**Appendix A: Definitions and parameters used in EPS Survey Document and EPS Calculator**

**Key power plant criteria reflected in the EPS survey**

**Turbine manufacturers**: Commerce reviewed the commercially available and purchased CCCTs from the three CCCT manufacturers that are active in the United States: General Electric, Siemens, and Mitsubishi.

**CCCT model design**: Manufacturers build a range of CCCTs. Generally the machines fall into three groups: 1. Small aero derivative, 2. Mid-sized mid to advanced technology, and 3. Larger advanced technology machines. Commerce tried to identify the CCCTs as precisely as possible based on the national survey results.

**Plant architecture**: For the 2017 survey, we focused primarily on CCCTs of “1x1” architecture (one combustion turbine followed by one steam turbine) as this is the primary format used in the Northwest. Several stakeholders commented during the 2012 EPS cycle that larger advanced H and J class “2 x 1” CCCTs, which exceed 1000 MW of capacity, are not likely to be built in the Northwest. We subsequently removed several larger format CCCTs from the 2012 EPS calculator.

**Purchased and available**: Commerce did not include in the survey CCCTs that, while listed as available on websites, had not been purchased and installed by utilities or independent power producers over the past five years and therefore cannot be considered “new, commercially available and purchased”.[[1]](#footnote-1)

**Parameters included in the EPS calculator**

**Heat rate**: A key performance metric for CCCTs, or any thermal power plant, is its heat rate. Heat rate is the amount of chemical energy input, expressed in British thermal units (Btu) needed to produce a kilowatt-hour (kWh) of electricity. GHG emission rates are calculated from heat rates, so this is the first piece of information needed for updating the state’s EPS. Typical heat rates for new CCCTs range from 6,300 to 7,300 Btu/kWh. A lower number represents a more efficient power plant.

**Power plant efficiency**: Another common performance metric is CCCT efficiency, and can be calculated from the heat rate. This is a measure of the percentage of the chemical energy in the fuel that is converted to electricity. It is calculated as 3,412 Btu, the amount of energy in one kWh, divided by the CCCT heat rate. Typical optimal efficiencies for new CCCTs range from 45 to 55 percent. A higher number represents a more efficient power plant.

**New and clean performance**: New and clean performance parameters are what GTW reports and represents the performance (heat rate or efficiency) of a power plant when it is new and generally running at optimal conditions (unless otherwise specified). New and clean performance values may be expressed on a net basis, where onsite power losses are taken into account.

**Lower Heating Value and System loss (gross vs. net output)**: CCCT performance is typically presented in terms of lower heating value (LHV) of a fuel and on a gross output basis. We convert it to the more widely used higher heating value (HHV) of natural gas. On-site parasitic losses to run equipment mean the net power available to the power grid is slightly lower than the gross value.

**Operational performance**: Operational performance (heat rate or efficiency) is what Commerce is focusing on for the EPS survey and EPS update. It represents real world CCCT performance and takes into account many factors that essentially increase the average heat rate (decrease the efficiency) and GHG emission rate of the CCCT. These factors are referred to in this document as de-rating factors. Two key adjustment factors that deserve special mention are plant degradation due to aging, stop/start cycling, and partial load operation.

Plant degradation, or aging, reflects the loss of efficiency that occurs as a plant is used and operational hours build up. In this analysis, the aging adjustment attempts to represent a middle-aged plant that is at the end of a maintenance cycle (maintenance partially restores CCCT performance).

Cycling a CCCT by stopping and starting it frequently reduces average efficiency and this is taken into account in the EPS survey and calculator. Operating a CCCT at partial output for extended periods, say at 50 percent or less of its rated output, also increases the average annual heat rate and decreases efficiency[[2]](#footnote-2). Frequently starting a CCCT from a cold or warm state also reduces overall efficiency. A start/stop/partial load adjustment factor was developed which reflected the above factors.

Other adjustment factors for duct firing and inlet cooling were also assessed and are incorporated into the EPS calculator.

The final operational heat rate approach used in the EPS calculator (and associated operational emission rate) is conservative. Note, Commerce did not focus on the most extreme possible combination of de-rating factors when determining CCCT operational performance measures, as this combination of factors is a low-probability event.

**Average GHG emission rate**: The quantity of greenhouse gases emitted (overwhelmingly CO2), expressed in pounds per megawatt-hour of electricity production calculated on an annual basis. This value can be calculated using the new and clean or the adjusted operational heat rate for a CCCT. Commerce used a simple average for determining the average GHG emission rate.

1. The survey includes the new and clean heat rate for 20 representative new CCCTs. Heat rate values are adjusted to take into account a number of design and operational factors that influence CCCT heat rate and GHG emissions. The survey does not include CCCTs that are commercially available, but were not sold/purchased and installed by utilities or independent power producers in the U.S. from 2012-2017. [↑](#footnote-ref-1)
2. Power plants often operate at partial output when load following. [↑](#footnote-ref-2)