Client:
Hanover Cube

PHOTOVOLTAIC AND SOLAR THERMAL FEASIBILITY STUDY

FOR

16-19 SOUTHAMPTON PLACE, LONDON

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CONTENTS

Page No.

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1.0 EXECUTIVE SUMMARY

This report has been produced to assess the feasibility of implementing solar power technologies as a part of the fit out works for 16-19 Southampton Place, London, WC1A 2AJ. The report was commissioned as a result of a Section 106 agreement for the proposed development dated December 2010 which required a study to be undertaken on the feasibility and location of photovoltaic and/or solar thermal panels.

An appraisal was carried out in respect to; available natural resources, available space, potential energy, carbon and fiscal savings and integration in the current building services and structure. As the building is a Grade II (star) listed building, the historical qualities have also been considered.

A more detailed analysis looking at the fiscal returns as well as carbon savings, demonstrated that the solar thermal (hot water) technology was deemed to be unviable based on the high financial payback for small carbon returns.

A photovoltaic (PV) system located on the flat roof to the centre of the proposed development is deemed to be technically viable based on an initial desk top study. A 1.4kWpeak array is predicted to reduce annual CO_2 emissions by 500kgCO_2/yr and payback in approximately 12 years, largely as a result of revenue from the feed in tariff (FIT).

Next steps would include further consultation with the planning department at Camden Borough Council to assess the visual impact of any proposed PV panels given the grade II (star) listing of the building, along with assessment of the structural loading impacts of the identified roof area.

2.0 INTRODUCTION

16-19 Southampton Place is a grade II (star) listed Georgian period building comprising of approximately 464m^2 office accommodation over the basement, ground and upper floors. There is a total building area of 1320 m^2.

This report investigates the opportunity for solar power to be integrated as a part of the fit out works. The technologies assessed are Photovoltaic (PV) panels for electricity generation and solar thermal panels for DHW heating.

The report assesses the natural resources available, presents a description of each technology, and assesses the feasibility of the technology on the site, and its potential for energy generation. The following factors have been considered:

- Energy generated from each LZC energy source per year
- Financial payback
- Land Use
- Local planning criteria
- Noise
- Any available grants

For each technology contained within this report, each has undergone a detailed feasibility study by understanding what the energy requirements of the building are, sizing the equipment to suit the building, then carrying out technical and financial feasibility studies to determine whether or not the technology is viable for this project.

3.0 SITE AND BUILDING SUMMARY

16-19 Southampton Place has a floor area of approximately 1320m^2 over 6 storeys and 464m^2 of office space. The building is located in a densely built up area of London, in the vicinity of Holborn Tube station and Bloomsbury Square gardens. The building, illustrated in figure 1, is a Grade II listed, Georgian terrace.

Figure 1: Front View (Looking South-West)

Figure 2: Aerial View, Building Highlighted in Yellow

Figure 3: 3D Arial View, Looking West, Building Highlighted in Yellow

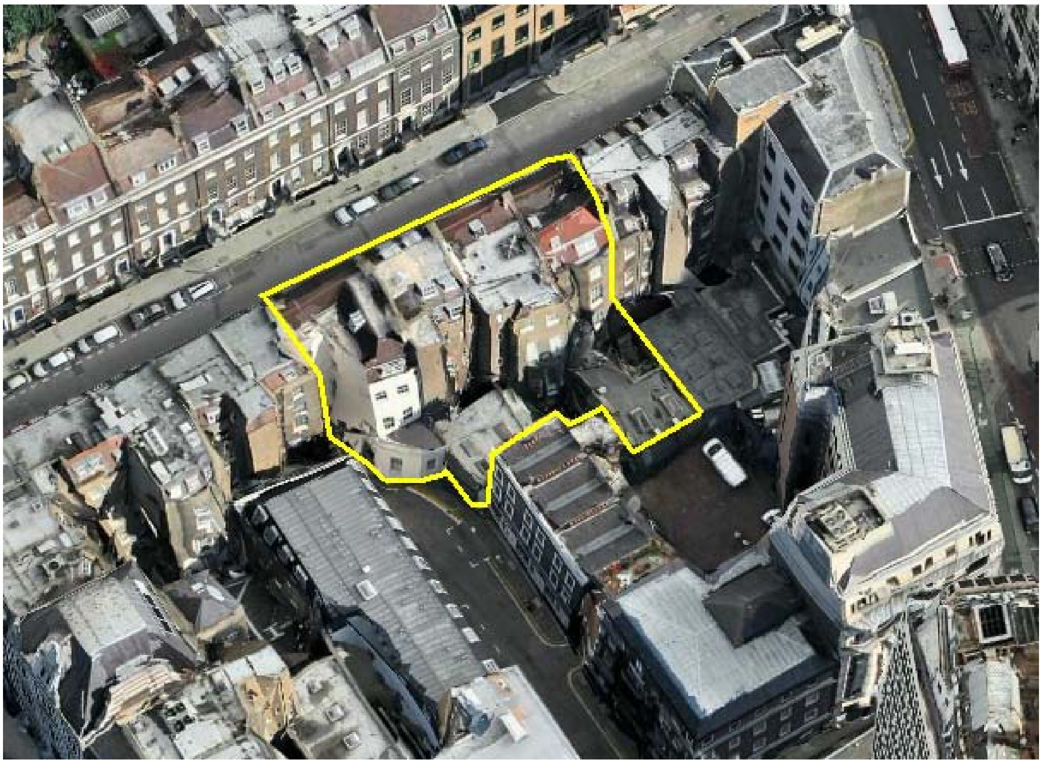

Figure 4: 3D Arial View, Looking East, Building Highlighted in Yellow

3.1. Listed Building Status

The Historic Buildings and Monuments Commission (HBMC), approved by the Secretary of State, allocates a grade scale status to selected buildings on the basis of their Special Architectural or Historic Interest

Southampton place is Grade II (star) listed on the Statutory List of Buildings. A Grade II (star) listed building may not be demolished, extended or altered without special permission from the local planning authority.

*ODPM released the **Companion Guide to Planning Issues** Pages 144-149 of this document cover solar PV and in particular, point 13 (p147):*

13. The technology will be familiar to most and from the planning point of view, whilst there are clearly implications for listed buildings and the sensitive front elevations of some conservation areas, in general 'solar panels' are to be encouraged. In some cases, provided the installation is not of an unusual design, or involves a listed building, and is not in a designated area, PV is regarded as "permitted development" and is thus deemed not to require a planning application. Unless the panels are of an unusual design, they should be treated as being within the plane of the existing roof slope for the purposes of Part 1, Class B1(b) of the Town and Country Planning (General Permitted Development) Order.

3.2. Roof Area Analysis

It is important in any solar panel analysis to ensure that there is available roof space that is not overshadowed for any significant period of time and that will no be overshadowed in the near future, i.e. any new structures being built in the vicinity or trees etc that might grow to overshadow the designated roof space.

Due to the listed nature of the building and it's locality in a conservation area, it is necessary to ensure that the visual impact of the solar panels is minimised. It is also important to consider any other features of the building that may be impacted by installing any solar panels.

The roof areas across 16-19 Southampton Place are varied for each address. This is illustrated in figures 3 and 4 in section 2.1 of this report.

The street facing sections of roof are mansard roofs (illustrated in figure 5), a roof that has two slopes to each side, and the lower slope being much steeper. This is typical of Georgian buildings.

It will not be possible to mount any solar panels on any of these areas of the available roof due to the visual impact.

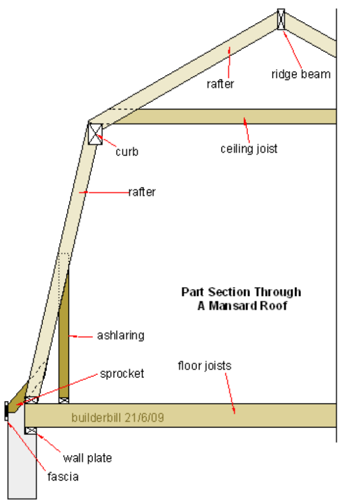

Figure 5: Mansard Roof

There are some areas of roof which are flat which would unlikely impact the visual impact of the building, from the street view, although care would have to be taken to ensure this would be acceptable to any on-looking buildings also.

Following discussions with the architect and the M+E Consultant, the following areas, illustrated in figure 6, behind number 17 Southampton Place, have been highlighted as potentially available for placing solar panels.

Outlined in red is the suggest location for solar panels.

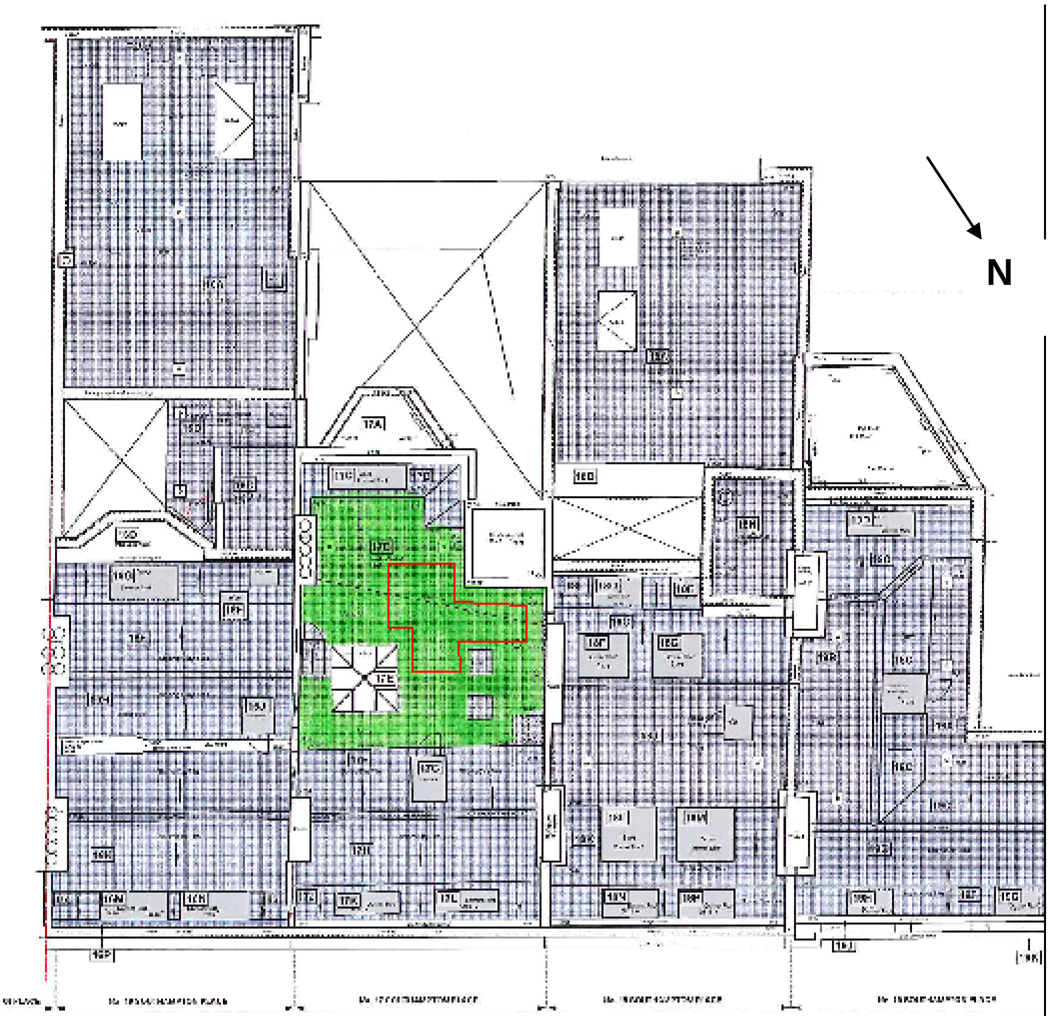

Figure 6: Flat Roof Areas Available for Solar Panels.

The flat area of roof area allocated has an available area of approximately 40m^2 altogether (minus the area of roof lights). This is taking into account the roof lights and chimneys. Of this space, outlined in red is the suggested area for locating he panels, which is equivalent to approximately 10m^2. This area has been suggested based on the location of the fall protection system, the location of the roof lights and the impact anticipated from the chimney sack on the south side of the roof.

The height of the allocated roof area is approximately 39m.

3.2.1. Overshadowing Analysis

The allocated roof area is on the south-west side of the building. South of the highlighted area is the roof over the rear section of number 16. The height of this section of roof is 28m. East of the allocated area, is the front section of number 16, which is between 37 and 39m. West of the allocated area is the rear section of number 18, this is at a height of 28m. Therefore none of the immediate roof areas are expected to overshadow any potential panels.

The chimney stacks featured in figure 6 will cause some overshadowing of the available roof area. As these are in the south corner of the available area, it is anticipated that they could have a significant impact.

4.0 ENERGY REQUIREMENTS OF THE BUILDING

Table 1 below outlines the typical energy consumption at 16-19 Southampton Place. The data has been obtained using a dynamic model simulation of the building using IES VE software.

Table 1: Typical Energy Consumption and CO_2 Emissions

Energy consumption (MWh / year)	194.7
CO2 emissions (tCO2 / year)	100

5.0 SOLAR POWER

5.1. Resource

In the London area there is an annual average solar energy availability of 1MWh/m^2 at the optimum (south facing) angle of 30^o from the horizontal plane. The amount of this energy that can be utilised is dependent upon the availability of un-shaded roof/façade space and efficiency of the solar panels considered.

It has been determined that up to 10m2 of roof space could be utilised for solar power technologies (photovoltaic and/or solar hot water). See figure 6 in section 3.2.

5.2. Solar Thermal Hot Water

Solar thermal systems use a heat collector which is usually mounted on a roof to heat the domestic hot water (DHW) supply through a coil in a hot water cylinder.

Solar water heating systems can provide a significant contribution towards domestic hot water requirements in Northern European locations. When used for pre-heating DHW, a system is typically sized to meet in the region of 50% of an office's annual hot water requirements; in the summer months, all of the hot water requirements might be generated from the solar thermal system, whereas a much lower proportion will be met in the winter. It should be noted that where solar hot water systems are used, space heating and supplementary domestic hot water heating would be still be required.

There are 3 common types of solar thermal collector available:

1) Glazed Flat Plate Collector

2) Evacuated Tubes

3) Absorbers

Glazed flat plate collectors are the most common solar collector, generally made from highly conductive materials such as copper, steel or aluminium so heat transfer is efficient. This kind of collector can be used to heat water to temperatures up to 100°C.

Evacuated tube panels house the absorber plate inside a vacuum pipe. Radiation is absorbed by the darkened absorber and transmitted as heat to the working fluid. This type of collector can heat water up to 150°C, and is more efficient than flat plate collectors due to the reduced loss of heat from the vacuum. Evacuated tube panels can also be installed flat, as the tubes can be orientated to the optimum pitch.

Absorbers are the least efficient of all designs as they do not take advantage of glazing to trap as much heat as possible. They are generally used for unessential low temperature heating such as swimming pools as they are cheap to produce.

5.2.1. Viability of Solar Thermal Technology for 16-19 Southampton Place

For the Southampton Place development, evacuated tube solar collectors would be the most appropriate as the visual impact will be minimised. Evacuated tubes could be mounted on the roof of 16-19 Southampton Place which has an available area of approximately 10m^2.

The system requires solar thermal collectors on the roof, ideally orientated between south-east and south-west. This will maximise the heat absorbed by the collector, and transferred to the fluid in the solar circuit pipes. The solar circuit then transports the hot fluid from the collectors to a hot water cylinder.

The proposed system could replace the current water cylinders with the required capacity of twin coil cylinders. This means the replacement cylinders would have a dual feed from both the solar thermal collectors and the current DHW system. Primary heating would be provided by the solar thermal circuit and boiler providing back up on days of low solar incident radiation and/or after sunset.

Thermostatic controls linking to a BMS control the flow of each coil.

Based on the information provided by the solar thermal manufacturer, energy generation and related CO_2 savings of applying a solar thermal system can be seen in the Table below:

Table 2: Required Solar Thermal Collectors to meet DHW Requirements

Technology	Collector area	Hot Water generation	Energy saving		CO_2 savings	
	(m^2)	(kWh/yr)	(kWh/yr)	(%)	(kg CO_2/yr)	(%)
Evacuated Tube	8	6000	6600	3	1307	1.3

The detailed business case reviews the whole life costs of the product. It does not only assess capital cost, running costs and energy savings from the product, but also look into the available grants, such as Renewable Heat Incentive (RHI)[1].

The life cycle cost analysis indicates the solar thermal technology is unviable. This is because the indicated capital cost (provided by the manufacturer) to install this solar thermal system (this is inclusive of the cost of the cylinders, pipe work and panels) is £16,000. On top of this there is a small bi-annual maintenance requirement, which could add another £600 per annum to the running costs. This results in a payback period of greater than 25 years.

The carbon savings of this technology are 13.7% of the total carbon emitted by the building.

[1] The RHI is a new Government-backed measure which is due to come into force later this year. This incentive allows a fixed income to be earned for every kilowatt hour of heat produced by renewable technology. An additional payment for 'exporting' surplus heat can also be obtained if the heat generated onsite is connected to a heat network.

5.3. Solar Photovoltaics

Photovoltaic (PV) panels consist of PV cells that generate electricity from solar energy. The cells are formed from a number of layers of a semi-conducting material, usually silicon. When photons strike the surface of the cell, an electric field forms across the layers and a flow of electricity is created. Contrary to popular belief, PV cells do not require direct sunlight to generate electricity as they will also produce a useful flow of electrons from daylight on a cloudy day. Up to a certain temperature, the greater the intensity of the light, the greater the flow of electricity.

There are 3 common types of photovoltaic cells in the commercial market:

1) Mono-crystalline

2) Poly-crystalline

3) Thin Film

Mono-crystalline is the most effective, under good light conditions, although also the most expensive. Poly-crystalline is also highly efficient in good light conditions, is slightly cheaper and has less embodied energy than mono-crystalline.

Thin film technology is the most efficient in poor light conditions, although not as efficient in good light conditions as the other two technologies. The 'panels' form an extremely sturdy, vandal-proof PV, which can be rolled and shaped to fit complex building forms and curves.

PV panels tend to be issued with a 20 to 25 year electrical warranty, and an expected system life of 40 to 60 years. It is generally recognized that the amount of energy required to produce PV is generated by the modules in 2-4 years of operation for crystalline technologies (the figure is dependent on the precise installation location).

5.3.1. Viability of Solar Photovoltaic Technology for 16-19 Southampton Place

Mono-crystalline panels have been considered within this study, due to their higher efficiency and the requirement to maximise the output available from the limited available space. As shown in figure 6 in section 3.2, 10m^2 is available for solar panels. However, the available space needs to be assessed against the dimensions of the panels and the additional space required for access and maintenance.

The electrical output from the PV could be connected into the mains supply for the building and directly reduce the electricity demand from the national grid. During times when the PV panels are producing more electricity than is used on site, the building becomes a net exporter of electricity to the grid and could receive revenue from the utility provider in excess of the import of electricity.

The PV option investigated is a 1.4kWp system with panels pitched at the optimum performance angle i.e. 30 degrees. This will mean that with sufficient space between them to allow for self shading, 10m^2 of panels can be installed generating 1210kWh of electricity over a year. This equates to 0.5 tonnes of CO_2 saved and a 0.5% CO_2 reduction of the emissions for the whole building.

Table 3: Potential Photovoltaic Outputs and Savings

Technology	Collector active area	Electricity generated	Energy saving		CO_2 savings	
	(m^2)	(kWh/yr)	(kWh/yr)	(%)	(kg CO_2/yr)	(%)
1.4kWp PV System	10	1,210	1,210	0.6	500	0.5

The technical and commercial feasibility of a photovoltaic system for 16-19 Southampton Place is presented in Table 6 below:

Table 4: Feasibility of Solar Photovoltaic Technology

Capital Cost (£)	8,100
Payback (years)	The payback is estimated to be approximately 12 years, taking the following factors into consideration: • Maintenance cost • Feed-in Tariffs (FITs) • (Assuming an RPI of 2% and an energy price uplift of a further 2%)
Land Use	The panels would be roof mounted and space would be required for the inverter.
Local Planning Requirements	Local planning would need to be sought to locate Photovoltaic panels on the building's roof.
Noise	None
Life cycle cost/ lifecycle impact of the potential specification in terms of carbon emissions	The detailed business case reviews the whole life costs of the product and assesses capital cost, running costs and energy savings from the product with a life time of 20 years. The carbon saving of this technology represents a 0.4% saving per year for the entire site.
Available grants	Feed-In Tariffs (FITs) were introduced in April 2010 by the Government to help increase the level of renewable energy in the UK. The main financial benefits are: • Get paid for the energy produced and used onsite • Additional payment is available if the energy produced is sold back to the grid • Save money by reducing the amount of energy supplied by energy supplier
To be carried out?	As can be seen from both the payback and life cycle costs, this technology presents a commercially viable solution to providing electricity from PV panels.
Next step	It is recommended that a site survey is undertaken to confirm the area of un-shaded available space.

This technology is considered a viable solution for 16-19 Southampton Place and should be investigated further.

6.0 SOLAR PANEL TECHNOLOGY ASSESSMENT

The following solar panel technologies have been assessed to determine their appropriateness for implementation at 16-19 Southampton Place.

- Solar thermal for domestic hot water (DHW) heating;
- Solar Photovoltaics (PV's) for electricity generation;

The technologies have been considered in respect to:

- Integration with the building services strategy;
- Available natural resources;
- Available space;
- Contribution to the building's energy loads;
- Listed Building located in a conservation area.

These studies are summarised within Table 8 and Table 9.

6.1. Technical Feasibility of Solar Panel Technologies

Table 5: Analysis of Available Resources and Suitability of Solar Technologies at 16-19 Southampton Place

Technology	Criteria	Requirement Met?
Solar Thermal		
Roof orientation	Is available roof facing south-west to south-east (through south)?	✓
Roof space	Is there sufficient un-shaded area?	✓
Hot water demand	Is there year round hot water demand?	✓
Hot water storage	Is there space for a hot water storage vessel?	✓
Solar PV		
Roof orientation	Are available roofs facing south-west to south-east (through south)?	✓
Roof space	Is there sufficient un-shaded roof area?	✓

Table 6: Summary of the Technical Feasibility of Solar Panel Technologies

Technology	Feasibility	Investigate Further?
Solar Thermal		
	Solar hot water heating systems use heat from the sun to pre-heat domestic hot water. The system requires solar panels be ideally south-east to south-west facing, linked to hot water storage cylinders by flow and return pipe work. The payback period has been calculated to exceed 20 years. As a result of that, this technology is not economically viable for the site.	✘
Solar Photovoltaic (PV)		
	The system requires PV panels be ideally south-east to south-west facing, linked by cabling to the building's electrical distribution board. • Un-shaded roof available; • When the building is not in use, electricity can be sold to the grid; • Increased feed-in tariffs have improved cost-effectiveness; • Sufficient area is required not only for PV panels but also for maintenance and cleaning.	✓

7.0 CONCLUSIONS

The site's resources were assessed to establish which of the following LZC technologies might be suitable for integration at 16-19 Southampton Place:

- Solar thermal for domestic hot water (DHW) heating;
- Solar Photovoltaics (PV's) for electricity generation;

An appraisal was carried out in respect to; available natural resources (wind and solar), available space, contribution to the building's energy loads, and integration with the building services strategy; which identified solar photovoltaic as the preferred renewable energy source.

The analysis demonstrated that there is available, flat, south facing area of roof available which could be used for locating either Solar Thermal or PV panels, or a combination of the two systems.

The solar thermal technology was deemed to be unviable based on the long payback for such a small carbon return.

The PV system is predicted to reduce annual CO_2 emissions by 500 $kgCO_2$/yr and generate £446 worth of savings and FIT revenue per year.

PV could technically and financially be considered a viable opportunity; however, as this building is grade II (star) listed and located within a conservation area, it is important to consult the listing building officer within the planning office regarding any suggested schemes to ensure that there is no conflict with the conservation or listed building status.