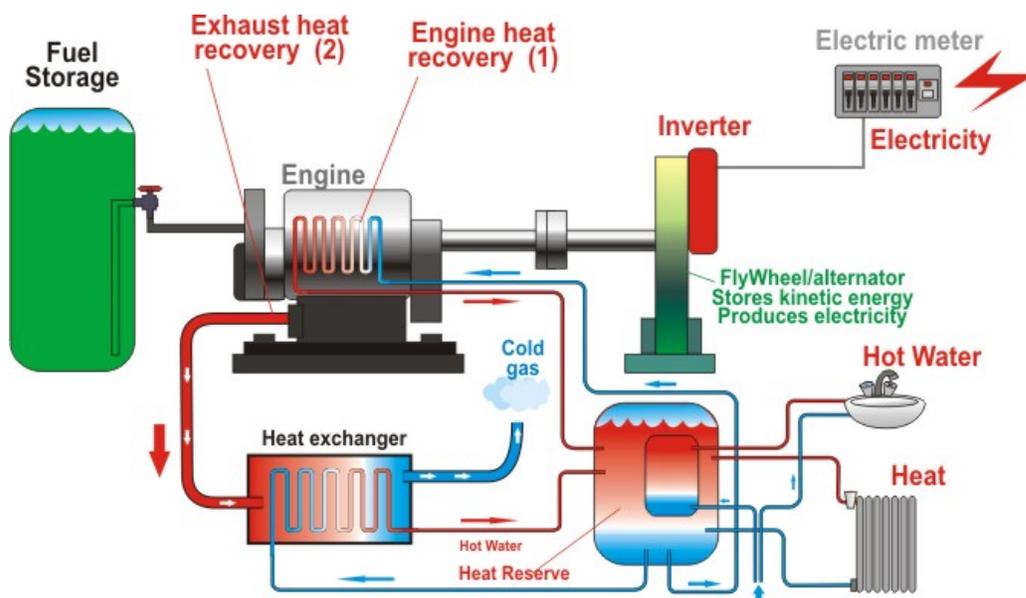


COMBINED HEAT & POWER

JULY 2018 TECH
BRIEF FOR
ADVANCED
MANUFACTURING
TALENT NETWORK



Clean Tech = Energy with Minimal CO₂ Evolved

Combined Heat & Power Systems (CHP), also known as cogeneration systems, are comprised of **high-efficiency technologies** using either fossil or renewable fuel to provide power, heat and cooling. Smaller CHP systems are scaled to support a single manufacturing facility. In areas like Manhattan, cogeneration plants provide high pressure steam for **district heating** as well as electric power. To provide cooling, steam is used with an **absorption chiller** or other heat exchanger.

CHP is invariably an on-site system. It is impractical to deliver steam and hot water over long distances. CHP is often the anchor power generation technology for a microgrid. Renewable energy technology such as solar, hydrogen fuel cells, use of biogas or biodiesel or wind turbines can be incorporated into a microgrid. They however are usually used for a fraction of the load. Although solar is affordable, it requires large, sunny areas. Fuel cells are expensive and biofuels are only available in certain areas.

In New Jersey, the natural gas grid is so reliable that using it at high efficiency is the best practical way to provide autonomous electricity when power from the regional power grid is lost, with a minimum of carbon dioxide (CO₂) emitted. Where possible, biogas can also be used.

Labor Force Takeaway

This tech brief is part of a series focusing on changes to the labor market in its move to a clean energy economy. Governor Murphy is aiming for **100% clean energy by 2050**. As AMTN develops programs, TAN recommends highlighting clean energy technologies including CHP as applications of reciprocating engines, turbines and heat exchangers. Adding fuel cell technology will also help future-proof programs.

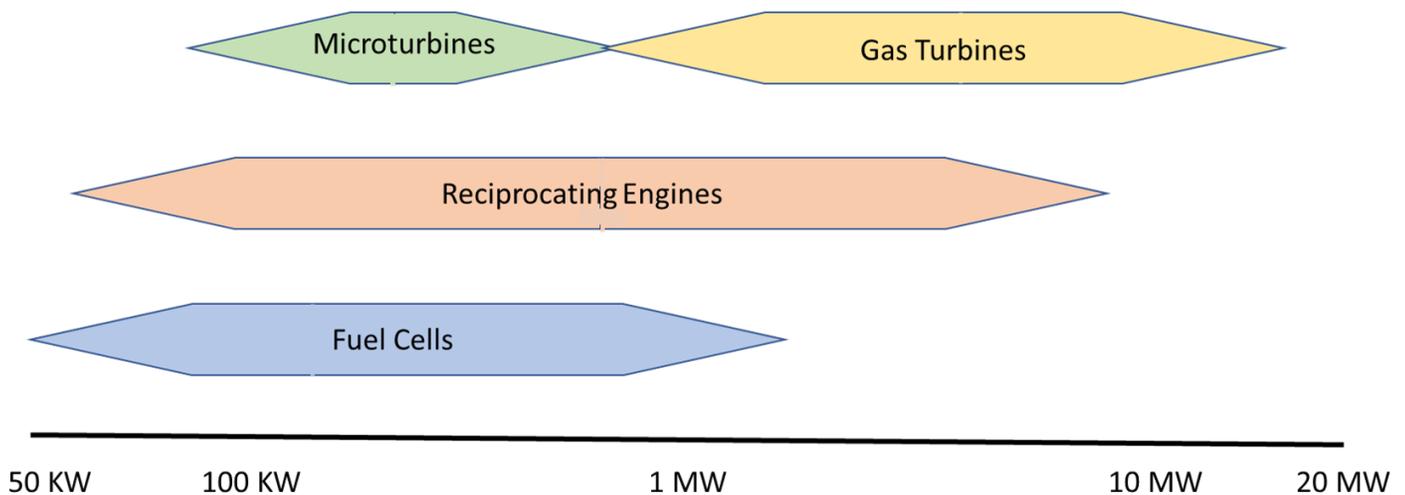
Clean Tech Used to Power Industry

Production facilities looking to reduce operating costs can benefit from Combined Heat & Power (CHP). CHP provides electric power and heat with a single fuel input source, generally natural gas. (Note that NJ could [develop capacity](#) to provide *biogas* to fuel CHP systems through [anaerobic digestion of waste](#).)

The heat produced as a by-product of power production is recovered and used for heating and/or cooling. CHP systems utilize waste heat on site instead of (1) obtaining electricity from the power grid (2) separately producing heated hot water or steam from a dedicated boiler and (3) air conditioning or providing refrigeration capacity using electric power. CHP systems typically [achieve 60% to 80% efficiency](#).

Considering the mechanics of CHP, conventional steam turbines, micro-turbines or reciprocating engines are typically used to turn generators in large systems. Alternatively, fuel cells can be used. A fuel cell produces electricity through a chemical reaction, but without combustion. It converts hydrogen and oxygen into water and in the process also creates electricity and heat. See figure below to compare CHP/cogen technologies in terms of the power they produce, as measured in watts.

Common CHP Technologies



Fuel cells operate much like batteries, except they do not require electrical recharging. Batteries store chemicals within their shell. An electrochemical reaction between an anode and cathode produces electricity to balance ion flow. Once ion flow has poisoned the cathode or depleted the anode, the battery dies. A fuel cell, on the other hand, receives the chemicals it uses from the outside. Theoretically it will not run out of fuel, and therefore never fail.

Direct emissions from a fuel cell vehicle are just water and a little heat. This is a huge improvement over the greenhouse gas emissions generated by the internal combustion engine. Furthermore, fuel cells have no moving parts and are therefore much more reliable than traditional engines.

To power factories of the future affordably, reliably and with resilience, new technology will be needed. The electrical grid is changing. Manufacturers can keep pace with these changes via skilled workers.