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

Burnham Boiler House

1 Introduction

1.1 Scope – Stakeholders & Interests

This report compiles findings from investigations carried out at the request of the Joint Logistics Support Organisation (JLSO), a division of New Zealand Defence Forces (NZDF). JLSO is tasked with provision of facilities management services for the combined forces base operations. Primarily we are reporting to Major W G Parke, Executive Officer for the JLSO.

Secondly the report is in the interest of the Energy Efficiency and Conservation Authority (EECA). Here, the interest is to support New Zealand's drive to lower its carbon footprint, and generally to promote sustainability initiatives conducive to resource conservation.

In conjunction with EECA, the Forestry Industry Development Agenda (FIDA) seeks to promote new markets for New Zealand's forestry industry and to enhance the profitability of the existing forestry resource through utilising more of the harvested product and resulting waste streams.

In addition, ECOsystems has partnered in other areas with the Electricity Commission (EC) where we have a common interest to reduce New Zealand's general electricity consumption and electrical peak demands on grid infrastructure. Where it has not deviated or conflicted with the primary contracted objectives and while it is in the interest of all parties we have included some consideration of EC interests and noted areas where significant electricity expenditure reductions could be achieved.

1.2 Secondary Stakeholders

We have identified the following organisations who have an interest in the outcome and recommendations of this report and any associated capital expenditure or programs of work. Key stakeholders include Fulton Hogan, Transpower, PAE. In all cases these companies' people have been forthcoming in the provision of information. They are key skill holders pertinent to the ongoing operation, reliability and availability of existing and potential future energy infrastructure assets as they are currently configured. To an extent they do have a commercial interest in maintaining business as usual practices where they underpin contracted revenue streams.

It is standard practice for us to conduct some level of business systems and organisational analysis when we work with a client. While our organisational model has identified these areas as a potential for conflict of interest we have seen no evidence suggesting this is an area of concern and that there appears to be considerable goodwill towards NZDF interests amongst the service provider base.

As it relates to energy efficiency, sometimes the organisational structure between key internal and external parties has a bearing

1.3 Objective

- **2.1** **Evaluate the opportunity to convert or replace coal fired boilers to woody biomass**. (**Primary Objective**)

- **2.2** Consider conversion options of;
  A: Wood chips
  B: Wood pellets
  C: Both the above options

- **2.3** Consider options for
  A: Plant replacement
  B: Plant conversion
  C: **Use of woody biomass as a duel fuel source**

- **2.4** Apply a depth of understanding of NZDF requirements
  (**Key Objective)**

- **2.5** Use the table top study methodology to discard any unfeasible solutions in the first instance (**Economic Objective**)

1.4 Reasoning Behind Proposed Fuel Change

1.4.1 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.

1.4.2 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.

1.4.3 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.

1.4.4 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 the atmosphere in the form of methane (CH_4). Methane as a greenhouse gas is considered to be 17 times more potent than carbon dioxide.

1.4.5 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 PM_{10} 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.

1.4.6 Operation & Maintenance

The proposed ***wood pellet fuel*** 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.

1.4.7 Public Relations & Green Image Marketing

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

1.5 ECOsystems Role

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

In terms of the actual conversion 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

2.1 Brief

An opportunity has arisen for NZDF to improve the economics surrounding the operation of the Burhnam site heating system.

Investigations of similar sites have been carried out courtesy of EECA and FIDA who are providing funding to assist conversion of traditional coal fired heating systems into more environmentally friendly wood waste derived pellet fuels.

Wood waste derived pellet fuel 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?

Pellet fuel is nearly three 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

B. In this study we include and exclude the sale of carbon credits that effected the pay back time of the technology we proposed

End Result

• Current fuel bill per year	:	**$452,000**
• Heating cost with conversion & changes proposed here, and sale of carbon credits	:	**$315,826**

2.3 *What's the Cost?*

The project costs by component are

Capital Costs	
Bunker	$69,000
MACT upgrade	$3,274,016
Pursuit of carbon credits & legal fees	$110,000
Total capital costs	**$3,453,016**

The MACT upgrade embodies a conversion to Maximum Achievable Control Technology. It is modeled on the approach designed for the Burnham boiler house. $3,000,000 of the MACT cost is an estimation of boiler house upgrades based on 75% of the larger upgrade carried out at Burnham.

2.4 *What's the Benefit?*

Revenue			$/GJ			
Baseline Fuel Bill	*73,638*	*x*	*$6.41*	***$471,921***		
GJ pellets	13,410	x	$18.95	$254,080		
GJ coal	31,289	x	$6.41	$200,524		
Sub total				**$454,604**		
Net year 1 benefit, fuel cost savings					**$17,317**	
Carbon Emissions						
Baseline coal emissions, tons	*6775*					
Proposal coal emissions, tons	2879		$/ton			
Carbon abated, tons P/A	**3896**	x	$35.00	$136,362		
Less credit sales / ETS trading fees				$20,454		
Net year 1 benefit, carbon abatement					**$115,907**	
Total year 1 savings						**$133,225**

	Inflationary NPV Simple 5 Year Model						
	Inflation %	Baseline	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**
Coal	4%	471,921	$490,798	$510,430	$530,847	$552,081	$574,165
Pellets	2%	$254,080	$259,162	$264,345	$269,632	$275,024	$280,525
Coal	4%	$200,524	$208,545	$216,887	$225,563	$234,585	$243,969
Subtotal			$467,707	$481,232	$495,194	$509,609	$524,493
Fuel cost savings			**$23,091**	**$29,198**	**$35,653**	**$42,472**	**$49,671**
Carbon Credits	2%	$115,907	**$118,226**	**$120,590**	**$123,002**	**$125,462**	**$127,971**
Total net revenue stream			**$141,317**	**$149,788**	**$158,655**	**$167,934**	**$177,642**

Net Present Value Indicators		(Taking account of inflation)	
Discount rate	15%		
NPV of fuel cost savings	$114,579	NPV of capital costs	$2,930,675
NPV of carbon revenue	$410,222		
NPV, total revenue stream	**$524,801**		
NET PRESENT VALUE OF PROPOSAL ASSUMING 5 YEAR LIFE CYCLE			**-$2,405,874**

(If the carbon credits sell)

Note, without the sale of carbon credits the NPV is -2,403,475. There is a marginal reduction in capital costs without the associated carbon credit pursuit cost. i.e. the comparison reflects no significant difference between the with and without carbon scenario

If the 3,000,000 of boiler replacement cost is removed, the difference between with and without carbon credits scenario is significant; positive $202,821 versus with credits, versus negative $135,044 without

2.5 *What We Have Done*

- Conducted analysis of the boiler, heating system and heating requirements

- Conducted cost benefit analysis of the surrounding economics of operating your current heating system using coal, if a switch were made to ***wood pellet fuel***

- Analyzed the carbon footprint of the current heating system and what it would be with pellet fuels

- Provided engineering designs and ideas to enhance the efficiency of the 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

  Currently, your boiler house lacks sufficient capacity margin to risk a conversion to lower CV woody fuels. Additional capacity is required.

2.6 *How Savings Would Be Made*

- Boiler optimisation to maximum achievable control technology. Primarily this is setting up of optimal grate burn rates through optimum settings of bed depth, grate speed, frontal and rear grate air flows, secondary air flow, total air flow, furnace pressure and excess air levels.

- Install demand management controls to automatically manage and control heat delivery according to schedule times of area occupancy and actual need for heat.

  Currently there is a manually activated remote set point control panel. The demand management system would build on this system and provide a computer generated front end.

- The deairator would increase boiler efficiency

2.7 *Overview of Heating System Efficiency*

The table below shows the cost of losses associated with the current coal situation.

Efficiencies & Losses - Actual, Coal

Average boiler efficiency, sustained			70%	**Sustained**
Distribution system efficiency			82%	
Demand management reduction potential			75%	
	GJ	TONS	KWH	$
Gross Purchase	**73,638**	3,143	20,454,950	$471,921
Average boiler losses	22,361	943	6,211,354	$141,576
Net boiler O/P	51,277	2,200	14,243,596	$330,345
Dist. System losses	9,230	396	2,563,847	$59,462
Net heat delivered	**42,047**	1,804	11,679,749	$270,883
Demand control loss	10,512	451	2,919,937	$67,721
Net heat required	**31,535**	1,353	8,759,812	$203,162

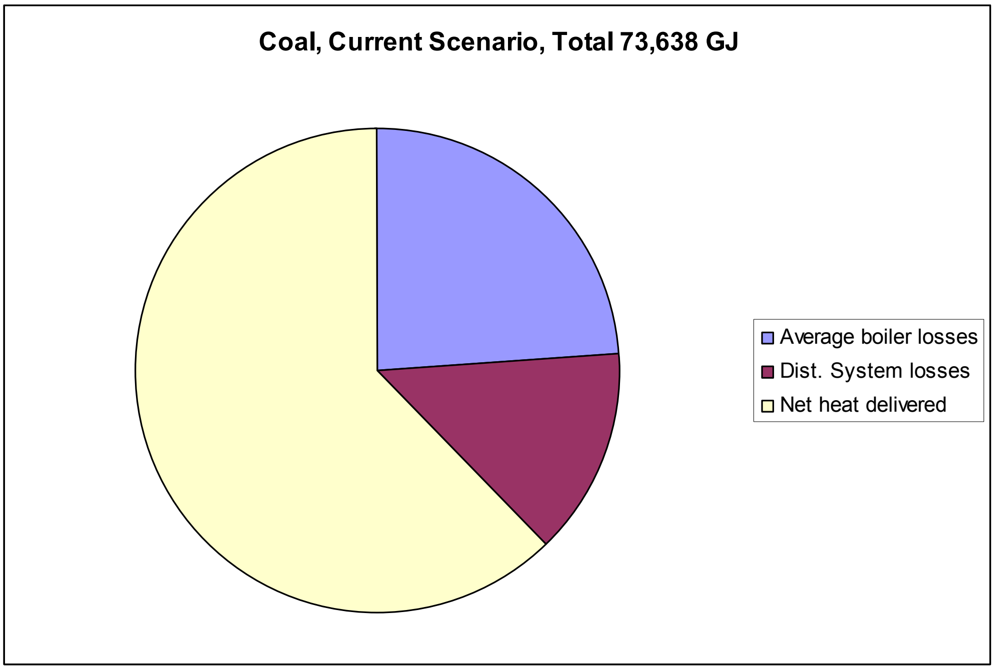
MACT Efficiencies, the Potential

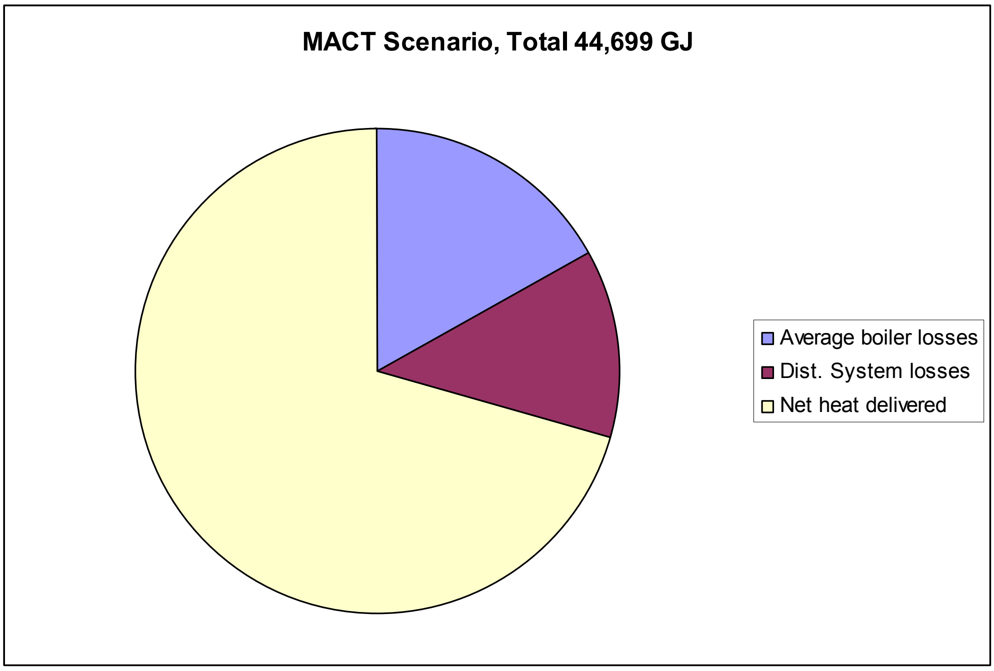
Average boiler efficiency, MACT			83%	**MACT**
Distribution system efficiency			85%	
	GJ	TONS	KWH	$
Gross Purchase Req.	44,699	1,918	12,416,459	287,969
Average boiler losses	7,599	326	2,110,798	48,955
Net boiler O/P	37,100	1,592	10,305,661	239,014
Dist. System losses	5,565	239	1,545,849	35,852
Net heat delivered	31,535	1,353	8,759,812	203,162
SCENARIO 2 CURRENT COAL, MAXIMUM ACHIEVABLE TECHNOLOGY SETUP				
Reductions	28,939	1,225	8,038,491	**$183,952**

Carbon Emissions Calculator - Coal Combustion Aspect

Coal combustion CO2 emission factor	0.092	tons / GJ	
Value of carbon	$35.00	per ton credit	
	TONS	VALUE	
Current Scenario CO_2 Footprint	6775	$237,114	
			SAVING
Scenario 1 CO_2 Footprint	6207	$217,252	**$19,861**
Scenario 2 CO_2 Footprint	4112	$143,932	**$73,321**

The graph shows proportionally how your 3143 tons / $471K of coal are used. Almost half is wasted. 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 44,699 GJ would be used.





2.8 Overview of Pellet Fuel Scenario, MACT Efficiencies

Boiler 1 (Post Conversion Babcock)

Total combined demand, MACT	**44,699**	GJ	***Wood***
Percent of load provided	30%		
Share of energy conversion	13,410	GJ	
Fuel consumption	706	tons P/A	
Fuel cost	$254,080	$ P/A	
Carbon emission	Neutral	tons P/A	

Boiler 2 (New Boiler)

Total combined demand, MACT	44,699	GJ	***Coal***
Percent of load provided	70%		
Share of energy conversion	31,289	GJ	
Fuel consumption	1319	tons P/A	
Fuel cost	$198,107	$ P/A	
Carbon emission	2879	tons P/A	

Summary

Total fuel bill	$452,187						
Less carbon abatement	$136,362	Produced tons	2,879	Saved tons	3,896	**Cost Saving**	**$156,096**
Net fuel bill	$315,826						

3 Availability of Fuels

Availability of suitable quality fuel is a defining point in determining the feasibility of conversion to biofuel.

Natures Flame, the pellet fuel manufacturer established by Solid Energy remains the market leader in terms of ability to offer and support long term ongoing security of supply of woody bio fuels to a consistent specification.

The most feasible and practical conversion options at this stage of the market revolve around pellet fuel based solutions. This could change rapidly as a third tier bio fuel energy retailer sector is likely to eventually develop. There are technical and other strong reasons in favor of pellet fuel, on balance of all practical considerations we see pellet fuel conversion as the lowest risk and most feasible option to consider as realistic solutions.

We have approached the pellet fuel manufacture with indications of pellet fuel volumes for if all sites were converted to pellet fuels based on current rates of coal consumption and have informal confirmation that the manufacturer will commit to supply at these volumes.

3.1 Economics of Fuel

We note initial reports of pellet fuel pricing being quoted at $500 per ton. At this price we understand scepticism towards pellet fuel conversion being a realistic proposal.

We since have informal confirmation that the NZDF wholesale rate for pellet fuels would be $330 per ton. For the purposes of our economic comparisons we have assumed $360 per ton in our calculations.

The economic factors in favour of pellet fuels at $330 to $360 per ton begin to stack up especially so when we take into account trends indicating steady increases in coal prices.

We anticipate that international global market pressures could see key grades of coal price inflation rates of 25%. Predominantly this is driven by a demand for steel and to an increasing extent to feed over seas power stations. We see these trends eventually being tempered by price increases shipping coal to overseas markets associated with shipping heavy fuel oil price increases, after which we foresee greater internal demand for coal resources from anticipated clean coal technologies. Additional to this are expected price increases associated with whatever form of emissions trading scheme New Zealand engages in under its Kyoto commitments.

In summary, we see that to make a proper economic comparison between coal and pellet fuel alternatives, we should factor in that the current low price of coal probably is not representative of tomorrow's price for coal.

Waste streams taken directly from the saw mill seem to offer an ideal and in theory low cost means of providing thermal energy. Barriers to accessing woody waste derived fuel direct from the mill are discussed briefly in an appendix.

4 Technical Findings

The technical analysis considered a broad range of challenges and complexities the details of which could fill 100 pages. The technicalities reported here represent the crux of matter key points which go on to define the core technical recommendations.

4.1 Main Boiler, Babcock Key Points

A) Babcock 3.5 MW Front Loader 18 Years old

B) Boiler design capable of high efficiency towards 90%

C) Mechanically capable of a high level of fine tuning for combustion parameters

4.2 Secondary Boiler, Vekos Key Points

A) Vekos 1.5 MW Top Loader 38 Years old

B) Boiler design typical efficiency as low as 67%.

C) Poor capability to improve efficiency through tuning or control modifications

4.3 Additional Information

A) Vekos boiler operating on more expensive higher calorific value coal, with an expectation that it would struggle to raise steam on lower CV fuel such as pellet fuel (the highest CV wood fuel available)

B) The boiler house contains the derelict shell of a decommissioned and now redundant boiler.

4.4 Technical Conclusions

A) Technically both boilers could be made to combust pellet fuels

B) The higher CV coal used in the Vekos and the redundant boiler suggest that the boiler house is operating at a reduced total installed capacity than the original designer intended. The result is a boiler house running closer to the red line, one cylinder not firing.

C) The low capacity of the Vekos relative to demand effectively makes this facility a single boiler installation, in that boiler 2 does not have the capacity to serve the required duty of boiler 1, should boiler 1 fail.

D) Babcock boiler currently serving as a lead boiler would be better relegated to secondary boiler duty to preserve and extend its remaining useful life.

Summary Conclusions

- Boiler house does not have sufficient back up capacity should boiler 1 fail.

- Vekos level of efficiency is obsolete in today's fuel and carbon economy.

  These boilers are known to typically plummet as low as 67%. The thermal transfer efficiency is reduced due to the top feed insertion impinging on premium heat exchange surface area and combustion efficiency control is limited due to mechanical design difficulties preventing proper management of primary and secondary air flows.

  NZDF requires technologies design rated to meet 80% efficiency but which can be pushed out to 90% plus.

- Considering the boiler house from an engineering risk perspective our advocated position has to be one of non interference until risks associated with failure of a single boiler are mitigated. (*Loss of essential services to a military installation*)

- Although either individual boiler could be made to handle and combust carbon neutral pellet fuel, the boiler house capacity as a whole does not have sufficient capacity at the mechanical level in its current state to cope with a lower calorific value fuel. While this could be corrected through software control of energy conversion and demand this is not advocated as robust engineering practice and increases the risk and complexity of any proposed projects and the surrounding technical and economic analysis.

- Systems theory teaches that for efficiencies to be robust they should in the first instance be embedded at the mechanical level, with automation used to optimise and enhance what the mechanical delivers, not correct for a failure of mechanical delivery.

4.5 Technical Recommendations

1) The primary flaw of the current boiler house is its lack of back up capability. There is only one boiler capable of meeting peak demand loads. Technically the nature and scale of duty served by this boiler house classes the assets as critical plant. Usually in critical plant combined boiler houses there are two or three boilers sized such that failure of any one does not affect the facilities capability to service peak demands.

   - **The facility requires additional boiler capacity to provide the appropriate level of backup security of supply**

2) Two thirds of the boiler house is occupied by obsolete or redundant steel. Scrap steel prices are currently good.

   - **Remove the Vekos and redundant boiler** (unless there is a compelling case to keep either)

   - Remove pipe work dead legs, rationalise remaining pipe work, revitalise insulation, renew paint work. (Green)

3) **Install new 3 – 5 MW solid fuel boiler**. A 3 MW boiler of similar capacity to the Babcock would suffice, however a 5 MW boiler is a more adequate replacement for the lost original design capacity of the Vekos and redundant boiler combined.

   The relatively larger furnace area of a 5 MW unit would lead for a system more practical system conducive to operating on wood chip in the future, the slightly more efficient 3 MW option provides ample margin for a pellet fuel level of energy density.

4) **Upgrade Babcock level control** system to minimum control safety system standards associated with unattended operation of steam boiler plant. (high integrity; fail safe; self checking)

5) **Consider installing a deairator**. The operator has proposed converting the redundant boiler shell to serve this function. Experience suggests there is a proper 'sized to duty' approach which would lead to the most efficient achievement of design objectives, and that there are key deairator internals integral to the design and sizing. If the deairator / device serving as a deairator / pressurised hot well is properly sized, it will add to the overall efficiency of the system, otherwise it could become a net energy burden.

   It would be better to have the floor space available for new boiler capacity; a new deairator can be design to fit out of the way and is usually installed on upstands.

6) **Upgrade Feed Pump system.** Additional pump capacity would be installed with a new boiler. Steam boiler feed pumps should inspire faith and confidence and regularly tested to ensure sufficient back up feed pump capacity starts automatically on failure of the primary feed pump. Any modifications made to a feed pump bank would normally be design verified; it would be unusual to see galvanized pipe fittings specified.

7) **Install new control system.** A new boiler would typically come with a computer driven PLC SCADA control package. This should be able to act as a front end for the existing Babcock PLC. We recommend consulting with us when formulating the control specification. We will advise on requirements conducive to adaptable multi fuel set ups conducive to tuning and optimisation.

Summary

1) Replace Vekos boiler and redundant boiler with a single 3MW – 5MW unit
2) Upgrade feed pump system
3) Install deairator
4) Upgrade Babcock level alarm system

Specify the new boiler as ‘Solid fuel suited to coal, pellet fuel or wood chip operation

Costing a new boiler is a complex exercise and should include a full heating system energy balance to first check the cost benefit of alternative options.

As an indication, the Burnham boiler house upgrade including a new 8 MW boiler cost $4,000,000. We see a 5 MW plant budget at around 75% of this value and have estimated a cost of $3,000,000 to effect the recommended changes.

5 Engineering Design Specifications

5.1 Earthworks

Earthworks should not be required as part of this proposal.

5.2 Fuel Bunker Upgrades

The fuel handling facility could be integrated under the upgraded automation system. Mechanically it is not suggested that major changes be made to the existing fuel system other than some minor tweaks if it is required to handle pellet fuels. The bunker associated budget allowance can either be spent on tweaking the existing fuel handling system, or alternatively a custom designed fuel hopper copied from the Burnham facility could be employed. Tweaks could include fitting dust covers to exposed conveyor runs.

5.3 Boiler House Upgrades & Refurbishments

The boiler house upgrade envisaged comprises a cut down version of what has been carried out at Waiouru. This is the removal of redundant plant and fitting of a new boiler with modern control system. The new boiler does not need to be as large as the Burnham system.

The Babcock boiler could be repainted in Army green. At some stage it may require a new grate motor and AC VSD.

5.4 Accumulator Tanks

Accumulator tanks are not specified as part of this proposal.

5.5 Fuel Transport - Bunker to Boiler

The existing transport system would be capable of handling a combination of pellets and coal while keeping the two fuels separate. A simpler way may be to install a standalone pellet hopper near the Babcock boiler

5.6 Boiler Pipe-work

Boiler pipe work adjustments are those necessary to plumb in the new boiler, removal of redundant dead legs, rationalisation of remaining in service pipes. It is good practice to unravel unnecessary complexity.

5.7 Control Equipment

The control equipment would be specified in a detailed design document. If a new boiler is ordered we can provide a specification on key features to incorporate into the controls, and key areas to be configured to specific methods. The intent is to provide a system which sustains MACT efficiency, rather than achieving it only for a single performance test.

The Babcock boiler would retain most of its control equipment, but this would be integrated into the new computer controlled front end.

The demand management system would comprise a number of networked microprocessor controlled relay units spread about the site. Once again there is a computer front end involved.

5.8 Ash Removal Equipment

The existing ash removal system would be retained in its current basic state. It could be modified to segregate coal ash from wood ash (one is toxic, the other inert)

5.9 Further Carbon Emission Reduction Work

Over and above the minimum requirements to convert the boiler 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 boiler combustion efficiency: 68% (+/- 5%)
  - Expected combustion efficiency :80%(+/- 5%)
  - **10 – 15% efficiency improvement**

- Improved energy management through automatic control of boiler heat to specific areas

  - **Associated with 35% - 40% energy reduction elsewhere**

These measures, in seeking to reduce fuel consumption by up to 40%, will see the same level of carbon emissions reduction, supplemental to the abatement achieved through carbon neutral fuel switching alone.

6 Risk Management

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

The key risk currently is the lack of secondary boiler capacity.

7 Conversion Contractors Details

We recommend RCR Energy systems a supplier of leading boiler systems and would advocate their involvement in commissioning of the new replacement boiler. The RCR approach to automation is also recommended.

This said we envisage that NZDF will have its own preferred contractors which we will advocate working with in a project management capacity.

A 3,000,000 capital replacement project is beyond the scope of this report to analyse in sufficient depth for the associated complexity. Whichever boiler manufacturer is awarded the replacement boiler contract would go on to be a key project manager and likely have their own nominated contractor teams.

The alternative is another Maxitherm boiler, in which case the contractors recommended by Lytleton Engineering would be involved.

8 Efficiency Guarantees

The Babcock boiler is a particularly efficient design for combustion plant of this generation and remains competitive today. Until the market is ready to move wholesale into next generation combustion technology.

Next generation boiler technologies incorporate a fluid bed combustion system. We will then expect to see furnace chambers designed to exploit gasification and hydro cracking. Until such technologies are commercially available, the Babcock can be considered a good design of boiler.

A key part of the Babcock boilers good performance is good engineering heritage. Babcock and Wilcox as one of the few remaining pioneering boiler manufacturers of the industrial revolution have had many years to hone and refine their boiler designs.

Babcock design efficiency capability	> 85%
Typical sustained efficiency	> 75%

The MACT proposal includes measures to ensure the Babcock goes on to sustain its design efficiency rating and push this out towards 90%.

No efficiency guarantees are offered for the Vekos boiler.

One of the most common reasons for low sustained boiler efficiency is excess air. Increasing the level of excess air is usually the easiest way of addressing poor combustion problems, perhaps associated with high fuel moisture and a smoky stack. Often the approach is to increase the air until the problem goes away.

9 Safety Features

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 controlled while only trained operators have access to the facility. The nature of risk would be potential for burns – e.g. through steam contact, 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.

As a **steam** boiler house there are additional precautions and compliance issues to take into account. Generally the key risk of catastrophic boiler failure would be associated with a LOC (Loss of coolant) incident such as a failure of the feed water supply, leading onto a furnace tube collapse. Such an event would demolish the boiler house.

Steam boilers of this size and type fall into one of two main boiler code classifications;

- Attended Operation
- Unattended Operation

In most cases these types of boilers have been upgraded to meet the requirements for unattended operation. In the conversion processes the boilers are upgraded to a higher level of control systems safety.

It is recommended that any conversion process encompass an upgrade to the Unattended class of control safety systems.

Additionally it is recommended that an automatic steam shut of valve be installed on each boiler as additional protection in the event of a feed pump failure.

Burn back control is not necessary and already incorporated mechanically into the stocker system.

A sprinkler system should be considered as a retrofit for the fuel silo system.

10 Project Management Timeline Plan

A project management timeline plan could be along the lines of

First Phase (12 Months) Objectives

- Preliminary phase, clarify options & firm up capital costs
- Tender for replacement boiler
- Order replacement boiler, possible 3 – 9 months lead time
- Commence removal of redundant plant
- Commence removal of Vekos boiler to coincide with end of winter
- install new boiler
- Commission system
- Optimise system to MACT efficiency, install demand management controls

Second Phase Objectives

- Implement pellet fuel conversion, using lessons learnt and designs implemented (by this point) at Burnham

11 Operation & Maintenance

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.

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.

12 Fuel Supply Arrangements

The proposed wood fuel supplier is that established by Solid Energy. There is capacity to supply at the required volumes.

Until the boiler house capacity upgrade is carried out, the facility should continue to operate on coal.

13 Economic Analysis

Economic analysis is contained in attached spreadsheets.

Appendix A Risk Analysis (Clause 4)

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 relative to the current 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. 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. Future ongoing technical support.

Solution

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

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 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 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 authorised service agents will be utilised for installation of key components of the conversion
- The boiler 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

- 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

Appendix B Contractor Documents

E.1 Pellet Fuel Supplier

nature's flame

Renewable fuel from Solid Energy

E.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 finalized 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