



ESOS Report

Glenair

Compliance with the *Energy Savings Opportunity Scheme*

Prepared for: Gordon Hartley
Glenair
40 Lower Oakham Way
Oakham Business Park
Mansfield
Notts
NG18 5BY

Prepared by: Matthew Watkins
Environmental Consultant
International Workplace

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Contents

Executive Summary.....	3
ESOS.....	5
STATIC ENERGY USE PROFILES.....	6
By energy source/location.....	6
By activity	7
CHRONOLOGICAL ENERGY USE PROFILES.....	9
NORMALISING FACTORS	10
Phase 1 (2, 2.5)	12
Phase 3	12
Phase 4&5	12
EMO REGISTER	13
Reduced base-load.....	13
Energy awareness.....	13
Monitoring and targeting	13
Reduced base-load.....	13
Energy awareness.....	14
Monitoring and targeting	14
Energy Contracts	14
AC and heating control	17
Solar PV	19



Executive Summary

Glenair occupy four industrial units on the Oakham Business Park in Mansfield; known as Phase 1&2, and Phases 3, 4, and 5. The total floor area of these sites is 3,381m², 1,852m², 1,072m², and 1,995m² respectively.

Site activities include (but are not limited to) HQ, supportive and light assembly (Phase 1&2), injection moulding, small scale CNC, product testing and injection moulding (Phase 3), large scale CNC machining (Phase 4), and warehousing and distribution functions (Phase 5).

Annual total energy use for the organisation is calculated at 3,075,982 kWh. This includes mains gas, electricity, LPG, and fuel for transport; responsible for 34%, 58%, <1%, and 8% of total company energy use respectively.

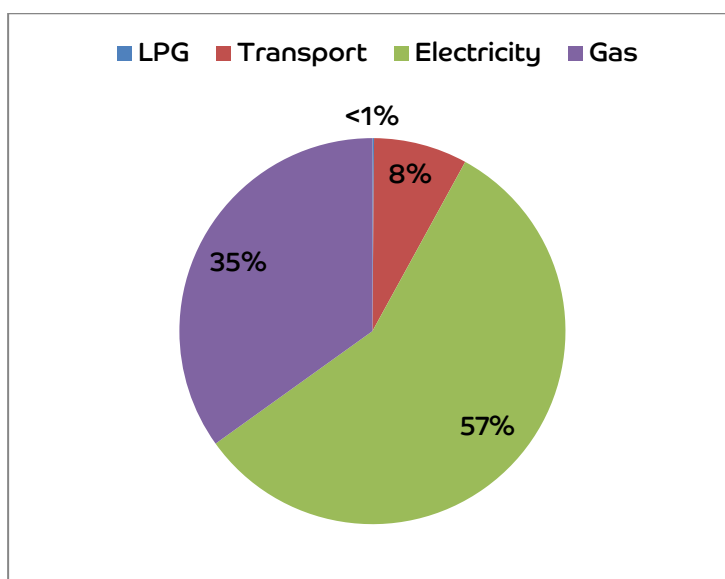


Figure 1- Energy use by source

The total annual energy cost to Glenair is £245,260 (+VAT, CCL, Reactive Power, FiT) split as below:

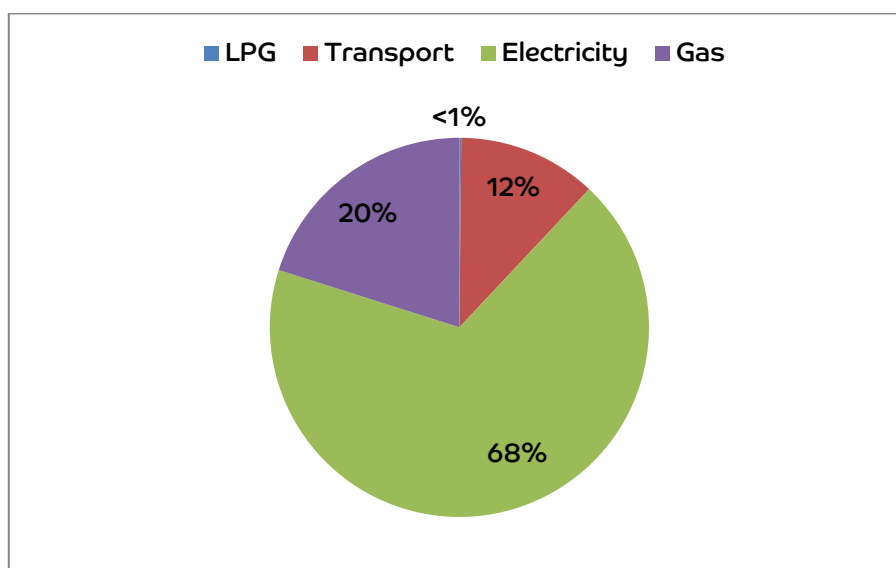




Figure 2- Energy use by cost

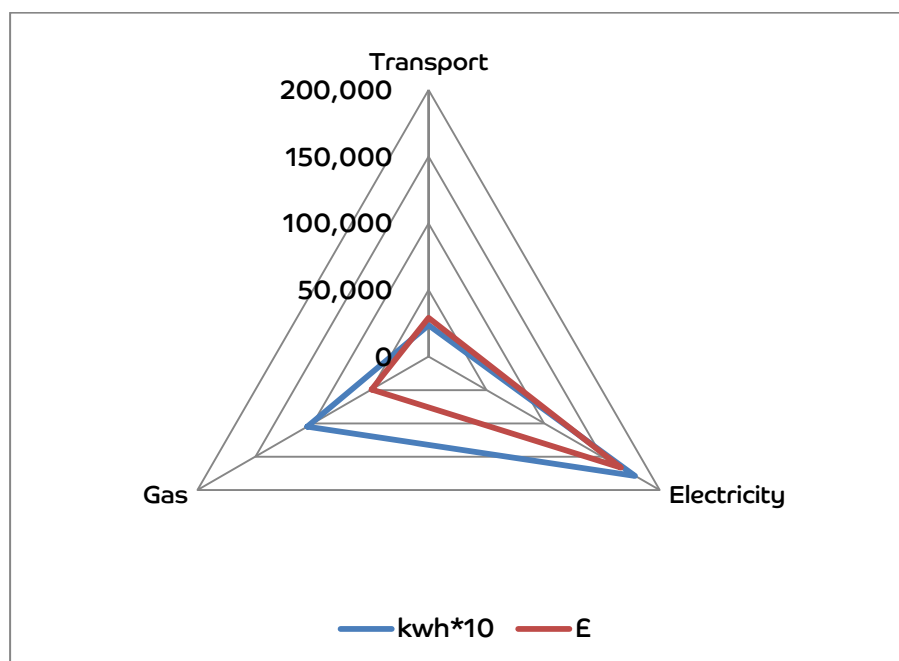


Figure 3- Energy use in relation to cost

Figure 3 demonstrates energy use in relation to cost; highlighting that both gas and electricity cost around £1 for 10 kWh, whereas mains gas is a significantly less expensive energy source.

Glenair's electricity use per £1 of turnover over the 12 month period of examination has been calculated at 0.06kWh. Gas consumption in relation to total building floor area this is equivalent to 146kWh/m².



Table 1.0 below summarises the Energy Saving Opportunities anticipated as a result of this project to yield the most significant financial and energy savings.

Table 1.0

EMO	Capital cost	Cost savings	ROI	NPV
<i>Reduced base-load</i>	Minimal	16,647 (at 75% base-load reduction)	0 years	£82,000 (5 year lifetime)
<i>Energy awareness</i>	£2,000	£12,263	0.2 years	£58,406 (5 year lifetime)
<i>Monitoring and targeting</i>	Savings included in Energy Awareness above.			
<i>Energy Contracts</i>	£0	£10,656	0 years	£21,153 (2 year lifetime)
<i>Lighting Upgrade Phase 4</i>	£22,140	£2,336	9.5 years	£-66 (8 year lamp lifetime)
<i>AC & Heating control</i>	£0	£8,435	0 years	£41,550 (5 year lifetime)
<i>Solar PV</i>	£500,000	£41,361	12.1	£285,340 (20 year lifetime)
<i>Further non-defined energy efficiency measures</i>	Further investigation required in order to quantify savings from these measures			

ESOS

ESOS is mandatory for UK organisations with over 250 employees, or which have an annual turnover of 50m Euros and a balance sheet greater than 43m Euros. Organisations included in the scope of ESOS will be those that meet these criteria on 31 December 2014.

The scheme is estimated to lead to £1.6bn net benefits to the UK, with the majority of these being directly felt by businesses as a result of energy savings. DECC estimates that the average cost of ESOS will be £17,000 but that it will generate benefits to the average business of at least £56,000. ESOS Energy Audits have the potential to increase businesses profitability and competitiveness by identifying cost-effective savings which, if implemented, will improve energy efficiency.



ESOS only affects UK business; however similar programmes will be launched in other EU member states under the EU Energy Efficiency Directive. It was determined that Glenair operations in Europe will not meet the entry criteria for inclusion in ESOS equivalent programmes implemented in other EU member states.

Organisations included within ESOS:

- Need to measure total energy consumption (including buildings, transport and any industrial processes).
- At least 90% of total energy consumption must be covered by: ESOS compliant energy audits, Display Energy Certificates (DECs), Green Deal Assessments, or an ISO 50001 accredited energy management system.
- Energy auditing activities dating back to 2011 may be used as long as it meets the minimum ESOS auditing criteria.
- ESOS assessments must be conducted or reviewed by a qualified ESOS Lead Assessor.
- The ESOS report must be reviewed by a board level director.
- The organisation must notify the Environment Agency of compliance with the scheme and maintain a compliance pack demonstrating the ESOS activities carried out (to be presented upon request).
- Submit ESOS returns on 5 December. ESOS will work on four-yearly cycles following the initial implementation of the regulations so the next compliance period will be from 2015-2019 and so forth.

Static Energy use profiles

By energy source/location

Table 2 below details Glenair's estimated annual energy consumption together with associated spend, based on the period 01/01/2014 - 31/12/2014.

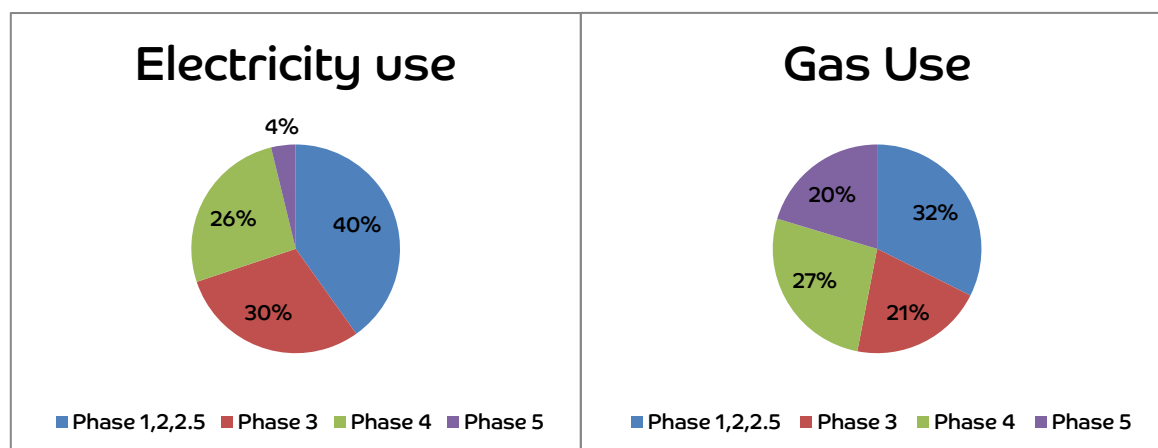
Table 2- Energy use by source and spend

Source	kWh	£	% total (kWh)
Electricity (P1,2,2.5)	716,661	65,268.58	27%
Electricity (P3)	531,237	49,121	20%
Electricity (P4)	470,183	45,342	18%
Electricity (P5)	67,830	6,783	3%
Gas (P1,2)	340,016	11,343	5%
Gas (P3)	216,818	8,258	3%
Gas (P4)	279,621	20,487	9%
Gas (P5)	213,465	9,233	3%
LPG	4,080	390	0%
Fuel card	180,229	7,050	3%
Grey fleet	55,842	21,985	9%
Total	3,075,981.99	245,260.04	100%



Figure 4 below presents electricity and gas consumption by Phase as a proportion of total consumption. It can be seen that most of Glenair's energy use occurs in Phase 1,2,2.5.

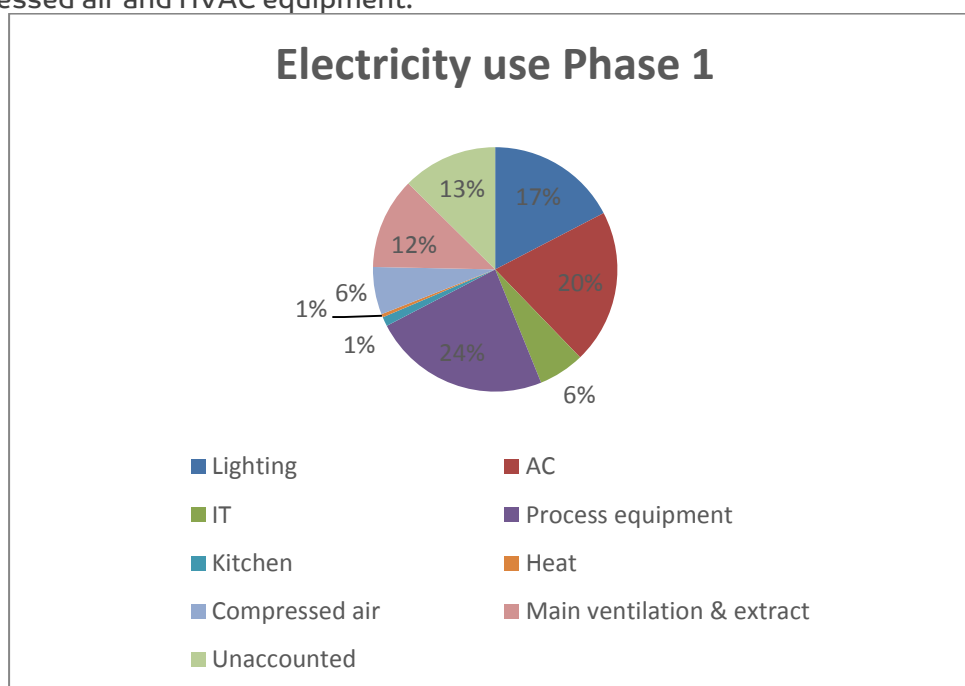
Figure 4- Electricity and gas use by Phase



By activity

Phase 1 activity summary

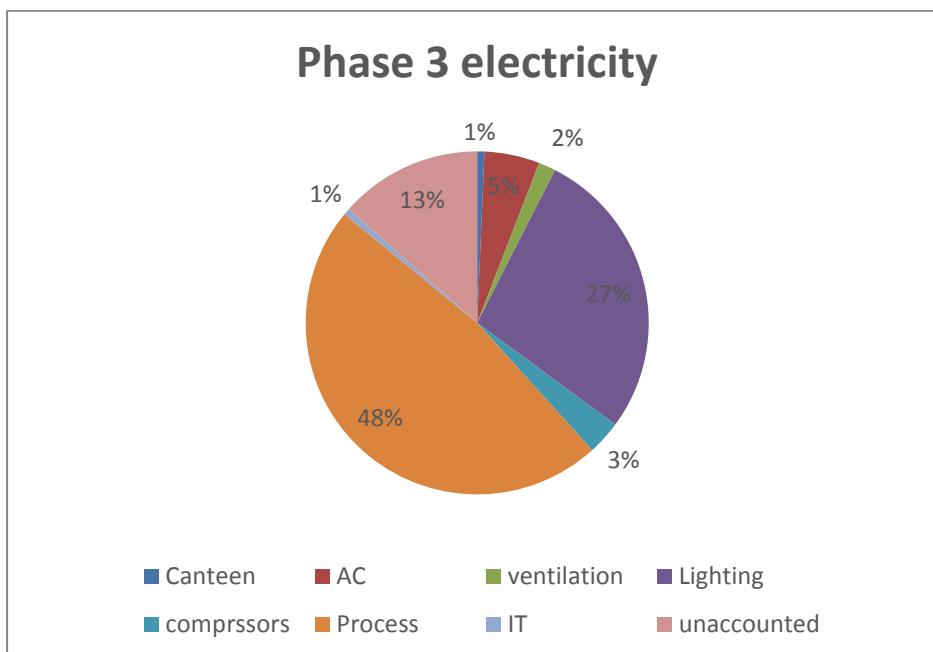
Activities undertaken in Phase 1(2 & 2,5) include office and administration, IT (including a server room), design, light assembly work (including fibre optics, and pure air equipment, component testing, and storage. Auxiliary energy uses include production of compressed air and HVAC equipment.





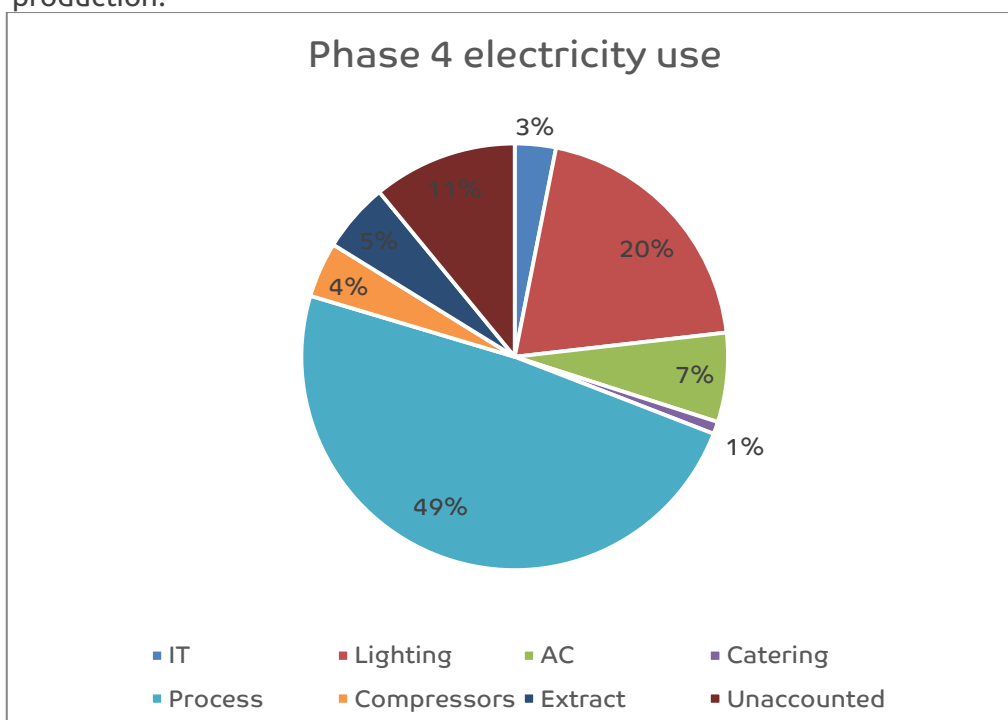
Phase 3 activity summary

Electricity is used for production machinery (CNC lathes, manual milling, injection moulding), compressed air, small power, extraction, AC, IT and office equipment, lighting, canteen activity. Natural gas is used for heating and hot water production



Phase 4 activity summary

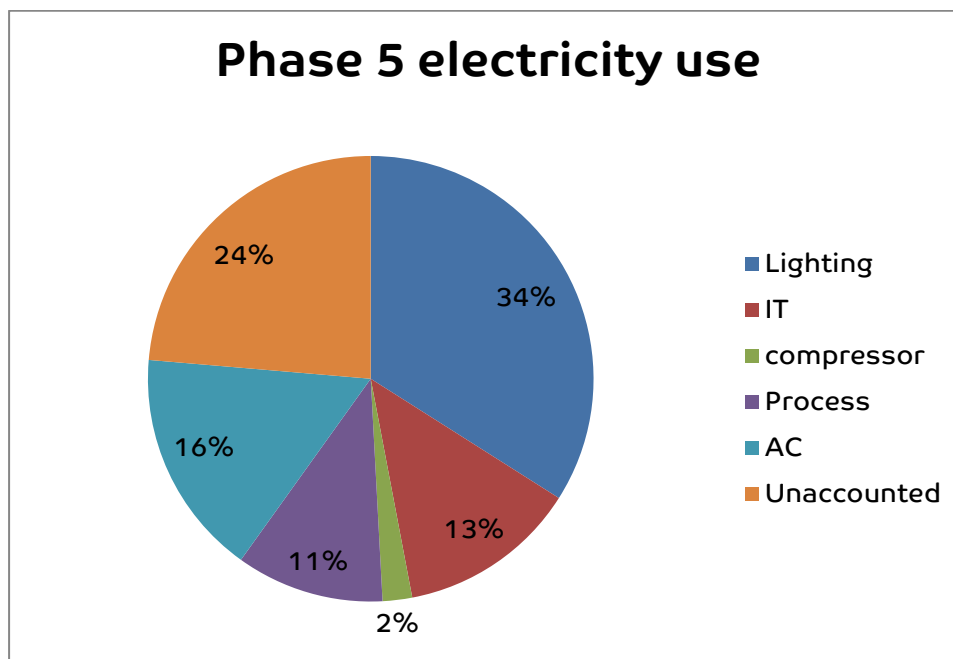
Phase four houses the heavy CNC machinery. Natural gas is used for heating and hot water production.





Phase 5 activity summary

Electricity is used for AC, lighting, FLT recharge, compressors, and some light assembly activities, canteen, IT and office equipment. Natural gas is used for heating and hot water production.



(The above profiles are based largely on site observation of rating plates, auditor experience and sparse direct measurement; they are as accurate as possible given the constraints of the project. We recommend sub-metering as a means of gathering data with increased accuracy in future).

Chronological energy use profiles

Table 3- Annual energy use profiles (by month)

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Electricity (P1,2)	69274	62409	58755	53536	55080	58540	70717	57068	59274	55686	52893	63429
Electricity (P3)	46679	40945	44799	42953	40441	44188	47936	47394	46853	44551	42249	42249
Electricity (P4)	32593	46951	36949	41070	43244	35150	45743	33590	37994	41347	38854	36698
Electricity (P5)	5653	5653	5653	5653	5653	5653	5653	5653	5653	5653	5653	5653
Gas (P1,2)	58464	55904	40391	37185	12164	1172	1651	3025	4223	20366	42889	74276
Gas (P3)	64683	59562	23090	6163	4974	1729	851	281	2900	18456	34129	63003
Gas (P4)	23302	23302	23302	23302	23302	23302	23302	23302	23302	23302	23302	23302
Gas (P5)	17789	17789	17789	17789	17789	17789	17789	17789	17789	17789	17789	17789
Total												



Figure 5- Electricity use by month

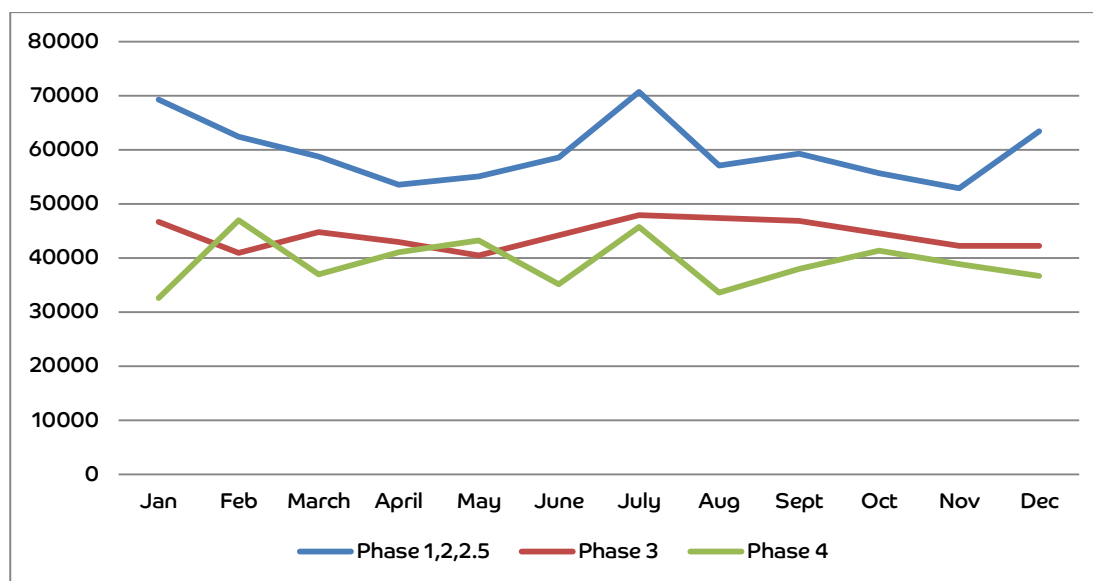
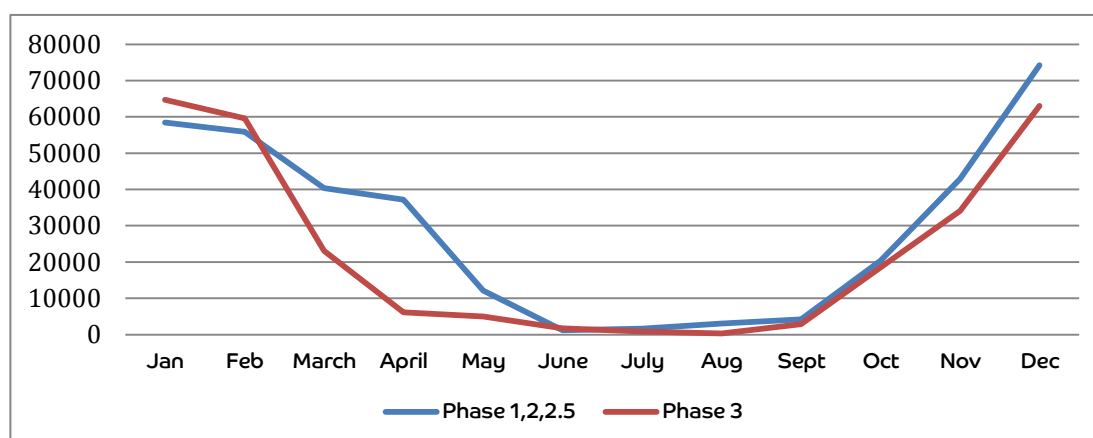


Figure 6- Gas use by month

As anticipated, gas use is almost zero in the summer months; meaning that the site heating is reasonably well adjusted in terms of thermostat setting.



Normalising factors

Table 4- Heating Degree days and turnover by month

	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
HDD (15.5°C)	322	280	254	167	113	81	54	56	41	123	188	263
Turn over	£2,23 9,620	£2,31 8,729	£3,111 ,036	£1,934,1 47	£2,02 3,993	£1,87 9,066	£2,50 4,724	£3,31 1,272	£2,50 3,503	£2,15 3,849	£2,12 2,218	£1,83 2,036

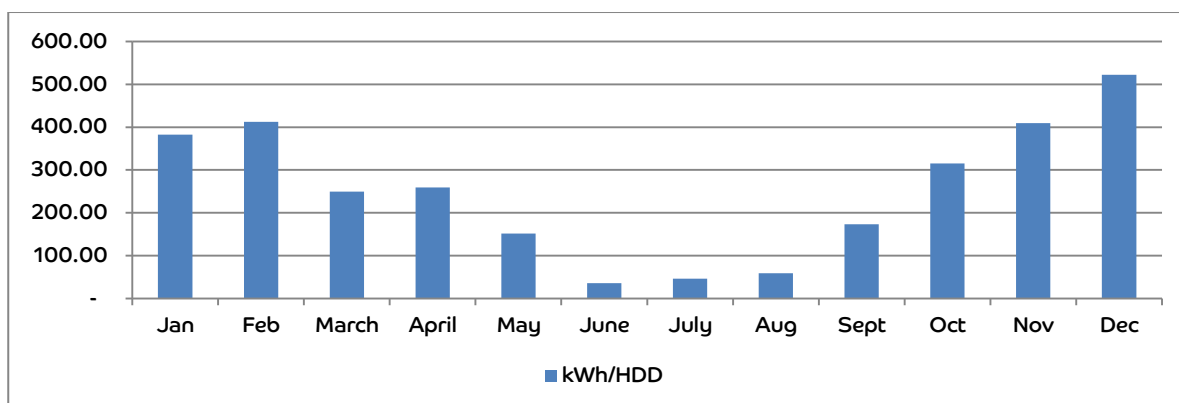


Figure 7- kWh gas use/HDD (Heating Degree Day)

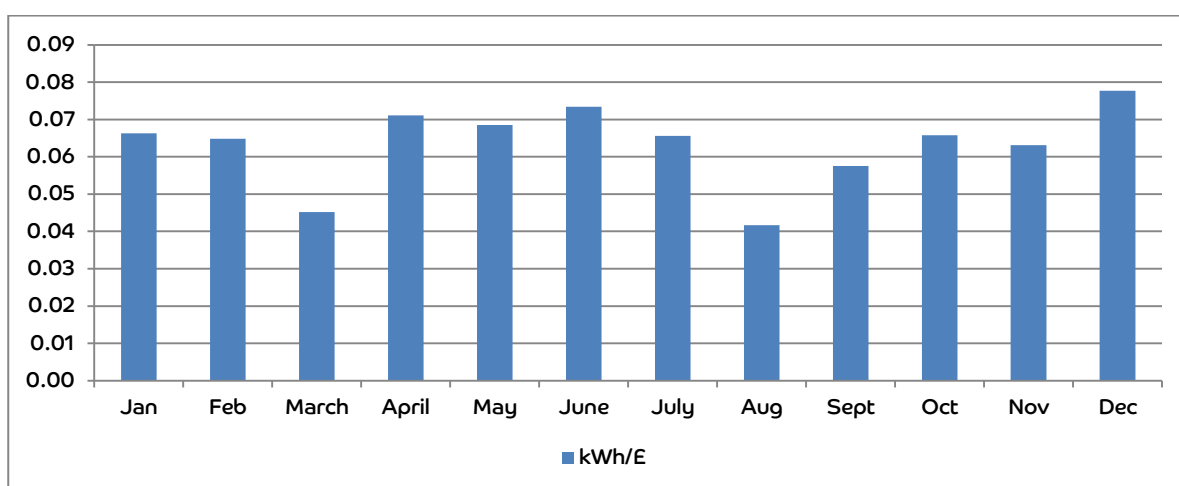


Figure 8- kWh electricity use/£1 turnover

Figure 9 shows that use of heating in comparison to exterior temperature is least efficient over the winter months - with heating being relatively well controlled over the summer.

Electricity use per £1 of turnover varies throughout the year with no clear discernible chronological pattern; however it should be noted that energy efficiency in relation to turnover is greatest when turnover is high - demonstrating the high base-load of installed equipment.

Building energy use per m² floor area is variable through the different Phases at Glenair based on the heterogeneous site activities and is therefore not useful to analyse. Gas use in Phases 1 and 2 are in accordance with what would be expected, however gas use in Phase 4 is over twice what would be anticipated, potentially due to significant consumption from braising equipment.

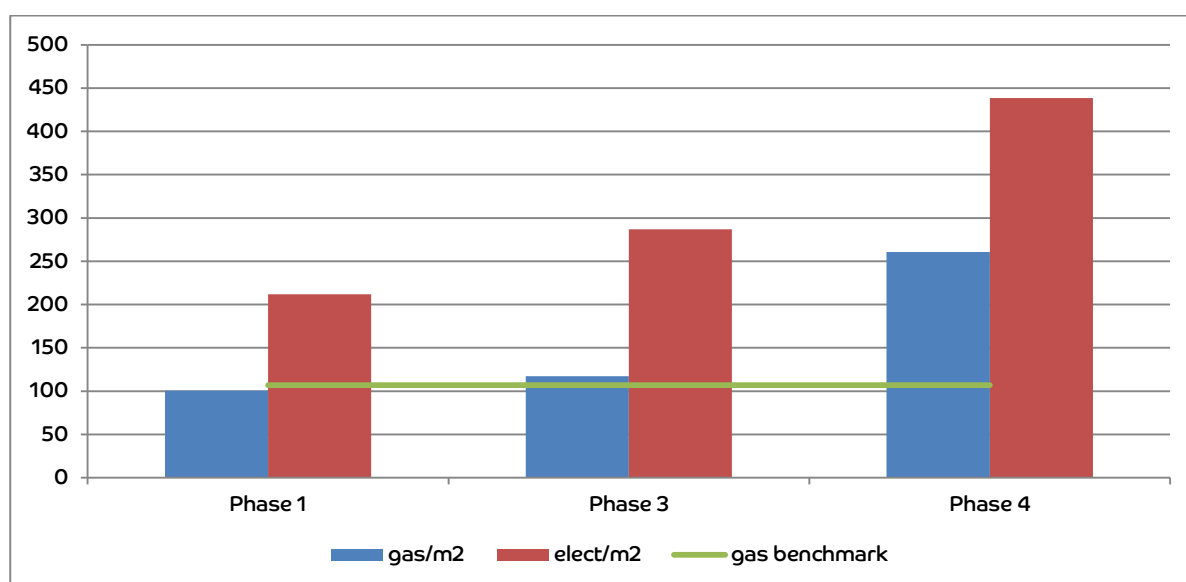


Figure 9- Electricity and gas use per m² of floor area in comparison to benchmarks

Power Factor and Base-load consumption

Phase 1 (2, 2.5)

Phase one has a base-load of between 46-58kW.

5.8-8.6% of monthly energy use on Sundays, averaging 51,600kWh per annum, at an annual cost of £9,441.

Power factor of Phase 1 was not available at the time of this review.

Phase 3

Phase three has a base load of between 22-36kW.

5.4-8% of monthly energy use on Sundays, averaging 35,593kWh per annum, at an annual cost of £5,551.

Power factor during the 12 month study period varied from 0.958907-1.000000; meaning that PF correction is functioning well and that there is no scope for reducing electricity bills through further improvement.

Phase 4&5

No half hourly electricity consumption reports are currently available for Phase 4&5.



EMO Register

EMO	Capital cost	Cost savings	ROI	NPV
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(NPV calculated at a rate of 0.5% in line with that of the bank of England)

Reduced base-load

Base-load energy consumption can be significant at between 46-58kW (Phase 1) and between 22-36kW (Phase 3). Reducing this offers significant potential for electricity cost reduction. This base-load results in consumption of 126,533kWh and 70,567kWh of electricity consumption in Phase 1 and Phase 3 respectively between 20:00 and 04.00, and a financial cost of £9,441 and £5,551 (Monday to Friday).

Electricity use on Sundays in Phase 1 and Phase 3 constitutes 5.4-7.2% of total electricity consumption; equating to 87,192kWh and an annual cost of £7,204.

Previous surveys of items left turned on overnight around the Glenair sites has revealed significant scope for improvement, with monitors, computers, ovens, extraction, lighting and other equipment turned on when not in use.

General staff awareness and motivation is one potential cause of this increased electricity base-load, however a further solution would be to designate one or more environmental champions who would have responsibility for ensuring all equipment is turned off when not required. If required this could be incentivised by the same programme used to encourage first aiders and other increases in staff responsibility level. Alternatively, responsibility could be assigned to the site night security guard for



turning off equipment. The total out of hours consumption at Phase 1 and Phase 3 amounts to £22,196 in electricity.

Data showing base-load consumption at Phase 4 and Phase 5 was not available at the time of this review, however further investigation may yield equivalent potential savings.

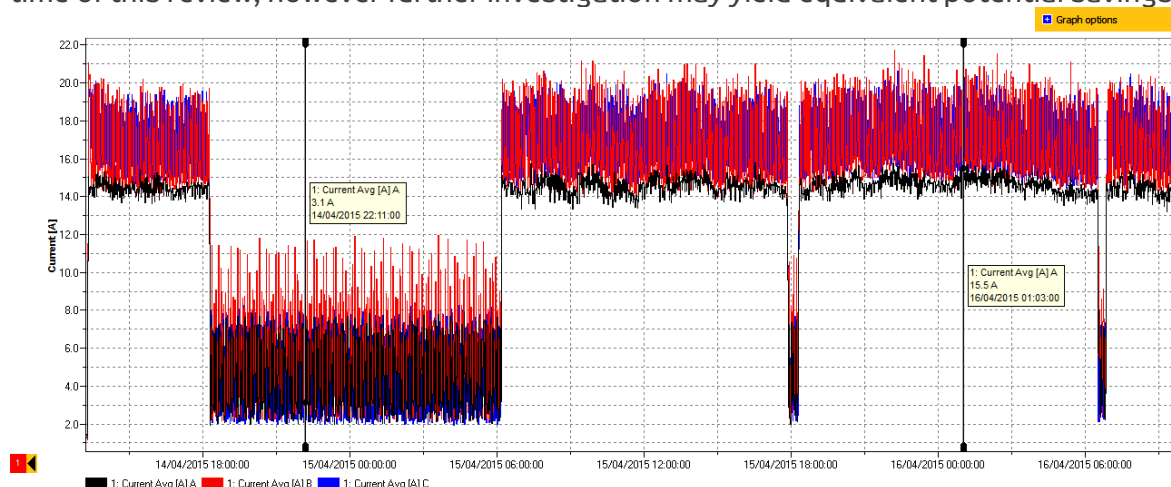


Figure 10-Data Logging from overmoulding machine Phase 4

These findings from half hourly billing are reinforced by data collection on-site. A data logger was used on one over-moulding machine in Phase 3 which recorded out of hours consumption (18:00-06:00) of 1.3kW. This machine is therefore costing an estimated £351 per annum to leave turned on at night when not required.

Energy awareness

Once annual resource consumption and spend has been determined, work with colleagues and other building users to achieve target reductions. The Carbon Trust states that savings of between 5% and 10% can be realised through a successful awareness campaign. How the message is communicated depends on a range of variables but it will need to be well planned and consider what support and resources might be needed, the current situation, the target audience, the reduction targets, and possible message and communication channels. It is recognised that this may be challenging in the setting of Glenair.

The new IEMA *Working with Environmental Sustainability, Managing with Environmental Sustainability, and Leading with Environmental Sustainability* courses offer environmental training for the non-specialist and could potentially assist with employee engagement. At a 5% total consumption saving; this would equate to 141,792kWh and £10,792. Assuming that appropriate training may be implemented for a cost of £2,000; this would make an extremely attractive investment.

Monitoring and targeting

Energy monitoring and target setting will not in itself achieve savings but taking regular meter readings will enable the identification of unwanted peaks in energy use. It is important to collect accurate consumption data so that what it is that's driving your consumption can be determined, realistic reduction targets can be set and the success of any efficiency measures can be quantified. Reduction targets should consider attitudinal and behavioural change as well as the impact that any physical measures might have.

Energy Contracts

Gas contract prices are highly variable between Phases. Phase 4 has one contract with Npower with a unit has a rate of 7.22p/kWh and a standing charge of £74.47 per ¼. The Southern Electric contracts for Phases 1 & 3 is priced at 2.504p/kWh with a monthly



charge of £235.75, the pricing of Phase 5 contracts was not known at the time of this review.

The 2.504p/kWh rate is a good price for mains gas, however the rate of 7.22p/kWh (even with the lower standing charges) is too high. Based on current annual consumption on this contract of 279,621kWh at a current annual cost of (£20,487 + CCL + VAT), savings of £10,656 (+CCL +VAT) would be generated by switching to the same SE contract as the other Phase buildings.

The electricity contract for Phase 1 is with EDF Energy and is charged at £0.089078p/kWh (Day) and £0.060145p/kWh (Night), with a standing charge of £0.907685p/Day. Further charges include an availability charge of £1.16186p/kWh and a reactive power charge of £0.00159p/KVArh.

Electricity for Phase 3 is provided by Npower at a cost of £0.095040 (Day) and £0.062300 (Night), with further charges for availability and reactive power.

Phase 4 is supplied with electricity through SSE at a cost of £0.10445 (Day) and £0.06108 (Night), with no apparent charges for availability or for reactive power and a £28.78 per month standing charge.

These charges are certainly much more consistent than for gas, however we still note a 10% difference in day rate between Phase 1 and Phase 4; potentially offering improvement in rates.

We recommend using a broker for both electricity and gas, combining the consumption of all sites into one contract to source the best deal for energy.

Lighting Upgrade

Lighting in Phase 5 uses modern, high efficiency luminaires covering lamps that are thought to be LEDs, which exhibit no further potential for energy efficiency gains.



Figure 11- High efficiency lighting in Phase 5



Lighting in Phase 4 includes 66 twin 6ft T8 fluorescent units, rated at 70W per lamp; with a total lighting capacity of 9.24kW. From discussions with Gordon Hartley, it is believed that this lighting is operational 24/7; consuming 80,111kWh of electrical power per annum, at a cost of £7,500.

Upgrading lighting to LEDs would provide a means of reducing the cost of operating site lighting; increasing luminous efficacy from 85 lux/w to 110 lux/w and reducing ballast and luminary losses.

The LED input energy required to achieve the current lux output is anticipated at 6.36kW, resulting in annual savings of 24,959kWh and £2,336.

The anticipated lifetime of the lamp would be approximately doubled from 20,000 hours for a fluorescent lamp to 40,000 for an LED (reduced from manufactures quoted figure by 20%); reducing maintenance labour costs by approximately 50%, but increasing the lamp value from £3 to £60 (from £0.50 to £2.70 per 1000 lumens).

Based on a rate of £100 p/day for lift hire and £500 p/day each for two skilled technicians over a ten year period, we anticipate the cost of maintenance of fluorescent lamps to equate to £11,200 and LED lamps to equate to £7,400 including lamps, equipment hire and maintenance.

At the eight year mark we would therefore estimate that an LED lamp upgrade would yield savings of £386 considering the cost of the upgrade (including fitting (estimated at £22,140)), the cost of replacement lamps (and labour for replacing defective units).

When adjusted for an interest rate of 0.5% this turns into a negative Net Present Value (see table 5 below).

Table 5- NPV LED Lighting

NPV Calculation

Discount Rate = .5 %

Initial Invest Amount = 22137

Number of years = 8

Year	Cash Flow	Present Value
1	2337	2325.37
2	2337	2313.8
3	2337	2302.29
4	7956	7798.85
5	2337	2279.44
6	2337	2268.1
7	2337	2256.82
8	548	526.57

Calculate **Reset**

Net Present Value (NPV) = -65.76

The embodied carbon in any LED lighting retrofit into the Phase 4 factory area would be considerable, hence from a climate change perspective it would take a significant period



of time to offset this through operation of the new system, however this report focuses solely on energy and financial costs.

Phases 1,2, and 3 would also benefit from LED lighting upgrade, however returns would be lower for areas without 24 hour use.

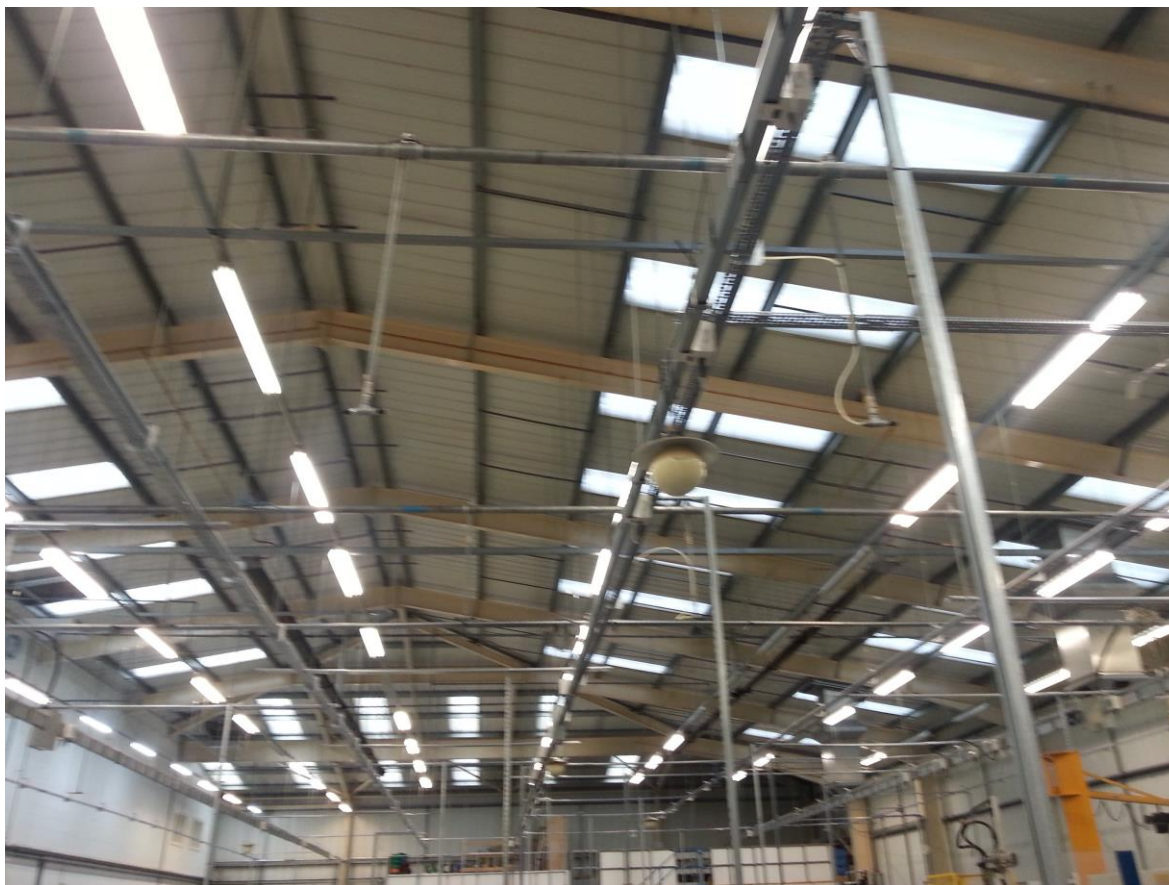


Figure 12- T8 Lighting in Phase 3

AC and heating control

Glenair has invested in multiple AC units over the past two years. In Phase 4, there are 14 stand-alone systems with split exterior and interior units. They have a combined input of 20.71kW for cooling and 22.63kW for heating. There are currently no policies in place to restrict the use of these units; reducing overheating/overcooling and concurrent operation of building gas fired heating and electric cooling systems. This setup is potentially extremely inefficient.

AC in other Phases includes a further 83 split units. Based on extrapolating the researched kW consumption of devices in Phase 4; we believe that the remaining systems to have an input of approximately 123kw for cooling and 134kw for heating.



Figure 13 AC Units in Phase 5

Estimated annual consumption of this system operation over all Phases of operations is 225,266kWh and an annual cost of £21,087 when operating at 19°C (as anecdotal evidence indicates). By changing all operations to use AC at 20.5°C instead; savings of £8,435 could be generated through reduced use. This may entail significant behavioural change (and assumes current operating temperatures as detailed above, cost reductions would be less significant for systems that currently use a higher set-point).

Gas fired heating

Phase 5 uses an Ideal Imax W60 boiler; this is a modern high efficiency model that functions at 89.1% efficiency. Phase 3 uses a Remeha Gas 1000 boiler and Phase 4 uses an Ideal Mexico Super 2 unit; neither of which are condensing units and will function at 70-80% energy conversion efficiency, this could be improved by 10% by upgrading to a modern boiler.

Offices constitute around 30% of the floor area in Phase 3 and 25% of the floor area in Phase 4 (however, the heated volume of air will be significantly smaller than in the high ceilinged factory area).

It is estimated that savings from upgrading boilers in these two locations would not achieve ROI that would be considered by Glenair (9-18 years with savings of £168 and £326 for Phase 4 and Phase 3 respectively).

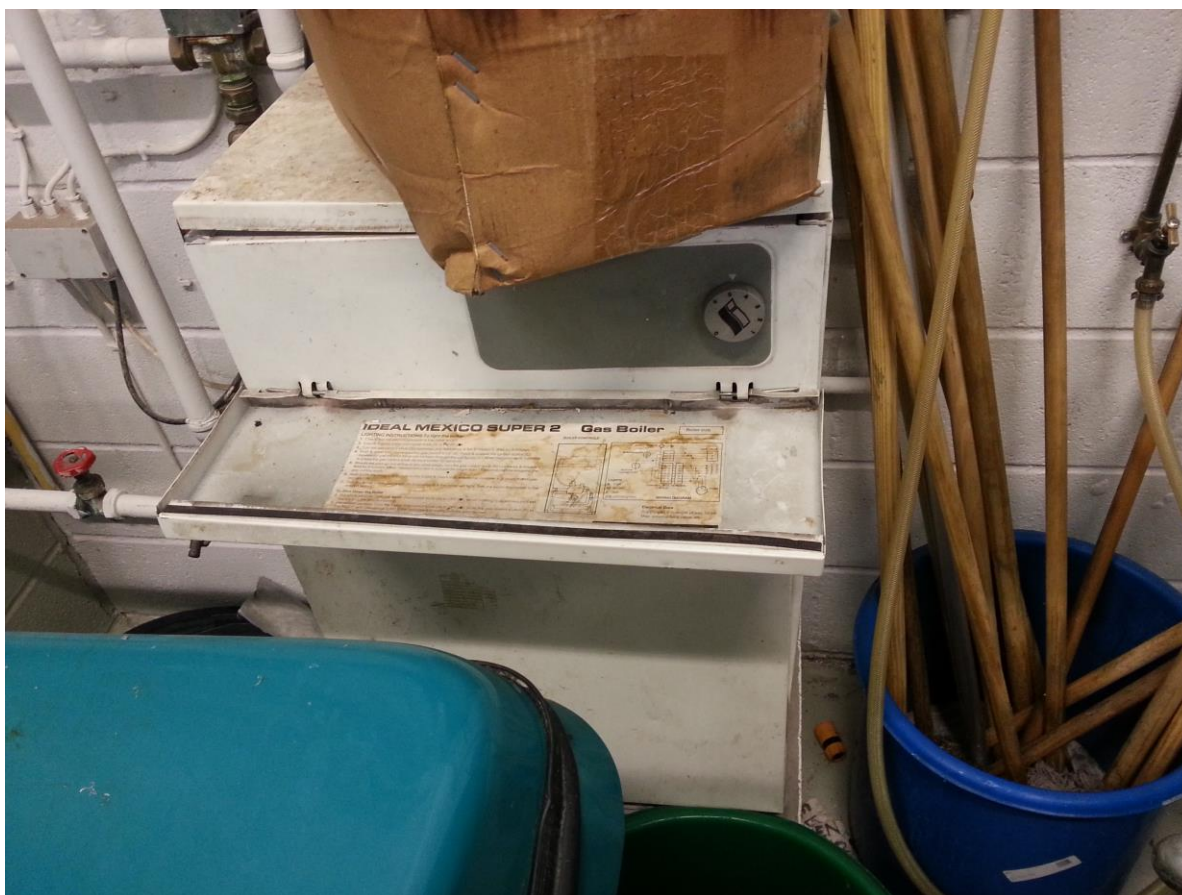


Figure 14- The current Phase 4 boiler

Solar PV

Glenair would benefit from generation of electricity through solar photovoltaic panels (solar PV). The optimum angle and orientation for solar panels is facing due south and angled at around 30°. It is thought that Glenair's Phase 1 building could provide space for around 2,000m² of panels at this orientation.

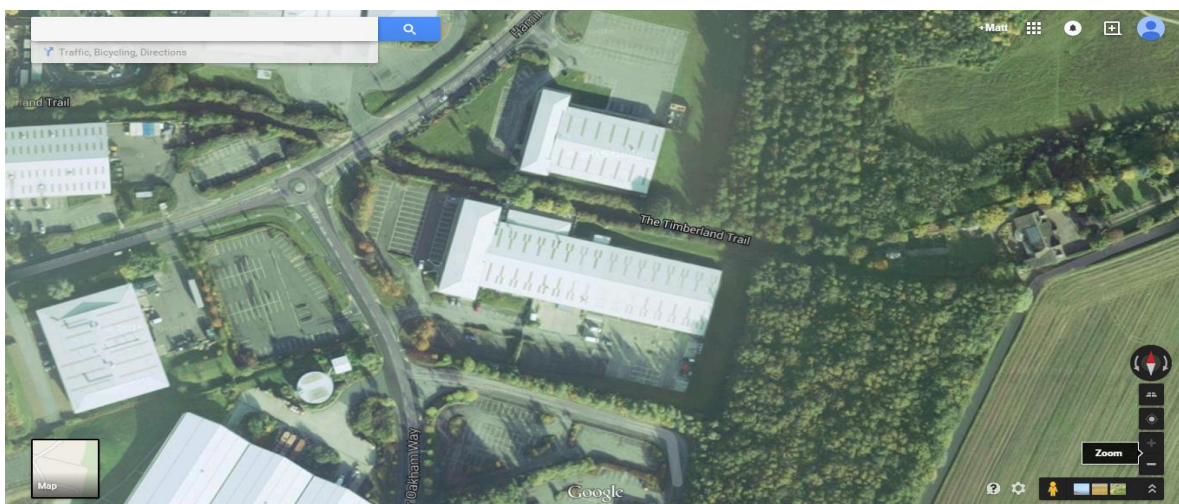


Figure 15- Glenair Phase 1,2,2.5 South orientated location

Based on an average panel size of 1.5m², producing 250W kWp, and an average output of 843.2kWh/kWp, we estimate that 28,1067kWh could be generated from such an array. At a generation rate of 6.16p/kWh, and an export rate of 4.85p/kWh (using 70% of power on site and avoiding consuming power from the grid at a rate of 8.88p/kWh) we



estimate that £19,958 would be avoided in electricity bill payments and a total income of £21,403 would be generated. We estimate the cost of such an investment at approximately equal to £400,000; however several quotes would be required to determine “real-world” installation costs.

High Efficiency Motors

It was noted at the time of the site visit that Glenair uses a significant amount of machinery with inductive motors. High efficiency motors should be specified as replacements when required, especially for machinery in operation for a significant number of annual hours.

VSDs

Variable Speed Drives mean that motors are not required to run constantly at full capacity; instead consumption of electrical power is reduced where this is feasible. VSDs can be useful in applications requiring a fixed specified motor output but will usually generate more significant savings when applied to an application where output can sometimes be reduced. Motors fitted with a VSD have the capacity to reduce output accordingly.

Building Envelope

The building envelope at Glenair was inspected at the time of the site visit and was found to be modern (post 1980) and in a good state of repair. That said; the buildings were all largely constructed with a single skin corrugated metal fabric with little insulative value. Considering the total gas cost of >£49,000 p/a, the insulation level of any new building should be considered (the cost of applying insulation to current Glenair premises is likely prohibitive to undertaking a retrofit).