Atlantic Energy

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Cornwall

# Carbon Audit for Bude-Stratton Town Council

October 2020

## Part 2

## Programme to reach zero carbon emissions from energy

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# Contents Section 2

## Main principles for achieving Zero Carbon from energy

1 *decide strategy and commit to zero carbon*

2 *decide if a task is necessary*

2 *determine the lowest energy demand method of achieving tasks*

3 *replace remaining demand with renewable energy sources*

4 *wherever possible ensure the renewable energy sources are local*

5 *improve the local environment through land management for carbon sequestration*

The task of achieving Zero Carbon for all Council activities is not easy as it requires a complete rethink and paradigm shift for all Councillors and Officers, as well as support from the local community. Every action requires energy, which generally is a hidden part of modern life. Now that climate change impacts have forced us to change how we demand and supply energy, more and more people and organisations are realising how our systems are completely dependent on high fossil fuel energy demands.

This section of the report aims to show how to change the Council energy system to one fit for the new purposes of the 21st Century.

A Council Zero Carbon energy system will also have many other benefits including:-

- reducing energy costs,
- increased potential for local community energy ownership
- increasing local economic benefit,
- reduced noise
- reduced local pollution around the town
- increased biodiversity
- attractive plantings for locals and visitors alike

# 0 Summary

## *0.1 Council carbon emissions*

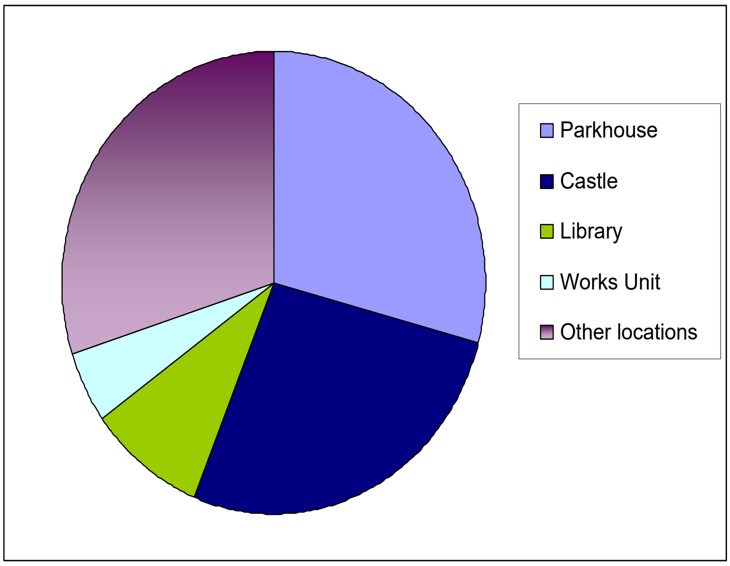
From Section 1 of this carbon audit it is apparent that the Council net fuel bill of £29,000 pa is responsible for about 100 tpa CO2e, with the main sources shown in the table below.

***Main sources of carbon emissions***

| Main sources of emissions | Carbon emissions | |
|---|---|---|
| | **CO2e tpa** | **% of Council total** |
| gas | 40.5 | 41% |
| electricity | 30.9 | 31% |
| liquid fossil fuels | 26.7 | 27% |
| **total main energy sources** | **98.1** | **99%** |
| | | |
| **Buildings to focus on** | | |
| The Castle | 26.0 | 26% |
| Parkhouse | 28.2 | 28% |
| Library | 8.5 | 9% |
| Works Unit | 4.8 | 5% |
| **totals** | **67.5** | **68%** |

This shows the areas of activity on which this section of the report is focussed. The pie chart below indicates all the buildings and facilities carbon emissions.

***Council buildings carbon emissions***



## *0.2 Methods of reducing emissions*

### *1 Corporate actions*

A key element for the Council as local leader and committed to the journey to zero carbon is to involve all members of staff and the Council to the journey through awareness raising and appropriate training from now on for the long term. Another key element is to appoint a Carbon and Energy Manager at a senior level, possibly part time, whose sole task is to develop the action plan and implement it as soon as possible.

### *2 Reduce energy demand*

This starts with setting up energy monitoring and control systems for all energy use in the Council, including the liquid fuels. Once energy use is monitored is it possible to determine the best carbon reduction methods and their priorities for investment. These systems need to control firstly heating systems and then electricity use, especially lighting. Calculations indicate that an investment of around £18,500 should yield savings of over £19,000 over five years and save over nine tonnes of carbon emissions.

The second major energy demand reduction action is the install a water source heat pump system for the three main buildings. This would cut out the need for gas heating and save 40 tpa CO2e or 40% of Council emissions. A feasibility study is suggested for this to ensure a good design and financial viability, for the major investment this would represent

### *3 Change remaining demand to renewables*

The easy big win here is firstly to change the electricity supply to a company which only supplies renewable energy sourced electricity, of which there are several available. This approach would save around £1,000 pa depending on the supplier chosen, and would achieve an early saving of 30.9 tpa CO2e or 31% of the Council's carbon emissions.

This would demonstrate the serious of the Council's intentions on the journey to zero carbon.

The second phase of changing demand to renewables is to install PV on Council buildings, which could include most Council buildings. Most roof tops are suitable, though the Castle would better suit a different approach being a Listed Building. In this case a suitably landscaped covid-safe open sided shelter, distant from the Castle to the north side of the entrance roadway would provide a space for visitors and potentially a location for the café to enable more earnings than presently possible. Together these options would cost about £62,000 with a return of £33,000 over five years and save 15.7 tpa CO2e

If the Council wishes to increase its local carbon reduction actions, it would be feasible to install a small land array on Council land to the SE corner of Summerleaze downs and sell the electricity directly to the two main users close by ie Sainsbury's and the Atlantic Rise. This would act as infill and enable a wild enclosing hedgerow to increase local biodiversity and enhance the local views. Direct sales to users is more viable than aiming to sell on the open market to distant purchasers as the prices are low at present.

This action could be larger or smaller depending on the Council and local views of the benefits and the organisational structure chosen. The area could produce up to about 450kW and save around 130 tpa CO2e or more than the Council's present emissions. If developed as a community owned scheme, there would be potential for local actions to reduce fuel poverty and increase biodiversity from the income over a number of years.

### *4 Buildings recommendations*

As noted above all the buildings need to be monitored and controlled in electricity and gas used, and lighting updated and changed to LEDs under suitable control systems. All accessible lofts need to be insulated to present standards as this is an investment with early financial returns and noticeable carbon reductions.

**The Castle** needs to be insulated using natural breathable rendering to reduce its heat demand and increase the internal temperature and humidity stability. Although expensive this would reduce running costs and there is a local example of this internal wall insulation being used in a Listed Building. A feasibility study would enable the costs and practical issues to be finalised. In the meantime the new control system could make significant inroads into the present gas use.

**The Parkhouse** walls in the old section should be insulated as part of the working up of the proposed heat pump system. This would enable the very old boiler to be switched off in the meantime without loss of comfort.

**The Library** requires the standard building approach of increasing the roof/loft insulation levels, updating lighting and installing a control system for the heating.

**The Works Unit** has a high electricity demand as direct electric heating is used for the office and crew room. The immediate proposal is to insulate the heated areas and to install an air-to-air heat pump which also provides dehumidification for the work clothes drying area. This would cut the electricity demand by 75% and hence be a early win on carbon and cost reduction, provided suitable controls are installed and operated.

### *5 Groundswork*

Apart from the Works Unit building actions noted above the grounds work team also use significant quantities of oil as petrol and diesel for machines and vehicles. The allocation of carbon to each activity has been an estimation only.

Five machines together use 80% of the machinery energy and 50% of all the liquid fuels used by the Council, mainly for grass cutting, producing seven tpa CO2e. At present the Council grounds are kept very neat with regular grass cutting. A change to some areas to allow wildflowers to bloom would not only increase local enjoyment and biodiversity it would also significantly reduce carbon emissions. All edges should obviously be kept neat so that the more open areas of flowers are seen to be intentional. This approach is gathering pace in several councils around Cornwall and upcountry.

As some of this is due to work with Cornwall Council it is proposed that the SLA is renegotiated to change towards wildflower verges and other actions to increase local carbon sequestration over North Cornwall.

The second step is to change the machinery over time to battery operated systems of which there are many commercial smaller machines such as strimmers, chainsaws, mowers, etc. Larger machines such as compact tractors with high torque are now available and the cost can be partly offset by selling the present machines.

The vehicles owned by the Council include one electric van and its use must be prioritised over the diesel similar van and potentially over the use of other vehicles in the Council fleet. It will take time to source battery driven pickup trucks for the Council as the present ones on the market are expensive, but as the demand grows the cost is expected to reduce to achievable levels.

The Council creates around one tpa CO2e from its soil amendments as direct carbon emissions. As this includes moss peat, it is recommended that the Council does not purchase any more peat compost as the environmental damage at the extraction sites is large and high carbon emitting. Instead a change of use of the present grass cuttings and increased use of local wood chipping to create composts and mulches would enable mulching of all flower beds to increase the soil health, and reduce watering requirements

## *0.6 Proposed action programme*

The proposed action programme is in three sections.

***1 First six months.*** Set up awareness programmes and employ a Carbon and Energy Manager, followed by the installation of monitoring of all Council energy use in detail. Electricity supply to be changed to a renewable supplier, and the feasibility study undertaken for the water source heat pump system. Develop a programme to reduce grass cutting in half and increase usage of the EV.

***2 Six months to eighteen months.*** Ensure staff and Members are being trained, develop the investment programme in detail, install building energy management systems and change lights to LEDs, increase loft and ceiling insulation to modern levels, insulate internal walls where needed.

Develop investment programme and start installation of PV systems on Council buildings and facilities; investigate the PV land array option, act on results of feasibility of water source heat pump system, investigate grant potentials for this.

Work with local ecological landscape designer on approaches to carbon sequestering approaches to the Council's land management, re-assess vehicles and machinery needs in the light of the new approach, change to battery systems where feasible, start making own composts.

***3 18 months to three years*** Increase local community participation, keep monitoring and improving controls on energy use, adjust investment programme as needed.

Install more PV on Council buildings, make investment decision on potential land array.

Renegotiate SLA with Cornwall Council, start planting for carbon sequestration, nitrogen fixing and increased biodiversity along with increased local community involvement in plantings for tiny forests and shelter belts etc

***Investment programme***

The proposed actions fall into several categories as noted in the individual sections of the report including reducing energy demand, changing to renewables and changing activities to low carbon ones.

One early Council decision is the balance of investments and activities between direct reduction of carbon emissions vs carbon offsetting and sequestration actions.

When viewed on a global scale it is clear that the target has to be zero direct carbon emissions, as it is not feasible to reach zero unless all emissions are cut. However there are practical issues, for the Council, around directly and quickly reaching zero carbon, which mainly centre around the scale of financial investments needed.

This suggests that one approach is to develop the direct reduction actions within the feasible financial envelope and in parallel develop the carbon offsetting and sequestration options, which are often cheaper. Carbon sequestration provides other environmental benefits, although the quantifying of carbon actually sequestered in the soil or growing biomass is fraught with difficulties.

### *1 investment programme: low cost reduce CO2e emissions by 50%*

| Action | net cost 5yrs/ tpa CO2e | tpa CO2e | Capital £ |
|---|---|---|---|
| Change to renewable electricity | - 162 | 30.9 | 0 |
| Monitoring and control systems | - 74 | 9.4 | 18,500 |
| Lighting to LEDs including gardens | - 1,538 | 5.2 | 5,000 |
| Reduce grass cutting | - 2,044 | 4.5 | 0 |
| Works Unit air-to-air heat pump | - 417 | 3.6 | 6,000 |
| **Totals** | | **53.6** | **29,500** |

This table shows how to half the Council's carbon emissions for around £30,000 investment, with the main reduction (30%) coming from changing your electricity supplier. This carbon offsetting can be regarded as an interim step whilst the rest of the programme is developed. The actual investments outlined here all payback financially within a relatively short time, as indicated by the column showing negative net costs over five years ie investment minus savings divided by carbon saved.

### *2 Next steps investment programme:*

| Action | net cost 5yrs/ tpa CO2e | tpa CO2e | Capital £ |
|---|---|---|---|
| Insulation-*lofts, some internal walls* | 2,099 | 17.2 | 87,000 |
| PV on Council buildings | 1,847 | 16 | 62,000 |
| Land management for c sequestration | 907 | 15 | 13,600 |
| Increase use of EV, install batteries | 1,600 | 2.5 | 15,000 |
| **Totals** | | **50** | **177,600** |

This table shows how further reductions can be made of another 50 tpa CO2e for around £180,000 investment, with 15 tpa CO2e coming from carbon sequestration and the rest being direct reductions of carbon based energy use. This section of investment shows a direct correlation between the investment costs and the amount of carbon saved.

Although the indicated carbon savings from these two sets of actions and investment appear to add up to around the 100 tpa CO2e target, in reality the Council would still be responsible for 37% of its carbon emissions.

The first stage therefore appears to be to achieve an actual emissions reduction of about 60 tpa CO2e or 60%, for approximately £200,000 investment, most of which will pay back within normal financial requirements. This 60% reduction from the two tables above is less than the indicated 100% reduction because some actions change the savings from others and there is some carbon sequestration which has been removed from the calculation.

The second three years could be devoted to reaching closer to or achieving the target, which would show Bude Stratton Town Council to be a leader in this field as well as increasing local energy resilience.

# 1 Corporate actions

The Council has already through it's declaration of a Climate Emergency and its March 2020 Climate Plan decided to aim for carbon neutrality by 2030. This is a major first step.

## *1.1 Behaviour change*

**Climate and energy awareness training**

As the awareness of the need to reduce energy related carbon emissions to Zero and how to achieve that is needed at all levels within the Council, it is important that all staff are engaged in awareness raising and training. Such actions also reinforce the Climate Emergency Declaration.

For all managers and Councillors, the following online course is recommended. Although this is a two day course, which may seem a long time to take staff from normal duties, it is both inspirational and well based scientifically, with ample discussion times allowed for all participants to learn from each other as well.

Example recommended courses:-

- ***Centre of Alternative Technology*** online Zero Carbon Britain 2 day course £75.00 course run at intervals

  *The course is based on the CAT report published in 2019, Zero Carbon Britain: Rising to the Climate Emergency, incorporates the very latest developments in science and technology to show that we can create a zero carbon Britain using only proven technology. During this two day course you will explore all aspects of climate solutions and scenarios presented in the research. Live lectures will cover a range of topics from renewable energy and energy efficiency to diets and land-use, looking at how these can work together to help us build a zero carbon future. Online workshops will enable discussion and debate among participants on catalysing action across all areas of society.*

- ***Centre for Sustainable Energy***, Bristol – one day online course for town and parish councils wishing to take practical action on their climate emergency declarations. The workshops cover:-

  - *A good grounding on the context from global to local levels.*
  - *An understanding of the role of local councils and their levers of influence.*
  - *The beginning of a practical action plan for their parish or town*
  - *Access to CSE resources and continued support.*

Follow up at climateemergency@cse.org.uk or 0117 934 1400.
Workshops can be run for whole counties, district-wide or for individual councils and are suitable for between 25-50 delegates, at a cost of £2,565.

***Chartered Institute of Building Services Engineers*** – run several relevant training courses on energy efficiency for buildings – both onsite and online. They cost around £330 per person/course.

***The Carbon Buddy Manual*** is a very useful tool developed and published by Colin Hastings, a Cornish author. It provides very valuable approaches both to reducing our individual carbon footprints but also to the human and group issues around reducing carbon, £12.99 each or ten for £99.99 from www.carbonbuddyproject.org. The author is an organisational psychologist so is well qualified for the task of organisational change towards low carbon.

## *1.2 Appoint carbon and energy manager*

You cannot manage what you do not measure.

A vital component of changing any system is to have a senior person tasked with seeing this through, both technically and in enthusing and continuing to ensure vigilance to the main aim by all staff and members. This task will require the appointment of a carbon and energy manager, whose functions are likely to include:-

- setting up and running energy and carbon awareness programmes at appropriate levels throughout the Council and for all Members
- setup a Building Log Book for each building to enable more efficient running of each building
- setting up and running the Zero Carbon investment programme with Council approval
- setting up and operating a strong metering and monitoring programme for all energy using buildings and facilities: effective decisions obviously require good information
- ensuring all equipment & machinery is fit for purpose and kept well maintained and efficient
- working with the local community on how to show progress and potentially visual changes and biodiversity increases on Council managed land

# 2 Reduce energy demand

The first step with energy reduction is the consideration of which tasks are actually needed and which could be done differently or less frequently.

This is particularly the question when considering the mowing regime for the Town's grass area for example. Proposals for reducing the energy and carbon requirements for the groundworks are considered later.

## *2.1 Set up management & control systems for all energy use*

- Ensure that all electricity, gas and oil tank meters are read and recorded each month, with senior management receiving comparative reports on progress and issues occurring.
    - It is only feasible to chart the progress towards zero carbon if energy use is properly recorded and controlled
    - The Council could set this up internally or let out a contract to an external specialist company
- Install full boiler/energy management control systems on all boiler plant

It would appear that none of the heated buildings have an energy management system in place, as each building appears to operate with manual control by building managers. Whilst this can be an effective method, it does not allow for changes in daily temperatures and the timelag for each building which is external temperature dependent.

- A complete building energy management system allows for the external temperature to determine when the heating system is switched on in relation to building occupied hours, it reduces the inefficiencies of boiler cycling when a building reaches its set temperature in whole or in part, and switches off to reduce waste at the end of each working day.
- See each main building actions for details
- At present all heating systems appear to be under the control of the building occupants with the consequence that there is little to no accounting for the local external temperature or how long the building takes to heat up with varying winter temperatures- with potentially significant energy wastage

- Potential costs and savings relate to the individual building situation. Building energy management systems can be expensive, costing up to £30,000 installed per building or at much lower capital cost if there are fewer controls, down to under £1,000 for the simplest. Given the local situation in the Town it is feasible to achieve energy savings of 15-40% for heating in the main buildings.

- Install automatic lighting control systems in main buildings
  - Whilst the Council already has a policy of encouraging staff to switch off lights when they are not needed, this often still leads to preventable waste
  - Several control systems are available which operate by IR sensing of the presence of people or by microwave sensors for movement. These methods can be installed in modular equipment so that lit areas for example are not lit when no-one is present. This would be a useful adjunct to the Castle lighting systems in particular, where graduated dimming upstairs might be helpful to allow the best use of daylight as available.

***Building energy controls and monitoring systems***

Appropriate building energy control and management systems are available from several suppliers. The systems with more complexity and higher control functions can cost several thousands of pounds to install, though many now operate with wifi connections throughout, reducing the installation cost. Generally this type of monitoring and control system pays for itself in reduced energy costs in 3-6 years.

*Clarkson Controls* 01562 730 874 dawn@clarksoncontrols.co.uk – experience with old manuscripts, paintings and furniture as well as office and school/sports buildings.
*Honeywell Controls* feature a central console, of appropriate complexity, with digital room thermostats with Eco feature required for example for areas in the library or other buildings or more for fully programmable controllers

*Tado.com* for small building boiler controls with room thermostats and local weather data integrated for energy saving control. c.£500+ depending on thermostats required, on mobile phone system.

*Efergy* for a relatively simple starter system c £300+ each building to install for three phase electrical monitoring for up to five circuits https://efergy.com

### *Lighting controls*

The main buildings under the Council control which could benefit from lighting controls are the Castle and Parkhouse. Given the aim of managing the process of reducing the Council's carbon footprint down to zero, and the present lighting situation in these buildings it would be most advantageous to implement lighting control via a modular system.

There are several manufacturers, suppliers and installers of lighting systems, but mainly these are focussed on larger buildings. CP Electronics noted below is probably the most relevant manufacturer for the Council. Outlines are provided in each relevant building detail below.

https://www.lightingcontrols.ltd.uk/

https://www.cpelectronics.co.uk/energy-saving-products/lighting-control-systems?
*Parts available from Edmundson Electrical in Plymouth and Barnstable*

### *Examples of ways to save electricity on office equipment:*

- Ensure that all office equipment is switched off when not in use. Although this is already part of the Council's Environmental Policy more action is needed to ensure that office equipment is switched off, not just allowed to go into hibernation mode where it still uses electricity.
  - Set computers to go into sleep/hibernation mode when not in use short-term- by judicious use of the power settings in each machine
  - Make sure all computers and their peripheries are switched off at the wall at night. Plug all peripheries such as printers, routers, scanners etc into an Extension Lead with USB and standard plug sockets with one power switch. This enables all devices to be plugged into a desk situated lead and switched off at night with one switch.
  - Only print what is absolutely needed as hard copy.
  - Ensure that any equipment purchased for the office has a high energy rating – replace older types of office equipment, as they can use between 50 and 90% more electricity than energy-efficient models.

## 2.2 Reduce energy demand of heating systems

The gas heating systems in use by the Council use around 220 MWh pa and create 40 tpa CO2e, some 40% of the Councils direct emissions. The change away from gas to renewable energy systems would therefore have a big impact on the Council's aims to reach carbon neutrality.

The present heating systems in Council buildings use either gas or electricity, and are mainly manually controlled. As noted above each main building needs a complete overhaul of its control systems to enable the installation of external temperature sensing systems, with heuristic programming to enable the systems to only switch on as needed depending on building use and temperature lift required.

The heating systems in use at the three largest buildings are gas fired boilers, with electrical heating at the Works Unit. Whilst some of the gas boilers may be efficient, especially the new Castle boiler, the major need to reduce the gas demand requires a rethink about heating methods for each building.

The main zero carbon method of reducing energy demand for heating is to change heating systems to renewable energy sources. These can be biomass energy, geothermal, water or air sources of ambient energy.

For the Council, biomass boilers are not thought appropriate as the buildings do not have the space for fuel stores and this type of boiler does require some maintenance, although only once a fortnight or so to remove ash. On the assumption that the Council would prefer to have local biomass supplies for its fuel, the fact that there is little local wood supply commercially available in this area would also be a negative point.

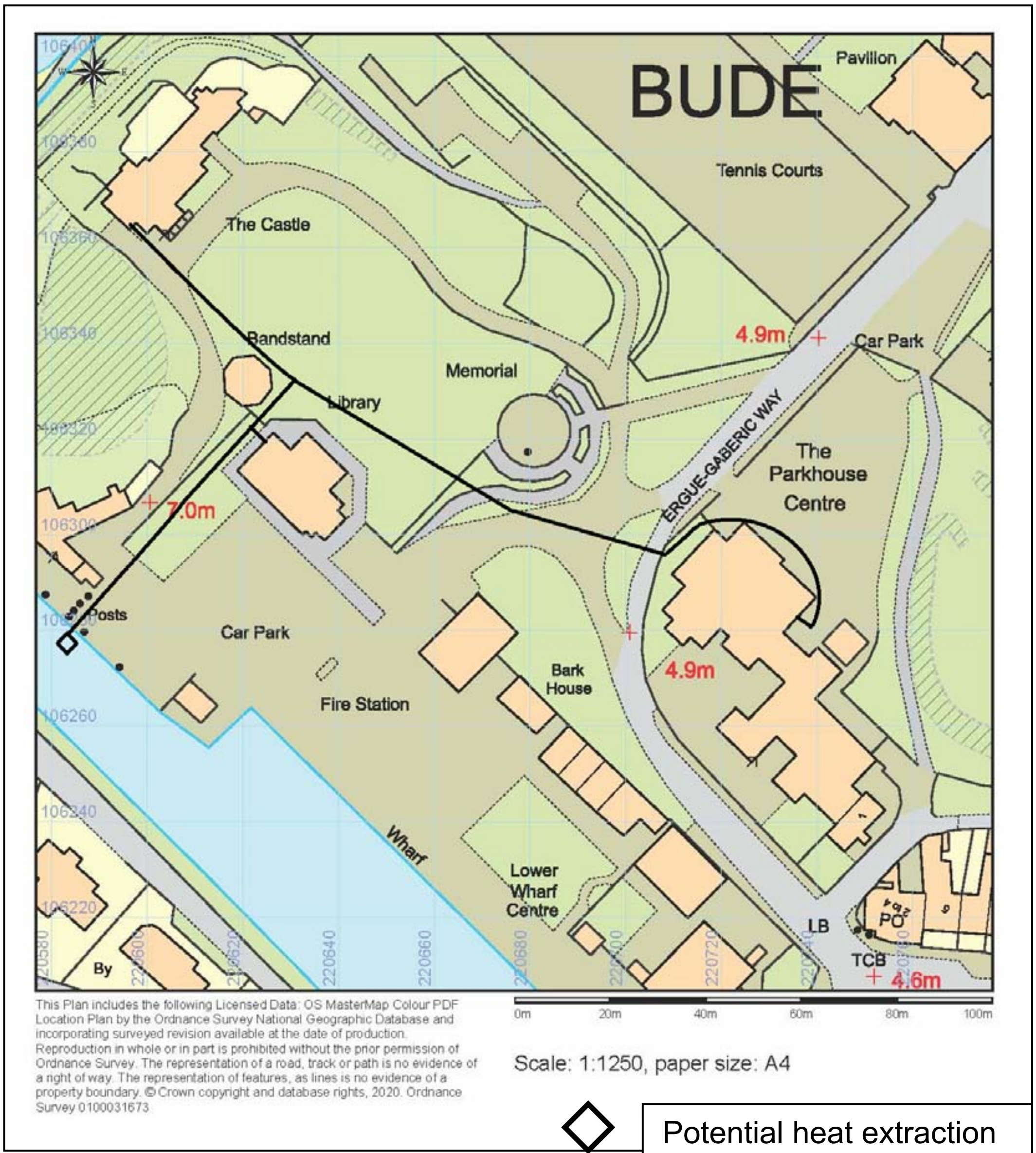
One method of reducing energy demand for heating is to change to heat pumps. Heat from a local ambient energy source is absorbed at low temperature into a fluid. This fluid passes through a compressor, increasing the temperature, and transfers that higher temperature heat to the heating and hot water circuits of the building. The local ambient energy source can be air, water, or the ground: all of these provide useful amounts of energy. They generally enable heating systems to operate with one third of the purchased energy requirement, as electricity, compared to gas boilers or direct electrical heating systems. This is achieved by taking the other two thirds from the surrounding natural environment, as noted above.

## 2.3 Change gas heating to heat pumps

There are several options for installing heat pumps to provide the heating for the three main buildings. These are:

- Air source: cheaper to install, but lower efficiency in winter with lower air temperatures when the heat demand is highest
- Ground source: higher system efficiency, which has two approaches
    - 1 requires drilling holes to provide warmth from the ground. In this sandy area this will require full casing of the drill depth to prevent sand ingress into the holes. Alternatively a piling rig can be used to provide more and shallower boreholes.
    - 2 requires slinkies, or long rolls of small diameter pipes to be set one metre or so below ground, preferably under grass for ease of installation. This approach needs wider areas of grass or tarmac to be used, but is not visible once installed
- Water source: the highest efficiency as water is the most heat conducting medium, allowing ease of heat transfer into the collecting pipeworks. As the Bude Canal is very close by and kept full all winter this would be a strong possibility. There are two options for the best use of this resource
    - Open pipe system transferring water from the Canal side to each of the three buildings via a single pipe. Each building to have its own heat pump system using the warmth in the piped water, which is then cooled by a few degrees and returned to the Canal.
    - Heat transfer matting/coils placed at the bottom of the Canal, with conducting fluid running through it collecting warmth and conveying that either to a large heat pump system with onward hot water pipes to each building or the directly warmed fluid being conveyed to a heat pump system at each building. The warmed fluid would then be pumped back cooler to the heat transfer system in the Canal for reheating. The single heat pump option would require more expensive well insulated pipe between the buildings.

*__Plan showing potential use of the heat in the Canal water for local heating__*




| | |
|---|---|
| ◇ | Potential heat extraction point |
| — | Pipe locations |

As can be seen from the plan above, the Library building is very close to the Canal and any pipes from the Canal can be placed mainly under the grass close to the Library. Transfer between the three buildings can also take place mainly under grass, which would reduce disruption and costs.

As the Canal lock gates are closed for the winter season, the water depth at this location should provide enough heat capacity to supply the required heat for the buildings proposed, without reducing the canal water temperature.

### *Main parameters for water source heat pump systems*

| Building | | kW | no | kW each | approx. boiler efficiency | MWh pa | floor area m2 | built |
|---|---|---|---|---|---|---|---|---|
| **Castle** | | 90 | 2 | 45 | 95% | 75 | 620 | 1830 |
| gas boiler Vaillant new | | | | | | | | |
| **Parkhouse Centre** | | | | | | | | |
| Potterton | Offices | 70 | 1 | 70 | 75% | | 870 | 1845-? |
| Worcester | Hall | 80 | 1 | 80 | 88% | 117 | 357 | 1980s? |
| **Library** | | | | | | | | |
| gas boiler | | 60 | 1 | 60 | 85% | 28 | 274 | 1985 |
| **total** | | **300** | | | | **220** | **2,121** | |

These figures assume that no action is taken to insulate the buildings to reduce their heating demand. Increasing insulation measures are vital to assist the reduction in heat demand and hence in ongoing costs.

### *Possible pipe lengths and installations*

| location | | ground surface | distance approx. m | possible demand kW | landowner |
|---|---|---|---|---|---|
| **start** | **finish** | | | | |
| Canal | Canal | canal bed | For open pipe ends or heat transfer pipework | | CC |
| Canal | Library | tarmac | 23 | | CC |
| | | grass | 30 | | CC |
| | | **total** | **53** | **60** | |
| Library | Castle | grass | 46 | | B-S TC |
| | | **total** | **46** | **90** | |
| Library | Parkhouse | grass | 25 | | B-S TC |
| | | tarmac | 85 | | B-S TC/CC |
| | | **total** | **110** | **150** | |
| **Totals** | | | **209** | **300** | |

This proposal will save the present gas use – with the Castle new boiler suggested to stay in place as backup for any exceptionally cold winters.

In addition the Castle has several temperature and humidity control devices, at present run on electricity which at least for the heating function could potentially be transferred to the heat pump system. This would save a significant proportion of the present electricity use at the Castle.

The use of water source heat pump systems for these three buildings should save nearly all the gas demand – approximately 97% and cut total purchased energy demand by two thirds from 220 MWh pa to around 75 MWh. As this purchased demand changes to electricity, there would be a cost in purchasing the increased electricity.

***Costs and savings: very approximate without building changes***

| **parameter** | **purchased energy demand MWh pa** | **£pa** | **emissions tpa CO2e** |
|---|---|---|---|
| Previous demand: gas boilers | 220 | £7,667 | 40.5 |
| New heat pumps: electricity | 75 | £11,229* | 1.2* |
| Savings | 145 | -£3,562 | 39.3 |
| Potential Renewable Heat Incentive payments for 20 years : assumes 1,300 hrs pa heating | 220 | £12,285^^ | |
| **Net benefit** | | **£8,723** | |
| **Possible range of capital costs** | **£** | | |
| Slinkies for each building | 480,000 - 540,000 | | |
| Borehole based ground source | 600,000 - 750,000 | | |
| Canal sourced heat pumps | 450,000 – 540,000 | | |

** assuming renewable sourced electricity used*

*^^ assuming only one round of 20% degression of price by March 2021*

It is not feasible at this stage to provide an accurate estimate of the returns on this approach to cutting carbon emissions as the complexities require detailed study to reduce uncertainties. The financial assessment would also depend to a great extent on the source of capital funds and whether government subsidy or grant funds can be achieved. The ages of the present boilers and when they have to be replaced is another major factor in this decision process, as the costs of new gas boilers can be discounted in this decision. It should also be noted that the government is moving towards the banning of new fossil fuel fired boilers in the next few years, as part of the legal requirement to achieve zero carbon in the UK.

The government has been operating a Non Domestic Renewable Heat Incentive since 2011, which aims to offset the increased capital cost of new renewable energy heating systems. This provides a subsidised benefit for each eligible kWh of renewable heat produced from relevant heating systems including heat pumps for twenty years. However the present scheme closes to new applicants on 31st March 2021.

The government has just concluded a consultation on new potential benefits to replace this system, but no decision has been announced yet. The recent consultation proposed a scheme of £4,000 capital grant for projects up to 45kWth, including heat pump systems and separate heat pumps for buildings sharing a heat loop. The potential new scheme could potentially enable the Library building to take advantage of the capital grant, as its heating system is/ could be under 45kW, with the existing boiler acting as backup, but the Castle and Parkhouse Centre each have a larger system.

### *Proposal*

Given the complexities of a decision such as this for the Council, it is proposed that a feasibility study is undertaken to determine the most effective option(s) for changing the heating systems of these three main buildings to heat pumps.

There are two options for the feasibility study:-

- The Council to urgently carry out a feasibility study with the aim of assessing options, achieving firm estimates of costs and value and making an application to the Non Domestic Renewable Heat Incentive before the March 2021 deadline
- The Council to apply to the Rural Community Energy Fund for a grant of up to £40,000 to carry out the feasibility study on heat pump options, provided the study is to assess systems covering more than one building. The next application window is December 2020, and the last one is March/April 2021

The advantage of the RCEF application is that if it is achieved for the next opportunity, it does reduce the upfront cost of the decision process, though this may reduce the longer term financial benefits.

Installing heat pump heating systems using the Canal water source, uses the local resource with the most efficient potential systems, as water source heat pumps can achieve Co-efficient of Performance (CoP) of over four, meaning four units of heat produced for each unit of electricity required.

However there are trade-offs to be made when designing a system for existing buildings with radiators.

The CoP of a heat pump will generally improve the lower the output temperature delivered: therefore the designer aims for a well designed heat emitter system such as underfloor heating where 35°C is sufficient to provide comfortable temperatures. However, if a heat pump is to be used in an existing building with limited heat emitters for the heat load, such as undersized radiators, then it will be appropriate to specify a high temperature heat pump to avoid the disruption that would be caused by refurbishing the heat emitter system.

There are now heat pumps capable of delivering output temperatures of up to 70°C + which is generally sufficient to warm a building with undersized radiators. Although the CoP will fall if output temperatures are raised to 70°C, a well designed inverter-driven high temperature heat pump with a good control system, including weather compensation, will only deliver 70°C when it is required: otherwise it will modulate the heat pump to deliver lower temperatures – at a higher efficiency – when the heating load is below peak requirements.

There are several consultants who could provide a practical experience based assessment of the options for a heat pump based assessment of the three main Council buildings.

*Example consultants with significant experience in this field*

- Geoscience, Falmouth  Robin Curtis Director  Curtis@geoscience.co.uk The most experienced consultants in this field in Cornwall and the UK, special skills in water and ground source heat pump applications
- Building Energy Solutions, London philjones100@virginmedia.com experienced consultant covering feasibility studies for a range of buildings and specialises in water source heat pump systems.
- For more consultancies see https://www.gshp.org.uk/GSHPA_Members_Consultants.html

# 3 Change remaining demand to renewables

## *3.1 Change electricity purchases to 100% renewables*

**Saves c.£0 - £1,000 pa and 30.9 tpa $CO_2e$**

**Annual cost - £35 - £0/ $tCO_2e$**

Changing all electricity to 100% renewable electricity supplies would save all the carbon emissions from the present electricity.

The key when deciding on a suitable supplier is to ensure that they are supplying electricity via contracts with renewable electricity producers, rather than the less certain method of purchasing REGO certificates – which are cheaply available certificates sold separately from the original renewable electricity generated.

Suitable suppliers which are direct sellers of renewable electricity include:-

- Good Energy: has own generation and contracts with RE suppliers
- Ecotricity: has own generation and contracts with RE suppliers
- Bulb: mainly contracts with RE suppliers, some wholesale RE
- Octopus: has some own generation, buys REGOs, invests in a smarter grid

| Supplier | Unit price p/kWh | Standing charge p/day | Annual cost £pa for 110,000kWh |
|---|---|---|---|
| Good Energy | 14.66 | 37.55 | 16,465 |
| Ecotricity | 16.35 | 24.00 | 18,298 |
| Bulb | 13.64 | 27.397 | 15,292 |
| Octopus | 14.22 | 29.20 | 15,945 |

Present cost of electricity is £17,587 plus the Climate Change Levy. The figures from the quotes in the table above indicate that changing to 100% renewable electricity would yield a saving of £1,000 + depending on the supplier chosen.

This proposed change is relatively easily undertaken and produces an immediate and substantial reduction in carbon emissions, without incurring extra costs. This task should therefore be an early win.

## *3.2 Produce renewable energy locally*

The second phase of replacing energy demand with renewable supplies is to produce it locally using the council's own resources – ie buildings, facilities and land. The easiest resource to use at present is the local solar energy option.

### *3.2.1 PV on Council buildings*

**1 Parkhouse**

Quotes have been received for the installation of solar PV on the roof of the Parkhouse Centre, suggesting a range of potential installation sizes from 11kW with batteries to 17 and 19kW without batteries.

It is not feasible on the information sent to comparatively assess the two quotes received as the battery based one gives very little information on expected generation or the purpose and benefit of the proposed not correctly sized battery system.

One quote is therefore taken as an illustration of the potential for the Parkhouse. The quote used here is the Naked Solar 17kW option.

*Carbon and financial saving*

5 tpa CO2e

Capital cost c £3,620/annual tonne CO2e saved

Annual savings £1,646

If measured over 10 years annual cost of carbon is - £1,280/t CO2e

This assumes that around 11,000 kWh pa is used in the building, saving the import cost of electricity and the rest being sold at the standard export price of 5.6p/kWh.

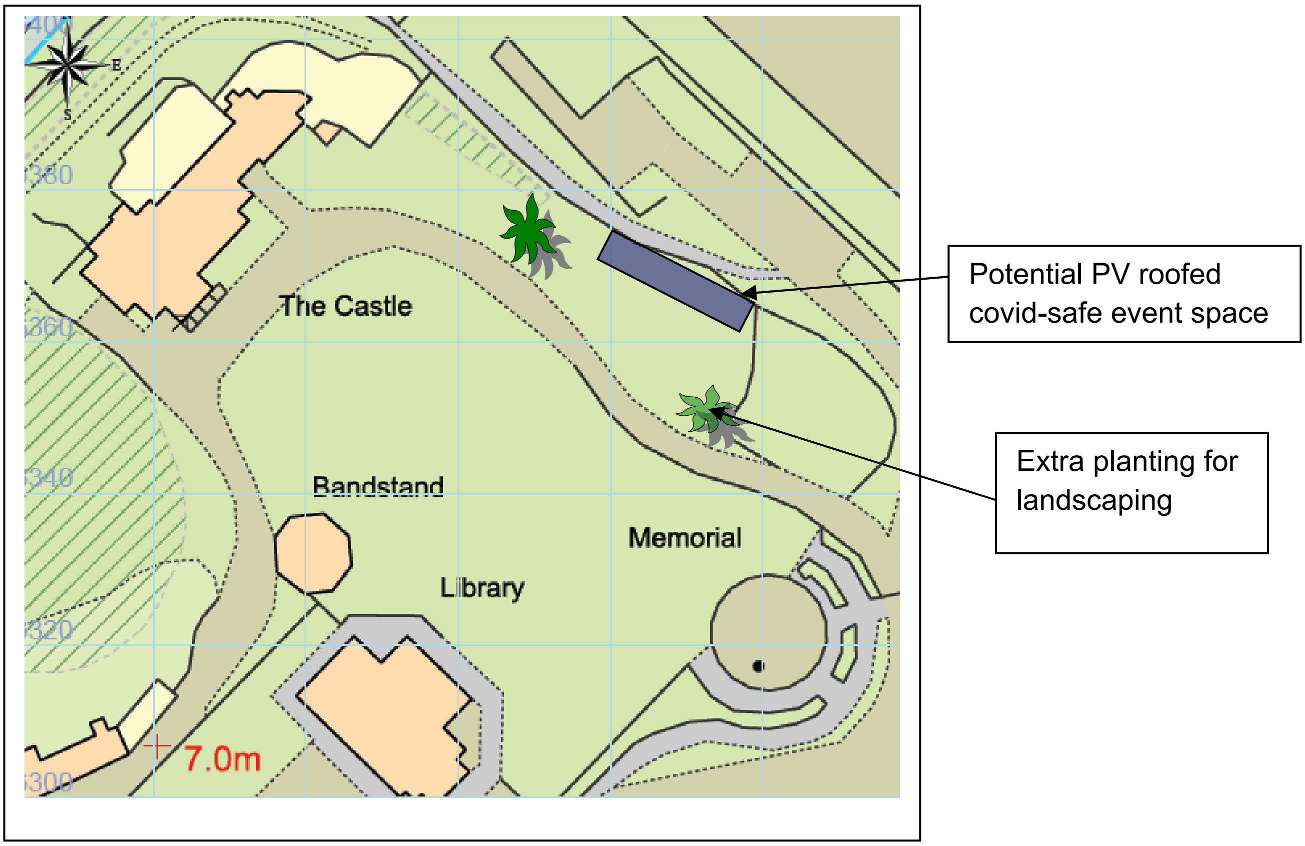
## 2 The Castle

The Castle could potentially have around 3kW on the back hidden section of the roof where it would not be visible. This would produce about 3,100 kWh pa, or some 7% of the annual electrical demand at the Castle. As the Castle is a Grade II listed building, whilst this installation would be both invisible and not damaging to the building fabric, it would require a long process with Building Conservation and obtaining planning permission.

A more useful strategy could be to install a covid friendly sheltered area towards the NE side of the front gardens. This would be generally open at the sides and could serve as an additional area for café visitors and as a shelter from sun and rain. Being open at the sides, it would enable covid restrictions to be met, whilst still providing a viable entertainment/visitor eating location. The main structure would need to be in keeping with the Castle building and set back to the NE side of the approach road, against the wall at that side of the lawn/garden area. The plan below indicates how this could be sited and extra plantings developed for screening and landscaping, so that the setting of the Castle is maintained. This space could also balance the bandstand on the other side of the lawn area.

Such a structure could potentially hold up to around 12kW of PV and produce some 12,600 kWh pa, which would be nearly 30% of the Castle's present annual electricity demand. This would save some three and a half tonnes of carbon dioxide equivalent a year.

***Possible PV roofed covid-safe event location***



As the structure would need to fit the surroundings it is not feasible to determine at this stage what the capital cost of the space apart from its PV roof would be. The cost of the PV onto the structure is likely to be in the range of £12,000 for 12kW, depending on supplier and whether there are other installations also underway.

*Carbon and financial saving*

3.5 tpa $CO_2e$

Capital cost c £3,500/annual tonne $CO_2e$ saved

Annual savings £1,850 or £520/annual t $CO_2e$

If measured over 10 years annual cost of carbon is - £178/t $CO_2e$

plus potential extra income from use of the extra space

At around 12kW this installation would probably enable all the electricity to be used by the Castle. At present the Castle uses around 3,700 kWh/month. The PV would produce about 1,500 units a month in the summer and some 550 units a month in the winter. For a larger installation further calculations would have to be made, and the value would depend on the Council's view of the value of the increased covid- safe space.

This installation would save the some of the cost of importing electricity, at around £1,850 pa. If this saving is balanced against the capital cost over ten years, the annual saving is around £178/t of $CO_2e$.

## 3 Library

The library roof faces SW and so makes a useful location for PV. This location could support around 9.7kW of PV and produce about 9,600 kWh pa. There is some shading from tall trees to the NW of the library building, though this should not have an impact until very late afternoon in summer. The Library uses around 9,640 kWh pa at present, so this level of PV would theoretically produce some 80% of the Library demand. As the Library is only open in the daytime, the supply would be well balanced with demand in that respect. However the demand in the summer would not be completely absorbed by the Library. The average summer months demand is about 930 kWh and the PV would produce about 1,100 kWh per month, meaning some electricity would be exported. The winter situation would be that all the electricity produced by the PV would be used in-house, with significant imports of electricity still required. This scale of PV installation would probably require three phase electrical supply to the system, which is not available at present. This will increase the capital cost, but does then enable other actions, such as a heat pump for space heating in the building.

*Carbon and financial saving*

2.6 tpa CO2e

Capital cost c £3,800/ann tonne CO2e saved

Annual savings £1,200 or £440/annual t CO2e

If measured over 10 years annual cost of carbon is - £58/t CO2e

## 4 Other buildings and facilities

### *Bus shelter*

Although this is a very small user of electricity and is in fact an unmetered supply, the impact of the low electricity use combined with the standard daily charge means that the effective p/kWh at the bus stop is 23.5 p/kWh for the units assumed to be used, plus the daily charge making the effective cost £1.27 per unit to the total of £360 pa.

If the bus shelter was removed from the mains electricity supply and a small PV, battery and control system installed in its place this would cost around £600-£700, with little to no operating cost.

***Example PV powered bus shelter, with pole mounted PV system***

***Example PV retrofit system on bus shelter roof***

Such a system if retrofit to the bus shelter would save around 78 kg of CO2e pa. Whilst not a large saving, compared to some of the higher carbon emissions of the Council, a change to a PV system here would be a visible change to help the process of heading to Zero Carbon becoming more real to the local population.

*Carbon and financial saving*

78kg pa CO2e

Capital cost c £8.9/ annual kg CO2e saved

Annual savings £360 against capital of £700

If measured over 10 years annual cost of carbon is £5.37/kg CO2e

For comparison this would be £537/ t CO2e saved

Examples of system suppliers for retrofit are:-

http://www.eets.co.uk/eetsservicesandproducts/renewablelighting/photovoltaicsolarpoweredlighting/default.htm

https://www.solarilluminations.co.uk/fl17-solar-bus-shelter-light

https://trueform.co.uk/products/solar-bus-shelter/

***Bude Light***

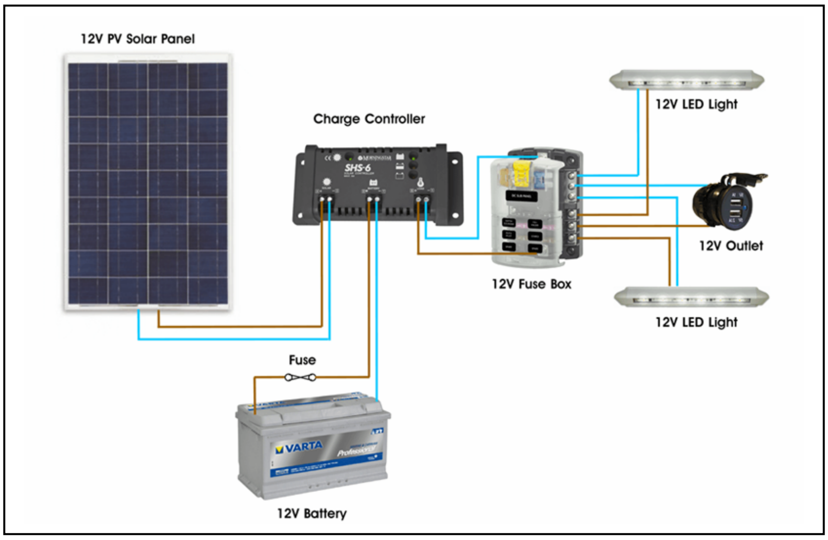
The Bude Light is also a small user of electricity, with a few very low wattage lights for the special display.  This can be disconnected from the mains in the same way as the proposed bus shelter revamp outlined above.

As less light is needed for the Bude Light, with the display lights being very low wattage, a suitable system would be around £200-250.  This could be installed in a robust cabinet with the PV panel facing south, or if this does not feel secure enough a similar system to the pole mounted PV system, pictured above could be chosen.

An example supplier is Wind and Sun at

http://www.windandsun.co.uk/products/Kits/Small-Off-Grid-Kits#.X1_QzNQ9Kpo

***Example system diagram***




Assuming the installation can be undertaken internally, apart from cutting off from the mains supply, the costs are low as noted above, and would save around £120 pa in units and daily charges.

*Carbon and financial saving*

40kg pa CO2e

Capital cost c £7.50/ annual kg CO2e saved

Annual savings £120 against capital of £300

If measured over 10 years annual cost of carbon is    £0.63/kg CO2e

For comparison this would be £630/ annual t CO2e saved

### *Pitch and Putt*

This building uses relatively little electricity over the year, averaging nearly 1,000kWh, with a little extra in the summer months, when the building is most in use.

The building has a suitable south facing roof for the installation of solar PV panels and could take around 3.5kW installed capacity, allowing for the permitted development rights requirement to leave one metre on each side and the bottom of the roof proposed. Such a system would produce around 3,600 kWh pa, of which most would be exported from the building to the local area. This would require a contract to sell the excess electricity. At present there are a number of electricity companies which undertake to purchase this type of electricity and the best price found so far is about 5.6p/kWh.

The figures are very approximate as it is not known what proportion of the electricity demand at this building is daytime and what is in the evening.

For a 3.5kW system around 994 kWh is likely to be used from a PV production of about 3,600 kWh pa. This would save £145 in reduced electricity import costs and provide around £148 income from the sale of electricity. Total value of £293pa, for a capital cost of c £4,400. To be cost neutral the capital cost of this system would need to be under £3,000, at present electricity prices.

*Carbon and financial saving*

1 tonne pa $CO_2e$

Capital cost c £4,334/ annual t $CO_2e$ saved

Annual savings £293 against capital of £4,400

If measured over 10 years annual cost of carbon is £147/tpa $CO_2e$

### *Cricket Pavilion*

The Cricket Pavilion has a suitable south facing roof, which could host a PV system of up to 10-12kW. At 12 kW this would yield around 12,700 kWh pa. At present the Council is not involved in the electricity use in this building, so it is not known what that might be. As the Cricket Pavilion is a new building with good facilities it is likely that it is normally in use in the evenings as well as daytime. For the purposes of calculation therefore this site is assessed as a very small bar from the electricity point of view. This would suggest that the building uses maybe 2,000-3,000 kWh pa, mainly in the summer. This is a broad guestimate only.

The roof of the cricket pavilion provides the opportunity to sell electricity to the tenants of the building, at lower than grid prices, but higher than the Council can otherwise achieve. A price of around 12-13p/kWh would save the Cricket Club money each year.

At 2.4 p/kWh the income from the Club would be around £200 pa, with the rest of the output being exported at around 5.6p/kWh, yielding a total income of around £820 pa. The capital cost would be around £13,600 with some allowance for three phase installation.

This site could be investigated to assess the most cost effective scale of PV installation and potentially the use of battery storage with a view to selling a higher proportion of the PV generated at the site.

The other option at this site could be to lay a cable to a potential EV location for electric vehicle charging. As cricket clubs are busiest in sunny weather, and club users are likely to be present for some hours, this could be a good location for EV charging. To keep grid connection costs down and yield the best benefit to the Council a slow charger would be likely to be the most cost-effective. This option does however depend on the grid connection to the club house and whether it can be easily upgraded to three phase, which would be necessary for all these options.

*Carbon and financial saving*

3.5 tonne pa $CO_2e$ for a 12 kW PV system

Capital cost c £3,900/ annual t $CO_2e$ saved

Annual savings

Option 1 12.2 kW PV saves £820 pa for £13,600 capital cost

Option 2 12.2 kW PV + 1 Fast 7kW Charge EV c £1,400 saves +£300pa ie totals £1,120 pa for £15,000 capital cost

If measured over 10 years annual cost of carbon is

For Option 1 £540/annual tonne $CO_2e$

For Option 2 £240/annual tonne $CO_2e$

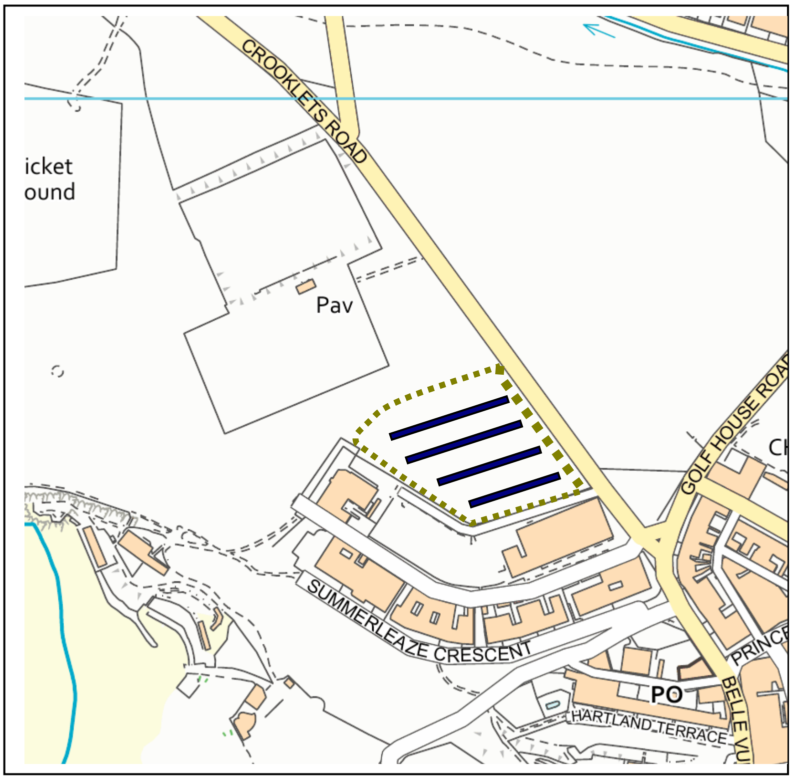
### *3.2.2 PV on Council land*

The Council owns land to the north of the main buildings on Summerleaze Down. This area is mainly laid to grass and provides an open area for recreation purposes for the Town. At present this area costs the Council significant carbon emissions to cut the grass and maintain verges etc. With around eight cuts a year, the emissions add up.

As the land abuts the edges of commercial buildings it is feasible to envisage a small solar PV array on part of this open area.


Aerial view of south east corner of Summerleaze Down

Indicative Solar PV array showing PV panel layout and enclosing wild hedging




example wildhedge

indicative PV array

The area of potential infill in the SE corner of the Council grounds next to Sainsbury's and the Atlantic Rise is nearly two acres. This could take up to around 450kW over several rows of panels.

The aim would be a direct private wire to the nearby two large electricity consumers. This would allow the sale of electricity at higher prices than the minimum guaranteed price under the government's pricing scheme, where the highest price at present is 5.6p/kWh.

A supermarket of the scale of the Sainsbury's here is likely to have a high electricity demand of potentially 680,000 kWh pa, mainly for refrigeration and lighting. This figure is based on industry surveys and is only indicative at this stage. Both demands are almost continuous and hence the PV can provide a high proportion of this demand if sized correctly. The total summer period daytime demand could be around 163,000 kWh, which indicates that a high proportion of the PV site output could be sold to the store.

Whilst the electricity price available from a large national chain would not be high, it should be feasible to negotiate a long term contract, which is essential for capital finance raising.

The other large electricity user next to this site is the sheltered housing at Atlantic Rise. With 28 flats for older people, this is likely to have higher daytime electricity demand as most residents would be in during the daytime. If it is feasible to negotiate a general agreement with the management at Atlantic House, this would yield a good price for the electricity compared to the Smart Export Guarantee mandated by the government, and it would also be helpful to the housing complex.

*Carbon and financial saving*

130 tonne pa $CO_2e$ for a 450 kW PV system

Capital cost c £405,000

Annual savings –*approx. assumptions only*

Direct private wire sales to Atlantic Rise (12p/kWh) , Sainsbury's (5.6p/kWh) and remainder to an electricity supplier at 5.6p/kWh

Total income £28,300 pa

Carbon cost over ten years is - £27,900/ annual tonne $CO_2e$

***Advantages***

- o A project of this scale would offset, by local renewable generation, all the energy related carbon emissions for which the Council is responsible.
- o In the long term the project would provide long term good yields to the Council
- o The area could  be screened with locally appropriate wild type hedging providing increased biodiversity in the area
- o This screening would enrich the visual environment while being in keeping with the general sweep of the landscape at this location
- o The combination of increased wild plants and a green energy scheme could be a local educational benefit and involve the local community (*see Tiny Forests later in this report)*
- o A single larger scheme such as this could be achieved with less management time than several smaller schemes

***Disadvantages***

- o Major decision requiring different tasks to the usual activities of the Council
- o Would lead to a change in the visual landscape in the Summerleaze area
- o Could lead to differences of opinion in the Council and with local residents, if a due process is not carried out with the local community

This action could be larger or smaller depending on the Council and local views of the benefits and the organisational structure chosen. The area could produce up to about 450kW and save around 130 tpa $CO_2e$ or more than the Council's present emissions. If developed as a community owned scheme there would be potential for local actions to reduce fuel poverty and increase biodiversity form the income over a number of years.

### 3.2.3 Summary of PV opportunities

The table below summarises the PV opportunities for the council with indications of costs and benefits for each option.

***Summary table of PV opportunities***

| location | installed PV | annual output | carbon saving | capital | net operating cost pa | 10 yr capital spread cost of carbon | straight payback |
|---|---|---|---|---|---|---|---|
| | kW | kWh | kg/tpa CO2e | approx. £ | £pa | £/ann t CO2e | yrs |
| **Parkhouse** one of quotes | 17.3 | 17,958 | 5.0 t | 18,111 | - 1,646 | - 1,280 | 11.0 |
| **Castle** covid-safe shelter, cost excl. structure costs | 12.0 | 12,600 | 3.5 t | 13,200 | - 1,850 | - 178 | 7.1 |
| **Library** SW roof | 9.7 | 9,600 | 2.6 t | 10,000 | -1,200 | - 58 | 8.3 |
| **Pitch and Putt** S roof | 3.5 | 3,600 | 1.0 t | 4,400 | - 293 | 147 | 15.0 |
| **Bus shelter** retrofit | 400W | 450 | 78 kg | 700 | - 360 | 537 | 1.9 |
| **Cricket Pavilion** S roof, sell to tenants | 12.0 | 12,600 | 3.5 t | 13,600 | - 820 | 540 | 16.6 |
| with EV charger | | | | 15,000 | - 1,120 | 240 | 13.4 |
| **Bude Light** box close by | 250W | 260 | 40 kg | 300 | - 120 | 630 | 2.5 |
| **Buildings totals/average** | **55.15** | **57,068** | **15.7 tpa** | **61,711** | **-6,589** | **5.43** | **9.4** |
| | | | | | | | |
| **PV land array** Summerleaze | **450** | **472,000** | **130tpa** | **405,000** | **-28,300** | **-27,900** | **14.0** |

The table of PV opportunities shows the wide range of potential for the Council to reduce its carbon footprint from local PV installations. This table has been arranged in ascending order of carbon cost/tpa CO2e.

The numbers are approximate, as full quotes are not possible at this stage, but do give a good indication of the potential.

The carbon cost has been calculated by dividing the capital cost by the annual carbon savings; the resulting figure is divided by ten on the assumption that the general aim is a ten year programme to journey to carbon zero. This figure of 10% of capital cost/annual tonne of carbon saved is then added to the net annual cost to achieve a rough estimate of carbon cost.

The annual net costs are all negative as at this stage this is the approximate net financial income/savings for each project. No account has been taken of annual operation and maintenance costs. Whilst the operating costs are not large, solar panels do need to be cleaned occasionally – especially if seagulls are in the area and the systems need to be insured and occasionally checked for electrical integrity. These costs depend largely on the number and type of systems which can be covered at the same time by any external specialists. PV panel cleaning can be undertaken by Council staff with appropriate access, de-ionised water and long handled brushes.

No account has been taken of the cost of finance raising, sales contract negotiations nor of any planning permissions needed, nor of the suggested plantings for the Castle grounds or the land array.

The table indicates the wide range of potential projects which the Council can undertake depending on the type of programme preferred.

Analysis of the figures shows that the key to financial success with these projects is making the most effective use of the electricity generated, either by using in-house or by selling direct to a third party able to benefit from a price which is viable for the Council.

If all the potential shown here for Council buildings is taken up this would directly reduce emissions by 15.7 tpa $CO_2e$ or some 50% of the Council emissions from electricity demand.

The PV land array outlined has the potential to effectively offset all the energy used by the Council for all its activities, and could provide a relatively simple, in management terms, method of achieving a net zero Council.

Decisions on such a project will need to encompass the views of the Council and local community on whether a community energy project is a worthwhile approach, with its potential to fund fuel poverty and biodiversity actions from the project income once costs are accounted for.

# 4 Buildings recommendations

Given the large number of buildings and facilities which are in need of change to upgrade, reduce energy costs and change to renewables it may be worth the considering entering into an Energy Management Contract. Under such a contract the contractor makes appropriate and agreed investments to reduce energy bills at their cost and the Council continues to pay the present energy bill levels. This is one method to obtain the finance to invest in the buildings, but care would be needed in this situation where the driver is not just finance but the aim of reducing carbon as well.

Once the Carbon and Energy Manager is in place, with an appropriate skill set, it is more feasible to assess the need or otherwise to let an external contract for this work.

***Building Log Book***

Each building must have a Building Log Book, which includes all relevant information such as the building standards and any changes to building structure, insulation levels, main energy using equipment, control systems along with their installation date, manufacturer and maintenance manuals. Building Logbooks are a legal requirement in new buildings and in existing buildings where services are changed. They improve access to information for building managers and others responsible for managing buildings, enabling them to improve the operation of their building. Specifically they provide a place to record ongoing building energy performance, which should help improve energy efficiency. Logging energy performance against design estimates and typical benchmarks will help identify energy problems. The Log Book provides a single place to keep key information about the building. See:-

- CIBSE TM31: Building Logbooks an authors guide
- GPG348 'Building logbooks a users guide' available at www.thecarbontrust.co.uk

## *4.1 The Castle*

As the local jewel in the crown, the Castle requires sensitive treatment to ensure that its heritage is maintained.

The carbon emissions at the Castle are around 26 tpa CO2e of which 13.8 tpa is from gas use and 12.2 tpa is from electricity demand,

As noted above in Section 3.2, one major option to reduce the gas used in the Castle is to change to a heat pump system. As the most cost-effective method is to use the Canal water heat for a system potentially encompassing all three local buildings, this option is discussed above rather than in detail again here.

As the cost of any purchased electricity is always going to be relatively high and hence would have a large impact of the financial viability of a Castle heat pump system, it is vital to reduce the heat demand as much as possible.

The walls are the largest element of heat loss from the Castle being around two thirds of the fabric heat loss (ie excluding air changes). The Castle walls being solid stone are not easy to insulate, and the Grade II listing also increases the challenge. However, if the aim of reaching zero carbon is to be achieved it is important to tackle even the harder tasks, especially where they have a big impact on the Council's carbon footprint.

There are several options for reducing heat loss through the Castle walls. As the building is listed and its external appearance has to remain unchanged, the potential choices of insulation are those which are suitable for internal use on solid stone walls. This requires a breathable natural material. There are several materials which meet this specification, available in plaster form, which would be needed to allow the existing wall structure to shine through.

The materials which meet this specification consist of a lime base with an addition of insulating material and possibly other additions.  The options include insulating renders which include hemp stems (Hempcrete), light weight expanded aggregates (Cornerstone Insulating Render from Cornish Lime), perlite- an expanded mineral (Bauwer) and cork with fibreglass mesh (Thermocork).

Each option is finished with lime plaster and breathable paints.

One major option is hempcrete, a healthy building material made out of hydraulic lime, water and industrial hemp. Hempcrete has a range of desirable thermal, structural and moisture-handling properties.  These include its resistance to rots and mould; it is moisture absorbent so reduces water retention in the building. Hempcrete has the major environmental advantages that it is carbon negative and the industrial hemp incorporated into it is helpful to biodiversity being low on inputs in the field.

Hempcrete absorbs heat and later reflects it back into the building, increasing comfort levels and making this approach a valuable asset to the heat pump system suggested in Section 2.3. If used at the Castle, this insulation would enable a heat pump system to work more effectively in this building.

The major disadvantage of this method of insulating the Castle is that it is expensive – as is any wall insulation, and the material has to be allowed to dry out between layers, which extends the working time required. This would cause disruption to the building users unless it was carefully planned.  The present pandemic restrictions on the Castle use may be a relatively good time to undertake this type of installation, when fewer users are coming into the building.

The layers and pre-treatment required vary between the different options, as does the effectiveness of the insulation- or the thickness required for a standard reduction in heat loss. An energy efficient 15cm of hempcrete can be sprayed directly onto bare stone or scored lime plaster, and does not require a vapour barrier, unlike most forms of insulation. This level of hempcrete plus a finishing layer of plaster would reduce the heat loss through the walls by two thirds and nearly halve the overall fabric heat loss.

If this type of insulation is installed it could save up to £6,600 pa in electricity costs via reduced heat demand from the proposed heat pump system and an estimated 85% reduction in the paintings preservation electrical costs.  These savings would be likely to show an effective return on the investment when including any reduced maintenance costs.  Building Regulations commentary suggests that energy efficiency options should consider a fifteen year payback as reasonable.

Example of hempcrete internal wall insulation in a stone barn renovation project

Whilst if may be argued that the Listed Building status of the Castle automatically precludes insulating the walls, the Cornwall Council guidance on this topic indicates that this is not necessarily the case.

*https://www.cornwall.gov.uk/environment-and-planning/strategic-historic-environment-service/guidance/technical-guidance/improving-energy-efficiency-in-historic-cornish-buildings/*

An example of a Cornish Listed Building with this type of internal wall insulation is the old Chapel at Cardinham, where the internal walls have been sprayed with hemplime to insulate the building.

A very rough estimate is that this insulation, with appropriate preparation and finishing would cost around £50-65,000 and potentially save around £9,000 pa in reduced energy costs under the proposed new heating scheme.  This estimate requires further work to be clearer on the actions, costs and benefits as noted in the proposals below.

***Old Chapel, Cardinham Grade II Listed with internal wall insulation***

### 4.1.1 Proposals

*Heating and insulation*

- Urgently quantify in detail the costs, benefits and any issues around insulating the Castle internal walls with hempcrete or similar, with a view to determining the most cost effective thickness and application method to reduce the Castle energy demand by around 30%.
    - It is recommended that a full assessment is carried out by the UKs most experienced insulating render practitioner and consultant in this field. Mr Graham Durrant, Hemp-Lime Spray Limited tel 07552 711004 email hemplimespray@yahoo.com
    - Estimated cost for this is approximately £1,200+
- Assess the impact on the need for the paintings' preservation climate control installations if hempcrete insulation and a heat pump system are installed.
    - If the proposed improvements are made and the present climate controls are reduced or not required, this could save up to around £3,500 pa in reduced electricity bills
- Set up the feasibility study for the water/ground source heat pump system for the three buildings, potentially including the feasibility work on the Castle insulation as part of that study.
- Even before any major reworking of the heating system assessed or installed it will be important to install a proper energy management system for the building to ensure the recently installed boiler is operated most effectively.
    - Check pump sizes to ensure heat reaches all radiators within an appropriate time
    - Install more and better located thermostats which should be part of the new energy management system
    - Ensure that the energy management system is correctly programmed to take account of the building fabric warm up time, the external temperature, timelag to cooling down and the opening hours of the building. If this is done correctly this control system will save at least 32,000kWh pa, nearly 40% of gas use, saving around £1,300 pa in reduced gas payments, compared to the winter of 2019/20.

*Electricity demand monitoring*

- o Install an electricity monitoring system, which could be temporary to determine how much electricity is used for the main functions. This needs to include the paintings environmental management system, the café, lighting and the office. Once how the electricity is used is understood the main electricity reduction options noted here and their financial viability becomes clearer. The Castle is the Council's largest electricity user by a large margin.

*Lighting*

- o Potentially add the lighting system to the building energy management control system to ensure the most efficient use of the present lights.
- o Increase the proportion of LED lights to 100%
- o Ensure appropriate staff are trained, understand and can set up the system effectively for each season.
- o It is suggested that the Castle should initially install an independent modular lighting control system for the first floor. This system would need to include movement sensors, daylight sensors and be time controlled. Such a system would cost around £3,500 and save around 10-15% of lighting electricity. Once this was undertaken a similar system could be installed for the ground floor.

*Café energy demand*

- o Re- assess the cooling requirements for the café to determine what is actually needed, and what has to be on all the time
    - o relocate the fridges and freezers not in the immediate vicinity to a nearby single cool space to reduce electricity demand. This could be a re-arranged area by the North windows by the kitchen back entrance, with appropriate screening from the open landing area
    - o switch off canned drinks chillers when café not open as these do not need to be cooled all the time.
- o Following the electricity monitoring data gathering re-assess the food heating options used in the café and institute switch off routines for when the café is closed.

## 4.2 Parkhouse

### 4.2.1 Proposals

*Heating and insulation*

As the Parkhouse uses over 50% of the Council's gas demand significant effort is required to reduce this through energy efficiency measures for the building. It is estimated that more heat is lost through the floor than the other fabric elements. As this can be expensive to insulate it is recommended that the floor should be properly insulated when the next refurbishment works are undertaken.

- The walls of the Old Junior School section of this building should be insulated. As the oldest part of the building this section loses over half the wall heat loss, compared to the newer and larger Ivor Potter Hall area. Judging by the age of this section of the building, the walls are solid and hence have high heat loss. This also indicates that a similar insulating render to that proposed for the Castle could be used for this section of the Parkhouse.
  - An appropriate level of insulating render would enable the old section to be warm and comfortable for office users with little extra heating and compensate for the potential removal of the old boiler, until the new suggested heat pump system is installed, which would then run more effectively, saving electricity costs.
  - See notes in the Castle section above for an assessment of costs for this action.
- Check the roof insulation level and if not at least 200mm of low conductivity insulant, then top up to 200mm to achieve an approximate U

value of around 0.14 W/m2K, the most recent regulation level, allowing for air movement through the space as required.

    - This could cost around £3,000 for rolls of insulation, for in-house staff installation. Savings in fuel and carbon costs would be up to 20,000kWh pa or 3.6tpa $CO_2$ pa, depending on the present level and quality of loft insulation.

- Ensure the feasibility study for the proposed water sourced heat pump system includes and assessment of a potential ground source system for the Parkhouse, which could be trench based (using slinkies) in the nearby open ground towards the Mound.

*Energy demand monitoring and control*

- Install an electricity monitoring system, which could be temporary to determine how much electricity is used for the main functions. This needs to include the Ivor Potter Hall area and its catering facilities, lighting and the offices. Once how the electricity is used is understood the main electricity reduction options become clearer.
- Install controls on the boiler system to enable external temperature and building occupation parameters to be better controlled

*Lighting*

- Institute a programme of changing all the lighting to LEDs throughout the building. This should also include the stage lighting in the Ivor Potter Hall, as LED stage lighting is now on the market at reasonable prices and very long life c 50,000 hours.
- Depending on the results of the electricity monitoring programme proposed above, it may be appropriate to install a lighting control system similar to that proposed for the Castle to enable better control and energy reductions in lighting demand.

## 4.3 Library

The library as a newer building than the other gas heated Council buildings shows a good correlation with the weather – being better insulated. However the EPC report from 2015, when the building was operated by Cornwall Council, shows that the gas use was at that time 10% lower than the present figure.

### 4.3.1 Proposals

*Heating and insulation*

- The reason for this increase in gas demand needs to be investigated and rectified as the next heating season starts. It is most likely to be the lack of a control system or decreased boiler efficiency which is the problem.
- Check the levels of loft insulation above the false ceiling and increase to the present required level of around 200mm. Given when the building was designed, it is likely that this will require another 100mm of insulation. This could be installed by in-house staff at a materials cost of around £700, and would save approximately 7-10% of the heating required, some £80-110 pa, and some 360-520kgCOe2.

*Energy demand monitoring*

- Install an energy management system to operate the boiler system in relation to opening/in use hours and the external temperatures through the season. For the Library this could cost around £300-800 – see Section 2.1 above. Such a system would with the present gas use and boiler save potentially 12% or more, around 3,400 kWh pa costing c.£140 pa. This gives a carbon saving of around 620kg $CO_2e$ pa and a financial payback of 2.5-6 years.

*Lighting*

- o Analysis of the electricity bills through the year indicates that the library has a high lighting and computers load. This is detectable when assessing electricity consumption for the hours the library is open, assuming one hour or so each side of opening hours. There is potentially 7kW of lighting installed, mainly in tube fluorescents and maybe 2.75kW of computer systems.
- o All lights should be changed to LEDs with focussed and special lighting for certain areas where lighting needs are different. This will save nearly 3,000kWh pa, £440 pa and 800kg $CO_2e$ pa.

## *4.4 Works Unit*

The Works Unit is a modern building with electricity as its only energy supply. The office and crew rooms total around 50m2 and have two electric radiators for their space heating. In addition electricity is used for, as noted in Section 1 of this carbon audit, charging the EV, washing and drying the staff work clothes, lighting etc.

From the pattern of electricity use and in particular the correlation of electricity demand with lower external temperatures, it is surmised that over 80% of the electricity demand is for space heating.

The table below aims to shed light on this, as the electricity use for heating is high for the area being heated. The table indicates the estimated “baseload” which is present each month for activities which take place all year round.

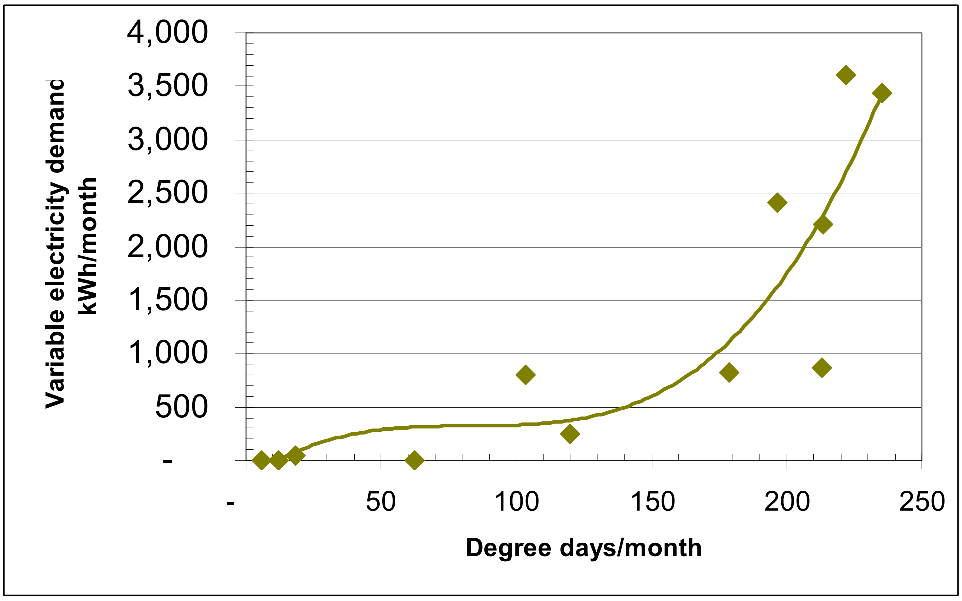
Then on top of this is the demand which varies with the external temperature. It appears that the office and crew room are each heated with an electric radiator, each of which it is thought to be 3kW. This makes an installed heating capacity of 6kW. The table shows that this 6kW is operated for between 7 and 30 hours each workday in the winter months, assuming weekday working. This shows that the space heating is not well controlled as it is on in the evenings, weekends and during holiday periods.

*Space heating demand through the year kWh*

| | electricity billed | base load | variable load | per workday | heating on for hrs in month | heating hrs per workday |
|---|---|---|---|---|---|---|
| | kWh | | | | | |
| Mar | 1,121 | 250 | 871 | 44 | 45 | 7 |
| Apr | 1,073 | 250 | 823 | 41 | 137 | 7 |
| May | 501 | 250 | 251 | 13 | 42 | 2 |
| Jun | 227 | 227 | - | - | - | - |
| Jul | 121 | 121 | - | - | - | - |
| Aug | 251 | 251 | - | - | - | - |
| Sept | 294 | 250 | 44 | 2 | 7 | 0 |
| Oct | 1,048 | 250 | 798 | 40 | 133 | 7 |
| Nov | 2,660 | 250 | 2,410 | 120 | 402 | 20 |
| Dec | 3,860 | 250 | 3,610 | 241 | 602 | 30 |
| Jan | 3,683 | 250 | 3,433 | 172 | 572 | 29 |
| Feb | 2,458 | 250 | 2,208 | 110 | 368 | 18 |
| **Totals** | **17,297** | **2,849** | **14,448** | | | |

As a check on the assumptions on electricity use for space heating, the graph below has been prepared showing the change in variable electricity demand against degree days in each month. The trend is clearly increasing with external coldness and the polynomial trend line shows an 80% correlation, reasonable for this level of analysis.

***Works Unit variable electricity demand against degree days***




In addition to this electricity use identified there is an estimated amount being used from the PV panels on the roof of the building. Section 1 of this report indicated that this could be around 5,600 kWh in addition to the assessed uses in the table above, taking the total electricity demand to around 22,897 kWh pa.

### 4.4.1 Proposals

*Monitor electricity demand*

- Install electricity monitoring in the building to determine exactly where the electricity is being used. Locations to monitor are:-
  - washing machine
  - Clothes dying
  - Each radiator x2
  - EV charging
  - Water heating
  - Machine tools and other

Such a system would cost £1,000+, but is the only way to understand electricity use in the building and to determine the most effective energy reduction options as well as the heating system needs.

In addition an export meter should be fitted to the output of the PV panels as the generation leaves the building. This will be in addition to the existing generation meter and the new meter will enable the Council to determine how much in-house benefit is being gained from the electricity from the panels. This is a simple subtraction of the export readings for each time period from the generation readings. An export meter costs around £150 plus an electrician to fit, and should not take more than one hour.

The electricity monitoring should be carried out over several months including winter time. This then enables a clear understanding of what is driving the electricity demand in this building and when that demand is occurring.

*Control the space heating*

Install a suitable heating control system which is well controlled so that the office and crew rooms are warm when needed and not when they are not in use. As these rooms are not in use all day because the staff are mainly out on site, it is important to ensure that the control system is correctly installed and operated to provide heat when needed and not otherwise. The type and cost of control system needed depends on the choices made about the heating system for this building.

*Install insulation around the heated areas*

Even though this is a new building and it is understandable that staff coming in from the biting wind and cold in the winter need a warm space for crib and other break times, it may be that the heating is on for excessive hours partly because the rooms do not keep the heat for long.

The insulation levels in the walls, floor and ceilings should be checked and improved where necessary to meet modern insulation requirements. Regardless of the heating system in operation this needs to be achieved. Improving the heat retention in the warm spaces will significantly reduce the heat demand.

It is also worth checking that the doors to the heated areas have automatic closers on them, and fitting closers if they are not already present. Leaving the door open very quickly looses the heat, especially in windy weather.

Most of this work can be carried out by Council staff as this work is not specialist in nature. Increasing insulation in the area where the staff want to be warm may be an attractive task for them.

*Change the heating system to an air source heat pump*

An air source heat pump uses the ambient energy in local air to work like a refrigerator in reverse. It extracts heat from the air and concentrates it via a compressor to a higher temperature to heat an indoor space. Given the present situation at the Works Unit without a wet central heating system it is likely to be more cost-effective to install an air-to-air heat pump system.

Such a system would allow a very quick warm up of the spaces needing heating and would only use one third of the expected electricity compared to electric radiators with similar controls.

An air-to-air heat pump with 6kW thermal output would require an electrical input of around 2-3kW. The kind of system which is appropriate for this building is a split unit system with one external unit and two heater units inside, one in each room. It is also worth investigating the potential for including the work clothes dryer function in the specification for this system.

The advantage of an air-to-air heat pump is that most systems are designed to also cool in high temperatures, which could be helpful to overheated outside workers in their break times, though it is likely that increased insulation would reduce this potential need.

Possible electricity demand – around 2.5kWe for 5-7kWth output and electricity use of around 1,300 kWh pa – depending on the hours of operation. Seasonal Coefficient Of Performance for this type of system can be around 4.0-5.9 for some systems eg Panasonic or Daikin. This means that 4-5.9 units of heat are produced for each unit of electricity used on average through the season.

There is a potential saving of around 13,000 kWh pa, provided that the system change also includes controls to heat the space when needed and not otherwise. The savings could be more if the clothes drying function is also included in a bigger air source heat pump system.

This would save around 3.6 tpa $CO_2e$ and £1,700 pa, for a capital cost for the new heat pump system of £5,000-6,500. This would give a straight payback of three to four years.

*Investigate the cost and value of installing batteries to store some PV electricity for later use*

Once the electricity monitoring has taken place is the time to investigate the potential for cost savings from a battery system for the Works Unit. It is thought that around 13,000 kWh pa is exported to the grid from the PV installation here. This is potentially a missed opportunity to save by using that electricity for onsite services.

As a general rule it costs around 6p/kWh for battery derived electricity, in terms of capital cost and losses in the battery system. It is therefore only worth investing in a battery system if at least that level of saving is possible. As purchased electricity is c.15p/kWh, it seems likely that this would be a good investment.

Once the electricity monitoring has been undertaken one of the tasks is to investigate how the Works Unit could make better use of the PV electricity. See also the later notes on changing Works machinery and vehicles to battery operated options.

Tasks to assess include:-

- Making sure that the washing machine is used only in daylight hours
- Possibly installing a hot water system to use PV electricity for later use in the building – for the washing machine or for showers?
- Potentially heating the polytunnel, or part of it, to produce plants for the town more cheaply and earlier in the season
- Winter PV output in relation to the space heating demand
- Timing of electricity demand by hour and season
- Use of a dehumidifier for clothes drying

*Follow up EPC recommendations from 2016*

***a) Recommendations with a short payback***

This section lists recommendations with a payback of less than 3 years:

| Recommendation | Potential impact |
|---|---|
| Replace tungsten GLS lamps with CFLs: Payback period dependent on hours of use. | LOW |
| Consider replacing T8 lamps with retrofit T5 conversion kit. | HIGH |
| Introduce HF (high frequency) ballasts for fluorescent tubes: Reduced number of fittings required. | LOW |

***b) Recommendations with a medium payback***

This section lists recommendations with a payback of between 3 and 7 years:

No recommendations were specified by the energy assessor.

***c) Recommendations with a long payback***

This section lists recommendations with a payback of more than 7 years:

| Recommendation | Potential impact |
|---|---|
| Install more efficient water heater. | MEDIUM |
| Consider installing building mounted wind turbine(s). | LOW |
| Add time control to heating system. | LOW |
| Consider installing solar water heating. | LOW |
| Consider replacing heating boiler plant with high efficiency type. | HIGH |

The EPC report from March 2016 made recommendations which are not entirely relevant now, but do need to be considered.

***EPC report recommendations***

The lighting in the building needs to be assessed and updated with appropriate new high efficiency luminaires. In the office and staff rooms the likely best fit are low wattage LEDs, which can use as little as 4W each in these circumstances.

In the high bay areas, the most efficient choice is usually the new focussed LED systems can save up to 80% of lighting electricity.

A free lighting survey and lighting design service is available from:-

https://greenbusinesslight.com/services/led-industrial-lighting/ national

www.plslighting.co.uk Cornwall based

Both of these companies also install new lighting systems including suitable controls- such as PIR - movement sensitive controls, daylight sensing etc

### 4.5 *The Triangle*

The Triangle uses 8,763 kWh pa costing about £1,300 pa. The location has a fountain which appears to be not functional and a series of light bulbs on a string around the small park area. The light bulbs appear to be a high wattage variety and this may explain the high electricity use for this area.

The demand profile suggests something of around 1kW is operating all the 8,760 hours of the year. Equally this could be the lighting, probably amounting to around 3 kW installed capacity being on for four hours or so per day in the winter and nine hours or more in the summer months.

There are two steps to reduce the energy and emissions costs of this location.

**The first step** is to install an external time clock to switch off in the daytime and late evenings in the summer and earlier through most of the winter when the park area is not used. This could cut demand by 30% or so.

This would save over 2,600 kWh pa with little loss of display value. The cost of an external time clock which can be set to agreed times is around £100. This will save nearly three quarters of a tonne CO2e pa and financial savings of nearly £400 pa.

This is an easy win with very low cost, a financial payback in three months.

**The second step** is to update and change the lighting system in this area to high efficiency low wattage LED lights. There are several long string mains operated systems on the market which can operate up to 900m of cable from one standard plug installation.

At present the lighting string is about 80m long and has around 100 bulbs. It is assumed that the lighting is to create an attractive setting rather than high intensity light, as there are also street lights in the local area.

One option for a long string approach with low wattage LEDs would be, for example, a combined external string of 100m with some 700 bulbs of 0.1W each, totalling 70 W. Such a string is available for around £450+. See for example:-

https://www.festive-lights.com/outdoor-led-string-fairy-lights-connectable-black-rubber-cable#description-tabs

This approach would enable a similar light level to the present system to be achieved, but with the potential to control more closely with the remote function and to develop more interesting features for this area. An example of this type of system is shown in the picture. As the Triangle has one large special tree, this may be an appropriate starting point for a new lighting scheme and could be an opportunity to involve the local community in a carbon reduction scheme with added local interest.

If the lighting system is changed to this approach, along with suitable timing control, the electricity use will reduce significantly to around 120kWh pa. This assumes the lights are on for five hours a day in the summer and 3-5 hours in the winter depending on the month.

The capital cost of c £500, would save £1,200 pa in reduced electricity cost, giving a straight payback of under six months. The carbon savings are around 2.4 t pa $CO_2e$.

## *4.6 Smaller facilities*

- Bus Shelter – see section 3.2.1 above for changing to PV powered
- Bude Light- see also section 3.2.1 above for changing to PV powered
- Crooklets Road- when other main buildings have been assessed, install electricity monitoring at this location to determine how best to cut demand and hence reduce carbon: consider hand dryers & LED lighting.
- Pitch and Putt – see section 3.2.1 above re installing PV on the roof and potentially use this electricity for the main season of electricity demand in the summer. LED lights, reducing cooling demand and potentially a battery system for using solar electricity in the evenings are items to consider
- Rattenbury Gardens- it appears that this area is similar to the Triangle with a long string of lightbulbs as the main electricity demand. The timing of the use indicates that the lights are on longer in the winter, when the area is less used than in the high use seasons. See The Triangle Section 4.5 above for how to reduce the costs and carbon footprint of this area.

# 5 Groundswork

Since the Section 1 Energy use and carbon emissions report was prepared it has become clear that there are more problems than expected in assessing the details of the Council's petroleum fuels demand.

One of the key factors which was previously unknown is that the onsite diesel tank is not only used for fuelling machinery, but also for diesel vehicle fuelling, thus making it difficult to determine how much energy is used by machinery and how much for transport.

In addition it appears that the Town Council has a Service Level Agreement with Cornwall Council for the provision of grass cutting and grounds maintenance over a large area of North Cornwall. The Town Council is paying for the energy for this task, which may be up to 80% of the time and energy used by the groundworks team.

An approximate re-assessment of the Town Council energy demand has therefore been made.

It is clear that to reduce the Town Council carbon footprint some action will be needed on Cornwall Council land/verges activity and the Service Level Agreement may need some adjustments at the next annual review.

The new rough estimate of fuels demand is shown in the tables below.

**Fuels purchased**

| **2019 approx** | **litres** | **cost £ exc. VAT** |
|---|---|---|
| diesel into tank | 5,000 | 5,208 |
| petrol for machinery | 1,449 | 1,532 |
| diesel via garage | 524 | 580 |
| Totals | **6,973** | **7,320** |

***Approximate breakdown of diesel and petrol demands***

| **Demand by** | **Litres pa** | **Energy kWh** | **% energy** |
|---|---|---|---|
| **petrol machinery** | 1,449 | 23,951 | 24% |
| **diesel vehicles** | | | |
| estimate from annual mileage | 2,600 | 36,002 | 36% |
| via garage | 524 | | |
| remainder via onsite tank | 2,076 | | |
| **diesel machinery** | | 40,489 | 40% |
| leaves for diesel machinery | 2,924 | | |
| **Totals** | **6,973** | **100,443** | **100%** |

The vehicle information suggests that around twenty six thousand miles are driven by the ground work team, which includes possibly 70-80% of their time operating for Cornwall Council around the whole of North Cornwall.

## 5.1 Machinery energy use

The machinery used by the groundworks team uses either petrol bought from the local garage or diesel from the onsite tank.

With updated information a rough estimate has been made of the proportions of energy used by each type of machinery, using estimates from the Works Unit.

***Energy use of petrol machinery – approximate figures only***

| Petrol machinery | number | approx. hrs pa | power kW | fuel used kWh | % of energy |
|---|---|---|---|---|---|
| Ferris zero turn mower | 1 | 100 | 27.4 | 10,952 | 46% |
| Baroness Ride On Mower | 2 | 150 | 12 | 7,200 | 30% |
| Rotavator | 1 | 90 | 4 | 1,440 | 6% |
| Chain saws | 6 | 90 | 3.5 | 1,260 | 5% |
| Strimmers | 5 | 170 | 0.9 | 612 | 3% |
| Kerston 15-weeder | 1 | 60 | 3.4 | 805 | 3% |
| Bore machine | 1 | 60 | 3 | 720 | 3% |
| Leaf Blowers | 5 | 90 | 1.4 | 504 | 2% |
| Push Mower | 5 | 150 | 0.4 | 246 | 1% |
| Hedge Cutters | 3 | 90 | 0.6 | 216 | 1% |
| **Totals** | | | | **23,955** | **100%** |
| **Litres of petrol used** | | | | **1,450** | |

The purchased petrol is around 1,450 litres for the year 2019/20, suggesting the table above gives a workable approximation of the actual energy use in petrol driven machinery.

The highest energy use is for the larger machines of which the Ferris zero turn mover uses nearly half the energy and the two Ride On Mowers use 30% between them.

As the diesel used by the Town Council groundworks team includes both that purchased at the garage for vehicles and the tank deliveries which are used both for vehicles and machinery it is more difficult to breakdown the two uses of diesel. The fuel used by vehicles was derived as shown in the table below, and that amount of fuel was subtracted from the total diesel purchased from both sources, to indicate the fuel used by diesel machinery. This figure was checked against the number, type and hours of operation of the listed machinery to gain an indication of accuracy.

***Energy use of diesel machinery: approximate figures***

| Machinery | approx. hours pa | power kW | energy used kWh pa | % of energy |
|---|---|---|---|---|
| John Deer tractor M115 | 60 | 85 | 22,174 | 53% |
| Land Rover cherry picker * | 85 | 27.3 | 10,548 | 25% |
| Kubota ride on mower | 70 | 19 | 5,743 | 14% |
| Spider mini grass cutter | 60 | 6.5 | 1,857 | 4% |
| Generator | 10 | 2.5 | 119 | 3% |
| **Totals** | | | **40,441** | **100%** |
| **Total litres used** | | | **2,921** | |

** active hours*

This table indicates around 2,900 litres of diesel used for machinery by the groundworks team. This correlates reasonable well with the calculation from the vehicle usage of diesel, which indicates that around 2,930 litres of diesel are used in machinery.

The key action point for this analysis is the relative importance in energy and hence carbon emissions of a few larger machines. The high carbon emitting machinery is the tractor and the cherry picker

Petrol

- Baroness ride on mowers x 2 30% of petrol
- Ferris Zero turn mower x1 46% of petrol

Diesel

- Land Rover cherry picker 25% of diesel
- John Deer tractor 53% of diesel

Together these five machines use 80% of the machinery energy and some 50% of the total energy in all the liquid fuels purchased by the Council. This indicates which areas of machinery use are the first to be tackled.

## *5.2 Reducing carbon in groundworks machinery*

There are two parts to the reduction of carbon from the ground works team activities, although the Cornwall Council SLA could complicate the situation.

### 5.2.1 Assessment of task needs

The first step in reducing carbon emissions from groundworks machinery is an assessment of which tasks are actually needed and at what frequency. The management of the grounds around the town is open to many new and more economical/environmentally sensitive ways of presenting the town to locals and visitors alike.

At present the Town grounds are kept very neat with tightly mown grass and a range of bedding plants installed each year. Soil treatment is covered in the section below on soil amendments, but the main contribution to carbon emissions is from the vehicles and machinery use by the staff carrying out their required duties.

The need to get to Zero Carbon along with many local people's understanding of the ecological emergency we are facing provides an ideal opportunity to re-assess how the grounds are managed. One example of another Town/City Council which has started down this approach with local success is Truro City Council which now has many popular wildflower central reservations. Plymouth now also has 120 sites for wildflowers and other wildlife such as bees and other pollinators.

### 5.2.2 Carbon reducing proposals

#### *1 Reduce grass cutting- now at 7 tCO2e pa*

- The assessment of energy use and hence carbon emissions from the Council machinery indicates that the main energy and staff time is spent on grass cutting with some 80% of petrol and nearly 20% of diesel being used this way. Grass cutting therefore creates nearly seven tonnes of carbon emissions a year, excluding the diesel costs of transporting machinery to site.

- Whilst it is recognised that some 80% of vehicle machinery use is for the Cornwall Council SLA, the first level of assessment indicates that the Town Council has responsibility for this set of emissions. The Town Council own land emissions are probably some 1.4 t CO2e pa.

- It is proposed that the Cornwall Council SLA should be renegotiated to significantly reduce the number of cuts each year in North Cornwall – or reduce the area cut to just that needed for visibility at junctions and to create a narrow rather than wide verge. This would help their own climate emergency plans

- See the work of Plantlife and their publications produced in collaboration with government and wildlife organisations eg *https://www.plantlife.org.uk/application/files/3315/7063/5411/Managing_grassland_road_verges_Singles.pdf*
- Increases the wildflowers and hence improves the experience of nature of road users in the local area.
- This action could save around 4 t $CO_2e$ pa.

- Start a town wide process and discussion about more ecological methods of managing the grassland.
  - Whilst the grass over Summerleaze Down is mainly left to grow with wide paths across being the main grass cutting work, this is only part of what could be achieved.
  - A wider range of wild plant species could be plug planted in appropriate locations to increase the biodiversity and visual interest of the Downs and other areas around the town
  - Investigate the impacts of allowing grass to grow longer in the lawn areas of the Town, with tightly mown paths for walkways and around the edges to provide clarity on the intent.
    - A regime of cutting outer edges at the present rate and inside sections either once or twice a year depending on the flowers to be encouraged. This could reduce carbon emissions by over half a tonne $CO_2e$ pa.
    - Would allow small pretty flowers such as daisies, clovers, birds foot trefoil etc to emerge in the lawns and increase pollinator insect opportunities
    - In front of the Castle this could provide a welcoming vista, especially for weddings and other celebrations
    - One example of this approach with an historic building is shown in the picture below.

***Approach to Kilkenny Castle***

An expert in this approach is Sid Hill who works throughout Cornwall, trained at Eden and specialises in increasing biodiversity in gardens and landscapes sidhilldesign@gmail.com tel 07415 439025

## 2 Plant for carbon sequestration

- Investigate the potential for mini-forests. These are small areas of 250$m^2$ or more, densely planted with a wide range of native trees and shrubs, which increase carbon sequestration and require no maintenance after three years. Several Town Councils are now developing their own Tiny Forests

  See https://earthwatch.org.uk/working-with-business/tiny-forests

  After four years a single Tiny Forest will provide:-

  - 500kg pa carbon sequestration
  - Attracts over 500 species of plants & animals
  - Connects the community to nature directly
  - Provides an outdoor classroom

- Investigate the potential for longer term plantings of the flower beds around the town. A wide range of open canopy small trees and bushes with nitrogen fixing plants and grasses amongst perennial plantings, all heavily mulched will:-

- reduce the maintenance requirements
- provide beauty all year round
- increase soil health
- potentially allows for local involvement in planting ideas

## 3 Change machinery to battery operated systems

The smaller machinery, which is all petrol driven, can relatively easily be changed to battery operated systems as there are commercial chainsaws, leaf blowers etc on the market. It is suggested that extra batteries are bought to allow for the long hours each machine is in use in the season. A complete change to battery systems for the small machines could save over 600kg $CO_2e$ pa.

The battery operated systems are also lighter weight and much quieter and would reduce the noise the workers are exposed to as well as nearby members of the public. It is suggested that these machines are changed to battery operated as each machine needs replacement over the next five years.

The larger machinery is more difficult to change to non fossil fuel sources as the market is not so well developed.

If the grass areas are managed differently, as suggested above, the need for new grass cutting machinery will diminish. A review of the present machinery and its age and efficiency should be conducted first in the light of decisions on the grass management regime. This will determine what machinery is needed in the longer term and when new machines are needed.

### Tractor

There are several battery operated tractors now on the market, all with enough power to match the present machinery operated by the Council. For example the John Deere tractor at 80kW which is operated for about 60 hours pa could be replaced with a battery operated tractor and used for more functions including some of the grass cutting duty. With higher torque, a smaller battery powered machine can be used successfully replace the present tractor.

Example machines now on the market include:-

- Alke

  https://www.alke.com/doc/alke-atx-electric-vehicles-catalog-eng.pdf

- Fendt e100 and 200 series  available via local dealer in Holsworthy range of sizes from 53- 80kW

  www.alansnowagriculturalengineers.co.uk

- Solectrac – range of compact battery tractors with accessories, including extra battery packs for longer running over five hours. USA based low priced.

  https://www.solectrac.com

Whilst these machines can be more expensive than fossil fuel tractors, prices are coming down and some countries now sell closer to par with diesel machines.

Major advantages:-

- The existing machine could  be sold to partially recoup the cost
- Would save £2,000 + pa in  fuel costs
- Saves over  6 $tCO_2e$ pa
- Could be charged from the Works Unit PV on non operational days
- Use in other duties would save more carbon and fuel costs than calculated here
- Electric machinery is significantly quieter, improving staff working conditions
- Lower maintenance costs

## *5.3 Vehicles*

The table below indicates the approximate fuel used by each vehicle operated by the Council. Calculations from the oil fuel purchases provide approximately the same results as shown in the table above.

The carbon cost of those vehicles running on diesel fuel is nearly ten tonnes $CO_2e$ pa.

*__Approximate diesel demand by vehicles__*

| Vehicle | | miles on clock | Very approx mpa | litres pa | kWh pa |
|---|---|---|---|---|---|
| WJ12 CZD | Land Rover | 36k | 6,000 | 941 | 13,155 |
| WA 69 ZUC | Isuzu D Max pickup truck | 4k | 6,000 | 802 | 11,220 |
| WJ18 UXB | Isuzu D Max pickup truck | 12k | 6,000 | 842 | 11,781 |
| LM 15 SYX | Vauxhall Box van | 108k | 5,000 | 583 | 8,151 |
| LG17 WLC | Combi electric | 23k | 3,000 | - | |
| **totals** | | | **26,000** | **3,168** | **44,307** |

### 5.3.1 Actions to reduce carbon emissions

**1 increase the use of the existing EV van**

The first step is to change the duty of the electric vehicle and start to use it in preference to the Vauxhall box van which at present does twice the mileage for a similar type of vehicle. The Vauxhall is also an older vehicle, and hence likely to be less efficient and higher in maintenance costs. It is also possible that the electric van could be used for some Land Rover journeys to save fuel.

Potential savings for a two thirds replacement of mileage would be around 1.5t $CO_2e$ pa for no extra cost, alongside diesel fuel savings of around £400 pa.

**2 replace diesel pickup trucks with electric versions**

Replace the pickup trucks with similar duty electric pickup trucks. Similar function battery pickup trucks, which can carry 0.8-1.6 tonne payload and tow higher weights than the present pickups, are available on the market in the USA, soon to be available here. Present US prices range around £55,000- £65,000. Several pickup trucks are due to hit the market in 2021 including from Rivian, Ford, GM, Workhorse, Atlis, Lordstown, and Bollinger.

Potential savings for each pickup replaced are approximately 3 t $CO_2e$ pa (6t $CO_2e$ pa for the pair) with fuel cost savings of over £800 pa each.

The electricity cost for the pickup vehicles could be met from the PV installation at the Works Unit and would require around 3,600kWh pa for each vehicle, or 7,200 kWh for both. This is significantly lower than the energy demand ` of the diesel as internal combustion engines are very inefficient and electric motors are very efficient with a primary energy saving of around 75% of delivered energy for the same mileage.

The PV installation produces around 18,493 kWh pa and exports possibly 12,800 kWh pa. The judicial use of daytime vehicle charging supplemented potentially with some battery storage for overnight charging would enable the Council to make more use on-site of the presently exported PV units. Daytime charging would save the full cost of the replaced fuels from the old pickup trucks. The use of batteries for overnight charging would require a control system to ensure the most cost-effective use of the daytime PV and the batteries together. As noted earlier, on average, batteries cost 6p/kWh of use in capital and operational costs.

***Carbon savings two pickup trucks***

6 t CO2e pa

Fuel cost savings £1,700 pa

Reduced maintenance costs c £1,000 pa

Annual savings £2,600

Capital cost for two c£130,000

Sale of two diesel trucks c £30,000

Net cost £100,000 approximately offset by requirement for replacement vehicles in say 5 years – say £34,000.

It is recommended that:-

- a close review is taken in 2021/22 to see how the prices are progressing on this type of vehicle, as prices should reduce over time
- a feasibility study is run for the PV Works Unit battery option to determine the best sizing and value options alongside operational programme requirements for the vehicles and the Works Unit controlled electricity demand
- monitoring of the mileage and uses of the pickup trucks and Land Rover is undertaken to determine the most fuel efficient operational options.

### 5.4 Soil amendments

The soil around the town is well known to be almost pure sand and hence the grounds work includes adding fertilisers and composts to improve the situation.

However as noted in Section 1 the carbon cost of such soil amendments is high, amounting to over one tonne $CO_2e$ pa, roughly half being fertilisers and half composts, excluding the high environmental and carbon cost of peat extraction and processing in particular.

It is also noted that the grass which is cut and collected is seen as waste and hence its soil amendment value is not used for the Council.

*Proposals to reduce carbon emissions and increase sequestration*

- review all soil amendment products and determine which local products could be used in their place
  - compost all grass and other clippings
  - compost all collected leaves
  - collect all cut wood, chip it and compost/use as mulches
  - investigate purchasing local greenwaste composts: Cornwall greenwaste is available in commercial quantities from The Green Waste Company at Roche tel 01736 322722

- stop purchasing peat composts completely
- where fertiliser is still deemed to be necessary, review local arisings of animal manures which could be left in water barrels and the fertilised water used instead. This would save both costs and carbon emissions
- minimally purchase organically recognised fertiliser such as Polysulphate which is mined as polyhalite in North Yorkshire, and with little processing produces a low carbon footprint, around 3% of that of ammonium nitrate. Provides S, K, Ca, and Mg: can be formulated to include N as required.
- follow the proposals earlier regarding reduction in grass cutting and tree planting and nitrogen fixing plants in several areas: this will help to build soil naturally and both sequester carbon and increase plant health
- review the options for some small areas of fast growing nitrogen fixing trees in open areas such as Summerleaze: wind resistant nitrogen fixers include Eleagnus umbellata (Autumn Olive) or Caragana arborescens (Siberian pea tree). Italian Alder can provide nitrogen for plants up to 25 metres distant.
- cut and remove clippings from wildflower areas to keep fertility low and increase wildflowers each year
- mulch all planting beds to build the soil – see the before and after pictures below of sandy soil with one year of mulching

***Sandy soil before and one year after mulching***

# 6 Proposed action programme

The key starting point for the programme to achieve zero carbon by 2030, is the involvement of the whole Council, both members and officers in understanding and emotional “buy-in” to the programme in its wider context as well as the individual detail.

To achieve the necessary commitment will take full scale leadership and the involvement and encouragement of the local community. The recent award of funds to the Bude Climate Partnership for work on local carbon reduction initiatives for helps in that regard, as it raises awareness in the local area.

## *6.1 Priority 1 Initiatives - first six months*

*1 Corporate initiatives*

- set up an awareness and training programme, starting with senior staff and Councillors and over time including everyone
- employ a Carbon and Energy Manager to help develop the action programme, install all the energy monitoring needed, and progress the investment programme to completion
- develop the investment and energy improvements programme

*2 Reduce energy demands*

- set up monitoring systems for all energy use throughout the Council, starting with the main buildings, the Works Unit and the liquid fuels use

*3 Change remaining demand to renewables*

- consolidate all electricity supply contracts and change to a renewables only supplier

*4 Building recommendations*

- develop the required Log Book for each building, to enable energy monitoring and system changes to be easily assessed
- undertake the feasibility study for the water source heat pump system for the main buildings
- install building energy monitoring systems, especially for electricity use
- install air to air heat pump system, including clothes drying in Works Unit staff and office spaces

- install export meter on Works Unit electricity supply to assess PV export

5 *Ground works*

- develop a programme to reduce grass cutting, by at least half
- increase the use of the existing EV, so decreasing use similar diesel vehicles such as the Box Van and potentially sometimes the Land Rover and pickup trucks
- stop purchasing peat composts

## *6.2 Priority 2 Initiatives - 6 – 18 months*

1 *Corporate initiatives*

- continue awareness and training programme, ensure all senior staff and Councillors have undertaken training and most other staff are involved
- develop community wide initiatives in conjunction with Bude Climate Partnership to increase their reach and help meet the Council's own targets
- ensure the Carbon and Energy Manager is fully supported and work continues on energy monitoring and all feasibility studies for major investments needed
- finalise the investment and building improvements programme and start to implement the main priority investments

2 *Reduce energy demands*

- analyse the results from the energy use monitoring, investigate anomalies, develop detail on building energy management systems and insulation needed
- implement building energy management systems
- install LEDs in all buildings to reduce lighting electricity demand

3 *Change remaining demand to renewables*

- develop investment programme for PV on buildings and potentially the local land array

4 *Building recommendations*

- install increased insulation in all accessible lofts, on the internal walls of the Castle and Parkhouse old section, and around the heated spaces in the Works Unit
- act on the results of the feasibility study for the water source heat pump systems for the main buildings and install decided system
- rectify why the Library uses more gas for heating than in 2015
- install clock control timers in Triangle and Rattenbury lighting systems
- update lighting systems to LEDs in the gardens and potentially involve the community in a new design for each location

*5 Ground works*

- work with Sid Hill, for example as a landscape designer for ecological low management cost approaches to a new ground management philosophy
- reassess machinery needs once new grounds management plan philosophy is developed
- change smaller machinery to battery powered as soon as replacements are needed, and the tractor as soon as possible
- install battery system at Works Unit and develop control parameters to ensure best use of the system for onsite use
- charge up machinery batteries at Works Unit PV system for first choice and from battery system as second choice
- start making own composts from clipped plant material, grass cuttings, leaves and wood chips
- use composts and wood chips to heavily mulch all flower and planting beds

## 6.3 Priority 3 Initiatives - 18 months - 3 years

*1 Corporate initiatives*

- continue awareness and training programme, ensure all senior staff and Councillors have undertaken training and all other staff are trained, up-date training as required
- continue and broaden community wide initiatives

- ensure the Carbon and Energy Manager is fully supported and work continues on energy monitoring and the major investment programme
- develop feedback on the investment programme and make any required adjustments to the programme to increase the speed of carbon reduction actions

2 *Reduce energy demands*

- keep energy monitoring going and rectify any problems identified
- install LEDs in all buildings to reduce lighting electricity demand

3 *Change remaining demand to renewables*

- develop investment programme for PV on buildings and potentially the local land array
- install at least two new PV systems on Council buildings
- make investment decision on the land array potential

4 *Building recommendations*

- review and organise café equipment to reduce electricity demand
- update lighting in Works Unit to LEDs with focussed LEDs in high bays
- disconnect Bus Shelter and Bude Light from mains supply and install own PV, battery and control systems

5 *Ground works*

- renegotiate Service Level Agreement with Cornwall Council to aim to implement improved wildflower maintained verges with much lower cutting regimes
- plant Council's own land for carbon sequestration on at least one third of open areas – with low lying plants or taller plants and wind resistant trees as appropriate
- develop Tiny Forests or wider complex plantings with local schools and environmental groups
- plant nitrogen fixing plants in large numbers where soil fertility is needed
- keep a watching brief for cost reductions on electric pickup trucks and any other new machinery which may be needed for the new ground regime- then invest when the financial parameters meet the Council's requirements.

## *6.4 Investment programme costs and savings*

Approximate costs and savings have been calculated to indicate the scale of action needed to move the Council to zero carbon. The costs are over the three year Action Programme outlined above and the savings are indicated over the first five years. Carbon savings are indicated in t CO2e on an annual basis.

The table gives approximate figures as there are uncertainties around most elements of the proposed action plan. The figures however do indicate the potential costs as well as the financial and carbon savings in outline.

The aim is to be able to show the type of investments needed and the costs of getting to zero carbon as well as the benefits.

The table is organised in the sections noted above for the outline action programme, but not all the smaller items noted in the programme are indicated on this table individually. This is to aid an overall approach and show which areas of activity are likely to give the best returns in finance and in carbon savings.

The totals are not added as there are numerous trade-offs between the different elements as they interact over time and with increased investment.

For example if a boiler control system is put in place it will save an estimated percentage of the presently used fuel for that building, but if the building is then better insulated or its heating system is changed to a more carbon efficient option this will reduce the energy used and for the same percentage saved the actual fuel saved will be less- or even not present – as in the case of changing a gas boiler to a electrically driven heat pump.

Therefore when finalising the Action Programme it will be important to be aware of the impacts of timing on both carbon and fuel savings.

Some investments do not have direct savings, such as the cost of a new Carbon and Energy Manager and the feasibility studies noted in the sections above. They are however essential enabling spending to ensure the success of the later investments and in the case of the Carbon and Energy Manager that it happens at all.

### *Very approximate costs and savings*

| Programme action | Costs £ over 3 yr plan | Savings £ over 5 yrs | Carbon savings t $CO_2$e pa |
|---|---|---|---|
| **1 Corporate** | | | |
| Awareness and practical training- external costs | 15,500 | | |
| Carbon & Energy Manager PT | 80,000 | | |
| **2 Reduce energy demand** | | | |
| Feasibility studies | 39,000 | | |
| Monitoring & control systems | 18,500 | 19,200 | 9.4 |
| Install water source heat pump system for three main buildings – *with renewable electricity supply* | 500,000 | 44,000 | 39.3 |
| **3 Change demand to renewables** | | | |
| Carbon Offset: Change to renewable electricity | 0 | 5,000 | 30.9 |
| PV on Council buildings | 62,000 | 33,000 | 15.7 |
| Carbon Offset: PV land array | 425,000 | 141,500 | 130.0 |
| **4 Buildings and facilities** | | | |
| Insulation-*lofts, some internal walls* | 87,000 | 50,900 | 17.2 |
| Works Unit air-to-air heat pump | 6,000 | 7,500 | 3.6 |
| Lighting to LEDs incl. gardens | 5,000 | 13,000 | 5.2 |
| **5 Ground Works** | | | |
| Increase use of onsite PV- machinery & vehicle & install battery system | 15,000 | 11,000 | |
| Machinery to battery systems<br>Smaller machines *net cost: sell existing*<br>Tractor *net cost : sell existing* | <br>7,500<br>32,000 | <br>2,200<br>4,000 | <br>1.5<br>2.9 |
| Reduce grass cutting | 0 | 9,200 | 4.5 |
| Land management for C sequestration, Tiny Forests, wider hedges, wildflowers etc total 2 ha | 13,600 | 0 | 15 |
| Mulching flower beds , etc *using own compost* | | 1,200 | 2 |
| Vehicles to electric : suggest wait on price reduction pickup trucks x2 *net cost sell existing* | 110,000 | 9,000 | 6.2 |

# 7 Conclusions

The aim of zero carbon held by the Council is a necessary one for the whole world and so is to be supported by everyone. This report aims to show that it is feasible to reach zero carbon within a fairly short time frame.

The details of the various activities and investments indicated here show that there are many ways to undertake this “journey to zero”.

One key element of this journey for the Council is that corporate buy in is vital and the awareness raising and training of all staff and Members is essential to success as everyone has a part to play. Equally it is vital that the Council appoints a senior staff member to undertake the myriad of actions and processes needed over the longer term to bring the Council decisions to fruition.

The Council’s present emissions are around 100 tpa CO2e from its use of electricity, gas and oil. Therefore the proposed actions aim to obviate the use of these energy sources where they are fossil fuel derived.

The proposed actions fall into several categories as noted in the individual sections of the report including reducing energy demand, changing to renewables and changing activities to low carbon ones.

One early Council decision is the balance of investments and activities between direct reduction of carbon emissions vs carbon offsetting and sequestration actions.

When viewed on a global scale it is clear that the target has to be zero direct carbon emissions, as it is not feasible to reach zero unless all emissions are cut. However there are practical issues, for the Council, around directly and quickly reaching zero carbon, which mainly centre around the scale of financial investments needed.

This suggests that one approach is to develop the direct reduction actions within the feasible financial envelope and in parallel develop the carbon offsetting and sequestration options, which are often cheaper. The carbon sequestration in particular is cheaper and provides other environmental benefits, although the quantifying of carbon actually sequestered in the soil or growing biomass is fraught with difficulties.

The tables below indicate several pathways to achieve carbon reduction at speed and the scale needed. They each indicate the annual carbon savings, indicative group financial investment required and the net cost over five years per annual tonne of CO2e. These tables do not include the extra internal costs to the Council.

***1 investment programme: low cost reduce CO2e emissions by 50%***

| Action | net cost 5yrs/ tpa CO2e | tpa CO2e | Capital £ |
|---|---|---|---|
| Change to renewable electricity | - 162 | 30.9 | 0 |
| Monitoring and control systems | - 74 | 9.4 | 18,500 |
| Lighting to LEDs including gardens | - 1,538 | 5.2 | 5,000 |
| Reduce grass cutting | - 2,044 | 4.5 | 0 |
| Works Unit air-to-air heat pump | - 417 | 3.6 | 6,000 |
| **Totals** | | **53.6** | **29,500** |

This table shows how to half the Council's carbon emissions for around £30,000 investment, with the main reduction (30%) coming from changing your electricity supplier. This carbon offsetting can be regarded as an interim step whilst the rest of the programme is developed. The actual investments outlined here all payback financially within a relatively short time, as indicated by the negative net costs over five year column.

***2 Next steps investment programme:***

| Action | net cost 5yrs/ tpa CO2e | tpa CO2e | Capital £ |
|---|---|---|---|
| Insulation-*lofts, some internal walls* | 2,099 | 17.2 | 87,000 |
| PV on Council buildings | 1,847 | 16 | 62,000 |
| Land management for c sequestration | 907 | 15 | 13,600 |
| Increase use of EV, install batteries | 1,600 | 2.5 | 15,000 |
| **Totals** | | **50** | **177,600** |

This table shows how further reductions can be made of another 50 tpa CO2e for around £180,000 investment, with 15 tpa CO2e coming from carbon sequestration and the rest being direct reductions of carbon based energy use. This section of investment shows a direct correlation between the investment costs and the amount of carbon saved.

Although the indicated carbon savings from these two sets of actions and investment appear to add up to around the 100 tpa CO2e target, in reality the Council would still be responsible for 37% of its carbon emissions.

The first stage therefore appears to be to achieve an actual emissions reduction of about 60 tpa CO2e or 60%, for approximately £200,000 investment, most of which will pay back within normal financial requirements. This 60% reduction from the two tables above is less than the indicated 100% reduction because some actions change the savings from others and there is some carbon sequestration which has been removed from the calculation.

### *3 carbon offsets and sequestration options*

| Action | net cost 5yrs/ tpa CO2e | tpa CO2e | Capital £ |
|---|---|---|---|
| PV land array | 2,181 | 130 | 425,000 |
| Change to renewable electricity | - 162 | 31 | - |
| land management for C sequestration | 907 | 15 | 13,600 |
| mulching own compost | - 600 | 2 | - |
| Totals | **2,326** | **178** | **438,600** |

This shows the options available for carbon offsets and actions to sequester carbon in the soil around the Town. The PV land array suggested for the area close to Sainsbury's could be larger or smaller depending on the choices the Council makes, and hence the carbon reduction will change.

The journey to carbon zero can be started with the investments and actions noted above and the Council can achieve a 60% reduction in local carbon emissions for around £200,000 plus extra internal costs. This level of investment is under seven times the present energy bill, of £29,000 pa) and would also show good returns in reducing the financial burden of energy purchases.

The outline programme in the previous section indicates that this could be achieved in less than three years, with the appropriate staffing and training within the Council.

The remainder of the programme would take longer but is still achievable, especially once some of the earlier investments free up potential finance to achieve the higher cost higher carbon reduction actions such as the water source heat pump system, which could cut out all the Council's gas demand, or 40% of carbon emissions in one hit.

The local community is likely to wish to help move these actions towards success and to celebrate the Council for this ambition and its achievements as the programme progresses.