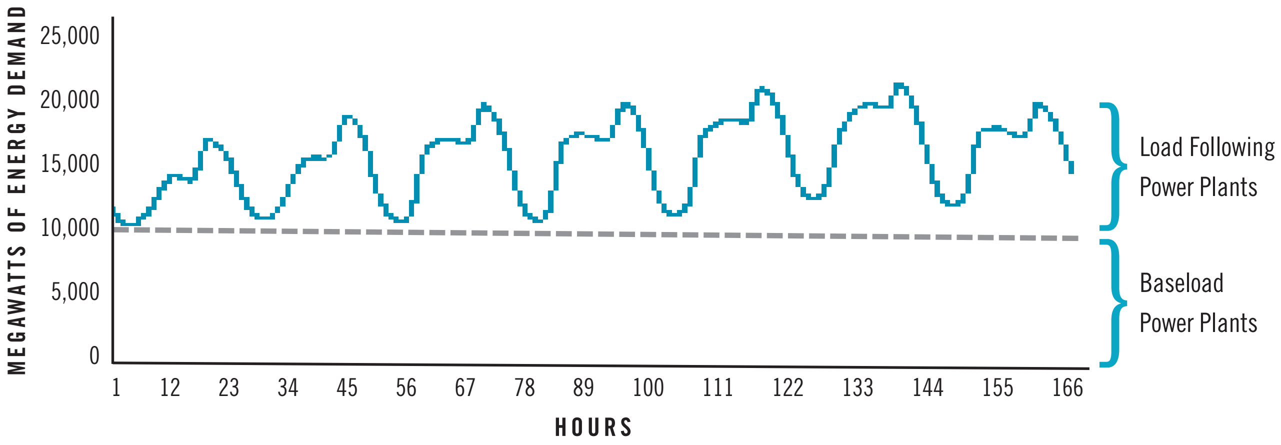
Other major functional categories include **must-run** and **intermittent** power plants. Must-run power plants are those whose operation is required to ensure the reliable transmission and delivery of grid electricity. Intermittent power plants are those that operate according to the availability of their primary energy source (e.g., wind, solar, run-of-river hydro, geothermal, and other generators whose primary energy source is not controlled by the operator). **For the purposes of these guidelines, must-run and intermittent plants can be treated as functionally equivalent to "baseload" power plants, since they do not respond to changes in load.**

Further functional distinctions are possible. For example, some studies will differentiate between baseload, intermediate, and peaking power plants (and sometimes other categories). Electricity reduction projects can also be classified into a wide range of different functional roles based on the timing of their activities. To account for displaced or avoided GHG emissions, however, it is only necessary to distinguish between baseload and load-following power plants. Section 7.1 of these guidelines provides guidance on classifying power plants according to these two categories.

A.2 Firm vs. Non-Firm Power Plants

Power plants can also be classified according to whether the power they provide is *firm* or *non-firm.* For the purposes of these guidelines, a firm power plant is one that can be consistently relied on to deliver power to the grid when the power is needed.[1] Most fossil-fuel power plants provide firm power, as do nuclear plants and hydroelectric plants with reservoirs. Power plants that cannot be consistently relied on provide non-firm power. Non-firm power plants include many types of renewables whose fuel or primary energy source is available only intermittently. Wind plants, for example, can only deliver power when the wind is blowing. Non-firm plants can also include those that provide power to the grid intermittently for contractual reasons. Some power plants, for example, are built primarily to provide electricity directly to a particular site, and sell electricity to the grid only when they have excess power available.

FIGURE A.1 Demand Met by Baseload vs. Load-Following Power Plants Over a Typical One-Week Period



The distinction between firm and non-firm power is not absolute. Many power plants that operate intermittently may nevertheless do so according to a regular and predictable schedule. To the extent they can be relied upon over certain time periods, the capacity they provide may be characterized as partially "firm." Some grid-connected project activities (including those that reduce demand for electricity), may have firm or non-firm qualities depending on how and when they operate.

NOTES

[1] In these guidelines, the distinction between "firm" and "non-firm" power sources is meant to distinguish between those that are consistently available to deliver power, and those that are only intermittently available. In other contexts these terms refer to contractual arrangements, which may or may not correspond to the definitions used here. For example, under a competitive market, a merchant power plant may sell electricity whenever the price is sufficiently high, without having a firm power contract. For the purpose of these guidelines, however, it would be considered "firm" because functionally it can be consistently relied on.

Annex B

Power Plant Capacity, Grid Capacity Demand, and Capacity Value

The electricity delivered by power plants is quantified in two different ways: in terms of *energy* or *generation* (measured in watt-hours) and in terms of *power* (measured in watts). A power plant's *generation* represents the total amount of electrical energy it delivers to the grid over a certain time period (a watt-hour is equal to 3,600 joules of energy). The *power* provided by a power plant indicates the rate at which it delivers electrical energy to the grid (one watt is equal to the transfer of one joule of energy per second). The *capacity* of a power plant indicates the maximum number of watts the plant is capable of delivering, i.e., the maximum number of joules per second.

Electricity Units

MULTIPLE	POWER/CAPACITY UNIT		ENERGY/GENERATION UNIT	
	NAME	SYMBOL	NAME	SYMBOL
1	Watt	W	Watt-hour	Wh
1,000	Kilowatt	kW	Kilowatt-hour	kWh
1,000,000	Megawatt	MW	Megawatt-hour	MWh
1,000,000,000	Gigawatt	GW	Gigawatt-hour	GWh

The distinction between generation and power is important because both can be viewed as a separate product or service provided by grid-connected project activities. All grid-connected project activities provide electricity generation as a product delivered to consumers. (In the case of electricity-reduction activities, the product is avoided generation, which is treated analogously; see Chapter 3.) In addition, the available power capacity of a project activity can constitute an essential "service" for grid operators concerned about meeting the grid's total power demand.

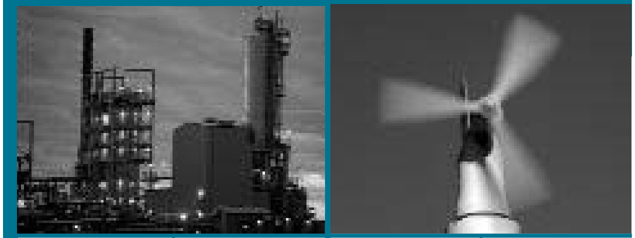
To keep the grid running smoothly, grid operators must have power plant capacity that can be reliably dispatched to meet total power demand. Total power demand is also referred to as the grid's "load." Grid operators must be able to meet fluctuating loads in real time, and ideally should have sufficient capacity available to meet the maximum (or "peak") load expected over a given year. Thus, it is important for the grid to have power plants that can be dispatched (i.e., called upon to deliver power) to meet different load levels, and for the capacity of all power plants to be sufficient to cover peak load.

Where there is insufficient capacity on a grid to safely and reliably meet load requirements,[1] new capacity must be added for the grid to operate in a stable fashion (i.e., with constant voltage). On most grids, there is always some level of demand for new capacity because of growing load requirements. Grid-connected project activities can help to meet this *capacity demand* to the extent that they provide *capacity value* to grid operators.

The capacity value of a power plant indicates the amount of power it can be reliably called upon to provide, and thus its ability to meet capacity demand. Capacity value is often defined in terms of the power plant's potential to contribute towards meeting peak load. For plants that provide firm power (see Annex A), this is roughly equivalent to the rated capacity of the power plant, determined by the size of its generators.[2] A coal plant capable of producing 500 MW of electricity, for example, will have a capacity value of close to 500 MW because it provides firm power. Non-firm power generators, however, will have a capacity value that is significantly less than their rated physical capacity. Where the power they provide is completely unpredictable (and thus has no "firm" characteristics) the capacity value may be zero. Thus, even though a wind power installation might be capable of producing 10 MW of electricity, its capacity value may be a small fraction of that, or even zero (see Figure B.1).

The capacity value of a particular power plant can also depend on the structure of the grid and the composition of other power plants on it. Even though a wind turbine provides non-firm power and is not dispatchable, for example, it may nevertheless have a positive, fractional capacity value because – together with other wind turbines – it provides a certain average level of reliable generation that can be applied towards meeting peak load.

FIGURE B.1 Physical Capacity vs. Capacity Value



COAL PLANT		WIND PLANT	
PHYSICAL CAPACITY	CAPACITY VALUE	PHYSICAL CAPACITY	CAPACITY VALUE
500 MW	500 MW	10 MW	1 MW
This plant can provide up to 500 MW of power, and grid operators will count all 500 potential MW towards meeting the grid's capacity demand.		This plant can provide up to 10 MW of power, but grid operators will count only 1 MW towards meeting capacity demand because it is non-firm.	

Finally, some power plants may provide firm power, but only during off-peak time periods. In effect this means they cannot be relied on to meet peak demand, so they may have a lower-than-rated capacity value.

The capacity value associated with a project activity is important, because it determines whether the project activity can help to meet capacity demand, which in turn helps determine the sources of GHG emissions that it will displace. Many types of project activities that reduce GHG emissions – most types of renewable energy, for instance – will have an associated capacity value that is lower than their physical power capacity.

NOTES

[1] Overall load requirements will be defined with respect to peak load. However, grid operators may also consider baseload capacity requirements - i.e., the "troughs" in the load curve in Figure A.1 (Annex A) – and seek additional baseload power plants to meet this demand, even where peak load can be reliably covered.

[2] Capacity value will actually be somewhat less that rated capacity, because power plants are inevitably subject to some amount of unpredictable forced outages. A more precise definition of capacity value is that it reflects the amount of capacity a power plant can be statistically relied upon to provide during times of greatest electricity demand.

Glossary

Additionality	A criterion often applied to GHG project activities, stipulating that project-based GHG reductions should only be quantified if the project activity "would not have happened anyway" – i.e., that the project activity (or the same technologies or practices that it employs) would not have been implemented in its baseline scenario.
Adjusted Consumption Baseline	The amount of grid electricity that would have been consumed without a project activity, adjusted to account for changes in usage unrelated to the project activity.
Barriers	Any factor or consideration that would (significantly) discourage a decision to try to implement the project activity or a baseline candidate
Baseline Candidate	Alternative technologies or practices identified within a specified geographic area and temporal range that could provide the same product or service as the project activity. For grid-connected project activities, baseline candidates consist of different types of power plants that are used to represent the alternative types of capacity that could have been built in place of the project activity (i.e., they are build margin alternatives).
Baseline Parameter	Any parameter whose value or status can be monitored in order to validate assumptions about baseline emissions estimates.
Baseline Procedures	Methods used to estimate baseline emissions. The *Project Protocol* offers two optional procedures: the project-specific procedure and the performance standard procedure.
Baseline Scenario	A hypothetical description of what would have most likely occurred in the absence of any considerations about climate change mitigation. For grid-connected project activities, the baseline scenario is presumed to involve generation from the build margin, the operating margin, or a combination of the two. (Where quantifying GHG reductions from an individual project activity, this presumption should be explicitly justified using the project-specific baseline procedure – see Chapter 8.)
Baseload	A type of power plant that operates continuously (or nearly continuously) to meet base levels of power demand that can be expected regardless of the time of day or year.
Benefits	The benefits (financial or otherwise) that would be expected to accrue to decision-makers involved with a project activity or a particular baseline scenario alternative, excluding any potential benefits related to GHG reductions.
Build Margin (BM)	The incremental new capacity displaced by a project activity. The build margin indicates the alternative type of power plant (or plants) that would have been built to meet demand for new capacity in the baseline scenario.
Capacity	The amount of power a power plant is capable of producing and delivering to the grid.
Capacity Demand	The level of need for new power plant capacity on a grid. Capacity demand may be explicitly determined by utilities and regulators as part of a planning process for meeting future load requirements (regulated grids), or it may be expressed in terms of the willingness-to-pay of utilities or other electricity service providers for new capacity to meet their customers' anticipated electricity needs (market-based grids).
Capacity Factor	The ratio of a power plant's actual generation to its maximum potential generation over a certain time period. The "maximum potential" generation is determined by assuming continuous output at the power plant's rated capacity. For example, a 10 MW plant operating for 10 hours would have maximum potential generation of 100 MWh; if it instead generated 50 MWh, it would have a capacity factor of 50 percent.

Capacity Value	The amount of power a power plant can be reliably called upon to provide, usually defined by its statistically reliable output during times of peak load. In these guidelines, it is assumed to indicate the amount of a power plant's capacity that may be considered "firm."
Capacity, Firm	Capacity that can be consistently relied on when power is needed on the grid. *Note: In these guidelines, the term "firm capacity" is used solely to indicate power capacity that is reliably available, and is not intermittent or unpredictable. It does not refer solely to contractual arrangements.*
Capacity, Non-Firm	Capacity that cannot be consistently relied on when power is needed on the grid. Non-firm capacity can include many types of renewables whose fuel or primary energy source is available only intermittently. It can also include capacity that is available to the grid intermittently for contractual reasons.
Capacity, Rated	The maximum amount of power a power plant can produce under normal operating conditions. (Also called "nameplate" capacity.)
Dispatch	The coordination of power plant operations in order to meet the load on a grid. A "dispatchable" power plant is one that can be directly called upon by grid operators to produce power, and whose output can be modulated in response to real-time fluctuations in demand for electricity.
Electricity Generation Project Activity	A grid-connected project activity that generates electricity and delivers it into the power grid, in effect displacing electricity from other sources.
Electricity Reduction Project Activity	A grid-connected project activity that reduces the need for grid-based electricity by either (1) improving the efficiency with which grid electricity is used for a particular application; or (2) generating electricity onsite so that supply from the grid is unnecessary.
Electricity Savings	The avoided electricity usage that results from an electricity reduction project activity. Electricity savings are determined by subtracting actual electricity consumption from a project's "adjusted consumption baseline."
End-User Activity	A specific energy-saving project activity implemented and managed by an electricity consumer, often at a single facility.
Energy	Formally, energy is defined as the amount of work a physical system can do on another. In these guidelines, energy refers to electrical energy generated by power plants and delivered to energy users over a power grid.
Generation	The electrical energy produced by a power plant or project activity.
GHG Assessment Boundary	A boundary encompassing all primary effects and significant secondary effects associated with a GHG project. If the GHG project involves more than one project activity, the primary and significant secondary effects from all the activities are included in the GHG assessment boundary.
GHG Program	A generic term for: (1) any voluntary or mandatory, government or non-government initiative, system, or program that registers, certifies, or regulates GHG emissions; or (2) any authorities responsible for developing or administering such initiatives, systems, or programs.
GHG Project	A specific activity or set of activities intended to reduce GHG emissions, increase the storage of carbon, or enhance GHG removals from the atmosphere. A GHG project may be a stand-alone project or a component of a larger non-GHG project.
GHG Reductions	A decrease in GHG emissions relative to baseline emissions.
Grid	A system of power transmission and distribution (T&D) lines under the control of a coordinating entity or "grid operator," which transfers electrical energy generated by power plants to energy users – also called a "power grid." The boundaries of a power grid are determined by technical, economic, and regulatory-jurisdictional factors.

Grid Operator	The entity responsible for implementing procedures to dispatch a set of power plants in a given area to meet demand for electricity in real time. The precise institutional nature of the grid operator will differ from system to system. The grid operator may be alternately referred to as a "system dispatcher," "control area operator," "independent system operator," or "regional transmission organization," etc.
Grid-Connected Project Activity	Any kind of project activity that displaces or avoids the generation of electricity distributed over power grids.
Intermittent	A type of power plant that operates according to the availability of its primary energy source (e.g., wind, solar, run-of-river hydro, geothermal, and other generators whose primary energy source is not controlled by the operator).
Load	The instantaneous level of demand for electricity on a grid, usually expressed in units of megawatts (MW).
Load-Following	A type of power plant whose output varies in response to fluctuations in load, and which operates when generation is needed during times of peak demand.
Megawatt (MW)	A unit of electrical power. One megawatt of power output is equivalent to the transfer of one million joules of electrical energy per second to the grid.
Megawatt-hour (MWh)	A unit of electrical energy equal to 3.6 billion joules; the amount of energy produced over one hour by a power plant with an output of 1 MW.
Must-Run	A type of power plant whose operation is required to ensure the reliable transmission and delivery of electricity on a grid.
Operating Margin (OM)	The set of existing power plants whose output is reduced in response to a project activity. These power plants are the last to be switched on-line or first to be switched off-line during times when the project activity is operating, and which therefore would have provided the project activity's generation in the baseline scenario.
Output	The amount of power generated by a power plant.
Peak Load	The maximum level of instantaneous electricity demand experienced by a grid within a certain time period. Peak load can be defined for periods as short as an hour or day. The annual peak load on a grid (maximum load level for the entire year) will determine its overall power capacity requirements.
Performance Metric	A rate that relates the level of consumption of relevant inputs (i.e., fuel) to the level of production (i.e., generation) for different baseline candidates. Performance metrics are identified as a preliminary step in developing a "performance standard" estimate of build margin emissions.
Performance Standard Procedure	A baseline procedure that estimates baseline emissions using a GHG emissions rate derived from a numerical analysis of the GHG emission rates of all baseline candidates.
Power	Power is the rate at which energy is transferred from one physical system to another. The standard unit for power is the watt, defined as the transfer of one joule of energy per second. In these guidelines, power indicates the rate at which a power plant transfers energy to the grid.
Power Plant	Any facility capable of generating electrical energy and transmitting it to energy users over a power grid.
Primary Effect	The intended change caused by a project activity in GHG emissions associated with a GHG source or sink. For grid-connected project activities, the primary effect is the reduction of combustion emissions from grid-connected power plants.
Project Activity	A specific action or intervention targeted at changing GHG emissions, removals, or storage.

Project Protocol	The *Greenhouse Gas Protocol for Project Accounting,* available at http://www.ghgprotocol.org.
Project-Specific Procedure	A baseline procedure that estimates baseline emissions by identifying a baseline scenario specific to the proposed project activity.
Secondary Effect	An unintended change caused by a project activity in GHG emissions, removals, or storage associated with a GHG source or sink.
Standard Baseline Emission Rate	An emission rate that can be used to estimate the displaced or avoided emissions for any project activity of a certain type implemented on a specific grid. Developing standard baseline emission rates is usually done in conjunction with GHG programs or trading systems that incorporate project-based GHG reductions.
Stringency Level	A GHG emission rate that is lower than or equal to the weighted average GHG emission rate of all baseline candidates (i.e., build margin capacity alternatives). Stringency levels may be specified as a GHG emission rate corresponding to a certain percentile (50th percentile or below), or to the lowest-emitting baseline candidate. Lower levels are more "stringent" because they will result in fewer quantified GHG reductions. Stringency levels are defined in the course of estimating a build margin emission factor using the performance standard procedure.
Wide-Area Program	A project that involves coordinated activities to help a large number of consumers reduce grid electricity consumption.

NOTE

[1] See Parker, Cybil P. (1993). Encyclopedia of Physics. U.S.A: McGraw-Hill, Inc.

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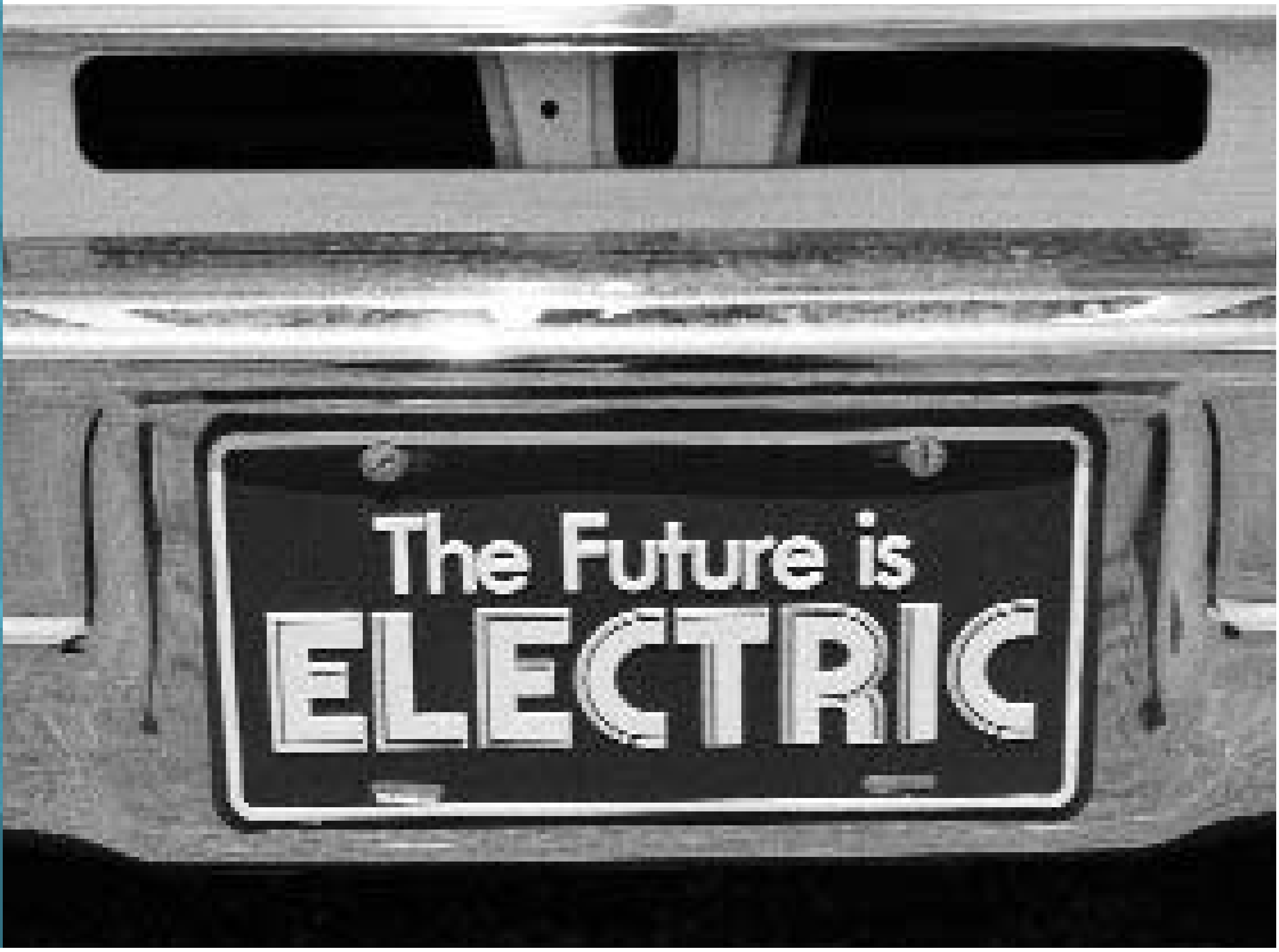

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