Section Four

Summary of Energy Proposals

4.1

General The Edge Development is cognizant of the pressing importance of constructing a low energy and low carbon development in order to comply with the requirements of a development of this type in the Great Yarmouth Borough. To this end, the Pleasure and Leisure Corporation has developed a comprehensive approach to the inclusion of low energy and renewable technologies within this development. This approach is summarised as follows:

1 The development, as legislated, will be constructed to comply at minimum with the latest version of Part L of the Building Regulations, 2006. Where Part L2 is applicable, the immediate energy use improvement increases over current regulations.

2 In addition to this, the development will use natural gas as its main source of heat energy for both space heating and hot water. Use of this fuel at the site further reduces the carbon footprint of the development and generates a more stringent carbon emissions target over alternative fuels.

3 At the current time strategies are being developed to explore the advantages of having either centralised plant or individual plant.

4 The development has targeted the following rating levels under the applicable sustainability assessment tools:

- 'Very Good' – BREEAM for commercial premises

These targets levels will ensure that sustainable design elements take on significant importance throughout the course of the design process.

4.2 **BREEAM Pre Assessment** The following table provides the services elements which are predicted for the building complex as a whole. These scores will need to be figured within the complete BREEAM study which includes traffic and ecology elements:

Credit Ref	Management	Expected Points (Not Guaranteed)	Comments
M01	Where evidence provided demonstrates that an appropriate project team member has been appointed to monitor commissioning on behalf of the client to ensure commissioning will be carried out in line with current Building Regulations, BSRIA/CIBSE guidelines and (where applicable), best practice and where there are complex systems then a specialist agent or manager is appointed. Evidence should also be provided to show that seasonal commissioning will be carried out during the first year of occupation of the building. NOTE: These point scores ARE cumulative.	1.67 1.67	This will be included within our specification – max points.
HW01	Where at least 80% of lettable area is adequately daylit.	0	Must reach 2% average day light factor – and this will be dependant on the size of windows etc. – could score points though in reality can be difficult to achieve 2% everywhere. As you will appreciate large elements of the scheme are unable to have day light either due to legislation or occupational requirements. In this respect the Casino is directed by gaming legislation that gaming floors must not be able to be looked into and in respect of Cinema's obviously they need to operate in a blacked out area. These two operations account for 90,000 sq ft of the footprint.
HW04	Where evidence provided demonstrates that high frequency ballasts are installed on all fluorescent and compact fluorescent lamps.	1.154	This would be included with our design – max points.
HW05	Where evidence provided demonstrates that all internal and external lighting, where relevant, is specified in accordance with the appropriate maintained illuminance levels (in lux) recommended by CIBSE.	1.154	This would be included with our design – max points
HW06	Where evidence provided demonstrates that lighting, in all occupied areas, is zoned to allow separate control.	1.154	This would be included with our design – max points
HW09	Where air intakes serving occupied areas avoid major sources of external pollution and recirculation of exhaust air.	1.154	To achieve points the air intake to the AHU has to be 20m from the nearest source of pollution. May be achievable, to be determined at design stage.
HW11	Where either: • In the case of mechanically ventilated and air conditioned buildings, fresh air is provided at 12l/s/person. OR • In the case of naturally ventilated buildings, trickle vents are provided on the majority of windows, where the windows openable area is the equivalent to 5% of the gross internal area of the building and the plan depth is no more than 15m otherwise extra ventilation is required.	1.154	12l/s per person will be included within our design – max points.
HW14	Where thermal comfort levels are assessed at design stage, this is used to evaluate appropriate servicing options, and appropriate thermal comfort levels are achieved.	1.154	This would be included within our design – max points.

Credit Ref	Management	Expected Points (Not Guaranteed)	Comments
HW15	Where evidence provided demonstrates that local control is available for temperature adjustment in each area to reflect differing load requirements.	1.154	This would be included within our design – max points.
HW16	Where evidence provided demonstrates that the risk of waterborne and airborne legionella contamination has been minimised.	1.154	The design would include dry air coolers – max points.
E01	Where the building demonstrates a percentage improvement above the requirement for CO2 emissions as set out in the 2006 Building Regulations. • +1% • +2% • +4% • +6% • +8% • +10% • +12% • +14% • +18% • +22% • +30% • +40% • +50% • +60% • >70% NOTE: These point scores are not cumulative, simply award the appropriate points score corresponding to the predicted level of achievement.	2.27	Building Regulations require a 28% reduction of Co_2 from the target building. This is a general item which encompasses the building insulation, window 'U' values, air tightness/permeability etc. together with the renewable element. The result cannot be determined until the SBEM calculation has been completed.
E02	Where electricity sub metering is provided for substantive energy uses within the building covering lighting and small power, and each of the following where present: • Humidification Plant • Cooling Plant • Fans (major) • If a building has other major energy consuming items, they should be covered as appropriate e.g. catering facilities.	0.76	This would be included within our design – max points.
E03	Where evidence provided demonstrates sub-metering of energy use by tenancy/areas is installed within the building.	0.76	This would be included within our design – max points.
E04	Where energy efficient external luminaires are specified and all light fittings controlled for the presence of daylight.	0.76	This would be included within our design – max points.

Credit Ref	Management	Expected Points (Not Guaranteed)	Comments
W01	Credits are awarded based on the improvement over standard specification of water fittings. A standard specification would include 6 litre flush toilets, urinals with no controls, a shower that uses 12-15 litres per minute, standard taps with no flow restrictors. In a formal BREEAM assessment the predicted water consumption will be calculated using the BREEAM water calculator, as a guide the following can be used as a rough estimate of likely number of credits: • where some of the fittings use less water than a standard fitting OR • where all of the fittings are low water or, where only some of the fittings are low water, rainwater or grey water systems are specified. OR • where the water fittings are all low water and rainwater or greywater fittings have been specified. NOTE: These point scores are not cumulative, simply award the appropriate points score corresponding to the predicted level of achievement.	2.50	We will use low water fittings and use grey water recycling in the design – so should be max points.
W02	Where evidence is provided to demonstrate that a water meter with a pulsed output will be installed on the mains supply to each building.	0.83	We will install a pulse meter – max points.
W03	Where evidence is provided to demonstrate that a leak detection system is specified or installed.	0	It would be very costly to provide leak detection to the full extent of the installed water services so this is not usually undertaken.
W04	Where proximity detection shut off is provided to water supply for all urinals and WC's.	0.83	This would be included in the design – max points.
P01	Where evidence provided demonstrates the use of refrigerants with a global warming potential (GWP) of less than 5 or where there are no refrigerants specified for use in building services.	0	This is not possible to achieve on a project of this size. None of the standard refrigerant gases would score points.
P04	Where evidence provided demonstrates that the specification of insulating materials avoids the use of substances with a global warming potential (GWP) of 5 or more in either manufacture or composition.	1	This will be included in our design.
P06	Where evidence provided demonstrates that the maximum dry NOx emissions from delivered space heating energy are: • ≤100 mg/kWh (at 0% excess O2). • ≤70 mg/kWh (at 0% excess O2). • ≤40 mg/kWh (at 0% excess O2). NOTE: These point scores are not cumulative, simply award the appropriate points score corresponding to the predicted level of achievement.	0	With either Bio-fuel or ground source heat pump we score no points here. We would have to use gas fired boilers installation to score points and obtain the 10% renewable from elsewhere – which would be significantly more costly.
P08	Where evidence provided demonstrates that on site treatment such as oil separators/interceptors or filtration have been specified for areas at risk from pollution, i.e. vehicle manoeuvring areas, car parks, waste disposal facilities, delivery facilities or plant areas.	1	This would be included within our design – max points.

Credit Ref	Management	Expected Points (Not Guaranteed)	Comments
P11	Where evidence provided demonstrates that : A feasibility study considering renewable and low emission energy has been carried out and the results implemented. OR In addition to the above, 10% of total energy demand for the building/development is supplied from local renewable or low emission energy, sources. OR In addition to the above and 15% of total energy demand for the building/development is supplied from local renewable or low emission energy, sources. NOTE: These point scores are not cumulative, simply award the appropriate points score corresponding to the predicted level of achievement.	2	The scheme is to be developed using the 10% of the total energy demand from local renewable sources as the target.
P12	Where evidence provided demonstrates that the external lighting design is in compliance with the guidance in the Institution of Lighting Engineers (ILE) Guidance notes for the reduction of obtrusive light, 2005.	1	This would be included within our design – max points.

Section Five

Sustainable Design Approach

5.1

Discussion – Assessing Sustainability The vocabulary of Sustainability and Sustainable Design and Construction has been steadily evolving over the past decade or so as the construction industry has attempted to quantify, assess and audit its response to this important environmental and social issue. The industry has witnessed the development of a series of assessment procedures that attempt to measure and quantify a particular project's approach. As projects are varied, there has developed a number of assessment techniques that reflect the inevitable variety in project type and their associated impact on the environment.

In the context of the Edge Development, and the associated sustainability assessment mechanisms, the development team has chosen the BRE's BREEAM.

Where generalities are possible, there are 8 broad categories in which the environment impact of a development is measured and quantified; these are, in no particular order:

1 Management
2 Energy
3 Transport
4 Pollution
5 Materials
6 Water
7 Land Use and Ecology
8 Health and Well Being / Internal Environment
9 Waste Management

This list is not comprehensive as individual assessment methods place emphasis to suit their particular requirements. For instance, the NEAT method includes for a separate section for recycling facilities where this is covered under 'materials' in other methods. For the purposes of this discussion, the above 8 categories will be reviewed.

5.2 **The Edge Development**

5.2.1 **General** The sections that follow discuss in a general manner the response of The Edge Development to the particular category of sustainable design. The development team has sought to achieve a balance of response across the range of sustainability issues.

5.2.2 **Management** The Management section is generally concerned with the process of construction and establishes criteria by which the sustainability of that process can be measured. Considerations under this category include: management of the energy and temporary materials used during the construction itself, responsible sourcing of these materials, management of the construction team, commissioning of systems and supply of non-technical guidance for building operators to achieve the environmental performance of the building.

The Edge Development will generally address the requirements of this section by:

1 Requiring that the constructor achieve an industry best practice standard under the Considerate Constructors scheme (or alternative);
2 Undertaking commissioning of the mechanical and electrical systems under the direction of a dedicated team member;
3 Requiring monitoring of site waste and water consumption and implementation of best practice standards in respect to air and water pollution;
4 Requiring the responsible sourcing or use of recycled site timber;
5 Providing documentation sufficient to allow for operation of the facility to meet its environmental performance;

5.2.3 **Energy** The Energy sections are generally concerned with reducing the overall energy consumption of a development. The topic of energy is perhaps the most easily quantified component of the sustainability vocabulary as it uses energy target data from established bodies (Building Regulations) as a comparator. These energy consumption figures are then often converted to carbon dioxide emissions to generate straightforward comparators and to promote the use of the low carbon technologies and fuels.

Other elements of this general section include good practice techniques that reinforce the overall goal of reducing energy consumption; these include, use of variable frequency drives, low energy lighting, Eco labelled white goods, energy metering, etc. All of which provide a starting point for achieving a low energy design and installation.

The Edge Development is committed not only to complying with the spirit of this section but also demonstrating that compliance. The techniques proposed for the development are discussed in greater detail in the sections that follow, specifically Article 4 – Energy Strategy and Article 5 – Renewable Energy.

5.2.4 **Transport** Under the general heading of Transportation are considerations of the location of the site/development with respect to established or new public transportation facilities and the provision of bicycle storage spaces and associated facilities. The intent here is to minimise the requirement for staff, visitors and residents (as the case may be) to travel via car to and from the site.

The Edge Development achieves a very high rating using this criterion as it: -

1 Is located in a highly developed urban area with easy access to a host of local amenities;
2 Is located near to the Great Yarmouth station for visitors and business travel;
3 Has design provisions for bicycle storage facilities for all types of occupants in order to promote this sustainable form of transportation;

5.2.5 **Pollution** The general category of Pollution is concerned with the levels of emissions from the development and their impact on the immediate local environment and/or infrastructure. The general emissions under consideration are: CO2 from energy consumed on site, NOx from combustion on site, emitted light, ozone depleting refrigerants, and increased levels of surface water run-off that is increased due to the development of the site itself.

The Edge Development proposes to address this section by implementing the following general measures:

1 Low energy design techniques (this is further discussed under section 4 and 5 of this report);
2 High efficiency, condensing gas boilers will be used to minimise NOx emissions;
3 Careful treatment of external lighting will minimise obtrusive light;
4 Use of low GWP refrigerants and insulation materials, and refrigerants with *minimal* ozone depletion potential;
5 The development is located on land with a high level of porosity; the development will utilise the porosity of the site to disperse rainwater during the design storm conditions.

5.2.6 **Materials** The Materials category is concerned with the general use of materials - their origin and composition - in the final constructed product. Consideration of recycling facilities is generally found in this category. The general aim here is to quantify the volume of material in the construction in terms of its sourcing, the environmental impact of the creation of the materials themselves, the volume of re-used materials, etc.

The Edge Development proposes to address the issues under this section as follows:

1 Specifying elements of the construction that achieve an 'A' rating from the Green Guide to Specification;
2 Requiring that the constructor obtain these materials from responsible and accredited sources;
3 Provide dedicated storage space for recycled materials in the commercial components of the project;

5.2.7 **Water** The aim of the Water category is to minimise the overall volume of water that is used on site.

The Edge Development will address the requirements of this section by:

1 Specifying low water fittings for the WCs, showers and wash hand basins;
2 Specifying Best Practice white goods;
3 Providing for rainwater storage for the purposes of site irrigation of landscaping;
4 Meter all incoming water to the site;

5.2.8 **Land Use and Ecology** The category of Land Use and Ecology is generally concerned with the impact that a development has on the natural habitat and wildlife; it is also concerned with encouraging development on land of little ecological value and enhancing the ecological value of the developed land. This is closely linked to efficient use of the land by optimizing the ratio of useable floor area to building footprint.

The Edge Development addresses the concerns of this category as follows:

1 The development is located on an existing site of little or no ecological value due to the nature of its location;
2 The Edge has been developed to make best use of the land available and optimizes the ratio of useable floor area to building footprint within the limits set by the site itself;

5.2.9 **Internal Environment** The general category of Internal Environment (for Health and Well Being) is concerned with the quality of life/work of the occupants. The aims of this category are intimately linked with those of the energy section in that a sustainable internal environment must balance the needs of occupants with the desire to minimize energy consumption.

The Edge Development will address the aims of this category by:

1 Providing adequate day-lighting for the purposes of improving quality of life/occupancy and minimising the requirement for artificial lighting where possible;
2 Providing adequate ventilation for space occupancy;
3 Providing outside air from spaces with minimal ambient pollution levels;
4 Providing and confirming that sound insulation meets with desired noise criteria for the developed space;

5.2.10 **Assessment Targets** As noted, this mixed-use development will use three (3) Sustainability Assessment Tools to audit and quantify our approach.

The Commercial scheme will use the BREEAM for leisure and targeting a 'Very Good' rating.

5.2.11 **Waste Management**

Construction Waste

The majority of UK waste management laws have been translated from EU Directives and form the current approach to sustainable waste management in the UK. The waste hierarchy, developed by Defra, summarises these principles and denotes that waste should be managed by reducing, reusing and recycling. Waste management methods adopted throughout the planning of this development would aim to embody this defining approach to sustainable waste management.

Principles of the waste hierarchy would be reflected during the construction of the development. A Site Waste Management Plan (SWMP) would be prepared for the site in accordance with principles of the DTI Site Waste Management Plans - Guidance for Construction Contractors & Clients - Voluntary Code of Practice (2004). The plan would demonstrate how waste would be handled during the construction process. Such principles would include, where possible, the re-use of existing on-site materials including secondary aggregates, whilst ensuring that waste arising from the construction process will be sorted on site, disposed of responsibly and recycled where appropriate.

Where recycling is not possible, waste would be removed from the site and disposed of appropriately. All wastes would be subject to controlled collection and storage on-site, to keep the construction site tidy, avoid unsightly accumulations of waste and minimise dust, pest infestation, odour and litter. Wastes would not be stored in areas of the site adjacent to sensitive environmental features or receptors.

Licensed waste carriers would remove the residual waste from site to suitable licensed disposal sites. The disposal sites would be identified in consultation with the Local Authority and the Environment Agency to ensure their suitability.

During this stage all relevant UK waste regulations would be complied with. The Construction Manager would keep waste transfer notes that fully describe the waste in terms of type, quantity and containment in accordance with the relevant regulations. This process will allow waste streams to be monitored from the site.

Occupant Waste Arisings

An assessment has been undertaken which identifies the potential waste arising during the operational phase of the development. The assessment has been based on published benchmarked data (English Partnerships, July 2001, Employment Densities: A Full Guide, BRE, SMART waste, and Environment Agency, 1999, National Waste Production Survey).

It must be noted that this assessment provides approximate estimates of likely waste arisings. Waste generation and recycling levels are ultimately dependent on the occupant's behaviour during the operational phase.

In order to calculate estimated waste arisings the floor areas were obtained for each land use. The land use areas were then used to estimate projected employee numbers for the development (taken from the Economic Appraisal submitted alongside the planning application) during the operational phase. According to each land use, the number of employees were then multiplied by waste generation per head factors obtained from the National Waste Production Survey, 1999. The results can be found in table XXXX below:

Estimations of waste per annum arising during site operation (based on employment estimate and benchmark data)

Land use	**m2**	**Operational Waste (Tonnes per annum)**		
		Non Hazardous	**Hazardous**	**Inert**
South Complex				
Hotel	7895.00	273.15	2.24	0.00
Casino	5607.00	616.76	9.42	0.00
Restaurant 1	460.00	155.06	17.26	0.00
Restaurant 2	305.00	101.90	11.34	0.00
Multi Storey Car Park	1659.00	2.00	0.00	0.00
		1148.87		
North Complex				
Restaurant 3	547.00	186.08	20.71	0.00
Restaurant 4	461.00	155.06	17.26	0.00
Restaurant 5	434.00	146.20	16.27	0.00
Restaurant 6	363.00	124.05	13.80	0.00
Bowling Alley	1858.00	106.26	1.55	0.00
Cinema	2905.14	75.28	3.12	0.00
		792.93		

The waste tonnages calculated from the survey data do not include any recycling facilities that may be put in place during the operational phase, however it is likely that a large percentage of the non-hazardous waste likely to be produced on site could be recycled or composted. In accordance with the BREEAM guidelines, recycling facilities would be provided so that cardboard and paper can be segregated on site. Space available within the waste storage areas would also allow for other recyclable waste to be collected. This could include:

- Plastics (including packaging film)
- Glass
- Batteries
- Timber
- Fluorescent Lamps
- Vegetable Oils
- Mineral Oils

Research into waste streams from similar developments has suggested that in a development of this nature; glass, vegetable oils, fluorescent lamps and plastic would be significant waste stream components and that recycling facilities for these should therefore be considered most appropriate for inclusion within the site. Due to the high percentage of catering space and in line with BREEAM guidelines, composting facilities are also recommended for inclusion.

Ample space has been provided for recycling and waste management facilities in order that these materials can be segregated. In the North and South Complexes 87m^2 and 135m^2 (respectively) of refuse storage space are proposed (including vehicle manoeuvring space). It is considered that this is sufficient space to contain the waste generated based on regular servicing of these areas by the appointed waste contractor.

To ensure that recycling and composting facilities are effective, auditing and monitoring could be conducted during the operational phase to examine on site sustainable waste management practices and revaluate waste production statistics. The success of any recycling scheme will depend on the programme undertaken by those responsible for the initiative. As part of this, information would be provided regularly to tenants to ensure correct use of site waste management facilities.

Credit Ref	Management	Expected Points (Not Guaranteed)	Comments
MW 13	Dedicated space for the separation and storage of recyclable waste.	1	Dedicated space has been provided for the separation and storage of waste. The provision of appropriate bins to collect a variety of waste types would enable this credit to be achieved.
MW 16	Compactor Bailer	1	A waste compactor has been specified for the development. Assuming credits for MW13 are met – 1 credit should be achieved.
MW 17	Composting	1	Space limitations prevent compost to be stored on site, yet composting paladins would be used to store organic waste prior to its removal by an appointed contractor.

Section Six

Energy Strategy

6.1 **General** The Energy strategy outlines 3 main goals to ensure that local borough council energy requirements are met; these are summarised under the following headings:

- Be Lean – Use Less Energy
- Be Green – Use Renewable Energy
- Be Clean – Supply Energy Efficiently

These 3 guiding principles set out the framework by which the issue of energy efficiency is considered. The first principle is, as noted, to use less energy. A modern design should incorporate best practice techniques to ensure that a facility is in itself an efficient 'user' of energy – that is has the minimum energy footprint possible.

Once the minimum baseline is established, consideration of renewable energy sources is undertaken; in effect, now that one has reduced the absolute volume of energy to be consumed, are there opportunities to generate this energy from low or zero carbon emission sources?

Finally, once the energy and carbon baselines have been established, consideration is given to ways to reduce the carbon footprint of the energy use itself – can cleaner design be developed? Can lower carbon emitting methods such as CHP be used? Can improvements be made in efficiency across the development by using systems such as community heating?

The following discusses The Edge Development's approach to this issue:

6.2 **Be Lean Proposals** The Edge Development will be constructed to meet the updated energy standards found in the Building Regulations, Part L 2006. Application of these regulations presents an immediate 20% improvement over previous requirements. Where Part L2 is applicable, a 28% improvement is realised immediately.

Low Energy design techniques that will be incorporated into the Edge Development include:

1 Variable speed drives on air handling units, chillers and cooling pumps.
2 High efficiency motors for fans and pumps.
3 Low-flow plumbing fixtures with automatic control to reduce energy required for domestic water pumps and hot water heating.
4 High efficiency heat recovery technology to reduce outside air heating energy demand in fresh air handling units.
5 High temperature difference pumping systems.
6 Temperature reset on air and water systems.
7 Direct Digital Energy Management and Control system for HVAC and Lighting.
8 Measurement & Verification (M&V) procedures to maintain optimal performance and allow for further optimization over the building lifetime through periodic checkups.
9 Occupancy sensors to light spaces only when people are present.
10 Implementing Fundamental Building Systems Commissioning by introducing commissioning standards and strategies early in the design process and ensuring implementation of selected measures in construction documents.
11 Optimized building material design and configuration, including robust detailing, to minimize heat losses and gains.
12 Low Energy lighting and lighting controls
13 Natural ventilation within the car park.

6.3 **Be Green Proposals** See section 7 following for a discussion of Renewable Energy sources.

6.4 **Be Clean Proposals** The aim of the Be Clean proposals is to improve the delivery of energy where it is required to minimise waste.

Section Seven

Renewable Energy

7.1 **Introduction** There are seven (7) renewable energy sources and techniques that are generally considered for inclusion within a large development setting such as Great Yarmouth; these are:

1 Wind Turbines – Stand Alone or Roof Mounted
2 Photovoltaic Panels
3 Solar Thermal Systems (Solar Hot Water Heating)
4 Biomass Heating
5 Combined Heat and Power Using Biomass
6 Waste Based Heat Recovery

The Edge Development has reviewed each of these major renewable techniques by establishing some general criteria for inclusion and then proceeding to an outline feasibility assessment consistent with the London Renewables guidelines for those that have been considered.

7.2 **Examining The Alternatives in the Context of Great Yarmouth** The Edge Development is located on the East Coast adjacent to an urban area. The site is located very near to a housing estate. The location of the site informs some of the decisions in respect to renewable energy sources.

7.2.1 **Biomass** In this context, it is necessary to consider separately the options of solid, wood chip or wood pellet, and liquid fuels. The applicability of providing a solid biomass type fuel for the development is called into question. One of the key considerations for a renewable (or sustainable) source/material is the embodied energy of the fuel/item. Where solid biomass fuels are concerned, a requirement to deliver the fuel over long distances tends to increase the embodied energy and begins to transform a carbon neutral fuel into a carbon emitting one.

There is no known biomass fuel supply chain within a 20-mile radius of The Edge Development site. However there is a recognised supplier in the form of Linton Fuels, who are located in Grays, Essex. We have interviewed this company and the ability to supply the required level of Fuel to the site is viable however this does present a significant level of additional tanker traffic to the facility.

It follows that the use of solid bio-fuel is discounted at this stage but the option of liquid bio-fuel is considered later in this document.

7.2.2 **Stand Alone Wind Turbines** The average wind speed in the vicinity of the site at 25 m above grade level is approximately 8.6 m/s according to Department of Trade and Industry information. The British Wind Energy Association suggests that large wind turbines become operationally viable with wind speeds of 7 m/s and above. Additional guidance from BWEA in respect to the ideal location for a wind turbine suggests: “it is essential that turbines should be sited away from obstructions, with a clear exposure or fetch for the prevailing wind.”

The location of the Great Yarmouth site is ideal for such a consideration. However a major concern would be the visual impact to the housing residents near the development and also the high background noise considerations. For these reasons, standalone wind turbines are not considered applicable for the development.

7.2.3 **Alternatives Under Consideration** The remaining alternatives are considered to be potentially applicable to the Edge Development and have been taken to the outline feasibility assessment stage consistent with the guidance in the London Renewables Toolkit.

7.3 **Outline Feasibility Assessments – Renewable Sources**

7.3.1 **Discussion** With the aim of providing energy from a renewable energy source for the development, outline feasibility assessments were undertaken for the following techniques:

1 Roof- Mounted Wind Turbines
2 Photovoltaic Panels
3 Solar Thermal Systems (Solar Hot Water Heating)
4 Liquid bio-fuel
5 Water Based Heat Recovery
6 Renewable Obligation Certification

These techniques were evaluated in terms of their cost per unit carbon dioxide reduction, their application in the context of the building form and aspirations for the development and their compatibility with the proposed mechanical and electrical systems on site.

Any renewable technology is required to be consistent with this type of distribution system. In the proposed central heating scheme, domestic hot water is generated within individual units using a traditional indirect cylinder served by constant temperature primary hot water from the central distribution loop.

A final consideration of any renewable technology is its applicability within the context of the building form. There are existing constraints on the site in terms of building elevation and the existing pattern of buildings. The technology must be considerate of the architectural aspirations of the development and of the locality in respect to its visual impact and spatial requirements.

7.3.2 **Roof Mounted Wind Turbines** As noted previously, the wind speed conditions at the Great Yarmouth site lend themselves to consideration of the application of smaller, roof mounted turbine units. With particular reference to the scheme itself, the installation would take consideration of the following:

1 The Great Yarmouth façade would be left clear of visible turbines as far as is possible.
2 6 units could be installed along the northern and southern blocks of the development.
3 The proposed units would be based on the Proven Energy Model WT1500, 15 kW wind turbines. These units consist of 3 blades at 9 m diameter, with a hub height of 10 – 15 m above the top of the building.
4 In the context of the scheme, this is nearly 60% again the height of the building.

The proposed installation would deliver approximately 33,800 kWh per year, offsetting carbon dioxide emissions of some 14,200 kg. This reduction would represent approximately 2.3% of the total carbon dioxide emissions from the site.

In the context of The Edge Development, it is anticipated that such a proposal might be contentious. Considerable design effort would be required to ensure that ambient noise levels could be maintained at a satisfactory level. Architectural treatment of the site would also be extensive.

Estimated capital costs for this type of installation would be in the order of £318,000 for a cost per unit carbon dioxide reduction of £7.36/kgCO2.

Summary – Roof Mounted Wind Turbines	
Proposal	6 @ 15 kW wind turbines Hub height at 10-15 m above roof 9m rotor diameter
Energy Savings	101,400 kWh per annum
Carbon Reduction	42,600 kg CO2
Capital Cost	£318,000
Cost per unit kg CO2	£7.36/kgCO2
% Reduction	1.45%

As a true renewable energy source the wind turbine offers an idyllic approach to the provision of electrical energy. However, in the case of the Edge Development, notwithstanding the foregoing, there are a number of issues which limit its effectiveness and hence, viability.

Generally, the use of such means of generating energy is in locations which are more exposed in attitude and their visual and acoustic penalties do not have an impact on the surrounding population.

7.3.3 **Photovoltaic Panels – Roof Mounted** Photovoltaic systems convert energy from the sun into electricity through semi conductor cells. Semi conductor modules are connected to an inverter that converts the direct current DC output into useful alternating current AC. PV systems can successfully operate in daylight conditions though sunlight will improve output.

Load balancing is an important consideration in the design of PV systems. Ideally, a daytime load is available to use all of the energy generated from the cells thus minimising the requirement for battery storage.

For a development such as Great Yarmouth, consistent daytime loads such as car park and landlord lighting are good candidates.

Site considerations such as available roof space are also relevant to the discussion. At Great Yarmouth, there is approximately 2000m of roof available for consideration of a PV installation. An installation of this size would yield the following:

1 Deliver approximately 211,000 kWh per year of electricity;
2 Offset approximately 89,000 kg of carbon dioxide;
3 Represent a reduction of approximately 3% of the site's carbon dioxide emissions;
4 Estimated capital costs for the installation would be in the order of £2,300,000 for a cost per unit carbon dioxide reduction of £25.70/kgCO2.

Like the roof mounted wind turbines above, treatment of such an installation would require care in order to minimize the visual impact of its presence. It is envisioned that further discussions with the planners would be required for such a proposal.

As well, the cost per unit carbon dioxide reduction (@£25.70/kgCO2) for this kind of installation is not particularly competitive with other available renewable sources.

Summary – Photovoltaic Panels	
Proposal	2000 sq.m. of PV panel installation South facing at incline
Energy Savings	211,000 kWh per annum
Carbon Reduction	89,000 kg CO2
Capital Cost	£2,300,000
Cost per unit kg CO2	£25.70/kgCO2
% Reduction	3%

It has been necessary, from the commercial perspective, that each type of energy generation is considered in isolation, so that an assessment can be made to consider if the source is able to satisfy the whole of the 10% energy from renewable sources. In this is the case it has been determined that in excess of 7000m^2 of cells would be required to satisfy that duty.

Consideration of the space availability, orientation, installation attitude and visual impact on surrounding properties shows that the use of this product is not viable. Even if a reduced area of cells were to be considered offering a contribution to the energy requirements, as noted above, therefore Photovoltaic cells are not deemed to be suitable for this development.

7.3.4 **Solar Hot Water Panels** The Edge Development, with its relatively high domestic hot water load due to restaurant and hotel components, is theoretically a good candidate for a solar hot water panel installation.

A theoretical 2000 sq.m. installation designed to offset the domestic hot water load in the complex would yield energy savings in the order of approximately 107,000 kWh per year, offsetting carbon dioxide emissions of some 138,500 kg. This would represent a reduction of approximately 4.5% of the site's total carbon dioxide emissions.

Estimated capital costs for this type of installation would be in the order of £2,000,000 for a cost per unit carbon dioxide reduction of £14.40/kgCO2.

Summary – Solar Hot Water Panels	
Proposal	2000 sq.m. of solar collection panels
Energy Savings	170,000 kWh per annum
Carbon Reduction	138,500 kg CO2
Capital Cost	£2,000,000
Cost per unit kg CO2	£14.40/kgCO2
% Reduction	4.5%

The same constraints apply to this energy source as with Photovoltaic panels with the same limitations and, for the same reasons, Solar Hot Water Panels have been discounted in this instance.

7.3.5 **Liquid bio-fuel i**nvestigations have taken place into heat generation by liquid bio fuels as an alternative option to the solid product.

Consideration has been given to the use of liquid bio-fuel as the base product offers few of the disadvantages of the solid product, not least its availability. However, a major issue with any fuel is to ensure that the products of combustion are adequately dealt with. The limits of discharge for the exhaust of the products of combustion for gaseous fuels are less stringent that for liquid fuels, the inclusion of bio-fuel is of no greater impact than traditional oil fired plant. All installations are governed by compliance with legislation, government imposts and Statutory Instruments and the proposal for the use of bio-fuel would fall within these dictates. It is clear that the installation would comply with all relevant requirements including The Clean Air Act, Building Regulations, Part J, for the storage of liquid fuels, associated references in the Standards BS799, BS2869, BS4256, BS4876, BS5000, BS5410, BS6361, BS6847, BS7420, BS7793, BS EN264, BS EN303, BS EN12514BS EN13842, BS EN15034, BS NE15035 for oil burning appliances, equipment, storage and supply and any other requirement necessary according to a controlling Authority.

Having confirmed that a compliant installation is viable in both technical and practical terms, investigations have centred on the availability of the product and the technology required for use. From an end user point of view, it is desirable to use as pure a product as possible with the consequence that the investigations were directed firstly at 100% bio-product.

Although the 100% pure product offered significant practical benefits in that the boiler plant could incorporate a low level discharge flue, even when combined with other gas fired boilers due to its low sulphur content, it has been discounted on the grounds that there are significant problems with its lack of lubrication properties and consequential high maintenance. Furthermore, such a product is of a high viscosity and it is not suitable for bulk deliver.

The first issue to consider was the limitations, if any, of the options of FAME and RME bio bases.

In the UK, liquid bio-diesel is being produced and used as heating oil but in relatively small quantities at differing geographical locations either by re-processing used vegetable and animal oils and waste cooking oils that may be mixed and cleaned/filtered. Further, pure rape seed or other oils can be used and processed as FAME.

Crude or raw vegetable oils can be used as heating fuel but, as noted in the foregoing, this has a high viscosity which, for standard pressure jet oil burners used in this type of application, would have to be reduced. This is achieved through a process called 'transestrification'. Here, reacting crude vegetable oils with methanol, in the presence of a catalyst, produces a methyl ester with Glycerine as a by product. Separating the Glycerine significantly reduces the viscosity of the vegetable oil and results in the product Fatty Acid Methyl Ester (FAME) which can be used directly or blended with gas oil or Kerosene.

RME (Rape Seed Methyl Ester) is a similar product but is based on transestrified Rape Seed oil rather than recycled other vegetable oils but still producing a Methyl Ester product having the same combustion characteristics as FAME.

Combustion research results show that the combustion efficiency of FAME and RME, in blended form, show some improvement over pure gas oil data with the consequence that the source of the base bio-product, whether it be FAME or RME is of little consequence in terms of effects on the products of combustion, plant efficiency and origins of the renewable element of the sustainable component of the energy used. As the majority of FAME is recycled, there would be a benefit in using this as the bio-fuel for the blend where possible. However, because of the relatively small scale of recycling for the FAME product the source may vary depending on availability but this may give rise to variations in product quality. Although plant can be set to operate with a product, which is either consistently good or consistently bad, accepting a product of varying standard offers combustion difficulties. Hence, whilst targeting the FAME product, if the variation in quality/cleanliness is excessive, it may be desirable to revert to an original product to ensure clean burning.

In view of the previously noted limitations for the use of B100 (transestrified 100% bio-product) a review was made of the options for a commercially available, technically viable and legislation satisfying blended fuel. To this end, the highest available percentage of bio-product in the blend is of importance to ensure that the stored blend is as small as possible whilst satisfying the various criteria. For example, to satisfy the renewable requirement, there needs to be a definitive quantity of bio-fuel used. However, if the blend was a B10 (10% bio/90% petroleum) then there would be a need to store 5 times as much blend as for a B50 (50% bio/50% petroleum base).

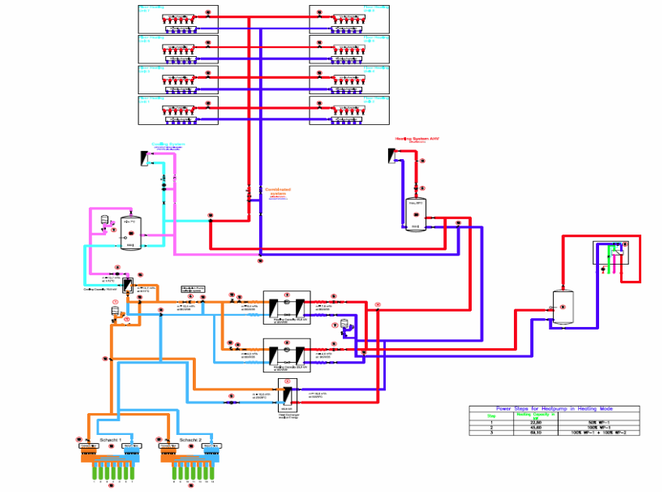
Although there are various standards for bio-fuel mixes, these are generally directed toward the transport industry. In fact, Central Government is still to acknowledge other uses and perpetuate a situation where Excise Duty would be payable on the bio-fuel used in the heating oil application and then have to be recovered by the end user! However, the basic commercial mixes range from B5 to B50 whereby the 'B' reference identifies the proportion of bio-product in the blend. In the case of this project, it has already been stated that the highest blend available offers considerable advantages in the storage of the blend with the consequence that B50 has been chosen for the project. Hence conclusions noted in the following are based on a B50 blend.

The B50 product is a mix of equal parts of bio-product and petroleum product. However, the actual petroleum element could be either Kerosene or 35 seconds fuel oil as both these options offer very similar characteristics in terms of Specific Gravity allowing a stable blend without problems of stratification. Generally the cost of Kerosene is slightly higher than that for 35 seconds as it is more refined but does offer fewer problems if low temperature storage is envisaged. Where the blend is to be stored outdoors, a Kerosene blend would be opted for, as its clouding temperature is lower than for 35 seconds. However, in this case, the bulk storage and oil transfer would be inside the building and not subject to conditions where clouding would become a problem, hence a blend of 35 seconds/bio-product has been considered appropriate in determining the plant sizes required to satisfy the 10% renewable energy resource.

7.3.6 **Water Based Heat Recovery** Investigations have taken place into the use of waste heat from the near by 400MW power generation plant. The plant consists of 4no. natural gas fired high pressure steam turbines. The plant generates high pressure steam which is used to drive a succession of turbines to produce electricity. Initial thinking was that waste heat from this process maybe used to provide a heat source to the proposed development. However from our inquires it has been ascertained that as part of the energy production water is drawn from the local river Yare and is used to cool the turbines and electrical generating equipment. This water is taken into the power plant, filtered to removed debris etc and is then passed around the plant and is finally dispelled to the sea via an offshore pipe system.

Having discussed the potential energy being transferred into this medium we have been informed that the cooling plant has a flow rate of approximately $9m^3$/sec, and that during the cooling process the river water is raised in temperature from around 10°C to 17°C. This means that the power station is passing approximately 250MW of heat energy out to sea.

We have therefore been investigating a means by which we would be able to harvest this low grade energy and use it to provide effectively free heat to the proposed development. The best means to do this is to use a variant on the existing 'Ground Source Heat Pump' technology. This uses the stored thermal heat within the earth in combination with a reverse cycle heat pump. This works as a fridge in reverse in that it concentrates the low level of background heat within the earth and uses it to provide high grade heat energy.



A system using the outfall from the power station, or there of, is entirely feasible. Water would need to be redirected to our site and a header provided in a plant enclosure. Tenants would then provide their own heat recovery plant within this enclosure to extract the heat from the waste water before it is passed either back to the power stations outfall system or directly out to sea.

As stated the energy needed to source this waste heat is minimal and therefore it provides and excellent means of renewable energy.

7.3.7 **Renewable Obligation Certification (ROC)** As part of the planning requirements a suitable source of 'local' renewable energy is to be provided. All of the above solutions are based on housing this renewable technology on site. However it must be noted that in the locality of the proposed development there are a number of significant renewable energy schemes, namely the off shore Scrubby Sands Wind Farm. Having contacted EON energy who own and manage this wind farm to inquire whether our scheme in place of an on site renewable could contribute to the existing wind farm we were informed that there are no plans to expand the site at this time.

Renewable Obligation Certificates or ROCs for short is the name given to the digital certificates which holds details of exactly how a unit of electricity was made, by whom and finally who bought and used it. These ROCs are traded separately to the actual electricity itself and work as a bonus premium on top of the price paid for the unit.

Energy Companies are now being required to generate a minimum of 10% of their electricity output from sustainable sources. If they have not managed to produce the required amount of green energy themselves they must buy ROCs on the open market to make up the shortfall. If they fail to buy the required amount fines can be imposed.

ROCs are good news for renewable energy as they ensure a certain minimum percentage of Green Energy is produced nationally and provide the financial incentive to encourage generators to invest in Renewable Energy Schemes of their own.

Many energy companies are now offering consumers the opportunity to purchase electricity from green energy sources. These green energy sources include, wind energy, hydro energy, biomass, solar energy and will begin to include marine energy sources such as wave power, tidal stream and tidal impoundments and tidal barrages.

This separation of renewable energy from oil, gas, coal and nuclear is possible due to the Renewable Energy certificate schemes now being developed worldwide; these certificates enable units of electricity, such as KWh to be identified as soon as they are produced and fed into the national grid. All units must be accounted for both in terms of how and when they were produced and who sold them to whom. Theoretically this means consumers can "buy" units from specific turbines, in reality the actual electrons running through a consumers meter will not have be generated by any source in particular, as generally all electricity, however it has been generated is fed into the national grid. Buying green electricity in the manner means that you are buying up certain tokens that acknowledge that every unit you have used has been made up for from a renewable source.

Having discussed this with EON Energy the potential to purchase our required level of renewable energy is real and we present this therefore as an alternative.

7.3.8 **Scheme Renewable Options** In regard to the production of renewable energy for the site a number of alternative methods have been reviewed. The following listing provides an indication of which of these technologies is considered viable for meeting the target of achieving 10% of the overall energy consumption of the site using local renewable energy sources.

Energy Source	Contribution & Viability	Comments
Roof Mounted Wind Turbines	1.45% Non Viable	In order to provide a meaningful contribution to the overall energy profile of the site a significant number of turbines would be required on the site. Whilst this may prove possible in engineering terms the option has been discounted due to the resulting levels of noise pollution in an area relatively close to a residential area.
Roof Mounted Photo Voltaic Panels	3% Non Viable	In order for this form of technology to provide a meaningful contribution to the energy target an extensive area of panels would be required which would not be practical to provide on this scheme. In addition to this the capital outlay and payback period is not something that would be possible for this development.
Solar Thermal Hot Water Production	1% Non Viable	Each of the intended users within the North and South Complex has a requirement for hot water production. Therefore it is possible for this technology to be adopted for the development, however the contribution to the reduction in the overall energy profile is only relatively small and therefore this is to be considered in conjunction with other proposals.
Bio Fuel Central Heat & Power Plant (CHP)	4% Viable	The introduction of a combined heating and power plant which would be run using liquid biomass fuels (i.e. bio fuel fuels which have been mixed with standard grade gas oil or kerosene to a prescribed percentage) would provide both hot water and electrical power to the facility via an energy centre. The ability of this proposal to provide the required levels of energy are dependant on the hot water load and therefore it will not provide a total solution but it will contribute to the renewable energy target. Plant areas have been allowed for within the scheme to facilitate this option.
Water Based Heat Recovery	6% Viable	There is a local industrial application which as a by-product of there manufacturing process transfer a significant level of waste heat out to sea via water initially extracted from the river Yare. It is proposed that using reverse heat cycle technology this heat could be harvested and used to provide medium grade heat to the various tenants within the North and South building complexes. This option would provide significant energy savings for the development. Plant areas have been allowed for within the scheme to facilitate this option.
Renewable Obligation Certification Scheme (ROC)	10% Viable	Under this option the intention is to use the governments recognised ROC scheme where as part of the tenants lease agreements they are required to import 10% of there total requirement energy from a renewable energy provider. This method of providing the 10% renewable energy means that the increased tariff being paid for each of the energy units being imported to the site is not only derived from a renewable source but also that a percentage of this increased tariff is invested in the development of new large scale renewable energy production schemes off site. The system is fully audited by the governments OFGEM.

It should be noted that the options for renewable energy have been considered for use in a multi tenancy facility, and that they shall be installed in a phased manner to match the occupancy of the facility and thereby keep the systems running at their most efficient levels.

Section Eight

Appendices

8.1 **Appendix A – Baseline Carbon Emissions From The Development**

		Predicted Annual Delivered Energy Requirements for:		Baseline Carbon Dioxide Emissions Arising From:		Total CO2 Emissions
		Electricity	Gas	Electricity	Gas	
Carbon Dioxide Emissions Factor				0.422	0.194	
Units	Area (sq.m)	KWhr/year	KWhr/year	kgC)2/year	kgC)2/year	Kg/C02/year
Site Totals	44,093	6,152,305	1,067,088	2,596,272	207,015	2,803,287

8.2 Appendix B – Building Load Calculation Sheets

Building Load Summary

	Services Load Summary	Internal Lanlords Areas	External Lanlords Areas South	External Lanlords Areas North	Casino	Restaurant 1	Restaurant 2	Restaurant 3	Restaurant 4	Bowling Alley	Hotel	Cinema	Restaurant 5	Restaurant 6	Total	
GENERAL LOADS	Electrical Loads kVA	57	93	12	1310	90	55	97	88	221	441	433	83	75	**3056**	**kVA**
	Mechnical Heating Loads kW	66	0	0	959	101	67	118	106	262	938	584	93	84	**3277**	**kW**
	Mechanical Cooling Loads kW	66	0	0	923	83	55	96	87	262	430	525	76	69	**2605**	**kW**
	Public Health Water Storage	948	0	0	974	805	213	375	337	156	13250	365	739	667	**17879**	**Litres**
	Building Area	719	14907	1659	5575	460	304	535	481	1868	4670	3378	422	381	**35359**	**m2**
PER M2	Electrical Total VA/m2	79	6	8	235	196	182	182	182	118	94	128	196	196	**86**	**VA/m2**
	Mechaical Heating w/m2	92	0	0	154	220	220	220	220	140	201	173	220	220	**93**	**w/m2**
	Mechanical Cooling Loads w/m2	92	0	0	166	180	180	180	180	140	92	155	180	180	**74**	**w/m2**

South Complex	kVA
Hotel	441
Casino	1,310
Restaurant 1	90
Restaurant 2	55
External Landlords Services South	93
	1,990 kVA
North Complex	
Bowling Alley	221
Cinema	433
Restaurant 3	97
Restaurant 4	88
Restaurant 5	83
Restaurant 6	75
External Landlords Services North	12
Internal Landlords Area	57
	1,066 kVA

Building Load Analysis

BUILDING & OCCUPANCY INFORMATION							MECHANICAL LOADS							ELECTRICAL LOADS							PUBLIC HEALTH	
Floor	Zone	Description	Area m^2	Sub Totals	Occupancy m2/Person	Predicted Occupancy	Fresh Air Volumes l/s/person	Fresh Air Volumes m^3/s	Kitchen Extract Volume (40ac / hr)	Heating Load w/m2	Total Heating Load kW	Cooling Load w/m2	Total Cooling Load kW	Elec Ventilation Load kW (2kw / m3 S&E)	Associated Elec Cooling Load kW	Lighting Elec Load w/m2	Lighting Load kW	Small Power w/m2	Small Power Load kW	Elec Load kVA	Cold Water Storage l/person	Cold Water Storage Capacity
Ground																						
	Internal Landords Area	Circulation	474	474	5	95	8	1		140	66	140	66	2	35	12	6	5	2	57	10	948
	External Landords Area South	Car Park Gnd	7,218											0	0	5	38	0	0	45	0	0
		Car Park 1st	7,218											0	0	5	38	0	0	45	0	0
		Car Park 2nd	7,218											0	0	5	38	0	0	45	0	0
		Street Lighting	300											0	0	5	2	0	0	2	0	0
		Service Yard South	560	22,514										0	0	5	3	0	0	4	0	0
	External Landords Area North	Street Lighting	800											0	0	6	4	0	0	5	0	0
		Servie Yard North	1,044	1,844										0	0	6	6	0	0	8	0	0
	Casino	Casino Gaming	3,838		5	767	12	9		150	614	180	690	28	368	25	96	100	384	1,094	1	767
		Restaurant	300	4,138	10	30	12	0	0	220	66	180	54	2	29	12	4	30	9	55	7	210
	Restaurant 1	Restaurant	460	460	4	115	12	1	2	220	101	180	83	9	44	12	6	30	14	90	7	805
	Restaurant 2	Restaurant	305	305	10	31	12	0	0	220	67	180	55	2	29	12	4	30	9	58	7	214
	Restaurant 3	Restaurant	547	547	10	55	12	1	1	220	120	180	98	4	53	12	7	30	16	100	7	383
	Restaurant 4	Restaurant	461	461	10	46	12	1	1	220	101	180	83	4	44	12	6	30	14	84	7	323
	Bowling Alley (18 lane)	Bowling Centre	1,858	1,858	12	155	12	2		140	260	140	260	6	139	12	22	5	9	220	1	155
	Hotel	Hotel	403	403	15	27	8	0		200	81	180	73	1	39	12	5	20	8	65	7	188
		Total	32,802			1,320		15	4		1,477		1,463	57	780		276		466	1,073		3,992
First Floor																						
	Zone	Description	Area m^2																			
	Lanlords Area	Circulation	245	245	5	49	8	0		140	34	140	34	1	18	12	3	2	0	29	1	49
	Casino	Back Of House	1,471	1,471	15	98	12	1		125	184	125	184	4	98	12	18	10	15	167	1	98
	Cinema (8 screens)	Cinema	2,905	2,905	8	363	8	3		200	581	180	523	9	279	12	35	5	15	421	1	363
	Restaurant 5	Restaurant	434	434	4	109	12	1	1	220	95	180	78	8	42	12	5	30	13	85	7	760
	Restaurant 6	Restaurant	363 381	381	4	95	12	1	1	220	84	180	69	7	37	12	5	30	11	75	7	667
	Hotel	Hotel	868		12	72	8	1		200	174	180	156	2	83	15	13	20	17	144	7	506
		Restaurant	200	1,068	4	50	12	1	1	220	44	0	0	4	0	12	2	30	6	15	7	350
		Total	6,594			836		8	3		1,196		1,044	34	557		81		78	937		2,793
Second to Sixth Floor																						
	Zone	Description	Area m^2																			
	Cinema	Cinema Projection	460	460	0	0	8	0		50	23	0	0	0	0	12	6	5	2	10	1	0
	Hotel	2nd Floor	750		0	25	8	0		200	150	80	60	1	32	12	9	10	8	61	100	2,500
		3rd Floor	750		0	25	8	0		200	150	80	60	1	32	12	9	10	8	61	100	2,500
		4th Floor	750		0	25	8	0		200	150	80	60	1	32	12	9	10	8	61	100	2,500
		5th Floor	750		0	25	8	0		200	150	80	60	1	32	12	9	10	8	61	100	2,500
		6th Floor	750		0	25	8	0		200	150	80	60	1	32	12	9	10	8	61	100	2,500
		7th Floor	750		0	25	8	0		200	150	80	60	1	32	12	9	10	8	61	100	2,500
		8th Floor	750		0	25	8	0		200	150	80	60	1	32	12	9	10	8	61	100	2,500
		9th Floor	750	6,000	0	25	8	0		200	150	80	60	1	32	12	9	10	8	61	100	2,500
		Total	6,460			200		2	0		1,223		480	5	256		78		62	501		20,000

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General Plant Space Allowances

		Lanlords Areas Internal	Landlords Area External South	Landlords Area External North	Casino	Restaurant 1	Restaurant 2	Restaurant 3	Restaurant 4	Bowling Alley	Hotel	Cinema	Restaurant 5	Restaurant 6		Total	
Building Area		719		1644	5607	460	305	547	461	1858	7471	3365	434	381		23,252	m^2
Electrical Loads kVA		57		12	1316	90	56	100	84	220	532	431	85	75		3,058	kVA
Mechanical Heating Loads kW		66		0	864	101	67	120	101	260	1048	581	95	84		3,389	kW
Mechanical Cooling Loads kW		66		0	928	83	55	98	83	260	529	523	78	69		2,772	kW
Air Volumes m^3/s		1		0	11	3	1	1	1	2	3	3	3	2		31	m3/s
Cold Water Storage		948		0	977	805	214	383	323	155	13544	363	760	667		19,138	Litres
Mechanical Services	**Space Allowance**																
Chillers (Water Cooled)	0.0276 m^2 per kW	2		0	26	2	2	3	2	7	15	14	2	2		77	m^2
Air Handling Units	8 m^2 per m^3/s	6		0	86	23	6	11	9	15	24	23	22	19		246	m^2
Boilers	0.08 m^2 per kw	5		0	69	8	5	10	8	21	84	46	8	7		271	m^2
Incoming Gas Boosters	0.015 per kW	1		0	13	2	1	2	2	4	16	9	1	1		51	m^2
Electrical																	
Sub Stations	0.04 m^2 per 1000kVA	-			-	-	-	-	-	-	-	-	-	-		122	m^2
LV Switch Room	0.1 m^2 per 100kVA	6		1	132	9	6	10	8	22	53	43	9	7		306	m^2
Standby Generator		-			70	-	-	-	-	-	-	-	-	-		70	m^2
Lift Motor Rooms	0.1 % Floor Area	72			-	-	-	-	-	-	50	-	-	-		122	m^2
Public Health																	
Cold Water Storage	0.8 m^2 per 1000 litres	1		0	1	1	0	0	0	0	11	0	1	1		15	m^2
															TOTAL	1,280	m^2

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8.3 Appendix C - **Energy Annual Loads**