

CARBON DIOXIDE EQUIVALENT INTENSITY INDEX PROCEDURES

PREPARED BY: AEMO Settlements and Prudentials
DOCUMENT REF: Not Applicable
VERSION: 4.00

EFFECTIVE DATE: 10 June 2019
STATUS: FINAL

Approved for distribution and use by:

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DATE: 10 June 2019

VERSION RELEASE HISTORY

Version	Effective date	Summary of changes
0.1	6 September 2010	Initial Draft
0.2	4 November 2010	Draft Determination
1.00	2 December 2010	Final
2.00	23 July 2013	Amended in accordance with 'National Electricity Amendment (Small Generation Aggregator Framework) Rule 2012 No. 8'.
3.00	11 December 2014	Incorporate the document titled "Carbon Dioxide Equivalent Intensity Index Notice July 2012" into the CDEII Procedures and other administrative changes.
4.00	10 June 2019	<ul style="list-style-type: none">• Procedure moved to new AEMO procedures template.• Updates for grammatical errors, inconsistencies and removal of obsolete references.• Updates to source of emission factor data.• Updates to website links.

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1. INTRODUCTION

1.1. Purpose and scope

These are the Carbon Dioxide Equivalent Intensity Index Procedures (**Procedures**) made under clause 3.13.14(a) of the National Electricity Rules (**NER**).

These Procedures have effect only for the purposes set out in the NER. The NER and the National Electricity Law prevail over these Procedures to the extent of any inconsistency.

AEMO must review these Procedures at least once every three years in accordance with NER clause 3.13.14(e).

1.2. Definitions and interpretation

1.2.1. Glossary

Terms defined in the National Electricity Law and the NER have the same meanings in these Procedures unless otherwise specified in this clause.

Terms defined in the NER are intended to be identified in these Procedures by italicising them, but failure to italicise a defined term does not affect its meaning.

The words, phrases and abbreviations in the table below have the meanings set out opposite them when used in these Procedures.

Term	Definition
AEMO	Australian Energy Market Operator
Carbon Dioxide Equivalent Intensity Index or CDEII (t CO ₂ -e/MWh)	Carbon Dioxide Equivalent Intensity Index for the NEM.
Carbon Dioxide Equivalent Intensity Index Procedures or Procedure	This document.
CO ₂ -e	Carbon Dioxide equivalent, which includes other gases which have an equivalent Greenhouse impact such as CH ₄ and N ₂ O.
Emission Factor (t CO ₂ -e/MWh)	The factor representing the amount of greenhouse gas emissions per unit of electricity (t CO ₂ -e/MWh) produced by a <i>generating system</i> .
Fuel Type	Type of fuel used by <i>generating system</i> to produce electricity.
GJ	Gigajoule
Gross Energy	The gross energy generated by a <i>generating system</i> , including auxiliary or house <i>load</i> .
MWh	Megawatt hour
NEM	National Electricity Market
NER	National Electricity Rules

Term	Definition
NGA Factors	National Greenhouse Accounts emission factors published by the Commonwealth Department with responsibility for environment.
NEMMCO	National Electricity Market Management Company
NTNDP	National Transmission Network Development Plan
Planning Database	The <i>NTNDP database</i> , or any database maintained and published by AEMO that supersedes the <i>NTNDP database</i> and includes emission factor assumptions.
t CO ₂ -e/MWh	Tonnes of CO ₂ -equivalent gas per megawatt hour, (expressed in metric tonnes).

1.2.2. Interpretation

These Procedures are subject to the principles of interpretation set out in Schedule 2 of the National Electricity Law.

2. CARBON DIOXIDE EQUIVALENT INTENSITY INDEX CALCULATION

The methodology for measuring the NEM Carbon Dioxide Equivalent Intensity Index follows a similar procedure to what had previously been followed by NEMMCO in producing the Greenhouse Intensity Index.

Sent out generation derived from *metering data* is combined with publicly available generator Emission Factors to provide a NEM-wide Carbon Dioxide Equivalent Intensity Index calculated on a daily basis and published on the AEMO website weekly, when *preliminary statements* are posted for each *billing period*.

Published versions of the Carbon Dioxide Equivalent Intensity Index will not be revised after publication, except as noted in section 3.6 (Manifest Errors).

2.1. Calculation

NER 3.13.14(b)(1) requires these Procedures to specify the methodology for calculating the Carbon Dioxide Equivalent Intensity Index.

The calculation requires two discrete sets of data:

1. The total *sent out generation* (MWh) from each relevant *generating system* and;
2. The carbon dioxide equivalent emissions per unit of electricity (t CO₂-e /MWh) generated by each relevant *generating system*.

The resultant Carbon Dioxide Equivalent Intensity Index for the NEM is reported in tonnes of CO₂-e per megawatt hour (t CO₂-e/MWh).

The following formula is used to convert the Emissions Factor for a *generating system* from t CO₂-e/GJ to t CO₂-e /MWh:

Formula 1:

$$EF_i = \left(\frac{3.6}{TE_i} \right) \times \frac{ef_i}{(1 - A_i)}$$

Where:

EF = Emission Factor for individual *generating system* (t CO₂-e /MWh).

i = *Generating system* comprising *scheduled generating units* or *market generating units* with available energy data & Emission Factor.

TE = Thermal Efficiency (MWh_(Gen)/MWh_(Fuel)) (%) sent out.

ef = Emission Factor for individual *generating system* (t CO₂-e /GJ), derived by summing the combustion emission factor (kgCO₂-e /GJ of fuel) and fugitive emission factor (kgCO₂-e /GJ of fuel).

A = Auxiliaries (% value). Set to zero, as Thermal Efficiency in supply inputs are based on *sent out generation* (i.e. auxiliaries are already accounted for).

3.6 = Conversion factor (1 MWh = 3.6 GJ)¹

Both direct and fugitive emissions for *generating systems* are included in the Emission Factor. These are "Scope 1" and "Scope 3" emissions respectively, as described in the NGA Factors.

The following formula is used to calculate the carbon dioxide equivalent emissions (CDE) for an individual *generating system*.

Formula 2:

$$CDE_i = EF_i \times E_i$$

Where:

CDE = Carbon Dioxide Equivalent emissions (t CO₂-e) from a *generating system*.

EF = Emission Factor for individual *generating system* (t CO₂-e /MWh).

E = *Sent out generation* (MWh) for a *generating system*. This value is the energy measured at the *connection point* to the *network* and consequently excludes the *intra-regional loss factor*.

i = *Generating system* comprising *scheduled generating units* or *market generating units* with available energy data & Emission Factor.

The total Carbon Dioxide equivalent emission for the NEM is calculated as:

Formula 3:

$$CDE_{Total} = \sum_i CDE_i$$

The Carbon Dioxide Equivalent Intensity Index for the NEM is calculated by:

Formula 4:

$$CDEII = \frac{\sum_i CDE_i}{\sum_i E_i}$$

¹ Energy conversion factor – 1 MWh is the equivalent of 3.6 GJ

Where:

CDEII = Carbon Dioxide Equivalent Intensity Index for the NEM (t CO₂-e /MWh).

The above equation produces a weighted average of the Carbon Dioxide Equivalent emissions of relevant *generating systems* in the NEM based on the volume of the *sent out generation*. Refer to section 2.4 for information regarding the energy included in the calculation.

2.2. Time Interval

NER 3.13.14(b)(6) requires these Procedures to specify the time intervals for publishing and updating the Carbon Dioxide Equivalent Intensity Index. The Carbon Dioxide Equivalent Intensity Index is published on AEMO's website at the same time as the NEM *preliminary statements*, which are issued five *business days* after the end of each weekly *billing period*. The Carbon Dioxide Equivalent Intensity Index is calculated and shown for each day within the *billing period*. The timing for publishing the Carbon Dioxide Equivalent Intensity Index is also included in the *spot market timetable* published on the AEMO website.

2.3. Emission Factors

Where available, Emission Factor data is sourced from the latest published Planning Database. The current version can be found on the CDEII webpage, under the Emission Factor Data Source heading, at:

<https://aemo.com.au/Electricity/National-Electricity-Market-NEM/Settlements-and-payments/Settlements/Carbon-Dioxide-Equivalent-Intensity-Index>

The Emission Factors are reviewed each time the Planning Database is updated. This ensures that the Carbon Dioxide Equivalent Intensity Index comes from a reliable source as per NER 3.13.14(c)(3).

Under NER 3.13.14(l), if AEMO is advised that an existing Emission Factor has changed for a given *generating system* based on a source that is publicly available and in AEMO's opinion, reliable, AEMO will as soon as practicable update the Emission Factor used in the calculations. Additionally, AEMO will update the reference table with these details as referenced in section 3.1 of these procedures.

2.3.1. Estimated Emission Factors

Where explicit Emission Factors are not available from the Planning Database, estimated data is used. The following methodology is used for the estimation:

Emission Factors are based on aggregated Emission Factor data sourced from the Energy section of the NGA Factors report in accordance with NER 3.13.14(c)(4). This data is based on the type of fuel of the *generating system* aggregated across the main greenhouse gases listed.

Since this data is captured as kg CO₂-e/GJ, this needs to be converted to t CO₂- e/MWh. This is done using the average value for Thermal Efficiency for *generating systems* of the same type as published in the Planning Database. The conversion is performed using Formula 1 listed in section 2.1 of this document, where the Auxiliary value (A) is set to zero.

AEMO publishes the source of the values used to determine estimated Emission Factors.

If the Planning Database does not specify an Emission Factor for a given *generating system* and no estimate is reasonably possible, that energy data is excluded from the calculation of the Carbon Dioxide Equivalent Intensity Index in accordance with NER 3.13.14(c)(1).

Estimated Emission Factors are updated when AEMO publishes an updated Planning Database, containing revised emission factor data, or when new NGA Factors are published.

2.4. Energy Data

AEMO calculates the Carbon Dioxide Equivalent Intensity Index using *sent out generation* data (in MWh). This is the same energy data used for market settlement. *Sent out generation* is consistently available across all relevant *generating systems* and provides a more accurate measure of the Carbon Dioxide Equivalent Intensity Index than Gross Energy, noting that Gross Energy is not always available for every *generating system*.

2.5. Assumptions

In calculating the Carbon Dioxide Equivalent Intensity Index, AEMO relies on the following assumptions:

- The publicly available data used as Emission Factors is accurate for each *generating system*.
- The mechanism used to estimate Emission Factors for *generating systems* where reliable publicly available data is not available is accurate.
- All assumptions used in the development of the Planning Database values concerning CO₂ emissions are carried over to the production of the Carbon Dioxide Equivalent Intensity Index.

3. CARBON DIOXIDE EQUIVALENT INTENSITY INDEX

3.1. Published Emission Factor Data

AEMO publishes the Emission Factors used to generate the Carbon Dioxide Equivalent Intensity Index for each *generating system* used to calculate the Index.

This lists the identifier used for the *generating system*, the Emission Factor, the NEM *region* to which the *generating system* is assigned, and the source of the Emission Factor, in accordance with NER 3.13.14(l)(1) and (2). Estimated values are marked as such. Any factors used to convert GJ based emission factors to MWh emission factors which have not been estimated can be sourced from the Planning Database. This includes the GJ based emission factors, thermal efficiencies and auxiliary values.

3.2. Updates to Emission Factors used in the Carbon Dioxide Equivalent Intensity Index

Following a review of the Emission Factors used in the Carbon Dioxide Equivalent Intensity Index, the new Emission Factors (including estimated values) are applied to the calculation of the Carbon Dioxide Equivalent Intensity Index as soon as practicable in accordance with NER 3.13.14(k). These updates are not applied retrospectively, hence once the Carbon Dioxide Equivalent Intensity Index is published for a given day it will not be changed, except as noted in section 3.6 (Manifest Errors).

Any updates to the Emission Factor data (including estimated values) used in the calculation of the Carbon Dioxide Equivalent Intensity Index will result in an update to the Emission Factor table in accordance with NER 3.13.14(o) and published as soon as practicable.

3.3. New Generating Systems

When new *generating systems* comprising *scheduled generating units* or *market generating units* are *connected* to the NEM *power system*, in accordance with NER 3.13.14(m)(1) and (2), AEMO updates the Carbon Dioxide Equivalent Intensity Index to include the CDEII data for the new *generating system* as soon as practicable.

If there is no reliable published Emission Factor for the new *generating system*, an estimated Emission Factor is used as outlined in section 2.3.1, according with NER 3.13.14(n).

As referenced in section 3.2 of this document, any updates to the *generating systems* or Emission Factors used in the calculation of the Carbon Dioxide Equivalent Intensity Index are updated in the published table as soon as practicable.

3.4. Carbon Dioxide Equivalent Intensity Index Format

AEMO publishes the following data on the AEMO website for Carbon Dioxide Equivalent Intensity Index:

Date – the given day to which the Carbon Dioxide Equivalent Intensity Index applies.

Carbon Dioxide Equivalent Intensity Index – for the given date (measured as t (CO₂-e)/MWh).

Total *sent out generation* – the total *sent out generation* from the NEM on the given date (measured as MWh).

Daily Total Emissions – summed across the NEM of all scheduled and market *generating systems* used in the Index (measured in t (CO₂-e)).

The data is provided in comma separated value format (.csv), sorted by date, including all Carbon Dioxide Equivalent Intensity Indexes from the commencement of Carbon Dioxide Equivalent Intensity Index reporting in 2011.

The NEM Region supplementary intensity indices are included within this file with the addition of the field:

RegionID – this has a value of QLD1, NSW1, VIC1, SA1, TAS1, or NEM (representing the NEM-wide value).

Refer to section 4.5 for more details.

3.5. Energy Metering Updates

Metering data from a *generating system* for any given day can change at any time through all of the *billing periods* up until the 30-week revision (30 weeks after the *billing period* for the given day). However, the Carbon Dioxide Equivalent Intensity Index will not be updated to account for these variations. The value published for a given day will not be changed, except as noted in section 3.6 (Manifest Errors).

3.6. Manifest Errors

The republishing of data will be at AEMO's discretion. If manifest errors are detected within the published values of the NEM-wide intensity index AEMO may republish the index values within five business days. If manifest errors are detected and new intensity indices are published a notification will be posted to the AEMO website.

4. NEM REGION SUPPLEMENTARY CARBON DIOXIDE EQUIVALENT INTENSITY INDEX CALCULATION METHODOLOGY

AEMO publishes supplementary Carbon Dioxide Equivalent Intensity Indices in the form of *region*-based factors. The *region*-based factors are determined according to NEM *region* and labelled accordingly. That is QLD1, NSW1, VIC1, SA1 and TAS1.

The NEM *regions* approximately equate to State boundaries (with the ACT being part of NSW). The full definition for NEM Regions may be found on the CDEII webpage, under the Regional Boundaries and Margin Loss Factors heading, at:

<https://aemo.com.au/Electricity/National-Electricity-Market-NEM/Settlements-and-payments/Settlements/Carbon-Dioxide-Equivalent-Intensity-Index>

4.1. NEM Region Supplementary Intensity Indices Calculation Methodology

In the calculation of NEM Region Carbon Dioxide Equivalent Intensity Indices, the Emission Factors are those used for the NEM-wide Carbon Dioxide Equivalent Intensity Index, however each index is calculated based on an aggregate at the NEM *region* level rather than across the entire NEM. Therefore, to calculate the NEM Region Intensity Indices, Formulas 1 and 2 as described in section 2.1 remain the same, however the aggregation Formulas would be described as follows:

The total Carbon Dioxide equivalent emission for the NEM *region* (CDE_{NR}) is calculated as:

Formula 5:

$$CDE_{NR} = \sum_{iNR} CDE_{iNR}$$

Where:

CDE_{iNR} = Carbon Dioxide Equivalent emissions (t CO₂-e) from a relevant *generating system* assigned to the *region* (QLD1, NSW1, VIC1, SA1 or TAS1).

iNR = *Generating system* comprising *scheduled generating units* or *market generating units* with available energy data and Emission Factor assigned to the *region*.

The Carbon Dioxide Equivalent Intensity Index (CDEII) for the NEM *region* ($CDEII_{NR}$) is calculated by:

Formula 6:

$$CDEII_{NR} = \frac{\sum_{iNR} CDE_{iNR}}{\sum_{iNR} E_{iNR}}$$

Where:

CDE_{iNR} = Carbon Dioxide Equivalent emissions (t CO₂-e) from a relevant *generating system* assigned to the *region* (QLD1, NSW1, VIC1, SA1 or TAS1).

E_{iNR} = *sent out generation* (MWh) for a relevant *generating system* assigned to the *region*. This value is the energy measured at the *connection point* to the *network* and consequently excludes the *intra-regional loss factor*.

The above equation produces a weighted average of the Carbon Dioxide Equivalent emissions of scheduled and market generation in a *region* based on the volume of the *sent out generation* generated.

4.2. NEM Region Supplementary Intensity Indices Energy Data

The energy data is calculated based on the location of production (i.e. at the *generating system's* location based on its assigned *region*) rather than the location of consumption (that is, ignoring *interconnector* flows).

4.3. NEM Region Supplementary Intensity Indices Emission Factors

The emission factors used in the supplementary intensity indices are the same as those used in the NEM-wide intensity index. Updates to the emission factors apply at the same time as they do for the NEM-wide intensity index.

4.4. NEM Region Supplementary Intensity Indices Publishing Timeframe

The supplementary intensity indices are published according to the existing timetable as the NEM-wide intensity index as described in section 2.2.

4.5. NEM Region Supplementary Intensity Indices Format

The supplementary intensity indices are published in the same csv file as the NEM-wide index as described in section 3.4. For each NEM *region*, for each day, a value is published for the intensity index for that *region*, the total energy, and the total emissions used to determine the intensity index for that *region* on the given day.

4.6. NEM Region Supplementary Intensity Indices Published Emission Factor Data

The published list of *generating systems* and Emission Factors also includes the *region* to which each *generating system* is assigned, as described in section 3.1.