Combined Heat and Power in North Carolina

Replacing Large Power Plants by Putting Wasted Energy to Work

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NC WARN is a member-based nonprofit tackling the accelerating crisis posed by climate change — along with the various risks of nuclear power — by watch-dogging utility practices and working for a swift North Carolina transition to energy efficiency and clean power generation. In partnership with other citizen groups, NC WARN uses sound scientific research to inform and involve the public in key decisions regarding their wellbeing.

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Combined Heat and Power in North Carolina: Replacing Large Power Plants by Putting Wasted Energy to Work

SUMMARY OF FINDINGS

Combined heat and power, also known as cogeneration, represents a tremendous untapped source of energy — and a timely opportunity to dramatically reduce carbon emissions while avoiding soaring electricity rates in the Carolinas.

CHP technology combines the on-site processes of electricity generation and heating or cooling in order to allow a wide range of facilities to use energy far more efficiently — by capturing and putting to work large amounts of thermal energy that is otherwise simply wasted into the environment. Many facilities already have existing waste heat streams and add electric generating equipment to their existing components when adopting CHP technology.

Although the fossil fuels that power CHP-equipped facilities are not clean, more efficient usage greatly reduces overall pollution including greenhouse gases.

As a proven energy efficiency technology in use worldwide for several decades at large industrial plants, recent advances make CHP practical and cost-effective at smaller facilities.

Thousands of facilities in North Carolina — including industrial plants, schools, hospitals, prisons, health clubs and hotels — could decrease their annual energy bills by 30% or more by adding CHP to their current heating or electric generation systems.

Paybacks on facility CHP investments average 4–7 years, but can be as low as 2–3 years. The estimated cost of CHP-generated electricity is approximately 6 cents per kilowatt hour — cheaper than most customers now purchase power from the grid.

CHP expansion is now being promoted by both the U.S. Department of Energy and Environmental Protection Agency. Their research inspired a presidential executive order in August 2012 calling for the equivalent of 40 large power plants from CHP by 2020.

Duke Energy and subsidiary Progress Energy could follow the lead of other U.S. utilities that are investing in CHP by installing and leasing systems to customers, or by launching utility-owned distributed CHP programs.

Utility-owned CHP programs would be paid for by all Duke-Progress ratepayers but would be far less expensive than new, centralized nuclear or natural gas-fired power plants. Thus, CHP can help save all North Carolina customers from rate hikes year after year.

North Carolina's CHP capacity might be the equivalent of around ten large power plants. Therefore, construction of new centralized power plants — and repeated rate hikes for electricity customers — can be avoided if even a substantial fraction of distributed CHP is implemented.

CHP capacity is also ready to be tapped in South Carolina, which shares Duke's distribution system with North Carolina customers.

The greatest barriers to the expansion of CHP in North Carolina are the lack of education about technology advances, and resistance by the state's electric utilities to adopt CHP-friendly policies.

A current legislative proposal to eliminate North Carolina's renewable energy tax credit would, if enacted, harm efforts to create jobs and energy savings from CHP.

A growing CHP market is a key step on the path toward stabilizing our climate and avoiding staggering rate hikes to pay for new power plants that simply are not needed.

With a monopoly over electric sales in North Carolina, Duke-Progress has a duty to take advantage of distributed CHP as an investment opportunity that will prove beneficial to the corporation and, more importantly, to the people of the state.

With so much electric generation capacity simply being wasted at present, the NC Utilities Commission must ensure a full examination of CHP before allowing Duke-Progress to move forward with plans for construction of billions of dollars in fossil-fueled or nuclear power plants.

NC WARN does not support use of dirty energy sources such as fossil fuels, biomass or waste incineration. We are concerned about the use of natural gas, which can pollute water sources and — if recovered by fracking — can produce even more damaging greenhouse gas emissions than coal. However, we are advocates of energy efficiency as a mechanism for reducing dependency on these sources within North Carolina's energy mix, and combined heat and power systems — though most often used in facilities powered by natural gas — are an energy efficiency technology that greatly reduces the amount of energy used and wasted.[1] Like weatherizing an old home or using energy-efficient light bulbs, CHP will not eliminate a customer's use of dirty energy sources but will contribute to a decrease in demand which greatly reduces carbon emissions, steers utilities away from the resources that harm our environment and deters them from building unnecessary plants that are financed out of ratepayers' pockets.

INTRODUCTION

The energy resource that can have the greatest impact on our energy future is efficiency — implementing strategies that maximize output from the energy we use. North Carolina is host to thousands of schools, hospitals, prisons, hotels, health clubs, military, manufacturing, industrial and commercial facilities that use a tremendous amount of natural gas, coal or biofuel energy — some of them around the clock. The boilers, furnaces and generators that keep these facilities running are extremely inefficient — with over half of the energy from the fuel that powers them being wasted. One solution to this dissipative energy use is combined heat and power.

Combined heat and power (CHP), also known as cogeneration, is a suite of efficiency technologies that could make a huge contribution to a cleaner, cheaper energy future in North Carolina. CHP systems allow a facility to combine electricity generation and heating or cooling processes in order to use energy more efficiently. Combining the two processes improves the combined efficiency from approximately 45% efficient to as much as 80% efficient.[2]

A surge in CHP deployment, along with increases in other efficiency measures and implementation of renewable energy, is the right path forward to preserving our climate and avoiding staggering rate hikes to pay for new power plants.

Implementing CHP as a distributed resource more widely across the state would make the biggest energy users more efficient — paving the way for a large decrease in the amount of coal, nuclear and natural gas resources that are needed. A surge in CHP deployment, along with increases in other efficiency measures and implementation of renewable energy, is the right path forward to preserving our climate and avoiding staggering rate hikes to pay for new power plants.

With low natural gas prices, the CHP market is poised to move forward. However, several factors are obstructing such improvements — including a current legislative threat to North Carolina's renewable energy tax credit, lack of widespread knowledge about CHP by potential investors, some negative policies put in place by electric utilities and the utilities' lack of initiative to pursue CHP as a component of their business plans.

Thousands of possibilities across North Carolina

The Four Seasons Hotel in Philadelphia, PA installed a 200 kW CHP system in 2009. The three microturbines take up minimal space on the facility's rooftop and make almost no noise, so they don't interfere with the hotel's day-to-day operations. Still, they make a tremendous impact. The system accommodates 30% of the hotel's electricity needs, 100% of its daily hot water use, and 15% of its heating needs. Hotel management expects that the system will pay for itself three to four years. Although this CHP system is out-of-state, it is a testament to the opportunity that the technology represents. There are literally thousands of facilities like the Four Seasons in North Carolina — including schools, colleges, hospitals, prisons, health clubs and hotels — that could make their daily operations more efficient with CHP and decrease their annual energy use more than 30%.

Photos: Capstone Turbine Corporation

HOW CHP WORKS

Combined heat and power technology allows for the simultaneous production of electricity and heating or cooling by an integrated system using one fuel. CHP allows a large amount of otherwise wasted heat, such as from a facility's boiler or electricity generator, to be captured and put to use at the facility.[3] Many facilities already have existing waste heat streams and add electric generating equipment to their existing components when adopting CHP technology.

Electricity production is typically an inefficient process, with around 55% of energy being wasted and discharged into the environment. CHP increases the combined efficiency of electric generation and heating or cooling to approximately 80%.[4] Eliminating waste allows a facility's energy needs to be met with less fuel — an overall benefit to the environment and the facility's finances.

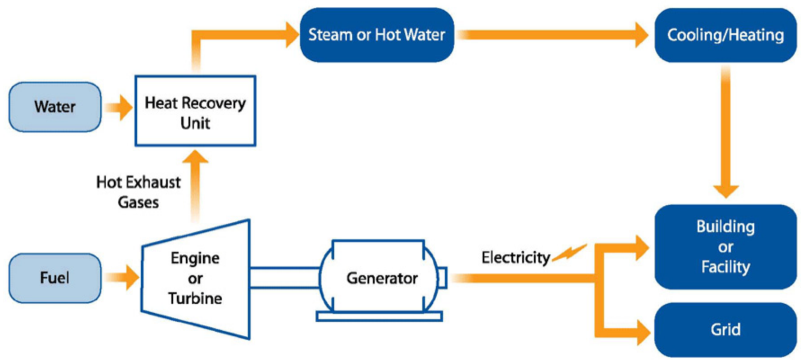
The estimated cost of CHP generated electricity, including operating costs, installation, cost of fuel and other considerations, is around 6 cents per kWh.

CHP can work with engines or boilers powered by natural gas, coal, oil, biomass or biogas.[5] While use of fossil fuels and biofuels is not ideal, implementing CHP allows for an overall reduction in the use of these dirty energy sources — a step closer in the transition to clean, renewable energy.

CHP can be installed as a new generating system. Alternatively, separate components can often be added to a facility's existing electricity generating or heating and cooling system so that the integrated system can be achieved at a lower cost.[6]

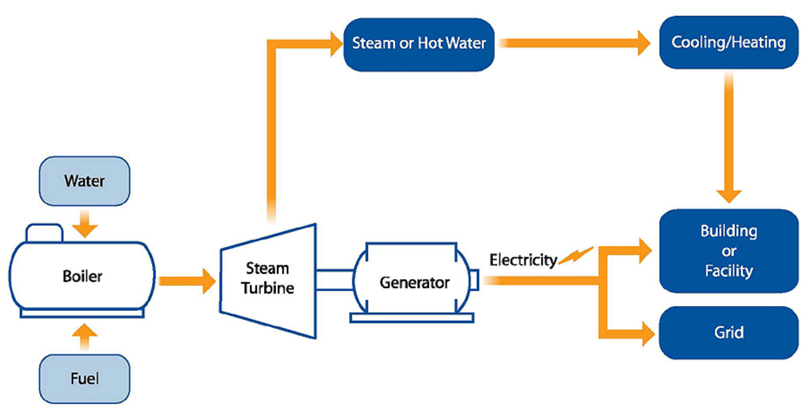
Two Types of Combined Heat and Power

Figure 1: Gas turbine or reciprocating engine CHP systems creating heating and cooling from electricity generation.



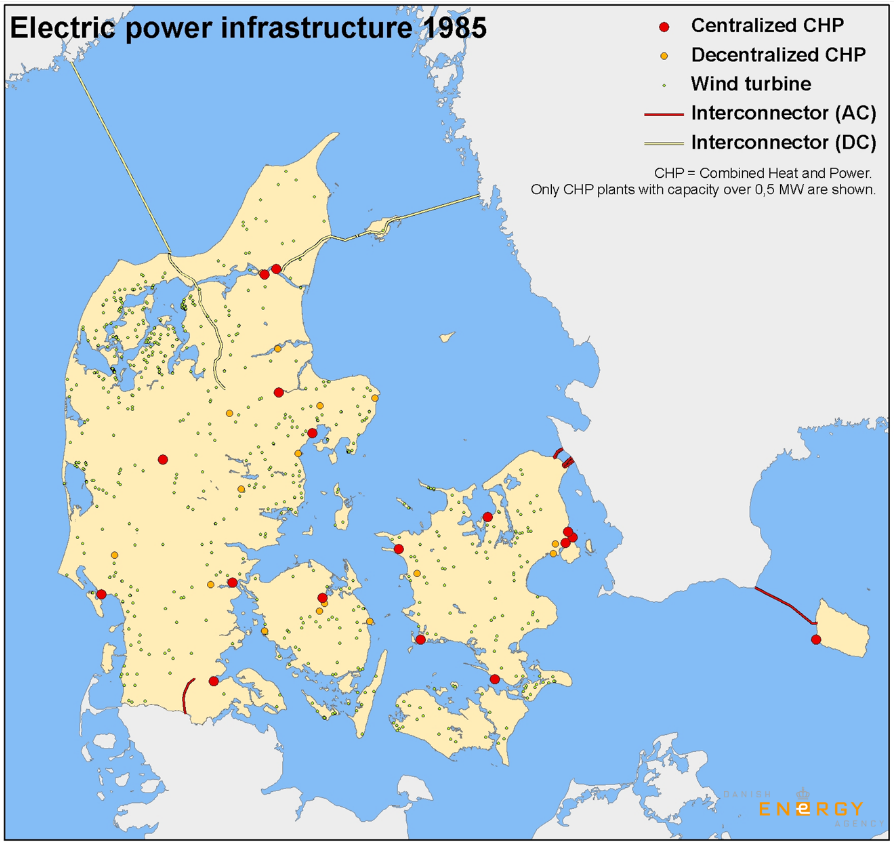
In this type of CHP system, a gas turbine or reciprocating engine generates electricity by burning natural gas or biogas. A heat recovery unit captures exhaust heat that would otherwise be wasted and converts it into useful thermal energy, usually in the form of steam or hot water. This type of system is best suited for industrial or commercial facilities requiring ample amounts of electricity and heat – including smaller facilities such as hospitals and hotels.

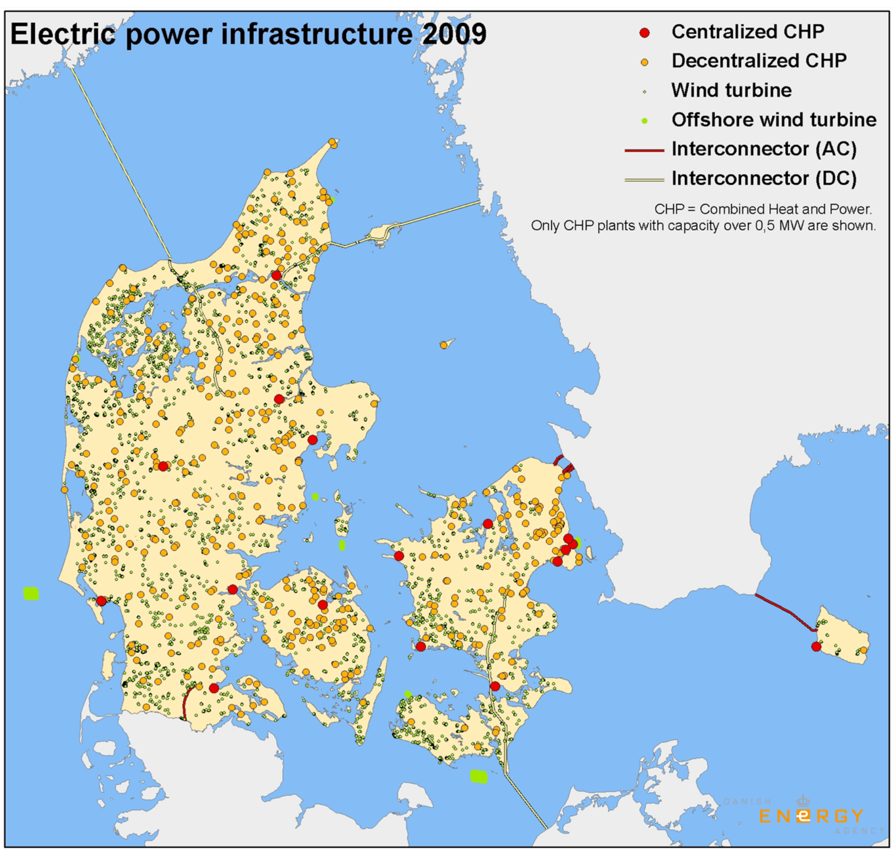
Figure 2: Steam turbine CHP systems creating electricity from heat generation



This type of CHP system adds electricity-generating capacity to a steam turbine normally used to produce a facility's heating.

Diagrams: U.S. EPA





The rise of distributed CHP in Denmark from 1985 to 2009

According to the Danish Energy Agency, cogeneration accounts for around 50% of electricity production in the country thanks to persistent government policies put in place starting in the 1970's that put efficiency ahead of continued reliance on imported oil and gas. Denmark is one of the few countries in the world that is energy independent.

Images: Energy Policy

System installations as large as utility-scale electric generating plants are achievable. However, recently CHP engine technology has advanced to the degree that a system can be installed cost-effectively at sizes as small as 50 kW.[7] These advances are significant because now CHP is marketable as a distributed energy source much like rooftop solar systems.

CHP is also economically practical. The average payback period for investment in a system is about 4 to 7 years but can be as low as 2 to 3 years for small systems at locations with substantial energy needs.[8] The estimated cost of CHP generated electricity — including operating costs, installation, cost of fuel and other considerations — is around 6 cents per kWh.[9]

The American Council for an Energy Efficient Economy (ACEEE) has extensively studied CHP market potential nationwide and on a state-by-state level. In a 2012 report assessing CHP as a potential a replacement for retired coal plants in twelve states including North Carolina, ACEEE assessed three cases for potential capacity.

The technical potential is an estimate reflecting all the existing facilities in the state well-suited to CHP installations of 1 MW or more. The study's conservative base case economic potential assumes a 50% acceptance by facilities considering a new CHP system with a two-year payback period. Finally, the study's utility economic case considers potential CHP capacity in the state if utilities use CHP as an investment opportunity.

In this scenario, the study realizes the capacity for large utilities to take on sizable distributed CHP projects that may have a longer payback. Unlike an individual business or service provider, utilities are able to recover the cost of capital projects in rates. Therefore this scenario assumes 100% acceptance by utilities of projects with a 5-year payback period or less, and 50% acceptance of projects with a 10-year payback period.[13]

ACEEE's study indicates that the untapped technical potential for large CHP systems (over 1 MW) in North Carolina is around 6,200 MW. The estimated base case economic potential in the state is 151 MW by 2020, and the utility economic case could yield about 1,300 MW of new large-scale CHP by 2020.[14]

It is important to consider that ACEEE's results only take into account potential systems of 1 MW or larger. With proper policies and incentives in place, smaller systems (as small as 50 kW) are practical and the possible capacity that is available grows substantially larger.

THE CHP MARKET IN NORTH CAROLINA

On a national scale, the Department of Energy (DOE) and Environmental Protection Agency (EPA) have both advocated for greater combined heat and power implementation. This support and research by these entities contributed to President Obama's executive order in August 2012 calling for an additional 40 GW of CHP capacity nationwide by 2020.[10] Potential for CHP across the country is so great that the DOE finds even a goal of this scale to be attainable.

The DOE has also studied the potential for CHP on a state-by-state basis and believes that — with agreeable policies put in place — it is practical to expect North Carolina can install an additional 2,600 MW by 2025.[11]

Research by the American Council for an Energy-Efficient Economy (ACEEE) indicates that the unused technical potential for CHP systems 1 MW or larger in North Carolina is around 6,200 MW. Past studies have suggested that the state also has substantial capacity for small systems from 50 kW to 1 MW.[12] When customers of all sizes are considered, North Carolina's CHP capacity might be the equivalent of around ten large power plants.

North Carolina is host to a large industrial sector and a large number of universities, community colleges and hospitals. Such facilities are ideal for CHP installation, so the state has enormous potential for development of the technology. Other sectors that are considered ideal include prisons, water and wastewater treatment facilities, hotels and health clubs.[15]

Despite these promising capacity estimates, there are currently only 61 sites with CHP installed in the state, providing a total of 1,530 MW of capacity.[16]

North Carolina's CHP capacity might be the equivalent of around ten large power plants.

North Carolina currently has a 35% renewable energy tax credit in place for investments up to $2.5 million. Those investing in CHP can take advantage of this significant credit — making payback periods, particularly for smaller-sized systems, even more manageable.

INHIBITING FACTORS TO GROWTH

Less than 2% of the current combined heat and power capacity in North Carolina has been developed in the past seven years.[17] This slowing of the market has in part been a result of the struggling economy and a period of extreme fluctuation in the price of natural gas — the most common fuel used in CHP systems. With natural gas prices currently low, CHP is an increasingly attractive investment opportunity because facilities are more likely to be comfortable relying on natural gas as a long-term fuel source.

One factor that CHP distributors believe stands in the way of broader deployment in the state is a lack of knowledge about the technology. Many companies that would be CHP installation candidates do not realize that, over decades of development, systems have been designed to more easily retrofit a facility's existing components and accommodate smaller sizes.

CHP in North Carolina

The CHP system installed at Fort Bragg in North Carolina integrates electricity generation and thermal activated cooling. The system is powered by natural gas and produces about 5 MW of power. This installation was a product of collaboration between the U.S. Army, Oakridge National Laboratory and the U.S. Department of Energy to serve as a model demonstrating that military bases can be ideal candidates for CHP installations.

Photo: U.S. DOE Southeast Clean Energy Application Center

Utility practices in North Carolina are another barrier. In ratings performed by ACEEE, Progress Energy's standby and backup power rates have been considered "neutral" toward CHP development and Duke Energy standby and backup power rates have been rated "poor".[18]

Duke Energy standby and backup power rates have been rated "poor" toward CHP development.

Standby rates are charges utilities impose on a facility with a distributed generation system, like CHP, when the system experiences a temporary outage and must rely on power from the grid. The utility not only charges for the energy used during the outage, but also a demand charge which is said to cover costs of the utility having the additional capacity in reserve to meet the facility's demand when the system experiences an outage.

In addition, many utilities implement demand charge "ratchets" that require that the facility continue to pay the demand charge for a designated amount of time after the outage has been resolved. This transforms the demand charge from a one-time fee into a recurring charge for the facility for anywhere from six months to a year.[19]

North Carolina utilities have long offered what are referred to as "economic development" rates to large industrial customers. These low rates discourage industrial facilities, typically ideal candidates for CHP installations, from investing in energy-saving opportunities. In effect, these rates encourage some of the largest energy users in the state to waste energy. Although the discounts may benefit industrial customers in the short term, they do not provide reliable long-term savings the way CHP can, thus they are not good for the energy future and economy of North Carolina.

Although the 35% state renewable energy tax credit is not set to expire until 2015, discussion within the North Carolina legislature of prematurely eliminating it is a severe threat to the potential CHP market. Removing this incentive would make the up-front investment in a CHP system by a business more difficult to bear.

AN OPPORTUNITY FOR DUKE ENERGY

As the nation's largest electric utility, and with North Carolina harboring such a sizable untapped potential along with additional capacity in the South Carolina portion of both the Progress Energy and Duke Energy service areas, the utilities are in a favorable position to become leaders in combined heat and power. As demonstrated by ACEEE's "utility case" in their 2012 CHP study, electric utilities are well positioned to make long-term investments in CHP systems.[20]

Utilities may directly invest in CHP by using utility-scale systems at their current power plants or by launching distributed installation programs at customer locations. This type of program would resemble the "North Carolina Solar Distributed Generation Program" that Duke Energy tested in 2009.[21] The costs of these distributed systems would be included in rates for all customers. However, CHP generated electricity is less costly than the new nuclear or natural gas-fired power that the utilities plan to pursue according to their Integrated Resource Plans (IRPs). An increase in the installation of CHP will eliminate the overall need for new power plants, thus benefitting all customers.

Duke Energy and subsidiary Progress Energy are in a favorable position to become leaders in combined heat and power.

Some utilities, such as Alliant Energy, serving Iowa, Minnesota and Wisconsin, have invested in CHP systems through various types of leasing programs. These programs allow the utility to absorb the initial cost of the CHP system for a facility, then the facility repays the utility over time from the savings gained through reduced energy use. At the end of the lease period, the facility has the opportunity to buy the system from the utility for permanent ownership and continued savings.[22]

Other electric utilities across the country have taken advantage of a growing CHP market in another way — by providing installation and maintenance services for facilities in their service area that want to invest in systems. Utilities such as Alliant Energy and PPL (serving Pennsylvania, Kentucky and Montana) offer construction and installation, as well as maintenance services, to their customers that are interested in, or already own, a CHP system.[23]

If Duke-Progress chooses — or is required — to pursue energy efficiency options such as CHP in North Carolina and its other

Southeast service areas, it could be a positive step toward eliminating the need for coal-fired plants in the region — all while saving ratepayers from the soaring bills that will result from Duke's plans to build centralized natural gas and nuclear plants.

CONCLUSION

Duke Energy CEO Jim Rogers has repeatedly said, "The most efficient power plant is the one that we never have to build."[26] Combined heat and power is a technology that embodies this statement. It allows the same energy needs of customers to be met with less fossil fuel burned at their facilities, and less need for large, centralized power plants — and therefore fewer rate hikes for customers and less risk to the health and economy of the state.

North Carolina's CHP capacity might be the equivalent of around ten large power plants.[27] Those could be coal-fired plants that Duke and Progress Energy could shut down to cut fossil fuel emissions or it could be nuclear and natural gas plants that Duke Energy would "never have to build".

In order for such potential to be realized, however, there are several barriers that North Carolina must first overcome. *The 35% state renewable energy tax credit must be protected in the current legislative session and all future sessions.*

Case Study: Alliant Energy

Alliant Energy is a multi-state utility serving parts of Iowa, Wisconsin and Minnesota. Alliant's Shared Savings Program helps business customers identify, carry out and even finance almost all types of energy efficiency opportunities — including combined heat and power systems.

In the Shared Savings Program, the utility finances the up front cost of a CHP system and the customer pays back the cost in monthly installments on its energy bill over five years. All along, the customer experiences the savings that result from the CHP system, so the monthly payment of the system is not actually an added cost (in fact, there are often savings above and beyond the cost of the monthly payment that directly benefit the customer). After five years, the customer gets to benefit exclusively from all of the savings resulting from the system.[24]

Alliant has also installed and operated utility-owned, distributed CHP systems in the Midwest. In 2006, the utility financed the majority of the cost for, and installed, ten 30 kW turbines at the wastewater treatment plant for the city of Sheboygan, Wisconsin. Alliant owns and maintains the system, which produces around 2 million kWh of electricity and 6 trillion Btu of thermal energy per year. The city benefits from its reduced energy usage and Alliant Energy benefits from the renewable energy credits from the system and also sells the excess electricity produced by the system to the city. It is estimated that the system saves the city about $80,000 per year.[25]

Utilities in North Carolina can use Alliant Energy and other utilities that invest in CHP as a model. Distributed CHP is not only advantageous to the end-use facilities but can also be profitable for utilities that pursue the technology within their service area.

Utility-financed CHP: Five of the ten microturbines installed and financed by Alliant Energy at the Sheboygan Wastewater Treatment Facility in Sheboygan, WI. *Photo: ACEEE*

Steps should be taken to educate business owners across the state about this technology, the practicality of investing in an installation, and the benefits that it provides. Duke-Progress could be a key player in moving awareness and success of this market forward.

The North Carolina Utilities Commission can initiate policy changes that encourage CHP investment, including reducing standby rates and reconsidering the use of economic development rates. Duke-Progress can also incorporate CHP into its business plan and use it as an investment opportunity for its business and a significant efficiency resource for its customers — like other utilities across the country have done successfully.

The time is now for Jim Rogers and Duke Energy to live up to the rhetoric and prioritize energy efficiency over building new power plants.

With a monopoly over nearly all of North Carolina's electricity sales, Duke-Progress has a duty to take advantage of the opportunities that CHP provides in order to curb carbon emissions and move the state toward a more efficient and affordable energy future.

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