Capabilities on project:
Energy
Environment

Section M

Estimates potential carbon savings achieved by the envisaged decentralised energy scenario(s) compared to conventional systems.

Current CO_2 emissions within Croydon

The data available from DECC has enabled the total CO_2 emissions of the Borough to be calculated, principally from the consumption of gas and electricity.

	tonnes CO2 p.a.
Total gas use domestic	*499,428*
Total gas use non-domestic	*110,871*
Total electricity use domestic	*338,531*
Total electricity use non-domestic	*390,392*
TOTAL for Borough	*1,339,221*

This data is shown graphically in Figure M1.

The CO_2 emissions associated with the heat demand is largely the gas emissions which is about 610,000 tonnes p.a. the majority of which is in the domestic sector.

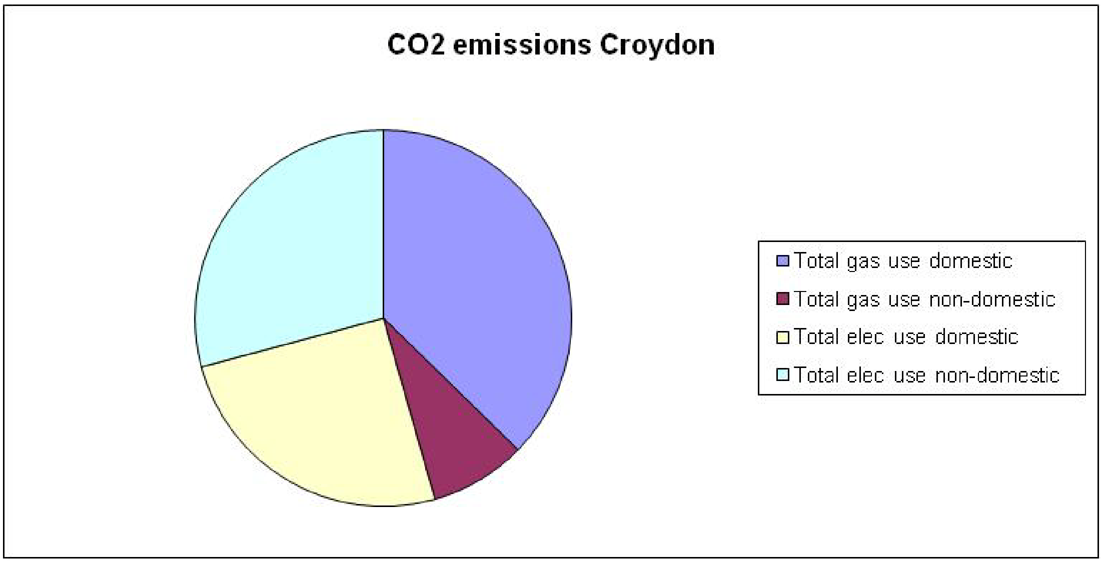

Figure M.1 – Croydon Carbon Emissions

There is an approximately equal split between the CO_2 associated with space and water heating (derived from gas) and electricity use, especially as some electricity use may be used for space or water heating. The CO_2 associated with domestic gas use is much larger than that of the non-domestic buildings. Although much of the housing is in lower density areas and less suitable for district heating any opportunity to supply the domestic sector should be taken as this is a major element of the emissions.

CO_2 benefits from CHP

CHP systems can produce heat with a low CO_2 content as the CHP process is more energy efficient than the production of electricity at power stations and heat in boilers. The energy efficiency improvement is about 30% and is illustrated in Figure M.2 which shows that an energy input of 100 units for a CHP system delivers heat and power that would need 140 units from conventional sources.

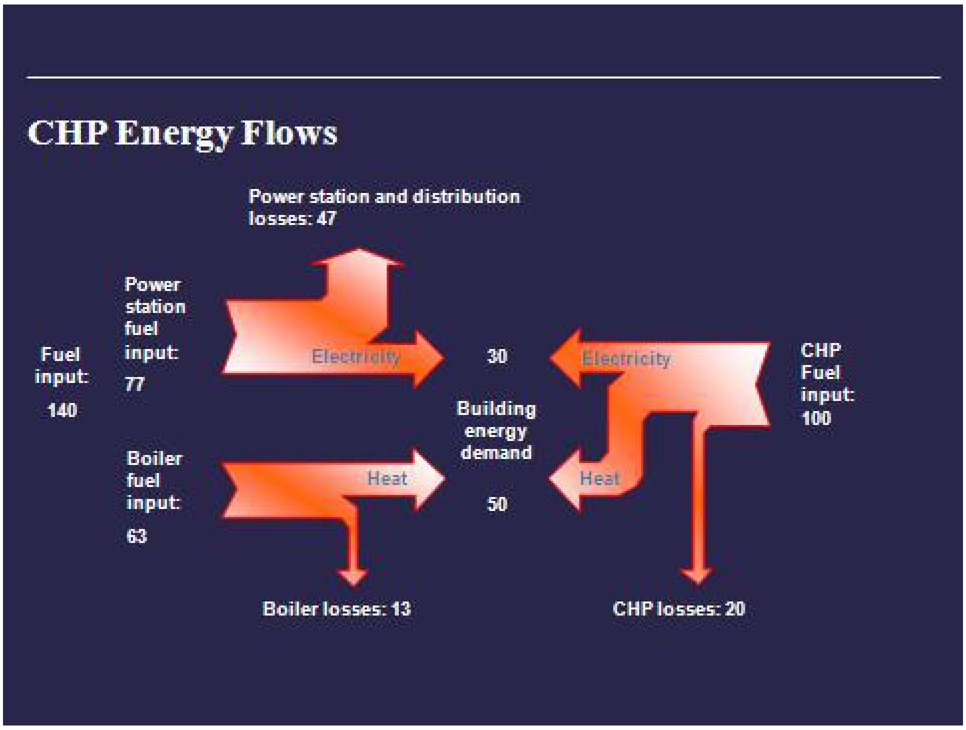

Figure M2 – Energy Efficiency of CHP

In addition to this benefit, there is a further benefit from the use of gas-fired CHP which is the displacing of coal-fired power stations. As electricity from coal-fired power stations has a much higher CO_2 content than gas-fired electricity production (even from smaller-scale less efficient systems such as gas-engine CHP) there is an added benefit from the operation of CHP. This second benefit will however reduce in time as the coal-fired power stations are closed down.

The CO_2 savings can be quantified by defining the CO_2 content of heat from CHP as follows:

CO_2 content of heat equals CO_2 emitted from gas used in CHP less CO_2 displaced at power stations by the electricity generated by CHP divided by heat supplied by the CHP.

This CO_2 content per unit of heat supplied can then be compared with the CO_2 content of heat supplied from other heating systems.

A critical part of the calculation is the emissions factor used in calculating the CO_2 displaced from power stations. As the mix of power stations changes this factor will also change. Figure M3 shows how the CO_2 content of heat from CHP will vary with the grid emissions factor assumed. At present the average grid emissions factor is about 520g/kWh and the power stations displaced by CHP will generally have a higher figure. In the longer term an emissions factor of 430g/kWh is predicted as used by the Government in national analysis of future CO_2 savings.

Figure M3 also shows the benefits of improving the electrical efficiency of the CHP systems, Typically, an efficiency of 37% will be achieved for larger gas-engines or gas turbine supplying district heating.

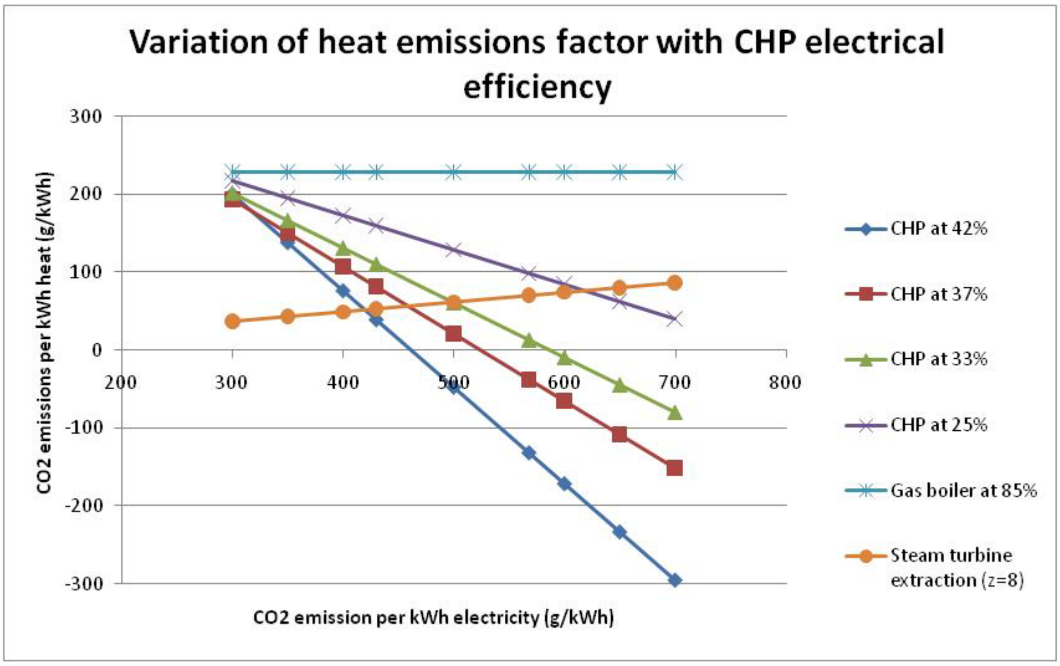

Figure M3 – CO_2 content of heat from CHP

The graph also shows the CO_2 emissions from heat extracted from a steam turbine based CHP system. This could be from a large energy from waste plant, a biomass-fired power station or a combined cycle gas turbine power station. It can be seen that in the longer-term when the electricity emission factor will be lower the steam turbine CHP systems would deliver lower CO_2 emissions.

If an emissions factor of 520g/kWh is assumed then the CO_2 content of the CHP heat will be about zero compared to around 220g/kWh for heat from gas boilers.

The analysis shows that for all three Zones supplied by gas-engine CHP heat delivering about 70% of the annual heat demand the CO_2 saving is 36,993 tonnes p.a. This is approximately a third of the total emissions associated with heat from the non-domestic buildings sector.

CO_2 savings from absorption chillers

The district heating supply can also be used to generate CO_2 savings through the use of absorption chillers. Again, the level of saving is dependent on the emissions factor for electricity.

At 500g/kWh electricity emissions factor the heat from CHP has a CO_2 content of around 40g/kWh. The CoP of a single effect absorption chiller is about 0.67 so the CO_2 content of cooling from a CHP/absorption chiller combination will be about 60g/kWh. This can be compared with the CO_2 content of cooling from a vapour compression chiller with a CoP of say 4 which at 500g/kWh electricity emissions factor would be 125g/kWh. There is therefore the potential for a 50% saving in CO_2 emissions from the supply of cooling from the CHP system.

However, as the grid emissions factor falls there will be a reduction in this saving as illustrated on the figure M4. At about 430g/kWh there will be negligible CO_2 savings.

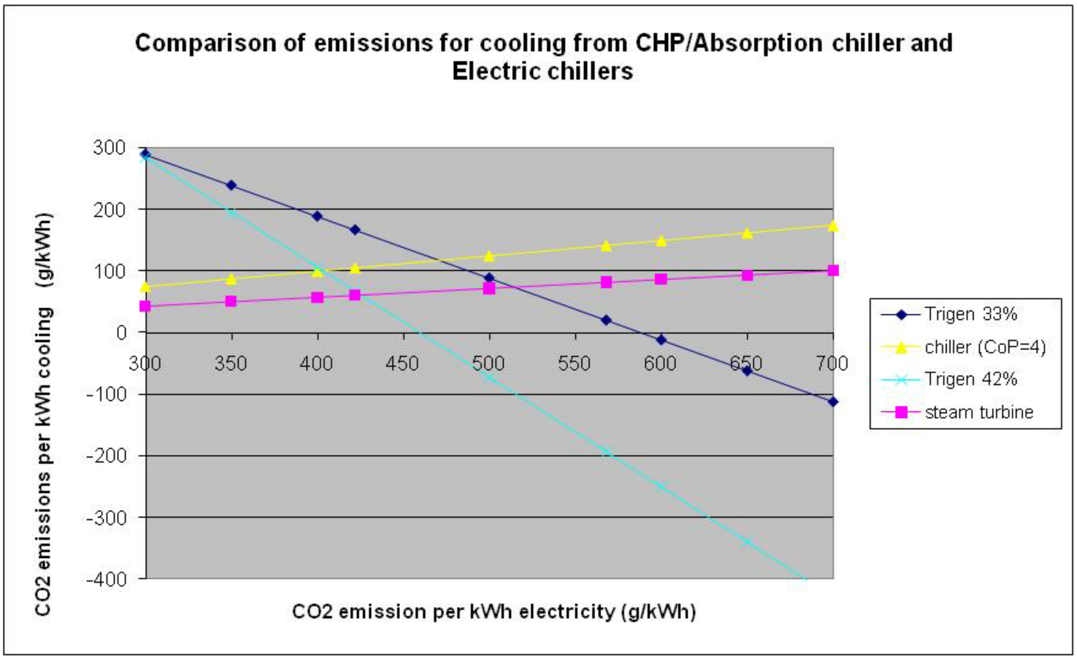

Figure M4 – Emissions savings from CHP and absorption chillers

CHP/DH should be seen as only one element of a strategy to reduce CO_2 emissions in the Borough and reductions in energy use through energy efficiency measures also need to be encouraged.

Capabilities on project:
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Section M Addendum

a) Summer cooling opportunities

From the work carried out so far the cooling demand is not extensive enough to justify a district cooling network. The efficiency of chillers has improved significantly in recent years and the use of absorption chillers will offer a reduced saving in the future as the grid decarbonises (see Figure M4).

There may be a case in examining options for a district cooling system but we would expect these to be localised systems and mainly supplying new buildings where the avoided cost of installing chillers in the buildings would help to justify the cost of the district cooling network.

Whilst it is true that the electricity from centralised electric chillers could be priced at the export electricity CHP price it is also necessary for the CHP to have sufficient heat demand to be operating to generate this electricity. This may be true for the parts of the system that are also supplying residential buildings where there will be a summer demand for hot water heating.

The options for supplying cooling should be kept under review as more detailed information becomes available as to the heating and cooling demand patterns over the year. Combining loads from different building types in a larger scheme would tend to enhance the prospects of a centralised district cooling system being viable however the costs of the DC network are likely to be relatively high in general.

b) Impact of grid decarbonisation

The benefits of a CHP project compared to other options are indicated in Figure M5 below. It can be seen that heat from a gas-engine CHP (35% electrical efficiency) remains lower carbon than heat from gas boilers above an electricity emissions factor of 300g/kWh (allowing for 10% losses in the district heating network).

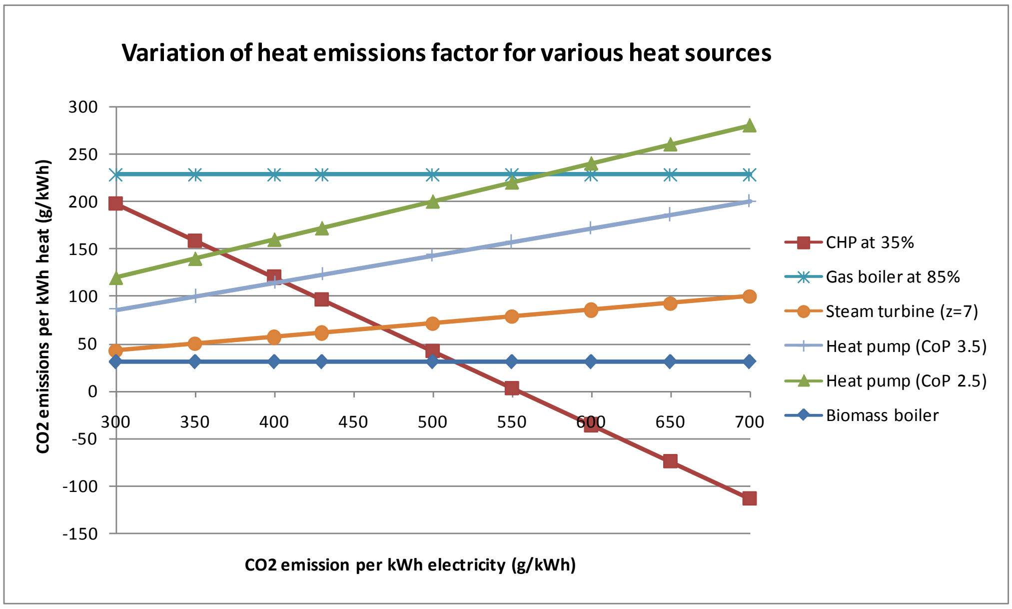

Figure M5 Variation of CO_2 emissions factor for various heat sources

The Government guidance on assessing CO_2 benefits (see Figure M6 on IAG 2010) on public sector projects states that a marginal emission factor should be used and their projection indicates that this factor will not reach 300g/kWh until 2033. There is therefore 23 years before a gas-engine CHP system will not be saving carbon. However, the advantage of a district heating system is that the heat source can be changed relatively easily and the use of energy from waste or large-scale heat pumps could become more viable heat sources within this timescale.

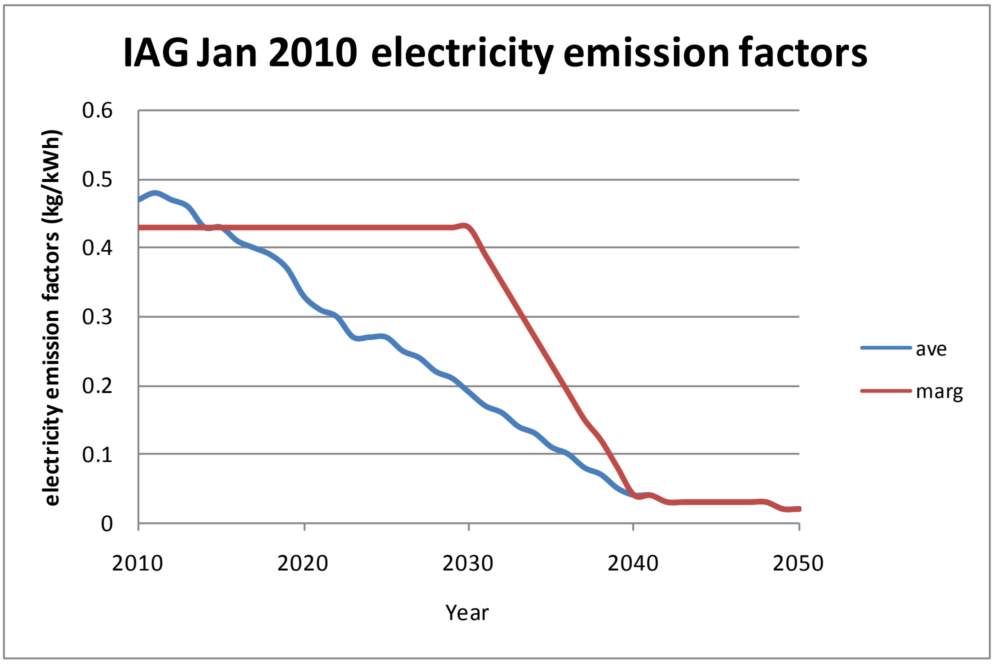

Figure M6 IAG 2010 electricity emission factors

c) Is it the best approach?

This study has reported that the various district heating networks are not commercially viable as the rates of return are too low (assuming current energy prices). The investment can be phased incrementally so that experience can be gained with the early phases before committing the entire expenditure. The net annual savings would rise as electricity and gas prices rise faster than inflation but this has not been taken into account in the business case to date. The project has not been tested against alternative energy investments as this was not part of the brief for the study.