Steps to Develop a Baseline:

A Guide to Developing an Energy Use and Energy Intensity Baseline and the Reporting Requirements for the *Save Energy Now* LEADER Pledge

Developing an energy use and energy intensity baseline is a valuable way to get started with energy management. Baselines create a benchmark for comparing energy performance from year to year.

How to get started:

A simple six-step process for developing an energy use and energy intensity baseline is outlined in Figure 1. Companies can adapt this process to their operations, or they may choose to use a more rigorous methodology. DOE will provide assistance to companies with questions about the baseline process for their operations.

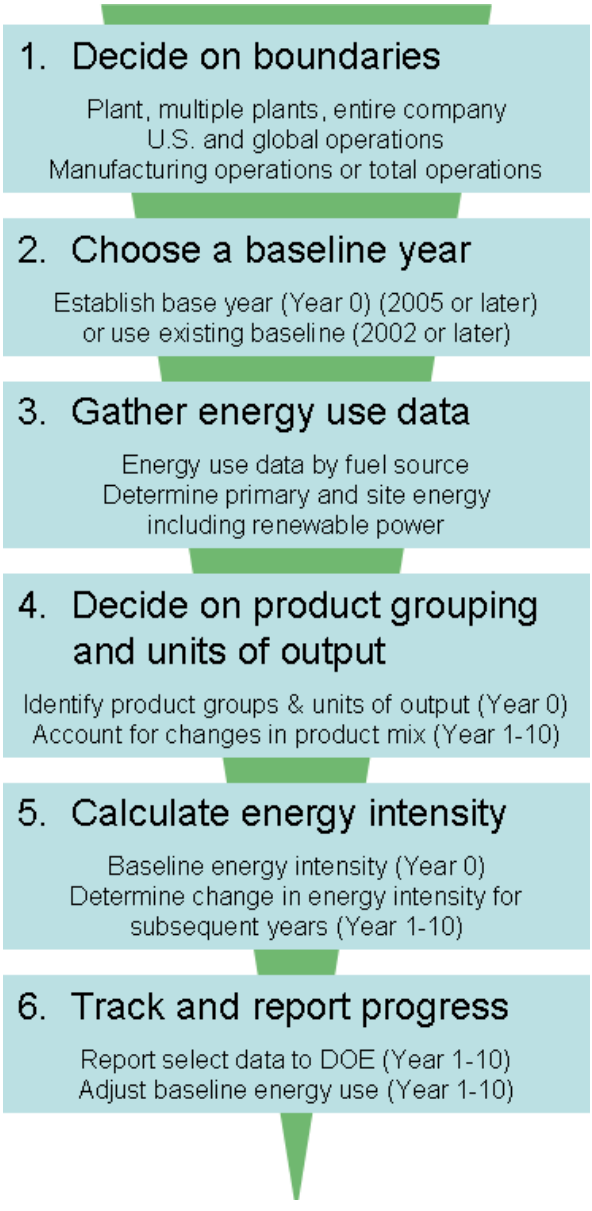
Baselining is the act of measuring energy use and energy intensity at a determined level of detail for the purpose of establishing a benchmark for future comparison to itself.

Energy intensity is defined here as the energy used per unit of output.

DOE has additional information and resources to help companies develop a baseline and report data to DOE for the Pledge. For example:

- **Pledge FAQ** – answers to the frequently asked questions about the Pledge
- **Pledge Agreement Form** – the form companies sign when making a Pledge
- **Pledge Annual Reporting Form** – spreadsheet companies submit to DOE each year during the Pledge period (Year 1-10)
- **Quick Plant Energy Profiler** (Quick PEP) – software tool to help companies profile energy use and potential cost savings in about one hour
- **Energy Intensity Assessment Matrix** – spreadsheet to help companies track energy intensity by product group and calculate the change in energy intensity compared to the base year (This is also included in the Quick PEP)

Figure 1. Steps in Setting a Baseline



Guidance for Companies who become *Save Energy Now* LEADERs

The Steps outlined in this document are tailored to help *Save Energy Now* LEADERs with their Pledge reporting requirements. The Pledge is focused on reducing the energy intensity of manufacturing and industrial operations (i.e., "end-use" technology and energy systems) and the carbon emissions related to energy use. The methods provided here are widely applicable so any company or plant may find these Steps useful in developing a baseline. Specifically, this document guides program participants with the following requirements:

In the base year (Year 0), companies are asked to establish energy use and energy intensity baselines, develop an energy management plan, and designate an energy leader or energy manager. Companies make a Pledge but there are no reporting requirements (See the Pledge Agreement Form and the Pledge FAQs).

In Year 1-10 of the Pledge period, report the following annually to DOE:

- ***Primary energy use by fuel type.*** Report the estimated amount of electricity, natural gas, oil, and other fuel types used each year. Energy losses during electricity generation, transmission, and distribution are included in the electricity estimates (see Step 3). The reported energy use data will enable DOE to estimate net reductions in energy use (Btus) and CO_2 emissions (tons) for Pledge program participants in aggregate. Pledge participants do not need to report CO_2 emissions; DOE will estimate CO_2 emissions based on reported energy use by fuel.

- ***Adjustments to the baseline energy use***. Modify the energy use baseline if the company undergoes significant changes impacting energy consumption (see Step 6).

- ***Change in energy intensity.*** For each Pledge year, compare the current year to the baseline year, and report the change in energy intensity (See Step 5). Energy intensities are based on primary energy use.

- ***Number of plants***. Report the number of plants participating within the boundaries of the Pledge entity. This should be updated annually (see Step 6).

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Step 1: Decide on boundaries

A baseline covers a carefully defined set of operations and activities which may span separate geographic locations. Defining the boundaries will establish "what is in and what is out."

Boundaries of a Pledging Entity

Includes:

- Industrial operations
- Building facilities and non-manufacturing energy use (optional)
- Onsite renewable power or energy recovery efforts such as combined heat and power (CHP) (optional)

Does not include:

- Purchased renewable energy credits (RECs)

For the Save Energy Now LEADER Pledge, the boundaries can be an entire company, part of a company, or an individual plant. The boundaries may include a part of or an entire global enterprise. However, U.S. energy data must be determined and reported separately from non-U.S. data. The entity establishing the baseline must be in financial or operational control of the operations and activities within the defined boundaries; activities outside the entity's control (e.g., suppliers, product distributors) should not be included. In this document, the term "company" and "pledging entity" refer to any organization, business unit, plant, etc. that is developing a baseline.

Step 2: Choose a baseline year

Companies are encouraged to choose as a baseline year the most recent year for which they have reliable data. To facilitate comparison, the baseline year must be fixed during the Pledge period. Companies without an existing baseline must establish a baseline for 2005 or later. DOE will recognize a company's previously determined energy intensity baseline for as early as 2002.

Step 3: Gather energy data

Companies need to gather their energy records for the base year selected. The energy records must include a breakdown of the energy used by type (e.g., electricity, natural gas, oil, coal). Energy use within the boundary may include manufacturing and industrial operations as well as non-manufacturing energy use (e.g., energy consumed in office buildings). These energy data are needed to calculate the energy use baseline. The **Pledge Annual Reporting Form** shows all the types of energy that will be tracked. The reported energy use data will enable DOE to calculate CO_2 emissions avoided for all participants in aggregate.[1]

Step 3 has Three Parts:

a) Determine the amount of fuel purchased by type
b) Determine the net electricity purchased
c) Calculate the amount of primary energy consumed

[1] DOE will estimate CO_2 emissions from energy use; non-energy CO_2 emissions are not included

This Step explains how energy data are used in determining what is included in an energy intensity calculation for purposes of Pledge reporting, and it explains how to convert electricity to primary energy. Such data are collected for different product groups. A product group is a collection of products that have similar energy intensities (i.e., energy use per unit of output) and similar units of output (e.g., tons of rolled steel, standard cubic feet of hydrogen, etc.). Within the boundary of the pledging entity, a company will need to consider whether energy use data are available for each product group and identify appropriate units of output – as described in Step 4. Step 4 also provides an explanation of the importance of grouping products in order to develop an energy intensity baseline that is more useful for energy management.

Useful Tool to Help Track Energy Use

The ***Quick Plant Energy Profiler*** (also called Quick PEP) can help industrial plant managers complete a plant profile in about an hour. Quick PEP is an online software tool provided by the U.S. Department of Energy that helps identify how energy is purchased and consumed at a plant. It can also identify potential energy and cost savings. The Energy Intensity Assessment Matrix, discussed below, is part of Quick PEP.
http://www.eere.energy.gov/industry/bestpractices/quickpep_tool.html

The energy data reported to DOE must be entered in terms of *primary* energy as specified in Section 106 of the Energy Policy Act of 2005. Primary energy accounting assures that the total energy required to generate, transmit, and distribute electricity offsite (i.e., before it reaches the plant gate) is considered in a company's total energy use estimate. Due to inefficiencies throughout this system, useful energy is "lost" along the path to the end-user. To simplify the conversion of electricity use to primary energy, companies may multiply the electricity purchased from the grid by a factor of three regardless of the source and location (i.e., multiplying electricity use by three accounts for generation, transmission, and distribution losses). A company may use more sophisticated methods for converting site electricity into primary energy, such as those incorporating temporal or geographic-specific conversion factors. Appendix A provides examples of electricity conversions.

Other adjustments to the energy accounts may be needed to develop a sound baseline. Energy accounting for the Pledge regarding feedstock energy use, cogeneration, onsite electricity generation, and renewables are explained below. Appendix B provides an example of how to determine net electricity use and calculate primary energy consumption.

> ***Feedstock energy use*** – Some industries use energy as raw material inputs (i.e., a feedstock) for their products. For example, chemical facilities convert natural gas into ammonia, methanol, and many other products. For the Pledge, feedstock energy should be excluded from the energy use data. However, byproducts from feedstock energy that are used as a fuel source should be included in the energy use data. Feedstock energy use is excluded so that DOE can approximate CO_2 emissions savings from the reported energy data.
>
> ***Cogeneration*** – Cogeneration is the production of electricity and a form of useful thermal energy (such as heat or steam) used for industrial, commercial, heating, or

cooling purposes.[2] A common application of cogeneration is the reuse of byproduct heat for electricity generation or for heating nearby operations. Electricity purchased 'over-the-fence' from a neighboring facility's cogeneration operations has a lower primary energy multiplier and fewer CO_2 emissions compared to electricity purchased from the grid. If a company consumes a significant amount of cogenerated electricity from a facility outside of its Pledge boundaries, it may choose to account for this fuel source separate from other purchased electricity. Companies may use a primary energy multiplier of 2 (instead of 3) for purchased cogenerated electricity.

Onsite electricity generation – Electricity generated onsite from waste heat, reuse energy, and other sources may be used at the plant site or sold offsite. Onsite generated electricity is accounted for by using data for 'net electricity purchases' since less electricity is purchased from offsite (due to electricity generated at the plant). Net electricity purchased is the amount purchased less the amount sold. Appendix B provides an example.

Renewable energy – *Renewable energy purchases from <u>offsite</u>* sources are not considered a reduction in net electricity consumption. For example, if a company purchases "green power" or Renewable Energy Credits (RECs), this does *not* affect the baseline energy use or energy intensity baselines. Companies do not need to report renewable energy purchased offsite to DOE.

Renewable energy generated <u>onsite</u> is treated the same as onsite electricity generation (described above.) If renewable energy is generated *onsite*, the amount of purchased energy is reduced, thus reducing a company's net energy purchases. Companies do not need to report onsite renewable energy generated to DOE.

The baseline energy use may need to be adjusted in subsequent years if the company undergoes major changes or if the methodology for calculating energy use changes during the reporting period (see Step 6 for details).

Step 4: Decide on product grouping and units of output

As mentioned in the previous Step, a product group is a collection of diverse products that have similar energy intensities (energy use per unit of output) and similar units of output (e.g., tons of rolled steel, standard cubic feet of hydrogen, etc.). Energy use data should be collected at a practical and cost-effective level of detail. If the energy intensities *or* units of output among products in a product group are significantly different, then energy use data should be collected separately, if possible. If energy use data are available only at an aggregated level (i.e., for all products combined), then the company may elect to manually allocate the energy use data to product groups or subgroups. Alternatively, the company may elect to combine all products into a single

[2] Definition of cogeneration from Department of Energy, Energy Information Administration. http://www.eia.doe.gov/glossary/

group. Appendix C provides several examples illustrating grouping products and selecting appropriate units of output.

Separating Products into Groups

Separating products into more than one group is appropriate for companies that manufacture products with a wide range of energy intensities or that need more than one unit of output to represent all their operations. Product grouping (also known as segmentation) is important for several reasons. Estimates of the change in energy intensity may be more accurate and valuable for energy management if energy data are segmented among many product groups rather than aggregated. Also, segmentation allows companies to account for changing product mixes in their energy intensity estimates. Changing product mixes between the baseline year and subsequent reporting years can result in a change in energy intensity, even if the energy use per product does not change. DOE would prefer companies to measure energy intensity changes not due to product mix shifts, but rather due to efforts such as increased manufacturing efficiency or new equipment. Segmentation among multiple product groups allows companies to account for such product mix changes. Appendix E provides an example of the how to account for changes in the product mix.

Spreadsheet Calculates the Change in Energy Intensity Compared to the Base Year

The **Energy Intensity Assessment Matrix** is a spreadsheet to help companies organize and track data for multiple product groups, calculate the change in energy intensity for each group, and calculate one overall change in energy intensity for the Pledge entity, which is needed for external reporting to DOE. The worksheet itself is for internal use and is not provided to DOE. Approaches for calculating an overall change in energy intensity are discussed in Step 5. The Matrix is also included in the Quick PEP tool.

Selecting Units of Output

The units of output selected should make sense for a company's business operations and be relevant to its energy management needs. Industrial businesses are diverse and face variable circumstances so companies need flexibility in selecting the units of output appropriate for their operations. DOE encourages companies to select units of output that adhere to the EPAct 2005 definition for energy intensity: *primary energy consumed for each unit of physical output in an industrial process*. Example units of output include:

- Number of products (e.g., cars, wafers, cans of paint)
- Mass of products (e.g., tons of steel, lbs of cereal)
- Size or volume of products (e.g., sq ft of plywood, cubic ft of nitrogen)
- Functionality (e.g., MHz processing capability, bytes of data storage)

Alternatively, companies may elect to use a financial unit of output (e.g., revenues, value of shipments, value added) for Pledge reporting. Some companies find that these units are convenient for aggregating or comparing across different products. Energy intensity measured with financial units (e.g., lbs of cereal per value of shipment) will vary as prices change, so companies using this type of output unit should normalize their figures based on an economic deflator or price index.

Allocating non-manufacturing energy use
Non-manufacturing energy use is optional in the energy intensity calculations. It may be allocated to different product groups using a consistent method from year to year.

Step 5: Calculate energy intensity

Energy intensity is broadly defined as the amount of energy use per unit of output. 'Energy use' was discussed in Step 3 and 'units of output' was explained in Step 4. This Step focuses on methods for combining these two terms to create an energy intensity baseline and for calculating a comparison of the baseline to energy use in subsequent years. This comparison is done as an "overall change" in energy intensity compared to the baseline for subsequent years within the Pledge boundaries.

Energy intensity can be tracked for each product group (or an aggregate of groups) to determine the baseline (Year 0). Subsequently, data can be tracked from year to year (Years 1-10) and can be compared directly to the data from the baseline year (Year 0). This is a useful procedure for energy management purposes.

For the Pledge, companies are asked to report one number – the *overall change* in energy intensity – for all the activities within the boundaries of the Pledge entity for Years 1-10. To calculate overall change in energy intensity, determine the energy use that would have been used in the current year if the energy intensity did not change compared to the baseline year. The current year's energy use using the energy intensity of the baseline year is called the 'business-as-usual energy use in the current year.' The overall change in energy intensity is calculated by comparing the actual energy use in the current year to the 'business-as-usual energy use in the current year.' The 'business-as-usual energy use in the current year' is calculated by applying the energy intensity for each product group in the baseline year to the production quantity in the current year. The percentage difference between the current year's actual energy use and the 'business-as-usual energy use in the current year' is the *overall change* in energy intensity. Appendix D provides detailed examples to illustrate this method. Calculating a *change* in energy intensity is necessary because adding energy intensities of different product lines would be like adding apples and oranges.

There is not a 'one size fits all' methodology for calculating energy intensity. The methods that companies choose for calculating energy intensity are expected to be as varied as the industrial sector itself. DOE asks companies that make a Pledge to report the change in energy intensity for Year 1-10 using a *consistent* methodology. This will allow for meaningful comparisons of energy use and energy intensity over time. Companies are also encouraged to document any changes to the data, boundary, estimation methods, or any other relevant factors each year.

Appendix D describes the preferred method for calculating overall change in energy intensity. Companies that make a Pledge may select this method or they can use their own method for tracking energy use and calculating overall energy intensity. The calculated change in energy intensity will depend on the particular method used; different

methods may *not* give the same value. It is important that companies use the same methodology each year during the Pledge period.

The **Energy Intensity Assessment Matrix** is a spreadsheet available from DOE that will automatically calculate an overall change in energy intensity based on the energy data entered following the approach described in Appendix D.

Step 6: Track and report progress

Companies must track their energy use by fuel type as primary energy (described in Step 3), the number of plants participating within the boundaries of the Pledge entity, and the change in overall energy intensity (Step 5), and report this data annually to DOE using the **Pledge Annual Reporting Form**. The reported information should be as complete, accurate and consistent as possible from year to year.

Data Reporting Requirements

Save Energy Now LEADERs must annually report:

- Primary energy use by fuel type
- Adjustment to baseline energy use, if necessary
- Change in energy intensity based on primary energy use
- Number of participating plants

Companies do *not* need to report CO_2 emissions.

DOE will estimate cumulative energy savings for program participates in aggregate based on the data received in the reporting forms.

Adjustment to Baseline Energy Use

A company's cumulative energy savings is the difference between the total energy use for the Pledge year (Year 1 – 10) and the total energy use for the baseline year (Year 0). In order to meaningfully compare energy use to the baseline over time, companies undergoing major changes will need to make adjustments to the baseline energy use. Such changes can include mergers, acquisitions, divestments, and closures/openings of operating units. Changes in the calculation methodology, improvement in the data, or the discovery of errors can also trigger the need to adjust the baseline. Adjustments to baseline energy use may be made during Year 1-10 (not Year 0). Appendix F provides examples to illustrate how companies can calculate an adjustment to the baseline energy use to account for major changes in energy use beyond the baseline year (Year 0).

Acknowledgement of Sources

Core underlying concepts in the six Steps described in this document are based on standards and guidance developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) as published in the *GHG Protocol Corporate Accounting and Reporting Standard*, March 2004. The *GHG Corporate Standard* provides broadly accepted and trusted guidance for companies and other types of organizations preparing a GHG emissions inventory and covers many of the same principles that are necessary for developing an energy use and energy intensity baseline. While the *GHG Corporate Standard* provided invaluable direction for this document, several key components of the energy use and energy intensity baseline methodology that are presented here are outside the scope of the *GHG Corporate Standard*. The Department of Energy's Industrial Technologies Program is responsible for the content of this document and its application to the requirements for energy intensity baselining identified in the Section 106 of the Energy Policy Act of 2005.

Appendix A: Converting Site (End-use) Energy into Primary Energy

Guidance for Companies choosing to use Temporal or Geographic-specific Conversion Factors

Companies can follow the methods described below to convert end-use electricity consumption into primary energy, or they can simply use a multiplier of 3 each year.

Offsite energy losses from electricity vary each year, depending on the fuel mix used to generate the electricity. The Energy Information Administration provides historical data on the national fuel mix for electricity generation and forecasts the fuel mix for the next several years, resulting in the following offsite electricity multipliers.[3] Companies can use the multipliers shown in Table A.1 to convert their end-use electricity into primary energy.

Prefix convention
kBtu = 1,000 Btu
MMBtu = 1,000,000 Btu
BBtu = 1,000,000,000 Btu

Table A.1 ***Primary energy use multiplier for offsite electricity purchases***

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Multiplier	3.025	3.034	2.979	2.995	2.998	2.973	2.965	2.961	2.954	2.951

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
Multiplier	2.949	2.956	2.954	2.950	2.945	2.944	2.943	2.945	2.946

Example A.1. Using More Exact Conversion Factors to Calculate Primary Energy
Suppose a company's energy records show that they purchased 10 MWh in 2007 and the exact same amount, 10 MWh, in 2008 (and they did not sell any electricity or divert any offsite). The company could use the data in Table A.1 to convert their end-use electricity into primary electricity:

For 2007
10 MWh x (3.412 MMBtu / MWh) x 2.973 = **101.4 MMBtu electricity**

For 2008
10 MWh x (3.412 MMBtu / MWh) x 2.965 = **101.2 MMBtu electricity**

The heat content of a megawatthour (MWh) of electricity produced, regardless of the generation process, is 3.412 million Btu (MMBtu).

The primary energy conversion factors can also vary based on geographic location. For instance, some regions generate a significant portion of their electricity from nuclear

[3] Based on an analysis of Energy Information Administration data from Annual Energy Outlook 2008 and 2005, http://www.eia.doe.gov/oiaf/aeo/aeoref_tab.html, Tables 2, 8, and 10. For historical heat rates (Btu/kWh) of electricity generation by source, see EIA Monthly Energy Review, Appendix A, Table A6. *Approximate Heat Rates for Electricity, and Heat Content of Electricity*, http://www.eia.doe.gov/emeu/mer/pdf/pages/sec12_6.pdf

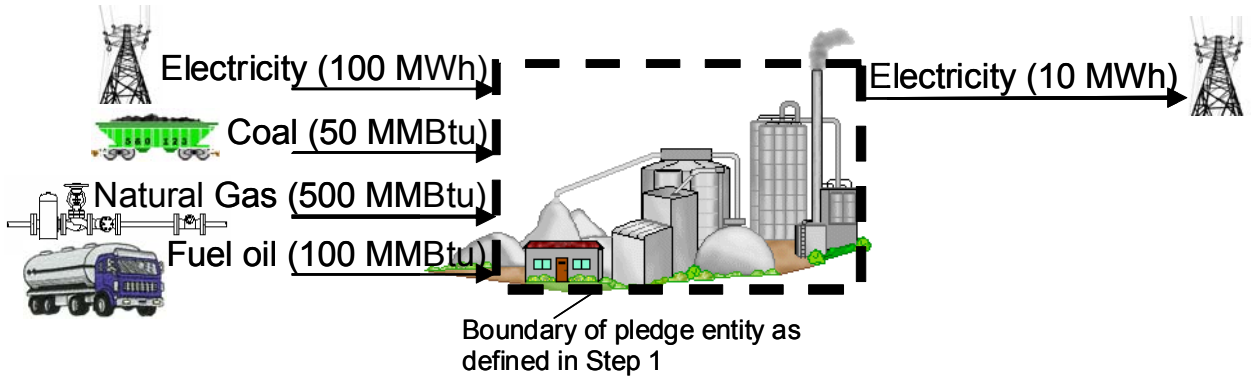
fission. According to the EIA, nuclear power plants have a slightly higher heat rate (amount of energy required to produce electricity) than typical fossil-fuel plants. Therefore, a region using more nuclear power in its fuel mix will have higher multipliers. There are many ways to define an electricity generation region (e.g., utility provider, Regional Transmission Organizations (RTO), states, NERC regions, etc.). Companies can choose any regional definition that is deemed appropriate given their geographic location(s). Geographic-specific multipliers can be estimated from publicly available sources such as The Emissions & Generation Resource Integrated Database (eGRID) (http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html). Again, companies are not required to account for geographic location and can use three as a simple multiplier for facilities located anywhere in the United States.

Appendix B: Net Electricity Use and Primary Energy Calculations

This appendix shows how to calculate net electricity use and convert end-use electricity into primary energy.

Example B.1 Calculating Energy Use for the Pledge Entity
A company has gathered their energy records for the base year and determined their fuel and electricity purchases and outflows, which are represented in Figure B.1. To determine total primary energy use, the company must A) Determine the amount of fuel purchased by type; B) Determine the net electricity purchased; and C) Calculate the amount of primary energy consumed.

Figure B.1. ***Energy use data for Sample Pledge Entity***



A. The ***amount of fuel purchased*** is provided in Figure B.1: 50 MMBtu coal, 500 MMBtu natural gas, 100 MMBtu fuel oil.

B. The ***net electricity purchased*** is the amount of electricity purchased less the amount of electricity sold: 100 MWh – 10 MWh = 90MWh.

C. The total ***primary energy consumed*** is net electricity from part B converted to Btus and multiplied by 3 [90 MWh x (3.412 MMBtu / MWh) x 3 = 921 MMBtu electricity] added to the amount of fuel purchased from A [50 MMBtu coal + 500 MMBtu natural gas + 100 MMBtu fuel oil].

The total primary energy consumed = 921 MMBtu electricity + 50 MMBtu coal + 500 MMBtu natural gas + 100 MMBtu fuel oil = **1,571 MMBtu**.

Appendix C: Illustrating Product Grouping and Units of Output for Baselining

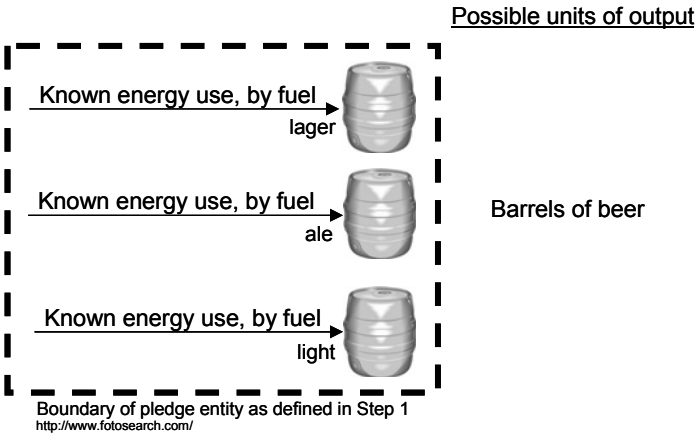
This appendix provides five examples of increasing complexity to show the importance of grouping products and selecting units of output for energy intensity calculations.

Consider a simple case of a company where the energy use does not vary depending on the type of product.

Example C.1 Company with products that can all be grouped together.

ABC Brewery makes several varieties of beer, and all varieties require approximately the same amount of energy to produce.

Since all products at the company use about the same amount of energy to produce, the company should treat its units of output as having one type of product. In this case, volume of product (e.g., barrels of beer) may be the most appropriate unit of output.

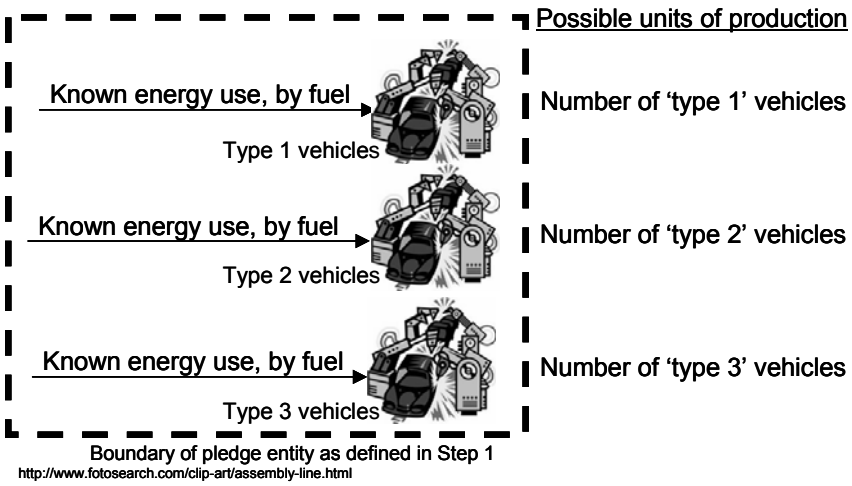


Example C.1 was a simple case with one unit of output. Many companies, however, will need more than one unit of output to represent all their operations. Energy intensity estimates may be more accurate and valuable for energy management if energy data are segmented among many product groups rather than aggregated. Companies will need to consider the complexity of their industrial operations and the availability of energy use data when deciding on the units of output for their operations. Examples C.2, C.3, C.4 and C.5 provide illustrative examples of companies selecting units of output.

Example C.2 Company with three distinct product groups. Energy use data available for each group.

An automobile plant assembles three types of vehicles in its facility; each vehicle type requires a different amount of energy to assemble.

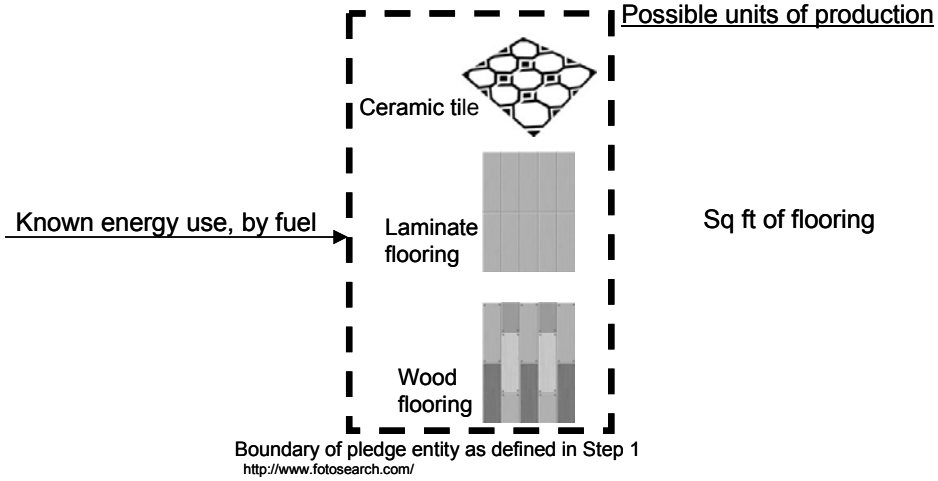
The company should select units of output specific to each product group such as 'number of vehicles' by type of vehicle, as shown in the figure below. The company may also use other units, such as mass (e.g., tons of vehicles) or functionality (e.g., vehicle horsepower). Calculations using diverse product groups are discussed in Step 5.



Example C.3 Company with three distinct product groups. Energy data available in aggregate, but not available separately for each group.

A flooring company manufactures three main types of flooring; each type requires a different amount of energy to manufacture. However, energy data are only available in aggregate; energy data are not available for each type of flooring separately.

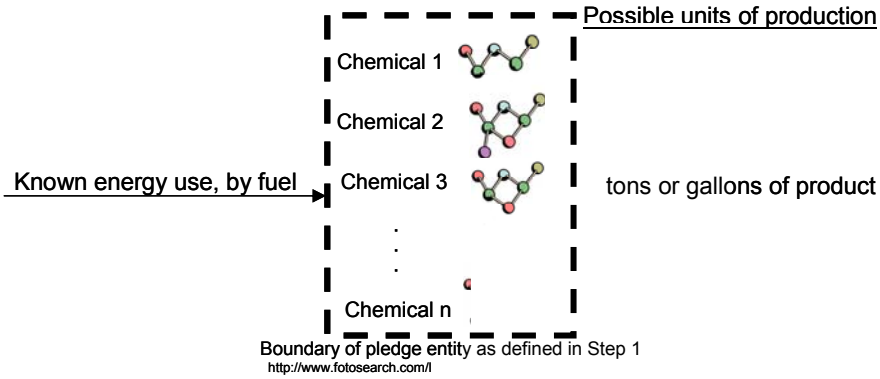
Due to lack of data, the company can select a *single* unit of output that represents the breadth of products within the Pledge boundary. 'Sq ft of flooring' provides an illustrative example that this company can use for their units of output. The company may choose other appropriate units, such as mass of shipments or number of tiles.



Example C.4 Company with many unique products that do not group easily into distinct product groups. Energy data are available in aggregate, but it is not available separately for each product or group.

A chemical company manufactures dozens of products. Although each product requires a different amount of energy to manufacture, the company collects energy data in aggregate; data are not available for each chemical product separately.

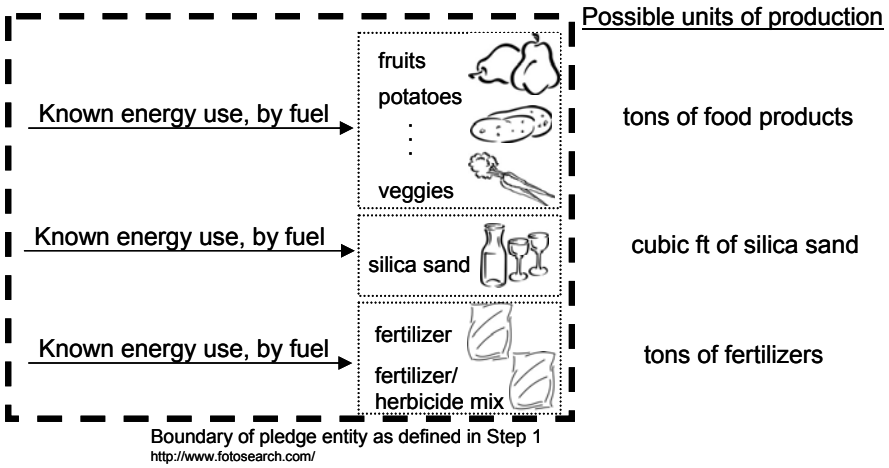
The company should select a single unit of output that represents the breadth of products within the Pledge boundary. For a range of products (e.g., diverse chemicals), the total mass or volume may be appropriate units. If the mass and volume vary too widely among products to be representative of the company's output, the total number of shipments or units of functionality could also be considered.



Example C.5 Company with many unique products, some of which can be grouped into distinct business operations. Energy data available in aggregate by business operation, but not available separately by product or group.

A diverse agribusiness company produces a wide range of products in 3 main business operations. Each product requires a different amount of energy to manufacture; the company collects energy data in aggregate by business operation. Energy use data are not available for each product separately.

The company should choose groupings for similar products and select groups such that the total energy use for that group is known. Since energy use data are known for each business operation, grouping products by business operation makes sense. In the illustrative example, the groupings are food products, silica sand, and fertilizers. If silica sand and fertilizers were processed in the same facility and energy data was only available at the facility level, then silica sand and fertilizers should be grouped together. In the illustration below, energy use data are available for each operation – silica sand and fertilizers – so they should be grouped separately. Units of output should represent the breadth of products, as possible. For a wide range of products, the total mass or volume may be appropriate units. If the mass and volume vary too widely among products to be representative of the company's output, the total number of shipments or units of functionality could also be considered. Consideration of diverse product groups (e.g., food products, silica sand, fertilizers) when calculating overall change in energy intensity is discussed in Step 5.



Appendix D: Calculating Change in Energy Intensity

Calculating a change in energy intensity requires data for the baseline year (Year 0) and data for at least one other year of the Pledge period (Year 1-10). Please use primary energy data. When a company establishes its baseline energy intensity, it will calculate the *absolute* energy intensity for each product group. In subsequent years, the energy intensity will be compared to the baseline year energy intensity to determine the *overall change* in energy intensity.

This appendix illustrates the importance of product grouping in calculating the overall change in energy intensity.

Example D.1 below shows a simple example of a company with one unit of output. This example illustrates how a company can calculate the absolute energy intensity for their baseline, and then calculate the change in energy intensity when they have data from subsequent years. Continuing the case presented earlier in Example C.1, this example is applicable for companies that have only one unit of output (Example D.1). In this situation, ABC Brewery's output is measured in terms of barrels of beer.

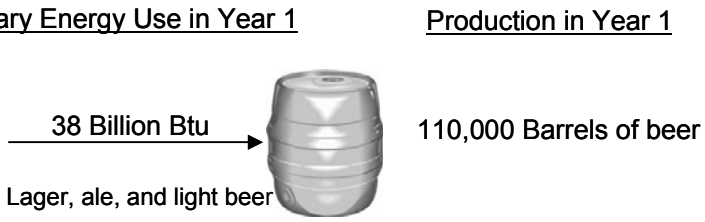
Example D.1 Company with products that can all be grouped together (i.e., only one unit of output for all operations).

In Step 3 and 4, it was determined that ABC Brewery's net primary energy use did not significantly vary by product; as a result, the company decided to use a single unit of output (barrels of beer). For the energy intensity baseline (Year 0), the company needs to calculate the absolute energy intensity. The baseline energy intensity is not reported to DOE. The baseline value is the basis from which the future energy intensity will be compared. The absolute energy intensity for this case is the net primary energy use divided by the barrels of beer produced in a given year.

Energy Intensity in Baseline Year = Net primary energy use / Output =
35 Billion Btu / 100,000 bbls = 350.00 kBtu / unit of output.

This is all that is required for establishing a baseline in this Step.

For subsequent years, the absolute energy intensity is again calculated, and then compared to the baseline as shown below.



Energy Intensity in Year 1 = Net primary energy use / Output =
38 Billion Btu / 110,000 bbls = 345.45 kBtu / unit of output

Overall Change in Energy Intensity in Year 1 =
(Energy Intensity in Year 1 – Energy Intensity in Baseline Year) / Energy Intensity in Baseline Year =
= [(345.45 – 350.00) / 350.00] x 100%
= -**1.30%**
This indicates that the energy intensity decreased 1.30% from the baseline year to year 1.

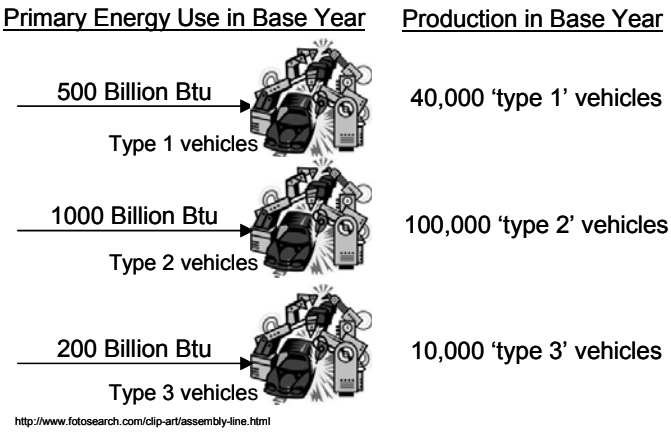
The example above is illustrative for companies using a physical unit of output as their measure of production for energy intensity calculations. Companies using economic units of output (e.g., Btu per dollar value of shipments) should index the economic measure to the baseline year to account for variation in prices. The producer price index from the U.S. Bureau of Labor Statistics provides a widely accepted index (http://www.bls.gov/ppi/), although companies may use whatever economic deflator or price index they deem appropriate.

A company with diverse physical units of output may want to calculate the absolute energy intensity for each product group separately for its baseline. In subsequent years of the Pledge period, the company will calculate absolute energy intensity for each product group. The *overall change in energy intensity* is calculated by applying the baseline energy intensities to the current year's production values, and comparing the resulting value (termed the 'business-as-usual energy use in the current year') to the actual energy use for the current year. The percent difference between the 'business-as-usual energy use in the current year' and the actual energy in the current year is the *overall change in energy intensity*. The examples below provide step by step guidance for using this method.

Example D.2 below illustrates the calculations necessary to determine the absolute energy intensity for the baseline and the change in energy intensity for subsequent years.

Example D.2 Company with three distinct product groups. Energy use data available and units of output defined for each group.

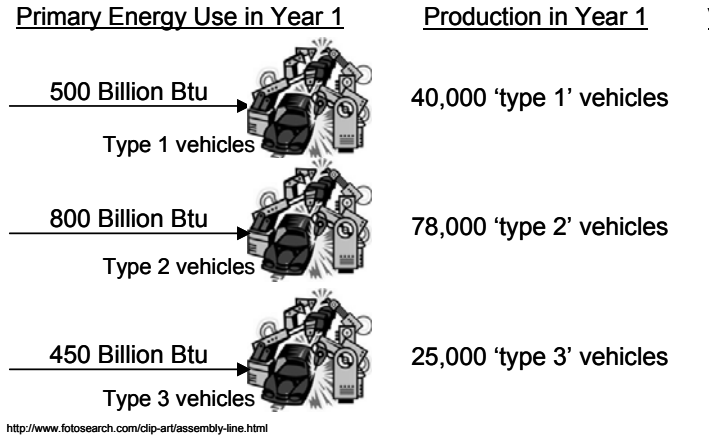
The automobile assembly plant's net primary energy use for each group was calculated in Step 3 and the results are shown in the diagram below. The number of units produced (i.e., number of vehicles) for each product grouping is also provided in the diagram.



Energy Intensity in Baseline Year = Net primary energy used / Output
Type 1 vehicles: 500 BBtu / 40,000 Type 1 vehicles = 12.5 MMBtu / Type 1 vehicle
Type 2 vehicles: 1,000 BBtu / 100,000 Type 2 vehicles = 10.0 MMBtu / Type 2 vehicle
Type 3 vehicles: 200 BBtu / 10,000 Type 3 vehicles = 20.0 MMBtu / Type 3 vehicle

For establishing a baseline, these calculations are all that is required for this Step.

For subsequent years, the change in energy intensity is calculated by applying the baseline year's energy intensities to the current year's production values. The resulting energy use (i.e., 'business-as-usual energy use in the current year') is then compared to actual energy use in the current year to determine the overall change in energy intensity. For this example, the energy use and output for Year 1 (the "current" year) of the Pledge period is provided in the diagram below.



Calculate the Overall Change in Energy Intensity:

Calculate the 'Business-as-Usual Energy Use in the Current Year' (Year 1)

'Business-as-Usual Energy Use in the Current Year' for Year 1 = Baseline Year Energy Intensity x Year 1 Production Quantity [summed for each product group]

Type 1 vehicles: 12.5 MMBtu / Type 1 vehicle x 40,000 Type 1 vehicles = 500 BBtu
Type 2 vehicles: 10.0 MMBtu / Type 2 vehicle x 78,000 Type 2 vehicles = 780 BBtu
Type 3 vehicles: 20.0 MMBtu / Type 3 vehicle x 25,000 Type 3 vehicles = 500 BBtu

Total 'Business-as-Usual Energy Use in the Current Year' = 'Business-as-Usual Energy Use in the Current Year' for each product group = 500 BBtu + 780 BBtu + 500BBtu = **1,780 BBtu**

Calculate the Actual Energy Use for the Current Year (Year 1)

Actual Energy Use for Year 1 = Sum of Energy Used for All Product Groups
From the diagram above:
Type 1 vehicles: 500 BBtu
Type 2 vehicles: 800 BBtu
Type 3 vehicles: 450 BBtu
Total Actual Energy Use = Actual Energy Use for each product group = 500 BBtu + 800 BBtu + 450BBtu = **1,750 BBtu**

Calculate the Overall Change in Energy Intensity for Year 1

Overall Change in Energy Intensity for Year 1 =
(Actual Energy Use for Year 1 - 'Business-as-Usual Energy Use in the Current Year' for Year 1) / 'Business-as-Usual Energy Use in the Current Year' for Year 1
Overall Change in Energy Intensity for Year 1 = [(1,750 BBtu – 1,780 BBtu) / 1,780 BBtu] x 100%
= -1.69%

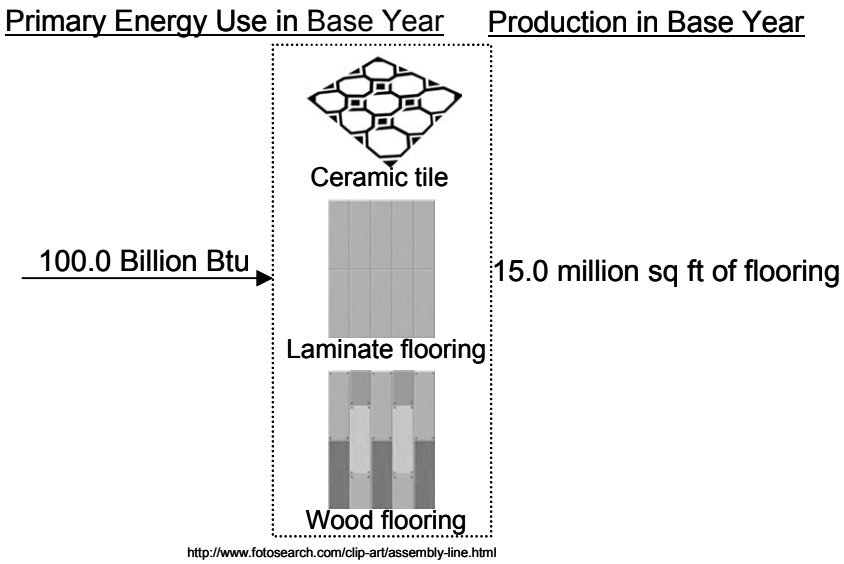
Notice that the overall change in energy intensity of -1.69% indicates *improvement* in energy intensity.

The above method represents one way to calculate overall change in energy intensity; companies may choose to calculate overall change in energy intensity using their own method. Regardless of method chosen, it is important that the method is consistent each year to ensure that the values are comparable over time.

Example D.3 below illustrates energy intensity calculations for a company that has diverse units of output but has aggregated energy use data (rather than separated energy use data for each product line). The calculation method is identical to Example D.1, which illustrated a company with one product group.

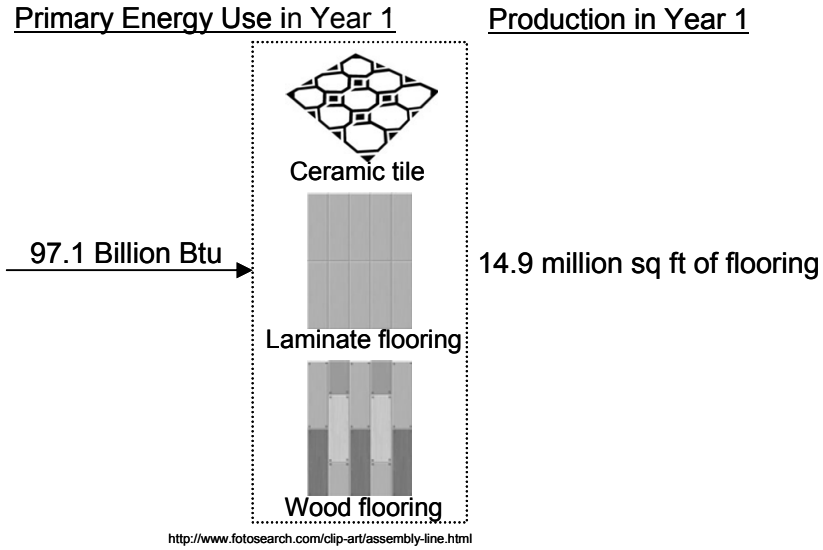
Example D.3 Company with three distinct product lines. Aggregated energy use data and units of output defined for the entire pledging entity.

The flooring company's net primary energy use – calculated in Step 3 – and total units of output for the base year are shown in the diagram below. This example does not require calculating the 'business-as-usual energy use in the current year' for Year 1, as was shown in the previous example. The energy intensity for the baseline is simply the primary energy use divided by the output, and the change in energy intensity is simply the percentage difference in Year 1 compared to the baseline year.



Energy Intensity in Baseline Year = Net primary energy use / Output =
100.0 BBtu / 15.0 million sq ft = **6.667 kBtu / sq ft of flooring.**

For subsequent years, the absolute energy intensity is calculated and compared to the baseline.



Energy Intensity in Year 1 = Net primary energy use / Output =
97.1 BBtu / 14.9 million sq ft = **6.517 kBtu / sq ft of flooring**

Overall Change in Energy Intensity in Year 1 =
(Energy Intensity in Year 1 – Energy Intensity in Baseline Year) / Energy Intensity in Baseline Year =
= [(6.517 – 6.667) / 6.667] x 100%
= -**2.25%**
This indicates that the energy intensity decreased 2.25% from the baseline year to year 1.

Appendix E: Accounting for Changes in Energy Intensity from a Change in the Product Mix

The **Energy Intensity Assessment Matrix** is a spreadsheet available from DOE that will help companies account for changes in the product mix. The product mix and a change in the product mix are *not* reported to DOE.

This example illustrates the importance of accounting for relative changes in product mix through product grouping. Companies should be aware that a change in product mix between the baseline year (Year 0) and subsequent reporting years (Year 1-10) can result in a change in energy intensity, even if the energy use per product does not change. For instance, in Appendix D Example D.2, vehicle 'type 3' consumes double the energy per unit compared to vehicle 'type 2'. If the production of vehicle 'type 3' increases, the total energy intensity for the company will increase (assuming all else equal to the baseline year). Recall that companies can account for product mix changes only if energy use data and units of output are available for product groups (i.e., the company in Example D.2 can account for product mix changes but the company in Example D.3 cannot because energy use is only available in aggregate).

Accounting for product mix changes can result in a far more accurate representation of a company's overall change in energy intensity. This is best illustrated by an example (Example E.1).

Example E.1 Continuing with Example D.2 in Appendix D, the company estimates the following primary energy use and output for the Baseline Year and Year 1.

	Baseline Year		Year 1	
Products	**Primary Energy Use**	**Output**	**Primary Energy Use**	**Output**
Type 1	500 Billion Btu	40,000	500 Billion Btu	40,000
Type 2	1000 Billion Btu	100,000	800 Billion Btu	78,000
Type 3	200 Billion Btu	10,000	450 Billion Btu	25,000
Total	1,700 Billion Btu	150,000	1,750 Billion Btu	143,000

As shown above in Example D.2, this company's total change in energy intensity from the Baseline year to Year 1 is -**1.69%** when it account for its diverse product mix.

If the company did not account for changes in product mix they would use the total energy use and output to calculate their change in energy intensity. Following the method outlined in Example D.1 for companies with a single product group, the company would calculate its change in energy intensity as shown below:

Energy Intensity in Baseline Year = Net primary energy used / Output =
1,700 Billion Btu / 150,000 = 11.3333 MMBtu / unit of output

Energy Intensity in Year 1 = Net primary energy used / Output =
1,750 Billion Btu / 143,000 = 12.2378 MMBtu / unit of output

Overall Change in Energy Intensity in Year 1 =

(Energy Intensity in Year 1 – Energy Intensity in Baseline Year) / Energy Intensity in Baseline Year =
= [(12.2378 – 11.3333) / 11.3333] x 100%
= **7.98%**
This indicates that the energy intensity increased 7.98% from the baseline year to year 1.

Using a single product group (i.e, aggregated energy use data and production data), the company would report an *increase* in energy intensity of **7.98%** instead of a *decrease* of **1.69%** as shown in Example D.2.

In this example (Example E.1), rolling all three of the diverse product groups together into one total value fails to capture the product-specific improvements in energy intensity that the company made between the Baseline Year to Year 1. Accounting for product mix changes more accurately represents the improvements made by the company (Example D.2). DOE recommends separating diverse product groups to account for changing product mixes.

Appendix F: Adjustments in Baseline Energy Use

Companies may follow the recommended approach outlined below for adjusting baseline energy use, or they may develop their own approach. For consistency, the company should use the same approach every year.

Example F.1 Continuing with Example D.2 and E.1 presented earlier, the company estimates the primary energy use and output for the Baseline Year and Year 1.

	Baseline Year 0		Year 1	
Products	**Primary Energy Use**	**Output**	**Primary Energy Use**	**Output**
Type 1	500 Billion Btu	40,000	500 Billion Btu	40,000
Type 2	1000 Billion Btu	100,000	800 Billion Btu	78,000
Type 3	200 Billion Btu	10,000	450 Billion Btu	25,000
Total	1,700 Billion Btu		1,750 Billion Btu	

In Year 2, the company adds a new vehicle type (i.e., product group) to its operations. The company estimates the following primary energy use and output for Year 2.

	Year 2	
Products	**Primary Energy Use**	**Output**
Type 1	400 Billion Btu	35,000
Type 2	900 Billion Btu	90,000
Type 3	350 Billion Btu	20,000
Type 4	*100 Billion Btu*	*10,000*
Total	1,750 Billion Btu	155,000

Note that Type 4 vehicles is a new product group that was not included in the baseline year energy use. The addition of the new product group represents a 'major change' and therefore the company should report an adjustment in the baseline energy use.

In this instance, the Adjustment in Baseline Energy Use equals the primary energy use for Type 4 vehicles in Year 2 = **100 Billion Btu**.

DOE will estimate the company's overall energy savings as follows:

Total primary energy use in baseline year	+	Adjustments to baseline energy use	—	Total primary energy use in current year	=	Energy savings in current year compared to baseline

In Year 2, considered the 'current' year, the energy savings compared to the baseline = [1,700 BBtu + 100 BBtu – 1,750 BBtu] = **50 Billion Btu.**

Example F.2 Continuing with Example F.1, suppose that the company eliminates two product groups in Year 3 and acquires a facility with three new product groups. The company estimates the following primary energy use and output for Year 3 (note that data for Year 0, 1, and 2 are provided in Example F.1).

	Year 2	
Products	**Primary Energy Use**	**Output**
Type 1	400 Billion Btu	35,000
Type 2	900 Billion Btu	90,000
Type 3	350 Billion Btu	20,000
Type 4	*100 Billion Btu*	*10,000*
Total	1,750 Billion Btu	

	Year 3	
Products	**Primary Energy Use**	**Output**
Type 1	500 Billion Btu	40,000
~~Type 2~~	~~900 Billion Btu~~	~~90,000~~
Type 3	450 Billion Btu	25,000
~~Type 4~~	~~100 Billion Btu~~	~~10,000~~
Type 5	*400 Billion Btu*	*38,000*
Type 6	*300 Billion Btu*	*40,000*
Type 7	*200 Billion Btu*	*30,000*
Total	1,850 Billion Btu	

Type 5, Type 6, and Type 7 vehicles are new product groups added to the Pledge entity through acquisition, and Type 2 and Type 4 vehicles were eliminated in Year 3. The addition and subtraction of new product groups represents a 'major change' and therefore the company should report an adjustment in the baseline energy use.

For Year 3, the Adjustment in Baseline Energy Use equals the primary energy use in ***Year 3*** for Type 5, Type 6, and Type 7 vehicles minus the ***Baseline*** energy use for Type 2 and Type 4 vehicles. Recall the baseline energy use:

	Baseline Year 0	
Products	**Primary Energy Use**	**Output**
Type 1	500 Billion Btu	40,000
Type 2	1,000 Billion Btu	100,000
Type 3	200 Billion Btu	10,000
Total	1,700 Billion Btu	

Since Type 4 vehicles were not included in the original baseline (they were added in Year 2), the baseline energy use for Type 4 vehicles should not be included in the Adjustment calculation. Therefore, the Adjustment in Baseline Energy Use is [Type 5 Energy Use + Type 6 Energy Use + Type 7 Energy Use – Type 2 Energy Use] =
(400 BBtu + 300 BBtu + 200 BBtu – 1,000 BBtu) = **-100 Billion Btu.**

As presented earlier, the company's overall energy savings are calculated as follows:

Total primary energy use in baseline year	+	Adjustments to baseline energy use	—	Total primary energy use in current year	=	Energy savings in current year compared to baseline

For Year 3, considered the 'current' year, the energy savings compared to the baseline = [1,700 BBtu + (-100 BBtu) – 1,850 BBtu] = **-250 Billion Btu**