VI. Renewable Resource Breadths

The Palestra Building has been under construction for the past 18 months, with a completion date for July 2006. However, the London Development Agency (LDA) has recently signed on as tenants for the fifth and sixth floors. This Agency will be responsible for all of the planning of the 2012 Summer Olympics in London. One of their primary requests has been to install both Solar PV cells and Wind Turbines on the roof with the intention of using any generated power in their office space, and possibly selling any excess energy back to the grid. London was granted the 2012 Olympics due in great part to their platform of a Zero Impact/"Green" design scheme, and the Agency wants to prove it is fluent with these technologies. As of a visit in March of 2006 no one was certain about any details for these plans: how many/large these technologies would be, their locations, or effectiveness. Therefore this report will complete a feasibility study for both technologies to better understand the amount of potential power that can be produced, smart uses for the energy, as well as cost impact of such decisions.

a. Solar Energy Breadth – Photovoltaic (PV) Cells

The mean solar radiation incident on the mainland of the United Kingdom is at best 5 kWh/m^2. The Palestra Building is tall enough relative to the surrounding structures so that there is an unobstructed southern exposure from the roof level, allowing maximum solar gains, as shown in the image to the right. However, the placement of the solar PV cells is crucial to the success of such a system. And unfortunately due to the

Figure 6.1 The Palestra Building super-imposed onto its lot.

timing of this addition to the design, there is little available space on the roof. The total area of the roof is 1236 m^2. Provisions were made for a 200 m^2 array of PV cells facing south.

Calculations

RETScreen International Clean Energy Project Analysis Software, Photovoltaic Project Model was used to create an energy simulation of the array of solar PV panels. The following calculations were based on a solar cell manufactured by BP Solar, BP 5160 S. Physical data coordinating to this model is summarized in Table 6.1.

Table 6.1 PV Cell Data

Model	BP 5160 S
Maximum Nominal Output	160 W
Maximum Panel Voltage	1000 V
Dimensions:	
Length	1596 mm
Width	790 mm
Height	0 mm
Weight	15 kg

Within the 100 m^2 allotted an array of 155 panels can be assembled, adding a total of 2325kg to the roof structure. The Annual Energy Produced by the modules is listed in Table 6.2. The 63 units can deliver over 8,000 kWh per annum. Currently the annual consumption for the space to be occupied by the LDA is 12,711,542 kWh. Therefore 0.16% of the demand can be met by solar energy.

Table 6.2 Estimated Annual Energy Produced

Specific Yield	102.4 kWh/m^2
Overall PV System Efficiency	10.20%
Renewable Energy Delivered	19,995 kWh

Cost Analysis

The financial summary for an investment in solar PV cells for the Palestra Building is summarized in Table 6.3.

Table 6.3 Cost Summary

Total Initial Cost	£205,303.00
Total Annual Cost	£ 880.00
Total Annual Savings	£31,152.00
Simple Payback	9.1 years
Years to Positive Cash Flow	6 years
Net Present Value (NPV)	£125,778.00
Annual Life Cycle Cost Savings	£12,805.00

The initial cost for the system is £205,000, with annual savings of £31,152.00. However the simple payback period is 9 years, with no positive cash flow until year 6. That length is quite long compared to what most investors would consider a strong investment where less than 3 years for a return is typical. All additional data, calculations, and specification sheets can be found in Appendix VI.

b. Wind Energy Breadth – Wind Turbine

The challenges that faced the implementation of a solar system on the roof of the Palestra Building hold true for the wind system as well. Although with wind turbines there is the additional sensitivity of height. You must be careful not to create an imbalance in the frame of the structure, or a 'top heavy' scenario. Recently the SWIFT Rooftop Wind Energy System™ has been developed and implemented in residential locations in Scotland. It is a modified wind system for smaller buildings, with a maximum output of 1.5kW based on a wind speed of 12.5 m/s. And at that rate it can displace up to 1.4 tonnes of CO_2 per year, making it easier to meet new building emission regulations.

Figure 6.2 Residential Application of SWIFT™ technology.

This product has recently received the support of the Scottish government, and is the only product of its type that has been approved for government grants making it possible for any person or company to afford renewable technologies. The micro-turbines are set for mass production in the coming months which will drive the price from the current £3500 to £1500 per unit. And much of the remaining sum will be eligible for a grant as well, bring the first costs down to practically nothing.

Figure 6.3 Commercial Application of SWIFT™ technology.

Building Regulations in the UK are beginning to require that every building provide at least 10% of its energy through renewable resources or Combined Heat and Power (CHP). In an area with high enough wind speeds, that percentage could easily be met with this wind technology.

Table 6.4 contains the technical data for each micro wind turbine.

Table 6.4 Rooftop Wind Turbine Specifications

Manufacturer	SWIFT™
Rated Output @ 12.5 m/s	1.5 kW
Output @ 4.6 m/s (London)	60 W
CO2 Displacement	1.4 tonnes per year
Turbine	5 blade HAWT wind turbine
Rotor Diameter	2.12 m
Weight	95 kg

Figure 6.4 shows the Power Curve for the Micro Turbine. As you can see its power output is highest between 12 and 20 m/s. Unfortunately the average wind speed in London is 4.6 m/s, resulting in 60W output per unit. Due to the small amount of power available it is unlikely that wind energy would be an efficient means of energy production for the Palestra Building. However because the National London Agency, a tenant in the Palestra Building, is set on installing wind technology regardless of the efficiency, it is beneficial to complete an analysis to see how the amount of energy gained may be effectively used.

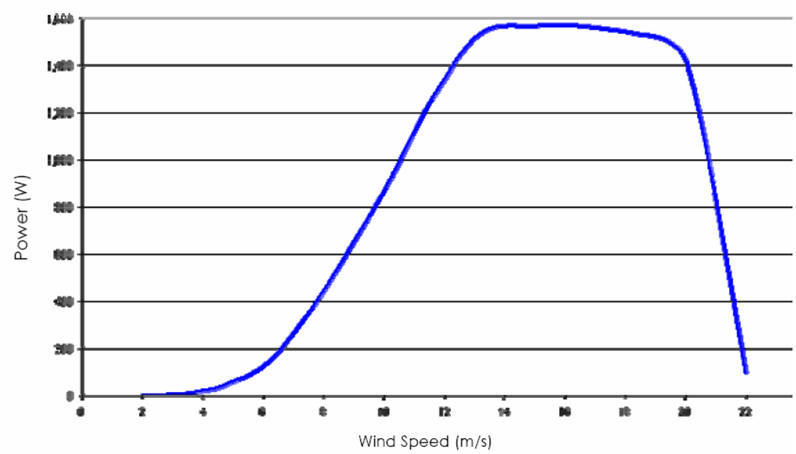

Figure 6.4 SWIFT™ Wind Turbine Power Curve

Table 6.5 Wind Turbine Costs

No. Units	10
Clearance Per Unit	2.12 m
Area Required	50 m^2
Total Weight	950 kg
Initial Investment	£15,000
Total Power Output	600 W
Annual Savings	120 kWh

Based on the limited amount of free area on the roof, the light weight of each wind turbine (95kg), and low power output from each, and the relatively low first costs, 10 units were assumed to be a reasonable numbers of fans for the system. Table 6.5 outlines the assumptions made for the Cost Analysis.

Payback Period

$$Payback\ Period\ (in\ years) = \frac{Initial\ Investment}{Annual\ Savings\ (Cash\ Flow)}$$

Assuming annual savings at peak electrical rate:

Annual Savings = 120 kWh * 4.592 p/kWh = 551.04p = £5.51

$$Payback\ Period = \frac{£15,000}{£5.51} = \mathbf{2722\ years}$$

The hypothesis that the wind technology would have little to no value for the Palestra Building is correct. With such a large payback period it would never be economical as long as the average wind speed for the area is so low. It is strongly suggested that wind technology not be installed, and invest the additional spaces and finances to increasing the efficiency of the Solar PV system which has much more potential to produce significant annual savings.

The only time wind turbines would still be a smart investment is if a Federal Grant covered all or most of the first costs for the turbine units. In that case all energy produced would be 'free' and while still not a useful amount of energy, it wouldn't be at a deficit to the project cost.