GGAS

GENERATION RULE

WORKED EXAMPLES

Example 1: Category A Hydro Generator

Assume

- Produced 1000 GWh of Net Sent Out Generation in 2004, and is connected to a regulated Transmission System in NSW.
- Has been assigned a Renewable Energy Certificate (REC) baseline of 700 GWh and a Marginal Loss Factor of 0.995 by the Office of the Renewable Energy Regulator (ORER).
- Has in place a PPA with a retailer which entitles the retailer to a maximum of 800 GWh a year.
- The generator elected to create 50,000 RECs from its production.

Step 1: Establish NSW Production Baseline

- Since ORER has assigned a REC baseline and a maximum output has been specified in the PPA, Clause 8.1(b)(ii) of the Rule applies . In this situation the NSW Production Baseline is the lower of the REC baseline and the maximum output assigned to the retailer under the PPA.

The NSW Production Baseline is therefore 700 GWh (the REC baseline).

Step 2: Calculate Emission Intensity (Equation 4)

- Calculate the Emissions Intensity of generation using Equation 4

  Emissions Intensity = Total Greenhouse Gas Emissions/Sent Out Generation

  In this case, since the Generating System is hydro, it has zero emissions. Ie:
  Emissions Intensity = 0 tonnes CO_2-e/MWh

Step 3: Calculate the number of NGACs that can be created

For a Category A Generating System, it is possible for both the ‘Generator’ of the Generating System and the ‘Deemed Retailer’ to create NGACs (depending upon the NSW Production Baseline assigned and actual production).

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Retailer

Based upon Equation 3 of the Rule, since Net Sent Out Generation (1,000,000 MWh), NSW Production Baseline (700,000 MWh), the Eligible Generation for the retailer is simply the NSW Production Baseline (700,000 MWh).

In line with Equation 1 of the Rule, the Deemed Retailer may therefore create:

Number of NGACs that may be created

= Eligible Generation x (NSW Pool Coefficient x Emissions Intensity Adjustment Factor – Emissions Intensity)*

(See table 9 of Schedule A*)

= 700,000 MWh x (0.906 tonnes CO_2-e/MWh x 0.975 – 0 tonnes CO_2-e/MWh)

= 700,000 x 0.88335 tonnes CO_2-e

= 618,345 tonnes CO_2-e

That is, the Deemed Retailer may create 618,345 NGACs in 2004.

Generator for the Generating System

Based upon Equation 2 of the Rule, since Net Sent Out Generation (1,000,000 MWh) – NSW Production Baseline (700,000 MWh) – RECs created/MLF (50,000 MWh/0.995) >0, Eligible Generation for the Generator of the Generating System is:

= Net Sent Out Generation – NSW Production Baseline – RECs created/Marginal Loss Factor

= 1,000,000 – 700,000 –(50,000/0.995)

= 249,749 MWh

In line with Equation 1 of the Rule, the operator of the Generating System may therefore create:

Number of NGACs that may be created

= Eligible Generation x (NSW Pool Coefficient x Emissions Intensity Adjustment Factor – Emissions Intensity)*

** See table 9 of Schedule A*)

= 249,749 MWh x (0.906 tonnes CO_2-e/MWh x 0.975 – 0 tonnes CO_2-e/MWh)

= 249,749 x 0.88335 tonnes CO_2-e

= 220,615 tonnes CO_2-e

That is, the Generator of the Generating System may create 220,615 NGACs in 2004.

Example 2: Category C Gas Turbine Generator

Assume

- Gas turbine Generating System connected to a regulated Transmission System in NSW.
- The Generating System produced 300 GWh of gross generation in 2004 from 2 PJ of natural gas.
- The Generating System's auxiliaries consumed 1 GWh of electricity, and 2 GWh of electricity was imported from the Network
- The Generating System had historical production of
    - 200 GWh of Net Sent Out Generation in 1997
    - 230 GWh of Net Sent Out Generation in 1998
    - 45 GWh of Net Sent Out Generation in 1999
    - 250 GWh of Net Sent Out Generation in 2000
    - 260 GWh of Net Sent Out Generation in 2001
- Production in 1999 was reduced due to disruption in gas supply

Step 1: Establish NSW Production Baseline

Using Clause 8.3(a) of the Rule, for a Category C fossil fuel Generating System, the NSW Production Baseline is calculated as the average annual Net Sent Out Generation during operations over the five calendar years from 1997 to 2001, adjusted for atypical events such as rebuilds, testing or not all units being commissioned. In the example, 1999 would be considered an atypical year due to the extended off-line period caused by pipeline failure. The average would then be calculated over the 4 typical years — 1997, 1998, 2000 and 2001.

The NSW Production Baseline would then be

= (200,000 MWh + 230,000 MWh + 250,000 MWh + 260,000 MWh)/4

= 235,000 MWh

Step 2: Calculate Adjusted Emissions Intensity

The first step is to calculate Total Greenhouse Gas Emission in accordance with Clause 10.1. For gas generation, the Total Greenhouse Gas Emissions are calculated as the sum of

- CO_2 emissions at the point of combustion (Equation 7)
- CH_4 emissions at the point of combustion (Equation 8)
- N_2O emissions at the point of combustion (Equation 9)

- fugitive CO_2 emissions (Equation 10)
- fugitive CH_4 emissions (Equation 11)

Equation 7 CO2 combustion emissions

= Energy Content of Fuel x CO_2 emission factor (Table 3 of Schedule A to the Rule) x combustion factor (Table 4 of Schedule A to the Rule) x 1000

= 2 PJ x 50.8 kt CO_2 /PJ x 0.995 x 1000

= 101,092 tonnes CO_2-e

Equation 8 CH4 combustion emissions

= Energy Content of Fuel x CH_4 emission factor (Table 5 of Schedule A to the Rule) x 1000 x 21

= 2 PJ x 0.008 kt CO_2 /PJ x 1000 x 21

= 336 tonnes CO_2-e

Equation 9 N2O combustion emissions

= Energy Content of Fuel x N_2O emission factor (Table 5 of Schedule A to the Rule) x 1000 x 310

= 2 PJ x 0.0001 kt CO_2 /PJ x 1000 x 310

= 62 tonnes CO_2-e

Equation 10 Fugitive CO2 emissions

= Energy Content of Gas x CO_2 emission factor (Table 2 of Schedule A to the Rule) x 1000

= 2 PJ x 2.60 kt CO_2/PJ x 1000

= 5200 tonnes CO_2-e

Equation 11 Fugitive CH4 emissions

= Energy Content of Fossil Fuel x CH_4 emission factor (Table 2 of Schedule A to the Rule) x 1000 x 21

= 2 PJ x 0.089 kt CH_4/PJ x 1000 x 21

= 3738 tonnes CO_2-e

Total Greenhouse Gas Emissions are then:

= 101,092 + 336 + 62 + 5,200 + 3,738

= 110,428 tonnes CO_2-e

From Equation 4, the Emission Intensity is calculated as:

= Total Greenhouse Emissions/Sent Out Generation

(*where Sent Out Generation = Gross Generation less Auxiliary Electricity Use*)

= 110,428 tonnes CO_2-e/299,000 MWh

= 0.369 tonnes CO_2-e/MWh

Step 3: Calculate the number of NGACs that can be created

Based upon Equation 2 of the Rule, since Net Sent Out Generation (300,000-1000-2000 MWh) – NSW Production Baseline (235,000 MWh) – RECs created/MLF (0) >0, Eligible Generation for the Generating System is:

= Net Sent Out Generation – NSW Production Baseline – RECs created/Marginal Loss Factor

(where Net Sent Out Generation = Gross Generation less Auxiliary Electricity Use less Import from Network)

= 300,000-1000-2000 MWh – 235,000 MWh – 0 MWh

= 62,000 MWh

In line with Equation 1 of the Rule, the operator of the Generating System may therefore create the following number of NGACs from the Generating System:

Number of NGACs that may be created

= Eligible Generation x (NSW Pool Coefficient x Emission Intensity Adjustment Factor – Emissions Intensity)

The Emission Intensity Adjustment Factors are given in Table 9 of Schedule A to the Rule. Since the Generating System is connected to the Transmission System in NSW, the Emission Intensity Adjustment Factor is 0.975. Therefore:

= Eligible Generation x (NSW Pool Coefficient x Emission Intensity Adjustment Factor – Emissions Intensity)

= 62,000 MWh x (0.906 tonnes CO_2-e/MWh x 0.975 – 0.369 tonnes CO_2-e/MWh)

= 62,000 x 0.51435 tonnes CO_2-e/MWh

= 31,889 tonnes CO_2-e

That is, the operator of the Generating System may create 31,889 NGACs in 2004.

Example 3: Landfill generation

Assume

A 20 MW landfill Generating System (classified as a Category D Generating System under the Rule) commenced commercial operation in July 2002.

- It directly exports electricity to the NSW Network via connection to Integral Energy's Distribution System.
- It's gross generation is 150,000 MWh in 2003, (it imports 6,000 MWh from the grid and also uses 4,000MWh on auxiliaries).
- The amount of landfill gas used in the Generating System is not measured. No supplementary natural gas is used in the Generating System.
- The Generating System is ORER accredited with a REC Baseline of zero and a MLF of 1.0
- It creates 146,000 RECs in 2004.

As the Generating System uses a Renewable Energy Source to create RECs from generation, it is ineligible to create NGACs from that same generation. However the Scheme does recognise the additional benefit of methane emissions avoided through use of that landfill gas for generation. As such, the applicant is eligible to create 'additional NGACs' under clause 9.5 of the Rule.

Calculating Net Sent Out Generation and Sent Out Generation (Definitions)

Net Sent Out Generation in 2004 (Gross Generation – Auxiliary Electricity Use – Electricity Imported from the Network) = 150,000 MWh – 4,000 – 6,000 MWh
= 140,000 MWh

Sent Out Generation (Gross Generation-Auxiliary Electricity Use) in 2004 = 150,000 - 4,000 MWh = 146,000MWh

Calculating Total Greenhouse Gas Emissions

Since the Generating System uses a Renewable Energy Source, Equations 14, 15 and 16 apply in calculating Total Greenhouse Gas Emissions.

Energy Content of waste methane used as Renewable Energy Source

Since the amount of methane used is not measured directly, it can be estimated in a manner acceptable to the Scheme Administrator. For example, using the default estimating method set out in Equation 16, it is assumed that Gross Generation less Auxiliary Electricity Use represents 36 per cent of the total energy content of all energy sources used is converted to Net Sent Out Generation.

[Note: 1 MWh = 3.6 GJ]

Energy Content of Renewable Energy Source (PJ) = (1/0.36) x 146,000 MWh x 3.6 / 1,000,000
= 1.46 PJ

CH_4 Emissions from Combustion (Equation 14)

CH_4 emissions from combustion = Energy content of Renewable Energy Source x CH_4 emission factor x 1000 x 21

No specific default factor is listed for the use of landfill gas in electricity generation. However, the applicant has documented and justified to the satisfaction of the Scheme Administrator that the emission factor listed for natural gas – Turbine (0.0080) would be most appropriate.

= 1.46 PJ x 0.0080 kt CH_4/PJ x 1000 x 21

= 245.28 t CO_2-e

N_20 Emissions at point of combustion (Equation 15)

N_2O Emissions at the point of combustion = Energy Content of Renewable Energy Source x N_2O emission factor x 1000 x 310

=1.46 PJ x 0.0001 kt N_2O/PJ x 1000 x 310

= 45.26 t CO_2-e

Fugitive CH_4 emissions avoided (Equation 16)

Fugitive CH_4 emissions avoided through the use of the fuel = Energy content of waste methane used as Renewable Energy Source x CH_4 conversion factor x 1000 x 21

= 1.46 PJ x 18 kt CH_4/PJ x 1000 x 21

= 551,880 t CO_2-e

Total Greenhouse Gas Emissions (Clause 10.1(b))

= CH_4 emissions at the point of combustion + N_2O emissions at the point of combustion – CH_4 emissions avoided through the use of the fuel

= 245.28 + 45.26 – 551,880

= - 551,589.46 t CO_2-e

Calculating Emissions Intensity (Equation 4)

Emissions Intensity = Total Greenhouse Gas Emissions/Sent Out Generation

= - 551,589.46/146,000

= - 3.778 t CO_2-e/MWh

Eligible Generation (Equation 2)

Eligible Generation = Net Sent Out Generation – NSW Production Baseline – RECs Created/MLF

= 140,000 MWh – 0 MWh – 146,000/1.0

= -6,000 MWh

Number of NGACs that may be created (Equation 1)

As eligible generation is ≤ 0, the eligible generation is zero.

Number of NGACs that may be created = Eligible Generation x (NSW Pool Coefficient x Emission Intensity Adjustment Factor – Emissions Intensity)*

(See table 9 of Schedule A)*

As a result no NGACs (for generation) can be created using Equation 1

Number of additional NGACs that may be created (Equation 6)

Number of additional NGACs that may be created = Number of RECs created/MLF x (NSW Pool Coefficient x Emissions Intensity Adjustment Factor – NSW Pool Coefficient -– Emissions Intensity)*

** See table 9 of Schedule A*

= 146,000/1.0 x (0. 906 t CO_2-e/MWh x 1.0 – 0.906 t CO_2-e/MWh -– *(-)3.778)*

= 551,588 t CO_2-e

Total number of NGACs

= Equation 1 entitlement + Equation 6 entitlement

= 0 + 551,588

= 551,588 NGACs

Example 4: Cogeneration

Assume

A company installs a 50 MW gas-fired cogeneration plant in 2002. It does not replace an existing boiler, and no other boiler is used on the site. The cogeneration plant produced 420,000 MWh in 2004, of which 15,000 MWh was used on auxiliaries and 5,000 MWh was imported from the network. The company does not measure the amount of steam used in its industrial process. The cogeneration plant consumed 3 PJ of gas in that year.

Calculating Net Sent Out Generation and Sent Out Generation (Definitions)

Net Sent Out Generation in 2004 (Gross Generation – Auxiliary Electricity Use – Electricity Supplied from the Network) = 420,000 MWh – 15,000 – 5,000 MWh = 400,000 MWh

Sent Out Generation (Gross Generation-Auxiliary Electricity Use) in 2004 = 420,000 – 15,000 MWh = 405,000 MWh.

Calculating Total Emissions

Calculate emissions from combustion using Equations 7, 8 and 9 of the Generation Rule

CO_2 emissions at the point of combustion (Equation 7)

CO_2 emissions at the point of combustion = Energy Content of Fossil fuel x CO_2 emissions factor x combustion factor x 1000

= 3PJ x 50.8 kt CO_2/PJ x 0.995 x 1000

= 151,638 t CO_2

CH_4 emissions at the point of combustion (Equation 8)

CH_4 emissions at the point of combustion = Energy content of Fossil Fuel x CH_4 emission factor x 1000 x 21

= 3 PJ X 0.0001 KT CH_4/PJ X 1000 X 21

= 6 t CO_2-e

N_2O emissions at the point of combustion (Equation 9)

N_2O emissions at the point of combustion = Energy content of Fossil Fuel x N_2O emission factor x 1000 x 310

= 3 PJ X 0.0001 KT N_2O X 1000 X 310

= 93 t CO_2-e

Calculate fugitive emissions associated with the use of the fossil fuel using equations 10 and 11.

Fugitive CO_2 emissions (Equation 10)

Fugitive CO_2 emissions associated with the production of the Fossil Fuel = Energy content of gas x CO_2 emission factor x 1000

= 3 PJ x 2.60 kt/PJ x 1000

= 7,800 t CO_2-e

Fugitive CH_4 emissions (Equation 11)

Fugitive CH_4 emissions associated with the production of the Fossil Fuel = Energy content of Fossil Fuel x CH_4 emission factor x 1000 x 21

= 3 PJ X 0.089 KT/PJ X 1000 X 21

= 5,607 t CO_2-e

Total Emissions

Total emissions = sum of combustion and fugitive emissions

= 151,638 t CO_2-e + 6 t CO_2-e + 93 t CO_2-e + 7,800 t CO_2-e + 5,607 t CO_2-e

= 165, 144 t CO_2-e

Adjustment of Total Greenhouse Gas Emissions for Cogeneration Plant (section 10.2) using Method 4 of Generation Rule

Method 4

Step 1: Determining the amount of heat used from the Cogeneration Plant

The amount of heat used is not directly measured. The Rule states that if this is not known assume it is 70% of the energy content of the fuel, less the energy content of the gross electricity generated.

*Energy content of steam = (0.7 * 3 PJ) – (420,000 MWh x 3.6 GJ/MWh / 1,000,000)*

= 0.59 PJ

[**Note**: 1 MWh = 3.6 GJ]

Step 2: Identify the appropriate fuel for the notional greenhouse gas emissions avoided

Since the cogeneration plant does not replace an existing boiler and there is no other boiler also supplying heat to the user of the cogenerated heat, the actual fuel of the boiler (natural gas) is assumed to be the fuel for the notional greenhouse gas emissions avoided.

Step 3: Calculate the amount of notional fuel avoided

For natural gas, divide the amount of heat used from the Cogeneration Plant by 0.80

= 0.59 PJ /0.8

= 0.74 PJ

Step 4: Calculate the notional emissions avoided

Calculate emissions associated with the use of the fossil fuel using equations 7, 8 and 9.

Equation 7 CO_2 emissions at the point of combustion (Equation 7)

CO_2 emissions at the point of combustion = Energy Content of Fossil fuel x CO_2 emissions factor x combustion factor x 1000

= 0.74 PJ x 50.8 kt CO_2-e/PJ x 0.995 x 1000

= 37,404 t CO_2-e

Equation 8 CH_4 emissions at the point of combustion

CH_4 emissions at the point of combustion = Energy content of Fossil Fuel x CH_4 emission factor x 1000 x 21

= 0.74 PJ X 0.0001 KT CH_4/PJ X 1000 X 21

= 1.5 t CO_2-e

Equation 9 N_2O emissions at the point of combustion

N_2O emissions at the point of combustion = Energy content of Fossil Fuel x N_2O emission factor x 1000 x 310

= 0.74 PJ X 0.0001 KT N20/PJ X 1000 X 310

= 23 t CO_2-e

Calculate fugitive emissions associated with the use of the fossil fuel using equations 10 and 11.

Equation 10 Fugitive CO_2 emissions

Fugitive CO_2 emissions associated
with the production of the Fossil Fuel = Energy content of gas x CO_2 emission factor x 1000

= 0.74 PJ x 2.6 kt/PJ x 1000

= 1,924 t CO_2-e

Equation 11Fugitive CH_4 emissions

Fugitive CH_4 emissions associated
with the production of the Fossil Fuel = Energy content of Fossil Fuel x CH_4 emission factor x 1000 x 21

= 0.74 PJ X 0.089 KT/PJ X 1000 X 21

=1,383 t CO_2-e

Total notional emissions avoided

Total notional emissions avoided = sum of notional combustion and notional fugitive emissions

= 37,404 t CO_2-e + 1.5 t CO_2-e + 23 t CO_2-e + 1,924 t CO_2-e +1,383 t CO_2-e

= 40,736 t CO_2-e

Adjusted total emissions

Adjusted total emissions = Total Emissions – Total emissions avoided

= 165,144 t CO_2-e – 40,736 t CO_2-e

= 124,408 t CO_2-e

Calculating Emissions Intensity (Equation 4)

Emissions Intensity = Total Greenhouse Gas Emissions /Sent Out Generation

= 124,408 t CO_2-e / 400,000 MWh

= 0.311 t CO_2-e /MWh

Calculating the number of NGACs that may be created (Equation 1)

= Eligible Generation x (NSW Pool Coefficient x Emissions Intensity Adjustment Factor – Emissions Intensity)

The Emission Intensity Adjustment Factors are given in Table 9 of Schedule A to the Rule. Since the Generating System is connected to the distribution system in NSW, the Emission Intensity Adjustment Factor is 1.0.

= 400,000 MWh x (0.906 t CO_2-e/MWh x 1.0 – 0.311 t CO_2-e/MWh)

= 238,000 NGACs