Stimulating diffusion of low-carbon technology: evidence from a voluntary program

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Voluntary programs are an increasing part of the environmental policy portfolio. These voluntary programs attempt to reduce environmental impacts through emission reduction pledges, improve the environmental awareness of firms or provide information to the public. A more novel use of voluntary programs has involved the acceleration of technology diffusion of environmentally beneficial technologies to overcome typical problems like lack of technical information, principal-agent problems or to lower the threshold of network externalities. However, this type of voluntary program is what will be needed for firms and councils to comply with the UK Climate Change Act of 2008 and/or the Climate Change (Scotland) Act of 2009. These Acts require medium and large public and private sector institutions to meet an emissions cap that is more stringent than the EU Emissions Trading Scheme.

One technology with a high potential for carbon emission reductions is combined-heat-and-power (CHP), also known as cogeneration. When combustion boilers burn fuels like oil, gas, and coal to spin a turbine for electricity generation, the generated heat usually dissipates without further use. CHP utilizes the excess heat from the combustion process and generates electrical or mechanical power from it. This means that more energy is created with the same amount of fuel. The overall efficiency gains depend on the type of CHP system and fuel used. For example a 5MW natural gas turbine on average increases overall efficiency from 49% to 75% when employing CHP; which is a comparable increase to applications for steam, diesel and gas turbines.

The Intergovernmental Panel on Climate Change considers CHP as a key technology for carbon mitigation due to its improved efficiency. An additional benefit of CHP systems is that it allows for generation to be distributed amongst the consumers, which can increase the efficiency of the electricity generation and distribution system (Strbac, 2008). Improved energy efficiency is a pillar of many governments' policy to reduce greenhouse gas emissions. The International Energy Agency (IEA, 2009) argues strongly for the potential of efficiency improvements to reduce energy use and related emissions. Within the European Union, the 20-20-20 targets for member states are to reduce energy consumption by 20% through increased energy efficiency.

The potential for reduced emissions at low costs has led many countries to introduce policies that encourage CHP adoption. Germany, for example, aims to increase its share of CHP in electricity generation to 25%. A number of U.S. states count CHP as a "renewable" technology in their renewable portfolio standard legislation as well as providing tax credits or grants for the adoption of CHP.

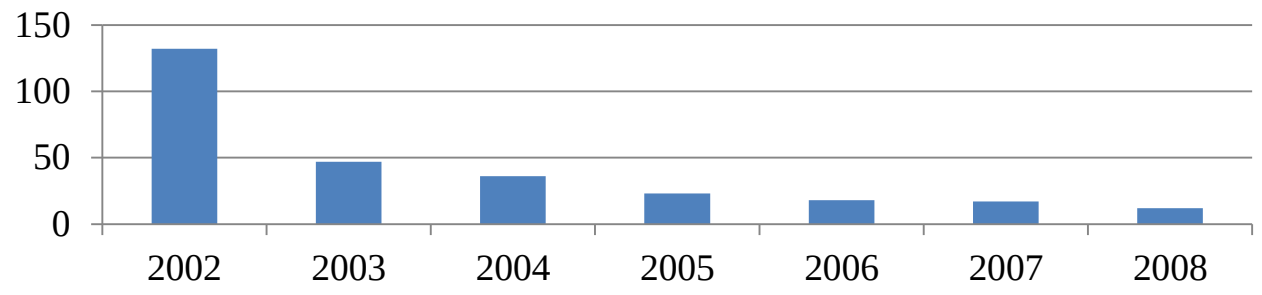
The US Environmental Protection Agency's Combined Heat-and-Power Partnership (CHPP) was established in 2001 and represents this new application of voluntary programs (US Environmental Protection Agency, 2010). Designed as a multi-sector federal voluntary program, it aims to facilitate the diffusion of CHP systems by giving early-stage consulting support to firms, public recognition as well as by providing a platform for contacts and knowledge transfer. Additionally the partnership brings various groups together to promote knowledge about CHP through workshops, conferences and web seminars. Currently there are 369 partners including federal, state and local government agencies as well as private organizations like energy users and producers, service companies, CHP project developers, consultants and manufacturers. When joining, partners agree to designate a liaison for the partnership and to report data on existing and planned CHP projects.

Analysis

Given the goals and structure of CHPP two hypotheses are to be discussed here. The first is whether the partnership has encouraged the installation of CHP applications and the second whether it has assisted knowledge transfers and spillovers that helped to increase CHP utilization. The first question is addressed by applying a conditional logistic probability model on a panel data set for large boilers in the United States. For the second question, we test whether the CHPP facilitates knowledge transfers that increased the efficiency and use of cogeneration in plants which have installed the technology. For this purpose we construct a variable to capture the usage of CHP to test for an increase in utilization and efficiency due to the program. The main data set used for the analysis is the US Energy Information Administration Form 906/920, which comprises a sample of large boilers in the electricity industry for the years 2001 through 2008. Table 1 gives the number of CHP systems installed each year in the data. Since the data start in 2001, we are not able to determine the year CHP systems installed before 2001 are installed.

A conditional logistic probability model estimates the probability of CHP installation at a given plant depending on factors that influence the installation decision. These include partnership in CHPP, the main fuel consumed, plant size, electricity prices, location, state renewable portfolio standards (comparable to Renewable Obligation Certificates

Table 1: CHP installations by year



in the UK), and other support measures at the state level. This probability is estimated for each plant in each year on the condition that the given plant has not installed CHP in a previous period. As soon as a plant has installed, the observations for this plant are dropped from the data set as otherwise the installation decision will be re-evaluated by the model for the next year although the plant already adopted the technology. In this case the estimates would be biased.

The data contain over 2700 plants with almost 1000 of them having installed a CHP system at some point in the sample. As there may be selection bias in the choice of firms to join CHPP, the partnership decision was instrumented for using membership in other voluntary programs, firm size, and number of previous CHP systems installed at the firm. Partnership in CHPP is positively associated with installation, though statistical significance varies with the control variables included. Results also show that smaller coal plants and large gas plants are the most likely plants to install CHP. Higher electricity prices are also associated with installation of CHP systems. Surprisingly, state renewable portfolio standards are found to not statistically alter installation behavior.

Next, the data is analyzed to determine factors that lead to utilization of the CHP system. The model assumes that partnership in CHPP, state renewable portfolio standards, the main fuel consumed, plant size, electricity and fuel prices, and other controls explain utilization. Panel data methods are used since utilization is available for each year that a CHP system is in use.

The hypothesis for the improvement of utilization from knowledge transfers and spillovers due to the program is supported by the data. This utilization analysis, in comparison to the previous method, includes observations only for plants in the data set that have CHP installed. We find that the CHPP has a significant effect on the usage of CHP at partner institutions compared to non-partners. This effect decreases (relative to non-partners) the longer the firm is in the partnership. There could be a number of explanations for this, perhaps all firms learn more about their CHP system as they use it but the partner firms acquire this knowledge quicker than non-partner. At this point we do not know what the reason is for the convergence in utilization among firms. Other factors that also have an influence on the utilization and which serve as controls in the analysis include the following: Plant size, electricity price and state environmental portfolio standards have a positive and statistically significant effect on usage. On the other hand utilization of CHP is negatively affected by the deregulation of electricity markets. Finally, coal plants tend to use their systems more than oil or gas plants.

Voluntary programs which encourage the adoption and diffusion of clean energy technology are of great interest to policymakers. There are many ways to structure such programs, so it is important to consider pathways which lead to diffusion. The CHPP provides partners with information about the benefits of adopting CHP and then provides platforms for those interested to continue exchanging knowledge. Given this framework, two analyses are undertaken to determine whether CHPP has encouraged installation and utilization of the CHP systems in its partners. The findings are generally positive, though not always robust to alternative econometric models and specifications.

References

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