

CO₂ from biomass boilers for greenhouse enrichment – the ProSelect GC6 System

Introduction

Biomass heating is now becoming more popular in the UK, largely because of the financial support that's available through the Renewable Heat Incentive (RHI).

Until now, the trend in greenhouse horticulture has been that ornamentals growers have been more enthusiastic about using biomass than edibles growers; one of the

biggest reasons is that biomass boiler flue gasses can't be used for CO₂ enrichment without cleaning them. This has a negative impact on the economics of using biomass heating on an edibles nursery because the grower either has to stick with gas heating when CO₂ is needed, or find an alternative source of CO₂.

Biomass flue gas cleaning

HDC projects PC287 and PE003 investigated the levels of contaminants in boiler flue gases and compared them to the safe limits for salad vegetable crops. PE003 concluded that cleaning technologies were needed to make biomass flue gases safe to use and a range of contaminants, including particulates SO_x and NO_x, were all problematic.

The development of practical biomass flue gas cleaning systems has made slow progress, but a commercial system is now being used on a nursery in British Columbia, Canada. Known as the ProSelect GC6 System, it was developed as a joint venture between a Dutch gas treatment company, Procede, and a Canadian salad vegetables grower, Sun Select Produce.

A group of growers and horticulture industry professionals from the UK visited the Sun Select nursery with the GC6 System in Delta, British Columbia in February 2014. This technical update summarises the findings of their visit.

The Sun Select GC6 installation

- The Sun Select nursery in British Columbia grows sweet peppers in greenhouses covering 10Ha.
- The GC6 System at the site operates with two biomass boilers, each of 7MW capacity.
- The system is designed to supply 5 tonnes of CO₂ per hour.
- The installation has been operational since April 2012.
- The capital cost of the ProSelect GC6 System was C\$5M (approx. £2.7M at current exchange rates).
- To date the installation is the only commercial example of the GC6 System.



The installation at Sun Select. The wide tower is the absorption tower, the horizontal tank is the CO₂ storage vessel and the narrow tower is the desorption tower.

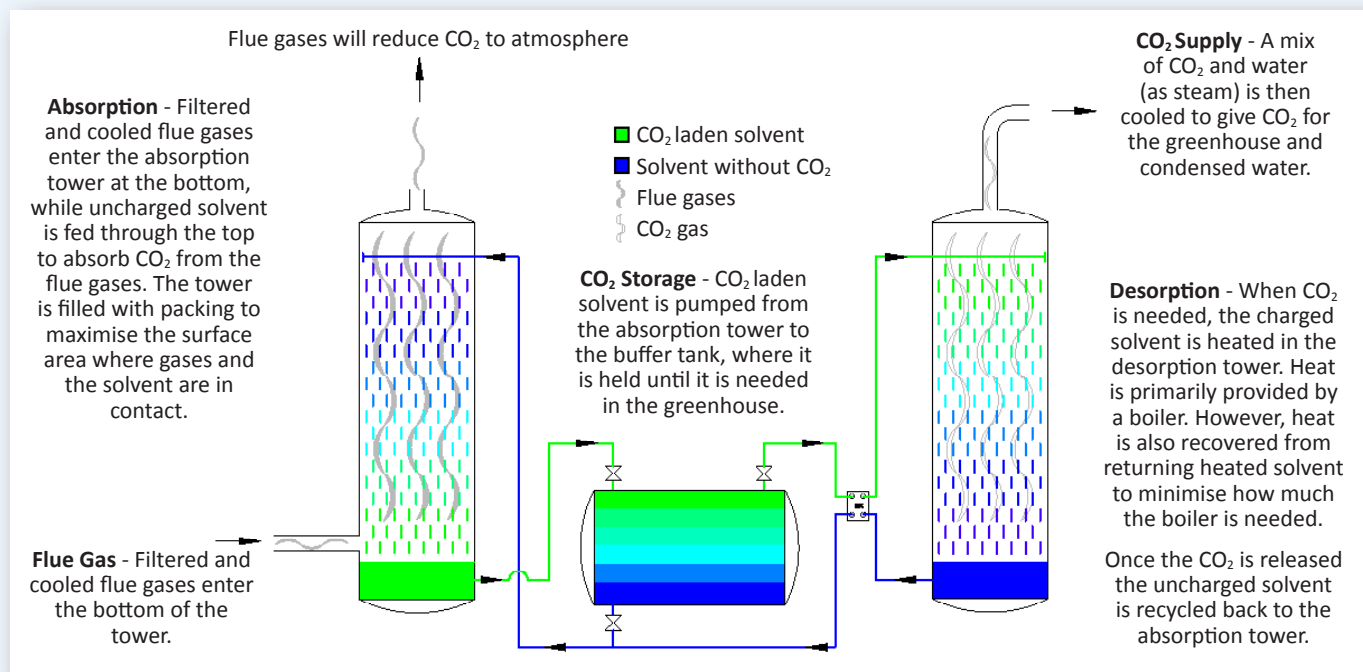
How the ProSelect GC6 System works

The basic principle of the GC6 System is very simple.

1. Biomass flue gases are passed through a chemical solvent which absorbs the CO₂ but rejects any pollutants.
2. CO₂ laden solvent is then stored in a tank where it is kept until it is needed in the greenhouse.

3. When CO₂ is required the solvent is heated to release the CO₂.

The diagram below gives a more detailed description of how the system works and shows the various system components and how they fit together.



The economics of GC6 in the UK

To assess the economics of the GC6 System in the UK a desk based appraisal has been used to compare the following heat and CO₂ supply scenarios:

1. A gas boiler.
2. A gas fired CHP with CO₂ recovery (e.g. CODiNOx).
3. A biomass boiler with GC6.

In all cases, the heat output of the equipment has been sized to meet the requirement of a typical UK tomato nursery. This has been assumed to be 380kWh/m² of heat per annum. Nursery areas of 5Ha and 10Ha have been used because the manufacturers of GC6 advise that this is a suitable size range for a commercial project.

From a CO₂ demand perspective, it has been assumed that all of the systems will match output of the CHP over the summer months.

Other assumptions made in the analysis are:

Gas price	60p/therm
Biomass fuel price	£80/tonne
Electricity sales value (from CHP)	£55/MWh
CHP operation & maintenance cost	£10/MWh(e)

RHI income has been included in the analysis for the biomass boiler with GC6. It is assumed that the RHI income is 2p/kWh. This is the current RHI rate for boilers of over 1MW capacity.

Both heat and CO₂ supply costs have been considered. When CO₂ demand is high and there is no heat demand i.e. in the summer, then all the running costs of the gas boiler have been attributed to CO₂.

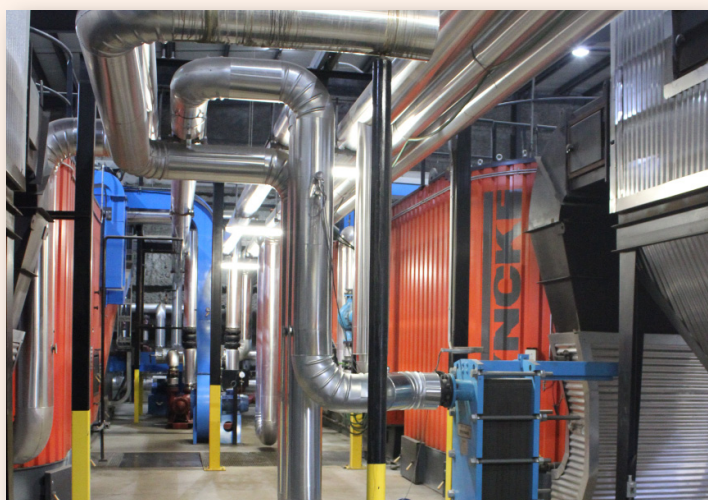
The results of the analysis are given in the table below and they show that using either CHP or biomass with GC6 requires a similar financial commitment.

System	Estimated payback period (years)	
	5Ha nursery	10Ha nursery
Gas fired CHP with CO ₂ recovery	6.6	5.6
Biomass boiler with GC6	7.5	6.7

Payback periods for CHP with CODiNOx and biomass with GC6 compared to a gas boiler

Other considerations

1. Compared to CHP the GC6 System is still relatively un-proven as it is currently only operating at the Sun Select site in Canada. This makes the long term reliability of the system difficult to assess.
2. Capital costs for the GC6 System are also uncertain and the estimates used in our economic analysis are based on the cost of the installation at Sun Select.
3. Without the financial support from the RHI, the payback of the GC6 System is likely to be very long. Simple calculations suggest it could be over 50 years.
4. A biomass boiler, with either the GC6 System or a gas fired CHP, will give similar quantities of CO₂ for enrichment. However, moving to the biomass system gives growers the opportunity to switch to a fuel source that is not directly linked to traditional energy markets. This means that, if the costs of traditional energy sources, like gas, go up at a faster rate than biomass, the biomass boiler with the GC6 System could be a better long term economic prospect.



Overall conclusions

- The ProSelect GC6 System is the first example* of a commercial cleaning system that allows biomass flue gases to be used for CO₂ enrichment. The system is a good demonstration of how alternative fuels can be used as a source of CO₂.
- The economics of using a biomass boiler with the GC6 System on a UK nursery are currently similar to using gas fired CHP. However, this option would need RHI income to make it viable.
- The long term reliability of the GC6 System is currently unknown because it has only been operational since 2012. Also, the economies of scale mean that it's not currently viable for nurseries of less than 5Ha.

* It is also believed that the Dutch manufacturer HoSt (www.host.nl) has delivered a biomass heating project with CO₂ recovery in Holland, but no technical details of this installation are currently available.