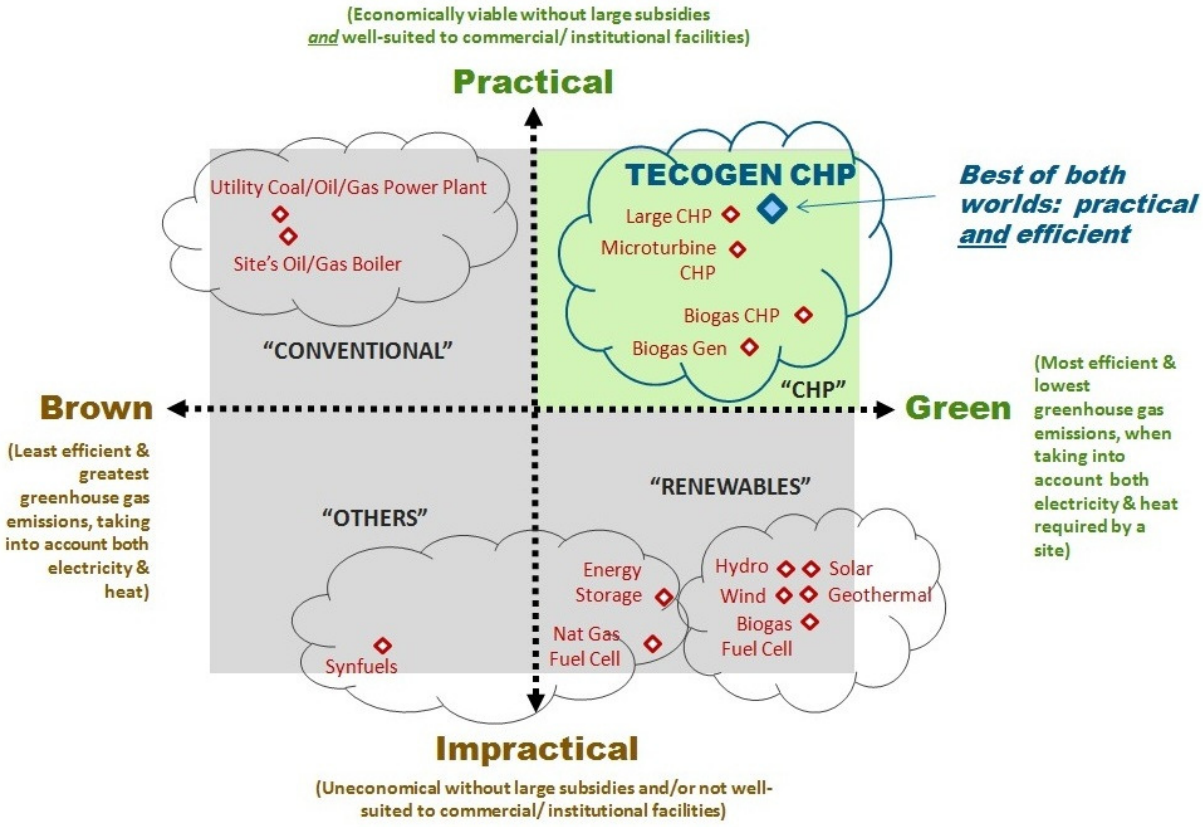
TECOGEN – "The Sensible Green Technology"

Every energy technology has its technical and economic characteristics, its pros and cons.

Among all the distributed generation technologies, Tecogen CHP (and some other types of CHP) offers end-users the most *sensible and complete* solution:

- **Tecogen CHP is practical to apply in commercial and institutional buildings.** It is quiet and compact, so fits easily into small spaces. It takes the same pressure of natural gas as the site's existing boilers do.
- **Tecogen CHP addresses both a site's electrical needs and its thermal needs.** At the same time as it is producing electricity or cooling for the building, Tecogen CHP makes "free" hot water (at temperatures as high as 230°F), which good building CHP applications can utilize most of the time.
- **The cost to install a Tecogen CHP system is reasonable.** It can be affordable for cash-strapped facilities. Tecogen's technology is viable without having to rely so heavily on taxpayer-funded government tax benefits and special politically-driven utility rebates to make it fly. Tecogen is a responsible choice.
- **Tecogen CHP utilizes only the most proven and practical components and technology.** Tecogen incorporates state-of-the-art engines, power electronics, controls, heat recovery, and emissions technology in its products, but stays grounded with standardized designs, many off-the-shelf components, an unequaled long-term track record, and established local factory service.
- **Tecogen offers the best value and highest overall efficiency of any distributed generation technology**. Tecogen CHP delivers the greatest "bang for the buck", in terms of real-world cost savings and greenhouse gas reductions achieved, per dollar invested to install the system.



Conventional utility power plants can often produce electricity at a reasonable cost, due to their economies of scale. That makes them "practical", in one way at least. But they are not very efficient, since more than half their input energy gets thrown away in the form of unused waste heat. And some of the electrical energy gets consumed by the long transmission and distribution system ("T&D losses"), en route to customers. Together, this means that the greenhouse gas emissions from utility power plants are high, especially if they're generating using coal or oil.

And utility power plants do nothing to help sites with their thermal needs. Sites must use their own boilers and water heaters to make the hot water they need for space heating, domestic hot water (DHW), and pool heating. While such on-site boilers can seem pretty efficient, they still burn gas that they don't necessarily need to. It's a shame that so much "waste" heat just gets tossed out at the utility power plant (as "thermal pollution"), far away from populated areas where heat is needed.

As a solution, combined heat and power (CHP) scales down the power plant appropriately, and locates it on-site, where the resulting "waste" heat can be utilized. CHP also eliminates power losses through the utility's long transmission & distribution system and relieves grid congestion.

Comparing Tecogen CHP to other alternative technologies, the following is clear:

- **Some alternative technologies (such as wind or solar) are more difficult to apply in commercial or institutional buildings.** This is due to siting difficulties in dense urban environments, resource constraints (poor wind profiles and shadows), and rooftop space limitations.
- **Some CHP technologies (microturbines) have lower overall efficiencies, require high-pressure gas (or the use of on-site gas compressors), and their performance must be de-rated whenever ambient temperatures get warm.**
- **Most alternative technologies (wind, solar, fuel cells) provide no grid back-up capability.** They can't keep the lights on during outages. Microturbines can do it sometimes, but typically would require big batteries to handle load swings.
- **Some technologies (solar, wind) are weather-dependent, so have much lower average outputs and are not controllable by the site.** Solar and wind DG systems can only produce when the sun is shining or wind is blowing. This means that, for the same kW capacity rating, solar and wind systems will generate far fewer kWh's of electricity per year. Average "capacity factors" for wind and solar systems are in the 20-30% range, versus 80-95% for most Tecogen CHP installations. In other words, for a solar or wind system to deliver the same electricity production on an annual basis (kWh/yr) as a Tecogen CHP system, its full-load kW rating must be 3-5 times larger.
- **Some technologies (fuel cells, wind, solar) just aren't economically viable without large subsidies, in the form of huge government rebates, utility mandates, and tax credits.**
- **In addition, these same technologies (wind, solar, and electric-only fuel cells) do not address a building's thermal requirements at all – they are "electric only".** That means that a facility must still burn the same amount of natural gas as ever in its space heating, domestic hot water, or pool boilers. That portion of the building's "carbon footprint" is not reduced at all by the supposedly zero-carbon renewable energy system.

Tecogen CHP technology offers facilities the ideal balance between ambitious benefits and long-term practicality.

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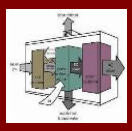
Tecogen
Advanced Modular CHP Systems

DG TECHNOLOGIES COMPARISON (100-kW system)

						
		TECOGEN-INVERDE MICROENGINE CHP	**SOLAR PV**	**MICROTURBINE CHP**	**ELECTRIC-ONLY FUEL CELL**	**WIND**
ENVIRONMENTAL/ EFFICIENCY	**Carbon Savings** lbs per year of CO2 reduction, per kW of capacity	***MOST***	LEAST	SOME	SOME	LEAST
	"Bang for the Buck" lbs per year of CO2 reduction, per $ of investment (before subsidies)	***MOST***	LEAST	SOME	SOME	LEAST
	Energy Produced	***POWER & HEAT***	POWER ONLY	POWER & HEAT	POWER ONLY	POWER ONLY
ECONOMIC BENEFITS	**Installed Cost** $/kW, before subsidies & tax benefits	***LEAST***	2nd MOST	2nd LEAST	MOST	2nd MOST
	Annual Capacity Factor	***>80-95%***	15-25%	>80-95%	>80-95%	20-35%
	Annual Operating Savings $ savings per kW of capacity, per year	***MOST***	LEAST	SOME	SOME	LEAST
	Payback before subsidies & tax benefits	***BEST***	WORST	2nd BEST	WORST	WORST
SITING CONSTRAINTS	**Space Required** square feet per kW	***1***	100	1	1	400
	Location Type	***Commercial buildings***	Roofs, parking lots, & open spaces	Commercial buildings	Commercial buildings	Open spaces
	Gas Compressor Required	***NO***	NO	YES	NO	NO
	Weather Conditions Dependency	***NONE***	SUNSHINE	<59^{o}F, TO AVOID DERATE	NONE	WIND
GRID BENEFITS	**Relieves Grid Congestion, Demand Response Ready, Dispatchable**	***YES***	INCONSISTENTLY	YES	YES	INCONSISTENTLY
	Able to Provide Site Back-up Power	***YES***	NO	YES	NO	NO