Hydrock

Dorset Innovation Park LDO

Energy Statement

For Purbeck District Council

Date: *13 November 2018*

Doc ref: *DIP-HYD-XX-ZZ-RP-ME-0002*

DOCUMENT CONTROL SHEET

Issued by	Hydrock Consultants Limited Over Court Barns Over Lane Almondsbury Bristol BS32 4DF Tel: 01454 619533 Fax: 01454 614125 www.hydrock.com	Client	Purbeck District Council
		Project name	Dorset Innovation Park LDO
		Title	Energy Statement
		Doc ref	DIP-HYD-XX-ZZ-RP-ME-0002
		Project no.	C-08277
		Status	S2 - Suitable for Information
		Date	13/11/2018

Document Production Record

Issue Number	P04	Name
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Document Revision Record

Issue Number	Status	Date	Revision Details
P01	S2	28/06/2018	Preliminary Draft Issue
P02	S2	06/07/2018	Revised Draft Issue
P03	S2	01/08/2018	Issued for LDO submission
P04	S2	13/11/2018	Updated NPPF references

CONTENTS

1. INTRODUCTION

1.1 Purpose of Report

Hydrock Consultants has been appointed by Purbeck District Council (PDC) to provide planning stage advisory services in relation to the design and construction of the proposed Dorset Innovation Park (DIP). This document informs the Local Development Order and will help the PDC planning department understand the methodologies behind the recommendations in this report.

This document summarises an initial options appraisal that has been carried out for potential centralised or de-centralised building services equipment that could be used to provide heating, hot water, cooling and electricity to the new development, with a focus on demonstrating how these can meet local, regional and national policy targets.

This report contains both advice for prospective stakeholders and mandatory requirements in order to comply with the LDO and PDC objectives.

Throughout this report carbon emissions are split into two categories:

- Regulated: Emissions associated with heating, cooling, hot water, lighting and any other fixed building services equipment (those that are covered under Building Regulations Part L1A and L2A); and
- Unregulated: Emissions that are associated with small power and plug-in items and any other process or plant equipment (these are not covered by Building Regulations Part L1 A and L2A).

1.2 Project Description

Dorset Innovation Park is a new innovation park that is being developed on the site of the former Winfrith nuclear energy test facility on the edge of Wool village near Wareham. The whole development will consist of a mixture of buildings housing light industrial, research & design, industrial and distribution.

Technical assessments relating to the proposed development are based upon an Illustrative Masterplan. This is set out in Figure 1 and is appended to the Statement of Reasons. The Illustrative Masterplan presents one potential development scenario and is reflective of the urban design and development plot principles set out within the Design Guide. The masterplan shows a scheme of 14 plots, consisting of 26 buildings.

The development aspires to be a flagship scheme and will be expected to provide high levels of sustainable design, innovation and wellbeing for occupants.

1.3 Executive Summary

The energy strategy for Dorset Innovation Park could adopt a number of different strategies, the basic principles are outlined as follows;

Centralised plant from the energy centre for;

- » Heating;
- » Cooling;
- » Hot water; and/or
- » Power.

How this is achieved depends on a number of factors; the level of initial capital investment, the operational commercial benefit of implementing highly sustainable systems and the technical viability of this approach. In terms of technical viability, the following key variables have been highlighted:

- Building usage and occupancy characteristics (demand diversity);
- Construction phasing and occupation;
- Building density; and
- Supply resilience.

The energy strategy must be robust and modular, as the site will be built over many years, whilst also being straightforward and flexible enough to provide a long-term approach to energy management and reducing operating costs.

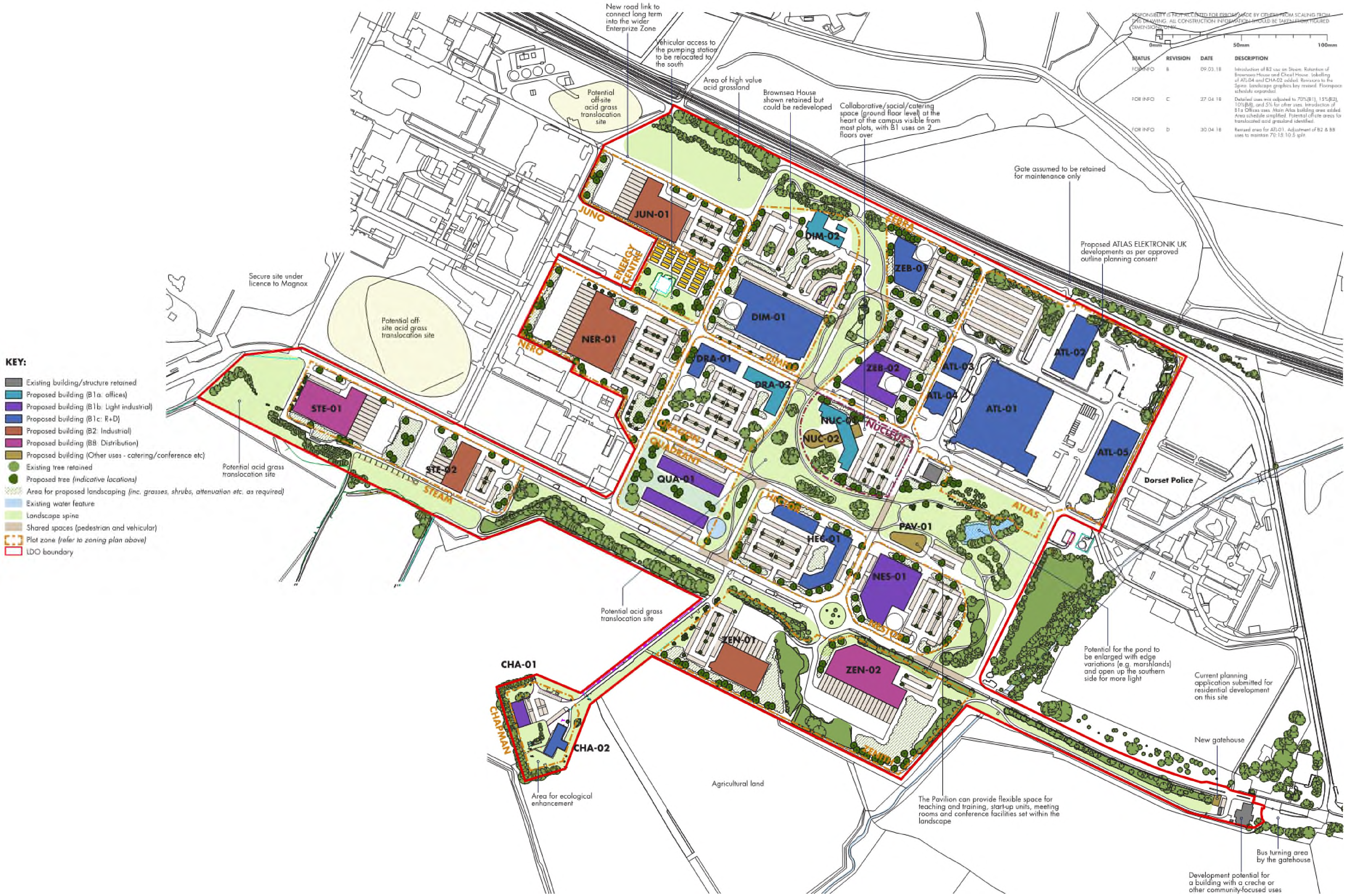
In order to understand what level of development could be achieved, a number of precedent studies of other innovation parks has been undertaken, see Precedents.

1.4 Area Schedule

The area schedule is shown in Table 1:

Planning use class	Percentage of site
B1a Offices	10%
B1b Research and Development	50%
B1c Light Industrial	10%
B2 General Industrial	15%
B8 Storage and Distribution uses	10%
Other (ancillary uses)	5%

Table 1: Percentage of planning uses



RESPONSIBILITY IS NOT ACCEPTED FOR ERRORS MADE BY OTHERS FROM SCALING FROM THIS DRAWING. ALL CONSTRUCTION INFORMATION SHOULD BE TAKEN FROM FIGURED DIMENSIONS ONLY.

STATUS	REVISION	DATE	DESCRIPTION
FOR INFO	B	09.03.18	Introduction of B2 use on Steam. Retention of Brownsea House and Chapel House. Labelling of ATL-04 and CHA-02 added. Revisions to the Spine. Landscape graphics key revised. Floorspace schedule expanded.
FOR INFO	C	27.04.18	Detailed uses mix adjusted to 70%(B1), 15%(B2), 10%(B8), and 5% for other uses. Introduction of B1a Offices uses. Main Atlas building area added. Area schedule simplified. Potential offsite areas for translocated acid grassland identified.
FOR INFO	D	30.04.18	Revised area for ATL-01. Adjustment of B2 & B8 uses to maintain 70:15:10:5 split.

Figure 1. Masterplan of Dorset Innovation Park

2. PLANNING POLICY

2.1 National

2.1.1 *National Planning Policy Framework (NPPF)*

The National Planning Policy Framework (NPPF) acts as a guidance for local planning authorities and decision makers, both in drawing up plans and making decisions about planning applications.

The NPPF sets out the Government's planning policies for England and how these are expected to be applied through local authorities. It sets out the Government's requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so.

The NPPF also provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.

2.1.2 *Building Regulations Approved Document Part L*

Building Regulations Part L2A (conservation of fuel and power in new buildings other than dwellings) sets required levels for CO2 emissions and stipulates the process for which to demonstrate CO2 emissions compliance.

To comply with Part L2A, non-domestic buildings are required to achieve a 6 to 12% reduction in CO2 emissions when compared to the previous version of Building Regulations, depending on the building type.

The updated version of L2A has also introduced Target Fabric Energy Efficiency levels (TFEE's), these are mandatory requirements for building fabric efficiency and have been introduced to ensure a "fabric first" approach to energy reduction.

2.2 Local

2.2.1 *Purbeck Local Plan*

The Local Plan, covering the period 2006-2027, is one of the Council's key strategies. It sets the spatial elements of the Council's vision and objectives for now and the future.

Objective 8.15 - Design

Objective 8.15.2 states that sustainable development objectives can be achieved through good design. Therefore, as stated in Policy D - Design, the council expects all developments to:

- Positively integrate with their surroundings;
- Reflect the diverse but localised traditions of building material usage found across the District;
- Avoid and mitigate effects of overshadowing, overlooking and other adverse impacts including light pollution from artificial light on local amenity;
- Demonstrate support for biodiversity through sensitive landscaping and through in-built features, which provide nesting and roosting facilities for bats and birds;
- Reflect the good practice advice, including appropriate densities, contained in District design guidance;
- Reflect good practice guidance contained in the Dorset and New Forest Contaminated Land Consortium of Local Authorities' planning advice note 'Development on Land Affected by Contamination';
- Demonstrate a positive approach to delivery of sustainable development objectives through site layout and building design, which should be as comprehensive as other policies and criteria allow.

In addition, when applicable:

- *Development of more than 1,000m^2 (net) of non-residential floor space should, having achieved a Part L of the Building Regulations pass, further reduce its regulated greenhouse gas emissions either by 10% via the use of on-site renewable energy generation, or by 20% overall;*
- *Achieve a BREEAM 'Very Good' rating or higher for new build non-domestic development up to 1,000m^2 (net) floor space, and as a minimum a BREEAM 'Excellent' rating for larger developments.*

It should be noted that the BREEAM policy in the local plan is being modified and is not imposed on new employment developments.

Since adopting policy D of the Local Plan the Council has commissioned a viability assessment by Andrew Golland dated September 2012 dated in respect of the proposed introduction of a community infrastructure levy.

The viability assessment indicated the marginal or lack of viability of commercial schemes at the time. Since 2013 Purbeck District Council has not insisted on compliance with the BREEAM requirements of the policy and have accepted individual viability assessments to evidence why BREEAM "very good or higher" compliance should not be required.

The 2018 review of the local plan (pre-submission stage to be approved by Council on 9 October 2018) is unlikely to include comparable requirements relating to the need for BREEAM requirements.

Objective 8.16 Renewable Energy

Objective 8.16.1 states that the Purbeck council has endorsed the Bournemouth Dorset and Poole Renewable Energy Strategy, focusing on the use of renewable energy for meeting the heating and electrical needs of Dorset. Therefore, as stated in Policy REN - Renewable Energy, the council encourages the sustainable use of energy generation, and will be permitted where:

- The technology is suitable for the location and does not cause significant adverse harm to visual amenity from both within the landscape and views into it;
- It would not have an adverse ecological impact upon the integrity of protected habitats unless there is no alternative solution and there are imperative reasons of overriding public interest;
- It would not cause interference to radar or telecommunications, or highway safety;
- It would not cause significant harm to neighbouring amenity by virtue of visual impact, noise, vibration, overshadowing, flicker (associated with turbines), or other nuisances and emissions;
- It accords with Dorset County Council's Landscape Change Strategy and includes an agreed restoration scheme, any necessary mitigation measures, with measures to ensure the removal of the installations when operations cease;
- Safe access during construction and operation is provided;
- It avoids causing harm to the significance and setting of heritage assets.

2.2.2 *Purbeck Design Guide - Supplementary Planning Document*

The Purbeck Design Guide is a supplementary planning document which provides an overview of design principles that support policies within the Purbeck Local Plan.

3. DRIVERS FOR SUSTAINABLE DESIGN

The innovation park intends to be a place for creativity and productivity to thrive. In order to attract these type of occupants, the park needs to have unique selling points when compared with other similar schemes.

3.1 Attracting Investment

Regenerating the area and constructing new buildings requires investment. This scheme needs to bring in bodies that will see a financial return on the capital they invest. One of these ways is to create a highly sustainable masterplan of buildings which are economic to run and comfortable for occupants.

The park looks to attract highly innovative and forward-thinking companies; thus, the park needs to reflect this in its approach to the site.

3.2 High Connectivity

It is understood that BT are offering to install a hyper speed fibre network within the site in order to provide speeds of over 100 Mb/s.

3.3 Dark Fibre

A new and innovative technology is Dark Fibre. This is a private and direct customer-controlled network fibre line which does not have the restrictions of normal fibre connections.

The capacity of the network is virtually infinite and is very secure. Dark fibre lines could be installed on site (potentially using existing ducts/abandoned dry mains) and activated when new tenant move in.

3.4 Reducing Fuel and Energy Consumption

In order to reduce the carbon footprint of the construction and occupation of the building on site, the amount of energy consumed should be as low as possible, whilst still meeting occupants comfort criteria.

Passive measures such as improving the fabric performance of buildings, improving air tightness, and increasing the window specification are all things which reduce unwanted losses and/or gains from the buildings. This also reduced the amount of energy required to condition the buildings.

The systems proposed should be in line with the energy hierarchy (Lean, Clean & Green). The hierarchy ranks the ways in which energy should be saved and generated. The Lean approach should be taken first, which aims to reduce the amount of energy required by a building through passive measures like improving the fabric performance.

Once this has been explored, energy should be generated cleanly, through energy efficient equipment.

The final option is to generate the energy 'greenly' using renewable technologies such as solar photovoltaics, wind and solar thermal.

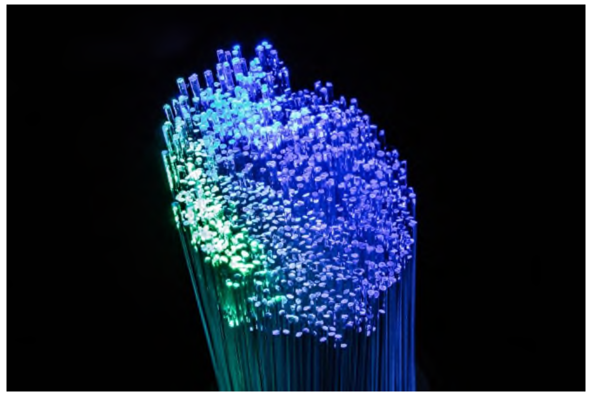


Figure 2. Dark fibre connection potential for DIP

4. EXISTING INFRASTRUCTURE

Based on existing services surveys, it is inconclusive as to exactly how much of the existing infrastructure could be reused for new proposals, if any. The following sections detail the suitability of new services using existing infrastructure.

It is encouraged that existing infrastructure is used where possible and provides a significant cost saving, whilst still providing the same level of service as a new infrastructure system would.

4.1 Potable Water

It is thought that the existing water main infrastructure on site could remain and be connected into if it is large enough to serve all buildings in the final condition. Consideration should be made to upgrading this infrastructure if it is understood to lose significant amounts of water through distribution around site from, leaks, cracks etc.

If this main is not useable, this could be used as the irrigation supply if possible.

4.2 Electricity

An extensive electrical network is present on site and should look to be reutilised by the new buildings if it is large enough for the new loads.

New infrastructure would most likely be required if an energy centre is used to distribute electricity to each plot, rather than individual connections.

If a significant amount of energy is to be exported from the site to the national grid, reinforcement works would most likely be required.

4.3 Natural Gas

The existing gas infrastructure on site does not appear to cover the whole development. This would need to be extended if and most likely enlarged in an energy centre or local supply scenario.

4.4 District Heating/Cooling

Any heating or cooling pipe network around the site should be buried to reduce heat losses, hence new trenches would need to be built for these services if chosen.

4.5 Data/Comms

The existing BT network on site appears to cover a large portion of the development. It I understood that BT are proposing to install a high-speed ring-network in the centre of the site for the development to use. This would most likely require new ducts and trenching on site to achieve this.

Existing ducting could be used to install Dark Fibre around the development, or this could be installed as part of the proposed BT upgrade.

5. SITE-WIDE ENERGY STRATEGIES

Energy Delivery Systems

There are two main ways of generating energy for buildings; locally or centrally. One is on a site-wide scale, which would mean either a single point of energy generation and distribution. The latter is the traditional route of having multiple points of generation across a site which would consist of one per building.

5.1 De-centralised System

5.1.1 *What is a de-centralised system?*

A de-centralised system is a building-by-building approach to energy generation. Each plot will have its own plant room which would contain the incoming utility connections, heating/cooling generation plant, ventilation plant and hot water generation plant. Each building is billed separately by the utility providers, and any excess energy is lost.

5.1.2 *When a de-centralised system is appropriate?*

A de-centralised system should be considered when the buildings on a site meet the following criteria;

- The site has a low density
- The buildings on site do not use a significant amount of energy
- The building usage and occupancy characteristics is not known and would not be known until each site is sold individually.

5.1.3 *Advantages & disadvantages*

A list of advantages and disadvantages are shown in Table 3.

Table 3. De-centralised Systems: Pros & Cons

Advantages	Disadvantages
Buildings are independent of each other	Individual Utility connections are required for each building
The owner of the building owns the building services plant	The building services cannot be adapted easily once installed to make use of new fuels/systems
	There will be lots of repetition in the types and size of plant purchased for each building
	Maintenance needs to be for each building and not for one central building
	Smaller, individual systems are less efficient
	Renewable technology would be required to meet planning requirements
	Plant is typically oversized and not utilised to its full capacity often.
	Plant areas are larger than that of a central system due to the local energy generation equipment

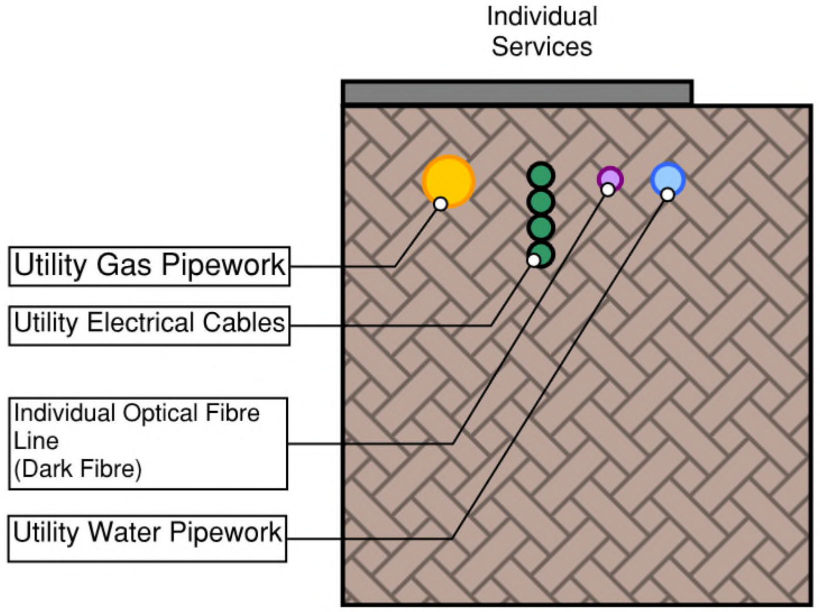


Figure 3. Individual Services Distribution in road.

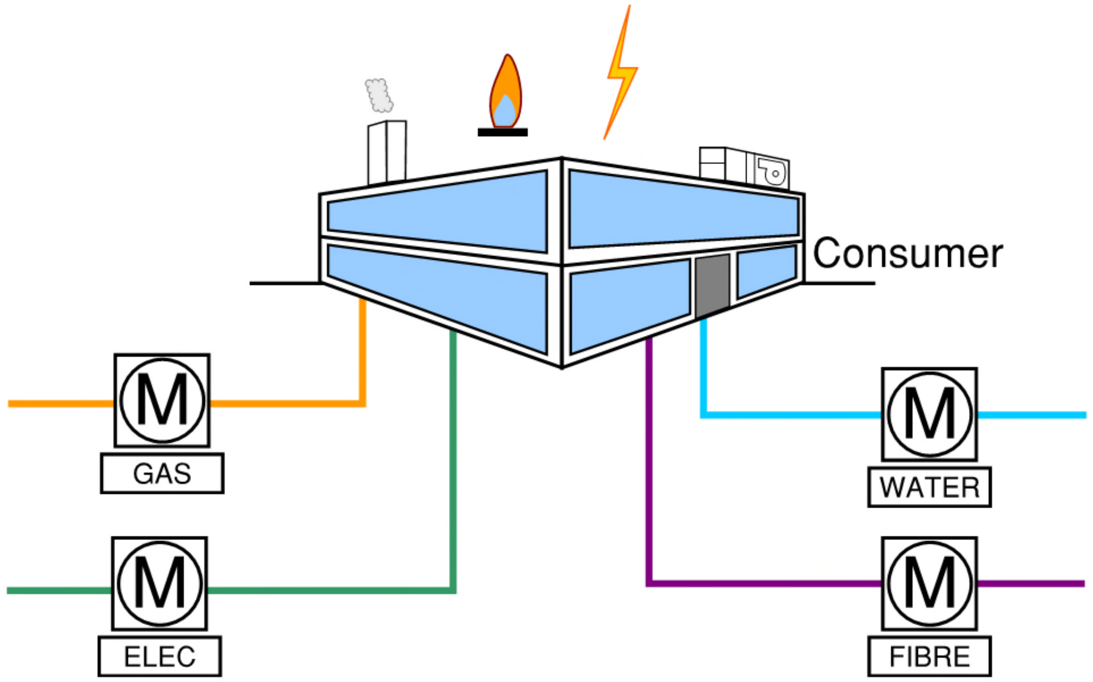


Figure 4. Local Energy Generation to each building

5.2 Central System

5.2.1 *What is central system?*

A central system is fed from a dedicated building on the site which houses all of the energy generation plant and distributes the useful energy to each building that is part of that energy network.

The central energy generating building on site is typically referred to as an energy centre. This building typically distributes; heating & hot water, cooling and power. But any single or combination of these products can form an energy centre, depending on the economic and client intentions.

An energy centre is normally operated by an independent energy provider. This company will then meter the energy usage of each building on site and bill accordingly. These rates will differ from standard utility company rates and will be the only option for tenants on the site. Typically, these rates are cheaper than the equivalent utility provider rates.

5.2.2 *When is a central system appropriate?*

A central system should be considered when the buildings on a site meet the following criteria;

- The site has a high density and regularly occupied buildings
- The buildings on site have a balanced and consistent energy demand.
- Each building that would require building-wide heating/cooling distribution (e.g. central boiler/chiller plant to serve each room in the building).
- The majority of buildings on site connect to the central system

5.2.3 *Advantages and disadvantages*

A list of advantages and disadvantages are shown in Table 4.

Table 4. Central Systems: Pros & Cons

Advantages	Disadvantages
One central distribution network	Single point of failure for site (excluding resilience)
Generation systems are independent of distribution	Requires an independent network operator
Energy generation plant is more efficient with larger and consistent energy demands	Expensive to run if underutilised on site
Single connection for utilities (Electric and gas)	Requires higher capital investment
Single maintenance regime for energy generating plant	Requires an individual plot on site.
Usually meets site wide carbon reduction requirements	No choice of utility provider
Adaptable to new fuels and energy sources when they become available	
Private Provider removes risk and capital investment required by Council.	

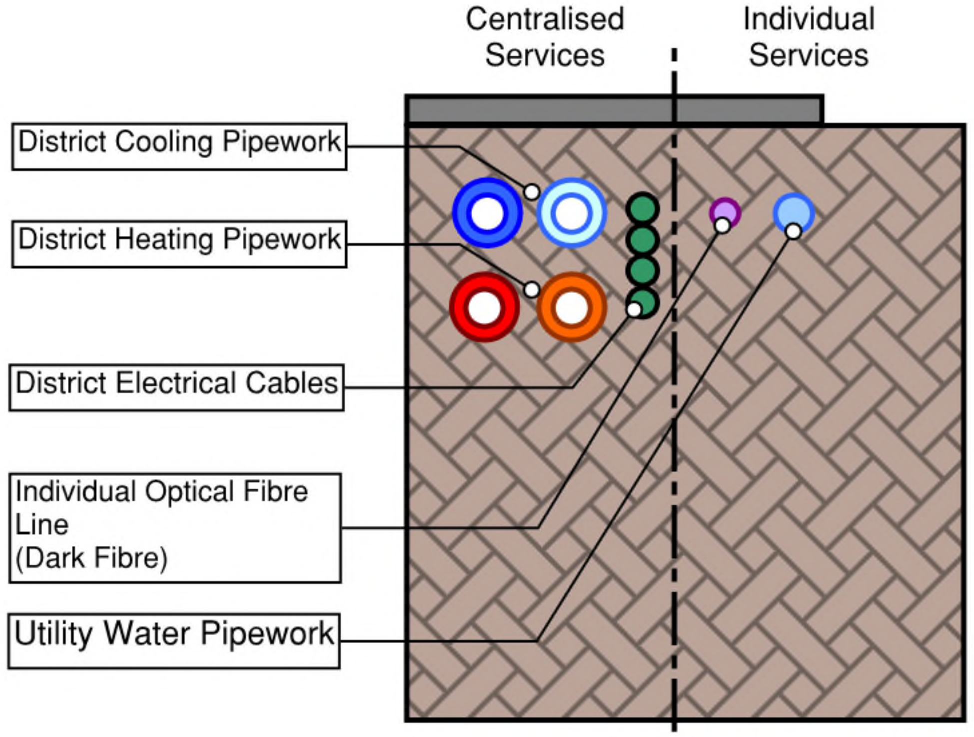


Figure 5. Central Services Distribution in Road

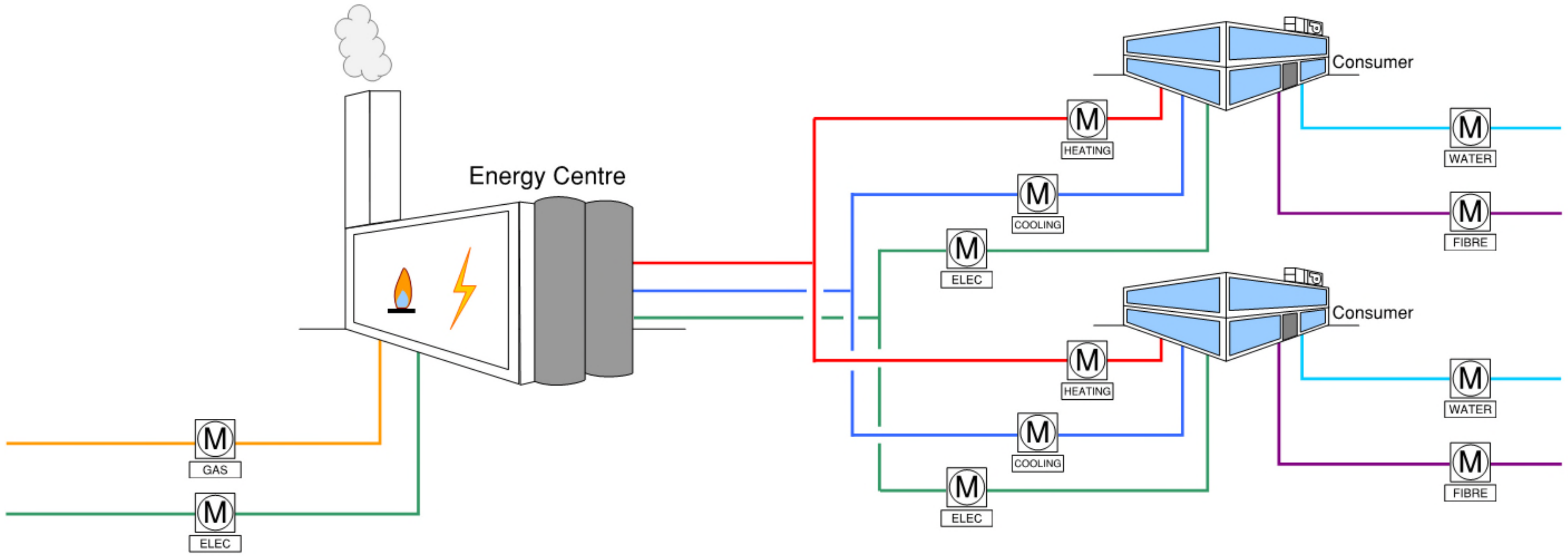


Figure 6. Central Energy Distribution to each building

6. PRECEDENTS - INNOVATION PARKS

6.1 Introduction

In order to understand existing benchmarks of sustainable design expected from an Innovation park, a number of existing science parks have been studied in order to shape the recommended energy strategy for this new development.

6.2 Bristol & Bath Science Park

Bristol & Bath Science Park is based in North Bristol near the M32 & M4 junction. The aim of the park is to facilitate innovation and inspire the next generation.

6.2.1 Energy & Sustainability

The two buildings currently on site have achieved a CEEQUAL Very Good rating. This is a rating method by the BRE which covers; civil engineering, infrastructure, landscaping and public realm projects.

The buildings also have a BREEAM Excellent rating.

200 square meters of solar panels aim to provide 10-15% of the buildings energy requirements including a solar water heating system (from a mixture of solar PV and Solar hot water panels).

A biomass boiler provides heating to both buildings, but it is understood to not be a system which could be expanded to be a site-wide system.

Dimmer-switch street lighting is installed to dramatically reduce lighting loads by adjusting lux levels based on the ambient lighting levels throughout each season.

6.2.2 Services

In order to attract potential tenants, a number of sustainable and innovative practices are put in place, these include;

- Dark fibre infrastructure - providing unlimited bandwidth and flexibility to tenants.
- Sustainable transport - electric car park charging points are provided and electric Brompton bikes are available for the tenants.
- Shower and drying facilities - these are across the site to encourage visitors to enjoy some fresh air and exercise.

6.3 Thames Valley Science Park

Thames Valley Science Park is located near Reading, outside of London. The park is spread over two sites and will have a total of 16 buildings when completed over a number of years.

Reading University has made a large investment into the park, much like UWE has with Bristol & Bath Science Park.

6.4 Liverpool Science Park

Liverpool science park is a not-for-profit organisation which operates on a fully-commercial basis. It provides flexible office space for the city's knowledge-based industries.

It also includes ten fully-fitted containment level two commercial laboratories. The site is currently made up of three buildings.

It is understood that each building has its own plant to meet its energy needs.

6.5 Exeter Science Park

Exeter Science Park is located in close proximity to the M5 and Exeter Airport. It uses a decentralised approach to energy generation with each building being a separate entity.

The Met Office have recently moved into the park with a new building on site.

Figure 7. Bristol & Bath Science Park (Courtesy of Alec French Architects)

Figure 8. Thames Valley Science Park

7. CONTEXT OF DORSET INNOVATION PARK

Site-specific strategies

7.1 Introduction

Following the introduction of de-central and central generation networks, along with a precedent study of existing innovation parks and energy centres, the next section looks at how this can be applied to Dorset Innovation Park.

7.2 Building usage and occupancy characteristics

The building types at Dorset Innovation Park consist of; Research & Development (R&D), office space, industrial and distribution. Both R&D and office building types fall under planning class B1 and have been assumed to have typical office loadings, this is the majority of the development covering 60% of the site buildings.

It is noted that there may be specific process loads for a proportion of the research and development units. These processes may not be able to have their process heating/cooling generated from a central building and distributed unless a significant number of the R&D building require the same processes.

The R&D buildings are expected to have a significant energy demand baseload for both cooling and power for server rooms. If this is the case, this will provide a constant and consistent baseload for the generation plant, allowing it to run continuously and hence more efficiently.

7.3 Construction Phasing & Occupation

The size of the site and diversity of the buildings on site means that buildings will be built and occupied over a number of years/decades depending on uptake and commercial interest.

This unknown speed of construction and selling of plots on site means that it is difficult to provide a methodology of what the site energy demands will be after each year from construction of the first building. Hence the independent operator of any central energy network may not have a financially viable scheme until a 'critical mass' of buildings have been built and occupied.

However, this could be overcome initially by the independent operator using the energy centre plot to generate electricity and be able to export this back into the national grid for profit. This is typically through the use of gas generators or large photovoltaic arrays (see Figure 11).

7.4 Building Density

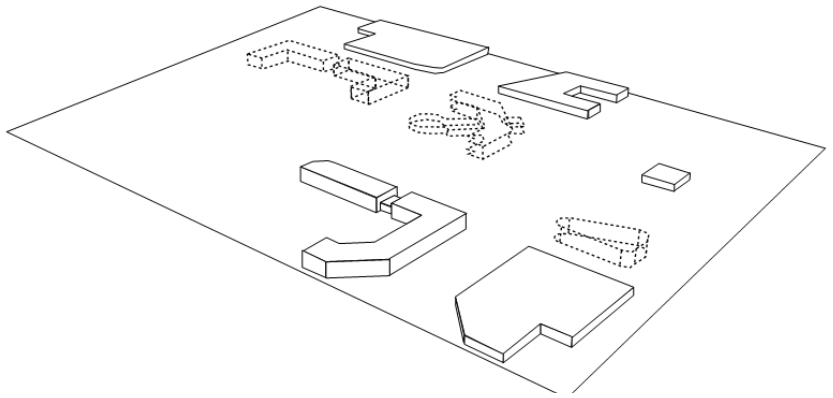
The DIP site has a large number of buildings on site which are of relative low to medium density. There is a higher density and height of buildings in the centre of the site, with a number of satellite plots which are a significant distance away from the proposed energy centre plot. These buildings which are further away are also relatively low energy users. This could result in the energy distribution network only serving the buildings central to the site if it is deemed unviable to supply the low energy usage and distant building on site. However, it is strongly encouraged that the centralised approach is mandatory to ensure prospective tenants connect to the energy centre in order to ensure it is not underutilised making the distribution system inefficient and redundant.

7.5 Supply Resilience

As more buildings are built and connected to the national grid, more strain is put on the network to provide energy to these new buildings. As well as this, the grid is now seeing the introduction of electric vehicles which is adding huge demand to the network.

The advantage of generating electricity locally and distributing locally is that there is more resilience provided to the site due to the isolation from the national grid supply.

Of course, the energy centre is the sole provider of all energy requirements to the site, and any disruption to this will have an effect on the buildings it serves. However, resilience in the form of standby systems and alternative means of energy generation can be provided within the energy centre.



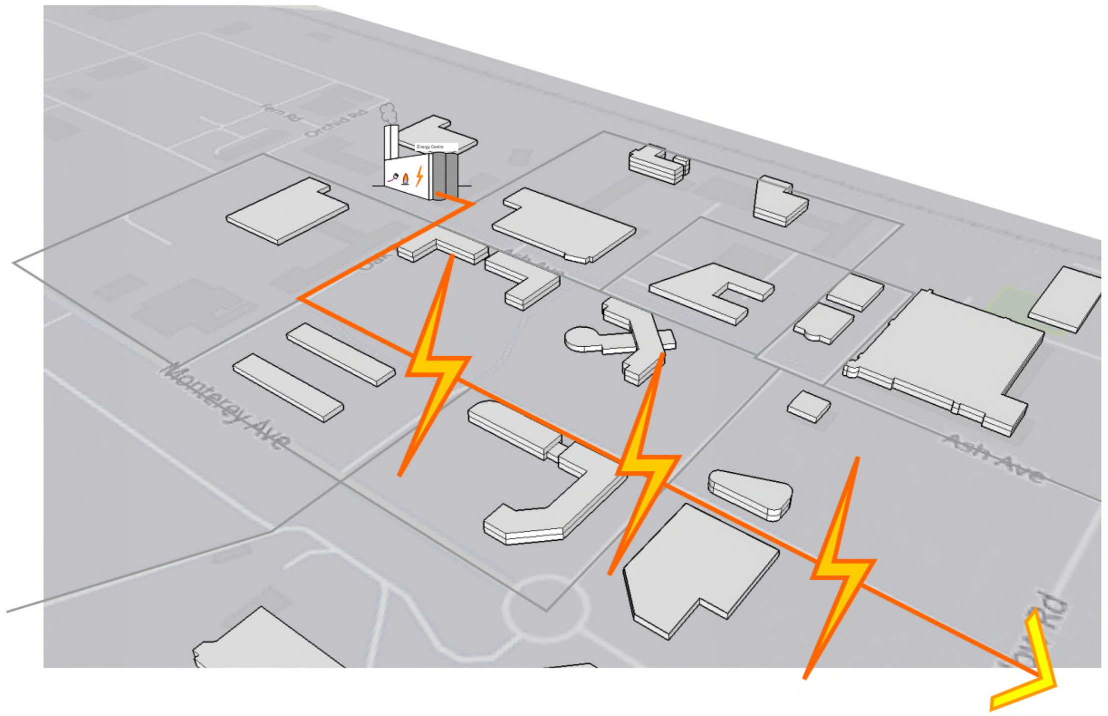


Figure 12. Independent Operator exporting electricity on site

8. SITE-WIDE ENERGY STRATEGIES

Introduction

The client brief calls for a robust energy strategy focussing on sustainable development principles. Hydrock recommend that this is achieved through a side-wide approach consisting of an energy centre on site distributing heating, cooling and power.

The building typologies all have different energy requirements and energy demand profiles. Building energy profiles have been modelled by Hydrock and an example arrangement of how the site could be powered over time has informed the following sections of this report.

8.2 Energy Centre

The energy centre on site needs to be built in a modular format to enable plant to be added in the future, as in the beginning, not all buildings will have been built and this is thought to happen over a time period of 25 years. This means that the energy centre will have to be established for the full-design energy generation capacity but will not be producing its full potential until all buildings on site are built and occupied. This issue can be overcome by generating energy for export to the national grid until local loads on the site are established.

8.3 Developing a Plot

When one of the innovation park plots is sold to a developer or end-user, the independent network operator would have to increase the peak output of the energy centre - increasing the capacity of the entire network to accommodate that new building. How this is achieved could be through reducing the amount of exported energy or changing the internal plant to cater for the new building connections. A site-wide network concept is shown in Figure 14. Site-wide District energy distribution.

If preferred, this would not apply to all plots based on the minimal energy demand from some building types such as storage or distribution. These building types will use relatively little energy and it may be more cost effective to install plant local to those buildings instead of increasing the size of the energy network to serve them. This also applies to plots which are a greater distance from the energy centre and may incur greater pumping costs for getting heating/cooling to that plot without it being economically beneficial to do so (Figure 15. Central site District energy distribution).

Atlas has been omitted from all district network calculations as it is understood that it is leased until the year 3015 and will have its own dedicated plant equipment. This will however have a maximum life of 25 years, so could be connected at a later date.

8.4 District Network

The district heating & cooling network should follow the roads of the site in order to make installation and identification simplest, away from building plots. Pipework should be buried in soft-ground adjacent to roads rather than incorporated under road networks to save significant capital costs (soft dig over hard dig).

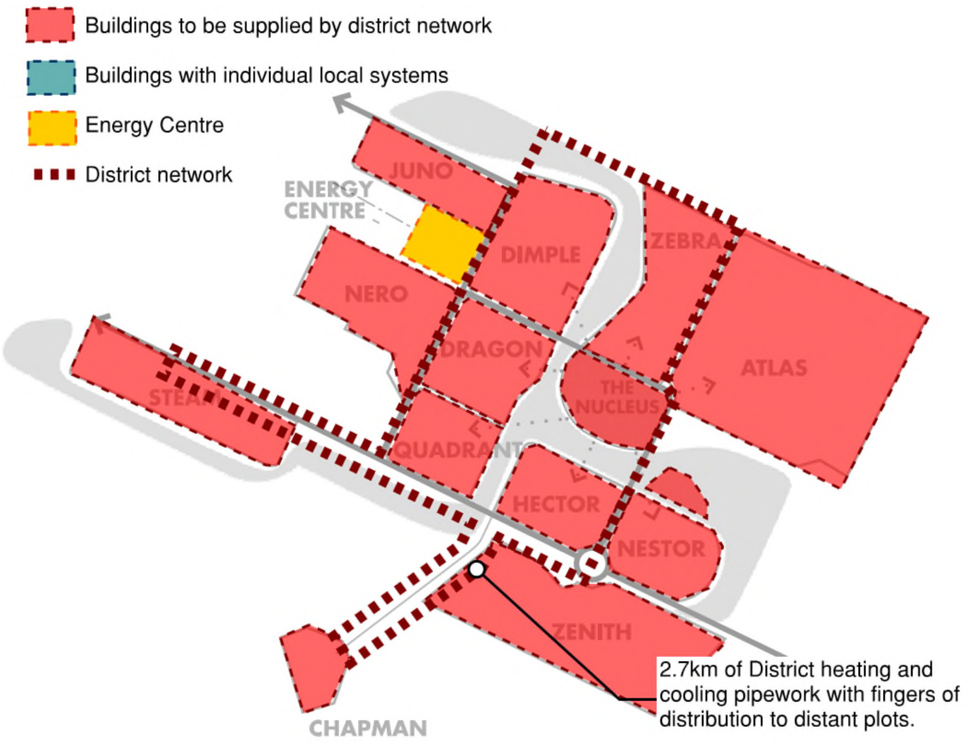


Figure 14. Site-wide District energy distribution

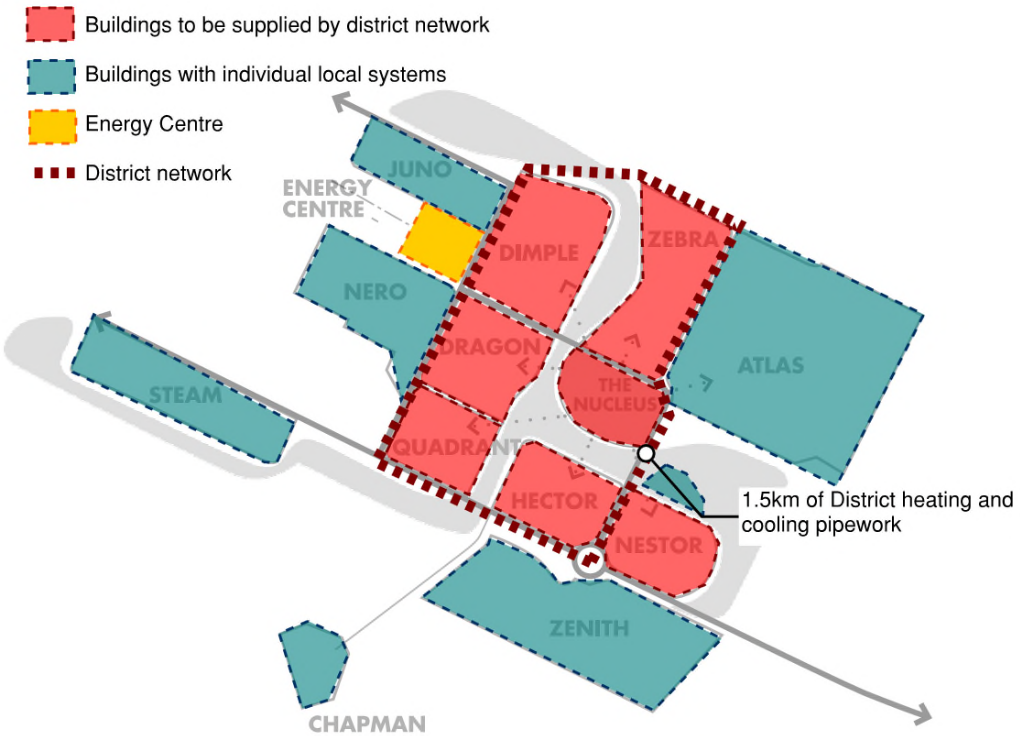


Figure 15. Central site District energy distribution

8.5 Energy Distribution

The distribution of the energy around the network is as important as the way the energy is produced. In order to reduce the risk of outages on the system, which could result in each building served by the energy network having to be shut down.

There are two main ways to distribute the heating and cooling service around a site; radial and loop.

A radial circuit (Figure 16) is where energy is distributed like a tree, where each building is a branch on the system. This composition means that any point off failure on the main branch will cause the system to fail or cut off all buildings downstream of the fault.

A loop circuit (Figure 17) is like a ring, with each building feeding of the ring. One point of failure on the main loop does not mean the system has to shut down, as the system can flow in either direction to serve all buildings on the loop.

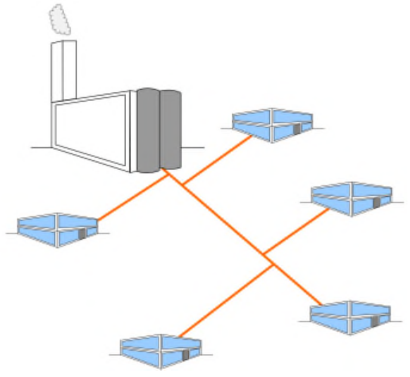


Figure 16. Radial Energy Circuit

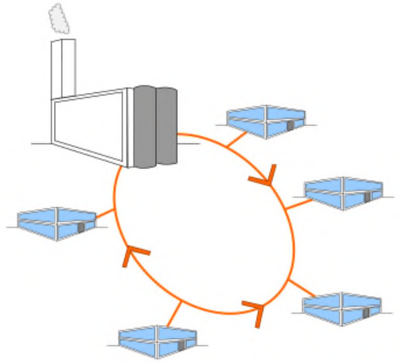


Figure 17. Loop Energy Circuit

8.6 Electrical Distribution

The electrical distribution for the site will be formed of a radial circuit, supplying each building individually. This is to avoid complications with ring circuits and will mean that each building can be made live when required.

8.7 Phased Approach

As it is understood that the site will be developed over 25 years, an exercise has been carried out which stipulates the energy demands of the site over that period, in order to forecast the no. of steps required for the modular energy centre.

The amount of development stipulated after the first five years is shown in Figure 19. Five years - Stipulated site development levels and district energy map.

The predicted energy demand after the first 5 years is shown in Table 5. Five years - Peak site-wide demands.

Table 5. Five years - Peak site-wide demands

	Heating/Hot Water	Cooling	Electrical
Site Peak loads	3.2 MW	3.5 MW	3.3 MW

Table 6. Completed Site Development - Peak site-wide demands

	Heating/Hot Water	Cooling	Electrical
Site Peak Loads	7.9 MW	7.8 MW	7.7 MW

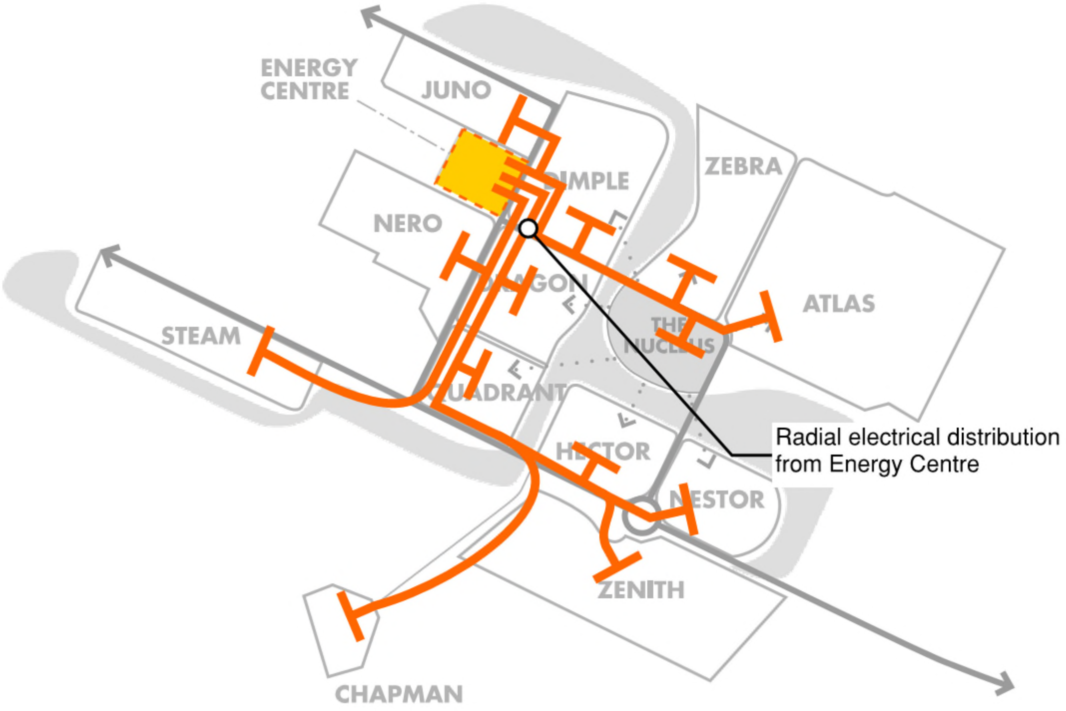


Figure 20. Electrical distribution - radial circuit

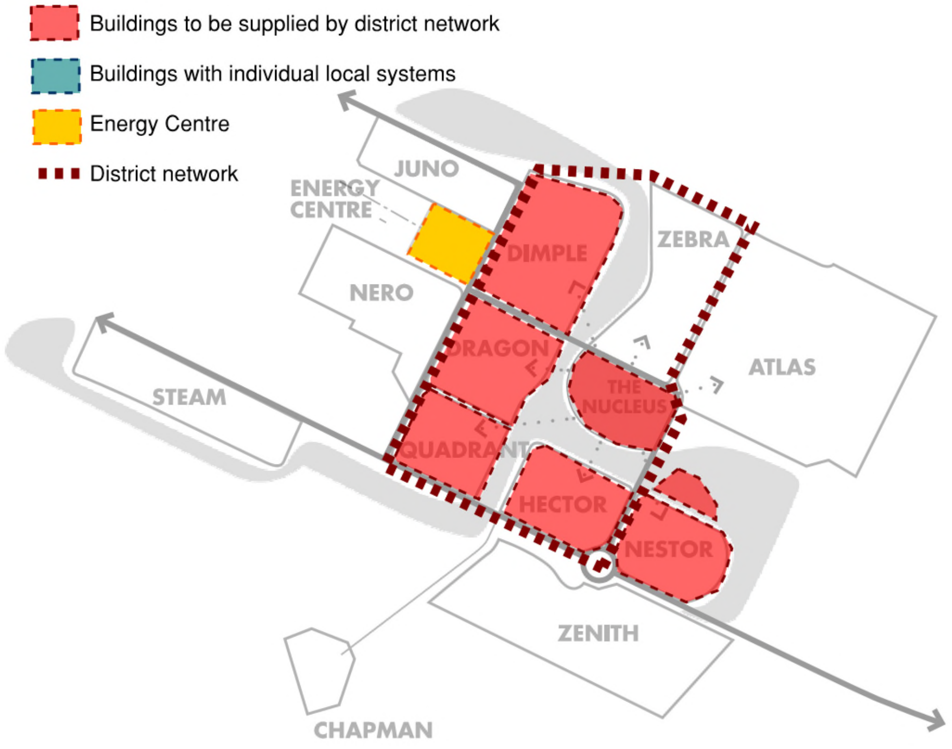


Figure 21. Five years - Stipulated site development levels and district energy map

9. PRECEDENTS - ENERGY CENTRES

9.1 Introduction

To inform the design and role of the energy centre, a case study has been analysed from around the UK.

9.2 Olympic Park, London

The Olympic Park in Stratford, London is served by two energy centres. This system provided low carbon district heating and cooling to a majority of buildings on the site.

The systems in place consist of; combined cooling, heat and power (CCHP) systems and biomass boilers.

The utility company operating the energy centres had two years to build both buildings and install the sitewide network of 16km heating and cooling pipework.

9.2.1 Energy Capacity

Each energy centre at the Olympic Park has an initial capacity of 46.5 MW of heating and 16 MW of cooling. The total capacity across the site (both energy centres combined) is 194.9 MW of heating and 64 MW of cooling.

The energy centre has been designed to be able to run using different types of fuel to enable the network to make use of advances in energy technology, helping to reduce its carbon emissions further.

The energy centre is sized for the maximum capacity. Inside each building, the modular concept of each item of plant is facilitated by all of the connections, distribution and flues are already installed, awaiting the future plant. This means that when new plant is required, there will be minimal disturbance to the centre and it will be a case of plug-and-play, maintaining operation of the energy centre throughout install.

9.2.2 Systems Installed

In order to understand the scale of the energy centre the following lists the installed systems for each service.

Heating/Hot water;

- 20 MW Dual-fuel gas/oil fired boilers
- 3.3 MW Gas-fired Combined Heat & Power (CHP) engine

Cooling;

- 4 MW Absorption chiller
- 7 MW Ammonia-based chillers

- Power;
  - 6.68 MW of electrical generation from CHP units.

In order to supply efficiently under light load conditions, both the cooling and heating systems have large buffer vessels in order to manage peaks and troughs in demand.

The heating system includes a 27.5 MWh capacity buffer vessel which will allow the CHP to run interrupted and charge this vessel around the clock. The same can be said for the cooling system, which has a giant 750 cubic metre vessel to increase the chilled water system capacity by 4.7 MWh.

There is a third tank which holds the make-up water for the hot and chilled water systems. These tanks can be seen in Figure 11. Olympic Park Energy Centre.

The absorption chiller is used in the summer, when the demand for heating and hot water is less so the heat recovered from the CHP units is used to drive the absorption process.

Heat rejection for the chillers is through the five roof-mounted cooling towers.

9.2.3 Form & Flues

The buildings have steel frame structures, with a wrap of pre-rusted cladding panels. This system allows cladding panels to be easily removed in the future so that modular plant can be added and positioned when new buildings come online and more capacity required.

The energy centres both feature a 45m screened flue in order to safely disperse the boiler waste gases and other pollutants away from the site.

Five cooling towers and two hot water storage tanks each weighing around 60 tons.

9.2.4 Site Distribution

In order to take the heating and cooling from the 16km network of pipework, buildings are connected to it by the use of prefabricated 'substations'. These units contain the heat exchangers for each system, with all the pipework and controls required. Each building will then connect to this via the pipework connections. This will be metered for each service so the utility can bill effectively.

The distribution pipework achieves a temperature drop of around 1°C per kilometre. This is achieved by using pre-insulated pipework and being buried 1m within the ground - reducing heat losses.

Figure 22. Olympic Park Energy Centre

The system operates on a variable volume, constant temperature philosophy.

9.2.5 Challenges

Whilst the energy demands of the Park's venues during the Olympic Games were known, the future energy demands of the site's legacy building were less well defined.

Redundancy has been designed into the system by total capacity, allowing the energy centre to still supply the majority of the sites demand whilst plant is down for maintenance.

9.3 Other Examples

Other Energy Centres of note in the UK are as follows;

- Gateshead Energy Centre
- Kings Cross Energy Centre

10. ENERGY CENTRE

Introduction

This section details the driving concept for the energy centre and initial sizing of what would be included in the building and its physical size and energy capacity.

10.2 Physical Form

The energy centre could either be a series of modular units or one large building which creates an envelope for the plant modules.

The advantage of stand-alone modular units is that the cost of building a housing is omitted. However, these are understood to be limited to the services they can provide due to limitations with flues and NOx producing equipment.

There would still be one central point of connection to the site distribution network, which would most likely take on an overhead type structural form to distribute cabling and pipework. The distribution will also be subject to the weather conditions if it is not housed in a purpose-built structure.

The advantage of having a building for all the equipment is that the monitoring, maintenance equipment, and finishes can all be to internal specification as opposed to being IP rated.

10.3 Flue Height

The flue height for the building based on a final installed heating capacity of 8MW is 24 metres. This is to allow for the dispersion of the boiler and CHP flue gases in a safe manner.

This is an example flue height and could be reduced if the amount of thermal storage is increased.

10.4 Phasing

Without a known phasing plan due to the early stages of design and uncertainty over start date, build time and potential tenants. The phasing plan needs to be robust enough to deal with these variables.

The approach of using an Independent District Network Operator (IDNO) to run an energy generation scheme on the site which exports energy to the national grid allows the LDO to happen independently of the IDNO operation. The IDNO can generate energy and income from exporting electricity to the grid, whilst buildings are built at DIP. When buildings become operational, the IDNO can charge the district network and provide energy to those buildings. If the initial load is too small to operate the network efficiently, temporary plant can be connected locally to the building at the point where it would connect to the network (via heat exchangers and incomers).

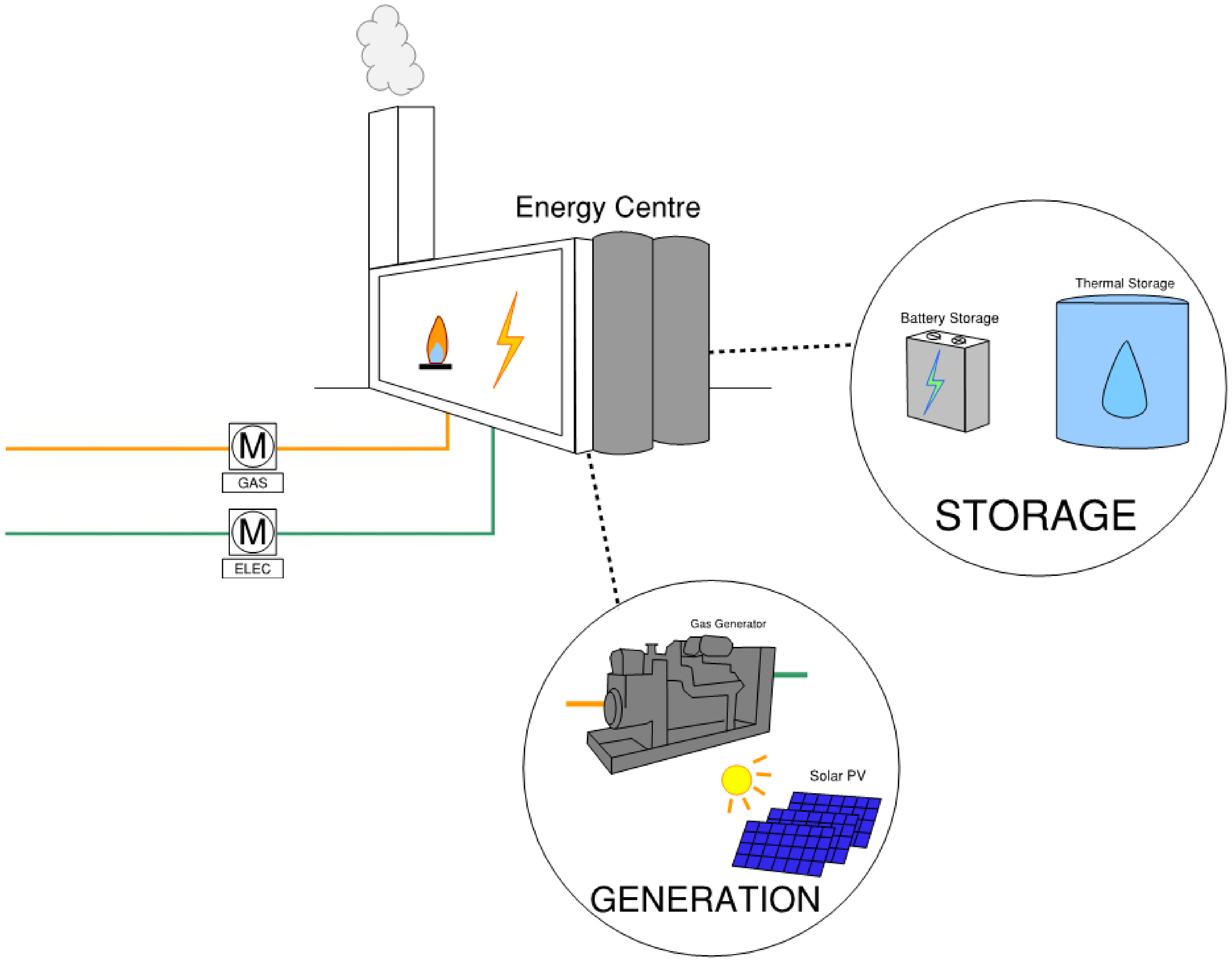


Figure 23. Energy Centre Storage and Green Generation examples

Once enough buildings are built, the IDNO can reduce the exporting operation to cater for the load of the buildings on site, or upgrade their equipment for the new load.

11. DESIGN PHILOSOPHY OF BUILDINGS ON SITE

Providing a roadmap for innovation

11.1 Sustainable Design

Buildings will be constructed in line with a design guide which will set what clients, architects and engineers should design to.

This design guide will ensure buildings on site are designed to the latest best practice guidance and have good sustainable credentials.

The design methodology will result in lower energy demands at the building level, thus reducing the size of the central or de-central networks required on site, reducing costs.

All buildings within masterplan will be required to reduce the notional CO_2 emissions by 10%. This is subject to change through the 25-year building period.

Similarly, design guides and technical memoranda may be developed and therefore the buildings will have to abide to the current regulations.

Following the sustainable design approach buildings should incorporate the following;

- Be predominately naturally ventilated to reduce mechanical ventilation and cooling loads
- Utilise external solar shading
- Have a means of providing passive cooling
- Have a narrow plan to allow cross-ventilation and high levels of daylight utilisation.
- Green roofs to reduce the urban heat island effect and increase biodiversity
- Water conservation - through grey and/or rainwater harvesting
- Have a fabric first approach - highly insulated buildings and have a high airtightness to reduce losses.
- Where mechanical systems and processes are required, they should be as efficient as possible.
- Process loads should be offset by renewable generation technology local to the building.
- Any waste energy produced from processes should look to be put back into the distribution network on site (e.g. heat rejection into the district heating pipework).

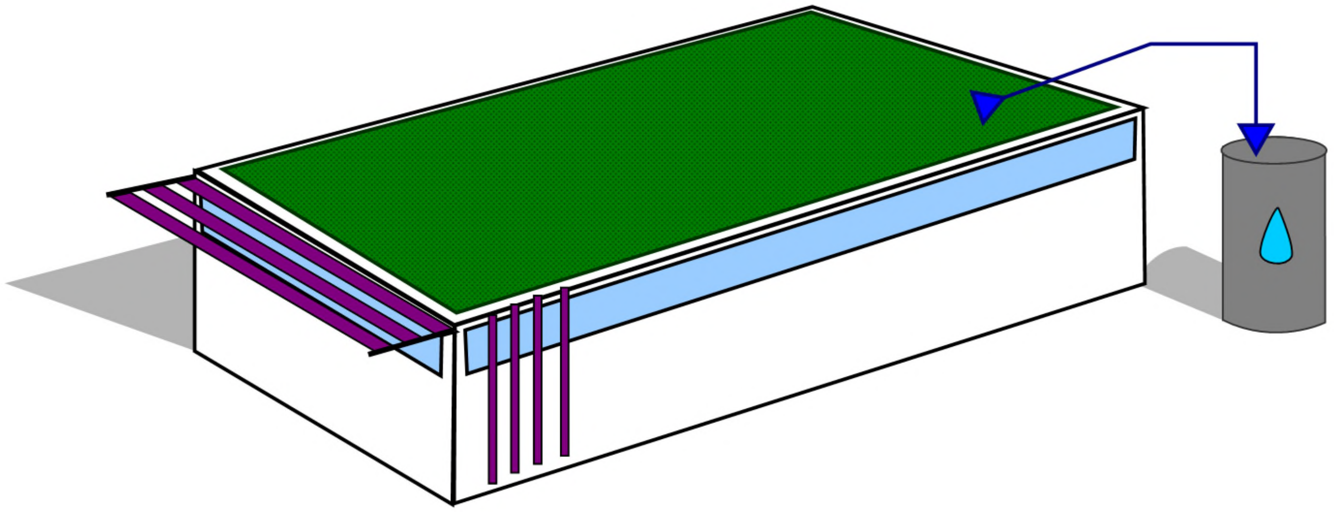


Figure 24. Sustainable Approach to design - Green roof, rainwater harvesting (grey/blue), external solar shading (purple)

12. ENERGY AND CARBON EMISSIONS

12.1 Introduction

This section of the report establishes the baseline energy consumption and associated CO2 emissions for the scheme. The baseline carbon dioxide emissions refer to a Building Regulations 2013 Part L compliant development.

Under Part L, residential areas of the development are to be assessed under the Simplified Building Energy Model (SBEM) methodology.

12.2 Simplified Building Energy Model (SBEM)

All building will be assessed using the SBEM calculation methodology. Each space will be assessed individually using the National Calculation Methodology (NCM) conditions for each planning use class using IES Virtual Environment software.

12.3 Internal gains

SBEM calculations use the weather file, solar gains are calculated based on the orientation of the building and the properties of the glazing.

All occupancy, lighting and equipment gains will be specified within the NCM internal conditions for each use class.

12.4 Building fabric

All fabric attributes for the baseline case will be as per the Part L2A notional building respectively. The tables below show the baseline U-values for a Part L2A baseline development, respectively.

The air permeability (air leakage index) is 5m^3/hr/m^2 at 50 Pa depending on the building typology.

Building Element	Part L2A 2013 Notional Building U-value
Roof	0.18 W/m^{2}k
Wall	0.26 W/m^{2}k
Floor	0.22 W/m^{2}k
Glazing	1.60 W/m^{2}k

Table 7: Part L2A Notional Building U-values

12.5 Energy Demand Assessment

All will be required to summarise the initial options appraisal that has been carried out for potential centralised or de-centralised building services equipment that could be used to provide heating, hot water and electricity to the new development. This will focus on demonstrating how these can meet local, regional and national policy energy targets.

The following energy demands have been based on the illustrative masterplan.

12.5.1 Space Heating & Hot water Demand

The total space heating demand for the site is estimated to be 7.9 MW.

12.5.2 Space Cooling Demand

The total space cooling demand for the site, including the server cooling, is estimated to be 7.85 MW.

12.5.3 Electricity Demand

The total electricity demand for the site, including ventilation, lighting and server power, is estimated to be 7.7MW.

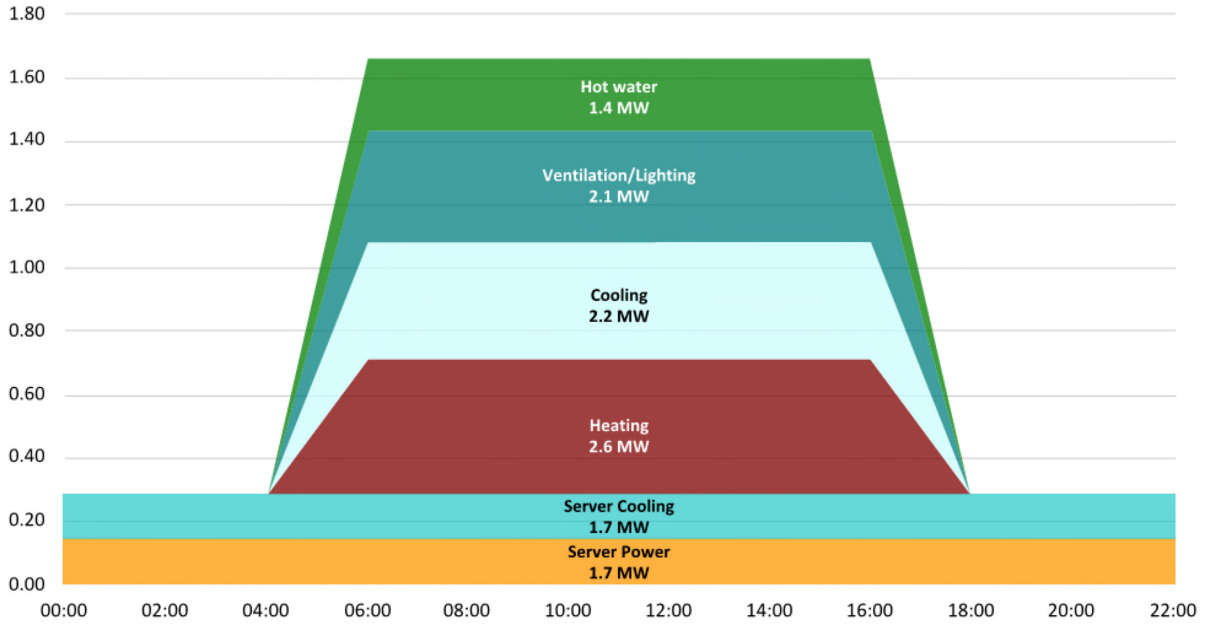


Figure 25: Estimated daily energy demand

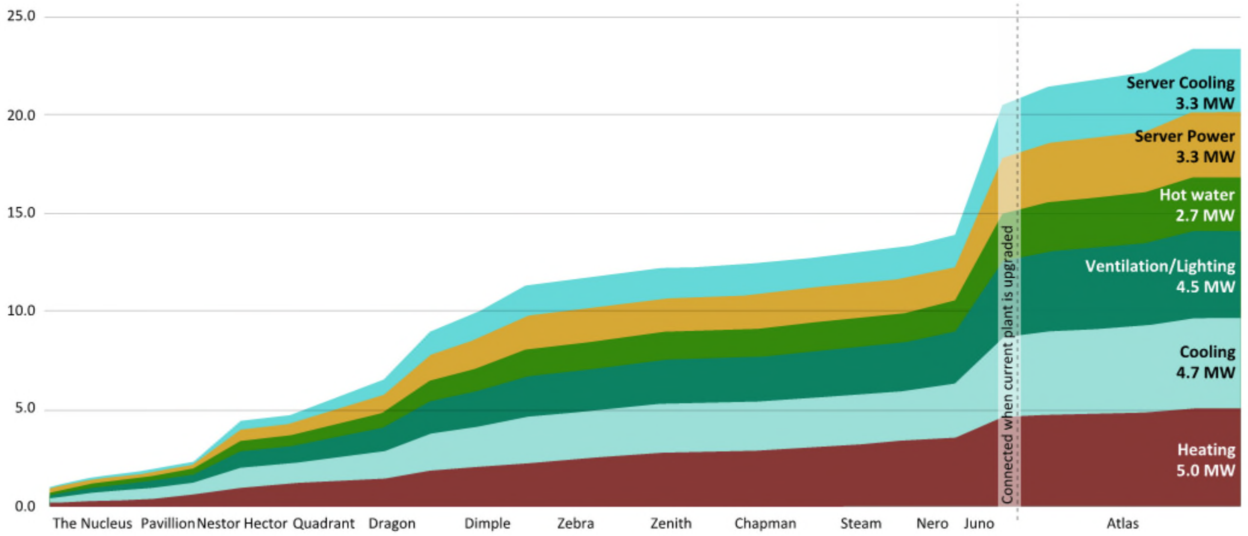


Figure 26: Estimated cumulative energy demand

13. RESIDUAL CARBON EMISSIONS AND RENEWABLE ENERGY

13.1 Introduction

Following the first two stages of the energy hierarchy (Lean and Clean), the residual carbon reduction will be met through renewable technologies.

13.1.1 CO_2 Reduction Target

All buildings within masterplan will be required to reduce the notional CO2 emissions by 10%. This is subject to change through the 20-year building period.

13.2 Renewable Energy Options

During the design process, a number of site wide heat generating technologies were given initial consideration;

- Air source heat pumps (ASHP);
- Open-loop (aquifer) ground source heat pump (GSHP);
- Biomass;
- Fuel cells;
- Solar Thermal Hot Water;
- Energy from Waste;
- Photovoltaics; and
- Wind turbines.

13.2.1 Air source heat pump

ASHPs work by using refrigerant at low temperatures to extract the heat from external air. The refrigerant is then compressed to increase its temperature, the high temperature is then passed onto the water serving heating and hot water circuits in the dwelling. ASHPs use a small amount of electricity to run the compressor but don't need a heat source installed as the heat is taken from the surrounding air. They can provide heat with external air temperatures as low as -15°C.

13.2.2 Ground Source Heat Pump

GSHP's use ground collector coils, through which a heat exchange fluid passes, coupled through a heat exchanger to a vapour compression machine. The system can provide heating or cooling, by absorbing heat from, or rejecting heat to, the ground.

A heat pump is defined as "a device which takes up heat at a certain temperature and releases it at a higher temperature" (BS EN 255-1, 1997). A few metres below the earth's surface, the ground is maintained at a constant temperature all year round between 10°C and 12°C. Ground source heat pumps (GSHP) can extract this energy to provide a carbon-efficient form of space heating and/or cooling for the buildings. A GSHP cannot be considered completely 'renewable' since it uses mains electricity to drive the compressor.

GSHP should be explored for DIP.

13.2.3 Biomass

A biomass system uses woodchips, pellets, or other natural products to burn in a large boiler system. This was widely adopted when it was brought to the commercial market, but over subscription of these systems has meant that the biomass fuel has to be sourced outside of the local or regional area, making it an expensive and unsustainable system.

13.2.4 Fuel Cells

Fuel cells convert chemical energy from a fuel into electrical energy. Hydrogen is typically used for energy centre applications and can be stored on site or generated on site to feed into the fuel cell. Fuel cells should be explored for DIP.

13.2.5 Solar Thermal Hot Water

Solar water heating systems use the energy from the sun to heat water. The systems use heat collectors, generally mounted on the roof in which a fluid is heated by the sun. This fluid is used to heat up water that is stored in either separate hot water storage vessel or a twin coil hot water storage inside the building. The anticipated life span of a SHW system is 30 years.

13.2.6 Energy from Waste

An energy from waste system consists of an on-site incinerator or anaerobic combustion chamber in order to extract energy from the refuse. This reduces the mass of waste product that would go to landfill and can contribute to meeting the onsite energy demand. The amount of waste produced by DIP is thought to be significant, and a small incinerator on site should be explored.

13.2.7 Solar Photovoltaics

PV panels work by converting the energy from sunlight into usable electricity via photovoltaic cells placed on the roof of buildings. These can be integrated into the roof itself or tradition "bolt-on" panels.

These can vary in efficiency with the most efficient panel having an efficiency of 21%, while most perform at around 15-18%.

PV panels have a low visual impact, have limited effects on the environment, and can be combined with battery storage if desired.

Solar PV should be explored for DIP.

13.2.8 Wind Turbines

Wind turbines work by converting the kinetic energy in wind into mechanical energy that is then converted to electricity. They are available in a range of sizes and designs and can either be free standing, mounted on a building or integrated into a building structure. Free-standing turbines should be explored for DIP.

Figure 27. Wind turbine

ENERGY SUMMARY

14.1 Conclusions

Dorset Innovation Park intends to be a leading example in sustainability and an economic hub for the local Dorset community.

The energy strategy for Dorset Innovation Park could adopt a number of different strategies, the basic principles have been outlined as follows;

Centralised plant from the energy centre for;

» Heating;
» Cooling;
» Hot water; and/or
» Power.

How this is achieved depends on a number of factors; the level of initial capital investment, the operational commercial benefit of implementing highly sustainable systems and the technical viability of this approach. In terms of technical viability, the following key variables have been highlighted:

- Building usage and occupancy characteristics (demand diversity);
- Construction phasing and occupation;
- Building density; and
- Supply resilience.

The energy strategy must be robust and modular, as the site will be built over many years, whilst also being straightforward and flexible enough to provide a long-term approach to energy management and reducing operating costs.

In order to understand what level of development could be achieved, a number of precedent studies of other innovation parks has been undertaken.

The phasing of the site will be fundamental to the energy strategy adopted and will need to be robust and cost effective over the development of the site. The energy centre should work as efficiently for the initial number of buildings, to when the site is fully occupied in the future.

A strategy of selling the energy centre plot to an independent district network (IDNO)operator has been explored. This option allows the IDNO to generate and export energy to the local grid as they wish, as well as supplying energy to the buildings on site.

This approach reduces the risk on having to build the buildings on site within a certain time frame and allows the economies of scale to work in the IDNOs favour - making the site an attractive investment.

Energy distribution methods have been described and advantages and disadvantages stated for each approach. The extent of the energy network has also been researched to find the optimum method. This report recommends that the energy network should serve all buildings on site, to encourage site-wide adoption - and that the buildings should be fed from a loop circuit as opposed to a radial circuit for resilience of the system.

A precedent study has been carried out on Energy Centres to determine what is provided within an energy centre and the types of generation plant typically found for different building types and site-wide planning use class mixes.

The energy centre concept has then been applied to the DIP site and how in this context it would best be approached. Recommended systems that would be installed within the energy centre have been listed. The diversity used for the energy centre is key and helps to reduce the size of incoming connection to the site from the utility providers and allows for more constant energy generation equipment to be used - which is inherently more efficient.

In conclusion, Hydrock recommend that Dorset Innovation Park should adopt the strategies within this report in order to attract innovative and sustainable companies to the park and meet the Purbeck local plan requirements.

The inclusion of lean, clean and green design will add value to the development and should result in cheaper energy for the site and free-running buildings. This will increase the long-term benefits to the local area - and creating a long-lasting legacy for the council, and an example to other innovation parks.

14.2 References

- Purbeck Local Plan
- CIBSE Guide F: Energy Efficiency in Buildings (2012)
- CIBSE Guide L: Sustainability (2007)
- CIBSE Knowledge Series KS01: Reclaimed Water
- CIBSE Knowledge Series KS11: Green Roofs
- CIBSE Heat Networks: Code of Practice for the UK
- CIBSE TM36: Climate change and the indoor environment: impacts and adaptation (2005)
- CIBSE TM37: Design for improved solar control (2007)
- CIBSE TM38: Renewable energy sources for buildings (2006)
- CIBSE TM55: Design for future climate: case studies (2014)
- CIBSE TM56: Resource efficiency of building services (2014)