Burnham Parish Council
Solar power feasibility study
Stage 2 feasibility report

Prepared by: Daniel Murray, Senior Consultant
Reviewed by: Helen Troup, Senior Consultant
Issued: 17th November 2017

Carbon Smart Ltd, 3rd floor, 105-107 Farringdon Road, London, EC1R 3BU
T: +44 (0)207 048 0450 | E: info@carbonsmart.co.uk | W: www.carbonsmart.co.uk

carbon smart

Contents

Executive Summary

Stage 2 findings

Carbon Smart have completed a feasibility assessment of the potential for solar PV at two sites belonging to Burnham Parish Council: Burnham Park Hall and George Pitcher Memorial Recreation Ground. This feasibility assessment builds upon the findings of the stage 1 pre-feasibility assessment, presenting the business case for a variety of options that were considered. Given the abundance of space at the Recreation Ground, three different scenarios specific to this site have been analysed, with the most favourable option in each scenario presented below. Our recommended options are highlighted in red:

	Burnham Park Hall	**George Pitcher Memorial Recreation Ground**		
	30 kWp roof mounted solar array	Scenario 1: 19.6 kWp roof mounted solar array to meet daytime demand	Scenario 2: 203.4 kWp roof & ground mounted solar array with private wire export at 9p/kWh	Scenario 3: 51.3 kWp roof & ground mounted solar array w/ Tesla battery storage
System size (kWp)	30.0	19.6	203.4	51.3
Electricity generated (kWh)	29,010	18,950	196,720	49,590
Carbon saved (tCO_2e)	11.2	7.3	75.6	19.1
Initial cost	£37,500	£24,500	£277,900	£107,900
Annual savings & revenue	£4,380	£3,230	£19,570	£6,740
Payback (years)	8.6	7.6	14.2	16.0
Return of investment (over 20 years)	12%	13%	7%	6%

The most favourable financial performance for a solar array at **Burnham Park Hall** would be realised if the array was limited to 30kWp. The most favourable financial performance at the **George Pitcher Memorial Recreation Ground** would be realised if a roof-mounted 19.6kWp was installed, sized to meet daytime demand.

Please note all financial metrics have been calculated using industry average costings, which are detailed in Appendix A. Actual costs may vary.

Burnham Parish Council may wish to consider the other options presented within this report if other considerations, such as maximising carbon savings or generating revenue streams, are a priority.

Burnham Park Hall

Optimal solution and rationale

Our recommendations for Burnham Park Hall is to install a 30kWp system on the south facing roof. A system of this size would generate just over 29MWh per annum, which represents approximately 10% of the electricity consumed at the site annually. An installation of this size would offer Burnham Parish Council a simple payback of 8.6 years, a return on investment of 12% over a 20-year study period and an internal rate of return over the same period of 13%. Please see Appendix A for the full business case for the proposed 30kWp system.

Whilst a larger system could be sized to fit on the available roof space, a 30kWp system offers to best return on investment. This is because it is not mandatory to fit an export meter on solar arrays sized at 30kWp or under. In the absence of an export meter, Ofgem assume that 50% of all generated electricity is exported to the grid. Given that Burnham Park Hall will use 100% of the electricity generated by the solar panels, limiting the size of the array to a 30kWp array will increase the annual savings made by Burnham Park Hall by providing Burnham Parish Council with access to the export tariff – everything generated onsite will be used onsite, offsetting electricity bills; additionally, the "deemed" 50% export means that they will also earn export payments for half of the power. Feed-in tariffs (FiT) supply a further revenue stream. Please note FiT's are scheduled to decrease over quarter by quarter – the FiT rates used for these calculations are valid as of Q3 2017.

A larger 41kWp solar array, which would generate more electricity and thus generate higher direct savings on electricity costs, could be sized to fit on the roof of Burnham Park Hall, however in the absence of any export tariff savings, a 41kWp would actually have a longer payback than the 30kWp system. Please see the 'Option comparison' section for further details.

A smaller system, such as the 16kWp system detailed in the 'Option comparison' section would also provide Burnham Parish Council with access to the export tariff. The 16kWp system was sized to fit on the largest portion of the roof without any obstructions, such as vents or eaves, however the metrics below demonstrate that this system performs no more favourably than the 30kWp system . Given that both costs and savings increase proportionally up to a system of 30kWp, a 16kWp system would give as good a return as the 30kWp system however it would meet just 6% of total electricity consumption on site. Should the upfront installation cost of a 30kWp system be an issue for Burnham Parish Council, then the smaller 16kWp is the next best option.

Option comparison

	41kWp array (maximum size)	30kWp array (optimal size)	16kWp array (minimum size)
Generation statistics			
System size (kWp)	40.9	30.0	16.1
Electricity generated (kWh/annum)	35,510	29,010	15,610

Carbon saved (tCO_2e)	15.2	11.2	6.0
Proportion of electricity provided	14.3%	10.5%	5.6%
Proportion of daylight electricity provided	24.3%	12.5%	9.65%
Financial metrics			
Study period (years)	20	20	20
Initial incremental cost	£51,100	£37,500	£20,200
Annual cost of cleaning panels	£200	£200	£100
Annual energy savings	£3,600	£2,700	£1,400
Annual financial incentive (FiT + export)	£1,600	£1,900	£1,000
Simple payback years	10.3	8.6	8.6
Simple return on investment	10%	12%	12%
Average return on investment (over study period)	5%	7%	7%
Net present value (over study period)	£2,441	£9.646	£5,191
Internal rate of return (over study period)	11%	13%	13%

Table 1 – Generation statistics and financial performance of 16kWp, 30kWp and 41kWp systems at Burnham Park Hall

Proposed location of panels

Figure 1 shows the proposed location of the solar panels on the south facing roof of Burnham Park Hall for the proposed optimal solution. It is anticipated that around 110 panels would be required to comprise a 30kWp array.

Figure 1 – Proposed location of solar panels for a 30kWp array on the roof of Burnham Park Hall

Shading analysis

Each solar panel is comprised of a number of solar cells. When sunlight is limited through shading, for example from nearby buildings or vegetation, solar cells stop generating electricity. In order to maximise the efficiency of solar panels installed at Burnham Park Hall therefore, it is crucial to ensure that shading is kept to a minimum.

The shading survey conducted during the site visit to Burnham Park Hall suggests that shading in the vicinity of Burnham is minimal. There are no buildings in the local area which could cast shade upon the Hall. There is some vegetation, predominantly trees, in close proximity to the south-east corner of the roof, which should be addressed. If the 30kWp system is chosen, then it may be possible to locate panels away from the south-east corner. If a larger system is chosen, then it may be preferable to either relocate this tree or ensure it is regularly trimmed to minimise shading.

Figure 2 – Trees shading the south-east edge of the roof at Burnham Park Hall

George Pitcher Memorial Recreation Ground

For the Hall, the amount of electricity consumed, combined with limited roof space, makes the proposed options relatively straight forward to select from. Conversely the low levels of daytime electricity consumption at the George Pitcher Memorial Ground, combined with an abundance of south facing roof space and available land for a ground mounted solar array, mean that a range of scenarios must be considered. There is potential to generate far more electricity than the site could consume.

With the site being used more frequently in the evenings than the daytime, the majority (62%) of electricity consumption actually occurs outside of the hours when a solar array would generate electricity. This means that even if Burnham Parish Council installed a solar panel sufficient to meet the on-site electricity demand, 62% of that electricity would need to be stored on site for night time consumption. In the absence of a storage solution, the Council could either export excess electricity to the grid or to a neighbour (via a private wire), but would still draw electricity from the grid in order to meet night time demands.

We have outlined three scenarios below, with different sizing options considered for each:

Scenario 1 – Burnham Parish Council install a solar PV array to match the on-site daytime electricity consumption only

Scenario 2 – Burnham Parish Council utilise all available roof and land space to maximise electricity production and sell excess electricity to a neighbour

Scenario 3 – Burnham Parish Council utilise all available roof and land space to maximise electricity production and store excess energy on site to cover night time electricity consumption

The final choice will depend on a range of factors, such as cost, complexity and the extent to which the Council is keen to go 'beyond the norm' by becoming a beacon of best practice. The variables for each scenario are explored further in the next section.

Please note that the shading survey conducted at the site suggests there may be significant shading along the southern edge of the Pavilion roof. Burnham Parish Council could therefore trim/remove the tree or situate the panels in the other available locations. Locating the panels elsewhere is likely to have a significant extra installation cost due the requirements for additional wiring, scaffolding for installation and so on. To keep costs to a minimum and identify the optimal payback periods, we have therefore assumed that Burnham could trim or remove the trees shading the Pavilion.

Scenario 1 – Roof-mounted solar PV on Pavilion to match daytime consumption

Optimal solution and rationale

The simplest option, with the lowest upfront installation cost, at the George Pitcher Memorial Recreation Ground would be for the Council to install a solar PV array sized to match daytime electricity consumption. Given that the daytime electricity demand on site is just under 19MWh, a solar array of approximately 20kWp would be required. This would meet 100% of daytime electricity demand and 38% of total on site electricity demand. An installation of this size would offer Burnham a simple payback of 7.6 years, a return on investment of 13% over a 20-year study period and an internal rate of return over the same period of 15%. Please see Appendix A for the full business case for the proposed 20kWp system.

Whilst a marginally larger system of 21kWp could be sized to fit on the available roof space, a 20kWp system offers to best return on investment. As discussed in the previous section, for both sizes of array it would be assumed that 50% is exported and thus would earn additional income from export

payments. For all electricity produced from the 20kWp system therefore, Burnham Parish Council would receive FiT payments and would offset the cost of electricity purchased from the grid (at 11p/kWh), whilst 50% would also qualify for the export tariff. On the other hand, whilst 100% of electricity generated by the 21kWp system would receive the FiT payments and 50% would receive the export incentives, only 95% of electricity generated would offset grid electricity (and thus result in a saving of 11p/kWh). The remaining 5% would simply be exported to the grid. Given that the cost of installation would increase proportionally with the size of the array, this means that the larger system has a longer payback period of 7.9 years.

Option comparison

	21kWp array (maximum size on Pavilion)	20kWp array (optimal size)
Generation statistics		
System size (kWp)	20.7	19.6
Electricity generated (kWh/annum)	20,000	19,000
Carbon saved (tCO_2e)	7.7	7.3
Proportion of electricity provided	41%	38%
Proportion of daylight electricity provided	106%	100%
Financial metrics		
Study period (years)	20	20
Initial incremental cost	£25,900	£24,500
Annual cost of cleaning panels	£100	£100
Annual energy savings	£2,100	£2,100
Annual financial incentive (FiT + export)	£1,300	£1,200
Simple payback years	7.7	7.3
Simple return on investment	13%	13%

Average return on investment (over study period)	8%	8%
Net present value (over study period)	£9,500	£10,200
Internal rate of return (over study period)	15%	15%

Table 2 – Generation statistics and financial performance of 20kWp and 21kWp systems on the roof of the Pavilion

Proposed location of panels

Figure 3 shows the proposed location of the solar panels on the south facing roof of the Pavilion at the George Pitcher Memorial Recreation Ground; the proposed, optimal solution. It is anticipated that around 70 panels would be required to comprise a 20kWp array.

Figure 3 – Proposed location of solar panels for a 20kWp on the roof of the Pavilion

Shading analysis

The shading survey conducted during the site visit to the George Pitcher Memorial Recreation Ground suggests that shading in the vicinity of the Pavilion could be problematic if left unaddressed. There are no buildings in the local area which could cast shade upon the Pavilion however there are some trees, shown in figure 4, in close proximity to the southern edge of the roof, which should be addressed. If locating the panels on the Pavilion, where they will be most visible, is the preferred option then the trees will likely need to be trimmed or relocated. If the location of the panels is not an issue, then it may be preferable to locate the panels on the roof of the Greenkeepers workshop and/or cottage, however the total available south-facing roof space on these buildings is unlikely to be sufficient for an array large enough to meet the daytime on-site electricity demand. Please note this shading analysis applies to all three scenarios for this site.

Figure 4 – Trees shading the southern edge of the pitched roof on the Pavilion.

Scenario 2 – Roof and ground mounted solar PV across site with private wire export to neighbour

Optimal solution and rationale

Utilising the roof space of workshop 1 (38m^2), workshop 2 (41m^2), the groundskeeper's cottage (30m^2), the Pavilion (145m^2) and the available land at the north-west of the site (1,170m^2) would give Burnham Parish Council a total usable area of 1,424m^2 (please see figure 5 for location of the various buildings and the land identified for ground mounted solar). This in turn could host a 203kWp solar array, of which 167kWp would be ground mounted and 36kWp would be roof mounted. An array of this size would generate approximately 197MWh per annum – far in excess of the total amount of electricity used on site. Generating excess electricity would allow Burnham Parish Council to access a revenue stream through sales to neighbours via a "private wire". The business case for this depends on two key variables:

1) The route and complexity of the private wire installation – *laying a private export wire would require trenching. The longer and more complex the trenching route, the more expensive the private wire installation.*
2) The re-sale price agreed with the neighbour – *Burnham Parish Council would need to agree a sale price for excess electricity which would be exported to a neighbour. The higher the agreed price, the more favourable the financial metrics for the Council, but the electricity client would expect to get a significantly lower price than their current utility provider offers.*

Using two routing options (complex vs. simple) and two re-sale prices (high price of 9p/kWh vs low price of 7p/kWh), the four options explored in the option comparison section have been calculated. Please see figure 6 for an illustration of the different routing options considered. The simple routing option, combined with a high re-sale price for excess electricity generated, produces the most variable financial outcomes. Were this to be the case, Burnham Parish Council would achieve a simple payback of 14.2 years, with a return on investment over a 20-year study period of 7%. Over the same study period, an internal rate of return of 7% would be achieved. Please see Appendix A for the full business case.

Figure 5 – The location of buildings and potential site for ground mounted solar at George Pitcher Memorial Recreation Ground

Figure 6 – the routing options considered for the installation of a private wire

carbon smart

Option comparison

	203kWp array Simple private wire route + high re-sale price	203kWp array Complex private wire route + high re-sale price	203kWp array Simple private wire route + low re-sale price	203kWp array Complex private wire route + low re-sale price
Generation statistics				
System size (kWp)	203.4	203.4	203.4	203.4
Electricity generated (kWh/annum)	196,700	196,700	196,700	196,7100
Carbon saved (tCO_2e)	75.6	75.6	75.6	75.6
Proportion of electricity provided	399%	399%	399%	399%
Proportion of daylight electricity provided	1,042%	1,042%	1,042%	1,042%
Financial metrics				
Study period (years)	20	20	20	20
Cost of panels	£254,300	£254,300	£254,300	£254,300
Cost of private wire installation	£23,600	£81,100	£23,600	£81,100
Total initial incremental cost	£277,900	£335,400	£277,900	£335,400
Annual cost of cleaning panels	£500	£500	£500	£500
Annual energy savings	£2,100	£2,100	£2,100	£2,100
Annual financial incentive (FiT + export)	£1,900	£1,900	£1,900	£1,900
Annual energy sales to neighbour	£16,000	£16,000	£12,400	£12,400

Simple payback years	14.2	17.1	17.4	20.9
Simple return on investment	7%	6%	6%	5%
Average return on investment (over study period)	2%	1%	1%	0%
Net present value (over study period)	-£67,300	-£124,700	-£105,600	-£163,000
Internal rate of return (over study period)	7%	5%	4%	3%

Table 3 – Generation statistics and financial performance of 20kWp and 21kWp systems on the roof of the Pavilion

Proposed location of panels

Figures 5 and 6 show the proposed areas for the installation of a 203kWp solar array. Of this approximately 36kWp would be roof mounted across the four buildings on site, whilst the remaining 167kWp would be ground mounted panels at the north-west corner of the site.

Figure 7 – Roof space to be utilised on the Pavilion, two workshops and the cottage

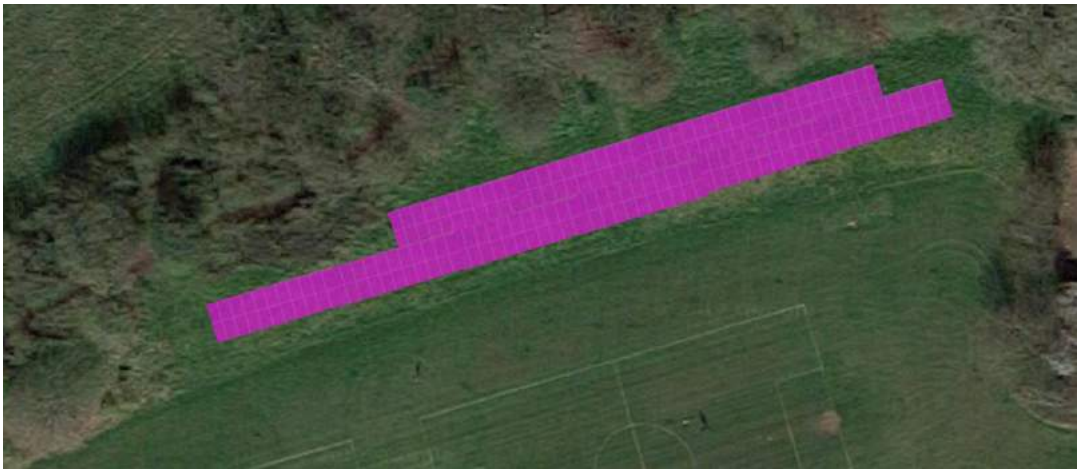

Figure 8 – Ground space to be used for a solar array at George Pitcher Memorial Recreation Ground

Shading analysis

The shading survey conducted suggests that, given the orientation of the various locations, the proposed panels on the roof space of the two workshops, the groundskeeper's cottage and the land available in the north-west corner of the site would have minimal amounts of shading at present (see figure 6). As highlighted in the shading analysis section of scenario 1, the roof of the Pavilion is current shaded along the southern edge by a number of trees. Were Burnham Parish Council to not install panels on the roof of the Pavilion for this reason, the total size of the solar array would fall to 183kWp, which would produce approximately 177MWh electricity per year.

Figure 9 – The roof of workshop 1 (left of image) and workshop 2 (right of image) have minimal shading

Scenario 3 – Roof and ground mounted solar PV to meet 100% of sites electricity demand with on-site energy storage

One of the barriers to fulfilling 100% of Burnham Parish Council's using solar PV is the intermittent nature of electricity generation. Peak generation from a solar array occurs during peak sunlight hours. The potential solution to this issue would be to size a solar array to match 100% of the Council's electricity consumption (including night time consumption), and store energy generated during the day to be used in the evenings.

Historically, the high upfront cost of energy storage has made the technology prohibitive. A number of factors, such as technological developments and significant improvements in efficiency, mean that the cost of various energy storage options are falling and are gradually becoming economically viable, particularly on a larger scale. One potential option open to Burnham Parish Council therefore would be to install a solar PV array sufficient to provide 100% of electricity consumed on site in combination with an energy storage solution.

Optimal solution and rationale

To meet total annual electricity demand at the George Pitcher Memorial Recreation Ground (49MWh), a solar array of approximately 51kWp would be required. There is an insufficient amount of roof space available to meet the full demand, however a 36kWp system could be housed on the available roof space. Burnham Parish Council could therefore split the 51kWp between roof mounted and ground mounted systems or alternatively could make the entire 51kWp a ground mounted system. For the purposes of this analysis, it has been assumed that 36kWp would be installed on roof space, with the remaining 15kWp to be ground mounted.

Currently the most common energy storage options are batteries and heat storage solutions. Many types of battery are now available however the two most common types are lead acid, generally used for larger systems, and lithium ion, which tend to be used on smaller scales but have higher costs. Once again, several heat storage options are on the market with two of the most common including thermal stores, such as hot water cylinders, and heat batteries however these solutions can generally only be used for space heating or hot water. For this analysis therefore, we have explored the business case for using two different types of popular battery on the market; the Tesla Powerwall 2 (a lithium ion phosphate battery) and the Powervault 4kWh Lead Acid battery.

The Tesla Powerwall 2 gives the best simple payback at 16 years. If Burnham were to pursue this option, a simple return on investment of 6% and an internal rate of return of 5% would be achieved over a 20 year study period.

Option comparison

	51kWp array with a Powervault battery	51 kWp array with a Tesla Powerwall 2 battery
Generation statistics		
System size (kWp)	51.3	51.3
Electricity generated (kWh/annum)	49,600	49,600
Carbon saved (tCO_2e)	19.1	19.1

Proportion of electricity provided	101%	101%
Proportion of daylight electricity provided	263%	263%
Financial metrics		
Study period (years)	20	20
Initial incremental cost	£135,700	£107,900
Annual cost of cleaning panels	£244	£244
Annual energy savings	£5,500	£5,500
Annual financial incentive (FiT + export)	£1,500	£1,500
Simple payback years	20.1	16.0
Simple return on investment	5%	6%
Average return on investment (over study period)	0%	1%
Net present value (over study period)	-£63,200	-£35,300
Internal rate of return (over study period)	3%	5%

Impact of shifting profile of energy consumption at George Pitcher Memorial Recreation Ground

As has been highlighted previously, the profile of electricity consumption at the George Pitcher Memorial Recreation Ground – high consumption in the evening and at night – means that the majority of energy is used at periods when solar panels will not be producing any energy. Currently of the 49.3MWh used on site, 18.9MWh (38%) is used during the day and 30.4MWh (62%) in used in the evenings. Two possible solutions have been proposed to this issue, exporting to a neighbour (explored in scenario 2) and storing energy on site (explored in scenario 3), however a more cost-effective solution would be to shift the profile of energy consumption to the day.

If, for example, Burnham were able to shift the profile such that 75%, or 37.0MWh, of energy was consumed during the day, a 38.3kWp solar array would be required at an installation cost of just under £48,000. Based on the Feed in Tariff payments and electricity savings, Burnham Parish Council would achieve a payback of 8.5 years.

The optimal payback for Burnham Parish Council would be achieved if 60% of electricity was used during the daytime. In this scenario, a 30kWp solar array would be required (at an installation cost of £37,500), which would not only qualify for the Feed in Tariff payments but also payments through the "deemed export" of 50% too. Combined with the savings on electricity purchased from the grid, a simple payback of 7.2 years would be achieved.

A more detailed business case has not been drawn up for this scenario as it has been deemed unlikely that Burnham Parish Council would be able to shift a suitably significant proportion of energy consumption to the daytime given the limited control Burnham Parish Council have over the buildings' use and the nature of the business run by the occupants, who run dance classes in the evenings. Therefore, this option has not been progressed any further.

carbon smart

Recommendations & issues to consider

Site	Option recommended	Rationale	Issues / considerations	Next steps
Burnham Park Hall	30 kWp roof-mounted system	A 30 kWp system is the maximise size which doesn't require an export meter and is thus the largest system Burnham Parish Council could install and use 100% of the electricity generated whilst still taking advantage of the export tariff	**Sizing:** • Is the Council's priority achieving the best payback possible or other considerations, such as carbon savings or maximising the amount of electricity self-supplied? **Feasibility:** • Need to confirm feasibility with the local DNO • Need to confirm electrical routes and space for the inverter	1) Discuss options with Clerk 2) Agree priorities and decide on sizing 3) Await confirmation from local DNO 4) Confirm electrical routes and inverter location 5) Confirm decision ahead of producing design documents
George Pitcher Memorial Recreation Ground	19.6 kWp roof-mounted system	A 19.6 kWp system is the largest system where Burnham Parish Council would use 100% of the electricity generated without an associated storage solution, and thus offers the most favourable financial metrics	**Sizing:** • Is the Council's priority achieving the best payback possible or other considerations, such as carbon savings or generating a revenue stream? • Would it preferable to trim/remove trees or accept a higher installation cost? **Consumption profile:** • Is shifting consumption to the daytime feasible? **If ground-mounted panels were pursued:** • Would squirrels on site damage solar panels? • Would a solar array be a security risk?	1) Discuss options with Clerk 2) Make a decision regarding trees shading Pavilion 3) Agree priorities and decide whether to pursue battery storage or private wire export 4) If grounded-mounted panels are pursued, begin planning discussions with Planning Offficers at South Bucks District Council **If recommended option is pursued:** 5) Confirm whether shifting energy profile is feasible

			• Would the close proximity to football pitches, put the panels at risk/ of damage? • Would need to begin application for planning consent? **Export:** • What re-sale price could be agreed with neighbours? • Could a private wire be laid in a direct route? **Feasibility:** • Assess type of land would private wire be laid across. Trenching through agricultural land is cheaper than highways, footpaths etc. • Confirm feasibility with the local DNO	6) If tree removal is not feasible, confirm installation on groundskeeper's cottage is feasible and assess increased costs 7) Await confirmation from local DNO 8) Confirm electrical routes and inverter location **If battery storage is pursued:** 4) Assess spatial considerations for battery units 5) Decide on location of panels 6) Await confirmation from local DNO **If private wire export is pursued:** 4) Begin discussions with neighbour to confirm feasibility 5) Confirm site boundaries and assess feasible private wire routes 6) Confirm land type of private wire route 7) Await confirmation from local DNO

Next steps

Carbon Smart will present the findings and recommendations of this feasibility study to the Clerk. This will include a discussion of the various options presented to gain an appreciation of the Council's primary objectives. Carbon Smart will ensure a decision is made by the local DNO, regarding the feasibility of installation and any associated costs, within the defined timescales (45 days from submission, due by end December 2017).

Once the options have been suitably reviewed and a decision has been made on the option(s) to pursue, the design document phase can commence, allowing the Council to approach prospective suppliers for pricing and contracting.

Should the Council wish to pursue energy storage or private export at the George Pitcher Memorial Recreation Ground, Carbon Smart will begin the appropriate conversations with installers, local planning officers from South Bucks District Council and/or neighbouring businesses.

We anticipate this work taking place in late November and early December 2017.

Appendix A: Detailed business cases

Burnham Park Hall

Install a 30kWp solar array on the roof of Burnham Park Hall				
Annual cost savings (£)	**Annual energy generation (kWh/yr)**	**Annual CO_2e savings (tCO_2e/yr)**	**Cost of implementation (£)**	**Estimated payback (Years)**
4,380	29,010	11	37,500	8.6
Observations	Burnham Park Hall, situated in Burnham Park which runs from Priory Road in the south to the High Street in the north, has a total usable roof space of approximately 286m^2, depending on the use of overhanding eaves and the balcony. The site visit revealed that whilst there are a number of trees in the vicinity of Burnham Park Hall, shading is likely to minimal.			
Details of recommendation	We recommend installing solar panels on the south facing roof of Burnham Hall. Approximately 210m^2 of the roof would be required for the installation of a 30kWp solar array. An estimated costing of the system is £37,500. Burnham Parish Council are eligible to take advantage of the governments Feed-in-Tariff (FiT). An Energy Performance Certificate (EPC) is not available for the Park Hall, however given the age of the building, it has been assumed that the Park Hall has an EPC rating of at least D. If a building has an Energy Performance rating of E or less, only the lowest rates of FiT subsidies are available, therefore the higher band of FiT subsidies have been used for the purposes of these calculations.			
Assumptions	Please note all assumptions and references are based on industry averages: Installation area: 210m^2 System size: 30kWp Annual electricity generated: 20,010kWh Carbon savings: 11.2 tCO_2e Costs attributable to DNO infrastructure upgrades: £0			

	Total installation cost: £37,500 FiT tariff rate: £0.0405 per kWh Annual income from FiT: £1,175 Export tariff rate: £0.0503 per kWh Annual income from export: £730 Unit price of electricity: £0.09 per kWh Annual cost savings from electricity purchased: £2,658 Cost of cleaning roof mounted panels per kW: £6.10 Annual cost of cleaning solar panels: £183 Total annual cost savings: £3,736 We also note that solar panels mostly for self-consumption (as in this case) are subject to additional business rates, as detailed in the 2016 autumn statement. Micro-generation plant (<50kWp) will not be subject to additional rates until the next ratings review (likely to be 2022), and there is significant lobbying effort to overturn this decision. For the time being, we have excluded this additional cost to the business, as they effectively have five years' grace period. If the business rates remain in force as described, this system would incur an additional £828/yr in business rates.
Main aims and objectives	Reduce electricity consumption from the grid on site Reduce carbon emissions due to electricity usage Installing renewables increases the future financial security of the business
Risk assessment	Disruption caused by scaffolding needed to install solar array Strength of roof sufficient to support solar array Relatively high upfront cost needed to install solar array

George Pitcher Memorial Recreation Ground – Scenario 1

Install a 19.6kWp roof-mounted solar PV on Pavilion to match daytime consumption				
Annual cost savings (£)	**Annual energy generation (kWh/yr)**	**Annual CO_2e savings (tCO_2e/yr)**	**Cost of implementation (£)**	**Estimated payback (Years)**
3,347	18,953	7.3	24,500	7.3
Observations	The George Pitcher Memorial Recreation Ground contains a number of buildings with suitable roof space for the installation of a solar array, including the Pavilion (145m^2), the groundsman's cottage (30m^2), 2 workshops (79m^2 combined) and up to 1,170m^2 of land for a ground mounted system. The aforementioned spaces are all south facing and shading analysis suggests that only the Pavilion would suffer from shading issues.			
Details of recommendation	We recommend installing solar panels on the south facing roof of the Pavilion. Approximately 137m^2 of the roof would be required for the installation of a 19.6kWp solar array. An estimated costing of the system is £24,500. Burnham Parish Council are eligible to take advantage of the governments Feed-in-Tariff (FiT). Given that the site has an Energy Performance Certificate (EPC) rating of 'C', Burnham Parish Council would qualify for the higher FiT rate, improving the annual cost savings achieved and reducing the overall payback.			
Assumptions	Please note all assumptions and references are based on industry averages: Installation area: 137m^2 System size: 19.6 kWp Annual electricity generated: 18,953kWh Carbon savings: 7 tCO_2e Costs attributable to DNO infrastructure upgrades: £0 Total installation cost: £24,500 FiT tariff rate: £0.0405 per kWh			

	Annual income from FiT: £768 Export tariff rate: £0.0503 per kWh Annual income from export: £477 Unit price of electricity: £0.11 per kWh Annual cost savings from electricity purchased: £2,103 Cost of cleaning roof mounted panels per kW: £6.10 Annual cost of cleaning solar panels: £120 Total annual cost savings: £3,347 We also note that solar panels mostly for self-consumption (as in this case) are subject to additional business rates, as detailed in the 2016 autumn statement. Micro-generation plant (<50kWp) will not be subject to additional rates until the next ratings review (likely to be 2022), and there is significant lobbying effort to overturn this decision. For the time being, we have excluded this additional cost to the business, as they effectively have five years' grace period. If the business rates remain in force as described, this system would incur an additional £541/yr in business rates.
Main aims and objectives	Reduce electricity consumption from the grid on site Reduce carbon emissions due to electricity usage Installing renewables increases the future financial security of the business
Risk assessment	Disruption caused by scaffolding needed to install solar array Strength of roof sufficient to support solar array Relatively high upfront cost needed to install solar array

George Pitcher Memorial Recreation Ground – Scenario 2

Install a 203.4 kWp solar array and export excess electricity to a neighbour				
Annual cost savings (£)	**Annual energy generation (kWh/yr)**	**Annual CO_2e savings (tCO_2e/yr)**	**Cost of implementation (£)**	**Estimated payback (Years)**
20,039	196,715	75.6	277,930	13.9
Observations	The George Pitcher Memorial Recreation Ground contains a number of buildings with suitable roof space for the installation of a solar array, including the Pavilion (145m^2), the groundsman's cottage (30m^2), 2 workshops (79m^2 combined) and up to 1,170m^2 of land for a ground mounted system. The aforementioned spaces are all south facing and shading analysis suggests that only the Pavilion would suffer from shading issues.			
Details of recommendation	We recommend installing solar panels on the south facing roof of the Pavilion, the cottage, the two workshops and the available land. This equates to approximately 254m^2 of roof space and 1,170m^2 of land that would be required for the installation of a 203.4kWp solar array. A 36.3kWp system would roof mounted and 167.1kWp would be ground mounted. An estimated costing of the system is £254,286. Burnham Parish Council are eligible to take advantage of the governments Feed-in-Tariff (FiT). Given that the site has an Energy Performance Certificate (EPC) rating of 'C', Burnham Parish Council would qualify for the higher FiT rate on the 36.3kWp system installed on the roof space, improving the annual cost savings achieved and reducing the overall payback. The ground mounted solar array would only qualify for the stand-alone FiT rate of 0.3p/kWh. It has been assumed of the 196,715kWh generated per annum, 18,877kWh is consumed by Burnham during the day time. The remaining 177,838kWh would be exported to a neighbour at an agreed price per kWh. This would require the installation of a private wire to the neighbouring site, which has been costed at £23,644 on the assumption that the trenching can be dug directly to the site.			
Assumptions	Please note all assumptions and references are based on industry averages: Installation area: 1,424m^2			

	System size: 203.4kWp Annual electricity generated: 196,715kWh Electricity to be used by Burnham: 18,877kWh Electricity to be exported: 177,838kWh Carbon savings: 75.6 tCO_2e Costs attributable to DNO infrastructure upgrades: £0 Cost of private wire per metre: £90 Length of private wire required: 263 metres Cost of private wire: £23,644 Cost of solar array: £264,286 Total installation cost: £277,930 FiT tariff rate for roof mounted array: £0.0405 per kWh FiT tariff for ground mounted array: £0.003 per kWh Annual income from FiT: £1,931 Sale price to neighbour: £0.09 per kWh Annual income from sales: £16,005 Unit price of electricity: £0.09 per kWh Annual cost savings from electricity purchased: £2,658 Cost of cleaning roof mounted panels per kW: £6.10 Cost of cleaning ground mounted panels per kW: £1.48 Annual cost of cleaning solar panels: £469 Total annual cost savings: £20,039 We also note that solar panels mostly for self-consumption (as in this case) are subject to additional business rates, as detailed in the 2016 autumn statement. Micro-generation plant (<50kWp) will not be subject to additional rates until the next ratings review (likely to be 2022), and there is significant lobbying effort to overturn this decision. For the time being, we have excluded this additional cost to the business, as they effectively have five years' grace period. If the

	business rates remain in force as described, this system would incur an additional £4,021/yr in business rates.
Main aims and objectives	Reduce electricity consumption from the grid on site Reduce carbon emissions due to electricity usage Installing renewables increases the future financial security of the business
Risk assessment	Disruption caused by scaffolding needed to install solar array Strength of roof sufficient to support solar array Relatively high upfront cost needed to install solar array Ground mounted panels could be a security risk Squirrels on site may cause damage to solar panels Panels would be close to football pitch. Stray balls may damage panels

George Pitcher Memorial Recreation Ground – Scenario 3

Install a 51.3 kWp solar array, combined with a Tesla Powerwall 2, on the roof space and land				
Annual cost savings (£)	**Annual energy generation (kWh/yr)**	**Annual CO_2e savings (tCO_2e/yr)**	**Cost of implementation (£)**	**Estimated payback (Years)**
6,981	49,593	19.1	107,857	15.5
Observations	The George Pitcher Memorial Recreation Ground contains a number of buildings with suitable roof space for the installation of a solar array, including the Pavilion (145m^2), the groundsman's cottage (30m^2), 2 workshops (79m^2 combined) and up to 1,170m^2 of land for a ground mounted system. The aforementioned spaces are all south facing and shading analysis suggests that only the Pavilion would suffer from shading issues.			
Details of recommendation	We recommend installing solar panels on the south facing roof of the Pavilion, the cottage, the two workshops and a section of the available land. This equates to approximately 254m^2 of roof space and 105m^2 of land that would be required for the installation of a 51.3kWp solar array. A 36.3kWp system would roof mounted and 15kWp would be ground mounted. An estimated costing of the system is £64,107. Burnham Parish Council are eligible to take advantage of the governments Feed-in-Tariff (FiT). Given that the site has an Energy Performance Certificate (EPC) rating of 'C', Burnham Parish Council would qualify for the higher FiT rate on the 36.3kWp system installed on the roof space, improving the annual cost savings achieved and reducing the overall payback. The ground mounted solar array would only qualify for the stand-alone FiT rate of 0.3p/kWh. It has been assumed of the 49,593kWh generated per annum, 18,877kWh is consumed by Burnham during the day time. The remaining 30,421kWh would be stored using a Tesla Powerwall 2 battery system. This battery unit has a daily output, on a full charge of 13.5kWh, therefore Burnham would require 14 units in order to meet their evening demand. At a unit cost of £6,250, the total cost of energy storage would be £43,750.			
Assumptions	Please note all assumptions and references are based on industry averages: Installation area: 359m^2 System size: 51.3kWp			

	Annual electricity generated: 49,298kWh Carbon savings: 19.1 tCO_2e Costs attributable to DNO infrastructure upgrades: £0 Total solar array cost: £64,107 Total battery installation cost: £43,750 FiT tariff rate for roof mounted solar: £0.0405 per kWh FiT tariff rate for ground mounted solar: £0.003 per kWh Annual income from FiT: £1,489 Unit price of electricity: £0.11 per kWh Annual cost savings from electricity purchased: £5,492 Cost of cleaning roof mounted panels per kW: £6.10 Cost of cleaning ground mounted panels per kW: £1.48 Annual cost of cleaning solar panels: £414 Total annual cost savings: £6,981 We also note that solar panels mostly for self-consumption (as in this case) are subject to additional business rates, as detailed in the 2016 autumn statement. Micro-generation plant (<50kWp) will not be subject to additional rates until the next ratings review (likely to be 2022), and there is significant lobbying effort to overturn this decision. For the time being, we have excluded this additional cost to the business, as they effectively have five years' grace period. If the business rates remain in force as described, this system would incur an additional £414/yr in business rates.
Main aims and objectives	Reduce electricity consumption from the grid on site Reduce carbon emissions due to electricity usage Installing renewables increases the future financial security of the business
Risk assessment	Disruption caused by scaffolding needed to install solar array Strength of roof sufficient to support solar array Relatively high upfront cost needed to install solar array

	Ground mounted panels could be a security risk Squirrels on site may cause damage to solar panels Panels would be close to football pitch. Stray balls may damage panels

105-107 Farringdon Road, London EC1R 3BU

+44 (0)20 748 0450

Daniel.Murray@carbonsmart.co.uk

Helen.Troup@carbonsmart.co.uk

www.carbonsmart.co.uk

Registered in England and Wales, Company number 6235381