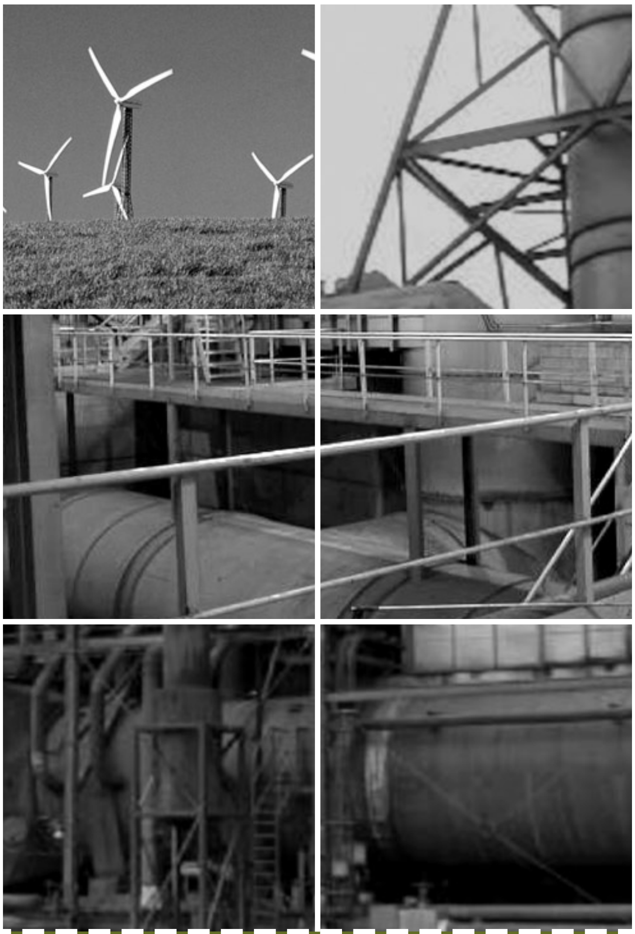

Ministry for the
Environment
Manatu Mo Te Taiao
Sustainable Management Fund

A Guide To
Estimating Greenhouse Gas Emission Reductions from New Zealand Projects

Energy Federation of
New Zealand (Inc)

Energy Federation of New Zealand Incorporated (EFNZ)

The Energy Federation of New Zealand Incorporated (EFNZ) produced these guidelines, with support from the Sustainable Management Fund and a consortium of companies. The EFNZ is a non-profit, membership-based organisation, which exists to promote the sustainable development and use of energy resources in New Zealand and globally. It was established in 1997 by the merger of the Energy Federation of New Zealand and the New Zealand branch of the World Energy Council. EFNZ runs an active programme of seminars, conferences, submissions and research projects, both independently and in collaboration with other energy sector organisations.

As a member of the World Energy Council, the Energy Federation:

- Liases with similar international organisations;
- Participates in international research projects on energy issues;
- Promotes New Zealand representation at World Energy Council meetings;
- Supplies information on the activities of the World Energy Council, and
- Participates in World Energy Council study committees.

A range of services are provided to members of the EFNZ including:

- Newsletters;
- Faxed or emailed circulation of news items;
- Seminars, conferences, workshops;
- Energy studies;
- Distribution of World Energy Council and other energy related international material;
- Collective research commissions;
- Participation in international studies and working groups;
- Representation of energy industry views;
- Member access to the global energy information system at www.worldenergy.org.

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These guidelines were developed on behalf of the EFNZ and the above companies by John Kessels and Julia Rackley of CRL Energy Limited. Further information and copies of these guidelines can be obtained by contacting:

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Disclaimer: Although the above organisations contributed to the development of these guidelines, the content of the guidelines may not fully represent the views of the above organisations.

Energy Federation of New Zealand (Inc) **Coal Association of New Zealand**

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[1] A Foundation of Research, Science and Technology (FRST) project: 'Promoting biofuels and other sustainable technology' was developed by Peter Read Consultancy Limited. A key objective of this study was the building of relationships between government officials and industry, which led to the development of the consortium of industry and Government officials involved in this study.

Foreword

New Zealand's ratification of the Kyoto Protocol in December 2002 has led to climate change becoming an issue of importance to all New Zealanders. The New Zealand Government now has a target to meet under the Kyoto Protocol and in order to meet this target they have introduced a climate change policy.

The Energy Federation and its members recognised that the New Zealand Government would respond to climate change with policies to reduce greenhouse gas emissions, and that this would imply a need for better emissions management in industry. One option for companies to reduce greenhouse gas emissions is through the implementation of greenhouse gas emission reduction projects. Research into better understanding the methodologies needed to estimate emission reductions from these projects was therefore undertaken. As a result of that research these technical guidelines have been produced to better inform and increase the understanding and awareness of companies, about the technical issues surrounding the estimation of greenhouse gas reductions from projects.

With the introduction of the Projects Mechanism by the Government, these guidelines will provide a valuable tool to promote the better understanding of the issues surrounding emission reduction projects, and will assist in the formulation of Projects proposal applications. The guidelines should be used in conjunction with any relevant Government publications.

On behalf of the EFNZ I wish to acknowledge the financial and in-kind contribution of the participating organisations. Thanks also to the Ministry for the Environment's Sustainable Management fund for co-funding this study.

Rob Whitney

Dr Robert Whitney
Chairman: Energy Federation of New Zealand Inc.

Contents

Executive Summary

A greenhouse gas emission reduction project is a specific activity aimed at delivering measurable and demonstrable reductions in greenhouse gas emissions.

The greenhouse gas impact of a project is assessed by estimating the greenhouse gas emissions of operations with and without the project. The difference between the two scenarios provides an estimation of the emission reductions resulting from the project.

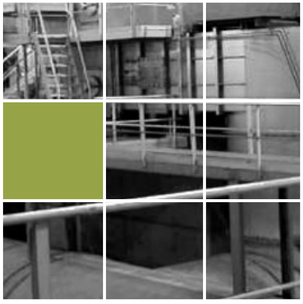
New Zealand has ratified the Kyoto Protocol and is therefore committed to managing its greenhouse gas emissions. In order to reach New Zealand's Kyoto Protocol target the Government has developed a package of climate change policies. A programme of domestic greenhouse gas emission reduction Projects forms part of this package and will have an important role to play.

These guidelines build on international experiences and can be used as a guide for organisations in estimating greenhouse gas emission reductions from a specific project.

Part A of the guidelines defines and discusses emission reduction projects, and the key concepts that must be considered when estimating emission reductions from a project.

Part B of the guidelines provides a general template, which can be adapted to specific projects, to estimate emission reductions. The information in Part A of the guidelines will be useful in completing the template, Part B also summarises some case studies of greenhouse gas emission reduction projects. Full details of these case studies can be found in Appendix 2.

The appendices of these guidelines include the detailed template and information on how the template has been applied to the various case studies. They also include an explanation of technical terms, units and conversion factors, and introductory information for people who have a limited knowledge of greenhouse gas emission reduction projects. Detailed information about different types of greenhouse gas emission reduction projects is also included in Appendix 3.



Introduction

In December 2002 the New Zealand Government ratified the Kyoto Protocol, committing New Zealand to reducing its greenhouse gas emissions to 307 million tonnes CO_2 equivalent in the first commitment period of 2008-2012. Under a ‘business as usual’ scenario, New Zealand’s actual gross emissions for the first commitment period will be 50 to 75 million tonnes CO_2 equivalent (or 14 to 20 percent) in excess of this target. The New Zealand Government has therefore developed a climate change policy package setting out its intentions for meeting this Kyoto Protocol target.

The New Zealand Government has developed a Projects (designated by the capital ‘P’) mechanism as part of this climate change policy. This Projects mechanism provides incentives for initiatives that deliver defined reductions in greenhouse gas emissions over the first Kyoto commitment period (2008-2012) in any sector of the economy.

The incentives for the first ‘exploratory round’, will be internationally tradeable when the Kyoto Protocol comes into force. The units are measured in tonnes of carbon dioxide equivalent (tCO_2e).

To qualify for consideration, emission reductions from Projects must be additional to those that would occur under a business-as-usual scenario. The objective is to secure improvements in emissions management that would not be economic unless an incentive was available. The minimum threshold for emission reductions for each Project is 10,000 tonnes CO_2 equivalent over the first commitment period (2008-2012).[2]

EFNZ recognized that greenhouse gas emission reduction projects were likely to play an important role in the Government policy, and were concerned that New Zealand had no standard guidelines for estimating emission reductions from such projects. With the help of Sustainable Management Fund (SMF) funding, the Federation joined with other interested parties to produce these guidelines.

These guidelines are intended to provide a standard method that New Zealand companies can follow to better understand and estimate their emissions abatement opportunities and the potential benefits from greenhouse gas emission reduction projects. One outcome of these guidelines will be that potential participants are better placed to meet relevant information requirements and prepare successful proposals for the Government’s Projects mechanism. In addition, they may be better placed to respond to other climate change polices such as the carbon charge, by evaluating abatement projects that may be economic for them to carry out with their own resources.

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[2] Further information on the Government’s climate change policy can be found at www.climatechange.govt.nz

A greenhouse gas emission reduction project (a “project”) is a specific activity aimed at delivering measurable and demonstrable reductions in greenhouse gas emissions. The objective of a project is to provide a real reduction in greenhouse gas emissions compared with a baseline emissions forecast. This is defined, as ‘environmental additionality’ which is when the greenhouse gas emissions produced by the project are less than those that would have been produced had an organisation not carried out the project. Examples of projects include: new renewable energy generation, efficiency upgrades in an energy-using plant; replacement of fossil fuel with biomass in a boiler or the utilisation of gas from landfills. The enhancement of a forest for carbon sequestration is an example of sinks enhancement. A sink is any natural or man-made system that absorbs and stores greenhouse gases, from the atmosphere. To be considered a sink, a system must be absorbing more greenhouse gases than it is releasing so that the store of carbon is expanding.[3] More detailed information in relation to different types of emission reduction projects can be found in Appendix 3.

Greenhouse gases are the atmospheric gases that have properties preventing some of the normal radiation of solar heat back into space. The six greenhouse gases that a project should focus on reducing are Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Perfluorocarbons (PFCs), Hydrofluorocarbons (HFCs), and Sulpher Hexafluoride (SF_6).

The following sections discuss the key concepts of estimating emission reductions from a project in detail. Further explanations of the technical terms associated with projects, and with climate change issues generally, are provided in the Explanation of Technical Terms, which can be found in Appendix 3. A list of useful contacts for further information in relation to greenhouse gas emission reduction projects can also be found in Appendix 3.

The following principles provide guidance for estimating the emission reductions from a project. They have been developed by the World Resource Institute and the World Business Council for Sustainable Development Greenhouse Gas Protocol, and are considered useful for New Zealand projects.

Efficiency: It is important to consider only projects that will result in emission reductions.

Simplicity: Project methodologies and reporting should remain as simple as possible. Highly complex methodologies and reporting would result in higher transaction costs for companies.

Credibility: Estimation methodologies must be credible so that third party stakeholders have confidence in the results.

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[3] Sinks enhancement projects will not be eligible for incentives under the Government Projects mechanism. The Government will have a separate incentives fund available for sinks enhancement projects.

Materiality: Companies need to determine which greenhouse gas emissions are material to a project and which are not. For example, an organisation might assess that the CO_2 emissions of its steam plant are material while minor greenhouse gases from its boiler emissions are not.

Transparency: In order to ensure credibility, it is important to use transparent methods to estimate and report greenhouse gas emissions.

Comparability and Consistency: It is important that long-term comparisons can be made between companies' historical, current and projected emission scenarios across an industry or for a stand-alone facility. This will allow companies to track the emission reduction progress of a project and will help to ensure the credibility of the emissions reporting. It will also provide consistency over time.

Flexibility: Estimation methodologies must be flexible in order to allow different organisations to adjust them to their own circumstances.

Verifiability: In order to ensure public credibility of the emission reductions from a project, it is important that an independent auditor periodically monitors and verifies the emission reductions achieved.

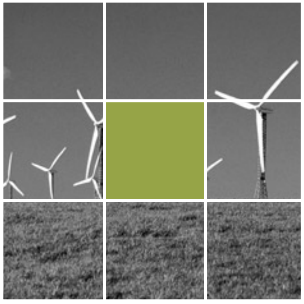
How to use the guidelines

Part A of the guidelines defines and discusses greenhouse gas emission reduction projects, and the issues that must be considered when estimating emission reductions from a project.

Part B of the guidelines provides a general template, which can be adapted to specific projects to estimate emission reductions. The information in Part A of the guidelines will be useful in completing the template. Part B also summarises some case studies of greenhouse gas emission reduction projects. Full details of these case studies can be found in Appendix 2.

The appendices include the detailed template and information on how the template was applied to the various case studies. They also include an explanation of technical terms, units and conversion factors and additional information on different types of greenhouse gas reduction projects.

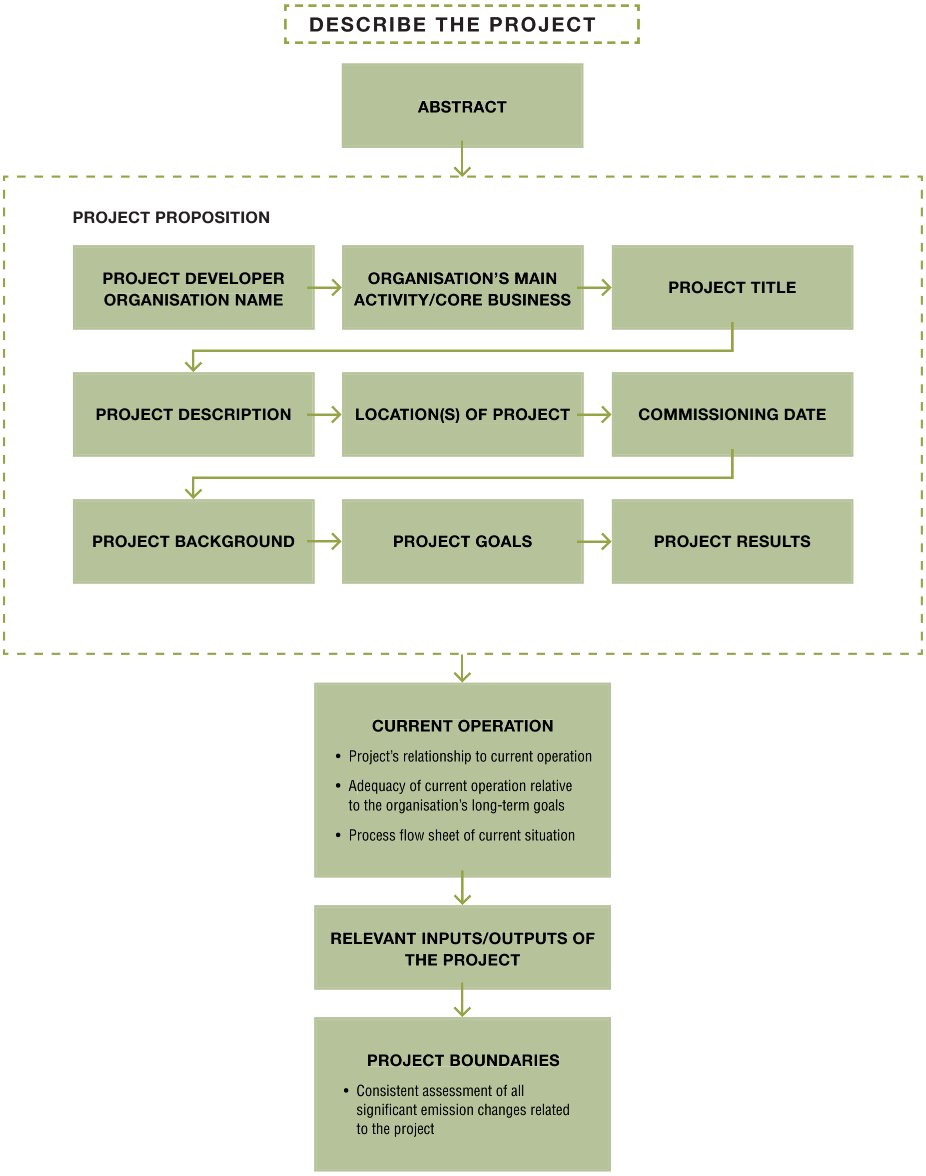
These guidelines are intended to assist organisations to estimate emission reductions from individual project opportunities. The utilisation of these guidelines does not guarantee a project will be eligible for incentives under the Government's Projects policy. Information about the Government's Projects policy is provided throughout the guidelines in text boxes. This information was accurate at the time of publication. Government policy is likely to continue to develop over time, however, and the New Zealand Climate Change Office should be contacted to ensure this information is still accurate.



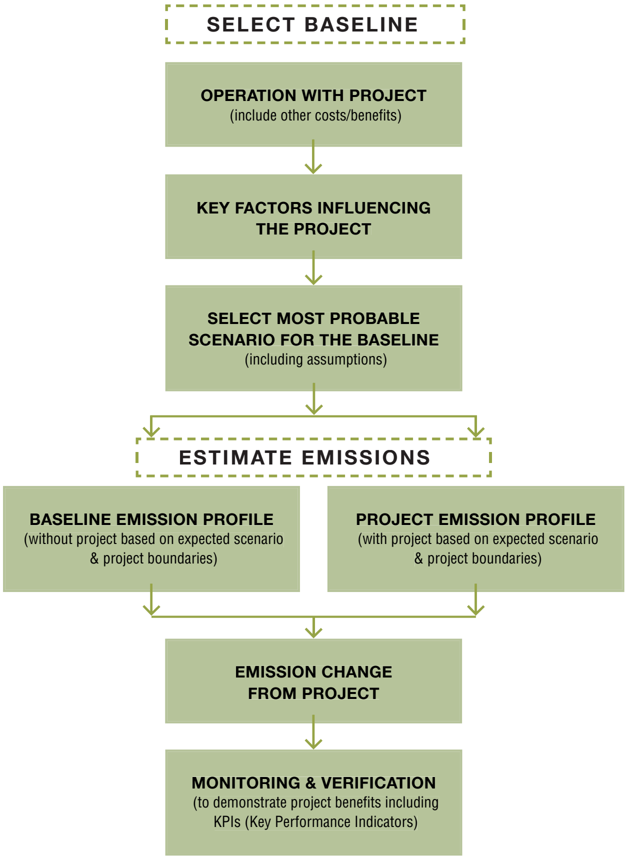
PART A Definition and Discussion of Greenhouse Gas Emission Reduction Projects

The process for estimating greenhouse gas emission reductions from projects is outlined in the flowchart below:

Estimating Greenhouse Gas Emission Reductions from Projects (part 1)



Estimating Greenhouse Gas Emission Reductions from Projects (part 2)



The process can be broken into three key categories:

1. Describe the project
2. Select baseline i.e. situation before the project
3. Estimate emissions

Part A of the guidelines outlines key concepts that should be considered when estimating greenhouse gas emission reductions from projects.

1. Describe the Project

A.1 →

A.1 Defining the project boundary

When estimating greenhouse gas emissions from a project, an organisation needs to establish the boundary of the project making it clear which greenhouse gases and which sources (or sinks) are included and which are excluded.

It is first necessary to specify a base year. This is a historic base year used for comparing emissions over time. The base year should be the year that is closest to the development of the project that has complete data available for it.

Once the base year has been selected, data for the base year should be assembled. The data required will depend on the project boundary.

The project boundary should be placed at the smallest sized notional border that includes all material emissions changed by the project (not just those that are owned directly by the organisation). Determining which emissions are material requires consideration of all relevant inputs and outputs including associated process and waste emissions.
Greenhouse gases related to a project do not need to be included in the project boundary if:

- The organisation can demonstrate that emissions are not material to the project, and/or;
- Emissions are not expected to increase or decrease as a result of the project implementation i.e. there is no ‘leakage’.

The kind of data that will be required will vary depending on the project and the organisation. It is likely to include:

- Energy-use data on the use of electricity, natural gas, diesel, petrol, coal, wood, solar, wind, and other fuels for the project;
- Activity data (industrial output or kilometres for cars, trains, aeroplanes, air/road/sea/rail freight or waste land filled for the project);
- Supporting text on annual variability to explain any major changes compared with previous years (for example, acquisition or closure of smaller plants);

- Assessment of off-site emission changes resulting from the project (for example if electricity use has changed, emissions from generation of electricity consumed by the plant; imported steam; off-site transport fuel combustion for raw materials or product distribution, or methane emissions from piped natural gas or from coal mining should be considered).

One way this information can be collected is by undertaking a greenhouse gas emissions inventory of the company's operation associated with the project, before the project was implemented. Some companies may have already completed a greenhouse gas inventory for the company's entire operation. However, it is not necessary to complete such an inventory before estimating emissions from a greenhouse gas emission reduction project as the boundary of the project may be so clear that the project can be considered independently of other company operations, e.g. a greenfield development or a new renewable energy project. There are a number of publications available which outline how to complete a company inventory of greenhouse gas emissions such as the New Zealand Business Council for Sustainable Development's guide.[4]

If a full organisational inventory is not available or required then this data can normally be gathered from engineering and/or accounting records. Some of this data may be required to meet Resource Management Act requirements. This data will include all the inputs and outputs that the project impacts upon and will act as a project inventory.

A.1. 1 Direct and indirect emissions

← A.1.1

When defining the project boundary, both direct and indirect emissions should be included.

Direct emissions are those from sources that are owned or controlled by the project developer, for example those emitted as emissions from its own landfill. Indirect emissions are those emitted as a consequence of the project developer's activities, but which are from sources owned or controlled by another organisation. In the case of an organisation seeking to improve the fuel efficiency of its truck fleet, for example, diesel emissions would be considered direct emissions. If instead the organisation were considering improving its distribution system through the siting of a new factory, reduced diesel emissions would be considered indirect emissions.

Indirect emissions associated with electricity use will be significant in a number of cases. They should be included in a project report because an organisation controls the amount of electricity it uses even if it cannot control the fuel and emissions mix associated with the electricity generation.

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[4] Further information on this guide can be found at www.nzbcsd.org.nz

2. Select Baseline i.e. Situation without the Project

A.2 →

A.2 Project baselines

In order to estimate emission reductions from a project, it is necessary to establish a baseline as a reference case. The baseline scenario should represent the most likely operation in the absence of the project. Establishing a baseline scenario requires a starting point based on historical emissions, and a hypothesised trend through the project life. This should be based on the most likely scenario for output and fuel use.

A.2.1 →

A.2.1 Assessing baselines

There are two broad approaches for assessing emission baselines from projects:

- A baseline using forecast data (projected or modelled) of what emissions would have been in the absence of the project, or
- A baseline of historical data, representing normal operations prior to the project, e.g. average of the last four years emissions, assuming no change in output.

A.2.2 →

A.2.2 Types of baselines

Below are definitions of several different types of baselines:

- **Project-by-project baselines** are those drawn up for individual projects on a case-by-case basis. Each baseline is used only for the project for which it is developed. The project-by-project approach is based on a combination of engineering judgement and site-specific analysis. This approach is established using project-specific assumptions, measurements or simulations for key parameters. For example if an energy efficiency project is carried out to improve the efficiency of a boiler, the baseline will be developed for that particular installation.

- **Sectoral baselines** are based on the assumptions, measurements or simulations for key parameters, which are used to establish them, and are specific to a particular sector. The sectoral baseline is intended to be relevant to all projects within that one sector. For example if a renewable energy project is established within the electricity sector, the project will be compared against the baseline for the electricity sector.

- **Benchmark or multi-project baselines** may be drawn up using an engineering approach, and aim to standardise emission levels or rates across a number of similar projects, for example for a particular technology or a particular industrial sector. For example the impact of one solar hot water heater would be assessed and the data would be utilised for an installation of 30 hot water heaters.

- **Baselines at a national level** (also known as "top-down" baselines) are highly aggregated and reflect the Government's targets and policies. The impact of individual projects can also be estimated against the national baseline. This baseline can be used to assess the effectiveness of specific policies on emission reductions. The New Zealand inventory in 1990 effectively sets the Kyoto baseline that will be used to assess whether New Zealand has met its emission reduction targets in 2008-2012 and beyond.

New Zealand is unique in its energy mix and in the nature and size of its industrial sector (with a high proportion of energy intensive primary processing). It is therefore suggested that for most sectors, a project-by-project baseline is appropriate. For some sectors, a benchmark baseline may be appropriate because it has the advantage of allowing for standardisation, which increases consistency and transparency as well as providing benefits in economies of scale through the focusing of resources.

A.2.3 Static and dynamic baselines

A.2.3

A static baseline is one that is fixed at the start of the project lifetime. In comparison to a dynamic baseline, a static baseline can result in lower transaction costs, as only one estimate is needed, and monitoring and reporting costs are reduced.

A dynamic baseline is one that is revised during the life of the project to suit changes in output or other project variables. Using a dynamic baseline means that there is less up front certainty over the amount of emission reductions a project will generate. This uncertainty can be reduced if project developers know the review timing and the basis on which baselines may be calculated.

To assist project developer certainty within the Government's Projects mechanism, the electricity emission factor will probably use a static sectoral baseline approach (resulting in a fixed value) that will be set for each round and will be static until 2012. This emission factor may change for Projects in subsequent rounds. Baseline selection can be very complex and Project developers should first consult the Project mechanism documentation, and if necessary discuss this with the Climate Change Office Projects staff at an early stage in the formulation of a Projects proposal.

A.3

A.3 Project lifetime

The economic and technical lifetime will depend on the type of project. For example, a renewable energy project involving hydro-electricity could have a lifetime of 40 years. For a steam line insulation upgrade, the project lifetime might be as little as two years before the upgrade would have happened as part of normal maintenance. In the case of forestry sequestration projects, the lifetime will depend on when harvesting occurs and whether replanting takes place.

In addition, if the project is being prepared for submission to the Government's Projects mechanism, or another source of emission reduction funding, it will have a crediting life determined by the requirements of the programme. For the Projects mechanism, the crediting life is limited to the first commitment period.

A.4

A.4 Additionality

The term additionality is used to assess whether a project will result in emission reductions "that are additional to any that would otherwise occur" (quoting the Kyoto Protocol). Discussion normally focuses on two different forms of additionality:

- Environmental additionality, and
- Investment additionality.

Environmental additionality occurs when a project results in emission reductions additional to those that would have taken place without the introduction of the project. Assessment of environmental additionality seeks to determine the effect on the atmosphere of the proposal.

Investment additionality is the notion that a project is made commercially viable through its ability to generate value in the form of emission reduction credits. The concept seeks to address questions like:

- Would it have proceeded anyway?
- When might it have proceeded anyway?
- Under what circumstances might it proceed?

For reasons of simplicity, these guidelines only discuss the concept of environmental additionality.

Investment and environmental additionality will be important eligibility criteria in the Government's Projects mechanism incentive scheme. Details of how they will be addressed will be included in the application form and other Project mechanism documents.

3. Estimate Emissions

The greenhouse gas impact of a project is assessed by estimating the greenhouse gas emissions of operations with and without the project. The difference between the two scenarios provides an estimation of the emission reductions resulting from the project. Further details on how to estimate emission reductions from a project can be found in B.2.

The greenhouse gas emissions of an operation are estimated utilising appropriate emission factors.

← A.5

A.5 Emission Factors

An emission factor is used to convert material usage or production into greenhouse gas emission terms. It is expressed in terms of the amount of gas released per unit of energy in the fuel or level of generation or production. Some emission factors are listed in Appendix 3.

The New Zealand Energy Information Handbook (JT Baines editor, 1993) has the most comprehensive list of energy factors (Some of these emission factors are also outlined in Appendix 3).

A company uses 2000 tonnes of sub-bituminous coal, 1,000,000 cubic metres of natural gas and 500,000 litres of diesel.

The emissions from burning coal are therefore calculated by:
Multiplying the amount of coal used by the average sub-bituminous coal gross calorific value by the Emission Factor for sub-bituminous coal.
= 2000 tonnes x 22.6 gigajoules (GJ) per tonne x 0.0912 tonnes CO_2 *per gigajoule of coal combusted*
= 4122 tonnes CO_2

The emissions from burning gas are calculated by:
Multiplying the amount to gas used by the gross calorific value of Maui Sales gas by the Emission Factor for gas.
= 1000000 cubic metres x $0.0381 GJ/m^3$ *x* $0.0687 tCO_2/GJ$
= 2059 tonnes CO_2

The emissions from burning diesel are calculated by:
Multiplying the amount of diesel used by the gross calorific value of diesel by the Emission Factor for diesel.
= 500000 litres x 0.0381 GJ/L x 0.0687 tCO_2/GJ
= 1309 tonnes CO_2

The total greenhouse gas emissions for this company are therefore:
$4122 + 2059 + 1309 = 7490 tCO_2e$

It is important to ensure that the conversion factor is in the same units as the emission factor and the appropriate emission factors are being used. The emission factor for every fossil fuel are different due to their different carbon levels, emission factor for one fuel can differ depending on the source. Further details on energy units, conversions, emission factors and estimating emission reductions can be found in Appendix 3.

A.6 →

A.6 Variability

A project developer and any assessing agency will want to know with a reasonable degree of certainty that emission reductions will be achieved from carrying out a project, and to manage the risks around this. In some cases it is difficult to know the exact level of emission reductions likely to result from a particular project, and this therefore needs to be considered in the estimation process. This means an assessment of the possible variability in the amount of reductions is useful. One approach to variability is unlikely to be appropriate to all situations.

It is likely that different performance expectations for different product or process output levels will be a major consideration in assessing the variability of emission reductions. One approach is to estimate upper limits and lower limits for all quantifiable output, energy usage and waste stream figures. The mid-range figures would be selected as the best estimate for the baseline and the project emissions.

The system used by the Dutch Government in their ERUPT tender process is to calculate all the emission reductions from the project and to note the potential issues that could impact on production from the project indicating a 95% confidence interval range on production levels. However their funding processes are based on expected production and resulting emission reduction estimates only.

Another option to assess variability would be to consider three scenarios: best guess, optimistic and pessimistic (with respect to both output and emissions performance).
The approach utilised in these guidelines is to calculate the most probable emission scenarios for the baseline and the project and to estimate percentage variability for each quantity. These percentages can then be combined to give the uncertainty on the emission reductions. This is a very comprehensive approach.

It is important that this aspect of the estimation process is kept as simple as possible. However as each project will have a different likelihood of variability the focus on this may be greater for some projects than others.

A.7 →

A.7 Monitoring and Verification

When developing the project it is important to consider what information will need to be gathered to consider the actual emission reductions from the project. Annual monitoring reports can be useful and if a third party is allocating credits or purchasing emission reductions then these reports may need to be verified by a third party.

PART B Workbook

B.1 Introduction to Part B: Workbook

B.1

Part B provides a technical guide in the form of a workbook for the estimation of greenhouse gas emission reductions from a project. The greenhouse gas impact of a project is assessed by estimating the greenhouse gas emissions of operations with and without the project. The difference between the two scenarios provides an estimation of the emission reductions resulting from the project. This workbook provides a standard mechanism for calculating this emission reductions estimate. The workbook should be used in association with Part A, which provides a detailed description of the key concepts that require consideration when estimating emission reductions from a project.

Each greenhouse gas emission reductions project will be unique. It is therefore difficult to develop a template that will cover every possible type of project.
The model template provided here is therefore aimed at providing a general guide for organisations planning an emission reductions project. The template can be adjusted as necessary as organisations develop their own projects.

A blank template form is shown in Appendix 1 and Appendix 2 shows examples of using the template.

B.2 →

B.2 Completing the Workbook

The three processes described above have been broken into ten sections in the template:

1. Describe project

1. Project proposition.
2. Description of current operation.
3. Identification of relevant inputs and outputs of the project.
4. Definition of project boundary.

2. Select baseline

5. Description of operation with and without the project and key factors influencing it.
6. Select the most probable scenario for the baseline.

3. Estimate emissions

7. Calculation of the estimated baseline emissions profile.
8. Calculation of the estimated project emissions profile.
9. Calculation of emissions change from the project.
10. Monitoring and Verification.

Describe the Project

Abstract

An abstract of the project should be provided to summarise the most important aspects of the project. Included in this abstract could be a flowchart showing the situation with and without the project.

Section 1 - Project proposition

This section requires introductory information to be completed such as the project developer organisation's name and the organisation's main activity/core business. If there is more than one organisation involved in the project the relationship between these organisations should be outlined.

Project summary

This section summarises the project, detailing the title, description, location(s) of project, commissioning date and background of the project. Describe the background of the project, the development of the project to date, including any studies that have been carried out, and note any relevant issues.

Project goals and expected results

This section requires the project goals and expected results to be described. This information should include a description of the primary goals of the project and the contribution that these goals will make to the organisation's strategic objectives. This description should include any secondary benefits of the project such as commercial opportunities from implementing the new technology. The specific output levels that are expected for the project to achieve its goals should also be outlined.

Section 2 - Description of current operation and the operation with the project

This section summarises the differences between the organisation's current operation and the operation with the project. It should include a description of the kind of products or services that are the output of the current operation. It should then describe any changes in the type, level or amount of this output after the project, including any expansion of production, change of product mix, increased energy efficiency or improved environmental performance as a result of the project. The adequacy of the current operation in relation to the organisation's long-term goals should also be outlined.

Section 3 - Identification of inputs and outputs of the project

In order to determine the greenhouse gas emission reductions from the project the greenhouse gas emissions from the current operation should first be identified. This can be undertaken by listing the inputs (energy sources, raw materials) and outputs (product and waste streams) for the current operation and for the situation after the project. Those that will not be affected by the project do not need to be included in the project boundary. This data should be based on the last year that has complete data and adjusted for any projected change in output.

The emissions outlined should include both on-site and off-site emissions.

On-site emissions include CO_2 emissions from fuel combustion or an industrial process. CO_2 emissions from materials handling and storage on-site and methane emissions from gas pipelines on the site should also be considered.

Off-site emissions would include CO_2 emissions from generation of electricity consumed by the plant or from off-site transport fuel combustion for raw materials or product distribution. CO_2 emissions from generating steam imported to a plant also count as off-site emissions. Other possibilities could be methane emissions from piped natural gas or from coal mining (particularly underground mining).

Other less obvious emissions sources (both on-site and off-site) should also be considered. They may be significant and so they need to be estimated if they are measurable and attributable to the project. If they are not captured they are termed 'leakages' because they are defined as the net change of human sourced greenhouse gas emissions that occur outside the project boundary. An example is that a raw material previously processed on-site might now be imported in a processed state, meaning the processing emissions are now off-site.

One way the greenhouse gas emissions from the organisation's current operation can be identified is by undertaking a greenhouse gas inventory. Further information on undertaking greenhouse gas inventories can be found at www.nzbcsd.org.nz. It may be that only a part of an organisation's operation is affected by the project so in that case only an inventory covering that area will be required. All direct, indirect and possible sources of leakage must be considered.

Information on the operation's emissions may also be listed in any air discharge resource consents that the organisation may hold.

Section 4 - Definition of project boundary

This section requires information about the development of the project boundary. The project boundary should be placed at the smallest sized notional border that includes material emission affected by the project (not just those that are owned directly by the organisation). The boundary definition should aim to provide a consistent approach to all significant emission changes related to the project. These emissions should include on-site and off-site emissions, whether or not they are directly controlled by the project developer.

When the project boundary has been decided, sources considered in the project assessment and any sources that are omitted should be justified. A useful but arbitrary guideline in determining whether a source is 'significant' is to exclude any sources that represent less than 2% of total equivalent greenhouse gas emissions or that differ by less than 2% emissions per unit output between the baseline and the project. As an example, methane or nitrous oxide emissions from fuel combustion or transport are typically much less than 2% of total emissions (on a tCO_2e basis).

Select Baseline i.e. Situation without the project

Section 5 - Description of operation with and without the project and key factors influencing it

This section requires information describing the operation with and without the project and key factors influencing the project. It should include a description of how operating with the project will differ from the current operation and list other costs and benefits.

This will involve listing all the significant regulatory, economic, environmental and technical factors that will influence:

- The production from the plant without the project.
- The production from the plant with the project, and
- The risks for the project.

Regulatory factors might include adopted or planned legislation, or sectoral reform.

Economic factors might include international or domestic market demand, existing incentives, changing energy prices, or the organisation's fuel supply policy and possible new investments.

Environmental factors could include weather, or requirements for environmental performance such as waste disposal or particulates, SOx and NOx emissions.

Technical factors might include the performance of new technology, optimum balancing of heat and power from cogeneration, fuel quality or product quality requirements, availability of alternative fuels such as wood waste, or frequency of equipment maintenance in relation to plant downtime.

Section 6 - Select the most probable scenario for the baseline

Select the most probable regulatory, economic, environmental and technical factors that will occur from those discussed above. Utilise these to describe the baseline scenario over the whole life of the project. All assumptions should be stated.

Decisions on baseline selection are fundamental to the determination of the project's emission reductions. The baseline should be established using the best knowledge available on likely future output. To ensure a consistent calculation methodology for the baseline and for the estimated project emissions, the same project boundary must be used for both calculations. If a dynamic baseline is used the baseline output level and the project activity level per unit output can be adjusted at regular intervals during the monitoring period to account for changing circumstances. If a static baseline is used, only the actual emissions from the project will change, the baseline will not.

Estimate Emissions

Section 7 - Calculation of baseline emissions profile

This section involves calculating the baseline emissions profile i.e. the greenhouse gas emissions that would be produced by the operation if the project is not to be implemented. For the chosen baseline, a spreadsheet should be used to calculate all on-site and off-site greenhouse gas emissions that can be estimated with a reasonable degree of accuracy.

For simplicity, the tables here present only the total fossil fuel usage and consequent total emissions in CO_2 equivalent. It is useful to compare these figures for baseline and project in biomass conversions because they summarise the change in total energy requirements allowing for reduced combustion efficiency and perhaps increased diesel usage from biomass collection and processing after the project.

The greenhouse gas emissions for **each individual fuel** should be calculated by:

1. Assessing the expected usage figures. One way this can be achieved is by:
    a. Working out the ratio of the current use **of each fuel** to the current output;
    b. Taking a best guess for future output (whether higher or lower than current) and mutiply it by the current fuel ratios to get the estimated future use **for each fuel**.

2. Calculating the emissions **for each fuel** by multiplying the amount by the gross calorific value by the relevant emission factor.
3. If necessary, these emissions should be converted into CO_2 equivalent. The conversion to tCO_{2_e} is done by using a factor called the global warming potential (GWP). For methane the GWP is 21, for nitrous oxide it is 310, for other gases refer to the table in Appendix 3.
4. The CO_2 equivalent emissions **for each fuel** can be added together to gain the total CO_2 equivalent emissions for the company.

The calorific value is the energy content of a fuel measured as the heat released on complete combustion in air. It is also sometimes referred to as the specific energy or higher heating value of a fuel. In New Zealand, it usually refers to the gross rather than net calorific value. The net figure indicates the amount of useful heat available and is calculated by subtracting from the gross figure the amount of heat required to vaporise water present in the original fuel and water formed during combustion.

The New Zealand Energy Information Handbook (JT Baines editor, 1993) has the most comprehensive list of energy conversion factors:

The company's total CO_2 emissions are calculated as follows:

For example, a company expects to use 2000 tonnes of sub-bituminous coal, 1,000,000 cubic metres of natural gas and 500,000 litres of diesel.

Emissions from Coal

The average sub-bituminous coal gross calorific value is 22.6 gigajoules (GJ) per tonne and the emission factor is $0.0912tCO_2/GJ$.

Emissions = 2000t x 22.6 GJ/t x 0.0912 tCO_2/GJ

= 4122 tonnes CO_2.

Emissions from Gas

The average Maui gas has a gross calorific value of 0.0390 GJ per cubic metre and the relevant emission factor is 0.0528 tCO_2/GJ.

Emissions = 1000000 x 0.0390 GJ/L x 0.0528 tCO_2/GJ

= 2059 tonnes CO_2

Emissions from Diesel

Diesel has a gross calorific value of 0.0381 GJ per litre and the relevant emission factor is 0.0687 tCO_2 per gigajoule of diesel combusted.

Emissions = 500,000 x 0.0381 GJ/L x 0.0687 tCO_2/GJ

= 1309 tonnes CO_2

Therefore the company's total emissions from their diesel, coal and gas use would be 7490 tonnes CO_2.

Section 8 - Calculation of project emissions profile

This section involves calculating the project emissions profile. The methodology for estimating emissions as outlined in Section 7 sould be followed, but the amount of fuel used will be the amount once the project has been implemented.

Section 9 - Calculation of emissions change from the project

The change in emissions due to the project is calculated by subtracting the project emissions from the baseline emissions. In the case of energy sources that do not change per unit output between baseline and project, the emissions will cancel each other out.

Section 10 - Monitoring and verification

Monitoring throughout the project is important to ensure that the planned greenhouse gas reductions are being achieved. The monitoring undertaken in relation to a project will vary depending on the organisation's approach. Factors to consider when designing a monitoring strategy include:

- How data will be collected;
- How often data will be collected;
- How missing data will be dealt with;
- Measurement methods;
- Duration of the measurement;
- Calibration methods and accuracy;
- Measurement uncertainties;
- Key factors for project performance;
- Key performance indicators;
- The parameters needed for emission calculation;
- How often monitoring reports will be independently verified and by whom.

B.3 Case Studies of emission reduction projects

B.3

These case studies are from a variety of sources. In some cases they are based on real situations, in others they are theoretical. In several cases the data is indicative rather than absolute. The purpose of the case studies is purely to give examples of a possible approach to quantifying greenhouse gas emission reductions.

B.3.1 Blue Mountain Lumber: Wood Waste Utilisation Project

B.3.1

In July 2000 a major expansion of the Blue Mountain Lumber (BML) sawmill in South Otago was completed. Prior to this expansion the sawmill operated at a smaller scale and had several boilers that were fire risks and at the end of their economic life. The original boilers were fuelled with a combination of wood residues and lignite. When considering the sawmill expansion, the costs and benefits of using wood residues or lignite fuel were considered. Although use of wood residues required a more expensive energy plant, this was the option eventually selected, as it allowed the use of lignite to be discontinued, and the increased steam loads to be fuelled entirely by site-generated wood residues.

The expanded sawmill processes approximately 160,000 cubic metres of logs annually and requires significant quantities of process heat to dry timber, heat buildings and preheat resins. The expanded sawmill also generates significant quantities of wood waste residues.

BML and Meridian Solutions (MS) formed a build, own, operate and transfer type energy partnership for MS to supply all of the steam required by the site and incinerate surplus wood residues for electricity generation. MS developed a new energy facility to provide BML with this energy supply. This is a cogeneration plant, consisting of a 10 megawatt (thermal) boiler and a 1.4 megawatt (electrical) steam turbine generator supplying all the steam and some of the electricity needed to run the sawmill.

By comparison with a baseline of lignite fuel and allowing for lower wood combustion efficiency, the wood waste fuel option avoided 36,000 tonnes CO_2 emissions per year based on a simple zero emission factor for wood combustion. Wood transport emissions were not material to project calculations because the wood waste was already on site. Lignite transport emissions and alternative disposal methods for the wood waste might have been material for the baseline case but they were likely to be of minor significance. In addition, the annual 3500 MWh of co-generated electricity is considered to provide extra emission savings of 1600 tonnes of CO_2 per year. The same amount of electricity could not have been co-generated on an economic basis by lignite firing.

The information from the project implemented by BML in 2000 has been used as a basis for this case study. However this information may differ from the actual situation.

B.3.2 →

B.3.2 New Zealand Steel Kilns: Waste Heat Utilisation

For the purpose of demonstrating an application, a hypothetical waste heat utilisation project has been developed.

This case study treats the previous NZ Steels kilns waste heat utilisation as a project to be undertaken this year, not including the waste heat utilisation from the multi-hearth furnace (installed in 1985).

Energy costs would be replaced with an additional benefit of increasing the plant's security of energy supply. It is argued that the value of emission reductions from the reduced requirement for electricity imported from the national grid will improve the economic feasibility of the project. The high cost of the equipment installation would require a level of investment that would be difficult to justify from the long payback period.

In the first five years, it is assumed for the baseline and the project that the plant gradually increases output and waste heat utilisation until operating at full capacity for the following ten years, generating a net 375 GWh annually (allowing for the power to operate the extra generator fans and pumps).

The electricity emission factor is the key methodology issue affecting the emission reduction outcome of this project. Application of a 470 tonnes CO_2 per GWh factor (assuming a 450 factor for the national grid and 4-5 percent grid losses supplying to NZ Steel) would result in a total saving of 2.5 million tonnes CO_2 over a 15-year lifetime of the project.

B.3.3 Mighty River Power: Landfill Gas Utilisation Project

← B.3.3

For the purpose of demonstrating an application, a hypothetical landfill methane utilisation project has been developed. A landfill to be used for a period of 10 years will supply methane to a set of generators to produce at a peak of 5 MW of electricity in the following years. The baseline is assumed to be the same volume of waste deposited in a landfill originally designed simply to minimise odour associated with aerobic decomposition.

Justification of a chosen baseline and its potential variability is an important part of any estimation of emission reductions. Estimates of variability here are very approximate for the purposes of illustrating the proposal rather than estimates based on landfill performance. Gas may be collected as part of landfill management and requires disposal by venting to the atmosphere, burning onsite through a flare, burning onsite through generators to produce electricity or purifying and selling for burning offsite. Here it is assumed the baseline is venting to the atmosphere. Designing a landfill to optimise anaerobic decomposition and methane emissions for utilisation has significantly higher capital and maintenance costs than a conventional landfill but the long term return from generated electricity and potential emission reduction credits would help offset those costs.

Since the CO_2 is biomass sourced, a zero emission factor is used for CO_2 emissions and the same applies for the CO_2 product of the methane combustion since no fossil fuel is used. The electricity generated indirectly avoids CO_2 emissions from a fossil fuel fired thermal power station. These are calculated using an emission factor of 450 tCO_2/GWh.

The total emission reduction from the project over the 20 year lifetime was assessed to be 1.06 million tonnes of CO_2 equivalent, 83 percent from the avoided methane emissions and 17 percent from the indirect electricity emissions avoided by generating power from the landfill gas rather than using fossil fuel derived electricity.

B.3.4 BP: Solar Power Systems

← B.3.4

BP Connect is promoting solar power as a renewable form of energy that can be used to reduce greenhouse gas emissions through its potential to make a useful contribution to the grid. PV solar is already an economic option for electricity generation in many remote locations and in some special circumstances where the alternative is to expand the capacity of the grid (the cost of which would then be factored into the electricity price). Solar power is only available on sunny days so, when connected to the grid, is used to supplement supply or offset demand from conventional sources. Capital and installation costs are high compared to conventional sources of electricity but these costs are expected to diminish over time, and operating costs are minimal.

This case study treats BP Connect's solar photovoltaic (PV) power systems in fifteen of its service stations as an emission reduction project. The electricity displaced at various locations is measured using the nationwide CO_2 emission factor rather than considering minor transmission differences due to location. Using this method, total greenhouse gas savings over twenty years for the fifteen service stations would be equivalent to about 1800 tonnes of CO_2.

B.3.5

B.3.5 Landcare Research EBEX21$^{®}$: Carbon Sequestration from Permanent Protection Forest

The purpose of the EBEX21$^{®}$ project is to demonstrate that carbon sequestration through the use of indigenous non-harvest sinks is commercially viable and scientifically valid. Landcare Research aims to have 10 organisations committed to forest restoration in the first year of the project with an additional 2000 hectares committed in years 2-3 of the project. This commitment from 10 organisations to offset their CO_2 emissions is treated as a case study. It is estimated that the project will prevent approximately 13,000 tonnes of CO_2 from entering the atmosphere within the following five years. This assumes that, on average, the organisations are small to medium sized enterprises or similar and the baseline of 1.5 tonnes of carbon absorbed per hectare per year is being achieved across all EBEX21$^{®}$ sites.

B.3.6

B.3.6 Lime kiln efficiency upgrade

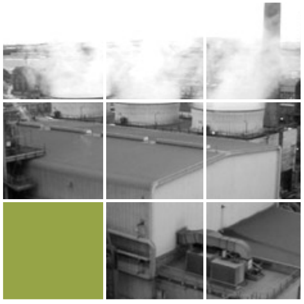
A hypothetical lime manufacturer is assumed for this case study to carry out a major upgrade on the coal firing system on one of its lime-burning kilns. The aim of the project is a 15% reduction in coal use per tonne of burnt lime. On the basis of a 30% projected increase in production, about 7,000 tonnes of CO_2 emissions would be saved each year from this upgraded firing system. As well as reduced CO_2 emissions the project will also reduce fuel costs and achieve additional savings from reduced costs for coal milling and for kiln refractories.

B.3.7

B.3.7 Building Research Association of New Zealand (BRANZ): Household Energy End-Use Project (HEEP)

BRANZ has developed the HEEP to assist market analysis of household energy consumption patterns so that energy suppliers and legislators are able to manage supply, transmission/distribution, energy efficiency, fuel switching and climate change issues effectively. Using HEEP allows the domestic energy market to be segmented into clearly defined and very specific sector groupings in order to understand how different types of households use energy, when, in what kind of appliances and with what kind of fuel, and under what circumstances/conditions. HEEP also shows how different household construction materials and methods influence energy consumption.

As a case study, HEEP acts as a tool to assess the baseline for a theoretical energy efficiency initiative to be applied to a range of households, too numerous to individually monitor. The total emission reductions for a major water heating upgrade programme is assessed.



APPENDIX ONE: Template

Template for Estimating Emission Reductions from Greenhouse Gas Emission Reductions Project

Describe the Project

Section 1 - Project Proposition

Abstract *(Summarise the most important aspects of the project including a flowchart which illustrates the situation with and without the project)*

Project developer organisation name(s) *(and relationships if more than one):*

Organisation's main activity/core business

Project summary

Title

Description *(Describe the most important features of the project)*

Location(s) of project *(Brief - no map required)*

Commissioning date

Project background *(Describe the development of the project so far including any studies that have been carried out and any relevant issues such as financial commitments. Either include the last part as in the final draft or omit the meaningless 'any relevant issues'.)*

Project goals and expected results

Goals *(Describe the primary goals of the project and/or the contribution it should make to the organisation's strategic objectives. Include any secondary benefits such as commercial opportunities from implementing new technology).*

Results *(What specific output levels are expected for the project to achieve its emission reductions)?*

Section 2 - Description of Current Operation

Describe how the project relates to the current operation. *(Describe the kind of products or services that are the output of the current operation. Will this change in type, level or amount after the project? Will the project expand production or change the product mix or increase energy efficiency or improve environmental performance)?*

Describe the adequacy of the current operation in relation to the organisation's long-term goals.

Section 3 - Identification of Relevant Inputs and Outputs of the Project

List inputs (energy sources, raw materials) and outputs (product and waste streams and associated greenhouse gas emissions) for the current operation and for the project. Denote those that will not be affected by the project.

On-site emissions

Off-site emissions

Section 4 - Definition of Project Boundary

Place the project boundary at the smallest sized notional border that includes all material emissions changed by the project *(but not those that are owned directly by the organisation).* **Explain** *(perhaps attach a flowchart indicating what would happen with and without the project)* **where the project boundary is drawn in terms of those sources considered in this project assessment and justify any sources that are omitted. These emissions should include on-site and off-site emissions, whether or not they are directly controlled by the project developer.**

Section 5 - Description of Operation with the Project and Key Factors Influencing it

Describe how operating with the project will differ from the current operation and list other costs and benefits. List all the significant regulatory, economic, environmental and technical factors that could influence:

- **The production from the plant without the project;**
- **The production from the plant with the project;**
- **The risks for the project.**

Regulatory

Economic

Environmental

Technical

Section 6 - Select the Most Probable Scenario for the Baseline

Select the most probable regulatory, economic, environmental and technical factors that will occur from those discussed above. Utilise these to describe the baseline scenario over the whole life of the project. All assumptions should be stated.

Section 7 - Calculation of Baseline Emissions Profile

This section involves calculating the baseline emissions profile i.e. the greenhouse gas emissions that would be produced by the operation if the project is not to be implemented. For the chosen baseline, a spreadsheet should be used to calculate all on-site and off-site greenhouse gas emissions that can be estimated with a reasonable degree of accuracy.

For simplicity, the tables here present only the total fossil fuel usage and consequent total emissions in CO_2 equivalent. It is useful to compare these figures for baseline and project in biomass conversions because they summarise the change in total energy requirements allowing for reduced combustion efficiency and perhaps increased diesel usage from biomass collection and processing.

To obtain these summary figures for total fossil fuel usage and consequent total emissions, greenhouse gas emissions for each individual fuel are calculated by:

1. **Working out the ratio of the current use of each fuel to the current output.**
2. **Taking the best guess for future output (whether higher or lower than current) and multiply it by the current fuel ratios to get the estimated future use for each fuel.**
3. **Calculating the emissions for each fuel by multiplying the amount of fuel by the gross calorific value by the relevant emission factor.**
4. **If necessary, these emissions should be converted into CO_2 equivalent. The conversion to tCO_{2e} is done by using a factor called the global warming potential (GWP). For methane the GWP is 21, for nitrous oxide it is 310, for other gases refer to the table in Appendix 3.**
5. **The CO_2 equivalent emissions can then be added together to gain to total CO_2 equivalent emissions.**

Baseline		**Unit**	**Year 1**	**Year 5**	**Year 10**	**Total over lifetime**	**Level of variability***
1	On-site biomass used	TJ					
2	Specific energy of biomass (gross #)	TJ/ tonne					
3	CO_2 eq. emission factor for biomass delivery to project ##	tonne/ TJ					
4	CO_2 eq. emissions	tonne CO_2 eq.					
5	Total on-site use of fossil fuels (gross #)	TJ					
6	Total CO_2 equivalent emissions	tonne CO_2 eq.					
7	Fuel efficiency of heat production	%					
8	Electricity produced	GWh					
9	Efficiency of electricity production	%					
10	Electricity from grid	GWh					
11	Total on-site electricity use	GWh					

12	Emission factor in grid	tonne CO_2/GWh					
	Other on-site emissions						
13	...	tonne CO_2 eq.					
	Other off-site emissions						
14	...	tonne CO_2 eq.					

Years 1, 5 and 10 have been selected in this forecast example but it may be useful to show intermediate years. A 10-year lifetime has been used in this example but many projects will have much longer lifetimes in terms of assessing emission reductions.

* If the quantity is likely to vary, estimate the range of values that it is 95% likely to lie between.

The convention in NZ is to use gross specific energy or higher heating value. 1 terajoule (TJ) = 1000 gigajoules (GJ). Greenhouse gas emission factors are usually calculated on the gross heat output basis.

Section 8 - Calculation of Project Emissions Profile

This section involves calculating the project emissions profile. The methodology for estimating emissions as outlined in Section 7 sould be followed, but the amount of fuel used will be the amount once the project has been implemented.

Project Emissions		**Unit**	**Year 1**	**Year 5**	**Year 10**	**Total over lifetime**	**Level of variability***
1	On-site biomass used	TJ					
2	Specific energy of biomass (gross #)	TJ/ tonne					
3	CO_2 eq. emission factor for biomass delivery to project ##	tonne/ TJ					
4	CO_2 eq. emissions	tonne CO_2 eq.					
5	Total on-site use of fossil fuels (gross #)	TJ					
6	Total CO_2 equivalent emissions	tonne CO_2 eq.					

7	Fuel efficiency of heat production	%					
	Electricity production						
8	Electricity produced	GWh					
9	Efficiency of electricity production	%					
10	Electricity from grid	GWh					
11	Total on-site electricity use	GWh					
12	Emission factor in grid **	tonne CO_2/GWh					
	Other on-site emissions						
13	...	tonne CO_2 eq.					
	Other off-site emissions						
14	...	tonne CO_2 eq.					

Calculation of the CO_2 equivalent emission factor per tonne of biomass delivered to the project requires projections of average diesel use from the transport (related to average haul distance) and processing (pre-treatment, handling and chipping). Such emissions accounted for here should not be included in the diesel usage below. CO_2 emissions from electricity usage in the transport and processing is usually too difficult to measure separately and so should be included in total usage below.

Section 9 - Calculation of Emissions change from the Project

Emissions changes are calculated using the spreadsheet entries for the baseline emissions and the project emissions. In the case of energy sources that do not change per unit output between baseline and project, the emissions will cancel each other out.

Calculation		Unit	Year 1	Year 5	Year 10	Total over lifetime	Level of variability*
1	Change in on-site biomass use	TJ					
2	Change in on-site use of other fuels	TJ					
3	Emissions change from replaced/reduced heat	tonne CO_2 eq.					

4	Change in electricity produced from on-site generation ***	GWh
5	Change in total electricity use	GWh
6	Emissions change from reduced electricity from grid	tonne CO_2 eq.
7	Other on-site emissions change	tonne CO_2 eq.
8	Other off-site emissions change	tonne CO_2 eq.
9	Total emissions change	tonne CO_2 eq.

Minus signs denote energy or emission reductions.

*** Gross rather than net electricity produced because any increased electricity use is accounted in line 5.

Section 10 - Monitoring and Verification

Describe the general monitoring approach

Describe how and how often the data will be collected

Explain how missing data will be dealt with

Describe the measurement methods

Describe the duration of the measurements

Describe the calibration methods and accuracy

Describe the measurement uncertainties

List key factors for project performance

List key performance indicators

Describe the parameters for emission calculation

How often monitoring reports will be independently verified and by whom

APPENDIX TWO: Case Studies

Emission Reductions from Blue Mountain Lumber’s Wood Waste Utilisation Project

Abstract

This case study is based on Blue Mountain Lumber’s biomass conversion project utilising wood waste. It raises useful issues in terms of baseline selection to demonstrate environmental additionality. We emphasise that this assessment has been developed to illustrate some issues and in no way indicates Meridian Solutions’ future planning.

In July 2000 a major expansion of the Blue Mountain Lumber (BML) sawmill in South Otago was completed. The expanded sawmill processes approximately 160,000 cubic metres of logs annually and requires significant quantities of process heat to dry timber, heat buildings and preheat resins. It also generates significant quantities of wood waste residues.

This is a cogeneration plant, consisting of a 10 MW (thermal) boiler and a 1.4 MW steam turbine generator supplying all the steam and some of the electricity needed to run the sawmill. Prior to this expansion the sawmill operated at a smaller scale and had several boilers that were fire risks and at the end of their economic life.

Section 1 - Project Proposition

Project developer organisation name(s) *(and relationships if more than one):*

BML and Meridian Solutions (MS, a business of Meridian Energy Ltd), formed a build, own, operate and transfer type energy partnership for MS to supply all of the steam required by the site and incinerate surplus wood residues for electricity generation. MS developed a new energy facility to provide BML with this energy supply.

Organisation's main activity/core business:

Meridian Solutions Wellington owns and operates the energy centre supplying steam and electricity to Blue Mountains Lumber. BML's sawmill operates 10 timber drying kilns.

Project summary

Title

Emission reductions from Blue Mountain Lumber's wood waste utilisation project

Description *(Describe the most important features of the project).*

The sawmill expansion project included the installation of a cogeneration plant, consisting of a 10 MW (thermal) boiler and a 1.4 MW (electrical) steam turbine generator supplying all the steam and some of the electricity needed to run the sawmill. By comparison with a baseline of lignite fuel and allowing for lower wood combustion efficiency, the wood waste fuel option avoided 36,000 tonnes CO_2 per year. In addition, the annual 3500 MWh of co-generated electricity is considered to provide extra emission savings of 1600 tonnes of CO_2 per year.

Location(s) of project *(Brief - no map required)*

Tapanui, South Otago

Commissioning date

July 2000

Project background *(Describe the development of the project so far including any studies that have been carried out and any relevant issues).*

The original boilers were fuelled with a combination of wood residues and lignite. When considering the sawmill expansion, the costs and benefits of using wood residues or lignite fuel were considered. Although use of wood residues required a more expensive energy plant, this was the option eventually selected, as it allowed the use of lignite to be discontinued, and the increased steam loads to be fuelled entirely by site-generated wood residues. The same amount of electricity could not have been co-generated on an economic basis by lignite firing.

The project relied on having sufficient wood waste to run the plant 90% of the time for 94% of the year (85% overall). Off cuts, sawdust and shavings total approximately 10% of the dried wood volume and there is an extra 3 to 6% from bark, which is generally excess to fuel requirements.

The emissions calculation was based on a simple zero emission factor for wood combustion. Wood transport emissions were not material to project calculations because the wood waste was already on site. Lignite transport emissions and alternative disposal methods for the wood waste might have been material for the baseline case but they were likely to be of minor significance.

Project goals and expected results

Goals *(Describe the primary goals of the project and/or the contribution it should make to the organisation's strategic objectives. Include any secondary benefits such as commercial opportunities from implementing new technology).*
BML's timber drying operation has allied goals of waste minimisation, reducing dependence on fossil fuels and reducing greenhouse gas emissions. Utilising wood waste will utilise a renewable resource and avoid the need to purchase lignite with its associated CO_2 emissions. Minimising energy costs is a key factor in maintaining the competitiveness of BML's timber drying.

Results *(What specific output levels are expected for the project to achieve its emission reductions)?*
The plant will operate consistently on wood waste, requiring no supplementary lignite. There will be sufficient wood waste to meet all the processing steam requirements as well as additional steam to generate 3500 MWh of electricity each year.

Section 2 - Description of Current Operation

Describe how the project relates to the current operation. *(Describe the kind of products or services that are the output of the current operation. Will this change in type, level or amount after the project? Will the project expand production or change the product mix or increase energy efficiency or improve environmental performance)?*
Increasing demand for timber drying capacity in Otago/Southland means that the plant needed to expand to full time operation and this provided an opportunity to upgrade handling facilities to utilise wood waste generated by the sawmill.

Describe the adequacy of the current operation in relation to the organisation's long-term goals.

BML has been increasing its hours of operation to 24hr and 7 days a week over the last year as demand has grown. The availability of excess steam from near continuous operation maximises the benefits from the previous investment in installing the steam turbine.

Section 3 - Identification of Relevant Inputs and Outputs of the Project

List inputs (energy sources, raw materials) and outputs (product and waste streams and associated greenhouse gas emissions) for the current operation and for the project. Denote those that will not be affected by the project.

On-site emissions

CO_2 emissions from wood waste combustion (a renewable resource) displace the CO_2 from the equivalent thermal output from lignite (a non-renewable resource). Sustainably managed forests are the sources of the wood waste fuel, so there is no question about the renewability of the fuel and the issue of sinks is not relevant here. CO_2 emissions associated with the wood waste transport and handling on-site would be a very minor contribution to total emissions and approximately the same as the equivalent emissions for delivered lignite.

Off-site emissions

Electricity usage in the plant is associated with generation CO_2 emissions and this is assessed using a nationwide Emission Factor. Generating power on-site reduces the need for external power and consequently reduces the indirect CO_2 emissions.

It is possible that the wood waste would otherwise be disposed of in a landfill, resulting in long term methane emissions but there is no means of assessing the benefits of avoiding those emissions by burning the waste as fuel.

The project would eliminate CO_2 emissions associated with the transport of wood waste for disposal and the transport of lignite from the mine. The amounts would be minor compared with lignite combustion and difficult to assess accurately so they are considered extra benefits that have not been quantified.

Section 4 - Definition of Project Boundary

Place the project boundary at the smallest sized notional border that includes all material emissions changed by the project *(but not those that are owned directly by the organisation).* **Explain** *(perhaps attach a flowchart indicating what would happen with and without the project)* **where the project boundary is drawn in terms of those sources**

considered in this project assessment and justify any sources that are omitted. These emissions should include on-site and off-site emissions, whether or not they are directly controlled by the project developer.

CO_2 emissions from renewably sourced wood waste are accounted as zero compared with those from the displaced lignite. Methane and nitrous oxide emissions resulting from incomplete combustion would be extremely minor and similar to those from lignite combustion.

Generating electricity on-site reduces the need for external electricity and consequently reduces the indirect electricity CO_2 emissions. Total electricity usage is approximately estimated to be the same for the baseline lignite case and the biomass conversion case so any emissions difference has not been assessed here.

Any long term methane emissions from alternative disposal of wood waste in a landfill can not be estimated with any degree of certainty.

Other CO_2 emission sources are considered negligible, including those associated with the wood waste transport and handling on-site, the transport of wood waste for disposal and the transport of lignite from the mine.

Section 5 - Description of Operation with the Project and Key Factors Influencing it

Describe how operating with the project will differ from the current operation and list other costs and benefits. List all the significant regulatory, economic, environmental and technical factors that will influence:

- **The production from the plant without the project;**
- **The production from the plant with the project;**
- **The risks for the project.**

Regulatory

No risks but the increased use of wood waste to replace a fossil fuel will help the Government achieve its renewable energy target for 2012.

Economic

The existence of a CO_2 emissions charge on lignite use or a renewable energy incentive would have shortened the payback period for the project.

Environmental

Boiler operation on wood waste has the potential to create high particulate emissions but boiler trials have demonstrated that the automatic boiler operation results in optimum combustion conditions.

Technical

There is a low risk that insufficient wood waste will be available for near continuous (85%) operation.

There is no risk of reduced operating hours from lower timber demand because there is likely to be excess wood waste and extra steam would then be available for cogeneration.

There is considered to be only a very low risk that ash fouling problems from wood waste utilisation may lead to a greater level of downtime than projected.

Section 6 - Select the Most Probable Scenario for the Baseline

Select from the range of expected baseline scenarios the most probable one given all the significant regulatory, economic, environmental and technical factors discussed above. All assumptions should be stated.

There are two main possibilities for baseline scenarios for this project:

1. The plant expansion is fuelled by lignite based on the net efficiency of the previous smaller boiler. The same amount of electricity would have been generated from the lignite combustion, so the project would have no electricity CO_2 emission benefits over the baseline scenario.
2. The plant expansion is fuelled by lignite based on the net efficiency of the previous smaller boiler. The electricity would only have been generated as a result of the wood waste utilisation project, so it is appropriate to calculate all the CO_2 emission benefits from avoiding imported electricity.

The second scenario was selected as the most probable one on the basis that the wood waste is effectively a zero cost fuel, whereas the cost of the lignite is sufficiently high that it could not be justified for generating electricity in this system.

Section 7 - Calculation of Baseline Emissions Profile

For the chosen baseline, calculate in a spreadsheet all on-site and off-site greenhouse gas emissions that can be estimated with a reasonable degree of accuracy. Use the expected output level of the proposed project as a base for determining the emissions associated with the baseline case.

For operation at 10 MW for 85% of the year, 267 TJ of steam energy is produced and this requires either 381 TJ of energy input on lignite (boiler efficiency 70 ± 3%) or 460 TJ of input on wood waste (boiler efficiency 58 ± 3%). The estimated uncertainty on these heat quantities and consequently on the emission savings is ± 10%.

Baseline		Unit	Year 1	Year 15	Total over lifetime	Level of variability*
	Heat Production					
1	Total on-site use of fossil fuels (gross #)	TJ	381	381	5717	±10%
2	Total CO_2 equivalent emissions	tonne CO_2 eq.	36284	36284	544261	±10%
3	Fuel efficiency of heat production	%	70	70		±3%
	Electricity Production					
4	Electricity produced	GWh	0	0	0	
5	Efficiency of electricity production	%				
6	Electricity from grid	GWh	5.1	5.1	77	±10%
7	Total on-site electricity use	GWh	5.1	5.1	77	±10%
8	Emission factor in grid **	tonne CO_2/GWh	450	450		
	Other on-site emissions					
9	...	tonne CO_2 eq.	0	0	0	
	Other off-site emissions					
10	...	tonne CO_2 eq.	0	0	0	

* If the quantity is likely to vary, estimate the range of values that it is 95% likely to lie between.

\# The convention in NZ is to use gross specific energy or higher heating value. 1 terajoule (TJ) = 1000 gigajoules (GJ). Greenhouse gas emission factors are usually calculated on the gross heat output basis.

Section 8 - Calculation of Project Emissions Profile

The project emissions are estimated using the same procedure as that used in Section 7 to calculate baseline emissions.

The excess steam available for power generation is dependent on the variability of timber processing requirements as well as the total plant availability so its uncertainty is expected to be higher at around ± 30%.

Project Emissions		Unit	Year 1	Year 15	Total over lifetime	Level of variability*
	Biomass use					
1	On-site biomass used	TJ	460	460	6900	±10%
2	Specific energy of biomass (gross #)	TJ/ tonne				±10% for moisture variability
3	CO_2 eq. emission factor for biomass delivery to project ##	tonne/ TJ	0	0		
4	CO_2 eq. emissions	tonne CO_2 eq.	0	0	0	
	Heat Production					
5	Total on-site use of fossil fuels (gross #)	TJ	0	0	0	
6	Total CO_2 equivalent emissions	tonne CO_2 eq.	0	0	0	
7	Fuel efficiency of heat production	%	58	58		±3%
	Electricity production					
8	Electricity produced	GWh	3.52	3.52	53	±30%
9	Efficiency of electricity production	%	19	19		±1%
10	Electricity from grid	GWh	1.58	1.58	24	
11	Total on-site electricity use	GWh	5.1	5.1	77	±10%

12	Emission factor in grid **	tonne CO_2/GWh	450	450		
	Other on-site emissions					
13	...	tonne CO_2 eq.	0	0	0	
	Other off-site emissions					
14	...	tonne CO_2 eq.	0	0	0	

Calculation of the CO_2 equivalent emission factor per tonne of biomass delivered to the project requires projections of average diesel use from the transport (related to average haul distance) and processing (pre-treatment, handling and chipping). Such emissions accounted for here should not be included in the diesel usage below. CO_2 emissions from electricity usage in the transport and processing is usually too difficult to measure separately and so should be included in total usage below.

Section 9 - Calculation of Emissions Change from the Project

Emissions changes are calculated using the spreadsheet entries for the baseline emissions and the project emissions. In the case of energy sources that do not change per unit output between baseline and project, the emissions will cancel each other out.

Calculation		Unit	Year 1	Year 15	Total over lifetime	Level of variability*
1	Change in on-site biomass use	TJ	460	460	6900	±10%
2	Change in on-site use of other fuels	TJ	-381	-381	-5717	±10%
3	Emissions change from replaced/reduced heat	tonne CO_2 eq.	-36284	-36284	-544261	±10%
4	Change in electricity produced from on-site generation ***	GWh	3.52	3.52	53	±30%
5	Change in total electricity use	GWh	0	0	0	

6	Emissions change from reduced electricity from grid	tonne CO_2 eq.	-1582	-1582	-23730	±30%
7	Other on-site emissions change	tonne CO_2 eq.	0	0	0	
8	Other off-site emissions change	tonne CO_2 eq.	0	0	0	
9	Total emissions change	tonne CO_2 eq.	-37866	-37866	-567991	±10%

Minus signs denote energy or emission reductions.

*** Gross rather than net electricity produced because any increased electricity use is accounted in line 5.

Section 10 - Monitoring and Verification

Describe the general monitoring approach

Wood waste tonnages are recorded daily and moisture and heat content is tested weekly. Boiler efficiency is measured annually.

Describe how and how often the data will be collected

Tonnages are recorded from the weighbridge as wood waste is delivered to the handling facility. The stockpile is sampled weekly to test for moisture and heat content. Efficiency is assessed during annual particulate emissions testing.

Explain how missing data will be dealt with

It would be assessed from weekly and seasonal usage patterns and recorded as assessed rather than measured.

Describe the measurement methods

Weighbridge. Lab testing for total moisture and specific energy. Efficiency is tested by assessing fuel input and steam output together with flue gas temperature.

Describe the duration of the measurements

Tonnages intermittent with deliveries. Standard stockpile sampling techniques will ensure samples are typical of a week’s waste usage. Efficiency is tested over a period of a few hours and if it proves to be highly variable from test to test, it will be measured more frequently.

Describe the calibration methods and accuracy

Weighbridge annually calibrated. Lab testing is IANZ accredited. Efficiency calibration is dependent on thermocouple calibration and positioning.

Describe the measurement uncertainties

Measurement uncertainties for the weighbridge, moisture, heat and efficiency testing are all negligible compared with the daily variability in these quantities.

List key factors for project performance

Maximising boiler efficiency through selection of automatic operation settings (also minimising particulate and other emissions). Minimising wood waste moisture by applying established storage methods. Minimising steam losses to maximise the amount of excess steam for power generation.

List key performance indicators

Steam use per cubic metre of dried wood. Electricity generated per cubic metre processed and per tonne of wood waste.

Describe the parameters for emission calculation

Lignite and electricity emission factors. Wood waste tonnage, heat content and boiler efficiency.

How often monitoring reports will be independently verified and by whom

Annual performance reports will be reviewed internally.

Emission Reductions from NZ Steel Kilns Waste Heat Utilisation

Abstract

This case study assesses the emission reductions from the 1997 NZ Steel kilns waste heat utilisation project, not including the waste heat utilisation from the multi-hearth furnace (installed in 1985). In the first five years, the plant gradually increased output and waste heat utilisation until operating at full capacity for the following ten years, generating a net 375 GWh annually (allowing for the power to operate the extra generator fans, pumps etc.). Energy costs were reduced with an additional benefit of increasing the plant's security of energy supply.

The electricity emission factor is the key methodology issue affecting the emission reductions outcome of this project.

Section 1 - Project Proposition

Project developer organisation name(s) *(and relationships if more than one):*
NZ Steel and its power generation service provider, Duke Energy.

Organisation's main activity/core business:
Iron and steel manufacture

Project summary

Title
Emission reductions from NZ Steel kilns waste heat utilisation

Description *(Describe the most important features of the project).*
Installing an additional generator to utilise waste heat from the kiln gases generates a further 390 GWh annually (including 15 GWh approximately to power the extra generator fans, pumps etc.) Applying a 470 tonnes CO_2 per GWh emission factor (assuming a 450 factor for the national grid and 4-5% grid losses supplying to NZ Steel) results in a total saving of 2.5 million tonnes CO_2 over a 15-year lifetime of the project.

Location(s) of project *(Brief - no map required)*
Glenbrook, South Auckland

Commissioning date
1997

Project background *(Describe the development of the project so far including any studies that have been carried out and any relevant issues).*
In 1985, two-generation units were installed to utilise waste heat from NZ Steel's multi-hearth furnace and in recent years these have been generating around 150 GWh annually. It was recognised that installing a further generator to utilise waste heat from the kilns would generate a further 390 GWh annually.

Project goals and expected results

Goals *(Describe the primary goals of the project and/or the contribution it should make to the organisation's strategic objectives. Include any secondary benefits such as commercial opportunities from implementing new technology).*
The project was approved because if Glenbrook's steel production is to remain internationally competitive, energy and other costs must be reduced wherever possible. Utilising waste gases that were flared before 1997 was also a high priority for NZ Steel in

reducing the environmental impact of its steel production. In the medium term, minimising the amount of electricity imported will reduce energy costs with an additional benefit of increasing the plant's security of energy supply.

Results *(What specific output levels are expected for the project to achieve its emission reductions)?*
Additional electricity generation is targeted to achieve 390 GWh annually and increased usage will be limited to 15 GWh.

Section 2 - Description of Current Operation

Describe how the project relates to the current operation. *(Describe the kind of products or services that are the output of the current operation. Will this change in type, level or amount after the project? Will the project expand production or change the product mix or increase energy efficiency or improve environmental performance?)*
Before the project, the plant generated only about one third of the potential electricity available from waste heat. The level of iron production is directly proportional to the electricity generated from the multi-hearth furnace waste heat.

Describe the adequacy of the current operation in relation to the organisation's long-term goals.
NZ Steel wanted to utilise the extra waste heat if the installation costs could be justified.

Section 3 - Identification of Relevant Inputs and Outputs of the Project

List inputs (energy sources, raw materials) and outputs (product and waste streams and associated greenhouse gas emissions) for the current operation and for the project. Denote those that will not be affected by the project.

On-site emissions
The plant's CO_2 emissions from coal, natural gas, diesel, limestone, coke and electrodes were not relevant to this project because they would be the same whether or not the project was undertaken.

Off-site emissions
The extra electricity generated from the kilns waste heat indirectly reduces CO_2 emissions from thermal power plants (and avoids transmission losses).

Section 4 - Definition of Project Boundary

Place the project boundary at the smallest sized notional border that includes all material emissions changed by the project *(but not those that are owned directly by the organisation).* **Explain** *(perhaps attach a flowchart indicating what would happen with and without the project)* **where the project boundary is drawn in terms of those sources considered in this project assessment and justify any sources that are omitted. These emissions should include on-site and off-site emissions, whether or not they are directly controlled by the project developer.**

The only assessed source is the electricity CO_2 emissions from the avoided grid power generation. Waste heat utilisation results in zero added fuel use and consequently zero direct CO_2 emissions. A negligible quantity of CO_2 from natural gas would be added to the baseline case because it would be used to stabilise the flame burning the kiln gases.

Section 5 - Description of Operation with the Project and Key Factors Influencing it

Describe how operating with the project will differ from the current operation and list other costs and benefits. List all the significant regulatory, economic, environmental and technical factors that will influence:

- **The production from the plant without the project;**
- **The production from the plant with the project;**
- **The risks for the project.**

Regulatory, Economic and Environmental

None

Technical

Installing a further generator was uncomplicated in engineering terms and the level of generated electricity was easily estimated from the previous generators' performance. The technology of waste heat utilisation from the multi-hearth furnace and from the kilns was well understood so there were not considered to be any risks for the output from the project.

Section 6 - Select the Most Probable Scenario for the Baseline

Select from the range of expected baseline scenarios the most probable one given all the significant regulatory, economic, environmental and technical factors discussed above. All assumptions should be stated.

The baseline scenario was simply the average operation and output in the three years preceding the 1997 project.

Section 7 - Calculation of Baseline Emissions Profile

For the chosen baseline, calculate in a spreadsheet all on-site and off-site greenhouse gas emissions that can be estimated with a reasonable degree of accuracy. Use the expected output level of the proposed project as a base for determining the emissions associated with the baseline case.

The figures below for years 6 to 15 represent approximately 95% availability of the plant for iron making and this would have a variability of ± 5%. The uncertainty on the emission factor arises from the 4.5 ± 0.5% estimated transmission losses.

Baseline		Unit	Years 1-5	Years 6-10	Years 11-15	Total over lifetime	Level of variability*
	Heat Production						
1	Total on-site use of fossil fuels (gross #)	TJ	87,000	87,000	87,000	261,000	
2	Total CO_2 equivalent emissions	M tonne CO_2 eq.	8.15	8.15	8.15	24.45	
3	Fuel efficiency of heat production	%	-	-	-		
	Electricity Production						
4	Electricity produced	GWh	713	750	750	2213	±5%
5	Efficiency of electricity production	%	-	-	-		
6	Electricity from grid	GWh	4485	4585	4585	13,655	±5%
7	Total on-site electricity use	GWh	5198	5335	5335	15,868	±5%
8	Emission factor in grid **	tonne CO_2/GWh	470	470	470		±0.5%
	Other on-site emissions						
9	...	M tonne CO_2 eq.	-	-	-	-	
	Other off-site emissions						
10	...	M tonne CO_2 eq.	-	-	-	-	

* If the quantity is likely to vary, estimate the range of values that it is 95% likely to lie between.

\# The convention in NZ is to use gross specific energy or higher heating value. 1 terajoule (TJ) = 1000 gigajoules (GJ). Greenhouse gas emission factors are usually calculated on the gross heat output basis.

Section 8 - Calculation of Project Emissions Profile

The project emissions are estimated using the same procedure as that used in Section 7 to calculate baseline emissions.

The electricity generated from the kilns and indirect CO_2 emissions avoided would have the same variability of ± 5%. The total 540 GWh is slightly conservative since it is estimated that an extra 10 to 15 GWh could be generated if a second melter was brought online.

Project Emissions		Unit	Years 1-5	Years 6-10	Years 11-15	Total over lifetime	Level of variability*
	Biomass use						
1	On-site biomass used	TJ	-	-	-	-	
2	Specific energy of biomass (gross #)	TJ/ tonne					
3	CO_2 eq. emission factor for biomass delivery to project ##	tonne/ TJ					
4	CO_2 eq. emissions	M tonne CO_2 eq.	-	-	-	-	
	Heat Production						
5	Total on-site use of fossil fuels (gross #)	TJ	87,000	87,000	87,000	261,000	
6	Total CO_2 equivalent emissions	M tonne CO_2 eq.	8.15	8.15	8.15	24.45	
7	Fuel efficiency of heat production	%	-	-	-	-	
	Electricity Production						
8	Electricity produced	GWh	2327	2700	2700	7727	±5%

9	Efficiency of electricity production	%	-	-	-	-	
10	Electricity from grid	GWh	2946	2710	2710	8366	±5%
11	Total on-site electricity use	GWh	5273	5410	5410	16,093	±5%
12	Emission factor in grid **	tonne CO_2/GWh	470	470	470	8366	±0.5%
	Other on-site emissions						
13	...	M tonne CO_2 eq.	-	-	-	-	
	Other off-site emissions						
14	...	M tonne CO_2 eq.	-	-	-	-	

Calculation of the CO_2 equivalent emission factor per tonne of biomass delivered to the project requires projections of average diesel use from the transport (related to average haul distance) and processing (pre-treatment, handling and chipping). Such emissions accounted for here should not be included in the diesel usage below. CO_2 emissions from electricity usage in the transport and processing is usually too difficult to measure separately and so should be included in total usage below.

Section 9 - Calculation of Emission Changes from the Project

Emissions changes are calculated using the spreadsheet entries for the baseline emissions and the project emissions. In the case of energy sources that do not change per unit output between baseline and project, the emissions will cancel each other out.

Calculation		Unit	Years 1-5	Years 6-10	Years 11-15	Total over lifetime	Level of variability*
1	Change in on-site biomass use	TJ	-	-	-	-	
2	Change in on-site use of other fuels	TJ	-	-	-	-	
3	Emissions change from replaced/reduced heat	M tonne CO_2 eq.	-	-	-	-	

4	Change in electricity produced from on-site generation ***	GWh	1614	1950	1950	5514	
5	Change in total electricity use	GWh	75	75	75	225	
6	Emissions change from reduced electricity from grid	M tonne CO_2 eq.	-0.72	-0.88	-0.88	-2.49	±5%
7	Other on-site emissions change	M tonne CO_2 eq.	-	-	-	-	
8	Other off-site emissions change	M tonne CO_2 eq.	-	-	-	-	
9	Total emissions change	M tonne CO_2 eq.	-0.72	-0.88	-0.88	-2.49	±5%

Minus signs denote energy or emission reductions.

*** Gross rather than net electricity produced because any increased electricity use is accounted in line 5.

Section 10 - Monitoring and Verification

Describe the general monitoring approach

NZ Steel continuously monitors its electricity generation and imported electricity using SCADA. Transpower also monitors these quantities using MARIA compliant (calibrated) meters.

Describe how and how often the data will be collected

Continuous

Explain how missing data will be dealt with

Unnecessary when there are two monitoring systems.

Describe the measurement methods

Describe the duration of the measurements

Describe the calibration methods and accuracy

Describe the measurement uncertainties

Negligible compared with the 5% output variability.

List key factors for project performance

Electricity generated from kilns waste heat and from the multi-hearth furnace and imported electricity and 95% plant availability.

List key performance indicators

Kilns generated GWh per unit output.

Describe the parameters for emission calculation

Electricity emission factor

How often monitoring reports will be independently verified and by whom

Internal environmental reporting audits

Emission Reductions from Mighty River Power Landfill Methane Utilisation

Abstract

This case study is based on a hypothetical landfill methane utilisation project. It is based on other Mighty River Power landfill operations designed to optimise anaerobic decomposition and consequent methane emissions for use in gas engines. The baseline assumes instead that the same volumes of waste are deposited in a landfill designed simply to minimise odour associated with aerobic decomposition. Consequently methane production (venting to the atmosphere) is only one half of the optimised design. The assessment is for 20 years of emission reductions for both the avoided methane emissions and the indirect benefits of avoided electricity generation.

Estimates of variability are very approximate for the purposes of illustrating the project rather than estimates based on landfill performance.

Section 1 - Project Proposition

Project developer organisation name(s) *(and relationships if more than one):*

Mighty River Power

Organisation's main activity/core business:
Electricity generation

Project summary

Title

Emission reductions from Mighty River Power landfill methane utilisation

Description *(Describe the most important features of the project).*

A landfill to be used for a period of ten years will supply methane to a set of generators to produce at a peak 5 MW of electricity in the following years. The total emission reduction from the project over the 20 year lifetime is assessed to be 1.06 million tonnes of CO_2 equivalent, 85% from the avoided methane emissions and 15% from the indirect electricity emissions avoided by generating power from the landfill gas.

Location(s) of project *(Brief - no map required)*

Commissioning date

2003

Project background *(Describe the development of the project so far including any studies that have been carried out and any relevant issues).*

Despite the implementation of the Waste Minimisation Strategy, a new landfill will be needed to cope with the increased waste volumes projected over the next 10 years.

As part of its power generation business, Mighty River Power operates landfill methane utilisation plants at Greenmount, Rosedale and Silverstream. Designing a landfill to optimise anaerobic decomposition and methane emissions for utilisation has significantly higher capital and maintenance costs than a conventional landfill but the long term return from generated electricity would help offset those costs.

The technology costs of collecting methane emissions are reduced by optimising landfill design to maximise the electricity generated. Gas is collected as part of landfill management and requires disposal by:

- venting to the atmosphere,
- burning onsite through a flare,
- burning onsite through generators to produce electricity or
- purifying and selling for burning offsite.

Project goals and expected results

Goals *(Describe the primary goals of the project and/or the contribution it should make to the organisation's strategic objectives. Include any secondary benefits such as commercial opportunities from implementing new technology).*

Modern landfills must be carefully designed to avoid leachate contamination of groundwater and to minimise localised air emissions such as dust and odour as well as methane emissions to the atmosphere. As landfill engineers gain more experience of regional geographical conditions, there is continual improvement in the design of future landfills. The landfill will be designed to optimise anaerobic decomposition; keeping air out also seals in methane so that the only escape route is through pipes connected to the gas engines.

The goal of the generation company is to burn the gas on site to generate electricity. As the site is embedded in a lines network, transmission from elsewhere in the country is avoided.

Results *(What specific output levels are expected for the project to achieve its emission reductions)?*

The technology is well established but a number of parameters will influence the variable amount of methane in the continuous gas flow for the next 20 years. No concrete output levels can be expected because of the unpredictability of waste input, anaerobic decomposition behaviour and local geographical and seasonal conditions. Figures presented here are for average expected methane levels and the tables include estimates of the range of expected output.

Section 2 - Description of Current Operation

Describe how the project relates to the current operation. *(Describe the kind of products or services that are the output of the current operation. Will this change in type, level or amount after the project? Will the project expand production or change the product mix or increase energy efficiency or improve environmental performance)?*

Conventional landfill design provides for minimum necessary regulatory standards to be met with regards to safety, and environmental impact.

Describe the adequacy of the current operation in relation to the organisation's long-term goals.

Conventional landfills allow methane to escape to the atmosphere or flare the methane where safety issues are paramount. Mighty River Power prefers to champion more environmentally acceptable landfills by designing landfills to maximise methane emissions for electricity generation and so offset the costs of the equipment while minimising environmental impact.

Section 3 - Identification of Relevant Inputs and Outputs of the Project

List inputs *(energy sources, raw materials)* **and outputs** *(product and waste streams and associated greenhouse gas emissions)* **for the current operation and for the project. Denote those that will not be affected by the project.**

Waste decomposition produces a mixture of CO_2 and methane, with a much higher proportion of methane being produced when anaerobic conditions are optimised. The project avoids methane emissions being vented to the atmosphere from a conventional landfill and the electricity generated indirectly avoids CO_2 emissions from a fossil fuel fired thermal power station.

On-site emissions

Methane emissions to atmosphere from the baseline conventional landfill are avoided. Modern landfill design allows negligible gas leakage (<1%). Gas engines operate at a sufficiently high temperature to ensure that methane and nitrous oxide emissions from incomplete combustion are also negligible.

Off-site emissions

The electricity generated indirectly avoids CO_2 emissions from a fossil fuel fired thermal power station. These are calculated using an emission factor of 450 tCO_2/GWh, based on the projected weighting for 2010 of conventional and combined cycle thermal power stations.

Section 4 - Definition of Project Boundary

Place the project boundary at the smallest sized notional border that includes all material emissions changed by the project *(but not those that are owned directly by the organisation).* **Explain** *(perhaps attach a flowchart indicating what would happen with and without the project)* **where the project boundary is drawn in terms of those sources considered in this project assessment and justify any sources that are omitted. These emissions should include on-site and off-site emissions, whether or not they are directly controlled by the project developer.**

Since the CO_2 is biomass sourced, a zero emission factor is used for CO_2 emissions and the same applies for the CO_2 product of the methane combustion since no fossil fuel is used.

Section 5 - Description of Operation with the Project and Key Factors Influencing it

Describe how operating with the project will differ from the current operation and list other costs and benefits. List all the significant regulatory, economic, environmental and technical factors that will influence:

- **The production from the plant without the project;**
- **The production from the plant with the project;**
- **The risks for the project.**

Regulatory and Economic

Central government and local authorities prefer to work cooperatively with landfill designers rather than impose regulations. Incentives to utilise renewable energy and to avoid methane emissions would help reduce the capital costs of methane utilisation.

Environmental

Localised environmental issues including leachate, odour and dust are the main concerns in landfill design. Avoiding methane emissions for their greenhouse contribution is increasingly being considered in landfill design. The risk of methane release is minimal because of the gas sealing design and flaring is required as a safety backup if the gas engines are not operational.

Technical

Most of the technical factors relate to the design of the landfill to optimise anaerobic decomposition as sections are filled and sealed off. Seasonal ground temperature, rainfall and organic content of the waste all influence the amount of gas flow and its composition. Earthquake and fire risks are managed in the landfill design. If methane flows were lower than projected, fewer gas engines would be installed to utilise the methane.

Section 6 - Select the most Probable Scenario for the Baseline

Select from the range of expected baseline scenarios the most probable one given all the significant regulatory, economic, environmental and technical factors discussed above. All assumptions should be stated.

Justification of a chosen baseline and its potential variability would be an important part of any estimation of emission reductions. Estimates of variability here are very approximate for the purposes of illustrating the proposal rather than estimates based on landfill performance.

The baseline is assumed to be the same volume of waste deposited in a landfill designed simply to minimise odour (associated with aerobic decomposition) and waste gases are vented to the atmosphere.

Section 7 - Calculation of Baseline Emissions Profile

For the chosen baseline, calculate in a spreadsheet all on-site and off-site greenhouse gas emissions that can be estimated with a reasonable degree of accuracy. Use the expected output level of the proposed project as a base for determining the emissions associated with the baseline case.

To develop the average conventional landfill behaviour projection, gas flows and gas content have been estimated from the monitoring of current landfills at various stages of their decomposition profiles. For the same volume of waste the landfill can carry, low and high methane release profiles have been estimated so that the selected baseline is the average of these two.

On average it has been concluded that methane release is one half of the same landfill optimised for methane production, with an expected variability (for 95% confidence levels) of 30% on the methane flow. The rate at which the landfill is expected to be filled is somewhat less variable at ± 10%, which would have a relatively small influence on the methane flow variability.

If for safety reasons, it is considered necessary to install flaring systems to burn the methane emissions in the conventional landfill baseline case, it is estimated negligible methane would be emitted. Therefore, using this alternative baseline would mean that no methane emission reductions would be included in the assessment, just electricity CO_2 emission reductions.

Baseline		Unit	Years 1-5	Years 6-10	Years 11-15	Years 16-20	Total over lifetime	Level of variability*
	Heat Production							
1	Total on-site use of fossil fuels (gross #)	TJ	0	0	0	0	0	
2	Total CO_2 equivalent emissions	tonne CO_2 eq.	0	0	0	0	0	
3	Fuel efficiency of heat production	%						
	Electricity Production							
4	Electricity produced	GWh	0	0	0	0	0	
5	Efficiency of electricity production	%						
6	Electricity from grid	GWh						

7	Total on-site electricity use	GWh	negligible	negligible	negligible	negligible	negligible	
8	Emission factor in grid **	tonne CO_2/GWh	450	450	450	450		
	Other on-site emissions							
9	...	tonne CO_2 eq.	114000	326000	284000	174000	898000	±30%
	Other off-site emissions							
10	...	tonne CO_2 eq.	0	0	0	0	0	

* If the quantity is likely to vary, estimate the range of values that it is 95% likely to lie between.

The convention in NZ is to use gross specific energy or higher heating value. 1 terajoule (TJ) = 1000 gigajoules (GJ). Greenhouse gas emission factors are usually calculated on the gross heat output basis.

** The grid emission factor should allow for grid losses appropriate for the plant site.

Section 8 - Calculation of Project Emissions Profile

The project emissions are estimated using the same procedure as that used in Section 7 to calculate baseline emissions.

A profile of the expected gas flow resulting from the waste volume assumptions provides the five yearly total figures below. They are based on the assumption from monitoring records that the average methane content is 52% by volume.

The variability of the methane flow is lower in the purpose designed landfill, assumed here to be ± 20% combining the variability of the expected waste volumes, gas flow and gas content. Generated electricity would also be ± 20%.

Project Emissions		Unit	Years 1-5	Years 6-10	Years 11-15	Years 16-20	Total over lifetime	Level of variability*
	Biomass use							
1	On-site biomass used	TJ	543	1556	1356	831	4286	±20%
2	Specific energy of biomass (gross #)	TJ/ tonne						
3	CO_2 eq. emission factor for biomass delivery to project ##	tonne/ TJ	0	0	0	0		
4	CO_2 eq. emissions	tonne CO_2 eq.	0	0	0	0	0	
	Heat Production							
5	Total on-site use of fossil fuels (gross #)	TJ	0	0	0	0	0	
6	Total CO_2 equivalent emissions	tonne CO_2 eq.	0	0	0	0	0	
7	Fuel efficiency of heat production	%						
	Electricity Production							
8	Electricity produced	GWh	45	130	113	69	357	±20%
9	Efficiency of electricity production	%	30	30	30	30		±3%
10	Electricity from grid	GWh	0	0	0	0	0	
11	Total on-site electricity use	GWh	negligible	negligible	negligible	negligible	negligible	
12	Emission factor in grid **	tonne CO_2/GWh	450	450	450	450		
	Other on-site emissions							
13	...	tonne CO_2 eq.	0	0	0	0	0	
	Other off-site emissions							
14	...	tonne CO_2 eq.	0	0	0	0	0	

Calculation of the CO_2 equivalent emission factor per tonne of biomass delivered to the project requires projections of average diesel use from the transport (related to average haul distance) and processing (pre-treatment, handling and chipping). Such emissions accounted for here should not be included in the diesel usage below. CO_2 emissions from electricity usage in the transport and processing is usually too difficult to measure separately and so should be included in total usage below.

Section 9 - Calculation of Emission Changes from the Project

Emissions changes are calculated using the spreadsheet entries for the baseline emissions and the project emissions. In the case of energy sources that do not change per unit output between baseline and project, the emissions will cancel each other out.

Calculation		Unit	Years 1-5	Years 6-10	Years 11-15	Years 16-20	Total over lifetime	Level of variability*
1	Change in on-site biomass use	TJ	543	1556	1356	831	4286	±20%
2	Change in on-site use of other fuels	TJ	0	0	0	0	0	
3	Emissions change from replaced/reduced heat	tonne CO_2 eq.	0	0	0	0	0	
4	Change in electricity produced from on-site generation ***	GWh	45	130	113	69	357	±20%
5	Change in total electricity use	GWh	0	0	0	0	0	
6	Emissions change from reduced electricity from grid	tonne CO_2 eq.	-20250	-58500	-50850	-31050	-160650	±20%
7	Other on-site emissions change	tonne CO_2 eq.	-114000	-326000	-284000	-174000	-898000	±30%
8	Other off-site emissions change	tonne CO_2 eq.	0	0	0	0	0	
9	Total emissions change	tonne CO_2 eq.	-134250	-384500	-334850	-205050	-1058650	±36%

Minus signs denote energy or emission reductions.

*** Gross rather than net electricity produced because any increased electricity use is accounted in line 5.

Section 10 - Monitoring and Verification

Describe the general monitoring approach

Gas flow and composition will be measured continuously as it feeds into the gas engines.

Describe how and how often the data will be collected

Generated electricity is continuously recorded.
Continuous monitoring data will be collated monthly. Well flow and composition sampling will be taken monthly.

Explain how missing data will be dealt with

Follow seasonal pattern from previous years and mark the data as approximate estimates.

Describe the measurement methods

Describe the duration of the measurements

Describe the calibration methods and accuracy

Describe the measurement uncertainties

Negligible compared with variability.

List key factors for project performance

Moderate to high levels of methane in well flow and full availability of gas engines for generation.

List key performance indicators

Annual methane generation and annual power generation.

Describe the parameters for emission calculation

Gas flow, methane levels and generated electricity. Electricity CO_2 emission factor.

How often monitoring reports will be independently verified and by whom

Internally reviewed annually.

APPENDIX THREE: Introduction to Climate Change Terminology

Greenhouse Gases

The thin film of mixed gases that surround the earth is called the atmosphere. Its composition creates the conditions necessary for the diversity of life on earth and is mostly made up of oxygen (21%) and nitrogen (78%).

The atmospheric gases that have properties preventing some of the normal radiation of solar heat back into space are called greenhouse gases.

Human activities have increased the production of greenhouse gases. These additional gases trap more of the sun's heat and lead to the greenhouse effect.

Each greenhouse gas has a global warming potential (GWP) that indicates the impact on the atmosphere of one tonne of the gas, compared to one tonne of CO_2. The GWP of CO_2 is 1. Table 1 indicates the GWP's of each of the greenhouse gases.

Table 1: Greenhouse Gases, their sources and GWPs

GHG	Chemical Formula	GWP[1]	Anthropogenic sources[2]
Carbon Dioxide*	CO_2	1	*Fossil fuel combustion,* land use conversion, industrial processes, biomass burning
Methane*	CH_4	21	Fossil fuel mining and combustion, *ruminant livestock,* landfills and other waste disposal, rice cultivation
Nitrous Oxide*	N_2O	310	*Agricultural soils,* fertiliser, industrial processes
Perfluorocarbons[3]	PFCs	6,500–9,200	Industrial processes, *Aluminium production*
Hydrofluorocarbons[4]	HFCs	140–11,700	*Industrial applications*
Sulphur Hexafluoride	SF_6	23,900	*Electrical switchgear,* aluminium smelting

1. *GWP = Global Warming Potential for 100 year time horizon. GWPs vary for different time horizons.*
2. *Principal anthropogenic sources (from juman activities) for New Zealand shown in italics.*
3. *PFCs are the family of gases that contain both fluorine and carbon e.g.* CF_4 *and* C_4F_6.
4. *HFCs are the family of gases that contain hydrogen, fluorine and carbon e.g.* CH_2FCF_6 *or HFC-134a and* $C_2H_4F_2$ *or HFC-152a.*

* *For the purposes of the Kyoto Protocol these gases are measured against a 1990 base year while the others can be measured against either 1990 or 1995.*

Reference: Dyson T, 2001[5].

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[5] Climate Change - a global issue. Is a renewable energy target an effective response for the New Zealand Electricity Sector?, Master of Applied Science Thesis, Massey University Library, Palmerston North, New Zealand.

Energy Units, Conversion Table and Emission Factors

The following energy units, conversion table and emission factors commonly used in New Zealand are selected from a more comprehensive list from the New Zealand Energy Information Handbook (1993). All energy units and energy based emission factors follow the New Zealand convention of being based on gross heat input (or higher heating value). Specific energy (or calorific value) figures for coal are particularly variable, depending on the coalfield, ash and moisture content.

These figures will be sufficiently accurate for most inventories or assessments. An organisation wanting the most up-to-date New Zealand specific emission factors could contact the Ministry of Economic Development, which has the role of continually reviewing energy values and emission factors.

Table 2: Energy Content and CO_2 Emission Factors

	Specific Energy	CO_2 Emission Factor
Petrol	47.3 MJ/kg	0.0666 tCO_2/GJ or 0.00230 tCO_2 per litre
Diesel	45.9 MJ/kg	0.0687 tCO_2/GJ or 0.00262 tCO_2 per litre
Light fuel oil	44.5 MJ/kg	0.0725 tCO_2/GJ or 0.00292 tCO_2 per litre
Maui natural gas	39.0 MJ/m^3	0.0528 tCO_2/GJ or 0.00206 tCO_2/m3
Bituminous coal	32.1 MJ/kg	0.0888 tCO_2/GJ or 2.85 tCO_2 per tonne
Sub-bituminous coal	22.6 MJ/kg	0.0912 tCO_2/GJ or 2.06 tCO_2 per tonne
Lignite	15.0 MJ/kg	0.0952 tCO_2/GJ or 1.43 tCO_2 per tonne
Electricity*		0.000450 tCO_2/kWh

* At the time the case studies were prepared, the Ministry of Economic Development has recommended an interim New Zealand electricity Emission Factor of 0.000450 tonnes of CO_2 per kWh.

Energy Units Conversions

1 kilowatt hour (kWh) = 0.0036 gigajoules (GJ)

1 gigajoule (GJ) = 277.8 kilowatt hours (kWh)

1 British thermal unit (btu) = 1.054 kilojoules (kJ)

1 btu per pound (btu/lb) = 0.002324 MJ/kg

Other Unit Conversions

1 tonne carbon = 3.664 tonnes CO_2

kilo = 1,000 = 10^3

mega = 1,000,000 = 10^6

giga = 1,000,000,000 = 10^9

tera = 1,000,000,000,000 = 10^{12}

peta = 1,000,000,000,000,000 = 10^{15}

1 pound (lb) = 0.4536 kilograms (kg)

1 cubic foot = 0.02832 cubic metres (m^3)

1 litre (L) = 0.001 cubic metres

1 mile = 1.609 kilometres

Explanation of technical terms

The following definitions are provided to assist readers with the technical terms used in the guidelines. They have been adapted from the United Nations Framework Convention on Climate Change glossary and the New Zealand Government Proposed Policy Package on Climate Change, April 2002.

Base year: an historic baseline year used for comparing emissions over time.

Baseline: a reference case that a organisation can use to comparatively estimate emission reduction performance over a period of time, usually annual emissions from a selected base year. A baseline is intended to establish what would have happened had the project not gone ahead.

Carbon sequestration: the uptake and long-term storage of carbon dioxide in forests, soils, oceans, or underground in depleted oil and gas reservoirs, coal seams and saline aquifers.

Cogeneration (or Combined Heat and Power): the simultaneous or sequential production of two or more forms of useful energy from a single energy source (for example, steam and electricity generation) to be used for either industrial purposes or district heating.

Commitment period: to allow parties some flexibility in meeting their greenhouse gas emission reductions obligations under the Kyoto Protocol, binding targets are for the total emissions over a five-year period, known as a commitment period. The first Kyoto commitment period, sometimes referred to as CP1, is 2008-12.

Direct emissions: emissions from sources that are owned or controlled by the organisation undertaking the project.

Dynamic baseline: a baseline, which is revised during the life of a project to reflect changes in output or other relevant variables.

Emissions: greenhouse gases released into the atmosphere.

Emission factor: a factor relating activity data (e.g. tonnes of fuel consumed or tonnes of product produced) and absolute greenhouse gas emissions.

Emissions Units: a unit representing one tonne of CO_2 equivalent. For a country to be in compliance with its Kyoto Protocol commitment, it must have and retire units equal in number to its emissions target for the commitment period. A country is initially assigned a number of units equal to its target (in New Zealand's case, five times its 1990 level of emissions).

Environmental additionality: an estimate of the amount by which greenhouse gas emissions are reduced, relative to the baseline, on account of a project. A project is environmentally additional if the greenhouse gas emissions produced by implementing the project are less than baseline emissions.

Greenhouse gases (GHGs): the major greenhouse gases responsible for causing climate change are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The Kyoto Protocol also addresses hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).

Hydrofluorocarbons (HFCs): a group of greenhouse gases used in a range of industrial applications.

Indirect emissions: emissions that are a consequence of the activities of the organisation undertaking the project but occur from sources owned or controlled by another organisation.

Intergovernmental Panel on Climate Change (IPCC): the IPCC was established in 1988 by the World Meteorological Organisation and the UN Environment Programme. It conducts rigorous surveys of the worldwide technical and scientific literature and publishes assessment reports that are widely recognized as the most credible existing sources of information on climate change. The IPCC also works on methodologies and responds to specific requests from the Convention's subsidiary bodies. (Refer to www.ipcc.ch).

Investment Additionality: is the notion that a project is only made commercially viable through its ability to generate value in the form of emission reduction credits.

Kyoto Protocol: the international agreement under the UNFCCC, setting legally binding targets for greenhouse gas emissions on countries listed in its Annex B.

Methane (CH_4): a greenhouse gas with emissions coming from ruminant livestock, landfills, coal mining and other sources.

Nitrous oxide (N_2O): a greenhouse gas with emissions coming from agricultural soils, nitrogenous fertiliser, fossil fuel combustion and other sources.

Perfluorocarbons (PFCs): a group of greenhouse gases used in a range of industrial applications and produced during aluminium smelting.

Project: a specific activity aimed at delivering defined reductions in greenhouse gas emissions.

Project boundary: a notional line of demarcation set around a project, within which its effect on greenhouse gas emissions should be considered and quantified.

Ratification: after signing the Convention or the Protocol, a country must codify it in legislation. The instrument of ratification must be deposited with the depositary (in this case the UN Secretary-General) to start the 90-day countdown to becoming a Party.

Renewable energy: energy taken from sources that are renewable, for example wind, solar, hydroelectric, geothermal energy, and biofuels.

Sink: any natural or man-made system that absorbs and stores greenhouse gases, from the atmosphere. To be considered a sink, a system must be absorbing more greenhouse gases than it is releasing so that the store of carbon is expanding.

Source: any activity or process, which releases a greenhouse gas into the atmosphere.

Static baseline: a baseline, which is fixed at the start of the project life and not revised thereafter.

Sulphur hexafluoride (SF_6): a greenhouse gas used in electrical switchgear and its industrial application.

United Nations Framework Convention on Climate Change (UNFCCC): an international agreement negotiated in 1992 and aimed at stabilising greenhouse gas concentrations, at a level that avoids dangerous human interference with the climate system.

Verification: the objective and independent assessment of whether a reported greenhouse gas inventory properly reflects the greenhouse impact in accordance with pre-established greenhouse gas accounting and reporting standards.

Types of projects

This section sets out the types of projects an organisation could consider as emission reduction projects. Please note that the project examples given are not inclusive of every possible energy, agriculture or transport related project that could be developed, and are presented here simply as examples.

Renewable Energy projects

Renewable energy is energy that is generated from renewable sources, for example solar, photovoltaic, wind, geothermal, biomass, biogas and hydroelectric technologies, and power from landfill gas recovery. Further options are the substitution of biomass for fossil fuels, and the displacement of energy-intensive materials by biomass.

Commercial/industrial efficiency projects

These projects reduce fuel consumption and emissions in energy and waste-intensive industries and may involve the application of innovative technologies. Practices include: advanced manufacturing and refining processes; cogeneration; efficient stream systems, and electric motors and drives. Projects could include:

- Generator efficiency: reducing fuel consumption by applying innovative technologies in electricity generation;
- Combustion efficiency: reducing fuel consumption by improving control equipment or by applying innovative combustion technologies;
- Cogeneration (or Combined Heat and Power): power plants that use the waste heat from power generation to supply heating;

- Waste heat utilisation: use of waste heat from industrial processes;
- Grid management: improving the grid management, hence reducing losses;
- Refrigeration efficiency: refrigeration systems, chillers, condensers, multiple effect evaporators, refrigeration compressors, procedural changes, maintenance or control of refrigeration systems, improved insulation;
- Lighting efficiency: substitution of fixtures (including lamps, ballasts, fittings and reflectors) or controls (movement, time, intensity), and maintenance.

Fuel switching projects

Fuel switching is the substitution of conventional technologies with less carbon-intensive fuel technologies. Fuel switching includes: re-powering; upgrading instrumentation, controls, and/or equipment, and the more efficient utilization of fuel.

Examples of fuel-switching projects are:

- Coal to gas; a change in the primary energy source for boilers, furnaces, etc, from coal-based products to natural gas;
- Oil to gas: a change in the primary energy source for boilers, furnaces, etc, from light or heavy oil products to natural gas;
- Electricity to gas: emission reductions from this fuel switch are dependent on the primary energy source for the electricity. For example, switching a system powered by electricity to natural gas results in emission reductions if the greenhouse gas intensity of the electricity is higher than the greenhouse gas intensity of the combined gas;
- Electricity to solar: emission reductions from this fuel switch are dependent on the primary energy source for the electricity. If the energy source for the electricity already results in zero emissions, this fuel switch would not result in any emission reductions. In other cases, switching a system powered by electricity (e.g space heating, water heating, appliances requiring electric current, etc) to solar energy will result in emission reductions. This fuel switch applies only to active solar systems, including solar space heating, water heating and photovoltaic-based solar energy;
- Natural gas to solar: switching a system powered by natural gas (e.g. space heating, water heating, appliances requiring heat etc) to solar energy can result in emission reductions.
- Waste heat utilisation/cogeneration: the utilisation of a combined heat and power system can displace energy demand for both grid electricity and/or energy required for process heat;
- Coal, oil or gas to biomass: full or partial switching to biomass will give an emission reductions, the size of which depends on any extra emissions used to collect and process the biomass.

Process design projects

Process design means the reconfiguration of energy systems and energy consuming activities to better economise on energy. This refers specifically to industrial heat recycling, physical process changes (system reconfiguration) and related activities. Projects can involve:

- Procedural changes, maintenance or control of process heating systems, installation of air/liquid heat exchanger to recover heat from furnace flue gas to pre-heat process fluid, installation of economiser on a boiler to improve overall boiler efficiency, and maintenance cleaning programme on heat exchangers to improve heat transfer;
- Procedural changes, maintenance or control of heating, ventilation and air conditioning systems;
- Variable speed drives on motors;
- Reticulation system efficiency;
- Improvements in process start-up/shutdown procedures to improve energy efficiency;
- Reducing process bottlenecking to improve energy efficiency;
- Heat pumps.

Energy efficiency of buildings

The energy efficiency of buildings can be improved through changes to methods of heating, cooling and lighting, and through the use of energy-saving appliances and equipment. Projects could involve:

- Space heating/cooling: energy efficiency for heating, cooling, and the use of energy-saving appliances;
- Lighting: energy efficiency for lighting and the use of energy-saving appliances;
- Building design;
- Energy efficiency for refrigeration and the use of energy-saving appliances.

Transport Projects

The transport sector generates 40% of New Zealand's gross CO_2 emissions and, the quantity of emissions is likely to increase as the population grows. Projects could include measures that encourage a reduction in the transport sector's contribution to gross emissions, for example:

- Switching to a lower greenhouse gas intensive fuel, including:
  - Petrol to natural gas;
  - Natural gas to hydrogen;
  - Switch to fuel cell (depending on the fuel source), and;
  - Petrol to electricity (depending on the electricity source).

- Increasing the technical or process efficiency of transport. Initiatives can be measured in energy demand per kilometre travelled, vehicle kilometres travelled, or tonne kilometres travelled. These projects could include:
  - Technical efficiency: related to the technical energy efficiency of the motorised system, and;
  - Load efficiency: related to the amount of energy required to deliver a measured unit of load/product.

- Switching to a lower emissions intensive transportation mode, including:
  - Switch to public transport;
  - Switch from heavy truck to rail.

- Traffic based management initiatives. These are policy-driven measures resulting in the reduction of vehicle kilometres travelled, including:
  - Increasing vehicle occupancy (for example, car pooling);
  - Teleworking, and;
  - City and neighbourhood design.

Agricultural Sector Projects

Projects could include:

- Manure management, and;
- Applying farm practices and technologies that reduce methane emissions from livestock.

Reforestation or afforestation projects

If a reforestation or afforestation project were to result in sinks enhancement (as defined in the UNFCCC), the following factors would need to be considered:

- Land use change or just replanting of a harvested forest;
- Permanent protection (legal covenant) or an intention to harvest;
- Long-term carbon sequestration rate;
- Pest control or eradication (related to fencing and maintenance).

Useful Contacts

The following organisations are useful contacts for further information in relation to greenhouse gas reduction projects.

New Zealand Climate Change Programme www.climatechange.govt.nz
Phone: (04) 917 7400

Ministry of Economic Development www.med.govt.nz
Phone: (04) 472 0030

Energy Efficiency and Conservation Authority (EECA) www.eeca.govt.nz
Phone: (04) 470 2200

New Zealand Business Council for Sustainable Development www.nzbcsd.org.nz

UN Framework Convention on Climate Change http://unfccc.int

World Business Council for Sustainable Development www.wbcsd.org