BISEPS Re-Energise: Strategic Energy Opportunities

West Sussex County Council with Manor Royal Business Improvement District

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Contents

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1 Executive Summary

Your Energy Sussex, an energy partnership led by West Sussex County Council (WSCC) won EU funding as part of the Business clusters Integrated Sustainable Energy PackageS (BISEPS) project. It is funded by a grant from the EU Interreg 2 Seas Programme to WSCC. It forms part of the Manor Royal BID's Re-Energise Manor Royal initiative and is also supported by Crawley Borough Council who are leading a complementary study of district heating opportunities at Manor Royal. The BISEPS project has 8 partners in Belgium, France, the Netherlands and WSCC in the UK and aims to:

- Develop a tool for high level assessment of opportunities for renewable energy in clusters of businesses, this would be used as a quick initial step to identify opportunities for more detailed feasibility work.
- Testing the tool in 'Living Labs', one of which is Manor Royal, by comparing the result of the tool with more traditional studies such as this one.
- Delivering renewable energy projects with businesses in the Living Labs to demonstrate the financial and environment benefits of renewables.

A key innovation of BISEPS is to consider the energy needs and resources of a group of businesses to drive synergies and cost savings, rather than looking at each in isolation. The project will run until March 2020.

This report was tasked with prioritising and identifying a small number of opportunities for low carbon energy generation technologies. These opportunities would be practical to progress in order to stimulate Manor Royal's transition towards a low carbon energy infrastructure and economy. The work focussed on electricity generation in view of the parallel study of district heating opportunities.

A 3-phase delivery programme was designed for the project to achieve prioritising and identifying a small number of opportunities. Phase 1 Opportunity Identification, Phase 2 Opportunity Appraisal and Phase 3 Opportunity Recommendation. A total of 4 opportunities were identified as economically attractive for implementing sustainable energy generating energy systems.

The next step to progress with these opportunities is to refine assumptions made by this study. Conducting feasibility studies on each of the opportunities identified would refine these assumptions. However, prior to commencing feasibility studies, this report recommends engaging with site stakeholders to coordinate their role in the proposed opportunities.

2 Project Overview

2.1 Background

WSCC is the UK member of a partnership of 8 organisations awarded funding from the EU Interreg 2 Seas programme to explore the potential for increased generation and use of renewable energy on business parks, including Manor Royal. The Manor Royal Business Improvement District (BID) and Crawley Borough Council are Key stakeholders and delivery partners in the UK part of the project.

The Business clusters Integrated Sustainable Energy PackageS (BISEPS) includes WSCC in the UK and others from Belgium, France and the Netherlands, Your Energy Sussex will be using Manor Royal as the UK 'Living Lab' to demonstrate a model for implementing low-carbon energy generation in a business park.

Sustain Ltd (we) were appointed as experts in decentralised energy generation and stakeholder engagement by Your Energy Sussex. A complementary project running concurrently to this project is focused on identifying and evaluating the potential for heat networks across the Manor Royal estate. This district heating project has been contracted to Ramboll. Together both projects are referred to as the Re-Energise Manor Royal project.

2.2 Objectives

WSCC, Crawley Borough Council and the BID team are focused on transitioning the Manor Royal estate to a local low carbon energy system.

This project has been designed to progress Manor Royal towards a low carbon energy system whilst making best use of resources available. The types of businesses and the macro economic landscape directly affects the technology, size and configuration of low carbon energy systems. It is therefore important to use resources efficiently when starting projects. It was agreed that the main objective of this project was to **identify and prioritise a small number of opportunities** that would be practical to progress. Each opportunity would have cost and return on investment estimates supported with structured actions to implementation.

By achieving a number of interim objectives this project will satisfy its main objective:

- ✓ Consider the feasibility of installing a range of energy generation technologies
- ✓ Engage site stakeholders with the project
- ✓ Use a systematic and transparent methodology for evaluating opportunities
- ✓ Provide a documented roadmap for progressing recommendations

2.3 Technologies

Below is a list of 15 low carbon energy generation technologies that are included within the scope of this project, and the associated energy they produce:

Technology	Heat	Power
Solar Photovoltaics (Solar PV)		✓
Solar Car Ports		✓
Solar Thermal	✓	
Wind		✓
Anaerobic Digestion	✓	✓
Ground-Source Heat Pump (GSHP)	✓	
Air-Source Heat Pump (ASHP)	✓	
Water-Source Heat Pump (WSHP)	✓	
Biomass	✓	
Combined Heat and Power (CHP)	✓	✓
Waste Heat Capture	✓	
Electricity Storage Battery		✓
Electricity Storage (vehicles)		✓
Energy from Waste (EfW)	✓	✓
Hydrogen		✓

Due to the presence of the complimentary district heating project the scope for heat generation or re-using technologies (in the case of Waste Heat Capture) focuses solely on the individual or immediate neighbouring buildings.

2.4 Acknowledgements

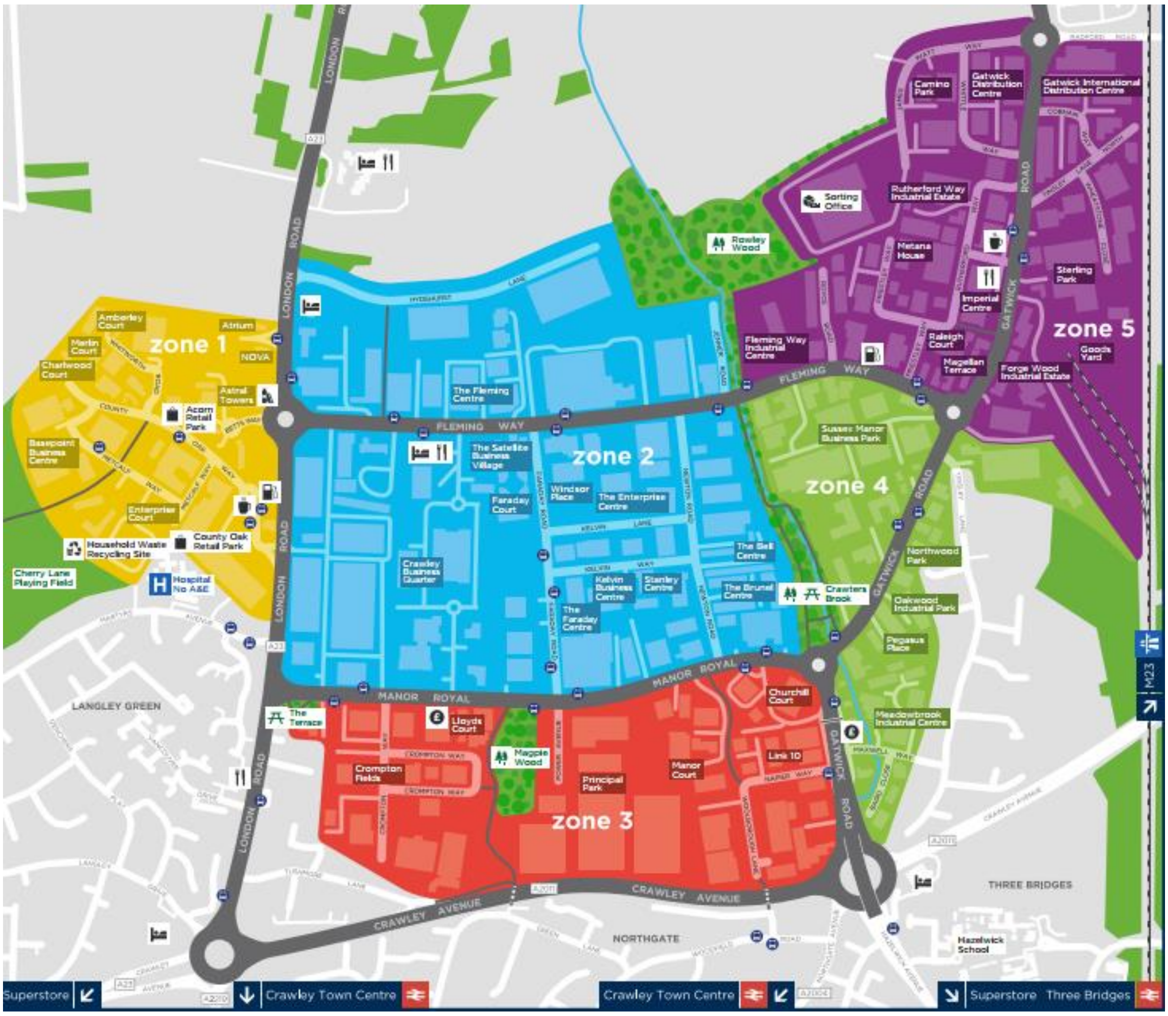
We would like to thank all of the stakeholders involved in the project, particularly the project team: Andrew Tolfts (West Sussex County Council), Ingrid Bennett (West Sussex County Council), Brett Hagen (Crawley Borough Council), Steve Sawyer (Manor Royal BID), and Eddie Finch (Auditel). Their support was invaluable to the project.

3 Manor Royal Introduction

3.1 Site Description

The Manor Royal estate is an important hub of economic activity in the south east which is important to the economic success of Crawley. It provides 25% of Crawley's total employment and 45% of all employment in the Gatwick Diamond. The Manor Royal BID has been working on Place Management to maintain and progress the estate as a successful business district. There are approximately 700 business premises (500 businesses) on-site ranging from Small-Medium Enterprises (SME) to Multi-National Corporations (MNC).

The estate is split into 5 zones, the zones are split geographically with a range of business activity within each zone.



(Source: Manor Royal website file:///X:/Clients/West%20Sussex%20County%20Council/101880-ESE_DE_%20WSCC_Manor_Royal_options/Incoming/Manor%20Royal%20Zonal%20Map.pdf)

4 Data Landscape

A variety of data sources are used to assess the potential for implementing low carbon energy systems into a particular environment. Before commencing the project the following data points were identified as necessary to support the methodology. This section of the report lists the subject data utilised in the project. For each piece of data we record its source and at which stage of the methodology it was used.

The table below summarises the primary and secondary data points used and during which phase(s) they are utilised.

Data	Source(s)	Phase 1	Phase 2	Phase 3
Geographic Information System	Software	✓		✓
Energy Demand	Auditel, CSE Heat Map, CIBSE Guide F	✓		✓
Energy Profile	Auditel, Ofgem		✓	✓
Power Network Infrastructure	UKPN		✓	✓
Planning Regulations	Crawley Borough Council		✓	✓
Business Category	Manor Royal	✓	✓	✓

4.1 Geographic Information System (GIS)

Used in: **Phase 1 – Feasibility Gateway**

The locations of businesses were provided by Manor Royal. We plotted these locations using GIS software to obtain spatial data relevant to the implementation of the proposed technologies. The spatial information regarding the physical buildings and the surrounding environment formed the data source for applying the criteria used for the Feasibility Gateway.

4.2 Energy Demand

Used in: **Phase 1 – Energy Demand Score**

A business's energy demand is important basic data to inform the assessment of opportunities. Multiple businesses can occupy a single location, and therefore multiple energy demands can contribute towards a building's energy demand.

The aim was to source both the electricity and heat demands directly from businesses. Prior to this project Auditel Ltd were commissioned to engage with businesses and obtain their energy data. This would be supplied to us for the purpose of the project. Due to access restrictions a limited amount of data was obtained.

As a contingency secondary data was sourced for the purpose of the project. The business categories for the remaining addresses were mapped to the closest business category listed in Chartered Institute for Building Services Engineers' (CIBSE) Guide F publication (Energy Efficiency in Buildings)[1]. Each category has an energy benchmark per square metre of internal floor area. Once produced these figures were then also summed as per their assignment to a single building.

By using secondary data the project's outputs cannot be confirmed without further investigation. The outputs we have produced are based on logic and experience, however there is an unavoidable potential for inaccuracy when using secondary data. For this project the use of secondary data has the following consequences:

1. Requirement to commit additional resources to collect primary data
2. Misrepresented potential for economic returns

For each technology configuration (see section 5.2.1) use of secondary data varies in its severity of impact. Please see matrix below for our views on the impact secondary data has on each technology configuration.

Technology Configuration	Cost	Energy Model	Appraisal
Solar PV			
CHP			
Solar Car Ports			
Solar PV + Battery			

By using secondary data we have assumed a series of typical demand profiles which are consistent throughout the day. For commentary of how variations to the secondary data would affects the results please see section 6.2.2. Energy Profile

Used in: **Phase 2 – Techno-Economic Model**

An energy profile for the purpose of this project is recorded energy consumption at regular intervals over a period of time, i.e. half-hourly energy consumption data. Collectively the energy consumption figures for every half hour over the course of the year represents the nominated locations energy profile.

For a number of businesses half-hourly electricity data was provided by Auditel. Where half-hourly data was unavailable for a business, a profile was generated using our hourly generator tool. The tool uses data published by Ofgem. Ofgem publish by sector typical electricity profiles for businesses. We divide the total energy consumption and apply a proportion to each half-hourly interval which collectively replicates the shape of the

[1] https://www.cibse.org/Knowledge/knowledge-items/detail?id=a0q20000008I7oTAAS

profile. Please see section 5.2.2.2 for an example of an energy profile produced using the hourly profile generator.

4.3 Power Network Infrastructure

Used in: **Phase 2 – Appraisal**

As we would be considering introducing electrical generation capacity into the existing grid, it is necessary to consider the condition and development status of the immediate and intermediate power network. The District Network Operator, UK Power Network (UKPN), provides the Manor Royal estate with electricity. They provide an informative online map of their infrastructure and its capacity for the region. By reviewing the 11kV, 32kV and 132kV substations we are able to identify potential issues for connecting additional generation technologies to particular locations.

4.4 Planning Regulations

Used in: **Phase 2 – Appraisal**

We made contact with Ian Warren, a Planning Officer at Crawley Borough Council. We were supplied with the following documents:

- Crawley Local Plan 2030
- Crawley Development Map
- Manor Royal Design Guide – Supplementary Planning Document
- Manor Royal Public Realm Strategy – Supplementary Planning Document
- Planning and Climate Change – Supplementary Planning Document
- Town and Country Planning

These documents form the basis of the Planning Regulations appraisal in Phase 2.

4.5 Business Category

Used in: **Phase 1 – Energy Demand Score and Business Suitability Score**

Phase 2 – Energy Profiles

The Business Categories supplied by the Manor Royal BID are used throughout the project. A business category refers to the principle activity occurring within the location that the business is occupying. The categories are standardised to demonstrate similarities between businesses. These categories were mapped to the CIBSE Guide F standard business categories to produce the annual energy demand figures. They were used to produce the Business Suitability score which assessed how particularly technologies typical perform in particular business category settings. They were also used to create typical Energy Profiles.

5 Methodology

A 3-phase delivery programme was designed for the project to achieve prioritising and identifying a small number of opportunities.

Phase 1 – Opportunity Identification

Use secondary data to review, compare, and rank the feasibility and initial performance expectations of all technologies for all businesses within the entire Manor Royal estate.

Use the scoring to identify a small list of opportunity clusters.

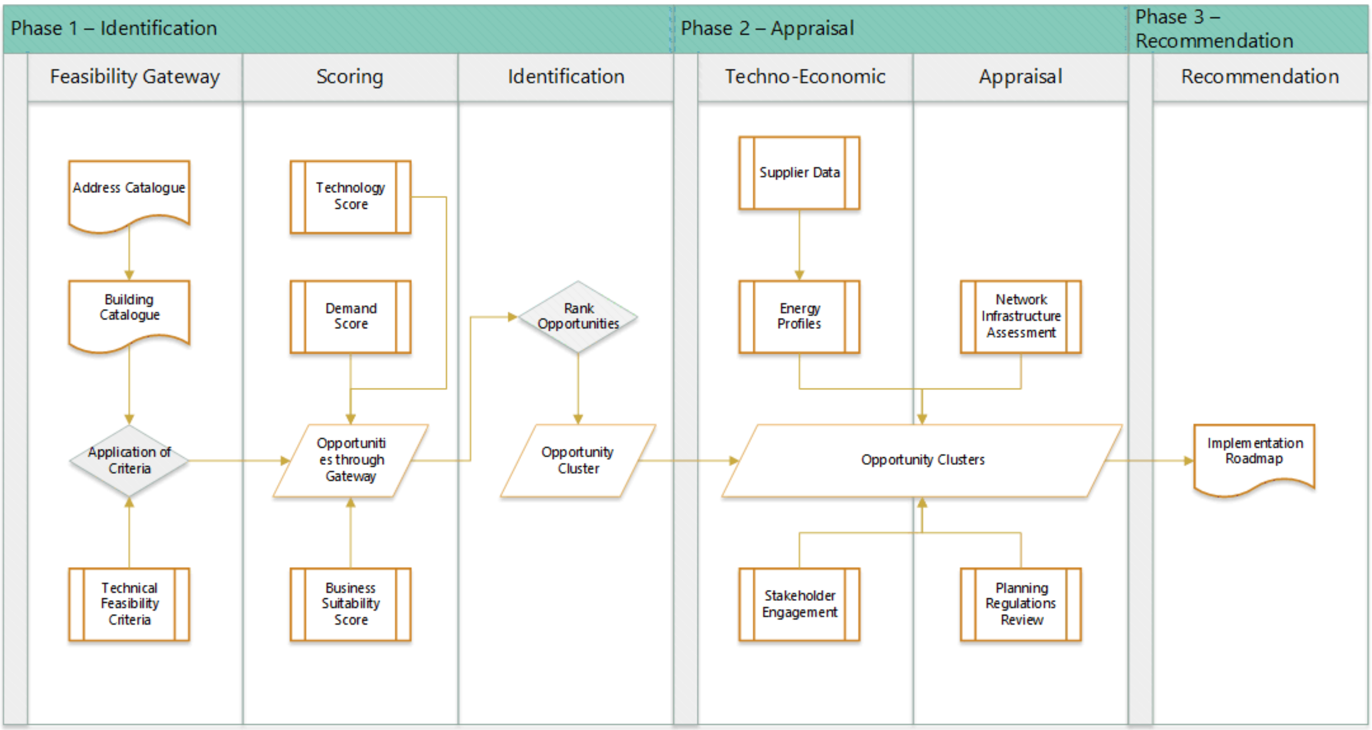
Phase 2 – Opportunity Appraisal

Conduct an appraisal of the opportunities at the top of the prioritised list of opportunities by conducting a more in-depth assessment.

Phase 3 – Opportunity Recommendation

Provide an Implementation Roadmap; provide a short document including outputs of the modelling conducted regarding the performance of technologies, and next steps to implementation.

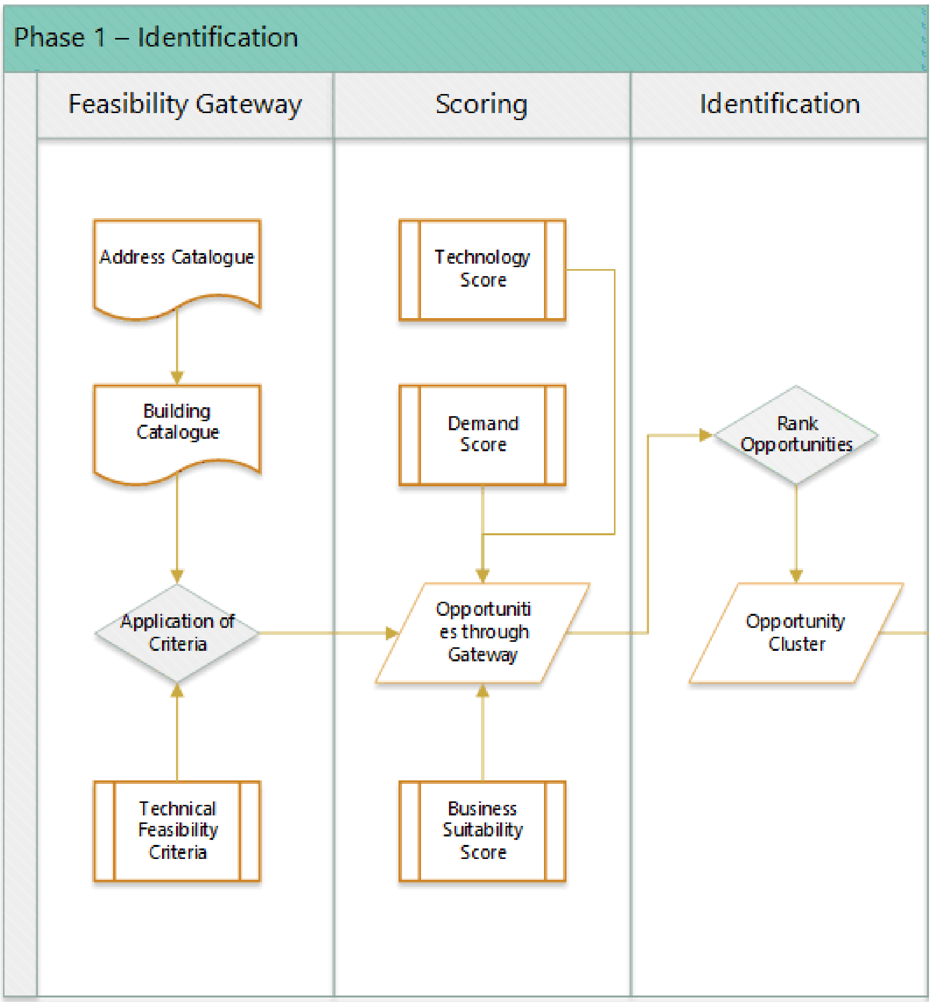
Provide a Project Report; documentation on the methodology of the project and how best to progress the short-list of opportunities identified by setting out actions necessary to deliver a solution.



5.1 Phase 1 – Opportunity Identification

The first phase of the project was designed to reduce a long-list of potential opportunities down to a short-list of feasible opportunities. This process of elimination and prioritisation is an efficient use of resources which can be subsequently focused on conducting a small number of thorough studies.

The process flow below illustrates how opportunities are assessed in terms of technical feasibility by passing through the 'Feasibility Gateway', how an opportunity is scored and assigned an 'Opportunity Score' and then finally how these are then ranked and categorised into identified 'Opportunity Clusters'.



5.1.1 Feasibility Gateway

A set of criteria were defined to assess whether a building has the physical characteristics required for installing each technology individually. If a building meets all of the criteria defined then the opportunity for that technology with that building passes through the Feasibility Gateway. Any instances where buildings do not meet the criteria for any given technology, they do not pass through the gateway and are excluded from the on-going scope of the project.

The criteria are summarised below:

Criteria	Threshold
Solar PV	
Roof orientation	135-225°
Roof clearance	>=400m^2
Solar Car Ports	
Car park	Y/N
Solar Thermal	
Roof orientation	135-225°
Roof clearance	>=50m^2
Low-temperature demand	Y/N
Wind	
Land availability	Y/N
Wind speed	>=6m/s
Radius from Gatwick	>=15mi
Anaerobic Digestion	
Land availability	Y/N
Access routes for delivery	>=B-Road
Air-Source Heat Pump	
Mounting space	>=4.2m^2
Low-temperature demand	Y/N
Ground-Source Heat Pump	
Mounting space	Y/N
Low-temperature demand	Y/N
Borehole spacing	<=14m boundary
Water-Source Heat Pump	
Mounting space	Y/N
Low-temperature demand	Y/N
Availability of aquifer	Y/N
Biomass	
Access routes for delivery	>=B-Road
Large storage location	>=5m^2
Low-temperature demand	Y/N
Combined Heat and Power	
Consistent electrical load	Y/N
Waste Heat Capture	
Expect recoverable heat	Y/N
Time of waste heat profile	24hr
Supply predictability	Y/N
Electricity Storage (behind the meter)	
Case study	Y/N
Solar PV combination	Y/N
Peak load	>5kW
Load factor (ratio between peak and mean load)	>70%
Electricity Storage (vehicles)	
Own company cars	Y/N
Energy from Waste	
Land availability	Y/N
Access routes for delivery	>=B-Road

Where appropriate the evidence behind the defined thresholds (previous page) is recorded within the Supply and Demand Catalogue (Feasibility Criteria tab) provided.

The thresholds were designed to focus on technical feasibility and not commercial attractiveness, e.g. the peak load threshold for electricity storage is set at more than 5kW as at the time of this assessment this was the smallest battery currently available as a standalone unit. However, there are a small number of thresholds that have been designed to reflect typical characteristics required when proposing particular technologies, e.g. the orientation of solar PV panel between 135 to 225° aspect to reflect between south east and southwest is desirable when proposing an economically viable installation.

5.1.1.1 Address Catalogue

The Address Catalogue was supplied by the Manor Royal BID detailing the business name, activity and gross internal floor area associated with individual addresses. Amongst other data points this data importantly listed the GIS coordinates for plotting addresses on a map. This allowed us to assign physical characteristics such as roof clearance, distance to gas network etc. to businesses within a building.

5.1.1.2 Building Catalogue

With technologies being applied at the building level it was necessary to formulate a second register, additional to the address level, the Building Catalogue.

Data for the Building Catalogue has been sourced from three different sources:
Level 1 – GIS/Address Catalogue
Level 2 – Business Category
Level 3 – Case Studies

Each data point required for the Building Catalogue has been sourced from one of the three levels. All levels are organised by priority, with level 1 being the preferred source.

There are three data points required at the building level which are summaries of address level data:

- Floor Area
- Business Category
- Energy Data

Floor areas have been sourced from two sources, in order of preference:

1. Manor Royal BID (Level 1)
   Floor area sourced from the Manor Royal BID per address, summing all floor areas of the businesses associated with individual buildings.
2. GIS Footprint (Level 1)
   Where no floor area was provided: We used building footprint as a proxy for gross internal floor area, as calculated by the GIS software.

A single business category for an entire building has been sourced from the following sources, in order of preference:

1. Floor area

Using floor area as a proxy for size of business and energy demand, the most 'dominant' business category within a building by floor area was assigned to that building.

2. Business count
   Where floor area was unavailable: rather than by floor area but by count of business category. The most frequent business category within a building was assigned.

Energy data has also been sourced from two sources, in order of preference:

1. Manor Royal BID
   As provided by the Manor Royal BID, assigning the energy data to an address and summing the data for all addresses associated with a single building
2. Benchmark
   At the address level, sourcing a benchmark kWh/m^2/ year figure according to the associated business category[2].

5.1.1.3 Application of Criteria

The criteria are applied to the Building Catalogue. At this stage this reflects the application of a technology to potentially multiple businesses within a single building. The instance of a technology that has successfully passed through the Feasibility Gateway is therefore referred to as an 'Opportunity' which progresses to the Scoring stage.

5.1.2 Scoring

To establish an understanding of the potential performance of each opportunity, a single score is assigned, an Opportunity Score. Each Opportunity Score is the product of a combination of three other scores; Technology Readiness, Building Demand and Business Suitability. Collectively the scores assess the technical, economic and environmental performance of each technology in a particular setting.

5.1.2.1 Technology Readiness

This is a qualitative assessment to indicate the 'readiness' of each of the technologies within the scope of the project. A set of 10 questions are asked of each technology covering technical performance, economic performance and environmental performance. A technology can score between 0-10 for each question, 0 being the worst, and 10 the best. Inherently with this form of assessment the results are subjective. However, the questions have been chosen to reflect absolute truths that could be supported with pragmatic justifications, and therefore mitigates the risk of user bias.

5.1.2.2 Energy Demand

Focusing on economic performance we established a principle that the higher the energy demand the greater the potential returns on investment.

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[2] https://www.cibse.org/Knowledge/knowledge-items/detail?id=a0q20000008I7oTAAS

Each technology is categorised as either power or heat energy demand, indicating the primary energy the technology will generate. Similarly each building has a calculated heat and power energy demand, see section 5.1.3 for information on the source of energy demand. Each demand for each building is scored between 0 and 10, 10 is assigned to the maximum demand on the Manor Royal estate and then all others are scored relative to this maximum.

5.1.2.3 Business Suitability

Focusing solely on technical performance the business suitability score assess' how well individual technologies typically perform in each of the identified Manor Royal business categories. For example, Combined Heat and Power (CHP) performs better when there is a consistent heat (low-temperature hot water (LTHW)) and electrical demand. Whereas electricity storage performs better when there are significant peaks and troughs so that demand can be moved to lower cost times. The business suitability score reflects the conditions where technologies perform better, and also where they perform worse.

As with Technology Readiness this is a subjective assessment according to Sustain's experience.

5.1.2.4 Opportunity Score

An opportunity is technology and building specific, the three scores above are combined to give a weighted overall score out of 10. Each score type is allocated an 'importance weighting' which collectively add up to 100%, i.e. if technology readiness is the only score that matters, energy demand and business suitability are not to be considered the following would apply:

Technology Readiness – 100%
Energy Demand - 0%
Business Suitability – 0%

At the time of this project the weightings were set to:

Technology Readiness – 20%
Energy Demand – 60%
Business Suitability – 20%

These weights adjust the 0 to 10 scores discussed above to calculate the single Opportunity Score. The weightings between the scores are editable in the Supply and Demand Catalogue ('Introduction' tab) to reflect changing priorities.

All three scores which provide a foundation for the opportunity score are updateable via the Supply and Demand Catalogue.

Technology Readiness – on the 'Technology Readiness' tab scores can be overtyped by the user

Energy Demand – When energy data is refined or updated for subsequent time periods columns V and W on the 'Catalogue' tab can be updated.

Business Suitability - on the 'Business Suitability' tab scores can be overtyped by the user

5.1.3 Identification of Clusters

With a single quantified score formulated from a systematic methodology we were able to confidently rank all opportunities. A new GIS layer containing the opportunity scores was then added onto the central Manor Royal GIS map. Categorising scores for either Power or Heat (as discussed in section 5.1.2.2) we manually identified clusters of high scoring power and high scoring heat opportunities. An Opportunity Cluster would be identified by the following criteria:

1. Multiple high Opportunity Scores
2. Close proximity to one another
3. Regional diversity between clusters

Using the criteria above, we are confident that the technologies proposed would be practical to implement and have a good return on investment. These clusters are designed to provide a foundation from which SMEs will benefit from at a later date. SMEs within proximity of these clusters will benefit by either:

1. Being introduced during the Feasibility Stage.
   There is the potential to use their smaller demand profiles to smooth out generation profiles and improve operational performance.
2. Become a Customer
   Post feasibility the potential for exporting energy beyond the on-site demands will be clearer. Neighbouring SMEs can enter Power-Purchase Agreements (PPAs) to procure energy at a lower rate from the low carbon energy network rather than the grid.

These 'opportunity clusters' were then proposed to progress through to Phase 2 for a more thorough appraisal.

A power and a heat cluster would contain multiple of the best scoring relevant technologies, i.e. those technologies serving power loads that scored highly would all be considered for each power cluster, and the same for heat loads. Below is a summary of the technologies considered by each type of cluster, as agreed by the project team.

Power	Heat
Solar PV	Air-Source Heat pump
Solar Car Port	Biomass
Electricity Storage	Solar Thermal
Combined Heat and Power	

Prior to commencing Phase 2, each cluster was presented to the project team and critiqued considering its contextual environment, e.g. stakeholder engagement and data availability. A cluster contains both the buildings and businesses within them. The 'Heat' opportunity clusters were placed on hold due to lack of heat demand data. These clusters were therefore not considered for Phase 2 of the project, as agreed with the project team.

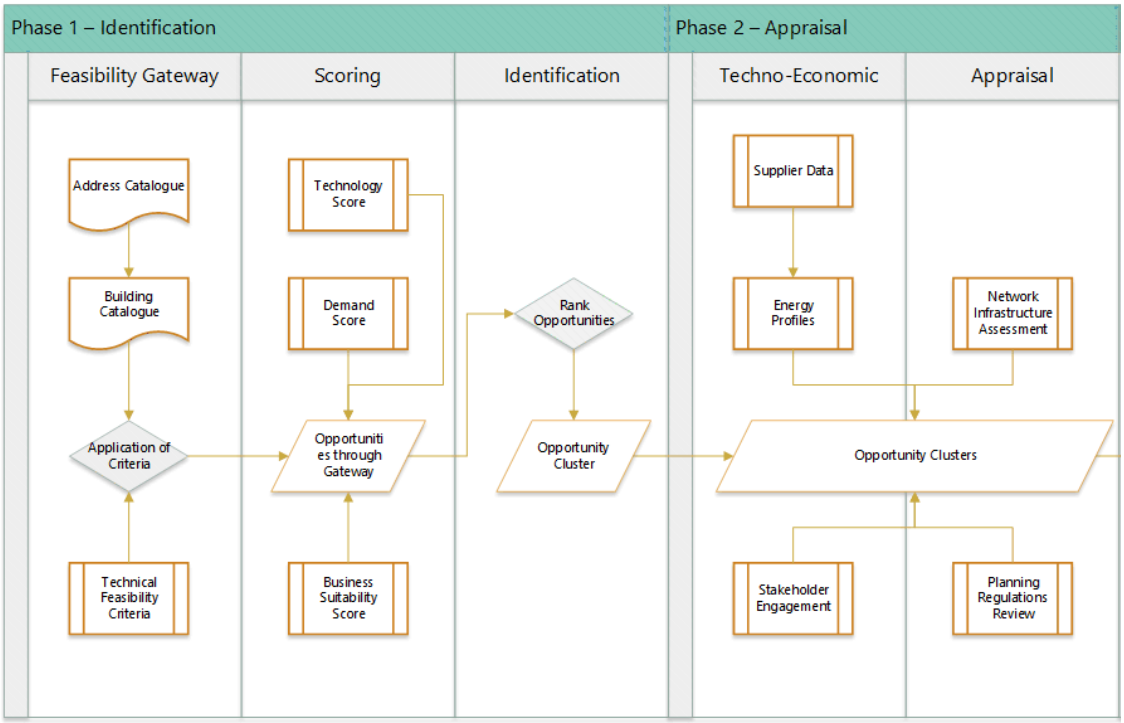
5.2 Phase 2 – Opportunity Appraisal

Phase 2 is designed to refine the assumptions made in Phase 1 and re-assess the performance potential of technologies in an Opportunity Cluster setting. Focused on four clusters a thorough energy modelling methodology replaces the theoretical scoring with quantified economic potential. This process uses a bespoke Techno-Economic Model to forecast the performance of various low carbon scenarios. The model is set to a total project lifetime of 25 years, the first year is allocated entirely to investment and then the systems are operational as of year 2.

Supporting the Techno-Economic Model is a contextual review of implementing low carbon technologies on the Manor Royal estate. This includes a review on planning regulations and an assessment on the status of the surrounding power infrastructure.

Therefore at this stage an Opportunity Cluster is subject to four assessments:

1. Energy Model
2. Techno-Economic
3. Appraisal
   a. Planning Regulations
   b. Network Infrastructure



5.2.1 Energy Model

EnergyPRO is an advanced, flexible modelling software used for analysis of electricity, heating and cooling loads. By importing the known and estimated energy demand profiles for each business into the software, each cluster could be analysed as a whole opportunity rather than building by building.

To focus resources on obtaining a set of practical outputs from energyPRO that could be evaluated using the Techno-Economic model we set four 'technology configurations' to be modelled per cluster. A 'technology configuration' is a scenario by which one or more technologies are modelled to provide energy for the proposed cluster. The technology configurations set were:

1. Solar PV
2. Solar Car Ports
3. CHP
4. Solar PV and Electricity Storage Battery

The configurations were designed to be pragmatic and, based on the data, reflect configurations that could be installed.

For each configuration it was necessary to establish a sizing approach. EnergyPRO requires sized technologies in order to establish the quantified potential of each technology and its relationship with the existing business loads. The sections below detail the sizing approach for each configuration.

Solar PV

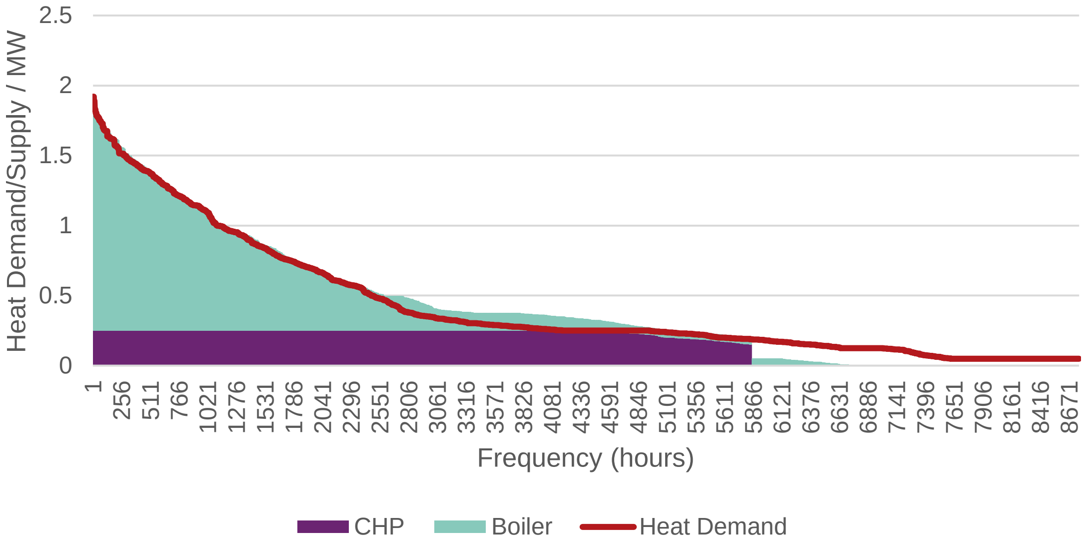
Each building within the cluster would house a solar PV array, where feasible. Arrays were sized from satellite imagery using desktop software, Google Earth Pro. Arrays were placed avoiding skylights and obstacles that were visible. A 1 metre border was also placed around obstacles, skylights and the edge of roofs to allow for access and safety considerations as well as compliance with permitted developments. To obtain the kWp generation capacity from the amount of panels that could be roof mounted we assume a conservative 250Wp capacity per panel.

Solar Car Ports

The generation capacity for solar car ports was modelled using the same approach to solar PV. Using satellite imagery we identified suitable car park locations adjacent to the proposed businesses, including the effect of shading from adjacent buildings. Using standard sizing assumptions a single car space would house 3 panels, also assumed to have a capacity of 250Wp per panel.

CHP

For CHP, by aggregating the heat demands in the cluster a heat demand graph could be created, this allows CHP and boiler capacity to be determined. A heat demand graph shows the frequency that particular heat demands occur for throughout the course of a year. Best practice dictates that CHP is sized to run for approximately 5000 hours of the year. For example the figure below (next page) shows the heat demand curve from Cluster 1 which suggests a 250kWth CHP engine providing heat would be suitable.



This graph shows how frequently different heat demands occur. For example, a heat demand of 0.7kW (y axis) or more occurs for approximately 1,786 hours per year (x axis).

Solar PV and Electricity Storage Battery

Electricity storage can be designed and sized for multiple strategies, a 'behind the meter' solution is typically designed to smooth an energy demand profile. As a stand-alone technology a battery is only able to move energy demand along a profile, however combined with a technology with generation capacity, i.e. solar PV, it is able to store locally generated electricity and discharge it at the most economical advantages points in the energy demand profile. We have therefore designed an approach which maximises the reduction of peak loads, we sized the battery to provide all of the energy demand between the hours of 4pm and 7pm, or the maximum size of the solar PV, whichever is greatest. The justification for this is to avoid all Distribution Use of System Charges (DUoS) charges where possible, these are charges in addition to the tariff paid for energy to compensate for energy demand during peak grid demand.

For clusters 2 and 4 the battery is sized to meet the entire 4pm to 7pm demand, for clusters 1 and 3 the solar PV is the limiting factor for sizing the battery.

5.2.2 Techno-Economic

A bespoke Techno-Economic model was built to simulate the economic impact of implementing various technology scenarios to replace the existing energy infrastructure. The model is built on an annual timeline and assumes capital expenditure in 2018 and project operation in 2019.

Capital and operational expenditures have been estimated for each cluster. Energy data is taken from the energyPRO modelling and inserted in the economic model. In the absence of energy prices supplied from businesses estimates have been taken from UK government energy price data by business size[3]. The energy prices are also forward indexed according to UK green book guidance[4]. For the solar projects Feed-In Tariffs (FiTs) are calculated in the revenues. The FiT scheme is due to end in April 2019, this means that any project commissioned post this date will not be eligible to receive the government subsidy. For all eligible projects commissioned before this date the government subsidy is guaranteed for the period of the tariff (up to 20 years). For information on how FiTs impact the results see section 6.2.2.1.

From the summation of the revenues and costs a total cash flow for each project is calculated and IRR, NPV and a simple payback term is calculated. The techno-economic model has been designed with the intention that it is updated by the user in subsequent stages of the project when assumptions are refined further.

5.2.2.1 Supplier Data

The original objective was to obtain costing from technology suppliers, ideally local to Manor Royal. However, as the data we would supply is entirely theoretical this would undermine the information they would provide in return. It was therefore deemed pragmatic to use robust theoretical costings sourced from government data, economic publications and previous project experiences.

CHP

Using a combination of SPON's 2015 (industry pricing publication) and previous internal CHP project pricing.

Solar PV

Using data published by UK government on actual install costs by size, last updated 25th May 2017[5]. Since the publication of this data WSCC has experienced approximately a 10 to 15% fall in the cost of solar PV.

Solar Car Ports

Using a publication from the solar industry. This publication suggests a $2.50 per watt cost for solar car ports[6] (2015). As the source is United States based we wanted to verify this. We also estimated cost based on the solar PV source above plus standard structural

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[3] https://www.gov.uk/government/statistical-data-sets/gas-and-electricity-prices-in-the-non-domestic-sector

[4] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

[5] https://www.gov.uk/government/statistics/solar-pv-cost-data#history

[6] https://solarbuildermag.com/news/costs-decline-solar-carports-will-spread-across-country/

costs. The estimates between the two methodologies varied by 2%, 1%, 6% and 2% for Opportunity Clusters Power 1 to 4 respectively. We believe this is an accurate estimate for the purposes of this stage of the project.

Energy Storage Battery

Information about the market costs of lithium-ion batteries[7] published by Bloomberg New Energy Finance (BNEF) in 2016 was used. According to this lithium-ion batteries cost $273/kWh (£196/kWh). We have added a 50% contingency to allow for infrastructure and preliminary works.

Similarly to Solar Car Ports we utilised a second metric of £305/kWh based on an actual installation cost of 400,000kWh (£122 million). When estimating the cost using this single project case study the estimates vary by -4% (they increase for the case study source) for all Opportunity Clusters.

Cost Forecasting

Costs for renewable energy generation and storage reduce annually. For example the BNEF estimate battery costs have reduced from approximately $1,000/kWh in 2010 to $273 in 2016. Solar PV has been through a similar experience in terms of annual reduction. We expect the cost per output (kW or kWh) of solar PV, solar car ports and batteries to reduce per annum over the coming years. There is less fluctuation for CHP as this technology has a longer history and is currently more stable than the other younger technologies mentioned.

All costs are editable in the Techno-Economic Model to allow for a more accurate model as assumptions are refined.

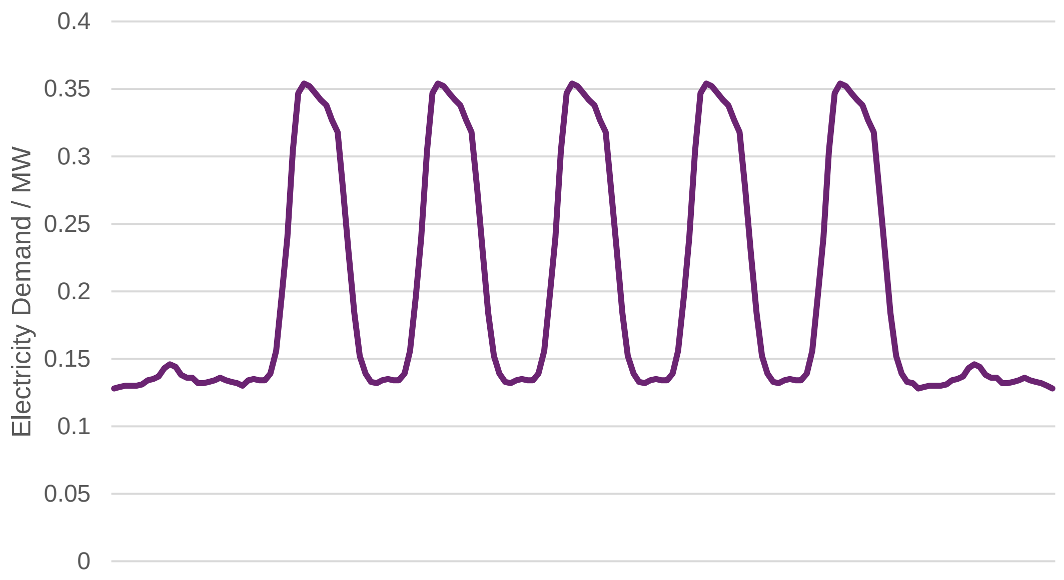
5.2.2.2 Energy Profiles

An energy profile is a progression from energy demand data to understand how much energy is being consumed when, rather than just how much overall. For Phase 1 annual energy demand was sufficient. However, in Phase 2 the methodology progresses to analyse how much energy is being demanded at any given time, this is quantified in half-hourly intervals.

As stated previously, energy data was originally meant to be supplied by Auditel. Due to limited data availability we proceeded to engage with the businesses within each cluster directly. An online survey was drafted to engage with businesses on the estate to obtain more in-depth profile data on their energy demand and associated characteristics. However, due to restricted resources and limited time availability no profile data was obtained. After discussion with the project team it was agreed that where data was unavailable secondary data would be used. We produced theoretical profiles according to the business activity (e.g. office, warehousing, retail etc.), see section 4.3 for more details

[7] https://data.bloomberglp.com/bnef/sites/14/2017/07/BNEF-Lithium-ion-battery-costs-and-market.pdf

on producing energy profiles. For example the weekly profile for the Doosan Babcock and Deloitte building (as they have the same business activity) was as follows:



5.2.2.3 Stakeholder Engagement

The scope of this project was originally designed to obtain and use feedback from stakeholders. The feedback would direct the configuration of the recommended opportunity clusters. The medium for this would be the online survey with follow-up interviews. However, due to the lack of success with the online survey discussed in section 5.2.2.2 stakeholder engagement has been limited to the Manor Royal BID event. At this event businesses attended to hear the progress the BID had been making on several projects, one of which was BISEPS and Re-Energise Manor Royal.

To successfully engage with stakeholders the project team agreed to progress with achieving the project deliverables. The deliverables would serve as tangible outputs that stakeholders could then engage with.

5.2.3 Appraisal

Supporting the techno-economic modelling is a qualitative assessment of the development context at Manor Royal, this includes the power network infrastructure and planning regulations.

5.2.3.1 Network Infrastructure

We used data provided by UK Power Networks at http://www.ukpowernetworks.co.uk. The Contracted Connections Register provides up to date data on the status of active and in development generators above 1MVA. In addition their online mapping tool provides indicative data on the capacity availability at each 132, 33 and 11kV level of substations as well as their associated location.

Surmising this data we are able to identify any potential risks that the existing power network infrastructure may pose when developing a low carbon energy system.

5.2.3.2 Planning Regulations

The planning regulations landscape set by Crawley Borough Council is an important facet of any proposed developments. This is a qualitative literature review of the following planning associated documents, as signposted to Sustain by Ian Warren, Crawley Borough Council, Planning Officer.

- Crawley Local Plan 2030
- Crawley Development Map
- Manor Royal Design Guide – Supplementary Planning Document
- Manor Royal Public Realm Strategy – Supplementary Planning Document
- Planning and Climate Change – Supplementary Planning Document
- Town and Country Planning

Definitive requirements of the regulations were extracted and assigned to the relative technologies they affect. In addition, guidance and best practice principles were documented for consideration when developing the opportunities in Phase 2.

The findings of the review are included within the Implementation Roadmap for each opportunity.

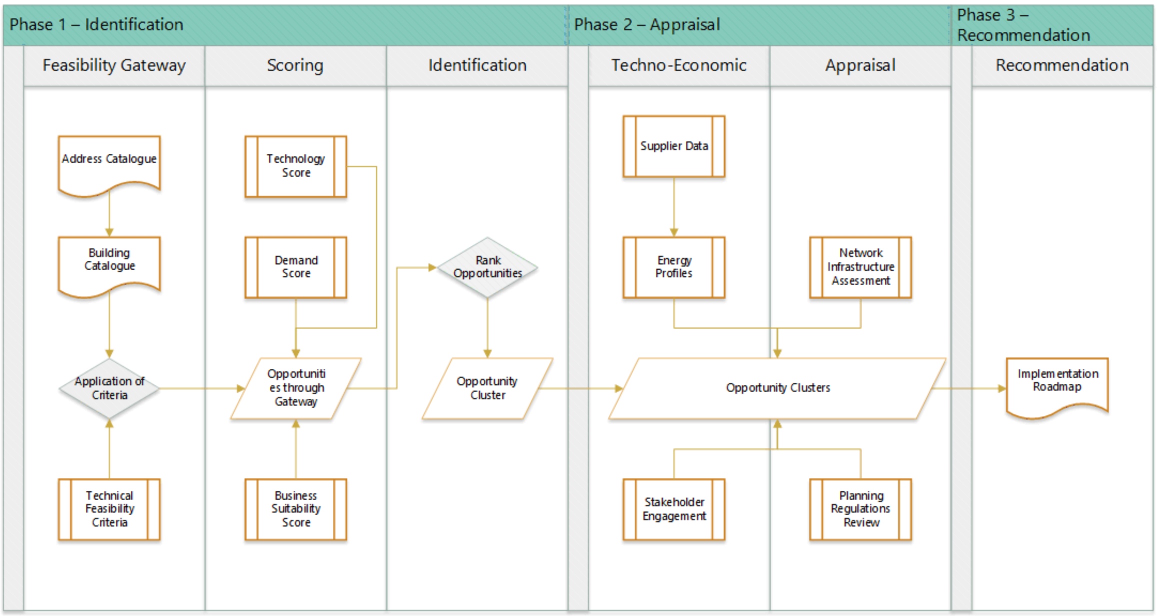
5.3 Phase 3 – Opportunity Recommendation

Phase 3 evaluates both previous phases by providing two distinct set of documents:

1. Implementation Roadmap (per opportunity cluster)
2. Project Report

These two documents are supported by the following deliverables:

- Supply & Demand Catalogue
- Opportunity Clusters List
- GIS Map and Layers
- Techno-Economic Model



5.3.1 Project Report

This project report is structured to provide initially a step-by-step explanation of the methodology and its justification and then subsequently an extract of results that summarise the progress of the project.

5.3.2 Implementation Roadmap

This is a standardised three-page document per opportunity cluster that has been designed to visualise the combined results of the Techno-Economic Model, the Appraisal and recommended Next Steps to progress with the opportunity.

6 Results

The subsequent sections detail extracts of results relevant to the progress of the project. For all results please see the relevant deliverable, documented at the start of each section.

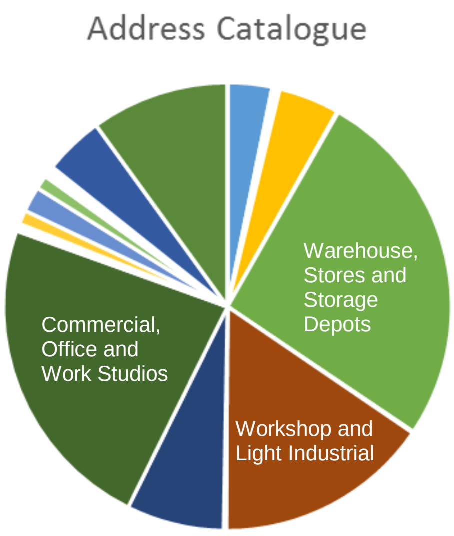
6.1 Phase 1

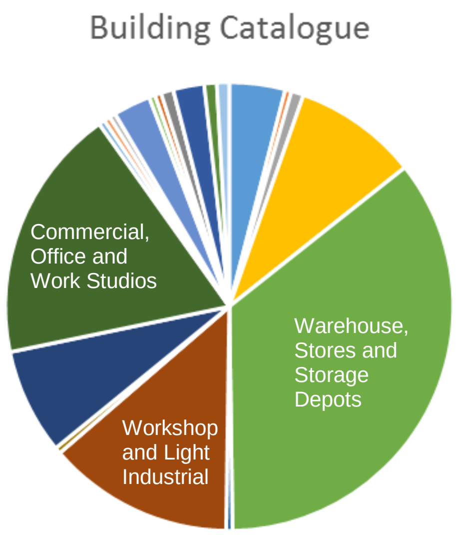
For all results from Phase 1 see Supply and Demand Catalogue

6.1.1 Address and Building Catalogues

Below is a visual representation of the range of business activities across Manor Royal, as provided in the Address Catalogue, supported with the associated data points below. These results have been selected as particularly important to the project as much of the analysis is driven by secondary data, which is derived from the business categories identified.

On the left, the Address Catalogue is predominantly 'Warehouses, stores and storage depots' and 'offices and work studios'. On the right is the business activity at the Building Catalogue level, as discussed in the methodology it is necessary to assign a main business category to a building, as in Phase 1 it is at this level the technology is being applied. There is little variance between the two visuals, which supports the methodology for formulating business category at the building level from the address level. For a full breakdown of the results see the Supply and Demand Catalogue.



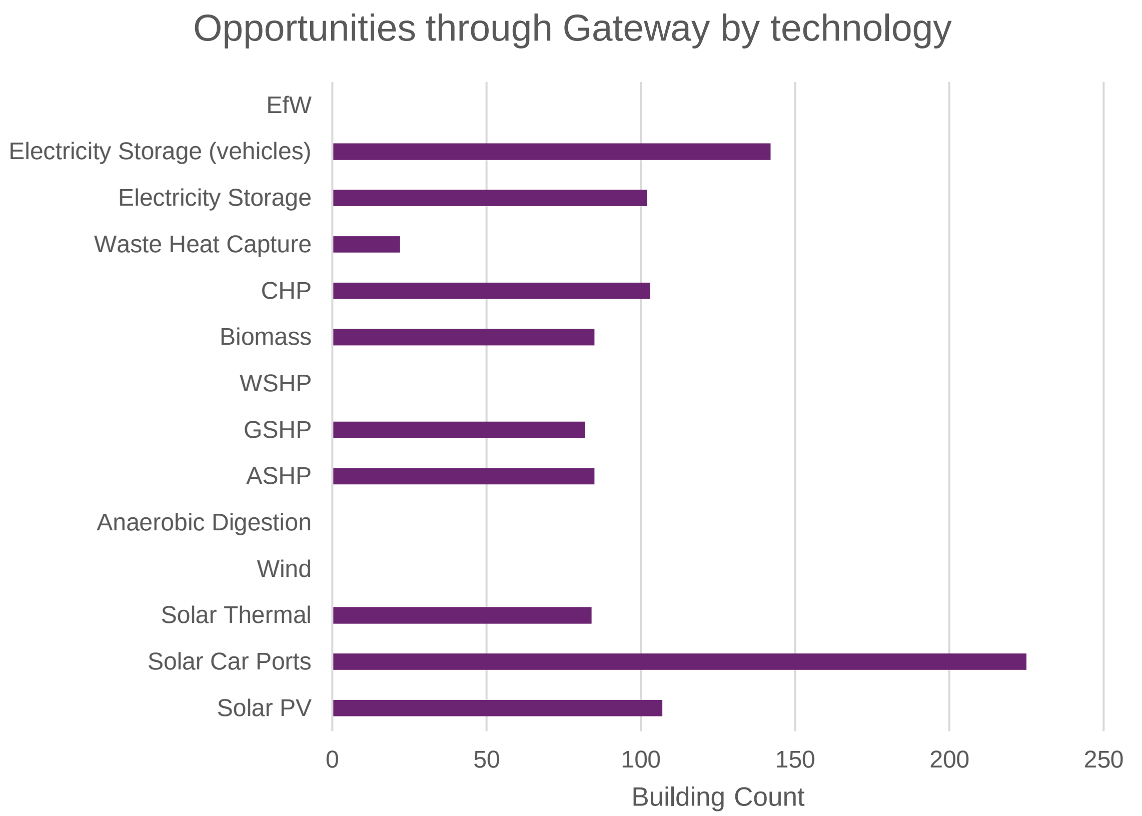


The table below (next page) details the business category breakdown numerically. The total number of addresses and buildings with a business category is slightly lower than the total records as some addresses were missing categories, and therefore some buildings were also.

Business Category	Address		Building	
	Count	%	Count	%
Total	1092		223	
Commercial	35	3%	9	4%
commercial, , offices and work studios	3	0%	1	0%
commercial, industrial	3	0%	2	1%
commercial, industrial, factories and manufacturing	48	4%	20	9%
commercial, industrial, mineral workings and quarries/mines	1	0%	0	0%
commercial, industrial, warehouses, stores and storage depots	286	26%	79	35%
commercial, industrial, wholesale distribution	1	0%	1	0%
commercial, industrial, workshops and light industrial	170	16%	30	13%
commercial, leisure, indoor and outdoor leisure and sporting activities	1	0%	0	0%
commercial, medical, GP surgeries and clinics	1	0%	1	0%
commercial, offices	77	7%	17	8%
commercial, offices, offices and work studios	253	23%	41	18%
commercial, retail,	2	0%	1	0%
commercial, retail, banks/financial services	3	0%	1	0%
commercial, retail, petrol filling stations	1	0%	1	0%
commercial, retail, restaurants and cafes	11	1%	0	0%
commercial, retail, shops and showrooms	20	2%	6	3%
commercial, transport, car parks and park & ride sites	11	1%	1	0%
commercial, utilities, telecommunications	3	0%	0	0%
features, places of worship	1	0%	1	0%
land, development, development sites	3	0%	2	1%
land, unused, vacant or derelict land	2	0%	0	0%
parent shell, property shell	47	4%	5	2%
residential, dwellings, flat	109	10%	2	1%
Hotels	0	0%	2	1%

6.1.2 Feasibility Gateway

Below is a breakdown of results of the Feasibility Gateway stage.

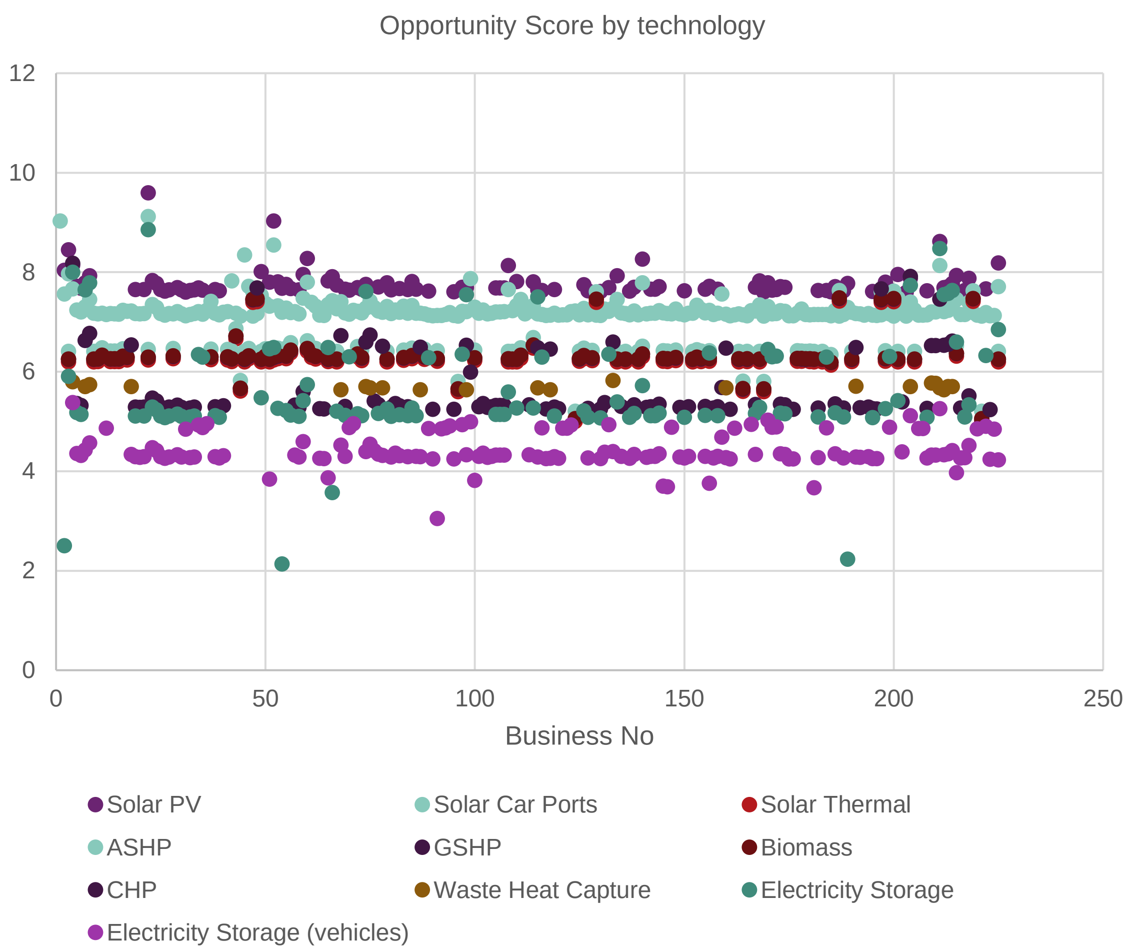


Energy-from-Waste, Water-source heat pump, Anaerobic Digestion and Wind were not deemed feasible on the Manor Royal estate due to site specific constraints. Therefore no opportunities for these technologies proceeded through the gateway.

The criteria for electricity storage vehicles and solar car ports was limited to the presence of car parking and owned car fleets. As a desktop exercise we had to assume that all businesses had allocated parking, and most business categories may require some form of small vehicle fleet as a minimum.

6.1.3 Opportunity Scores

As the opportunity score informed the proposal of opportunity cluster for Phase 2, it was important that any anomalies were addressed at this stage. By plotting the results on a single visual we can see how scores vary by technology, see next page.



To accurately review the visual above we must consider the source for the data points.

1 – Methodology

The Opportunity Score is a weighted combination of Business Suitability, Demand and Technology Readiness. Currently theses weights are set at 60%, 20% and 20% respectively. The highest weight Business Suitability means an Opportunity score is highly dependent upon how well a technology will perform for each business activity. This means there will be a concentration of data points for the most frequent business types.

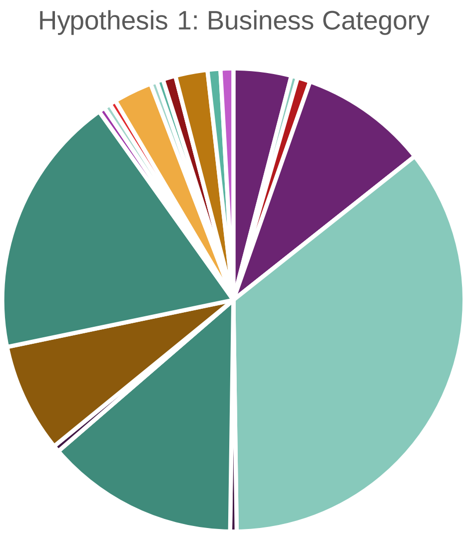
2 – Data Source

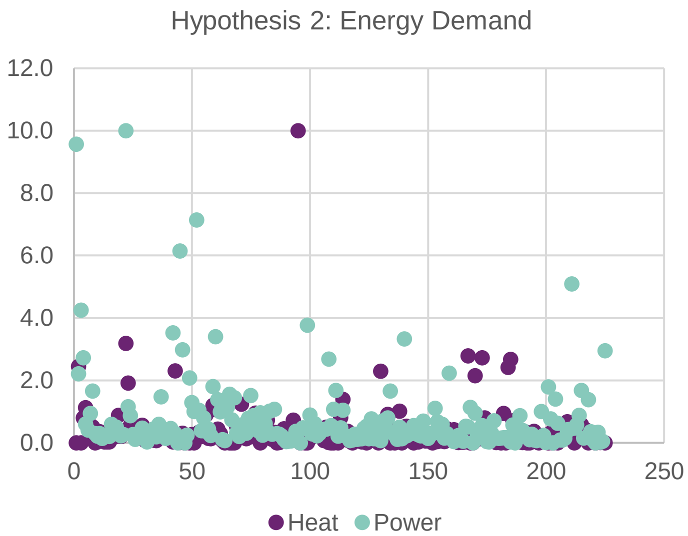
Business Suitability and Technology Readiness are scored by business category. Whereas Demand is based on combining both primary and secondary data, multiplying the floor area (primary) by a benchmark (secondary), this is also categorised by business category. Therefore, a business' assumed business category is very influential in determining its overall Opportunity Score.

There are a small number of what would appear to be anomalies. However, these are for Electricity Storage which is likely to score low on both technology readiness and for particular unsuitable business categories.

Considering points 1 and 2 above we have the following hypothesis for the largely horizontal correlations per technology:

1. Most businesses are of a similar category and therefore business suitability scores are similar.
2. Most businesses consume similar amount of energy, close to the median. As the majority of data is sourced from benchmarks this hypothesis would suggest that the premises across the site are of similar sizes.





The two figures above illustrate that both hypotheses above may be true.

Hypothesis 1, there are a 25 business categories in total, however 75% of the buildings on the Manor Royal estate are assigned to only 4 of these categories. Therefore, with a large concentration of business categories, and the influence business categories has on the Opportunity Score (discussed above) we can confidently say that Hypothesis 1 is causing the horizontal correlations of Opportunity Scores.

Hypothesis 2; 215 and 208 buildings score less than 2 out of 10 on heat and or power for energy demand respectively, as shown by the large concentration of scores along the x axis of the graph. Demand is scored on a relative scale, i.e. the largest demand is scored 10 and all other demands are scored relative to this. The largest demand is far away from the median, this means the *relative* variations around the median cause the demand score to vary less. If the largest score was closer to the median, the demand score would fluctuate from the median more. The high concentration around the median with few anomalies (large demands) means that the Demand score varies less and subsequently contributes to the horizontal correlations of Opportunity Scores. These anomalies should be reviewed as a priority for data accuracy and potentially removed in further analysis to focus the analysis on the majority of the business park.

These findings provide context and justification for how the scores are calculated at this stage.

6.1.4 Opportunity Clusters

Four Opportunity Clusters were identified to progress into Phase 2 for further assessment. These clusters focused on ‘Power’ related opportunities, identifying the opportunity to implement electricity generating technologies. ‘Heat’ clusters were not included in this stage due to lack of heat data and the impact inaccurate data would have on the outcomes, as agreed with the project team.

6.2 Phase 2

For all results from Phase 2 see Implementation Roadmap for the appropriate opportunity cluster, supported by the Techno-Economic Model.

6.2.1 Techno-Economic Model

For the full results of the Techno-Economic Modelling see the workbook provided.

Net Present Value (NPV)

NPV = Present value of cash outflow - Present value of cash inflow

The NPV is used to represent the profitability of an investment whilst accounting for inflation over a predetermined lifetime.

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_o$$

C_t = net cash inflow during period $_t$

C_o = total investment costs

r = discount rate

t = number of time periods

Internal Rate of Return (IRR)

The IRR is a discount rate that makes all NPV results equal to zero. Generally, the higher the IRR, the more desirable the investment.

We have not included the cost of borrowing within the IRR.

Simple Payback

Simple payback is a measurement which determines the point in a project’s lifecycle that the cash inflows (including energy savings) exceed the investment costs not factoring in discount of future flows due to uncertainty and inflation

The table below details the Internal Rate of Return (IRR), Net Present Value (NPV) and Simple Payback results for each technology configuration for each cluster.

Opportunity Cluster	Technology Configuration	IRR (%)	NPV @ 3.5% (£)	Simple Payback (yrs)
Power 1	Solar PV	14.1%	£675,898	7
	CHP	25.3%	£1,871,770	5
	Solar Car Ports	4.3%	£74,096	15
	Solar PV + Battery	5.6%	£212,332	13
Power 2	Solar PV	17.1%	£3,019,173	6
	CHP	24.8%	£1,373,728	5
	Solar Car Ports	3.0%	-£23,034	17
	Solar PV + Battery	6.5%	£651,188	12
Power 3	Solar PV	13.4%	£568,940	8
	CHP	11.5%	£703,427	9
	Solar Car Ports	4.5%	£65,276	15
	Solar PV + Battery	5.3%	£165,035	13
Power 4	Solar PV	11.8%	£604,104	8
	CHP	20.8%	£1,752,139	6
	Solar Car Ports	2.1%	-£213,936	19
	Solar PV + Battery	6.0%	£144,797	12

As the FiT scheme is due for closure in April 2019 we have modelled a scenario whereby no FiT revenues are included within the forecast from the Techno-Economic Model.

Please see below for the impact of removing FiT revenue from the Techno-Economic Model:

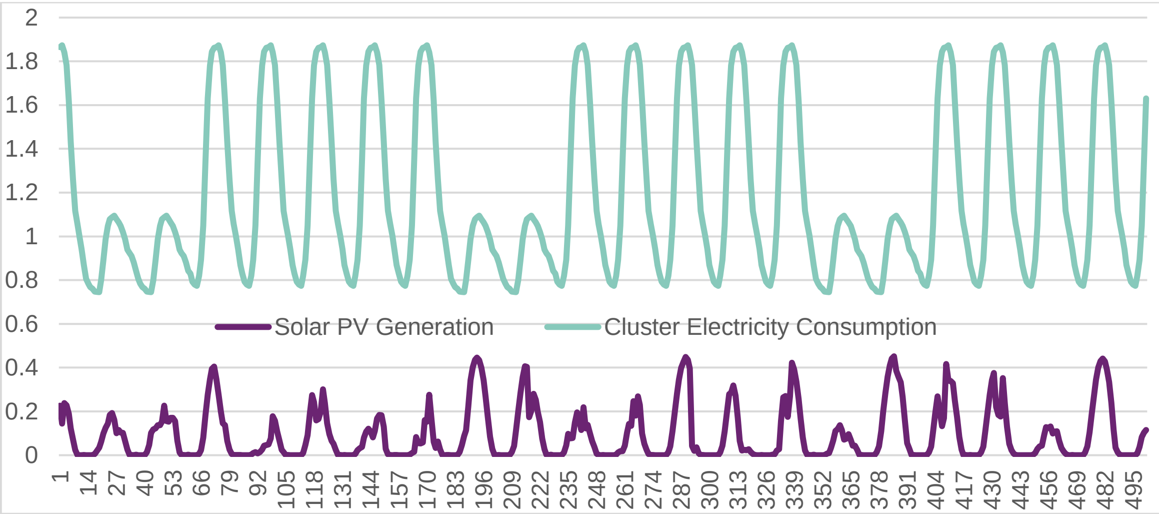
Opportunity Cluster	Technology Configuration	IRR (%)	NPV @ 3.5% (£)	Simple Payback (yrs)
Power 1	Solar PV	12%	£550,547	8
	CHP	No Impact		
	Solar Car Ports	3%	-£26,457	17
	Solar PV + Battery	4%	£92,611	15
Power 2	Solar PV	16%	£2,881,102	6
	CHP	No Impact		
	Solar Car Ports	2%	-£82,390	20
	Solar PV + Battery	6%	£519,334	13
Power 3	Solar PV	12%	£459,675	8
	CHP	No Impact		
	Solar Car Ports	3%	-£5,756	17
	Solar PV + Battery	4%	£60,678	15
Power 4	Solar PV	10%	£471,462	9
	CHP	No Impact		
	Solar Car Ports	2%	-£238,052	20
	Solar PV + Battery	4%	£18,092	15

6.2.2 Technology Configurations

Each configuration scores similarly, but not identically, for each cluster. This is due to a combination of the modelling approach, the data used and the principles of the technologies.

6.2.2.1 Solar PV

The performance of Solar PV is not directly dependent upon the energy loads of the business. Although the technology will generate electricity regardless of energy demand, its economic viability is impacted upon when energy is used on site as this will vary saving and export returns. However, the power loads within the clusters are significantly larger than the generating capacity of solar PV, and therefore the time of use factor is less influential. For the majority of the operational time the solar PV is able to continually generate without exceeding the building demands and therefore there is no need for exporting. As demonstrated by the figure below representing solar PV for Opportunity Cluster, Power 1. The X axis represents a sample of 500 hours over the course of summer, the y axis represents power (MW).



Solar PV performs worse for cluster 4 due to curvature of the roof on one building which restricts the ability to optimise tilt and orientation. If solar PV was not considered for this building the return on investment would improve. Investment costs would decrease proportionally to the amount of panels installed but removing an individual site with poor performance would increase the overall performance of the cluster.

Secondary Data Impact

A more inconsistent or lower demand would increase the potential for electricity generated from solar PV to be exported to neighbouring businesses. Secondary data has minimal impact on energy generation because it will be able generate and distribute the specified quantity of electricity regardless of the consumer. However, the arrangement for distributing the energy generated will have an effect on the capital cost for infrastructure. So although the energy generation potential won't be impacted, the overall return on investment will be. Secondary data has a minimal impact upon the potential for solar PV, deviations from the existing assumptions can be routinely managed.

All clusters are recommended to consider solar PV due to the economically viability, low impedance on business and well-developed nature of the technology. The economics and reliability of performance are most likely to be accepted by stakeholders.

6.2.2.2 CHP

A gas-fired CHP solution is the configuration that is most dependent upon a business' energy demand. As explained in section 5.2.1 a CHP engine is sized to run for approximately 5,000 hours per annum. The heat demand data therefore determines the size of the CHP and the amount of both heat and power this technology will generate. Therefore, the higher and more consistent a heat demand is the longer a larger engine can operate and generate larger amounts of electricity. The consistency of operational hours is a pre-requisite for a well performing CHP solution.

Cluster 3 performs worse when considering CHP due to expected inconsistency in heat demand which is currently determined by business suitability. There are a number of light manufacturing businesses within this cluster which reduces the potential returns for CHP. This is because they are less likely to have a consistent LTHW demand, this would reduce the size of the CHP.

The combination of a high and consistent heat demand within cluster 1 would suggest a well performing CHP solution. The consistency is sourced entirely from secondary data, as most of the business premises are office based. However, cluster 2 which performs very similarly uses approximately 50% actual data providing a more confident output. We understand there is a CHP engine in-situ at one premises. The premises owner should be engaged to understand its size, performance and any potential for improvements to the existing infrastructure.

Secondary Data Impact

The use of secondary data has the greatest impact on CHP of all the technology configuration. Continual operational hours are key to the efficient generation of heat and electricity from a CHP engine. If the secondary data incorrectly predicts consistent heat demands rather than inconsistent the potential for CHP is over estimated. As stated above, the engine is sized to run for approximately 5,000 hours, if the primary data suggests that the demand for 5,000 hours is lower than this then the CHP engine and subsequently the potential for CHP is reduced. Secondary data has a significant impact on the estimated potential for CHP, further data must be gathered before proceeding with the opportunity.

It must be noted that although CHP may be a lower carbon technology as it is generating electricity, it is not a renewable technology as it uses a gas-fired engine to do so. There are alternate low carbon CHP engines on the market, including fuel cell and biomass. However these are currently less 'technology ready'.

6.2.2.3 Solar Car Ports

As solar car ports have additional structural costs in comparison to solar PV, its return on investment is negatively affected when compared to a roof mounted solution.

The same explanation of time of use and generation capacity that applies for solar PV also applies for solar car ports. All of the electricity generated is assumed to be wired directly into the neighbouring business. Solar car ports can be explored to provide electricity for electric vehicle charging points. This demand configuration was outside the scope of this project. However, it is recommended that this option is discussed with stakeholders in subsequent stages.

Clusters 2 and 4 both perform worse than 1 and 3 as a number of panels would have to be orientated East and West. East and West installs were included within the sizing to demonstrate the difference in economic performance between south and non-south facing orientations.

This configuration would be recommended where roof constructions may be deemed unsuitable, require extensive reinforcement costs or if the demand for electric vehicle charging points grows.

Secondary Data Impact

The same commentary for solar PV regarding secondary data also applies for Solar Car Ports. The determining factor for the generation potential is the size of the technology installed. The size and consistency of demand will impact the cable and infrastructure arrangement for using the energy generated. This will have an impact on the capital costs rather than the energy generation potential. Secondary data has a minimal impact on Solar Car Ports, deviations from the existing assumptions can be routinely managed.

6.2.2.4 Solar PV + Battery

As with CHP, the effectiveness of the solar PV and energy storage battery is heavily reliant upon the extent and time of energy use across the businesses. Sized to meet the entire energy demand, where possible, between 4pm and 7pm the battery's primary objective is to reduce additional energy charges, namely DUoS charges. We used the DUoS red-band tariff rate published by UKPN, combined with the energy profile between 4pm and 7pm to estimate potential savings for this solution.

All clusters perform similarly to one another for this configuration. It is expected that the larger businesses would have higher peak loads and therefore higher additional charges, which would improve the business case for this configuration. This configuration is therefore anticipated to be most suitable for cluster 3.

Secondary Data Impact

Secondary data will determine the amount of energy being used at any given time of the day. The primary aim for the battery is to maximise a reduction in energy consumption during peak periods. The cost of a battery system has been estimated as directly proportionate to its size. Therefore, if the amount of demand during peak periods reduces, so does the cost, and therefore the overall size of the opportunity its impacted but not necessarily the proportional return on investment. Secondary Data has a reasonable impact upon the economic potential for Solar PV and Battery systems. However, the size and configuration can be easily altered to reflect changes as the project progresses.

6.2.3 Infrastructure Review

An assessment of the infrastructure status map published by UKPN identified the capacity status of sub-stations connected to Manor Royal. The map offers the capacity status of sub-stations at the 11kV, 33kV and 132kV level as well as a geographical boundary heat map of capacity status.

There are three 132kV sub-stations which potentially feed the Manor Royal Estate (as well as the Crawley town area), the map does not confirm which of these stations do or do not feed Manor Royal. The 'Three Bridges Local', 'Three Bridges Main' and 'Three Bridges Grid' are listed as providing the 33kV sub-stations at Manor Royal. All are highly utilised, 'Three Bridges Local' is recorded as having 'significant demand capacity'. Demand capacity for the remaining sub-stations is unknown.

'Crawley Industrial East' and 'Crawley Industrial West' are the two 33kV sub-stations feeding the Manor Royal site. Both record 'network issues' under limiting constraints. West has a limited demand capacity, and east significant demand capacity.

Dozens of 11kV sub-stations feed the Manor Royal site, every station is recorded to have an 'unknown' demand capacity.

Manor Royal is located within a "flexible distributed generation zone". As indicated by the findings at each sub-station level this means that there are network constraints within the area. This may cause the cost of connection to be higher than typical. There is an offering within these zones to connect to the existing network without reinforcement or before reinforcement. This may lower the connection cost. However the customer would need to accept a reduction on exports so that the network is kept within existing operational limits. UKPN should be consulted about a Flexible Distributed Generation zone feasibility study.

6.2.4 Planning Regulations

To evaluate the planning requirements within the context of this project we undertook a literature review of the planning documents provided by Crawley Borough Council. We identified those requirements that would apply to the four opportunity clusters and the technologies being considered. The following sections identify the relevant policies and our recommendations for complying with them, where possible.

6.2.4.1 Gatwick Airport

Crawley's Local Plan 2030 map highlights the boundary for 'Gatwick Safeguarded Land', land which is reserved for the expansion of Gatwick airport if required. Parts of cluster 4 in the north-east corner are included within the Gatwick Safeguarded Land boundary, and therefore must comply with Policy GAT2. However, according to this policy 'small-scale building works are likely to be approved' within this area. We would therefore expect adding generation technologies which do not consume additional land to be accepted. However Gatwick airport must be consulted as a stakeholder for development within this area.

6.2.4.2 Neighbouring Residential Area

Opportunity cluster 3 which is situated in the south-western corner of Manor Royal neighbours a residential area, mainly Tushmore Avenue. Developments in this area would need to comply with policy EC4; 'the proposed development cannot adversely impact upon the amenity, function or setting of the neighbouring residential area'. The development of roof-mounted solar panels, ground-mounted solar car ports, and or an energy storage solution is unlikely to adversely impact upon the neighbouring area. In regards to the infrastructure supporting the technologies, the sub-station we expect to be serving the cluster are all located on-site and not within the adjacent residential area. Therefore any network or sub-station work would not expect to interrupt the residential area. However, we recommend engaging with Crawley Borough Council early on in the process and offering a proposal of how the proposed development(s) would not adversely impact the neighbouring residential area.

6.2.4.3 Manor Royal Design Guide

The Manor Royal Design Guide is a supplementary planning document which offers a consistent approach to improvement projects on the estate. As creating a modern visual identity forms part of this approach we suggest that the aesthetics of these technologies must consider the approach detailed in the design guide. We refer particularly to the solar car ports which have a clear visual impact on the surrounding environment. Additionally, any development of an energy centre to house proposed technologies should consult with the design guide to support the consistent visual identity of Manor Royal. The requirement for an energy centre is not anticipated for the proposed power technologies, but will be required for any proposed networks as assessed by the district heating study.

7 Evaluation

This study sets out a data centric process for identifying opportunities for local low carbon energy systems. Due to constraints in obtaining data, secondary sources have been used to progress the project. By doing so we have been able to both provide a tangible output that can be used to engage stakeholders as well as identifying a small number of practical opportunities for low carbon energy systems. The economic performance of these opportunities can be refined as further accuracy is obtained with additional business data.

The economic performance of stand-alone generating technologies (solar car ports and solar PV) is less impacted by the use of secondary data. Technologies which consume and or replace existing capacity (CHP and batteries) are more dependent upon the data used.

The techno-economic model suggests healthy returns on the proposed investments, using the given assumptions. The more 'technology ready' solutions (solar PV and CHP) return the initial investment sooner due to the lower costs as supply chains are more established. The assessment in section 6.2.1 highlights the financial impact of not benefiting from the feed-in tariff which is due for closure in April 2019. Across the projects proposed not receiving FiT payments adds approximately 1 or 2 years on the length of time it takes for the initial investment to be recovered. However, this is a purely financial appraisal, social and environmental objectives need to be considered within the investment appraisal.

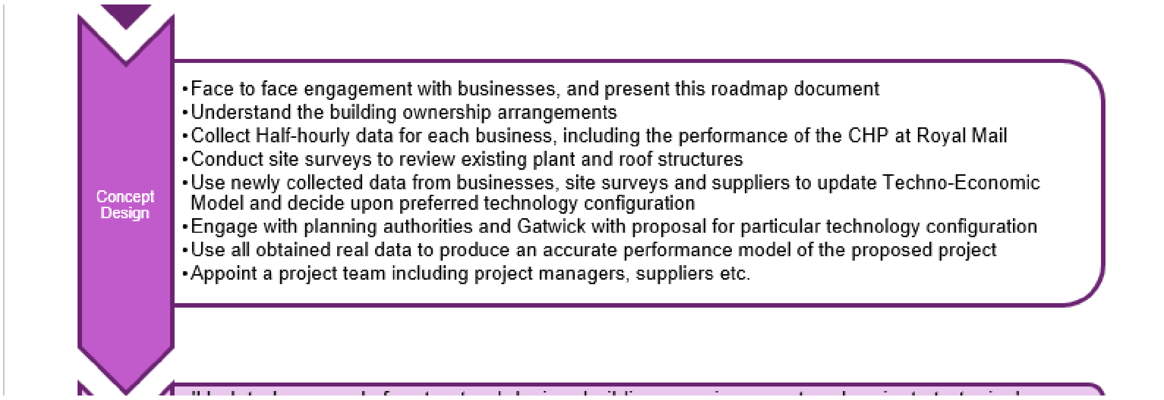
This study was designed to achieve a number of interim objectives that collectively would satisfy one overall objective.

- ✓ Consider the feasibility of installing a range of energy generation technologies
- × Engage site stakeholders with the project
- ✓ Use a systematic and transparent methodology for evaluating opportunities
- ✓ Provide a documented roadmap for progressing recommendations

Unfortunately this study has been unsuccessful at engaging site stakeholders which has limited the primary data inputs. However, documented secondary data sources have been used as a contingency in order to achieve the main objective: **prioritise and identify a small number of opportunities**. Although the desire was to include the site stakeholders in establishing the shortlist, the project team now agree that the most effective approach is to use the outputs of this study to engage the site stakeholders and refine the already established shortlist.

8 Next Steps

We have presented the RIBA Plan of Works which details 8 stages for the development of works projects. We recommend following these stages where appropriate for structuring successful progression with each opportunity cluster. This study aligns with the successful completion of the first two stages, with progress into the 3rd, Concept Design. The actions listed in Concept Design are designed to be sequential and reflect the content of a Feasibility Study.



However, prior to the Feasibility Study we do recommend completing the first action for all four clusters, “face to face engagement with businesses, and present this roadmap document”. It is imperative that before commencing the Feasibility Studies we understand their perceptions of the technologies proposed, site ownership arrangements, their organisational objectives, and investment potential. The stakeholders’ involvement will directly affect the scoping of the Feasibility Studies.

Once stakeholders have been engaged the scope of the feasibility studies will be clearer regarding:

- Technology configurations
- Site install practicalities
- Investment arrangements
- Energy system operational models

We understand that there is a need to finalise all feasibility studies by December 2018. We would expect the feasibility studies to take between 3 to 5 months and would therefore advise that they should commence no later than May 2018 to allow for delays when engaging with third party stakeholders.

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