The Role of Incentives in Promoting CHP Development

Nate Kaufman and R. Neal Elliott, American Council for an Energy-Efficiency Economy

ABSTRACT

State policies and regulations can help mitigate or eliminate regulatory and market barriers that stymie the installation of combined heat and power (CHP) systems, especially barriers imposed by utilities that resist distributed generation. Financial incentives can play a role in promoting CHP development by mitigating the additional costs that result from these barriers. To help focus the priorities of state policymakers and regulators, this paper analyzes CHP installation data and compares them for each state to regulatory policies and financial incentives applicable to CHP. Based on our analysis, we suggest that states should focus primarily on eliminating regulatory barriers, while using financial incentives to complement regulatory reform and encourage CHP development.

Introduction

Many state policymakers recognize the energy, environmental, and economic benefits of combined heat and power (CHP) systems. CHP systems currently comprise 8.6% of total generating capacity in the United States, though its achievable potential generating capacity exceeds 20% (ORNL 2008). One of the greatest obstacles to achieving this potential is the upfront capital cost of CHP projects. In response, a number of states offer financial incentives in the form of grants, bonds, rebates, tax credits, and loans for CHP developers or owners to install new systems or retrofit existing systems with CHP. Financial incentives on both the state and federal levels have effectively led to increased installations.

In addition to first cost, however, other market barriers to system development exist that must be addressed before the technology can reach its full potential throughout the U.S. Among these key barriers are (Eldridge et al. 2009):

- Onerous utility interconnection standards and practices;
- Unreasonable utility tariffs; and
- Air quality regulations that do not reflect the reduced emissions associated with displaced utility generation.

These market hurdles often add cost, uncertainty, and delay to projects. Further complicating the issue is the variance in regulatory and market landscapes from state to state. In the past 15 years, however, significant advances have been made on regulatory barriers, including the establishment of a technical standard for interconnection and the U.S. EPA's issuance of guidance on output-based emissions regulations (Eldridge et al. 2009).

For more than a decade the American Council for an Energy-Efficient Economy (ACEEE) has studied market barriers to CHP and over the past three years has tracked which states have the most practical and effective policies for CHP as part of the annual *State Energy Efficiency Scorecard* (Eldridge et al. 2009). In the absence of strong federal regulations, state lawmakers and regulators can be instrumental in establishing interconnection standards, tariff

designs, environmental regulations, and other policy measures that can dramatically impact the attractiveness of CHP projects. State activity is essential in creating a market environment that encourages CHP. Over the past several years, an increasing number of states have worked to develop and implement "CHP-friendly" policies, while others have done little.

This paper focuses on the relative impact of state financial incentives and the removal of regulatory and market barriers. More-qualitative market indicators are compared with more-quantitative data on actual installation of CHP systems over the last five years. Based on this comparison, we show that while financial incentives for CHP may indeed encourage development, they may not be sufficient alone to create a favorable market for CHP. Rather, the removal of regulatory and market barriers is often fundamental to the successful implementation of CHP systems. In the current fiscal environment, expanding state financial incentives may be difficult. Because our research indicates that addressing regulatory barriers can be effective even in the absence of incentives, state policymakers should make it a priority in the current economy to remove these regulatory barriers.

Background on CHP

CHP systems, sometimes called cogeneration, generate power and thermal energy in a single, integrated system. CHP is more energy efficient than separate generation of electricity and thermal energy because heat that is normally wasted in conventional power generation is recovered as useful energy (Elliott and Spurr 1999). Rather than a single technology, CHP represents the application of a suite of technologies in a particular system context. CHP can use a variety of fuels and configurations are site specific. CHP applications predate the electric utility model, with Edison's Pearl Street Station in Manhattan serving as the first commercial electric generation and CHP system in 1882 (Casten 1998).

Because CHP installations are capital-intensive projects, financial barriers can represent a key hurdle to project implementation. While financial incentives can help to mitigate costs associated with market barriers, in many cases developers and owners find their projects stymied by the costs of regulatory and market uncertainty, most notably for smaller CHP systems for which regulatory compliance costs and utility fees represent a large portion of project costs relative to large systems (Elliott and Spurr 1999).

Despite the widely acknowledged benefits of CHP, many state policies still present barriers to its wider adoption. Some barriers exist because of a lack of awareness by lawmakers and regulators, or a lack of administrative staff time to address them. Others exist because differences in opinion among decision-makers over which policies reflect the public good or how CHP impacts incumbent market players.

Review of CHP Incentives

Financial incentives for CHP may take the form of grants, loans, tax credits, rebates, or bond financing. Financial incentives for CHP are often bundled with either incentives for end-use energy efficiency technologies or with incentives for renewable energy technology. Therefore, not all incentive pools that could apply to CHP will necessarily be available to a specific CHP project. When incentive pools—for grants, loans, or bond financing, for example—are limited, CHP may be forced to compete with renewable energy projects, often making it more difficult for CHP projects to receive funding awards.

Many CHP developers are especially supportive of tax credits for CHP projects. Tax incentives at the state level can apply to corporate, property, or sales taxes. However, tax incentives cannot be used by tax-exempt organizations such as hospitals, universities, and colleges, where CHP installations have proven particularly beneficial (Spurr 1998).

In October 2008, Congress enacted a federal investment tax credit for CHP systems up to 50 MW in capacity (DSIRE 2010). While this federal incentive will be available through 2016, it is unlikely that the credit has yet manifested a significant impact on CHP installations because CHP systems typically take between 24 and 48 months to develop (Elliott and Spurr 1999). We can therefore discount the impact of this development on installation data at this point.

Available CHP Data Resources

In order to compare the relative impact of state financial incentives to regulatory policies, we draw from ACEEE's *State Energy Efficiency Scorecard* (Eldridge et al. 2007; 2008; 2009) for policy and regulation assessments and from ICF International's database for CHP installation data (ICF 2010). The CHP portion of the *Scorecard* ranks five policy categories:[1]

1) The presence of an interconnection standard that explicitly applies to CHP systems;
2) The nature of tariffs and standby rates imposed on CHP systems by large utilities;
3) The presence of financial incentives for CHP.[2]
4) The presence of output-based emissions regulations;
5) The eligibility of CHP in renewable portfolio standard (RPS) or energy efficiency resource standard (EERS).

ICF International's CHP database contains comprehensive information on CHP installations throughout the United States by year and by state. The database includes data on every CHP system installed, including capacity, fuel, and the year in which it began operating.

Exploring State CHP Installation Data

The ACEEE *Scorecard* identifies states providing financial incentives for CHP (see Table 1) with varying degrees of accessibility, longevity, and substantiality. Many of these states also maintain the most favorable regulatory policies. Connecticut, Ohio, Oregon, and New York—all states with relatively favorable regulatory environments—have also offered incentives for CHP. Virginia, Louisiana, Georgia, and Wyoming have poor regulatory environments for CHP and do not offer incentives for development. Some states offer financial incentives but have not implemented good regulatory policies, and vice versa. These states are the most useful models for examining the relative impacts of incentives and regulatory reform. Indiana, Maine, Massachusetts, and Texas maintain good regulatory environments but modest or no incentives, while Alaska, Florida, Idaho, and Vermont have incentives but poor regulatory environments.

[1] Net metering, whereby a distributed generation system receives retail credit for at least a portion of the electricity it generates, can also play a role in incentivizing CHP, though it typically only applies to systems smaller than 2 MW, and in most states only smaller than 1 MW. To date, our scorecard has not explicitly included net metering.

[2] For the purpose of this paper's analysis, financial incentives—a weighted category in the scorecard—have been removed from each state's overall policy rankings and isolated as a separate a metric.

Table 1. Incentives vs. Regulatory Environments: State Examples

		Regulatory Environment	
		Good	*Bad*
Incentives	*Good*	CT, OH, OR, NY	AL, AK, ID, VT
	Bad	IN, ME, MA, TX	GA, LA, VA, WY

These policy data, combined with data on new CHP capacity in each state over the five-year period from 2005 to 2009, can provide insights into the relative impacts of state regulatory policies and incentives.

Table 2. State Leaders, New Installed CHP Capacity, 2005–2009

State	Capacity (MW)	Number of New Sites (2005–2009)	Avg. Capacity of New Sites (MW)	Average ACEEE Scorecard Incentives Score (Max 4)	Average ACEEE Scorecard Regulatory Policy Score (2007–2009) (Max 5)
Texas	380.8	8	47.6	0	5
Connecticut	181.9	61	3.0	3	5
California	113.0	137	0.8	1	5
New York	98.8	94	1.1	3	3
Washington	97.6	8	12.2	1	3
Wisconsin	83.0	20	4.2	1	4
Nebraska	70.0	1	70.0	0	1
Pennsylvania	50.9	24	2.1	2	3
Ohio	48.6	7	6.9	4	5
Alabama	47.0	3	15.7	2	0

Table 2 organizes the CHP installation data by the total new installed capacity from 2005 to 2009. This perspective reflects the benefit of displaced electricity generation from the grid. However, because of the wide range of system capacity (ranging in the ICF database from 1.2 kW to 224 MW), this metric can be misleading, since a few large projects can cause a state to appear to have more active CHP markets than it does. Although Texas far surpasses every other state in new capacity—with over 300 MW installed over the last five years—a single installation accounts for 75% of this capacity. Similarly, Nebraska ranks seventh in new capacity from 2005 to 2009, but all of its capacity is associated with one project. Thus, capacity may not necessarily be the most significant parameter reflecting CHP market activity.

In Table 3, we order states by the number of new systems. On this list, Texas does not even fall within the top ten. Large states like Texas inherently have a higher likelihood of new capacity installation, regardless of fuel type or individual system size, but Texas pales in comparison to the number of new installations in large states like California and New York.

Table 3. State Leaders, New CHP Installations, 2005–2009

State	Number of New Sites (2005–2009)	Capacity (MW)	Avg. Capacity of New Sites (MW)	Average ACEEE Scorecard Incentives Score (Max 4)	Average ACEEE Scorecard Regulatory Policy Score (2007–2009) (Max 5)
California	137	113.0	0.8	1	5
New York	94	98.8	1.1	3	3
Connecticut	61	181.9	3.0	3	5
Massachusetts	32	36.7	1.1	0	4
Pennsylvania	24	50.9	2.1	2	3
Wisconsin	20	83.0	4.2	1	4
New Jersey	18	14.1	0.8	1	4
North Carolina	13	17.6	1.4	2	3
Oregon	10	38.8	3.9	4	3
Vermont	10	3.2	0.3	3	2

When states are sorted by average capacity of new installations, a majority of the leading states are ones with unfavorable regulatory environments and poor financial incentives, including Nebraska, North Dakota, Arizona, and Iowa. This can be attributed in part to the fact that large CHP systems installed at energy-intensive manufacturing facilities are often much easier to finance and push through regulatory hurdles as a result of internal capability within the firms and the ability to procure expertise to address these barriers. In addition, many of these large projects go the route of PURPA qualifying facilities, bypassing local utility barriers (see the discussion on system size below). In this category, we find states where a small number of large projects result in a relatively high new installation capacity total, such as Arizona, Florida, and Missouri.

Normalizing the new CHP capacity in each state by the state's energy consumption provides another perspective for state-by-state comparison. Connecticut and Nebraska hold the lead in capacity normalized by per capita energy use, with South Dakota, North Dakota, and Montana not far behind. Capacity normalized by state population—which eliminates the factor of disparate consumption levels per capita in each state—yields the same states in the top five spots. A normalization of the number of installations by both state energy consumption and by state population places Connecticut and Vermont as the leading states.

Comparing New Installations to State Policy

When the states are sorted by new installation capacity from 2005 to 2009 (Table 2), we find that a clear majority of the top 10 states have favorable regulatory policies and favorable incentives for CHP. The notable exceptions are Texas, Washington, Nebraska, and Alabama. Texas, as mentioned above, has a favorable regulatory environment but historically no financial incentives. Like Texas, Washington has offered poor state financial incentives, but a relatively amenable regulatory environment. In contrast, Alabama has had some level of financial incentives over the past three years—though only three CHP systems have been installed—and Nebraska has offered little in the way of incentives, though its high level of installation capacity is reflective of only one project, as noted above. Discounting Alabama and Nebraska because of their scarcity of new installations, we see that the most significant exceptions to the rule in terms of capacity are Texas and Washington. These states are both examples of where financial incentives played little or no role, yet some of the highest capacity installations in the country

were still installed. Conversely, some states that have offered modest incentives for CHP but have unfavorable regulatory policies—such as Alaska, Mississippi, Vermont, and Idaho—saw less than 4 MW in total new installation capacity over the past five years.

Using the number of new installations rather than total capacity as a metric (Table 3), we find that of the top ten states, nine have moderately favorable to favorable regulatory environments. Only one state in the top ten, Vermont, has an unfavorable regulatory environment. Vermont also has the second-most financial incentives offered of the states in this grouping, after Oregon. This could be construed to counter our hypothesis, at least in part. However, Vermont is a fairly unique state with respect to energy and energy efficiency (see the full discussion on Vermont below). When states are ordered by number of new installations, we again find some states with financial incentives but prohibitive regulatory environments exhibiting a dearth of new CHP systems, including Alabama, Alaska, and Idaho.

We can then look at the normalized forms of both our capacity and new installations metrics. When capacity is normalized by either energy consumption or population, it is unsurprising that several of the top-performing states are states with low populations and low total energy consumption, such as Nebraska, North Dakota, Montana, and South Dakota. These states all have relatively unfavorable regulatory environments and have offered few if any financial incentives for CHP over the past three years. These states installed only one, four, seven, and three new CHP systems respectively over the last five years, and their placement at the top of the list is reflective of the relatively large combined capacity of these installations (between 16 and 70 MW) and their low populations and energy consumption levels.

Looking at the new installations metric normalized by population, we find that most of the leading states are simply states with low populations—Vermont, Montana, Rhode Island, North Dakota, Wyoming, and South Dakota—with a few states with high populations mixed in because they installed so many new systems—Connecticut with 61, Massachusetts with 32, and New York with 94. Each of the low-populated states in this top tier installed fewer than 8 new systems, with the exception of Vermont, which installed 10. Each one of these states also maintains an unfavorable regulatory environment and offers poor financial incentives, once again with Vermont as the exception with regard to incentives (see the full discussion on Vermont below). The new installations metric normalized by energy consumption yields mostly the same results, though interestingly California moves into the top 10—presumably because of its low energy consumption levels per capita—and Wyoming falls out of the top 10—presumably because of its high energy consumption levels per capita.

Comparing Leading States' New Installations

Looking at our data in the opposite direction, we can sort the states based on the favorability of their regulatory policies, as well as based on the extent of their financial incentives. When sorted based on regulatory policies, we find that most of the top-ranked states have seen substantial new CHP installations over the past five years. The leaders in regulatory rank—Texas, Connecticut, California, Illinois, and Ohio—have all installed over 25 MW of CHP in the past five years, and have all installed seven or more systems. Illinois has seen the smallest capacity of new installations of these states, with 26.8 MW, and Ohio has installed the fewest systems, with seven. Examining the new state order for outliers based on capacity and number of new installations, we find that a few states with poor regulatory environments have high capacity numbers—Alabama with 47 MW, Nebraska with 70 MW, and North Dakota and Montana with

23. As has already been discussed, these were either very large systems on average or there were simply too few new installations—three, one, seven, and four, respectively—to warrant inferences about the efficacy of these states' regulatory environments.

Sorting states by financial incentives offered presents a different picture. While several states with good financial incentives also have favorable regulatory policies—for example, Connecticut, New York, Ohio, Oregon, and Pennsylvania—several states appear in the top tier that have previously not been leaders in any category, such as Florida, Idaho, North Carolina, and Alaska. Vermont, with its relatively strong incentives, also ranks highly. Of the states that have strong incentives but unfavorable regulatory policies, we see some disparities in the seeming efficacy of the incentives. Florida has installed three new systems with an average capacity of 14.6 MW; Vermont has installed 10 new systems with an average capacity of 0.3 MW; Idaho has installed two new systems with an average capacity of 1.9 MW; North Carolina has installed 13 new systems with an average capacity of 1.4 MW, and Alaska has installed one new system with a capacity of 0.4 MW. It should be noted that North Carolina's regulatory environment is ranked in the third highest tier (out of six), while Alaska, Florida, Idaho, and Vermont are ranked in the fourth highest tier.

Little consideration should be given to Alaska and Idaho in this category, as they only installed one and two new installations, respectively. Financial incentives certainly could have played a role, but again, the installation of so few systems cannot reasonably be extrapolated as a justification for the efficacy of financial incentives in a prohibitive regulatory environment. Florida, North Carolina, and Vermont warrant some closer attention, as outlined below.

Conversely, several states that notably lack strong financial incentives for CHP still exhibit impressive new installation figures. The most notable is Massachusetts, which despite only installing 36.7 MW of capacity over the past five years, did so with 32 new systems. In fact, Massachusetts ranks fourth in the country in new installations. Other states with no financial incentives but relatively many new installations include Colorado with nine installations and Texas with eight installations. Indeed, Texas has historically offered no financial incentives for CHP but leads the nation in newly installed capacity. Other states with relatively high new capacity but with no financial incentives include Missouri with 10.7 MW, Arizona with 16.3 MW, Iowa with 16.9 MW, South Dakota with 16.5 MW, and Montana with 23.3 MW. However, each of these states has an unfavorable regulatory environment and installed few new projects over the past five years.

For the ten states with the highest-ranked regulatory policies, the total number of new installations is 301, the total new capacity is 891.7 MW, and the average capacity per new system is 7.0 MW. For the ten states with the best financial incentives, the total number of new installations is 225, the total new capacity is 487.7 MW, and the average capacity per new system is 3.6 MW. Ohio and Connecticut fall in both categories.

State Outliers

Florida. Florida, which maintains a mediocre regulatory environment, saw three new systems installed from 2005 to 2009 with a combined capacity of 43.9 MW—one site representing 36.5 MW and the other two at 3.2 and 4.2 MW. The large site, installed by Smurfit Stone Container Corporation at a wood products plant, was a qualifying facility under PURPA. Therefore, it was able to bypass regulatory processes at the state level, per PURPA Section 210. This data point, a significant one, is therefore not relevant to our analysis. The other two systems installed in

Florida were both undertaken by municipal utilities—Ocala and Gainesville, respectively. CHP systems installed by utilities are inherently exempt from utility-related barriers, and municipal utilities lie outside the state regulatory environment scored in ACEEE's annual scorecard.

North Carolina. North Carolina received a moderate ranking for its regulatory policies primarily for its strong interconnection regulations. However, in practice, other regulatory barriers prove burdensome for CHP development (McAllister 2010). The 13 sites that have been installed in North Carolina over the past five years are almost all in municipal utility territory; that is, they are not subject to the same regulations as systems in investor-owned utility (IOU) territories. They are also almost all located in the eastern part of the state, where contracts between IOUS and the region's municipal electric utilities and electric cooperatives include a significantly punitive coincidental peak clause. A company called PowerSecure has worked with the municipal utilities and electric cooperatives to install new CHP projects that are qualifying facilities under PURPA, which allows them to circumvent the terms of the contract that put a restrictive limit on the amount of permissible distributed generation in these service territories.

Vermont. Vermont is the only state where we find especially strong financial incentives, an especially weak regulatory environment, and relatively impressive numbers for new CHP installations and normalized new capacity. However, before Vermont may be viewed as a rejection of our hypothesis, the realities of the state's regulatory environment, energy efficiency players, and recent installations must be taken into account. In Vermont, despite a lack of favorable regulatory policies, certain programs, utility energy objectives, and other factors help to encourage CHP development (Cinadr 2010). Vermont is unique in its recent energy savings goals, aiming to save 261.7 GWh between 2006 and 2008; it handily beat these goals. Efficiency Vermont, the state's "efficiency utility," which has its own set of savings goals, provides technical assistance for CHP developers. Additionally, the state subscribes to strong renewable energy goals through its *Sustainably Priced Energy Enterprise Development* (SPEED) program, and seven of the state's ten CHP projects over the past five years are fired by biomass (including wood), an eligible renewable technology. Finally, net metering is available for systems less than 250 kW, which applies to three of the ten systems.

Discussion

Based on the above analysis of available data, it is clear that both financial incentives and favorable regulatory policies at the state level can contribute to encouraging CHP implementation. Many states with favorable regulatory policies also offer incentives, which together strongly promote CHP. However, while financial incentives are certainly useful drivers of development, our analysis suggests that they alone are not necessarily sufficient to help push CHP toward its full potential.

As displayed in Table 1, there are examples of states with both favorable and unfavorable regulatory policies, states with strong and weak financial incentives, and intersects of both. The states with both favorable regulatory policies and strong financial incentives exhibit strong numbers of CHP system installations, as well as new capacity. States with both unfavorable regulatory policies and weak or no financial incentives typically exhibit weak numbers for both capacity and installations, with the exceptions of a few states—including Nebraska, Montana, North Dakota, Iowa, and Arizona. The exceptions, as discussed above, have implemented too

few systems—and too large systems, as will be discussed—to be able to defend an argument that regulatory policies and financial incentives do not play an important role in CHP development.

In Table 1, the important points of examination are where unfavorable regulations intersect with strong incentives and where favorable regulations intersect with weak incentives. Examining these states can provide useful insights about which state policy actions matter most.

Good Regulations, Bad Incentives

While there is a great deal of overlap between states with favorable regulatory environments and states with relatively strong incentives[3] for CHP, some states exhibit the former but not the latter. These states include Indiana, Maine, Massachusetts, and Texas. Texas and Massachusetts have had no financial incentives for CHP but Massachusetts has seen impressive new installation numbers and Texas has seen impressive new capacity figures. In contrast, Maine has installed only two systems over the past five years totaling 4.5 MW and Indiana has installed eight systems totaling 2.2 MW.[4]

Bad Regulations, Good Incentives

States that maintain unfavorable regulatory policies but relatively strong financial incentives for CHP include Alabama, Alaska, Idaho, and Vermont.[5] With the exception of Vermont, the states in this category installed three or fewer new CHP facilities over the past five years. Additionally, these states' total new capacity—with the exception of Alabama—fell below 4 MW. In Alabama, three new systems were installed, totaling 47 MW of capacity. However, two of the three systems in Alabama—which account for 99% of the state's new capacity—were qualifying facilities under PURPA, enabling them to circumvent regulatory barriers at the state level (see discussion on system size below). For these reasons, along with the Vermont discussion above, these states do not reject the hypothesis that addressing regulatory barriers should be the primary policy priority.

Other Factors

Size matters. As mentioned briefly above, the capacity of a CHP system is a key factor in the success of its implementation. Typically, systems over 20 MW serve loads at large industrial facilities and are owned by companies with the time, financial resources, and staff to overcome key regulatory obstacles. Additionally, state-level interconnection standards often do not apply to large CHP systems, as they are left subject to federal interconnection standards at the transmission level. Developers of large systems are typically better equipped to overcome regulatory and utility barriers than developers of smaller systems, and regulatory barriers tend to

[3] Incentives vary widely from state to state. The states that are generally considered to have "relatively strong financial incentives" here are states that have demonstrated a dedication to CHP through new incentives each year, long-lasting incentives, or renewed incentives over the past three years, as well as states that have offered incentives that ACEEE has deemed fairly accessible and fairly substantial.

[4] More research must be done to determine potential reasons for the dearth of new CHP installations in Maine and Indiana. ACEEE intends to publish a more comprehensive report in the fall of 2010 exploring the unquantifiable factors that lead to CHP development or the lack thereof.

[5] Florida and North Carolina can also apply to this category, but due to the aberrance of these states as discussed at length above, we can discount them from consideration as potential rejections of our hypothesis.

be a less significant cost factor for these large systems. If regulatory costs are uniform for both small and large projects, which they are in many states, large projects are typically more cost-effective due to the relatively less burdensome effect of these costs. Installing CHP systems as PURPA qualifying facilities, which allows developers to circumvent many state barriers, is another strategy for large systems that is often enough to make CHP cost effective.

For these reasons, state regulatory policies and financial incentives generally tend to have a greater impact on small systems, often helping to determine whether a small system will even be installed. This factor likely played a role in the implementation figures from various states, notably those where we see weak regulatory policies, a few large installations, and few or no small installations, such as Nebraska, Alabama, and Missouri. For market transformation to truly occur for CHP development, smaller CHP projects must be given equal footing with larger projects, enabling systems of all sizes to penetrate and help to reshape the marketplace.

Facilitation by state players. Over the past decade, many states have established programs and in some cases entire organizations to provide technical assistance for energy consumers looking to implement efficiency measures. Some state entities, such as Efficiency Vermont, can assist businesses in determining where the obstacles are to CHP implementation and working around them. Project facilitation can help reduce uncertainty and consequently project costs. Such assistance is much more beneficial for small projects for which the cost of addressing barriers is a large share of the total project cost. Federally funded technical assistance centers for CHP, known as Clean Energy Application Centers, can also provide valuable assistance, though their impact cannot be analyzed as a state-sanctioned initiative. While state programs offering technical assistance specifically for CHP development are rare, they can serve to increase the number of small CHP installations in their state, and very well may have played a role in some of the installations that occurred in states with poor regulatory environment, such as Vermont.

Incentivization through renewables. Some CHP systems can receive incentives that are reserved for renewable energy projects. While some states accept CHP systems with any fuel source to be able to count toward state energy savings or renewable energy mandates or goals, others give precedence to strictly renewable energy projects. Still, renewable-fired CHP, predominantly biomass, is often eligible for satisfying certain renewable energy goals, as well as receiving other renewable-centric financial incentives. Renewable projects tend to be smaller and treated more favorably at the state level than strictly energy efficiency projects. This factor could have promoted the development of smaller, biomass-fired systems in several states.

Extending the CHP Experience to Other Energy Efficiency Projects

The experience with the relative impacts of incentives and regulatory barriers on CHP installation can provide some important insights into other energy efficiency opportunities. In particular, the CHP experience is most applicable to other capital-intensive projects such as boiler and chiller plant projects and district energy systems. These types of projects involve complex engineering challenges and can run afoul of many regulatory hurdles that may significantly increase transaction costs. A 1999 International Energy Agency (Ostertag 1999) discussion paper suggested that increased project transaction costs can have a stifling effect on energy efficiency project implementation. Thus policy efforts focusing on eliminating regulatory

and market barriers may be an attractive option, particularly in the current fiscal environment, in which government provision of significant financial incentives may be problematic.

Conclusion

Based on our analysis, financial incentives have proven beneficial in encouraging CHP. However, it is not clear that they are sufficient to create a healthy market for CHP development on their own. On the other hand, there are substantial indications that removing regulatory and market barriers can significantly improve the market for CHP. And while incentives can also play a role in mitigating the costs of overcoming regulatory and market barriers, addressing the barriers themselves is critical for state to maintain a healthy and sustained CHP market.

Our analysis indicates that system size is a key parameter in determining the effect of financial incentives on CHP development. Incentives appear more beneficial for smaller systems, as they represent a greater proportion of total project costs. For larger systems, financial incentives appear to play a less critical role in determining the viability of a project. Regulatory hurdles like input-based air emissions regulations, unreasonable utility tariffs, and burdensome interconnection standards can discourage large projects. However, the large firms that tend to develop these systems typically have the deeper resources to overcome such hurdles, so while financial incentives provide additional wherewithal to mitigate the barriers' transaction costs and the costs of delay, the barriers remain the primary hurdle to project implementation.

Having a good regulatory environment is necessary for CHP development at all levels. Financial incentives alone do not always work to increase CHP development, and they are most effective when paired with a positive regulatory environment. Successful implementation of CHP, and the path to market transformation, is a combination of good regulation, coordinated financial incentives, and sufficient education and marketing. These elements should be implemented in a coordinated and cohesive manner to maximize market penetration.

These findings can be extended to other capital-intensive, energy-efficient systems. While a myriad of financial incentives exist for energy-efficient measures and systems, states would also be wise to closely examine hidden market and regulatory barriers that increase transaction costs and discourage implementation of these energy efficiency opportunities.

References

Casten, Thomas R. 1998. **Turning Off the Heat: Why America Must Double Energy Efficiency to Save Money and Reduce Global Warming**. Prometheus Books. Amherst, NY.

Cinadr, Matt (Efficiency Vermont). 2010. Personal communication. February.

[DSIRE] Database of State Incentives for Renewables and Efficiency. 2010. Web site accessed March 2. http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F&re=1&ee=1.

Eldridge, Maggie, Bill Prindle, Dan York, and Steve Nadel. 2007. **The State Energy Efficiency Scorecard for 2006**. ACEEE-E075. Washington, D.C.: American Council for an Energy-Efficient Economy.

Eldridge, Maggie, Max Neubauer, Dan York, Shruti Vaidyanathan, Anna Chittum, and Steven Nadel. 2008. **The 2008 State Energy Efficiency Scorecard**. ACEEE-E086. Washington, D.C.: American Council for an Energy-Efficient Economy.

Eldridge, Maggie, Michael Sciortino, Laura Furrey, Seth Nowak, Shruti Vaidyanathan, Max Neubauer, Nate Kaufman, Anna Chittum, and Sarah Black. 2009. **The 2009 State Energy Efficiency Scorecard**. ACEEE-E097. Washington, D.C.: American Council for an Energy-Efficient Economy.

Elliott, R. Neal and Mark Spurr. 1999. **Combined Heat and Power: Capturing Wasted Energy**. ACEEE-IE983. Washington, D.C.: American Council for an Energy-Efficient Economy.

[ICF] ICF International. 2010. **Combined Heat and Power Installation Database**. Arlington, Va.

McAllister, Keith (Clean Energy Applications Program Manager, North Carolina State University). 2010. Personal communication. March.

[ORNL] Oak Ridge National Laboratory. 2008. **Combined Heat and Power: Effective Energy Solutions for a Sustainable Future**. Oak Ridge, Tenn.: United States Department of Energy.

Ostertag, Katrin. 1999. "**Transaction Costs of Raising Energy Efficiency**." Presented at the IEA International Workshop on Technologies to Reduce Greenhouse Gas Emissions. May. Washington, D.C.: Fraunhofer Institute for Systems and Innovation Research.

Spurr, Mark. 1998. **District Energy Systems Integrated with Combined Heat and Power: Analysis of Environmental and Economic Benefits**. Report to the U.S. Environmental Protection Agency. Minneapolis, Minn.: International District Energy Association.