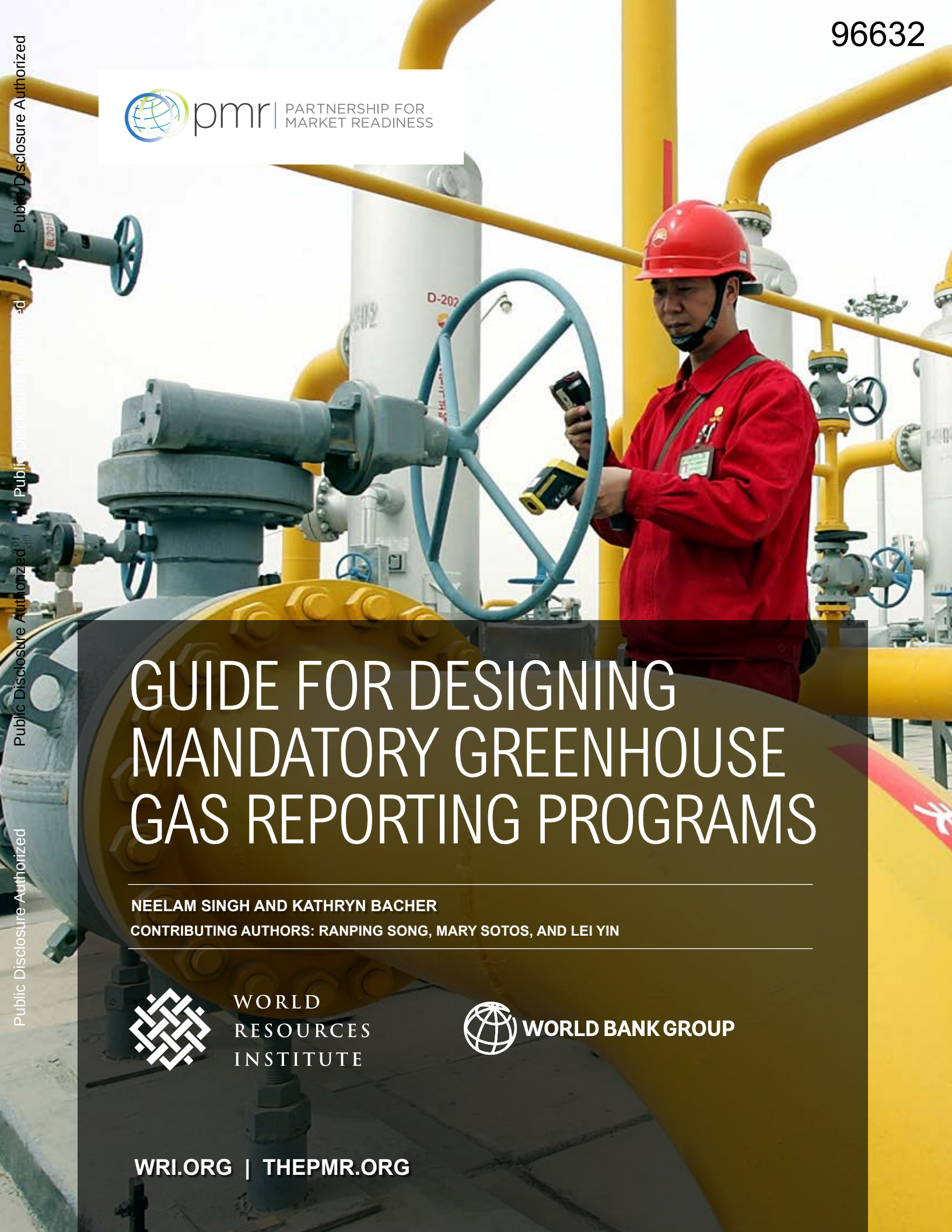

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GUIDE FOR DESIGNING MANDATORY GREENHOUSE GAS REPORTING PROGRAMS

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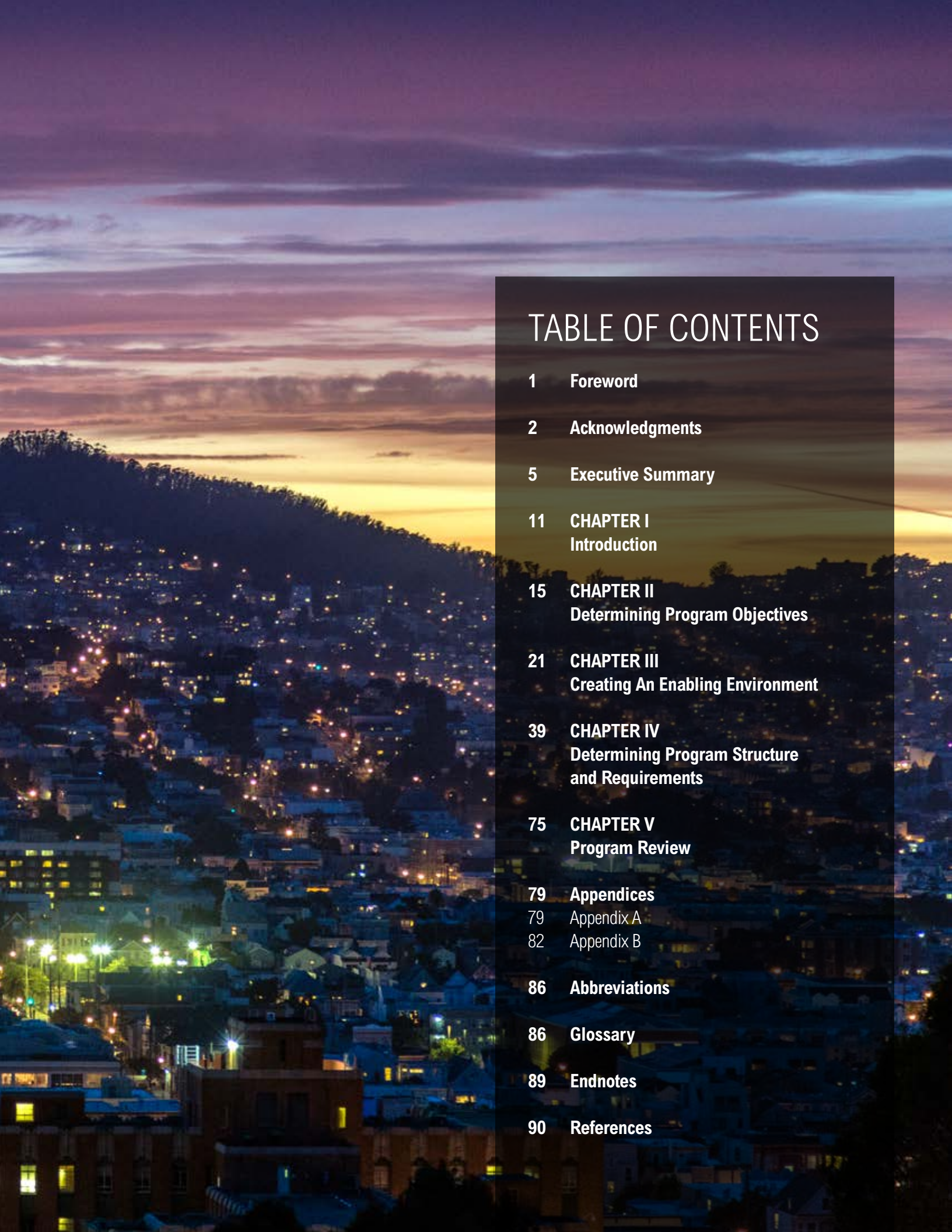

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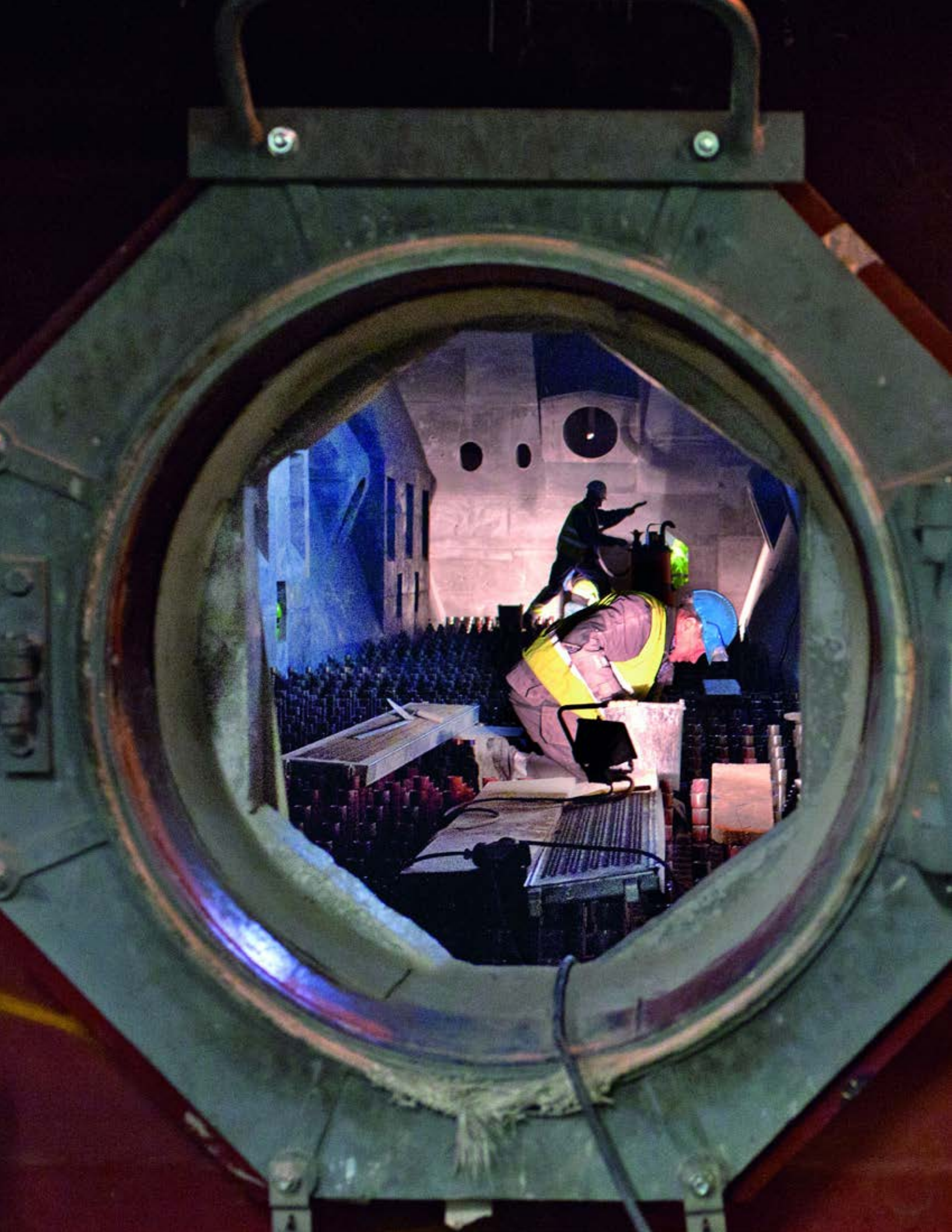

FOREWORD

Measurement leads to understanding, which in turn informs and spurs action.

This is why a growing number of countries and sub-national regions have created programs that require facilities and companies to measure and report their greenhouse gas (GHG) emissions. With these insights in hand, policymakers are better equipped to set strategies for scaled up greenhouse gas reductions. Today, over 40 countries already mandate emitters to provide GHG emissions-related data.

This report, prepared jointly by the World Resources Institute and the World Bank's Partnership for Market Readiness, provides comprehensive, step-by-step guidance on designing mandatory greenhouse gas reporting programs for policymakers who wish to establish similar initiatives in their jurisdictions. It is a useful reference for practitioners that draws on the lessons learned from reporting programs around the world and enables development of new programs to fulfill domestically relevant objectives.

The *Guide for Designing Mandatory Greenhouse Gas Reporting Programs* builds on both our organizations' expertise in this field. WRI has years of experience in promoting standard methodologies for greenhouse gas accounting and measurement at various national and sub-national levels via the Greenhouse Gas Protocol. PMR supports countries in the preparation and implementation of climate change mitigation policies, including technical assistance on the monitoring, reporting, and verification systems that support those policies. Together, we have produced a resource that can support jurisdictions in designing a system that can correspond with such a significant undertaking.

Our hope is that an increasing number of governments worldwide will develop strong and effective greenhouse gas reporting programs for their jurisdictions, creating a resource that facilitates decisionmaking and leads to meaningful and nationally appropriate climate action.

Andrew Steer
President
World Resources Institute

Mr. Christian Grossmann
Director of Climate Change
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ACKNOWLEDGMENTS

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Australia	Department of the Environment	Gareth Prosser (also a reviewer)
Australia	Department of Foreign Affairs and Trade	Ken Xie (reviewer only)
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Chile	Ministry of Energy	Ignacio Fernandez
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South Africa	Department of Environmental Affairs	Jongikhaya Witi (also a reviewer)
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EXECUTIVE SUMMARY

Over the past decade, greenhouse gas (GHG) reporting programs have emerged at the regional, national, and subnational levels to provide information on emission sources and trends. As more jurisdictions plan to design and implement these programs, this report draws on the experience of 13 existing and proposed programs to guide policymakers and practitioners in developing GHG reporting programs. Businesses, industry associations, civil society, and funding agencies may also find this guide useful in facilitating their participation in the development of a reporting program.

GHG reporting programs can be voluntary or mandatory. Unlike a voluntary program (in which participation is voluntary), a mandatory program obligates entities (companies and facilities) to report their emissions at regular intervals. This report focuses on mandatory reporting programs, but much of the information can be applied to the design of voluntary programs.

Mandatory reporting programs provide credible information about GHG emissions and their sources, which can help establish a strong foundation to support mitigation policies. These programs also enable governments and industries to understand their emissions-related risks and opportunities so they can efficiently focus on mitigation activities that will produce the greatest GHG reductions. Mandatory reporting programs bring consistency and enhanced accuracy in reporting entity-level emissions through rigorous calculation and quality management methods.

A reporting program encompasses several components, such as a secretariat or program administrator, reporting entities, emissions accounting and quantification methodologies, and a data management system.

Until now, little information has been available for policymakers on designing GHG reporting programs based on experiences and insights from existing programs. This report analyzes the objectives and design features across 13 programs and recommends options to consider in establishing a new program. It is meant as a reference for policymakers and practitioners developing economy-wide or sector-specific reporting programs.

The mandatory programs researched for this report include: Australia's National Greenhouse and Energy Reporting Scheme, California's Mandatory GHG Reporting Program, Canada's GHG Emissions Reporting Program, China's proposed national reporting program, European Union's Emissions Trading System, France's Bilan d'Emission de GES, Japan's Mandatory GHG Accounting and Reporting System, Mexico's National Emissions Registry, Norway's Emissions Trading System, South Africa's proposed GHG reporting program, Turkey's GHG Reporting Scheme, United Kingdom's GHG Reporting Program, and the United States' GHG Reporting Program.

Establishing mandatory GHG reporting programs is a resource- and time-intensive process that can be daunting for jurisdictions with limited capacity and resources. It is, however, feasible to make a meaningful beginning and obtain reliable information to serve local objectives. Jurisdictions can implement GHG reporting programs in phases by starting with a few major sectors or large emission sources or with simpler methodologies. They can incorporate additional components over time to spread out the cost as they strengthen reporting capacity. For example, programs can start with a basic data management system and scale up or link with other databases. An initial learning period offers an opportunity to gradually enhance capacity within the program and among reporting entities, raise awareness, build consensus around a set of long-term objectives, and gain valuable experience to inform the next phase of the program.

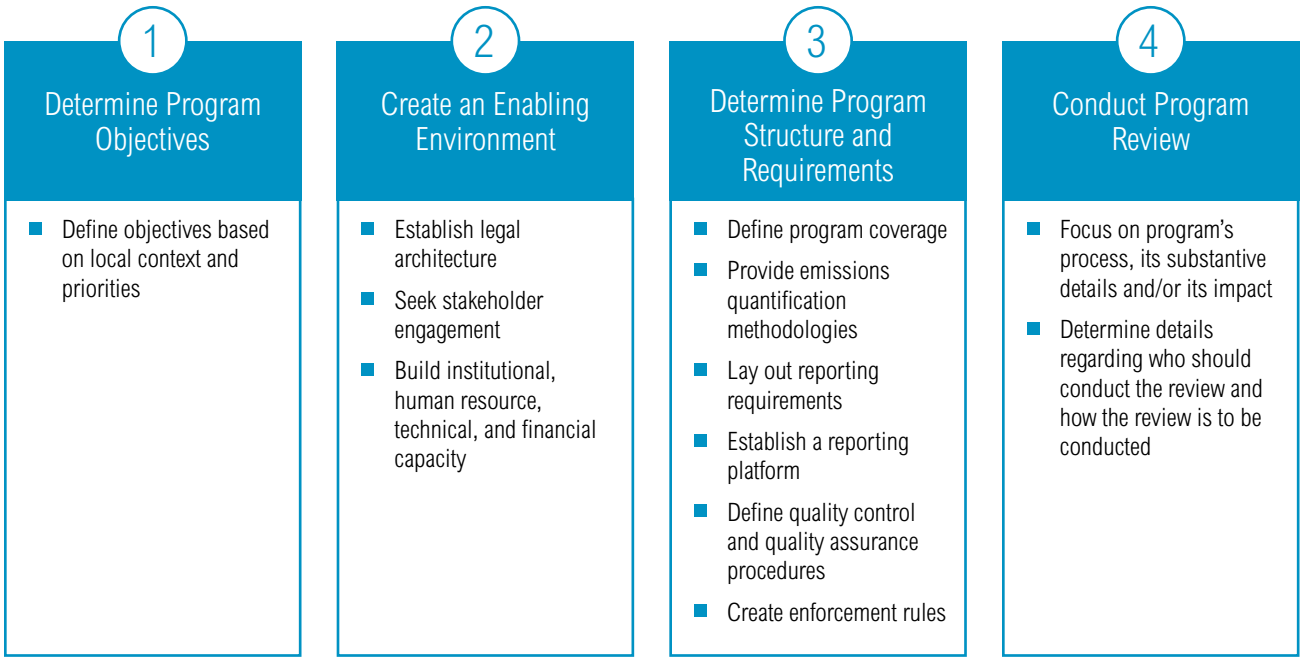
Four broad steps are necessary to establish a reporting program (Figure ES-1):

- Determine program objectives.
- Create an enabling environment for program design and implementation.
- Determine program structure and requirements.
- Conduct program review.

Step 1: Determine Program Objectives

Defining program objectives is the first step toward developing a GHG reporting program because these objectives influence design decisions. Programs can modify their objectives over time as domestic policy evolves and the reporting entities' capacity to report emissions improves. Reporting programs can serve a wide range of objectives and individual programs may pursue different objectives based on priorities specific to their jurisdictions.

Figure ES-1 | **Steps to Establish GHG Reporting Programs**



The following are common objectives of reporting programs:

- Facilitate evaluation of national or subnational policies, identify new mitigation opportunities, and inform the development of new policies.
- Support policies or regulations such as emissions trading schemes or carbon taxes that require emissions data from individual entities to operate in a transparent, credible manner.
- Enhance the overall quality of emissions data reported by entities.
- Promote transparency in GHG reporting and provide emissions-related information to stakeholders.
- Improve and/or validate the national GHG emissions inventory.
- Help reporting entities assess their climate risks and opportunities.

Step 2: Create an Enabling Environment

Building a strong foundation for a reporting program requires ensuring a strong legal architecture; stakeholder support; and adequate institutional, human, technical, and financial resources.

The legal architecture for a reporting program includes the law that mandates entities to report, and the accompanying rules and regulations specifying the implementation of the law. It is influenced by the jurisdiction's legal system and method of establishing rules and procedures. Mandatory reporting programs can be anchored in an existing law or in new legislation. Using an existing law may be quicker than developing new legislation. Existing laws, such as those related to air quality, environmental protection, and corporate sustainability, may be able to support GHG reporting programs with little or no amendment. A comprehensive legal review can help evaluate whether, and how, an existing law may be used. New legislation developed specifically to support the reporting program may be preferable in the absence of suitable existing legislation or if using existing laws would limit the effective design and operation of the reporting program.

Adequate institutional, human, technical, and financial capacity within the jurisdiction is necessary to effectively design, implement, and sustain a reporting program. Programs can build on existing institutions or establish a new set of arrangements. Programs also require professionals with technical knowledge to design and operate the program. Tasks that are human-resource intensive (e.g., data validation) or highly technical (e.g., data collection system development) can be outsourced.

Financial capacity involves understanding the costs related to program design and implementation and ensuring that a sufficient budget is available to start and sustain the program. Some major program costs are those related to staff, outreach, training, developing and maintaining an emissions data management system, and facilitating compliance and enforcement.

Stakeholder support and engagement during program design, and development can secure buy-in, resolve conflicts, promote transparency, and improve reporting entities' preparedness and compliance rates. Consultations can help establish a common understanding of program objectives and rationale, inform the technical details and rules of the program, and provide training so entities can report accurately. Establishing a plan that explains why to engage, whom to engage with, when to engage, what issues to engage on, and how to engage can improve the effectiveness of stakeholder engagement throughout the design and implementation of the program.

Step 3: Determine Program Structure and Requirements

Designing a reporting program requires developing rules and requirements for key design elements to ensure reliability, consistency, accuracy, transparency, and completeness of the data. These design elements include program coverage, emissions quantification methodologies, reporting procedures and schedules, reporting platforms and data disclosure, quality control and assurance, and enforcement (Figure Es-2). Various options under each program design element allow the flexibility to address context-specific objectives and circumstances.

Figure ES-2 | **GHG Reporting Program Design Elements**

- **PROGRAM COVERAGE**
  Who reports what?
- **EMISSIONS QUANTIFICATION**
  How to calculate and measure emissions?
- **REPORTING PROCEDURES & SCHEDULES**
  What to report and how often?
- **REPORTING PLATFORMS & DATA DISCLOSURE**
  Where to report and who has access to reported information?
- **QUALITY CONTROL & ASSURANCE**
  Who verifies what and how?
- **ENFORCEMENT**
  What measures to apply in case of noncompliance?

Program coverage

GHG reporting programs can determine their scope by defining:

- Whether the program is applicable at the facility and/or company level
- Whether only emissions from sources controlled by the reporting entity (direct emissions) must be reported, or if reporting entities must also report emissions that are the consequence of their activities (indirect emissions)
- Applicability requirements (e.g., annual emissions or energy consumption threshold) to determine which entities must report, and when they can cease reporting
- Which GHGs reporting entities should report

Factors such as program objectives, cost to reporting entities, and administrative burden influence decisions related to program coverage.

Emissions quantification

Programs provide guidance on how reporting entities should calculate their emissions from various sources. Emissions can be quantified using calculation-based or direct measurement methods. Calculation-based methods are based on measurements of activities that drive emissions (such as the amount of fuel consumed) and emission factors (such as the GHG content of fuels). Direct measurement involves directly measuring the emitted GHGs. Programs can provide reporting entities with a technical guide on quantification methodologies for different emission activities so they can calculate emissions from individual sources. The methodologies are often categorized in tiers, or data quality levels, of generally increasing accuracy. Higher tier methods are usually required for major emission sources. Programs can decide how prescriptive the methodologies should be given their objectives and the capacities of their reporting entities.

Reporting procedures and schedules

Reporting programs define the type of information entities should submit, and specify related details such as frequency of reporting and records to be retained. This helps ensure consistency across reporters, assess compliance, and obtain relevant data to realize program objectives.

Reporting platforms and data disclosure

Program administrators also need to develop a data management system to collect the reported information. Data management systems can range from simple spreadsheets to sophisticated web-based systems. The appropriate system can be selected based on factors such as the number of reporters; the time and resources needed to design and develop the system; associated training needs; security and data protection features; and potential to scale it up to include more reporters, GHGs, or emission sources.

Reporting programs should state what kind of information will be disclosed publicly. When making this decision, programs should seek a balance between promoting transparency and protecting confidentiality within the bounds of local laws governing disclosure of commercially sensitive information.

Quality control and quality assurance

Programs can employ various measures to enhance quality along the entire chain of data collection, quantification, monitoring, reporting, and verification. They can facilitate quality assurance by prescribing calculation and monitoring methodologies, designing data management systems, and undertaking compliance assistance activities, such as training. To ensure quality, programs can either review and audit submissions themselves or require third-party verification. Typically, programs require reporters to submit self-certified information and then conduct some level of review themselves even when the submissions are verified by a third-party. Factors influencing the choice of quality control and assurance measures include program objectives, the cost for the program administrator and reporters, and capacity within the program to take on a verification role.

Enforcement

Enforcement measures are necessary to ensure that all entities report their emissions accurately, submit them on time, and perform revisions when needed. Programs can apply increasingly strict options if reporters fail to comply, for example, first, giving a firm deadline; next, imposing monetary fines; and finally, applying legal penalties.

Step 4: Conduct Program Review

Periodic review helps evaluate the program's effectiveness and make modifications if necessary. A review process lends credibility to the program by providing an opportunity to seek feedback from stakeholders, identify good practices as well as inefficiencies, and assess the program's impact. Policymakers can determine who should conduct the review and how often. Reviews can focus on the program's process (e.g., administrative efficiency), its substantive details (e.g., whether the objectives need to be revised), and/or its impact (e.g., number of reporters).

CHAPTER I

INTRODUCTION

Measuring greenhouse gas (GHG) emissions is crucial to understanding the emission trends of companies and facilities so that targeted and effective mitigation strategies can be developed. GHG reporting programs provide a platform to gather emissions data from these entities and help mainstream the measurement and reporting of GHG emissions.

Emissions data are needed to understand how to influence the emissions trajectories of different sectors, support policies such as emissions trading schemes that require emissions information from facilities, set realistic policies and evaluate their effectiveness, help reporting entities assess their climate risks and opportunities, and provide information to stakeholders.

A reporting program basically comprises a secretariat or program administrator, reporting entities, emissions accounting and quantification methodologies, data management systems, and review and verification methods.

Reporting programs can be voluntary or mandatory. Voluntary programs, in which participation by entities to report their GHG emissions is voluntary, may be developed by the government, nongovernmental organizations, or business associations. Programs with voluntary participation include the Brazil GHG Protocol program, The Climate Registry, and CDP, a global initiative to promote emissions disclosure by companies. Mandatory programs are developed by the government and require regulated entities to estimate and report their GHG emissions at regular intervals. Examples of mandatory programs include Australia's National Greenhouse and Energy Reporting Scheme, the European Union Emissions Trading System, Turkey's GHG Reporting Scheme and the GHG Reporting Program in the United States.

Voluntary programs help entities become familiar with calculation methodologies, emissions data management procedures, and reporting protocols. Jurisdictions considering mandatory programs often capitalize on the GHG quantification and reporting knowledge of entities that participated in voluntary initiatives. Mandatory programs are likely to be more prescriptive in their requirements, which brings greater consistency and accuracy (Defra 2010; Gray and Shimshack 2011; U.S. EPA 2008).

GHG reporting programs establish a monitoring, reporting, and verification (MRV) system for facilities or companies, which can inform national or subnational mitigation policies and goals. GHG reporting programs should be well-aligned with national and subnational objectives and rooted in domestic priorities.

Developing countries with a lack of reliable emissions data can particularly benefit from reporting programs, but they are often challenged in developing sustainable programs because of insufficient resources and inadequate capacity. Embedding an emissions reporting program within a jurisdiction's broad climate and energy strategy can spread the resources needed across multiple policies and agencies. A new program is more easily justified if it can serve multiple policies or agencies.

The *Guide for Designing Mandatory Greenhouse Gas Reporting Programs*, a collaboration between the Partnership for Market Readiness and the World Resources Institute, offers guidance for policymakers and practitioners in developing mandatory GHG reporting programs. It also provides information to stakeholder groups that wish to participate effectively in the development and design of these programs. Stakeholders may include the entities that expect to be regulated, industry associations, environmental and academic groups, multilateral organizations, and funding agencies.

The report is meant as a reference for policymakers and practitioners developing economy-wide or sector-specific programs that address national and subnational priorities and objectives. It highlights the major design elements of a reporting program and discusses various factors influencing decisions under each element. Where relevant, the report highlights initial steps that jurisdictions with limited resources can take to make tangible progress toward establishing reporting programs. Although the emphasis is on the design of a mandatory reporting program, many aspects of the report are relevant for developing voluntary programs.[1]

The mandatory programs researched for the report include (Figure 1):

- Australia (National Greenhouse and Energy Reporting Scheme)
- California (Mandatory GHG Reporting Program)
- Canada (GHG Emissions Reporting Program)
- China (proposed national reporting program)
- European Union (EU Emissions Trading System)
- France (Bilan d'Emission de GES)
- Japan (Mandatory GHG Accounting and Reporting System)

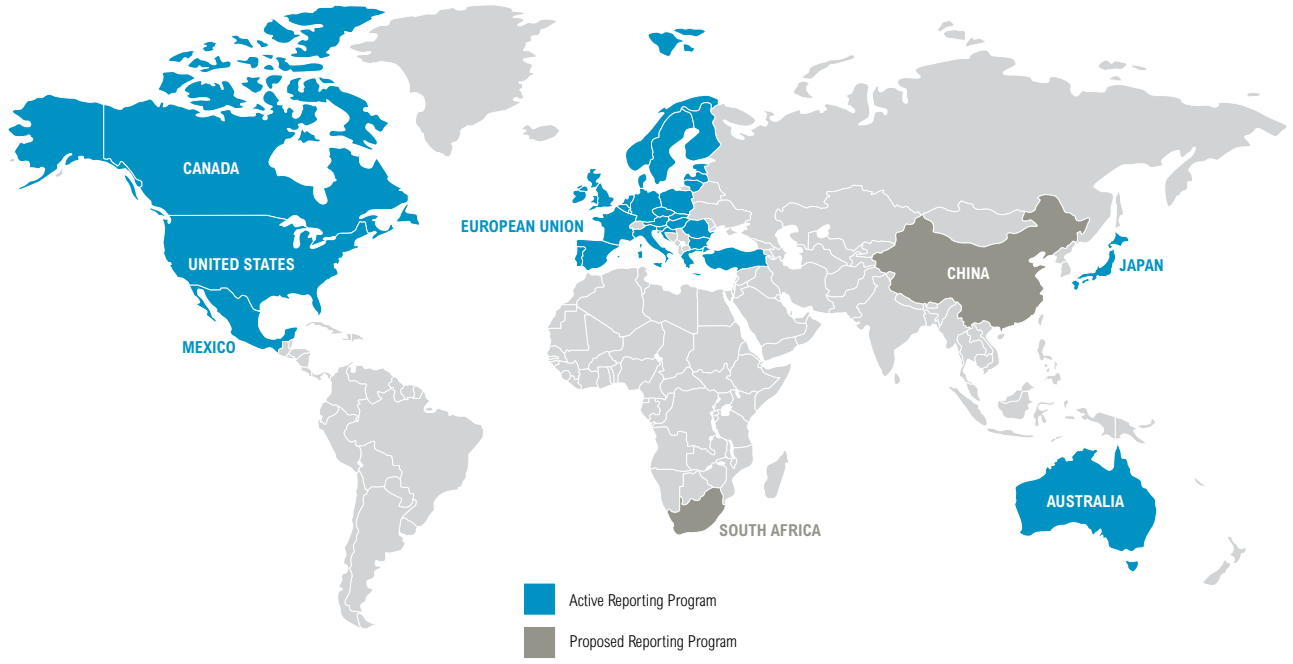
- Mexico (National Emissions Registry)
- Norway (Emissions Trading System)
- South Africa (proposed national GHG reporting program)
- Turkey (GHG Reporting Scheme)
- United Kingdom (GHG Reporting Program)
- United States (GHG Reporting Program)[2]

Hereafter, the existing and proposed programs are referred to by their respective jurisdictions irrespective of their formal name.

These programs were chosen because they represent a range of experiences and insights from older, newly established, and proposed programs, and from industrialized as well as developing countries. We interviewed staff members from these programs either specifically for this report or for a preliminary publication on this topic.[3] The guidance given here is based on information synthesized from these interviews, as well as from program websites, official documents, and a wider literature review. An attempt has been made to identify design options and provide practical recommendations while recognizing that reporting programs are context specific.

This report is organized into four chapters. Chapter 2 describes the objectives that mandatory reporting programs can fulfill. Chapter 3 discusses creating an enabling environment for program design and implementation. Chapter 4 focuses on program structure and design, including coverage, emissions quantification, reporting requirements, reporting platforms and data disclosure, quality control and assurance, and enforcement. Chapter 5 concludes with a discussion of how a program can adopt a regular review process to ensure that it remains relevant and effective. In each chapter, key considerations or recommendations for policymakers are identified. A checklist of questions for policymakers is also provided for each design element to guide the decisionmaking process.

Figure 1 | **Mandatory GHG Reporting Programs Researched for this Report**



CHAPTER II

DETERMINING PROGRAM OBJECTIVES

Defining program objectives is the first step toward developing a mandatory greenhouse gas reporting program because the objectives will determine many design decisions. Objectives can be short term or long term. They should be reviewed and modified over time as policy and business contexts evolve and as reporting entities' capacity improves. Reporting programs can serve multiple objectives.

Some of the major objectives of setting up a reporting program are to:

- Facilitate policymaking by analyzing emissions data at different resolutions (entity, sector, or economy-wide).
- Support policies and regulations, such as emissions trading schemes, which require detailed source-level data.
- Improve GHG data quality to support policy objectives.
- Provide information to stakeholders to facilitate their involvement.
- Inform national GHG inventories under the United Nations Framework Convention on Climate Change.
- Help reporting entities assess their climate risks and opportunities.

Jurisdictions may pursue different objectives for a reporting program based on their priorities (Table 1). For instance, while one jurisdiction may want the reporting program to support an emissions trading scheme, another may use the program mainly to improve data quality and provide information to stakeholders. To promote sustainability, the long-term objectives of reporting programs should be aligned with key strategic policies in the jurisdiction, such as national climate change policies, energy policies, low-carbon roadmaps for the economy, and mitigation goals.

Some common examples of program objectives are discussed in Chapter 2.1–2.6.

2.1 Facilitate Policymaking Through the Analysis of Emissions Data at Different Resolutions

Reliable, detailed data from a mandatory program can help policymakers formulate comprehensive sector or economy-wide policies and actions to reduce emissions. Emissions data analyzed over time and at different resolutions—entity, sector, or economy-wide —can help evaluate existing policies and actions, identify new mitigation opportunities, and inform the development of new policies and actions. For example, governments pursuing mitigation in a certain sector may use data from facilities, along with other information, to gain a better understanding of the range of efficiencies across the sector and establish a realistic emissions intensity goal. Annual reporting over time can indicate the impact of the policy in each entity's emissions trajectory.

This objective has major implications for the program's design including the types of emissions to be reported, the emissions threshold (by sector or economy-wide), as well as the kind of data that must be collected to support meaningful policy formulation (e.g., total emissions versus emissions per unit of output) (see Chapter 4).

The Australian reporting program has identified informing policy formulation as one of its objectives (Australia, Department of the Environment 2014a). The GHG data collected through that reporting program is the basis of emissions projections to inform climate change policy. The program also collects data on energy production and consumption, which informs energy efficiency policy development (Prosser 2015a). The newly established Mexican reporting program plans to use the information gathered to develop mitigation policies (Alvarez and Alarcon-Díaz 2014).

2.2 Support Policies and Regulations That Require Detailed Source-Level Data

Reporting programs are the foundation of certain policies, such as GHG emissions trading programs and certain carbon taxes, which require source-level data from individual entities to operate in a transparent and credible manner. The Californian and EU reporting programs were both designed to support emissions trading schemes (European Commission 2014a; CARB 2013a). Mexico's program is meant to be the first step toward the development of a carbon market (Alarcon-Díaz 2015a).

When planning and designing market-based instruments, policymakers need GHG emissions data gathered by reporting programs to make informed decisions, such as which sectors of the economy should be covered and what emissions threshold to use to determine policy coverage. Reporting programs are fundamental to determin-

ing an entity's liability under emissions trading and carbon tax schemes. For example, in an emissions trading scheme, a liable entity is required to surrender an emissions allowance for each metric ton of CO_2 equivalent (tCO_2e) emitted. The reporting system verifies each entity's annual emissions and determines the number of allowances that must be surrendered.

Implications for design elements include decisions regarding coverage, emissions calculation and monitoring methodology, and verification (see Chapter 4). GHG reporting programs supporting emissions trading and carbon tax schemes provide a uniform methodology to calculate, report, monitor, and verify emissions. This is essential to building trust in carbon markets, which themselves depend on publicly available, reliable data for their smooth and efficient functioning. Further, reporting systems can provide reliable emissions data at the entity level to determine baseline emissions and, where relevant, inform the allocation of allowances or tax credits and exemptions. The lack of reliable emissions data can adversely affect trading and tax schemes. For example, in the European Union, after verified emissions data were released at the end of the EU Emission Trading Scheme's first compliance cycle in 2006, carbon prices fell because it became clear that a lack of accurate data when the scheme began had resulted in an initial overallocation of emission allowances (European Commission 2014b).

2.3 Improve Data Quality and Consistency

Reporting programs may also be designed to improve the overall quality of emissions data submitted by reporting entities. Even if entities in a region had been calculating and reporting their emissions under a voluntary program, a mandatory program with standardized calculation methodologies and verification systems can increase stakeholder confidence in the reported data. Improving data quality and consistency is a crucial first step toward achieving other program objectives, such as supporting emissions trading schemes and informing national inventories. Reporting programs seek to enhance data quality through several ways, such as reviewing and improving quantification methodology, using updated emission factors, or requiring better monitoring. This objective is likely to influence program design elements related to calculation and monitoring, data quality, and verification (see Chapter 4).

New programs in jurisdictions with little experience in emissions reporting can take incremental steps toward improving the quality of reported data, such as training reporters, or beginning with simpler calculation methods using easily available default emission factors then adopting more rigorous methods over time. For example, one of the objectives of both the Mexican and Turkish reporting programs is to improve the quality of their GHG emissions data (Alvarez and Alarcon-Díaz 2014). Their emphasis in the initial period will be to build capacity among reporters, service providers, and the programs themselves.

2.4 Provide Information to Stakeholders

This objective promotes transparency in GHG reporting and is commonly included in reporting programs. In addition to policymakers, other stakeholders such as investors, environmental organizations, companies, researchers, customers, and the general public, are interested in GHG emissions information. These groups may seek emissions data at different resolutions for a range of purposes. For example, they may use these data to inform investment decisions, support policy analysis and advocacy campaigns, or inform customer choices. Almost all reporting programs share and disclose reported data either at an entity level, and/or in an aggregated form for use by stakeholders (also see

Chapter 4.4). For example, data from the Australian program is used by the Australian Bureau of Statistics, to produce yearly energy statistics that monitor changes in the supply and use of energy over time (Prosser 2015a).

Programs need to find a balance between reporters' confidentiality concerns about disclosing emissions-related information and stakeholders demand for transparency. Stakeholders may seek access to data with sufficient detail to conduct meaningful analysis and inform their decisions, whereas entities may want to publicly disclose only aggregate emissions. This objective has implications for program design; for example, in terms of specifying the level of disaggregation for emissions data and seeking greater transparency in the use of calculation methodologies (see Chapter 4).

2.5 Inform National Inventories Under the UNFCCC

Countries that are party to the United Nations Framework Convention on Climate Change (UNFCCC) may set up mandatory reporting programs to improve their national inventory estimates, as is done with the Australian, Canadian, Norwegian, and U.S. programs (Environment Canada 2011; CER 2012a; Anderson 2014). Source-level data from entities can be used to improve accuracy and/or provide validation to national emissions estimates. This can enhance the quality of national inventories, thus strengthening the foundation for subsequent mitigation efforts (Singh, et al. 2014). For example, the Australian reporting program collects data in a form readily useful for the national inventory. Entities must provide enough information to classify the data into categories, such as industrial process emissions and fossil fuel combustion, that are relevant for the national inventory (Singh, et al. 2014).

However, emissions data from reporting programs can only be used in national inventories under certain conditions, for example, when sources under both systems are defined in the same way (Singh, et al. 2014). To support this objective, program design needs to be consistent with the national inventory. This influences decisions related to threshold definitions, the sectors and emission sources to be covered, calculation methods, and the level of disaggregation required in reported data (see Chapter 4).

2.6 Help Reporting Entities Assess Their Climate Risks and Opportunities

Reporting entities themselves can derive significant benefits from the exercise of quantifying their emissions. Reporting programs can support entities in measuring their emissions, which is the first step toward managing emissions over time. GHG measurement and monitoring helps entities identify major sources of emissions and assess their climate risk. Risks may include impact on entities' operations from factors such as fluctuating energy prices and shifting consumer demand and consumption patterns in response to growing awareness about climate change (Kauffmann, Less, and Teichmann 2012). Measurement also enables entities to develop mitigation strategies, prioritize abatement opportunities, and remain competitive in a carbon-constrained world. Tracking and reporting GHG emissions can lead entities to a better understanding of their emissions profile, which can drive them to invest in more efficient technology, drive innovation, and identify new business opportunities that involve a lower carbon footprint. Reporters can also benchmark themselves based on reported data from other entities—either at an entity level or aggregated at a sector level.

This objective has design-related implications in terms of including elements that would assist entities in accurately and consistently measuring and tracking their emissions and related performance indicators. For example, programs can provide detailed guidance on what to measure, how to measure it, and what to track and report (see Chapter 4).

The UK program recommends that reporters set a base year and a target of their choice to track their emissions. The target can be an absolute reduction in emissions compared with the base year, or an intensity target based on an appropriate normalizing factor (e.g., metric tons of manufacturing output). The program also recommends that reporters develop at least three key performance indicators associated with their environmental impacts (Defra 2013). They should report their progress against targets annually and provide information on measures implemented to reduce their GHG emissions. The French program was also set up to help reporters understand their climate risks and opportunities.

Table 1 | **Objectives of Various GHG Reporting Programs**

Program Objectives	Australia[a]	California	Canada	European Union	Mexico	Turkey	United Kingdom	United States
Facilitate policymaking through the analysis of emissions data	✓	✓	✓	✓	✓	✓	✓	✓
Support policies requiring detailed source-level data	[b]	✓		✓	✓		✓	
Improve data quality and consistency	✓	✓	✓	✓	✓	✓	✓	✓
Provide information to stakeholders	✓	✓	✓	✓	✓	✓	✓	✓
Inform national inventories	✓		✓	✓	✓			✓
Help reporting entities assess their climate risks and opportunities	✓	✓	[c]	✓		✓	✓	

Notes:
a. The Australian program has another objective: to avoid duplication of similar reporting requirements in the states and territories (CER 2014a).
b. This is no longer a stated objective given the repeal of the carbon tax in 2014 (Australia, Department of the Environment 2014b).
c. This is not an explicit objective but it is expected that the program supports this objective.

Source: Compiled from country program websites by interpreting and synthesizing stated program objectives and from information obtained through program staff interviews. Programs may also implicitly support other objectives.

PROGRAM OBJECTIVES

Key Considerations

- Identifying GHG reporting program objectives is the first step because objectives influence subsequent design decisions.
- GHG reporting programs can serve a wide range of objectives. The choice of objectives will depend on national and subnational priorities and context.

Checklist of Questions to Guide Decisionmaking

- Have domestic priorities been considered in determining the program objectives?
- Have objectives been defined for short-term and long-term time frames?

CHAPTER III

CREATING AN ENABLING ENVIRONMENT

Strong legal architecture, adequate institutional, human, technical, and financial capacity, and regular stakeholder engagement provide a robust foundation for designing and implementing reporting programs.

An early focus on these enabling factors can help a program reach its full potential and achieve the stated objectives.

3.1 Legal Architecture

The legal architecture includes the law that mandates entities to report their emissions, and the accompanying rules and regulations specifying the arrangements to implement the law (Figure 2). A well-defined legal architecture is central to a mandatory reporting program because it establishes the obligation for entities to report, and provides a basis for the institutional, administrative, and compliance and enforcement arrangements for the program (also see Chapter 4).

3.1.1 Existing versus new legislation

Policymakers can either anchor the program in an existing law, with an amendment if necessary, or develop new legislation. A comprehensive legal review may have to be undertaken to assess whether, and how, existing legislation may be used to establish a mandatory GHG reporting program (Witi 2015). Existing laws in environmental protection, air quality, pollution control, and corporate sustainability can support GHG reporting programs. Alternatively, program administrators can develop new legislation to support the reporting program. Table 2 lists the laws underpinning a few mandatory reporting programs.

Many factors, including the program's objectives, buy-in from reporting entities, political context, available resources, and legal and institutional capacity, can help program designers decide which option to pursue. Implementing the program using an existing law even if it requires an amendment, is likely to be quicker and more cost-effective, compared with developing new legislation. However, if this approach limits the scope of the program, establishing new legislation may be a more desirable option. For example, one of the reasons Australia opted for new legislation was that no existing legislation supported the program's objective of streamlining reporting and overriding various state reporting laws with a national program.

Using existing legislation may allow the reporting program to take advantage of established systems, procedures, compliance, and enforcement measures. However, new legislation can also align with related laws and use existing systems and procedures. The legal review can help identify legislation with reporting obligations that the GHG reporting program could adopt or build upon to minimize additional burden on reporting entities. For example, Mexico allows entities from energy and industry sectors reporting under the national pollutants database system (Registry of Emissions and Transfer of Pollutants) to continue to report at the facility level, while outlining corporate-level obligations for entities from other sectors (Alarcon-Díaz 2015b). Australia adopted the existing reporting obligations for electricity generators (Prosser 2015a). It is also important to identify legislation that could influence the requirements of the mandatory reporting program, such as legislation related to data confidentiality, access to information, or competitiveness (Witi 2015).

3.1.2 Laws and regulations

The legal system in individual jurisdictions will influence the specific legal arrangements supporting GHG reporting programs. The legal architecture to support the reporting program normally has several layers, depending on the country, which include the primary legislation, secondary legislation or regulations, and accompanying rules and guidelines established by the program administrator and

Figure 2 | **Enabling Factors**

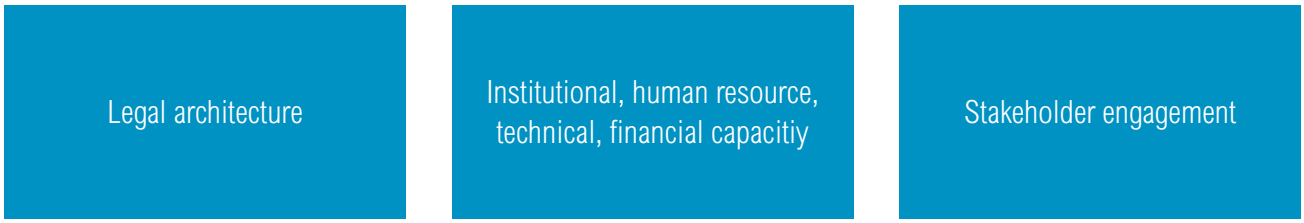


Table 2 | **Laws Underpinning Mandatory Reporting Programs**

JURISDICTION	LAW	SOURCE	EXISTING/ NEW LEGISLATION
Australia	National Greenhouse and Energy Reporting Act, 2007	http://www.comlaw.gov.au/Details/C2007A00175	New
California	California Global Warming Solutions Act (AB 32), 2006	http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf	New
Canada	Canadian Environmental Protection Act, 1999	http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=CC0DE5E2-1&toc=hide	Existing
European Union	Directive No. 2003-87-EC establishing a scheme for greenhouse gas emission allowance trading within the Community, 2003, and its revisions	http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32003L0087	New
France	Grenelle 2 Act, 2010	http://www.developpement-durable.gouv.fr/IMG/pdf/Grenelle_Loi-2_GB_.pdf	New
Japan[a]	Act on Promotion of Global Warming Countermeasures, 1998	http://www.cas.go.jp/jp/seisaku/hourei/data/APGWC.pdf	Existing
Mexico	General Climate Change Law, 2012	http://www.inecc.gob.mx/descargas/2012_lgcc.pdf	New
South Africa[b]	National Environmental Management Act: Air Quality Act (Act 39 of 2004)	http://www.saflii.org/za/legis/consol_act/nemaqa2004454.pdf	Existing
Turkey	Regulation on Monitoring, Reporting and Verification of Greenhouse Gas Emissions, 2012		New
United Kingdom	Climate Change Act, 2008; Companies Act, 2006	http://www.legislation.gov.uk/ukpga/2008/27/pdfs/ukpga_20080027_en.pdf	Existing
United States	Clean Air Act, 1970	http://www.epw.senate.gov/envlaws/cleanair.pdf	Existing

Notes:
a. The original 1998 Act did not include provisions for the GHG mandatory reporting program, which were introduced in the revision of the Act in 2005 (enforced in April 2006).
b. Proposed reporting program.

other relevant authorities. The primary legislation establishes the obligation to report, the institutional arrangements, the enforcement provisions, and sets limits beyond which the detailed regulations and rules cannot go. The secondary legislation is often used to specify the details of the program. These details may also be specified in rules and guidelines established by the administrator, which also provide practical interpretation of the law.

For instance, Mexico's General Climate Change Law requires that the environment ministry (SEMARNAT) develop regulations that define the reporting threshold and specify other program design elements such as GHGs to be reported; calculation methodologies; a monitoring, reporting, and verification system; and links with other reporting programs. The law also legally obliges covered entities to report emissions to the program administrator (Kadas 2014). SEMARNAT published the reporting regulations in October 2014. The technical requirements related to quantification methodologies (e.g., global warming potential values to be used, GHGs to be reported, emission factors to be used) will be published in secondary laws, called the "secretarial agreements." In Australia, the *National Greenhouse and Energy Reporting Act 2007* (amended), along with its regulations and *the National Greenhouse and Energy Reporting (Measurement) Determination,* form the legislative framework of the country's reporting program (Australia, Department of the Environment 2014c). The *Measurement Determination* provides methods for calculating GHG emissions. The Act identified the greenhouse and energy data officer as the program administrator, but in 2012 the function was transferred to a new agency, the Clean Energy Regulator, which is now responsible for administering legislation to reduce emissions and increase the use of clean energy (CER 2014b).

The time needed to pass a bill, develop regulations, and institute the legal and regulatory framework varies in different jurisdictions and needs to be factored into the timeline to establish a GHG reporting program. For example, in some jurisdictions an impact assessment may need to be completed to demonstrate the net benefit of the proposed requirements before the new law is passed.

LEGAL ARCHITECTURE

Key Considerations

- The jurisdiction's legal system will influence the legal architecture governing the reporting program.
- Policymakers can either anchor the reporting program in an existing law or develop new legislation based on factors such as program objectives, available resources, and legal and institutional capacity.
- The legal architecture may include the primary legislation, mandating the relevant entities to report, and secondary legislation, with rules and regulations specifying the arrangements to implement the law and establish the reporting program.
- Establishing key laws and regulations can be a lengthy process and policymakers should budget sufficient time to finalize the legal architecture.

Checklist of Questions to Guide Decisionmaking

- Has a comprehensive assessment been done to ascertain if an existing law can support the reporting program?
- Did the assessment consider how other legislation (e.g., related to competitiveness and confidential business information) might interact with the legislation supporting the reporting program?

3.2 Capacity Building

The presence of appropriate institutional, human resource, technical, and financial capacity among potential reporters and program administrators can provide a strong foundation on which to establish a reporting program. An increased level of preparedness among all key players is more likely to lead to a program that is well-designed and successfully implemented. Strengthening institutional, human, technical, and financial capacities can be one of the first areas of focus for jurisdictions with limited resources.

3.2.1 Institutional capacity

Institutional capacity refers to the existence of effective institutions and agencies with a mandate to lead or support the design, implementation, and administration of the reporting program. Transparent and effective institutional arrangements can help to streamline program administration, efficiently deploy resources to achieve program objectives, and result in long-term sustainability of the program. This requires a clear understanding of the various functions needed to support the program, deciding whether existing institutions can undertake these roles or if new institutions are needed, and defining how they will interact with each other.

The following entities can facilitate the development and implementation of reporting programs by undertaking the functions discussed below:

- **LEGISLATIVE OR LAWMAKING BODY:** It develops the legislation or amends the existing law to mandate reporting. Lawmakers may draft the detailed rules to govern the program, or may outline the broad principles and objectives of the program and direct the program administrator to develop the detailed rules. An arrangement in which distinct entities carry out the functions of making and administering the rules can promote good governance and enhance credibility.
- **ADMINISTRATING BODY:** This body is tasked with implementing the program as per the rules established by the legislation and regulations. In some programs, the administrating agency may also be responsible for developing the detailed rules for reporting and verification. Program administrators collect, analyze, synthesize, and present the reported data; provide monitoring and reporting guidance; set verification and accreditation guidelines to ensure the quality of data and may also verify the data; provide training to reporting entities; conduct outreach; and undertake compliance measures.
- **REPORTING ENTITIES:** These entities are responsible for providing accurate, reliable data, and may employ inventory developers and verifiers to facilitate this task.
- **AUDITORS AND VERIFIERS:** These professionals conduct audits in accordance with the verification and accreditation guidelines. Professionals doing energy audits or air quality regulatory audits in a jurisdiction can acquire expertise related to GHG audits. Program administrators may also perform the emissions auditing and verification function.
- **ACCREDITATION AGENCIES:** These agencies provide an independent assessment of verifiers' technical competence—in emissions accounting as well as in calculation and measurement of GHGs from specific sources or sectors—and impartiality to carry out verification in accordance with the program rules.
- **JUDICIAL COURTS AND AGENCIES:** Their role is to resolve disputes and exercise legal penalties in an impartial manner to enforce the law. Accreditation agencies may also take the appropriate action to respond to any complaints against verifiers.

Jurisdictions may build on existing institutions or establish a new set of arrangements to design and administer the GHG reporting program (Table 3). This decision can be based on factors such as the cost effectiveness of the selected option; required skills, systems, and resources; and the broader legal system. Policymakers can start by mapping existing institutions in terms of their capacity and expertise to support or lead the program. They can identify gaps as program planning and design progresses.

Desk research, stakeholder consultations, targeted questionnaires, interviews, and workshops are some tools that can facilitate a comprehensive assessment of existing institutions relevant to GHG reporting and their administrative and technical capacities.

Multiple agencies can also share responsibility to administer the program. For example, in Japan, the Ministry of Environment (MOE) acts as the program administrator, but different ministries manage different industry sectors and reporters submit their GHG reports directly to the appropriate ministry for their sector (Singh and Mahapatra 2013) (Figure 3). Individual ministries compile and submit GHG reports to MOE and the Ministry of Economy, Trade, and Industry (METI) (Sekiya 2007).

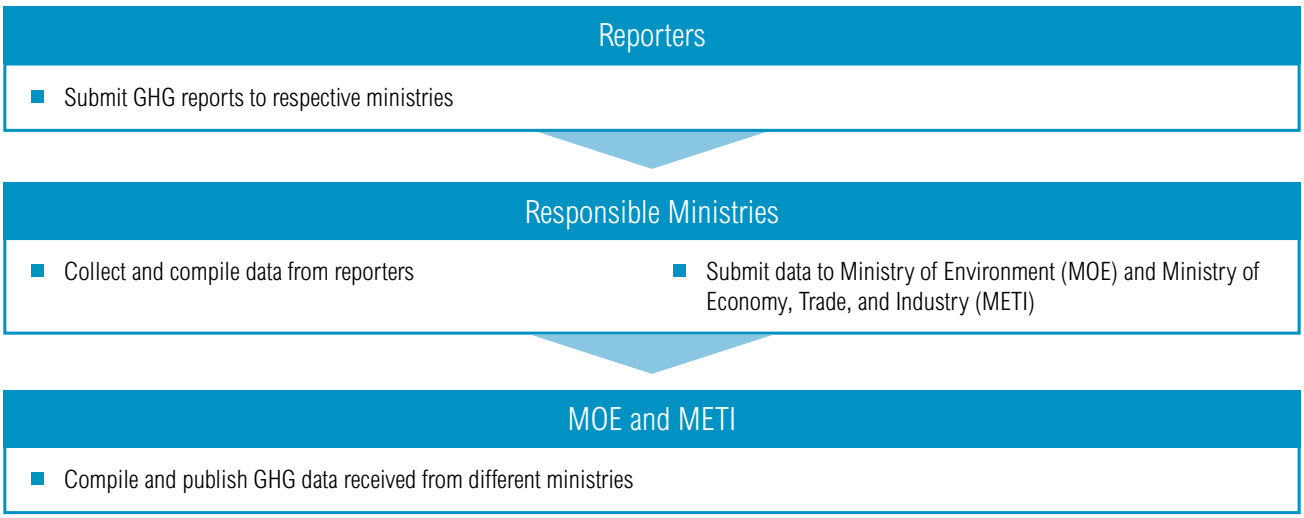
GHG reporting programs usually pertain to activities under several departments or ministries such as environment, climate, energy, industry, treasury, and commerce. Therefore, even when a single agency designs and/or implements the program, it may be helpful for all related departments to be engaged from the outset. This may be done through a working group with representation from relevant departments and agencies, and/or other stakeholders. For example, in South Africa, the Department of Environmental Affairs is coordinating with other departments such as the Department of Energy and the Department

Table 3 | **Institutional Arrangement Options for Reporting Programs**

INSTITUTIONAL ARRANGEMENT	ADVANTAGES	CHALLENGES	EXAMPLES
Mandate an existing agency with data collection and verification experience	Existing technical expertise and administrative capacity to manage the reporting program	■ In some countries, existing capacity may be quite limited ■ May need to adapt, expand, or work closely with other agencies to satisfactorily carry out new responsibilities	Environment Canada, South Africa's Department of Environmental Affairs (DEA), U.S. Environmental Protection Agency (EPA) are existing agencies implementing reporting programs
Establish a new agency or a new branch in an existing agency	Ability to establish institution with most effective design	Likely to involve higher upfront cost and capacity building	Australia established a new agency, the Clean Energy Regulator, to administer its reporting program[a]
Multiple existing agencies with data collection and verification experience share responsibility	■ Accommodates existing institutional structures ■ Spreads out upfront investment ■ Taps widespread expertise ■ An efficient option where more than one agency is already involved in data collection and monitoring	■ Requires clear division of roles, decisionmaking and authority to minimize potential conflicts ■ Needs a well-defined process for coordination and information sharing	■ The Japanese and United Kingdom reporting programs follow this model ■ The EU program requires EU Member States to facilitate coordination if multiple competent authorities are involved in monitoring and reporting of GHG emissions (European Commission 2012c)

Note: a. An existing government department developed and administered the Australian reporting program for the first five years.

Figure 3 | **Institutional Structure for GHG Reporting in Japan**



Source: Singh and Mahapatra 2013.

of Mineral Resources, which have the authority to collect energy and fuel data respectively from potential reporters. It is signing a memorandum of understanding with each department to formalize the coordination process (Witi 2014).

Allocating adequate budget and financial resources to the responsible agency(ies) is also critical to enable them to successfully carry out their functions (see Chapter 3.2.3).

INSTITUTIONAL CAPACITY

Key Considerations

- A clear understanding of various functions needed to design and support the program is an important first step toward building institutional capacity.
- Factors such as cost effectiveness, required skills, systems and resources, and the broader legal system, can help designers decide whether existing institutions can perform the necessary functions, or new institutions are needed. Each approach has its associated benefits and challenges depending on the local context.
- When multiple agencies are involved in designing and implementing the program, clear division of roles and decisionmaking authority, a transparent process for information sharing, and allocating adequate resources can minimize coordination challenges.

Checklist of Questions to Guide Decisionmaking

- What roles and functions need to be undertaken to develop and implement the reporting program?
- Have existing agencies been mapped to assess how they can support the reporting program?
- Have clear roles and responsibilities been articulated for agencies that may be involved in program administration?

3.2.2 Human resource and technical capacities

A mandatory reporting program requires human resources and technical capacity to design and operate the program. Human resource capacity refers to the availability of skilled staff to support technical and nontechnical functions needed to plan, design, establish, operate, and maintain a reporting program. Nontechnical functions may include those related to managerial, convening, and communication activities. Supporting technical functions requires human resources with knowledge related to aspects such as emissions accounting standards; sector-specific and cross-sector emission sources, emission factors, and calculation methodologies; data collection and management systems; and auditing and verification. Effective implementation of the reporting program also needs adequate technical capacity among the reporting entities and service providers.

An important decision for administrators is how many employees to hire and what skills they should have. The number and skill level of staff may depend on factors such as the scale of the program, the number of reporting entities, compliance and enforcement requirements, and the program budget. For instance, California's program with its rigorous calculation, reporting, and verification requirements underpinning a cap-and-trade policy covers about 750 facilities and has about 12 staff members—mostly with graduate degrees (Singh and Mahapatra 2013; CARB 2014a).Turkey's program covered about 600 facilities in its first reporting year and has five staff members–all with graduate degrees in engineering. The Australian program covers roughly 1,000 reporting entities providing information for about 10,000 facilities and has a team of 50 spread across different divisions engaged in a range of activities, such as data collection, random audits, verification, outreach, and education (Singh and Mahapatra 2013). Reporting programs should also consider the time needed to seek necessary authorization in their jurisdictions for staffing these positions.

Reporting programs need industry experts, engineers, economists, data analysts, information technology (IT) experts, lawyers, communications experts, compliance officers, and auditors, among others. However, these experts and professionals may not be needed full-time. While the legal structure is being put in place and rules are being designed, there is a greater need for policy analysts, legal specialists, regulators, industry experts, economists, lawyers, and communications experts. As the program moves into the implementation phase, the desired skill set is likely to include data analysts, industry experts, software developers,

trainers with industry knowledge, and verifiers and auditors with expertise in technical audits.

In the absence of adequate skilled staff, some programs have outsourced human resource-intensive or technical tasks to qualified consultants. Outsourcing may be a useful option while programs develop in-house expertise and capacity, which can take time and resources. However, outsourcing also requires program oversight and contractor management. Over time, programs may internalize these jobs and build capacities among staff on operational, methodological, and implementation issues through a sustained training initiative. Examples of reporting programs that outsource operations include the Japanese reporting program, which has four regular staff members and outsources operations such as a help desk service for technical questions and data validation to private consulting companies (Singh and Mahapatra 2013). The U.S. program also seeks support from specialized contractors on several technical aspects, including engineering, data systems, and IT support (Singh and Mahapatra 2013). The Californian and Turkish programs rely on their own staff for most activities, but outsource the development of data systems (Singh and Mahapatra 2013).

Programs also need to invest in building technical capacity among the reporting entities and service providers, which may improve the quality of reported data and facilitate compliance. This can be done as part of the stakeholder engagement process through training workshops, regular exchanges of information between the program and reporters, program websites, and so on. It can also start while the program is being designed and developed as part of building the foundation for a successful program. For example, South African program administrators are already training potential reporting entities to use more accurate quantification methods and build their capacity in advance of the launch of the reporting program (Witi 2014). Programs may also find it useful to start building a pool of experts in emissions accounting and quality assurance, who can provide these services to reporters when the program becomes operational. For example, the newly established reporting programs in Mexico and Turkey involved consultants and potential verifiers, along with reporting entities, in training workshops.

Jurisdictions can also draw on knowledge from voluntary programs. For example, France had a voluntary program for a decade before the mandatory reporting program was established. The voluntary program had created expertise and technical materials on which the mandatory program was able to build. In addition to building technical capacity, programs may also need to include sufficient time for entities to acquire, install, and operate proper monitoring and measurement equipment.

HUMAN RESOURCE AND TECHNICAL CAPACITIES

Key Considerations

- The number and skill level of staff depends on the scale and nature of the program, and on financial resources.
- Outsourcing is an option for programs that lack in-house expertise and capacity in certain areas. Programs can decide to internalize these activities over time.
- Investing in capacity building among the reporting entities can greatly improve data quality and program acceptance.

Checklist of Questions to Guide Decisionmaking

- Has the existing human resource and technical capacity in the jurisdiction been tapped to support the design and development of the program?
- Has an assessment been done to ascertain the number and skill level of staff persons needed? Did the assessment consider needs during the design as well as implementation phases? Has outsourcing of some functions been considered?

3.2.3 Financial capacity

Financial capacity refers to the availability of sufficient financial resources to design and implement the reporting program. Some of the major ongoing costs associated with program management include staff time and costs associated with stakeholder engagement, including outreach and training; developing and maintaining a data management system; and monitoring, verification, compliance, and enforcement. These costs should be determined in the short-to-medium- as well as the long-term to ensure program sustainability. The design phase of the program is likely to incur costs associated with developing quantification methods or conducting analysis to determine program coverage, which can be budgeted as a one-time expense. If multiple agencies are involved, early coordination can ensure that budget allocations are in accordance with program responsibilities and that they are available in a timely manner.

Programs should identify potential source(s) of funding to support the institution(s) charged with program implementation and administration. In jurisdictions with limited resources, identifying financial resources can provide impetus to the program. These sources may be domestic or international, and include budget appropriations, fuel taxes, international public finance (bilateral or multilateral) and so on. For example, the World Bank's Partnership for Market Readiness initiative helps build systems for GHG data monitoring, reporting, and verification in developing countries, among other activities. The initiative has financially and technically supported countries, such as Turkey, to design and implement GHG reporting systems (PMR 2013a).

Programs should engage potential funders from the beginning to secure early buy-in and avoid delays in arranging financial resources. For example, SEMARNAT liaised with the Ministry of Finance as it began planning the Mexican reporting program to lay the foundation for a subsequent budget request for 10 staff positions for the reporting program (Alarcon-Díaz 2015a).

Table 4 presents a summary of the proportion of costs incurred toward staffing and performing various program functions (e.g., conducting outreach, drafting regulation, establishing verification rules), as reported by program administrators. The costs involved in executing different functions depend on a variety of factors, such as the existing capacity among reporters in the jurisdictions, program objectives, and the sophistication of the program.

Programs should identify financial resources and engage potential funders from the beginning to secure early buy-in and avoid delays.

Table 4 | **Program Administration Cost Levels for Staff and Various Functions**

PROGRAM FUNCTIONS	COST FOR DIFFERENT PROGRAMS					
	Australia	Canada	California	France	Turkey	United States
Staff	High	Not Applicable[a]	Not Applicable[a]	Moderate	Moderate	Not Applicable[a]
Pre-regulation outreach and discussions	Low	Moderate	Low	High	Low	Moderate
Drafting regulation	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Initial setting up of program infrastructure	High	High	Moderate	Moderate	Low	Moderate
Initial introduction to reporting entities	Moderate	Moderate	Moderate	Low	Low	Moderate
Data management system	Moderate	High	High	Moderate	Moderate	Moderate
Support systems[b]	Not Applicable[a]	Low	Not Applicable[a]	Moderate	Not Applicable[a]	Not Applicable[a]
Verification system	Moderate	Low	Moderate	Low	Moderate	Moderate
Analysis/ summarizing reported data	Low	Moderate	Low	Moderate	Low	Low[c]

Notes: Programs provided a relative, qualitative estimate for each function. Costs were not compared across programs. Programs used the following guidance to provide cost estimate: Low–less than 25 percent of total program cost; Moderate–25–50 percent of the total program cost; High–more than 50 percent of the total program cost.
a. Cost not separately identified by programs because it is incorporated in the cost of other functions.
b. Any infrastructural, institutional, technical or other major recurring expenses (e.g., IT, telephones) that are essential to operate the program but are not covered in other categories.
c. This cost is likely to increase as the U.S. Environmental Protection Agency collects multiple years of data and begins to analyze trends more thoroughly.

Source: Singh and Mahapatra 2013; Icmeli 2015a.

FINANCIAL CAPACITY

Key Considerations

- Financial capacity involves identifying funding sources, and budgeting and allocating resources for activities related to design and implementation.
- Early coordination among multiple agencies involved in program implementation can avoid delays and potential conflicts over the availability of adequate resources.

Checklist of Questions to Guide Decisionmaking

- Has a budget been prepared that outlines various program costs during the design and implementation phases? Has an estimate been made for financial resources needed to sustain the program over the long term?
- Have domestic as well as international funding sources been considered to support the program?

3.3 Stakeholder Engagement

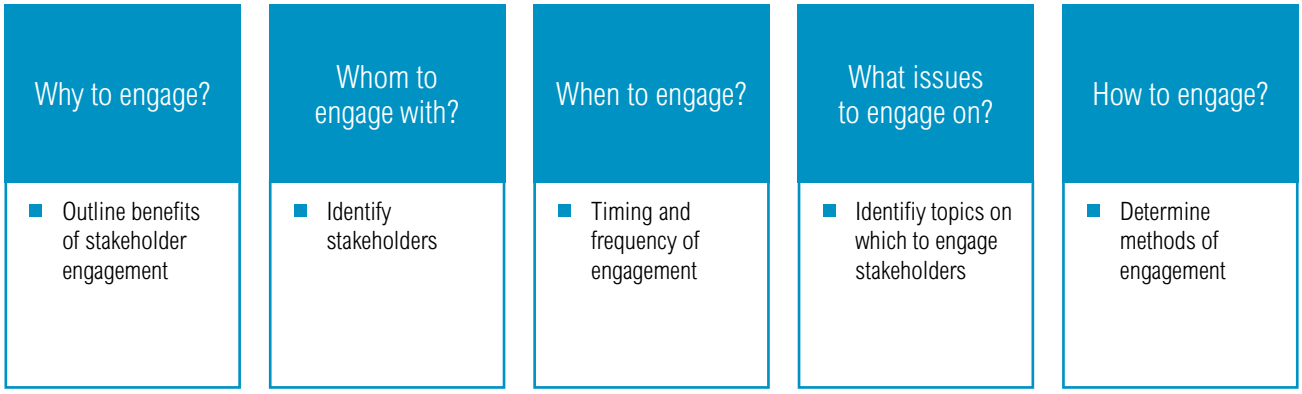
Early stakeholder involvement and a shared understanding of program objectives can result in a variety of benefits. Policymakers and program administrators can lay out a plan that defines the process for stakeholder engagement and addresses issues such as why to engage, whom to engage with, when to engage, what issues to engage on, and how to engage (Figure 4). The plan provides a structured approach to stakeholder engagement that can make the process more efficient and effective. The following discussion describes each element of the engagement plan.

3.3.1 Why to engage

In many jurisdictions, policymakers seek stakeholder input to program design as a standard procedure or because of legal requirements. Stakeholder engagement can improve program design and yield multiple benefits, including (PMR 2013b; PMR 2013c; Matthes 2013):

- Greater transparency in rulemaking
- Enhancing trust between stakeholders and policymakers, which in turn promotes open communication
- Facilitating development of a program that reflects national priorities and circumstances
- Promoting higher compliance rates through improved preparedness among reporting entities
- Identifying sectors and entities that may not be familiar with GHG reporting and may need additional support and training
- Avoiding misinformation, resolving conflicts, and securing consensus and buy-in
- Drawing on widespread expertise for complex issues and strengthening program design
- Generating positive interest, alleviating general skepticism, and creating a sense of ownership
- Raising and maintaining public support

Figure 4 | **Components that a Stakeholder Engagement Plan Should Address**



3.3.2 Whom to engage with

The next step is to identify the stakeholders and map their interests and concerns related to the reporting program. Potential stakeholders include (Figure 5):

- **NATIONAL AND SUBNATIONAL GOVERNMENT AGENCIES AND DEPARTMENTS:** Engagement with various agencies and departments is necessary to improve coordination, seek necessary approvals, reach consensus within the government, and avoid misalignment with other policies and measures (PMR 2013b).
- **REPORTING ENTITIES:** These may include, for example, high-level executives, facility managers, staff from engineering, environment, health and safety, accounting, and legal divisions. Entities from some sectors may need immediate or greater attention depending on the program objectives (e.g., sectors with a large number of reporting entities with limited capacity, sectors with more heterogeneity among entities).
- **TRADE AND SECTOR ASSOCIATIONS:** Trade and sector associations typically have relationships with potential reporting entities, and can play a crucial role in disseminating information, securing buy-in, and resolving conflicts.
- **TECHNICAL EXPERTS FROM VARIOUS INDUSTRY SECTORS:** Industry experts can provide valuable feedback related to sector-specific concerns, for example, ensuring that the prescribed calculation and monitoring methodologies are practical to implement.
- **OTHER REPORTING PROGRAMS:** Existing or past voluntary or mandatory reporting programs in the jurisdiction can provide rich lessons for program design and implementation. Engaging with existing programs is also important to avoid duplication and seek ways to harmonize reporting requirements if needed.
- **SERVICE PROVIDERS AND CONSULTANTS:** These include professionals, such as inventory practitioners and verifiers. Service providers need to understand the program rules and requirements so that they can help reporters submit high-quality data and comply with the program. Their involvement can also enhance the program design process because they may have had prior experience with GHG reporting.
- **INTERNATIONAL ORGANIZATIONS AND FUNDING AGENCIES:** These can support the establishment of the program, help seek technical expertise, facilitate outreach activities, and disseminate information on proposed rules and requirements.
- **ENVIRONMENTAL ORGANIZATIONS, ACADEMIA, AND MEDIA:** These stakeholders can help disseminate information and build support for the program. Academic researchers and technical experts from environmental organizations and other civil society groups can also lend their expertise during the policy formulation and design phases.

Figure 5 | **Typical Stakeholder Groups**

Government	Industry	Others
Relevant ministries Environmental agencies Energy agencies Industry agencies Legal departments Local governments	Potential reporting entities Industry or trade associations Service providers and consultants	Environmental groups Civil society Other reporting programs Development and aid agencies Researchers, scientists, and technical experts Media

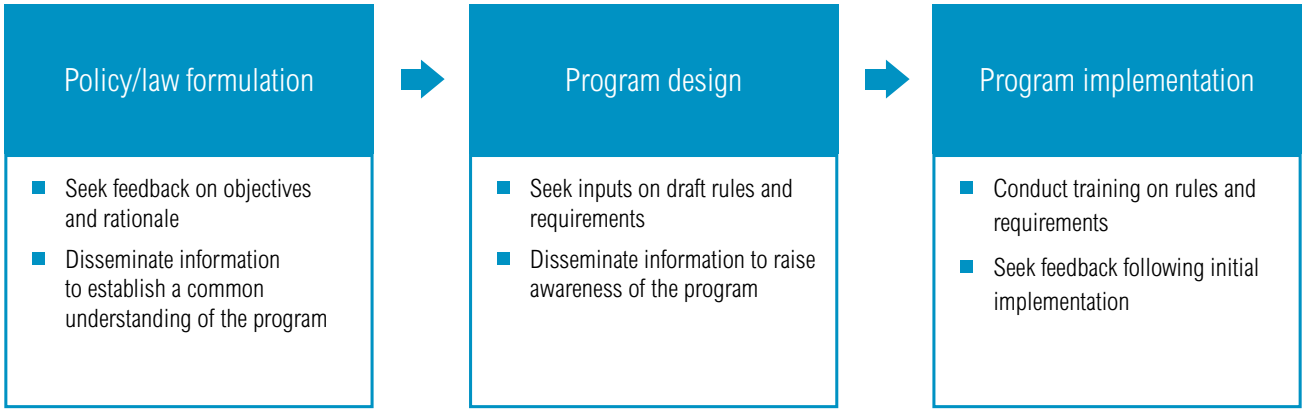
3.3.3 When to engage

Consultations with stakeholders can begin as the policy and legislation are formed and continue through the design and implementation phases of the reporting program.

In the initial phase, engagement is crucial to establish a common understanding of program objectives and rationale. For jurisdictions with limited resources, engaging stakeholders to raise awareness and build a constituency for the program can be a good starting point. This may include outreach as well as consensus building across relevant government departments on issues, such as the institutional, human, technical, and financial capacities needed, and potential program objectives.

During the design phase, consultations with stakeholders can inform the technical details of the program and help refine the rules and requirements. As the program moves into implementation, its focus changes to building reporting entities' capacity and providing training to improve compliance. During this phase, stakeholder engagement also provides crucial feedback to modify the program as necessary (Figure 6).

Figure 6 | **Focus of Stakeholder Engagement During Each Phase of the Program**



Stakeholder engagement is an ongoing process using a range of forums to reach a diverse set of groups.

3.3.4 What issues to engage on

A range of topics may be covered in consultations depending on participants' level of knowledge and preparedness and their specific interest in the program. These include:

- Rationale for the program and its proposed objectives
- Institutional and administrative arrangements
- Design of the program, including technical issues (e.g., coverage and applicability, quantification and monitoring methodologies, data management, quality control and quality assurance)
- Sector-specific issues, compliance and enforcement

Policymakers can also use these discussions to alleviate general skepticism about climate change and its impacts, and demonstrate the need for mitigation strategies while explaining the significance of collecting source-specific GHG data.

3.3.5 How to engage

Stakeholder engagement is an ongoing process using a range of forums to reach a diverse set of groups. The choice of methods employed to seek stakeholder inputs depends on who is being engaged and at which program stage, available resources, and the nature of the topic discussed. For example, some topics may be more appropriate for technical discussions with facility engineers, while other topics may be more suitable for stakeholders from a variety of backgrounds. Program administrators may use the following methods to convey information, address concerns, and gather feedback:

- Solicit written comments to draft laws, regulations, rules, and requirements.
- Provide explanatory documents (e.g., technical guidance, issue briefs), impact assessments, and cost-benefit analysis to facilitate discussions.
- Hold open meetings and presentations for diverse groups of stakeholders.
- Conduct smaller, more focused discussions with select groups of stakeholders (e.g., meetings with reporting entity representatives to obtain feedback on methodology and emissions data to be collected).
- Establish working groups or committees with a mandate to engage stakeholders on specific issues.
- Conduct targeted one-on-one conversations, in-person meetings, and emails.
- Hold public hearings and webinars.
- Develop program websites, which can be an excellent way to provide a number of resources (e.g., guidance documents, presentations, flowcharts, FAQs) and offer continued support and information to reporting entities.
- Use help desks, hotlines, and social media tools to interact with stakeholders.
- Formally seek stakeholder feedback on any revisions to the program design.

Box 1 illustrates how the U.S. program has engaged stakeholders through different stages of the program development.

In addition, the following good practices can be adopted to ensure a smooth and productive engagement process:

- Engage stakeholders as early as possible and draw up an engagement plan to guide the process.

BOX 1 | STAKEHOLDER ENGAGEMENT IN THE U.S. REPORTING PROGRAM

The U.S. Environmental Protection Agency (U.S. EPA), which was tasked with developing the U.S. reporting program, has engaged closely with stakeholders since it began drafting the Greenhouse Gas Reporting Rule in 2008 (Table B1.1). The rule forms the basis of the reporting program.

During the rule development process, U.S. EPA's emphasis was on informing stakeholders, addressing their concerns, and seeking feedback to inform the program design. It organized public hearings, meetings, and webinars, and invited written comments from stakeholders to support rule development. It also tapped trade associations and nongovernmental organizations to disseminate information and communicate with a wide range of stakeholders.

Outreach efforts continued after the publication of the proposed rule, and once the rule was finalized, to build capacity, facilitate compliance, and ensure high-quality reports (Chiu, et al. 2014). The U.S. EPA organized webinars and meetings to explain program requirements, for example, what was included in the reporting rule, how to register as a reporter, and what monitoring and reporting emissions entailed. As the implementation phase began, the agency gave special attention to assisting reporters that did not routinely deal with air pollution regulations.

The U.S. EPA continues to organize targeted meetings and webinars during the reporting window each year and as new guidance is added or an amendment is made to the rule. It uses the program website to provide detailed sector-specific guidance for all emission sources covered under the rule along with factsheets, a comprehensive list of FAQs, a monitoring checklist, slide decks, a sector-specific list of the kind of data that can be considered confidential, as well as announcements and reminders for important dates and events.

TABLE B1.1 | OUTREACH AND TRAINING ACTIVITIES CONDUCTED UNDER THE U.S. PROGRAM

METHOD OF ENGAGEMENT	NUMBER OF EVENTS[a]
Meetings	200+ starting with rule development in February 2008
Webinars	130 since the rule was published in October 2009
Help desk questions	33,000+ since rule publication
FAQs	1,200 hits per day during reporting window

Note: a. As of September 2013.
Source: Sibold 2013.

- Plan for multiple opportunities to seek feedback.
- Use a variety of formats.
- Tailor information to different stakeholder groups based on their specific concerns, and be informed about stakeholder concerns prior to engaging.
- Manage stakeholder expectations because reaching a consensus may not be possible for every situation. Identify champions who support the policy and can help engage and convince their fellow stakeholders.
- Ensure transparency by making draft documents, comments received, and responses to comments publicly available.
- Communicate the outcomes of the stakeholder engagement process and clearly explain how it led to revisions in program design and policy.

STAKEHOLDER ENGAGEMENT

Key Considerations

- Programs should prepare an engagement plan identifying why to engage, whom to engage with, when to engage, what issues to engage on, and how to engage.
- Stakeholder engagement can promote transparency, inform decisionmaking, improve reporting entities' preparedness, resolve conflict, and avoid misinformation.
- A range of topics may be covered in stakeholder discussions using a variety of methods. The choice of method should be tailored to the topic and consider the needs of the stakeholders.

Checklist of Questions to Guide Decisionmaking

- Has a stakeholder engagement plan been developed that identifies stakeholders and issues to be discussed with each group of stakeholders?
- How will different groups of stakeholders be consulted?

CHAPTER IV

DETERMINING PROGRAM STRUCTURE AND REQUIREMENTS

Six key program design elements define the structure of reporting programs and ensure reliability, accuracy, consistency, transparency, and completeness of the data. This chapter presents an overview of these elements and illustrates the main decision points.

These elements and decision points include:

1. Defining coverage in terms of applicable entities and emissions sources and GHGs (*who reports which emissions*)
2. Providing calculation methodologies for different emission sources and data monitoring requirements (*how to calculate and measure emissions*)
3. Determining reporting requirements and schedules (*what to report and how often*)
4. Developing reporting platforms and data disclosure rules (*where to report and who has access to reported information*)
5. Deciding on verification procedures for quality assurance and control (*who verifies what and how*)
6. Establishing enforcement rules (*what measures to apply in case of noncompliance*)

4.1 Program Coverage

The first design element determines the scope of the program by defining the reporting entities, determining which entities need to report, and which GHG emissions will be reported. Mandatory reporting programs can be sectoral (e.g., electricity generation, cement manufacturing), subnational (e.g., Alberta in Canada; California in the United States), national (e.g., Canada, France, Japan, United States) or multinational (e.g., the European Union). When designing a mandatory GHG reporting program, two fundamental questions regarding program coverage are:

1. Which entities will be subject to the program requirements? (*Who*)
2. Which emissions will be reported by those entities? (*What*)

4.1.1 Defining the reporting entity

Programs must determine whether the requirements will be applicable at the level of a facility (e.g. a plant or installation) or a company. They must also determine whether to require entities to report their direct emissions only or also their indirect emissions (as defined below under "direct and indirect emissions").

Facility or Company

If programs decide that their requirements will apply to facilities, they should define what constitutes a facility for the purposes of the program. Broadly speaking, a facility refers to an installation (e.g., a power plant or a cement manufacturing plant) with potentially several emitting activities and sources located within a physical boundary. In some sectors, such as oil and natural gas and electricity distribution, the notion of a physical boundary may not be applicable and there may be multiple emission sources spread over a vast area. A facility may need to be defined differently for these sectors.

In the EU and U.S. programs, the reporting entity is an individual facility. The U.S. program defines a facility as "any physical property, plant, building, structure, source, or stationary equipment, located on one or more contiguous or adjacent properties, in actual physical contact or separated solely by a public roadway or other public right-of-way, and under common ownership or common control, that emits or may emit any GHG" (U.S. EPA 2009a). In the oil and natural gas (onshore) sector, the U.S. program defines a facility to include all emissions associated with wells owned or operated by a single company in a specific hydrocarbon producing basin (Bradbury, et al. 2013). In electricity distribution, a facility refers to the electric power system, which comprises all electric transmission and distribution equipment, linked through electric power transmission or distribution lines, and functioning as an integrated unit (U.S. EPA 2009b).

If a program requires reporting at the company level, that is, companies are responsible for reporting emissions, it must define what constitutes a company. Programs in Australia and the United Kingdom cover companies, which may comprise one or more facilities. For emissions reporting at the corporate level, the program needs to define how to consolidate emissions from different facilities and operations within the company. The GHG Protocol *Corporate Reporting Standard* outlines three methods to consolidate emissions: equity share, operational control, and financial control. The operational and financial control methods are known as control-based approaches (Box 2) (WRI and WBCSD 2004). Programs can specify the consolidation approach to be used to bring consis-

tency in emissions reporting across entities. Some programs, such as the Australian program, require that emissions data be reported at both facility and corporate levels.

Program objectives play a significant role in determining how to define the reporting entities. For example, if the program's primary objective is to support an emissions trading system, reporting obligations should be aligned with who has the liability to comply under the trading system. This liability could be at the facility level (e.g., as in the EU program), or at the corporate level (e.g., as in the proposed national reporting program in China). The UK and French mandatory reporting programs aim to promote disclosure of GHG emissions and related risks and opportunities at the corporate level, hence companies have been identified as reporting entities. Programs interested in meeting multiple objectives, such as the Australian program, include both facility and corporate reporting.

Direct and Indirect Emissions

The GHG Protocol *Corporate Reporting Standard* classifies an entity's GHG emissions into three "scopes." Scope 1 emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of energy purchased by the reporting entity for its own consumption. Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting entity (Figure 7). Programs must determine whether to require entities to report only their direct emissions (Scope 1) or also indirect emissions (Scope 2 and 3 emissions). Table 5 shows the coverage of emissions across different reporting programs.

What indirect emissions, if any, should be reported, depends on factors such as program objectives, administrative burden and the entity's reporting burden. For example, a reporting program set up to inform energy efficiency policies can gain valuable insights into electricity consumption patterns and trends from Scope 2 emissions reporting (Rich 2008). The Australian program requires entities to report Scope 2 emissions and electricity consumption data. This data is useful to inform policy affecting electricity end use across different economic sectors (Prosser 2015a). Scope 2 reporting also allows the entities themselves to better understand how much of their emissions are from electricity use. This information enables them to undertake energy efficiency and demand-side measures to reduce their emissions.

Some programs encourage Scope 3 reporting to help entities manage their emissions as well as to collect policy-relevant information. The Californian and U.S. programs require some entities to report on direct and indirect emissions to yield data relevant for policy formulation for both upstream and downstream sources, without significantly increasing their reporting burden. Data from upstream sources (e.g., natural gas and petroleum producers and importers) inform policies such as low carbon fuel standards and carbon taxes (U.S. EPA n.d.a);

BOX 2 | CONSOLIDATION APPROACHES

Three methods can be used to consolidate emissions from facilities to obtain total emissions at a corporate level.

EQUITY SHARE APPROACH: Under this approach, a company accounts for GHG emissions from each facility according to its share of equity in respective facilities.

CONTROL-BASED APPROACHES: There are two control-based approaches–financial and operational. A company has financial control over a facility if it has the ability to direct the facility's financial and operating policies to gain economic benefits from its activities. The company has operational control if it has full authority to introduce and implement the operating policies in the facility. Generally, a company accounts for 100 percent of GHG emissions from facilities over which it has financial or operational control. It does not account for GHG emissions from facilities over which it has no control.

The Australian program uses the operational control approach to consolidate GHG emissions at the corporate level whereas the French program allows a choice between operational and financial control approaches (CER 2012b, MEDDE 2011).

For more information, refer to WRI and WBCSD 2004.

When both direct and indirect emissions are reported, they should be clearly distinguished from each other and not be aggregated at the program level to avoid double counting.

data from downstream sources (e.g., from facilities in electricity generation and industrial sectors) are necessary to formulate and assess the impact of end-use emission standards.

The Californian and U.S. programs, in particular, require entities that supply fuels and GHGs to the economy to report on the GHG emissions that would result if the supplied fossil fuels or GHGs were completely combusted, released, or oxidized (U.S. EPA n.d.a.). These indirect emissions are released outside the entities' facility, for example, gasoline produced by a refinery may be used by millions of individual cars (use of sold products).[4] But capturing them as direct emissions from small sources through reporting by individual entities is not practical, and would involve a significant administrative burden. These emissions can instead be reported as indirect emissions by a fewer number of regulated entities.

When both direct and indirect emissions are reported, they should be clearly distinguished from each other and not be aggregated at the program level to avoid double counting.

Figure 7 | **Scopes 1, 2, and 3 as defined in the GHG Protocol *Corporate Reporting Standard***

SCOPE 1 (DIRECT EMISSIONS)	■ Emissions from sources owned/controlled by the entity. ■ For example, emissions from fuel combustion in a power plant, limestone processing in a cement manufacturing plant.
SCOPE 2 (INDIRECT EMISSIONS)	■ Indirect emissions that result from the reporting entity's activities but occur in sources not owned or controlled by the entity. ■ Specifically, emissions from the generation of electricity, heat, or steam purchased by the entity for its own consumption.
SCOPE 3 (INDIRECT EMISSIONS)	■ All indirect emissions (besides Scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions. ■ For example, emissions from disposal of the entity's waste, extraction of fuels used at the entity, production of materials purchased by the entity, transportation of materials purchased or sold by the entity, or use of products by consumers.

Sources: WRI and WBCSD 2004; WRI and WBCSD 2011.

Table 5 | **Emissions Coverage in Reporting Programs**

JURISDICTION	LEVEL OF REPORTING	DIRECT EMISSIONS (SCOPE 1)	INDIRECT EMISSIONS FROM PURCHASE OF ELECTRICITY, HEAT, OR STEAM (SCOPE 2)	OTHER INDIRECT EMISSIONS (SCOPE 3)
Australia	Corporate and facility	✓	✓	Encouraged
California	Facility (and corporate)[a]	✓	[b]	✓[a]
Canada	Facility	✓		
European Union	Facility	✓		
France	Corporate	✓	✓	Encouraged
Japan	Corporate and facility	✓	✓	Encouraged
Mexico	Corporate and facility	✓	✓	
Turkey	Facility	✓		
United Kingdom	Corporate	✓	✓	Encouraged
United States	Facility (and corporate)[a]	✓		✓[a]

Notes:
a. Entities supplying fuel and other GHGs into the economy report at corporate level.
b. California requires reporting of purchased electricity, heat, or steam, but does not require the industrial user of purchased energy to calculate the emissions associated with the indirect energy because the suppliers of electricity and steam report them under the program.

Sources: Singh and Mahapatra 2013; Alarcon-Díaz 2015b; Icmeli 2015b.

4.1.2 Defining program applicability

Program designers must decide *which* facilities and/or companies are subject to reporting. Often reporting programs do not require every facility or company within their jurisdiction to report, given cost- and capacity-related constraints. They may define a threshold, above which facilities or companies must report, or identify other applicability requirements. Table 6 lists applicability requirements commonly seen in reporting programs (also see Table A1 in Appendix A for applicability requirements for individual reporting programs).

The decision involves determining both the type of applicability requirement and its level. Considerations influencing a program's applicability requirements include:

- The objectives of the program–Applicability requirements determine the program coverage, which should be defined in a way that

Table 6 | **Applicability Requirements for Entities in Reporting Programs**

APPLICABILITY REQUIREMENT	DESCRIPTION
Emissions threshold	Threshold defined in terms of annual emissions of carbon dioxide equivalent (CO_2e) (e.g., 25,000 metric tons CO_2e [tCO_2e]), so that all entities emitting equal to or more than the defined quantity are required to report their emissions. For example, the Canadian program applies to all facilities in the country emitting 50,000 tCO_2e or more annually; the U.S. program employs a 25,000 tCO_2e threshold (Environment Canada 2010; U.S. EPA 2009a). This kind of threshold could be applied economy-wide to all sectors or defined for individual sectors.
Energy threshold	Threshold defined in terms of annual energy consumption. For example, in Japan, companies with annual energy consumption of 1,500 kiloliters of oil equivalent or more must report (MoE and METI 2010).
Source categories	All entities within a certain source category (sector/subsector) are required to report their emissions. For example, the U.S. program requires all facilities producing adipic acid, aluminum, ammonia, cement, lime, nitric acid, petrochemicals, silicon carbide, soda ash, or titanium dioxide to report (U.S. EPA 2009a).
Production tonnage threshold (sector-specific threshold)	Threshold defined for entities in a sector in terms of production. For example, paper manufacturing facilities producing more than 20 metric tons per day are required to report in the EU program (European Parliament 2009a).
Number of employees	Threshold is based on the number of employees. For example, in France, companies with more than 500 employees are required to report their emissions (Kauffmann, Less, and Teichmann 2012).
Publicly traded companies	Applicability is defined by whether a company is publicly trading on a stock exchange. For example, all UK companies listed on the London stock exchange are required to report under the UK program (Defra 2012).
Transport capacity	Threshold defined specifically for freight and passenger transport in terms of transport capacity, such as number of railroad cars, number of vehicles, aggregate tonnage of ships, and maximum takeoff weight of airplanes. For example, in Japan, companies with at least 300 railroad cars or at least 200 vehicles are required to report (MoE and METI 2010).

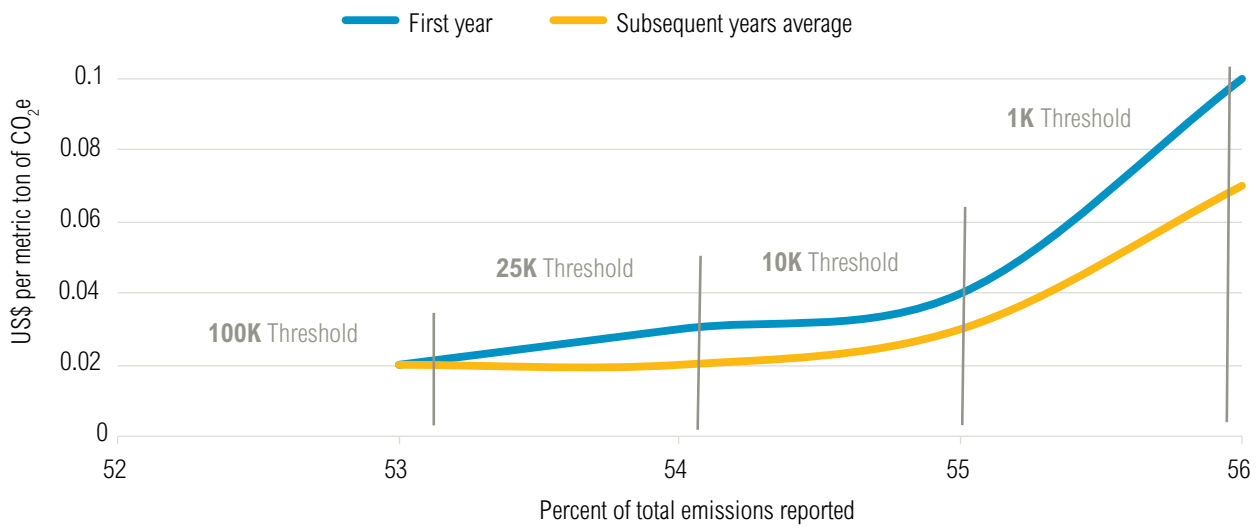
helps achieve the program objectives. Whereas an emissions threshold is appropriate for a program underpinning an emissions trading scheme, a program seeking to improve data quality may want to define its applicability requirement to capture large emitters across the economy or focus on a few sectors with little existing data. To support the objective of improving the quality of the national inventory, the program may define applicability to include all sources within sectors where better source-level data can be used to cross check with national inventory estimates. Programs with the objective of influencing policy formulation may establish applicability requirements that allow for the collection of a wide range of data to inform both demand and supply-side energy policies. For example, they may establish an energy threshold defined in terms of energy generation (for supply-side policies) or electricity consumption (for demand-side policies).

- Cost to the reporters–The U.S. program analyzed the average reporting cost per metric ton of emissions (Figure 8). By lowering the threshold beyond a certain point (from 25,000 tCO_2e to 10,000 tCO_2e) the cost to the reporter increased, without a correspondingly large increase in additional emissions captured. This analysis helped the program select 25,000 tCO_2e as the most practical threshold (U.S. EPA 2009c). Reporting programs in Australia, Mexico, and Turkey conducted similar analyses when deciding their reporting thresholds.

- Cost to the program administrator–To manage their costs, programs may want to seek a balance between the emissions covered and the number of reporting entities. Generally, small reporters entail higher administrative costs per unit of emissions relative to big emitters. But, programs can include simplified reporting and compliance requirements for smaller emitters to reduce their administrative costs. For example, the Californian reporting program allows simplified reporting for entities that emit between 10,000 tCO_2e and 25,000 tCO_2e to help reduce the program's administrative burden (CARB 2014b).[5]

- The existence of other reporting programs (voluntary or mandatory, GHG or non-GHG)–If similar programs exist, program administrators could adopt similar rules and requirements to foster consistency and ease the reporting burden for facilities that may have to report to more than one program. For example, to select its economy-wide emissions threshold, the United States adopted 25,000 tCO_2e threshold for reporting used by the existing Californian reporting program (CARB 2013b). In Turkey, the reporting program adopted the same applicability requirement as the EU reporting program to achieve harmonization in requirements.

Figure 8 | **The Average Reporting Cost per Metric Ton of Emissions Increased as the Threshold Level Decreased, U.S. Program**



Source: U.S. EPA 2009c.

Program administrators may modify the requirement(s) over time to include new reporting entities and sectors. For example, the U.S. program increased the covered industry sectors from 29 in 2010 to 41 in 2011 (U.S. EPA 2010). The French program started with the largest companies and subsequently added others. The Canadian program lowered its reporting threshold from 100 metric kilotons CO_2e ($ktCO_2e$) to 50 $ktCO_2e$ in 2009 leading to an almost 50 percent jump in the number of reporters (Environment Canada 2010). Starting small can allow program staff to gain experience and build capacity before implementing the program at a large scale. Programs should be clear from the beginning about their plans to scale up to provide entities with regulatory certainty.

Programs can also provide guidance as to what happens when the reporting entity ceases to meet the applicability requirements. Typically, programs allow entities to stop reporting if they no longer meet the applicability requirements for a specified number of consecutive years. This helps maintain continuity of data by preventing a situation in which entities stop reporting for a year because they no longer meet the applicability criteria due to short-term or temporary changes, but begin reporting again in the following year if they fulfill the criteria. Programs may require entities to notify the program by the reporting deadline if they are no longer subject to reporting, and explain the reasons for the change in their applicability status.

For example, in the U.S. program, if an entity's reported emissions are less than 25,000 tCO_2e per year for five consecutive years, or less than 15,000 tCO_2e per year for three consecutive years, or if the entity ceases to operate all applicable GHG emitting processes and operations, it can notify the U.S. EPA and stop reporting. Reporting must resume if annual emissions in any future calendar year increase to 25,000 tCO_2e or more (U.S. EPA 2009a). The Canadian program requires reporters to notify the program administrator if they no longer meet the reporting threshold in a particular year because of changes in production levels, technologies, and so on (Environment Canada 2015). In China's proposed national reporting program, an entity once found applicable should continue to report for five years before evaluating its applicability again (Song 2014).

Programs can use simple, user-friendly online tools that let reporters check their applicability. These can be particularly helpful for small emitters.

Programs may also allow facilities not meeting the applicability requirements to report voluntarily as is done by the Canadian program.

4.1.3 Identifying which GHGs to report

Program designers need to determine exactly which GHGs reporting entities should report. As with other program coverage aspects, factors such as program objectives, administrative burden, cost of reporting, and capacity levels can influence the number and type of GHGs covered in the program.

Programs in Australia, California, and the United Kingdom require reporting for the six original GHGs under the Kyoto Protocol. These are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The Californian and U.S. programs also require reporting of nitrogen trifluoride (NF_3). Programs may specify GHGs to report for each sector covered under the program because not all GHGs are relevant to all sectors. Whereas CO_2, CH_4 and N_2O are released from fossil fuel combustion, an emissions source generally present across sectors, other GHGs, such as PFCs, SF_6 and NF_3, are specific to certain sectors. For example, tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) are emitted from aluminum production, SF_6 from magnesium production, and NF_3 from electronics manufacturing (U.S. EPA 2014a).

Jurisdictions may also require reporting of other pollutants; for example, entities under the Mexican program report black carbon emissions (Alarcon-Díaz 2015b) because the information is required to support the national climate change policy to reduce black carbon emissions (Alarcon-Díaz 2015b; SEMARNAT 2014).

Programs can start with requiring reporting of CO_2 emissions only and allow the entities to build capacity before requiring other GHGs to be reported. This approach also allows time to develop the program architecture (Ellerman and Joskow 2008).

PROGRAM COVERAGE

Key Considerations

- Policymakers must make the following decisions to define reporting program coverage:
  - Who will be covered – facilities and/or companies (reporting entity)?
  - What will be reported – only direct emissions, or direct and indirect emissions; what type of indirect emissions (e.g., emissions from the generation of electricity purchased for own consumption, emissions from the use of fuels produced by the covered entity)?
  - How to assess which entities are subject to reporting (applicability requirements)?
  - Which GHGs to report?
- Factors that inform decisions related to program coverage include program objectives, cost to reporters, and administrative burden.

Checklist of Questions to Guide Decisionmaking

- Have program objectives been considered in determining which entities will be required to report?
- Has the program decided whether, and which type of, indirect emissions should be reported considering the associated reporting burden and relevance of the reported data in supporting program objectives?
- Have applicability requirements been set to define program coverage after considering factors such as cost to the reporter, cost to the administrator, and program objectives?
- Have factors, such as cost of reporting and capacity levels, been considered when determining which GHGs to report?

4.2 Emissions Quantification

Once program administrators determine coverage, the next step is to identify how reporting entities will determine their emissions. There are two broad ways to determine GHG emissions:

- Calculation-based approaches
- Direct measurement approach

These approaches are not mutually exclusive and can be used in combination to determine emissions from different sources in a reporting entity.

Further, programs can provide guidance outlining calculation and monitoring methods that should be used for specific sources to improve consistency and accuracy of emission estimates.

4.2.1 Calculation-based approaches

Calculation-based approaches include the *emissions factor approach* and the *mass balance method*. These approaches do not directly measure GHG emissions, but, instead, measure the activity, such as fuel consumption, leading to emissions, and provide an estimate of emissions from that activity. The decision regarding which approach to use typically depends on the emissions source. For example, the emissions factor approach is appropriate for sources such as fuel combustion and calcination. The mass balance approach is more suitable for calculating process emissions in industries such as petrochemicals production and integrated iron and steel manufacturing.

The Emissions Factor Approach

The emissions factor approach is a common multistep process used when a fuel or material is directly related to emissions. The calculation steps are as follows:

1. Multiply activity data (such as quantity of fuel combusted or raw material consumed) by an emission factor, and other factors as needed to correct for nonemitted carbon because of incomplete chemical reactions.

   For example, methane emissions from municipal solid waste landfills may be calculated as:

   - CH_4 emissions = Activity data (tons of waste disposed in the landfill annually) x Emission factor for CH_4 (based on site-specific waste composition and amount of methane collected and destroyed at a particular site)

2. Repeat step 1 using an emission factor for each GHG being reported to obtain corresponding GHG emissions.

3. Multiply emissions for each GHG by its global warming potential (GWP) value to obtain emissions in CO_2 equivalent (CO_2e). CO_2e represents a consistent, comparable metric of total atmospheric impact of GHGs.

   - Emissions (in CO_2e) = CH_4 emissions x GWP of CH_4

This approach can use a range of simple to sophisticated methods to obtain activity data and emission factors (discussed below).

ACTIVITY DATA

Activity data refers to the measure of activity resulting in emissions. It varies depending on the emission sources, which include stationary combustion of fossil fuels, fugitive emissions, process emissions, and waste management (Table 7).

EMISSION FACTORS

An emissions factor is a value that relates a given quantity of activity to the GHGs emitted (e.g., tons of carbon dioxide emitted per ton of fossil fuel consumed). Reporting entities may use published country-specific emission factors (e.g., a representative average based on many samples taken across the country), or international defaults (e.g., published by Intergovernmental Panel on Climate Change [IPCC]),[6] or use facility-specific emissions factors (e.g., derived from analysis of samples of fuel being combusted at the facility).

The choice of emission factors used is typically based on their availability and the emission source. For example, emissions from waste depend on its composition and treatment; therefore, detailed information on the composition and treatment methods is generally needed to determine the quantity of CO_2 and CH_4 emissions released from municipal solid waste landfills.

Programs can also influence the choice of emission factors (also see Chapter 4.2.4). They can provide a list of default emission factor values to be used, as well as lay out the requirements to be followed to derive site-specific emission factors. Requirements can include details such as how often fuel samples

Table 7 | **Examples of Activity Data for Various Emission Sources**

TYPE OF EMISSION SOURCE	EXAMPLE OF ACTIVITY DATA
Stationary combustion of fossil fuels	Fuel-flow meter data, facility fuel consumption records (monthly bills)
Process emissions (e.g., cement manufacturing, pulp and paper manufacturing, adipic acid production)	■ Quantity of limestone used, quantity of clinker ■ Quantity of fossil fuels used in chemical recovery furnaces, quantity of makeup chemicals added, quantity of adipic acid produced
Fugitive emissions (e.g., underground coal mines)	Quarterly or more frequent sampling of liberated CH_4 from ventilation shafts
Waste management (e.g., municipal solid waste landfill)	Measured or estimated values of annual waste disposal quantities
Mobile combustion	Distance travelled, fuel consumed

should be taken for a comprehensive analysis, what can be considered a representative sample, and equations to use to calculate emission factors. They may allow the use of international default values from the IPCC for minor sources of emissions in a reporting entity. Programs requiring Scope 2 emissions reporting may also want to provide electricity-generation-related emission factors for their jurisdiction.

In addition, program administrators may lay down a process for entities to provide rationale and supporting evidence if they significantly improve the emission factors used. For example, the EU program requires that reporters revise their annual monitoring plan to reflect changes in calculation methodology, which can include changes in the quality of emission factors. If an entity applies a higher tier (quality level) factor, such as site-specific emission factors, instead of the lower tier factor based on the national inventory values, it should update the monitoring plan indicating the revised emission factor (Tharan 2015).

The Mass Balance Method

The other calculation-based approach, the mass balance method, is based on determining the balance of GHGs entering and leaving the entire entity or a specific unit or process within the entity. It calculates the difference between the amount of GHGs entering the process through feedstocks and the amount exiting the process through products (U.S. EPA 2014b). This difference represents the GHGs released into the atmosphere.

The mass balance approach is used in situations where it is possible to directly monitor the changes in GHG quantity (e.g., changes in HFC or PFC inventory) or where it is difficult to relate emissions to individual input materials through an emission factor (e.g., in chemical processes) or when the final product contains embedded carbon that is not released as CO_2 emissions (European Commission 2012a). For example, the Australian, EU, Mexican and U.S. programs require use of the mass balance approach to estimate emissions from integrated iron and steel facilities. In these integrated facilities, it is difficult to identify emissions attributable

to each part of the production process. Carbon also leaves the system embedded in steel, the product (Tharan 2015). Therefore, emissions are estimated from the activity as a whole by estimating the carbon content of input and output (Australia, Department of the Environment 2014c). Examples of other sectors where the mass balance approach is used include hydrogen production, ferroalloy production, fluorinated gas production, and petrochemical production (U.S. EPA 2009a).

4.2.2 Direct measurement approach

The direct measurement approach involves measuring the emitted GHGs using measurement equipment. GHGs can be measured directly where they are vented from the entity (usually out of a stack) into the open air, using a continuous or periodic emissions monitoring system. The monitoring system continuously or periodically measures the concentration of GHGs in the flue gas and the flue gas flow volume. For each emission point or stack, average concentration and average flow rates taken at periodic intervals are used to determine emissions for that period. These are then aggregated over the year for total emissions. Programs can specify the frequency of measurement for emissions sources. For example, both the EU and U.S. programs require hourly measurements; if more frequent measurements are taken, entities calculate an hourly average (U.S. EPA 2009d; European Commission 2013).

This approach is useful when a number of different fuels and input materials are used. For example, direct measurement can be used when combusting various waste types in cement kilns, because it does not depend on knowing the carbon content or quantities for individual fuels. However, direct measurement is generally not suitable for measuring fugitive emissions that are not emitted through a defined point source, for example, emission leakages from equipment, storage tanks, and pipeline systems. It is also not practical for facilities with multiple exhaust stacks or for small emitters given the large cost involved in installing direct measurement equipment (Table 8).

Accuracy of the emissions value obtained from direct measurement depends on proper installation of the measurement system, performance tests, and calibration and monitoring. Programs may also require that emissions measured directly are corroborated by calculations, as does the EU program (European Commission 2013).

When using the direct measurement approach, programs can provide guidance regarding:

- Measurement equipment: This includes providing guidance related to the type of measurement equipment installed, including all the instrumentation and software required to measure emissions on a practically continuous basis and transferring meter readings to the entities' data management systems.
- Certifying the measurement equipment: Programs can prescribe that the equipment used be certified. For example, the U.S. program requires that the installed continuous emissions monitoring system (CEMS) for stationary fuel combustion sources that includes a gas monitor or a stack gas volumetric flow rate monitor, must be certified in accordance with the program regulations (U.S. EPA 2009d.).
- Calibration and monitoring requirements for measuring equipment: For example, the EU program requires that all relevant measuring equipment be calibrated, adjusted, and checked at regular intervals in accordance with the quality assurance requirements. The U.S. program requires that all measurement devices be calibrated according to the manufacturer's recommended procedures, an appropriate industry standard, or another method specified in the regulations (U.S. EPA 2009d).
- Frequency of measurements, sampling, and data aggregation: For example, in the case of measurements from two (or more) stacks, the EU program requires that the data from hourly measurements is first aggregated for the year for each individual source and then summed up for the two stacks to get total emissions (European Commission 2013).
- Substituting missing data: Missing data may be due to reasons such as equipment failure. The EU program, for instance, lays out detailed requirements for calculating substitution values when data is missing and requires entities to describe the process followed to fill data gaps in their monitoring plans (European Commission 2013).

Though programs often provide direct measurement as an option available to entities to quantify their emissions from many sources, such as power generation, cement, aluminum production, and iron and steel, it is not widely used because of its high cost compared with other calculation methodologies (U.S. EPA 2013).

Table 8 | **Estimated Costs to Upgrade to Continuous Emissions Monitoring Systems for CO_2**

CURRENT SCENARIO	ANNUAL COST TO UPGRADE TO CEMS (USD)
Emission source has no continuous emissions monitoring system (CEMS) - Add CO_2 analyzer, flow meter, and infrastructure	70,265
Emission source has CEMS for other pollutants—Add CO_2 analyzer and flow meter	56,040
Emission source has CEMS for other pollutants—Add CO_2 analyzer only	20,593
Emission source has CEMS for other pollutants—Add flow monitor only	24,511

Note: CO_2 analyzer is used to detect and measure the gas concentration in a CEMS. Flow meter is used to measure gas flow rate.
Source: U.S. EPA 2013.

The three ways to estimate the GHG emissions discussed above are briefly compared in Table 9.

4.2.3 Global warming potential values

Global warming potential (GWP) is a measure of how much heat a greenhouse gas traps in the atmosphere relative to the amount trapped by carbon dioxide over a specified time period, say 100 years. GWP values allow comparison of different types of greenhouse gases by converting metric tons of emissions of different GHGs into a single unit called carbon dioxide equivalent (CO_2e). This is done by multiplying GHG emissions with the corresponding GWP value, published by the IPCC. Programs typically require entities to report their emissions in CO_2e.

GWP values are published in IPCC assessment reports and can change based on improvements in methods as well as changing interactions and impacts of gases in the atmosphere. For example, the GWP value for methane was changed from 25 to 28 (for a 100 year time horizon) from the IPCC Fourth Assessment Report to the Fifth Assessment Report. Similarly the GWP for nitrous oxide was changed from 298 to 265 (IPCC 2007; IPCC 2013).

To ensure consistency in reporting, program administrators should decide which GWP values to use for emission calculations and notify reporters of any changes. Programs could adopt GWP values from the latest IPCC assessment report or could use the GWP values in the national inventory. For instance, the U.S. program now requires that entities use GWP values mostly from the Fourth Assessment Report rather than those from the Second Assessment Report. The U.S. EPA amended the rule to reflect GWP changes and published a factsheet on the program website to disseminate the information to the reporters. The amendment also ensured that the mandatory reporting requirements were consistent with the U.S. national inventory practices. The newly established Mexican program is using GWP values from the Fifth Assessment Report.

When the GWP value is changed, programs can also clarify whether entities should recalculate emissions for previous years. This may be particularly relevant for programs, such as the UK program, that encourage reporters to track their progress over time by setting a base year and reduction target.

4.2.4 Providing technical guidance on emissions quantification

Programs can provide detailed technical requirements and guidance to reporters to quantify their emissions. They can develop a range of methods to quantify emissions that rely on either the direct measurement or calculation-based approaches.

Table 9 | **Comparing Direct Measurement and Calculation-Based Approaches to Estimating GHG Emissions**

DIRECT MEASUREMENT APPROACH	CALCULATION-BASED APPROACHES
■ Measure emissions directly at the point where air flows from the facility into the open air using continuous or periodic emissions monitoring systems ■ Useful when a number of different fuels and materials are used ■ Specific monitoring and maintenance requirements for measurement equipment ■ Not practical for small emitters and facilities with multiple exhaust stacks	■ Two approaches: □ Emission factor approach: Based on the amount of fuel consumed and its carbon content (Emissions = activity data x emission factor) □ Mass balance method: Based on the balance of GHGs entering and leaving a defined process in the facility ■ Uncertainties in the input values of activity data and emission factors are reflected in the calculated emissions

The requirements may include aspects such as the quantification approach to be used, GWP values to be used, monitoring methods to be followed, how to obtain activity data, and how to calculate emissions factors. Many programs, such as those in Australia, California, the European Union, and the United States, provide detailed source-specific calculation requirements.[7] These requirements specify calculation methods for each emissions source, for example, providing methods that can be used to quantify emissions from solid fuel combustion. These can be supplemented with explanatory material on program websites and by providing a help desk or hotline to support entities not familiar with calculating emissions. Programs should ensure that individual guidance provided through the help desk or hotline is consistent with the technical requirements.

In deciding just how prescriptive the methods should be, programs typically rely on factors such as their objectives, reporters' capacity and level of preparedness, and the calculation approach being used. For example, if a program's objective is to support an emissions trading scheme, which puts a price on each ton of emissions, prescribing exact methods can bring greater consistency in emissions calculations because it ensures that all reporting entities follow standardized methods. If a program's objective is to support and contribute to the national inventory, it can align source and sector definitions with those used in the national inventory.[8] It may also require entities to use published national emission factors instead of global defaults where appropriate (Singh and Mahapatra 2013). For example, in the Australian program entities must provide enough information to classify facility-level data into categories used in the national inventory, that is, by industrial process and by fossil fuel combustion.

When the program revises or updates the calculation methods, it can do so either by proposing an amendment to the reporting rule or by updating the appropriate guidance document and notifying the reporters. Programs may also allow entities to submit an improved calculation methodology or calculation factor at any time for the program administrators' consideration. Reporting programs applicable at the corporate level can also provide guidance on how to consolidate emissions from facilities to obtain total emissions for the company.

Categorizing Methods in Tiers

The range of methods provided by programs to quantify source-specific emissions are often categorized in tiers. Tiers represent differences in data quality, accuracy, and uncertainty; the higher the tier, the greater the data quality and the methodological complexity.

The concept of tiers is borrowed from the IPCC, which introduced tiers to prepare national inventories of GHG emissions. Tier 1 is the simplest method to quantify emissions. It uses default emission factors and requires the least disaggregated activity data (e.g., quantity of fuel consumed). Tier 2 and 3 methods are based on source-, technology-, region-, or country-specific emission factors, and require highly disaggregated activity data (e.g., actual fuel consumption statistics by fuel type, economic sector, and combustion technology) (UNFCCC 2009).

Programs can categorize emissions quantification methods in tiers representing differences in data quality and accuracy. The higher the tier, the greater is the level of data quality.

In general, higher tiers are more difficult and costly to apply than lower ones (European Commission 2012a). For example, a lower-tier method will allow the use of a calculation approach with easily available global default values for emission factors. A higher tier method will require a site-specific emission factor, which may need sampling and analysis of a fuel to assess its carbon content and other qualities that could affect actual combustion emissions (Australia, Department of the Environment 2014c). Higher-tier methods consider the characteristics of fuels consumed at a particular facility and, thus, obtain more accurate emissions estimates for that facility, but at a higher cost.

Higher tiers are generally accompanied with lower uncertainty values reflecting improved accuracy of measurement. In a calculation-based approach, uncertainty in reported emissions is a combination of the uncertainties in the data used to quantify emissions: emission factors and activity data (Ritter, Lev-On, and Shires 2006). In direct measurement, uncertainty arises from equipment measurement error (GHGP 2003). Assessing uncertainty can start a process of investigating data quality and identifying opportunities to improve it (GHGP 2003). Programs can require entities to assess and report uncertainty to highlight the value of higher-tier methods in improving accuracy (Prosser 2015b). Australia requires companies to assess uncertainty for each emission source in their facilities (CER 2013). The EU program also requires reporting of the uncertainty in estimates and defines tiers based on permissible uncertainty levels.

Programs can develop a set of criteria to help entities select the appropriate tier for quantifying emissions. For instance, they can require that reporting entities apply higher-tier methods for their major emission sources, because the increased cost and effort to improve data quality and accuracy may be easier to justify for a large quantity of emissions. Appendix B describes how the Australian, EU, and U.S. programs use tiers to categorize calculation methods.

Jurisdictions implementing new reporting programs can start with a pilot learning phase with simple emissions calculation requirements. Reporters can initially use a simple methodology (lower tier in terms of data quality) and eventually adopt a more rigorous (higher tier) quantification methodology. The use of a pilot phase can avoid placing undue burden on reporters and allow them to gain expertise, build capacity, and put the necessary systems in place. For example, the U.S. program allowed reporters to use best available monitoring methods in the beginning of the program, understanding that it may not always be feasible for a new reporter to immediately install and operate all of the required monitoring equipment necessary to apply a higher-tier method (U.S. EPA n.d.b.). South Africa is considering a grace period of four years for entities to graduate from Tier 1 to Tier 2 or 3 methodologies (Witi 2015).

EMISSIONS QUANTIFICATION

Key Considerations

- Emissions quantification approaches include direct measurement and calculation-based approaches. The direct measurement approach measures the emitted GHGs and the calculation method determines emissions based on the amount of fuel consumed and its carbon content.
- Programs can establish source-specific calculation methods and provide accompanying guidance to improve consistency and accuracy of emission estimates.
- These methods can be categorized in tiers, which represent differences in terms of data quality and accuracy. The higher the tier, the greater is the level of data quality. In general, higher tiers are more difficult and costly to apply than lower ones.

Checklist of Questions to Guide Decisionmaking

- Have quantification methodologies been provided based on the need for consistency and accuracy? Have country-specific emission factors and global warming potential (GWP) values been specified to further promote consistency in calculations?
- Are methodologies categorized in tiers? If so, have clear criteria based on factors, such as the quantum of emissions, permissible uncertainty, the type of activity data and emission factors used, been laid out to define the tiers?
- Have factors such as program objectives and reporters' capacity been considered in deciding how prescriptive the methodologies should be? Has a pilot learning phase for reporting entities been considered?
- Have solutions, such as additional guidance and a help desk, been considered to help entities correctly apply the calculation methods?

4.3 Reporting Procedures and Schedules

Program designers must also determine reporting procedures during the design phase. This includes specifying the type of information that should be reported, the frequency of reporting, deadlines for report submission, and recordkeeping requirements.

4.3.1 What is to be reported?

Programs should lay out the information that entities must provide to ensure consistent reporting over time and across reporters. The reporting process allows programs to assess compliance with their requirements (e.g., calculation methods to be used for specific emission sources) and obtain meaningful data to inform their objectives. Programs may need to modify the requirements over the first few years as experience builds, and stakeholders identify new information to be captured or they may find that some types of data are not particularly useful to collect.

Contents of a GHG emissions report may include:

- Name, location and contact information of the reporting entity. If the reporting entity is a facility, give the name and identifying information for the parent company.
- Name and contact information of the reporting entity's designated representative (e.g., owner or operator of the entity) responsible for submitting, signing, and certifying the reports. If a reporting entity has multiple owners or operators, the program will need to establish a process to identify which one has the legal obligation to report. For example, the U.S. program asks the designated representative to certify that if there are multiple owners and operators, he/she has provided a written notice to

the owners and operators regarding his or her selection as a designated representative (U.S. EPA 2009a).

- Reporting period and date of submittal.
- Emissions information such as:
  - Total emissions in metric tons of CO_2e with additional information including emissions disaggregated by GHG, by source or activity type, and by site or facility (in a corporate-level program), range of uncertainty in the emissions value, and CO_2 emissions from biomass combustion
  - If Scope 2 emissions are covered, information on energy consumption and emissions in metric tons of CO_2e from purchased energy [electricity, heat or steam]
  - If Scope 3 emissions are covered or encouraged, information on these emissions in metric tons of CO_2e and related activity data (for example, emissions from the sale of fossil fuels and quantity of fuels sold, by type).
- Input data for emissions calculations and related information for individual operations and processes (e.g. energy content or carbon content values for fuels used in calculating CO_2 emissions for each type of fuel burned, frequency at which these values were determined (e.g., once a month, once per fuel lot), quantity of waste in landfills at the start of the reporting year).
- Emissions quantification methodologies and tiers of activity data for emission sources.
- Third-party verification or self-certification statement, as applicable.
- Additional data needed to inform policies depending on specific objectives may also be collected. For example, programs could obtain output data (e.g. tons of product manufactured) from reporting entities that are used to validate baselines if allocations under a trading scheme are to be based on an intensity baseline. Output data can also support policies related to GHG performance standards or energy efficiency standards.
- Information related to entities' emission reduction goals and measures implemented to achieve the goals, may also be collected.

Some of the above information, such as input data for emissions calculations and tiers used, can also be included in a monitoring plan (see Chapter 4.5.1).

4.3.2 Other reporting details

Programs also need to decide on reporting periods and timelines for report submission, and what kind of records they need to retain and for how long.

Reporting Periods

Most programs opt for an annual reporting period following either the calendar or fiscal year (Table 10). The choice may depend on the financial reporting period prevalent in the jurisdiction. Program objectives may influence the decision. For example, if the objective is to use the data to inform the national inventory, it may be helpful to align the reporting period with the period in the inventory. If the program is supporting an emissions trading scheme, the reporting period should be consistent with the compliance period of the trading scheme. The Australian program uses the fiscal year in keeping with the financial reporting period of the country. The Canadian program uses the calendar year to align with the national inventory (CER 2014c; Environment Canada 2015).

The French program is an exception with reporting required every three years, and the reporter allowed to choose the most appropriate 12-month period (Kauffmann, Less, and Teichmann 2012, Singh and Mahapatra 2013). The French program's objective of helping entities assess their climate risks and opportunities influenced the decision to opt for reporting every few years. The program decided that entities needed a reasonable length of time to identify reduction opportunities and implement mitigation measures, and that reporting over three years better reflected the impact of mitigation measures adopted. Beginning December 2015, the program will require entities to report every four years to align the GHG reporting requirements with new mandatory energy audit requirements (European Parliament 2006; Bellasio 2014).

Programs also need to specify the reporting timelines. It is practical to have a 2–4 month gap between the end of the reporting period and the last date for data submission to allow sufficient time for entities to prepare and verify their reports. Reporting timelines should be aligned with schedules for emission trading systems or national inventories, depending on the program objectives.

Recordkeeping

Programs may ask entities to maintain records and retain them for a definite period of time after submitting the emissions report. The records are needed to provide the program administrator with sufficient evidence of the reporting entity's compliance with the regulation and for verifiers to verify GHG emissions data. Often programs choose the same duration to retain records as specified under other laws pertaining to industry in the jurisdiction. For example, the Mexican program requires document retention for five years following the practice of taxation records being retained for five years in the country (Alarcon-Díaz 2015b). Programs may also want to align their document retention period with that of emissions trading schemes.

Another factor to take into account is the cost of retaining records either physically or virtually. The Mexican reporting program calculated that it would cost roughly US$10,000 for entities to retain records for five years (Alarcon-Díaz 2015b).

Program administrators can specify where facilities must store the records, but in general, the records are only required to be made available to the program administrator or the verifier when needed.

Table 10 | **Reporting and Record Retention Periods Across GHG Reporting Programs**

JURISDICTION	REPORTING PERIOD (CALENDAR/FISCAL/OTHER)	RECORD RETENTION PERIOD (YEARS)
Australia	Fiscal year (July 1—June 30)	5
California	Calendar year	3
Canada	Calendar year	3
European Union	Calendar year	10
France	12 month period every 3 years	Not specified
Mexico	Calendar year	5
Turkey	Calendar year	10
United Kingdom	12 month period, recommended to be aligned with entities' financial reporting period	Not specified
United States	Calendar year	3

Sources: Respective reporting program websites.

REPORTING REQUIREMENTS AND SCHEDULES

Key Considerations

- Programs should specify what should be reported to ensure consistency across reporters, help assess compliance, and obtain data to fulfill their objectives.
- Other requirements that should be laid out include period of reporting (calendar vs fiscal year) and period of record retention.

Checklist of Questions to Guide Decisionmaking

- Have the reporting requirements been identified based on factors such as what kind of information is needed to assess compliance and what kind of data can provide adequate information to serve program objectives?
- Does the decision about record retention consider factors such as consistency with recordkeeping requirements under similar laws in the jurisdiction, associated costs, and the time period considered sufficient to verify compliance?
- What is the rationale behind the chosen reporting period?

4.4 Reporting Platforms and Data Disclosure

Programs need to decide how to collect and report GHG emissions and what kind of information to disclose publicly.

4.4.1 Reporting platforms

A reporting platform is a data management system that facilitates the reporting, organization, and analysis of GHG data. A data management system, in its most basic form, collects and stores the reported information. It can also support quality assurance and quality control activities, track emissions over time, and facilitate analysis and sharing of data with stakeholders (PMR 2013d).

Data management systems can range from simple spreadsheets with data submitted by entities and compiled by program administrators to a more sophisticated online system used by reporters, verifiers, and administrators.[9] Web-based systems require more resources but can perform more functions compared with a spreadsheet-based system (Box 3). Programs can also begin with simpler systems and incorporate additional features or adopt a more sophisticated system over time. Programs often outsource the development and management of data management systems. For web-based systems, programs will need to budget staff time to work closely with software developers who are likely not familiar with GHG quantification and reporting.

One of the first steps in developing data management systems is to decide what kind of features and attributes the system should have. These may include details such as the type/quantum of data to be collected, data analysis to be performed, quality control and assurance features, linkages with existing data management systems, and data security and confidentiality. Programs can select the attributes of their data management system based on factors such as:

- The number of entities expected to report under the program
- Reporting entities' level of comfort using web-based systems
- Training needs for both reporting entities and program administrators
- Time needed to design and develop the data management system
- Flexibility and potential to scale up—in terms of serving more entities as the program extends its coverage, and/or meeting the requirements of multiple policies

BOX 3 | WEB-BASED REPORTING PLATFORMS

A web-based system can:

- Facilitate program management and implementation (e.g., standardize and track data submissions, email participants about deadlines and updates)
- Handle large volumes of data and large numbers of entities
- Allow data access to multiple users (e.g., reporters, verifiers, administrators) with different levels of access
- Support efficient data processing leading to reduced administrative burden (e.g., automated data entry, review, validation and submission; built-in checks for data entry errors and outliers; extracting customized reports)
- Ensure an enhanced degree of security (e.g., user log-in credentials, two user authentication)
- Support data needs associated with multiple policies through a single point of data entry

- Integration with other data systems
- Data security requirements
- Expertise of available IT providers
- Development and ongoing maintenance costs

Programs can prepare a template that lists the information to be reported by entities and, where applicable, by third-party verifiers, as well as the desirable features in the system, such as data range checks (discussed in Chapter 4.5.1). The template can map out details including information and data to be entered by the reporters, underlying calculations to be performed, default values for calculation factors that can be included, and how to assess compliance (Jacquier 2014). This gives developers the components to start building the data management system. For example, Turkey's reporting program first developed a reporting template, which served as the starting point for IT experts to develop the online database. The program also tested the template on-site with a representative group of entities to assess whether the terms were understandable and the required information was being captured (Icmeli 2015b). The template was modified and finalized after incorporating the feedback from testing.

Programs may also find it helpful to launch the data management system in a pilot mode either for a defined period of time or for a subset of reporters from each sector before scaling it up. This provides another opportunity to make revisions, rectify any technical problems as entities submit their information, and develop a user-friendly and practical reporting platform.

Finally, these are some considerations to keep in mind while designing database management systems (PMR 2013e):

- Structure standardized data forms–Forms standardized for the program reporting requirements can improve consistency in responses and ensure the submissions contain the information needed to comply with the reporting rules.
- Incorporate features to minimize errors–For example, minimization of errors can be achieved by narrowly defining data entry fields and automatic checking of input data for web-based systems, providing emission factors to avoid calculation errors, and requiring submissions to be reviewed by more than one person.
- Facilitate verification–This involves incorporating features to support verification by program administrators as well as third-party verifiers, such as providing access to verifiers to review the emissions report before it is submitted.

- Ensure security and data confidentiality–There needs to be a high degree of confidence that the data cannot be tampered with, particularly if emissions data from the reporting program are used to determine an entity's liability under a trading system or carbon tax. Further, it is important to build trust among the reporters that the data management system has security provisions to ensure the confidentiality of any commercially sensitive data they submit. Some measures to enhance security and minimize the risk of cyber hacking in web-based systems include requiring log-in credentials, resetting IDs and passwords at regular intervals, mandatory two-user authentication to make submissions or changes, setting time windows for data entry, using virtually and physically secure servers to host data, and introducing differentiated levels of access for various users.

- Ensure compatibility with other data systems–Other data systems can include national inventories and emissions trading registry, as relevant. For example, aligning with national inventories requires that source and sector definitions are consistent in the two systems and entities report source-level data that can be aggregated for use in the inventories (Singh, Damassa, et al. 2014). To ensure compatibility with trading registries, the measurement, reporting, and verification provisions underlying the data management system should be robust, credible, and transparent. There should be enough confidence in the reporting system that a ton of emissions reported is indeed a ton emitted. Verified, high quality emissions data from the reporting data management system can be used to determine allowance allocations. Programs may need to decide whether to build a system that is well-integrated with other data systems, or whether a stand-alone, independent system would suffice. Table 11 lists some advantages and challenges associated with independent and integrated systems.

- Treat electronically submitted data at par with paper submissions–When programs allow online submission, it is important to ensure that the electronically submitted data carries the same legal weight and status as paper submissions (Chiu 2012). This can be accomplished by including a provision in the regulation that accords electronically submitted information, electronic signatures and a certification statement the same legal weight as signed paper submissions. For example, the U.S. EPA's Cross-Media Electronic Reporting Regulation (CROMERR) has set standards for electronic submittals so that they can be treated at par with corresponding paper submittals (U.S. EPA 2012).

Table 11 | **Comparing Independent and Integrated Data Management Systems**

INDEPENDENT DATA MANAGEMENT SYSTEMS	INTEGRATED DATA MANAGEMENT SYSTEMS
ADVANTAGES	
■ May be developed more quickly ■ Likely to be simpler, less costly	■ Lower reporting burden because data needed under multiple policies is reported only once ■ Allows for greater coordination and comparison across different policies ■ Easier to aggregate and analyze data
CHALLENGES	
■ Difficult and more time consuming to aggregate and compare data across different systems ■ Operating multiple independent systems may impose higher costs in the long run ■ Separate training likely required for each system	■ Likely to have higher setup costs ■ More time is needed up-front to identify and align data requirements of separate policies

Source: PMR 2013e.

4.4.2 Data disclosure and confidentiality

Promoting emissions disclosure and transparency in emissions reporting may be an objective for some reporting programs. Thus, the way in which the data are shared publicly is another key program design element. The reported data may be disclosed in a summary form or may be disaggregated and searchable through an online database.

In addition, programs may present annual data analysis identifying trends and statistics such as distribution of emissions by geographic location and economic sector, total number of entities reporting by location and sector, total direct and indirect emissions reported, and trends in total emissions over time.

Table 12 summarizes the ways in which the data submitted under different programs are publicly disclosed in terms of access to information, data presentation, and the level at which they are shared. Confidentiality issues related to commercially sensitive data can be a major concern for reporters given that emissions and activity data can reveal valuable information to competitors. Data on production, raw material consumption, facility operation, and future operations can be used to glean sensitive information on capacity, market position, and costs. Disclosure of such information may harm competitors and/or consumers (U.S. Federal Trade Commission 2010). It is important to treat confidential information in a way that builds trust among reporters without sacrificing the transparency and usability of reported data. Program administrators can evaluate the sensitivity around these issues among the reporters during the stakeholder consultation phase. Programs should also check for any existing laws governing confidentiality of reported data in their jurisdictions.

The way in which reporting entities' confidentiality concerns are resolved plays a crucial role in determining what information is publicly disclosed. For example, the U.S. EPA requires emissions data of all covered facilities to be reported and available to the public. However, certain activity data that are inputs to emissions calculations, which

Table 12 | **Public Access to Data in Different Programs**

Data Element/ Information	Australia	California	Canada	European Union	France[a]	Japan	Turkey	United Kingdom	United States
I. ACCESS TO DATA									
Public access to information	✓	✓	✓	✓	✓	✓		✓	✓
Information available on a centralized online platform	✓	✓	✓	✓	✓	✓			✓
II. DATA PRESENTATION									
Downloadable format (pdf or Excel files)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Information online (web pages)	✓	✓	✓	✓	✓	✓		✓	✓
Searchable/ interactive database	✓		✓	✓	✓		✓		✓
III. LEVEL OF DETAIL									
By individual GHGs	✓	✓	✓	✓	✓	✓	✓	✓	✓
Facility level	✓[b]	✓	✓	✓		✓	✓		✓
Corporate level	✓				✓	✓		✓	✓[e]
Sector level		✓	✓	✓		✓	✓		✓
Geography-based[c]	✓[d]	✓	✓	✓	✓		✓		✓

Notes:
a. France launched an online database in March 2015. Data submission is voluntary but it will become mandatory after a new law (the Energy Transition for Green Growth Act) comes into force.
b. Facility data is publicly available for electricity generators only.
c. Some programs allow viewers to access emissions data for their choice of geographic units such as a state or province.
d. The Clean Energy Regulator plans to publish summaries of emissions in different states.
e. Some corporate entities required to report indirect emissions.

Sources: Singh and Mahapatra 2013; Icmeli 2015b; Prosser 2015b.

are considered sensitive business information, are declared confidential and not disclosed (U.S. EPA 2011). Further, the disclosed data is aggregated in a manner that it cannot be used to back-calculate the confidential information.

Similarly, the Californian program recognizes GHG emissions as publicly available information. Other information, such as activity and process-related data reported to the program administrator, can be designated as confidential business information. This designation allows the reporter to protect information that could potentially threaten its competitiveness. However, if someone files a request for public information, the reporter, rather than the program administrator, must defend data confidentiality (Singh and Mahapatra 2013).

In Canada, facilities can request confidentiality by submitting a written request with appropriate justification and supporting documentation to the program administrator. They can also appeal within 30 days if the confidentiality request is denied (Environment Canada 2015). The Japanese reporting program also allows requests to treat certain data as confidential (Singh and Mahapatra 2013).

REPORTING PLATFORMS AND DATA DISCLOSURE

Key Considerations

- Data management systems range from simple spreadsheets to sophisticated web-based systems, which can serve many functions.
- Important considerations in designing reporting systems include incorporating features to promote consistency, minimize errors, enable verification, ensure security and data confidentiality, and ensure compatibility with other data systems.
- Programs need to find a balance between disclosure and protecting confidential business information.

Checklist of Questions to Guide Decisionmaking

- Is development of the data management system based on factors such as the number of reporters, ease of reporting, availability of features to facilitate compliance, need for security, potential for scale up, and alignment with other systems?
- Is the decision regarding what level of data is publicly disclosed based on program objectives as well as confidentiality concerns? Are data disclosure and confidentiality rules consistent with domestic laws governing commercially sensitive information?

4.5 Quality Control and Quality Assurance

This design element focuses on ensuring that high quality, accurate data are reported to the program. Quality control (QC) and quality assurance (QA) measures enhance quality along the entire chain of data collection, quantification, monitoring, reporting, and verification. Programs can develop quality control and assurance requirements to improve transparency, consistency, comparability, completeness, and confidence in emissions estimates (IPCC 2000).

Both QC and QA improve data quality, but each refers to a distinct set of activities and the terms are not interchangeable. While QC is conducted by responsible staff of the reporting entity during the data collection and reporting process, QA is undertaken by an independent party after emissions have been calculated and an initial emissions report has been prepared (Figure 9).

4.5.1 Quality control

Quality control refers to routine and consistent checks applied during all stages of preparing an emissions report, from data collection to final reporting. Programs can focus their quality control measures in the following areas:

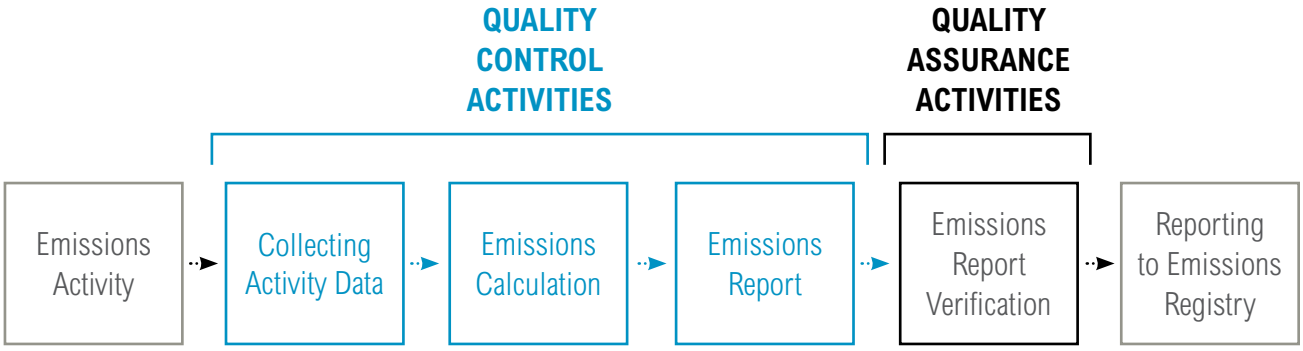
- Calculation and monitoring methods
- Data validation
- Compliance assistance

Calculation and Monitoring Methods

Programs can prescribe calculation and monitoring methodologies for reporting entities to facilitate submission of high quality data. Chapter 4.2.4 discusses programs' role in prescribing calculation methodologies. In addition, programs can require a complete documentation of the methodologies employed by reporters in the form of a monitoring plan, as in the EU program. The monitoring plan, which serves as a manual for the facility operator to monitor and report emissions, is considered the most important management instrument for the reporting entity in the EU program. A monitoring plan can include information, such as:

- Basic information to identify the installation including the contact person's information.
- A list of GHG emission sources, and fossil fuels, raw materials or intermediate products that need to be monitored to calculate emissions. For example, for a district heating facility that burns natural gas and light fuel oil to produce heat, emission sources include a natural gas fired boiler and a light fuel oil fired boiler.

Figure 9 | **Quality Control and Quality Assurance Activities in a GHG Reporting Program**



Source: Adapted from (PMR 2013e)

- Activity data (e.g., estimated quantity of fuel consumed) and calculation factors (e.g., emission factor values, their sources and tiers, and rationale for the choice of emission factor used).
- Description and rationale for the emissions quantification approaches used (discussed in Chapter 4.2).
- Description of "who takes what data, when, from where and how, and does what with it" to ensure that data are produced, collected, processed and stored in a controlled way. This identifies:
  - Who is responsible for data collection (positions of responsibilities, job titles)
  - What is to be measured or tracked and how frequently (e.g., fuel volume every month, amount of raw material consumed in a kiln on a daily basis, net calorific value to be determined every time a new batch of fuel is consumed)
  - How is it measured or where is it found (e.g., sales invoices from the fuel supplier, reading from a gas flow meter or a weighing scale, a publicly available data source)
  - Where is it recorded (e.g., in a physical file, in entity's IT-based data management system).
- Assessment of risks of errors, misrepresentations and omissions in data collection and monitoring. Risk may arise from:
  - Human-induced factors; for example, the operator fails to read digital display on gas flow meter, misreads it, or records it incorrectly (e.g., transposes numbers or copies data incorrectly)
  - Equipment related factors; for example, flow meter display disappears, weighing scale malfunctions
  - Data transmission and archive factors; for example, electronic data transmission fails to work, data collection software becomes corrupted.
- Description of quality control measures to mitigate the identified risk of misstatements. These will be a combination of source- or process-specific measures as well as generic measures (e.g., periodic staff training, assigning clear lines of responsibility, cross checking fuel volume on supplier invoices with the reading on the gas meter, ensuring that at least two people review the final emissions report, data archiving) (Box 4).

Programs can provide a template on their websites to develop the monitoring plan.[10] Reporting entities can submit the completed template at the beginning of the reporting period for administrator's approval. For instance, the EU program requires installations to submit a monitoring plan to the relevant competent authority at the national level for approval. The U.S. EPA asks entities to prepare a plan though it does not require them to submit it to the agency (U.S. EPA 2009a). Programs can also advise reporting entities to regularly collect this information even if there is no requirement to put it together as a plan.

Depending on their capacity, programs may also conduct site inspections to ensure that the reporting entity's monitoring plan reflects actual practice. For example, the program administrator may verify that the installed meters are of the type discussed in the plan, that necessary records are retained and archived as stated in the plan, and that all GHG sources have been identified (European Commission 2012a). Information in the monitoring plan can be revised as frequently as needed to reflect changes in production processes, monitoring instrumentation, addition of new emitting activities, and other relevant changes.

Data Validation

Programs can improve quality control by establishing a number of controls in data management systems to validate data before emissions reports are submitted. Data management systems can incorporate various types of checks, range checks, year-to-year checks, statistical checks, and algorithm checks—to alert the reporter to potential errors during data entry. For example, the U.S. EPA's electronic reporting system provides real-time validation of data with the help of over 4,000 built-in checks, which detect common mistakes such as missing data or cases in which the entered value is outside the expected range (Chiu 2014). The Australian program also has built-in validations and cross checks in the data management system to detect data entry or calculation errors.

Compliance Assistance

Programs can ensure quality control by building capacity around the reporting program's requirements—a "compliance assistance activity." Through training and information dissemination, factsheets, interactive technical manuals, minicourses on the reporting system, online resources such as FAQs, and help desks, programs can support entities in their reporting and facilitate compliance with reporting requirements. Programs in Australia, California, Canada, the European Union, Turkey, and the United States provide many examples of compliance assistance measures. For example, the European Commission maintains an up-to-date website with guidance material such as a sample monitoring plan and templates for emissions report. The U.S. reporting program conducts targeted meetings and webinars during the reporting window each year; and provides a help desk, detailed sector-specific guidance, and factsheets for all emission sources; a comprehensive list of FAQs; a monitoring checklist; and slide decks to facilitate reporting. The Canadian program provides technical information through seminars, conferences, and training materials.

BOX 4 | QUALITY CONTROL MEASURES APPLIED IN A COAL-FIRED POWER PLANT

A coal-fired power generation plant uses the quantity of coal combusted in the power generation process as key input data to quantify its GHG emissions. The primary source of this input data is a device that weighs coal right before its combustion. The power plant can adopt the following quality control measures:

- Cross check – metered quantity of fuel consumption can be cross checked with annual energy balance, which is based on purchased fuel quantities and changes in stock.
- Accuracy of monitoring device – weighing device can be calibrated in accordance with the local or national standards, or as per manufacturer's specifications.
- Staff training– periodic training can be arranged for data collectors.
- Data archiving– original monitoring records can be archived in the internal database.

4.5.2 Quality assurance

Quality assurance or verification refers to periodic reviews of the emissions report performed by independent experts[11] after quality control procedures have been implemented. These assessments verify that the reported information represents the best possible emissions estimates given available data (IPCC 2000). They provide additional confidence that the reported results are complete, consistent, accurate, transparent, and relevant.

It is not practical for assurance providers to assess the accuracy of every piece of data used in emissions calculations; therefore, the risk-based approach is often used. This approach begins with a comprehensive risk evaluation of misstatements, which involves reviewing the emissions sources, calculations, data flow, and quality control measures to identify areas with the greatest potential for error.

Based on the risk assessment results, the assurance provider will typically select samples representing the entity's data collection and management systems, input data, methodologies, and monitoring systems and review these closely for misstatements or misrepresentation of the entity's emissions. Programs can define when a misstatement is considered significant or "material" in terms of the percentage of total emissions. For example, a material misstatement may be defined as the aggregate of errors, omissions, and/or misrepresentations that lead to a discrepancy of 5 percent or more between reported emissions and the assurance provider's estimate.

Assurance Methods

A reporting program can employ one or more of the following methods for quality assurance (Table 13):

- Self-certification by the reporting entity
- Review by program administrators
- Third-party verification

In practice, self-certification is commonly seen across programs and is applied in combination with the other two approaches. Further, it is possible for programs to apply all three approaches together as program administrators may perform some form of audit (e.g., random desk reviews) even for third-party verified reports.

Programs may select an assurance method based on factors such as the program objectives, the cost for the program administrator and reporters, and existing capacity and resources within the program to take on the verification role. For example, programs whose objective is to underpin trading schemes tend to favor third-party verification given their need for confidence in the robustness and completeness of data from each reporter.

Table 13 | **Quality Assurance Methods**

QUALITY ASSURANCE APPROACH	DEFINITION
Self-certification	Formal assertion by the reporting entity of the accuracy of its emissions report
Review by program administrators	External review undertaken by the program administrator
Third-party verification	Review by a qualified third party

SELF-CERTIFICATION

Self-certification is a quality assurance statement issued by the reporting entity to confirm that it complies with program requirements and to declare that the GHG emissions are correctly estimated (Table 14). Programs may require reporting entities to self-certify their emissions report irrespective of whether another quality assurance approach is mandated (Box 5). However, self-certification alone is typically not considered sufficient assurance of the reliability and accuracy of reported information, especially when the reporting program is supporting emissions trading. Given the high degree of confidence required in emissions data in such cases, assurance from an independent, external agency carries more weight. Most programs review the reported data themselves or require third-party verification in addition to self-certification (Table 15).

BOX 5 | SELF-CERTIFICATION UNDER THE U.S. REPORTING PROGRAM

The U.S. reporting program requires reporting entities to appoint a "designated representative," who certifies and signs GHG emissions reports submitted to the program. The designated representative electronically signs the following certification statement with the entity's submission:

"I am authorized to make this submission on behalf of the owners and operators of the facility or supplier, as applicable, for which the submission is made. I certify under penalty of law that I have personally examined, and am familiar with, the statements and information submitted in this document and all its attachments. Based on my inquiry of those individuals with primary responsibility for obtaining the information, I certify that the statements and information are to the best of my knowledge and belief true, accurate, and complete. I am aware that there are significant penalties for submitting false statements and information or omitting required statements and information, including the possibility of fine or imprisonment."

Source: U.S. EPA 2009a.

The presence of adequate internal assurance and quality control processes can increase an entity's management's confidence in reported data and help it self-certify its emissions without hesitation. Internal assurance is performed by staff members from within the reporting entity who were not involved in the GHG emissions reporting process. It can help reporting entities identify and correct errors and further strengthen quality control measures before the emissions report is submitted to the program or before third-party verification is sought.

REVIEW BY PROGRAM ADMINISTRATORS

Under this approach, the program administrator verifies the reported data and conducts audits to assess compliance with the program requirements (see Table 14). Thus, the program design needs to include detailed reporting requirements for the administrators to have sufficient information to verify emissions estimates. For instance, entities may be required to provide detailed information on activity data, calculation methodologies, and monitoring procedures, and maintain records to be made available during audits and site visits. This approach is similar in process to third-party verification (discussed in next Chapter). It includes activities such as reviewing the monitoring plan, evaluating submissions for errors and inaccuracies, conducting site visits to check the implementation of quality control measures, interviewing personnel, reviewing records, and performing independent tests of monitoring systems.

Most reporting programs include some form of review by the program administrator, even if they require third-party verification. For example, the Australian, Canadian and U.S. reporting programs perform this kind of review. The Australian program administrator validates data before it is published to identify order of magnitude errors, query major shifts in emissions from a particular facility or source, and so on (Prosser 2015b). Environment Canada conducts compliance and data quality checks of the submitted data and follows up with facilities if there are questions (Environment Canada 2015). Similarly, the U.S. EPA uses electronic data checks and staff performs manual reviews of the data and emission reports. It also has the authority to conduct audits and site visits of the reporting entities.

This approach is less costly to the reporter compared with the costs of third-party verification because it does not involve a verification fee. But it requires more time and resources on the part of the program administrator. However, administrators can choose whether to build their own technical capacity, or potentially outsource some quality assurance tasks. Outsourcing this activity to contractors is different from third-party verification because programs typically maintain oversight of the contractors and reporters do not pay for the review, as is often the case for third-party verification. The first few years of the program may require more quality assurance activities including audits and site visits, as reporting entities become familiar with reporting requirements and calculation and monitoring methodologies. Programs may manage their own costs related to emissions verification by adopting rigorous quality control measures to improve the quality of submissions (ERG 2009).

THIRD-PARTY VERIFICATION

Under third-party verification, independent verifiers assess the accuracy of the emissions report and its conformity with program requirements (see Table 14) (The Climate Registry 2014). Many mandatory reporting programs, especially those directly supporting emissions trading schemes, require third-party verification to ensure that the reported data are in compliance with regulations. For example, the Californian, EU, Mexican, and Turkish programs require reporters to seek independent, third-party verification for their emission reports. In Australia, the Clean Energy Regulator conducts random audits and can require third-party verification if it has grounds to doubt the accuracy of reported data. Programs may also allow entities to voluntarily opt for third-party verification for a high degree of confidence in their emission reports, given that verification findings can help improve the entity's internal emissions monitoring and reporting process.

Most reporting programs include some form of review by the program administrator, even if they require third-party verification.

Third-party verification typically includes the following steps:

- Obtaining an understanding of the entity's activities, including monitoring methodology and equipment, data flow, and quality control system
- Conducting a risk analysis of methodologies and control system to identify potential areas with significant risk of misstatements
- Verifying emission estimates by undertaking a detailed review (e.g., re-computing, reviewing evidence, cross checking) of GHG data (e.g., original data sources, spreadsheet calculations) and identifying material discrepancies
- Preparing a verification report to record findings, which entities usually need to retain for a specified period of time (e.g., the California program requires facility operators to retain the report for five years)
- Providing an assurance statement and discussing areas for improvement. Verifiers must maintain their independence and are not allowed to offer their services to implement the findings.

A well-laid out verification process combined with a rigorous system to accredit verifiers and ongoing regulatory oversight can enhance the overall quality of third-party verification and promote accountability. Programs can require that only accredited verifiers perform third-party verification, and develop verification and accreditation standards to ensure high quality emission reports and qualified service providers. Under the Mexican program, for example, verification bodies should be accredited by the Mexican Accreditation Entity (EMA) and should also be approved by SEMARNAT, the program administrator.

Program administrators can produce a verification standard that explains the process verification bodies need to implement to verify reporters' emissions. The standard can also include requirements for verifiers to seek accreditation and establish competency, impartiality, and independence. Programs can also use the standard to provide guidance on issues such as what constitutes a material misstatement, level of assurance, a simplified verification process where applicable, and how to resolve disputes related to verification findings. They will need to decide, for example, the frequency of site visits during the verification process, how often verification bodies will be changed to reduce potential conflict of interest, and when to allow a simplified verification process. Program administrators may also retain general oversight of the process and selectively participate in audits and site visits, as is done in California's reporting program (CARB 2008).

As programs develop their verification standards, they can draw from internationally recognized standards, such as those from the International Organization for Standardization (ISO):

- ISO 14064-3 specifies the process that verifiers should undertake to establish the level of assurance, determine the verification approach, assess GHG data and information systems, evaluate GHG assertions, and prepare verification statements.
- ISO 14065 provides requirements for verification bodies.
- ISO 14066 provides competence requirements for verification teams.

Programs may consider developing the verification standard in advance of the first reporting period to allow time for verifiers to seek accreditation and evaluate the first set of emission reports. Program administrators can also ease reporters into the process by implementing a transition period, which can be used to build verification experience and capacity among reporters as well as verifiers. For example, the Californian program made third-party verification optional during the first year of the program (CARB 2008). If there are few qualified verifiers, programs can begin with a pilot verification phase. Turkey's program has adopted this approach to give potential verifiers an opportunity to gain experience and eventually seek accreditation (Icmeli 2015b). Another approach is to require reporters to verify their reports every few years instead of annually. For example, with only three third-party verifiers in 2014, the Mexican program decided to require reporters to seek third-party verification once every three years. The program will also phase in verification over time by requiring only top emitters (more than 1 million tCO_2e [$MtCO_2e$]) to verify their emissions in the first reporting year (Alarcon-Díaz 2015a).

The cost of third-party verification varies depending on the size and complexity of the reporting entity, scope of verification, existing quality control measures, and available documentation of monitoring and quantification methods. It can cost anywhere from US$5,000 to US$500,000 (Loreti 2001). In most GHG reporting programs, such as the EU program, reporting entities select the verifier and pay for verification. However, in China's emissions trading scheme pilot programs, the regulatory authority assigns verifiers to reporting entities and covers the cost of verification for the first one or two years (Song 2014).

Programs that require third-party verification can also outline the process to accredit verifiers in an accreditation standard. Accreditation involves an independent assessment of the verifier's technical competence—in emissions accounting as well as in calculation and measurement of GHGs from specific sources and/or sectors—and impartiality to carry out verification in accordance with the program rules (European Commission 2012). It is granted by an accreditation body for a definite

period of time to perform verification activities and assess reporting entities' conformance with compliance requirements. The accreditation body may review the verifiers' documents, visit their premises to assess their management systems and competence arrangements, and observe the verifier carrying out verification activities, for example, on a site visit to a reporting entity. Once accreditation has been granted, the accreditation body regularly monitors verifiers' performance to ensure consistency and quality of the verification process. It also resolves disputes between reporting entities and verifiers. Programs can draw from ISO 17011, which provides general requirements for accreditation bodies assessing and accrediting verifiers.

Program administrators can work with an existing accreditation agency, as Turkey did, or set up a new accreditation body. Or they may perform the accreditation role themselves; for example, the California Air Resources Board also accredits verifiers.

It is common to accredit verifiers for a limited period of time, after which they are expected to seek accreditation again. For example, the national accreditation bodies in the EU program accredit verifiers for up to five years at a time (European Commission 2012d). Programs can publish a list of accredited verification bodies from which reporting entities can choose. These lists can also indicate sector-specific expertise, as is done by the Californian program (CARB 2008).

Table 14 | **Comparison of Quality Assurance Methods**

QUALITY ASSURANCE APPROACH	ADVANTAGES (PROGRAM ADMINISTRATOR'S PERSPECTIVE)	CHALLENGES (PROGRAM ADMINISTRATOR'S PERSPECTIVE)
Self-certification	■ Puts the legal obligation to ensure accuracy on the entity ■ Relatively low-cost option (for both entity and the administrator)	May not instill sufficient confidence in the reported data if it is the only quality assurance mechanism in place
Review by program administrators	Carries a high level of confidence when conducted in a rigorous and transparent manner per guidelines.	■ Labor and cost intensive for the administrator ■ Demands high level of technical capacity
Third-party verification	Carries a high level of confidence when done by accredited third-party verifiers per guidelines	■ Higher cost to the reporter that may affect program uptake ■ Relatively costly option for the administrator if the cost is borne by the program

Table 15 | **Assurance Methods in GHG Reporting Programs**

JURISDICTION	SELF-CERTIFICATION	REVIEW BY PROGRAM ADMINISTRATORS[a]	INDEPENDENT THIRD-PARTY VERIFICATION
Australia	✓	✓	✓
California	✓	✓[b]	✓
Canada	✓	✓	
European Union	✓		✓
Japan	✓		✓
Mexico	✓		✓
Turkey	✓		✓
United Kingdom	✓		✓
United States	✓	✓	

Notes:
a. Depending on the program, this could include random checks or systematic/periodic verification.
b. California audits a random sample of GHG reports in addition to a full review by the third-party verifiers.

Sources: Singh and Mahapatra 2013; Alarcon-Díaz 2015b; Icmeli 2015b.

QUALITY CONTROL AND QUALITY ASSURANCE

Key Considerations

- Quality control and quality assurance measures enhance quality along the entire chain of data collection, quantification, monitoring, reporting, and verification.
- Programs can prescribe calculation and monitoring methodologies, design data management systems, and undertake compliance assistance activities to ensure quality control.
- For quality assurance, programs can require self-certification in combination with regulatory authority review, and/or third-party verification.
- Programs can develop verification and accreditation standards to streamline the third-party verification process. Further, they can identify accreditation agencies to provide oversight for verifiers.

Checklist of Questions to Guide Decisionmaking

- Have measures been defined to enhance entities' knowledge of rules and requirements to ensure quality control?
- What features does the data management system include that can help ensure quality control?
- Have clear monitoring and calculation methodologies been provided to ensure quality control?
- Have quality assurance rules been established that take into account factors such as program objectives and costs to the reporter and the administrator?
- Have clear guidance and standards for verifiers and accreditation agencies been developed to govern the third-party verification process?

4.6 Enforcement

Programs can establish enforcement measures to ensure that all entities report their emissions accurately, submit them on time, and perform revisions as needed. Even though reporting programs' emphasis is often on facilitating voluntary compliance, enforcement measures may be needed, for example, when an entity fails to comply with program requirements despite the program administrator's repeated efforts. If third-party verification is required, programs need to specify measures that can be taken against a verifier who does not comply with the verification requirements.

Strong enforcement measures can lead to improved participation and compliance rates. The nature of enforcement measures may be influenced by program objectives; for example, in programs supporting emissions trading schemes, a strong enforcement mechanism is needed so that the scheme's integrity is maintained and noncompliance does not diminish the value of emission allowances. Programs may want to ensure that reporters are familiar with the repercussions of noncompliance before the reporting period begins.

Programs can establish a set of instruments to be used in case of noncompliance**.** These may range from soft options such as notifications asking entities to comply within a defined time period, to hard options such as imposing monetary fines and criminal penalties. Depending on the gravity of offense, programs may choose to apply the enforcement instruments in sequence starting with the softer options. For example, while the Australian program administrator provides help and education for minor violations, it has the mandate to initiate investigations and pursue civil action for more serious violations. For cases that involve consistent violations or dishonest behavior, the program administrator may issue infringement notices or pursue court action, and both actions are made public. Additionally, the program issues fines of up to US$285,000 (AUD 340,000) for failure to apply for registration and applies daily fines of up to US$14,000 (AUD 17,000) for each day of noncompliance (CER 2014c). The EU program publishes the names of the noncomplying reporters in addition to imposing penalties.

ENFORCEMENT

Key Considerations

- Enforcement measures ensure that reporters provide the required information in a timely manner and perform revisions if needed.
- Programs can apply various options, ranging from soft (e.g., notifying reporters to comply by a deadline) to hard (e.g., fines and criminal penalties) measures to enforce the rules and requirements.

Checklist of Questions to Guide Decisionmaking

- Have enforcement measures been developed to improve compliance rates and realize the program objectives?

CHAPTER V

PROGRAM REVIEW

Review refers to comprehensively examining the design and implementation of the greenhouse gas reporting program to assess its effectiveness and undertake modifications as needed.

Periodic program reviews help in (Sachweh 2014):

- Lending credibility to the programs in the same way that the quality assurance process brings credibility to the reporting entities' emissions reports
- Receiving constructive feedback from stakeholders through a systematic process and identifying areas of improvement
- Giving policymakers evidence to demonstrate the program's utility and its impact, and justify allocating resources for the program
- Examining whether the program is fulfilling its defined objectives
- Assessing capacities and resources
- Identifying good practices, inefficiencies, and any requirements that are not being met
- Providing oversight and avoiding complacency

Reviews may be focused on the program's process, its substantive details, and/or its impact.

Review of a program's process may include assessing aspects such as administrative efficiency (for example, how quickly does the program answer reporters' queries? Are tools made available to reporting entities to facilitate compliance?), data security, the degree of oversight on reporting entities' quality assurance process, and the overall level of compliance. Process-focused reviews may be carried out frequently to provide timely feedback to the program administrator on how efficiently the program is being implemented.

Assessment of the program's substantive details may include reviewing each design element to ensure that it continues to be relevant. Questions to be asked include, for example, whether the program should consider new objectives, whether the applicability threshold needs to be revised, whether the calculation and monitoring methodologies have been updated as needed, and what kinds of outreach and information dissemination efforts are being implemented to facilitate compliance. The review could also assess which data have been particularly useful (or not useful) to data users, such as government agencies, as well as which data have been particularly problematic for entities to report and why.

Finally, the review can assess a program's impact, which may be measured in terms of indicators such as the number of entities reporting to the program, emissions coverage, or progress made toward program objectives. For example, has the program improved data quality or informed national inventories? This kind of review can also be performed every few years to ensure that the program continues to generate meaningful impact.

Program administrators may want to determine details regarding who should conduct the review and how the review is to be conducted. These details can be integrated into the rulemaking process itself to formalize the review process. Reviews may be conducted at a predefined interval by an independent body, which ensures an impartial, objective assessment. The independent assessment can also seek systematic feedback from stakeholders. For example, the Australian government established the Climate Change Authority, an independent agency that conducts reviews of many of Australia's climate change policies including the GHG emissions reporting program. The review requirement is part of the *National Greenhouse and Energy Reporting Act,* which states that the Authority should conduct periodic and special reviews of the legislation. Whereas periodic reviews are undertaken every five years, special reviews can be conducted at the environment minister's request (Australian Government 2014a). Each review includes public consultation and must be submitted to the environment minister and published on its website (Climate Change Authority n.d.). The Australian Department of the Environment also conducts an annual review of the *National Greenhouse and Energy Reporting (Measurement) Determination,* the technical guidelines for calculating emissions.

Reviews lend credibility, facilitate stakeholder feedback, identify good practices and inefficiencies, and demonstrate program impact.

Other programs undertake regular revisions based on ongoing stakeholder feedback and their implementation experience rather than conducting a formal, periodic review process. For example, Canadian program administrators reduced the economy-wide emissions threshold from 100,000 tCO_2e to 50,000 tCO_2e in 2009—five years after the program had been introduced (Environment Canada 2010). The U.S. EPA issues amendments for technical corrections and general revisions as needed. It seeks feedback from stakeholders through a public comment period before amendments are finalized (U.S. EPA 2014c).

PROGRAM REVIEW

Key Considerations

- Reviews lend credibility to the program, facilitate feedback from stakeholders, help identify good practices as well as inefficiencies, and provide an opportunity to demonstrate the program's impact.
- Programs can formalize a review process in the authorizing legislation by designating who should conduct the review and how often.
- Reviews can focus on the program's process, its substantive details, and/or its impact.

Checklist of Questions to Guide Decisionmaking

- Does the review process specify who will conduct the review and how often?
- Does the scope of the review process consider potential benefits such as assessing progress made against objectives, lending credibility to the program, and identifying good practices and inefficiencies?

APPENDIX A EXAMPLES OF APPLICABILITY REQUIREMENTS IN GHG REPORTING PROGRAMS

This appendix shows the requirements used by 11 of the 13 GHG reporting programs reviewed in this report to determine which entities are required to report their greenhouse gases and which gases must be reported. The two programs not included here are proposed programs that have not yet set official requirements.

Table A1 | **Type of Applicability Requirements in GHG Reporting Programs, Description, and GHGs Reported**

GREENHOUSE GAS (GHG) REPORTING PROGRAM	TYPE OF APPLICABILITY REQUIREMENT	DESCRIPTION	GHGs TO BE REPORTED
Australia National Greenhouse and Energy Reporting Scheme	Emissions and energy threshold	■ All facilities must report if annual emissions ≥ 25,000 metric tons of CO_2e (tCO_2e) or if the total amount of energy produced or consumed ≥ 100 terajoules ■ All corporate groups must report if annual emissions ≥ 50,000 tCO_2e or if the total amount of energy produced or consumed ≥ 200 terajoules	Facilities must report CO_2, CH_4, N_2O, SF_6, specified HFC and PFC emissions
California Mandatory GHG Reporting Program	Emissions threshold and source categories	■ All facilities must report if annual emissions ≥ 25,000 tCO_2e ■ Some source categories are required to report irrespective of emission levels (e.g., cement production, lime manufacturing, petroleum refineries) ■ Facilities can opt for abbreviated reporting if combustion and process emissions are ≥ 10,000 tCO_2e and < 25,000 tCO_2e ■ Suppliers of petroleum products, natural gas and natural gas liquids, and carbon dioxide must report if annual emissions that would result from consumption of products produced and sold are ≥ 10,000 tCO_2e	Facilities must report CO_2, CH_4, N_2O, SF_6, HFCs, PFCs, NF_3, and other fluorinated GHG emissions
Canada GHG Emissions Reporting Program	Emissions threshold	All facilities must report if total annual direct emissions ≥ 50,000 tCO_2e	■ Facilities must report CO_2, CH_4, and N_2O emissions ■ Facilities must also report SF_6, PFC, and HFC emissions originating from industrial processes or industrial product use

GREENHOUSE GAS (GHG) REPORTING PROGRAM	TYPE OF APPLICABILITY REQUIREMENT	DESCRIPTION	GHGs TO BE REPORTED
European Union Emissions Trading System	Emissions threshold, production tonnage, and source categories	■ All facilities with a total rated thermal input exceeding 20 megawatts (MW) (except in facilities for incineration of hazardous or municipal waste) must report ■ Specific source categories are required to report irrespective of emissions level (e.g., production of aluminum, ammonia, and coke, refining of mineral oil) ■ Specific production tonnage requirements by industry (e.g., manufacture of glass: melting capacity that exceeds 20 metric tons/day, production of steel: capacity exceeding 2.5 metric tons/hour)	■ Facilities must report CO_2 emissions ■ Facilities that produce primary aluminum must also report PFC emissions ■ Facilities that produce nitric, adipic, glyoxal, and/or glyoxylic acid must also report N_2O emissions
France Bilan d'Emission de GES	Number of employees	Companies with 500 employees or more, public bodies with 250 employees or more, and local authorities with more than 50,000 inhabitants must report emissions	Entities must report CO_2, CH_4, N_2O, HFC, PFC, and SF_6 emissions
Japan Mandatory GHG Accounting and Reporting System	Emissions threshold, energy threshold, number of employees, and transport capacity	■ For energy origin CO_2, all entities with annual energy consumption ≥ 1,500 kiloliters crude oil equivalent ■ For nonenergy CO_2 as well as for other GHGs, all entities must report if annual emissions ≥ 3,000 tCO_2e and the company has at least 21 employees ■ Entities with specified transport capacities must report (e.g., those that have passenger transport with at least 300 railroad cars or 200 buses)	All facilities must report CO_2, CH_4, N_2O, HFC, PFC, and SF_6 emissions
Mexico National Emissions Registry	Emissions threshold	Facilities and companies must report if annual emissions ≥ 25,000 tCO_2e (covers specific activities within the energy, transport, industry, agriculture, waste, and business/service sectors)	All facilities must report CO_2, CH_4, N_2O, HFC, PFC, HCFC, CFC, SF_6, NF_3, halogenated ether, halocarbon, and black carbon emissions from sources including mobile sources
Norway Emissions Trading System	Emissions threshold, production tonnage, and source categories	■ All facilities with a total rated thermal input exceeding 20 megawatts (MW) (except in facilities for incineration of hazardous or municipal waste) must report ■ Specific source categories are required to report irrespective of emissions level (e.g., production of aluminum, ammonia, and coke, refining of mineral oil) ■ Specific production tonnage requirements by industry (e.g., manufacture of glass: melting capacity that exceeds 20 metric tons/day, production of steel: capacity exceeding 2.5 metric tons/hour)	■ Facilities must report CO_2 emissions ■ Facilities that produce primary aluminum must also report PFC emissions ■ Facilities that produce nitric, adipic, glyoxal, and/or glyoxylic acid must also report N_2O emissions

GREENHOUSE GAS (GHG) REPORTING PROGRAM	TYPE OF APPLICABILITY REQUIREMENT	DESCRIPTION	GHGs TO BE REPORTED
Turkey GHG Reporting Scheme	Emissions threshold, production tonnage, and source categories	■ All facilities must report if aggregated rated thermal input exceeds 20 MW ■ Specific source categories are required to report irrespective of emissions level (e.g., production of aluminum and ammonia, refining of mineral oil) ■ Specific production tonnage requirements by industry (e.g., manufacture of glass: melting capacity that exceeds 20 metric tons/day, production of steel: capacity exceeding 2.5 metric tons/hour)	■ Facilities must report CO_2 emissions ■ Facilities that produce primary aluminum must also report PFC emissions ■ Facilities that produce nitric, adipic, glyoxal, and/or glyoxylic acid must also report N_2O emissions
United Kingdom GHG Reporting Program	Publicly traded companies	All UK incorporated companies whose equity share capital is listed officially on the main market of the London Stock Exchange, a European Economic Area, or has dealt on the New York Stock Exchange/NASDAQ must report annual emissions	All entities must report CO_2, CH_4, N_2O, HFC, PFC, and SF_6 emissions
United States GHG Reporting Program	Emissions threshold, energy threshold, and source categories	■ Some source categories must report irrespective of emission levels (e.g., production of cement, aluminum, lime manufacturing, and industrial waste landfill) ■ Some source categories must report if annual emissions ≥ 25,000 tCO_2e (e.g., production of lead, iron and steel, and pulp and paper manufacturing) ■ Facilities not covered by the source category requirements above must report if annual emissions ≥ 25,000 tCO_2e and the aggregate maximum rated heat input capacity of the stationary fuel combustion units at the facility is 30 million metric British thermal units per hour (mmBtu/hr) or greater ■ Some suppliers must report GHG quantities that would result from consumption of produced and sold products irrespective of emission or energy levels (e.g., petroleum refineries that distill crude oil, all producers of coal-to-liquid products, industrial GHGs, CO_2 suppliers) ■ Some suppliers must report if they meet emissions or energy threshold requirements (e.g., importers/exporters of an annual quantity of coal-to-liquid products and petroleum products where emissions that would result from consumption of imports and exports would be equivalent to ≥ 25,000 tCO_2e, local natural gas distribution companies that deliver ≥ 460,000 thousand standard cubic feet of natural gas per year)	■ All facilities must report CO_2, CH_4, and N_2O emissions ■ Some sectors require reporting of additional GHGs (e.g., aluminum production: CF_4 and C_2F_6; magnesium production: SF_6)

Note: See Abbreviations for names of greenhouse gases.

Sources: (U.S. EPA 2009a; CARB 2013b; CARB 2014b; CER 2014d; Defra 2013; Diario Oficial de la Federación 2014; Environment Canada 2015; The European Parliament 2009b; Citepa 2014; Ministry of the Environment (Japan) 2014; Ministry of Environment and Urbanization (Turkey) 2014.

APPENDIX B: CATEGORIZING EMISSIONS CALCULATION METHODS IN TIERS

Programs often provide emissions quantification methodology for individual emission sources and categorize them in data-quality tiers. This appendix describes how the Australian, EU, and U.S. programs define tiers to classify quantification methods.

Australia's reporting program

In *Australia, the National Greenhouse and Energy Reporting (Measurement) Determination 2008* (Australian Government 2014b), provides methods to calculate GHG emissions under the National Greenhouse and Energy Reporting Act of 2007 (Australian Government 2014a). It is revised annually to reflect updates to emission factors and improvements in estimation methods, and in response to stakeholder feedback.

Emission sources covered in the *Measurement Determination* include fuel combustion for energy; fugitive emissions from the extraction of coal, crude oil, and natural gas; industrial processes; and waste management. The Measurement Determination provides detailed requirements and descriptions of information needed to calculate emissions, including methods, equations, how to estimate the quantity of fuel used, and procedures for sampling and analyzing fuels and raw materials.

The *Measurement Determination* is accompanied by technical guidelines that provide additional guidance and industry examples to help reporters understand and apply the calculation methods.

The Measurement Determination lays out four methods of quantifying emissions, three of which depend on calculations, while the fourth involves direct measurement (Figure B1) (Australian Government Department of the Environment 2014c).

METHOD 1: Method 1 specifies the use of national average factors as emission factors. The *Measurement Determination* provides a list of average factors for different sources. These factors are to be used in the absence of better information about the qualities of fuels or raw materials used at a particular facility. Qualities refer to carbon, ash, and moisture content of a fuel and may vary significantly from source to source.

This method is useful for fuel sources that are relatively homogenous (e.g., standard liquid fossil fuels that are expected to be similar across most facilities). If better information on fuel qualities is available, the reporter may use methods 2 or 3.

METHOD 2: This method depends on sampling and analysis of fuels or raw materials actually used in the facility. It requires the use of more accurate, facility-specific calculation factors based on the qualities of fuels or raw materials (e.g., for solid fuels, these qualities refer to carbon, ash, and moisture content of the fuel). Therefore, this method is appropriate for fuels whose qualities vary depending on the source, such as coal.

The method requires that representative and unbiased samples of fuels consumed in the facility be obtained for analysis. Fuel and raw material analysis must be done in accordance with Australian or equivalent international standards.

METHOD 3: This method is very similar to method 2, except that it requires both sampling and analysis of fuels or raw materials in accordance with Australian or equivalent international standards. (Method 2 requires Australian or equivalent international standards to be followed for analysis only, not for sampling.)

METHOD 4: This method involves direct measurement of GHG emissions by either continuous or periodic monitoring. The *Measurement Determination* provides requirements for design, installation, and maintenance of direct emissions measurement systems, including requirements for location of sampling positions, measurement of flow rates and gas concentrations, and the frequency of measurements based on internationally recognized standards and practices. Reporters using this method are also required to reconcile the emissions value against an estimate obtained using method 1 if it is available.

Figure B1 | **Methods to Estimate CO_2 Emissions Under the Australian Reporting Program**

METHOD 1	METHOD 2	METHOD 3	METHOD 4
■ Calculation based ■ Uses national default emission factors which are provided in the quantification requirements	■ Calculation based ■ Uses facility-specific emission factor: sampling and analysis of fuel or raw materials actually used in the facility ■ Analysis as per Australian or equivalent international standards	■ Same as method 2, BUT: ■ Uses Australian or equivalent international standards for both fuel or raw material sampling and their analysis	■ Based on direct measurement of emissions ■ Must be reconciled with emissions estimate using method 1

The *Measurement Determination* allows reporters to select one of these methods to calculate emissions for each source. Reporting entities have the flexibility to select a method according to their capacity level and data availability with some exceptions. For example, for CH_4 and N_2O emissions from solid fuel combustion, only method 1 is prescribed because solid fuels are a minor source of emissions for these two GHGs (Table B1). Similarly, direct measurement is the only method prescribed to estimate fugitive emissions of CH_4 and CO_2 from coal extraction in underground mines. Method 1 cannot be used to calculate emissions from solid fuel combustion by electricity generation facilities with a capacity of 30MW or more and generating more than 50,000MWh of electricity in the reporting year.

The European Union's reporting program

The European Commission regulation on monitoring and reporting of GHG emissions includes rules governing the quantification of emissions (European Commission 2012b). In addition, the program has developed detailed guidance to support reporters in implementing the program rules.

The program requires reporters to follow a three-step process (Figure B2) to determine which calculation method to apply. Reporters begin by categorizing themselves into category A, B, or C according to their average annual emissions (Table B2) (European Commission 2012a).

The next step is to determine whether the emission sources are major, minor, or de-minimis. The program defines these categories as:

- Major sources—All sources not defined as minor or de-minimis.
- Minor sources—Sources that add up to less than 5000 tCO_2e/year or to less than 10 percent of the total of all monitored emissions, up to a total of 100,000 tCO_2e/year, whichever is higher in terms of absolute value.
- De-minimis sources—Sources that add up to less than 1,000 metric tons of CO_2e per year (tCO_2e/year) or, less than 2 percent of the total of all monitored emissions, up to a total of 20,000 tCO_2e/year, whichever is higher in terms of absolute value. These sources should no longer be included in minor sources.

The EU program defines tiers for each of the two emissions quantification approaches: calculation-based and direct measurement. In general, the program requires higher-tier methods for major sources, while lower-tier methods may be used for minor sources.

Calculation-based approaches

For calculation-based approaches, tiers are defined for activity data as well as for emission factors.

For the *activity data* (e.g., amount of fuel), the tier is defined in terms of maximum permissible uncertainty (Table B3).

Table B1 | **Methods Provided in the *Measurement Determination* to Calculate Emissions from Combustion of Solid Fuels**

METHOD	CO_2	CH_4	N_2O
1	Provided	Provided	Provided
2	Provided	Not provided	Not provided
3	Provided	Not provided	Not provided
4	Provided	Not provided	Not provided

Figure B2 | **Determining the Appropriate Calculation Method to Apply under the EU Program**

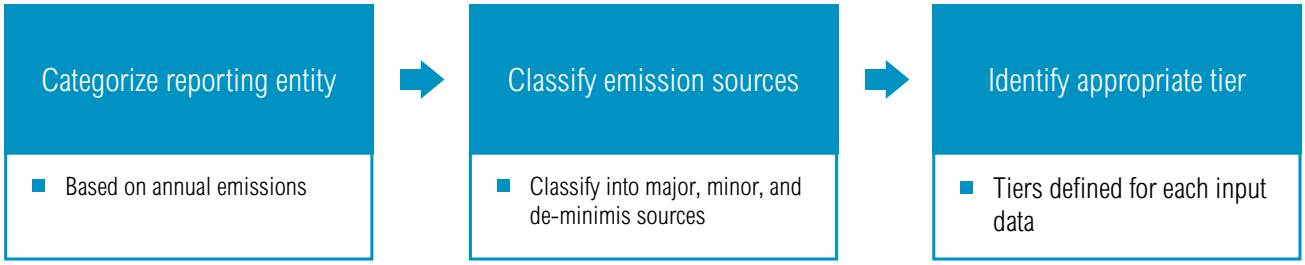


Table B2 | **Categorizing Reporters Based on Annual Emissions**

CATEGORY	AVERAGE ANNUAL EMISSIONS (METRIC TONS OF CO_2e)
A	< 50,000
B	50,000 – 500,000
C	>500,000

Table B3 | **Tiers Defined in Terms of Permissible Uncertainty in Calculation-Based Approaches: Example of Activity Data Related to Solid Fuel Combustion in the EU Program**

TIER	MAXIMUM PERMISSIBLE UNCERTAINTY IN AMOUNT OF FUEL (IN PERCENT OF FUEL AMOUNT)
1	±7.5
2	±5
3	±2.5
4	±1.5

For example, if the maximum permissible uncertainty in the amount of fuel is 5% (Tier 2), and the estimated amount of fuel is 100 metric tons, the actual amount of fuel can be between 95 and 105 metric tons.

For emission factors, tiers are defined as:

- Tier 1—use standard factors based on IPCC 2006 Guidelines for *National Greenhouse Gas Inventories* (list is included in the regulation), or other constant values based on fuel supplier data or historical data agreed with the competent authority.
- Tier 2a—use country-specific emission factor for the fuel.
- Tier 2b—derive emission factors using values established as per national or international standard (e.g., net calorific value provided by the fuel supplier).
- Tier 3—derive emission factors based on sampling and analyses done in accordance with the rules given in the regulation.

Direct measurement approach

For the direct measurement approach, tiers are defined in terms of permissible uncertainties in the measurement of each GHG. The program provides guidance to determine uncertainty associated with the values of GHG concentration and flue gas flow. Table B4 gives an example of tiers for measuring CO_2 emissions using continuous emissions monitoring systems (CEMS).

Table B4 | **Tiers Defined in Terms of Permissible Uncertainty in Direct Measurement Approach: Example of CO_2 Emissions Measured Using CEMS in the EU Program**

TIER	MAXIMUM PERMISSIBLE UNCERTAINTY IN CO_2 EMISSIONS MEASURED USING CEMS (IN PERCENT OF TOTAL EMISSIONS)
1	±10
2	±7.5
3	±5
4	±2.5

Note: CEMS = continuous emissions monitoring systems.

Reporters are then required to apply tiers based on their category (A, B, or C), emission source (major, minor, or de minimis) and the quantification approach (calculation-based or direct measurement). Table B5 summarizes tier requirements for calculation-based approaches.

The U.S. reporting program

The U.S. program has established requirements for calculating GHG emissions for each source category, such as stationary fuel combustion sources, electricity generation, and aluminum production.

Calculation methods are classified as Tier 1, Tier 2, Tier 3, and Tier 4. These differ in terms of rigor and effort involved in obtaining activity data and estimating calculation factors. As with other programs, the lower tiers require fewer measurements than the higher tiers, but the latter generally yield more accurate emission estimates. For example, in case of stationary fuel combustion, applying respective tiers entails the following (U.S. EPA 2009d):

- Tier 1—this is the simplest calculation and requires measuring fuel use. The program provides default emission factor values to be used when applying this method.

- Tier 2—this method requires entities to measure both fuel use and high heat value (HHV). It uses the same emissions factor as Tier 1.
- Tier 3—using this tier requires entities to measure fuel use and carbon content for solid and liquid fuels, as well as molecular weight for gaseous fuels.
- Tier 4—this tier requires the use of a CEMS.

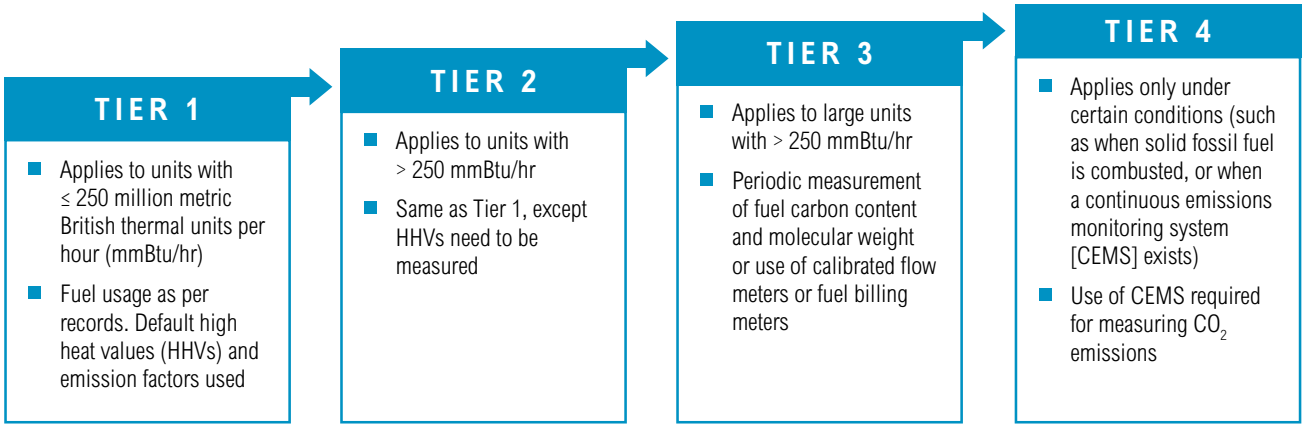
The program further lays out conditions to determine which calculation method (corresponding to each tier) must be applied under what circumstances. For example, the Tier 1 method may be used by entities with maximum rated heat input capacity of 250 million metric British thermal units per hour (mmBtu/hr) or less. However, if entities routinely perform fuel sampling and analysis, then they cannot apply the Tier 1 method and must use a higher tier method. Tier 1 may also be used in municipal solid waste entities of any size that do not produce steam, if they are not required to use Tier 4. Municipal solid waste units that generate steam must use Tier 2. Figure B3 illustrates the tier approach for calculating CO_2 emissions from fuel combustion.

Table B5 | **Tier Requirements for Calculation-Based Approaches in the EU Program**

SOURCE	CATEGORY A	CATEGORY B	CATEGORY C
Major	Tier requirements for each source (e.g., solid fuels, liquid fuels, coke production)	Highest tier defined for activity data and calculation factors	Highest tier defined for activity data and calculation factors
Major, but technically not feasible or unreasonable costs	Up to 2 tiers lower,[a] with Tier 1 being the lowest possible tier	Up to 2 tiers lower,[b] with Tier 1 being the lowest possible tier	1 tier lower,[c] with Tier 1 being the lowest possible tier
Minor	Highest tier technically feasible and without unreasonable costs (Tier 1 is the lowest possible tier)		
De minimis	Conservative estimation, unless a defined tier is achievable without additional effort		

Notes:
a. Up to 2 tiers lower than the tier required for the combination of Major source-Category A.
b. Up to 2 tiers lower than the tier required for the combination of Major source-Category B.
c. 1 tier lower than the tier required for the combination of Major source-Category C.

Figure B3 | **Simplified Representation of the U.S. EPA's Tier-Based System for Calculating CO_2 Emissions from Stationary Combustion Sources**



Source: U.S. EPA 2010b

ABBREVIATIONS

C_2F_6	hexafluoroethane
CEMS	continuous emissions monitoring systems
CF_4	tetrafluoromethane
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CROMERR	cross-media electronic reporting regulation
DEA	Department of Environmental Affairs, South Africa
EMA	Mexican Accreditation Entity
EU ETS	European Union Emissions Trading System
GHG	greenhouse gas
GWP	global warming potential
HFCs	hydrofluorocarbons
HHV	high heat value
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
IT	information technology
kg	kilogram
Kl	kilo liter
$ktCO_2e$	metric kilotons of carbon dioxide equivalent
kWh	kilowatt hour
METI	Ministry of Economy, Trade, and Industry, Japan
mmBtu	million metric British thermal units
MOE	Ministry of Environment, Japan
MRV	monitoring, reporting, and verification
Mt	million metric tons
Mtce	million metric tons of coal equivalent
$MtCO_2e$	million metric tons of carbon dioxide equivalent
MWh	megawatt hour
N_2O	nitrous oxide
NF_3	nitrogen trifluoride
PFCs	perfluorocarbons
PMR	Partnership for Market Readiness
SEMARNAT	Secretariat of Environment and Natural Resources, Mexico
SF_6	sulphur hexafluoride
t	metric tons
tCO_2e	metric tons of carbon dioxide equivalent
tCO_2e/year	metric tons of carbon dioxide equivalent per year
UNFCCC	United Nations Framework Convention on Climate Change
U.S. EPA	United States Environmental Protection Agency
WRI	World Resources Institute

GLOSSARY

Activity data	A quantitative measure of activity that results in greenhouse gas (GHG) emissions. Activity data is multiplied by an emissions factor to derive the GHG emissions associated with a process or an operation. Examples of activity data include kilowatt hours of electricity used, quantity of fuel used, output of a process, number of hours equipment is operated, distance traveled, and floor area of a building.
Allowance	A commodity issued by an emissions trading program that gives its holder the right to emit a certain quantity of GHG emissions.
Base year	A historic datum (a specific year or an average over multiple years) against which an entity's emissions are tracked over time.
Black carbon	A climate forcing agent formed through the incomplete combustion of fossil fuels, biofuel, and biomass.
Carbon dioxide	A naturally occurring gas, also a by-product of burning fossil fuels from fossil carbon deposits, such as oil, gas, and coal; of burning biomass; of land use changes; and of other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured and therefore has a global warming potential of 1.

Carbon tax	A levy on the carbon content of fossil fuels. Because virtually all of the carbon in fossil fuels is ultimately emitted as carbon dioxide, a carbon tax is equivalent to an emission tax on each unit of CO_2 equivalent emissions.
CO_2 equivalent	The universal unit of measurement to indicate the global warming potential (GWP) of each of the seven GHGs covered by the United Nations Framework Convention on Climate Change, expressed in terms of the GWP of one unit of carbon dioxide.
Consolidation	Combination of GHG emission data from separate operations that form part of one company or group of companies.
Data management system	A system for collecting and storing GHG emissions information from reporting entities. The system facilitates the reporting, organization, and analysis of GHG data. It can also support quality assurance, quality control and verification activities, track emissions over time, and facilitate analysis and sharing of data with stakeholders.
Direct GHG emissions	Emissions from sources that are owned or controlled by the reporting entity.
Direct measurement	Directly measuring GHG emissions in the exhaust stream using continuous or periodic emission monitoring systems (CEMS or PEMS).
Double counting	Occurs when two or more reporting entities take ownership of the same emissions or reductions.
Emission factor	A factor that converts activity data into GHG emissions data (e.g., kg CO_2e emitted per liter of fuel consumed, kg CO_2e emitted per kilometer traveled).
Emission source	Any physical unit or process that releases GHGs into the atmosphere.
Emissions	The release of GHGs into the atmosphere.
Emissions trading system	A system that sets an overall emission limit, allocates emission allowances to participants, and allows them to trade allowances and emission credits with each other.
Fugitive emissions	Emissions that are not physically controlled but result from intentional or unintentional releases of GHGs. They commonly arise from the production, processing transmission, storage, and use of fuels and other chemicals, often through joints, seals, packing, or gaskets.
GHG Protocol	A multistakeholder collaboration convened by the World Resources Institute and World Business Council for Sustainable Development to design, develop, and promote the use of accounting and reporting standards for businesses and governments.
Global warming potential	A factor describing the radiative forcing impact (degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of CO_2.
Greenhouse gas reporting programs	Any voluntary or mandatory international, national, subnational, government, or nongovernmental initiative that collects information on, or regulates GHG emissions or removals from reporting entities.
Greenhouse gases (GHGs)	For the purposes of this report, GHGs are the seven gases covered by the United Nations Framework Convention on Climate Change: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).
Indirect GHG emissions	Emissions that are a consequence of the operations of the reporting entity, but occur at sources owned or controlled by another entity. They are categorized as Scope 2 and Scope 3 emissions.

Intergovernmental Panel on Climate Change (IPCC)	International body of climate change scientists. The role of the IPCC is to assess the scientific, technical, and socioeconomic information relevant to understanding the risk of human-induced climate change.
Jurisdiction	The geographic area within which the GHG reporting program is administered. Jurisdictions can be subnational, national, or multicountry regions.
Mass balance method	A method to calculate GHG emission based on determining the balance of GHGs entering and leaving the entire entity or a specific unit or process within the entity.
Materiality threshold	A concept employed in the process of verification. It is used to determine whether an error or omission is a material discrepancy or not.
Mobile combustion	Burning of fuels by transportation devices such as cars, trucks, trains, airplanes, or ships.
Process emissions	Emissions generated from manufacturing processes, such as CO_2 that is emitted from the breakdown of calcium carbonate ($CaCO_3$) during cement manufacturing.
Program objective	Refers to an objective, goal, or aim of a GHG reporting program, such as improving data quality and informing mitigation policies.
Scope 1	Direct GHG emissions from sources owned or controlled by the reporting entity.
Scope 2	Emissions associated with the generation of electricity, heating/cooling, or steam purchased for the reporting entity's own consumption.
Scope 3	Indirect emissions other than those covered in Scope 2.
Source	Any process, activity, or mechanism that releases a greenhouse gas into the atmosphere.
Stakeholder engagement plan	A plan that defines the process for stakeholder engagement and addresses issues such as why to engage, whom to engage with, when to engage, what issues to engage on, and how to engage.
Stationary combustion	Burning of fuels to generate electricity, steam, heat, or power in stationary equipment such as boilers and furnaces.
Third-party verification	An independent assessment of the reliability, completeness, and accuracy of emissions-related information submitted by reporting entities.
Uncertainty	1. Quantitative definition: Measurement that characterizes the dispersion of values that could reasonably be attributed to a parameter. 2. Qualitative definition: A general term that refers to the lack of certainty in data and methodology choices, such as the application of nonrepresentative factors or methods, incomplete data on sources and sinks, or lack of transparency.

ENDNOTES

1. Also see WRI and WBCSD 2007.

2. Respective program websites for the existing programs discussed here:
   Australia: http://www.cleanenergyregulator.gov.au/National-Greenhouse-and-Energy-Reporting/Pages/default.aspx
   California: http://www.arb.ca.gov/cc/reporting/ghg-rep/ghg-rep.htm
   Canada: http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=040E378D-1
   European Union: http://ec.europa.eu/clima/policies/ets/monitoring/documentation_en.htm
   France: http://www.bilans-ges.ademe.fr/
   Mexico: http://dof.gob.mx/nota_detalle.php?codigo=5365828&fecha=28/10/2014
   Turkey: http://www.csb.gov.tr/projeler/iklim/
   United Kingdom: https://www.gov.uk/government/publications/environmental-reporting-guidelines-including-mandatory-greenhouse-gas-emissions-reporting-guidance
   United States: http://www.epa.gov/ghgreporting/

3. Interviews with GHG reporting program staff and experts from Australia, China, the European Union, France, Mexico, Norway, South Africa, Turkey and United States were held during 2014–15. We had interviewed program staff from Australia, California, Canada, the European Union, France, Japan, Turkey, the United Kingdom and United States for the 2013 WRI publication (Singh and Mahapatra 2013). Interviews are cited in references.

4. See WRI and WBCSD 2011 for more information on this category (Category 11, Chapter 5 of the Standard).

5. The Californian program also allows these reporters to use simpler emissions quantification methods, and does not require third-party verification, which helps lower the reporting entity's cost of compliance.

6. IPCC has a global emission factor database which provides current default emission factors, categorized as per IPCC 2006 Guidelines for National Greenhouse Gas Inventories at http://www.ipcc-nggip.iges.or.jp/EFDB/main.php.

7. For further information on source-specific calculation methodologies, policy makers may refer to the following resources:
   Australian National Greenhouse and Energy Reporting Scheme, https://www.cleanenergyregulator.gov.au/National-Greenhouse-and-Energy-Reporting/Legislation-and-regulations/Development-and-Review/Pages/default.aspx;
   U.S. GHG Reporting Program, http://www.epa.gov/ghgreporting/reporters/subpart/index.htm;
   EU Emission Trading System, http://ec.europa.eu/clima/policies/ets/monitoring/documentation_en.htm;
   Intergovernmental Panel on Climate Change, http://www.ipcc-nggip.iges.or.jp/public/2006gl/

8. The IPCC has developed extensive methodological guidance to support countries in reporting national GHG inventories: *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000), 2003 Good Practice Guidance for Land Use, Land-Use Change and Forestry, and 2006 IPCC Guidelines for National Greenhouse Gas Inventories.*

9. For examples of data management systems, see PMR 2013e.

10. For an example of a monitoring plan template, see "Monitoring Plan for the Emissions of Stationary Installations" at http://ec.europa.eu/clima/policies/ets/monitoring/docs/t1_mp_installations_en.xls.
    For an illustrative monitoring plan and a plan update, see "Exemplar Monitoring Plan" at http://ec.europa.eu/clima/policies/ets/monitoring/docs/t1_mp_installations_example_en.xls and "'Exemplar Monitoring Plan Update" at http://ec.europa.eu/clima/policies/ets/monitoring/docs/t1_mp_installations_update_example_en.xls.

11. In this report, these experts are interchangeably referred to as GHG assurance providers, verifiers, or auditors.

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ABOUT PMR

The Partnership for Market Readiness (PMR) is a global partnership that supports countries to assess, prepare, and implement carbon pricing instruments in order to scale up GHG mitigation. It also serves as a platform for international cooperation where countries share lessons learned and work together to shape the future of cost-effective climate change mitigation.

The PMR brings together more than 30 countries, various international organizations, and technical experts to facilitate country-to-country exchange and knowledge sharing and, as such, enables enhanced cooperation and innovation.

The PMR includes 13 Contributing Participants, which provide financial support to the PMR trust fund, and 17 Implementing Country Participants, which receive funding to finance the assessment, technical ground work, design, and piloting of market-based approaches to GHG mitigation.

In addition, the PMR created a new category of participant—the Technical Partner—to include countries and subnational jurisdictions that have made significant progress with the implementation of a carbon pricing instrument, and that can either benefit from specific technical support in the form of funding, and/or provide expert advice and share relevant experience with other PMR participants.

The PMR also supports countries' efforts to determine post-2020 mitigation scenarios and identify packages of effective and cost-efficient policies—including carbon pricing instruments—to achieve climate change mitigation. Much of this support will contribute to the Implementing Countries' work to prepare the mitigation component for their "intended nationally determined contributions" (INDCs) under the United Nations Framework Convention on Climate Change process.

Through its Technical Work Program, the PMR promotes best practices and facilitates efforts to establish common standards and approaches for GHG mitigation. Drawing upon country experience, global industry experts, and in-house resources, the PMR Secretariat generates a host of knowledge products on various economic policy instruments and technical elements related to carbon pricing.

Finally, the World Bank serves as the PMR Secretariat, trust fund manager, and principal delivery partner to the Implementing Country Participants.

For more information on the Partnership for Market Readiness, please visit the website: www.thepmr.org.

ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity and human well-being.

Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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