



Ministry for the  
**Environment**  
*Manatū Mō Te Taiao*



# Guide to Reporting for *Geothermal Fluid Activities* under the New Zealand Emissions Trading Scheme

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# 1 Overview

As part of the New Zealand Emissions Trading Scheme (NZ ETS), stationary energy participants are required to monitor and report on their greenhouse gas emissions from 1 January 2010. The details of these reporting obligations are set out in the Climate Change (Stationary Energy and Industrial Processes) Regulations 2009 (SEIP regulations).<sup>1</sup>

Persons who use geothermal fluid, including geothermal steam or two-phase fluid, to generate electricity or industrial heat are required to participate in the NZ ETS. In most cases the participant is not the owner of the geothermal field.

Users of geothermal fluid may apply for a unique emissions factor (UEF) for the CO<sub>2</sub> and CH<sub>4</sub> emissions from the use of geothermal steam or geothermal fluid.

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<sup>1</sup> The Climate Change Response Act 2002 and related regulations are available at [www.legislation.govt.nz](http://www.legislation.govt.nz)

## 2 Process for becoming a registered participant

Geothermal fluid users, along with others in the stationary energy and industrial processes sectors, will become mandatory participants in the NZ ETS when their reporting obligations begin on 1 January 2010. Surrender obligations begin on 1 July 2010.

The Climate Change Response Act 2002 (the Act) requires mandatory participants to register as participants within 20 working days of carrying out the ETS activity. In the geothermal sector, this is likely to be within 20 working days of 1 January 2010 ie, 1 February 2010.

To register as a participant you must:

- first, apply to open a holding account which will ultimately be used for surrendering and receiving NZUs. A participant who will be involved in more than one activity can use a single holding account for all activities.

To open a holding account, register as a user on the New Zealand Emission Unit Register (NZEUR) website at [www.eur.govt.nz](http://www.eur.govt.nz). Once registered, use the online application form to open an account

- second, register as a participant by completing an online participant notification form at [www.eur.govt.nz](http://www.eur.govt.nz).

## 3 Using geothermal fluid

*Climate Change (Stationary Energy and Industrial Processes) Regulations 2009: 18–20*

### 3.1 Overview

The formula for calculating emissions associated with using geothermal fluid accounts for greenhouse gas emissions resulting from the release of non-condensable gases in the fluid. This takes place either after separation of steam from fluid, or in the direct use of two-phase geothermal fluid.

The basic calculation is: Emissions = Activity data × Emissions Factor

The activity data reflects the amount of a product – either steam or two-phase geothermal fluid – which will give rise to emissions. Emissions factors are specific to particular plants, not fields.

Any plant using geothermal steam or two-phase fluid not listed in the SEIP Regulations must use the “any other” emissions factor provided, or apply for approval to use a unique emissions factor (see section 4).

### 3.2 Information you are required to collect

The following information must be collected for each class of geothermal fluid in the year:

Information to collect	How to collect
For a plant that uses geothermal steam:	
<ul style="list-style-type: none"><li>tonnes of each class of geothermal production steam used</li></ul>	<p>Include both high pressure and low pressure steam:</p> <ul style="list-style-type: none"><li>resulting from all ‘flashes’ of geothermal fluid</li><li>obtained directly from geothermal wells</li><li>released as an emergency discharge</li></ul> <p>Exclude any steam associated with:</p> <ul style="list-style-type: none"><li>well testing and bleeding</li><li>the disposal of spent geothermal fluid</li><li>unused but maintained geothermal wells</li></ul> <p>as measured by venturi meter or annubar meter or plant supervisory control and data acquisition system or similar system</p>
For a plant that uses two-phase geothermal fluid to produce electricity or heat through a process other than production of geothermal steam:	
<ul style="list-style-type: none"><li>tonnes of each class of two-phase geothermal fluid used</li></ul>	<p>Include all geothermal fluid as recorded at geothermal fluid transmission monitoring points or provided in point of sale information</p>

### 3.3 Record keeping

Participants must retain sufficient records to enable the Chief Executive of the Ministry of Economic Development to verify the emissions a participant reports in their emissions return. Records must be retained for a period of at least seven years after the end of the year to which they relate. This includes any records relating to a unique emissions factor.

### 3.4 Example calculation

Geothermal Plant A uses 845,000 tonnes of high pressure geothermal steam and 567,000 tonnes of low pressure geothermal steam in a year in its generation of electricity. As the plant is not listed in the emissions factor table, it must use the “any other” emissions factor.

Class of geothermal fluid used	Tonnes of production steam	Emissions factor (tCO <sub>2</sub> -e/t)	Emissions (tCO <sub>2</sub> -e)
Any other plant or process using geothermal steam to produce electricity or industrial heat	845,000 + 567,000 = 1,412,000 t	0.0300	42,360
<b>Total</b>			<b>42,360</b>

The total emissions to be reported for the activity of using geothermal fluid for the purpose of generating electricity or industrial heat are:

$$\text{Emissions} = 1,412,000 \times 0.0300 = 42,360 \text{ tCO}_2\text{e}$$



## 4 Unique emissions factors

*Climate Change (Unique Emissions Factors) Regulations 2009: 14–17*

### 4.1 Overview

A geothermal fluid user may apply for approval to use a unique emissions factor (UEF) for a particular geothermal plant. This allows a geothermal participant to use a UEF if there are changes in plant technology or the properties of the geothermal field. It also allows a participant to subtract emissions associated with any reinjected non-condensable gases.

Samples of steam or two-phase fluid and any reinjected condensate must be taken at a sufficient frequency and duration to ensure extrapolations provide representative estimates of emissions across the full range of operating conditions.

### 4.2 Applications

The UEF must be based on the sampling, testing and calculation methods set out in regulation, the results of which must be independently verified.

An application for approval of a UEF must:

- describe the class of geothermal fluid covered by the UEF with well-defined parameters so the fuel may be easily identified and accounted for separately from fuel that is not within the class
- be accompanied by a verifier's statement and a plan for ongoing testing
- be submitted to the Chief Executive of the Ministry for Economic Development by 31 January in the year following the first year to which the UEF relates.

### 4.3 Eligibility

An application may only be submitted if the UEF differs from the default emissions factor that would otherwise apply by more than the estimated uncertainty. As defined in regulation, this is the uncertainty associated with sampling and testing used to establish the unique emissions factor, estimated at a 90 per cent confidence level.

The participant is required to estimate the uncertainty around the unique emissions factor and submit this information to the verifier.

### 4.4 Verification

The sampling, testing and calculations undertaken to develop a UEF must be independently verified. A recognised verifier must review the records provided by the applicant and assess

these against the process outlined in the regulations to establish and calculate the UEF. A list of recognised verifiers will be posted at [www.eur.govt.nz](http://www.eur.govt.nz).

## 4.5 Use of a unique emissions factor

Details of approved unique emissions factors, including the name of the participant and any conditions of approval, will be published in the *New Zealand Gazette*.

If approved by the Chief Executive, a unique emissions factor may be used until:

- there is a material change in any of the information or factors on which the Chief Executive's approval was based, or the relevant legislation, or
- any conditions to which the approval is subject cease to be met or complied with.

To assist in determining when a material change might occur, participants are required to submit a plan for ongoing sampling and testing with their application. The Chief Executive may also grant approval subject to any conditions considered appropriate. This could, for example, include a requirement to submit the results of ongoing testing at a later date.

### Example 1: Geothermal steam

The formula is a weighted average of the separation point-specific emissions factors and thus takes into account variations in the amount of greenhouse gases in high and low pressure steam, and well as differences in the volumes of those steams used.

Information to collect	How to collect
<ul style="list-style-type: none"><li>• tonnes of steam produced per hour</li></ul>	<ul style="list-style-type: none"><li>• through a venturi flow meter or other equipment with equivalent accuracy</li><li>• at, or downstream of, each separation point or at a mix point if there are multiple transmission lines</li></ul>
<ul style="list-style-type: none"><li>• representative samples of the geothermal steam</li><li>• representative samples of the steam condensate being reinjected, if an adjustment is sought</li></ul>	<ul style="list-style-type: none"><li>• in accordance with the stated standards or</li><li>• alternative published methodology with equivalent accuracy and reliability</li><li>• at, or downstream of, each separation point or at a mix point if there are multiple transmission lines</li></ul>
<ul style="list-style-type: none"><li>• mean mass fraction of CH<sub>4</sub> in the representative samples</li></ul>	<ul style="list-style-type: none"><li>• gas chromatography</li><li>• performed by an accredited laboratory</li></ul>
<ul style="list-style-type: none"><li>• mean mass fraction of CO<sub>2</sub> in the representative samples</li></ul>	<ul style="list-style-type: none"><li>• standard chemistry titration analysis methods</li><li>• performed by an accredited laboratory</li></ul>

### Step one: sample and test

Geothermal Energy Limited (GEL) wishes to apply for a unique emissions factor. GEL takes several samples of high pressure and low pressure steam from sampling ports located near the separation points. It considers the samples it has taken to be representative of the full range of operating conditions of the plant.

These samples are tested and mean values for CO<sub>2</sub> and CH<sub>4</sub> are recorded. GEL also records the tonnes of high and low pressure steam per hour flowing to the generation plant. The firm also

wishes to account for some reinjected condensate and undertakes the same sampling and testing on the condensate.

Class of steam	Tonnes per hour (A)	Mean CO <sub>2</sub> (tCO <sub>2</sub> /tS)	Mean CH <sub>4</sub> (tCH <sub>4</sub> /tS)	Emissions factor (tCO <sub>2</sub> e/tS)
Separation point 1: High pressure steam	351	0.04609687	0.00059829	0.05866097
Separation point 2: Low pressure steam	202	0.00316832	0.00000684	0.00331188
Total steam	336			EF <sub>s</sub> = 0.0384
Reinjected condensate	14			EF <sub>R</sub> = 0.014

## Step two: calculation

Using the data above, GEL calculates the UEF for which it seeks approval:

$$\begin{aligned}
 \text{UEF} &= \frac{(351 \times 0.05866097) + (202 \times 0.00331188)}{336} - 0.014 \\
 &= 0.03844304 - 0.014 \\
 &= 0.02444 \text{ tCO}_2\text{e} / \text{t steam}
 \end{aligned}$$

## Step three: estimate uncertainty

GEL estimates the uncertainty associated with the sampling and testing undertaken, at a 90 per cent confidence level, to be plus or minus 9 per cent. The expected maximum emissions factor is

$$1.09 \times 0.0244 \text{ tCO}_2\text{e} / \text{t steam} = \mathbf{0.02664 \text{ tCO}_2\text{e} / \text{t steam}}$$

As the DEF that would otherwise apply is 0.0300 tCO<sub>2</sub>e / t steam for “any other plant”, this UEF passes the eligibility threshold.

## Example 2: Geothermal two-phase fluid

Information to collect	How to collect
<ul style="list-style-type: none"> <li>representative samples of the geothermal two-phase fluid</li> <li>representative samples of the single-phase fluid being reinjected, if an adjustment is sought</li> </ul>	<ul style="list-style-type: none"> <li>in accordance with the stated standards or</li> <li>alternative published methodology with equivalent accuracy and reliability</li> </ul>
<ul style="list-style-type: none"> <li>mean mass fraction of CH<sub>4</sub> in the representative samples</li> </ul>	<ul style="list-style-type: none"> <li>gas chromatography</li> <li>performed by an accredited laboratory</li> </ul>
<ul style="list-style-type: none"> <li>mean mass fraction of CO<sub>2</sub> in the representative samples</li> </ul>	<ul style="list-style-type: none"> <li>standard chemistry titration analysis methods</li> <li>performed by an accredited laboratory</li> </ul>

## Step one: sample and test

GEL uses two-phase geothermal fluid as a source of heat. Steam is released through the use of multiple heat exchangers. All geothermal fluid used is reinjected.

The firm takes samples of both the two-phase fluid and the reinjected single-phase fluid over the course of several months and gets these tested for concentrations of CO<sub>2</sub> and CH<sub>4</sub>. It considers these samples to be representative of the full range of the plant's operating conditions.

Class of two-phase fluid	Mean CO <sub>2</sub>	Mean CH <sub>4</sub>	Emissions factor
Two-phase fluid used	0.05338564	0.00141497	EF <sub>fluid</sub> = 0.08310674
Single-phase fluid reinjected	0.05334410	0.00140266	EF <sub>T</sub> = 0.08288199

## Step two: calculation

Using the data above, GEL calculates the UEF for which it seeks approval:

$$\begin{aligned}
 \text{EF} &= ((m\text{CO}_2 + (m\text{CH}_4 \times 21)) - ((m\text{CO}_2 + (m\text{CH}_4 \times 21))) \\
 &= 0.00022475 \text{ tCO}_2\text{e} / \text{ t two-phase fluid}
 \end{aligned}$$

## Step three: estimate uncertainty

GEL estimates the uncertainty associated with the sampling and testing undertaken, at a 90 per cent confidence level, to be plus or minus 21 per cent. The expected maximum emissions factor is

$$1.21 \times 0.00022475 \text{ tCO}_2\text{e} / \text{ t two-phase fluid} = 0.000271947 \text{ tCO}_2\text{e} / \text{ t two-phase fluid}$$

As the DEF that would otherwise apply is 0.0003 tCO<sub>2</sub>e / t two-phase fluid for “any other plant”, this UEF passes the eligibility threshold.

# Reference list

ASTM E1675 – 04e1 Standard Practice for Sampling Two-Phase Geothermal Fluid for Purposes of Chemical Analysis: <http://www.astm.org/Standards/E1675.htm>

ASTM E947 – 83(2007) Standard Specification for Sampling Single-Phase Geothermal Liquid or Steam for Purposes of Chemical Analysis: <http://www.astm.org/Standards/E947.htm>

Climate Change Response (Emissions Trading Scheme) Act 2008: <http://www.legislation.govt.nz/act/public/2008/0085/latest/DLM1130932.html>

Climate Change Response (Stationary Energy and Industrial Processes) Regulations 2009: [www.climatechange.govt.nz/consultation/draft-regulations-seip/index.html](http://www.climatechange.govt.nz/consultation/draft-regulations-seip/index.html)

Climate Change (Unit Register) Regulations 2008: <http://www.legislation.govt.nz/regulation/public/2008/0357/latest/DLM1634227.html>

Climate Change (Unique Emissions Factor) Regulations 2009: <http://www.climatechange.govt.nz/consultation/draft-regulations-seip/index.html>

ISO 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories: [http://www.iso.org/iso/catalogue\\_detail?csnumber=39883](http://www.iso.org/iso/catalogue_detail?csnumber=39883)

ISO 5167 (parts one to four): Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full: [http://www.iso.org/iso/iso\\_catalogue/catalogue\\_tc/catalogue\\_detail.htm?csnumber=28064](http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=28064)

Review of Carbon Emission Factors in Draft Stationary Engine and Industrial Process Regulations: Using Geothermal Fluid (Ian Thain, Geothermal & Energy Technical Services Ltd, May 2009) <http://www.climatechange.govt.nz/consultation/draft-regulations-seip/review-carbon-emission-factors.pdf>