

## 1. Executive Summary

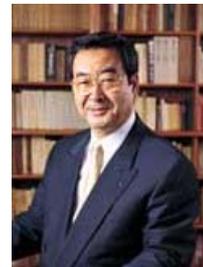
Ricoh Company, Ltd., with headquarters in Minami Aoyama, Tokyo, Japan, one of the world's leading suppliers of office automation equipment, has been trial evaluating Powerboss in the UK for the last 18-months with very good results. The success of the trial means that Ricoh UK now sees Powerboss as an important element in helping them achieve the stringent corporate goals the Ricoh group has set itself to save energy and reduce Carbon Dioxide (CO<sub>2</sub>) gas emissions. From the UK trial the way is now open for HESCO to promote the adoption of Powerboss to Ricoh's fourteen sites in Japan and beyond.

This case study, presented in five sections, gives a summary of Ricoh's corporate energy and emissions reduction goals and shows how Ricoh's adoption of Powerboss in Japan could help to achieve these objectives. Typical data from the UK trial is presented together with an excel spreadsheet which converts actual measured performance data into monetary savings and shows how, based on an appropriate mark up for HESCO, Ricoh can still show a return on their investment in two years.

## 2. Introduction

Ricoh Company Ltd is a global manufacturing company renowned for its state-of-the-art office automation, electronic devices and photographic equipment. Worldwide, the company employs 74,200 people and in the fiscal year ending March 31<sup>st</sup> 2002 the company recorded consolidated net sales of 1,672 billion yen and consolidated net income of 61 billion yen. In Japan sales totalled 902 billion yen, representing a global increase of 8.7% from the previous year.

Globally Ricoh is an excellent prospect for adoption of the Powerboss. It employs many of the applications that are particularly well suited to Powerboss including injection moulding machines and vacuum compressors to name just two, furthermore it has robust business and environmental policies that are driving the company to increase plant efficiency, and reduce both energy cost and CO<sub>2</sub> emissions. The Ricoh group's environmental vision "aims at pursuing sustainable management and continues environmental conservation practices<sup>(1)</sup>" Ricoh specifies in its Group Sustainability Report 2002 (Kankyō-Keiei Houkokusho) the direct actions it will take to reduce the global environmental impact of its business.



*Masamitsu Sakurai*

There are many elements to the policy but a central theme is, of course, company compliance with the Japanese National commitment to the Kyoto Protocol to promote reduction in total greenhouse gas emissions<sup>(2)</sup>. Specifically in 2001 Ricoh was the first leading manufacturer in Japan to join e-mission 55 and make a commitment to reduce CO<sub>2</sub> emissions by 13% from the 1990 level by 2010.

Clearly new technology, such as Powerboss, that can reduce both electrical energy costs and environmental emissions, offers excellent synergy with Ricoh's corporate business and environmental objectives.

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(1) *Masamitsu Sakurai – President & Chief Operating Officer Ricoh Co., Ltd.*

(2) *Ricoh Group Sustainability report 2002 – pages 35 & 36*

Ricoh has 26 manufacturing sites worldwide. Fourteen are in Japan with another twelve overseas in the USA, Taiwan, China, Hong Kong, Korea and two in the UK - Ricoh UK Products Ltd in Telford, Shropshire England and GR Advanced Materials Ltd in Sterling, Stirlingshire, Scotland.

### **3.0 Ricoh Group Environmental Action Plan (fiscal 2002 – fiscal 2004) and how PB can contribute**

In their policy document entitled "Group Environmental Action Plan" Ricoh specify definite goals that have been established to reduce the company's environmental impact. Specifically in terms of CO<sub>2</sub> emissions and energy consumption and the goals are:

- Reduce CO<sub>2</sub> emissions at plants and offices 62% by fiscal 2010 in terms of emissions per sales unit and 13% in terms of total amount emitted (Ricoh in Japan compared to fiscal 1990 figures)
- Reduce CO<sub>2</sub> emissions 20% per sales unit (all Ricoh business sites in Japan, compared to fiscal 2000 figures)
- Reduce CO<sub>2</sub> emissions 2% (the Ricoh Group in Japan, compared to fiscal 2000 figures)
- Reduce the amount of energy used 20% per sales unit (Ricoh Group manufacturing subsidiaries outside Japan, compared to fiscal 2000 figures)

In common with many "Blue Chip" companies Ricoh now make investment decisions based on minimum through life cost rather than simply minimum capital cost. Through life cost includes a consideration of reduced operating costs and improved environmental conservation. Furthermore Ricoh's FY 2001 Group Environmental accounting guide goes on to specify in the calculation of social cost section that for a clearer comparison environmental impact is now calculated in terms of monetary value. The reference figure used in evaluating new investments is in the range ¥ 16,000 / tonne CO<sub>2</sub> to ¥ 11,945 / tonne CO<sub>2</sub> abated. These figures, based on actual investments to reduce CO<sub>2</sub> appear very high and should be used cautiously. Please refer to the separate file "Discussion – value of CO<sub>2</sub>" for a considered view of the likely value of CO<sub>2</sub> emissions abatement in Japan.

Adoption of Powerboss will reduce Ricoh's CO<sub>2</sub> emissions. The technical details of this are discussed in section 4, but broadly Powerboss is able to reduce CO<sub>2</sub> emissions by a combination of reducing the real power consumed in an electric induction motor and by substantially reducing the reactive power in the site electrical distribution system. Reference to the Federation of Electric Power Companies <sup>(3)</sup> (FEPC) web site advises the 2001 Japanese average CO<sub>2</sub> emissions per kVA of Electricity consumed was 0.37 kg CO<sub>2</sub> / kVA. This figure is based on a pool average of all the Japanese utility electricity generating plant and specifically excludes self-generators which would be expected to have higher emissions.

Combining FEPC's estimate of CO<sub>2</sub> emissions per kVA electricity consumed and a value assigned to these reductions from the "discussion – value of CO<sub>2</sub>" paper allows us to calculate a monetary value associated with adoption of Powerboss for reduction in emissions. This is discussed in detail in section 5.

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(3) Source data FEPC website – [www.fepec.or.jp](http://www.fepec.or.jp)

## 4.0 Pilot project – Ricoh UK Products Ltd, Telford.

In their continuous search to reduce energy consumption and CO<sub>2</sub> emissions Ricoh UK products took a decision early in 2002 to trial a Powerboss unit on a 55kW 800 tonne plastic injection moulding machine producing paper trays and associated components for Ricoh photocopiers. A single Powerboss was fitted as a trial unit and has delivered good results. The management of Ricoh are happy to demonstrate the Powerboss installation to HESCO and this will be organised as part of Mr Niizuma's UK training.

Real, reactive and apparent power savings of 10%, 26% and 23% respectively were recorded. Annual reduction in electrical energy consumed (based on the planned 7,200 hours per year operation) is 3,888 kWh and a corresponding reduction in CO<sub>2</sub> emissions of ca 8 tonnes pa. The "through life" energy reduction is forecast to be ca 23,000 kWh with an associated reduction in CO<sub>2</sub> emissions of ca 50 tonnes.

The 800 tonne plastic injection moulding machine, which is the largest of eight injection moulding machines on site, has a 55kW main drive motor. Seven other injection moulding machines have 22kW drive motors. The load cycle (time on-load versus time off load) varies depending on the component being produced, but as the following Circutor AR5 traces indicate 40% on-load, 60% off-load is typical. All eight injection moulding machines (workload permitting) operate 24 hours per day 6 days per week.

The Circutor AR5 data recorder is used to measure real power, reactive power, current and power factor with and without Powerboss in circuit. The traces are reproduced below.

### 4.1 Active (Real) Power

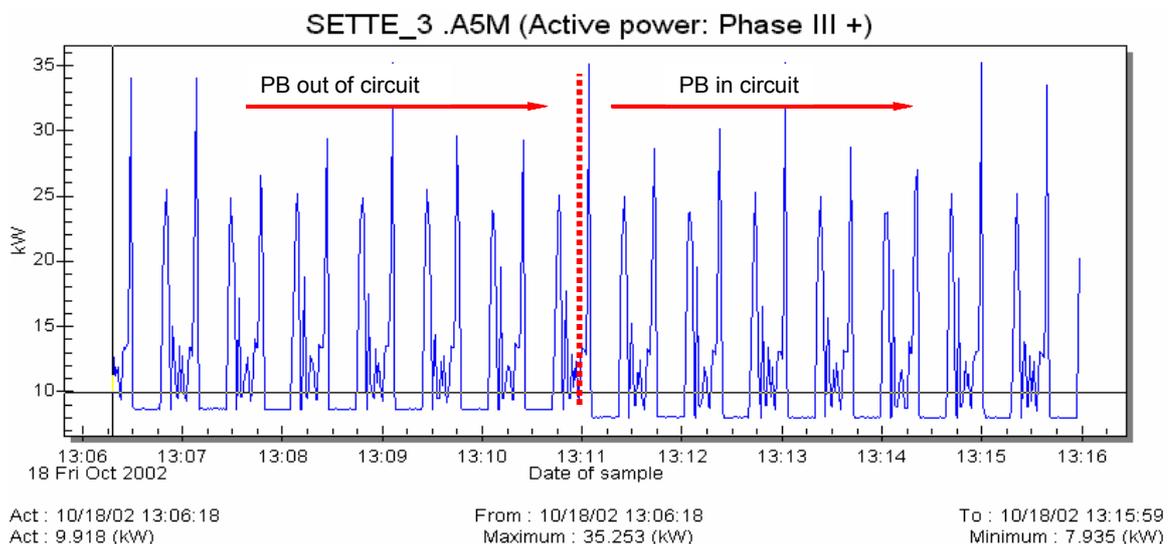


Figure 1 Active (real) power trace

Figure 1 shows a reduction in active (real) power in the no-load condition from 9kW without Powerboss to 8.1kW with Powerboss. This is a real power saving of 0.9kW or 10% which is typical for a well constructed motor of this power rating.

## 4.2 Reactive Power

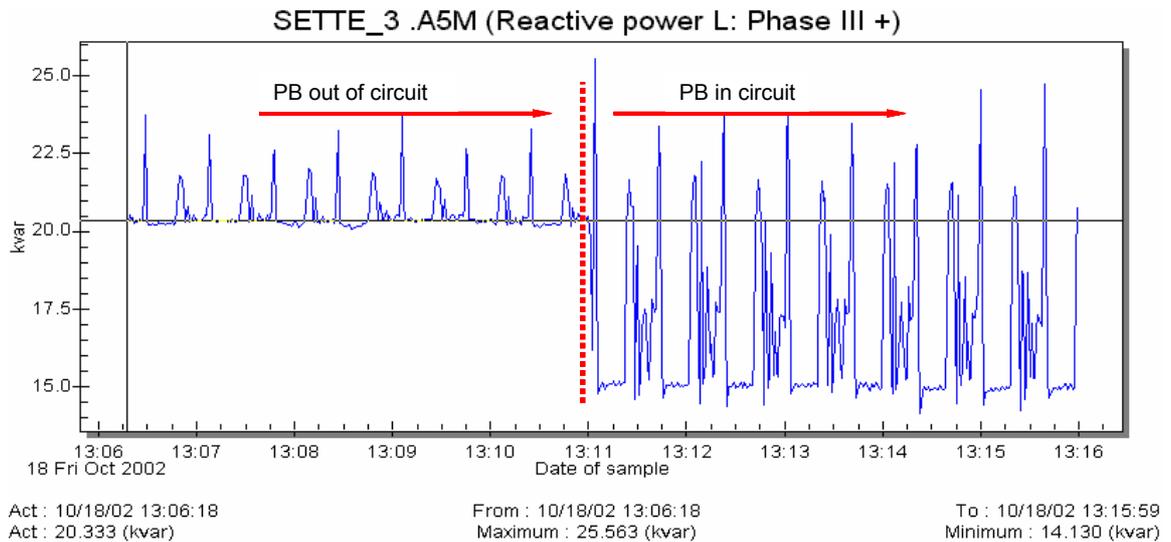


Figure 2 Reactive power trace

Figure 2 shows a reduction in reactive power in the no-load condition from 20.4 kVAr without Powerboss to 15.1 kVAr with Powerboss. This is a reactive power saving of 5.3kVAr or 26%, which again is typical. Whilst kVAr savings are not paid for directly by the user they are important because a reduction in kVAr assists in the management of the local electrical distribution system by reducing the amount of capacitive current needed to correct the system power factor. A reduction in kVAr translates directly into reduced motor temperature, helping to extend its life by minimising bearing and insulation operating temperatures. Reduction in kVAr also increases the real power capacity of the existing distribution system allowing more equipment to be added before the system power factor correction equipment needs to be upgraded.

## 4.3 Apparent Power

Whilst we do not have a trace of apparent power it can be calculated simply using Pythagoras Theorem applied to the AC electrical "power triangle"

$$\text{Apparent power} = \sqrt{(\text{real power})^2 + (\text{reactive power})^2}$$

At the no-load condition, as before, apparent power with and without out Powerboss in circuit is calculated as follows:

**With Powerboss in circuit**

$$\text{Apparent power} = \sqrt{8.1^2 + 15.1^2}$$

$$\text{Apparent power} = 17.1 \text{ kVA}$$

**Without Powerboss in circuit**

$$\text{Apparent power} = \sqrt{9.0^2 + 20.4^2}$$

$$\text{Apparent power} = 22.3 \text{ kVA}$$

This calculation shows a reduction in apparent power from 22.3 kVA without Powerboss to 17.1 kVA with Powerboss. This is an apparent power saving of 5.2 kVA or 23%, which again is typical.

Apparent power or kVA savings are crucial, because apparent power is the power that appears to the source (the power generation facility) because of the circuit impedance. Since the impedance is the total opposition to ac, the apparent power is that power the voltage source "sees". This fact is very important in calculating the reduction in CO<sub>2</sub> emissions directly associated with installing Powerboss. CO<sub>2</sub> emissions reduction resulting from fitting Powerboss are proportional to the reduction in apparent power (kVA) not real power kW or reactive power kVA.

#### 4.4 Current and Power factor

To complete the evaluation current and power factor readings were taken with and without Powerboss in circuit.

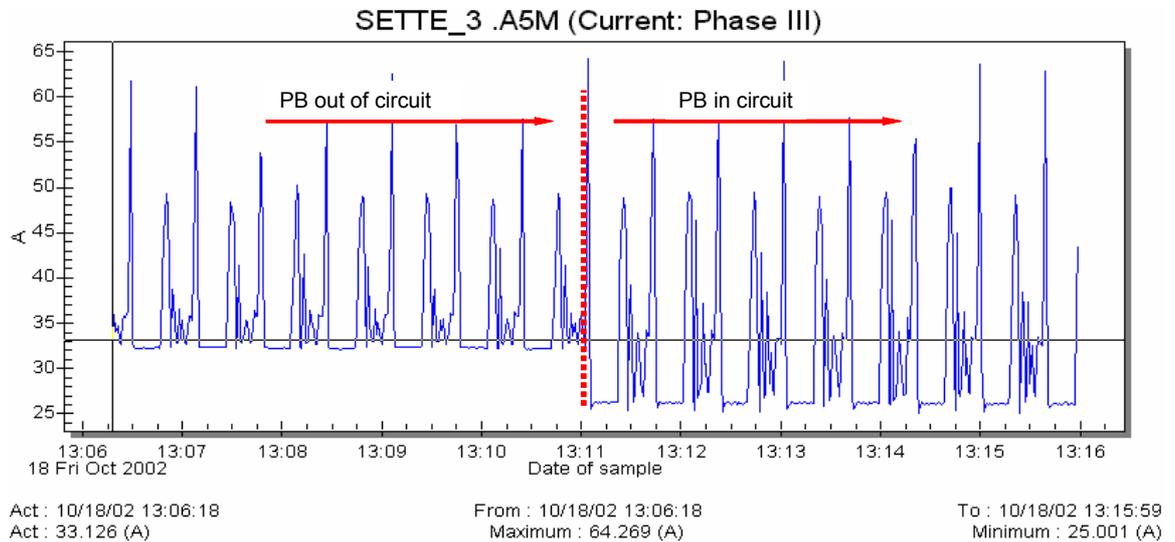


Figure 3 Current trace

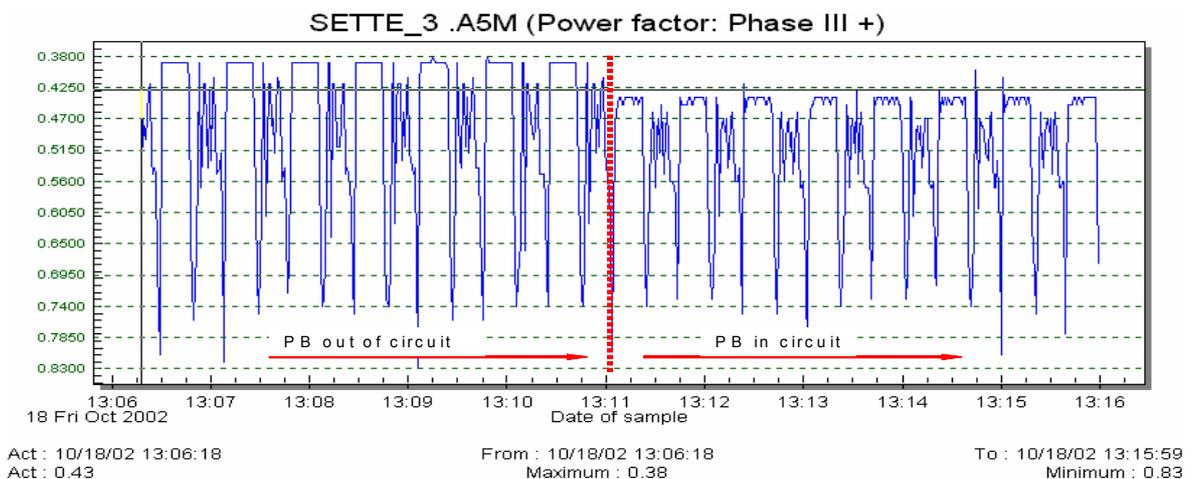


Figure 4 – Power factor trace

## 4.5 Initial commissioning

Initially, when the Powerboss was first installed, a minor problem was experienced. With the soft start function enabled it was observed that the motor load was increasing to full load before the end of the Powerboss ramp-up period. This had the effect of causing the motor to stall. This problem was quickly rectified, by reprogramming the Powerboss and the unit has given trouble free operation in continuous service now for 18-months

## 5.0 Forecast value of Powerboss to Ricoh Japan

In this section we examine the benefits for Ricoh Japan in adopting Powerboss. To forecast this, the results of the Ricoh UK Manufacturing trial (as detailed in Section four) are used as a basis. We have created a simple excel spreadsheet that estimates the value to Ricoh of purchasing Powerboss based on Japanese market prices and assuming the technical performance measured in the UK trial project is repeated in Japan.

The spreadsheet produces the following *induction motor energy audits*. The first, *Project 1*, is for the single Powerboss installed on the 800 tonne injection moulding machine, the second, *Project 2*, addresses the seven 22kW injection moulding machines, with the overall project summary sheet pulling these results together. These sheets are intended to form part of HESCO's sales tool specifically targeting Ricoh.

### 5.1 Variables used in the value forecast spreadsheet

The spreadsheet used to forecast the value of Powerboss to Ricoh in Japan is underpinned by two main assumptions.

- That Powerboss technical performance will be the same in Japan as it is in the UK.
- That the following commercial assumptions reflect accurately the market in Japan. (If HESCO feel this is not true, change them at will in the "input" sheet then re-print the results sheets). Specifically the following has been assumed:-

Financial information		
Cost of capital	10.0%	Percent
CO <sub>2</sub> abatement value	¥ 1,000	per tonne CO <sub>2</sub>
Electricity price	¥ 13.5	per kWh
JPY / GBP exchange rate	¥ 195.0	per GBP

Technical information		
CO <sub>2</sub> emissions per kVA consumed	0.37	kg / kVA

## 5.2 Value to Ricoh – 1 x PB, 55kw Injection moulding m/c

		<b>Induction Motor Energy Audit</b>	
		Reference:	
		Contact:	
		Date:	
<b>Reference information</b>			
Customer:	Ricoh		
Site:	UK Manufacturing		
Location:	Telford, Shropshire UK		
<b>Project 1</b>			
<b>1 off Large (55kW) injection moulding m/c</b>		<b>60% unloaded operation</b>	
<b>Operating Profile</b>			
hrs / day	days / week	weeks / year	life (years)
24	6	50	6
<b>Investment</b>			
model no.	unit cost	unit inst. cost	total cost
PML110V2	¥ 247.697	¥ 74.309	¥ 322.006
<b>Performance</b>			
	without PB	with PB	saving
Real power	9.0 kW	8.1 kW	0.9 kW 10%
Reactive power	20.4 kVAr	15.1 kVAr	5.3 kVAr 26%
Apparent power	22.3 kVA	17.1 kVA	5.2 kVA 23%
<b>Annual Savings 7,200 hrs pa</b>			
	energy / emissions	value	total savings
Real power	3,888 kWh/yr	13.5 ¥/kWh	¥ 52,488
CO <sub>2</sub> savings	8.25 tonnes/yr	1.000 ¥/tonne	¥ 8,250
		<b>Total Annual Saving</b>	<b>¥ 60.738</b>
<b>Lifetime Savings 6 years</b>			
	energy / emissions	value	total savings
Real power	23,328 kWh	13.5 ¥/kWh	¥ 314,928
CO <sub>2</sub> savings *	49.50 tonnes	1.000 ¥/tonne	¥ 49,500
		<b>Total Lifetime Saving</b>	<b>¥ 364.428</b>
		<b>Total Investment</b>	<b>¥ 322.006</b>
		<b>Return on investment</b>	<b>5.30 years</b>
Status:			
Signed:			

\* <http://www.fepec.or.jp/menu/kankyo/kankyo1.html> Average emissions = 0.37 kg CO<sub>2</sub> / kVA

### 5.3 Value to Ricoh – 7 x PB, 22kW injection moulding m/c

		<b>Induction Motor Energy Audit</b>	
		Reference:	
		Contact:	
		Date:	
<b>Reference information</b>			
Customer:	Ricoh		
Site:	UK Manufacturing		
Location:	Telford, Shropshire UK		
<b>Project 2</b>			
<b>7 off Small (22kW) injection moulding m/c's</b>		<b>60% unloaded operation</b>	
<b>Operating Profile</b>			
hrs / day	days / week	weeks / year	life (years)
24	6	50	6
<b>Investment</b>			
model no.	unit cost	unit inst. cost	total cost
PBC55	¥ 119,870	¥ 35,961	¥ 1,090,821
<b>Performance</b>			
	without PB	with PB	saving
Real power	5.5 kW	4.2 kW	1.3 kW 24%
Reactive power	10.0 kVAr	8.0 kVAr	2.0 kVAr 20%
Apparent power	11.4 kVA	9.0 kVA	2.4 kVA 21%
<b>Annual Savings 50,400 hrs pa</b>			
	energy / emissions	value	total savings
Real power	39,312 kWh/yr	13.5 ¥/kWh	¥ 530,712
CO <sub>2</sub> savings	26.59 tonnes/yr	1.000 ¥/tonne	¥ 26,590
<b>Total Annual Saving</b>			<b>¥ 557,302</b>
<b>Lifetime Savings 6 years</b>			
	energy / emissions	value	total savings
Real power	235,872 kWh	13.5 ¥/kWh	¥ 3,184,272
CO <sub>2</sub> savings *	159.58 tonnes	1.000 ¥/tonne	¥ 159,580
<b>Total Lifetime Saving</b>			<b>¥ 3,343,852</b>
<b>Total Investment</b>			<b>¥ 1,090,821</b>
<b>Return on investment</b>			<b>1.96 years</b>
Status:			
Signed:			

\* <http://www.fepec.or.jp/menu/kankyo/kankyo1.html> Average emissions = 0.37 kg CO<sub>2</sub> / kVA

## 5.4 Overall project - value summary

		<b>Overall Project Summary</b>	
		Reference:	
		Contact:	
		Date:	
<b>Reference information</b>			
Customer:	Ricoh		
Site:	UK Manufacturing		
Location:	Telford, Shropshire UK		
<b>Summary Information</b>			
1 off Large (55kW) injection moulding m/c		60% unloaded operation	
7 off Small (22kW) injection moulding m/c's		60% unloaded operation	
<b>Total Investment</b>			
number of units	total unit cost	total inst. cost	grand total cost
8	¥ 1,086,790	¥ 326,037	¥ 1,412,826
<b>Total Annual Savings</b>			
	energy / emissions	value	total savings
Real power	43,200 kWh/yr	13.5 ¥/kWh	¥ 583,200
CO <sub>2</sub> savings *	34.84 tonnes/yr	1,000 ¥/tonne	¥ 34,840
<b>Total Annual Saving</b>			<b>¥ 618,040</b>
<b>Total Lifetime Savings</b>			
	energy / emissions	value	total savings
Real power	259,200 kWh	13.5 ¥/kWh	¥ 3,499,200
CO <sub>2</sub> savings *	209.08 tonnes	1,000 ¥/tonne	¥ 209,080
<b>Total Lifetime Saving</b>			<b>¥ 3,708,280</b>
<b>Investment highlights (pre tax)</b>			
Total investment			¥ 1,412,826
Total income			¥ 3,708,280
Return on investment, simple payback			2.29 years
Internal rate of return			73%
Net present value	10.0%		¥ 1,407,338
<b>Status:</b>		<b>Environmental footnote: **</b>	
<b>Signed:</b>		6,900 mature trees would be required to reduce annual CO <sub>2</sub> emissions by 34.8 tonnes.	

\* <http://www.fepec.or.jp/menu/kankyo/kankyo1.html> Average emissions = 0.37 kg CO<sub>2</sub> / kVA

\*\* The Green Lane™, website - An average mature tree absorbs ca 5.0 kg CO<sub>2</sub> pa