Client: **Sea Lanes Brighton Ltd**

Project: **Sea Lanes Swimming Pool and Business Units**

Document: **Energy Statement**

Project No: **2020/643**

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Contents

SEA LANES

1.0 Executive Summary

The requirement to address and minimise energy consumption for a heated outdoor swimming pool operating all year round is clearly a major consideration financially as well as environmentally.

A number of opportunities for energy saving have been identified using the Sport England methodology of Lean, Mean and Green and are proposed for implementation as described in this report including:

- Improved swimming pool tank insulation
- The use of an insulated pool cover
- Wind screening around the pool enclosure
- Heat recovery from waste water from showers and backwashing filters

By far the biggest load is the evaporative and convective loss from the pool surface. This loss will be dramatically reduced by about 35% through the use of an insulated pool cover.

The total energy saving measures result in a 44% reduction. Overall, this will save an estimated 590 tonnes CO_2 per annum.

Sea Lanes Brighton intends to incorporate extensive energy monitoring of systems in order to build a data base of energy and water consumption over time. This will be used to monitor and analyse the effectiveness of the various elements of the system and carry out refinements as time progresses to further reduce operational energy consumption.

Solar thermal and solar photovoltaic renewable technologies will provide on-site renewable energy and in order to meet the very high peak heating loads during the cold windy days in Winter in the most efficient manner it is proposed to heat the pool using high-efficiency gas fired condensing boilers together.

Proposals have been future proofed to ensure that the heating plant is compatible with a switch from natural gas to hydrogen in line with emerging Government policy.

Sea Lanes - Energy Statement Summary		
	kWh	$kgCO_2$
Total estimated energy/carbon before improvements	6,385,443	1,340,943
Total estimated energy/carbon after improvements	3,562,288	748,080
Energy/carbon saving	2,823,155	592,863
	44%	44%

Table 1 - Sea Lanes Energy Statement Summary

2.0 Introduction

The energy consumption of the proposed swimming pool facility is fundamental to the scheme's viability. A mean, lean, green approach, as recommended by Sport England, has been used to identify and reduce the energy requirements.

MEAN. Taking a fabric first approach to the design to establish opportunities for reducing the energy requirements by reducing heat losses to the environment through the use of thermal insulation, pool cover and wind screening.

LEAN. Identifying opportunities for waste heat recovery from filter backwashing and showering.

GREEN. Considering the opportunities for integrating renewable technologies into the scheme.

In developing the scheme strategy, it soon became evident that there is a lack of available data on similar facilities.

Sea Lanes Brighton intends to incorporate extensive energy monitoring of systems in order to build a data base of energy and water consumption over time. This will be used to monitor and analyse the effectiveness of the various elements of the system and carry out refinements as time progresses to further reduce operational energy consumption.

3.0 Energy Requirements

The annual and peak energy requirements for the swimming pool have been calculated to establish the required capacity of the heating plant and assess the effectiveness of energy saving measures.

The swimming pool is intended to operate all year round with the pool water heated to a target temperature of 25°C.

Operating hours will be circa 07:00am to 21:00h/22:00h.

The swimming pool is external and the heating requirements vary enormously across the seasons and changing weather conditions.

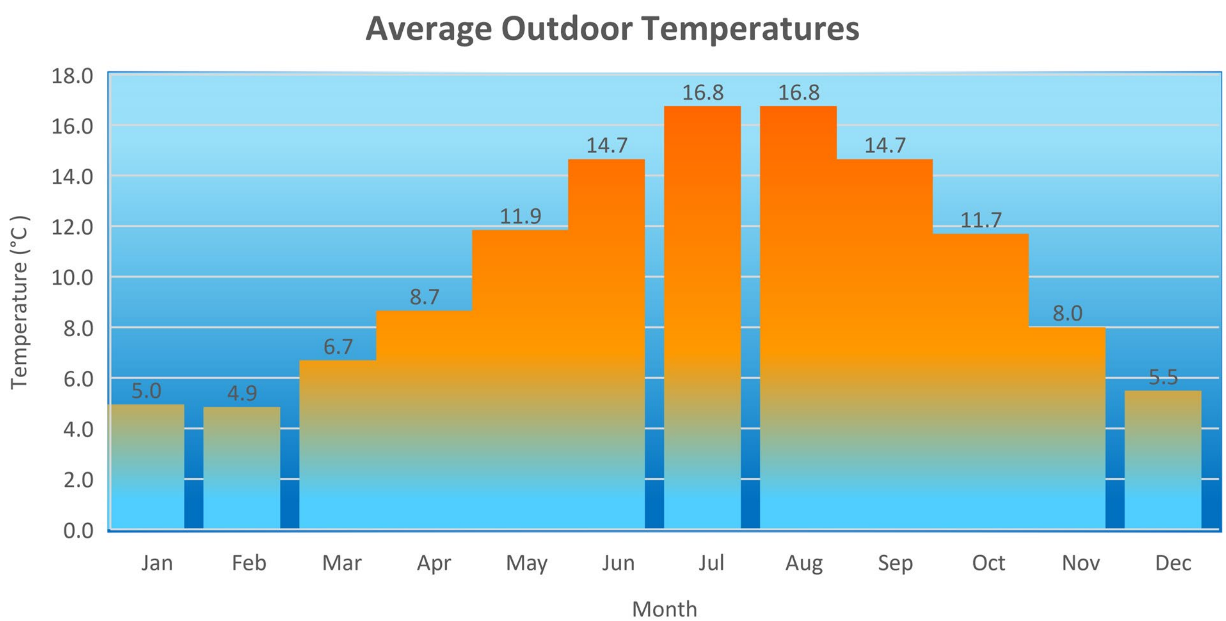

Figure 1 - Average Outdoor Temperatures (Shoreham)

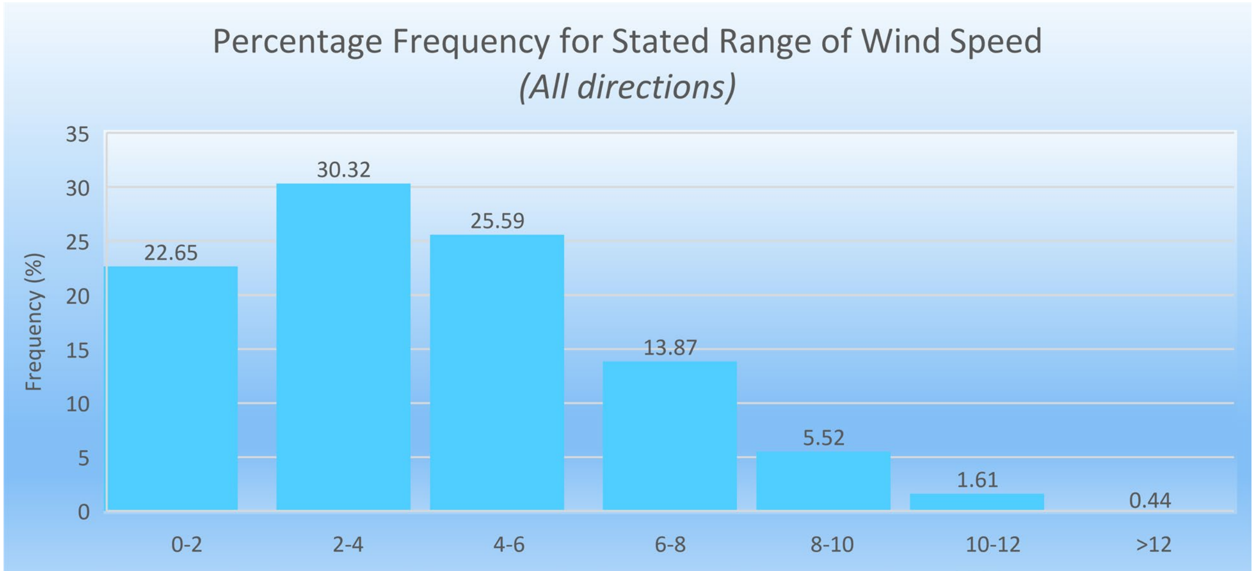

Figure 2 - Percentage Frequency for Stated Range of Wind Speed
Source: CIBSE GUIDE A (Southampton)

The day-to-day heating requirements for the swimming pool can be summarised as follows:

- Heat loss through the pool sides and floor
- Heat loss through radiant, convective and evaporative losses from the pool surface
- Heat required to replace water loss due to filter back washing
- Heat required to replace water loss due to bather loads
- Heat required to raise the temperature of water displaced by rainfall
- Hot water required for showers

All of these energy loads have been estimated through calculation and, where information is available, compared to empirical data obtained from other heated external pools.

Annual Energy Loads (before improvements)			
Heat loss - sides/base	26,115	kWh	0.41%
Heat loss - exposed surface	5,748,750	kWh	90.03%
Filter backwashing	33,963	kWh	0.53%
Bather loads	274,626	kWh	4.30%
Rainwater displacement	10,885	kWh	0.17%
Showers	291,104	kWh	4.56%
Total	6,385,443	kWh	100.00%

Table 2 – Annual Energy loads

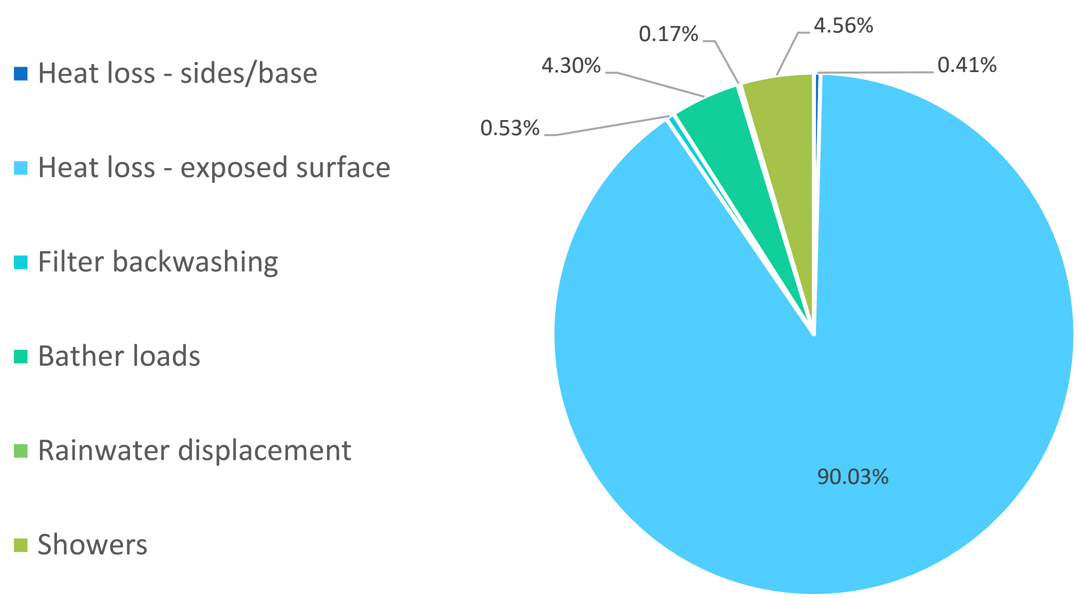

Figure 3 - Annual Energy Loads

4.0 Energy Saving Measures

4.1. Improved insulation

The thickness of the insulation enclosing the sides and base of the tank will be increased to reduce heat loss to the ground.
Part-L of the Building Regulations recommends a U-value of 0.25 w/m2K for swimming pool tanks.
By upgrading the insulation, the U-value can be reduced to approximately 0.13 w/m2K cutting the heat loss by almost a half (48%).

Improved insulation		
Heat loss - Building Regs	26,115	kWh
Heat loss - Improved insulation	13,580	kWh
Energy saving	12,535	kWh
	48.00%	

Table 3 – Improved Insulation

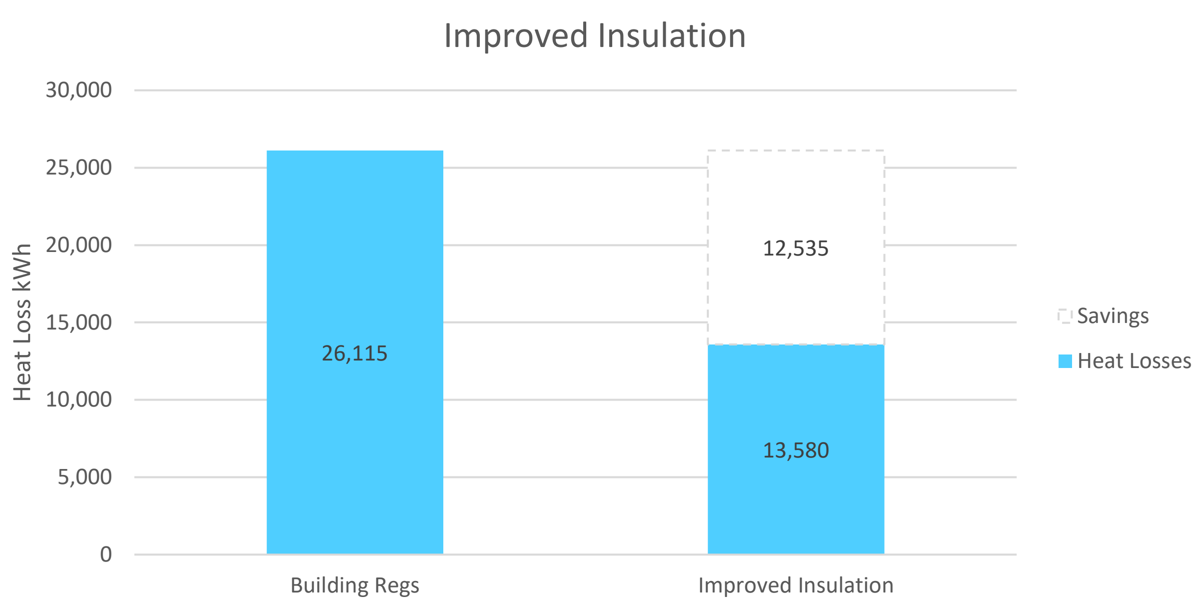

Figure 4 - Improved Insulation

4.2. Insulated pool cover

The vast majority of the annual heating load is through evaporative and convective losses to atmosphere.
These loads vary greatly depending on external temperatures, humidity and wind speed together with the turbulence of the pool surface caused by swimmers.

The estimated average losses due to evaporation and convection at the pool surface are in excess of 1000 w/m2.

An insulated pool cover installed over the surface will practically eliminate the evaporative and convective components of these heat losses when the pool is not in use.

Over a 9-hour closure time, the insulated pool cover will reduce losses by 35%.

Insulated Pool Cover		
Surface losses no cover	5,748,750	kWh
Surface losses - cover 9hrs	3,684,281	kWh
Energy saving	2,064,469	kWh
	35.91%	

Table 4 – Insulated Pool Cover

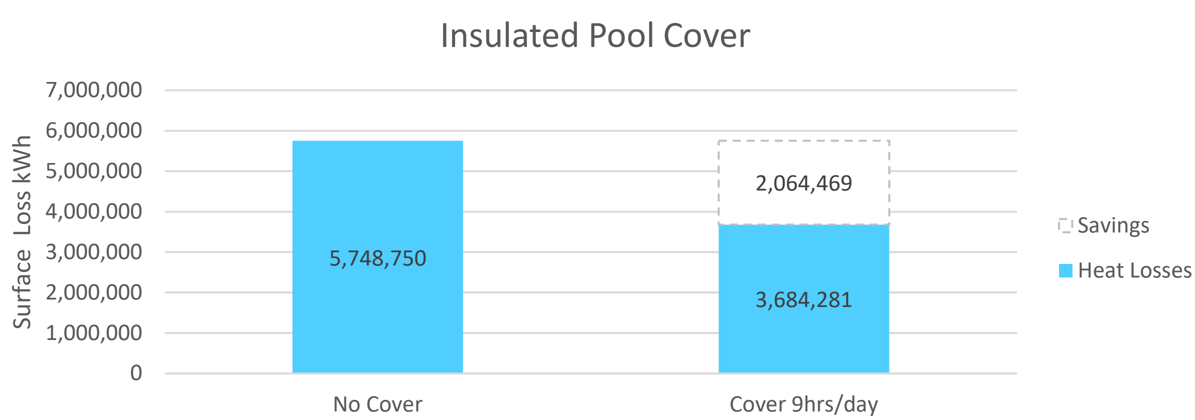

Figure 5 - Insulated Pool Cover

4.3. Wind screening

The evaporative and convective heat loss from the pool surface under a typical range of wind speeds varies by a factor of four.

To mitigate these effects, the proposal is to erect wind screens in strategic positions around the pool enclosure.

If the wind speed across the pool can be reduced by (say) 20% then this will reduce the evaporative losses by about the same proportion.

The exact size, location and configuration of the wind screens will be subject to further analysis.

Wind Screening Benefits	
Surface losses no wind screens	3,684,281 kWh
Reduction due to wind screening	718,594 kWh
Energy saving	718,594 kWh
	19.50%

Table 5 - Wind Screening Benefits

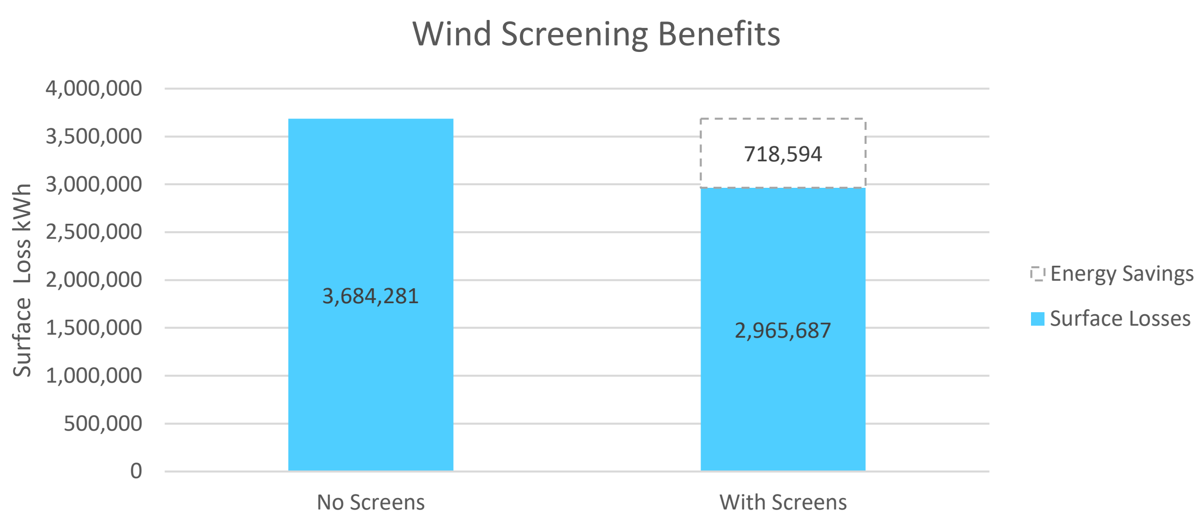

Figure 6 – Wind Screening Benefits

4.4. Shower controls

The quantity of hot water consumed by bathers showering after their swims will be controlled by the use of flow restrictors to limit the shower flow rates together with automatic valves to ensure the showers are not left running after they have been vacated.

4.5. Waste water heat recovery

Energy is lost as and when warm water flows into the drains during filter backwashing and when bathers take showers.

This heat will be partially recovered by the installation of a waste water heat recovery system.

A simple waste-water heat recovery system consists of pipe coils wrapped around the outgoing drain pipes. As fresh water flows into the system through the pipe coil it will pick up a proportion of the waste heat from the warm water flowing to the sewer.

When averaged out over the year, the swimming pool facility will discharge around 27 cubic metres of water per day into the sewers from back-washing the filters and bather showering.

This equates to approximately 27,000kWh per month of which up to 10% can be recovered.

Waste Water Heat Recovery		
Energy loss from backwash	33,963	kWh
Energy loss from showers	291,104	kWh
Waste-water recovery	27,557	kWh
Energy saving	27,557	kWh
	8.48%	

Table 6 – Waste Water Heat Recovery

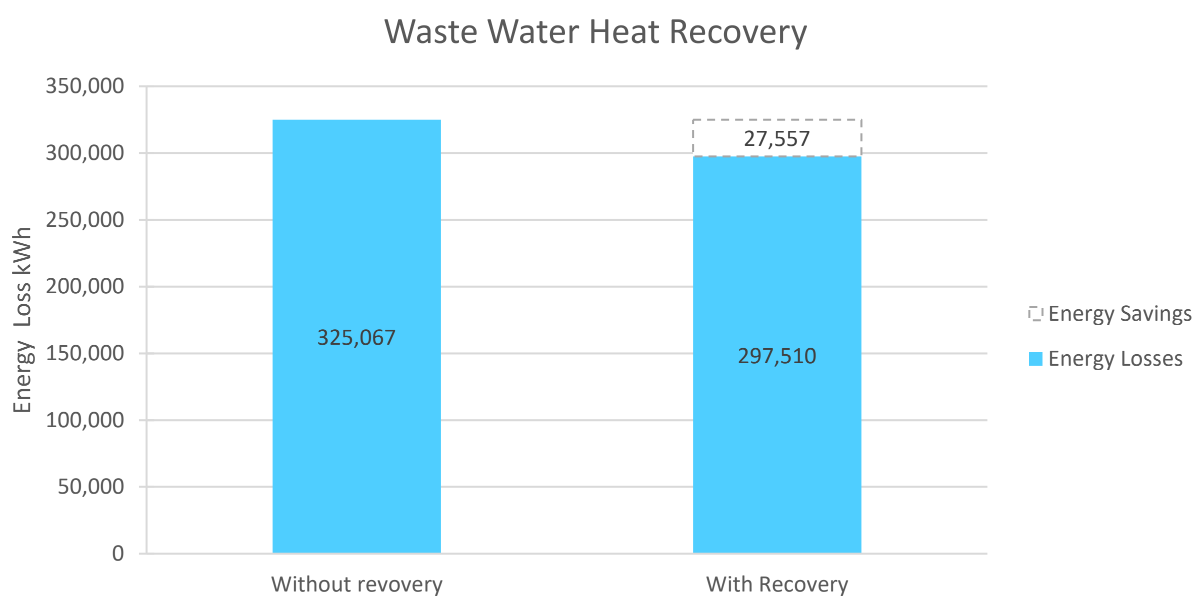

Figure 7 - Waste Water heat Recovery

4.6. Summary of energy saving measures

By implementing all of the above described energy saving measures the estimated annual energy consumption has been reduced significantly.

Energy monitoring controls including temperature sensors, flow meters and energy meters will be installed on the system to allow data collection and analysis and enable the pool management team to continuously monitor and refine the energy consumption.

Energy Improvement Summary		
Total Energy before improvements	**6,385,443**	**kWh**
Improvement Savings		
Improved insulation	12,535	kWh
Insulated pool cover	2,064,469	kWh
Wind screening	718,594	kWh
Waste water heat recovery	27,557	kWh
Total Energy after improvements	**3,562,288**	**kWh**
Total savings	**2,823,155**	**kWh**
	44.21%	

Table 7 – Energy Improvement Summary

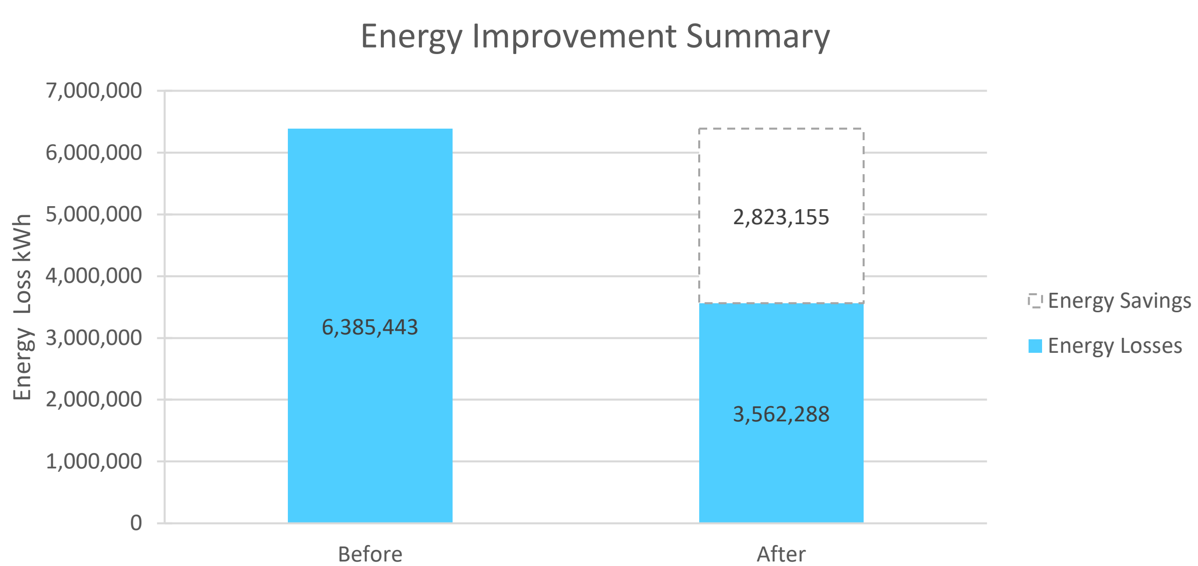

Figure 8 - Energy Improvement Summary

5.0 Renewables

The roof of the changing rooms, previously allocated as a terrace area, has been re-allocated to be used for photo-voltaic (PV) and/or solar-thermal panels. Due to walkways and green roofs this is the only available roof space within the consented scheme that is suitable.

The PV panels will produce electricity which will be fed back into the plant room and used to run the pumps and other equipment.

The solar-thermal panels will be used to generate hot water for the pool and the showers.

Out of an approximate total of 45m2 of panels, the current proposal is to allocate 15m2 to solar-thermal and 30m2 to PV.

The precise allocation will be adjusted as part of the detailed design process

The estimated annual yield and carbon savings achieved through the use of PV and solar-thermal panels are as follows:

Renewable Technologies				
System	Area (m2)	Yield (kWh)	Carbon savings ($kgCO_2/kWh$)	
			Factor	$kgCO_2$
Photo-voltaic	30	5400	0.23	1242
Solar-thermal	15	10500	0.21	2205

Table 8 – Renewable Technologies

6.0 Heating plant

The following options for the heating plant were discounted at an early stage;

- **District heating**
  There are no current or foreseeable plans for a district heating scheme in the vicinity (although the system could be connected in the future should circumstances change).
- **Biomass boilers**
  Sourcing suitable fuel, regular fuel deliveries (by lorry), fuel storage requirements, ongoing maintenance and air-quality management issues rendered biomass option as unattractive.
- **Oil fired boilers**
  Fuel deliveries, running costs, carbon emissions and air-quality management issues all render the use of oil-fired boilers as unattractive.
- **Marine source heat pumps**
  Attractive in principle but ruled out due to high civil engineering costs and complications with licensing and planning issues.

The following types of heating plant have been actively considered:

- Combined Heat and Power
- Air source heat pumps
- Ground source heat pumps.
- Gas fired condensing boilers

Each type of plant has been assessed in terms of:

- Carbon emissions
- Capital costs
- Running costs
- Energy costs
- Space requirement

The peak heating loads have been calculated using a variety of approaches including CIBSE Guides and the results cross checked against the installed plant at other similar facilities.

To keep the swimming pool facility operating throughout the year, the heating system must be designed to cope with all but the severest winter weather and be responsive to fluctuating conditions.

The calculated peak output for the plant to meet this requirement is 1250kW and the plant selections have been based on a peak output of 1500kW. London Fields, which is a similar sized facility, also has installed boiler capacity of 1500kW

Although attractive in theory, a heat pump solution for such a high peak heating load is not economically viable nor practical to install. There is also insufficient electrical capacity currently available in the vicinity to drive such a large heat pump installation (c 400kVA).

The conclusion and proposed solution is therefore to use gas fired condensing boilers since these are the only viable option – primarily due to the high capital costs of the plant and lack of available electrical capacity and also to ensure best reliability.

The boiler manufacturers have provided assurance that the boilers can be easily switched from natural gas to hydrogen as a fuel source. This key element of future proofing the heating plant aligns the project with the Government's 2020 plan for a green industrial revolution [1]and the emerging Hydrogen Strategy that is due for publication in 2021.

Heating Plant Options (1500kW output)	Gas boilers	ASHP	GSHP
Capital costs (equipment)	£70,000	£360,000	£300,000
Boreholes			£750,000
Utility upgrade costs (gas/power connections)	£45,000	£75,000	£75,000
Grid consumed energy (kWh)	3,749,777	1,187,429	989,524
Fuel costs (£/year)	£149,991	£142,492	£118,743
Carbon emissions (kgCO_2/year)	787,453	273,109	227,591
	100%	35%	29%
Annual heating requirement (kWh)	3,562,288	3,562,288	3,562,288
Efficiency	95%	300%	360%
Grid consumed energy (kWh)	3,749,777	1,187,429	989,524
Carbon emissions (kgCO_2/kWh)	0.21	0.23	0.23
Tariffs (£/kWh)	0.04	0.12	0.12

Table 9 - Heating Plant Options

[1] https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution

Notes:

ASHP – Air source heat pumps
GSHP – Ground source heat pumps
Carbon emissions based on SAP10 factors.
The total carbon emissions assume the energy saving measures described earlier in the report have been implemented.

Combined Heat and Power (CHP)

The carbon emissions for various sizes of CHP unit have been assessed using the SAP10 carbon emissions factors as follows:

Carbon Emissions Factors ($kgCO_2/kWh$)			
	gas	electricity	
SAP2012	0.216	0.52	$kgCO_2/kWh$
SAP10	0.21	0.23	$kgCO_2/kWh$

Table 10 – Carbon Emissions Factors

These new factors have been published by the BRE to take account of the increased contribution of renewable energy generation from wind farms and photo-voltaic panels.
It can be seen from the following table that when using these latest factors, CHP units no longer offer carbon savings.

Combined Heat and Power		
100kW CHP (25kWelec / 50kW heat)		
Daily running hours	15	hrs
Annual running hours	5250	hrs
Input gas (kWh)	525,000	kWh
Output heat	236,250	kWh
Output electricity	183,750	kWh
SAP10 - CARBON EMISSIONS (kgCO2/kWh)		
Input gas	110,250	$kgCO_2/kWh$
Equivalent heat from gas boilers (85% efficient)	58,368	$kgCO_2/kWh$
Equivalent electricity grid supplied	42,263	$kgCO_2/kWh$
Carbon increase due to CHP	9,620	$kgCO_2/kWh$

Table 11 – Combined Heat and Power

7.0 Conclusion

In conclusion, following a detailed and involved analysis, the proposal is to implement a range of energy saving measures to reduce the annual energy consumption by around 44% and to heat the Sea Lanes pool facility using renewables and high-efficiency, gas fired condensing boilers initially fuelled by natural gas with hydrogen earmarked as the natural low carbon replacement fuel.

The system will be fitted with energy monitoring controls and these will be continually reviewed during the ongoing operation of the facility in order to assess, refine and optimise the energy consumption over time.

The estimated annual carbon emissions before and after energy saving measures and the implementation of renewables are shown in the table below.

Sea Lanes - Energy Statement Summary		
	kWh	$kgCO_2$
Total estimated energy/carbon before improvements	6,385,443	1,340,943
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Table 12 – Energy Statement Summary

Tables Index

Charts Index