GREENHOUSE PRECINCT DESIGN EXAMPLES

FOR

WOODHOUSE PASTORAL COMPANY PTY LTD

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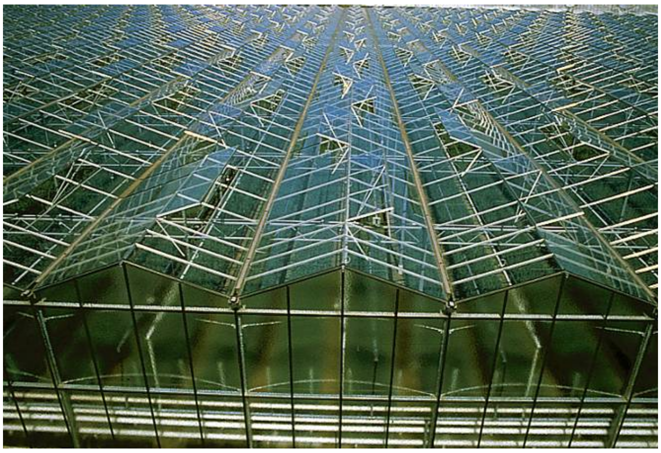
GLASSHOUSE EXAMPLES



INTERNAL ANCILLARY EQUIPMENT EXAMPLES

As can be seen from the above CO_2 graph, more CO_2 gives a higher rate of photosynthesis (growth) and more light increases the optimum CO_2 concentration, therefore glasshouses are preferred over polythene greenhouses due to a higher annual radiation sum (total annual light capture).
Given that all plant photosynthesis (growth) parameters are provided, fruit quality and shelf life is also significantly enhanced.
CO_2 is captured from the flue gasses from a natural gas boiler system that has a condensor to pre-cool these gases before distributing via delivery tubes in each growing row.
Efficient CO_2 enrichment technology delivers for every gram of CO_2, ±6 grams Tomatoes, ±4 grams Capsicums, ±5 grams Eggplants and ±11 grams of Cucumber.

Natural Gas Boiler System

Flue Gas Condensor

CHP System: (combined heat & power)

Many Dutch greenhouse growers use these natural gas cogeneration engines to produce electricity for grid connect and local enterprise energy needs and harvest the otherwise waste products of Heat and CO_2 for use in the greenhouse.
Some technology design changes are required when selecting either Boiler or CHP systems as their available thermic output changes per m^3 of gas.
i.e.

- Boiler: $1m^3$ natural gas = ± 1.8kg CO_2 = $8.3kW_{th}$
- CHP: $1m^3$ natural gas = ± 1.8kg CO_2 = $4.5kW_{th}$ + $3.2kW_{electric}$

Therefore heat buffer tank needs to be ± 30% larger to offset lower heat output of CHP gas engines.

General design principles allow for ± 0.4MW capacity per Ha of greenhouse however this will depend on metrics of electricity and gas pricing and demands of the local climate.
In Australia today, CHP systems are used as stand-alone power stations but are only 35 – 40% efficient, however when matched to a greenhouse the efficiency rises up to 92%.

connected to a 'heat buffer' tank in an 'open buffer' configuration (as shown above)
This way the boiler can be used to produce CO_2 (for crop enrichment thru the day), and excess heat stored in the buffer (large insulated hot water tank) for later use by the crop at night.

Heat Buffer Tank

Heat buffer tanks are not so much about energy conservation (however they do assist in this role), but rather maintain higher levels of CO_2 enrichment for increased crop yields.
Some projected energy savings are in the order of ±5% as the boiler modulation is more efficient with a lower controlled setting during the day as opposed to a higher maximum setting.

Greenhouses with no CO_2 enrichment system could produce tomatoes in the order of 49.9kg/m^2 (499tonnes/ha), whereby the efficient use of a heat buffer should see a significant annual average rise to 600ppm, resulting in a yield increase of ±16.5kg/m^2/yr to 63.4kg/m^2. (an extra 135 tonnes of tomatoes for 1ha, as per Tomsim)

In addition, utilising natural gas thru the day to produce CO_2 for the crops could result in as much as 585 tonnes per year of less CO_2 being emitted to the atmosphere (n.b. normally CO_2 lost when heating at night as plants can only assimilate during the daylight hours)