OVESCO

Mountfield Road Lewes
Community Energy Options

Grant-funded by the DECC's
Local Energy Assessment Fund

OVESCo
Outline Feasibility Assessment of District Heating

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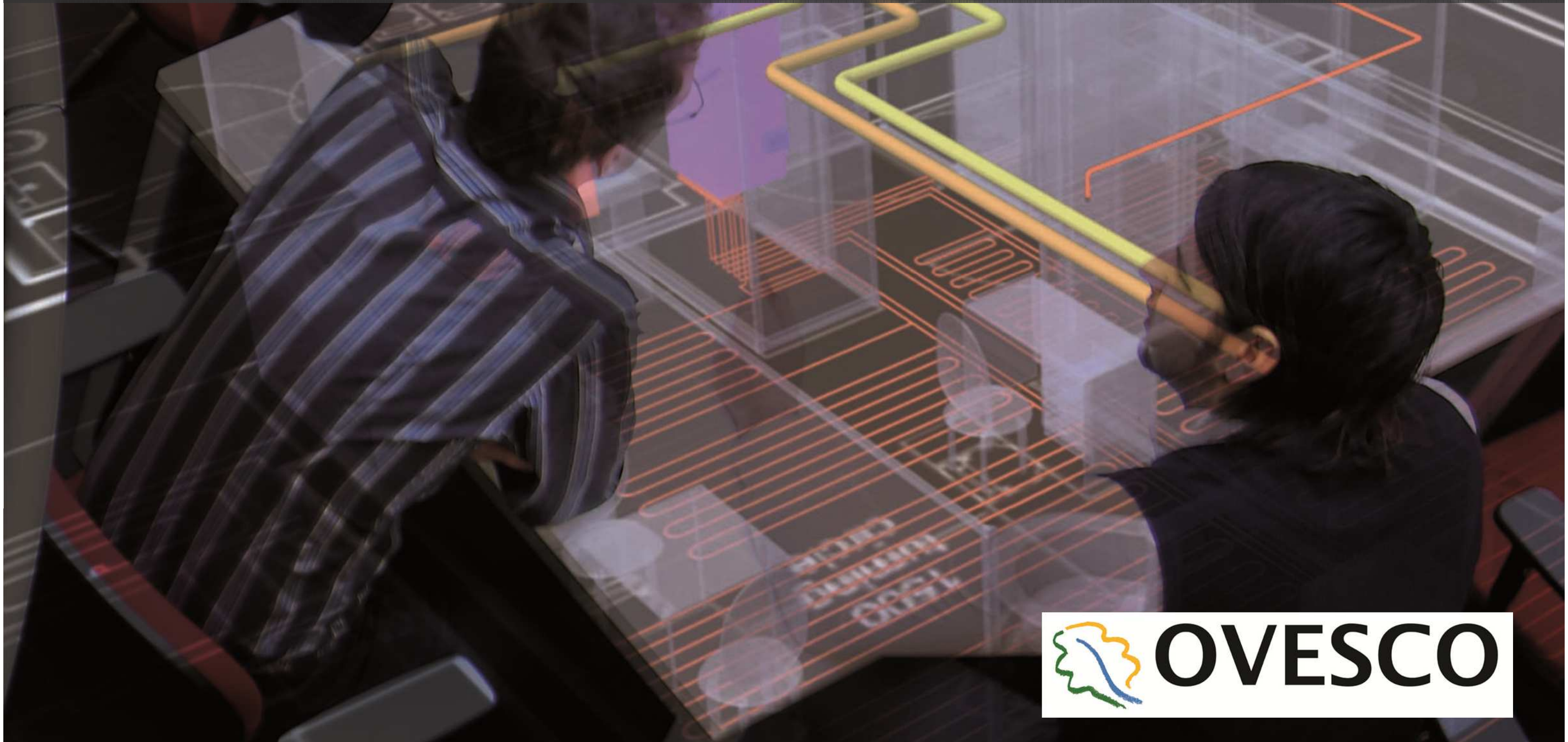
27th March, 2012

HOARE LEA



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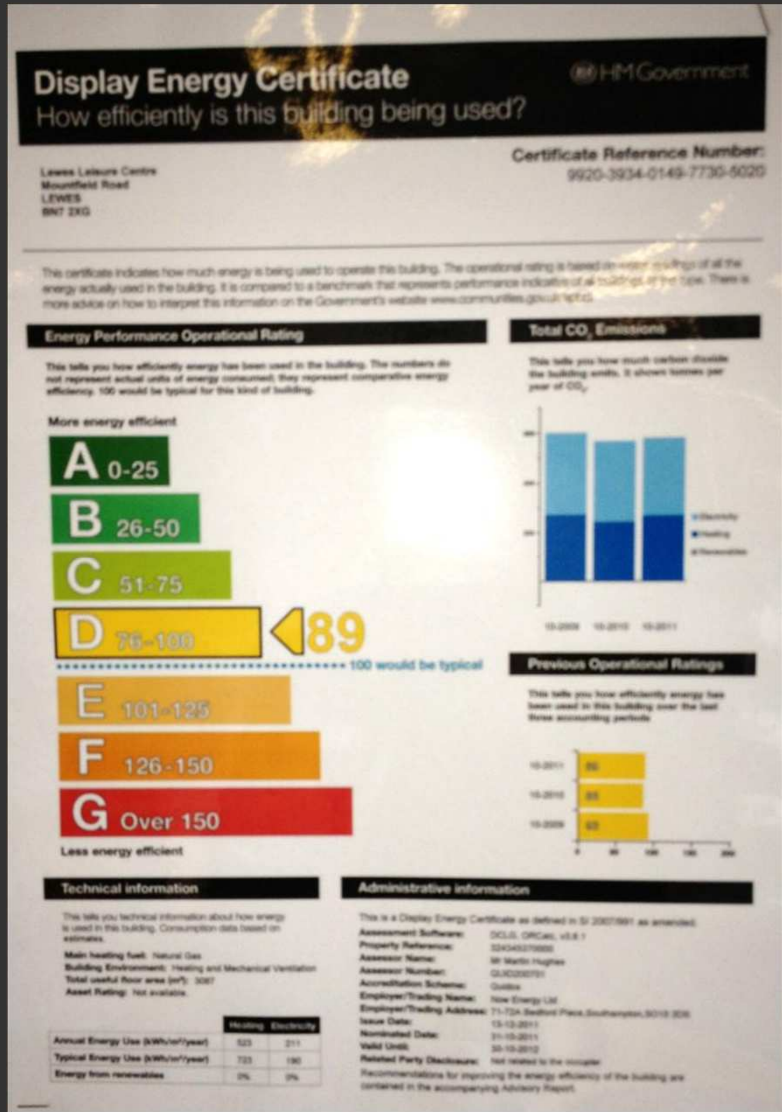
Contents

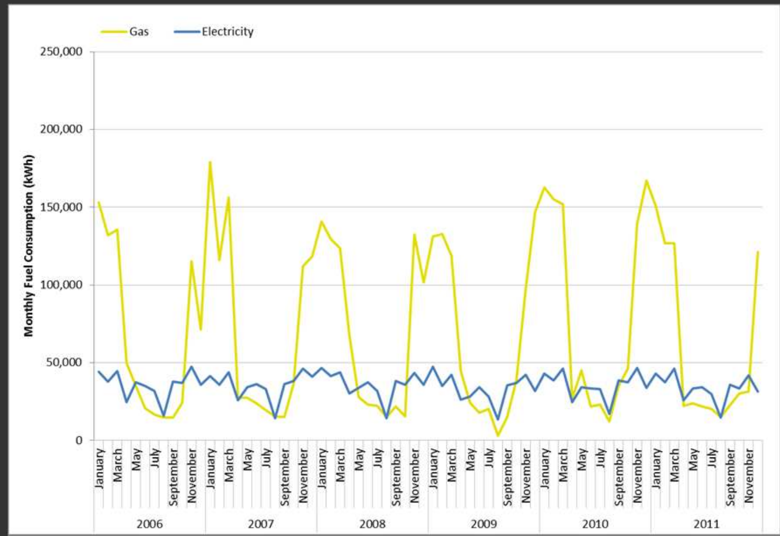
Scope of the Assessment

- Visual survey of the estate and installed plant.
- Review of energy consumption data.
- Creation of an estate wide energy profile.
- Outline feasibility assessment of a district heating network.

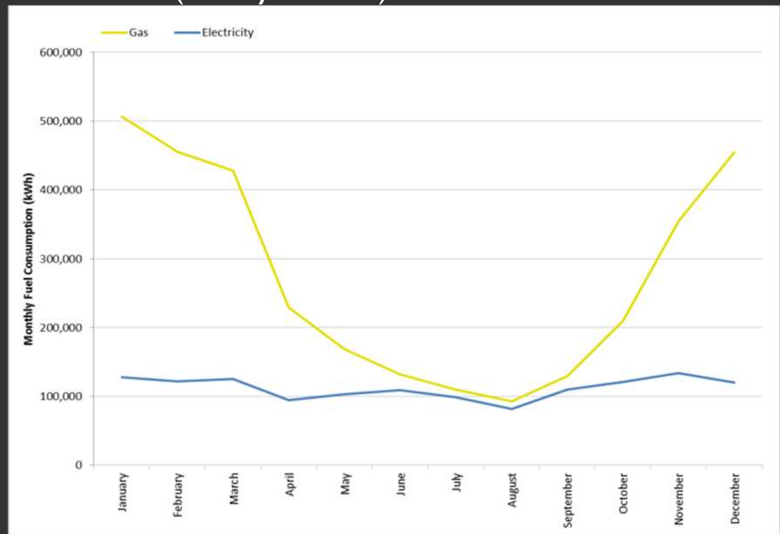


Methodology – Initial Data

- 6 years worth of gas and electricity consumption for each building (2006-2011).
- Any missing data was corrected using trend analysis.
- Monthly averaging for each building to create typical design year profile for gas and electrical consumption.



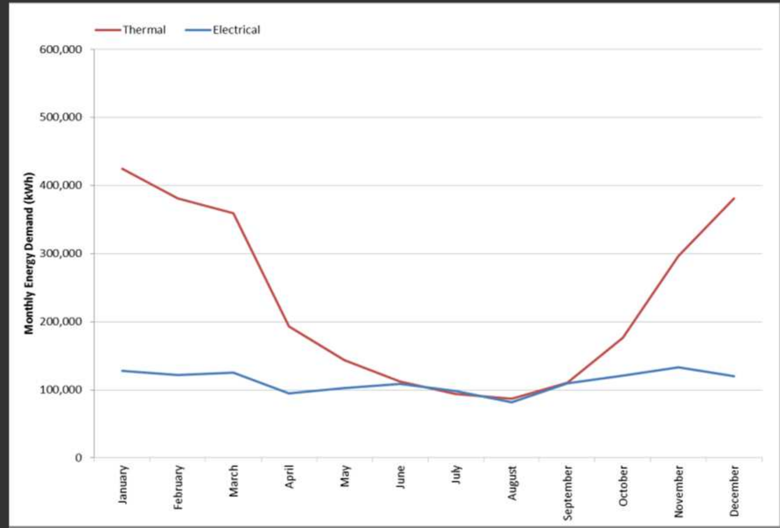
Initial Data (Priory School)



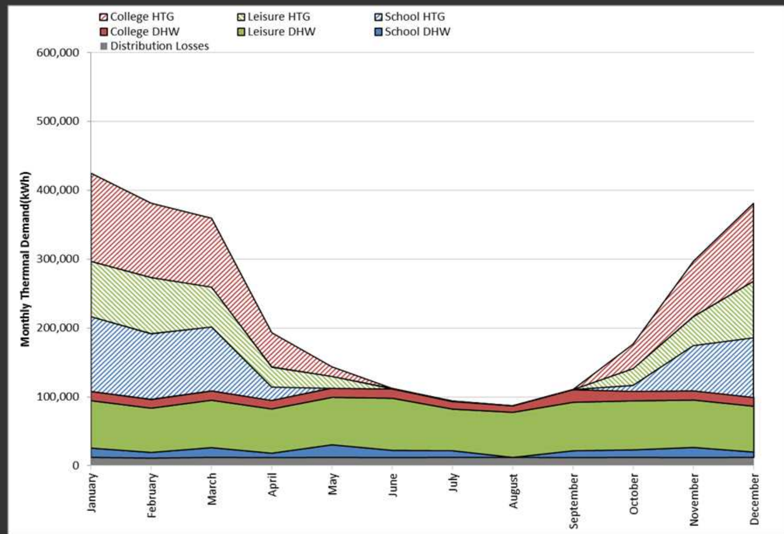
Typical Design Year Fuel Consumption

Methodology – Demand Assessment

- Plant efficiencies recorded during site visit or estimated where not available.
- Gas consumption associated with non-thermal demand e.g. cooking was deducted from the total.
- Likely future electrical generation from the PV panels at the Leisure Centre accounted for.
- Thermal demand split from total to show space heating and hot water demand at each building.



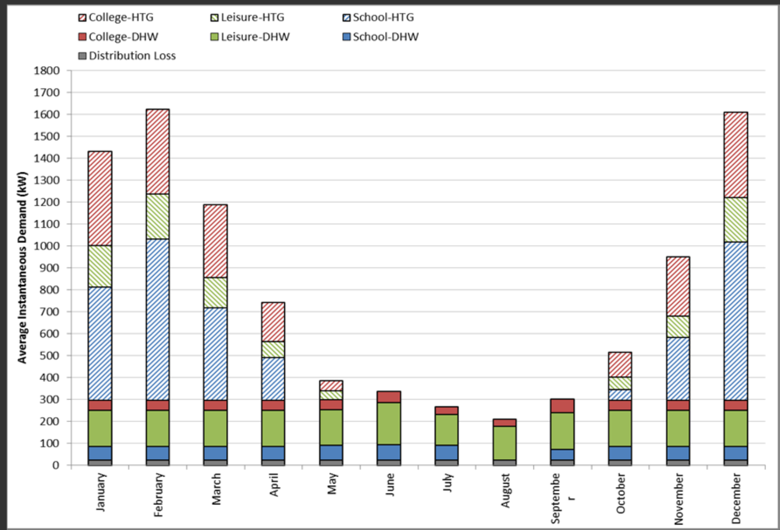
Typical Design Year – Demand Assessment



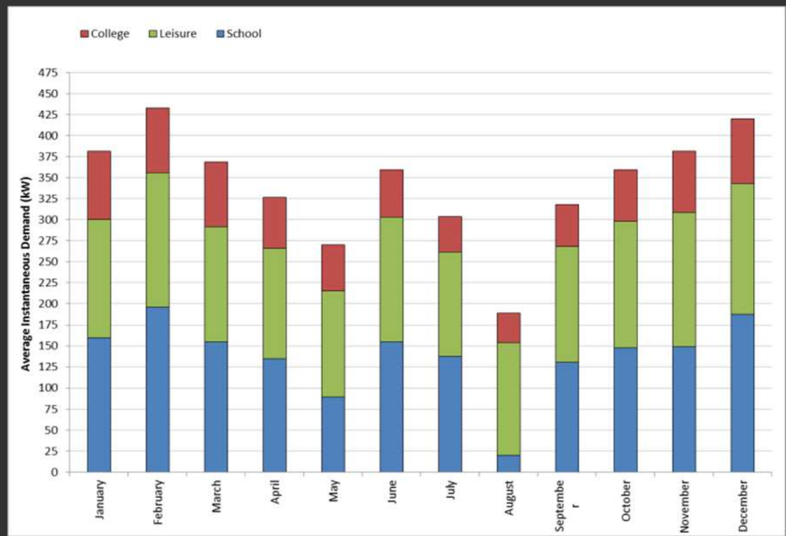
Typical Design Year – Thermal Demand Split

Methodology – Load Assessment

- Through understanding of the occupied hours, average thermal and electrical loads were estimated for each month.
- Not representative of the peak load.
- Peak loads estimated based on industry benchmarks per m^2 of building area.



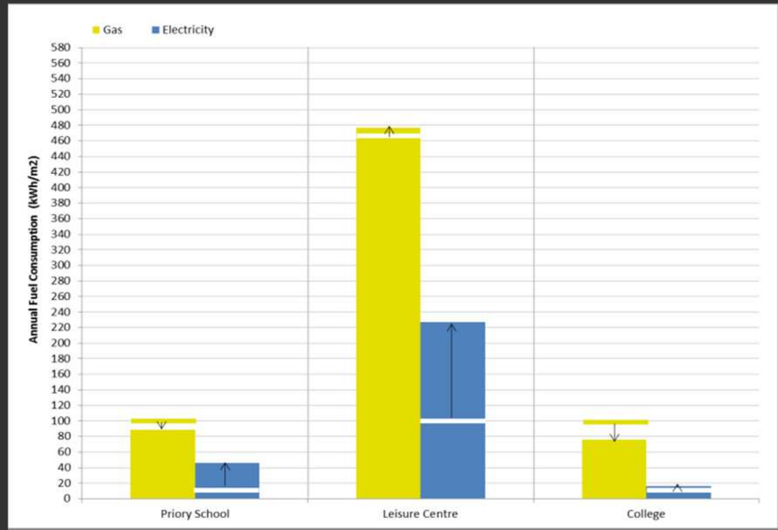
Average Thermal Load Profile



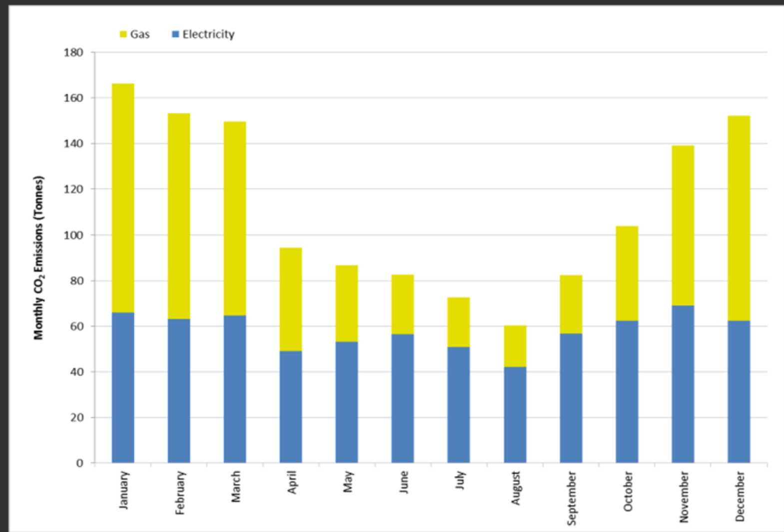
Average Electrical Load Profile

Methodology – Benchmarking

- Existing fuel consumption figures were benchmarked against industry standards.
- Results indicate broadly comparative figures other than Leisure Centre electricity.
- This could be as a result of the cooling in the Projectile Hall which might not be present in the benchmark.
- Estate CO_2 emissions estimated to be 1,343TCO_2/yr (~500 new build homes).



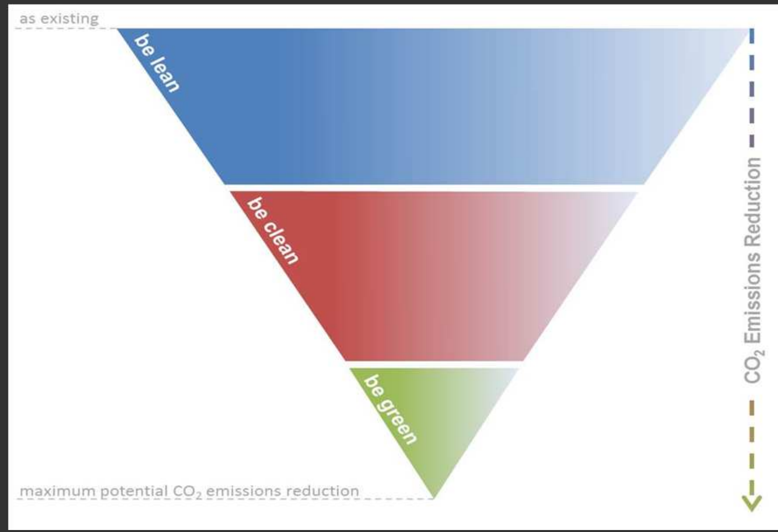
Benchmarking Assessment (kWh/m^2)



Current CO_2 Emissions Profile

Energy Hierarchy

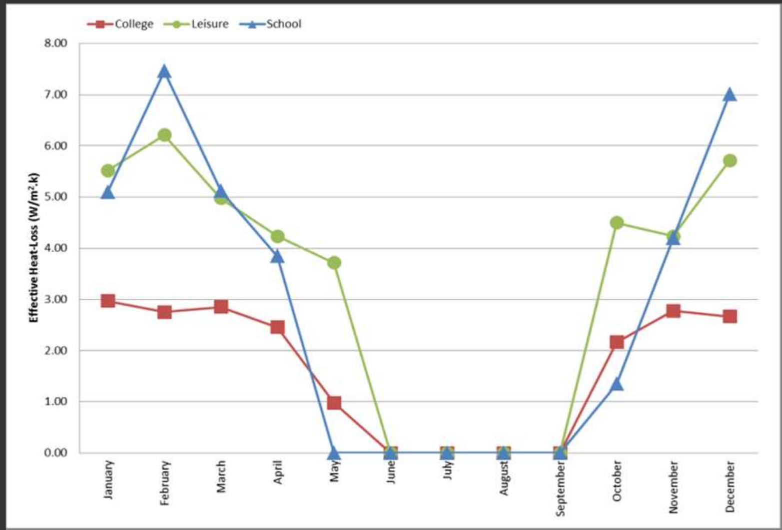
- Be Lean
  - Reduce the demand for energy by improving the efficiency of the building fabric.
- Be Clean
  - Use clean sources of energy i.e. efficient plant such as CHP, and match these with good control philosophies.
- Be Green
  - Use renewables.



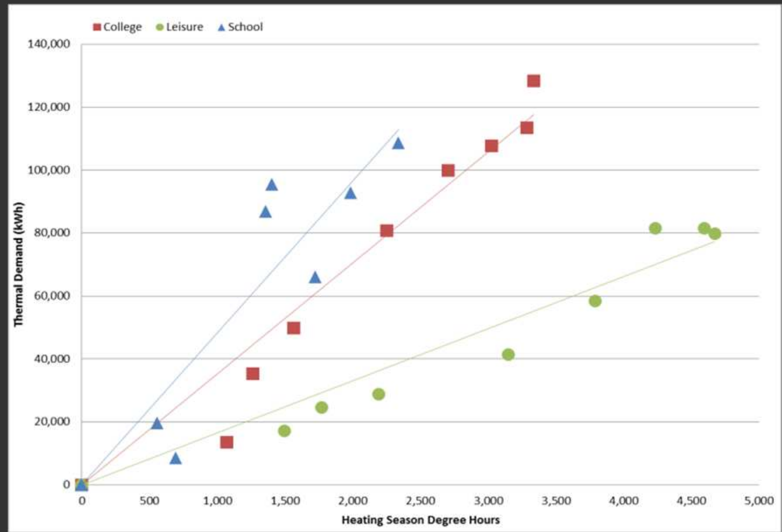
Energy Hierarchy

Energy Hierarchy – Be Lean

- Potentially scope for reducing the demand for energy at the estate by improving efficiency.
- Leisure & School indicate a ventilation-loss driven space heating demand.
  - School – open doors
  - Leisure – pool hall ventilation
- College has flatter curve but at ~ 3W/m^2.K is much higher than new build typical of ~1.0 – 1.5W/m^2.K.



Effective Heat Loss (W/m^2.K)

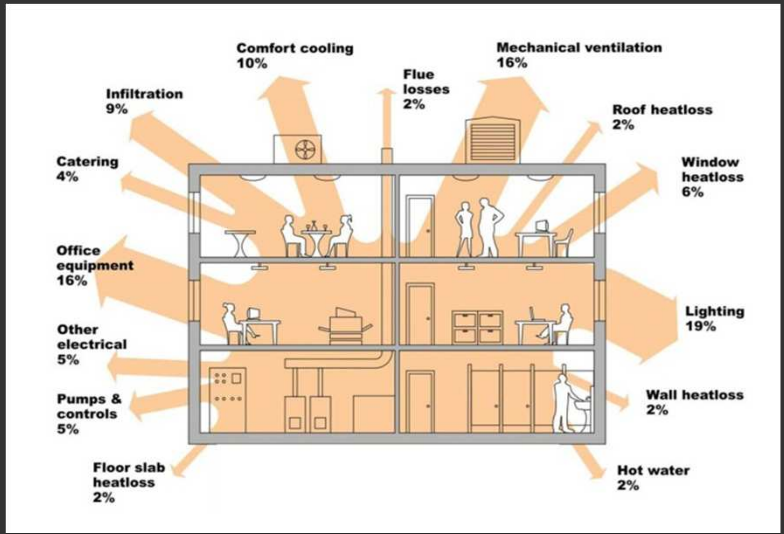


Space Heating Efficiency Trends

Be Lean – Possible Measures

- Draught proofing.
- Self-closing doors.
- Sealing of construction joints.
- Provision of insulation to walls & roofs.
- Upgrade windows.
- Heat recovery ventilation.

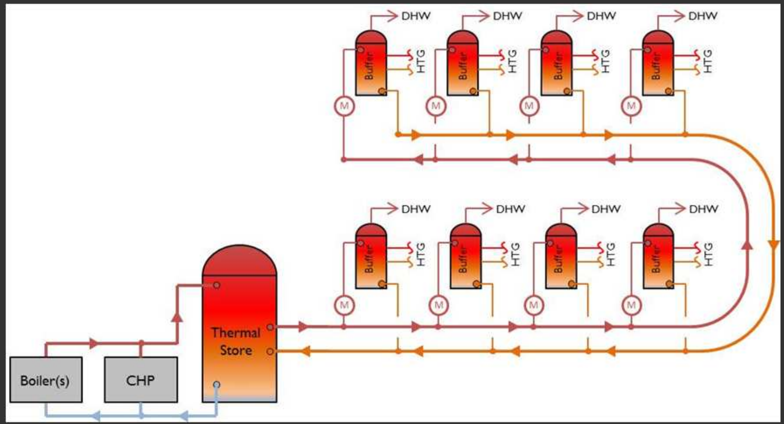
Priory School – Sources of Heat Losses (Ventilation)



Sources of Energy Consumption (Royal Academy of Engineering)

What is District Heating?

- Centralised network
- Replaces individual systems
- Hot water flow & return pipework
- Heat interface to each end-user
- Technology ignorant – Heat can be sourced from any method e.g. Gas Boiler, CHP, Biomass Boiler etc. or combinations.
- Some inherent inefficiencies from pipework heatloss and pumping.



Outline DH Network

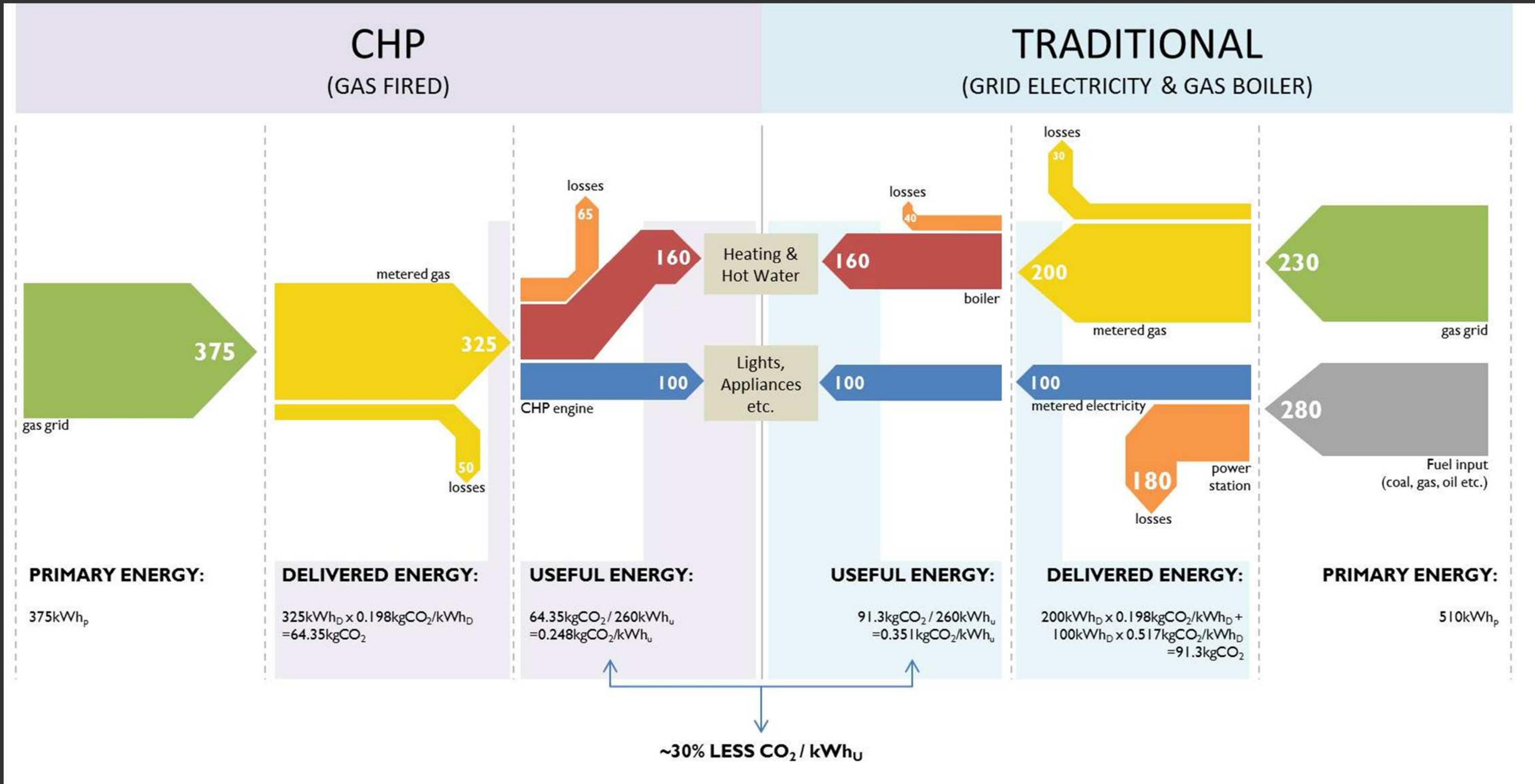
What is CHP?

- Combined Heat & Power engine.
- Gas fired engines are typically internal combustion engines.
- Biomass fired engines are more complex – Stirling engine (external combustion), utilising gasification or pyrolysis.
- For every unit of heat, ~ 0.6 units of electricity are produced (variable).

Gas fired CHP

Gasified Woodchip fired CHP

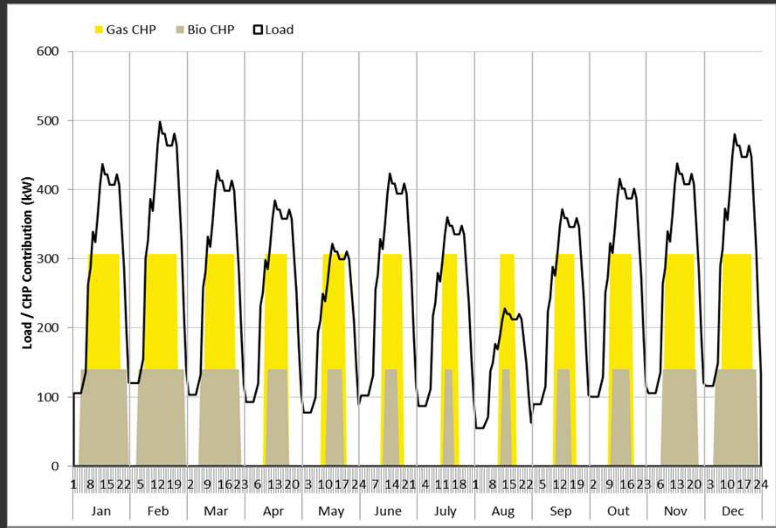
What is CHP?



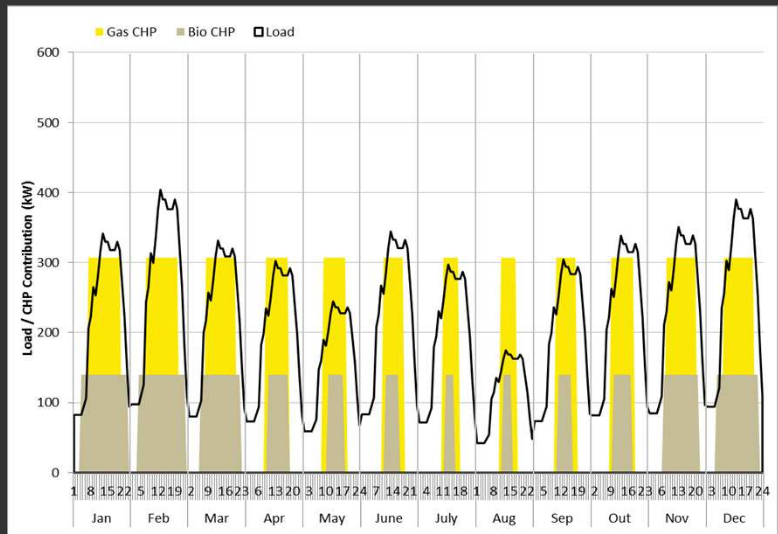
CHP vs Traditional Sources Sankey Diagram

CHP Profiling

- Electrical output from CHP is best used on-site.
- Sale price to the grid is less than purchase price from the grid.
- Profile of the likely electrical demand, typical occupied day in each month.
- Likely to have LV connections to the Leisure Centre & School only.
- Sales to grid ~ 6% (gas) 1% (biomass).



CHP Profile (Estate)

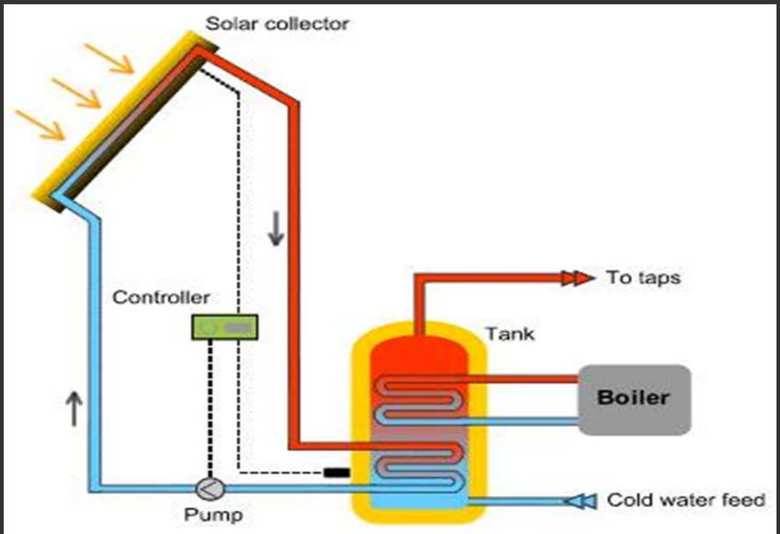


CHP Profile (Leisure & School)

Other Potential Technologies
Decentralised Options – Solar Thermal

- Array of Flat Plate or Evacuated Tube panels to generate hot water from solar energy.
- Output ~ 685kWh/m²/yr
  (at 60% seasonal efficiency).
- CO_2 savings: ~165kg/m²/yr
  (relative to gas boiler at 80% efficient, ~0.01% of existing estate emissions).
- For a 10% CO_2 emissions reduction, require array of ~985m².
- 985m² would generate ~40% of the annual DHW demand.

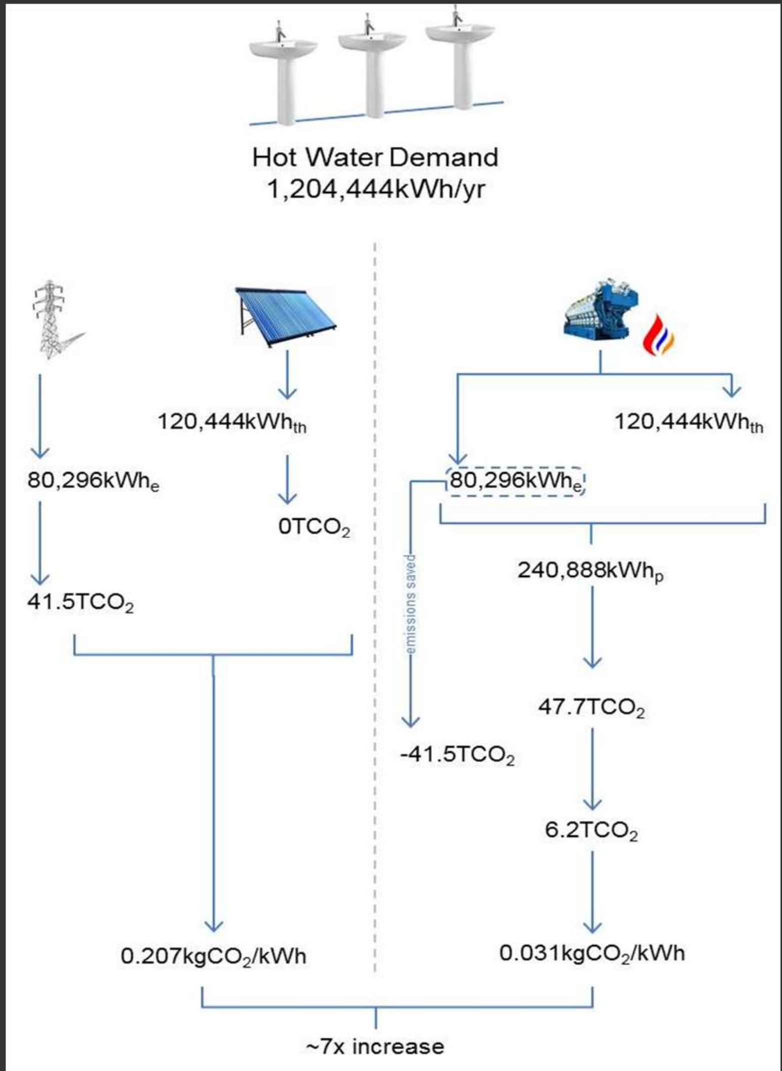
Solar Thermal Panels



Solar Thermal – Indicative Schematic

CHP or Solar Thermal?

- CHP requires a high base-load of heat demand for continuous operation throughout the year.
- CHP can conflict with other technologies such as Solar Thermal.
- CO_2 emissions can be reduced further by use of CHP rather than Solar Thermal and grid electricity, with roughly a 7x difference (per kWh used).

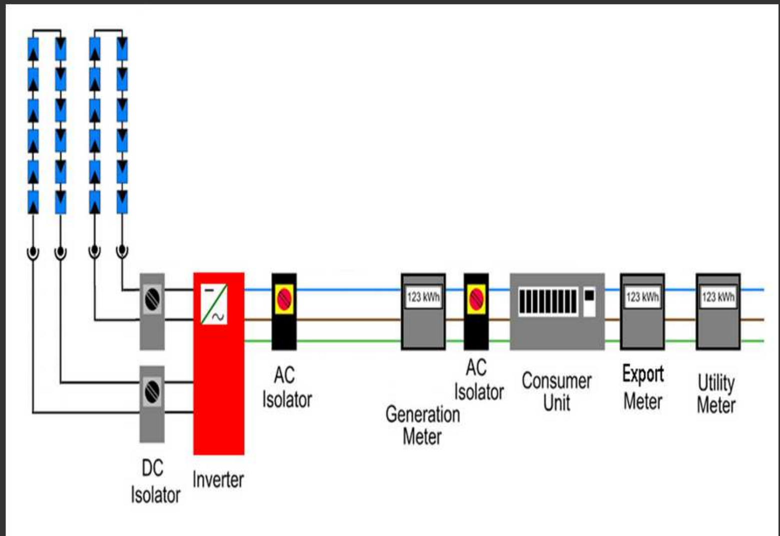


CHP vs Solar Thermal CO_2 Emissions

Other Potential Technologies
Decentralised Options – Photovoltaic

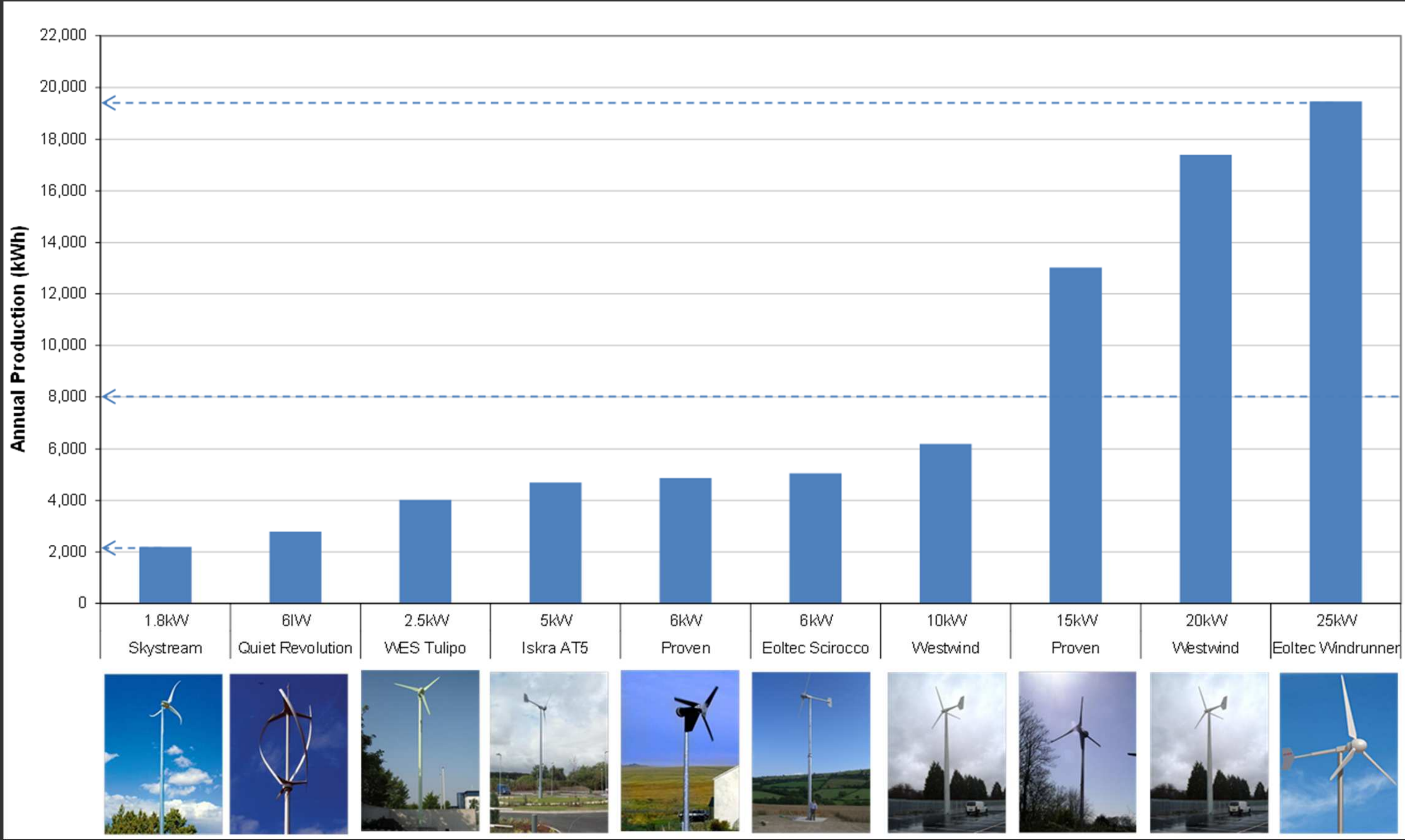
- Array of Mono / Poly-crystalline panels to generate electricity from solar energy.
- Output ~ 210kWh/m^2/yr
  (at ~15% seasonal efficiency).
- CO_2 savings: ~110kg/m^2/yr
  (~0.008% of existing estate emissions).
- For a 10% CO_2 emissions reduction, require array of ~1,220m^2.
- Ad-hoc implementation – area requirement too large for a single roof?

Photovoltaic Panels



PV – Indicative Schematic

Other Potential Technologies
Decentralised Options – Wind Turbines



Other Potential Technologies
Decentralised Options – Wind Turbines

- Average wind speed on-site ~4.3m/s @ 10m above ground (DECC database).
- Output ~ 8,000kWh/unit/yr (average of various turbine sizes).
- CO_2 savings: ~4,130kg/unit/yr (~0.3% of existing estate emissions).
- For a 10% CO_2 emissions reduction, require ~ 33No. turbines.
- Land take ~ 75m^2/unit = 2,550m^2 for 33No. bank of turbines.

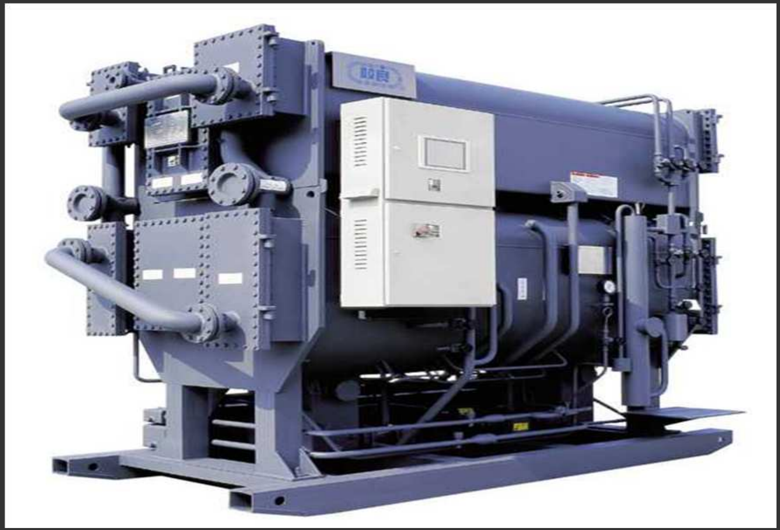

Wind Turbines

Technology	Annual Output Potential	Size Requirements*	Comments
Solar Thermal	~685kWh/m^2	~985m^2	Not suitable in conjunction with CHP.
PV	~210kWh/m^2	~1,220m^2	Possible but roof space lease constraints possible.
Wind Turbines	~8,000kWh/unit	~33No. units @ ~75m^2/unit^	Lack of suitable area. Susceptible to poor operation.

Table 5.1: Summary of De-Centralised Technology Options

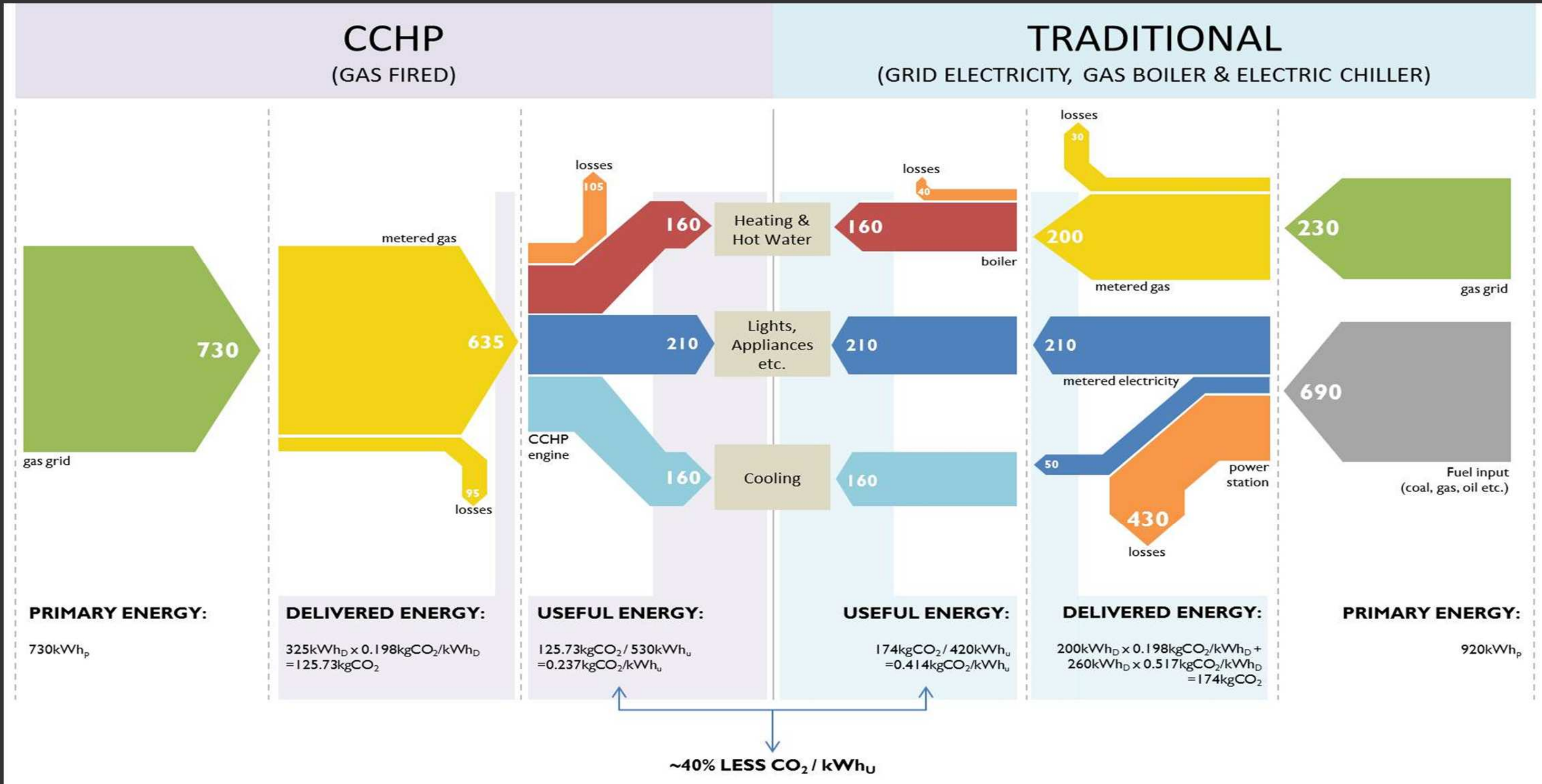
Other Potential Technologies
Centralised Options – CCHP

- Combined Cooling, Heat and Power Engine.
- Standard CHP is coupled to an Absorption Chiller to produce chilled water.
- Additional cooling load can result in longer run hours for the CHP and result in additional CO_2 emissions savings relative to the traditional case.
- CCHP has same conflict with Solar Thermal.



Lithium Bromide Absorption Chiller

Other Potential Technologies
Centralised Options – CCHP



- Low demand for cooling makes CCHP less favourable

Other Potential Technologies
Centralised Options – Anaerobic Digestion

- Breakdown of organic material in the absence of Oxygen to produce Methane.

- Methane thereafter combusted in boilers to produce useful heating. Can also be used in CHP.

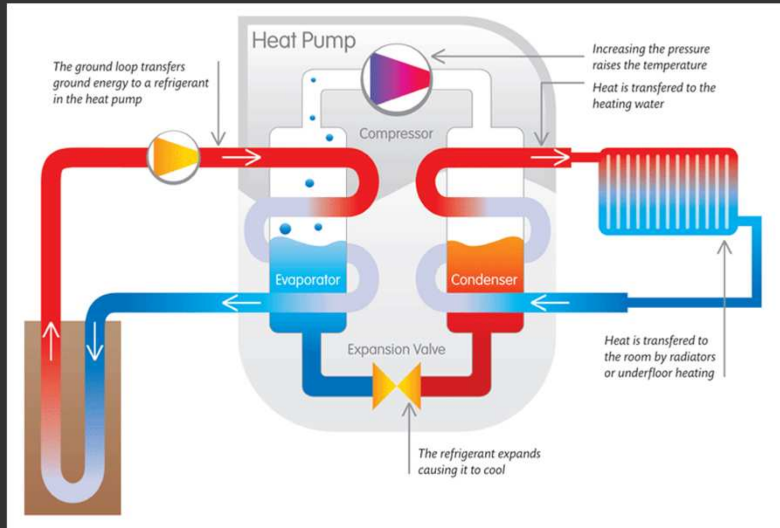
- Requires large and constant supply of fuel. Suitable sources could be Kitchens and Food Technology rooms at the School, and the Canteen at the College.

Small scale AD plant.

- Low availability of organic matter makes AD less favourable.

Other Potential Technologies
Centralised Options – Ground Source Heat Pumps

- Extract heat from the ground.
- Can be highly efficient when operating with matched heating and cooling i.e. heat extract in winter, heat reject in summer.
- Low cooling demand means system would be heat dominant.
- Low potential for output to avoid permafrost, or use of deep boreholes.
- Non-matched demand makes GSHP less favourable.



Indicative GSHP Schematic

Other Potential Technologies
Centralised Options – Biomass Boiler

- Generate heat from combustion of wood fuel.
- High efficiency and good turn-down ability.
- Requires large fuel store.
- Requires fuel deliveries.
- Requires regular maintenance.
- Can yield high CO_2 emissions savings.
- Biomass boilers are considered favourable.

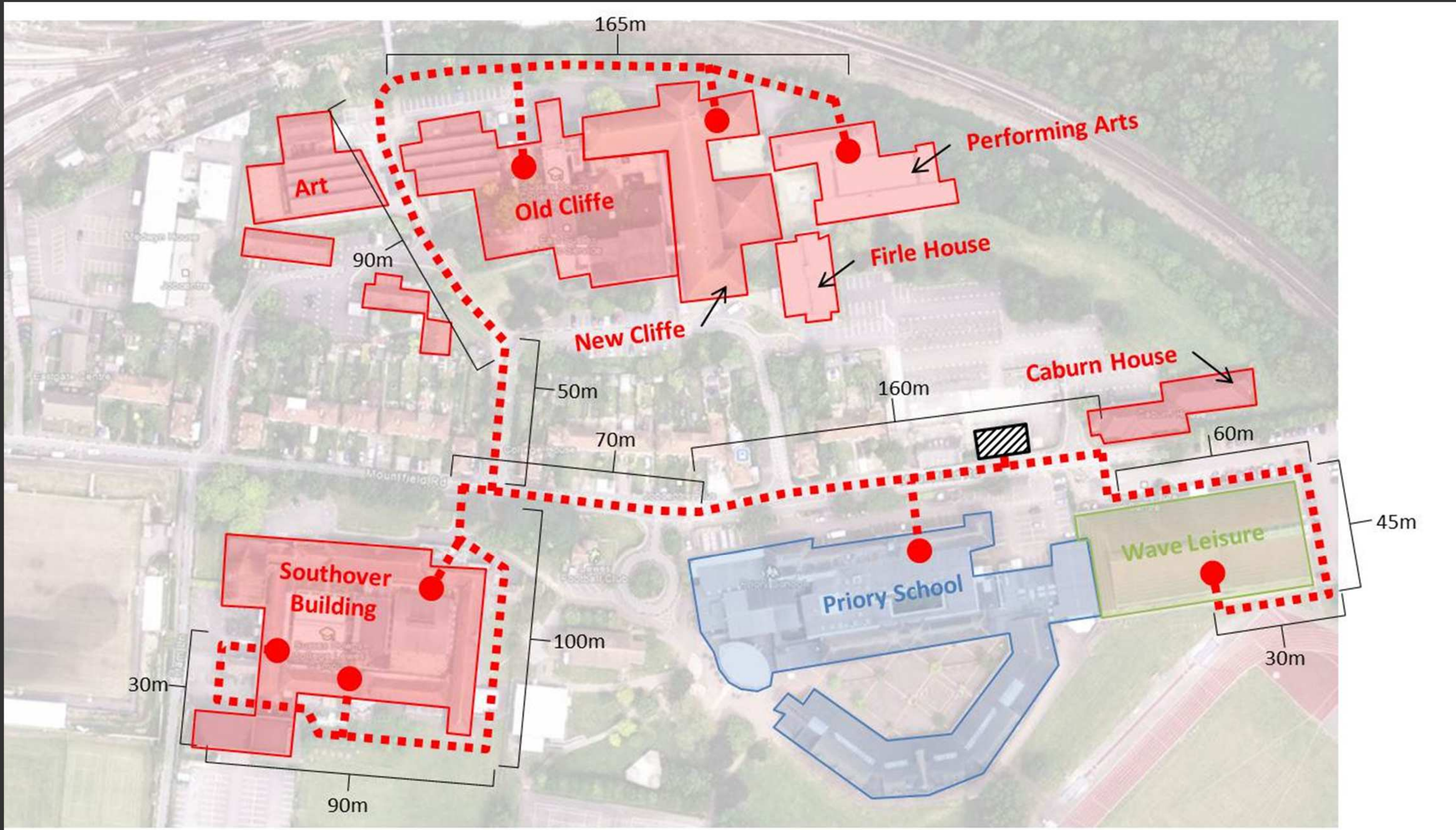
Biomass boiler plant

Tested System Options

	Option 1		Option 2		Option 3	
Gas CHP	Y	$357kW_{th}$ $307kW_{e}$	Y	$357kW_{th}$ $307kW_{e}$	N	
Gas Boiler	Y	3x 780kW	N		N	
Biomass CHP	N		N		Y	$560kW_{th}$ $140kW_{e}$
Biomass Boiler	N		Y	2x $725kW_{th}$	Y	2x $620kW_{th}$
Thermal Store	Y	$300kW_{th}$	Y	$1.5MW_{th}$	Y	$1.5MW_{th}$
Backup Provision	2x 750kW Gas Boilers		2x 750kW Gas Boilers		2x 750kW Gas Boilers	
TOTAL CAPACITY	$4.50MW_{th}$ $307kW_{e}$		$4.81MW_{th}$ $307kW_{e}$		$4.80MW_{th}$ $140kW_{e}$	

Table 5.2: Summary of Outline feasibility assessment Options

Tested System Options
Network Extent



Tested System Options
Phasing

- Phase 1 could be to connect the Leisure Centre as this has the largest proportion of the energy demand.
- Phase 2 – School.
- Phase 3 – College.

User	Thermal	Electrical	Combined
Leisure Centre	45%	52%	47%
School	25%	31%	27%
College	30%	17%	25%

Table 5.3: Summary of Energy Demand Split

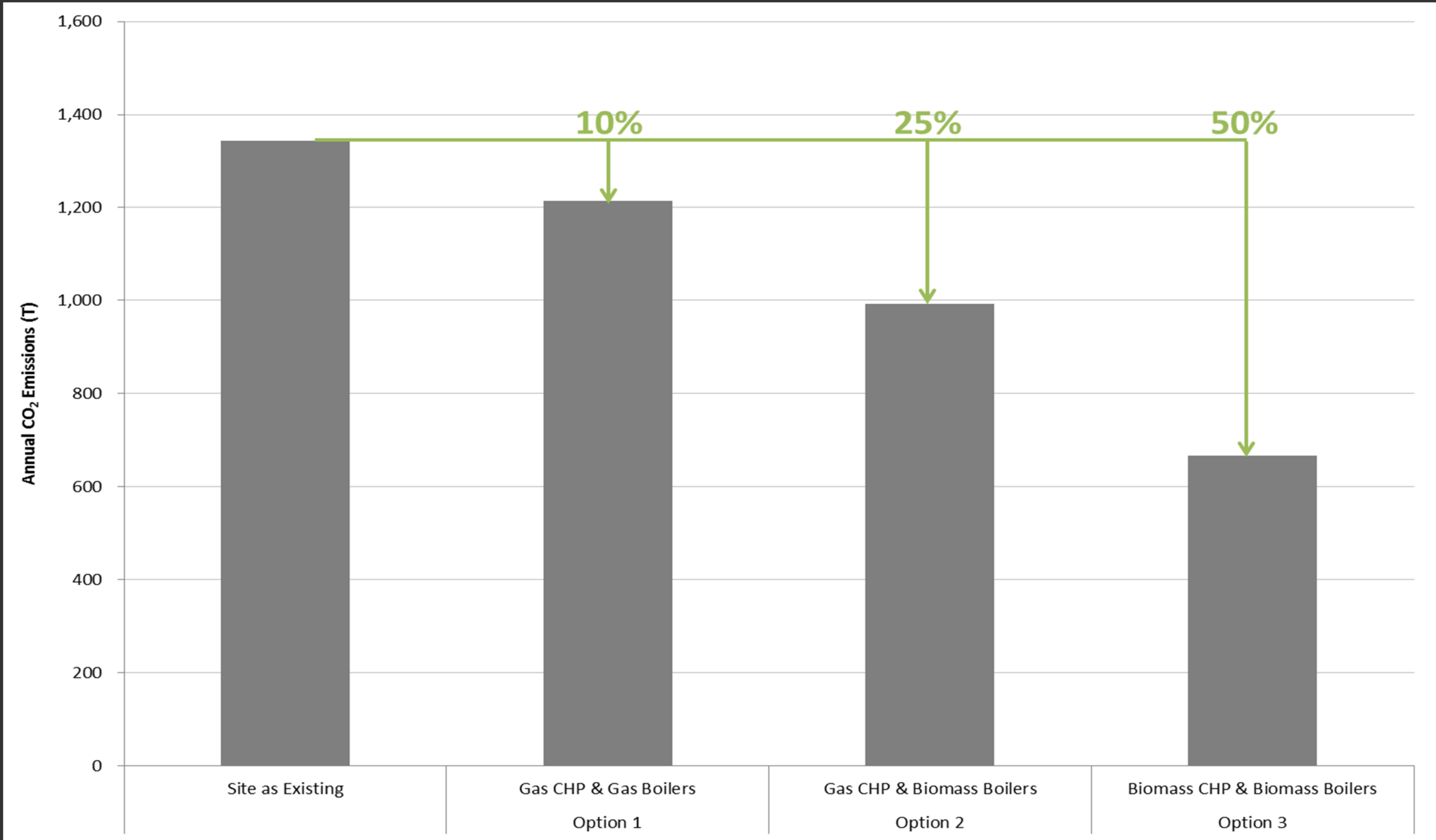
Tested System Options
Procurement

- 3 Potential options for procurement:

1. Through nationwide third party ESCO such as Scottish & Southern for design, construction, operation and management of a scheme;
2. Directly through OVESCo with commissioned design and construction via specialists, or
3. Stakeholder community ownership.

Example of Community Ownership

Results
CO_2 Emissions



Results
Capital Expenditure

- Total cost range from ~£2.1M - £3.7M.
- Inclusive of design fees at 5% and contingencies at 15%.
- Cost of plant and energy centre dependent on plant output capacity.

		Option 1	Option 2	Option 3
Infrastructure	Network Installation	£1,000,000	£1,000,000	£1,000,000
	Utility Upgrades / New Supplies	£200,000	£200,000	£200,000
	Works to Existing Plant Rooms	£80,000	£80,000	£80,000
	Construction of Energy Centre	£60,000	£314,500	£467,500
Plant	Gas Boilers	£58,515	n/a	n/a
	Backup Boilers	£37,500	£37,500	£37,500
	Gas CHP	£276,300	£276,300	n/a
	Biomass Boiler	n/a	£360,750	£310,000
	Biomass CHP	n/a	n/a	£925,000
	Thermal Store	£18,000	£90,000	£90,000
Sub Total		£1,730,315	£2,359,050	£3,110,000
Design Fees (at 5% of ST)		£86,516	£117,953	£155,500
Contingencies (at 15% of ST)		£259,547	£353,858	£466,500
TOTAL		**£2,076,378**	**£2,830,860**	**£3,732,000**

Table 6.1: Summary of Likely Capital Expenditure

Results
Operational Expenditure

- Total annual operational expenditure range from ~£40k income - £16k cost.
- Inclusive of governmental support under the RHI and RO.
- Inclusive of sale of heat and electricity to estate end-users at equivalent rate of current gas and electricity purchase.

		Option 1	Option 2	Option 3
Fuel	Gas	£103,704	£77,625	£2,743
	Biomass	n/a	£38,667	£107,395
	Electricity	£20,342	£20,342	£26,788
Maintenance	Gas Boiler	£1,600	n/a	n/a
	Backup Boilers	£1,600	£1,600	£1,600
	Biomass Boiler	n/a	£3,200	£3,200
	Gas CHP	£12,280	£12,280	n/a
	Biomass CHP	n/a	n/a	£69,500
	Facilities Manager	£25,000	£25,000	£25,000
Support	RHI	n/a	£12,121	£26,620
	ROCs	n/a	n/a	£55,892
	LECs	£6,211	£6,211	£2,860
Sales	Heat	£77,643	£77,643	£77,643
	Electricity (to End-Users)	£115,528	£115,528	£56,445
	Electricity (to the Grid)	£2,473	£2,473	£94
NET EXPENDITURE		**-£37,328**	**-£35,262**	**£16,673**

Table 6.2: Summary of Likely Operational Expenditure

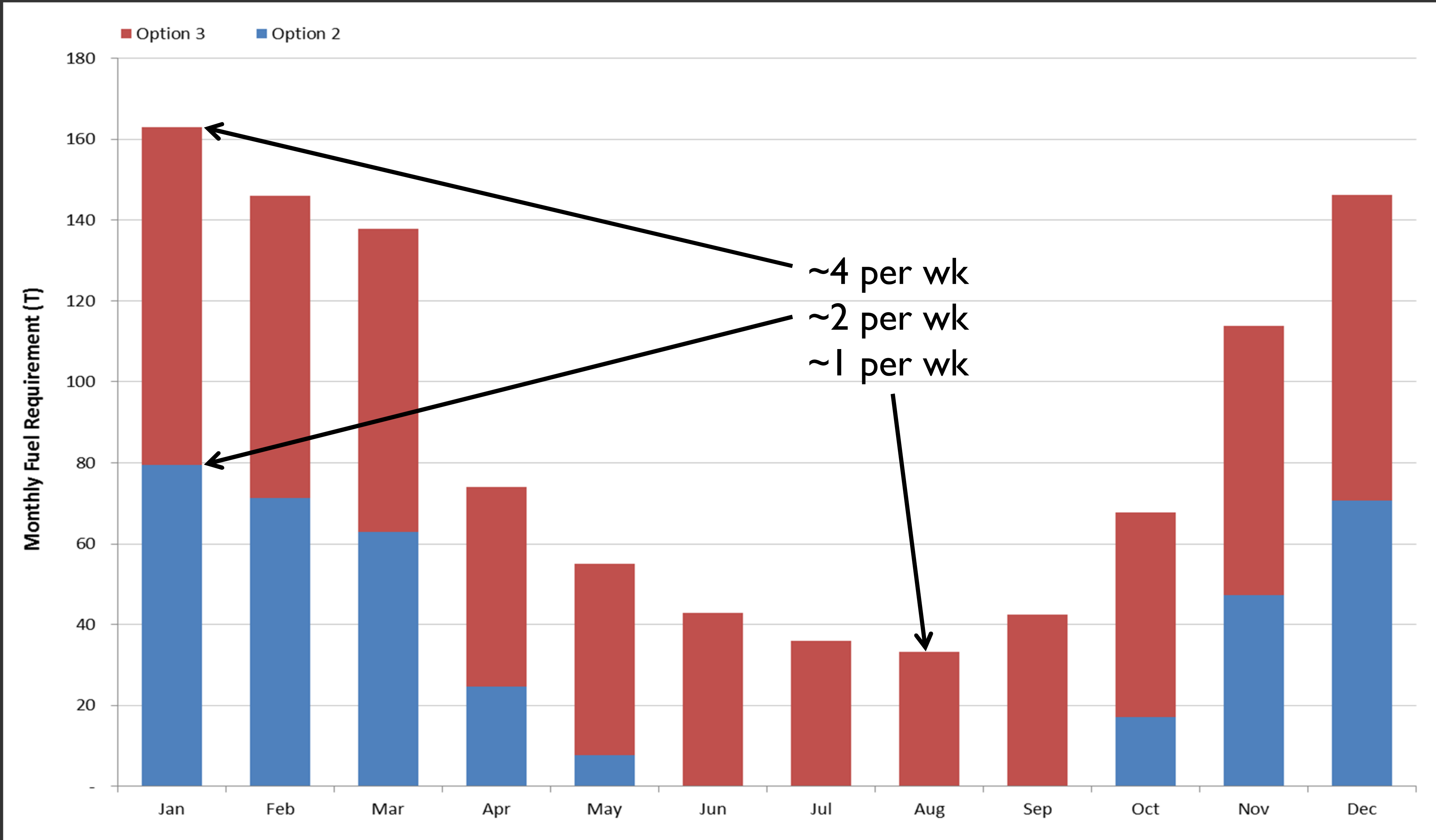
Results
Simple Payback

- Payback unlikely to occur within lifetime of the plant.
- Option 3 unlikely to yield payback.
- Cost per tonne of CO_2 savings ranges from ~£300/T to £500/T
- CRC CO_2 cost ~ £12/T (Carbon Trust)
- Improve payback by reducing costs & improving returns.

	Option 1	Option 2	Option 3
CapEx + Life OpEx	£1,329,826	£2,125,623	£4,065,457
Total Life CO_2 Savings (T)	2,587	7,032	13,526
Cost per CO_2 Saving	£514	£302	£301
Simple Payback	56	80	No Payback

Table 6.3: Summary of Simple Payback Calculation

Results
Fuel Deliveries



Results
Private Residents

- Estimated annual thermal demand per dwelling to be ~15,750kWh.
- Estimated gas cost per dwelling £760 per annum.
- After network connection estimated cost £550 per annum.
- Estimated cost to connect ~ £10,000 per dwelling.
- Payback (to residents) at year 48.
- Likely CO2 emissions savings of ~3.2T per dwelling.


Biomass boiler plant

Conclusions

- Favourable technologies that could be implemented at the estate include:
  - CHP (gas or biomass), and
  - Biomass boilers
- Others also feasible on ad-hoc basis.
- District heating could be installed at the estate, requiring ~1,000m of pipework.
- 3 options tested, with potential for 10%, 25% or 50% CO_2 savings.

Conclusions

- Capital expenditure for the options tested ranges from £2.1M - £3.7M.
- Operational expenditure for the options tested ranges from ~ £40k income - £16k cost.
- Payback is unlikely to occur during plant life.
- The cost per tonne of CO_2 emissions saved over the plant life ranges from ~£300/T - £500/T.

Conclusions
Where Next?

- Potential for reduction in CapEx and / or increase in OpEx.
- Detailed feasibility study of preferred option.
- Study should include discussions with local utilities.
- Study could include lifetime cost appraisal and assessment of phasing, lease of plant, on-site energy improvement measures etc.

Conclusions
Overall Message

"Good potential for CO_2 emissions savings but costs appear prohibitive."

Conclusions and moving forward

• Hoare Lea's concluded a district heating network would make carbon savings, but would be very financially challenging to implement beyond the Leisure Centre alone.

• The Leisure Centre needs to replace its boilers in the next two years. This will be a critical moment to plan the Leisure Centre's future needs and to consider the future needs of the other stakeholders.

• The initial Outline Feasibility Assessment looked at three options. All three were based on a large-scale district heating scheme.

• This meant that the total scheme required a 1KM piped network which, based on a cost of £1000/M, would require an estimated £1million to install.

• The report has allowed OVESCO and all the stakeholders to consider future ways of moving forward.

Options for altering the network design to reduce costs

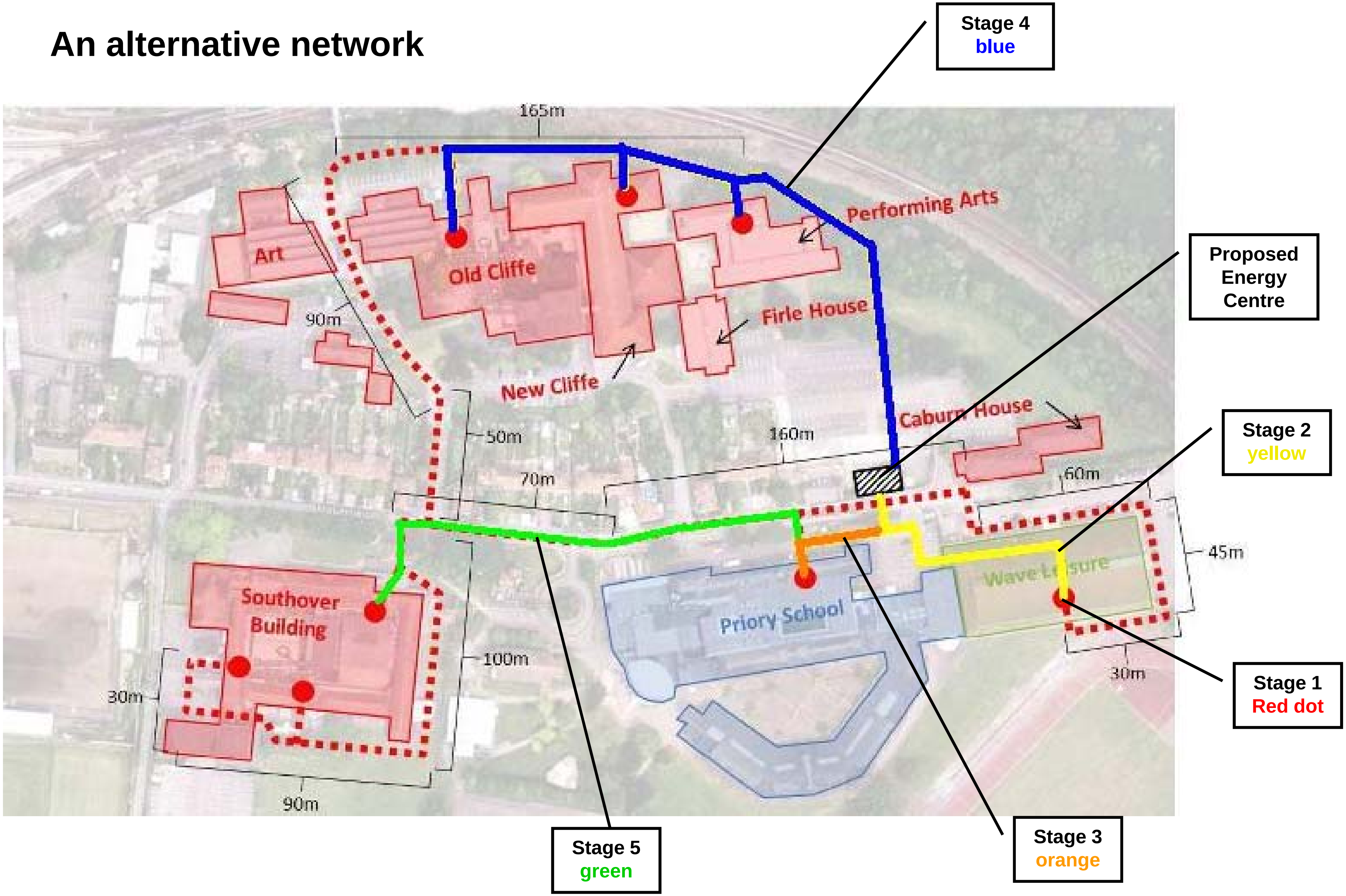
OVESCO is now considering alternatives to the first proposal for the district heating network.

1. Focus on the Leisure Centre as the first stage of a phased redevelopment for electricity and heat supply to the entire site. At this stage, future expansion must be considered when sitting any new boilers and CHP plant.

2. Reroute the district heating network and install in stages to reduce the size of the network Avoid where possible roads, to minimise disruption, and use grass verges to reduce installation costs.

3. Consider routing the network through buildings in the ceiling void to shorten the network, reduce costs and facilitate access.

An alternative network



Additional proposals for cost reductions

1. The report allowed for maintenance costs for the CHP plant. SterlingDK already allow for maintenance cost. It may be possible to reduce the maintenance costs.

2. The report assumed that there will be a capital cost for replacing existing boilers to back up the district heating network.

3. Payback does not take into account possible rises in future natural gas prices.

4. The report used standard costs for building an Energy Centre and did not take into account use of an existing building to reduce costs.

5. The report allowed for a cost to connect the CHP plant to the National Grid. This may not be required.

6. The report did not include any reduction in servicing costs for the eight separate boiler houses, many of which need replacement boilers.

7. The report does not include any grant funding to finance the district heating network. Inclusion of grant funding within the requirements for State Aid Rules would reduce capital costs.

Looking to the future

The key stakeholders in Mountfield Road are likely to have, in the next couple of years, an opportunity to develop the energy efficiency of their individual sites, and the ability to generate community-backed decentralised heat and power.

Mountfield Road, as a major site in Lewes used by the wider public, could take a lead in a transition to a low-carbon future if all the stakeholders work together and consider not only their individual needs but also the needs of the wider community.

To succeed, Hoare Lea's report, commissioned by OVESCO and funded by LEAF, should be used as the basis for continued collaboration between all the key stakeholders in Mountfield Road.

To this end, OVESCO has applied for, and has succeeded in reaching Stage 2 of, the Co-operative Energy Challenge, which aims to support groups and organisations in the UK that wish to establish co-operatively owned and managed energy installations that preferably also bring benefits to their community.

The directors of OVESCO would like to thank all those who supported and took part in the Mountfield Road Lewes Community Energy Options report.

Wave Leisure, Lewes District Council, Priory School, East Sussex County Council, South Downs College, Mountfield Road Residents Association, Transition Town Lewes, The Town Council, local councillors, Lewes FC, local residents, Hoare Lea, Department of Energy and Climate Change, The Energy Savings Trust and The Centre for Sustainable Energy.

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Tel: 01273 472504

OVESCO is currently working with the following organisations for a low carbon future