GREENHOUSE AUDIT & ENERGY COST REDUCTION PLAN

Townsville City Council

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ACKNOWLEDGEMENTS

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1.0 EXECUTIVE SUMMARY

Global warming has the potential to force great changes to both global and local economies. Because so many modern practices (in particular the use of energy) result in the release of greenhouse gasses, adequately dealing with global warming requires an organisation to adopt a strategic and well-reasoned energy policy.

For some City Councils, global warming is perceived as a threat, for others an opportunity. This report demonstrates the extent to which Townsville City Council (TCC) can profit from global warming.

In the 2000-2001 financial year TCC was responsible for the release of global warming gasses equivalent to around **120,000 tons** of CO_2. Without proper policies in place, this figure is likely to rise in the future. Most of these emissions were the result of waste management practices. However, electricity demand, waste water treatment and fuel use were also major contributors.

TCC is able to save a great deal of money and promote sustainable development by reducing greenhouse emissions and by capturing value from what are currently considered wastes. These practices are not new to TCC. At the Cleveland Bay and Mt St. John waste water treatment plants, for example, what used to be a waste is now a tradeable commodity. In this instance, the potent greenhouse gas, methane, which was once burnt-off, is now sold and provides an income stream that offsets some of the costs associated with running the plant.

Similar economies arise from simply reducing the demand for energy. A case study is the Dalrymple Road depot in which 15% reductions in energy bills can accrue at no cost by simple modifications to energy management practices.

For some councils, adoption of greenhouse and energy management policies lead to cost savings that more than cover the cost of specialist staff who implement the necessary changes. There are a number of successful programs that assist councils to profit from global warming, and joining these programs is one of the recommendations of this report.

2.0 INTRODUCTION

This report details the extent to which Townsville City Council (TCC) contributes to global warming and the business and public health benefits associated with reducing these emissions. The report examines TCC's energy demand, reliance on fossil fuels, options for energy efficiency, potential greenhouse gas emission reductions, and cost savings. This report has two separate parts, a Global Warming Audit and a site specific energy audit.

The Global Warming Audit (GWA) identifies the greenhouse emissions associated with Council's operations using financial year 2000-2001 as the baseline. It also seeks to identify profitable ways in which TCC can reduce emissions. An introduction to the science of the greenhouse effect is intended to assist readers to understand the terminology and methods used in greenhouse emission work. For this reason, an introduction to the science of the greenhouse effect is the subject of **Section 2**.

Greenhouse emissions take a number of different forms. Emissions associated with electricity consumption under council control (**Section 3**) include energy for council buildings, sewerage pumping stations and waste water treatment plants. Other emissions include methane released from waste water treatment plants (**Section 4**), carbon di-oxide emissions from the tailpipes of TCC's vehicle fleet (**Section 5**), and methane from solid waste landfills (**Section 6**).

The GWA also investigates the use of an alternative fuel for some of TCC's vehicle fleet. Biodiesel has the potential to deliver significant greenhouse emission reductions and health benefits for all Townsville residents. Furthermore, an opportunity exists for Townsville to be become a manufacturing base for this sustainable fuel. The biodiesel assessment is the subject of **Section 8**.

The site specific energy audit has been included to offer a concrete example of the energy and dollar savings to be made from simple energy management procedures. The site chosen was the Dalrymple Road Depot in which six buildings were assessed for energy efficiency. This audit can be found in **Appendix 1.**

While every effort has been made to ensure the accuracy of this report, much required information was not available. For example, it has not been possible to determine TCC's contribution to the energy demand for street lighting. Due to such constraints, this report is to be regarded as a preliminary study. Uncertainties associated with this report are stated for each area of study. With these caveats aside there remains a sound basis for a series of recommendations for Council. The discussion and recommendations following from this information are to be found in **Section 9**. The attached CD Rom provides a resource manual for Greenhouse topics discussed within this report.

3.0 GLOBAL WARMING SCIENCE

3.1 INTRODUCTION

Global warming is regarded as the most serious of all the global environmental problems. This is because every living organism on earth shares just one atmosphere and because no single country, no matter how powerful, can solve the global warming problem alone. Global warming is caused by human interference with a natural process known as the greenhouse effect. While the science of the greenhouse effect was discovered at the end of the 19th Century it seems that global warming is to be major issue of the 21st Century.

For the foreseeable future, the global warming debate will continue, as will the amount of atmospheric carbon. In the meantime, much can be done at the local level to determine where the man-made sources of global warming emissions come from and to assess the business opportunities associated with reducing them. The process of accounting for global warming emissions is referred to as a global warming audit (GWA).

Conducting a GWA can be a complex task as there are many variables that need to be considered. Because of the limited timeframe in which this work was conducted and the absence of some important pieces of information, this work should be regarded as indicative and not definitive. This audit is based on simple scientific principles and this report is most easily understood with these in mind.

3.2 SIMPLE SCIENTIFIC PRINCIPLES

The science of the greenhouse effect dates back to the late 1800s. In the years of the European industrial revolution, a Swedish chemist named *Svante Arrhenius* (1859–1927) made an interesting discovery. His experiments demonstrated that some naturally occurring atmospheric gasses had the effect of trapping heat in the atmosphere. The analogy is made with a horticulturalist's greenhouse, a glass shed used for growing warm-weather plants in cold climates. In a horticulturalist's greenhouse, sunlight penetrating the glass is turned into infra-red radiation upon striking the plants and soil inside. Infra-red radiation is what we generally refer to as 'heat'. Due to the insulating properties of glass, the heat reflected from the plants and soil is unable to leave the greenhouse. This causes an increase in heat inside the greenhouse. The *greenhouse effect* is a natural process for our planet and it explains why the earth's atmosphere is relatively warm compared with the coldness of space.

However, human activities – in particular the burning of fossil fuels – is increasing the amount of greenhouse gasses in the atmosphere. This is leading to a process of atmospheric warming, so-called global warming.

The world's foremost body on the science of global warming is the *Intergovernmental Panel on Climate Change* (IPCC), a body coordinated by the United Nations Environment Program and the International Meteorological Organisation. The IPCC employs hundreds of scientists from around the world, over forty of them from Australia. The IPCC has established a framework by which all countries can discuss the complexities of climate change in a common language. One of the key phrases in this language is *global warming potential* (Zillman, 2001:169-184).

There are many different gasses that contribute to global warming. These include naturally occurring gasses such as methane, carbon di-oxide and even water vapour. Many man-made chemicals are also greenhouse gasses, for example, refrigerant gasses such as freon, and other chemicals used in industry such as hydroflorocarbons (HFCs). However, not all gasses have the same capacity to heat the atmosphere. Methane for example is 21 times more powerful as a greenhouse gas than is carbon di-oxide (CO_2). However, because of the abundance in which CO_2 is produced by human activities this gas has the greatest impact on global warming. For this reason all other greenhouse gasses are measured against CO_2. Therefore, methane is said to have a *global warming potential* of 21 (GWP 21).

All global warming gasses have an assigned GWP. To give an example of an extreme case, HFC-21, a hydroflourocarbon manufactured for the computer industry, has a global warming potential 21,000 times that of CO_2 (GWP 21,000) (CD\Greenhouse Issues\Grin Suprise). By multiplying the amount of a gas by its GWP, it is possible to determine its impact on the atmosphere measured as an *equivalent to carbon di-oxide*. Therefore, all figures in this report are converted to a CO_2 equivalent, measured in tons. The symbol used throughout this document for CO_2 equivalent is **CO_{2e}** (or CO2e where the fonts do not allow subscript figures).

As there is a close correlation between CO_{2e}, energy consumption, and energy expenditure, it follows that reductions in CO_{2e} can result in savings of money. Furthermore, because reducing CO_{2e} can have human health benefits this report lays part of the foundations for sustainable development in Townsville. This is because sustainable development, or sustainability, relies on social, economic and environmental benefits. It is these benefits that this report seeks to identify.

The following chapters detail the emissions of CO_{2e} from TCC's operations. Because electricity demand is associated with nearly all of council's operations, such as lighting, air conditioning and pumping waste water, this shall be the first emission source to be considered.

4.0 ELECTRICITY CONSUMPTION

The electricity from the mains supply that powers Townsville comes from a range of different sources. While local plants contribute power during times of peak demand, base-load power is 'pooled' in the mains supply. This means that many power stations, some hundreds of kilometres distant, contribute to Townsville's power supply. These stations mainly use coal as a fuel, although some use renewables such as wind and hydropower. Others use natural gas or diesel fuel. For this reason it is not easy to determine the global warming significance of electricity use. Fortunately, however, the Australian Greenhouse Office has produced a set of standardised regional coefficients for assessing the emissions associated with electricity use around Australia. For the north Queensland region the coefficient is:

1 kWh electricity = 1.040 kg CO_2

(Australian Greenhouse Office Factors and Methodologies)

Because energy in the mains supply is pooled, global warming emissions produced through the use of electricity are not emitted at the site where the electricity is used. Instead, they enter the air where the electricity is produced, the exception being wind and hydropower which have no emissions associated with the production of electricity[1]. Nonetheless, it is standard to consider CO_2 emissions associated with electricity use being the responsibility of the organisation that *uses* the power. This is the case for TCC, and TCC's electricity demand is rated a CO_{2e} according to the number of kilowatt hours consumed.

4.1 TCC'S ELECTRICITY DEMAND

In some ways electricity demand is the easiest of all the sources of greenhouse emissions to assess. In theory, all that is necessary to get accurate information is to tally up the kilowatt hours from the electricity bills and multiply the figure by the CO_{2e} coefficient (1.04 kg CO_{2e} per kilowatt). However, determining the number of kilowatt hours (kWh) that TCC uses is not so straightforward.

This is because TCC administrative practices do not record kWh information and retrieving this information by indirect methods is difficult. TCC has over 400

[1] This equations is perhaps not so clear give the recent evidence that some dams release copious amounts of greenhouse emissions resulting from the anaerobic breakdown of flooded vegetation. Source:CD\Greenhouse Issues\Raising a Stink and Trouble Bubbles for Hydropower.

separate energy accounts with Ergon, regional Queensland's retail energy provider. Evidence suggests that TCC receives over 1080 separate electricity bills per year. Some information from energy bills is recorded on the Financial Services database. This includes a bill reference number and price for metered energy demand. However, information detailing kilowatts of energy consumed or tariffs, two pieces of information that would permit a global warming assessment, are not entered into the Financial Services database. While it is possible to gain a rough idea of kilowatts from electricity costs, without tariff information, the error of this method becomes difficult to calculate. However, despite the shortcomings of Financial Services' database, there are a number of other methods by which kWh, and thus global warming emissions, can be accessed.

One option is to manually retrieve all the energy bills for a given year by visiting the appropriate boxes in the Financial Services storage vault and record the kWh recorded there. However, there is a logistical problem associated with locating the 1080 separate bills from thick folders stored in many hundreds of different boxes in the vault. The time required to access each bill, write down the pertinent details then replace the boxes on the shelf in the correct place, could be prohibitive.

An alternative is to contact Ergon and request of them kWh data from their database. Ergon have indicated that they are prepared to do this - but at a cost of some $5,000.

Both of these methods were beyond the scope of this study. Therefore, in order to establish a good ball park figure for TCC's electricity demand the following methodology was used.

4.2 METHODOLOGY

Financial services database holds a string of data, which indicates the reference number of the bill, the meter number and the dollar cost of each separate bill. To make sense of this database it is necessary to split the data into two sections, those in which the total bill is less than $15,000 dollars and those that are greater than $15,000 dollars.

The reason for this is that the standard tariff under which most the bills are metered is tariff 20. Under tariff 20 there are two separate fees for each kilowatt hour consumed. The first 10,000 kWh is billed at 11.59c\kWh. Subsequent kilowatt hours are billed at 10.11c\kWh. Therefore, bills that are over $15,000 are likely to be bills for which 10,000 kWh has been reached in the billing period after which the other billing rate comes into effect.

To gain an estimate of the total kilowatt hours associated with the incurred charge over $15,000, it is first necessary to subtract the 10% GST from the bill, subtract the service charge of $97 per account, then separate the remaining cost into the first 10,000 and the subsequent kWh. By dividing this part of the bill by the cost of its separate components it is possible to determine how many kilowatt hours of electricity were consumed. From this it is a simple multiplication by 1.040 to determine CO_{2e}.

For bills of less than $15,000 it is assumed that the user did not consume more than the 10,000 kWh per month. This makes the figures simpler. However, for these smaller bills, another complexity arises. For some of TCC's accounts there is no electricity meter, just a set annual fee. An example of this would be a lone street lamp which is calculated to have a given energy demand. Rather than meter the usage, council pays a set fee for the service based on an assumed monthly demand.

All of this billing information is included in the Financial Services database shown in **Appendix 2: Electricity < $15,000 and Electricity >$15,000**. While this methodology has been used to calculate emissions associated with electricity consumption, a thorough assessment of the information on the database indicates an odd number of bills for many of the accounts. This creates further uncertainties in the emissions estimation.

Townsville City Council electricity demand is estimated at 22,831 tons of $CO_{2e.}$

4.3 DISCUSSION

To demonstrate that financial savings are possible, a number of site specific recommendations have been made in relation to the Dalrymple Road Works Depot. These are found in the Energy Audit located in **Appendix 1**. However, as has been illustrated above, for TCC to clearly see the benefits associated with implementing these recommendations, better access to energy information will be required.

For efficient and cost saving energy management, business unit managers should have full access to their own energy information. This is because their daily decisions determine the size of energy bills and the amount of energy consumed. At present, energy billing is handled by Financial Services with minimal input from business unit managers. This is an impediment to efficient energy conservation and minimising expenses on electricity.

The electricity database held by Financial Services shows an account number for each meter or each separate bill. However, only a small number of these have a location associated with them. A thorough analysis of the electricity billing structure in council will allow for a rationalisation of the energy billing method. One simple option is to incorporate kilowatt hours and tariff information from the electricity bill into the Financial Services database. A suggestion has been made that this information could be included in the datafields associated with Environmental Services that are currently not in use.

4.4 RECOMMENDATIONS

- Financial Services database to include tariff and kilowatt hours and location information.
- Business unit managers to have access to their energy information.
- Business unit managers to report their energy demand and to seek opportunities to reduce demand.
- Undertake a review of existing energy audits that have been produced for TCC. It is believed that there are as many as ten of these.
- Where feasible, implement the recommendations of these energy audits.
- Undertake further energy audits to determine where cost savings can be made.
- Council should implement the recommendation of the Dalrymple Road Energy Audit and use it as a case study that could be applied Council-wide.

A further discussion of this issue can be found in **Section 9: Discussion and Recommendations**.

5.0 WASTE WATER

5.1 INTRODUCTION

Townsville City council operates three main waste water treatment plants with a fourth soon to be commissioned. The two commissioned plants are on the mainland and the other two plants located on Magnetic Island. Greenhouse emissions associated with waste water management arise because of a number of factors relating to energy demand and methane emissions. The methodology for measuring these emissions is described below.

5.2 METHODOLOGY

The methodology used to determine the CO_{2e} of Townsville City Council's waste water treatment plants is based on the Australian Greenhouse Office Factors and Methods V2 and information derived from discussions with personnel in Citiwater and Financial Services. Sources of greenhouse emissions are described under the following headings.

- Energy demand for waste water pumping
- Methane emissions from waste water treatment
- Energy demand for waste water treatment

The methodology used to determine greenhouse emissions from waste water treatment follows is detailed in *Factors and Methodologies V2*. However, full information was not available to meet all the requirements and for this reason some assumptions were made.

5.2.1 Energy Demand for Pumping

The energy demand for pumping sewage to the waste water treatment plants was assessed in a NORQEB energy audit (NORQEB, 1996). In order to make the figures contemporary, we have allowed for an annual increase in electricity demand of 5%. This accounts for increased water flow through existing infrastructure and additional infrastructure commissioned due to urban expansion. It is stressed that the 5% annual increase in electricity demand for sewage pumping is an arbitrary figure based on a professional estimate. It is included for indicative purposes only.

It is believed that pumping waste water has already been accounted for in the electricity billing spreadsheet derived from Financial Services. Nonetheless, for illustrative purposes it is useful to know that **2,068 tons CO_{2e}** is associated with the electricity demand for waste water pumping. The calculations upon which this figure is based are shown in **Appendix 2 – Waste water.**

5.2.2 Methane Offput Through Waste Water Treatment

Many municipal waste water treatment plants use anaerobic digesters to process the solid component of the waste water, the sludge. A biproduct of anaerobic digestion is methane. From a greenhouse perspective, methane is very important because a single molecule of this gas has the same global warming influence as 21 molecules of carbon di-oxide (GWP21). Therefore, small reductions in methane emissions result in much larger savings of CO_{2e}.

For Townsville, the anaerobic digestion process occurs in large, sealed vats and the methane is collected. Until recently, a small portion of this explosive gas was burnt to provide heat to assist in the anaerobic digestion process and the rest was flared off. More recently, however, the methane gas has been used to drive a generator that provides up to 1\3 of the power required for the running of the plant. From an emissions inventory perspective, this makes the figures somewhat more complex. These calculations will be detailed below, but first, an explanation of the methodology for determining methane emissions from waste water treatment plants such as the one in Horseshoe Bay, Magnetic Island, where there is no methane capture.

Australian Greenhouse Office Factors and Methods V2 present a methodology for determining methane emission from waste water treatment plants based on the number of users of the system. These persons are referred to as *equivalent persons* (EP) as the number represents an average for the amount of waste they produce. The calculation relies on the multiplication of the EP by the amount of organic matter (sludge) produced per person per year, 18.25 kilograms per annum. With 4000 EP associated with the Horseshoe Bay plant, this makes 73,000 kg of organic waste processed per year. Next, multiply this figure with the default methane emission factor, which is 0.25 kg methane per kg of sludge. Thus the Horseshoe Bay plant produces 18,250 kg of methane per year. Multiply this with the global warming potential of methane (21) and this yields a carbon dioxide equivalent of 383,250 kg or **383 tons CO_{2e}** per annum.

The final assessment of global warming emissions associated with waste water treatment relates to the energy demand of the waste water treatment plants themselves.

5.2.3 Energy Demand for Waste Water Treatment

The emissions relating to energy demand of the Cleveland Bay and Mt St John plants is confused by the use of methane produced in the anaerobic digesters for electricity generation. For this study it has not been possible to obtain all the necessary data to calculate the emissions accurately. However, it is believed that the system captures and burns all of the methane produced in the digesters so it is not necessary to calculate methane emissions for these two plants. Furthermore, it is believed that the electricity data obtained from Financial Services contains data relating to energy demand of the waste water treatment plants themselves. In this case, the emissions have already been accounted for.

Even if complete figures were available of electricity consumption of the plants, the calculations would not end there, because of the financial flows associated with the methane generators which are:

1. TCC sells methane to Stanwell.
2. Stanwell uses the methane to produce electricity, which it sells to Ergon.
3. Ergon sells the electricity to TCC to run the waste water treatment plant.

5.3 DISCUSSION

Notwithstanding the above, estimated methane output from the Horseshoe Bay waste water plant is **383 tons of CO2e**.

The use of the sewer for waste water treatment has a history dating over a hundred years. While modern sewerage treatment technology has undergone various technological adaptations, there has been a similar suite of developments in non-sewer human, waste treatment systems. So much so that there are now dozens of alternatives to the traditional sewer system. For many of the situations in which the use of the sewer is the forgone conclusion, there exists a range of technological alternatives. In fact there are many dozens of effective and inexpensive alternatives to dealing with human waste that do not require the high costs associated with the sewer. The names of a few include:

- Biocycle
- Living Machines

- Dowmas
- Envirocycle
- Ecolet
- Vital Resource Management

Some modern technological developments that involved sewerage treatment plants include systems whereby the organic component of sewerage sludge is converted into useable liquid fuels. Townsville is already making good use of what used to be a waste resource by burning methane produced in the digesters and making electricity from it. However, without a thorough technical analysis of global waste water technology, it is not possible to determine which modern technologies would make cost effective savings to the existing sewer infrastructure in Townsville. The corollary holds true: a technical analysis of worldwide waste water treatment technology may well indicate that there is much money to be saved by investing in modern environmental technologies.

5.4 RECOMMENDATIONS

- Investigate the use of Australian and international sewer and non-sewer waste water treatment technologies to identify which have the best environmental and cost savings for Townsville.
- Support the ongoing push to amend State legislation that currently prohibits the use of non-sewer technology in sewered areas This will help promote the legislative options for more cost effective waste water treatment systems.
- Survey the public for their support of non-sewer options to waste water treatment.
- When waste water treatment pumps are to be replaced ensure that the energy rating of the replacements are incorporated in the decision making process.

6.0 VEHICLE FLEET

Council operates an extensive fleet of over with 500 vehicles and pieces of plant. Inclusive in this list is trucks, vans, heavy and light plant, sedans, utes, four wheel drives, ride on lawn mowers, whipper snippers, brush cutters and litter blowers. All of these use liquid fuels, either diesel or petrol.

To determine the emissions associated with this equipment is relatively easy, as council has maintained records of fuel usage for all of its equipment. Therefore, by multiplying fuel consumption by the appropriate emissions coefficient it is possible to determine the equivalent carbon di-oxide emissions. Emissions associated with council workers driving to and from work were excluded from the calculation except where the costs of this were reflected in the fuel bills analysed.

In the baseline financial year 2000-2001 council's operations consumed 1,096,504 litres of diesel fuel and 413,371 litres of petrol. This accounted for **2950 tons CO_{2e}** for diesel and **933 tons CO_{2e}** for petrol. In total therefore, council's direct use of fossil fuels resulted in the emission of **3883 tons of CO_{2e}.**

6.1 DISCUSSION

Much can be done to reduce the fuel consumption of vehicles. Commonly heard initiatives involve regular maintenance to keep the vehicle in top working order and converting petrol powered vehicles to run on compressed gas. Even the manner in which vehicles are driven can reduce fuel consumption -rapid acceleration and excessive speed, are big consumers of fuel. However, even the most modern vehicle is an energy inefficient machine, losing over half of the energy contained in the fuel as waste heat. This is a result of the continued reliance on the internal combustion engine as the primary power source. Ultramodern cars referred to as hypercars will soon be in showrooms (Source: CD\Hybrid and Hypercars\Recent Hypercar News). These modern vehicles boast technological advantages such as fuel cells and regenerative braking (storing the kinetic energy of the vehicle's deceleration in batteries). The energy efficiency, fuel costs and global warming emissions of hypercars will very likely prompt the swift demise of the internal combustion engine once they can be produced at marketable prices.

In the meantime, however, there are other approaches to a vehicle fleet that can reduce greenhouse emissions and save money. Principle among these is to use the car less. An assessment of how many vehicle trips are made that could be replaced with a 5-minute walk will probably demonstrate this point[2]. Other approaches rely on allowing greater flexibility of use of vehicles so that trips requiring only one person are conducted in smaller vehicles. Fundamentally, however, the bulk of the energy demand from vehicle use is due to the fact that in a City with only a small network of public transport, there is little option but to drive. Furthermore, because of the reliance on private transport, there is the high maintenance required for City roads. This again is a source of Council fuel expenses and demonstrates the cycle of expense that can come about from the lack of sustainability and systems thinking in transport infrastructure development.

6.2 RECOMMENDATIONS

- Fuel efficiency should be a factor in the decision to purchase or lease new vehicles.
- Petrol vehicles should be converted to gas where the economics are favourable (a government program exists to facilitate the switch).
- TCC should agree to fuel its diesel vehicles with biodiesel (see **Section 8** - biodiesel assessment).
- Vehicles should be maintained in good working order and driven in an energy efficient manner.
- TCC should investigate the economics of purchasing hybrid vehicles now on the Australian market. The *Toyota Prius* and the *Honda Insight* both integrate efficient petrol motors with electric motors. These vehicles are most cost effective for long highway journeys where there is no requirement to carry a heavy payload.
- TCC should conduct an assessment of vehicle trips to identify underlying patterns and determine whether simple cost effective solutions lie beneath.
- TCC should promote car pooling so that staff are rewarded for sharing travel costs.
- TCC should ensure that public transport has a high priority in the Planning Schemes currently under development.

[2] A recent technological adaptation to replace walking for short journeys is the Segway Human Transporter, other wise known as 'Ginger'. A very sophisticated replacement for the motor car on short journeys. Source: CD\Segway HT\Segway HT.

7.0 SOLID WASTE

Establishing the global warming emissions associated with landfill is more difficult that for the use of fuel use and electricity because the coefficients for relating between tonnes of waste and tonnes of CO_{2e} is very information intensive. This information includes the design of the landfill, the composition of the waste it contains, climactic variables and a range of other factors. Citiwaste does possess a number of documents that provide some of the necessary information and this information has been assessed for the purposes of this audit. For example, in 1999, TCC undertook an assessment of the contents of its Vantassal Street landfill. When combined with a simple methodology used by the Factors and Methods V2 the information contained in this report provides sufficient data with which to conduct a preliminary estimate of CO_{2e} from council's landfill sites.

Global warming emissions associated with solid waste management also come from the fuel used to transport the waste from urban areas to the tip. However, the emissions from this source have already been calculated in the previous section on fuels.

7.1 METHODOLGY

From this data the following annual rates of waste disposal associated with TCC operated landfills are shown:

Vantassal Street domestic:	87,918 tons
Vantassal Street commercial:	37,679 tons
Cungulla domestic:	1,544 tons
Majors Creek domestic:	3,343 tons
Picnic Bay domestic:	4,658 tons

Noticeably absent from these figures are the calculation for woods and recyclables collected by TCC kerb side recycling program. Because both the wood and recyclables are transferred to independent companies, the emissions associated with their disposal are beyond TCC control and thus beyond the scope of this assessment.

Like waste water treatment plants, landfills contribute to global warming through the emission of methane gas. Methane is produced in landfills by the biological breakdown of organic matter in an environment free of oxygen, so called anaerobic digestion. The percentage of organic matter in municipal waste varies greatly according to the types of waste contained in the tip. Calculating the CO_{2e} emissions of a land fill requires knowledge of the total weight of all waste taken to the landfill. The percentage of that weight that is carbon (the organic proportion), the use of a general coefficient to calculate tons of methane production according to the total mass of organic proportion, and finally, methane's GWP to calculate CO_{2e}.

The organic proportion of the waste varies according to a number of categories. Glass and metal, for example, have no organic component. Paper\carboard \textiles and food scraps have an organic component totalling 30 and 21% respectively. Therefore 1 ton of paper waste is said to have an organic proportion of 300 kg. Given sufficient time, in a landfill the organic component of waste will be broken down by anaerobic bacteria and will be released as methane. The rate at which this release occurs is determined by the amount of moisture in the landfill among other factors. In Townsville, the landfills are dry for much of the year. However in the absence of the necessary data to determine the emissions as a result of this factor, it has been decided to use the standardised figures provided by the Factors and Methods V2. The data and calculations that support these figures can be found in **Appendix 2**.

7.2 DISCUSSION

TCC's solid waste management practices account for emissions of **90,146 tons CO_{2e}** per year. This is by far the largest source of global warming emissions under TCC's control. Clearly the size of these emissions is largely dependent on the volume of waste created in Townsville, something over which TCC has little direct control. Furthermore, TCC currently spends many thousands of dollars on a kerbside recycling program. Like many councils, TCC has reason to question the cost benefit of the kerbside recycling program as recycling can be an environmentally harmful and costly activity. However, many innovative options are available to turn a waste into a resource. Modern biodigesters for example, can ensure that organic wastes generate methane in a controlled process that allows the capture of this valuable gas. Furthermore, a smart recycling program can capture those materials that have the greatest economic value and use the profits from this to offset the costs associated with proper disposal of materials that are less economically viable.

7.3 RECOMMENDATIONS

- Council should assess the cost effectiveness of the kerbed recycling program to derive maximum environmental benefit and cost effectiveness from this popular service.
- Where technically and economically feasible, TCC should adopt the process of methane capture from its landfill sites.
- Alternatively, given the scale of emissions associated with landfill methane, TCC should investigate separation of biological wastes for the use in a biodigester to produce electricity.
- Council should promote local industry to make use of the recyclable or reusable wastes.

8.0 BIODIESEL ASSESSMENT

8.1 INTRODUCTION

Conventional diesel fuel is manufactured from crude oil extracted from the earth's crust. Despite its global use, there are serious problems associated with the use of petroleum-based diesel (petrodiesel). These problems include the emission of global warming gas carbon di-oxide released as a result of the combustion of the fuel, and serious human health impacts, similarly linked to exhaust emissions. TCC's operations account for the use of over 1 million litres of petrodiesel in the baseline year of 2000-2001. This report seeks to outline more clearly the environmental and health impacts of the use of petrodiesel and to examine a viable alternative to petrodiesel, a diesel fuel that has as its source not crude oil, but vegetable and animal oils.

8.2 PETRODIESEL

The utility of diesel as a fuel can not be challenged. The fuel is relatively non-toxic to humans in a liquid state, it has a high energy content and it can be used to power a variety of machines from light vehicles to large ships. Furthermore, it is relatively inexpensive although, as with all petroleum fuels, global events influence its retail price. Despite these benefits, petrodiesel has serious environmental and health problems associated with its wide spread use.

Global warming is caused by the increase in concentrations of certain gasses in the atmosphere that have the capacity to trap heat. The combustion of fossil fuels such as petrodiesel, contributes greatly to this global problem. This is because petrodiesel has its origin deep below the earth's surface and when it is burnt it adds to the carbon already in the atmosphere. To illustrate the relationship between diesel fuel and global warming emissions it is useful to note that burning one litre of petrodiesel results in the production of approximately 2.7kg of $C0_{2.}$ Therefore, as TCC used 1,096,504 litres of petrodiesel in 2000-2001, this released **2950 tons CO_{2e}** into the atmosphere.

From a human health perspective, the damage caused by diesel fuel has only in recent years become clear. For many years there has been debate about the specific cause of air pollution related cancer. Air pollution is a complex science and a major challenge has long been to identify which of a brew of man-made chemicals is specifically linked to individual health impacts. In recent years, the answer has become much clearer.

In 1997, for example, Japanese researchers at the Kyoto University, using a test that measured the cancer-causing potential of toxic substances, identified a chemical believed to be the most carcinogenic compound ever analysed. The chemical is known in short as nitro-PAH. Nitro-PAH was discovered to have 20% greater toxicity than its closest rival, a chemical that, perhaps not surprisingly, had the same source: petrodiesel exhaust. While nitro-PAH occurs in very small quantities, its extreme toxicity suggests that it alone may well be responsible for 60,000 deaths in the USA and 10,000 in the UK annually (CD\biodiesel\Devil in the Diesel).

In an other study, titled *No Breathing in the Aisles* (CD\biodiesel\No breathing in the aisles) the *Californian Natural Resources Defence Council - Coalition for Clean Air* details the impact of children's health associated with the exposure to petrodiesel fumes in school buses. The report opens with the information that 30 epidemiological studies have confirmed the carcinogenic nature of diesel exhaust.

The environmental and health impacts associated with petrodiesel exhaust are exacerbated by its widespread use. Furthermore, the forecasts for diesel use indicate that these issues will grow in the future as economic growth leads to the increased use of diesel fuel in society.

However, despite this grim scenario, there is a viable alternative to petrodiesel. The adoption of this alternative could lead not only to the reduction of both global warming emissions and health impacts, but could also create local jobs and allow for more of the dollars spent on fuels to remain in the Townsville community. The key to this solution is a diesel fuel that is made not from petroleum hydrocarbons, but from plants. Because the adoption of this alternative would lead to economic, social and environmental benefits, the alternative described below has the hallmarks of sustainable development. The key to this investment in sustainability is referred to as **biodiesel**.

8.3 WHAT IS BIODIESEL

Biodiesel is a diesel fuel made from natural materials. Biodiesel can be made from a range of natural oils and fats most notably vegetable oil and tallow. Tallow itself comes from cattle that derive their energy from plants. Therefore it is logical to refer to biodiesel as coming from plants whether it is manufactured from vegetable or animal oils.

To make biodiesel requires the ingredients to undergo a reaction referred to as trans-esterification. In simple terms, the oils are mixed with natural chemicals such as methanol and bicarbonate soda. The resultant reaction separates the solution into two parts, one part biodiesel, and the other part glycerine. This process can be conducted with such simple technology as a 44 gallon drum, a vegetable or animal oil (used oil from a fish and chip shop will do), a mixer, a heater and a micron filter. Commercial biodiesel necessarily requires more sophisticated technology in order to received internationally recognised quality control certification.

In some senses, biodiesel is more diesel than petrodiesel. The first diesel engines, manufactured by French industrialist Mr Rudolf Diesel at the turn of the 20th century were designed to run on vegetable oils (CD\Biodiesel\Rudolf Diesel). One of the earlier models ran on peanut oil. Given that biodiesel is made from natural ingredients rather than crude oil that has undergone chemical changes at great depths and pressures for millions of years deep below the ground, it is not surprising that biodiesel is more benign to the environment and to human health.

8.4 ECOLOGICAL AND HEALTH BENEFITS OF BIODIESEL

When either biodiesel or petrodiesel are burnt they produce gaseous carbon emissions in the form of CO_2. However the fundamental difference between the two fuel sources is that biodiesel carbon emissions originally came from the atmosphere in the first place. On the other hand, the carbon released from burning petrodiesel came from the earth's crust. Because biodiesel is made from plants, burning the fuel simply puts back into the atmosphere the carbon that was taken from the atmosphere when the plants were growing. As a result of this, there is **no net increase in atmospheric carbon** resulting from burning biodiesel. Likewise, because petrodiesel comes from below the earth's surface, burning it puts carbon into the atmosphere that was not there before. This results in a **net increase in atmospheric carbon** levels (2.7kg CO_{2e} per litre). The fact that biodiesel allows for a cycling of atmospheric carbon is a crucial difference between the two fuels and the key to understanding the greenhouse benefits of biodiesel.

From the human health perspective, biodiesel is far superior to petrodiesel. Many of the toxins associated with petrodiesel are contained in the liquid fuel and are released to the air upon combustion. Biodiesel, on the other hand is relatively free from these toxins to begin with and therefore the fuels burns much cleaner (CD\Biodiesel\Biodiesel Health).

Having made the case for the environmental and health benefits of biodiesel, we should now consider the economic benefits associated with its use. Discussions are under way between the author of this report and a Western Australian company that is presently in the process of building a biodiesel plant in Perth. *Australian Renewable Fuels* have a business plan that states, in short, that if they are able to receive commitments to purchase 15 million litres of biodiesel per annum, they will establish a plant that will manufacture 40 million litres per year. To put this into perspective, TCC uses 1 million litres per year and 40 million litres is probably not far off the annual diesel consumption of the whole of Townsville.

Closer to home, discussions are under way with a Cains based company that has the capacity to produce up to 800,000 litres of biodiesel per annum. It is possible that this plant may be operational before that of Australian Renewable Fuels.

While it is far from certain that Australian Renewable Fuels will eventually set up base in Townsville, it is inevitable that biodiesel will come to this town eventually, perhaps by truck from Cairns. Commercial biodiesel has only just become available in Australia through a Sydney company. Others are sure to follow. Promoting the expansion of the biodiesel industry, Stanwell Power Corporation, in September 2001 launched publicised a tender to establish a biodiesel plant in central Queensland.

In regards to commercialisation of biodiesel, Australia is well behind the times. In France, for example, all diesel fuels sold to the public contains at least 5% biodiesel. Even in America, the bastion of petroleum fuels, the government has mandated that 10% of all diesel used by the US postal service must be biodiesel.

8.5 RECOMMENDATIONS

- All new diesel powered vehicles purchased by TCC should be selected with an eye on their fuel consumption, with the more efficient vehicles given preference.
- TCC should promote the introduction of biodiesel to Townsville by agreeing, where economically viable, to use this fuel instead of petrodiesel
- All diesel powered vehicles should be maintained in peak running order to maximise the efficient use of their fuels
- TCC should request that its service providers examine the benefits of biodiesel as an alternative fuel for their fleet.

- Upon adopting biodiesel, TCC should advertise to the public and to neighbouring councils the dangers of widespread use of petrodiesel and the benefits of biodiesel.
- Council should implement a process of continual improvement to progressively reduce the amount of fuel used in its operations.

9.0 DISCUSSION AND RECOMMENDATIONS

9.1 DISCUSSION

The purpose of this section is to discuss issues that have been raised above and put them into the context of a broader approach by TCC on energy and greenhouse issues. The recommendations below represent great opportunities for TCC as a Council that moves with and ahead of the times. In doing so, TCC will capture the value that exists in saving money on energy expenses and the value associated with being prepared for events and markets that are very clearly in the near future.

Townsville City Council's operations accounted for the release of **around 120,000** tons of greenhouse gas emissions in the baseline year of 2000-2001. Under a business as normal scenario, it is likely that these emissions will increase, probably at a rate that parallels economic development or population growth in the City. However, this is not a forgone conclusion. A global trend that becomes more established as time goes by is the *decoupling* of economic activity from the increase in global warming emissions. This does not happen by chance, but is the result of deliberate efforts. This report has highlighted many opportunities for TCC to reduce its greenhouse emissions without jeopardising economic growth. One key area that could demonstrate emission reductions and see a cost benefit is in the use of electricity. However, before these benefits can be realised, a number of strategic actions are required.

Obtaining information about TCC's electricity consumption is a time consuming process as there are over 400 separate billing reference numbers and no central repository in council where all the billing information can be easily accessed. Even accessing TCC's information through the Ergon Energy database is no small challenge given the costs involved. Furthermore, evidence suggests that TCC has over the past decade collected a sizeable amount of energy audits. It is unclear to what extent the recommendations of these audits have been implemented, or indeed where these energy audits can be found. It is for these reasons that it would be very difficult for council to implement rigorous energy efficiency programs without some modification to the administrative arrangements presently in place.

From the energy audit of Dalrymple road depot and other information presented here, there is good reason to assume that council could greatly benefit from a rigorous energy management program. Apart from the kudos associated with energy efficiency, there is a considerable amount of money to be saved. Most energy audits of buildings indicate that implementing managerial changes as simple as resetting timers on air conditioners and turning appliances off when they are not needed, savings of 10-15% can be achieved with no cost. Implementing such simple changes as these, council-wide, could result in many thousands of dollars saved money that could be put into other projects or reinvested in energy efficiency to create more savings.

The adoption of energy efficiency and renewable energy by council would demonstrate a recognition that there are many alternatives to deal with ongoing demand for services. In some senses, organisations easily fall into a technological time warp, continuing to rely on technologies and practices that have their origins in antiquity. This is often done at the expense of adopting technologies that are more in keeping with the modern world. The last decade has seen an explosion in the demand for personal computers and the associated systems with which they interact, such as the internet. No such revolution has swept Australia's waste water treatment practices despite some unique technological advances. Likewise, Australia now boasts one of the highest per capita ownerships of mobile phones. Yet despite our world famous and ample sunshine, no such pattern exists for the use of rooftop renewable energy. The non-adoption of these technologies has a number of roots, one of which can be financial constraints. However, more importantly, the key constraint is often the structured nature of organisations that adopt practices of non-innovation. There is much to be gained from contemporary technology, not the least of which is the profitability that comes from providing a given service in a more cost-effective manner. Without a policy of investigation and innovation, the value of these modern machines and systems will remain off limits.

9.2 RECOMMENDATIONS

9.2.1 Energy Management

Recommendation 1 - Employ specialist staff dedicated to internal energy and greenhouse management.

A first stage in council addressing its energy demand would be to establish some mechanism whereby each business unit has access to its energy information and can use this to create programs that will reduce energy demand. This will at least give business unit managers the opportunity to assess and to track

changes in their energy demand. However, this argument can only go so far. Energy typically is not one of the highest expenses for business and as such it is often ignored because of higher priorities. Furthermore, most business managers are not trained in energy management, which is a specialist field.

A simple solution to this would be to employ staff who would be responsible for interpreting and reducing all of TCC's energy demand and greenhouse gas emissions. To ensure that this position was successful, a number of initiatives could be put in place to ensure the TCC Energy Officer's (TCCEO) best performance.

- TCCEO has access to all TCC energy information
- TCCEO works in cooperation with business units to reduce energy and greenhouse emissions
- A percentage of savings from TCCEO programs return to the department
- A percentage of savings from TCCEO programs go for capital investment for energy reduction initiatives
- A percentage of savings from TCCEO programs pays the wages of TCCEO staff.

Some of the duties of the TCCEO will be:

- Establish energy\greenhouse baselines
- Review all existing TCC energy audits
- Co-ordinate purchase of energy (tariffs and conditions)
- Conduct staff energy training
- Undertake Cities for Climate Protection roles (see below)
- Implement energy reduction and renewable energy programs

Furthermore, by using a percentage of monies saved through energy efficiency measures to promote further energy efficiency measures, the TCCEO can be the catalyst for ongoing reductions in Council's contribution to global warming and expenses on electricity. This process would be greatly assisted with a slush fund from which initial energy efficiency programs could be funded.

An existing TCC funding block could be use to catalyse this project. The Energy Efficiency and Renewable Energy Audit project, funded by Queensland EPA Sustainable Industries Division is still in its project brief stage but could easily be amended to include the preliminary works for the establishment of the TCCEO position.

9.2.2 International Programs

Recommendation 2 - Join Cities for Climate Protection and other ICLEI programs.

Another solution would be to join one of the international programs that assist local council's to manage energy better. One such organisation is the *International Council for Local Environmental Initiatives* (ICLEI). ICLEI runs three programs, Local Agenda 21 (LA21), Cities for Climate Protection (CCP) and new program simply called Water. Because energy management is tied closely to sustainability, the focus of LA21, and because a water audit of TCC would likely indicate dramatic money savings through a water conservation program, it would be wise to sign on for all three simultaneously. By joining CCP, resources would come available to assist council in energy management (CD\ICLEI\Cities for Climate Protection and Local Agenda 21).

An example of where such a program has worked well is Maroochy Shire on the Sunshine Coast. Maroochy Shire employs three people on its energy \greenhouse staff, the energy savings they deliver pay for their wages. The Maroochy website (www.maroochy.gov.au) describes some of their programs and the process by which they joined ICLEI and designed their programs.

9.2.3 Revegetation for greenhouse sequestration

Recommendation 3 - Investigate the role of existing revegetation programs as part of TCC's response to global warming and as a business case study.

It has been shown that greenhouse issues are becoming a significant factor for decision-makers in the new century. Modern managers need to consider the threats associated with global warming but also the opportunities. As an example of the opportunities, consider the COP 6 (Sixth Commission of Parties) meeting in Morocco held in October 2001 as part of the IPCC Kyoto Protocol process. In this meeting, representatives of the world's governments established global mechanisms for calculating the sequestration of atmospheric carbon using plants. Since US opposition to reducing global warming emissions, the focus of the Kyoto Protocol has been to absorb carbon from the atmosphere rather than to limit the carbon put into it by the use of fossil fuels.

In the meantime, viewing the COP 6 meeting as an opportunity, much is to be gained from tying TCC's ongoing revegetation programs with the credits that will very soon be available to those who plant trees and register those trees as carbon sinks. Australia is already very well advanced amongst other nations in establishing mechanisms for trading in carbon and it can be assumed that as soon as international rules are established Australia will benefit greatly from this new market. Just how much money will be available for TCC to gather from carbon credits resulting from tree planting exercises is dependent on how many trees are planted, the species and a host of other factors. However, the fact remains that planting trees is soon to become a new global industry.

9.2.4 Planning Schemes for the 21st Century

Recommendation 4 - Draft the IPA Planning Schemes to promote the use of energy efficiency and modern energy and water technology throughout Townsville.

Tree planting, energy conservation, greenhouse reduction strategies: these are all in the ambit of sustainability. Sustainability, put simply, is the integration of social, economic and environmental parameters in decision making. Most contemporary legislation calls for sustainability. The most important piece of legislation in this regard is the 1997 Integrated Planning Act (IPA). IPA is Queensland's predominant planning and development legislation and its principle object, its purpose, is to seek to achieve ecological sustainability. Like many council's, TCC is currently drafting Planning Schemes, local planning guidelines that will allow Townsville to integrate sustainability into its future development. An enormous opportunity exists to integrate a considered greenhouse strategy into the Planning Schemes. Many technologies now exist that allow residences to be totally self-sufficient in energy production and to reduce the energy demand on waste water treatment and other council services. An example of these technologies is grid interactive photovoltaics (GIPV) - rooftop solar panels that make electricity and feed it into the grid. The solar panels allow the householder to produce their own free electricity and the grid connection allows them to sell the excess to the grid and receive energy when the sun goes down. Modern GIPVs are glued to colorbond roofing material allowing builders to 'wire up the roof'. The integration of modern renewable energy technology into Townsville's building industry should be promoted and it can be promoted through the appropriate provisions in the Planning Schemes.

Grid connected photovoltaics are one of a series of modern technologies that can assist TCC and Townsville to reduce the environmental and monetary costs associated with providing the goods and services that the council's constituents demand. Another example of this technology that will not only reduce the consumption of water, but energy consumption as well, is a waste water treatment system known as Vital Resource Management (www.vrm.com.au). VRM is proprietary technology that relies on sophisticated biological treatment of waste water using minimal energy and allowing for partial reuse of the purified water for watering gardens, flushing toilets and even, with the appropriate add-ons, potable water supplies. Given the dollar costs associated with pumping water dozens of kilometres to the treatment plants and the costs associated with running these plants, there are very sound economic reasons for adopting alternatives to the sewer.

9.2.5 TCC as example to Townsville

Recommendation 5 - TCC should lead by example to assist Townsville to become the prototype city benefiting from greenhouse issues and the challenge of sustainability.

Finally, the above recommendations are all suggested as ways that TCC can benefit from adopting the appropriate stance on greenhouse issues. By the same token, the recommendations apply to all users of energy in Townsville, to all householders and businesses. Should Townsville take a pro-active stance on greenhouse and implement the necessary changes to derive value from what others perceive as a threat, there is good reason to believe that the city will follow suit. To this end, TCC should implement the changes recommended in this report as a way of leading by example. This will have flow on effects. For example should Townsville decide to adopt the use of biodiesel, this will promote the establishment of a manufacturing plant in the city. Second, TCC should selectively invest in grid connected photovoltaics. The wide spread adoption of grid connected photovoltaics will provide the basis for a jobs intensive industry. Third, with TCC as the business model, the promotion of energy efficiency and renewable energy city-wide, will create employment for energy managers, their wages paid out of savings in energy bills. In this way there will be social, economic and environmental benefits flowing from a council led initiative. This is the basis of sustainable development and the fundamentals of what some, for example author of *Natural Capitalism*, Paul Hawken, are referring to as the 'next industrial revolution'.

Townsville is well placed to become the prototype city of Australia for its innovative use of natural resources and technology. With the City's institutions including James Cook University, the Australian Institute of Marine Science, the CSIRO laboratories and others, Townsville is said to have the highest per capita population of scientists and technologists in Australia, probably the southern hemisphere. Much can be achieved to address contemporary concerns for the integration of social, economic and environmental factors. By harnessing the latent power of the City, Townsville could rapidly become a city renown in this country for its innovative adoption of the fruits of modern technology. The greenhouse issue represents a tremendous opportunity to spur the development of smart thinking. Already in Townsville, world class industrial practices are being employed that demonstrate that there is an ongoing severance between the production of goods and services (for example metals processing) and the degradation of the physical environment through such processes as global warming and depletion of freshwater supplies. Townsville would be well served economically in both the short and long term to harness this vein of innovation and promote it throughout all sectors of society. TCC is well placed to facilitate this process.

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Appendix 1

Dalrymple Road Depot Energy Audit

Appendix 2
Tables and Calculations

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