www.eia.doe.gov Energy Information Administration

Estimation of Carbon Dioxide Emissions in the *Short-Term Energy Outlook*

Introduction

Energy-related carbon dioxide (CO_2) emissions account for about 98 percent of U.S. CO_2 emissions (EIA, *Emissions of Greenhouse Gases Report*). The vast majority of CO_2 emissions come from fossil fuel combustion (coal, natural gas, and petroleum), with small amounts from the nonfuel use of energy inputs, and emissions from electricity generation using non-biogenic municipal solid waste and geothermal energy. Other sources include emissions from industrial processes, such as cement and limestone production.[1]

The EIA *Short-Term Energy Outlook* (*STEO*) is a monthly forecast of energy supply, consumption, and prices that looks forward from 12 to 24 months (every January the outlook is extended through December of the following year). The *STEO* provides a history and forecast of CO_2 emissions from the consumption of the three fossil fuels: coal, natural gas, and petroleum. The historical and projected CO_2 emissions are available as monthly, quarterly, and annual data series from either the *STEO* Table 9a. U.S. Energy Indicators or from the *STEO* Custom Table Builder[2]. Long-term forecasts of CO_2 emissions are available in the EIA *Annual Energy Outlook*. The short-term forecasts for CO_2 emissions are calculated from the *STEO* projections of fossil fuel consumption and estimated conversion factors of CO_2 emissions per unit of fuel consumed calculated from the historical *Monthly Energy Review (MER)* database and the *Emissions of Greenhouse Gases Report*.

Forecast Procedures

STEO CO_2 emission projections are based on *STEO* projections of fossil fuel consumed (in quadrillion Btu) and calculated CO_2 emissions factors (million metric tons CO_2 emissions per quadrillion Btu fuel consumed). The calculated CO_2 emissions factors are based on historical emissions and consumption reported in the

[1] For a more detailed explanation of the calculation of anthropogenic CO_2 emissions refer to EIA Documentation for Emissions of Greenhouse Gases in the United States 2006.

[2] The historical monthly CO_2 emissions in the *STEO* database are from the EIA *Monthly Energy Review* (*MER*). The monthly MER data are benchmarked to the annual *Emissions of Greenhouse Gases* report. The MER will begin publishing monthly emissions in August 2009.

MER. The historical MER data, in turn, are benchmarked to the annual *Emissions of Greenhouse Gases* report.

The *STEO* may not exactly reproduce the *MER* energy consumption and CO_2 emissions history because *STEO* projects some fuel consumption at a more aggregated level and can not account for differences in nonfuel use. For example, the *STEO* does not disaggregate total petrochemical feedstock into naphtha feedstock and gas oil feedstock, which is necessary for accurate CO_2 emissions accounting. Consequently a benchmarking procedure is used to scale forecast CO_2 emissions calculated by the *STEO* model up or down based on a benchmark factor calculated from the most recent 12 months of CO_2 emissions history published in the *MER*, by dividing the *MER* emissions by the *STEO* calculated emissions. A summary of annual average CO_2 emission benchmarking factors is provided in Table 1.

Table 1. STEO CO_2 Emission Benchmarking Factors

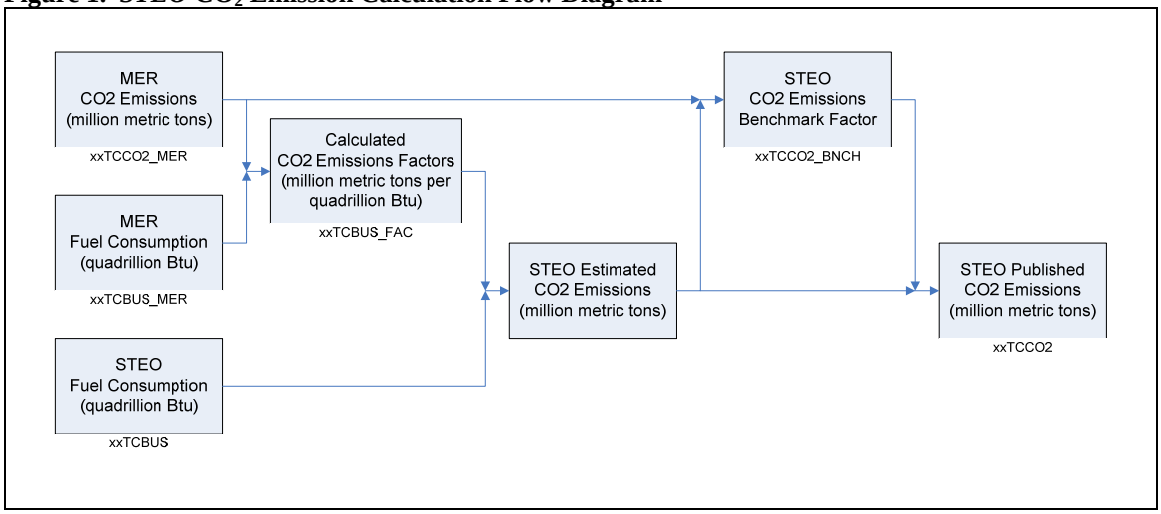
	Natural Gas	Petroleum	Coal
1994	1.0053	1.0009	0.9980
1995	1.0069	1.0009	0.9996
1996	1.0077	1.0009	0.9989
1997	1.0110	1.0009	1.0002
1998	1.0078	1.0009	0.9990
1999	1.0050	1.0009	0.9973
2000	0.9985	1.0009	1.0039
2001	1.0011	1.0009	1.0049
2002	1.0104	1.0009	1.0081
2003	1.0121	1.0009	1.0074
2004	0.9967	1.0009	1.0081
2005	1.0027	1.0009	1.0001
2006	0.9988	1.0006	1.0046
2007	1.0015	1.0007	1.0036

Source: EIA, *Short-Term Energy Outlook*, August 2009.

Detailed Methodology

A flow chart of the *STEO* procedure for calculating CO_2 emissions is shown in Figure 1, followed by details of the calculation procedures.

Figure 1. *STEO* CO_2 Emission Calculation Flow Diagram



1. Download two variables (fuel consumption and CO_2 emissions) for each of 23 fuels from the historical *MER* database:

*xx*TCCO2_MER = CO_2 emissions from fuel *xx*, million metric tons per month
*xx*TCBUS_MER = Fuel xx consumed, quadrillion Btu per month

where *xx* is:

AB = Aviation gasoline blending components
AR = Asphalt and road oil
AV = Aviation gasoline blend components
BD = biodiesel
CL = Coal
DF = Distillate fuel oil
EO = Fuel ethanol
FE = Petrochemical feedstocks
JF = Jet fuel
KS = Kerosene
LG = Liquefied petroleum gas
LU = Lubricating oil
MB = Motor gasoline blending components
MG = finished motor gasoline
MS = Miscellaneous petroleum products
NG = Natural Gas
PC = Petroleum coke
PP = Pentanes plus
RF = Residual fuel oil
SG = Still gas
SN = Special naphthas
UO = Unfinished oils
WX = Waxes

2. Calculate historical CO_2 emission conversion factors[3] by dividing monthly total CO_2 emissions (million metric tons) by total product consumption (quadrillion Btu) reported in the *MER*.

xxTCCO2_FAC = xxTCCO2_MER / xxTCBUS_MER

xxTCCO2_FAC = annual average CO_2 emission factor for fuel xx, million metric tons CO_2/quadrillion Btu fuel consumed

The CO_2 emission conversion factors from the most recent full year of historical data are used through the forecast.

3. Estimate historical CO_2 emissions from the *STEO* database using the calculated historical CO_2 emission conversion factors and *STEO* estimates of total fuel consumed:

xxTCCO2 = xxTCBUS * xxTCCO2_FAC

xxTCCO2 = STEO estimate of CO_2 emissions from fuel xx, million metric tons per month

4. Calculate *MER*-to-*STEO* CO_2 emission benchmark factors (shown through 2007 in Table 1), which are equal to the CO_2 emission reported by the MER divided by the CO_2 emissions estimated from the STEO model:

xxTCCO2_BNCH = xxTCCO2_MER / xxTCCO2

xxTCCO2_BNCH = *MER*-to-*STEO* CO_2 emission benchmark factor for fuel xx

5. Extend the historical *MER*-to-*STEO* CO_2 emission benchmark factors over the forecast period using a 12-month moving average:

xxTCCO2_BNCH = @MOVAV(xxTCCO2_BNCH , 12)

xxTCCO2_BNCH = forecast of *MER*-to-*STEO* CO_2 emission benchmark factor for fuel xx
@MOVAV(..) = moving average of previous 12 months

6. Replace the estimated historical CO_2 emissions in the STEO database with values reported in the *MER*:

xxTCCO2 = xxTCCO2_MER

7. Forecast CO_2 emissions based on STEO forecasts of fuel consumption, the CO_2 emission conversion factors, and the *MER*-to-*STEO* CO_2 emission benchmark factors:

[3] The calculated *STEO* CO_2 emission conversion factors are not the same as carbon or CO_2 emissions coefficients. The calculated *STEO* factors may include an adjustment for non-fuel use depending on the fuel.

xxTCCO2 = (xxTCBUS * xxTCCO2_FAC) * xxTCCO2_BNCH

xxTCCO2 = *STEO* estimate of CO_2 emissions from fuel xx, million metric tons
xxTCBUS = *STEO* estimate of total fuel xx consumed, quadrillion Btu
xxTCCO2_FAC = CO_2 emission factor for fuel xx, million metric tons CO_2/quadrillion Btu fuel
xxTCCO2_BNCH = *MER*-to-*STEO* emission benchmark factor for fuel xx

Total petroleum emissions are calculated as the sum of the individual petroleum fuels.