LANCASTER UNIVERSITY

ARUP

Lancaster University

Infrastructure
Masterplan
2007 - 2017

Lancaster University
Infrastructure Masterplan
2007 - 2017

Issue

- Final Draft

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1. Introduction

The infrastructure masterplan aims to provide an implementation plan for infrastructure projects for the period 2007 to 2017. The infrastructure project consists of upgrade and replacement of mechanical, electrical and fire alarm infrastructure services along with remedial works to highways and drainage.

The masterplan draws from Arup's Sustainable Energy Infrastructure Study (SEIS). The SEIS presents an economically expedient series of solutions to rejuvenate the energy generation and related infrastructure services whilst addressing campus expansion requirements and reduction of the University carbon footprint.

It is estimated that these projects will reduce the campus energy consumption by as much as 10%. Energy efficiency and the addition of renewable energy projects over the period of this masterplan has the potential to reduce campus carbon dioxide emissions by over 2,300 tonnes per year based on 2007 figures.

The masterplan also draws from the fire alarm strategy produced by Arup and the campus drainage and highways studies produced by SKM.

The long term plan requires significant capital commitment. The capital investment options associated with the procurement of new engineering services have been identified in the Sustainable Energy Infrastructure Study (SEIS).

2. Energy Policy Statement

Lancaster University recognises that all aspects of its operations consume energy. The university is committed to be as efficient as possible in its use of energy and natural resources in order to minimise both its impact on the environment and its energy costs. It is recognised that major changes will be required in the longer term in order to achieve these aims. The university will thus adopt the following principles.

- Monitoring & measuring energy use in all parts of the University, quantifying consumption and identifying significant and abnormal energy use.
- Reduce energy consumption through a targeted programme of works designed to minimise usage and improve efficiency.
- Develop an ongoing programme of preventative maintenance in order to improve the efficiency of campus centralised energy and heat transmission systems.
- Procure energy from renewable, and/or local sources in order to minimise greenhouse gas emissions, fossil fuels usage and transmission losses.
- Generate electricity and heat on campus using the most efficient methods, selecting and testing renewable sources where possible.
- Consider the energy usage implications of all major campus developments, achieving the highest possible energy efficiency standards, with BREEAM ratings of ‘Excellent’ for new build and or ‘Very Good’ for redeveloped buildings.
- Comply with all relevant legal requirements, sector targets and other energy related guidance to which the University subscribes.
- Consider energy usage implications of procurement decisions at an early stage and fully integrate energy lifecycle information into purchasing decisions.
- Use and develop the unique research and commercial innovation resources present at the campus to advise and assist in energy efficiency matters.
- Report on energy use, costs and associated emissions to Departments and University senior management.
- Work with staff, students, commercial partners, contractors and visitors to ensure all are fully aware of Lancaster University Energy Policy, and associated procedures, providing a programme of education and advice as necessary.

3. Electrical Infrastructure

The University is undergoing significant development, which will require an increased electrical supply to the site and various modifications to the high voltage electrical infrastructure. Below is a summary of the required works.

The University has commenced a procurement process for additional capacity for the site. The University's existing authorised supply capacity is 7.5 MVA, an application for a further 3 MVA by 2012 and a further reserve of 3 MVA by 2020 has been made thus safeguarding the University's electrical requirements for the foreseeable future. The new supply will require a 33 KV underground supply from the centre of Lancaster to the University.

The University presently owns, operates and maintains its own high voltage ring main which consists of 12 high voltage (11kV) substations. In order to provide the increased load by 2012 the ring main will have to be rationalised and divided into two ring mains.

The majority of the substations, transformers and switchgear were manufactured, constructed and installed during the 1960's and 1970's and are now operating beyond their expected life when compared to Chartered Institute of Building Services Engineers (CIBSE) life expectancy of 30 years

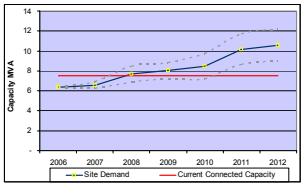
Due to the age and obsolescence of the switchgear and transformers, these have been identified for replacement within the next decade. Although the manufacturers of the existing equipment have indicated spares are currently available, no timescales are available as to how long this may continue.

It is difficult to fully determine the overall condition of the high voltage cables without taking sample cuts, however, from experience underground high voltage cables generally have extremely long lives of 40 - 60 years. It is therefore proposed to pressure test and make repairs as required over the next decade.

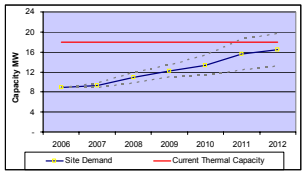
The existing Combined Heat and Power (CHP) unit has an electrical output of 1.6 MWe and the ability to run on either gas or oil. This unit is approaching the end of its economic life and will be replaced subject to the outcome of a detailed economic appraisal and feasibility study.

The low voltage switchboards (400 V) associated with each substation will be renewed in accordance with the programme for the high voltage switch gear.

Budget costs for this work are identified within the masterplan.



4. Heating Infrastructure



A substantial part of the heating services infrastructure has reached the end of its economic life due to its age and significant investment is required to bring the assets back to an acceptable condition.

In addition the current CHP unit is approaching the end of its economic life, due to spares becoming rare or obsolete.

The central heating infrastructure consists of three dual fuel hot water boilers and the CHP provides the primary heat source for the University base load.

The existing boilers are gas fired and backed up by diesel oil. There are 2 boilers with a capacity of 3.5 MW and 3rd with a capacity of 7 MW, therefore delivering a total peak output of 14 MW. Currently they are supported by the existing CHP which generates approximately 3.3 MW of heat output.

The current hot water provision is supplemented in local storage calorifiers by 1.8 MW installed capacity of electric immersion heaters controlled by time clocks and thermostats.

Over 80% of the heat load is generated at the central plant and distributed around the site through pipework located within the underground service duct to satellite plantrooms located within individual buildings. The heat is transferred via non storage heat exchangers for heating systems and via storage calorifiers for domestic hot water usage. The plant and equipment will require replacement within the next decade.

The infrastructure project includes for the provision of a new energy centre, which includes high efficiency dual fuel boilers, CHP, new cold water storage tanks and associated ancillaries. The energy centre replacement project will be subject to a detailed planning strategy designed to minimise disruption to the University.

In order to fully determine the condition of the district heating mains pipework it is to be subjected to detailed non intrusive and intrusive analysis over the next 9 months. From a visual inspection, the pipework appears to be in reasonable condition given its age.

The engineering services within satellite plantrooms will be replaced as part of the infrastructure project.

The building management system and controls will be upgraded as part of the energy centre and satellite plant room upgrades.

At this stage costs have been included for the replacement of the district heating mains, gas and water pipework.

A budget cost for this work has been identified within the infrastructure masterplan.

The option of decentralisation has been considered within the SEIS report and discounted due to increased maintenance costs, lower plant efficiency, higher spatial requirements and increased plant and infrastructure capital cost.

5. Water and Gas Infrastructure

The main cold water supply for the University consists of two substantial water storage tanks, which are located within the energy centre, where two large electric pumps and a diesel standby pump distribute supplies to the site.

The cold water is distributed through the underground service duct to individual buildings through approximately 3 km of 300mm steel pipe. The University also has a second water distribution network that is used for the fire hydrants, this is approximately 3 km of 150mm steel pipe.

The gas supply around site is also distributed through the underground service duct to individual buildings.

The majority of the pipework was installed during the 1960's and 1970's and is therefore coming to the end of its economic life, due to its age when compared to CIBSE life expectancy of 25 – 35 years. This has been confirmed by a visual inspection, where both the gas and water distribution infrastructure is showing signs of ageing, corrosion and degradation.

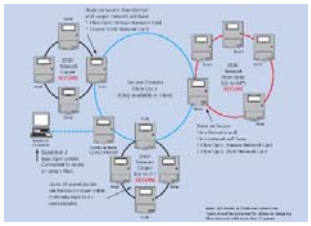
The pipework will be subjected to a detailed non intrusive and intrusive analysis over the next 9 months at the same time as the heating mains.

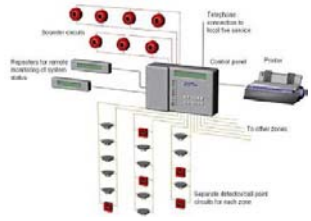
Budget costs for this work have been included within the infrastructure masterplan.

6. Fire Alarm Infrastructure

The current arrangement of the fire alarm system has been developed and progressively installed over a long period of time and therefore a wide range of installation methods have been used across the University campus. These include:-

- A large number of different fire alarm types makes operating difficult and increases maintenance csots.
- Limited reporting capabilities with non-addressable or non-intelligent fire alarm systems.
- Limited system resilience with many single points of failure





It is proposed the University fire alarm system will be networked using fibre optic cables and latest technology panels, facilitating a University wide fire alarm network. This proposal includes:-

- Fully addressable fire detection, reporting across campus with the Campus Security Lodge as the Hub.
- Other monitoring positions of the site wide system through the communication network.
- A resilient fire alarm network, based around a series of interconnected ring networks offering multiple paths around the network.
- A consistent approach to the fire alarm system design that will make operating and maintenance of the system much easier across the Campus.
- Upgrade of existing fire alarm equipment to be compatible with the optical fibre network.

Budget costs for this work have been included within the infrastructure masterplan.

7. Underground Service Duct

The underground service duct represents a significant asset to the University. From an initial visual inspection the ducts appear to be in a reasonable condition but a full structural survey will be required to confirm this. The main problems are lighting, water ingress, standing water, drainage and asbestos. Funding to address these problems has been included within the infrastructure masterplan.

An asbestos survey has been carried out and asbestos containing materials identified. In accordance with the University's asbestos management plan, asbestos will be removed, prior to any work taking place within the area.

Water ingress will be investigated and eliminated so far as reasonably practicable. Drainage will be improved to eliminate the hazard of standing water.

The general and emergency lighting will be upgraded.

It is proposed to take a 2 stage approach to the issue of mechanical services distribution throughout the spine duct and satellite plantrooms. The objective of stage 1 will be to determine the full extent of the problem faced and stage 2 will evolve from these investigations.

Structural modifications will have to be made to the underground service duct to facilitate the removal and re-installation of the pipework.

8. Highways and Drainage

Highways Infrastructure

The more recently introduced developments have meant a high frequency of heavy plant and delivery vehicles being present. The carriageway has therefore seen accelerated erosion and whilst the planned expansion will continue, the condition of the highway is such that repairs need to be programmed in order that the University maintains a safe means by which vehicles may pass.

SKM structural engineers are working on a detailed programme to survey, report and implement remedial works necessary to maintain the Estates major and feeder roads. Until this report has been received the full extent of the repair works will be unknown. Notwithstanding this the Estates Department have undertaken a desk-top exercise in order that budget costs for the likely remedial carriageway works are established.

Drainage Infrastructure

The main campus water drainage infrastructure consists of gravity system that runs north to south. The existing surface water drainage system has experienced various flooding incidents in previous years.

A study by SKM has indentified a number of measures that should be put in place to relieve the local flood issues and to avoid overloading the trunk pipes. These include:-

- An overflow from the area adjacent to the chaplaincy centre down the hill to the existing lake
- The provision of a number of below ground attenuation tanks
- Pipe upsizing measures

These measures have already been incorporated into new developments including, Management School, LEC and Infolab.

The existing Foul water system has experienced no reported flooding incidents, reports indicate sufficient capacity for existing usage.

9. Energy Efficiency

During 2008 - 2009 it is proposed to install electricity and heat metering to all main building incomers enabling energy to be automatically monitored on a building by building basis.

When the automated metering is installed, monitoring and targeting can commence as demand and consumption information will be available.

Energy surveys will be commissioned, the outcome of which will result in reduced energy consumption through a targeted program of work designed to minimise energy consumption and improve efficiency.

The University is planning to participate in the Higher Education Carbon Management Programme, and use this programme, together with existing services as a framework for improving energy management and reducing carbon emissions across the campus.

Departmental energy efficiency will be assessed as part of an ongoing programme of energy and environmental audits. The existing departmental environmental champions will be utilised by the environmental and sustainability manager to assist in delivering energy saving initiatives at a local level.

The existing and planned heat and electric metering / monitoring system will be utilised by the estates department to collate tables providing a detailed and comprehensive picture of campus energy use.

10. Sustainable Energy Proposals

Sustainable energy infrastructure opportunities have been investigated and viable solutions presented below. Opportunities and options excluded are presented here.

Bio-oils

It is currently proposed that Bio-oils be used as the secondary fuel for the energy centre that will house the CHP and central boilers. This solution will contribute to a low carbon footprint with the least spatial impact and most conventional plant. With this solution the University would be provided with operational flexibility to achieve carbon targets.

Liquid bio-fuels are any liquids produced from organic sources which can be used to produce useful energy most simply within conventional boiler plant burners.

Biomass

It is recommended that the installation of small Biomass boilers on a new development would allow the university to gain experience of the technology without significant cost or risk.

Crops maybe grown especially for biomass fuel such as short rotation coppice (SRC) of willow, hazel, poplar and miscanthus (elephant grass). Wood sourced biomass is the most common biomass resource and it comes in two main forms, wood chip and wood pellet. Wood chip is the cheapest and most readily available. The recommended Biomass solution focuses on a conventional biomass boiler installation with storage facility. The boiler would raise hot water for heating and domestic hot water.

Wind Turbines

Presently wind turbine viability is being assessed in detail and it is anticipated that an assessment would reveal that one to three relatively large wind turbines could make a substantial contribution to site electricity supply and cost. This would also present a statement of corporate commitment to sustainability.

Discounted Technologies

The SEIS study considered other renewable technologies which were discounted. These included Photovoltaic Solar Cells, Solar Hot Water, Hydrogen Fuel Cells, Ground Source Heat Pumps and Anaerobic Digestion. Further details are available within the sustainable energy infrastructure study.

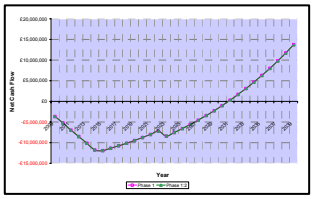
11. Cost Summary

The projected cost of implementing in full the 2007 – 2017 infrastructure masterplan is £24,400,000.

The indicative cost of the works is based upon current day prices, with no allowance made for inflation. This has been prepared by Arup in conjunction with the University and checked by RLB quantity surveyors.

The headline costs are broken down as follows.

Strategic Reports		£150,000
Asbestos Removal		£250,000
Mechanical Infrastructure		£6,000,000
Electrical Infrastructure		£5,500,000
Site Infrastructure		£3,600,000
Risk Factor and Contingency		£5,300,000
VAT @ 17.5 %		£3,600,000
	Total	**£24,400,000**



The cost for each individual project will need to be confirmed by an early feasibility study as each project is drawn forward from the masterplan as a specific project.

Procurement of the complete infrastructure project requires a carefully selected delivery mechanism. This mechanism for each element can consist of a single party model or a collaborative third party model with varying degrees of responsibility for financing, delivery and operation.

12. Conclusions and Recommendations

Conclusion

A substantial amount of the University's infrastructure is coming to the end if it's economic life due to its age and condition with certain assets presenting a serviceability risk. Significant investment is required to upgrade the infrastructure, in particular the engineering services.

It is predicted that the electricity supply capacity will be overloaded by late 2009 and a new supply from the centre of Lancaster is required as a matter of priority. The switchgear and transformers are in a reasonable condition, but there is a serviceability risk associated with this plant and equipment due to their age, significant investment will be necessary to replace this equipment over the next 10 years.

It is becoming increasingly difficult to maintain the condition and serviceability of the existing CHP, central boiler plant and central water storage plant. This represents a risk to the reliability and continuity of heating and water supplies, moreover the current heating arrangements are expensive to operate and lack flexibility.

The primary heating, gas and water services distribution pipework requires a detailed analysis to determine the level of expenditure needed over the next 10 years. The analysis will require extensive non destructive and destructive testing of the pipework within the underground services duct. Initial visual inspections show signs of ageing, corrosion and degradation particularly to the gas services Wholesale replacement will cause major disruptions to the University and will need careful planning and execution.

The underground service spine requires remedial work to rectify the problem of water ingress and standing water.

Substantial remedial work will be required to the highways due to accelerated corrosion caused by high volumes of heavy plant and vehicles due to high number of recent new major developments

The existing campus surface water drainage system has experienced various flooding incidents over recent years. As the campus is developed further, remedial works will be needed to alleviate the flooding problems. There have been no reported flooding incidents associated with the foul water drainage system.

To meet the ever increasing environmental and financial requirements, sustainable energy infrastructure opportunities have been investigated and viable proposals presented.

Procurement of the infrastructure project will require a carefully selected delivery mechanism. If funds are available the procurement option could be for the university to self finance all elements of the infrastructure upgrade project, this way the university does not incur any monthly charges or long term contracts. Should the required level of funds be unavailable then a third party approach could be considered.

Conclusions and Recommendations

Recommendations

The infrastructure masterplan has been developed based on an analysis of each of the main infrastructure elements, determining how best to meet the Universities future needs in the short, medium and long term. The infrastructure masterplan outlines optimal, proposed solutions, but these will be subject to detailed economic and feasibility assessments as part of the design and development process. The main recommendations of the masterplan are given below:-

- The electrical supply capacity is increased within 18 months to meet the demands of the university over the coming decade. The electrical infrastructure is substantially renewed over the next decade.
- The existing central boiler plant and CHP plant are replaced within 3 years with CHP and dual fuel boilers which can operate on gas and a sustainable bio-oil.
- The existing main site water storage tanks and pumps should be replaced within 2 years.
- The condition and extent of the infrastructure distribution pipework systems is to be determined within 9 months and replaced where necessary within 5 years.
- The highway infrastructure is completely resurfaced over the next 5 - 10 years with remedial repairs competed within the next year.
- Automated energy metering of every building is implemented as soon as practically possible, energy surveys and energy initiatives are implemented with a targeted programme of works designed to minimise usage and improve efficiency.
- The estates department to produce league tables detailing faculty and departmental energy usage during the previous period.
- The fire alarm infrastructure be upgraded to an addressable system with the main hub being located within the security lodge.
- Renewable technologies in the form of bio-oil, Bio-mass and wind should be further considered as the most appropriate technology for the University and should be included as part of the infrastructure upgrade.
- To ensure that the campus surface water network is managed sustainably the flood relief measures identified in the SKM report should be implemented

All of the above recommendations will require significant investment over the next decade. It is estimated that an investment of £24,400,000 will be required to provide a reliable infrastructure.

Conclusions and Recommendations

Action Plan

A “live” action plan has been established by the University and Arup to identify the tasks that have been highlighted during the various studies including the SEIS and need to be addressed through the infrastructure project.

Cost Plan

An initial cost plan has been developed by the University, Rider Levett Bucknell and Arup and is presented within this masterplan. The capital cost for all the work mentioned previously has been broken down into sections and costs assigned to each logical work package.

Project Plan

An illustrative project plan has been developed by the University and Arup to outline the extent and timeframe of work that needs to be undertaken over the next decade to ensure security of supplies and infrastructure fabric to the university and its buildings.

Activity Plan

To illustrate the amount of work that is being undertaken as part of this project and also the year it is currently scheduled to happen, annual illustrations have been provided giving a visual impression of the infrastructure project

Action Plan

Live Action Plan (Rev 6)

Ref	Recommendation	Action	Priority	Responsibility	Capital Costs	Benefits	Time Scale	Additional Comments
1	Asbestos enabling works.	University to prepare and issue Asbestos Removal Tender.	1	LU	See Infrastructure Masterplan Cost Assumptions.	-	See General Infrastructure Project Plan.	LU to Tender
2	Upgrade the universities HV supply network thus increasing capacity.	LU have appointed an M&E consultant to conduct capacity study and tender additional capacity.	1	LU / M&E Consultant	See Infrastructure Masterplan Cost Assumptions.	Further site expansion possible	See General Infrastructure Project Plan.	Application to UU made
3	Develop a contingency plan to reduce site electrical base load.	Desk study required to identify possible methods of reducing the site base load.	1	LU / M&E Consultant		This may buy the university additional time to procure the additional capacity	See General Infrastructure Project Plan.	
4	Develop a control strategy for the Electric immersion heaters so they do not operate un-necessarily.	LU to appoint an M&E consultant to develop a control strategy so the operation of the electric immersion heaters is limited.	3	LU / M&E Consultant		Energy saving potential	See General Infrastructure Project Plan.	
5	Replace the boiler and the associated plant.	LU to tender appointment of M&E consultant to conduct a further more specific study and tender the replacement work.	1	LU / M&E Consultant	See Infrastructure Masterplan Cost Assumptions.	Increased efficiency of plant operation	See General Infrastructure Project Plan.	Tenders received
6	Refurbish the existing distribution network. Certain areas may need to be removed.	LU to appoint an M&E consultant to conduct a further more specific study and tender the refurbishment work.	1	LU / M&E Consultant	See Infrastructure Masterplan Cost Assumptions.	Reduced pipework losses through improved insulation.	See General Infrastructure Project Plan.	Tenders received for NDT
7	Develop a contingency plan to mitigate risk of District Heating Failure. (Option 2)	Option 1 - Temporary heat source for different failure scenarios to be evaluated by M&E consultant.	1	LU / M&E Consultant		Site could continue operation in the event of failure through the installation of temporary boilers	See General Infrastructure Project Plan.	Carry out detailed analysis of existing pipework.
		Option 2 - M&E Consultant to work with a contractor to determine the condition of the pipework.	1	LU / M&E Consultant		Time to failure can be estimated and allow for repair at a suitable time (Summer)	See General Infrastructure Project Plan.	
8	Detailed study into the replacement of the current combined heat and power (CHP) unit with recommendations into the most appropriate technology.	LU have appointed an M&E consultant to conduct a detailed CHP study detailing options, payback and plant configurations.	2	LU / M&E Consultant	See Infrastructure Masterplan Cost Assumptions.	CHP assists the university building regulation compliance. It also allows the university to make CO_2 savings over a conventional approach.	See General Infrastructure Project Plan.	Short and medium term studies completed

Ref	Recommendation	Action	Priority	Responsibility	Capital Costs	Benefits	Time Scale	Additional Comments
9	Develop a primary metering system and strategy for the university.	LU has appointed an M&E consultant to work with the university with the aim of developing a system that allows the university to monitor energy usage at infrastructure level.	**1**	LU / M&E Consultant	See Infrastructure Masterplan Cost Assumptions.	A metering system allows the university to compare the energy usage of all its building and allows the university to its resources	See General Infrastructure Project Plan.	Planned implementation during summer 2008.
10	Develop a secondary metering system and strategy for the university.	LU has appointed an M&E consultant to work with the university with the aim of developing a system that allows the university to monitor energy usage at building level.	**3**	LU / M&E Consultant		A metering system allows the university to compare the energy usage of all its building and allows the university to its resources	See General Infrastructure Project Plan.	Phase 1 of the metering
11	Appraise the opportunity available for a wind turbine / wind farm on the newly purchased agricultural land.	LU to appoint a consultant to conduct an options assessment appraisal into the viability of installing a large scale wind turbines.	**3**	LU / CT		A wind turbine installed on the universities land will make a statement of its commitment to the environment. It would also act as a second source of electric to the site.	See General Infrastructure Project Plan.	Partnership for Renewable are currently working with the university to develop a commercial case for the installation of a wind turbine within the campus.
12	Replacement of existing calirifiers with plate heat exchangers.	LU to continue with the current replacement program and draw on the M&E consultants expertise as and when required.	**3**	LU are currently developing the strategy	See Infrastructure Masterplan Cost Assumptions.	The installation of plate heat exchangers reduces the number of items that need to be inspected by the insurance inspector.	See General Infrastructure Project Plan.	
13	Develop a general housekeeping regime to ensure that the central service spine is kept clean and tidy.	LU to review the cleanliness of this area on a regular thus keeping this area.	**Ongoing**	LU		General Aesthetics	See General Infrastructure Project Plan.	
14	Installation of new submerged pumps within the central spine duct.	LU to replace the current submersible pumps in the service spine with new heavy duty pumps. LU to draw on an M&E consultants expertise as and when required.	**1**	LU		The service spine will be accessible at all times without the need for Wellingtons.	See General Infrastructure Project Plan.	
15	Consider the Installation of a biomass element within the energy centre upgrade.	LU to appoint an M&E consultant to conduct a further more specific study and tender the replacement work.	**3**	LU / M&E Consultant			See General Infrastructure Project Plan.	
16	Consider the option of farming short	On Hold.	**3**	LU / M&E Consultant			See General	Dependant on

Ref	Recommendation	Action	Priority	Responsibility	Capital Costs	Benefits	Time Scale	Additional Comments
	rotation coppice on university land.						infrastructure Project Plan.	biomass boiler installation.
17	Design, Build, Finance, Operate and Maintain (DBFOM) should be considered as a means of achieving additional capacity.	LU to appointed an ARUP to conduct work around the best way to finance there refurbishment work.	**1**	LU / M&E Consultant		-	See General Infrastructure Project Plan.	
18	Installation of a replacement cold water storage/break tank and ancillaries.	LU to replace the current cold water storage/break tank and associated ancillaries.	**2**	LU	See Infrastructure Masterplan Cost Assumptions.	-	See General Infrastructure Project Plan.	Currently programmed for 2009
19	Upgrade the current oil storage facility.	LU to upgrade / reline the existing storage tanks. Consideration should be made for bio-oil storage.	**2**	LU	See Infrastructure Masterplan Cost Assumptions.	-	See General Infrastructure Project Plan.	
20	Upgrade and refurbish the existing HV substations / network on campus.	LU to appoint an M&E consultant to conduct a further more specific study and tender the replacement work.	**3**	LU / M&E Consultant	See Infrastructure Masterplan Cost Assumptions.	Resilience of supply	See General Infrastructure Project Plan.	
21	Upgrade and refurbishment of HV to LV supplies stopping at the first LV board.	LU to appoint an M&E consultant to conduct a further more specific study and tender the replacement work.	**3**	LU / M&E Consultant	See Infrastructure Masterplan Cost Assumptions.	Resilience of supply	See General Infrastructure Project Plan.	
22	Upgrade and refurbishment of the existing drainage network	LU to appoint a civil engineer to generate a detailed design and generate tender documents.	**2**	LU / Civil Engineer	See Infrastructure Masterplan Cost Assumptions.	-	See General Infrastructure Project Plan.	
23	Upgrade and refurbishment of the existing highways infrastructure	LU to appoint a civil engineer to generate a detailed design and generate tender documents.	**3**	LU / Civil Engineer	See Infrastructure Masterplan Cost Assumptions.	-	See General Infrastructure Project Plan.	
24	Upgrade and refurbishment of the existing fire alarm network	LU to appoint a civil engineer to generate a detailed design and generate tender documents.	**2**	LU / M&E Consultant	See Infrastructure Masterplan Cost Assumptions.	Health and Safety	See General Infrastructure Project Plan.	
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The table below gives a brief explanation of the priorities.

	Description
Priority 1	Attention required in the short term – Business Critical
Priority 2	Attention required in the medium term – Potential for Failure
Priority 3	Attention required in the long term – Long term security questionable

Cost Plan

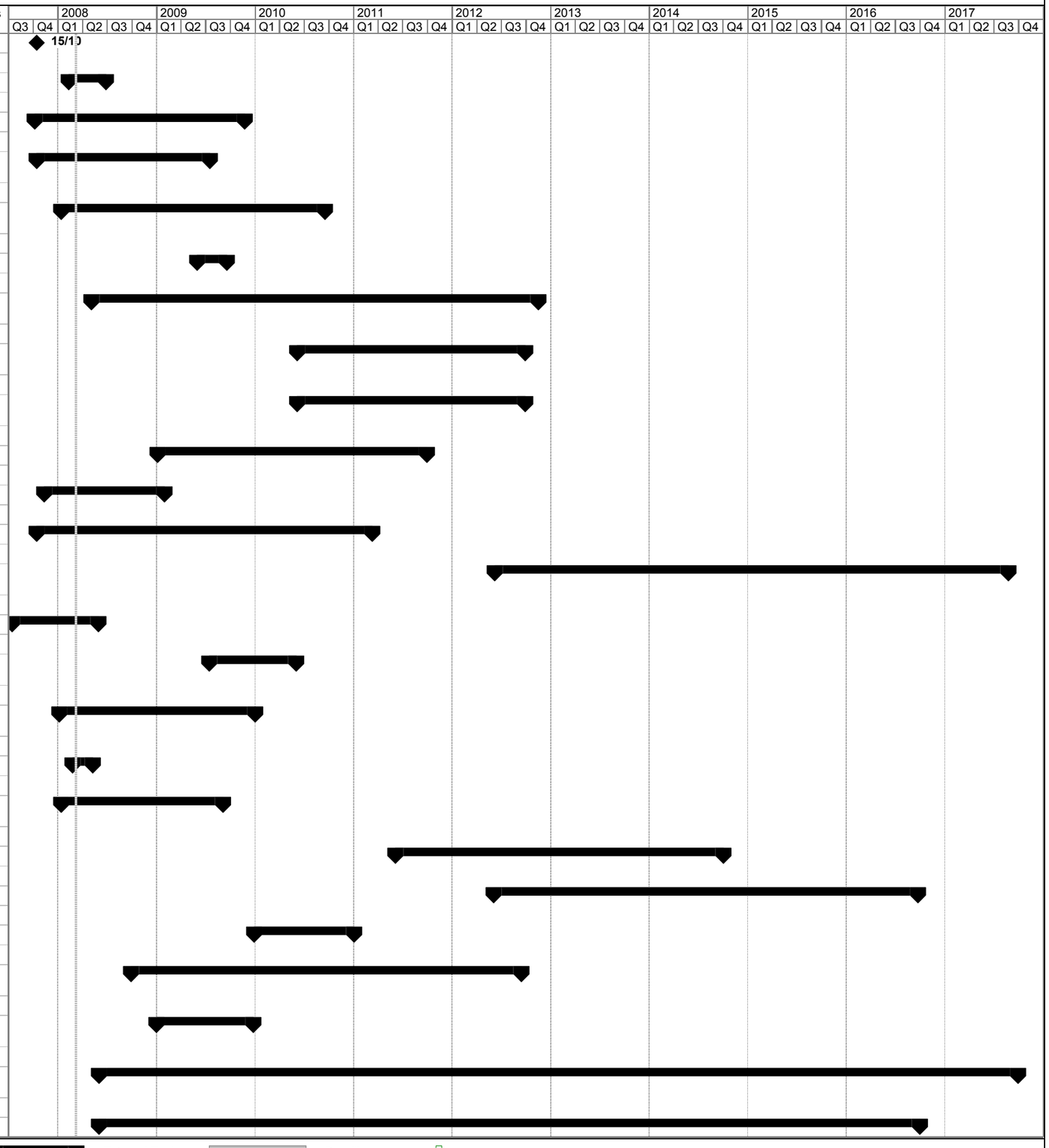
Infrastructure Masterplan Cost Assumptions

	Capex Cost Breakdown	Estimated Costs												
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	**Totals**	**Assumptions**
Prelim Work	Asbestos removal within boilerhouse and service spine		£250,000										**£250,000**	LU Estimate
Strategic Reports	Fire Alarm Infrasrtucture Study	£30,000											**£30,000**	Fees
	Drainage and Highways	£25,000	£25,000										**£50,000**	Fees
	Sustainable Energy Infrastructure Study	£75,000											**£75,000**	Fees
Mechanical infrastructure improvement	CHP plant replacement and associated ancillaries				£650,000	£650,000							**£1,300,000**	£650 / kWe
	Replacement of boiler plant for use as standby / top-up boilers				£980,000	£490,000							**£1,470,000**	£70 / kWt
	Biomass Boiler												**£0**	£150 / kWt
	Refurbishment of District Heating Pipework (assumed 3km in existing service spine)				£300,000	£300,000	£300,000						**£900,000**	£300 / m
	Refurbishment of Gas Pipework (assumed 1.5km in existing service spine)				£100,000	£100,000	£100,000						**£300,000**	£200 / m
	Replacement of Cold Water Storage / Break Tanks and Ancillaries (211m³)		£60,000	£83,000									**£143,000**	Estimated using Spons 2008
	Replacement of cold water distribution pipework (assumed 2km in existing service spine)				£100,000	£100,000	£100,000						**£300,000**	£150 / m
	Oil storage tank re-line / replacement			£75,000									**£75,000**	Estimated using Spons 2008
	Upgrade existing satellite heat stations.						£250,000	£250,000	£250,000	£250,000	£250,000	£250,000	**£1,500,000**	Estimated £50,000 / Heat station
Electrical Infrastructure Improvements	Procurement of additional HV capacity		£1,500,000										**£1,500,000**	Estimated
	Upgrade the HV Substations, switch gear and associated equipment.							£468,756	£468,756	£468,756	£468,756		**£1,875,024**	Estimated using Spons 2008
	Upgrade the Primary HV Substations, switch gear and associated equipment.						£423,868						**£423,868**	Estimated using Spons 2008
	Upgrade LV supply and switchgear to each building							£226,875	£226,875	£226,875	£226,875		**£907,500**	Estimated £25,000 / Building
	Implement a primary metering strategy for every building		£75,000	£75,000									**£150,000**	Estimated £2,500 / Building
	Upgrade of University Fire alarm infrastructure		£52,500	£52,500									**£105,000**	£35 / m
	Building Management System upgrade			£130,000	£130,000		£40,000	£40,000	£40,000	£40,000	£40,000	£40,000	**£500,000**	Estimated
Site Infrastructure Improvement	Refurbishment and upgrade of the underpass			£850,000									**£850,000**	G&T Estimate
	Refurbishment and upgrade of site drainage system			£125,000	£125,000	£125,000	£125,000						**£500,000**	G&T Estimate
	Increase the Capacity of the Pond		£100,000	£100,000									**£200,000**	G&T / MW Estimate
	Structural upgrade to Central Service spine			£125,000	£125,000								**£250,000**	LU Estimate
	Highway improvement		£200,000	£200,000	£200,000	£200,000	£200,000	£200,000	£200,000	£200,000	£200,000		**£1,800,000**	RLB Estimate
Additional Costs	Contingency	£13,000	£226,250	£181,550	£271,000	£196,500	£153,887	£118,563	£118,563	£118,563	£118,563	£29,000	**£1,532,439**	10% of capital cost
	Risk Factor	£13,000	£226,250	£181,550	£271,000	£196,500	£153,887	£118,563	£118,563	£118,563	£118,563	£29,000	**£1,532,439**	10% of capital cost
	Design and Project Management	£19,500	£339,375	£272,325	£406,500	£294,750	£230,830	£177,845	£177,845	£177,845	£177,845	£43,500	**£2,298,659**	15% of project cost
Totals	**Total Capital Cost**	£175,500	£3,054,375	£2,450,925	£3,658,500	£2,652,750	£2,077,472	£1,600,602	£1,600,602	£1,600,602	£1,600,602	£391,500	**£20,817,929**	
	VAT	£30,713	£534,516	£428,912	£640,238	£464,231	£363,558	£280,105	£280,105	£280,105	£280,105	£68,513	**£3,620,388**	
	Total Capital Cost + VAT	£206,213	£3,588,891	£2,879,837	£4,298,738	£3,116,981	£2,441,029	£1,880,707	£1,880,707	£1,880,707	£1,880,707	£460,013	**£24,308,317**	

Project Plan

ARUP

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Lancaster University Infrastructure Action Plan**				
2					
3	**Removal of Asbestos within all Project Areas (AP 1)**	**100 days**	**Mon 11/02/08**	**Fri 27/06/08**	
6					
7	**Upgrade the Sites Existing HV Network (AP 2)**	**556 days**	**Mon 08/10/07**	**Mon 23/11/09**	
19					
20	**Procure Additional Capacity to Allow for Site Expansion (AP 3 & 4)**	**460 days**	**Mon 15/10/07**	**Fri 17/07/09**	
25					
26	**Replacement of Central Boilers and Associated Ancillaries (AP 5,6,7 & 19)**	**700 days**	**Mon 14/01/08**	**Fri 17/09/10**	
29					
30	**Oil Tank Refurbishment**	**80 days**	**Mon 01/06/09**	**Fri 18/09/09**	
32					
33	**Replacement / refurbishment of existing thermal distribution infrastructure**	**1185 days**	**Mon 05/05/08**	**Fri 16/11/12**	
37					
38	**Replacement / refurbishment of existing cold water distribution infrastructure**	**605 days**	**Mon 07/06/10**	**Fri 28/09/12**	
40					
41	**Replacement / refurbishment of existing gas distribution infrastructure**	**605 days**	**Mon 07/06/10**	**Fri 28/09/12**	
43					
44	**Replacement of CHP and Associated Ancillaries (AP 8)**	**715 days**	**Mon 05/01/09**	**Fri 30/09/11**	
48					
49	**Implementation of a Energy Monitoring System (AP 9 & 10)**	**320 days**	**Mon 12/11/07**	**Fri 30/01/09**	
52					
53	**Assess feasibility of a wind turbine (AP 11)**	**890 days**	**Mon 15/10/07**	**Fri 11/03/11**	
58					
59	**Upgrade and Replace Hot Water Calorifiers in Satellite Plantrooms (AP 12)**	**1360 days**	**Fri 08/06/12**	**Thu 24/08/17**	
61					
62	**The General House Keeping of the University (AP 13)**	**230 days**	**Mon 16/07/07**	**Fri 30/05/08**	
64					
65	**Upgrade the Central Service Spine, Mechanically, Electrically and Structurally (AP 14)**	**230 days**	**Thu 16/07/09**	**Wed 02/06/10**	
67					
68	**Review Potential Fuel Sources that are Renewable (AP 15 & 16)**	**520 days**	**Mon 07/01/08**	**Fri 01/01/10**	
71					
72	**Define the Most Appropriate Project Deliver Method (AP 17)**	**55 days**	**Mon 25/02/08**	**Fri 09/05/08**	
74					
75	**Replacement of Cold Water Storage System and Associated Ancillaries (AP 18)**	**430 days**	**Mon 14/01/08**	**Fri 04/09/09**	
79					
80	**Replacement and Upgrade of Existing HV Network (AP 20)**	**870 days**	**Mon 06/06/11**	**Fri 03/10/14**	
82					
83	**Replacement and Upgrade of Existing LV Network (AP 21)**	**1125 days**	**Mon 04/06/12**	**Fri 23/09/16**	
85					
86	**Upgrade the existing Underpass**	**265 days**	**Tue 29/12/09**	**Mon 03/01/11**	
88					
89	**Upgrade the Site Drainage system and expansion of Lake Carter**	**1035 days**	**Mon 29/09/08**	**Fri 14/09/12**	
92					
93	**Upgrade and standardisation of the sites Fire Alarm Infrastructure**	**257 days**	**Thu 01/01/09**	**Fri 25/12/09**	
95					
96	**Upgrade and standardisation of the Sites Building & Energy Management System**	**2435 days?**	**Mon 02/06/08**	**Fri 29/09/17**	
98					
99	**Upgrade the existing Highways**	**2175 days**	**Mon 02/06/08**	**Fri 30/09/16**	



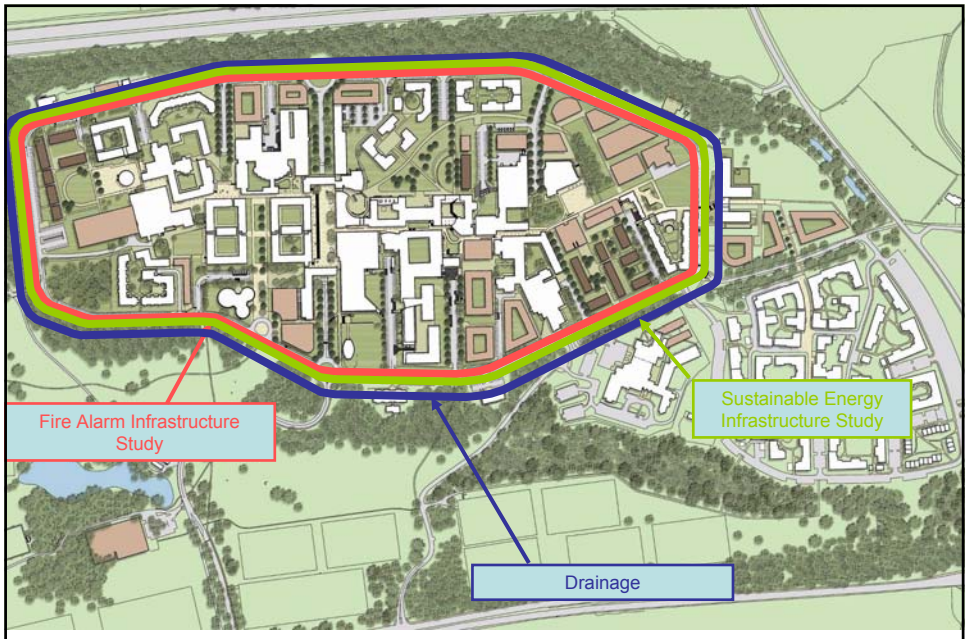
Project: LU Energy Centre Project Plan
Date: Thu 06/03/08

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

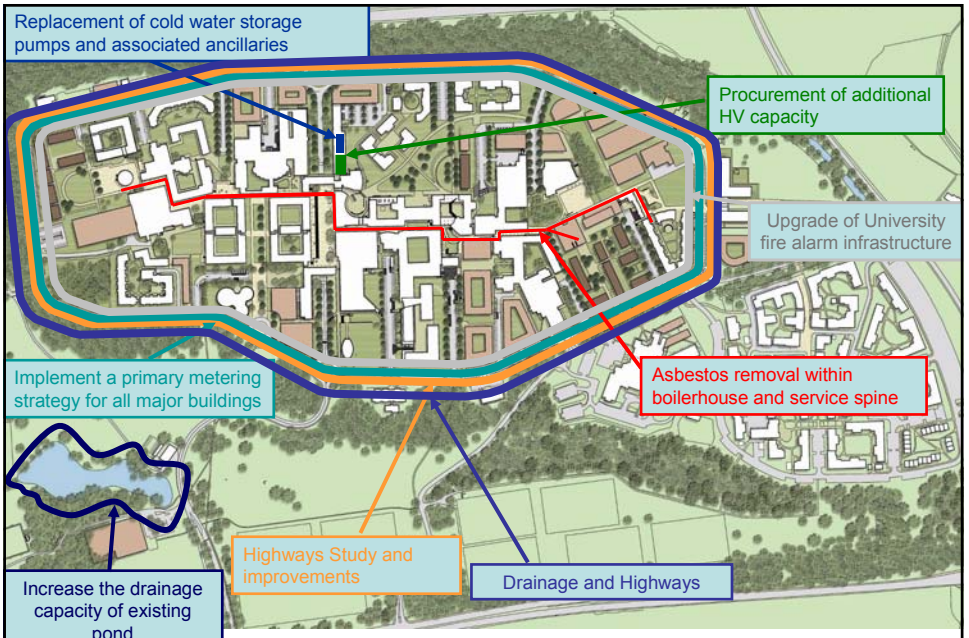
Activity Plan

Lancaster University Infrastructure Masterplan

Activity Plan 2007 to 2017 Rev 6



Lancaster University Infrastructure Masterplan - 2007



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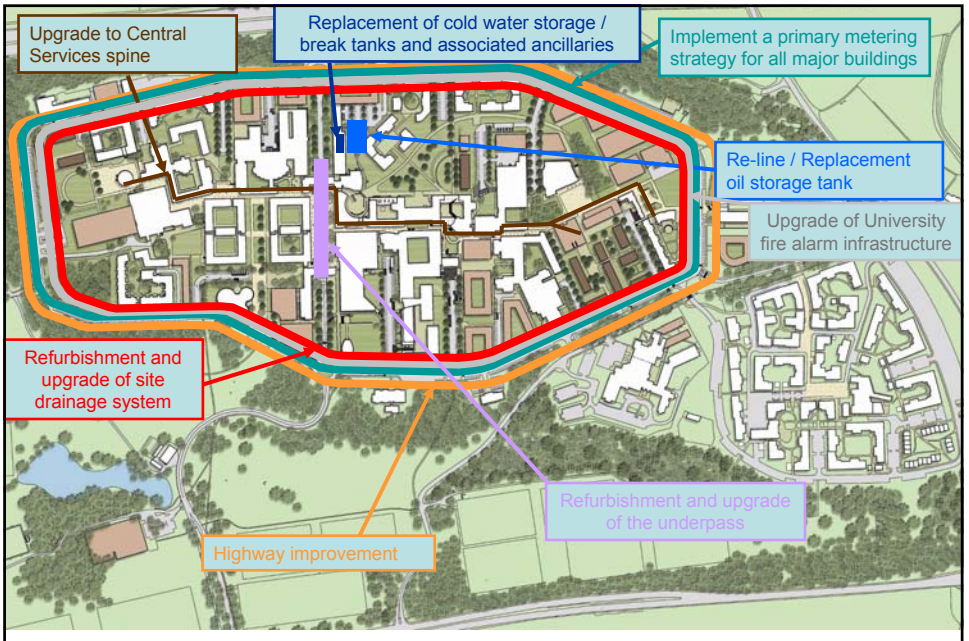

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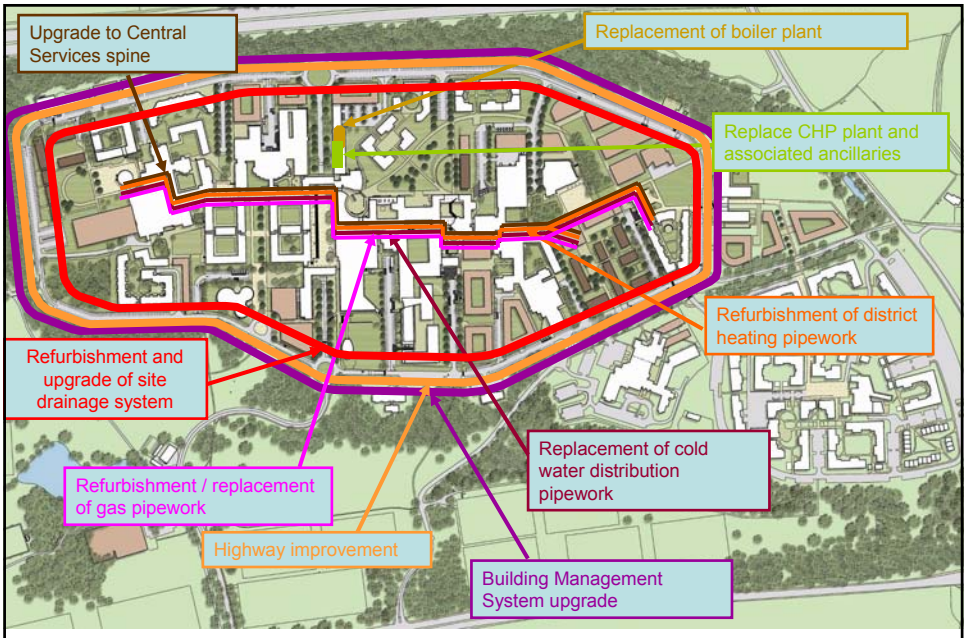

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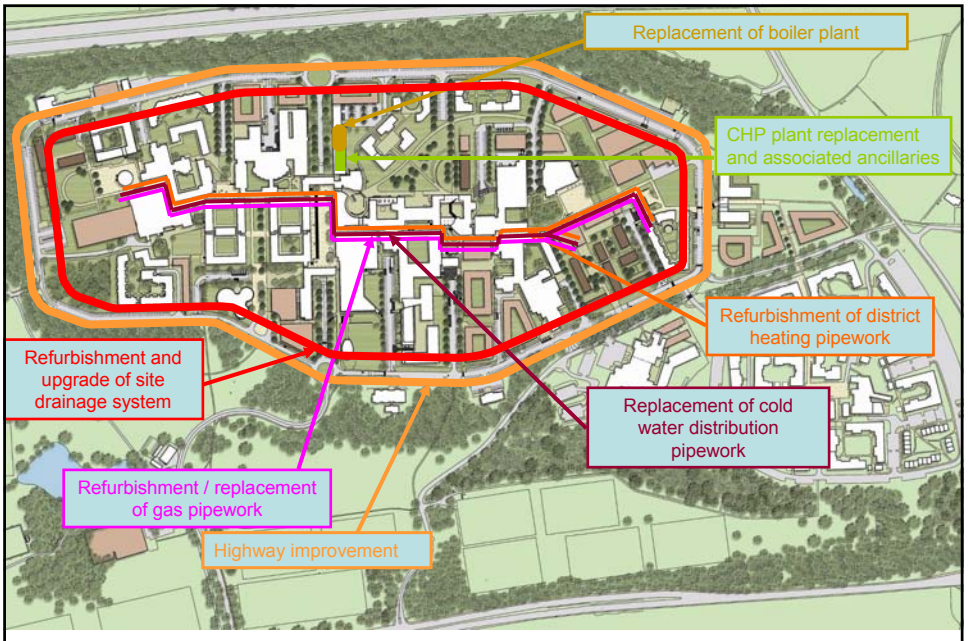

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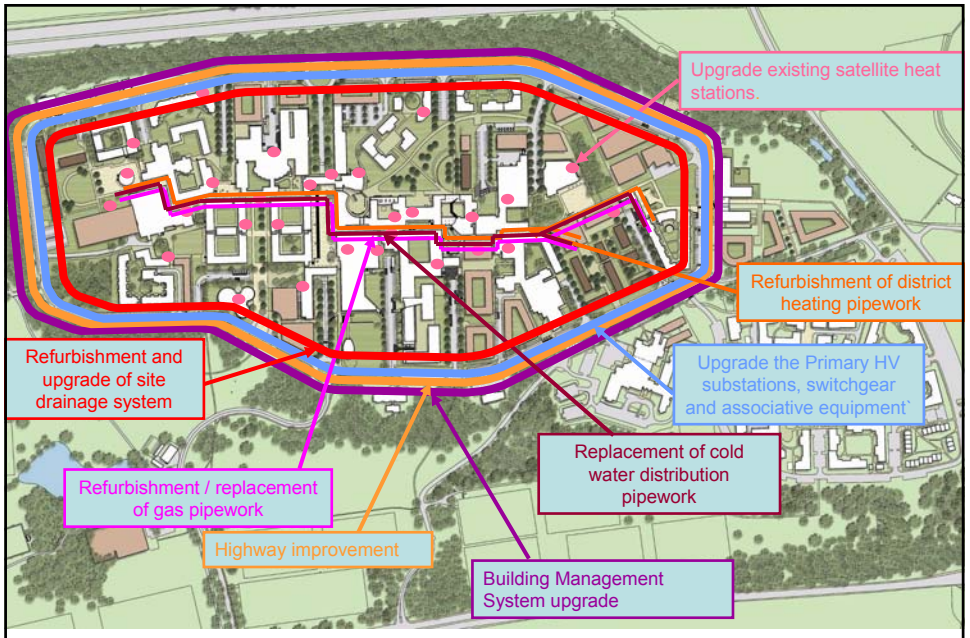

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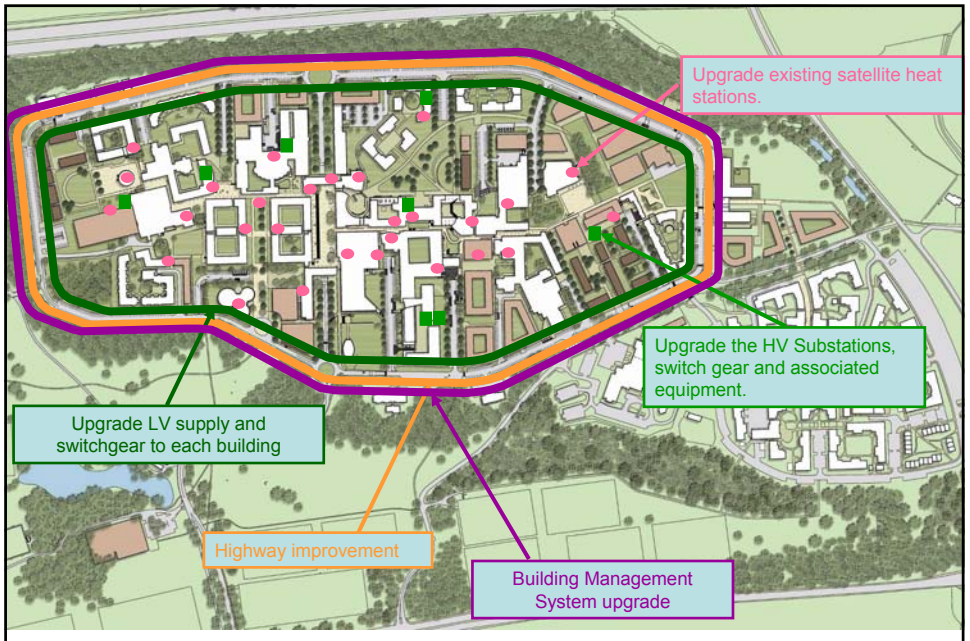

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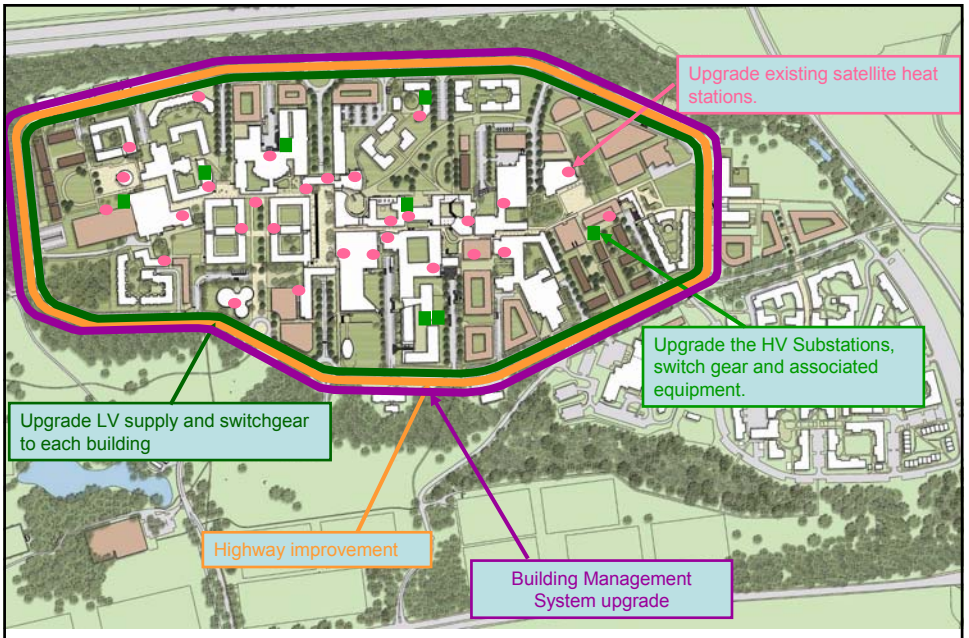

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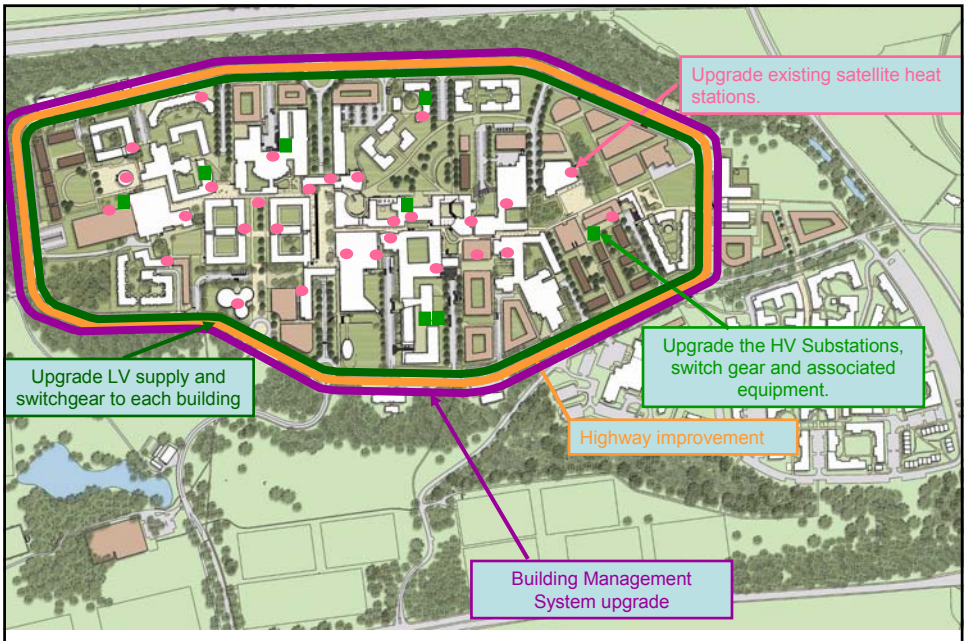

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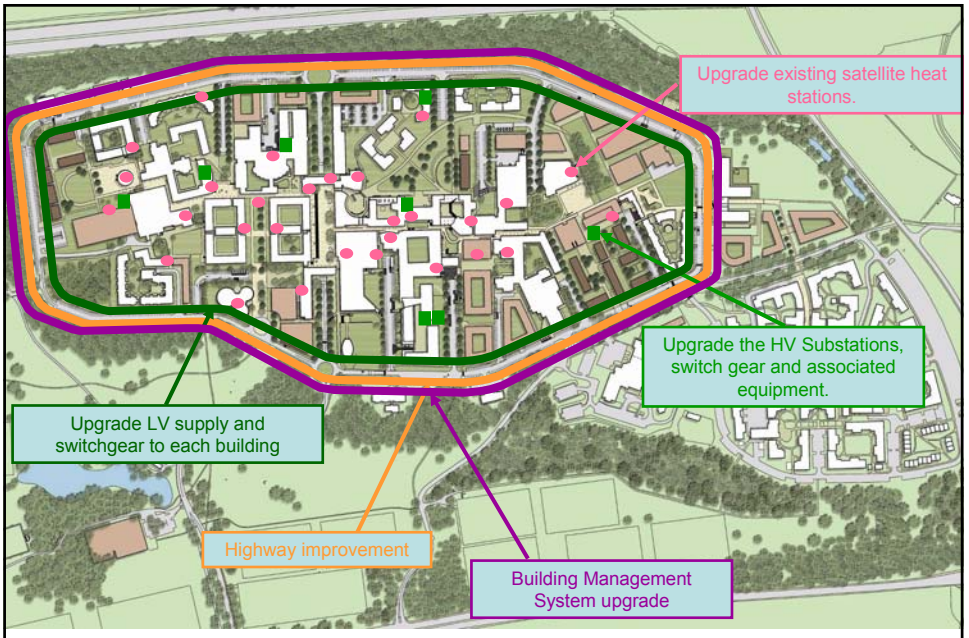

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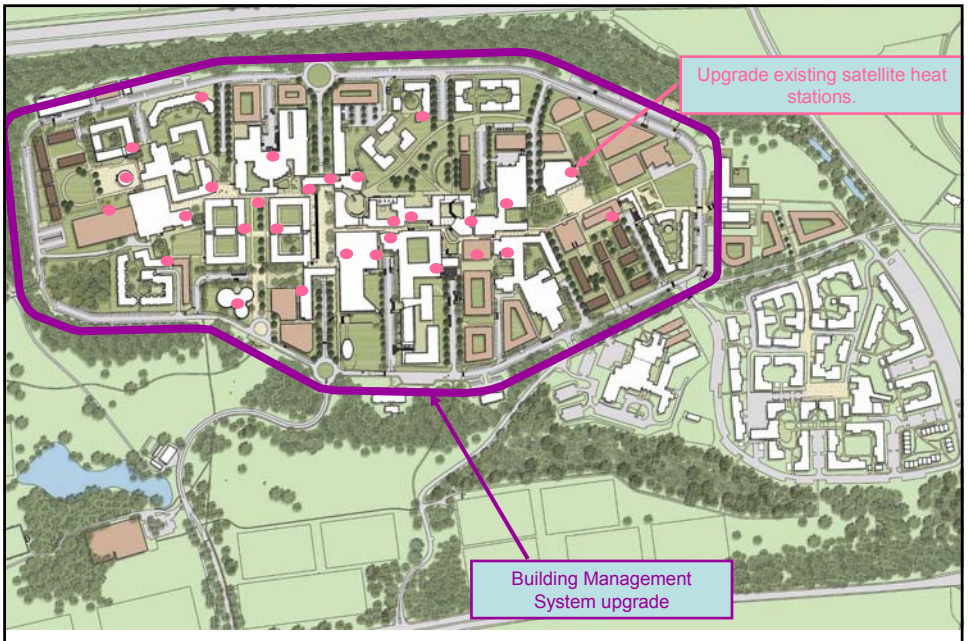

Lancaster University Infrastructure Masterplan - 2017