Australian Government

Department of the
Environment and Heritage
Australian Greenhouse Office

Generator Efficiency Standards (GES)

Abatement Calculator

User Guide

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1. INTRODUCTION

The *Generator Efficiency Standards (GES) Technical Guidelines (version 1.2, January 2001)* offers broad guidance on the costing of GES actions. The Australian Greenhouse Office (AGO) developed the *GES Abatement Calculator* to help GES participants carry out cost analyses in a consistent way.

The costing calculator includes:

- A spreadsheet-based model that calculates the cost of abatement in **$/tonne CO_2-e** terms (see note below); and
- this User Guide.

Note: carbon dioxide equivalent emissions (CO_2-e) are defined in equation (1) of the *GES Technical Guidelines.* Cost is expressed in dollars per tonne CO_2-e emissions. Hence the abbreviated metric is **$/tonne CO_2-e**.

The GES Abatement Calculator is preloaded with examples for coal-fired and gas-fired power stations to assist users to become familiar with it.

2. THE GES ABATEMENT CALCULATOR

Cost of abatement

Generator Efficiency Standards is an initiative that encourages fossil fuel power stations to implement all cost effective actions that will improve the efficiency of energy conversion and so reduce the greenhouse intensity of their operations.

GES members are encouraged to include financial assessments of proposed abatement actions in their GES Action Plans. Financial assessments should be conducted in terms of the $/tonne CO_2-e metric (referred to in this document as the 'cost of abatement'). When the cost of abatement is negative, the benefits to the generator (from reduced fuel and operations costs) exceed the cost of the plant modifications (or other actions) needed to achieve the abatement. Accordingly, generators are expected to implement these actions.

There are further initiatives that could be undertaken to reduce or avoid emissions at a positive cost of abatement. Some reductions are available at a very low cost, but the cost will increase as the cumulative 'emissions avoided' increases. At the point where generators require extensive redesign of their plant to reduce emissions, the cost of abatement will increase to a prohibitive level.

A threshold of $10/tonne CO_2-e is an indicative level beyond which the AGO does not expect generators to undertake abatement under a voluntary initiative such as GES.

General description

The GES Abatement Calculator determines the cost of abatement by evaluating the costs and benefits of carrying out an action. The cost/benefit analysis is carried out using a standard **Net Present Value (NPV)** methodology and the abatement cost is the NPV below zero. Hence a positive NPV indicates a negative cost of abatement.

The costs and revenues are escalated at a percentage of the consumer price index and the net cash flows over the years in which the actions would apply are discounted back to the present day's value to reflect the 'time value of money'. An improvement project would be considered viable if the NPV of the project were zero or greater with all relevant factors affecting the financial analysis taken into account. A negative NPV indicates that a project would generate insufficient revenue to offset the capital cost and changes in operating costs.

Noting that the cost of greenhouse gas abatement is defined as the NPV below zero, a positive NPV indicates that a project would be viable purely on financial grounds without assigning any value to the greenhouse gas abatement that occurs. The default behaviour of the model is to assign a zero value to the greenhouse gas abatement. This default should only be altered where the revenue resulting from a greenhouse gas abatement action is well known prior to its implementation.

The model uses equations from the *GES Technical Guidelines* to calculate the greenhouse intensity in **kg CO_2-e/MWh sent-out** for the plant before the modification or action (called 'business as usual') and after the action (called 'after modification').

The current version of the calculator (27 February 2005) is arranged in two sections, each comprising three worksheets in an Excel workbook for:

1. Coal-fired plant (which can be expanded to cater for other fuels). This uses the methodology in the *GES Technical Guidelines* Section 7.2 Eqn. (11).

2. Gas-fired plant. This uses Table 5.1 to evaluate the emission factor for the gas being used and then the formula on page 51 of the *GES Technical Guidelines* to calculate the greenhouse intensity.

Note: *Provision has been made to include the effects of tax and depreciation. Generally, these would be set to zero to provide a consistent approach to the assessments. They have been included to account for unusual circumstances relating to the modification ie. where it may attract a special tax concession or increased depreciation. The use of values other than zero should only be used if there is a good justification to do so.*

Choice of factors

- **Discount rate**: A discount rate in the range of 12 per cent to 16 per cent is typically encountered in NPV assessments for these types of actions. A default discount rate of 14 per cent has been set in the workbook and any changes to this default should be based on suitable justifications.

- **Duration**: The duration of proposed actions has been set at 20 years to reflect the notional life expectancies commonly used within the industry for plant modifications.

How to use the GES Abatement Calculator

The model considers the major operational, cost and revenue effects of a plant modification. The greenhouse intensity calculation worksheets for both coal and gas plants allow the user to change the fuel properties that may affect the greenhouse intensity.

All user-editable fields in the workbook are highlighted in bright yellow. The main inputs that can be varied on the Input/Output worksheets are:

- **Auxiliary load** – some modifications change the auxiliary load required for the plant, either increasing or decreasing the amount of electricity available for sale.

- **Capacity factor (and reliability)** – some modifications change these, either increasing or decreasing the amount of electricity available for sale.

- **Efficiency** (expressed as heat rate) – the user can nominate the change in heat rate on a yearly basis as the effect of the modification may vary over time.

- **Fuel price** – this may vary according to fuel source or preparation.

- **Fuel properties** – ash content (for coal), calorific value and emissions factors.

- **Capital cost** of the modification, divided into six possible items, and with expenditure able to be spread over the full 20-year period covered by the model.

- **Changes in operating cost** – personnel, materials and contracts.

- **Average forecast pool price** – specified in $/MWh, this determines the revenue earned from the sale of electricity. Given that pool prices could vary quite considerably, it is important to give this input careful consideration. The calculator may also be used to perform high/low pool price sensitivity analyses.

- **Estimated revenue from greenhouse gas abatement** – specified in $/tonne CO_2-e, this defaults to zero because revenue from the implementation of modifications is usually uncertain. A case where it might be well known is if a generator were eligible for carbon revenue under a voluntary or regulatory scheme.

In addition, the NPV calculation worksheets contain several more variables that can be manipulated:

- **Tax rate** – Default is set at 0%.
- **Depreciation rate** – Default is set at 0%.
- **Discount rate** – Default is set at 14%.
- **Consumer Price Index (CPI)** – By default, this is set to 2.5% for all 20 years of the model.
- **Capital expenditure (CAPEX), operations and maintenance costs (O&M), revenue,** and **fuel cost escalation** – These parameters default to 100% of CPI, but can be adjusted if the user has justification to do so.

GES Abatement Calculator methodology

The greenhouse intensity is calculated for the 'before' and 'after' case on a yearly basis. The greenhouse gas abatement is calculated by multiplying this change in greenhouse intensity by the 'after modification' electricity output, expressed in MWh.

The NPV of the greenhouse gas abatement over the calculation period is determined by:

a) Escalating the \$/tonne CO_2-e cost of greenhouse gas abatement, using the current cumulative CPI. There may be reasons why this would change, eg carbon revenue available under a voluntary or regulatory scheme;

b) Converting these values to real \$ values (ie. discounting by the cumulative CPI);

c) Obtaining real \$ per year values by multiplying by the tonne CO_2-e abated for the year;

d) Discounting these \$ values by the discount rate to obtain an NPV of greenhouse gas abatement; and

e) The \$/tonne CO_2-e of abatement is changed (by the "goal seek" function) until the sum of the NPVs from the financial analysis and the abatement analysis are zero. A button in the spreadsheet will perform this goal seek operation automatically when pressed.

The resultant \$/tonne CO_2-e value is the cost of the greenhouse gas abatement.

3. EXAMPLES

The accompanying spreadsheet (GES Abatement Calculator) gives an example of modifications to a coal-fired and a gas-fired plant.

Coal-fired example:
This is an example of a modification to a 400 MW base load coal-fired unit that uses wet cooling (via a cooling tower). The unit is load limited in summer by high back pressure due to poor cooling tower performance. To overcome this, the proposed modification is the replacement of the cooling tower with a new tower that has a high performance fill pack.

Gas-fired example:
This is an example of a modification to a 385 MW intermediate-load single-shaft combined cycle gas turbine. The modification is installation of inlet evaporative cooling.