

**Feasibility Study-
Replace or Convert NZDF/RNZAF Coal-fired Boiler from Coal to Woody
Biomass (Wood Pellets)**

NZDF/RNZAF Woodbourne Air Base

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1 Introduction

1.1 Purpose of Document

Provide a Proposal for requirements for feasibility study to replace or convert NZDF/RNZAF Woodbourne Air Base coal fired boilers, from coal to woody biomass heating fuel, and to detail the surrounding economics.

In this proposal we have two parts, part one refers to the feasibility of the conversion of the current coal fired boilers, and part two will discuss the feasibility of a new boiler or boilers to replace the current two coal fired boilers.

1.2 Reasoning Behind Proposed Fuel Change

1.2.1 Environmental Perspective

Woody biomass based fuel produces less noxious emissions to air and to land, given that toxic trace elements such as arsenic, antimony and sulfur compounds present in coal are not present in untreated woody biomass fuel.

1.2.2 National Economic Interests

NZ wastes up to 30% of its annual forestry harvest; that product which is not of suitable size and quality for saw mill processing. Overseas this product is used as a feedstock for the production of wood pellet fuel. Importing such practices to New Zealand is also expected to improve the financials of the forestry sector, by providing a market for more of the harvested product.

1.2.3 Sustainability

Woody biomass is classed as a renewable resource. Typically in New Zealand, forestry harvesting is based on a 20-30 year cycle, meaning that woody biomass fuel used today can be replaced within 25 years. Further more, it is suggested that in the future, additional plantations might be grown specifically as energy / fuel feedstock material. This being the case, it is likely that a tree species could be selected and / or engineered to mature in less than the typical 25 years it takes to mature a typical pine plantation intended for traditional lumber markets. This is as opposed to the time cycle to produce coal, which takes 250,000 years for a low grade lignite variety and up to 450,000 for a high grade bituminous variety.

1.2.4 Carbon Abatement

Coal is associated with relatively high emissions of carbon dioxide, whereas woody biomass is classed as carbon neutral. The science behind this is based upon the short time cycle to regenerate woody biomass and that when a tree is cut down generally another will grow in its place. It is also worth noting that current practice has the waste wood material left to rot in the bush. The natural decomposition process causes the carbon entrained within the wood to emit to atmosphere in the form of methane (CH₄). Methane as a greenhouse gas is considered to be 17 times more potent than carbon dioxide.

1.2.5 Regulatory Trends

There is a global trend of increasing impetus across all sectors to adopt cleaner technologies where they are available. In particular we are seeing an increasing stringency amongst regulators to target sources of particulate and PM₁₀ emission. The regulators are aware that by comparison, woody biomass such as pellet fuel produces far less of such emissions than an equivalent coal installation. It is expected that mechanisms such as the granting of ongoing resource consents will increasingly take into account such factors and favor installations of technology seen to have environmental benefits.

1.2.6 Operation & Maintenance

The proposed **wood pellet fuel/woody biomass** produces significantly less ash and clinker formation. This is associated with reduced cleaning, maintenance and disposal costs. The ash produced is an inert material, unlike the coal ash which is considered a toxic waste product. It can be disposed of in gardens or used as a compost material. Coal ash and clinker, produced in much larger quantities, is required to be collected and disposed of in a municipal waste landfill facility, with associated transport and disposal costs.

Pellet fuel is less abrasive than coal so there is reduced loading and wear on fuel feed components.

1.2.7 Public Relations & Green Image Marketing

The NZDF could make a conversion to **wood pellet fuels/woody bio mass** a promotional decision as an example of social responsibility. To this extent, case studies would be provided and published on behalf of the NZDF.

1.3 Stakeholder

New Zealand Defense Force (NZDF/RNZAF)

1.4 ECOsystems Role

Provide background consultancy, feasibility study, risk analysis, engineering designs, and economic and environmental cost benefit analysis.

In terms of the actual conversion or replacement itself, we can provide project management services, conduct tendering, liaise with contractors and provide a monitoring and feedback service for the stakeholder.

We can also engage in procurement and supply of controls equipment based around a design to improve the fuel and operating efficiency of the existing installation, to offset the higher cost of pellet fuel relative to the by comparison, very cheap coal prices currently enjoyed by the NZDF/RNZAF.

2 Executive Summary (Current boilers)

2.1 Brief

An opportunity has arisen for New Zealand Defense Force (NZDF/RNZAF) to improve the economics surrounding operation, to convert the current boilers from coal to a woody biomass (wood pellets) of the Woodbourne Air Base site heating system.

Wood waste derived pellet fuel (woody biomass) is a carbon neutral form of bio fuel. It has been used commonly for many years in Europe, Canada and the USA. As a refined fuel it is consistent and reliable in its burning properties.

The drivers behind funding conversion to this fuel are environmental, particularly carbon abatement, and national economic interests relating to efficiencies in the forestry sector.

2.2 What's the Catch by converting the current boilers?

Pellet fuel is nearly two times the price of coal.

But

- Coal is currently at an artificially low price. Its cost to the customer does not take into account the cost of environmental damage associated with coal mining, coal combustion and the resulting emissions to land and air.
- The coming carbon economy is set to be a sure driver for coal price increases
- Pellet fuel heating may not be cost competitive with coal heating, but it holds it's own when stacked up against other alternatives such as electrical heaters

And

- A. We have identified how to improve the efficiency of the heating system, reduce losses and better use heat around the RNZAF base Woodbourne and boost the current boiler outputs
- B. By re-tubing the current boilers there is an opportunity to extend the life time of the current boilers
- C. The proposal involves the sale of carbon credits

End Result

•	Current heating cost per Person per year	:	\$177.84
•	Heating cost with conversion & changes proposed here	:	\$159.97
	This include the sale of carbon credits		

2.3 What's the Cost

- Assuming the sale of carbon credits; fuel, operation & maintenance costs will realize a net reduction.
- The project costs by component are

2x Digital Combustion Management	\$21,498
2x Furnace Pressure Control	\$10,908
2x Burn back control	\$11,085
2x Boiler control upgrade package	\$17,964
Demand management system	\$4,680
Programming & commissioning	<u>\$17,920</u>
	\$84,055

Project cost (Hardware, Labour cost for Electrician, Plumber, Boiler manufacturer/fitter, programming and commissioning)

- At savings of \$20,311 per year, the simple pay back for the Woodbourne site is 4.1 years (this include the sale of carbon credits)

Note that there are additional benefits which have not been valued in the payback calculations. These include reduced caretakers hours, another site has opted to do this and through wider scale **centralized automatic control of lighting and heating**, they have consistently held their energy purchases (electrical & gas) at 50% of levels prior to implementation of this technology. This is over a period of expansion and increasing site hours



Lighting in Hangar No.4

Suggestion is to control lighting by daylight harvesting or under runner technology.

2.4 **What We Have Done**

- Conducted preliminary and detailed engineering analysis of RNZAF base Woodbourne site boilers, heating system and heating requirements
- Conducted cost benefit analysis of the surrounding economics of operating your current heating system using coal, and if a switch was made to **pellet fuels**.
- Conducted a benefit analysis of the surrounding economics of operating a “new” boiler or boilers to replace the exiting boilers all together, and operated on a woody biomass (part two of the feasibility study)

- Analyzed the carbon footprint of the current heating system and what it would be with pellet fuels
- Provided engineering designs to enhance the efficiency of the current heating system with improved smarts, meaning that although pellet fuels are more expensive, less energy would need to be purchased
- Background consultancy, including looking at the security of supply, price volatility and risk analysis associated with pellet fuels/woody biomass

In short, your heating system could be converted to pellet fuels with little to no changes required to the basic system, but this could lead to a two fold increase in fuel prices.

We set about identifying a method to improve operational efficiency with the target of making bio fuel conversion a revenue neutral proposition.

In actuality what we identified could lead to a net cost saving for the RNZAF base Woodbourne.

2.5 How Savings Would Be Made

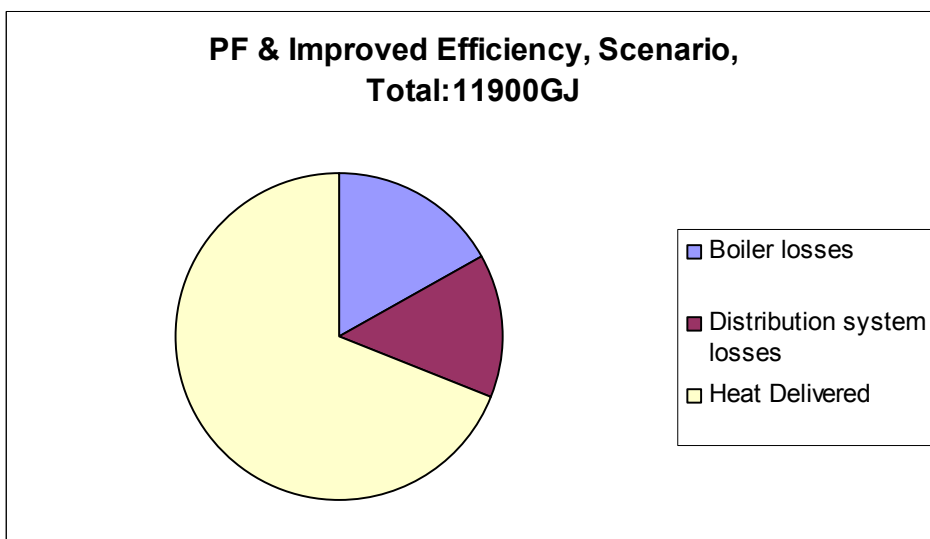
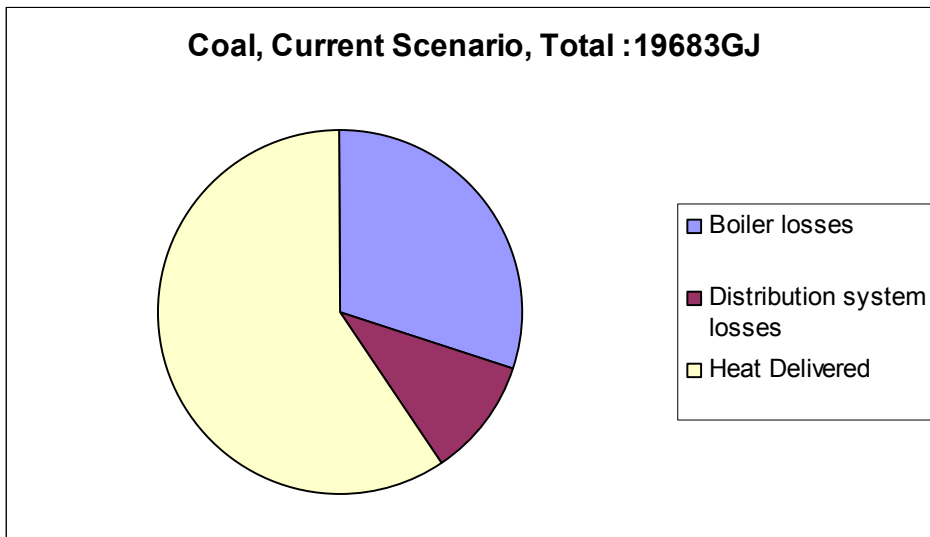
- Install digital combustion management to reduce boiler losses through controlling under fire and over fire air in accordance to measured flue gas oxygen concentrations
- Optimize management controls to automatically manage and control heat delivery according to schedule times of area occupancy and actual need for heat.
- Re-tubing the current boilers
- Or as a second option to replace the current coal fired boilers with a “new” woody biomass boiler or boilers of approximately 3.5Mega/4.0Mega to support the future expansion, with the latest automation and combustion control imbedded in the system (part two of the feasibility study)

2.6 Overview of Heating System Efficiency

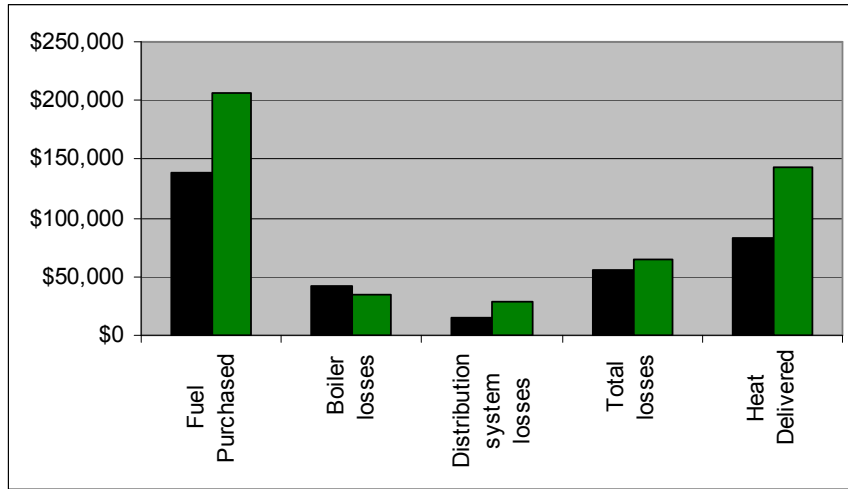
The table below shows the cost of losses associated with the current coal situation (black) and compares this with the cost of losses if the proposed changes with the current boilers are made.

	\$	Tons	GJ	\$	Tons	GJ
Fuel Purchased	\$139,239	729	19683	\$206,686	626	11900
Boiler losses	\$41,772	219	5905	\$35,137	106	2023
Distribution system losses	\$14,620	77	2067	\$29,163	88	1679
Total losses	\$56,392	295	7972	\$64,300	195	3702
Heat Delivered	\$82,847	434	11711	\$142,386	431	8198

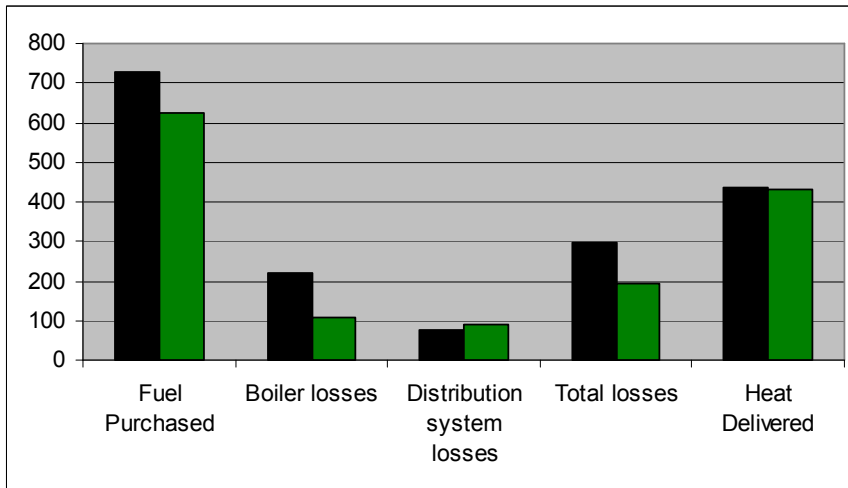
The graph below shows proportionally how your 729 tons / 19683GJ / \$140K of coal are used. The graph does not show, that of the actual heat Delivered; only +/- 70% is really required. The bottom graph shows how it is proposed that 626 tons / 11900 GJ /\$207K of pellet fuel would be used. This time nearly three quarters of the energy purchased is utilized.



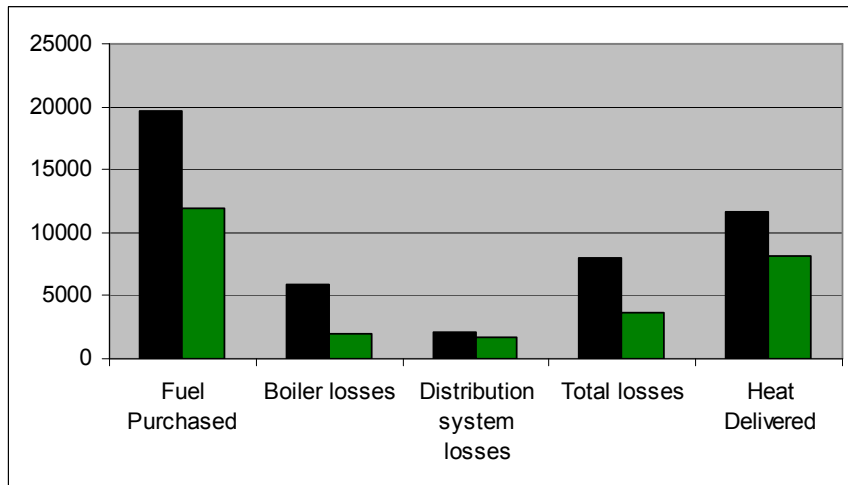
Cost



Quantity of fuel in tons



Quantity of energy in GJ



The three preceding bar graphs compare the proportion of losses from three different angles

- Cost
- Quantity of fuel in tons
- Quantity of energy in GJ

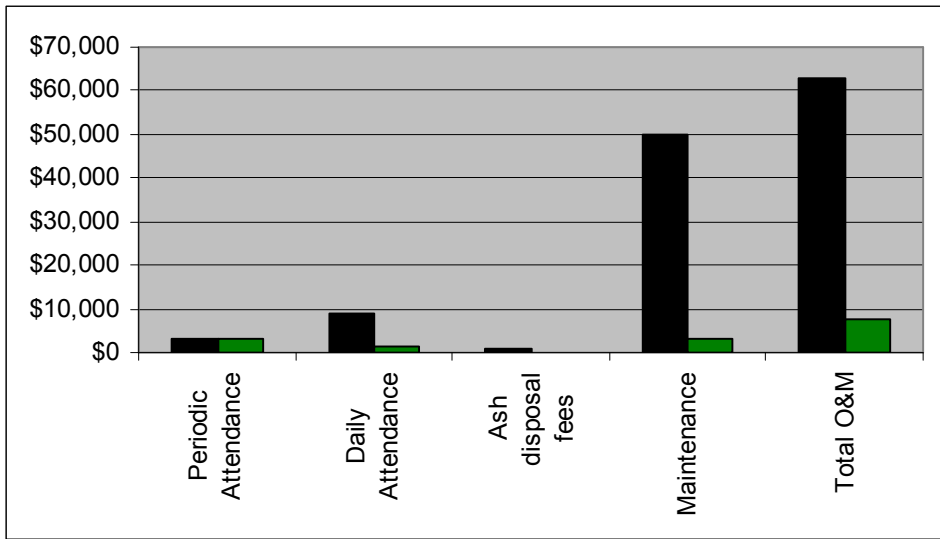
The key trends shown in the graphs are

- Pellet fuel costs more than coal
- Currently more energy is purchased than is needed

2.7 Overview of Cost Benefit Comparison

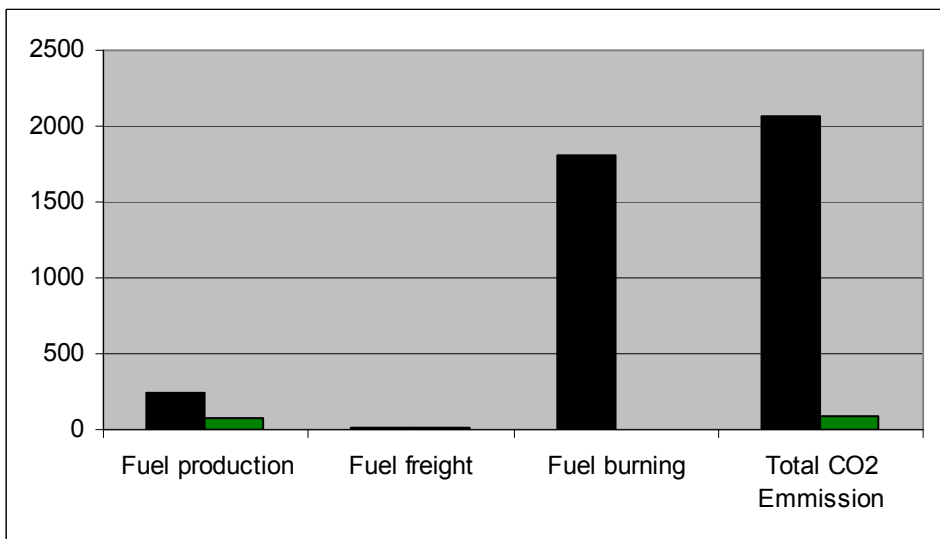
The table below shows the operating and maintenance costs of the current heating system on coal and compares this with those anticipated after the proposed changes. O&M cost savings are a factor of reduced boiler attendance time due to the additional automation and due to reduced ash and clinker byproducts of pellet fuel combustion. The table goes on to take account of the effect of carbon credit sales, and works this into a net cost of heating per person cost comparison.

	BAU	HEP	Difference	
Annual Fuel Bill	\$139,239	\$206,686	\$67,447	
Periodic Attendance	\$3,200	\$3,200	\$0	
Daily Attendance	\$8,960	\$1,280	-\$7,680	
Ash disposal fees	\$800	\$0	-\$800	
Maintenance	\$50,000	\$40,000	-\$10,000	
Total O&M	\$62,960	\$44,480	-\$18,480	
Tons P/A CO₂ Emission			Abatement	Credit Value
Fuel production	244	75	169	\$5,917
Fuel freight	9.43	9.97	-1	-\$19
Fuel burning	1811	0	1811	\$63,379
Total CO₂ Emission	2064	85	1979	\$69,277
Total Cost Of Heating	\$202,199	\$181,888	\$20,311	
Heating Cost per Person	\$177.84	\$159.97	\$17.86	



Graph above shows current O&M costs versus what would be anticipated after the changes proposed here. Attendance drops due to automation and reduced ashing out requirements. Ash disposal fees drop as the ash byproduct of pellet fuel is not considered a toxic waste, as is the case with coal ash. Coal produces significantly more ash than pellet fuel and contains trace elements such as arsenic and other toxic metals.

Graph below shows the comparative carbon emissions associated with manufacture, transport and burning of coal versus pellet fuels. The difference between the green and black total emissions is the quantity of carbon abated. Each ton of carbon abated has been valued at \$35, an estimate of what the resulting carbon credits might be sold for.



2.8 Explanation of Proposed Efficiency Technology

With the current two boilers wood pellet trials are already conducted, and therefore we know that a conversion to wood pellets fuel is technically an option.

Note: In the Questionnaire for Desktop Analysis it is stated that the boilers have thin boiler pipes.

Pellet fuel has slightly less calorific value than coal. This means that for a given heat output, more fuel has to be pushed into the boilers. There are also different requirements for over fire air, also termed secondary air.

Digital Combustion Management (DCM)

This comprises software, microprocessor based controls, flue gas oxygen sensors, motorized controls for over fire air dampers and automatic adjustment of fuel feeder screw speeds, primary and secondary air.

Furnace Pressure Control

This comprises software, microprocessor based controls, motorized controls for damper throttles and VSD control for induced draft fans
With Furnace Pressure Control you have sustained efficient furnace pressure control. Efficiently as an automatic balanced draft system

Demand Management System

A Demand Management System is already in place (Novar) and therefore some optimization is an option. For example DCM and DCS integration. Heat can be controlled to separate areas by automatic control of area pumps. The boiler room has several pumps distributing the hot water to different sites (calorifiers) **(See photo's below)**

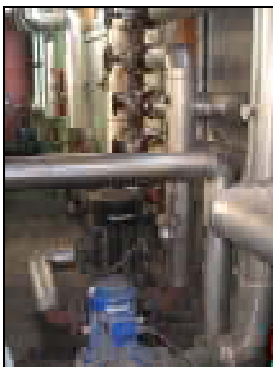


Photo above shows pumps located in the boiler house and pumps in No.4 hangar

Any potential Demand Control System could be refined by retrofitting automatic valves in key points on the distribution system. The valves would be connected to the DCM system.

3 Engineering Design Specifications (Current boilers)

3.1 Earthworks

Earthworks are not required as part of this proposal.

3.2 Fuel Bunkers Upgrades

Fuel bunker upgrades are required under the scope of the conversion project proposal. See appendix A for more details.

3.3 Boiler House Upgrades & Refurbishments

See appendix B for further commentary. Boiler house upgrades & refurbishments are not required in Wood pellet conversion as part of this proposal, beyond recommended and routine service and maintenance requirements already envisaged under Business As Usual (BAU) practices (i.e. currently practiced).

3.4 Accumulator Tanks

Accumulator tanks are not specified as part of this proposal.

3.5 Fuel Transport - Bunkers to Boilers

The existing facilities pull through auger feeder systems will be retained without mechanical modifications as wood pellet trials already being conducted, other than the recommended service checks specified under S2 of Appendix B. The operating characteristics of the feed screws are dictated by the control systems VSD (Variable Speed Drive) which will be reconfigured to reflect the differing fuel burn rate required with pellet fuel. Clause 3.7 discusses the nature of required controls modification.

3.6 Boiler Pipe-work

Adjustments to the boiler pipe-work are not envisaged under the scope of this proposal to existing boilers configuration.

3.7 Control Equipment

See Appendix C for details. Retrofit of additional automated control is proposed in order to meet the requirements for pellet fuel burning and to improve the net fuel efficiency of the facility.

See Appendix C for proposed equipment details.

3.8 Ash Removal Equipment

Ash removal equipment is not specified as part of this proposal.

3.9 Further Carbon Emission Reduction Work

Over and above the minimum requirements to convert the boilers to pellet fuel, some aspects of the controls package offered seek to reduce fuel consumption from three separate angles;

- Improved combustion efficiency through automatic continuous fuel to air ratio tuning.
 - Estimated current boilers combustion efficiency : 70% (+/- 5%)
 - Expected combustion efficiency : 83% (+/- 5%)
 - **5 – 15% efficiency improvement**

- Improved energy management through automatic control of the boilers heat to specific areas of the RNZAF base Woodbourne site, or times when only some areas of the site are occupied.
 - **Associated with 15% - 30% energy reduction elsewhere**

These measures, in seeking to reduce fuel consumption by up to 30%, will see the same level of carbon emissions reduction, supplemental to the abatement achieved through carbon neutral fuel switching alone.

4 Risk Management (Current boilers)

Appendix D describes project risks and details the steps embedded in the proposal to address them.

The key issue is one of timing and the current thin boilers pipes

5 Conversion Contractors Details (Current boilers)

The proposal anticipates using the boiler manufacturer and/or their authorized service agents for critical stages of the retrofit installation. Additionally, the fuel supplier is on hand for project management technical support.

<i>Fuel Supplier</i>	<i>Natures Flame</i>	<i>See Appendix E1</i>
	<i>Solid Energy</i>	<i>See Appendix E1</i>
<i>Boiler Manufacturer/type</i>	<i>Heatserve</i>	<i>See Appendix E2</i>
<i>Fuel augers</i>	<i>TAYLORS</i>	
<i>Authorised Service Agent</i>		<i>See Appendix E3</i>
<i>Service Agent</i>		<i>See Appendix E4</i>

6 Efficiency Guarantees (Current boilers)

This proposal is for conversion of existing boilers.

The existing boilers have been designed to achieve 80% combustion efficiency. In practice, this would be met during a commissioning sign off test, with the boilers in optimal condition and with an optimum set up for performance trials, with fuel and air dampers carefully set with a combustion analyzer for reference.

The existing boilers do not have the means to ensure that the design efficiency is maintained, and the fuel to air settings, control for induced draft fans do not automatically change to suit changing load, conditions, variances in the fuel supply, and deterioration in boiler performance.

The boilers appear to have been operating at below 70% efficiency. This can be estimated on the basis of unburnt carbon in the fly ash, signs of poor and even positive furnace pressure control, and signs of low temperature combustion. The indicators all point to too much excess air pushing unburnt fuel through the heat exchanger passes, and with it unnecessary heat losses to the stack. Running with too much excess air is common where boiler tuning has to be done by feel and where the installation is prone to smoky operation (the attendant over corrects by increasing combustion air, which has the appearance of correcting a Smokey fire, but really just dilutes the combustion gases and causes other problems).

In short;

Boilers design efficiency	80%
Boilers actual sustained efficiency is less than	70%

Our Guarantee;

At worst, sustained operation at design efficiency	80%
Expected actual efficiency target	83%

i.e. The changes will see sustained and continuous operation at maximum efficiency, which we expect will be a small margin of improvement over the stated design efficiency.

7 Safety Features (Current boilers)

The boilers and boiler house are an existing facility and the installation is in accordance with industry practices.

Safety is primarily by way of access control. The boiler house facility is locked off and separate from other buildings with only the property manager, caretaker and service personnel routinely accessing the facility.

Risk of injury associated with the facility is low while only trained operators have access to the facility. The nature of risk would be potential for burns – e.g. through touching hot surfaces or handling hot ashes. These risks are addressed through common sense and experience on the part of the boiler attendants.

Electrical protection is by way of standard circuit protection measures, i.e. enclosure of live parts in locked cabinets or conduit boxes and by the use of appropriate fusing on the part of the electrical contractor.

It is common practice in wood fired solid fuel facilities to include protection against **burn back**. Burn back is a condition which can occur at low firing rates, or if the fuel supply is running low. The condition occurs if the fire is able to burn back from the furnace, travel back up the feed screw and make its way into the fuel bunker. This can also occur with coal; however coal has a higher ignition point and therefore does not catch alight as easily as wood fuel.

The protection against burn back is specified into the project proposal. It consists of a temperature sensor in the fuel feeders, with an automatic system to quench water into the feeder if burn back is detected. This system is monitored and can raise an alarm.

The burn back control safety system has been installed as a matter of course in pellet fuel conversions which have already occurred. Feedback indicates that the burn back systems have never been triggered; suggesting that in practice the risk of burn back is low.

The segregated concrete construction of the boiler house is such that if, in a worst case scenario, the fuel bunker was to catch fire, the fire would be contained in the concrete boiler house facility, which is not attached to surrounding buildings.

Under international risk assessment standards for automated machinery, as applies to moving parts, the installation would be deemed low risk. Moving parts such as the combustion air fan are concealed behind protective covers. The feed screws are not exposed and their movement is slow and predictable.

Larger boiler house facilities have emergency stop buttons mounted outside the boiler house and this is an option if desired but is not suggested as necessary. The drawback is mischievous triggering of the emergency stop button shutting down the site heating system. An external emergency stop button would be specified if there were a high pressure steam hazard involved.

8 Operation & Maintenance (Current boilers)

A supplement will be amended to the existing boiler operating and maintenance manual. This will include manufacturer's data sheets for new components supplied. The data sheets include information on servicing and maintenance.

The components supplied are typical of boiler industry control equipment and of the type that boiler service agents would expect to encounter.

The operation will not fundamentally change from current methods, although some attendance duties currently carried out would no longer be required due to the new automation and fuel.

Commissioning and tuning instructions will be provided for inclusion in the manual. The methods are typical of solid fuel systems and digital combustion management technology employed elsewhere, which a combustion engineer would expect to encounter.

The combustion tuning is carried out automatically by the new controls, which will constantly adjust the ratio of fuel and air supplied for combustion. Optimizing the automatic tuning system is a simple process the boiler attendant can carry out. Instructions on this will be included in the manual updates. Optimization would not be routinely required once the system is commissioned.

9 Project Management Timeline Plan (Current boilers)

If required a project time line plan will be set up. The project timeline is set around the longest delivery lead time, and the re-tubing of the current boilers by the service agent or boiler manufacturer. For the automation we need 6 weeks from receipt of order for the oxygen sensor system. Key stages are kept flexible to accommodate the availability of contractor labour with preferred access windows on the part of RNZAF base Woodbourne

10 Fuel Supply Arrangements (Current boilers)

Refer to Appendix H.1 for fuel supplier documentation. The proposed fuel supplier is Solid Energy's subsidiary Natures Flame. The basis discussed with Natures Flame is for a minimum 3 year fixed price variable volume contract. Final contract documentation has yet to be provided but it is expected that the fuel will be offered at around \$330 per ton.

Natures flame has confirmed that they can supply up to two or three deliveries per week, which is the most that would be expected during the peak of Winter. The fuel would be trucked the 336km from the manufacturing facility in Christchurch.

11 Economic Analysis (Current boilers)

Economic key facts are summarized in the executive summary and detailed in the appendixes I spreadsheets.

Appendix A Fuel Bunker Upgrades current boilers (Clause 3.2)

Problem

A wood fired heating system requires a secure and dry storage facility. The principle requirements are based around:

- P1. Ability to handle bulk pellet fuel deliveries
- P2. Degree of weather proofing / protection against ingress of moisture
- P3. Storage capacity
- P4. Ability to reliably provide fuel to the transport system
- P5. Health & safety

Solution

Executive Summary Key Points

RNZAF base Woodbourne existing coal bunkers and boilers can continue to be used with little requirements for modification (except the re-tubing of the boilers and weather proofing the bunkers by high bay roller door and extension), beyond those already underway. The resultant heat storage capacity will be 30% less with pellet fuels than with coal.

S1. Existing facility is NOT OK to receive bulk pellet deliveries

- Currently, a tip truck delivers coal at around 8 tons per time for each bunker
- Coal is deposited into the storage bunkers by a tip truck
(See photo below)
- A conveyer truck must deliver the pellet fuel to the refurbished fuel bunkers



S2. Existing facility known to be weather proof

- There are no visual signs of rain water leakage into the fuel bunker except by the open bunker entrance
- The existing fuel bunkers needs a weather proof high bay roller door and extension in front of the bunkers

S3. Energy storage capacity with pellet fuel will be 40% less

- The existing facility comfortably accommodates 2x10 tons of coal, at 27.0 GJ/ton, this equates to 540 GJ of stored energy
- The packed density of coal is 800kg/m³, versus 650kg/m³ for pellet fuel, therefore 2x 8.12 tons of pellet fuel can be stored in the same space 2x10 tons of coal occupies 16.25 tons of pellet fuel equates to 309 GJ of energy (@ 19 GJ per ton
- The difference of 231 GJ, (540 – 309) equates to an energy storage capability reduction of +/- 40% with pellet fuels

S4. Augers currently fit for purpose

Augers type: TAYLORS 75 series bunkerflow stokers

S5. Existing bunker is not lockable

- The existing fuel bunker and fuel transport system has operated for a number of years without incident
- Access is by way of open outside bunkers
- Moving machinery within the bunker is not exposed, generally being covered by the heaped fuel. In addition the machinery does not move very fast, nor is its operation unpredictable. The level of security provided is sufficient for the relatively low level of hazard within the bunker itself.

Appendix B Boiler House Upgrades & Refurbishments current boilers (Clause 3.3)

Problem

The commissioned pellet fuel boilers facility needs to be based around a suitably appointed boiler house with all items of plant in good and clean serviceable condition.

- P1. All traces of coal, clinker and coal ash buildup will need to be removed to avoid impinging on combustion gas analysis tests during commissioning and combustion controls setup
- P2. Initial tuning and calibration of digital combustion management systems requires that the boilers be in a known condition and state of repair, representative of the ongoing conditions they will be operated under
- P3. Commissioning calibration of the distribution system demand management controls, requires testing of an operating heat distribution system

Solution

S1. Clean boiler house

- Remove unburnt coal, dust & debris from bunker and boiler house
- Remove charcoal, ash & clinker debris from furnace
- Remove fly ash from behind top inspection hatches, clean heat exchanger surfaces
 - **Retain a sample of fly ash**
- Remove grit from behind bottom inspection hatches
- Empty & clean flue grit arrestors
- Leave inspection covers open
- Decontaminate facility of remaining coal residue
 - Vacuum / sweep / wash, as and where practical

S2. Arrange boilers annual service, maintenance and re-tubing to coincide with conversion project

- To be conducted by the boiler manufacturer or the authorised service agent
- Allowing for routine annual and any known or identified required works e.g.
 - Any required maintenance or repairs to furnace, refractory, tonneau, door seals and gaskets

- Lubrication, checks, freeing or replacement of moving parts including front and rear auger bearings/mechanics
- Checks of fan belts, belt tensioning, alignment & bearings
- Removal of surface corrosion from exterior surfaces, repaint with green paint suited to high temperatures and protection against corrosion
- Service report to comment on works, findings, recommendations, condition of internals, photographs
(See interlude below)
- **Sample of boiler water to be obtained**

S3. Staged commissioning process

- Achieve sign off on electrical, mechanical & controls commissioning with preliminary trial burn conducted for calibration of digital combustion management controls & sensors
- Tested and working boiler system with trial run prior to the heating season; preliminary combustion gas analysis test results for verification purposes and to support commissioning calibrations
- Cold weekend tests of heat up and cool down times for system optimization
- Provision for remote online monitoring & diagnostics (internet)

Action Required

- I. **NZDF/RNZAF base Woodbourne to arrange boiler house clean up in accordance with specifications in clause 3.3 section S1**
- II. **NZDF/RNZAF base Woodbourne to arrange for the annual boilers servicing in accordance with specifications in clause 3.3 section S2, to include corrosion repairs / repainting**

Appendix C Control Equipment current boilers (Clause 3.4)

Problem

Inadequately controlled combustion processes are associated with high fuel consumption, higher emissions, lower heat output, lower responsiveness, higher maintenance costs, and can lead to hazardous operating conditions. The higher cost of pellet fuels places a higher value on addressing system losses.

- P1. The boilers fuel-to-air regulation requires constant manual hit and miss adjustment to avoid creating black smoke and inefficient operation
- P2. A burn back control is required for greater fire protection

Solution

Executive Summary Key Points

The existing pumps are controlled by a Demand Management System to stipulate heat to specific areas. In conjunction with efficient combustion control and demand management smarts, a fuel reduction target between 30% – 50% would be envisaged as an offset against higher pellet fuel costs.

S1. Retrofit heat management system

- Connect the site pumps to the DCM system (integration with Intech system)
- Check locations for additional bypass valve controls if needed

S2. Retrofit automatic digital combustion management system

- Install sensors to measure flue gas temperature and residual oxygen content
- Optimize the already installed variable speed drives on the augers to regulate combusted air through fan speed control.
- Install a servo actuator to control the air dampers
- Integrate combustion control with the boiler management system

S3. Retrofit automatic digital Furnace Pressure Control

- Install sensors to measure boiler pressure
- Install variable speed drives on the inducted draft fans
- Integrate induct draft fan control with the boiler management system

S4. Retrofit automatic burn back control system

- Install temperature sensors in the fuel feed augers
- Mount solenoids on water (fire hose installation) installation

- Fit solenoids to the fuel feed augers, plumb the solenoids to the water system near by
- Make drain holes on the bottom of the fuel feed augers
- On detection of burn back via the temperature sensor, the system causes the solenoid to dowse water into the screw
- Secondly, the burn back system signals the fuel feed auger to drive at 100% speed to ensure any fire does not feed back towards the fuel store
- Thirdly, the burn back system causes an alarm to be raised through a connection with the boiler management system

Appendix D Risk Analysis current boilers (Clause 4.0)

Problem

Potential issues associated with the proposed project are discussed below with commentary addressing the associated risk management methods and contingency planning options.

- P1. Economic Risk; the higher price of pellet fuels/woody bio mass fuels relative to low cost coal fuel could be seen by the site as unaffordable
- P2. Economic risk; the site might be concerned that volatility in pellet fuel pricing might lead to escalating costs
- P3. Security of supply; the site might be concerned that there could be a shortage of pellet fuel in the future
- P4. Technical feasibility; the site might be concerned that technical challenges might prevent the conversion from delivering in the described manner
- P5. Current state of the boilers (thin boilers pipes as stated by the caretaker)
- P6. Boilers are under capacity at this moment (as stated by the caretaker)
- P7. Labour Constraints; there could be a labour shortage of key skills required to implement the conversion
- P8. Time Constraints; the site's decision making process and / or project requirements might over run desired time line stipulations
- P9. Future ongoing technical support.

Solution

S1. Enhance boiler and heat control to reduce operating costs and amount of fuel required

- *At 70% combustion efficiency, the cost of unburnt fuel and heat lost up the chimney is \$41,772 p/a worth of coal. The visual inspection suggests the boiler is operating at around 70% efficiency, based on the obvious presence and quantity of unburnt carbon in the boiler fly ash.*
***Note 1**
- At 85% distribution system efficiency, the cost of piping system heat losses is an additional \$14,620/a worth of coal. 85% distribution system efficiency is a typical value.
- Therefore, out of the \$139,239 of coal purchased in 2007, a total of \$56,392 worth would not have been required, had the system been operating at 100% efficiency. The portion actually required to meet the net heating demand with the system as it stands was \$82,847

- Of the \$82,847 of the net fuel requirement, demand can be categorized as follows:
 - A) Fuel used to provide heat to the RNZAF base Woodbourne during occupied base hours

B) Fuel used by default heating the entire site regardless of whether all rooms/hangars are currently occupied, current outdoor and indoor air temperatures, individual occupant preferences and solar gain discrepancies ~ e.g. north facing areas being too hot, while south facing areas demand heating.

***Note 2**

Notes : The greyed out section of text describe the key areas of interest to target for energy bill reductions (*The low fruit areas*)

Note 1: See S2 of Appendix C for technical details of the proposed digital combustion management system, aimed at taking combustion efficiency to a sustained 83%

The implication is a feasible target of 30% > 50% fuel reduction, depending on the sophistication of energy and combustion management control technology employed.

Additionally it is envisaged the fuel change and technology recommendations will lead to a reduction in attendance and ash disposal costs, currently estimated at around \$62,960 P/A.

Refer to the associated cost benefit spreadsheets for detailed analysis / basis of figures presented here.

S2. Three Year fixed pricing fuel supply contracts to be negotiated, with 2 standby alternative fuel options available as contingency in a worst case scenario

- The fuel supplier will present a contract stating pricing arrangements for a minimum 3 year period
- Discussions (already discussed for other sites) with the fuel supplier suggest they intend to manage supply capacity such that the market does not associate pellet fuels with price volatility
- Alternative fuel options include wood chip, and reinstatement of coal, although neither option is suggested at this stage as a recommendation, both options remain as a check against excessive pellet fuel price increases at the end of the initial 3 year contract

S3. Proposed fuel supplier has proven capacity to manage fuel supply

- Natures Flame has been suggested as the recommended fuel supplier given that they have the resource and infrastructure of Solid Energy at their disposal
- We are aware of a disruption in the North Island supply chain as a result of a recent fire at a central saw mill. We observed that this did not effect supply commitments to commercial clients
- At this moment Solid Energy has plans for a major expansion for renewable energy manufacturing capacity with a biomass production facility to be built in Taupo and Christchurch (see Press Release of 26 February 2008)
- We believe that there is an economic case for other market players to invest in pellet fuel manufacturing facilities and expect that, at the end of the initial 3 year supply contract, there will be additional sources available
- The raw feedstock material, wood waste, is a by product associated with the forestry industry and with the paper and pulp industry. We envisage these industries continuing for the foreseeable future

S4. Proposal based around tried and tested methods and reputable suppliers

- Manufacturers and / or their authorized service agents will be utilized for installation of key components of the conversion
- The boilers would be inspected and serviced prior to the conversion
- Digital Combustion Management is based on long standing methods of efficient combustion control
- Key parts will be sourced from reputable suppliers, e.g. Siemens, ABB and Clipsal Schneider.
- Key parts will be considered prior to specification such that the resulting facility is conducive to ongoing service and maintenance
- Solid Energy have pellet fuel combustion engineers available for troubleshooting
- The methods advocated are methods known to work elsewhere, for example as described in case studies of other site's who have made the conversion
- The energy savings predicted are in line with those consistently achieved at other sites using our demand management software and automation systems

S5. Contingency options if labour constraints become an issue

- We recommend Taymac Boilers and Mecserve service agents as the preferred labour suppliers
- Failing this, ECOsystems can engage the services of specific trades contractors and micro-manage electrical & mechanical aspects
- In a worst case scenario the project timeline might be manipulated to align with the availability of preferred labour supply

- S6. Contingency options if decision making process lags behind desired timelines to effect funded conversion prior to next heating season**
- Information package comprising of this report, the executive summary and cost benefit workings to be provided for discussion
 - Manufacturers and / or their authorized service agents will be utilized for installation of key components of the conversion
 - Site could opt to proceed with conversion under its own budget, where the economic case is compelling
- S7. Proposal based around technology suited to ongoing support from site's existing boiler service contractors**
- Automation system based around proprietary hardware
 - Technical operating and maintenance manuals to be supplied

12 Executive Summary (“New” boiler or boilers)

12.1 Brief

After our site visit to RNZAF base Woodbourne and discussions we learnt that the current boilers are under capacity for the current base energy requirements, further in this discussion we learnt that the current 2 boilers have thin boiler pipes, and the 2 oil fired boilers are at there end of life expectancy. At this moment there is a feasibility Study underway, to replace the current 2 coal fired boilers for a second hand boiler to be purchased in the near future.

An opportunity has arisen for New Zealand Defense Force (NZDF/RNZAF) to replace their 2 current coal fired boilers with a new biomass fueled boiler or boilers of approximately 3.5 to 4 Mega to comply with the higher energy needs now and in the future.

In place of the idea of a second hand boiler which still has to be converted to woody bio mass fuel and installed with the latest automation controls, and the conversion of the boiler room to house the second hand boiler there are several options to be considered.

- To replace the current boilers (oil and coal fired boilers) for a new boiler to provide solely the heat requirements of the site
- To replace the two current coal fired boilers for two “new” woody biomass (wood pellet) fired boilers with a capacity of 2.000MW each to comply with the base future energy heating needs
- To replace the two oil fired boilers for a single woody biomass boiler that provides heat to the SafeAir plating site and will be a back up for the current “refurbished” boilers. This implementation requires that the current coal fired boilers be re-tubed and a DCM system has to be installed to address the current energy needs as in part one of the feasibility study
- Any combination of options stated above

Wood waste derived woody biomass is a carbon neutral form of bio fuel. It has been used commonly for many years in Europe, Canada and the USA. As a refined fuel it is consistent and reliable in its burning properties.

The drivers behind funding conversion to this fuel are environmental, particularly carbon abatement, and national economic interests relating to efficiencies in the forestry sector.

12.2 What's the Catch?

High capital cost with a new boiler or boilers

But

- With a “new” boiler installation or installations you immediately address several issues
 - Current boilers' thin pipes issue
 - Under capacity for the current base energy requirements and extra resources for the future
 - Conversion to woody bio mass
 - Redundancy of the 2 current oil fired boilers
 - Fuel bunker upgrade
 - Latest boiler technology and automation
 - Low maintenance
 - Reduced caretaker hours
 - Lower ash emissions
- Coal is currently at an artificially low price. Its cost to the customer does not take into account the cost of environmental damage associated with coal mining, coal combustion and the resulting emissions to land and air.
- The coming carbon economy is set to be a sure driver for coal price increases
- Woody bio mass fuel heating may not be cost competitive with coal heating, but it holds its own when stacked up against other alternatives such as electrical heaters

And

- With a “new” boiler installation or installations, you have higher boiler efficiency and therefore less fuel needed
- The latest technology, and a base to improve and expand in the future
- The proposal can involve the sale of carbon credits

13 Economic Analysis (“New” boiler or boilers)

Economic key facts are summarised in the executive summary and detailed in the appendix L

Appendix E Fuel Bunker (Clause 5.2)

Problem

A wood fired heating system and “new” boiler installation or installations requires a secure and dry storage facility and a redesign of the current boiler house setup. The principle requirements are based around:

- P1. Ability to handle bulk woody biomass fuel deliveries
- P2. Degree of weather proofing / protection against ingress of moisture
- P3. Storage capacity
- P4. Ability to reliably provide fuel to the transport system
- P5. Health & safety

Solution

Executive Summary Key Points

RNZAF base Woodbourne existing coal bunkers can continue to be used with no big requirements for modification (weather proofing by high bay roller door and extending the current fuel bunkers) beyond those already underway. The resultant heat storage capacity will be up to 50% less with woody bio mass fuels than with coal. **Note:** that the fuel feed installation must be practical for the “new” boiler(s) installation.

Appendix F Boiler House Upgrades & Refurbishments (Clause 5.3)

Problem

The commissioned “new” boiler facility needs to be based around a suitably appointed boiler house, (could be size issues) with all items of plant in good and clean serviceable condition.

- P1. Current size of existing boiler house, to house the “New” boiler installation

- P3. Size of access doors for installation of “New” boiler may not be sufficient in height and width

- P4. To house the new boiler outside the existing boiler house facility will require new piping.

- P5. All traces of coal, clinker and coal ash buildup will need to be removed to avoid impinging on combustion gas analysis tests during commissioning and combustion controls setup

- P6. Commissioning calibration of the distribution system and “New” boiler installation and demand management controls, requires testing of an operating heat distribution system

Solution

S1. Clean boiler house

- Removal of old boilers by NZDF or “New” boiler manufacturer or authorized service agent
- If necessary: break out wall or access doors to comply with bigger size of “New” boiler or boilers
- Making place outside the boiler house facility to house the new boiler, fuel bunker and de-ashing facility
- Remove unburnt coal, dust & debris from boiler house
- Decontaminate facility of remaining coal residue
 - Vacuum / sweep / wash, as and where practical

S2. Arrange access to boiler house to replace “New” boiler(s)

- Installation of “New” boiler(s) and equipment, conducted by the boiler manufacturer or the authorized service agent

S3. Staged commissioning process

- Achieve sign off on electrical, mechanical & controls commissioning with preliminary trial burn conducted for calibration of “digital” combustion management controls & sensors
- Tested and working boiler system with trial run prior to the heating season; preliminary combustion gas analysis test results for verification purposes and to support commissioning calibrations
- Cold weekend tests of heat up and cool down times for system optimization
- Provision for remote online monitoring & diagnostics (internet)

Action Required

- III. **NZDF/RNZAF base Woodbourne to arrange boiler house clean up and comply with bigger access requirement for “New” boiler(s) in accordance with specifications in clause 5.3 section S1**
- IV. **NZDF/RNZAF base Woodbourne to arrange for the “New” boiler(s) installation and servicing in accordance with specifications in clause 5.3 section S2**

Appendix G Risk Analysis (Clause 6.0)

Potential issues associated with the proposed project are discussed below and are partly the same as in part one of this feasibility study with commentary addressing the associated risk management methods and contingency planning options.

- P1. Economic Risk; the higher price of woody bio mass fuels relative to low cost coal fuel could be seen by the site as unaffordable
- P2. Economic risk; the site might be concerned that volatility in woody bio mass fuel pricing might lead to escalating costs
- P3. Security of supply; the site might be concerned that there could be a shortage of woody bio mass fuel in the future
- P4. Technical feasibility; the site might be concerned that technical challenges might prevent the conversion from delivering in the described manner
- P5. Labour Constraints; there could be a labour shortage of key skills required to implement the conversion
- P6. Time Constraints; the site's decision making process and/or project requirements might over run desired time line stipulations
- P7. High capital cost of a new boiler or boilers installation
- P8. Future ongoing technical support.

14 Engineering Design Specifications (“New” boiler or boilers)

14.1 Earthworks

Earthworks could be a requirement as part of this proposal if the option of a boiler installation outside the current boiler house facility is chosen

14.2 Fuel Bunkers Upgrades

Fuel bunker upgrades are required under the scope of the conversion project proposal. See appendix F for more details.

14.3 Boiler House Upgrades & Refurbishments

See appendix G for further commentary. Boiler house upgrades & refurbishments are required for replacement of “new” boiler(s) installation and woody bio mass fuel operations system, as part of this proposal, beyond recommended and routine service and maintenance requirements already envisaged under Business As Usual (BAU) practices (i.e. currently practiced).

14.4 Accumulator Tanks

Accumulator tanks are not specified as part of this proposal.

14.5 Fuel Transport – Bunker to Boiler

The existing facilities pull through auger feeder systems could be replaced by “new” or with mechanical modifications as woody bio mass fuels are different than coal.

14.6 Boiler Pipe-work

Adjustments to the boiler pipe-work are envisaged under the scope of this proposal by “new” boiler(s) configuration.

14.7 Control Equipment

Boiler control equipment will be provided by the boiler manufacturer or authorized service agent on the “new” boiler(s) installation

14.8 Ash Removal Equipment

Ash removal equipment is not specified as part of this proposal, but it could be a part of the “new” boiler installation

14.9 Further Carbon Emission Reduction Work

- Improved combustion efficiency through automatic continuous fuel to air ratio tuning.
- Improved energy management through automatic control of the boilers heat to specific areas of the RNZAF base Woodbourne site, or times when only some areas of the site are occupied.
 - **Associated with 25% - 30% energy reduction elsewhere**

These measures, in seeking to reduce fuel consumption by up to 30% - 50%, will see the same level of carbon emissions reduction, supplemental to the abatement achieved through carbon neutral fuel switching alone.

15 Risk Management (“New” boiler or boilers)

Appendix E describes project risks and details the steps embedded in the proposal to address them.

The key issue is one of timing.

16 Conversion Contractors Details (“New” boiler or boilers)

The proposal anticipates using the boiler manufacturer and their authorised service agents for critical stages of the installation. Additionally, the fuel supplier is on hand for project management technical support.

Fuel Supplier	Natures Flame	<i>See Appendix E1</i>
	Solid Energy	<i>See Appendix E1</i>
<i>Boiler Manufacturers/type</i>	<i>Taylors</i>	<i>See Appendix G</i>
	<i>Easteel</i>	
<i>Authorised Service Agent</i>		<i>See Appendix E3</i>
Service Agent		<i>See Appendix E4</i>

17 Efficiency Guarantees (“New” boiler or boilers)

This part of the proposal is for the “new” boiler installation.

We estimated that a “new” boiler or boilers installation will have been designed to achieve 90% (or up) combustion efficiency. In practice, this would be met during a commissioning sign off test, with the boiler(s) in optimal condition and with an optimum set up for performance trials, with fuel and air dampers carefully set with a combustion analyzer for reference.

A “new” boiler can and will have an efficiency of 90% and more
Specifications are usually for a new boiler installation of 95%. This depend on the automation chose, boiler manufacturer and boiler type or system

i.e. The changes will see sustained and continuous operation at maximum efficiency.

18 Safety Features (“New” boiler or boilers)

The safety features will be supplied by the “new” boiler manufacture or stay partly the same be replacing the current boilers for a “new” boiler installation in the exiting boiler house facility

See for more information: 7 safety Features (Current boilers)

19 Operation & Maintenance (“New” boiler or boilers)

A supplement will be amended to the boiler operating and maintenance manual. This will include manufacturer’s data sheets. The data sheets include information on servicing and maintenance.

The components supplied are typical of boiler industry control equipment.

The operation will fundamentally change from current methods; some attendance duties currently carried out would no longer be required due to the new boiler installation, automation and fuel.

Commissioning and tuning instructions will be provided in the manual. The methods are typical of solid fuel systems and digital combustion management technology employed elsewhere, which a combustion engineer would expect to encounter.

The combustion tuning is carried out automatically by the new controls, which will constantly adjust the ratio of fuel and air supplied for combustion. Instructions on

this will be included in the manual updates. Optimization would not be routinely required once the system is commissioned.

20 Project Management Timeline Plan (“New” boiler or boilers)

If required a project time line plan will be set up. The project timeline is set around the longest delivery lead time, which is dictated by the boiler manufacturer and/or authorized service agent from receipt of order. Key stages are kept flexible to accommodate the availability of contractor labour with preferred access windows on the part of RNZAF base Woodbourne

Appendix H Contractor Documents

H.1 Pellet Fuel Suppliers



H.1 Pellet Fuel Supplier Press Release

Solid Energy plans major expansions

Tuesday, 26 February 2008, 2:43 pm

Press Release: Solid Energy NZ

26 February 2008

Solid Energy plans major expansions of renewable fuel production

Solid Energy is planning major expansions of renewable energy manufacturing capacity, with new biomass and biodiesel production facilities to be built in Taupo and Christchurch.

Solid Energy's Nature's Flame business will build a third wood pellet plant in the Aratiatia Industrial Park, north-east of Taupo. It will be capable of producing up to 150,000 tonnes per year of the clean-burning fuel and when operational in the second half of 2009 will confirm the company's position as the largest producer of wood pellets in the Southern Hemisphere. The other Nature's Flame plants (at Rotorua and Rolleston,) together can produce 60,000 tonnes

The Taupo plant's initial capacity will be 60,000 tonnes a year, and will expand to 150,000 tonnes in the next stage, for which plans are already complete. Nature's Flame has the long-term supply agreements for the wood residues it needs to support this expansion, which is expected to create at least 10 jobs. Andy Matheson, Solid Energy General Manager Renewable Energy, says the New Zealand market for wood pellet fuel continues to experience good growth and the business will also begin exporting.

"In Europe, North America and increasingly in Asia, wood pellet heating continues to gain market share and there is a strongly growing international trade in pellets," he says. "In New Zealand, we see continuing demand growth for wood pellets to heat homes, offices and public buildings such as schools. And wood pellets' near-zero carbon footprint is also making this fuel increasingly attractive to businesses looking for environmentally-sustainable process heat."

New Canterbury plant will produce high-quality biodiesel

Biodiesel New Zealand has commenced planning for a large-scale production facility at industrial location in Christchurch. Capable of producing 15 million litres of high-quality biodiesel a year, the plant is expected to begin operating late this year. The development is being designed to allow rapid expansion to double production. The expansion will create approximately 15 new jobs.

Biodiesel New Zealand's three-year target is to produce 70 million litres per year of its transport fuel, approximately half the Government's total 2012 biofuels target (3.4% cent of all fuel sold). The business currently produces more than 1 million litres a year from a small plant in Christchurch.

Biodiesel New Zealand's feedstocks include used cooking oil collected from restaurants and food preparation businesses throughout New Zealand, and locally-grown oilseed rape crops. The business already has a nationwide network collecting used cooking oils. The new plant will include a facility to extract oil from harvested oilseed rape grown for the business.

Since Spring 2007, Biodiesel New Zealand has been developing supply relationships with South Island farmers and has successfully completed a trial programme and harvest on 700 hectares. Contracts are now being finalised with growers for more than 6,000 hectares of autumn-sown oilseed rape (OSR) crop.

"Our high-quality biodiesel is made to meet the highest current international standard," says Andy Matheson. "Our biodiesel's properties mean it can be used in high-ratio blends without engine modification and we have strong demand from a range of customers who value its characteristics. OSR based biodiesel has superior cold temperature performance, making it particularly suited to New Zealand's climate. Local biodiesel production also help meet New Zealand's energy security aims outlined in the recently release Energy Strategy. We have had an enthusiastic response from the farming community and the new plant, our first major step in reaching our initial three- year target, will be operating ahead of next year's harvest."

ends

H.2 Mecserve, Authorized Boiler Service Agents



MECSERVE LIMITED
PO Box 19648
WOOLSTON
CHRISTCHURCH
PH: 384 9919
Fax: 384 2194
Mob: 0274 335 593
mecserve@xtra.co.nz



email: mecserve@xtra.co.nz

H.3 Manufacturers product Overview

Data Sheet
SS/ZDT-FG Issue 10

Low Temperature Zirconia Oxygen Analyzer ZDT-FG

- **Environmental certification**
 - MCERTS SIRA certificate MC99000 1/00
- **User-friendly**
 - language options
 - selectable system alarms
 - comprehensive diagnostics
 - Includes reference air supply
- **Reliable**
 - steel enclosure
 - NEMA 4X/IP66
 - proven track record



Superior technology and
quality from the world
leader in oxygen
measurement

ABB

Measuring equipment In situ Oxygen analyzer

Oxygen analyzer with ZrO₂ probe



Application

Measurement of the oxygen concentration in flue gases from furnaces and in all types of inert gases in the temperature range 20...1400 °C.

Design

Each oxygen analyzer comprises

- a probe which measures the oxygen concentration directly in the flue gas duct (in situ),
- an evaluation unit which converts the measured signal of the probe into a standardized signal and
- the electric and pneumatic connections (only electric cables with 7MB1 943-8DF... to -8CK...).

The design, material and length of the oxygen probes can be optimally adapted to the conditions of use, thus ensuring long service lives and high availability.

Because of the large maximum distance of 150 m between the probe and electronics, the components can be mounted in optimum locations.

OXITEC ECONOMY

The OXITEC ECONOMY oxygen analyzer (7MB1 943 -8DF... to -8CK...) is suitable for small and medium-size furnaces operated with natural gas or oil. The flue gas temperature at the point of installation should be less than 400 °C and have a low dust concentration.

The probe lengths of 300 mm, 500 mm and 800 mm permit optimum adaptation to the respective cross-section of the flue gas duct.

A high-temperature probe with a cooling/protective tube either 500 mm or 1000 mm long is available for flue gas temperatures up to 1400 °C.

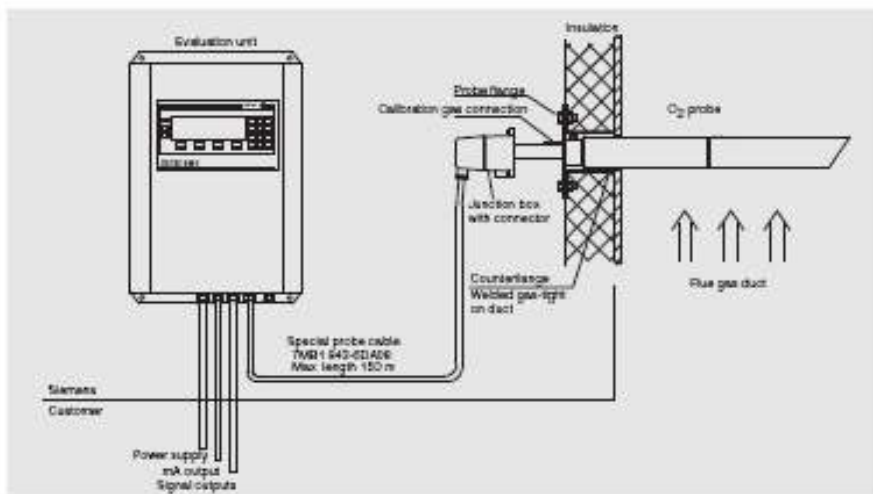


Fig. 5/1 Design of OXITEC ECONOMY oxygen analyzer for small and medium-size power plants

5

H.3 Taymac Boiler, Stoker Design

UNDERFEED STOKERS

Three models: Pull Through Hopper Feed Bunker Flow
8 Sizes
150 to 3,000 kW to burn rates



Suitable for a range of solid fuels including:

- All types of coal
- Wood pellets
- Wood shavings and sawdust
- MDF dust
- Hogged wood waste

Modern PLC's and VSD's allow the stoker to be tuned to give clean controlled efficient combustion.

Clean controlled efficient combustion is the key to minimising emissions of particulate, NO_x and SO_x.

EMISSION CONTROL

Taymac have available a range of emission control technologies. Systems are custom designed to suit the particular installation.


OTHER PRODUCTS

- Hot Water Boilers / Diesel / LPG / Natural Gas
- Diesel Storage Tanks
- Industrial Fans
- Vacuum Tanks
- Air Pollution Control Equipment
- Fuel Storage Systems
- Fuel Conveying Systems
- Stacks
- Calorifiers
- Grit Arrestors
- ID Fans
- Heat Dumps
- Pipework and Heat Exchangers
- Gas Scrubbers
- Ash Handling Systems

INSTALLATION & MAINTENANCE

Taymac work with local contracting companies who are able to provide these services in most areas. If required, Taymac's own installation team is available. Our experienced engineers are also able to undertake the commissioning.


TAYMAC
19 Taurus Place, Bromley
PO Box 19 757
Christchurch, New Zealand
Phone: (03) 389 7149
Freephone: (0800) 829 622
Fax: (03) 389 7078
Email: sales@taymac.co.nz
Website: www.taymac.co.nz

Address  <http://www.taymac.co.nz/>

Taymac

Taymac Manufacturing Limited February 5, 2008

Taymac has been serving the New Zealand and overseas market for over 100 years.



[INTRODUCTION](#)

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[PROJECTS](#)

[LINKS](#)

[CONTACT US](#)

Business Statement

To exceed our customers expectations

Location

Office and Manufacturing Factory
19 Taurus Place
Bronley
Christchurch
New Zealand
Phone ++ 64 3 369 7149
Fax ++ 64 3 369 7070
Email sales@taymac.co.nz

Company Name

Taymac Manufacturing Limited trading as Taymac

Ownership

Hollaby Holdings Limited
Vortex Engineering Ltd

Employees

35 staff

Workshop and Fabrication Capability

High Bay Workshop 1600m²
Low Bay Workshop 1545m²
Office & Amenities 405m²
TOTAL 3630m²

The Taymac workshop also houses

Machine Shop
Fitting Shop
Sheet Metal Shop
Spray Booth

Main Plant and Equipment - Fabrication Shop:

Parley Wizard Computerised Plasma cutting machine
Dye 120mm Hydraulic Guillotine
Dye 120 T Press Brake
Pulnick
10mm Plate Rolls
6 ton pinch plate rolls
Power Hack saw
MIG, Flux-core, TIG and Arc Welders
Pan Test Bed

H.4 Clipsal C-BUS (Clipsal Schneider)



Appendix I Economic Analysis Spreadsheets (Current boilers)

NZDF/RNZAF base Woodbourne Specific Data		
Roll (current boilers)		
Current Population	1137	People
Projected increase over 5yrs	2200	People
Current Fuel Purchases		
Cost per ton	\$191	\$/ton
Cost per GJ	\$7.07	GJ
Boiler Load Profile, Current		
Boiler and delivery system efficiency	60	%
Boiler efficiency	70	%
Delivery system efficiency	85	%
Boiler operating load	100	% MCR
Distribution system operating load	100	%MD
Peak season max weekly heat demand	894	GJ/wk
2006/2007 heating season	40	wks/yr
Fuel Properties, Coal		
Calorific Value energy rating of fuel	27	GJ / ton
Packed density of fuel	800	kg/m3
CO2 Combustion Emissions Factor	0.092	tons / GJ
CO2 Fuel production Emissions Factor		
Distance fuel travels from factory via truck	336	km
Bunker Capacity, Coal		
Bunker storage capacity(2x10tons)	20	tons
Coal energy storage capacity	540	GJ
Operation & Maintenance, Current		
Annual servicing costs (incl. ash disposal?)	\$50,000	
Daily attendance requirements	7	hrs / wk
Periodic attendance requirements	2.5	hrs / wk
Ash disposal costs	\$20	p/wk

Economic Data		
Attendance rate	\$ 32	p/hr
Carbon credit	\$35	\$/ton unit
Inflation rate, delivery costs	4	% p/a
Discount rate (for NPV calculations)	8	% p/a

Energy Analysis - Current Coal		
Annual energy GJ Requirement	19683	GJ
GJ / Person - 2007	17	GJ / p/a
Tons p/a (report of 900ton, 729 tons validated)	729	tons
Annual cost of fuel	\$139,239	p/a
Annual cost of heating per Person	\$122.46	P/A

Proposed Pellet Fuel Purchases		
Cost per ton	\$330	\$/ton
Cost per GJ	\$17.37	GJ
Boiler Load Profile, Proposed Improvements		
Boiler and delivery system efficiency		%
Boiler efficiency	83	%
Delivery system efficiency	85	%
Boiler operating load	75	% MCR
Distribution system operating load	70	%MD
Peak season max weekly heat demand		GJ/wk
2007 heating season	40	wks/yr
Fuel Properties, Pellet Fuel		
Calorific Value energy rating of fuel	19	GJ / ton
Packed density of fuel	650	kg/m3
CO2 Combustion Emissions Factor	0	
CO2 Fuel production Emissions Factor	120	kg/ton
Distance fuel travels from factory via truck(Rolleston/Nature flame)	336	km
Bunker Capacity, Pellet Fuel		
Bunker storage capacity	16.25	tons
Pellet energy storage capacity	309	GJ
Operation & Maintenance, Proposed		
Annual servicing costs	\$50,000	
Daily attendance requirements	1	hrs / wk
Periodic attendance requirements	2.5	hrs / wk
Ash disposal fees	\$0	p/wk

Energy Analysis - Current Pellet Fuel Equivalent		
Annual energy GJ Requirement	19683	GJ
GJ / Person - 2008	17.31	GJ / p/a
Tons required	1036	tons
Annual cost of fuel	\$341,863	p/a
Annual cost of heating per Person	\$300.67	P/A

Efficiency Analysis : As is, Coal	GJ	Tons	\$
Total Energy Purchase	19683	729	\$139,239
Combustion efficiency losses	5905	219	\$41,772
Distribution system losses	2067	77	\$14,620
Sum of Losses	7972	295	\$56,392
Net heat into delivery system	13778	510	\$97,467
Net heat to end use (radiators, FCU's)	11711	434	\$82,847

Efficiency Analysis : Pellets, Improved	GJ	Tons	\$
Total Energy Purchase	11900	626	\$206,686
Combustion efficiency losses	2023	106	\$35,137
Distribution system losses	1679	88	\$29,163
Sum of Losses	3702	195	\$64,300
Net heat into delivery system	9877	520	\$171,549
Net heat to end use (radiators, FCU's)	8198	431	\$142,386

O&M : As is, Coal	Hrs	\$
Daily attendance annual totals	280	\$8,960
Periodic attendance annual totals	100	\$3,200
Annual cost of ash disposal		\$800
Annual servicing maintenance costs		\$50,000
Total O&M annual cost	380	\$62,960

O&M : Pellets, Improved	Hrs	\$
Daily attendance annual totals	40	\$1,280
Periodic attendance annual totals	100	\$3,200
Annual cost of ash disposal		\$0
Annual servicing maintenance costs		\$40,000
Total O&M annual cost	140	\$44,480

Carbon Footprint : As is, Coal		
Number of deliveries required	36.45	P/A
Carbon emission, truck fuel miles	9.43	tons
Carbon emission, mining & processing	244.215	tons
Carbon emission, combustion	1811	tons
Coal Mining Fugitive Emissions Calculator		
Emission factor for bituminous coal	16.75	t CH ₄ / kTon
Equiv. CO ₂ greenhouse gas potency for CH ₄	20	t CO ₂ / CH ₄
Tons methane released P/A	12.21	tons
Equivalent CO ₂ emission tonnage	244.215	tons
Total net carbon emission	2064	tons

Carbon Footprint : Pellets		
Number of deliveries required	39	P/A
Carbon emission, truck fuel miles	9.97	tons
Carbon emission, manufacture	75	tons
Carbon emission, (neutral)	0	tons
Total net carbon emission	85	

Misc Data		
Wood chip CO ₂ factor	0	kg/tonne
Wood chip energy rating	11.4	GJ / tonne
Percent fuel storage capacity reduction, coal - pellets	43	%
Diesel energy rating	0.0358	GJ / litre
Truck diesel CO ₂ emissions per km	0.77	kg/km

Efficiency Analysis : Coal, Improved	GJ	Tons	\$
Total Energy Purchase	11900	441	\$84,182
Combustion efficiency losses	2023	75	\$14,311
Distribution system losses	1679	62	\$11,878
Sum of Losses	3702	137	\$26,189
Net heat into delivery system	9877	366	\$69,871
Net heat to end use (radiators, FCU's)	8198	304	\$57,993

	\$	Tons	GJ	\$	Tons	GJ
Fuel Purchased	\$139,239	729	19683	\$206,686	626	11900
Boiler losses	\$41,772	219	5905	\$35,137	106	2023
Distribution system losses	\$14,620	77	2067	\$29,163	88	1679
Total losses	\$56,392	295	7972	\$64,300	195	3702
Heat Delivered	\$82,847	434	11711	\$142,386	431	8198

	BAU	HEP	Difference
Annual Fuel Bill	\$139,239	\$206,686	\$67,447

Periodic Attendance	\$3,200	\$3,200	\$0
Daily Attendance	\$8,960	\$1,280	-\$7,680
Ash disposal fees	\$800	\$0	-\$800
Maintenance	\$50,000	\$40,000	-\$10,000
Total O&M	\$62,960	\$44,480	-\$18,480

Tons P/A CO ₂ Emission				Credit Value
		Abatement		
Fuel production	244	75	169	\$5,917
Fuel freight	9.43	9.97	-1	-\$19
Fuel burning	1811	0	1811	\$63,379
Total CO₂ Emission	2064	85	1979	\$69,277

Total Cost Of Heating	\$202,199	\$181,888	\$20,311
Heating Cost per Person	\$177.84	\$159.97	\$17.86

Cost figure	\$84,055	\$84,055.30
Savings per year	\$20,311	4.14 years

	2008	2009	2010	2011	2012
Woodbourne population	1137	1403	1669	1934	2200
Energy purchases - GJ	19683	19683	19683	19683	19683
Energy costs	\$139,239	\$139,239	\$139,239	\$139,239	\$139,239
O&M	\$62,960	\$62,960	\$62,960	\$62,960	\$62,960
Total cost of heating	\$202,199	\$202,199	\$202,199	\$202,199	\$202,199
Cost of heating per person	\$177.84	\$144.14	\$121.19	\$104.54	\$91.91
Carbon Credit Revenue	0	0	0	0	0

	2008	2009	2010	2011	2012
Woodbourne population	1137	1403	1669	1934	2200
Energy purchases - GJ	11900	11900	11900	11900	11900
Energy costs	\$206,686	\$206,686	\$206,686	\$206,686	\$206,686
O&M	\$44,480	\$44,480	\$44,480	\$44,480	\$44,480
Total cost of heating	\$251,166	\$251,166	\$251,166	\$251,166	\$251,166
Cost of heating per person	\$220.90	\$179.05	\$150.53	\$129.85	\$114.17
Carbon Credit Revenue	\$69,277	\$69,277	\$69,277	\$69,277	\$69,277
Net cost of heating	\$181,888	\$181,888	\$181,888	\$181,888	\$181,888
Net cost of heating per person	\$159.97	\$129.67	\$109.01	\$94.04	\$82.68
Carbon revenue per person	\$60.93	\$49.39	\$41.52	\$35.82	\$31.49

Difference (Net benefit)	\$20,311	\$20,311	\$20,311	\$20,311	\$20,311
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Appendix J Lifetime cost calculated over 15 years (Current boilers)

1.1 Simple payback basis

In the spreadsheet calculation below we see the conversion cost of \$84,055 with the simple pay back time of 4.1 years including Carbon credit revenue and -1.7 excluding Carbon credit revenue. The numbers are calculated with the improvements as proposed in executive summary, paragraph 2.3

With carbon credits

Conversion Cost	Subsidy	Net Cost
\$84,055		\$84,055
Simple Payback for RNZAF base Woodbourne		
4.1		

With out carbon credits

Conversion Cost	Subsidy	Net Cost
\$84,055		\$84,055
Simple Payback for RNZAF base Woodbourne		
-1.7		

1.2 Net Present Value (without sale of carbon credits)

The Net Present Value is calculated over a period of 15 years as required. In the spreadsheet below we see the Net Present Value of -\$370,377.32. The cash flow figure of -\$48,966 is calculated by taking the future operating cost from the BAU operating costs. See executive summary, paragraph 2.6. This is without the sale of carbon credits.

Net Present Value (NPV)	
15%	Annual discount rate. This might represent the rate of inflation or the interest rate of a competing investment.
-84,055	Initial cost of investment
-48,966	Return from first year
-48,966	Return from second year
-48,966	Return from third year
-48,966	Return from fourth year
-48,966	Return from fifth year
-48,966	Return from sixth year
-48,966	Return from seventh year
-48,966	Return from eighth year
-48,966	Return from ninth year
-48,966	Return from tenth year
-48,966	Return from eleventh year
-48,966	Return from twelfth year
-48,966	Return from thirteenth year
-48,966	Return from fourteenth year
-48,966	Return from fifteenth year
Formula	Description (Result)
-\$370,377.32	Net present value of this investment (-370,377.32) without the sale of carbon credits

1.3 Net Present Value (with sale of carbon credits)

The Net Present Value is calculated over a period of 15 years as required. In the spreadsheet below we see the Net Present Value of \$34,710.93. The cash flow figure of \$20,311 is calculated by taking the operating cost from the BAU operating costs. See executive summary, paragraph 2.6. This is with the sale of carbon credits estimated of \$35 a ton.

Net Present Value (NPV)	
15%	Annual discount rate. This might represent the rate of inflation or the interest rate of a competing investment.
-84,055	Initial cost of investment
20,311	Return from first year
20,311	Return from second year
20,311	Return from third year
20,311	Return from fourth year
20,311	Return from fifth year
20,311	Return from sixth year
20,311	Return from seventh year
20,311	Return from eighth year
20,311	Return from ninth year
20,311	Return from tenth year
20,311	Return from eleventh year
20,311	Return from twelfth year
20,311	Return from thirteenth year
20,311	Return from fourteenth year
20,311	Return from fifteenth year
Formula	Description (Result)
\$34,710.93	Net present value of this investment (34,710.99) with the sale of carbon credits

1.4 Internal Rate of Return (without the sale of carbon credits)

The Internal Rate of Return is calculated from a payment period of a year and a present day amount of \$202,199 which will give us an internal rate of return of 0% over 15years. This is without the sale of carbon credits

Internal Rate of Return (IRR)	
-84,055	Initial cost of a business
-48,966	Net income for the first year
-48,966	Net income for the second year
-48,966	Net income for the third year
-48,966	Net income for the fourth year
-48,966	Net income for the fifth year
-48,966	Net income for the sixth year
-48,966	Net income for the seventh year
-48,966	Net income for the eighth year
-48,966	Net income for the ninth year
-48,966	Net income for the tenth year
-48,966	Net income for the eleventh year
-48,966	Net income for the thirteenth year
-48,966	Net income for the fourteenth year
-48,966	Net income for the fifteenth year
Formula	Description (Result)
0%	Investment's internal rate of return after ten years (0%)
0%	Internal rate of return after fifteen years (0%)
	without the sale of carbon credits

1.5 Internal Rate of Return (with the sale of carbon credits)

The Internal Rate of Return is calculated from a payment period of a year and a present day amount of \$202,109 which will give us an internal rate of return of 21% over 15years. This is with the sale of carbon credits estimated of \$35 a ton

Internal Rate of Return (IRR)	
-84,055	Initial cost of a business
20,311	Net income for the first year
20,311	Net income for the second year
20,311	Net income for the third year
20,311	Net income for the fourth year
20,311	Net income for the fifth year
20,311	Net income for the sixth year
20,311	Net income for the seventh year
20,311	Net income for the eighth year
20,311	Net income for the ninth year
20,311	Net income for the tenth year
20,311	Net income for the eleventh year
20,311	Net income for the thirteenth year
20,311	Net income for the fourteenth year
20,311	Net income for the fifteenth year
Formula	Description (Result)
20%	Investment's internal rate of return after ten years (20%)
23%	Internal rate of return after fifteen years (23%)
	with the sale of carbon credits

Appendix K Equipment Supplier Documents (“New” boiler or boilers)

K.1 Suggested and examples of boiler manufactures or boiler converting specialist

Address <http://www.taymac.co.nz/>

Taymac

Taymac Manufacturing Limited

February 5, 2008

Taymac has been serving the New Zealand and overseas market for over 100 years.

Business Statement

To exceed our customers expectations

Location

Office and Manufacturing Factory
19 Taurus Place
Bransley
Christchurch
New Zealand
Phone ++ 64 3 369 7149
Fax ++ 64 3 369 7070
Email sales@taymac.co.nz

Workshop and Fabrication Capability

High Bay Workshop 1650m²
Low Bay Workshop 1545m²
Office & Amenities 405m²
TOTAL 3600m²

The Taymac workshop also houses

Machine Shop
Fitting Shop
Sheet Metal Shop
Spray Booth

Company Name

Taymac Manufacturing Limited trading as Taymac

Main Plant and Equipment – Fabrication Shop:

Parley Wizard Computerised Plasma cutting machine
Dye 120mm Hydraulic Guillotine
Dye 120 T Press Brake
Pulnix
16mm Plate Roll
6 inch pinch plate roll
Power Hackzaw
MIG, Flux-core, TIG and Arc Welders
Pan Test Bed

Ownership

Hallaby Holdings Limited
Vortex Engineering Ltd

Employees

35 staff

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**New Zealand**

Miller Street,
PO Box 191,
Dannevirke,
Ph +64 6 374 6089,
Fax +64 6 374 7341

Australia

273 Boundary Rd,
Box 704, Braeside,
Victoria 3195,
Ph +61 3 9586 5777,
Fax +61 3 9580 9820

Hastings

960 Omaha Road,
PO Box 2553,
Stortford Lodge,
Hastings,
Ph +64 6 873 7055,
Fax +64 6 870 7005

Head office and factory is situated in Dannevirke.

Technical Centre which includes Sales, Design, and Project Management is located in Hastings. The Australian Head Office is located in Melbourne. Service centres are located throughout Australasia

Appendix L Economics (“New” boiler or boilers)

Due to the many options discussed in part two of the feasibility study, we recommend a secondary report of the economics to be analyzed further. In this report we will specify the economics after a choice is made, for the option in part two of this report (new boiler or boilers)
We also can include the option of the second hand boiler as stated.