



**ENERGY STAR[®] Challenge
for Industry**

Professional Engineer Guide

Introduction

The U.S. Environmental Protection Agency's ENERGY STAR program provides guidance, tools, and recognition to help companies improve their energy performance. ENERGY STAR is a voluntary partnership program that companies choose to join.

Through ENERGY STAR, the U.S. Environmental Protection Agency (EPA) offers a number of forms of recognition, including certification for product and facility energy efficiency.

The **ENERGY STAR Challenge for Industry** recognizes individual plants for achieving a 10 percent reduction in energy intensity from an established baseline. To be recognized by EPA for this accomplishment, sites must sign-up for the ENERGY STAR Challenge for Industry. If the site achieves a 10 percent reduction in energy intensity within 5 years of the date of its baseline, the site can apply for recognition.

The application for recognition through the ENERGY STAR Challenge for Industry requires having a Professional Engineer verify the site's energy intensity reduction by reviewing energy and related data. It is the responsibility of the site applying for recognition to complete and submit the application for recognition under the ENERGY STAR Challenge for Industry.

A Professional Engineer (PE) provides unbiased engineering services and is legally bound to uphold standards of ethics. Because of this high level of professionalism, the EPA requires that a PE must validate each Statement of Energy Improvement that is used to apply for plant recognition in meeting the ENERGY STAR Challenge for Industry. PE verification is also required for other forms of ENERGY STAR recognition such as the [building and plant label](#).

The PE conducting the verification process for the ENERGY STAR Challenge for Industry is permitted to be employed by the organization or site participating in the Challenge for Industry.

The PE's key role is to verify that all data supplied to EPA on the Statement of Energy Improvement are correct and the facility has followed the basic requirements of the ENERGY STAR Challenge for Industry. The PE should first review the steps for participating, which are provided in **Appendix 1**.

The PE must verify that the data about the site are accurate. This includes verifying the site's physical characteristics, operating characteristics, and energy consumption.

The PE is not obligated to conduct additional analysis, but should be able to use his/her professional judgment to assess whether data tracked and recorded are accurate and reflect usage at the site.

Validating a Statement of Energy Improvement requires the PE to review categories of user-provided information. These verifications by the PE are one step in the review process for EPA recognition. For more on the application process, which is the responsibility of the site, see **Appendix 2**.

This document, the *ENERGY STAR Challenge for Industry Professional Engineer Guide*, is intended to assist the PE community in understanding the requirements of the ENERGY STAR Challenge for Industry and the Statement of Energy Improvement.

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Review and Verification Process Overview

EPA recommends the following steps for conducting the review.

1. Confirm the site's physical characteristics.
2. Confirm site and operating information is accurate.
3. Review energy and related data for accuracy.
4. Verify energy intensity reduction.
5. Verify avoided greenhouse gas emissions, if reported.
6. Stamp and sign the Statement of Energy Improvement.

Energy Tracking Plans and Procedures

Sites participating in the ENERGY STAR Challenge for Industry are asked to confirm that existing company procedures are in place to manage the data required to track energy performance or create an energy tracking plan.

For sites that do not have existing procedures, EPA provides sites with an Energy Tracking Plan (ETP) template to help sites establish the basic management procedures and documentation needed for the ENERGY STAR Challenge for Industry. Sites are not required to submit their ETP to EPA for review or approval.

The ETP or equivalent system provides specific information that the PE will need when verifying energy performance and that the sites have followed the basic requirements of the ENERGY STAR Challenge for Industry.

Feedback & Questions

EPA is committed to continually improving the content of this document, and welcomes all comments that may help us do so. All applicable contact information is provided in **Appendix 5**.

EPA thanks you for choosing to take part in the ENERGY STAR Challenge for Industry.

1. Site Physical Characteristics

Objective

The site must meet the definition of an industrial site. Further, the physical characteristics (e.g., address) displayed on a site's Statement of Energy Improvement must match those of the site applying for ENERGY STAR Challenge for Industry recognition.

Background and Expectations of PE

The PE is expected to verify that the site is an industrial site. Industrial sites are considered those engaged in industrial production (see *Requirements* below).

The PE is expected to verify the accuracy of the site's recorded physical characteristics, which include site name, location, parent company information, and contact names.

Requirements

The primary activity at the site must be associated with production within the industrial sector. EPA recognizes the following NAICS classifications as industries within the industrial sector for the ENERGY STAR Challenge for Industry.

Manufacturing (NAICS codes 31 – 33) - Manufacturing comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembling of component parts of manufactured products is considered manufacturing, except in cases where the activity is appropriately classified as construction.

Mining, Quarrying, and Oil and Gas Extraction (NAICS codes 21) - Mining, Quarrying, and Oil and Gas Extraction comprises establishments that extract naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas.

For sites with large mixed uses (e.g., R & D, administration, and manufacturing) the manufacturing and R & D (typically laboratories) portion of operations should represent a minimum of 50 percent of each site's total energy use.

The site must be located within the United States of America or its territories. A 5-digit ZIP code must be recorded for buildings located in the USA or its territories.

All the data used to track energy performance must be associated and connected to the site named on the Statement of Energy Improvement.

Hints & Tips

The U.S. Census Bureau North American Industry Classification System (NAICS) web site provides definitions on major industry categories and their sub-industries. See <http://www.census.gov/eos/www/naics/>.

2. Operating Characteristics

Objective

All recorded non-energy operating characteristics tracked and used to calculate the site's energy intensity metric and reported on the Statement of Energy Intensity must be reviewed for accuracy when applying for ENERGY STAR Challenge for Industry recognition.

Background and Expectations of PE

Sites participating in the ENERGY STAR Challenge for Industry select an energy intensity metric, set a 10 percent reduction goal, and establish an energy tracking system for monitoring their energy intensity over time. To achieve the ENERGY STAR Challenge for Industry, sites must reduce their annual intensity by 10 percent within 5 years.

A site's energy intensity metric can be based on a unit of production or on the site's gross square footage depending on the nature of energy use at the site. (See **Appendix 1: Steps for Participation, Step 2**). In addition, sites may also choose to normalize their metric for other non-energy related factors, such as weather.

The PE is expected to review production data or gross square footage used to calculate the energy intensity to ensure it is accurately accounted for in the energy tracking system. Other data used for normalization should also be reviewed.

The PE is also expected to confirm that data used reflect the whole facility and not a single process or individual part of site. The PE is not expected to conduct independent measurements, but instead should consult company records and supporting documentation.

Requirements

The energy intensity metric used must capture energy for the whole site and meet the criteria described in **Appendix 1: Steps for Participation, Step 2**.

- ★ For production-based energy metrics, confirm that production units used for calculating the energy intensity metric and tracked in the site's energy tracking system are consistent with numbers from official company production records.
- ★ For building-based metrics, confirm that the gross square footage of the site used for calculating the energy intensity metric and tracked in the energy tracking system are consistent with company records.

If the site's energy intensity metric is normalized for other variables, confirm that the approach was applied consistently during the tracking period and that the data used in the tracking system match the primary source of normalization data.

Hints & Tips

The site's Energy Tracking Plan (ETP) or equivalent system should document the rationale for selecting the energy intensity metric used. The ETP should also list the sources of all information and data used for calculating and tracking energy intensity over time.

Original specifications, design documents, and "as-built" drawings can be used to confirm certain physical characteristics.

3. Energy Consumption

Objective

The energy data reported on the Statement of Energy Improvement must be verified to ensure that the energy consumption for each type of fuel used within the site is accurate, reported in BTUs, and properly converted to source energy.

Background and Expectations of PE

All sources of the energy consumed at the site must be accurately accounted for in the energy tracking system selected by the site. These include fuel sources such as electricity (grid purchases, on-site solar and on-site wind), natural gas, fuel oil, diesel fuel, district steam or hot water, district chilled water, propane, coal, coke, kerosene, biomass, process gases, TDF, municipal waste, and so on.

The PE is expected to review energy consumption documentation for each energy source used at the site to ensure that energy purchased or generated is accounted for in the energy tracked for the Challenge.

Documentation provided by the site must demonstrate that energy consumption for each energy source was tracked from the baseline year to the year of achieving the Challenge reduction goal.

All energy must be converted from “site” energy to “source” energy. Source energy, also known as total primary energy, accounts for losses due to generation efficiency, and during transmission & distribution. Ratios for converting energy use from site to source energy are provided in **Appendix 3**.

The PE must also verify that no fuels were excluded. If a site exports electricity or steam, the quantity of these exports should be subtracted from the site’s energy use total.

Requirements

Verify that all fuel sources used are tracked. Sites are expected to track all forms of energy that are required for operating the facility and manufacturing processes. Considerations for the most common sources of fuels follow.

- Grid Electricity – When electricity is purchased from the grid, verify that the user tracked the total amount of as-billed electricity consumption. This will typically be found on monthly electric bills.
- Natural Gas – When natural gas is purchased from a supplier, verify that the user tracked the total amount of as-billed natural gas consumption. This will typically be found on monthly gas bills.
- Fuel Oil and Propane – If fuel oil or propane is combusted, then the amount of fuel purchased and combusted must be tracked. Unlike electricity and natural gas, these fuels may not be delivered or measured on a month-to-month billing period.
- Coal – If coal is purchased and consumed on site, the quantities or BTU value of fuel used must be tracked. Like fuel oil, these fuels will likely not be delivered or measured on a month-to-month billing period.
- District Energy (hot water, chilled water, steam) – If district energy is purchased from the utility, the monthly quantity of consumption should be tracked. Verify that the user tracks the total amount of as-billed district energy consumption. This will typically be found on monthly bills. All purchases of district energy must be accounted for in the site’s total energy consumption.

- On-Site Solar and Wind Electricity – Sites are required to track the amount of electricity that is generated from on-site solar or wind energy sources and used on site. Site should account for and factor out any energy sold to the grid. Confirm that all energy generated and used on-site from these sources is accounted for in full.
- On-Site Combined Heat and Power (CHP) – CHP systems consume a single input fuel (e.g., natural gas) to produce both heat and electricity. In these situations, the input fuel is the required data point to be tracked. Verify that all input fuels are included in the total energy consumed. This may be found on monthly bills for a fuel such as natural gas, or from other irregular billing periods for diesel oil or coal. The user should not include the amount of heat and electricity generated from the CHP system in their total energy calculations.
- Wood and Biomass – If wood or biomass fuels are purchased and consumed on site, the quantities or energy value of these fuels must be tracked and accounted for. Like fuel oil, these fuels will likely not be delivered or measured on a month-to-month billing period. Internal company records are considered acceptable records for documenting fuel use.
- Waste fuels – If waste fuels, such as municipal solid waste, animal by-products, tire-derived fuels (TDF), and other by-products of production are combusted as fuel, either quantity or fuel value of these fuels should be tracked and accounted for. Like fuel oil or biomass, these fuels will likely not be delivered or measured on a month-to-month billing period. Internal company records are considered acceptable records for documenting fuel use.
- Process gases – If gases created by industrial process are combusted as fuel, the volume or fuel value of those gases must be tracked and accounted for as part of the site's total energy consumption. Internal company records based on either metered fuel use or engineering estimates that document the quantity of process gases consumed should be reviewed to ensure proper tracking.

All forms of energy purchased and used on site must be converted to British Thermal Units (BTUs), summed and reported on the Statement of Energy Improvement for each year during participation in the Challenge for Industry. These numbers represent the total annual “site” energy reported for each year on the Statement of Energy Improvement. The PE must verify that the total site energy reported on the Statement of Energy Improvement accurately accounts for the total annual energy used at the site.

All forms of energy purchased and used must also be converted to source energy, summed and reported on the Statement of Energy Improvement for each year during participation in the Challenge for Industry. These numbers represent the total annual “source” energy reported for each year on the Statement of Energy Improvement. The PE must verify that all energy was properly converted to source energy, and that total source energy reported on the Statement of Energy Improvement accurately accounts for the total annual energy used at the site.

Hints & Tips

Review the site's Energy Tracking Plan to determine the sources of energy tracked and the primary sources of the data. Then review actual monthly energy bills, electronic billing records, and other data sources provided by the site to make sure the energy data were accounted for properly.

Energy Consumption Q& A

To verify the monthly energy consumption, must monthly bills from the utility company be independently obtained?

No. If the PE is confident based on his/her review that all of the energy sources and meters are accounted for, then independently obtained monthly utility bills are not required.

Are monthly utility bills needed to verify the monthly energy consumption of each fuel?

Not always. Based upon the judgment of the PE, a site-wide energy tracking system that fully tracks consumption of all fuels may be used instead of utility bills, particularly if that tool is integrated with an electronic billing system.

Should the electrical outputs of co-generation units be included as part of the site's monthly energy consumption?

No. The energy input required by the co-generation unit must be accounted for, but not the electricity that is generated.

Should the electrical outputs of renewable energy (on-site solar and wind) be included as part of the total energy consumption?

Yes. Sites must report the full electric requirement of the site. This includes the electricity that comes from on-site solar and wind electricity and is consumed on site.

4. Energy Intensity Improvement

Objective

Verify that the site has achieved the 10 percent reduction in energy intensity within 5 years of its baseline established in its ENERGY STAR Challenge for Industry application.

Background and Expectations of PE

Sites participating in the ENERGY STAR Challenge for Industry establish a baseline year, and then set a 10 percent annual reduction goal which must be achieved within a five-year period of the baseline. It is acceptable for sites to achieve the 10 percent reduction in fewer than five years.

Sites may set a retrospective baseline of up to three years prior to the date they register to participate in the Challenge for Industry, provided the company was an ENERGY STAR partner during that entire time. For example, a site that registered for the Challenge for Industry in April 2010 could set a baseline beginning in April 2007.

The PE is expected to verify that the site has accurately calculated its energy intensity and energy intensity reduction, and that the 10 percent reduction goal was achieved within five years of the baseline.

The ENERGY STAR Statement of Energy Intensity (SEI) will automatically calculate energy intensity based on the energy and operating characteristics entered into the form. However, if the site uses a multi-variant energy intensity metric that has been normalized for different factors, the numbers for that metric should be entered on the SEI. In this situation, the PE should verify that correct intensity numbers are used.

Requirements

Verify that the energy intensity metric was correctly calculated using source energy, and the data entered into the Statement of Energy Intensity is accurate.

Verify that the site has achieved the 10 percent annual reduction in energy intensity goal within five years of the baseline.

5. Annual CO₂e Avoided

Objective

If a site chooses to report avoided carbon dioxide equivalent (CO₂e) emissions, the PE should verify that the emissions reported on the Statement of Energy Intensity were accurately calculated.

Background and Expectations of PE

Reporting avoided emissions is optional but encouraged. Providing avoided emissions helps sites and EPA communicate the site's accomplishments in protecting the environment through improved energy performance.

Annual avoided CO₂e that is reported can be based on estimates using default emissions factors. Any reporting of avoided CO₂e emissions is considered voluntary and does not apply to any current or future regulatory reporting requirements. The PE is not expected to verify a site's greenhouse gas inventory nor conduct any additional measurements to determine any greenhouse gas reductions.

Sites are permitted to estimate avoided greenhouse gas emissions two ways:

Intensity-based - Sites can calculate the difference between what emissions would have been had the baseline intensity level remained constant versus actual emissions at the improved performance level.

Absolute - Sites can determine the absolute reduction greenhouse gas emissions associated with reduced energy use.

Sites are asked to convert emissions to carbon dioxide equivalent, which enables sites to account for CH₄ and N₂O from combustion of fuel. **Appendix 4** provides default emissions factors for CO₂, CH₄, N₂O and guidance on converting to CO₂e.

Requirements

Confirm that the site is using emissions factors provided by the U.S. Environmental Protection Agency. (See **Appendix 4**)

Verify that avoided CO₂e emissions estimates were correctly calculated.

Appendix 1: Steps for Participation.

The ENERGY STAR Challenge for Industry is designed to award recognition to only individual industrial sites. To gain recognition in the ENERGY STAR Challenge for Industry, the site's company must be an ENERGY STAR partner.

Step 1: Identify an energy intensity metric

Start by identifying an energy use intensity metric that will be used to track progress towards the 10 percent reduction goal at each site.

The metric must capture the energy use intensity of the whole site – not individual processes or energy sources – and must account for all forms of energy (solid fuels, electricity, gases, etc.).

All energy should be expressed in British Thermal Units (BTUs), and converted from “site” energy to “source” energy. For more information, see [“Understanding Source and Site Energy”](#) on the ENERGY STAR Web site.

Energy loads at the site will need to be assessed in order to determine the proper metric.

- If 60 percent or more of the site's energy load is directly linked to industrial processes, then the intensity metric should reflect a measure of production – for example, BTU/pound of product. Sites are encouraged to use existing production-based energy intensity metrics as long as they meet the criteria mentioned above.
- If 60 percent or more of the site's energy load is due to non-production process utility systems – such as lighting, heating, and ventilation – then the energy metric should reflect a building metric, such as BTU/square foot. Sites using a building metric are encouraged to use [Portfolio Manager](#), which normalizes for building area and weather.
- For sites with energy loads not meeting either of these criteria, please select a metric most representative of the site's operations and provide a rationale for the metric to EPA.

Sites that wish to normalize production-based energy intensity metrics for other factors are encouraged and permitted to do so.

Step 2: Select an energy tracking method

Sites using a production-based energy intensity metric (BTU/product) are encouraged to use existing energy tracking systems. For sites that currently do not have a tracking system, EPA offers the **ENERGY STAR Energy Tracking Tool**. For industries where an **ENERGY STAR Plant Energy Performance Indicator (EPI)** is available, use the EPI to track and verify performance.

Sites using a building-based energy intensity metric can use EPA's on-line [Portfolio Manager](#) tool to track energy use, or another existing system that normalizes for weather. Within Portfolio Manager, sites must use the “Other” space type category option.

Step 3: Set a baseline and 10 percent improvement goal

A full twelve-month period must be selected for the baseline year (e.g., April 2007 through March 2008). The baseline year represents your level of performance before the Challenge period.

You have the option of choosing a site baseline of up to three years prior to the date of signing up for the Challenge as long as your company was an ENERGY STAR partner during that entire time. For example, a site that takes the Challenge for Industry in November 2009 can set a baseline beginning in November 2006 if the company was an ENERGY STAR partner at that time.

If your company became a partner within the past year, the prior 12 months to joining ENERGY STAR can serve as the baseline year. For example, if you join in 2009, the baseline year can begin in 2008.

To determine your baseline energy use intensity, begin by totaling the site's energy use across a full twelve months. If using a production-based metric (e.g., pounds of product), divide the total energy use by the total of that production metric (e.g., BTU/pound of product). If using a building-based metric (e.g., square feet of building area), divide the total energy use by the total of that building metric (e.g., BTU/square foot). The result of either calculation is the average annual energy use intensity for the baseline year.

After the baseline is set, calculate the 10 percent reduction target. For example:

Baseline annual energy intensity = 500 BTU/pound of product
Improvement goal = 10% (i.e., a 50 BTU/pound of product reduction)
Target annual intensity = 450 BTU/pound of product

Step 4: Establish an energy tracking plan

Tracking energy use over time requires some simple planning to assure accuracy. Use the **Challenge for Industry Energy Tracking Plan template** to create a basic plan to ensure proper data management and documentation if your company does not have existing procedures or processes.

Step 5: Sign up for the Challenge

Complete the **ENERGY STAR Challenge for Industry Registration Form** and send it to the EPA's ENERGY STAR program.

Step 6: Track energy use and achieve the 10 percent reduction

Execute initiatives, projects, and other strategies to improve energy intensity while measuring their impacts through your tracking system. Use ENERGY STAR resources to help your site improve!

Step 7: Verify savings and apply for recognition

On achieving the 10 percent improvement goal, have the savings verified and send the completed application to the EPA to receive recognition.

A Professional Engineer (PE) is required to verify the 10 percent reduction in annual energy intensity, and stamp and sign the **Statement of Energy Improvement**, which is then included with the recognition application materials sent to the EPA. As part of this process, the PE will review the Energy Tracking Plan, and the data used to calculate the baseline and subsequent improvement in energy performance.

When the EPA has received and approved the application for recognition, you will be sent:

- Letter of Congratulations on EPA Letterhead;
- Framed Certificate of Accomplishment; and
- Communication materials.

Additionally, your site will be recognized publicly on the ENERGY STAR Web site, and a letter will be sent to your company's CEO.

Sites meeting the 10 percent reduction goal earn the right to distinguish themselves as achieving the ENERGY STAR Challenge for Industry.

Appendix 2: Recognition Application Process

How to Apply for ENERGY STAR Challenge for Industry Recognition

1. Determine that the site has achieved the 10 percent reduction goal.
2. Organize materials, data sources, and other information required for PE verification.
3. Have a Professional Engineer verify that all information provided on the Statement of Energy Intensity is true and accurate to the best of their ability. The Statement of Energy Improvement must be signed and dated at the time of the review. The Statement of Energy Intensity must also be stamped by the Professional Engineer.
4. Mail the signed Recognition Application Letter and signed and stamped Statement of Energy Improvement (SEI) to EPA.

Appendix 3: Source-Site Energy Ratios

Source-Site Ratios used by ENERGY STAR	
Fuel Type	Source-Site Ratio
Electricity (Grid Purchase)	3.340
Electricity (On-site Solar or Wind Installation)	1.0
Natural Gas	1.047
Fuel Oil (1,2,4,5,6, Diesel, Kerosene)	1.01
Propane & Liquid Propane	1.01
Steam (Purchased)	1.45
Hot Water	1.35
Chilled Water	1.05
Wood / Biomass	1.0
Coal / Coke	1.0
Process Gases	1.0
Other fuels burned on site	1.0

Appendix 4: Default Emissions Factors

The following tables include default emissions factors used by the U.S. EPA.

Emissions from Electricity

Emissions associated with electricity purchased from the U.S. electrical grid should be calculated using a regional emission factor from the U.S. EPA's eGRID database available online at <http://cfpub.epa.gov/eGRIDweb/ghg.cfm>.

Sites should identify their eGRID region using the map on that web page, select the annual output emission rates for that region, and convert to CO₂e.

Emissions from Fuel

Default CO₂ Emission Factors and High Heat Values for Various Types of Fuel

Fuel Type	Default High Heat Value	Default CO ₂ Emission Factor
Coal and Coke	mmBtu/short ton	kg CO₂ /mmBtu
Anthracite	25.09	103.54
Bituminous	24.93	93.40
Subbituminous	17.25	97.02
Lignite	14.21	96.36
Coke	24.80	102.04
Mixed (Commercial sector)	21.39	95.26
Mixed (Industrial coking)	26.28	93.65
Mixed (Industrial sector)	22.35	93.91
Mixed (Electric Power sector)	19.73	94.38
Natural Gas	mmBtu/scf	kg CO₂ /mmBtu
Pipeline (Weighted U.S. Average)	1.028 x 10 ⁻³	53.02
Petroleum Products	mmBtu/gallon	kg CO₂ /mmBtu
Distillate Fuel Oil No. 1	0.139	73.25
Distillate Fuel Oil No. 2	0.138	73.97
Distillate Fuel Oil No. 4	0.146	75.06
Residual Fuel Oil No. 5	0.140	72.95
Residual Fuel Oil No. 6	0.150	78.12
Still Gas/Refinery Gas	0.143	66.73
Kerosene	0.135	72.36
Liquefied Petroleum Gases (LPG)	0.092	62.98
Propane	0.091	63.03
Propylene	0.091	67.78
Ethane	0.096	62.64
Ethylene	0.100	67.45
Isobutane	0.103	65.39
Isobutylene	0.103	67.74
Butane	0.101	65.18
Butylene	0.103	67.73
Naphtha (<401 deg F)	0.125	68.04
Natural Gasoline	0.110	66.83
Other Oil (>401 Deg F)	0.139	76.40
Pentanes Plus	0.110	69.24
Petrochemical Feedstocks	0.129	70.97

Default CO₂ Emission Factors and High Heat Values for Various Types of Fuel

Fuel Type	Default High Heat Value	Default CO ₂ Emission Factor
Petroleum Coke	0.143	102.45
Special Naphtha	0.125	72.32
Unfinished Oils	0.139	74.49
Heavy Gas Oils	0.148	74.90
Lubricants	0.144	74.27
Motor Gasoline	0.125	70.22
Aviation Gasoline	0.120	69.66
Kerosene-Type Jet Fuel	0.135	72.61
Asphalt and Road Oil	0.158	75.38
Crude Oil	0.138	74.49
Fossil Fuel-derived Fuels (Solid)	mmBtu/short ton	kg CO₂ /mmBtu
Municipal Solid Waste (units that do not generate steam)	9.95	90.7
Tires	26.87	85.
Fossil Fuel-derived Fuels (Gaseous)	mmBtu/scf	kg CO₂ /mmBtu
Blast Furnace Gas	0.092×10^{-3}	274.32
Coke Oven Gas	0.599×10^{-3}	46.85
Biomass Fuels - Solid	mmBtu/short ton	kg CO₂ /mmBtu
Wood and Wood Residuals	15.38	93.80
Agricultural Byproducts	8.25	118.17
Peat	8.00	111.84
Solid Byproducts	25.83	105.51
Biomass Fuels - Gaseous	mmBtu/scf	kg CO₂ /mmBtu
Biogas (Captured methane)	0.841×10^{-3}	52.07
Biomass Fuels - Liquid	mmBtu/gallon	kg CO₂ /mmBtu
Ethanol (100%)	0.084	68.47
Biodiesel (100%)	0.128	73.84
Rendered Animal Fat	0.125	71.04
Vegetable Oil	0.120	81.53

Default CH₄ and N₂O Emission Factors for Various Types of Fuel

Fuel Type	Default CH ₄ Emission Factor (kg CH ₄ /mmBtu)	Default N ₂ O Emission Factor (kg N ₂ O/mmBtu)
Coal and Coke	1.1×10^{-02}	1.6×10^{-03}
Natural Gas	1.0×10^{-03}	1.0×10^{-04}
Petroleum	3.0×10^{-03}	6.0×10^{-04}
Fossil Fuel-derived Fuels	3.2×10^{-02}	4.2×10^{-03}
Blast Furnace Gas	4.8×10^{-04}	1.0×10^{-04}
Coke Oven Gas	2.2×10^{-05}	1.0×10^{-04}
Biomass Fuels - Solid	3.2×10^{-02}	4.2×10^{-03}
Biomass Fuels - Gaseous	3.2×10^{-03}	6.3×10^{-04}
Biomass Fuels - Liquid	1.1×10^{-03}	1.1×10^{-04}

Converting to Metric Tons of CO₂e

1. Determine the total emissions of CO₂, CH₄, N₂O from fossil fuel combustion.
2. Convert all emissions to metric tons, if necessary. 1 kilogram = .001 metric tones
3. Calculate metric tons of CO₂e using the following equation:

$$\text{CO}_2\text{e} = \sum_{i=1}^n \text{GHG}_i \times \text{GWP}_i$$

Where:

- CO₂e = Carbon dioxide equivalent, metric tons/year.
GHG_i = Mass emissions of each greenhouse gas metric tons/year.
GWP_i = Global warming potential for each greenhouse gas (see table below).
n = The number of greenhouse gases emitted.

Common Name	Chemical formula	Global warming potential (100 yr.)
Carbon dioxide	CO ₂	1
Methane	CH ₄	21
Nitrous oxide	N ₂ O	310

Appendix 5: Contact Information

Mailing Address:

ENERGY STAR Challenge for Industry
U. S. Environmental Protection Agency (6202J)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Contact information for questions:

- **E-mail:** challengeindustry@epa.gov
- **Web-site:** www.energystar.gov (Go to *Buildings and Plants* section for Industry)
 - More on the ENERGY STAR Challenge for Industry:
<http://www.energystar.gov/challengeindustry>