Variable Speed Drive Energy & Savings Calculator

Customer: Another

Site: Another

Plant: Primary Loop Pumps

Date: 04-Oct-16

Survey by: J. Wyant

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Site: Another **Plant:** Primary Loop Pumps **Date Of Survey:** 04-Oct-16 **Survey By:** J. Wyant

EXISTING FIXED SPEED PLANT SCHEDULE

Plant Description	*Motor Description*	*Motor Rated Power (kW)*	*Motor Rated Current (A)*	*Running Current (A) Line*	*Operating voltage*	*Motor Power Factor (pu)*	*Estimated Motor Eff (pu)*	*Calculated Input Power (kW)*	*Measured Input Power (kW)*	*Running Time Day Tariff (Hrs/year)*	*Running Time Night Tariff (Hrs/year)*	*Electricity consumed per Year Day Tariff (kWh)*	*Electricity consumed per year Night Tariff (kWh)*	*Running Cost (£/Year) Day Tariff*	*Running Cost (£/Year) Night Tariff*
Primary Loop	Pump 1	15	30	28.7	415	0.8	0.85	16.50		3,102	1,277	51,194	21,075	4,607	1,370
Primary Loop	Pump 2	15	30	27.9	415	0.8	0.85	16.04		3,102	1,277	49,767	20,488	4,479	1,332

The calculations above have several steps depending on the information available and work as follows:-
- If actual measured power is available in kW then by inputting these values into the column 'Measured Input Power' these values of actual consumed power are used for all further calculations and no other data is used
- If an actual power reading is not available but a current measurement is available then the power is calculated using an estimated power factor and the values displayed in the 'Calculated Input Power' column
- If no measured data is available then a calculation is performed using the rated motor power, efficiency and the estimated motor load, the result is also displayed in the 'Calculated Input Power' column
- The electricity cost used is either the day & night tariff or the average tariff depending on which data is available from the customer

	kWh Day	kWh Night	£ Day	£ Night
	100,962	41,563	£9,087	£2,702

Estimated motor load (%)	**80**
Electricity cost day (p/kWh)	**9**
Electricity cost night (p/kWh)	**6.5**
Average Electricity cost (p/kWh)	

Total Hours (Day)	**6,204**
Total Hours (Night)	**2,554**
Total Yearly Hours	**8,758**

TOTALS **Total kWh** **142,525**

kg/CO2 **61,286**
kg/C **16,731**

Total Running Cost £11,788

NOTES: As no power readings were available we have made the assumption the all motors are running under 80% load

The electricity tariffs inclusive of the climate change levy for the day and night costs are current customer charges. We have estimated the day period as 07.00 to 24.00 and the night period as 00.00 to 07.00.

VARIABLE SPEED DRIVE APPLICATION

Efficiency Saving from new EFF1 motor	DAY SPEED PROFILE			NIGHT SPEED PROFILE			Cube Law Factor Day	Cube Law Factor Night
		Speed profile %	Time profile (P.U.)		Speed profile %	Time profile (P.U.)		
%		100			100		1.000	1.000
	Max revised day PU	90	0.7	Max revised night PU	90		0.729	0.729
	1	80	0.3	1	80	1	0.512	0.512

Plant Description	*Motor Description*	*Total Motor Input Power (kW)*	*Running Time Day Tariff (Hrs/year)*	*Nominal electricity consumed per year Day Tariff (kWh)*	*Running Time Night Tariff (Hrs/year)*	*Nominal electricity consumed per year Night tariff (kWh)*	*Cube Law Factor Day*	*Cube Law Factor Night*	*Final Motor Power Day (kW)*	*Final Motor Power Night (kW)*	*Final Electricity consumed per year Day Tariff (kWh)*	*Final Electricity consumed per year Night Tariff (kWh)*	*Running Cost (£/Year) Day tariff*	*Running Cost (£/Year) Night Tariff*
		16.50					1	1.000						
Primary Loop	Pump 1	16.50	2,171	35,836			0.729	0.729	12.0		26,124		2,351	
		16.50	931	15,358	1,277	21,075	0.512	0.512	8.4	8.4	7,863	10,790	708	701
		16.04					1	1						
Primary Loop	Pump 2	16.04	2,171	34,837			0.729	0.729	11.7		25,396		2,286	
		16.04	931	14,930	1,277	20,488	0.512	0.512	8.2	8.2	7,644	10,490	688	682
									Totals		67,029	21,280	6,033	1,383

TOTALS			
	Total kWh	**88,309**	
	kg/CO2	**37,973**	
	kg/C	**10,367**	
			Total running Cost £7,416

Drive Control Ltd

Energy Calculator

We have estimated the above speed profiles, whereas the eventual speed control profile could be adapted through careful monitoring of the respective plant.

Note: Maximum operational time is calculated as being: -
100% of the original operational day time
100% of the original operational night time

Fans are turned off for other time periods

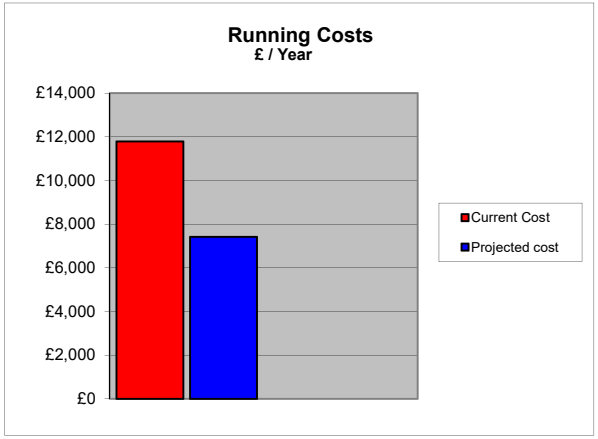
For purposes of calculation, we have indicated a speed profile as follows:-

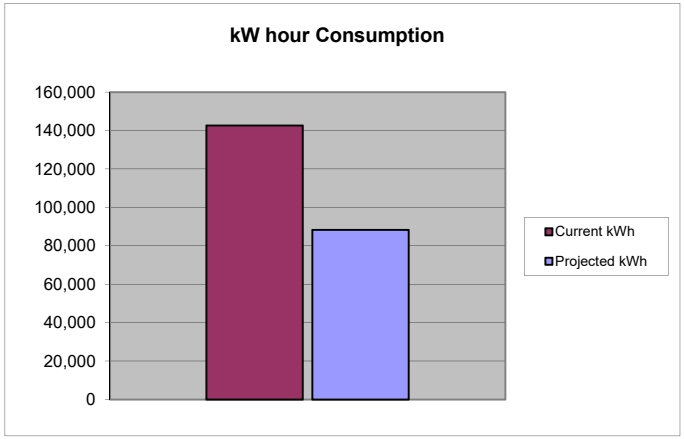
100%	speed for		of the revised operational time during the day tariff
90%	speed for	70.0%	of the revised operational time during the day tariff
80%	speed for	30.0%	of the revised operational time during the day tariff
100%	speed for		of the revised operational time during the night tariff
90%	speed for		of the revised operational time during the night tariff
80%	speed for	100%	of the revised operational time during the night tariff

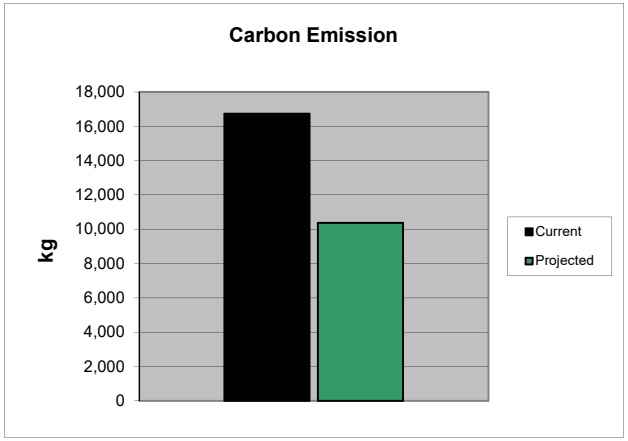
The subsequent overall Electrical Consumption (kWh) has reduced from	**142,525**	to	**88,309**	a reduction of kWh	**54,216**
The subsequent financial cost (£/year) has reduced from	**£11,788**	to	**£7,416**	a reduction of	**£4,372**
The subsequent carbon emissions (kg) have reduced from	**16,731**	to	**10,367**	a reduction of kg	**6,364**
The subsequent carbon dioxide emissions (kg) have reduced from	**61,286**	to	**37,973**	a reduction of kg	**23,313**

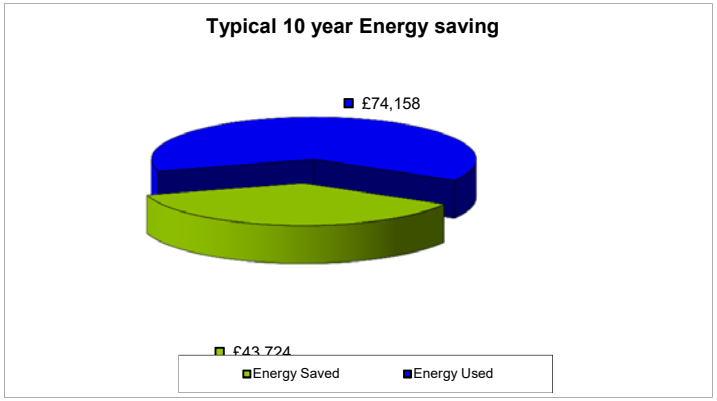
These calculations are based on the pump / fan affinity laws and as such are a theoretical indication of energy savings; although all effort is undertaken to ensure accuracy actual savings may differ from these results depending on unquantified system variables..

Note: Carbon dioxide and Carbon calculations are based on the DETR Environmental Reporting Guidelines 1999









10 Year Energy Figures	
Energy Saved	£43,724
Energy Used	£74,158
Total Energy Saving	**37.1%**

Overall Plant Payback Period

Payback is essentially a function of the costs of the variable speed drives / savings in running costs

True payback however needs to take into account implementation costs which can encompass the following:-

- Fitting the VSD's adjacent to the motor onto uni-strut framework, directly onto a wall or inside a control panel
- Modifying the existing control panels power wiring to remove or by-pass the original starters
- Modifying the starter control circuits in conjunction with the existing controls strategy
- Modification of the existing or replacement of the power cabling from the control panel to the motor to integrate the VSD
- Installation of a new local isolator (if not installed) or replacement of existing if it is unsuitable for operation with a VSD
- Supply and Installation of new control transducers and wiring (if required)
- Supply and Installation of new control cabling from the existing control panels into the VSD
- Engineer and Commission the BMS/Control System (if installed) and prove operation to Engineers (to be done by BMS supplier)
- Commissioning of VSD
- Provide O + M Manuals and modify / supply control panel wiring diagrams
- However, do note that the ABB ACH 550 Variable Speed Drives can be readily programmed in "Closed Loop Control" whereby a new temperature/pressure detector can be wired directly into the VSD to provide local control, without the need for expensive interfacing into a BMS System outstation that may not be conveniently located

Project Specific Installation Notes

This installation will require:

- Mounting of VSD's onto uni-strut framework
- Alteration of existing power wiring from the existing isolators
- Removal of redundant control components
- Installation of clamp temperature transducer

Project Specific Operational Notes

- The drives would operate under closed loop temperature control when in auto
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General Notes

Installation works completed by the customers competent in house staff under Drive Control Ltd supervision would reduce implementations costs and improve payback.

COSTING SCHEDULE & PAYBACK CALCULATIONS

Equipment Costs:

Quantity	*Type*	*Rated Power*	*Rated Current*	*IP Rating*	*Unit Price*	*Total Price*
		kW	A		£	£
2	ACH580-01-032A-4+B056	15	32	55	980	1,960
					Total	£1,960

Implementation Costs:

Plant Description	*Motor Description*	*Electrical Installation & Panel Works*	*Mechanical Installation*	*Control & Instrumentation*	*Site Consultation & Survey*	*Application Design, Documentation & Commissioning*	*Total*
Primary Loop	Pump 1	1,070		138			1,208
Primary Loop	Pump 2	1,070		138			1,208
		£2,140		£276			£2,416

Specific Plant Payback Periods (Estimated)

Plant Description	*Motor Description*	*Present Running Cost*	*Revised Running Cost*	*Drive & Implementation Cost*	*Yearly Savings*	*Payback Period*	*ECA Total*
		£	*£*	*£*	*£*	*Months*	*£*
Primary Loop	Pump 1	5,977	3,760	2,188	2,217	11.8	
Primary Loop	Pump 2	5,811	3,655	2,188	2,155	12.2	
	Totals	**£11,788**	**£7,416**	**£4,376**	**£4,372**	**12.0**	**£4,100**

Leasing Options		
Quarterly Energy Savings	*3 Year Lease Cost*	*5 Year Lease Cost*
£/Quarter	£/Quarter	£/Quarter
£1,093	**£459**	**£328**
Savings Utilising Lease Purchase	£/Quarter	£/Quarter
	£634	**£765**

ENHANCED CAPITAL ALLOWANCES

As an incentive for business to invest in energy savings (low carbon technologies), the government announced that designated equipment, as specified in the UK energy technology list will now qualify for tax relief in the form of Enhanced Capital Allowance (ECA).
Enhanced Capital Allowances are given at 100% of expenditure in the first year. This means that the whole of the qualifying investment can be set against tax for the year in which the equipment was purchased. This provides a significant cash flow boost over the normal Capital Allowance of 25% on a reducing balance basis, which would spread the tax relief over a much longer period.

All energy saving variable speed drive projects qualify for ECA.

It is important that the company accountants are made aware of energy saving variable speed drive capital projects.
The relevant costs of the projects should be included on the company tax return to claim all Enhanced Capital Allowances.

ECA Calculations

	Normal Capital Allowance	*ECA*	*First year saving with ECA*	*Savings second year onward*	*Balance remaining after first year*	*Months remaining after first year*	*Monthly saving second year onward*	*Months remaining to repay after first year*	*Non ECA equipment costs*	*Non ECA equipment payback time*	*Payback period including ECA*
			£	£	£	£	£		£	*Months*	***Months***
Corporation Tax Rate %	30	30	£5,602	4,372	-1,502	0.0	364	-4.1	£276	0.063	**7.9**
% of expenditure to which allowance applies	25	100									
Nominal investment	£4,100	£4,100									
Amount set against tax	£1,025	£4,100									
First year recovery @ 30% tax	£308	£1,230									
ECA cash flow benefit in first year		**£923**									

Note that other factors need to be taken into account, which will improve the Payback Period, although it is not possible to put an actual cost to these savings.

- Improve both the motors efficiency and power factor.
- Possible reduction in Max. demand tariff
- Reduction in motor maintenance due to reduced starting currents and mechanical impact, particularly on couplings.
- Greatly improved motor monitoring, above that of a conventional overload, ensuring no sudden motor failures.
- Reduced wear on the Drive Belts with associated supply and fitting cost reduction.
- Reduction in maintenance costs and replacement of conventional switchgear.
- Infinite flexibility of the air / water system which will lead to omission of noise and turbulence.
- Improved system performance through better and faster control responses.
- Simplified commissioning procedures.

The ABB ACH 550 is a sensorless vector controlled Variable Torque HVAC Variable Speed Drive dedicated specifically for HVAC Building Services applications with the following features:

1). Pre - Configured HVAC application macros. Macros for supply & return fans, cooling tower fans, booster pumps, & condensers are programmed into the drive.

2). Assistant control panel as easy to use as a mobile phone. The panel is detachable & able to copy parameters from one drive to another , the panel can also be mounted on the cabinet with a special fixing kit.

3). Factory fitted standard features comprising:

- EMC filters for first environment.
- Swinging Dc chokes. ABB's patent pending swinging DC choke lets the ABB drive for HVAC deliver, at partial loads, up to 25% less harmonics to the network compared to a normal choke of an equal size.
- Motor overload protection with PTC or PT100
- Modbus, N2 & FLN fieldbus connectivity. Commonly used HVAC fieldbuses are embedded into the memory of the drive, ensuring they are always there when needed.
- Real time clock. External timer circuits are no longer needed, with a real time clock for starting & stopping the drive or changing the speed according to the time of day or night. This helps save energy & increases the efficiency of the entire HVAC system. It also facilitates maintenance by keeping a timed log of events.
- Interactive assistants. Three interactive assistants facilitate the start up, maintenance and diagnostics of the drive, enabling set-up without the need to refer to manuals.
- Help button. The control panel has a built in help function to guide the user, enabling clear text advice without the need to refer to manuals.
- Flux optimisation. The magnitude of the flux varies depending on the load. This results in reduced energy consumption and lower noise levels. Silent operation mode further reduces noise in domestic applications.
- Full flow at 40 degrees C in IP 21 & IP 54. The drive is rated for continuous operation to 40 degrees with full current.
- HVAC software without compromise. The ABB drive for HVAC delivers a complete solution with a tailor made configuration that will save you time & money.
- Full power range, from 0.75kW to 355kW covering the vast majority of HVAC applications.

Variable Speed Drive Energy & Savings Calculator Synopsis

Customer:	Another
Site:	Another
Plant:	Primary Loop Pumps
Date:	04-10-16
Survey by:	J. Wyant

Electricity cost day (p/kWh)	9
Electricity cost night (p/kWh)	6.5
Average Electricity cost (p/kWh)	

Total Hours (Day)	6,204
Total Hours (Night)	2,554

Total Yearly Hours	8,758

Operational Notes

- The drives would operate under closed loop temperature control when in auto
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Plant Calculations

Plant Description	Motor Description	Motor Rating (kW)	Consumed Power (kW)	Yearly Consumption kWh	Present Running Costs (£)	Revised Running Costs (£)	Installation Cost (£)	Yearly Savings (£)	Payback Period (Months)
Primary Loop	Pump 1	15	16.50	72,270	5,977	3,760	2,188	2,217	11.84
Primary Loop	Pump 2	15	16.04	70,255	5,811	3,655	2,188	2,155	12.18
		Totals	**32.55**	**142,525**	**11,788**	**7,416**	**4,376**	**4,372**	**12.0**

This sheet is a synopsis of our comprehensive VSD energy savings calculator

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