White Paper

Utility Combined Heat and Power Programs—the Hot New Trend in Efficiency

By Anna Shipley and Anne Hampson, ICF

Shareables

- Combined Heat and Power (CHP) systems provide cost-effective approach to meet energy efficiency goals.
- Baltimore Gas & Electric anticipates that 19.5% of total Commercial and Industrial (C&I) kWh program savings will come from CHP projects.
- CHP projects funded through efficiency programs have been achieving a Total Resource Cost (TRC) in the range of 1.3-1.7

Executive Summary

As traditional energy efficiency programs, such as lighting, become saturated and codes and standards continue to increase in stringency, it is becoming increasingly difficult to sustain the level of energy savings through traditional efficiency approaches. This creates the need for innovative efficiency programs that can step in and continue to deliver energy savings. Whether implemented with other energy efficiency solutions or alone, combined heat and power (CHP) can contribute much more significantly to energy efficiency targets than many other efficiency technologies. CHP systems are most common in commercial, industrial, or multifamily residential applications, and because CHP is typically sized to address a large portion or all of a facility's thermal and electrical demand, it contributes a substantial amount of savings for each system installation.

To give perspective, in Baltimore Gas and Electric's (BG&E) 2015–2017 EmPower Maryland Program filing, it is anticipated that 19.5% of the total Commercial and Industrial (C&I) kWh program savings will come from CHP projects. These results will also come from a surprisingly low number—only around a dozen—of total participants. What this means for a utility is that the administrative burden of implementing CHP programs is relatively low, with just a handful of customers needed to achieve significant results.

How cost effective are CHP programs?

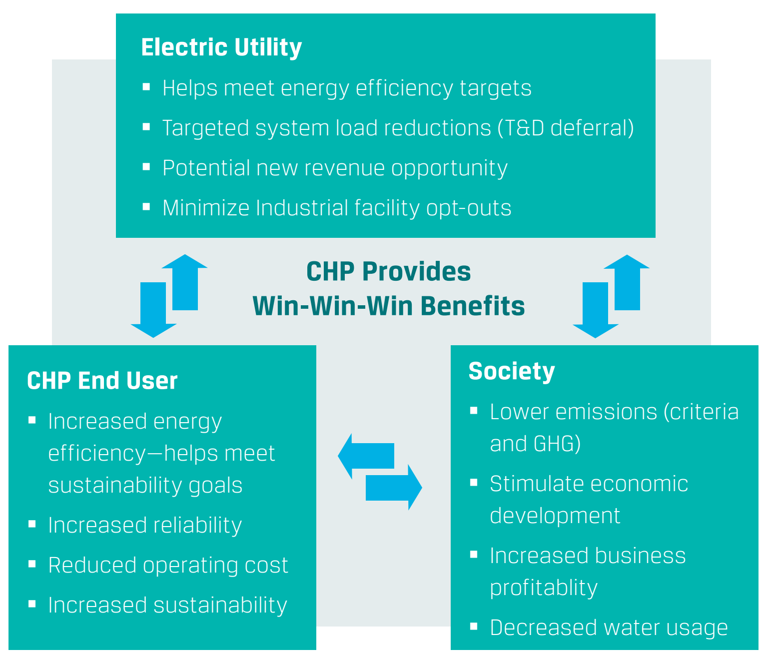
CHP projects funded through efficiency programs are all cost effective, with typical projects achieving a total resource cost in the range of 1.3–1.7. These values can be further increased depending on the avoided grid costs. Exact TRC's may vary by state.

Why Should a Utility Consider Including CHP as Part of an Energy Efficiency Portfolio?

Utilities receive significant benefits from CHP programs. In its program documentation, AEP Ohio lists factors including increased sustainability; helping customers be more competitive and productive through energy intensity reductions; and the utility's desire to move beyond the commodity and vendor relationship to a partnership with their customers as reasons for implementing their program.

CHP systems not only offer utilities the ability to help meet mandated energy efficiency targets or goals, but they also provide a less expensive path to achieving those energy savings. By promoting CHP at customer sites, utilities can pursue targeted system load reductions to avoid large transmission and distribution (T&D) investments. CHP can help to reduce industrial facility opt outs by providing an alternative path to reducing utility-connected load while also driving increased participation in energy efficiency programs. Although CHP is a more complex and capital-intensive efficiency technology to implement than many energy efficiency measures, the high programmatic returns and customer benefits make it an appealing and underutilized area for utility efficiency program focus.

EXHIBIT 1. CHP BENEFITS TO ELECTRIC UTILITIES, END-USERS, AND SOCIETY



CHP provides benefits to a variety of stakeholders, including the utility, end users, and society as a whole (Exhibit 1). Utility customers who install CHP systems can also experience both technical and financial benefits. In addition to the increased sustainability and energy efficiency improvements of a CHP system, the reduction in operating costs compared to the traditional boiler heating system can provide financial savings for end users. CHP systems can also provide end users with increased reliability in their operations. Customers with CHP do not have to rely only on the electric grid for critical operations during periods of system outages, but can instead continue to operate and provide heat and power as usual. Along with the benefits that CHP systems can provide to utilities and end users, they can also offer significant benefits to society as a whole. CHP systems have the ability to significantly decrease emissions and water usage when compared to traditional grid power, can stimulate economic development in a variety of communities, and provide business profitability to the many players involved in the development of a CHP project.

Utility Program Options for Combined Heat and Power

Utilities have several options for incorporating a CHP program into their energy efficiency program mix. Many utilities include CHP as an available efficiency measure in their "custom" C&I programs. This approach may not be sufficient to significantly encourage the adoption of CHP for a number of reasons, including it being one of the more capital-intensive C&I efficiency measures. The implementation of CHP also involves environmental permits, interconnection applications, feasibility assessments and other up-front costs, and procedures that simpler measures do not require. Expertise in navigating this complex process is key to CHP adoption, which is why other utilities have implemented standalone CHP programs that can provide this focused expertise. The current utilities with specific CHP programs in their energy efficiency portfolio share several common incentive structures.

Who is already sold on CHP?

CHP incentives as a standalone program

- Baltimore Gas & Electric
- New Jersey Clean Energy Program
- Eversource Energy
- Pepco
- Commonwealth Edison

CHP incentives as part of a custom program

- PECO
- Dayton Power & Light
- AEP Ohio

Incentive Designs for Combined Heat and Power

Utilities typically offer two major types of incentives for CHP programs: capacity incentives and production incentives.

- **Capacity** incentives are typically issued on a $/kW basis to help buy down the initial capital outlay for a customer. Systems must typically meet a minimum efficiency requirement to qualify for the incentive. A 65% minimum efficiency is typical, but some programs allow for a slightly lower efficiency (60%) requirement for smaller CHP systems, recognizing that applications with lower thermal demands or capacity factors are unable to achieve higher efficiencies.
    - **Design** capacity incentives are issued pursuant to submission of a commitment letter and review of system design specifications. This model of incentive helps to not only lower the initial capital outlay for a customer, but also lower the project risk. Since there is always a

possibility that a project will not be considered viable after a detailed feasibility analysis (including nonsystem costs such as permitting and interconnection), providing this type of payment helps to increase the number of customers who will consider CHP as an energy efficiency option. This type of incentive is the simplest to administer, as it requires only a review of design specifications and performance estimates. ComEd offers a few interesting variations on a standard design incentive, for example, offering to pay 50% of the cost of a feasibility assessment and 50% of an interconnection fee—up to a cap.

- **Installation** capacity incentives are issued upon system commissioning and inspection. These incentives are typically issued in a tiered system based on project size (Table 1). BG&E and Pepco are two utilities that offer this incentive. Breaking a design and installation incentive into two parts rather than one adds a bit of administrative cost but ensures that the system is installed according to the design specifications.

- **Production** Incentives are issued on a $/kWh basis for electricity that is produced for a certain period of time after the system is operational. Typical timeframes for production incentives are in the range of 18 months to 5 years. Production incentives ensure that the system is operated efficiently and properly maintained. They have become more popular in recent years because of issues that arose with capital incentive programs, where projects were funded and then not well maintained, leading to lower efficiencies than expected. While production incentives do not help with the barrier of high upfront capital investments for CHP, they do provide a guaranteed cash flow for the project after it becomes operational and meets the measurement and verification requirements.

TABLE 1. BG&E CHP INCENTIVE PROGRAM DESIGN STRUCTURE

Incentive Type	Payment and Tier Structure	
Design incentive	$75/kW	
Installation incentive	$275/kW (<250 kW)	$175/kW (> 250 KW)
Production incentive	$0.07/kWh (first 18 months)	

Notes: CHP systems must be a reciprocating engine or gas turbine with a minimum operating efficiency ≥ 65%. Total incentives capped at $1.25 million/project, and project must be operational by December 31, 2017.

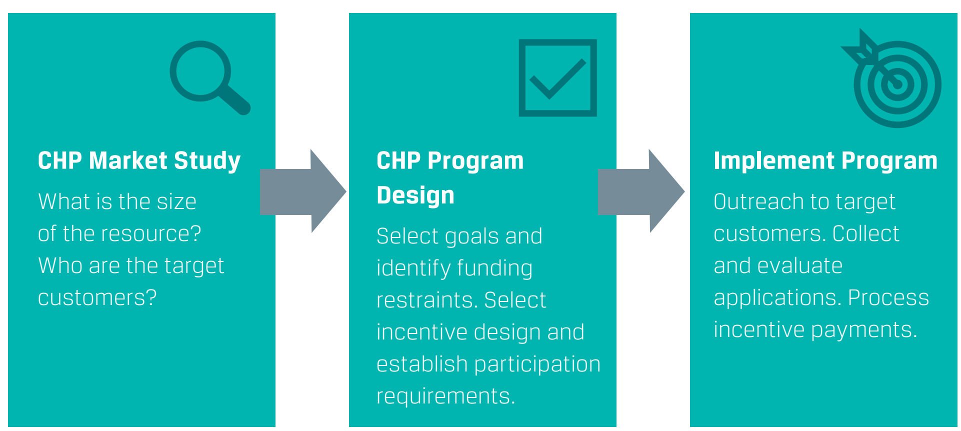
Example Utility Combined Heat and Power Program Structure

While there are many different incentive structures present in the 13 utility CHP programs, the key design features for BG&E CHP incentive program are highlighted as a case study in Table 1. BG&E offers a combination incentive with part of the funding going to capacity incentives and part going to production incentives, thereby achieving the benefits of both types.

How Can a Utility Go About Setting Up a Program?

Given the technical advantages CHP can provide compared to traditional efficiency measures—and the vast amount of CHP potential in the United States—utilities can begin to take advantage of this opportunity by creating CHP-specific programs (Exhibit 2). The first step in establishing a utility CHP program is to determine what the market and potential for energy efficiency demand reductions are in the service territory. This first step will provide an understanding of the total resource and which market sectors and customers should be targeted. Utility territories with a significant amount of industrial customers will want to take their unique attributes into account during the program design phase, whereas territories where the large customers are commercial and institutional facilities will have different priorities to consider during program design. For example, industrial customers typically require quicker paybacks for energy projects than commercial/institutional customers, necessitating a program offering that optimizes payback reduction.

EXHIBIT 2. ESTABLISHING A CHP PROGRAM

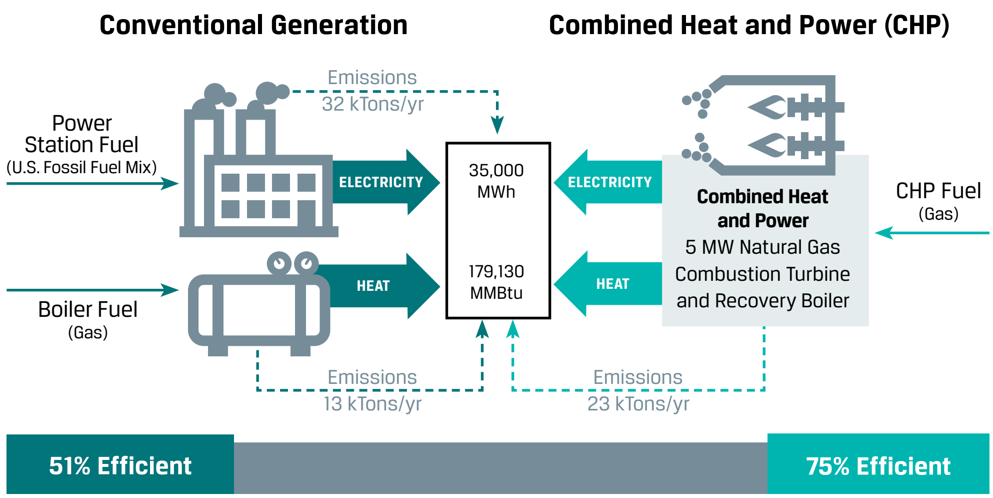


Once the market and available resource are better understood, the next step will involve designing the incentives, which will vary based on market need, available funds, and timelines. Minimum system efficiency requirements, eligible system sizes, types of incentives, and incentive caps can be set to attract the specific customers and markets that will provide the most benefit for the service territory. An optimization analysis also ensures that the utility gets the most energy savings for its money invested in the program. The final step is program implementation, which includes outreach to the target customers, evaluating incentive applications, conducting measurement and verification procedures, and processing incentive payments.

Combined Heat and Power: Generation or Efficiency?

Utility energy efficiency programs have traditionally focused on residential and commercial/industrial end-use measures such as lighting, HVAC, motors, and building envelope technologies to achieve their energy and peak reduction goals. According to Lawrence Livermore National Laboratory (2016), the residential and commercial sectors are able to convert 65% of the energy coming into their facilities into useful services, and the industrial sector converts 80% of consumed energy into useful services. Efficiency programs have focused on this 35% and 20% of lost energy, respectively. This contrasts with the conversion of energy in the electricity generation sector, which converts only 36% of fuel into useful energy services, with 64% being lost in the form of heat.

EXHIBIT 3: CHP ACHIEVES SIGNIFICANTLY HIGHER EFFICIENCIES THAN CONVENTIONAL ELECTRIC AND THERMAL GENERATION

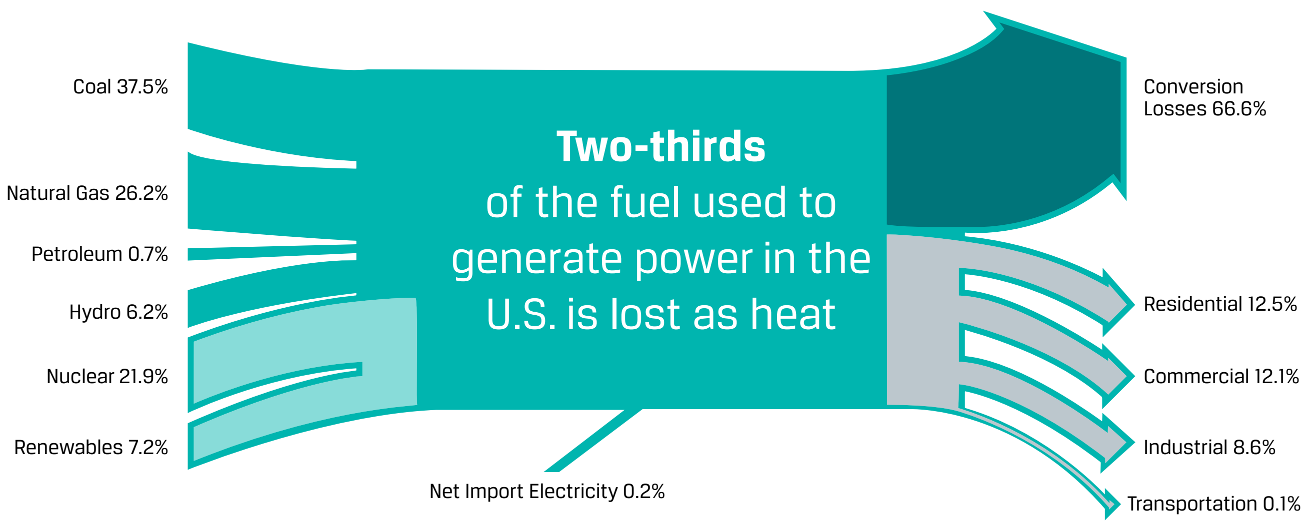


CHP is one of the few technologies that lies in the intersection of demand-side energy efficiency and supply-side efficiency. CHP improves the efficiency of the end-use sectors and reduces the thermal losses in the electricity generation sector (Exhibit 3). Thus, as a single measure, it can contribute more significantly to energy efficiency targets than other technologies by addressing inefficiencies in both supply and demand. A study by Oak Ridge National Laboratory states that increasing the CHP share of U.S. electricity generation to 20% (from 8% today) would result in a savings of 5.3 quadrillion Btu (Quads) of fuel annually, the equivalent of nearly half the total energy currently consumed by U.S. households (ORNL 2008).

CHP is unique among energy technologies in that it produces two types of energy—electricity and heat—from one fuel source. While many consider CHP to be an electricity generation technology, it is actually used primarily as a steam or hot water producer with the added benefit of generating electricity. Many industrial and commercial sites require a significant and consistent form of thermal energy for process energy, domestic hot water, or space conditioning. For an industrial or commercial building, CHP is a cross-cutting technology that supplies energy while also reducing energy demand. As such, it is considered an energy-efficiency measure, lowering a facility's energy demand and increasing its efficiency.

CHP reduces the 20% to 35% losses in the end-use sectors and the 67% losses in electricity generation (Exhibit 4). Energy efficiency programs focus on the end-use inefficiencies in the residential, commercial, and industrial sectors. As the energy flow graphic shows, those inefficiencies are just a small portion of the total systemwide losses. CHP reduces the customer electrical demand, resulting in higher overall efficiencies and lower overall carbon emissions.

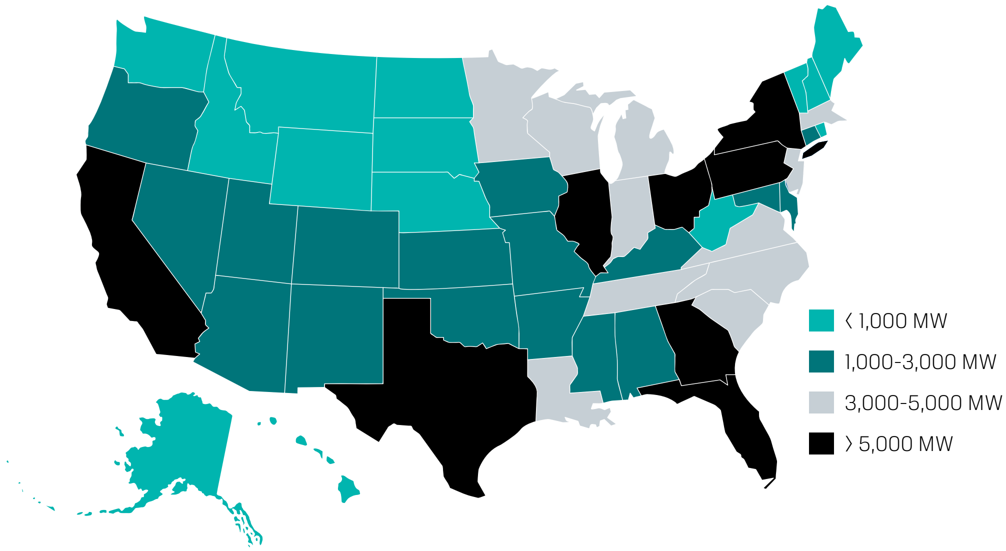
EXHIBIT 4: ENERGY LOSSES—THE CURRENT MARKET FOR CHP



Source: Estimated U.S. Energy Consumption, Lawrence Livermore National Laboratory 2015

While CHP has long been a commercialized and well-understood technology, it still remains underutilized. The technical potential for CHP in the commercial and industrial sectors is substantial, and current CHP installations only capture a fraction of it.

EXHIBIT 5: CHP TECHNICAL POTENTIAL CAPACITY BY STATE



The Department of Energy CHP installation database shows that there are existing CHP installations in every state, demonstrating that CHP can be utilized nationwide. While CHP systems can be used in a variety of locations, the technical potential for CHP typically coincides with large population centers, as it is regularly used at hospitals, universities, and other facilities located in densely populated areas. Although significant potential for large-scale CHP installations still exists, there has recently been increasing interest in smaller sized CHP systems (250 kW–5 MW). The emergence of packaged CHP systems has facilitated a portion of the growth in these smaller sized installations. Packaged systems make installing CHP more like an appliance and will enable highly replicable installations that can deliver energy savings at low program costs.

Conclusion

CHP is a proven, but underutilized, technology that makes use of what is normally wasted in the generation process, turning it into useful thermal energy. Utilities that have included CHP in their portfolio are seeing that it is a cost effective and productive measure for meeting efficiency program targets. Including CHP programs as part of a utility's energy efficiency portfolio can be an effective way to capture an untapped efficiency measure that offers significant benefits to a utility, the end user, and society.

About ICF

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About the Authors

Anna Shipley is a Senior Manager at ICF with over 20 years of experience and commitment in the energy-efficiency and distributed generation field. Her current focus is combined heat and power (CHP) and distributed generation (DG) technologies and policy (including regulatory, environmental, federal and state). Her recent work has included exploring the opportunities CHP as a resiliency resource, customer-sited CHP as a grid resource, non-disruptive demand response implementation, and industrial energy efficiency programs and technologies. Ms. Shipley holds a B.S. in Chemical Engineering from the University of Maryland and is a 2015 CHP Association CHP Champion.

Anne Hampson is a Senior Manager at ICF with over 14 years of experience in market and policy analysis in the areas of power generation and energy efficiency. She leads ICF's efforts in the development and management of databases on installed CHP capacity as well as operational reliability of DG equipment. She has conducted analysis and research on market issues, regulatory policies, economic incentives, reliability issues, and performance characteristics of distributed generation equipment. Ms. Hampson has successfully led utility-level CHP Market Potential studies. Ms. Hampson holds a B.S. in Integrated Science and Technology from James Madison University, and an M.B.A. with a concentration in Environmental Policy and Management from George Washington University.

For more information, contact:

Anne Hampson
anne.hampson@icf.com +1.703.934.3324

Anna Shipley
anna.shipley@icf.com +1.703.272.0007