POLAR POWER INC.

Micro Cogeneration Unit

Integrates a heat pump and generator into a simple package delivering Air-conditioning, Space heating, Electrical power generation & Hot water.

Simultaneously this unit provides:

- 34,000 Btu/hr of air conditioning.
- Up to 30,000 Btu/hr for heating hot water.
- Up to 6 kW of DC power for battery charging.

Or

- In the heating mode it provides up to 36,000 Btu/hr of space heating
- Up to 6 kW of DC power for battery charging
- Up to 30,000 Btu/hr for heating hot water.
- The heat from the exhaust can be combined with the heat pump for a total output of 66,000 Btu/hr.

Applications:

Homes, offices, restaurants, markets, convenience stores, solar and wind powered homes, telecommunication e co-tourism cottages and hotels, farms, military field posts, marine, recreational vehicles, trucks.

Custom models are available in larger electrical and HVAC capacities.

Polar's cogeneration unit makes the most reliable, efficient, and cost effective use of energy from fuel. Polar's micro-cogen unit can operate from natural gas, propane, or gasoline. Diesel and other fuel models are available.

The assembly is noise attenuated for quite operation.

Typically most applications will use a generator to produce electrical power to run an electric compressor as part of a typical airconditioner / heat pump, this is not efficient. Fuel is wasted in converting mechanical power into electrical power (generator) and back again into mechanical power (motor) as required to drive the refrigeration compressor.

The Micro-cogenerator's efficiency and cost savings is based on reducing fuel consumption by using the engine to direct drive both the alternator (generator) and the air-conditioning compressor at the same time. The air-conditioning compressor uses an electric clutch to disenguage it from the engine when cooling/ heating is not required. Fuel consumption is reduced by more than 50% over typical applications by eliminating the unnecessary conversion processes.

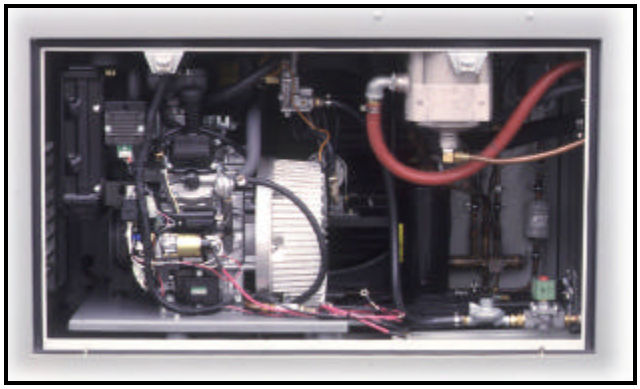
Engine maintenance is reduced because the engine does not have to run continuously while the air-conditioner cycles on and off, nor does the engine operate at full speed without a load.

The unit as shown here is configured as a hydronic heating and cooling system. Hydronics use chilled or hot water as a means of delievering air-conditioning and heating from the micro cogeneration unit to the desired areas. Simple plumbing connects heat exchangers (fan coils) installed in various areas (rooms) throughout the facility. The fan coils in each area

Micro Cogeneration Unit

creates the heating and cooling effect. Hydronics is the quitest and most confortable form of heating and cooling. The micro-cogeneration is perfect for radiant floor heaters and provides hot water for washing and bathing.

The Micro-cogen units are also available as split and unitary or central systems.



Polar's Natural Gas or Propane Micro-cogeneration system is comprised of the following subsystems:

Polar Power Model 6200 Alternator – 6.5 kW

- High Efficiency Alternator for low fuel consumption
- Permanent Magnet Hybrid Homopolar Technology for reliability
- Up to 250 amps continuous output for faster battery charging with lower engine run time
- Available in 12, 24, 48, 96, 120 VDC, and 120/240 VAC 50/60 Hz.
- Precision Voltage and Current regulation for optimized battery charging
- Very low Ripple output for longer battery life
- Very clean power output for computer and telecommunications loads
- No alternator parts to wear out or require servicing
- Designed to last for decades
- Excellent compatibility with most inverters, DC voltage regulation is unaffected by inverter ripple

Kawasaki Model 620D Engine - 20 HP

- Liquid cooled, 4-cycle, OHV engine for quite operation
- Two cylinder, V-Twin for low vibration and compactness
- Operates on natural gas, propane, and gasoline
- Full pressurized lubrication system with spin-on oil filter for long engine life
- Full transistor ignition system for reliable starting
- Solenoid shift type electric starter for reliable starting
- Automatic oil makeup with 2 quart capacity.

Cooling/Heating

- 34,000 Btu/hr heat pump.
- 30,000 Btu/hr Model 30 stainless steel exhaust heat exchanger for heating hot water for washing, bathing, swimming pools, and hot tubs.

Enclosure

- Sound attenuated enclosure producing only 68 dBA at 21 feet (similar noise level as a central air-conditioning or condensing unit).

Controls

- Microprocessor based control system regulating battery charging, air and hot water temperatures, and safety functions.

22520 Avalon Blvd • Carson, CA 90745 • Tel (310) 830-9153 • Fax (310) 830-9825 • *www.polarpowerinc.com*

POLAR POWER INC.

Micro Cogeneration Unit

The Hydronic system offers the following advantageous and disadvantageous:

1. Circulating water can carry more that 10 times the amount of heat that air can, so for cooling and heating only small water flow rates are required for environmental control. This translates into the use of 1-inch plumbing pipes as opposed to using 8 to 16 inch air ducts. Much less energy is required to circulate water as opposed to air. The water pump and small fans in the heat exchangers will consume less energy than the large blower required to force air through out the house.
2. Superior temperature control from room to room. Each room with a fan coil unit can utilize its own precision thermostat and fan speed control. Rooms not requiring environmental control can be completely shut off. Temperature regulation to within 1° to 3° Fahrenheit (.6° to 1.7° C) is practical so you do not feel the "chills" or discomfort typical of most heating and cooling systems as they cycle on and off. Circulating water in place of air provides two distinct advantages. Due to its high specific heat (ability to store heat and cold) water can provide continued cooling and heating after the heat pump is shut down. This helps smooth out the heat pump compressor cycling, as the compressor stays off longer and stays on longer and there are only small temperature changes in the water temperature. Using the individual precision thermostats in each room to control temperature is practical because we are only controlling a small electric fan. A precision thermostat controlling a heat pump is not practical because the frequent on/off cycling will destroy the compressor. The hydronic system properly installed (no water hammering) is very quite compared to an air duct delivery system. Flowing water makes very little noise as compared to the noise created by large blower moving volumes of air through the air ducts.
3. The hydronic systems allow for the incorporation of other cooling and heating technologies such as ground loop cooling and solar thermal heating. Supplemental propane heaters can be added for additional heat or to reduce engine run time.
4. Storing the hot/cold water in tanks can create thermal reservoirs. This is very efficient for heating and air-conditioning in desert communities where the nights are cold and the days are warm. During the night the water is cooled (with the heat pump off) due to the natural low air temperatures and during the day the cool water is circulated for air-conditioning. In winter the heat during the day is absorbed by the water and during nighttime provides heating. The heat pump is then used to supplement the heating and cooling effect as needed.
5. The hydronic system facilitates the recycling of engine exhaust heat for space heating.
6. Many homeowners enjoy heated floors. Here plumbing is buried under the floor and the hot water passes through heating the floor and the room.
7. The hydronic system costs more to purchase than the unitary and split systems.
8. As with any plumbing system there is always the possibility for water leaks.

To complete the system requires:

- Propane fuel tank or connection to natural gas line (local propane vendor or Gas Company).
- Hydronic fluid to air heat exchangers (Polar or others) or radiant floor system (provided by others).
- Hydronic water pump, plumbing, reservoir, and valves (Polar, local stores such as Grangers or Home Depot).
- Hot water pump (Polar, local stores such as Grangers or Home Depot).
- Concrete mounting pad (local contractor) or precast concrete blocks (Home Depot or others).
- Electrical connections to the battery/inverter system (Polar or others).

Cost is $9,985.

- Add $150 for 48 Vdc.
- Add $2,500 for a Diesel engine in place of gas.
- Hydronic heating/cooling heat exchangers are bid by requirement. Some systems may incorporate a central heat exchanger and others will use heat exchangers in each room.
- Central heat exchangers will range in cost of $300 to $400; room-by-room heat exchanges will range in cost from $90 to $200.

POLAR POWER INC.

Micro Cogeneration Unit

The advantageous and disadvantageous unitary or central systems:

A central heat-pump system has all the components located within one enclosure. Air is circulated between the house and the Micro-cogen unit.

1. Many prefab houses and mobile homes are already set up with air ducting.
2. Two large 12 to 16 inch air ducts must exit the house and connect to the micro-cogeneration unit.
3. System is lower in cost.
4. Balancing the air distribution through ducts has frequently caused problems for the contractor and the homeowner. One or two room either get too hot or too cold. Fan and air noise is also a common problem.

To complete the system requires:

- Propane fuel tank or connection to natural gas line (local propane or Gas Company).
- Hot water pump (local stores such as grangers or home depot).
- Concrete mounting pad.
- Electrical connections to the battery/inverter system (Polar or others).

Cost is $9,950.

- Add $150 for 48 Vdc.
- Add $2,500 for a Diesel engine in place of gas.

The advantageous and disadvantageous of spilt systems:

A split system has the fan coil (also referred to as an evaporator) installed inside the house and has two refrigerant lines connecting it to the Micro-cogeneration unit.

1. Many prefab houses and mobile homes are already set up with air ducting.
2. The refrigeration lines connecting the fan coil to the Micro-generation unit are less than 1 inch (25 mm) bundled together.
3. Systems are lower in cost.
4. Balancing the air distribution through ducts has frequently caused problems for the contractor and the homeowner. One or two room either get too hot or too cold. Fan and air noise is also a common problem.

To complete the system requires:

- Propane fuel tank or connection to natural gas line (local propane or Gas Company).
- Hot water pump (local stores such as grangers or home depot).
- Concrete mounting pad.
- Electrical connections to the battery/inverter system (Polar or others).
- Fan coil / evaporator with expansion valve for inside the house (Polar or Others)

Cost is $9,500.

- Add $150 for 48 Vdc.
- Add $2,500 for a Diesel engine in place of gas.