Appendix 2 - Anaerobic Digestion

The heat requirement for the houses is presumed to average out at 57kw. Therefore the CHP should be sized to meet this demand, if there is a heat dump facility (ground heating in polytunnels or similar) to utilise the heat when demand is less than the average and an additional source of heat available to meet the peaks in demand above the average demand.
There are now duel fuelled CHP units available for biogas, which operate on 94% biogas and 6% diesel. The units are available from 25-100kw outputs. These units have a 50% thermal output and between 36-40% electric output (depending on the kw output) when operating at full capacity. They have a low maintenance requirement because they are duel fuelled and modified specially to burn biogas, so it is assumed that each CHP will operate for 8000hours per year.

If a digester is to process wastes that contain animal protein, or to process manures from a number of farms and return the resultant fertiliser to land then the material processed must be pasteurised. A digester and pasteurisation system requires about 40% of the total energy produced by the system to operate the system. Therefore to produce about 57kw of spare heat (additional to heat required for the process) when using electrically efficient CHP would require 165kw of installed CHP capacity.

Biogas output from a digester depends on many factors, feedstock type, quality and dry matter, the retention time in the digester, the combination of feedstock, the temperature of the process, and the type of technology used. It is proposed that this digester should operate on 75% slurry (assumed to be 8-10%DM) and 25% food/sewage sludge (assumed to be 20-25%DM). Percentage mix is by dry matter content (DM). The retention time is calculated assuming a requirement of 2kgDM/cu m digester/day, and will be about 22 days. This mix of feedstock could be expected to produce 2cu m biogas to each cu m digester capacity.

About 1550cu m of biogas would be required to supply 165kw CHP. Therefore the digester size should be 800cu m. This size plant could operate under a waste permitting scheme, which only costs €200/yr. Over 1,000cu m plants would have to operate under a waste licence which costs about €50-80,000 to establish and €10,000pa to maintain.

The housing development is estimated to require 876,000kwh pa (100kw) of electricity (although in reality the demand would fluctuate considerably). This means there would be 444,000kwh (55.5kw) electricity not required for the development. Therefore this surplus would be available for other purposes or for export to the grid.

Biogas can be stored cost effectively for a period on a 24hr cyclical basis. Therefore it would be possible to install different size CHP (say 2x100kw) CHP units along with some gas storage, and operate them intermittently in relation to the demand peaks for electricity and or heat. Further study would be required to ascertain if this approach was desirable.

An 800cu m digester being fed 38t/day of material at 12%DM could produce 11,000cu m liquid fertiliser and 2760cu m fibre per year, if the digestate is separated after it leaves the digester. This is preferable if the fertiliser is required for grassland management, but not necessary for arable land. The nutrient value of both of these products will depend entirely on the nutrient value of the feedstock. Generally it can be expected that the anticipated feedstock would produce a liquid fertiliser product with about 1kg of mineralised nitrogen per cu m liquid. There would also be about 100g additional nitrogen in the form of organic nitrogen. However it is mineralised nitrogen that plants can utilise directly. The mineralised nitrogen can directly replace artifical nitrogen. It has been shown in trials in Denmark that 98kg of artificial nitrogen can be replaced by 100kg of total nitrogen in digested and separated digested material.

There are also significant savings in greenhouse gas emissions of methane and nitrous oxide when the slurry is digested and used as a fertiliser compared to storing and spreading it as untreated slurry. There are also greenhouse gas savings arising from reduced artificial fertiliser use (energy is required for manufacture and transportation and nitrous oxide is produced during manufacture and after application) but these savings are not calculated or considered in this assessment.

The fibre is an ideal soil conditioner and fertiliser for arable farming, particularly as land that is continually used to produce arable crops has become depleted in organic matter. Alternatively it can be used as a peat replacement in compost manufacture.