Atlantic Energy

Quenchwell

Carnon Downs

Truro TR3 6LN

Cornwall

Carbon Audit for Bude-Stratton Town Council

August 2020

Part 1

Carbon emissions

Energy costs

Contents Part 1

Council Carbon emissions and energy costs

Part 1 Carbon emissions

1 Energy use calculations

All fossil fuel energy use creates greenhouse gas emissions and are the cause of around 75% of global warming emissions throughout Europe. The assessment of the use of fossil fuels is therefore the main first step to determining the Council's greenhouse gas emissions.

The purchased fossil fuel energy sources are electricity, gas and liquid petroleum fuels comprising petrol and diesel. These energy sources are used for heating and lighting the buildings and other facilities, and operating the grounds maintenance staff machinery and vehicles.

This analysis estimates the carbon emissions from electricity and gas purchases to determine the annual energy demand of each building, with each main building considered in turn. Summaries of energy demand of the buildings and main facilities are then provided.

The liquid fuels purchases are then analysed and the greenhouse gas emissions expressed as carbon dioxide equivalents are calculated.

When assessing the gas heating demand for each relevant building, other sources of information are used to determine how well the heating system is performing. The extra information used includes the building details such size, building standards used at the build time and the local external temperatures in the measured period.

The local external air temperature is a key determinant for the heating demand of any building. The data used for this assessment is the local or regional measurement of degree days. This is measurement of the number of days in each time period when the air temperature is below an agreed base temperature all day. Each degree below the base temperature for 24 hours is one degree day. For this analysis the base temperature is taken as 15.5^0 C and the local data is taken as that recorded at the meteorological station at Chivenor, Barnstable area, some 25 miles along the coast.

1.1 Parkhouse Centre

The Parkhouse Centre, is a large building, the first stages of which were built in 1842, has been extended and its functions changed several times over the years in between. This makes assessing the building structure from an energy point of view complex task.

The active floor area is nearly 1,000 m2, with around 60% of the floor space being devoted to the halls for social events in the Hall and the rest being the Centre with its office functions.

1.1.3 Electricity

Electricity is used for lighting, controls, computers and other office equipment as well as for some air conditioning and other functions.

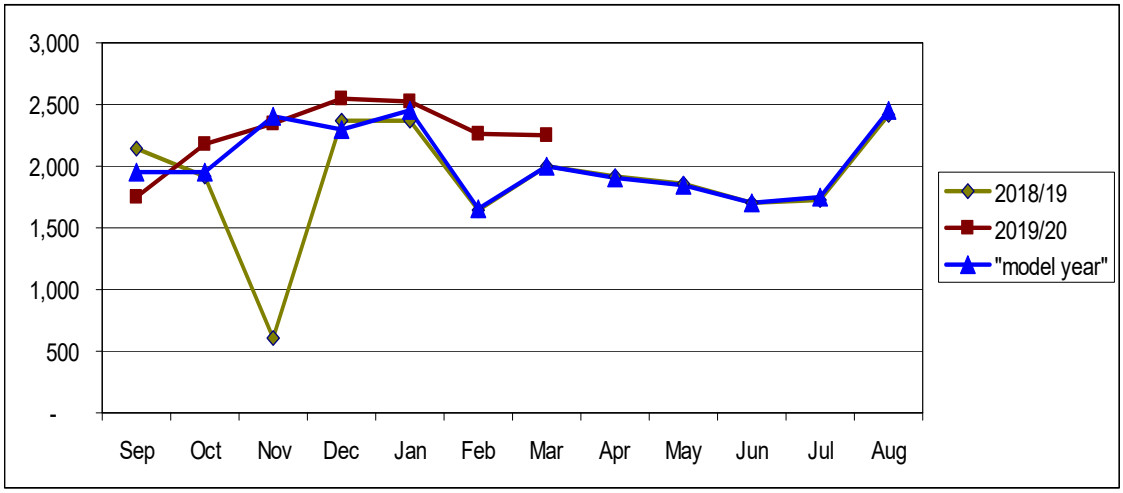
There are some issues around assessing the annual electricity use as the present electricity supplier has presented many monthly bills with estimated energy use. Whilst any inaccuracies from these estimated figures do work through in the annual totals as an occasional reading is made, it does present difficulties in assessing when the electricity has been used and hence in assessments on how to reduce the demand and the consequent carbon impact. The figures in the table below have therefore been adjusted to provide a " model year" as a method of assessing annual electricity use.

Parkhouse electricity use 2018-2020 kWh/month

Year	2018/2019	2019/20	"model year"
Sep	2,146	1,752	1,950
Oct	1,912	2,175	1,950
Nov	611	2,351	2,400
Dec	2,367	2,552	2,300
Jan	2,367	2,520	2,450
Feb	1,647	2,256	1,650
Mar	1,995		2,000
Apr	1,918		1,900
May	1,854		1,850
Jun	1,707		1,700
Jul	1,726		1,750
Aug	2,418		2,450
Total	**22,668**		**24,350**

xxx *estimated bills*

Graph of Parkhouse electricity use kWh/month



This shows a roughly even spread of electricity use through the year, with increases in the height of the summer season, as would be expected from the higher use of the social spaces rented out by the Council.

The “model year” is arrived at by smoothing some of the estimated monthly electricity demand to a more likely use, consistent with the totals when the actual readings are taken.

The expected “model year” electricity demand is therefore around 24,350 kWh pa. The present contract is for unit charges of 13.53p/kWh which amounts to a total of £3,295. Added to this for the electricity bills as a whole are the charges for the daily standing charge, Climate Change Levy and VAT.

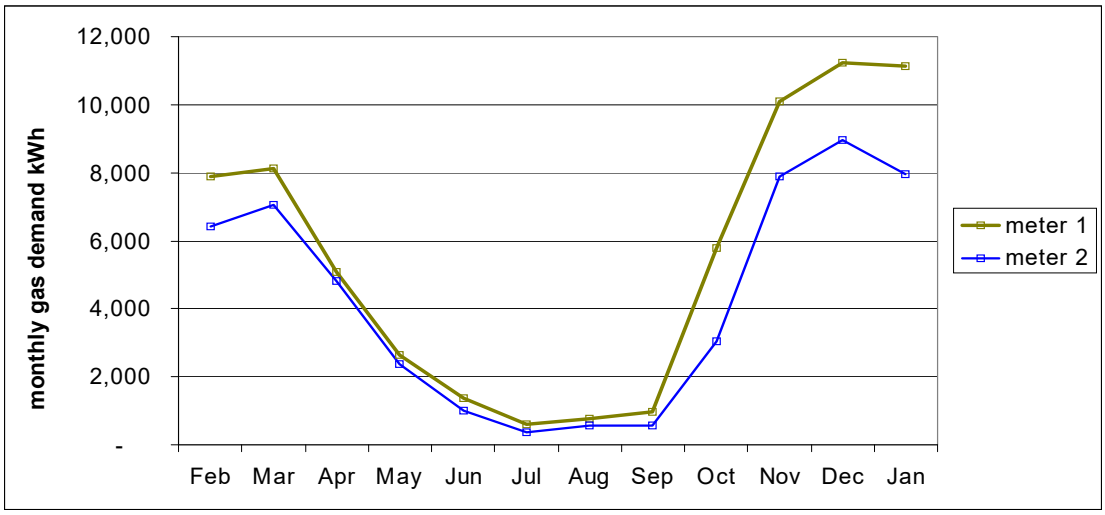
1.1.2 Gas

Gas is used in two gas boilers for central heating and hot water provision in the two parts of the building, with Meter 1 heating the Centre and offices and Meter 2 the Hall as the social area let out for functions.

Gas demand at Parkhouse kWh/month

	gas use by month	meter 1 Centre	meter 2 Hall	total
2019	Feb	7,884	6,425	14,309
	Mar	8,118	7,060	15,178
	Apr	5,067	4,810	9,877
	May	2,628	2,372	5,000
	Jun	1,359	991	2,350
	Jul	601	367	969
	Aug	779	568	1,347
	Sep	969	579	1,548
	Oct	5,792	3,057	8,848
	Nov	10,085	7,897	17,982
	Dec	11,240	8,952	20,193
2020	Jan	11,118	7,953	19,071
	totals	**65,639**	**51,031**	**116,671**

Graph showing gas demand by the two boilers for Parkhouse

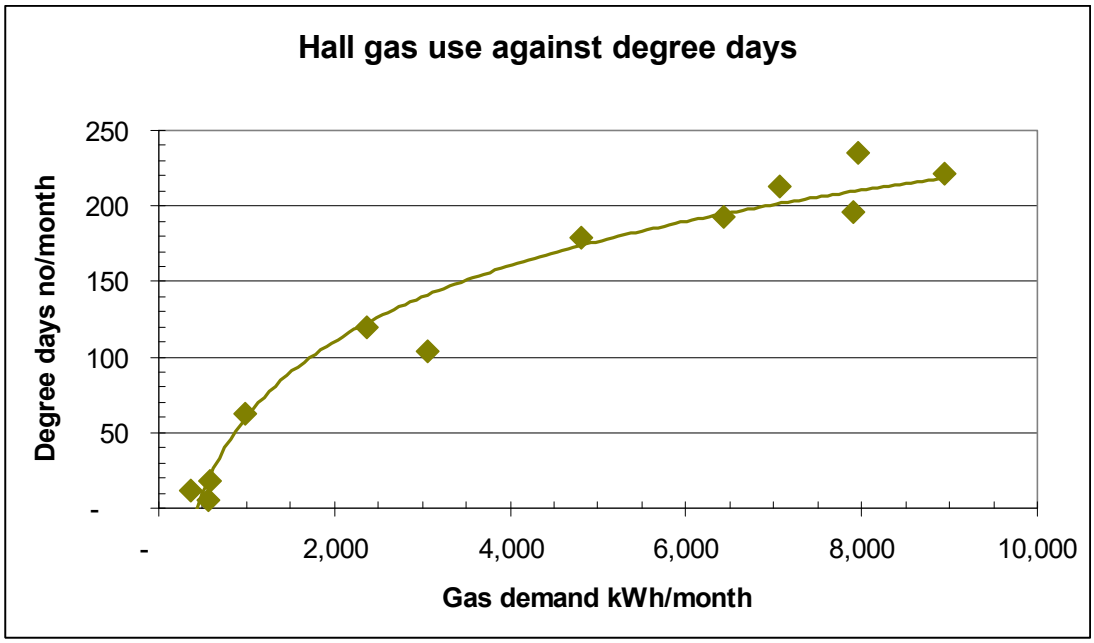


The graph above shows lower gas demand for the Hall during the colder winter months, compared to the Centre heating demand each month, as would be expected from its lower use.

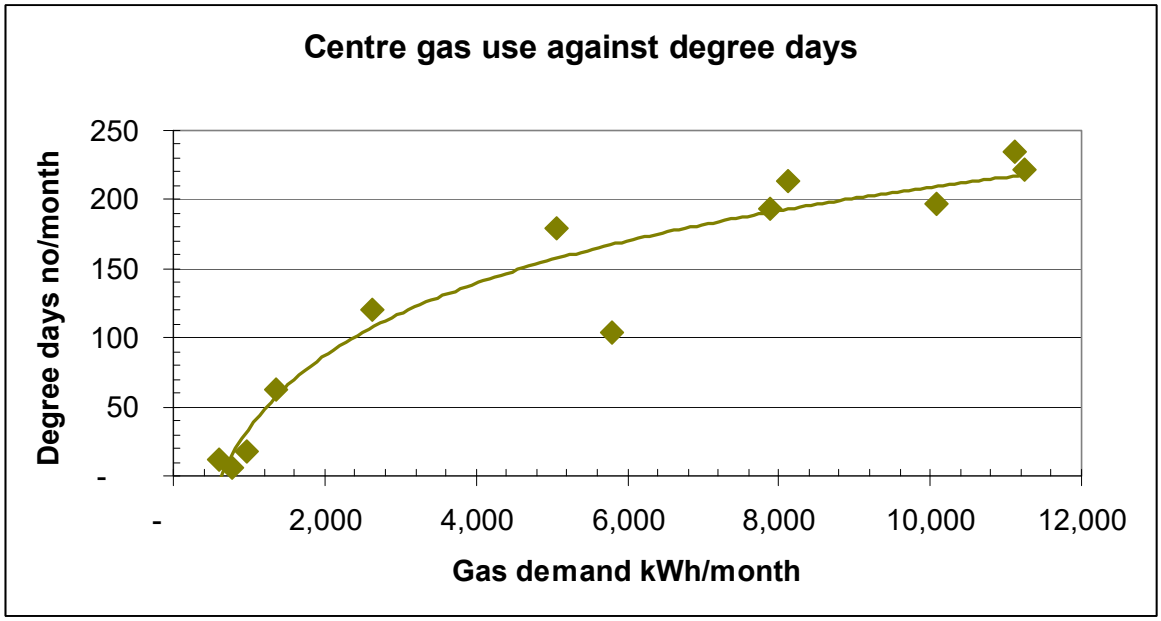
Correlation with degree days

The Centre and the Hall show similar pattern in relation to the gas use against degree days or increasing coldness. Both of these boilers show the same shape of curve, logarithmic with a high R2 or correlation, of over 95%, showing a high correlation between external temperatures and the gas demand in each portion of the Parkhouse Centre

Hall gas use against degree days meter 2



Centre gas use against degree days meter 1



The shape of the curves, levelling out at lower temperatures suggests that the boilers may be struggling to meet demand in colder weather.

A closer look at the gas consumption vs degree day data shows that the two boilers have an a range of kWh demand per degree day which is around 33 for the Hall and 42 for the Centre, through most of the year. However in August when no space heating is required this jumps to over 100 for the Hall and is unexpectedly high in July, August and September for the Centre.

It is not clear whether this is due to domestic hot water requirements or the space heating being switched on for longer than needed, or when it is not required.

1.2 Castle

The Castle includes the popular Museum and Café, and is amongst the oldest buildings in Bude. This large building of around 620 m2 floor area was built of solid stone before energy efficiency concerns impinged on building standards. Whilst the Castle has thick walls, being of solid stone, the walls conduct heat through the width of the walls at much higher rates than more recent buildings with more insulating materials in their construction.

Very rough estimate of U values[1] and heat demand

Fabric element	**Rough U value W/m^2 degC**	**Approximate area m2**	**Heat demand at temp lift of 1^{0}C W**
walls	2.8	556	1,579
floor	1.13	307	347
windows	4	64	256
roof	0.26	340*	88
Total fabric losses			**2,373**

**approximate*

[1] U value is a measure of the rate of expected heat loss through the fabric elements of a building, with lower U values showing better insulation levels and hence slower heat loss.

The fabric heat demand at the average local winter temperature are therefore around 2.4 kW times 13 ^{0}C temperature difference –ie 31 kW.

The losses due to air changes also have to be included in any assessment of heat demand for the building. If an assumed air changes per hour in this old building are say 1.8, this adds another 14kW

Total building heat demand at the local average winter temperature is therefore approaching 45 kW.

The table above does show the most important element of heat loss from this building is likely to be the solid stone walls, at over 50% of the fabric heat loss expected.. It is recognised that the Castle is Grade II listed which could lead to issues when considering how to reduce the energy demand of this precious building.

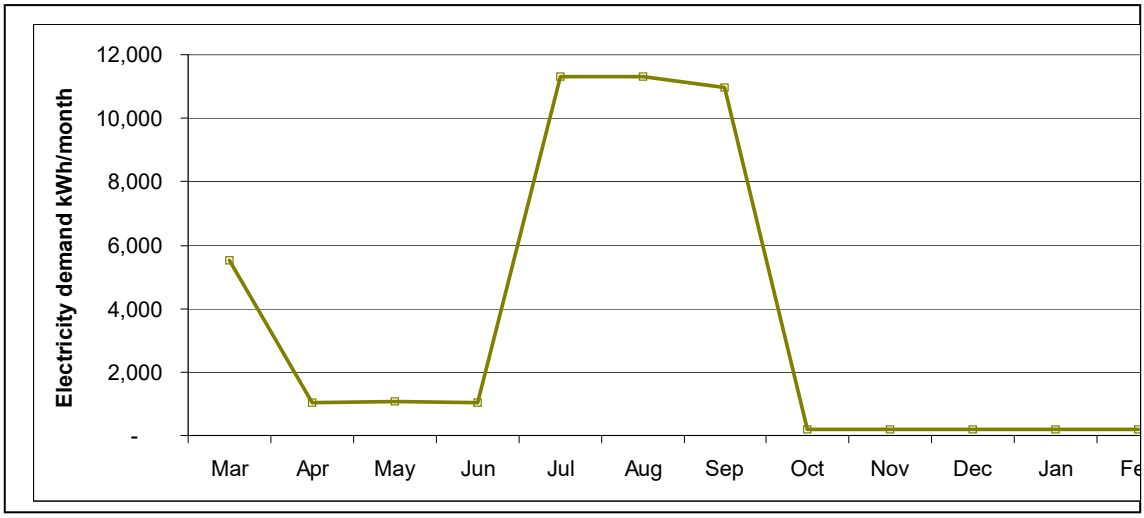
1.2.1 Electricity use

There have been significant problems with assessing the electricity used at the Castle because of the low number of actual meter readings and the use of estimated figures by the electricity supplier. Added to this has been the apparent lack of electricity use over the last winter, when it appears the meter was broken. Why the electricity supplier changed their bills from their usual estimates to very low figures for last winter is unclear.

Electricity demand paid for kWh

Month	kWh used
Mar	5,536
Apr	1,034
May	1,069
Jun	1,034
Jul	11,326
Aug	11,325
Sep	10,979
Oct	183
Nov	197
Dec	205
Jan	205
Feb	191
Total	**43,284**

Castle electricity billed in 2019/20 kWh/month



This is obviously very inaccurate, leading to further investigation and the compilation of an example year for electricity demand at the Castle. The "model year" has been estimated from the very few actual meter readings made over the last eighteen months.

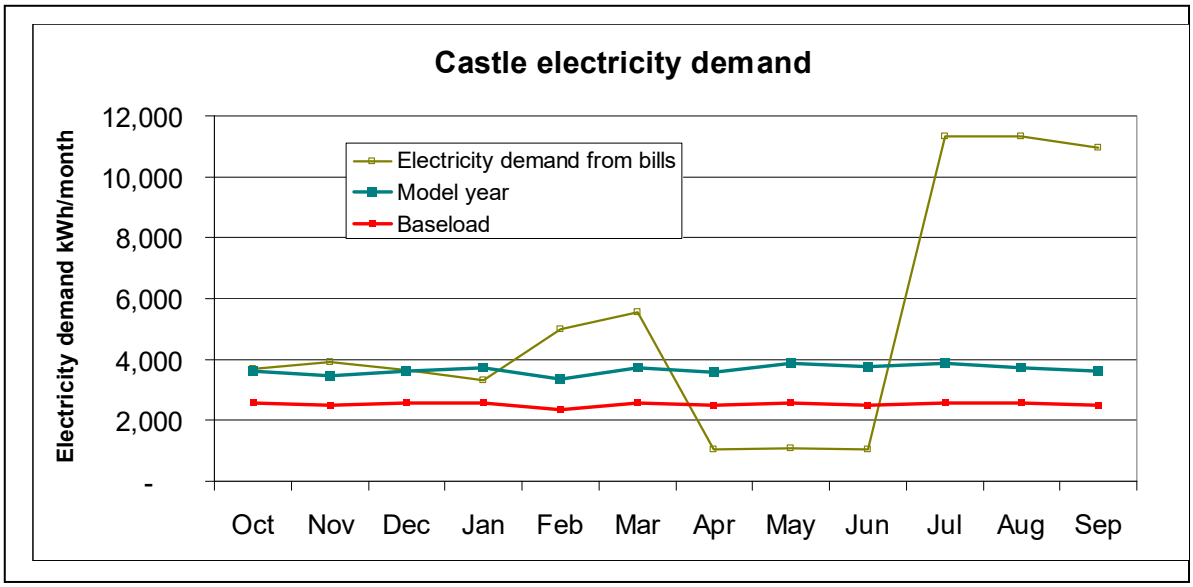
Electricity demand from actual meter readings

Date		Days since last reading	Units used	kWh/day	Months covered
2018	29 Sep - 28 Oct	30	3,694	123	Oct
2018/19	28Oct - 14 Jan	78	9,056	116	Nov Dec
2019	14 Jan- 8 May	114	13,662	120	Jan Feb Mar Apr
2019	8 May- 19 Jul	72	9,045	126	May Jun Jul
Totals		**325**	**35,457**	**121**	**Average Oct- Jul**
New meter					
2020	16 Mar – 10 Jul	116	9,680	83	Lockdown Mar- Jul

The new meter having been read on 10th July following its installation on 16th March gives a useful background electricity demand for the building when the café is closed and the display lights off, as this is nearly all in the lockdown period. This "baseload" figure is nearly 70% of "normal" demand, which as the café and lighting displays were switched off in this period suggests some heavy electricity loads operating all the time.

Further detail on the climate control equipment for the Museum paintings and the refrigeration requirements of the café are needed so that carbon reduction methods for these activities can be assessed.

Graph of Castle electricity "model" year and baseload kWh/month



Main uses of electricity in this building are

- Lighting
- Refrigeration
    - Freezers 4
    - Fridges 5
- Café heating appliances 7 and hot lights 6
- Computers, peripherals & similar 6
- Climate control equipment for Museum paintings

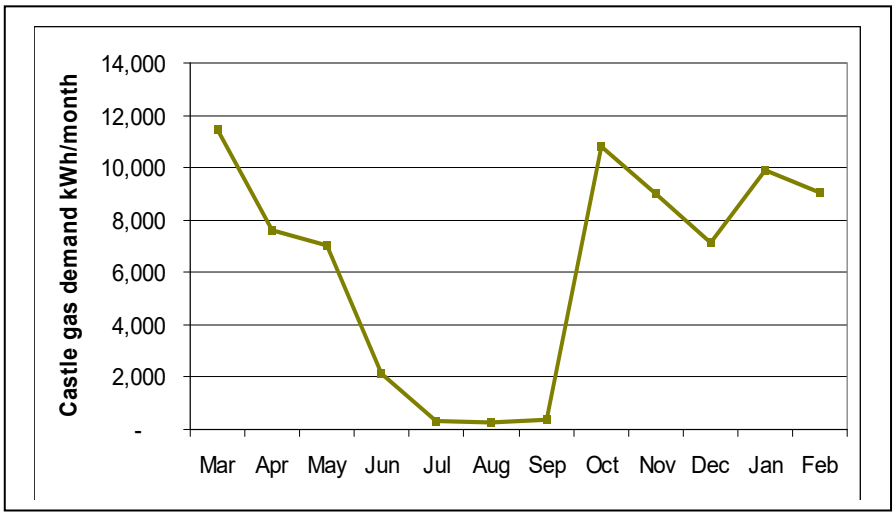
1.2.2 Gas

The gas bills for the Castle have been analysed and the following information is based on that information for 2019/20. Whilst this gas demand is relevant to the situation up to the summer of 2020: a new gas boiler has been recently installed and this should show an improved situation with reduced gas demand from the higher expected efficiency of the new boiler.

Gas demand at the Castle 2019/20

Month	Gas kWh
Mar	11,447
Apr	7,597
May	7,049
Jun	2,138
Jul	312
Aug	279
Sep	391
Oct	10,790
Nov	8,986
Dec	7,112
Jan	9,915
Feb	9,062
total	**75,079**

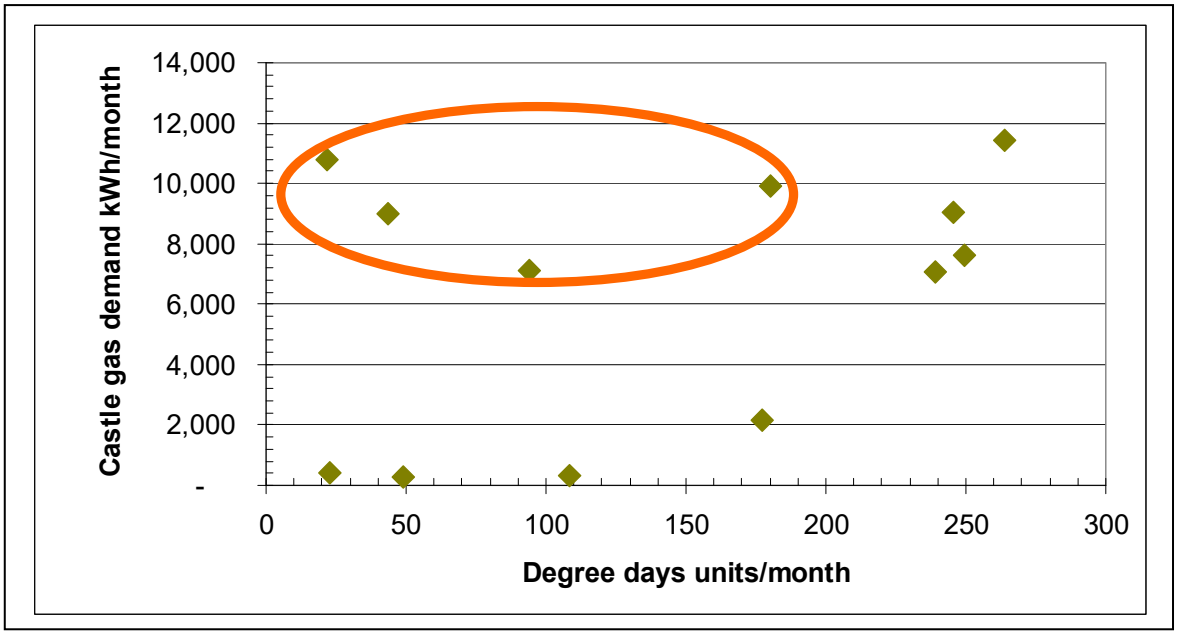
Graph of gas demand at the Castle 2019/20



The demand for gas at the Castle, whist higher in the winter as would be expected has shown little relationship to actual local temperatures – as measured by degree days. Degree days are an estimate of the amount of heating needed from a base figure of 15.5^0C external temperature, as noted earlier.

The scattergram below of gas demand for each month against degree days shows this, with the months of October to January all within the orange oval.

Castle gas demand against degree days 2019/20



If the anomalous figures for the months included in the orange oval are ignored, the rest of the scattergram shows a clear exponential curve with an R2 of 92%, which is a high degree of correlation. This figure suggests that control of the Castle boiler system has not related to the external temperature for most of the winter period from October 2019 to January 2020, and that the boiler was turned on for most of the opening hours regardless of external temperature.

1.3 Library

The Library is a newer building and hence was constructed with higher insulation standards, which impacts particularly on the heating requirements of the building. The useable floor area is 274m2, and the building opened in 1985. The Building Regulations in force at that time were those of 1976, as the 1985 changes were likely not in force as the building was under construction at the time. Calculations from the 1976 Building Regulations standards suggest a heat demand of around 33kW assuming air changes of 1.5 an hour and a temperature difference of 18^0C.

1.3.1 Electricity

Electricity demand in the library is a steady figure of 27-37 kWh per day, over the year. As the electricity bills have sometimes been for one month and sometimes for a quarter it is not feasible to estimate a detailed pattern of demand. As electricity is used for lighting and computers during opening hours these requirements are expected to remain mainly dependent on the hours of opening.

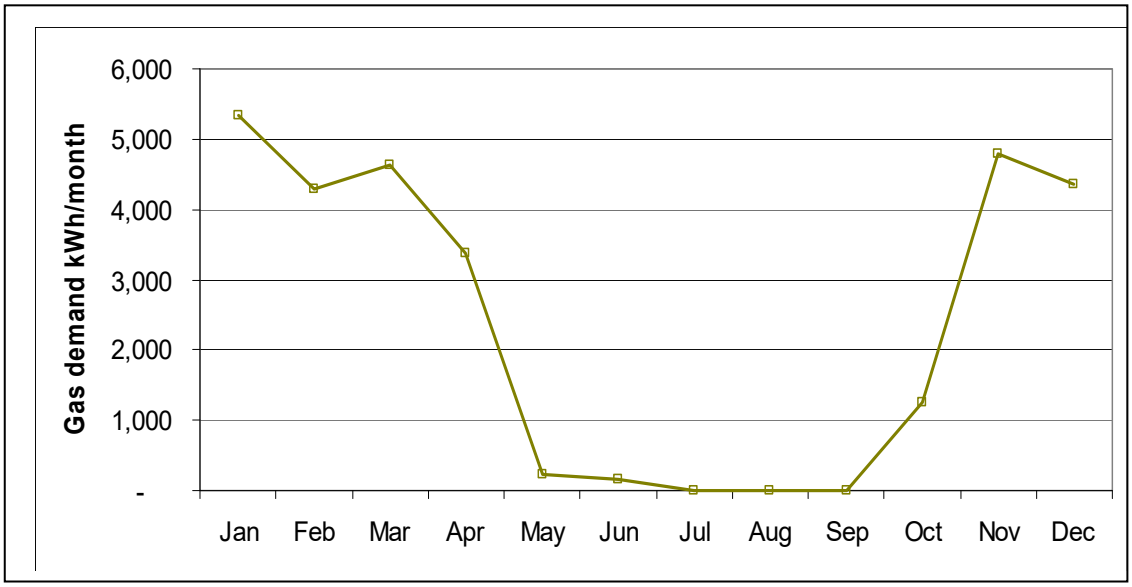
Total annual demand was around 11,945 kWh for the year 2019/20.

1.3.2 Gas

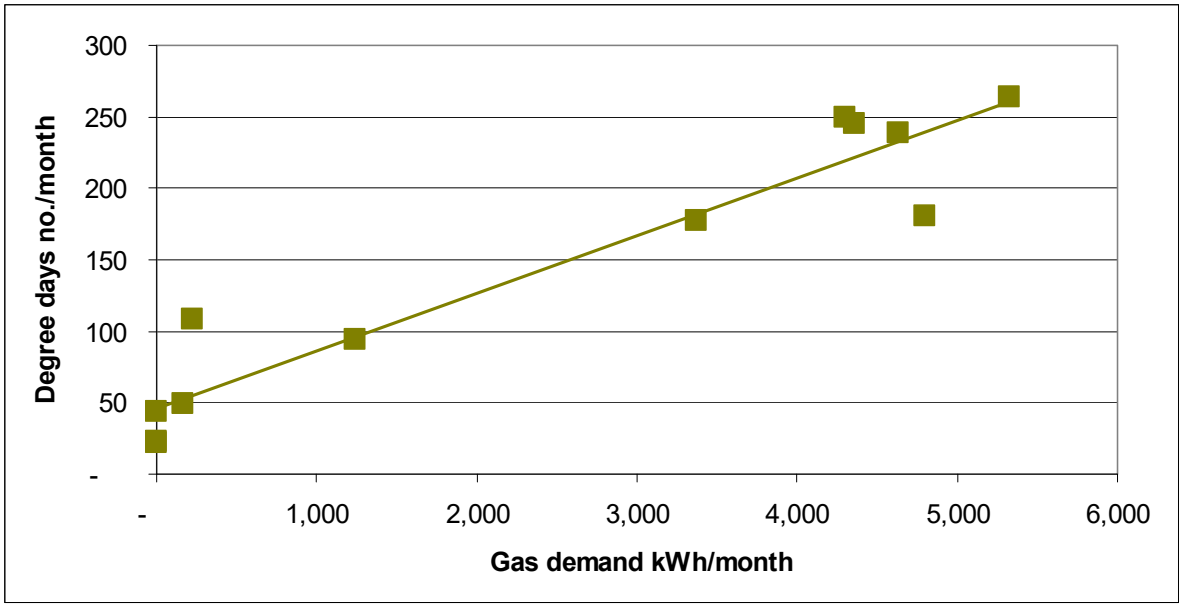
Gas demand at the Library kWh/month 2019/20

Month	Gas demand kWh
Jan	5,329
Feb	4,298
Mar	4,631
Apr	3,374
May	223
Jun	168
Jul	-
Aug	-
Sep	-
Oct	1,244
Nov	4,798
Dec	4,354
Total	**28,419**

Graph of gas demand kWh/month



Heating gas demand against degree days



The library graph of heating gas demand against degree days each month shows a clear and regular trend of increasing demand against decreasing temperatures (increasing average degree days). The relatively close agreement of the temperature drop against gas demand increase reflects the relative newness of the library building, and hence its higher insulation levels than some of the Council buildings.

The Library was the subject of an Energy Performance Certificate assessment in 2015. This resulted in a rating of C in the range A-G and an index figure of 69 against a typical 100 for this type of building.

Library EPC assessment 2015

Technical Information

This tells you technical information about how energy is used in this building. Consumption data based on actual meter readings.

Main heating fuel: Natural Gas
Building environment: Heating and Natural Ventilation
Total useful floor area (m²): 273.7
Asset Rating: Not available

	Heating	Electricity
Annual Energy Use (kWh/m²/year)	94	58
Typical Energy Use (kWh/m²/year)	177	70
Energy from renewables	0.0%	0.0%

The most recent energy use as a benchmark for assessments of energy efficiency and carbon cutting actions is shown in the table below vs the figures from 2015.

Energy demand per m2 comparison of 2015 and 2019/20

energy source	energy demand		demand per m2		
	kWh	%	2015	2019/20	% change
electricity	11,945	30%	58	44	-25%
gas	28,419	70%	94	103	+10%
Totals	**40,364**		**152**	**147**	

The table shows that electricity use has dropped in the last five years, possibly due to refits on lighting or increased computer energy efficiency. However the gas demand has noticeably increased in this period.

These are significant figures, especially the increase in gas demand for the building, which needs investigation.

Possible reasons for the increase in gas demand include an increase in opening hours and hence heating hours, a reduction in boiler efficiency, different boiler with reduced efficiency, demand for higher temperatures within the building during opening hours or heating when the building is not in use.

1.4 Works Unit

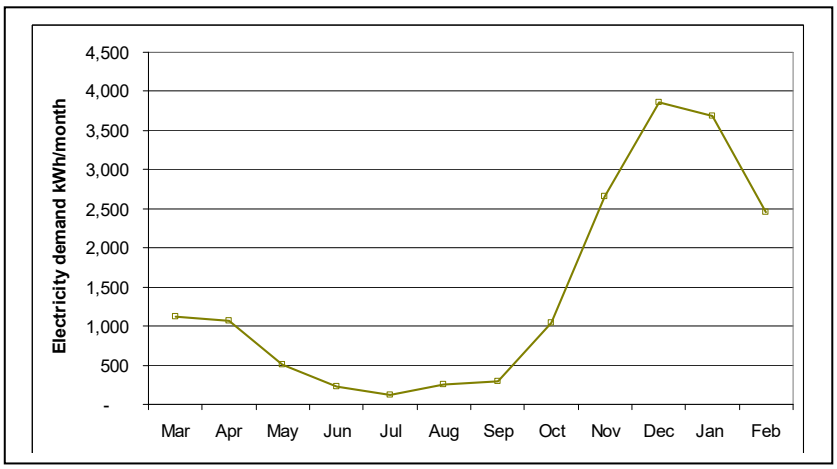
This is a modern building with PV on the roof. The electricity generated from this installation is covered elsewhere in the report. The unit is used by the grounds maintenance staff and the energy demand is met entirely by electricity. Some of the demand is met by the rooftop PV, but this is not metered, as only the generation of the PV is metered.

Electricity demand at Works Unit kWh/month

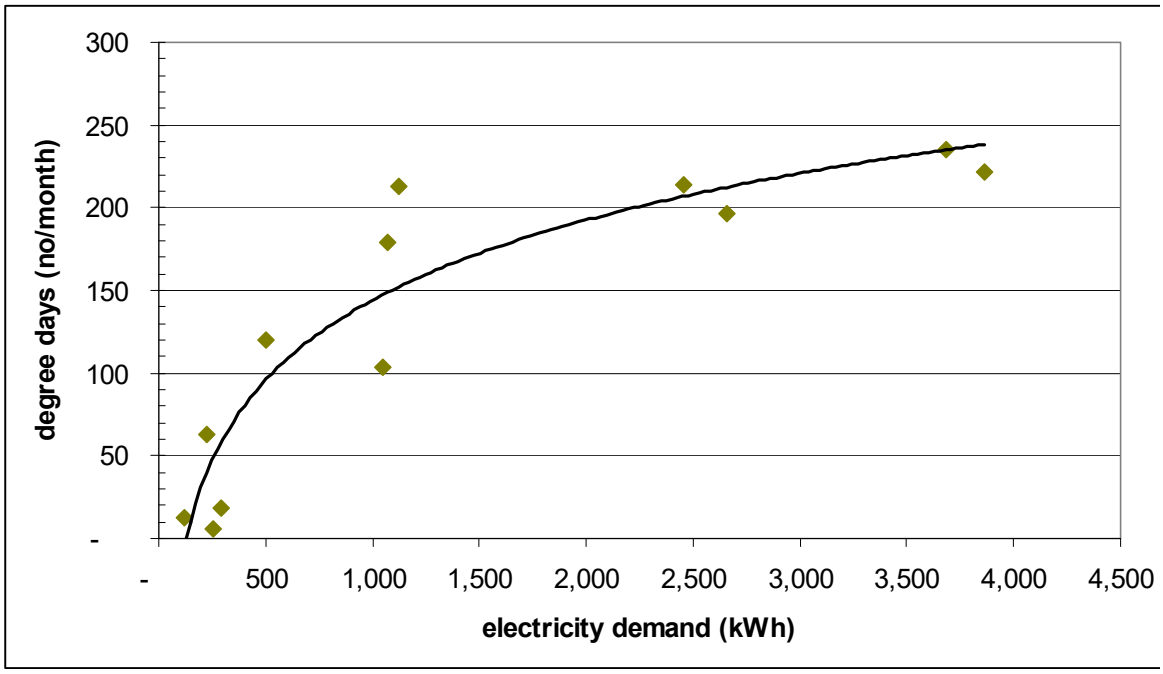
Month	kWh
Mar	1,121
Apr	1,073
May	501
Jun	227
Jul	121
Aug	251
Sep	294
Oct	1,048
Nov	2,660
Dec	3,860
Jan	3,683
Feb	2,458
Total	**17,297**
Unit price p/kWh	14
cost of units £pa	**2,340**

The graphs below show how the electricity demand varies through the year at the Works Unit. In particular the scattergram of electricity demand against the degree days in each month – or demand against increasing coldness, shows how much of the electricity demand is temperature dependent and hence is likely to be for space heating. The trend line fits with an 86% R^2, suggesting a good correlation with external air temperatures through the year.

Graph of electricity use at Works Unit



Monthly electricity demand against degree days



There are some demands which are regular throughout the year, such as the EV charging and the use of the washing machine for work clothes, clothes drying and lighting.

The electric vehicle is driven for around 3,000 miles pa, and charged for around four hours per week. This is likely to use around 70kWh/month.

Making assumptions from the shape of this demand curve, suggests that over 80% of the energy demand at the Works Unit is for space heating at approximately 14,000 kWh pa.

This suggests an inefficient space heating system is in use at this location, given the small area which is heated. At present the space heating is by electric radiators which are on during winter working hours and controlled by a thermostat.

1.5 Other buildings/facilities

The other buildings and facilities investigated for which energy bills have been received are all smaller users of energy, and hence have not been the subject of detailed assessment..

None have gas, leaving only electricity bills to be addressed.

Electricity demand (kWh) and unit cost at smaller facilities

Month	Crooklets Rd	Pitch & Putt	Rattenbury Gardens	Bus Shelter*	Bude Light	Helebridge	Total
March	704	10	79	24	11	2	830
April	139	90	88	24	11	1	353
May	-	266	81	24	10	-	381
June	-	79	81	24	12	4	200
Jul	625	103	29	24	22	12	815
August	-	144	-	24	28	17	213
September	-	104	1	24	11		151
October	618	73	-	24	21	-	736
November	-	32	27	24	8	-	91
December	-	31	107	24	11	4	177
January	757	34	119	24	2	-	936
February	-	31	114	24	-	-	169
Total	**2,843**	**997**	**726**	**282**	**147**	**51**	**5,046**
Unit price p/kWh	15.81	14.39	14.45	14.45	14.97	14.45	
Annual cost of units £pa	**449**	**143**	**105**	**41**	**22**	**7**	**768**

**unmetered supply – assumed at 282kWh pa*

The total of electricity use for these locations is some 5,000 kWh pa costing around £770 in units. In addition at each location there is also the daily charge to be covered when considering the financial issues involved.

2 Summary of energy use

2.1 Electricity demand

The table below shows the demand for electricity at each of the highest demand locations: which are the Castle, Parkhouse Centre, Works Unit, Library, and the Triangle.

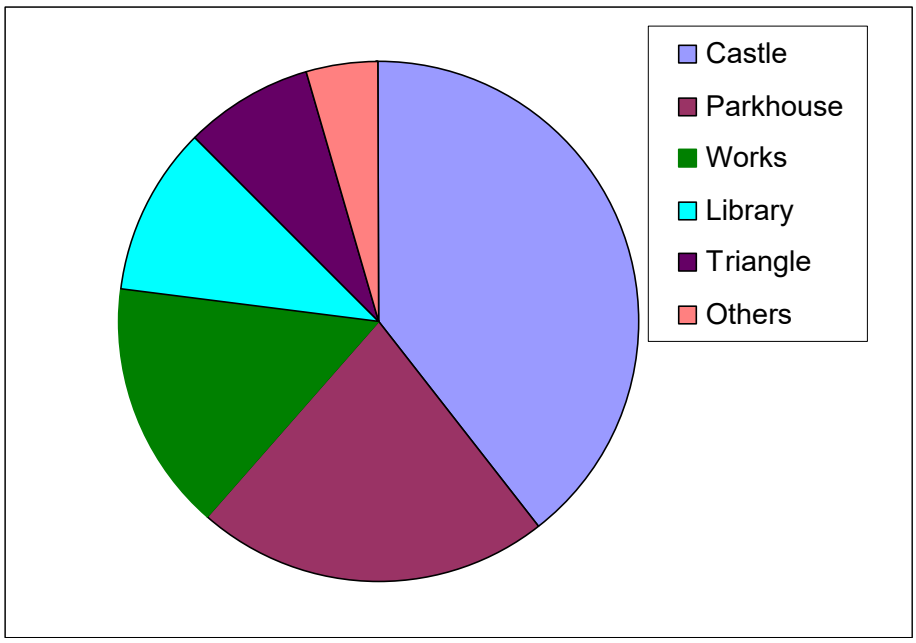
Electricity demand at main facilities kWh per month

	Castle	Parkhouse	Works Unit	Library	Triangle	Total main facilities
March	3,715	2,000	1,121	846	854	8,536
April	3,595	1,900	1,073	909	878	8,355
May	3,894	1,850	501	874	888	8,007
June	3,769	1,700	227	930	875	7,501
July	3,894	1,750	21	910	837	7,512
August	3,739	2,450	251	950	845	8,235
September	3,618	1,950	294	998	808	7,668
October	3,599	1,950	1,048	1,122	786	8,505
November	3,483	2,400	2,660	1,086	775	10,404
December	3,599	2,300	3,860	1,122	531	11,412
January	3,715	2,450	3,683	1,155	312	11,315
February	3,356	1,650	2,458	1,043	374	8,881
total	**43,977**	**24,350**	**17,297**	**11,945**	**8,763**	**106,332**
price p/kWh	13.53	13.53	13.53	15.40	14.45	
cost of units £pa	**5,951**	**3,295**	**2,340**	**1,840**	**1,266**	**14,692**

Summary of electricity demand for all locations

Location	kWh pa	%
Castle	43,977	39%
Parkhouse	24,350	22%
Works	17,297	16%
Library	11,945	11%
Triangle	8,763	8%
Others	5,046	5%
total	**111,378**	**100%**

Electricity demand in Council facilities



The table above and the accompanying pie chart comparing the electricity demand at each location give clear indications of where the priorities lie in determining actions to both reduce electricity demand and to reduce the associated carbon emissions.

The cost of the units of electricity charge to the Council is around £16,200 pa plus the various daily charges and the Climate Change Levy.

2.2 Gas use in buildings

The key buildings under Council control where gas is used are the Parkhouse Centre, the Castle and the Library, with the Parkhouse Centre using over 50% of the total gas demand.

Gas demand in main buildings kWh

	Parkhouse	Castle	Library	total
March	15,178	11,447	5,100	31,725
April	9,877	7,597	2,905	20,379
May	5,000	7,049	223	12,272
June	2,350	2,138	168	4,655
July	969	312	-	1,281
August	1,347	279	-	1,626
September	1,548	391	-	1,939
October	8,848	10,790	1,244	20,882
November	17,982	8,986	4,798	31,766
December	20,193	7,112	4,354	31,659
January	19,071	9,915	5,329	34,315
February	14,309	9,062	4,298	27,670
totals	**116,671**	**75,079**	**28,419**	**220,168**
Percent of demand	**53%**	**34%**	**13%**	**100%**
Unit price p/kWh	3.289	3.585	4.004	
Annual cost of units £pa	**3,837**	**2,692**	**1,138**	**7,667**

The cost of units of gas to the Council is £7,700 pa plus the cost of various daily charges and the Climate Change Levy.

2.3 Liquid Fuels

The table below shows the assessment of the totals of bought in oil based fuels, for use in machinery and vehicles. This shows that nearly 7,000 litres of DERV, petrol and diesel were bought in 2019/20. It is not feasible to be completely accurate on when the purchased amounts are used, as the DERV is delivered to a large tank in 1,000 litre lots – which will not equate to when it is used. Equally the petrol driven machinery is fuelled from petrol cans filled up at the local petrol station and the purchases are not entirely separated out for petrol driven vehicles which may also be filled up at the same time as the petrol can. This analysis is therefore an approximation.

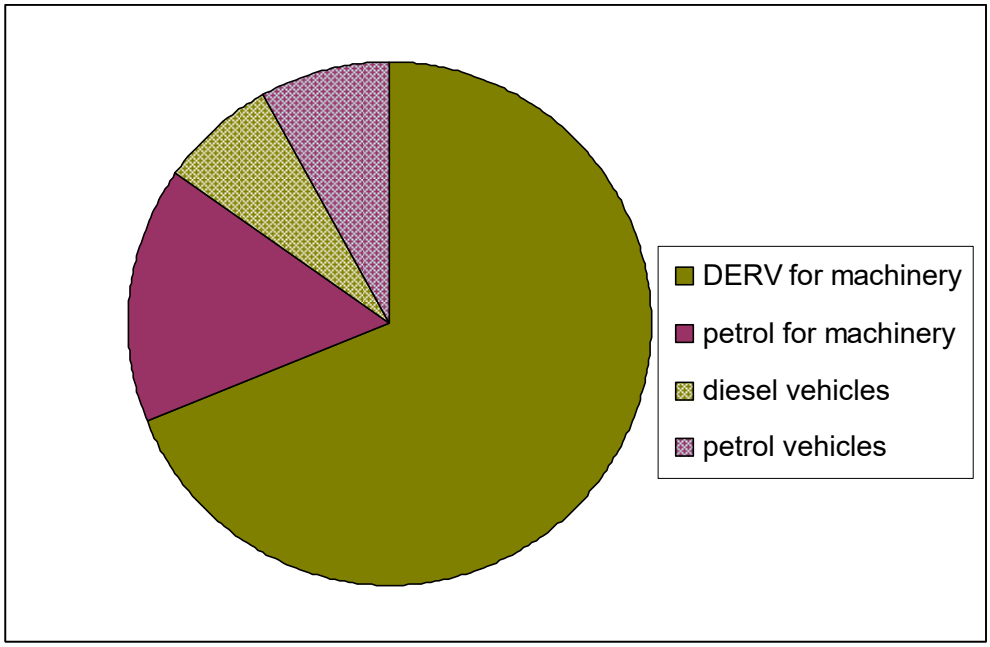
Petroleum fuels purchased 2019/20

approx	amount	cost excl VAT	net CV	density	energy content		
	litres	£	kWh/kg	kg/litre	kWh/litre	MWh*	%
DERV for machinery	5,000	5,208	11.83	0.854	13.85	69.2	71%
petrol for machinery	966	1,032	12.18	0.737	16.53	16.0	15%
diesel vehicles	524	580	11.87	0.840	14.13	7.4	7%
petrol vehicles	484	403	12.18	0.737	16.53	8.0	7%
Totals	**6,974**	**7,223**				**100.6**	**100%**

1 MWh equals 1,000kWh

Whilst the amount of petrol for machinery use may be an underestimate, it is clear that nearly 90% of petroleum fuels used are for the ground maintenance machinery.

Approximate uses of liquid fuels purchased



The cost of petroleum fuels to the Council is around £7,200 pa.

2.4 Renewable electricity generation

PV installation on roof of Works Unit

This installation of 19.95 kW with a Declared Net Capacity of 17kW- allowing for internal electricity uses generates around 18,500 units a year.

PV generation for 2019/20 for each invoice period

from	to	days	Generation kWh	kWh/day average
01-Jul-19	24-Sep-19	86	6,034	70.2
24-Sep-19	18-Dec-19	85	1,055	12.4
18-Dec-19	13-Mar-20	86	1,577	18.3
13-Mar-20	31-Mar-20	18	1,623	90.2
01-Apr-20	17-Jun-20	78	7,032	90.2
estimate rest of the year Jun-Jul		13	1,172	
total for year		366	**18,493**	

The Council earns around £2,850 a year in FIT tariff and export tariff payments. The summer months of April to September provide around 77% of the energy generated.

However the figures for each month when analysed in kWh/day for each period do not appear to following the expected pattern. For example the average output for PV system in March will be much lower than that for April to June when the sun is at its highest in the sky. There may be some estimated figures in the payments made to the Council.

The following table gives a more likely estimate of the generation each month from this system, within the annual payments received.

The table also breaks down the hours when PV generation is potentially useful for the building occupiers, and an estimate of how much electricity could be being supplied from the PV to building uses.

However this is an estimate only as there is no data to suggest what PV generation is actually used by the building. This is only possible to assess if an export meter is fitted to the system..

It is therefore possible at present that the Works Unit is consuming an extra 5,600kWh pa of “unmetered” PV supply on top of the invoiced electricity from the external supplier. If this is the case the analysis of the Works Unit electricity demand will need re-assessment.

Rough estimate of PV generation against Works Unit electricity imported demand

	PV output kWh/day estimated	PV generation kWh/month	Works Unit demand kWh/month	Useful PV generation hrs/day	PV generation potentially used	
					%	kWh
Mar	30	900	1,121	8.0	100%	900
Apr	45	1,350	1,073	11.9	67%	906
May	95	2,945	501	13.4	10%	298
Jun	100	3,100	227	14.3	7%	227
Jul	96	2,976	121	13.9	4%	121
Aug	80	2,480	251	12.6	10%	251
Sep	70	2,105	294	11.9	14%	294
Oct	25	775	1,048	6.9	100%	775
Nov	12	372	2,660	4.6	100%	372
Dec	12	385	3,860	3.8	100%	385
Jan	18	568	3,683	4.9	100%	568
Feb	19	537	2,458	7.0	100%	537
Totals		**18,493**	**17,297**		**30%**	**5,634**

The calculations in this table assume that the Works Unit is open for use by staff from 8am to 4.30pm.

3 Greenhouse gas emissions from Council operations

The usual expression of greenhouse gas emissions is as their carbon emissions as summed by CO2e – or carbon dioxide equivalents.

CO2e means the equivalent to CO2 gas with all the other greenhouse gases such as methane and CFCs added in as per their individual Global Warming Potential- which is expressed relative to CO2 as CO2 equivalents.

The CO2e coefficients for each energy source are taken from the joint Defra and BEIS government departments publication which gives the co-efficients each year. The electricity CO2e figure changes each year depending on the proportions of wind and solar vs gas and coal used to generate the grid electricity supply.

See https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019 for full details of methods.

3.1 Greenhouse gas emissions for electricity use

The table below indicates the greenhouse emissions from electricity use by Council facilities, as measured in tonnes of CO2e for each kWh used.

The co-efficient includes the generation and transmission and distribution losses and totals 0.27730 kg CO2e/kWh used.

Greenhouse gas emissions from electricity use

Location	Energy		CO2e tpa
	kWh pa	%	
Castle	43,977	39%	12.2
Parkhouse	24,350	22%	6.8
Works	17,297	16%	4.8
Library	11,945	11%	3.3
Triangle	8,763	8%	2.4
Others	5,046	5%	1.4
total	**111,378**	**100%**	**31**

3.2 Greenhouse gas emissions from gas use

The greenhouse gas emissions from gas are assessed against the figure of 0.18385 kg CO2e/kWh of gas used from the government guidelines noted above for 2019. This is the emissions for the gross CV of gas demand.

Greenhouse gas emissions from gas demand

Location	kWh pa	Emissions	
		tpa CO2e	Percentage
Parkhouse	116,671	21.4	53%
Castle	75,079	13.8	34%
Library	28,419	5.2	13%
total	**220,168**	**40.5**	**100%**

3.3 Greenhouse gas emissions from oil based fuels

The use of oil based fuels is related to the ground works carried out by the Works Department and hence their energy demand relates to the use of vehicles and machinery for use around the town.

Oil derived fuels **2019 approx figures**

Fuel type	Energy used	carbon coefficient	ghg emissions	
	total kWh	kgCO2e/kWh	tonnesCO2e	%
DERV for machinery	69,235	0.273	18.91	71%
Petrol for machinery	15,956	0.246	3.93	15%
Diesel vehicles	7,405	0.260	1.93	7%
Petrol vehicles	7,995	0.246	1.97	7%
Totals	**100,591**		**26.73**	**100%**

As would be expected from the dominance of the diesel driven machinery energy demand the largest component of the oil emissions is from the Derv purchases.

3.3 Greenhouse gas emissions from soil amendments

The greenhouse gas emissions from the grounds activities and the management of the open spaces under the Council's control are estimated differently from the direct energy demand calculations. The direct emissions under the Council control which have been estimated relate to the purchase of soil amendments such as fertilisers and composts. It is not feasible within the bounds of this report to accurately estimate the emissions from soil disturbance, though measures to reduce this can be outlined.

Some companies are shy about publishing the greenhouse gas emissions from either the production or use of their products. This assessment covers only the use of these products and does not consider the not inconsiderable greenhouse as emissions from the manufacture of these high energy demand products, as that is a topic for any Scope 3 assessment of the Council carbon footprint.

Purchased soil amendments – approximate figures

Soil amendment		**kg pa**	**N kg pa**	**kgCO2e/kgN**	**kg CO2 e pa**
fertiliser					
Yara Kristalon		50			
	nitrate		5.65	7.6	43
	urea		1.85	13.9	26
	other		42.5	3.5	149
	Total				**217**
ICL NPK 20:10:10		250			
	nitrogen		50	7.6	**380**
total fertiliser					**597**
compost					
Levington Sphagnum moss peat			litres pa	2,250	
99% carbon based		146			
	Total compost via weight of peat				**536**
Total soil amendments					**1,134**

The use of soil amendments directly produces just over one tonne pa of CO2e each year. This does not include the high environmental degradation and additional carbon emissions in the extraction of peat or the energy costs of the manufacture of fertilisers.

3.4 Total direct carbon emissions

The table below summarises the totals calculated in this report.

3.4.1 Buildings and main facilities

Greenhouse gas emissions from Council buildings

Building	Energy source	Energy demand	Carbon emissions	
			CO2e tpa	%
Castle	electricity	43,977	12.2	
	gas	75,079	13.8	
	total	**119,056**	**26**	**36%**
Parkhouse	electricity	24,350	6.8	
	gas	116,671	21.4	
	total	**141,021**	**28.2**	**40%**
Library	electricity	11,945	3.3	
	gas	28,419	5.2	
	total	**40,364**	**8.5**	**12%**
Works Unit	electricity	**17,297**	**4.8**	**7%**
Triangle	electricity	**8,763**	**2.4**	**3%**
Others	electricity	**5,046**	**1.4**	**2%**
Total		**331,547**	**71.4**	

This table shows that Council buildings use around 332 MWh (331,547kWh) pa and produce over 70 tonnes pa CO2e.

The largest carbon emitter is the Parkhouse at over 28 tpa CO2e and 40% of building emissions, with the Castle a close second at 26 tpa and 36% of emissions.

3.4.2 Groundworks

Activity	Energy source	Energy demand kWh pa	Tpa CO2e
Works Unit	Electricity	**17,297**	**4.8**
Fuels			
	Diesel machinery	69,235	18.91
	Petrol machinery	15,956	3.93
	Diesel vehicles	7,405	1.93
	Petrol vehicles	7,995	1.97
	Total	**100,591**	**26.73**
Soil amendments			1.13
Totals		**117,888**	**32.66**

The groundworks activities of the Council add considerably to the Council carbon footprint, mainly because of the high use of diesel for machinery. The total from oil based fuels is nearly 27 tpa CO2e. In total the emissions associated with the grounds maintenance and flower displays including soil amendments is 33 tpa CO2e once the Works Unit building is included.

3.4.3 Total Council carbon emissions

The table below shows how the total of Council carbon emissions sums to nearly 100 tonnes pa of CO2e.

Council carbon emissions

Emission source	Energy source	Energy demand	Carbon emissions		
			CO2e tpa	% of buildings	% of Council
Castle	electricity	43,977	12.2		
	gas	75,079	13.8		
	total	**119,056**	**26**	36%	27%
Parkhouse	electricity	24,350	6.8		
	gas	116,671	21.4		
	total	**141,021**	**28.2**	40%	29%
Library	electricity	11,945	3.3		
	gas	28,419	5.2		
	total	**40,364**	**8.5**	12%	9%
Works Unit	electricity	**17,297**	**4.8**	7%	5%
Triangle	electricity	**8,763**	**2.4**	3%	2%
Others	electricity	**5,046**	**1.4**	2%	1%
Total		**331,547**	**71.4**	**100%**	**73%**
Grounds work inc soil additions		**100,591**	**27.9***		**27%**
Grand total		**432,138**	**99.2**		**100%**

* *excluding Works Unit*

This is nearly all due to fossil fuel use, amounting to around 432,100kWh pa or 432 MWh pa.

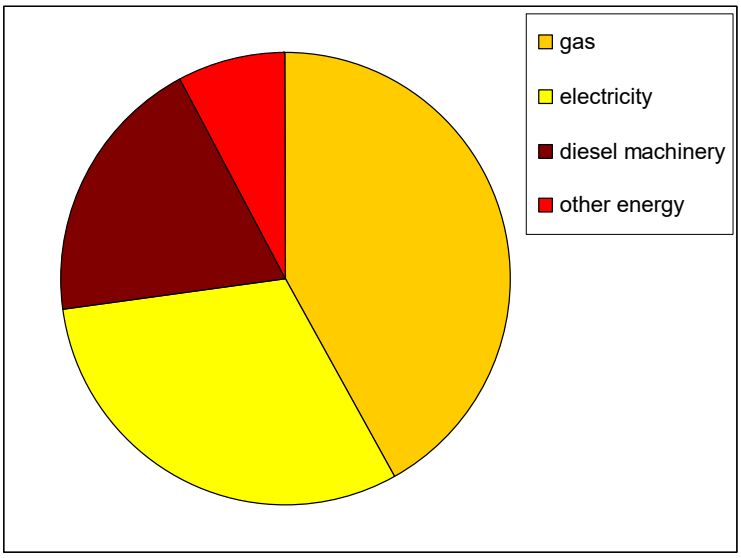
The main sources of the carbon emissions under the Council's control in this Scope 1 and Scope 2 analysis are shown in the table and pie charts below.

The carbon savings from the Council's PV installation are about 5.13 tpa CO2e. If this is counted in the total the net effective carbon emissions for the Council activities are 94.1 tpa CO2e.

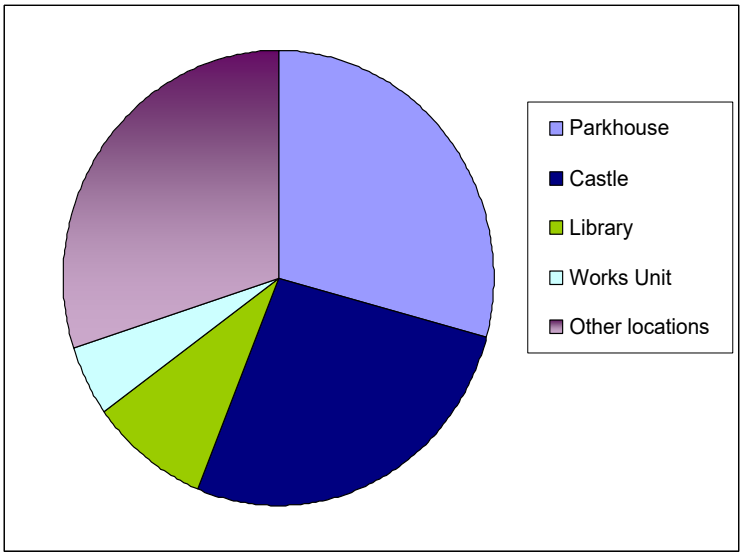
The calculations in the following section will be based on the actual carbon emissions, rather than the net emissions.

Main sources of carbon emissions

Main sources of emissions	Carbon emissions	
	CO2e tpa	% of Council total
gas	40.5	40%
electricity	30.9	31%
diesel machinery	18.9	19%
total main energy sources	**90.3**	**91%**
Buildings to focus on		
Castle	26.0	26%
Parkhouse	28.2	28%
Library	8.5	9%
Works Unit	4.8	5%
totals	**67.5**	**68%**



Sources of energy emissions by energy type



Sources of emissions by building

The analysis leading to this total allows a clear path to be determined on how to rapidly reduce the Council's emissions towards Zero Carbon.

Part 2 of this report shows how to reduce the Council's emissions and the methods needed to achieve this aim.

4 Annual costs of energy demand

The analysis of the Council's energy bills has enabled the total costs of energy to the Council to be assessed. This is summarised in the table below.

Summary of energy costs

Energy type	Energy used		Annual cost £pa^^		
	MWh pa *	%	unit costs	total costs	% of costs
electricity	111.4	26%	16,200	17,587	53%
gas	220.2	51%	7,667	7,871	25%
liquid fuels	100.6	23%		7,223	23%
totals	**432.2**	**100%**		**31,913**	**100%**

**1 MWh is 1,000 kWh ^^ excluding CCL*

The table shows that energy purchases cost the Council around £32,000 pa, with over half the cost being electricity: the most expensive fuel making up a quarter of demand.

PV earnings

The earnings from the PV system on the Works Unit roof can be offset against this cost. The PV income is generally about £2,850 pa.

This makes the net effective energy bill £29,063 pa.