Guidance for Normalizing Environmental Performance Results

Normalization is the process of adjusting environmental performance measurements to account for increases or decreases in production over time. Normalization is integral to measuring and reporting environmental performance in the Performance Track program, both when applying to the program as well as when completing an Annual Performance Report. This guidance document was developed to assist facilities with the normalization requirements for the Performance Track program**. As a general rule, normalization should be based on levels of production at a facility.** Depending on the facility, "production" may refer to manufactured products, to services rendered, or some other productive output from the facility. In some situations it is difficult to determine the best way to quantify changes in production. This document contains numerous detailed examples to illustrate how a facility might normalize and report data in a variety of situations.

The guidance focuses on normalizing data related to future commitments and annual results. The procedure for **normalizing past achievements** for the application is slightly different. For more information on normalizing past achievement data, click here.

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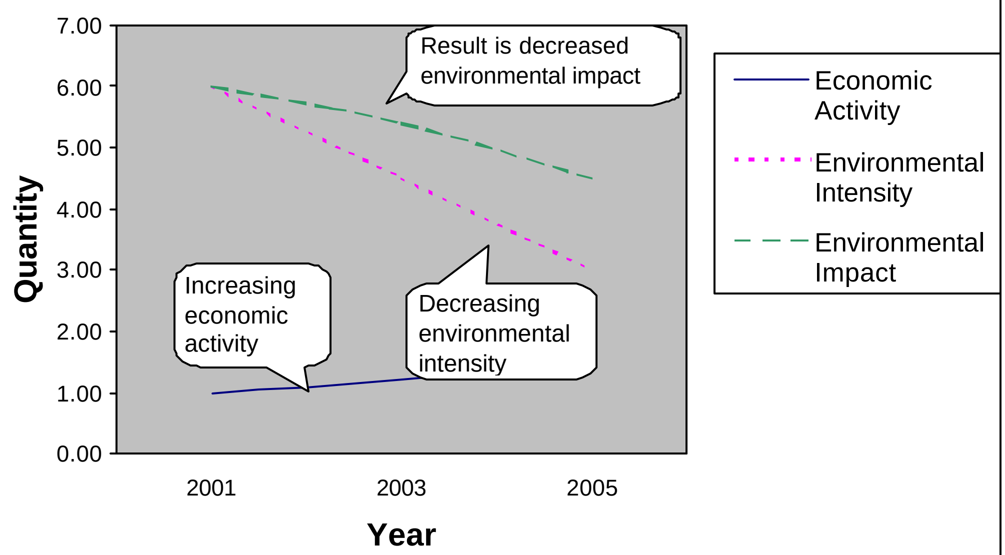
1. Introduction

What is normalization?

Quantitative measures of a facility's environmental impact or performance (e.g., pounds of toxic air emissions, gallons of water used) are directly affected by two factors – (1) the level of economic activity (e.g., number of cars produced) and (2) the amount of resources used and pollution generated per unit of economic activity (e.g., gallons of water per car produced, pounds of NOx per car produced). One goal of environmental management is to reduce this second factor – the environmental intensity of activities – in order to reduce environmental impacts. The relationship between these factors is demonstrated in Figure 1.[1]

Figure 1: Relationship Between Environmental Performance Factors



The environmental intensity of an activity is also known as "eco-efficiency," a term originally introduced by the World Business Council for Sustainable Development (WBCSD). In simple terms, eco-efficiency means reducing the amount of resources, waste and pollution needed to

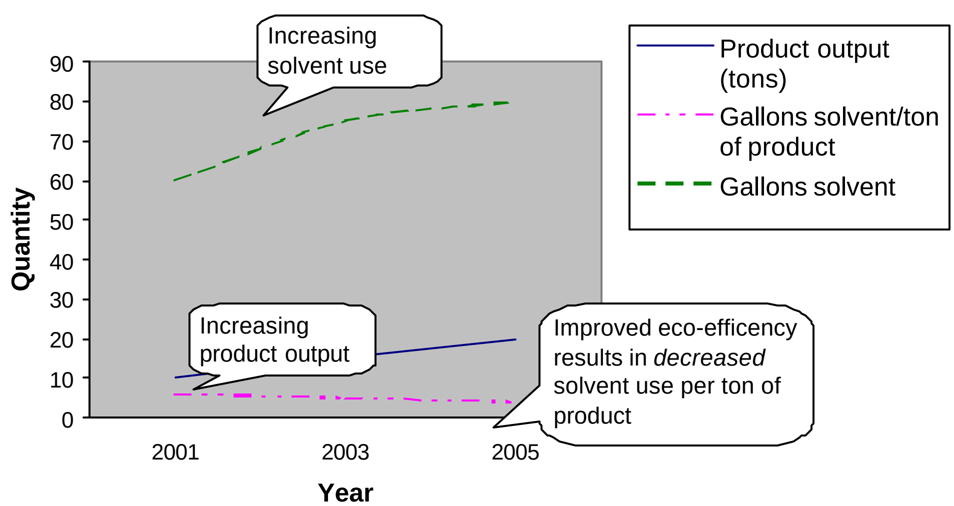
[1] The trends of the lines in Figure 1 are for illustrative purposes. Depending upon the rate with which economic activity is increasing and environmental intensity is decreasing, environmental impact may increase (e.g., economic activity increases at a faster rate than the decline in environmental intensity), decrease (e.g., decreasing environmental intensity is occurring faster than the increase in economic activity), or remain the same (decreasing environmental intensity and increasing economic activity are occurring at a similar rate).

create goods and services.[2] Thus, eco-efficiency gains are realized by decreasing the environmental intensity of a product or service.

In order to determine improvements in a facility's eco-efficiency, changes in the level of economic activity must be held constant or normalized. For example, a facility's solvent usage may decrease from one year to the next due to decreased economic activity (e.g., producing *fewer* products), eco-efficiency gains (e.g., using less solvent to produce the product), or a combination of both factors. Dividing the amount of solvent used by the level of production provides a clearer sense in trends in environmental impact beyond what is dictated by different levels of production. Thus, normalization adjusts for changes in economic activity (such as product output, monetary value of services provided) in order to differentiate between changes in environmental impacts resulting from eco-efficiency versus changes in production level.

This effect is depicted in Figure 2. A tool and die manufacturer has been increasing its production levels between 2001 and 2005 (as shown by the product output line), which results in increased solvent usage between 2001 and 2003. However, in this same time period, the manufacturer improves its eco-efficiency (i.e., uses fewer gallons of solvent per product). Thus, even though product output and total solvent use has *increased*, solvent use per product *decreases*.

Figure 2: Changes in Product Output



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[2] WBCSD defines eco-efficiency as follows: ***"Eco-efficiency is achieved by the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the earth's estimated carrying capacity."*** (www.wbscd.org)

Benefits of normalization

Normalized environmental performance data benefit facilities, environmental policy makers, and interested members of the public:

1. *Facilities* can normalize to compare their performance over time (e.g., months, seasons, years, or between shifts) or compare performance of different production lines or facilities.
2. *Policy makers* seeking to reduce the environmental intensity of economic activities are provided useful data for assessing policy outcomes.
3. *Public/other stakeholders* can assess a facility's performance over time using information that accounts for changes in economic activity, an important determinant for environmental performance.

Normalization in the Performance Track program – Overview

Normalization is integral to measuring and reporting environmental performance in the Performance Track program, both when applying to the program as well as completing the program's Annual Performance Report. The following information is reported in the Performance Track Application (see Text Box 1 for more detailed definitions):

Reporting on past achievements:

1. A past and present **annual quantity**, which is a measurement of an environmental indicator (e.g., total materials used) that has not been adjusted for production.
2. A past normalizing factor that indexes production in the past to production in the current year. Thus, if you are using 2001 for the past and 2003 for the present, your normalizing factor is:

   Normalizing factor = production in 2001 ÷ production in 2003

3. A **basis for normalization** describes the metric you use for calculating the normalizing factor. The basis generally is based on product output (quantity, weight, volume).

Reporting on future commitments:

1. A current and future **annual quantity**, which is a measurement of an environmental indicator (e.g., total materials used) that has not been adjusted for production.
2. The **intended basis for normalization** describing your facility's intended approach for calculating the normalizing factor in subsequent Annual Performance Reports. The basis generally is based on product output (quantity, weight, volume).

For the Annual Performance Report, the following information is required:

1. An **actual quantity**, which is a measurement of an environmental indicator (e.g., total materials used) that has not been adjusted for production.

2. A **normalizing factor**, which is an index of your production in the current year and production in your baseline year. For example, if you produced 12,000 computers in the current year and 10,000 computers in the baseline year, your normalizing factor would be 1.2 (12,000 divided by 10,000). Reporting a normalizing factor, instead of actual production levels, protects confidential business information such as production level.
3. The **basis for normalization** describes the metric you use for calculating the normalizing factor. The basis generally is based on product output (quantity, weight, volume).
4. The **normalized quantity** is a measurement of an environmental indicator that is adjusted for production.

Text Box 2 provides a summary of the relationship between normalizing factor and normalized quantity. Even if your commitment is for an absolute goal (i.e., irrespective of changing economic activity), you will need to report normalized quantities in your Annual Performance Report in order to demonstrate eco-efficiency progress.

Section 2 provides further detail and examples to assist your reporting of this information.

Principles of normalization

The following principles present guidance on selecting and reporting your facility's normalization approach and basis of normalization:

1. ***Consistency.*** Tracking normalized quantities over time requires that you use a consistent basis of normalization. Thus, you should use the same basis for your normalizing factor throughout the three-year Performance Track membership cycle. If your normalizing factor in your first Annual Performance Report (APR) is based on quantity of product output, for example, then product output should be the basis of your normalizing factor in your second and third reports.
2. ***Relevancy.*** Your basis for normalization should be relevant to your achievement or commitment. For example, if your commitment is to reduce the use of hexavalent chromium in your plating lines, your basis of normalization should be relevant to the production output of your plating operations (e.g., square feet of plated parts). If your hexavalent plating lines represent the only use of hexavalent chromium in your facility, then the most relevant basis of normalization is production output from these lines (e.g., square feet of hexavalent chromium plated parts).
3. ***Transparency.*** Your facility's method of normalization should be transparent – that is, to aid the understanding of your facility's environmental performance, you should provide a description of your approach to normalization. For example, you should adequately describe the basis of your normalizing factor (e.g., number of employees, number of patient days, tons of steel produced) and any modifications you have made to this factor.

Text Box 1: Definition of Key Terms

Normalization is the process of adjusting environmental performance measurements to account for increases or decreases in production over time. Normalization allows one to study trends in eco-efficiency to assess whether facilities are reducing their use of resources and waste produced per unit of goods or services produced.

An **annual quantity**, reported in the Application Form, is the annual measurement of an environmental indicator that has not been adjusted for production.

An **actual quantity**, reported in the Annual Performance Report, is the current annual measurement of the environmental indicator in any given year (e.g., pounds per year). The actual quantity is a figure that has not been adjusted for production.

A **normalized quantity** is the measurement of the environmental indicator after it has been adjusted for production.

A **normalizing factor** allows for the conversion of actual quantities to normalized quantities. The normalizing factor essentially serves as a production index, which is calculated as the measure of production in the current year divided by the level of production in the baseline year. The normalizing factor for the baseline year is always 1.0. If production increases after the baseline year, the normalizing factor would be greater than 1.0. Conversely, if production decreases after the baseline year, the normalizing factor would be less than 1.0. For example, if Company X's production increased from 3.2 million units of production in the baseline year to 4.3 million units of production in the next year, then that company's normalizing factor for that period would be 1.34 (4.3 million divided by 3.2 million).

Facilities in Performance Track report normalizing factors, but not actual production data, in order to protect confidential business information.

The **basis for normalization** is the method of determining production levels. In simple cases, the basis for normalization may simply be the number of units of production (e.g., number of cars produced) or the mass of production (tons of steel produced). In other cases, the basis for normalization can be more complicated. The following sections of this paper discuss examples of different bases of normalization, and how to determine the most appropriate basis for normalization.

Text Box 2: Relationships Between Normalization Terms

Normalizing factor = production in current year ÷ production in baseline year

Actual quantity ÷ Normalizing factor = Normalized quantity

Should environmental performance data always be normalized?

Some environmental performance indicators are not likely to be closely related to changes in production and therefore do not need to be normalized. These include:

- ***Land conservation***
- ***Odor***
- ***Noise***
- ***Vibration***

2. Selecting an Appropriate Basis for Normalization

This section describes how to select an appropriate basis for normalization, and how to calculate a normalizing factor. Broadly speaking, normalization is designed to account for changing levels of production on a facility-wide basis, and therefore the basis of normalization should be the facility's total production levels.

The following two indicators in the Material Procurement category (Upstream Stage) use a different basis for normalization:

- ***Recycled content***
- ***Hazardous/toxic components (Total or specific)***

For these two indicators, the basis of normalization is the quantity of the specific material procured (Example 1).

The remainder of this section considers three types of facilities – manufacturing, service, and mixed manufacturing/service – in turn, and suggests appropriate bases of normalization for various situations at each type of facility.

The basic approach to normalizing at manufacturing facilities

For manufacturing facilities, developing normalizing factors that measure production should be relatively straightforward. For example, a car manufacturing facility could use the number of vehicles produced in a given year to normalize their environmental commitments. Similarly, a steel manufacturer could base their normalizing factor on the tons of steel the facility produces annually. For most manufacturing facilities, normalizing environmental performance with a production-based normalizing factor is not only easiest, but also the most appropriate way of measuring performance.

In order to calculate a basic normalizing factor, divide the production in the current year by production in the baseline year. Then, in order to calculate the normalized quantity, divide the actual quantity for a given year by the normalizing factor for that year (see Example 2 below). Also note that in order to protect confidential business information, you should not report production data to the Performance Track program; rather, you only need to report the normalizing factor and the basis for normalization.

Keep in mind that if your facility's production declines, you could achieve a reduction in actual quantities, but show an increase in normalized quantities if your company did not reduce its environmental impacts as quickly as it reduced production (see Example 3 below). This is logical: you would expect a facility with declining production levels to have declining environmental impacts as a direct result of declining production. In order to show improvements in eco-efficiency, you need to show that environmental impacts declined *more* than production levels.

One reason that environmental impact per level of production may increase in the event of declining production is fixed production inputs. For example, your facility may have to heat and light its entire manufacturing operation, regardless of production levels. This is a fixed environmental cost. Even if production declines, your facility would still require the same amount of energy for heating and lighting. Therefore, unless you found other ways to increase its energy efficiency, your facility would become less eco-efficient if production declines. In this case, the challenge to improve eco-efficiency is to eliminate fixed environmental costs, or find other eco-efficiency improvements to offset fixed environmental costs.

More complex examples of normalizing at manufacturing facilities

In the examples above, the basis for normalization was a very straightforward measure of production: total amount of product produced. This basic approach is preferred for the purposes of Performance Track reporting, as it is easiest for facilities to report and most consistent with the principles of normalization. However, in some cases you may wish to account for specific conditions at your manufacturing facility, such as situations where:

- You have multiple manufacturing processes or a heterogeneous product mix (Example 4);
- Both production and non-production activities contribute to an environmental indicator (Example 5); or
- Your facility's product quality changes significantly (Example 6).

In these situations, the best way to account for these circumstances is to *qualitatively describe* the impact of these situations on progress towards the environmental performance commitment in the narrative section below the performance commitment table.

Example 1: Normalizing Recycled Content for Paper Procurement

A facility is reporting on its recycled content for its paper procurement. In the baseline year, the facility purchases 1,000 pounds of paper. Fifty percent (i.e., 500 pounds) contains a recycled content of 25%. Thus, in the baseline year, the facility is purchasing 125 pounds of recycled paper – i.e., 0.25 * 500. (This quantity is analogous to the annual or actual quantity reported in the Performance Track Application or Annual Performance Report, respectively.) The facility commits to reaching a facility-wide goal of 225 pounds of recycled paper, based on baseline paper procurement levels. An appropriate basis of normalization is quantity of paper purchased, measured in tons. The facility has the following paper procurement levels over a four-year period:

	Baseline Year	Year 1	Year 2	Year 3
Paper Procurement (in lbs)	1,000	1,000	1,200	1,500
Recycled Paper Procurement (in lbs)	500	550	600	700
Recycled content (%)	25	25	30	50
Actual Quantity (measured as pounds of recycled content purchased per year)	500 * .25 =125	550 * .25 =138	600 * .30 =180	700 * .50 =350

For each year, the facility divides the paper procurement in that year by the procurement in the baseline year to determine the normalizing factor. Then, the facility divides actual quantities by the normalizing factor to determine normalized quantities, as shown below:

	Baseline Year	Year 1	Year 2	Year 3
Normalizing factor	1,000 ÷ 1,000 = 1	1,000 ÷ 1,000 = 1	1,200 ÷ 1,000 = 1.2	1,500 ÷ 1,000 = 1.5
Normalized Quantity (per year)	125 ÷ 1 = 125	138 ÷ 1 = 138	180 ÷ 1.2 = 150	350 ÷ 1.5 = 233

Therefore, the facility fills in the performance commitment table as follows:

Category: Material Procurement					
Indicator: Recycled Content					
	Baseline (as stated in your application)	**Year 1**	**Year 2**	**Year 3**	**Performance Commitment (the goal stated in your application)**
Calendar Year	2000	2001	2002	2003	
Actual Quantity (per year)	125	138	180	350	
Measurement Units	Pounds of recycled content				
Normalizing Factor*	1	1	1.2	1.5	
Basis for Normalizing Factor	Tons of paper procured				
Normalized Quantity (per year)	125	138	150	233	225

* Calculated above. Facilities do not report calculations for determining the normalizing factor to Performance Track.

Thus, this facility has met its performance commitment.

Example 2: Normalizing at a Manufacturing Facility with Increasing Production

A glass manufacturing facility is reporting on its total hazardous waste generation. The facility commits to reaching a facility wide goal of 3,000 tons of hazardous waste per year, based on current production levels. Therefore, the facility is making its commitment on a normalized basis. An appropriate basis of normalization is production of glass, measured in tons of glass produced. The facility has the following production levels over a four-year period:

	Baseline Year	Year 1	Year 2	Year 3
Production Level (in tons)	300,000	360,000	400,000	420,000

For each year, the facility divides the production in that year by the production in the baseline year to determine the normalizing factor. Then, the facility divides actual quantities by the normalizing factor to determine normalized quantities, as shown below:

	Baseline Year	Year 1	Year 2	Year 3
Normalizing factor	300,000 ÷ 300,000 = 1	360,000 ÷ 300,000 = 1.2	400,000 ÷ 300,000 = 1.3	480,000 ÷ 300,000 = 1.6
Actual Quantity (measured in tons of hazardous waste per year)	4,280	4,500	4,600	4,750
Normalized Quantity (per year)	4,280 ÷ 1 = 4,280	4,500 ÷ 1.2 = 3,750	4,600 ÷ 1.3 = 3,538	4,750 ÷ 1.6 = 2,969

Therefore, the facility fills in the performance commitment table as follows:

Category: Waste					
Indicator: Total Hazardous Waste					
	Baseline (as stated in your application)	**Year 1**	**Year 2**	**Year 3**	**Performance Commitment (the goal stated in your application)**
Calendar Year	2000	2001	2002	2003	
Actual Quantity (per year)	4,280	4,500	4,600	4,750	
Measurement Units	Tons of hazardous waste				
Normalizing Factor*	1	1.2	1.3	1.6	
Basis for Normalizing Factor	Mass of Production: tons of glass produced				
Normalized Quantity (per year)	4,280	3,750	3,538	2,969	3,000

* Calculated above. Facilities do not report calculations for determining the normalizing factor to Performance Track.

Even though the actual quantity of hazardous waste generated by the facility increased each year, the amount of hazardous waste generated per level of production decreased each year, demonstrating that the facility continually improved its eco-efficiency and met its performance commitment.

Example 3: Normalizing at a Manufacturing Facility with Declining Production

The same glass manufacturer as in Example 2 commits to reaching a facility wide goal of 4,000 tons of hazardous waste per year, based on current production levels. However, due to changes in market conditions, the facility experiences declining production levels over time, and thus has a declining normalizing factor in each successive year.

	Baseline Year	**Year 1**	**Year 2**	**Year 3**
Production Level (in tons)	300,000	240,000	180,000	120,000
Normalizing factor	300,000 ÷ 300,000 = 1	240,000 ÷ 300,000 = 0.8	180,000 ÷ 300,000 = 0.6	120,000 ÷ 300,000 = 0.4

The facility's waste does not decline as rapidly as production because of fixed waste generation factors. Holding production constant at baseline year levels, the normalized quantity of waste *increases*, as shown below:

Category: Waste					
Indicator: Total Hazardous Waste					
	Baseline (as stated in your application)	**Year 1**	**Year 2**	**Year 3**	**Performance Commitment (the goal stated in your application)**
Calendar Year	2000	2001	2002	2003	
Actual Quantity (per year)	4,280	3,800	3,000	2,200	
Measurement Units	Tons of hazardous waste				
Normalizing Factor	1	0.8	0.6	0.4	
Basis for Normalizing Factor	Mass of Production: tons of glass produced				
Normalized Quantity (per year)	4,280	4,750	5,000	5,500	4,000

In this case, the quantity of hazardous waste generated did not decrease as rapidly as did production. As a result, the normalized quantities increased, causing the facility to miss its performance commitment. The facility could qualitatively explain the reasons that it missed its performance commitment (e.g., fixed waste generation factors) in the comment section following the performance table.

Example 4: Multiple manufacturing processes / heterogeneous product mix

In some cases, manufacturing facilities may produce several different types of products, each of which contributes to the environmental indicator of concern. For example, a paint manufacturer produces two lines of paint, one of which is a high-VOC paint, and other is a low-VOC paint. The manufacturer is reporting progress towards their commitment to reduce VOC emissions to 105 tons of VOCs per year, based on current production levels in the baseline year. In this case, both eco-efficiency and production levels for high- and low-VOC paint lines influence the actual level of VOC emitted in any given year.

Changes in the relative level of production for high- and low-VOC paint lines would impact overall levels of VOC emissions. In the baseline year, 65% of production is low-VOC paint and 35% high-VOC paint. In the next year, due to consumer demand, the mix of outputs changes, so that some production is shifted from low-VOC to high-VOC paint. Assuming overall production levels were held constant, this would increase overall actual VOC emissions. Since the mix of products produced is a production decision made by the facility, a normalizing factor based on the total amount of all products produced is most appropriate. However, a facility may qualitatively describe how a change in product mix has affected performance levels. For the paint manufacturing facility, an acceptable approach to calculating normalizing factors would be as follows:

	Baseline Year	**Year 1**	**Year 2**	**Year 3**
Production Level (in gallons)				
High VOC Paint	21,000	35,000	37,000	40,000
Low VOC Paint	39,000	25,000	28,000	30,000
Total	60,000	60,000	65,000	70,000
Normalizing factor	60,000 ÷ 60,000 = 1	60,000 ÷ 60,000 = 1	65,000 ÷ 60,000 = 1.08	70,000 ÷ 60,000 = 1.16

For the same time period, the facility's VOC emissions were as follows:

VOC emissions (in tons)				
	Baseline Year	**Year 1**	**Year 2**	**Year 3**
High VOC Paint	52.5	87.5	92.5	100
Low VOC Paint	58.5	37.5	42	45
Total	111	125	134.5	145

The calculations above are for the facility's reference and would not be provided to Performance Track.

(Example continues on next page.)

Example 4, Continued…

The facility would fill in the performance commitment table as follows:

Category: Air Emissions					
Indicator: VOCs (Total)					
	Baseline (as stated in your application)	**Year 1**	**Year 2**	**Year 3**	**Performance Commitment (the goal stated in your application)**
Calendar Year	2000	2001	2002	2003	
Actual Quantity (per year)	111	125	134.5	145	
Measurement Units	Tons of VOCs				
Normalizing Factor	1	1	1.08	1.16	
Basis for Normalizing Factor	Mass of Production: Total gallons of paint produced				
Normalized Quantity (per year)	111	125	125	125	105
Briefly describe how you achieved improvements for this indicator or, if relevant, any circumstances that delayed progress: Increasing consumer demand for high-VOC paint resulted in a changed product mix with higher VOC emissions, thus delaying progress towards our goal.					

Quantitatively adjusting the normalizing factor

There are also a few situations where the normalizing factor can be *quantitatively adjusted* to account for specific conditions at a facility. The one specific situation where you may develop a customized normalizing factor is where an environmental commitment does not pertain to all production lines (Example 7). If your environmental commitment pertains only to some production lines, but not others, the basis of normalization should be the total amount of production *only* for production lines relevant to the environmental commitment.

In cases where energy use is affected by changes in weather (e.g., where weather affects need for heating and air conditioning in offices or retail spaces), you may adjust energy use using heating degree days (HDD) and cooling degree days (CDD) as described in Appendix 1. Because energy use for heating and cooling is typically a small percentage of total energy use in manufacturing facilities, this adjustment is usually more germane to non-manufacturing facilities.

Example 5: Production and non-production activities contribute to environmental indicator

At some manufacturing facilities, both production and non-production activities (such as general management and staff support) may contribute to environmental impacts (such as energy or water use). A common situation occurs when administrative or management staff at a facility use energy and water and create solid waste. In this case, both production and non-production activities are contributing to the same environmental impact. Another example of non-production environmental impacts is the case of greenhouse gas emissions from employee travel. All of these activities are related to production, albeit indirectly, since these activities occur in order to support production. Therefore, the most appropriate basis of normalization is total production levels (i.e., total mass, volume, or units of product produced). However, a facility may qualitatively describe the influence of non-production activities on progress towards its environmental performance commitments.

For example, a textile manufacturing facility commits to reducing its water use facility-wide. The facility uses water in its production lines, to water the lawn on its property, and for employee bathrooms and kitchens. Since all activities at the facility indirectly support production, the most appropriate basis of normalization is total production levels. No specialized production index is warranted. The facility may make progress on its environmental commitment by conserving water in any area of the facility, e.g., by reducing water use in production lines, installing low-flow fixtures in employee bathrooms, and/or substituting drought resistant plants for a lawn in the facility's landscaping. If water use increases in one area and decreases in another, the facility can describe these influences qualitatively in the space below the performance commitment table.

Example 6: Changes in Product Quality Affect Environmental Performance

An electronics manufacturer commits to reducing hazardous materials used in its production process. The facility implements several eco-efficiency programs within its production lines to reduce hazardous material components, however changes in product design and product quality (e.g., trends towards smaller, more sophisticated electronic components) have an even greater influence on the type of materials required for production. In light of this fact, the facility incorporates environmental considerations into the early stages of product design, in order to ensure that changes in product design enhance, rather than detract from, progress towards environmental performance commitments. The facility's basis of normalization is still total units produced (without regard for change in product sophistication), however the facility *qualitatively* describes changes in product quality and its influence on environmental performance in the narrative following its performance commitment table.

Example 7: Environmental commitment does not pertain to all production lines

If an environmental commitment pertains only to some production lines, but not others, the basis of normalization should be the total amount of production for production lines relevant to the environmental commitment. For example, an electroplater has two production lines, a chrome-plating line and a nickel-plating line. The manufacturer commits to reducing use of chromium, a toxic, bio-accumulative metal used in chrome plating. In this case, the nickel plating line does not contribute toward the environmental indicator being reported. Therefore, the electroplater uses only production from the chrome-plating line as the basis for normalization for this environmental performance commitment.

	Baseline Year	**Year 1**	**Year 2**	**Year 3**
Production Level (in tons)				
Nickel Plating Line	3,000	4,000	5,000	6,000
Chrome Plating Line	4,000	4,500	6,000	6,500
Total	7,000	8,500	11,000	12,500
Normalizing factor ***Based solely on chrome plating line***	4,000 ÷ 4,000 = 1	4,500 ÷ 4,000 = 1.125	6,000 ÷ 4,000 = 1.5	6,500 ÷ 4,000 = 1.625

The facility fills in the performance commitment table as follows:

Category: Material Use					
Indicator: Hazardous Materials Used (Hexavelent Chromium and Compounds)					
	Baseline (as stated in your application)	**Year 1**	**Year 2**	**Year 3**	**Performance Commitment (the goal stated in your application)**
Calendar Year	2000	2001	2002	2003	
Actual Quantity (per year)	2,000,000	800,000	300,000	15,000	
Measurement Units	Pounds of Hexavalent Chromium and Compounds Used				
Normalizing Factor	1	1.125	1.5	1.625	
Basis for Normalizing Factor	Production: Square Feet of Products Plated from the Chromium Plating Line				
Normalized Quantity (per year)	2,000,000	711,111	200,000	9,231	20,000
Briefly describe how you achieved improvements for this indicator or, if relevant, any circumstances that delayed progress: Decreased chromium use through substitution of trivalent chromium for hexavalent chromium. Trivalent chromium is less toxic and has 20 times the life of hexavalent chromium.					

Normalizing at non-manufacturing, government, or service facilities

For facilities primarily engaged in retail trade, professional services, or any other non-manufacturing activities, defining production can be difficult. Fortunately, in most cases, number of employees provides a good proxy for output levels. Even though employment may not immediately rise or fall with changes in output, it is a relatively good indicator. However, service facilities may also choose other bases of normalization, so long as they are logically (if indirectly) linked to production, and so long as they are facility-wide (to correspond with facility-wide commitments). The following table lists sample bases of normalization in a number of different non-manufacturing sectors. If dollar value of sales is used as a basis of normalization, all dollar values should be adjusted for inflation (see Appendix 2 for instructions.)

TABLE 1: Example Bases Of Normalization For Non-Manufacturing Facilities

Sector	Bases of Normalization
Public Facilities and Institutions, Research Organizations	Number of employees, number of work hours
Post Office	Volume of mail processed
Cleaners	Pounds of clothes cleaned
Hotels	Lodging room nights
Hospitals	Number of hospital beds
Retail	Number of employees, square feet of retail space, or volume of sales (adjusted for inflation)
Energy	Total energy production (Btu, mmBtu, KwH, or MwH)
Fuel oil delivery	Gallons of oil sold
Utilities, Sanitary Services	Number of households served

Example 8 demonstrates how a non-manufacturing facility can normalize its performance data.

Example 8: Normalizing at a Service Facility

A government research office commits to reducing transportation energy through an employee commuter carpool program. The commitment is to reduce transportation energy use from a total of 60,000 gallons of gas used for employee commuting each year to 50,000 gallons of gas, based on current levels of "output," where output is defined as research activity at the facility. Thus, this commitment is made on a normalized basis. Number of employees serves as a proxy indicator for output. The facility has the following employment levels over a four-year period:

	Baseline Year	Year 1	Year 2	Year 3
Number of Full Time Employee Equivalents	300	315	325	360

For each year, the facility divides the employment in that year by employment in the baseline year to determine the normalizing factor:

	Baseline Year	Year 1	Year 2	Year 3
Normalizing factor (Measures in number of Full Time Employee Equivalents)	300 ÷ 300 = 1	315 ÷ 300 = 1.05	325 ÷ 300 = 1.08	360 ÷ 300 = 1.2
Actual Quantity (measured in gallons of gas used for employee commuting per year)	60,000	62,000	68,000	75,000
Normalized Quantity (per year)	60,000 ÷ 1 = 60,000	62,000 ÷ 1.05 = 59,048	68,000 ÷ 1.08 = 62,963	75,000 ÷ 1.6 = 46,875

Therefore, the facility fills in the performance commitment table as follows:

Category: Energy Use					
Indicator: Transportation Energy Use					
	Baseline (as stated in your application)	**Year 1**	**Year 2**	**Year 3**	**Performance Commitment (the goal stated in your application)**
Calendar Year	2000	2001	2002	2003	
Actual Quantity (per year)	60,000	62,000	68,000	75,000	
Measurement Units	Gallons of gas used for employee commuting				
Normalizing Factor*	1	1.05	1.08	1.2	
Basis for Normalizing Factor	Number of full time employee equivalents (FTEs)				
Normalized Quantity (per year)	60,000	59,048	62,963	46,875	50,000

* Calculated above. Facilities do not report calculations for determining the normalizing factor to Performance Track.

Despite an increasing number of employees (indicating increased production) the facility decreased the amount of gasoline used for employee commuting on a normalized basis and met its performance commitment.

Mixed use facilities with manufacturing and service components

In some cases, facilities may include both a manufacturing and service component. For example, a computer manufacturer produces electronic components and also has a management consulting business onsite. In general, a manufacturer's administrative offices, employee cafeteria, or other on-site services that support manufacturing operations should not be distinguished as separate services. However, if a facility produces both a manufactured product and a service that generates independent revenue streams, they can be accounted for separately in the normalization process. Otherwise, select a basis of normalization for the type of operation that produces revenue (manufacturing or service).

If a facility does include both a manufacturing and service component, it can create a normalizing factor based on a weighted production index of the two activities. For example, to calculate a normalizing factor for a commitment to reduce solid waste from manufacturing and service operations, a facility would use the following equation:

$$\text{Normalizing Factor} = \left\{ \left(\frac{\text{Solid waste from manufacturing in current year}}{\text{Total solid waste in current year}} \right) * \left(\frac{\text{Manufacturing production in current year}}{\text{Manufacturing production in baseline year}} \right) \right\} +$$

$$\left\{ \left(\frac{\text{Solid waste from service in current year}}{\text{Total solid waste in current year}} \right) * \left(\frac{\text{Service employees in current year}}{\text{Service employees in baseline year}} \right) \right\}$$

Example 9 illustrates this situation in more detail. Example 10 demonstrates what to do if a service operation at a facility, such as research and development, both supports manufacturing at the facility and also generates its own revenue stream by selling its services to other companies. In either situation, if the facility does not have enough information to distinguish contributions to the environmental indicator from the service versus manufacturing sides of the operation, it can simply use total production, or total number of employees, as the basis of normalization.

Example 9: Normalizing for a Mixed Use Facility

A pharmaceutical facility manufactures prescription drugs and also maintains a research laboratory that provides R&D services solely to outside clients (thus producing a separate revenue stream). The facility makes a commitment to reduce solid waste facility-wide. The facility develops a weighted production index using the equation described in this document. For example, for 2001, the facility calculates the following weighted normalizing factor:

$$\text{Normalizing Factor} = \left\{ \left(\frac{\text{100 tons solid waste from manufacturing in 2001}}{\text{150 tons total solid waste in 2001}} \right) * \left(\frac{\text{5,000 tons manufacturing production in 2001}}{\text{4,500 tons manufacturing production in 2000}} \right) \right\} +$$

$$\left\{ \left(\frac{\text{50 tons solid waste from R\&D in 2001}}{\text{150 tons total solid waste in 2001}} \right) * \left(\frac{\text{55 R\&D employees in 2001}}{\text{50 R\&D employees in 2000}} \right) \right\} = 1.11$$

The facility would go through a similar process for each year in which performance data is being reported, and would then fill out the performance commitment table using the weighted normalizing factor calculated for each year, as shown below:

Category: Waste					
Indicator: Total Solid Waste					
	Baseline (as stated in your application)	**Year 1**	**Year 2**	**Year 3**	**Performance Commitment (the goal stated in your application)**
Calendar Year	2000	2001	2002	2003	
Actual Quantity (per year)	180	150	140	130	
Measurement Units	Tons of solid waste				
Normalizing Factor	1	1.11	1.2	1.4	
Basis for Normalizing Factor	Weighted index of production and employment				
Normalized Quantity (per year)	180	135	117	93	100

Alternatively, if the facility does not have enough data to separate waste from R&D vs. manufacturing, the facility can simply use total production levels as the basis of normalization as shown in Example 2, or total number of employees as a basis for normalization as shown in Example 8.

Example 10: Normalizing for a Mixed Use Facility, where R&D Supports Production and also Provides a Separate Revenue Stream

A pharmaceutical facility manufactures prescription drugs and also maintains a research laboratory that provides R&D services both to the facility's own manufacturing processes and to outside clients. The facility makes a commitment to reduce solid waste facility-wide. The facility develops a weighted production index using the equation described in this document. For example, for 2001, the facility calculates the following weighted normalizing factor:

$$\text{Normalizing Factor} = \left\{ \left(\frac{\text{100 tons solid waste from manufacturing and supporting R\&D in 2001}}{\text{142 tons total solid waste in 2001}} \right) * \left(\frac{\text{5,000 tons manufacturing production in 2001}}{\text{4,500 tons manufacturing production in 2000}} \right) \right\} + \left\{ \left(\frac{\text{42 tons solid waste from R\&D for outside clients in 2001}}{\text{142 tons total solid waste in 2001}} \right) * \left(\frac{\text{44 R\&D employees working for outside clients in 2001}}{\text{40 R\&D employees working for outside clients in 2000}} \right) \right\} = 1.11$$

The facility would go through a similar process for each year in which performance data is being reported, and would then fill out the performance commitment table using the weighted normalizing factor calculated for each year, as shown in Example 9.

If the facility does not have sufficient information to separate waste from R&D services supporting the facility's own manufacturing vs. outside services, the facility can use the equation for developing a normalizing factor shown in Example 9. Alternatively, if the facility chooses, it can decide not to develop a weighted normalizing factor, and can simply use total production levels as the basis of normalization as shown in Example 2, or total number of employees as a basis for normalization as shown in Example 8.

Appendix 1: Adjusting Energy Use for Heating Degree Days and Cooling Degree Days

Energy savings resulting from your facility's commitment to reduce energy use can be determined by comparing energy use before and after implementing energy savings programs. Mathematically, this is expressed as:

(1) Energy savings = Baseline energy use – Post-retrofit energy use ± Adjustments[3]

Or

(2) Post-retrofit energy use ± Adjustments = Baseline energy use – Savings

The "adjustment" term in the above equation is used to align energy use in the two time periods to the same set of conditions. Conditions that may affect energy use include weather, building occupancy, and facility production level. These adjustments may be positive or negative.

Methods for "adjusting" or normalizing energy use data for changes in production level or building occupancy (e.g., number of employees) are presented in earlier sections of this guidance document. Thus, this appendix focuses on the approach for adjusting energy use data when an additional factor – weather – also impacts energy use. This adjustment may be more relevant for non-manufacturing facilities where energy used for heating and cooling represents a large portion of the facility's total energy use – 49% of commercial building energy use is for space heating and cooling, while energy use for space heating and cooling in manufacturing facilities represents 3% of total energy use. The US Department of Energy's Energy Information Administration publishes reports providing end-use energy statistics for various types of commercial establishments and manufacturing industries.[4] These statistics can help you gauge whether energy use for heating and cooling are likely to be a small or large percent of your facility's total energy use.

A facility's energy use can be adjusted for changes in weather via Heating Degree Days (HDD) and Cooling Degree Days (CDD). HDD and CDD were initially developed by engineers as a way to relate each day's temperature to the demand for fuel to heat and cool buildings. HDD are the cumulative number of degrees in a month or year by which the mean temperature falls below 65°F, while CDD are the cumulative number of degrees in a month or year by which the mean temperature is above 65°F.

HDD are calculated for days with an average temperature less than 65°F by subtracting the average temperature for a day from 65°F, and then summing this calculation on a monthly or yearly basis. CDD are calculated in the same way for temperatures above 65 degrees. Thus, the

[3] This equation and description is borrowed from *International Performance Measurement & Verification Protocol: Concepts and Options for Determining Energy and Water Savings, Vol. 1*, IPMVP, March 2002 www.epmvp.org

[4] End use energy consumption information for commercial and industrial sectors is available from the US Department of Energy, Energy Information Administration, http://www.eia.doe.gov.

higher the number of HDD and CDD, the more heating and cooling energy is required to maintain a comfortable indoor temperature.

Standard reports of HDD and CDD for specific geographic regions are available from the National Weather Service at http://www.ncdc.noaa.gov/oa/documentlibrary/hcs/hcs.html. Additional information for HDD and CDD in specific locations may be available at http://www.wrh.noaa.gov/wrhq/nwspage.html.

Adjusting energy use for HDD and CDD requires the following steps:

1. First, you must ascertain whether there is a statistically significant relationship between energy use and HDD/CDD. This is done via regression analysis, using baseline energy use data (i.e., energy use before your facility implemented its energy use reduction commitments) and weather data. Depending upon other factors affecting your facility's energy use, the regression analysis may also consider other variables such as occupancy and production.

   There are many software tools to assist you with this step. Standard software tools such as *Excel* contain statistical analysis capabilities required for regression analyses. The Resources section at the end of this appendix provides links to some additional tools specifically developed for analyzing energy use and savings. In general, at least 12 months of baseline energy use data are needed for assessing the statistical relationship between energy use and weather.

2. If there is a statistically significant relationship between energy use and HDD/CDD, the equation representing the best fit regression model can be used to calculate the *expected energy use* for the current reporting year if the energy use reduction commitments were not implemented (i.e., the expected energy use for the current reporting year where weather and production are the only variations). The difference between the *expected energy use* and the *baseline energy use* represents the *adjustment* needed to bring the base year energy use to the conditions of the current year (i.e., baseline weather and production conditions versus current year weather and production conditions). You would report your normalized energy use by subtracting the *adjustment* for weather and production from the current reporting year energy use.

The following example further illustrates this approach.[5]

[5] This example assumes you are familiar with statistical techniques such as regression analysis.

Example 11: Energy use is affected by changes in weather

A hotel has committed to reducing its total energy use while also adding an additional wing to its building. Baseline and Year 1 data are presented below:

	Baseline Year	Year 1
Actual Quantity (MMBtu)	12,530	12,920
Total Lodging Room Nights	124,000	144,000
HDD	220	375
CDD	80	165

The hotel's energy use increased between the baseline year and Year 1. However, at the same time, the hotel's occupancy rate (as measured by lodging room nights) increased. Compared to the baseline, there were also more heating degree days and cooling degree days in Year 1.

To assess whether both changes in occupancy rate and weather affected total energy use in Year 1, a regression analysis was conducted using occupancy rate, HDD, and CDD as the independent variables. Results of the regression analysis, based on 12 months of data for the baseline year, yielded the following equation:

Monthly energy use = 973 + (0.9 * HDD) + (3.1 * CDD) + (0.03 * Monthly lodging room nights)

Where HDD = monthly heating degree days

CDD = monthly cooling degree days

This equation predicts the expected monthly energy use in Year 1 *assuming the relationship between weather, occupancy conditions, and energy use in Year 1 are the same as the baseline year*. The baseline energy use and results from applying the equation are below:

		Year 1				
Month	**Baseline monthly energy use**	**HDD**	**CDD**	**Lodging room nights**	**Expected monthly energy use**	**Actual monthly energy use**
1	1,100	0	60	12,000	1,517	1,140
2	1,090	0	60	11,000	1,487	1,120
3	1,070	0	40	13,000	1,485	1,140
4	1,010	0	5	12,000	1,348	1,020
5	1,010	5	0	11,000	1,308	1,020
6	1,020	30	0	13,000	1,391	1,060
7	1,030	50	0	12,000	1,380	1,060
8	1,040	50	0	11,000	1,350	1,080
9	1,040	60	0	13,000	1,419	1,100
10	1,040	60	0	12,000	1,389	1,060
11	1,040	60	0	11,000	1,359	1,050
12	1,040	60	0	13,000	1,419	1,070
Total	12,530				16,850	12,920

Example 11, Continued…

The expected monthly energy use column calculates the quantity of energy used per month ***if*** weather and occupancy conditions were the only difference between the Baseline Year and Year 1 (i.e., no energy conservation measures were implemented). Thus, any differences between the expected and actual baseline energy use represents the adjustment needed to bring the base year energy use to the conditions of the current year (i.e., baseline weather and production conditions versus current year weather and production conditions). Energy savings and normalized quantity of energy use for Year 1 can be determined from Equations 1 and 2 as follows:

Total Energy Savings = Baseline Year Energy Use – Total Actual Energy Use Year 1 + Adjustment

Normalized Energy Use Year 1 = Total Actual Energy Use Year 1 – Adjustment

The hotel would complete the performance commitment table as follows:

Category: Energy Use					
Indicator: Total Energy Use by Fuel Type					
	Baseline (as stated in your application)	**Year 1**	**Year 2**	**Year 3**	**Performance Commitment (the goal stated in your application)**
Calendar Year	2000	2001	2002	2003	
Actual Quantity (per year)	12,530	12,920			
Measurement Units	MMBtu				
Normalizing Factor					
Basis for Normalizing Factor	Regression analysis based on 12 months baseline energy use data, HDD, CDD and lodging room nights.				
Normalized Quantity (per year)	12,530	8,760			8,000

Resources

There are numerous software tools and other resources to assist you in these calculations. Resources include:

The *M&V Guidelines: Measurement and Verification for Federal Energy Management Projects*, published by the Federal Energy Management Program (FEMP). The *M&V Guidelines* provide Federal energy managers, procurement officials, and energy service providers with standard procedures and guidelines for quantifying savings and can be downloaded at http://www.eere.energy.gov/femp/financing/espc/measguide.html.

International Performance and Measurement Verification protocol (IPMVP), which like the above reference, provides protocols and procedures for quantifying energy use savings. http://www.ipmvp.org/products_services.html

Weather Normalized Building Energy Performance Reporting is a spreadsheet tool that assesses energy savings after controlling for weather variations. The software can be downloaded at http://www.pnl.gov/conserve-energy/wnpr/

Etracker, a software tool developed by University of Dayton, adjusts building energy use for changes in weather. This tool can be downloaded at http://www.engr.udayton.edu/weather/.

US Department of Energy's website provides a listing of over 200 energy-related software tools http://www.eere.energy.gov/buildings/tools_directory/

Metrix Utility Accounting System is an example of a software tool you can purchase to assist you in tracking your facility's energy use and savings. A free, time-limited evaluation copy of Metrix can be downloaded from http://www.abraxasenergy.com/metrix.php.

Appendix 2: Adjusting Dollar Values for Inflation

In some cases, service facilities may choose a basis for normalization that is expressed in dollar terms (e.g., value of sales). In this case, it is very important to adjust dollar values over time to account for inflation, so that inflation does not distort analysis of production trends. In other words, all dollar figures should be expressed in terms of real (rather than nominal) dollars using the value of money in the baseline year. Be sure to adjust dollar figures for inflation *before* calculating your normalizing factor. The dollar figures are just an input into calculating the normalizing factor, and should not be reported to Performance Track.

There are a number of possible indices that can be used to adjust for inflation. For businesses, the Producer Price Index (PPI) series is generally the most appropriate index to adjust for inflation, since the PPI measures the average change over time in the selling prices received by domestic producers for their output. A primary use of the PPI is to deflate revenue streams in order to measure real growth in output. Industry specific PPIs are available for 500 industries, based on 4-digit SIC codes. PPI values can be found at the U.S. Department of Labor's Bureau of Labor Statistics website, at http://www.bls.gov/ppi/home.htm#data.

To adjust dollar figures for inflation using the PPI, complete the following steps:

Step	**Calculation**
1. Identify the PPI for your baseline year. For example, if your manufacturing facility is reporting performance commitments compared to a baseline year of 1999, you could select the total manufacturing industries PPI for 1999, which is 128.3.	PPI for 1999 (baseline year) = 128.3
2. Divide the PPI index for the current reporting year by the PPI index for your baseline year chosen in step 1. For example, if you were reporting progress on your commitments in 2002, you would select the PPI value for 2002 from the same PPI index you used in step 1 (in this case, total manufacturing industries).	2002 CPI = 133.7 133.7 / 128.3 = 1.04
3. Divide the current (or nominal) dollar amount for the given year by the result from step 2. This is the real dollar amount expressed in baseline year dollars. For example, if you were adjusting the current dollar value of sales for 2002 into baseline year dollars, you would divide 2002 sales by 1.04 to get the value of sales in 1999 dollars.	2002 dollar value = $10 million $10,000,000 / 1.04 = $9,615,385 (in 1999 dollars) Sales of $10 million in 2002 dollars would be equivalent to sales of $9.6 million in 1999 dollars.

Keep in mind that this process of adjusting values for inflation is only necessary when the basis of normalization is expressed in dollar terms, which is only recommended for service facilities. Manufacturing facilities should express production in volume, mass, or unit terms.