

# Carbon Dioxide Inventory and Tracking in Portfolio Manager

## Emission Factors Revised: September 2007

### Introduction:

Commercial and industrial buildings in the United States contribute 45 percent of our national emissions of greenhouse gases.<sup>1</sup> Carbon dioxide (CO<sub>2</sub>) emissions resulting from the consumption of electricity and fossil fuels in these buildings comprise the vast majority of these greenhouse gases. The carbon dioxide accounting and tracking function in ENERGY STAR's Portfolio Manager was designed to provide users with the ability to record, track, and communicate the carbon dioxide emissions associated with the energy use of their buildings. The methodology for calculating CO<sub>2</sub> emissions in Portfolio Manager was designed to be consistent with the Greenhouse Gas Protocol<sup>2</sup> developed by the World Resources Institute (WRI) and World Business Council for Sustainable Development, and as such is compatible with the accounting, inventory and reporting requirements of Environmental Protection Agency's (EPA) Climate Leaders program, as well as other state and NGO registry and reporting programs.

### Methodology for Calculating a Building's Total CO<sub>2</sub> Footprint:

The Portfolio Manager methodology is designed to account for all CO<sub>2</sub> emissions associated with energy use in a building. This inventory includes CO<sub>2</sub> emissions from both fossil fuel consumed on-site (referred to as direct emissions), as well as the emissions generated off-site at power plants that deliver heat or electricity to the building (referred to as indirect emissions). For both direct and indirect emissions, Portfolio Manager utilizes a default fuel analysis approach to calculate a building's total CO<sub>2</sub> emissions footprint. The approach assigns a default carbon factor for each fuel consumed in a building. These fuel specific factors include the carbon oxidation factor of the building's stationary combustion equipment, carbon content, and heating value. These fuel specific factors are used to compute the emissions associated with the fuel consumption at the building. Any precombustion emissions associated with the energy used to extract, process, or deliver fuel to the building are not included.

#### Calculating Direct CO<sub>2</sub> Emissions:

For *direct* CO<sub>2</sub> emissions, each fuel is assigned a carbon content, a carbon oxidation factor, and a carbon to CO<sub>2</sub> ratio to arrive at an emissions factor expressed in mass of CO<sub>2</sub> per unit of fuel energy. Measured (billed or metered) site energy consumption is then multiplied by the following factors shown in **Table 1**.

**Table 1. Direct CO<sub>2</sub> Emission Factors**

Fuel Type	lbs CO <sub>2</sub> / kBtu <sup>3</sup>
Natural Gas	0.11638 <sup>4</sup>
Fuel Oil (No. 2)	0.15966
Wood	0.20488 <sup>5</sup>
Propane	0.13830
Liquid Propane	0.13874

Kerosene	0.15781
Fuel Oil (No. 1)	0.15966
Fuel Oil (No. 5 & No. 6)	0.17198
Coal (anthracite)	0.22619
Coal (bituminous)	0.20403
Coke	0.22293
Fuel Oil (No. 4)	0.15966
Diesel	0.15966

Calculating Indirect CO<sub>2</sub> Emissions:

Similarly, Portfolio Manager uses default emission factor values to determine *indirect* CO<sub>2</sub> emissions from purchased electricity or district energy. For district heat (hot water or steam), use of a default emissions factor does not require the user to obtain boiler efficiency, fuel mix, or fuel emissions factor values from their energy supplier. For purchased district chilled water, the user must obtain the chilled water production method from the energy supplier. For indirect emissions resulting from the consumption of hot water or steam, measured site energy consumption is multiplied by the following factors shown in **Table 2**.

**Table 2. Indirect CO<sub>2</sub> Emission Factors (hot water and steam):**

<b>Fuel Type</b>	<b>lbs CO<sub>2</sub> / kBtu</b>
District Heat	0.1741 <sup>6</sup>
District Chilled Water – Electric Driven Chiller	0.1538 lbs CO <sub>2</sub> /kbtu * (eGRID subregion rate in lbs CO <sub>2</sub> /kbtu divided by 0.64611) <sup>7</sup>
District Chilled Water – Absorption Chiller using Natural Gas	0.16004 <sup>8</sup>
District Chilled Water - Engine-Driven Chiller using Natural Gas	0.10676 <sup>9</sup>

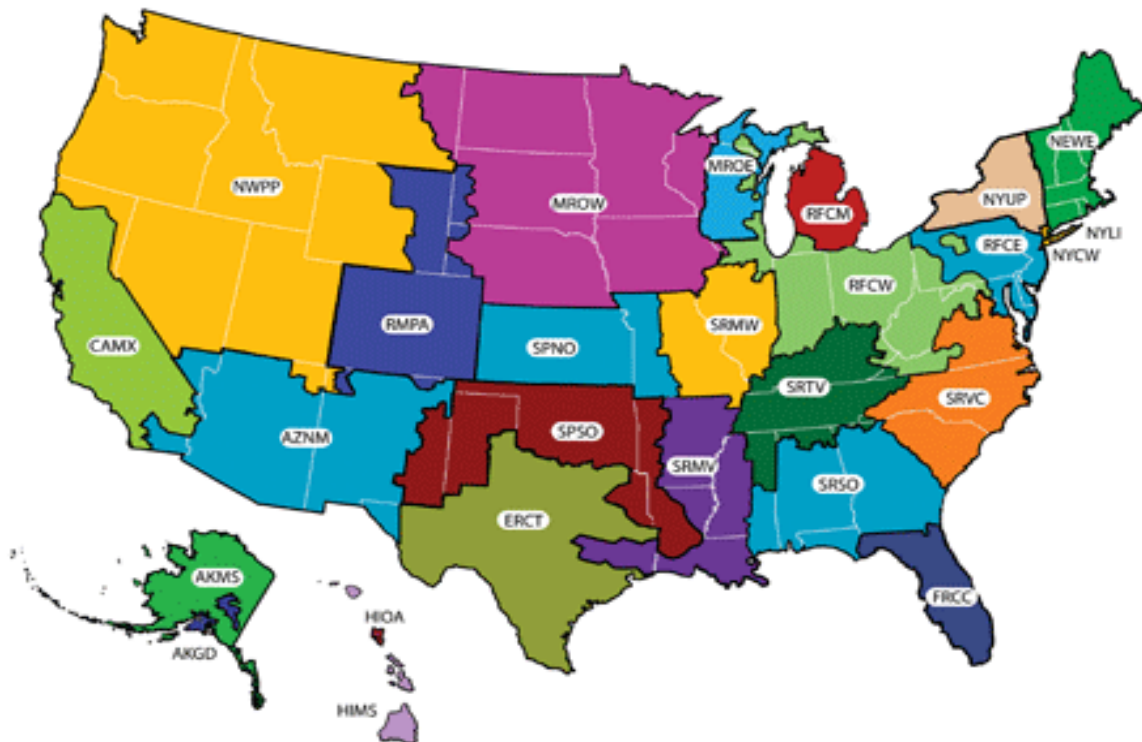
For indirect emissions resulting from the consumption of purchased electricity, site electricity consumption is multiplied by the average electricity production output emission rates of the electricity grid serving the building, according to its eGRID subregion. These factors represent the average emissions from the all grid connected electricity generation units (baseload, intermediate, and peaking). These factors are shown in **Table 3** and the location of these eGRID subregions are shown in **Figure 1** below.

**Table 3. Indirect CO<sub>2</sub> Emission Factors (electricity):**

<b>Electricity Grid by eGRID Subregion</b>	<b>lbs CO<sub>2</sub> /kBtu<sup>10</sup></b>
AKGD (South/Central Alaska)	0.368
AKMS (Most of Alaska)	0.141
AZNM (Southwest US)	0.368
CAMX (Southwest Coast)	0.258
ERCT (Most of TX)	0.416
FRCC (Most of FL)	0.389
HIMS (HI excluding Oahu)	0.427
HIOA (Oahu Island)	0.506
MROE (Eastern WI)	0.545

MROW (Upper Midwest)	0.532
NEWE (New England)	0.266
NWPP (Northwest US)	0.270
NYCW (NYC)	0.270
NYLI (Long Island, NY)	0.414
NYUP (Upstate NY)	0.240
RFCE (Mid-Atlantic)	0.321
RFCM (Most of MI)	0.481
RFCW (Ohio Valley)	0.456
RMPA (CO-Eastern WY)	0.597
SPNO (KS-Western MO)	0.578
SPSO (TX Panhandle-OK)	0.516
SRMV (Lower Mississippi)	0.333
SRMW (Middle Mississippi)	0.540
SRSO (Southeast US/Gulf Coast)	0.437
SRTV (TN Valley)	0.438
SRVC	0.336
National Average	0.399

**Figure 1. Electricity Grid by eGRID Subregions:**



#### **Mapping a Building to an eGRID Subregion:**

Given the interconnected nature of the electric transmission and distribution system and the resulting inability to identify the generation source for the electricity used, eGRID subregions were selected as a practical resolution of electricity origin to determine

electricity emissions factors. An eGRID subregion, as defined by the U.S. EPA's Emissions & Generation Resource Integrated Database (eGRID), represents a portion of the U.S. power grid that is contained within a single North America Electric Reliability Council (NERC) region, which have similar emissions and resource mix characteristics, and may be partially isolated by transmission constraints. A building is located inside an eGRID subregion by mapping its zip code to its eGRID subregion. In many cases, a zip code is not confined within one eGRID subregion. In these instances, the user is asked to identify his/her electric distribution utility in order to locate that building within an eGRID subregion<sup>11</sup>. When a building has been mapped to an eGRID subregion, Portfolio Manager will also compare the grid fuel mix and the emissions factors for that building against the national averages. Finally, the user may also specify an individual power generation plant when the building is making a direct purchase of electricity from that plant. In some instances, a user may have a direct purchasing agreement or contract with a specific electric utility plant. The power purchase agreement specifies the terms and conditions under which electric power will be generated and purchased.

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<sup>1</sup> Inventory of U.S. Greenhouse Gas and Sinks: 1990-2005. "USEPA #430-R-07-002, Table 2-16: U.S. Greenhouse Gas Emissions by Economic Sector and Gas with Electricity-Related Emissions." April 2007. 14 June 2007 .

<sup>2</sup> World Resources Institute and the World Business Council for Sustainable Development, *The Greenhouse Gas Protocol; A Corporate Accounting and Reporting Standard*. Revised Edition. <http://www.ghgprotocol.org/DocRoot/7e9ttsv1gVKekh7BFhqo/ghg-protocol-revised.pdf>

<sup>3</sup> U.S. Environmental Protection Agency, Climate Leaders Program, Direct Emissions from Stationary Combustion Sources, October 2004. [http://www.epa.gov/climateleaders/resources/cross\\_sector.html](http://www.epa.gov/climateleaders/resources/cross_sector.html)

<sup>4</sup> Assumes HHV of 1027 Btu/scf. HHV is de-rated for buildings at altitude by three digit zip.

<sup>5</sup> Considered biogenic carbon by IPCC. Typically reported separately as CO<sub>2</sub> emissions from non-fossil fuel combustion.

<sup>6</sup> from EIA 1605B reporting guidelines:

Weighted average based on EIA 1998 MEC survey data on the quantities of natural gas, coal, and residual and distillate fuel oils consumed as boiler fuel. Carbon coefficients provided in EIA's Assumptions to the Annual Energy Outlook 2003, and EIA/OAF efficiency assumptions of 80, 81, and 82 percent for natural gas, coal, and petroleum boilers, respectively. Value does not include transmission losses.

Note: unlike Portfolio Manager site to source conversions, 1605B guidance makes no CO<sub>2</sub> intensity distinction between district hot water and district steam

<sup>7</sup> from EIA 1605B reporting guidelines: "chilled water efficiencies based on California Climate Action Registry, General Reporting Protocol (10/92), Value does not include transmission losses.

Emissions Factor expressed in kg CO<sub>2</sub>/ton hour cooling purchased = 0.837 \* Regional Electricity Emissions Factor, expressed in MT CO<sub>2</sub>/MWh"

<sup>8</sup> from EIA 1605B reporting guidelines: "chilled water efficiencies based on California Climate Action Registry, General Reporting Protocol (10/92)"

0.871 kg CO<sub>2</sub>/ton hour\*(2.205 lbs CO<sub>2</sub>/kg)\*(ton hour/0.012 MMBtu)

<sup>9</sup> from EIA 1605B reporting guidelines: "chilled water efficiencies based on California Climate Action Registry, General Reporting Protocol (10/92)"

0.581 kg CO<sub>2</sub>/ton hour\*(2.205 lbs CO<sub>2</sub>/kg)\*(ton hour/0.012 MMBtu)

<sup>10</sup> U.S. EPA's Emissions & Generation Resource Integrated Database (eGRID). eGRID2006 Version 2.1 contains the complete release of year 2004 data. The data are organized to reflect the owner, operator and electric grid configuration as of October 1, 2006. [www.epa.gov/cleanenergy/egrid](http://www.epa.gov/cleanenergy/egrid)

<sup>11</sup> Zip code mapping accomplished through the InteliMap Inc.'s Utility Boundaries software product, also utilized by EPA's Power Profiler. Non-US buildings are assigned the US national average emission factor.