Methodology for Estimating 1990 Electricity Load-based Emissions for Washington State

Stacey Waterman-Hoey, CTED Energy Policy Division 10/11/07

Background

This paper provides an overview of the methodology and assumptions used to estimate Washington State's electricity load-based emissions for the year 1990. A load-based analysis determines the emissions from electric power generation which is sold to Washington State consumers, wherever the generating facility was physically located. Another way to analyze emissions is using a source-based (also called "production-based") method. A source-based method includes only the generation facilities physically located within the geographic boundaries of the state. Washington's electric sector emissions using the source-based method are estimated at 7.5 million metric tonnes CO_2e in 1990, about 9% of Washington State's total gross GHG emissions. In 2005, the electric sector emissions, using the source-based method, were about 15% of the State's total gross GHG emissions.

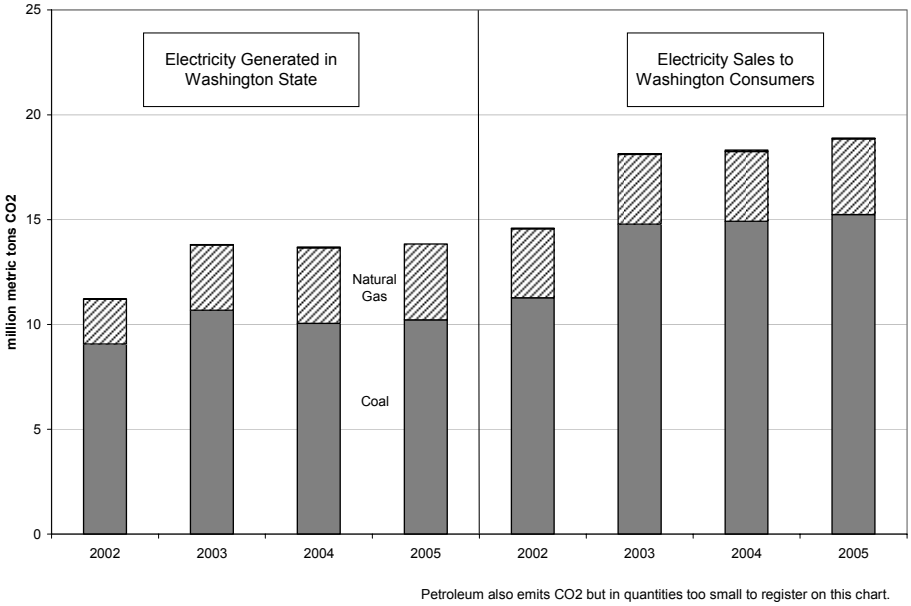
Estimating load-based emissions is more challenging than the source-based approach. The western states, along with 2 Canadian provinces, are part of a very large, interconnected grid system called the Western Intertie which is governed by the Western Electricity Coordinating Council (WECC). Any generating facility within this 14-state region encompassing the western half of the US can sell electricity to anyone else within that region. The interconnectedness of the system means that consumers in Washington State rely on power generated all over the western states.

Beginning in 2000 as a result of legislative action (RCW-1929A), Washington State has tracked sales of electricity by generating resource. The tracking system, known as Fuel Mix Disclosure, creates a "label" much like an ingredients label for food, for each electric utility in the state. The label shows in percentages how the electricity they consumed was generated. Utilities are required to report to the state which generating facilities they own or have long-term contracts for which were used to serve their retail customers in Washington. They are also required to annually disclose the fuel mix label to their customers along with their utility bills.

This data has provided Washington State with the unique ability to estimate load-based emissions going back to about 2000 and to make the following observations. The electricity which is generated within Washington State is largely hydro and as a result, Washington has the lowest emissions per megawatt-hour of electricity for in-state generation of any state in the U.S. However, due to the seasonality of the hydro-system, we export much of the surplus hydro-based generation and rely on imports to meet our peak winter needs. The electricity we import in exchange is primarily coal and nuclear-based. As shown in Figure 1 for the years 2002 to 2005, this phenomenon results in

Washington State consumers relying on electricity which is about 20% higher in emissions than electricity generated within the state.[1]

Figure 1 Estimated CO2 emissions for Washington State Electricity, Generated and Consumed, 2002-2005



Source: *Washington's Greenhouse Gas Emissions: Sources and Trends*, Stacey Waterman-Hoey and Greg Nothstein, WA State Dept. of Community, Trade & Economic Development, Energy Policy Division, December 2006.

1990 Load-Based Emissions Estimate

The Governor's Climate Change Challenge[2] has necessitated the estimation of load-based emissions from the electric power sector in Washington back to 1990, pre-dating the availability of data from Fuel Mix Disclosure. As much as possible, the 1990 methodology presented here relies on the same methodology currently used for the Fuel Mix Disclosure process.

Oregon has participated in Washington's process since its inception. This 1990 load-based analysis was calculated for both Washington and Oregon. California is also in the

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[1] Data for Electricity Sales to Washington customers in 2000 and 2001 are not shown here since they were compiled while the Fuel Mix Disclosure was still under development, and have greater uncertainty than the 2002-2005 values.

[2] From Executive Order 07-02 **WASHINGTON CLIMATE CHANGE CHALLENGE NOW, THEREFORE, I**, Christine O. Gregoire, Governor of the state of Washington declare the state's commitment to address climate change by:

1. Establishing the following greenhouse gas emissions reduction and clean energy economy goals for Washington State:
    - By 2020, reduce greenhouse gas emissions in the state of Washington to 1990 levels, a reduction of 10 million metric tons below 2004 emissions;

process of estimating 1990 load-based GHG emissions, and appears to be following a similar approach.

In 1990, some but not all data was available in electronic form and the original data still available is limited. The most crucial data used for the analysis was obtained from hardcopies in specialty libraries, like the Washington State University Energy Program Library, or was found at the state archives. Key goals that underlie the development of the 1990 approach are to ensure that the calculations are 1) transparent, 2) based on publicly available data, and 3) consistent with the Fuel Mix Disclosure. These estimates could potentially be improved by gathering data from utilities, generating facilities, transmission authorities and others. However, it is likely that not all of these entities will have retained detailed records of power transactions back to 1990. Additionally, many entities are no longer in existence or have changed ownership.

It is important to keep in mind that this analysis represents the estimated emissions from electricity consumed by Washingtonians in 1990. Individual entities may have emission estimates that differ from our estimates. This analysis is not designed to provide disaggregated entity-level data.

Methodology

Generation and Emissions

As with Fuel Mix Disclosure, the 1990 estimate begins with generation and fuel use data for individual facilities located within the Western Intertie. This data is available from the Energy Information Administration's (EIA) Forms 906 and 920. Generating plant operators report monthly fuel use and MWh output to the EIA. To estimate emissions for the facilities, the fuel use data is multiplied by fuel-specific emissions rates for CO2. The fuel use is expressed in million British thermal units (MMBtu), the emission rates are in pounds of CO2 per MMBtu rate (CO2Lbs/MMBtu). Table 1 shows the fuels, units, CO2 rates and the source data.

Table 1 Fuel and CO2 emission factors

Description	Physical Units	MMBtu/Unit	CO2Lbs/MMBtu	Source Of CO2 Emission Rate
Anthracite Coal	short tons	15.02	227.38	EIA Electric Power Annual 2000 Volume II, Table A4
Bituminous Coal	short tons	18.62	209.571	EIA Electric Power Annual 2000 Volume II, Table A4
Lignite	short tons	18.88	215.95	EIA Electric Power Annual 2000 Volume II, Table A4
Heavy Oil	Barrels (42 gal.)	6.29	173.72	EIA Electric Power Annual 2000 Volume II, Table A3
Light Oil	Barrels (42 gal.)	5.83	161.27	EIA Electric Power Annual 2000 Volume II, Table A3
Natural Gas	thousand cubic feet	1.03	116.38	EIA Electric Power Annual 2000 Volume II, Table A3
Coke	Barrels (42 gal.)	6.02	225.13	EIA Electric Power Annual 2000 Volume II, Table A3
Waste	short tons	9.95	91.9	Only approx. 1/3 of MSW heat content is from non-biogenic

				materials. This CO2 rate takes that into account.
Landfill Gases	thousand cubic feet	0.49	116.38	EIA Electric Power Annual 2000 Volume II, Table A3
Other	N/A	15.02	0	
Water	MWh (pumping energy)	3.41	0	
Wood	short tons	10.90	0	Considered part of the natural carbon cycle so zero CO2 emissions
Geothermal	N/A	0	0	
Solar—Thermal	N/A	0	0	
Solar—Photovoltaic	N/A	0	0	
Wind	N/A	0	0	
Nuclear	N/A	0	0	

Combining the facility-level fuel-use data for 1990 and the fuel-specific emissions rate results in the total CO_2 output of each facility. The total emissions from all facilities in the Northwest Power Pool in 1990 are reported in Table 2.

Table 2 Gross Emissions from NWPP facilities, 1990

	MWh	Million Metric Tons CO2
Biomass	410,147	-
Coal	73,154,928	73.3
Gas	2,509,818	1.4
Geothermal	151,825	-
Hydro	147,373,165	-
Nuclear	11,815,846	-
Oil	172,454	0.2
Total	**235,588,182**	**74.9**

Utility ownership of facilities

The next step begins with the assumption that a utility's owned or contracted resources were used first to meet the needs of that utility's customer load. 1990 utility ownership shares for large thermal resources located in the northwest is found in the Pacific Northwest Utility Conference Committee (PNUCC) Northwest Regional Forecast of Power Loads and Resources, July 1990-June 2010, Tech Appendix (March 1990). The PNUCC report only covers ownership of facilities located within the region.

Ownership data for out-of-region facilities could be found only for the investor-owned utilities (IOUs), based on their 1990 FERC Form 1 filings. However, the IOUs were the primary entities purchasing power from out of the region. Some of the larger publicly-owned utilities owned their own generating resources but these facilities tended to be located within the region and so were discoverable in the PNUCC data.

Utility ownership is then matched to facilities and facility-level generation and emissions. Due to lack of publicly available data, no attempt was made to estimate power exchanges or resale of power.

Allocate facility output to customers
The MWh sales by utility is available in the EIA 1990 Electric Sales and Revenue Report. To allocate generation and emissions to utilities with customers in multiple states, all of their owned or contracted generation was pooled and apportioned relative to their sales to Washington customers.

Net System Mix
All of the generation which was known to be owned or contracted by WA utilities is allocated to customers in Washington (this analysis was also applied to Oregon). The unassigned generation which remains in the Northwest Power Pool is called the net system mix (also referred to as unspecified power) and is assumed to represent wholesale or spot market sales as well as exports from the region.

A couple of utilities in Washington and Oregon did not own or contract enough resources to cover their native loads. The difference between their owned/contracted resources and sales to retail customers was assigned the fuel mix and emissions of the net system mix, as it is assumed that that shortfall was met by the wholesale market. Utility-owned generation in excess of the utility's native load was assumed to be part of the net system mix. The carbon intensity of the net system mix was calculated as 0.39 metric tons CO2/MWh.

BPA full requirements customers
Public utilities which did not own large thermal resources were assumed to purchase hydro and nuclear generation from BPA, based on their priority access to BPA resources. This includes all of the full and partial requirements customers of BPA.

Regional imports
Regional imports into the NWPP are not estimated because the region was at a net surplus at that time.

Results

The methodology described here leads to an estimate of emissions from electric power consumption in Washington for 1990 of 18.0 million metric tons of CO2, as shown in the following tables. This implies a carbon intensity of 0.197 metric tons of CO2 per MWh. Table 3 reports the generation by type of fuel, as assigned to utilities serving Washington and Oregon customers based on ownership of resources. This generation assigned to the State utilities in this table excludes market purchased by the utilities. The Net System Mix represents the generation that was available for purchases by utilities in the NWPP. Table 4 follows the same format as Table 3 but reports CO2 emissions rather than

generation. Table 5 reports the generation and emissions assigned to Washington customers, including an allocation of generation and emissions from market purchases, based on the rates calculated for the Net System Mix.

Table 3 Utility Ownership of Facility Output (prior to assigning market purchases)

Fuel	NWPP Total electricity output	Assigned to WA utilities (inlc BPA)	Assigned to OR utilities (incl BPA)	Net System Mix *
	MWh	MWh	MWh	MWh
Biomass	**410,147**	224,094	-	186,053
Coal	**73,154,928**	12,289,897	15,610,990	45,254,040
Gas	**2,509,818**	20,817	837,571	1,651,430
Geothermal	**151,825**	12,271	45,267	94,287
Hydro	**147,373,165**	61,770,228	18,225,672	67,377,265
Nuclear	**11,815,846**	5,001,015	5,449,057	1,365,774
Oil	**172,454**	2,081	-	170,373
Total resources	**235,588,182**	**79,320,402**	**40,168,557**	**116,099,223**

*including electricity assigned out of state, and BPA sales outside WA and OR.

Table 4 Assignment of Specific Facility Emissions to Utilities (prior to assigning market purchases)

Fuel	NWPP Total Emissions	Assigned to WA utilities (inlc BPA)	Assigned to OR utilities (incl BPA)	Net System Mix *
	Million Metric tons CO2	Million Metric tons CO2	Million Metric tons CO2	Million Metric tons CO2
Biomass	**-**	-	-	-
Coal	73.3	13.3	15.6	44.3
Gas	1.4	0.02	0.4	0.96
Geothermal	-	-	-	-
Hydro	-	-	-	-
Nuclear	-	-	-	-
Oil	0.2	0.003	-	0.150
Total resources	**74.9**	**13.4**	**16.1**	**45.5**

**including electricity assigned out of state, and BPA sales outside WA and OR.

Table 5 Estimated Washington 1990 load-based fuel mix and CO2 emissions

	MWh	Million Metric Tons CO2
Biomass	224,094	-
Coal	12,289,897	13.35
Gas	20,817	0.02
Geothermal	12,271	-
Hydro	61,770,228	-
Nuclear	5,001,015	-
Oil	2,081	0.003
Market purchases	11,725,749	4.59
Total	**91,046,151**	**17.96**