Natural Gas-Driven Chiller With Custom Air Handlers For Indoor Grow Facilities

INTRODUCTION

As the size of indoor grow facilities become larger, it becomes more difficult to position individual D/X integrated systems throughout the facility and run refrigerant piping out to remote condensers. In these large facilities, a centralized system can offer many benefits from an operational standpoint, as well as providing a reduction in the cost of energy, therefore improving profits.

These larger facilities will benefit from a heat recovery chiller of some type. The hydronic loop can provide the chilled water to cool the lighting heat gain and remove moisture that is a by-product of the plants' evapotranspiration. The system can also supply the hot water required for the dehumidification process and winter heating requirements of the facility. For a successful application, the hydronic components must be integrated together to ensure the cultivator can achieve the design temperature and humidity set points with little deviation. The use of systems with integrated on site recovered hot water provides the highest level of energy efficiency.

NATURAL GAS CHILLER

A natural gas engine-driven chiller, such as a Tecogen TECHOCHILL unit, cuts costs by as much as 30-60% when compared to conventional electric chillers and helps facilities avoid punitive peak-demand electricity charges. As an added bonus, additional savings can be realized by recovering waste heat from engines for heating needs such as dehumidification, in other words providing the energy needed for reheating the air in an air-handling application.

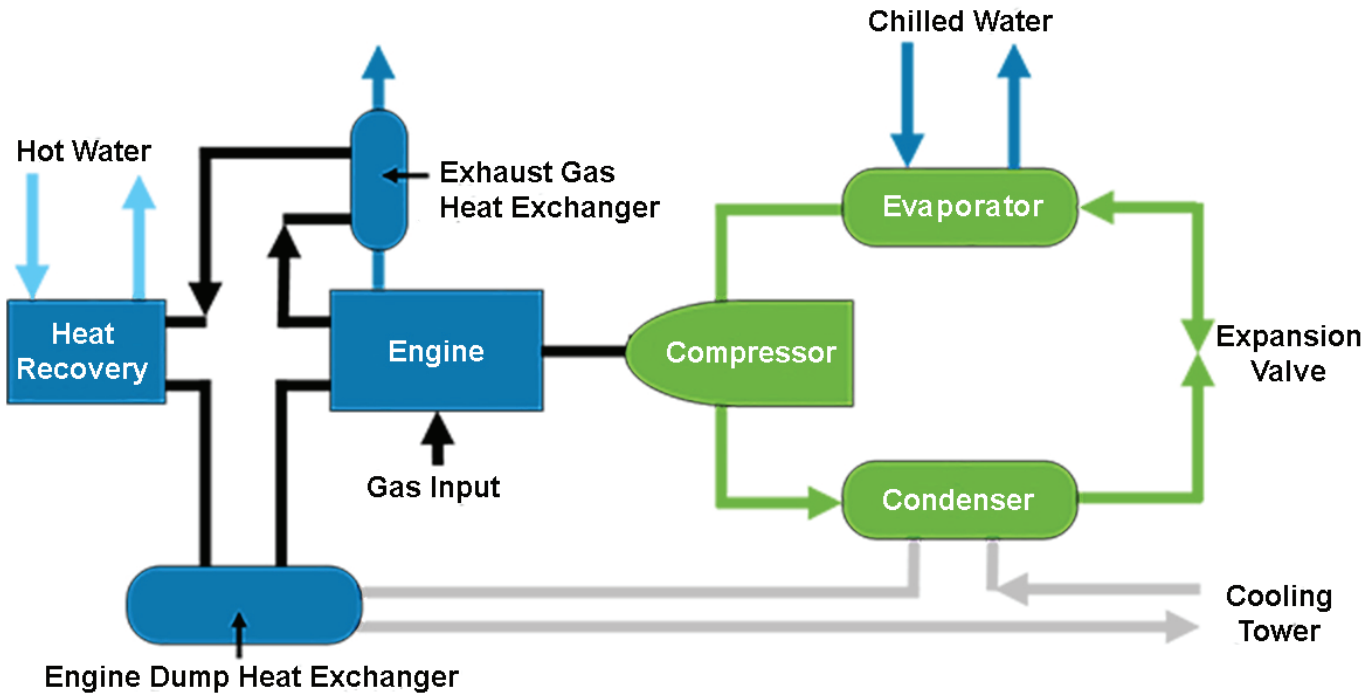

Figure 1 - Natural Gas Chiller Schematic

The true power of this technology is most evident in the summer-time, when electricity rates are at their highest—often incurring peak usage charges for traditional electric chillers—but when natural gas pricing is "off peak" and especially affordable.

Other benefits include:

- Eliminate or reduce significantly the need for costly electrical infrastructure upgrades
- Free high-grade waste heat available anytime the chiller is operational for reheat
- Chillers will continue running on minimal electric power in case of electric blackout, reducing the size of the required back-up generation equipment.
- High energy efficiencies qualify for utility incentives and tax credits
- Modular and compact design eases installation – Since:
  - No oversized pumps or cooling towers are required
  - These chillers can fit into the same tight mechanical room spaces that electric chillers do

The natural gas chiller has several main components:

- The gas engine is the core to create the power to operate the chiller's compressor and the free hot water source.
- The chiller to create the cold water is part of a refrigeration loop.
- A heat recovery loop captures the waste heat from the engine and transfers this to the hot water loop or what is not used out to the outdoors via cooling tower.

CUSTOM AIR HANDLERS

The air handler, such as Desert Aire's GreenAire™ dehumidification system, must be able to simultaneously control the temperature and humidity in a cultivation room to tight standards in order to maximize the yield for the grower. By controlling both together, the air handler can maintain the exact vapor pressure deficit (VPD) that is being targeted for the crop being grown.

Most fan coil units are for comfort cooling applications and do not have the sophisticated controls necessary for tight temperature and humidity control. A specially designed air handler must be employed to change the water flow rate, water temperature, and air speed to adjust to the ever changing demands as the crop grows.

Since most of these larger facilities require more than one air handler for redundancy and control, they must also link together on a control loop to act as one system.

The air handling system like GreenAire™ will provide the following functions for the indoor grow facility:

- Dehumidification
- Cooling
- Heating (with energy recovery)
- Air Filtration (including High MERV options)
- CO_2 control (optional)

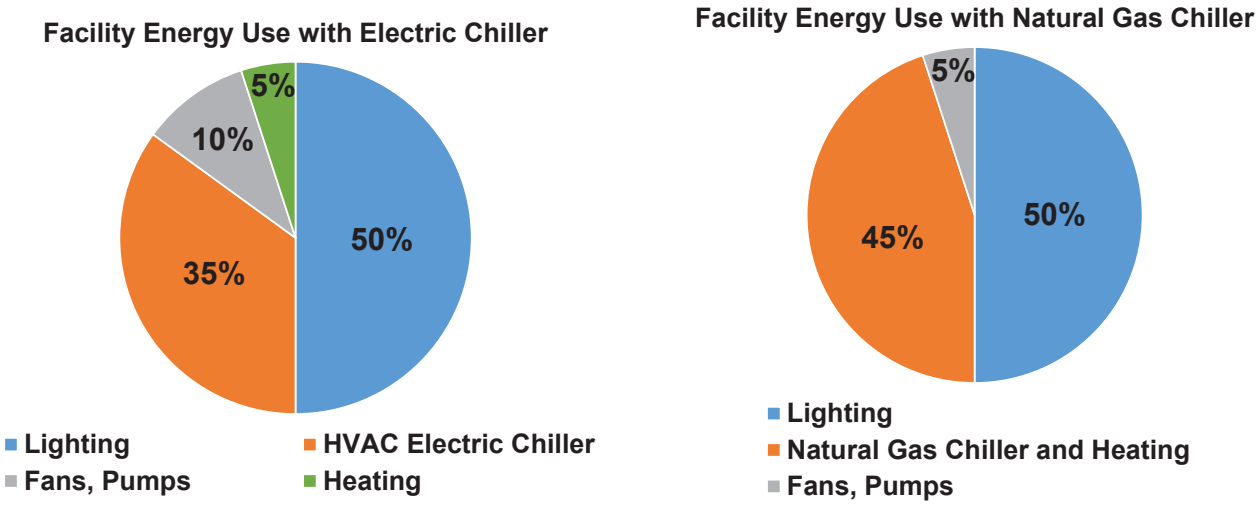

Figure 2 - Facility Energy Usage Comparison

SOURCE OF ENERGY

The natural gas chiller removes a major component from the power grid, thus reducing the required total energy at the job site. This becomes very important if the power grid does not have enough capacity, or if the job site is too far away from a source to overcome the expense of bringing power to the site.

The Facility Energy Usage Comparison in Figure 2 shows the shift from electrical energy as the power source, to a hybrid model that utilizes low-cost natural gas to power the chiller.

A benefit of a centralized system is that the waste heat from the cultivation rooms can be used as a heating source for the rest of the facility, potentially eliminating the need for other heating sources. The building can often be totally heated from the free by-product energy recovered from the natural gas chiller's engine.

The shift from electric-powered to natural gas-powered chillers will typically yield significant operating savings for a facility owner, of 50% or more, due to the relative prices of electricity and gas, as shown in the cost graph below. Operating savings and efficiency gains become even greater with the utilization of the gas chiller's free engine heat recovery. No additional input energy is required to produce this energy, and there's no performance penalty for the chiller.

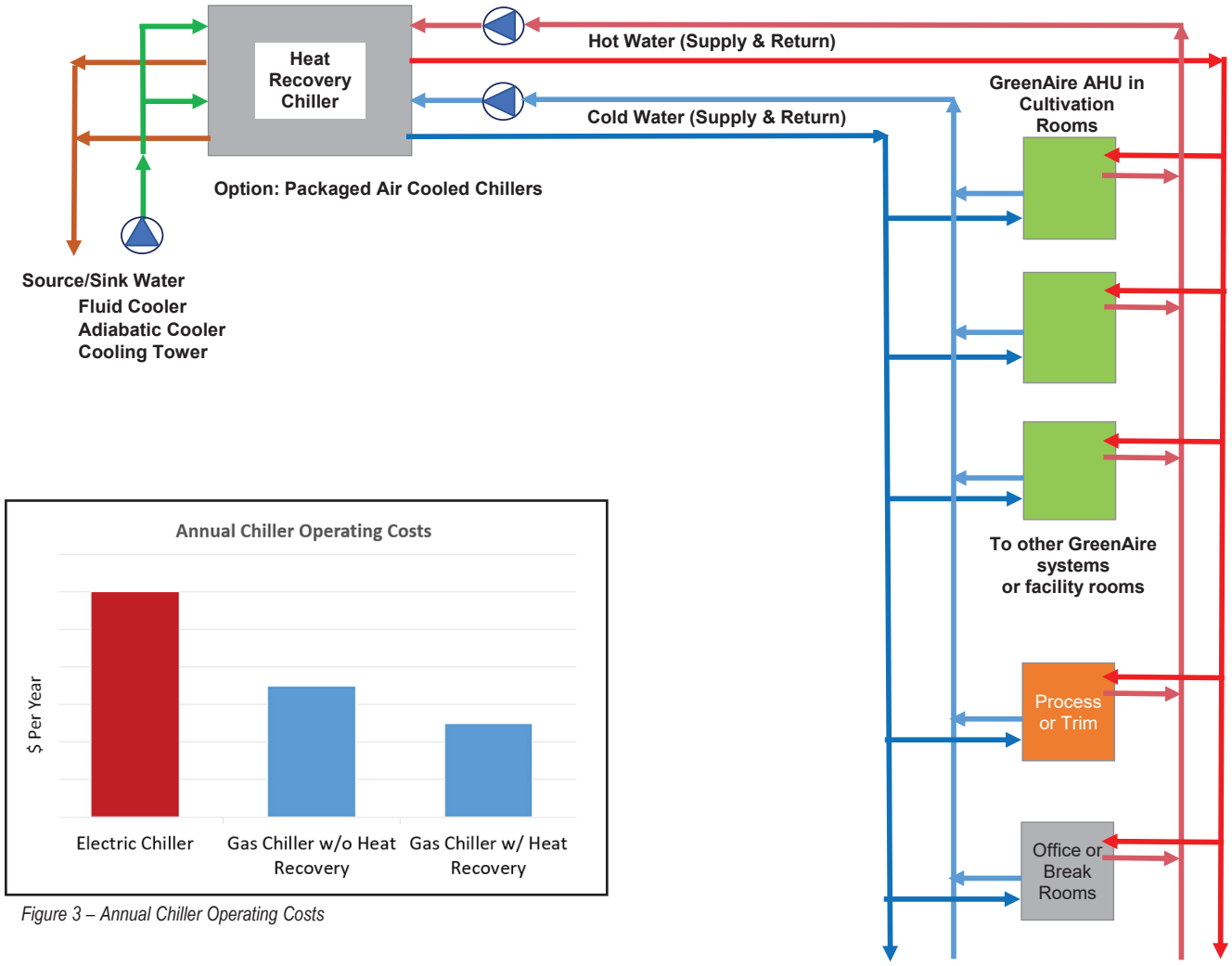

Figure 4 – Cultivation Facility Schematic

Figure 3 – Annual Chiller Operating Costs

SYSTEM CIRCUITS

The hydronic system consists of several sub-circuits. The output of the chiller produces chilled water typically in the 35°F to 42°F (2°C to 5°C) range, in order to meet the high dehumidification load within these spaces. The second circuit is the recovered heat in the form of hot water recovered from the engine and exhaust waste heat of the chiller. This circuit is used to heat the zones for dehumidification or winter heat loss. The final circuit is to reject the remaining heat to an outdoor condenser or cooling tower.

One of the large advantages of creating this hydronic system is that the heat captured from any of the grow rooms can be re-routed to another or grow room or other spaces. If one grow room requires cooling while the other requires heating, the systems automatically use the heat that would have been rejected. In this way, the whole system is allowed to recover energy where needed and new energy required for heating the indoor plant environments is not likely to be required.

While a clear advantage of using the hydronic loop is the sharing of energy, the integration must be carefully approached and coordinated by the mechanical engineer. The load requirements of the non-cultivation rooms may require a larger chiller, so the calculations must be made in advance of selecting the chiller size. In addition, the conventional fan coils to be used in these other areas may have other specific water temperature and flow rate requirements which the engineer can define. It generally is very beneficial to spend this extra effort on plant wide integration.

Desert Aire GrowAire™ systems are uniquely designed to leverage the potential advantages of natural gas driven chillers in this application. Internal pumps and valves included inside the GreenAire™ systems are specifically created to balance the temperature and flow rates of cold water. Larger heat exchangers transfer heat over a wider range of entering water temperatures. The use of a natural gas chiller and the GreenAire™ system combines to create the optimal conditions and high energy efficiency.

CONCLUSION

For owners that would like to leverage low-cost natural gas to reduce operational costs, downsize their electrical infrastructure and back-up generation, and unlock lucrative utility incentives and tax credits, using an integrated system such as a natural gas engine-driven chiller coupled to a series of purpose-built air handlers for indoor cultivation is the ideal solution.

The two complimentary systems will provide the cultivator with precise grow room temperature and humidity control, while providing substantial utility cost savings, increasing the profitability of the facility with lower production costs and higher quality products and increased yield.

ABOUT TECOGEN

The Tecogen name has been synonymous with efficient, reliable and clean combined heat and power systems for on-site energy production for nearly four decades. Tecogen's proven distributed generation systems provide increased resiliency, lower energy costs, and decreased greenhouse gas emissions to the buildings they serve.

The original designer of packaged cogeneration equipment, for over four decades Tecogen has pioneered the development of efficient, reliable and clean technologies for on-site energy production. With over 2,400 units shipped, Tecogen has an industry-leading reputation for delivering quality, technically superior products that reduce energy costs, cut greenhouse gas emissions and alleviate congestion on the national power grid.

ABOUT DESERT AIRE

Desert Aire's calling is to provide customers with indoor air quality solutions that help people live, work and play in healthy and productive environments. As recognized leaders in dehumidification, Desert Aire applies deep engineering expertise, advanced technology and focused support to meet design goals with solutions that are accurate, durable and efficient.

Over 1 million square feet of cultivation area is served by Desert Aire controlled environment agriculture air handlers. By monitoring each, the company has gained significant experience in sizing the solution to maintain very tight design conditions that can vary to meet the needs as the plants grow.

DESERT AIRE

Tecogen
Advanced Modular CHP Systems