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Do Combined Heat and Power plants perform? Case study of publicly funded projects in New York

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HIGHLIGHTS

- Low utilization of CHP indicates underperformance.
- Possible causes of underperformance are examined.
- Better pre-engineering assessment and performance-based incentives are recommended.

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ABSTRACT

We investigate lower than expected capacity factors of Combined Heat and Power plants using a publicly available dataset of hourly performance for plants in the state of New York. Low utilization of a CHP indicates underperformance. We examine possible causes of this underperformance including economic arbitrage, poor maintenance and operational practices, oversizing of plants, and reliability and resiliency needs. Based on seasonal and weekday/weekend capacity factor averages, we find that there is not enough evidence to support the economic arbitrage cause. Out of 99 plants in the dataset, 64 plants have average capacity factor below 60%, indicating they are either oversized and/or poorly maintained. This suggests that the current practice of one-time fixed incentive ($/kW) favors investment in capacity with no incentive for utilization (unlike a production credit which incentivizes generation $/kW h). From a policy perspective, this paper recommends better pre-engineering assessment for correct sizing, as well as revision of incentives based on performance. Additional information should be collected so that a more accurate ongoing analysis of the societal benefits of CHP projects can be made. Lastly, the energy efficiency gap may be smaller than is commonly assumed and other options should be explored to meet energy efficiency goals.

1. Introduction

Benefits of energy efficiency as a building block for achieving emissions reduction goals and its viability as a 'low hanging fruit' are widely accepted. Combined Heat and Power (CHP or cogeneration), which is defined as sequential or simultaneous generation of multiple forms of useful energy through an integrated machine (EPA, 2008), is considered a proven energy efficiency solution for industrial, commercial, and large residential customers. Overall efficiency of CHP can range between 60% and 80%, much higher than compared to the average efficiency of 33% for fossil-fueled power plants in the U.S.[1] A 2012 Executive Order by President Obama called for setting up 40 GW of new CHP capacity by the year 2022.[2] CHP can also help states comply with their emissions reduction obligations under the EPA's final Clean Power Plan Rule announced on August 3, 2015.[3]

As of December 31, 2014 there were 4438 CHP projects in the United States, adding up to 82.73 GW of capacity.[4] Significant

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[1] U.S. EPA Combined Heat and Power Partnership, Basic Information http://www.epa.gov/chp/basic/efficiency.html

[2] Executive Order – Accelerating Investment in Industrial Energy Efficiency https://www.whitehouse.gov/the-press-office/2012/08/30/executive-order-accelerating-investment-industrial-energy-efficiency

[3] U.S. EPA Clean Power Plan Final Rule http://www2.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants

[4] U.S. Department of Energy Combined Heat and Power Installation Database https://doe.icfwebservices.com/chpdb/

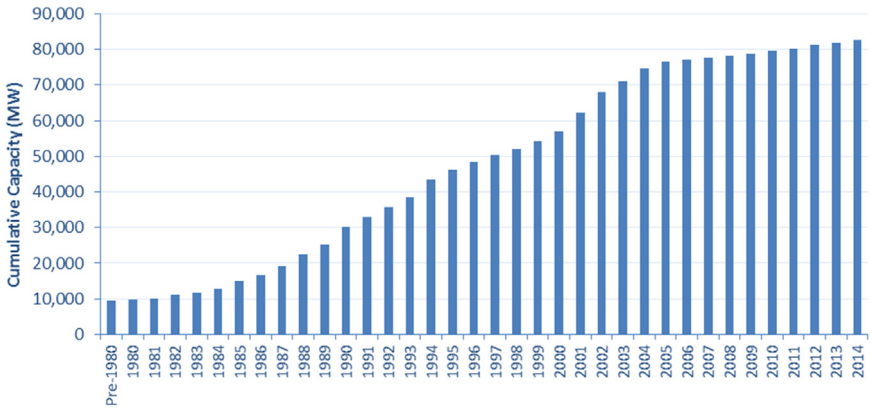

Fig. 1. U.S. Historical Trend of CHP Capacity Addition. Source: U.S. DOE Combined Heat and Power Installation Database.

capacities were added during the early 1990 s and afterwards during 2001 and 2002 (Fig. 1).

Recognizing the benefits of CHP, many states have formulated financial measures (direct incentives such as grants, rebates; and indirect incentives such as tax relief, low-interest loans, feed-in tariffs) and policy intervention (output-based emissions regulation, including CHP in state portfolio standards, standardizing utility interconnection agreements) to promote investments.[5] Twenty-three states recognize CHP as part of their Renewable Portfolio Standards or Energy Efficiency Resource Standards.[6] Per the ACEEE (2014) State Energy Efficiency Scorecard, 16 states rank favorably[7] on the parameter of providing financial incentives to CHP.

New York ranks sixth in CHP scores for the year 2014 (ACEEE, 2014). Whereas the state ranks well on financial incentives and measures such as including CHP in the RPS, it scores low on policy interventions such as standardized interconnection procedures and output-based emissions regulations. New York has a total installed CHP capacity of 5775 MW (40% installed at commercial establishments and 60% at industrial establishments) and ranks fourth in terms of installed capacity (after Texas 17,557 MW; California 8797 MW; and Louisiana 6106 MW).[8] The New York State Energy Research and Development Authority (NYSERDA) has been actively incentivizing CHP projects in the state since 2000 and expects CHP to deliver energy, environmental, and economic benefits such as peak electric demand reduction, higher fuel-use efficiency, emissions reduction, and lower energy costs. Over the last decade the agency has spent around $125 million in funding CHP projects in New York.[9] The CHP Demonstration Program was run for eleven years (2000–2011), and additional incentives were provided to projects under the 'CHP in the Existing Facilities Program' (during 2006–2011). New programs launched in 2012 include both a CHP Acceleration Program,[10] which provides incentives for the installation of pre-qualified, pre-engineered packaged systems up to 1.3 MW, and a CHP Performance Program,[11] which provides incentives to systems larger than 1.3 MW and which can provide summer on-peak demand reduction.

Investments in creating new CHP facilities (in New York State as well as throughout the U.S.), however, have fallen short of harnessing what is believed to be CHP's full achievable potential. Technical potential for CHP in New York State totals up to an additional 8500 MW at 26,000 sites (split evenly between upstate and downstate markets), with a market penetration of additional 764 MW by the year 2012 for projects with a payback period of less than 8 years (NYSERDA, 2002). In reality, the state has been able to add 580 MW between 2002 and 2014.[12]

A study conducted by ONSITE SYCOM Energy Corporation for the Department of Energy (DOE) estimated a country-wide technical potential of additional 74,638 MW of CHP capacity (potential for each type of application shown in Fig. 2) over the existing 4926 MW of installed CHP capacity at the commercial/institutional sector (OSEC, 2000).[13] This study used the DOE Energy Information Administration 1995 Commercial Buildings Energy Consumption Survey to estimate electric and thermal energy requirements for various building types, which was combined with MarketPlace Database[14] to identify potential CHP sites by its Standard Industrial Classification code. A facility with moderate to high operating hours (> 4000 h per year) was assumed to be eligible for CHP.

A more recent study by the consulting firm ICF International for the American Gas Association estimated 124.7 GW of additional CHP technical potential (56 GW of industrial installations and 68 GW of commercial/institutional installations) (ICF, 2013). Out of this technical potential only around 6.4 GW of capacity was estimated to have a payback period of less than 5 years. This estimate is based on identifying applications where CHP provides a reasonable fit to the electric and thermal needs, by quantifying the number and size distribution of target applications, and then estimating CHP potential in MW capacity. This untapped potential analysis is based on benefits to the private investor (potential in terms of MW was categorized into three payback categories representing degree of economic potential), but does not consider broader social benefits. The National Resource Defense Council reports an untapped CHP potential in the US for a minimum 50 GW to a maximum 200 GW (NRDC, 2013), although the basis

[5] For more information on state-specific financial and policy interventions for CHP, please see the dCHPP (CHP Policies and Incentives Database) maintained by the CHP Partnership at EPA. http://www.epa.gov/chp/policies/database.html

[6] U.S. Energy Information Administration http://www.eia.gov/todayinenergy/detail.cfm?id=8250

[7] For a state to be eligible for 0.5 points, at least one available incentive must (a) apply to all CHP regardless of fuel; (b) be a production credit, an investment credit, a credit for installed capacity, or a grant; (c) apply to both the commercial and industrial sector.

[8] U.S. DOE Combined Heat and Power Installation Database https://doe.icfwebservices.com/chpdb/

[9] http://chp.nyserda.ny.gov

[10] http://www.nyserda.ny.gov/PON2568

[11] http://www.nyserda.ny.gov/All-Programs/Programs/Combined-Heat-and-Power-Performance-Program

[12] U.S. DOE Combined Heat and Power Installation Database https://doe.icfwebservices.com/chpdb/

[13] Bruce Hedman was the Principal Investigator of this analysis. He later joined ICF and has worked on several similar studies estimating the potential of CHP in the United States.

[14] The MarketPlace Database was maintained by iMarket Inc., and was based on the Dun and Bradstreet financial listings. It includes information on economic activity, location, and size of commercial and industrial facilities in the U.S.