Expanding the Pool of Federal Policy Options to Promote Industrial Energy Efficiency

Marilyn A. Brown and Matt Cox, Georgia Institute of Technology
Roderick Jackson and Melissa V. Lapsa, Oak Ridge National Laboratory

ABSTRACT

Improving the energy efficiency of industry is essential for maintaining the viability of domestic manufacturing, especially in a world economy where production is shifting to low-cost, less regulated developing countries. Numerous studies have shown the potential for significant cost-effective energy-savings in U.S. industries, but the realization of this potential is hindered by regulatory, information, workforce, and financial obstacles. This report evaluates seven federal policy options aimed at improving the energy efficiency of industry, grounded in an understanding of industrial decision-making and the barriers to efficiency improvements. Detailed analysis employs the Georgia Institute of Technology's version of the National Energy Modeling System and spreadsheet calculations, generating a series of benefit/cost metrics spanning private and public costs and energy bill savings, as well as air pollution benefits and the social cost of carbon. Two of the policies would address regulatory hurdles (Output-Based Emissions Standards and a federal Energy Portfolio Standard with Combined Heat and Power); three would help to fill information gaps and workforce training needs (the Superior Energy Performance program, Implementation Support Services, and a Small Firm Energy Management program); and two would tackle financial barriers (Tax Lien Financing and Energy-Efficient Industrial Motor Rebates). The social benefit-cost ratios of these policies appear to be highly favorable based on a range of plausible assumptions. Each of the seven policy options has an appropriate federal role, broad applicability across industries, utilizes readily available technologies, and all are administratively feasible.

Introduction

Advanced technologies combined with manufacturing best practices offer significant potential to curb industry's energy consumption and greenhouse gases (GHG) emissions while becoming more competitive, but the realization of this potential has proven difficult. This report develops and evaluates a series of federal policy options, grounded in an understanding of industrial decision-making and the barriers impeding efficiency improvements. For further details on this analysis, a full report is available (Brown, et al., 2011).

The U.S. industrial sector presents a large and unique opportunity to promote a clean energy economy. It accounts for nearly one-third of total US energy consumption, including the direct combustion and conversion of a great deal of fossil fuels – 9 quads of petroleum products, 8 quads of natural gas, and 2 quads of coal (EIA, 2010b, Table A2). Large firms with more than 250 employees are responsible for about two-thirds of industry's energy consumption, but small and medium-sized manufacturing enterprises in aggregate consume more energy than many entire nations – such as South Korea, Mexico, and Australia (EIA, 2010a, Table A1). While chemical manufacturing, petroleum refining, pulp and paper, and iron and steel manufacturing dominate industrial energy use, the sector is diverse in terms of products, manufacturing processes, and business practices. This diversity promotes competition and innovation, but it also can complicate the process of transformation and modernization. A large body of literature suggests that most firms could cost-effectively reduce their energy use and carbon emissions.

A number of barriers to increasing investments in industrial energy efficiency help to explain the existence of a large energy-efficiency gap in U.S. industry (CCCSTI, 2009; Brown, Cortes, and Cox, 2010). A DOE "Workshop on Policy Options to Address Non-Technical Barriers to Increased Energy Efficiency in U.S. Industry" was held on September 30, 2009, in Washington, DC, to provide broad-based input for this research project. The workshop participants generated and rated a list of 34 specific non-technical barriers to advancing energy efficiency in industrial processes. Their results underscored the problems of capital rationing, efficiency as a non-core investment, lack of knowledge and specialized expertise, and utility disincentives. In addition, participants emphasized problems of overly layered permitting processes and new source review requirements under the Clean Air Act. The consensus views of workshop participants was assimilated with a literature review of key obstacles using a three-fold typology focused on financial, information/training, and regulatory barriers.

Drivers that could motivate industrial energy efficiency are also numerous. While the uncertainty of future energy costs is a deterrent to capital-intensive energy upgrades, firms can achieve greater financial stability through energy efficiency. In addition, pressure from shareholders, consumers, regulators, and internal actors to set and attain sustainability and environmental goals encourages action (National Academies, 2009). Furthermore, efficiency helps American business to remain competitive in the global marketplace.

Selection of Policy Options

To arrive at the seven policy options for analysis presented in this paper, the research team established eight evaluation criteria:

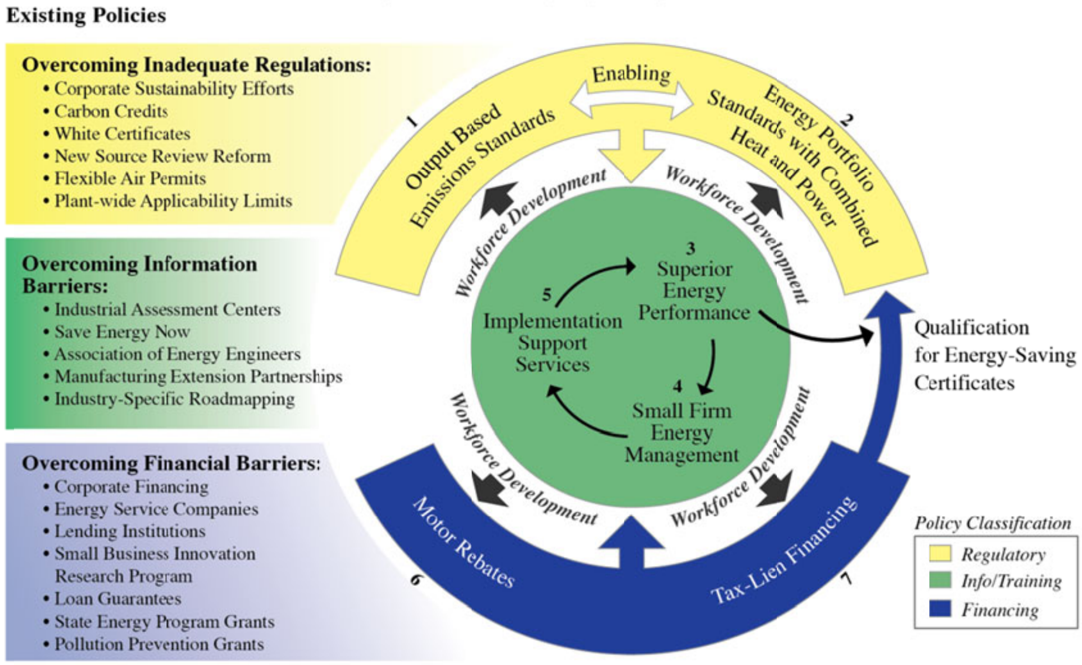
- **Appropriateness of the federal role**. The policy must clearly define an appropriate federal role, one that does not pre-empt state or local action.
- **Broad applicability**. Since the number of proposed policy options and measures to be analyzed is small, but the desired impact is large, those policy options selected for analysis should be as broadly applicable as possible.
- **Significant potential benefits**. Those options that produce large benefits should be favored over those producing fewer benefits.
- **Technology readiness**. The policy options selected should address barriers and/or risks of mainly an institutional, policy, or non-technical nature.
- **Cost effectiveness.** In selecting policies to study, consideration should be limited to those that would be expected to have reasonable costs, a strong social benefit, and a relatively high benefit-to-cost ratio.
- **Administrative feasibility**. Policies selected should be fairly easy to implement, manage, and enforce. Some may require training a large workforce for implementation, while others may be able to focus training on limited players within the delivery system. The latter is obviously more desirable.
- **Additionality**. The selected policy options should each represent different approaches to barriers or to different market segments. Each policy option should be evaluated in terms of the independent contribution it could make above and beyond existing policies.

- **Potential for rapid implementation**. Preference should be given to policies that can deliver benefits rapidly.

The researchers met with stakeholders from government, industry, and other relevant sectors, consulted the academic and industry literature, and examined legislative actions to provide insights into the political feasibility of various federal policy options.

Figure 1 shows the seven analyzed policy options that passed the initial screening based on the eight evaluation criteria. The figure reflects the fact that any new policy initiatives must be integrated into the landscape of policies and programs that are already in place (illustrated by the left-hand boxes). The numerous arrows and linkages in this figure highlight the portfolio nature of the seven policies.

Figure 1. Policy Synergies



Policy Summaries

The seven policy options under consideration include two that would address federal and state regulatory hurdles that limit the opportunities for firms to invest in efficiency and, in particular, energy-saving combined heat and power (CHP) systems.

Output-Based Emissions Standards (OBES) would provide financial incentives and technical assistance to states to spur adoption of OBES – as authorized by the EPA – to reduce energy consumption, emissions of criteria air pollutants and GHG, and regulatory burdens. This program would not require any new authority for DOE, as it would use authorities and criteria of the State Energy Program to achieve this regulatory change. Several states have already implemented variants of these standards within their jurisdictions, and a national effort could lead to widespread cogeneration at factories and large facilities over the near and long terms.

A *Federal Energy Portfolio Standard with CHP* would require federal legislation that mandates electric distributors to meet an EPS with CHP as an eligible resource and to extend and expand the current investment tax credits for CHP. Such standards exist in several states, and EPS proposals have been considered in several bills before Congress. This policy option would concurrently establish measurement and verification methods for qualifying CHP resources and encourage a national market for trading energy-efficiency credits.

Three of the policy options would help fill information gaps and workforce training needs in industry, targeting small, medium, and large firms:

Incentives to promote the adoption of the *Superior Energy Performance (SEP)* program would facilitate a broader market penetration of energy management systems that foster continual improvement in the energy efficiency of industrial facilities. Incentives would include 1) a federal production tax credit for energy-efficiency savings of facilities that become SEP certified; 2) the ability of verified energy savings to be counted as an energy-efficiency credit in compliance with meeting energy-efficiency or renewable energy portfolio requirements; 3) an energy-efficiency grant for 30% of eligible certification costs; and 4) recognition programs. DOE, universities, and private sector partners are already laying the groundwork toward adoption of SEP, but a committed federal policy could lead to cultural changes and market transformation for facilities and service providers, particularly at large firms.

Implementation Support Services (ISS) would work with existing Industrial Assessment Centers (IAC) to increase the implementation of energy-saving opportunities identified in IAC energy audits. ISS would foster higher implementation rates by leveraging existing relationships between industrial facilities, financial institutions, and engineering firms. Providing this level of technical and business support subsequent to initial IAC energy assessments would not only generate additional energy savings, but would also facilitate the workforce development of undergraduate business students with an understanding and appreciation of energy management. This policy option would necessitate an increase in the funding level of the IAC program to permit additional energy assessments at industrial facilities.

Small Firm Energy Management would provide small manufacturing firms (five to 49 employees) with energy management software tools to build in-house capacity to manage energy use and identify potential energy savings opportunities, and potentially qualify small firms to be part of IAC assessments. Current ITP programs provide few services and programs tailored to the needs of these important manufacturing enterprises, which are often the crucible of innovation and economic growth. While addressing only a small-percentage of industrial sector energy use, this cost-effective program would allow these small businesses without in-house capacity to reduce their energy bills and carbon footprints, thereby improving their economic viability. Establishment of this program would require Congressional appropriation of DOE funding.

The final two policies would tackle financial barriers, as they provide new opportunities for capital for energy-efficient systems, equipment and operations.

Tax Lien Financing of industrial energy-efficiency improvements**,** also known as Property Assessed Clean Energy (PACE) financing, would require federal legislation to enable municipalities to establish clean energy taxation districts, which can issue tax-free bonds for certified energy-efficiency and alternative energy projects. To address the risk of firm closures (particularly during economic recessions), DOE would offer federal loan guarantees to provide security for the bond purchasers and provide a standardized format for the application process. Municipalities have established PACE financing within their communities; however, the industrial sector has not yet been able to participate in these beneficial programs that would help increase access to capital for energy efficiency projects.

The *Energy Efficient Industrial Motor Rebates***,** similar to recent legislative proposals, would authorize and appropriate funding for the DOE to implement a program to provide industrial firms and motor manufactures with rebates for purchases of certified high-efficiency motors of 25 to 500 horsepower that replace motors that predate the Energy Policy Act of 1992. The goal is to accelerate adoption of the Energy Independence and Security Act of 2007 standard motors. DOE would give priority and additional technical assistance to companies that include motor upgrades as part of a system-wide optimization of their facilities and promote further efficiency measures.

Quantitative Policy Analysis

The seven policies as a whole are designed to complement one another in order to achieve maximum savings, but each is also evaluated individually to determine if it could produce significant and cost-effective energy savings and carbon emissions reductions, if implemented on its own. Spreadsheet analysis is the principal evaluative tool, supplemented by Georgia Tech's version of the NEMS, which was used to evaluate OBES and EPS with CHP. The *Annual Energy Outlook* (EIA, 2010b) reference case forecasts the industrial fuel consumption of the nation by energy sources out to 2035. Investments stimulated from each policy are assumed to begin in 2011 and to occur through 2035 (or shorter in the case of the Industrial Motor Rebate program, which is a short-term "stimulus" policy). Energy savings are then modeled to degrade at a rate of 5% after 2035, such that all benefits from the policy have ended by 2055.

The *AEO 2010* also provides estimates of the carbon intensity of electricity generation based on generation resources over time. The CO_2 intensities of various types of combustion fuels used in industry were derived from the EPA (2007). The benefit of reduced CO_2 emissions are estimated by subtracting the emissions in the reference case from the policy scenario and then multiplying by the social cost of carbon, an estimate of the damages caused by a ton of CO_2 in a given year. The social cost of carbon used in this analysis is the central value of the U.S. Government Interagency Working Group of the Social Cost of Carbon (EPA, 2010), which range from $23/metric ton in 2011 to $47/metric ton in 2050 (in $2008).

The public health and environmental benefits of reduced emissions of criteria pollutants are estimated using the damage estimates contained in a recent National Research Council report (NRC, 2010). This analysis excludes climate change, mercury, ecosystem impacts, and other environmental damages, but does include public health and crop damages, for example. Damage estimates are provided for SO_2, NO_x, $PM_{2.5}$, and PM_{10}. For this analysis, emissions from the electricity sector and from industrial heat production are included and the policy scenarios are compared to the *AEO 2010* reference case.

Policy Evaluation from the Private and Societal Perspectives

Each of the policies is first evaluated from a private-sector, industrialist's perspective to assess the business case for the required private-sector leverage. Without a sufficient motivation to invest private capital, the industrial policy options will not achieve their goals. While a detailed financial analysis of each policy was not feasible, assessing the up-front private-sector investment costs relative to the stream of energy-expenditure reductions provides a basis for approximating the overall cash-flow attractiveness of the policy to industrialists. Present-value calculations for the private-sector assessment were conducted using a 7% discount rate to be consistent with Office of Management and Budget guidelines (OMB, 2002; 2009), which recommend the use of 3% and 7% discount rates when evaluating regulatory proposals. Our use of a 7% discount rate for evaluating the private industrialist's perspective is less than the 10% value used in some other studies such as McKinsey and Company's analysis (Granade, et al., 2009).

The policies are then evaluated in terms of their net societal benefits and their total social benefit-cost ratios. On the benefits side of the metrics we include monetized energy savings, CO_2 mitigation, and reductions of criteria air pollutants; on the costs side, we include both the private investments required as well as the public investments and administrative costs. Different benefit-cost ratios use different combinations of benefits and costs, depending on the purpose of the analysis. Present value calculations for the societal benefit-cost analysis were conducted using a 3% discount rate, with a 7% rate used in sensitivity analyses, consistent with Office of Management and Budget guidelines (OMB, 2002; 2009).

Additional sensitivities are conducted to evaluate uncertainties surrounding participation rates, free ridership, levels and timing of public subsidies, and rates of energy saving. For example, we evaluate an EPS supported by an investment tax credit that operates for 25 years (in the principal policy) but consider a 10-year duration in a sensitivity analysis. In addition, we evaluate the difference between assuming a rate of penetration of 60% versus 40% of recommended measures by small firms participating in the SFEM program. The energy saved by free riders, who would have adopted these programs without the supporting policies, are not included in the benefit totals, but they do impact the public costs when subsidies are provided to such firms. Benefits of the seven policies are also not additive, as they can both overlap in addressing identical markets and opportunities, and they also can work synergistically, producing more benefits when one policy enables another, as happens with workforce development programs. Cost effectiveness also involves assessing the overall public costs of each policy and the ability of these public investments to leverage energy savings and carbon dioxide emission reductions. The focus on overall government costs is particularly important given current concerns regarding public deficits and the desire to constrain government spending. In addition we estimate the extent of government leveraging by calculating the ratio of public costs to the TBtu of energy saved and the ratio of public costs to metric tons of avoided CO_2.

Finally, a stakeholder assessment is conducted for each of the policies to identify the principal organizations that would likely advocate for their creation and those groups that would represent the greatest opposition. Critical stakeholder analysis provides many important benefit such as revealing power asymmetries between stakeholders, making stakeholder and their power relations more visible, promoting a common understanding of key agendas, and identifying zero sum tradeoffs and incommensurable views among stakeholders that must be resolved before consensus about a policy option can occur (Brown and Sovacool, 2001, Chapter 6).

Private-Sector Perspective

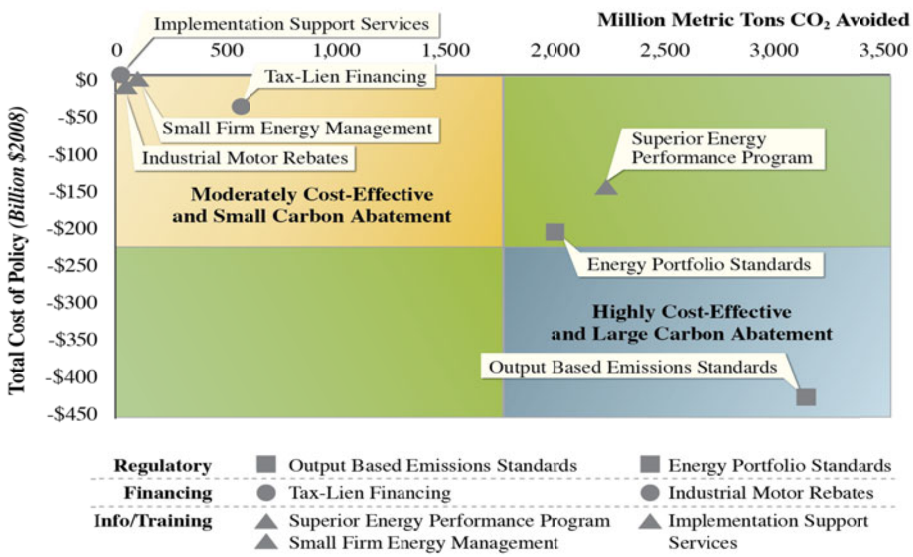
Comparing the present value of up-front private-sector investment costs with the present value of the stream of energy-expenditure reductions suggests that each of the policies would be attractive to industrialists. OBES offer the largest present value of energy savings ($223 billion through 2055) relative to the associated private investment of $23 billion. It also has the largest private benefit-cost ratio. In contrast, the Industrial Motor Rebates program saves manufacturers

$908 million in energy savings, but it requires a private investment that is nearly as large, at $210 million. Thus, it has the smallest net present value to industrialists and also the smallest private benefit-cost ratio.

Societal Perspective

Figure 2 compares the net total cost of each policy with the million metric tons of CO_2 avoided over the same timeframe. For this chart, we calculated net total costs by subtracting the present value of the energy savings from the present value of the private and public costs. We do not include the value of local pollution abatement, similar to Granade, et al. (2009). The result for each of the seven policies is a negative net total cost, meaning that the present value of the energy savings benefits exceed the present value of the private and public costs.

Figure 2. Net Costs and Carbon Abatement From Seven Industrial Energy-Efficiency Policies*



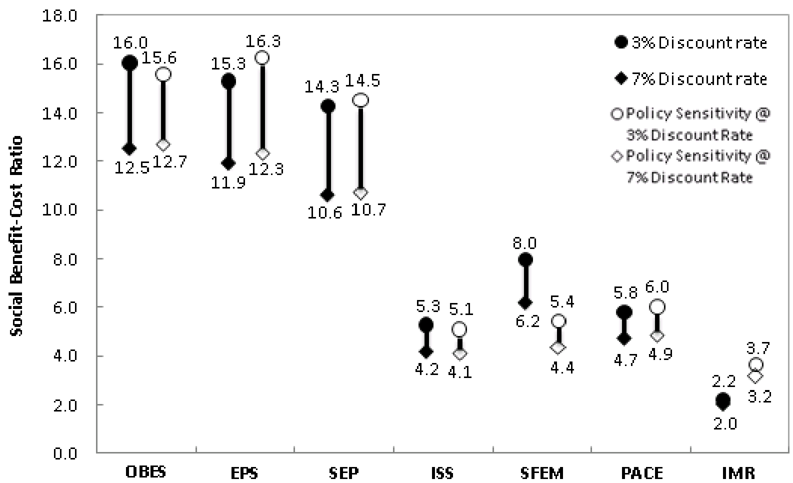
* "Total Cost of Policy" refers to the present value of cumulative private and public investment and administrative costs minus the present value of cumulative energy savings.

Four of the seven policies are situated in the upper left-hand quadrant, characterized by small carbon abatement impacts (ranging from 4 to 566 million metric tons of CO_2 abated over the 2011-2055 evaluation period) and modest cost-effectiveness (ranging from $1 to $37 billion of negative costs). At the other extreme, OBES is the only policy that is situated in the lower right-hand quadrant described as highly cost-effective (at $424 billion of negative costs) with large carbon abatement (more than 3,000 million metric tons of CO_2). The remaining two policies (Superior Energy Performance and Energy Portfolio Standards with CHP) offer large carbon abatement (1,990 to 2,230 million metric tons of CO_2), but they are only moderately cost-effective (at $146 to $206 billion of negative costs).

Social Benefit-Cost Ratios

The social benefit-cost ratios of these policies are highly favorable when one considers the avoided damages from CO_2 emissions and criteria pollutants. To emphasize the variable results produced by different sensitivity analyses, Figure 3 shows a range of four benefit-cost ratios for each of the seven studies. These include sensitivities around discount rates (three versus seven percent), key policy features (e.g., the duration of subsidies in the energy portfolio standard), and variable assumptions about impacts and participation rates (e.g., a five-year versus a 10-year adoption period for Output-Based Emissions Standards). In each case, benefits include the social cost of carbon abatement and reduced criteria pollution.

Figure 3. Social Benefit-Cost Ratios for Each Policy and its Sensitivities



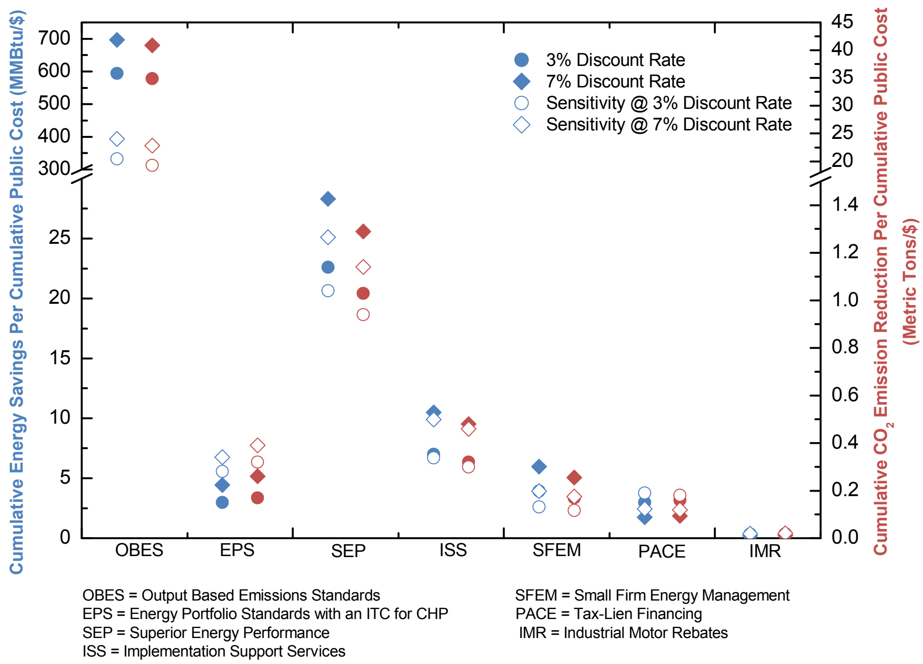
OBES = Output Based Emissions Standards
EPS = Energy Portfolio Standards with an ITC for CHP
SEP = Superior Energy Performance
ISS= Implementation Support Services
SFEM = Small Firm Energy Management
PACE = Tax-Lien Financing
IMR = Industrial Motor Rebates

The results show that the benefits of each of these policies would likely outweigh their costs of implementation, even in the scenario with the higher discounting of energy savings over time and the less favorable assumptions about policy design and participation. The Industrial Motor Rebate policy has the lowest social benefit-cost ratios (ranging from 2.0 to 3.7). At the other extreme, the OBES and EPS with CHP have the highest ratios (both ranging from 12 to 16).

Leveraging Ratios

Each policy offers a significant amount of leveraging in terms of saved energy per public costs and the ratio of avoided CO_2 emissions per public cost. OBES has the highest leveraging ratios for both energy saved and CO_2 displaced; a public dollar spent on OBES, for example, would generate nearly 600 MBtu of cumulative saved energy. The SEP program also offers substantial public leveraging of energy savings and CO_2 mitigation, with the second highest ratios. The leveraging ratios are smallest for PACE and the industrial motor rebate program, with ratios for CO_2 ranging from 0.01 to 0.16 metric tons of cumulative CO_2 avoided per public dollar invested (Figure 4).

Figure 4. Leveraging Ratios: Energy Savings and CO_2 Emissions Reductions Per Public Dollar Invested



Stakeholder Analysis

The direct beneficiaries of these policies – the industrial firms and companies that will provide equipment and support the upgrades – are all likely to strongly favor their creation. The public sector stakeholders should also find their improved role in supporting industrial energy efficiency to be consistent with their civic-minded goals. The general public may not support the upfront financial burden of some of these efforts, but they will receive long-term economic and environmental benefits from implementation. Environmentalists will likely support the reduction in greenhouse gas and criteria pollutant emissions, although they may have some reservations about regulatory changes, particularly amending the Clean Air Act to legislate OBES.

The utility sector will have mixed views of these policy options, because they could negatively impact the profits of many electric utilities, particularly in the 40 states without decoupling. Even in decoupled states (where profits are not coupled only to the retail sales of energy), these federal efforts may cut into utility revenues: they will be selling less energy to industrial customers and may not be able to act in providing them the efficiency services that could offer a return on the utility's investment. Utilities with good management and "modern" business models have moved into energy-efficiency services as a revenue part of their business – partly in response to regulatory pressure but also from recognition that energy-efficiency services can be "good business."

The outlook will vary for each policy option based on the utility's ownership (investor-owned or public), primary fuel supply (natural gas utilities will support CHP policies, which would expand their market share), expected load growth and need for capacity expansion (some utilities may prefer the economics of avoiding construction of new generation due to lower load growth, while others may be seeking the opportunity to build), and state regulatory environment. Distributed generation through CHP may be viewed with particular skepticism by electric utilities, as they will not receive revenue from grid sales, but natural gas retailers could see an expansion of demand for gas-generated cogeneration systems. On the other hand, utilities may also see benefits in supporting industry and helping energy-intensive companies in their service territory become more competitive and expand their levels of production through these policies.

Summary Assessment of Policy Options

Each of these seven policy options has an appropriate federal role, broad applicability across industries, utilize readily available technologies (or new technologies that will be available over the course of the implementation period), are administratively feasible, and have additionality and synergy with other efforts. Other strengths are the market transformation impact of the Superior Energy Performance program, the development of information technology products for Small Firm Energy Management, and the additionality of Tax Lien Financing. While Output-Based Emissions Standards have a narrow focus on a single technology (CHP), a federal Energy Portfolio Standard might have many free riders. While the Industrial Motor Rebates have relatively high public costs, their benefits nevertheless exceed their costs under a range of plausible assumptions, including assumed market and stakeholder responses. A generalized stakeholder assessment indicates that industrial firms, service providers, and others would support these policy options, while utilities, which might experience revenue erosion, would find them unfavorable.

A more complete analysis of the impacts of industrial energy-efficiency investments might increase the social benefit-cost ratios of these policies. There is a growing literature that documents several categories of "non-energy" financial benefits including reduced operating and maintenance costs, improved process controls, increased amenities or other conveniences, water savings and waste minimization, and direct and indirect economic benefits from downsizing or elimination of other equipment (Prindle, 2010). On the other hand, the avoidance of environmental damages that contributes to the high societal benefit-cost ratios of these seven policies could be overstated if EPA regulations are tightened over the next several decades and if a price is put on the cost of carbon.

Conclusions

The energy-efficiency gap in the U.S. industrial sector is large. Our analysis suggests that policies could help motivate businesses to focus more of their resources on lean energy systems. The seven federal policy options evaluated here would require sustained public commitment and resources, and their success would require substantial capital, time, and effort by industrial facilities. These seven policies would bring expansive benefits to all regions of the country, but would have the greatest impact in manufacturing-heavy regions, such as the South and Midwest where energy-intensive industrial activity is concentrated. With the right policy environment, industry could shrink its energy-efficiency gap and become a bigger part of the climate solution while at the same time strengthening its competitiveness. These are not the only means to build a low-carbon industrial sector, but the detailed analysis using rigorous and fully documented analytic methods show that this portfolio offers a significant opportunity for policy-makers to help industry reduce their consumption of energy resources, become more competitive, and protect the environment.

Acknowledgments

Support for this research was provided by the Department of Energy's Office of Policy and International Affairs, Climate Change Policy and Technology Program. Assistance with the analysis of the Small Firm Energy Management program was provided by Rodrigo Cortes, and assistance with the analysis of Industrial Motor Rebates was provided by Ben Deitchman, both from the Georgia Institute of Technology.

References

Brown, Marilyn A. and Benjamin K. Sovacool. 2011. *Climate Change and Global Energy Security:Technology and Policy Options* (MIT Press).

Brown, Marilyn A., Roderick Jackson, Matt Cox, Rodrigo Cortes, Benjamin Deitchman, and Melissa V. Lapsa. 2011. *Making Industry Part of the Climate Solution: Policy Options to Promote Energy Efficiency.* Oak Ridge National Laboratory, ORNL/TM-2010/78, May. http://www.ornl.gov/sci/eere/publications.shtml

Brown, Marilyn A., Rodrigo Cortes-Lobos and Matthew Cox. 2010. "Reinventing Industrial Energy Use in a Resource-Constrained World" in Fereidoon Sioshansi (ed.) *Smart Living in the Coming Age of Scarcity*. Maryland Heights, MO: Elsevier Press: Chapter 8.

Brown, Marilyn A., Jess Chandler, Melissa V. Lapsa, and Benjamin K. Sovacool. 2008. *Carbon Lock-In: Barriers to Deploying Climate Change Mitigation Technologies*, Oak Ridge National Laboratory, ORNL/TM-2007/124. http://www.ornl.gov/sci/eere/publications.shtml

Committee on Climate Change Science and Technology Integration (CCCSTI). 2009. *Strategies for the Commercialization and Deployment of Greenhouse Gas Intensity-Reducing Technologies and Practices*. Washington, DC: U.S. Department of Energy, DOE/PI-0007. http://www.climatetechnology.gov/Strategy-Intensity-Reducing-Technologies.pdf

Energy Information Administration. 2010a. *International Energy Outlook 2009.* http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2010).pdf

Energy Information Administration (EIA). 2010b. *Annual Energy Outlook 2010.* http://www.eia.doe.gov/oiaf/aeo/index.html

Granade, Hannah Choi, Jon Creyts, Anton Derkach, Philip Farese, Scott Nyquist, and Ken Ostrowski. 2009. "Unlocking energy efficiency in the U.S. Economy." McKinsey & Company, http://www.mckinsey.com/clientservice/electricpowernaturalgas/downloads/US_energy_efficiency_full_report.pdf.

National Academies. 2009. *Real Prospect for Energy Efficiency in the United States.* Washington, DC: The National Academies Press.

National Research Council. 2009. *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use.* Washington, DC: The National Academies Press.

Office of Management and Budget (OMB). 2002. *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (http://www.whitehouse.gov/omb/rewrite/circulars/a094/a094.html).

Office of Management and Budget (OMB). 2009. *2010 Discount Rates for OMB Circular No. A-94,* December 8 http://www.whitehouse.gov/omb/assets/memoranda_2010/m10-07.pdf

Prindle, Bill. 2010. *From Shop Floor to Top Floor: Best Business Practices in Energy Efficiency.* Washington, DC: Pew Center.

U.S. Environmental Protection Agency (EPA). 2007. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2001. Annex B. Washington, DC: U.S. EPA. http://www.eia.doe.gov/oiaf/1605/coefficients.html

U.S. Environmental Protection Agency (EPA). 2010. *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866.* http://www.epa.gov/otaq/climate/regulations/scc-tsd.pdf