Submission

Time-Varying Calculation of GHG Emissions from Supplied Electricity

Submission on the Technical Guidelines for the Estimation of Greenhouse Emissions and Energy at Facility Level

Prepared for
Department of Climate Change

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(Revised)

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CONTENTS

1. PURPOSE

The purpose of this submission is to propose that the National Greenhouse and Energy Reporting System should recognise that the greenhouse gas (GHG) emissions intensity of electricity supplied to end-users varies with the time of day, with the days of the week, and with seasons.

We understand that the variation over time in the emissions intensity of supplied electricity was considered during the development of the framework for the Australian National Greenhouse Accounts. At that time, it was reportedly decided not to implement time-varying calculation of GHG emissions from supplied electricity because the differences resulting from the introduction of such a calculation methodology were seen as immaterial.

This submission argues that this issue should be re-examined. In particular, the submission recommends that emissions attributed to facilities that use large quantities of electricity predominantly at particular times of day, and/or on specific days of the week, and/or during certain times of the year should be calculated using time-variable emission indices.

2. BACKGROUND

Generally, the National Greenhouse and Energy Reporting System calculates the GHG emissions produced during an energy-consuming activity by multiplying energy consumption figures by appropriate emission factors (ie tonnes of carbon dioxide equivalent emitted per unit of the relevant energy form). The Department of Climate Change provides emission factors most commercially supplied energy forms.

However, the situation is more complicated in the case of electricity. The GHG emissions intensity of supplied electricity varies as the generation mix of the supply system changes with the time of day. When the mix includes a larger proportion of high GHG-emitting generators (such as coal-fired power stations), the emissions intensity is higher than at times when the mix includes a larger proportion of low GHG-emitting generators (such as hydro power plants and wind turbines). For electricity end-uses that take place predominantly at certain times of the day (eg pumping for water supply systems) there is likely to be material differences between emissions calculated using standard emission factors ("time-static factors") as compared with using indices that recognise the variations in emissions intensity with time of day ("time-varying indices"). Similar material differences are likely to occur for electricity end-uses that take place predominantly on specific days of the week or during certain times of the year.

3. TIME-VARYING EMISSIONS INTENSITY OF ELECTRICITY

Data on the electrical energy sent out by individual power stations can be obtained from the National Electricity Market Management Company (NEMMCO). These data provide a record of changes over time in the generation mix in the National Electricity Market (NEM). It is possible to use this information to calculate time-varying GHG emission indices. These indices can then be applied to emissions calculations to account for the variations over time in the emissions intensity of supplied electricity.

3.1 Emissions Intensity of Electricity Supplied in NSW

Figures 1 and 2 show annual and five-year average GHG emission indices for electricity supplied in NSW for each of the 48 half hour periods during the day over the five calendar years 2003 to 2007. Across the day, there is a variation of 12.1% between the lowest and highest five year average emission indices.

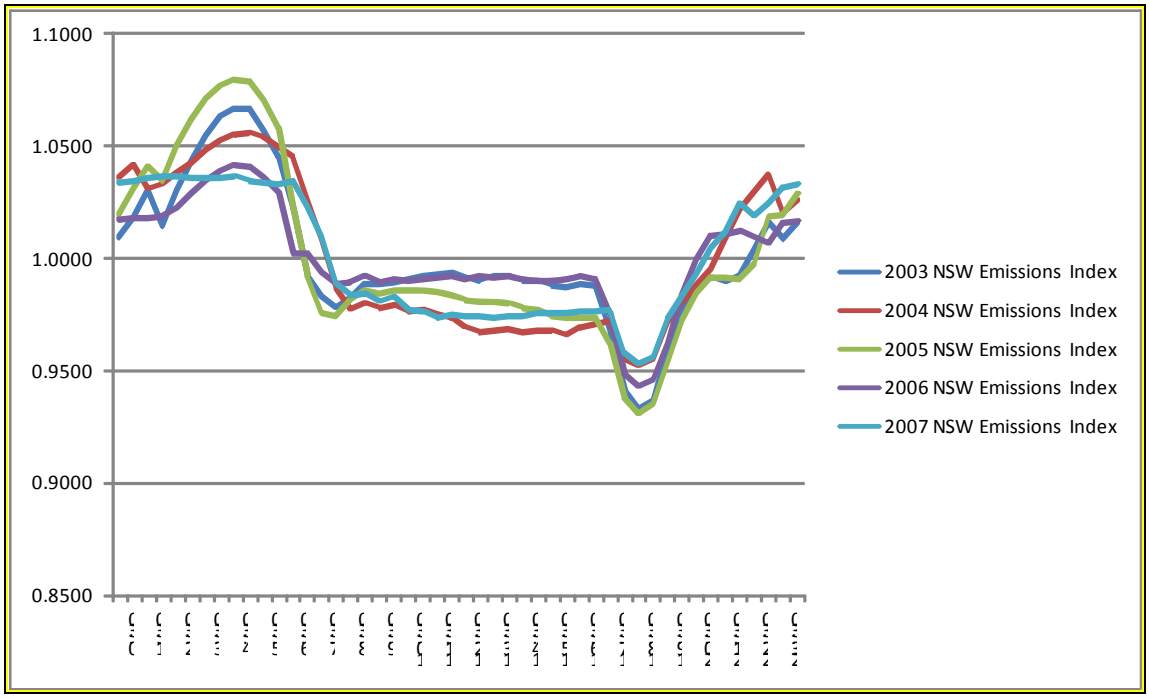

Figure 1. Annual Average GHG Emission Indices for Electricity Supplied in NSW, Calendar Years 2003 to 2007

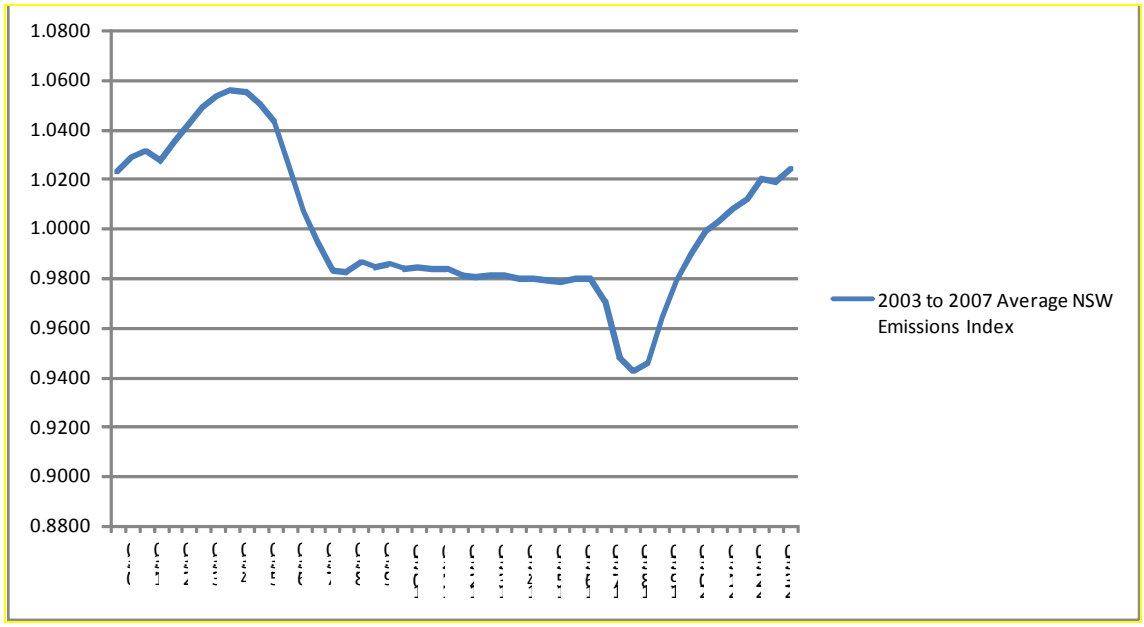

Figure 2. Five Year Average GHG Emission Index for Electricity Supplied in NSW, Calendar Years 2003 to 2007

3.2 Calculation of Half-Hourly Emission Indices

The half-hourly emission indices in Figures 1 and 2 were calculated as follows:

- NEMMCO data[1] were obtained for the monthly average electrical energy (MWh) sent out by each major power station located in NSW in each of the 48 daily half hour NEM trading periods during each of the five calendar years;
- a specific GHG emission factor (tCO2-e/MWh) for each individual power station was calculated from data supplied by ACIL Tasman[2];
- monthly average emissions (tCO2-e) for each power station were calculated for each half hour trading period;
- monthly average net electrical energy flows (MWh) into the NSW NEM region on each of the interconnectors linked to NSW were calculated from NEMMCO data for each half hour trading period;
- monthly average emissions (tCO2-e) were calculated for each interconnector flow into NSW for each half hour trading period, using the average emission factor[3] for the NEM region (either Victoria or Queensland) from which the electrical energy was imported into NSW;
- the energy data were summed to give the monthly average total electrical energy (MWh) generated in, and imported into, the NSW NEM region for each half hour period;
- the emissions data were summed to give the monthly average total emissions (tCO2-e) for electricity supplied in NSW for each half hour period;
- the total emissions data were divided by the total energy data to give a monthly average emission factor (tCO2-e/MWh) for electricity supplied in NSW for each half hour period;
- monthly average half-hourly emission indices were then calculated by dividing the monthly emission factor for each half hour period by the average of the 12 monthly emission factors for the same half hour period in each calendar year.

This calculation methodology has some limitations. Particularly, half-hourly energy sent out data and specific GHG emission factors are available only for the major power stations located in NSW, principally the coal-fired stations and the larger gas turbine and hydro stations. Data are not available for smaller generators powered by gas and renewable energy (mainly small hydro and wind).

Over the five year period 2003 to 2007, the total energy (MWh) generated in, and imported into, the NSW NEM region, as calculated by this methodology, is equivalent to 99.6% of the NSW demand over this period. Therefore, the discrepancies caused by the missing generator data are quite minor.

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1 NEMMCO data were supplied by Global-Roam Pty Ltd using their computer software product NEM-Review.

2 ACIL Tasman Pty Ltd (2007). *Fuel Resource, New Entry and Generation Costs in the NEM: Report 2- Data and Documentation*. Brisbane, ACIL Tasman.

3 Department of Climate Change (2008). *National Greenhouse Accounts (NGA) Factors*. Canberra, DCC.

Most of the generators for which data are not available have lower emission intensities than the major power stations. Therefore, the half-hourly calculated emission factors are probably very slightly higher than they would be if all the data were available. This is likely to have a minimal impact on the calculated emission indices.

3.3 Weekly and Seasonal Variation in Emissions Intensity

Figure 3 demonstrates how the emission indices for electricity supplied in NSW vary by days of the week (weekdays versus weekends and public holidays) and by season (summer versus winter). For the purposes of calculating the indices, 'summer' is defined as October to March and 'winter' is defined as April to September

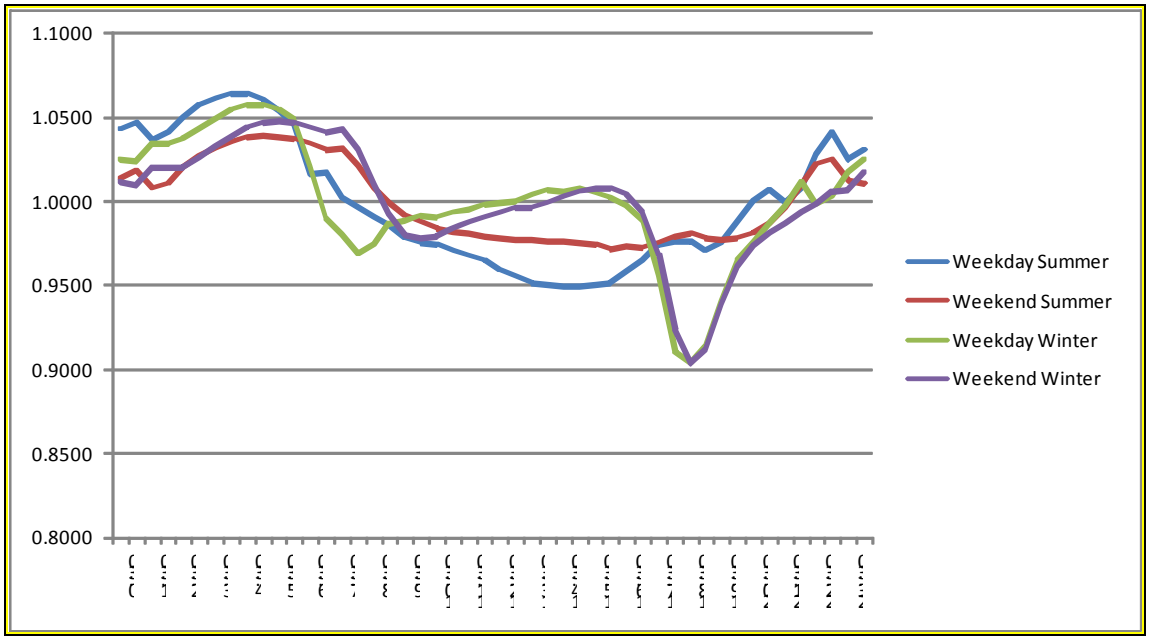

Figure 3. Five Year Average Weekly and Seasonal GHG Emission Indices for Electricity Supplied in NSW, Calendar Years 2003 to 2007

Figure 3 demonstrates that there is also significant weekly and seasonal variation in the emissions intensity of electricity supplied through the NEM.

4. IMPACTS OF TIME-VARYING EMISSIONS INTENSITY

The time-varying emission indices in Figure 3 were used in modelling to calculate the GHG emissions produced by a large water supply pumping facility located in NSW.

Historical river inflows data were used in a model that dispatched the pumps at times when prices in the NEM were low (mainly in the late evening and early morning). The model was used to calculate the emissions that would have been produced by the pumping facility over the 30 year period from April 1974 to March 2004.

Calculations using the time-varying emission indices produced emissions quantities over the 30 year period that were 334 kt CO2-e (2.9%) higher than the quantities calculated using time-static standard emission factors.

Subject to approval by the facility owner, it may be possible to provide the Department of Climate Change with these modelling results on a confidential basis.

5. RECOMMENDATION

This submission demonstrates that the greenhouse gas emissions intensity of electricity supplied to end-users varies with the time of day, with the days of the week, and with seasons. These variations are relatively small but can be significant for facilities that use large quantities of electricity predominantly at particular times of day (eg water supply pumping facilities), and/or on specific days of the week (eg sporting venues), and/or during certain times of the year (eg agricultural facilities such as cotton gins). Therefore, it is recommended that emissions attributed to such facilities should be calculated using time-variable emission indices.