Industrial Electric Productivity: Myths, Barriers & Solutions

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ABSTRACT

There is an enormous gap in the electric productivity of the nation. If the country achieved the normalized industrial electric productivity of the top ten performing states, the U.S. would save 300,000 gigawatt-hours (GWh) each year, over the lifetime of the efficiency measures. This is the equivalent of 8% of all electric retail sales.

Increasing industrial electric productivity is a significant near-term opportunity that can reduce electricity costs, carbon dioxide emissions per unit of output, and increase profits. RMI believes that increasing industrial electric productivity is an untapped source of value, and is important to the longevity of industry in the United States.

While factors exogenous to industry play a role in shaping electricity productivity, RMI believes it is more important to identify and overcome key and common barriers that constrain business' ability to economically improve electric efficiency. Using three case studies, we provide details about how diverse industrial companies- high technology, oil and gas, and food production and distribution—have recognized and captured large efficiency opportunities despite these barriers.

Finally, society, as well as industry, must re-think how industrial energy efficiency is valued, and what the appropriate incentives should be. There are a number of policies that can aid industrial companies in overcoming barriers to increased efficiency, such as access to low cost financing, and education on holistic design address energy efficiency opportunities.

Electric Productivity and Energy Efficiency

RMI's analysis has found that the national average electric productivity is approximately $3.80 GDP/kWh, while the average of the leading ten states is $6.10 GDP/kWh (RMI 2009).[1] Closing this gap will save over 1.2 million GWh, or approximately 30 percent of national electricity use. This is the equivalent of over 60 percent of coal-fired generation output in the U.S.

The focus of the overall electric productivity research was whether the gap can be closed through aggressive use of energy efficiency, while maintaining a 2.5 percent annual growth in GDP. (One way to increase productivity is to focus on efficiency to achieve more throughput for the same unit of energy.) The analysis indicates that all sectors – residential, commercial and industrial can achieve significant electricity savings and that the U.S. can close the electric productivity gap.

In this paper we investigate reasons for the productivity gap in the industrial sector and actions needed close it. While we believe there are a myriad of potential factors that could help close the gap, our analysis, and more than 25 years of experience, suggest that there are compelling reasons to believe that industry, itself, is best placed to drive improved electric

[1] For more information on RMI's electric productivity report, please see the full-length report and interactive electric productivity website available at: www.ert.rmi.org

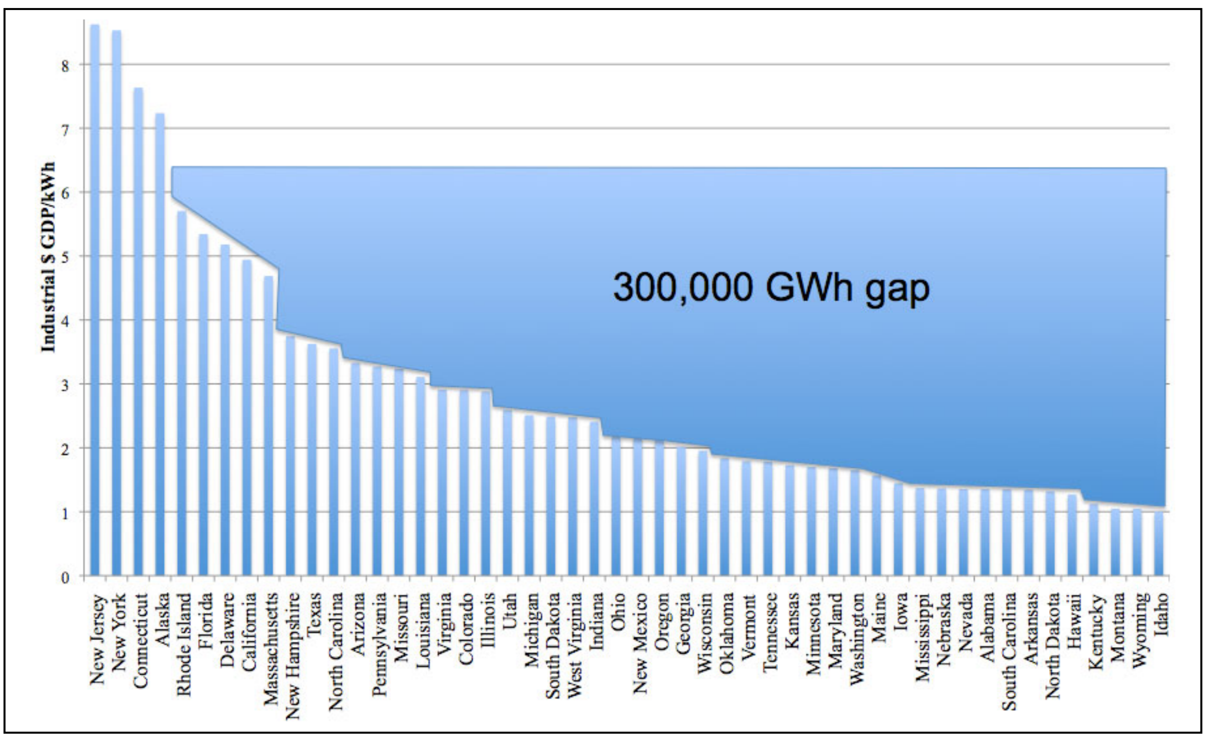
productivity by overcoming longstanding barriers to improved efficiency. In the remainder of this paper we:

- Size the industrial electric productivity gap and show that improvement in a few key areas could yield significant efficiency results;
- Suggest that differences across states, such as electricity price, incentives and industrial mix may account for part of the gap, but likely only play an enabling role in why the gap exists;
- Summarize our experience on the root cause barriers to better industrial electrical efficiency;
- Provide case studies based on our work in several industrial sectors that reinforce the need to tackle efficiency barriers by revamping the way that industries design and build new facilities and processes or retrofit existing facilities;
- Summarize the implications and actions needed for both industry leadership and policy makers in order to rapidly and economically close the gap.

Sizing the Prize: The Industrial Electric Productivity Potential

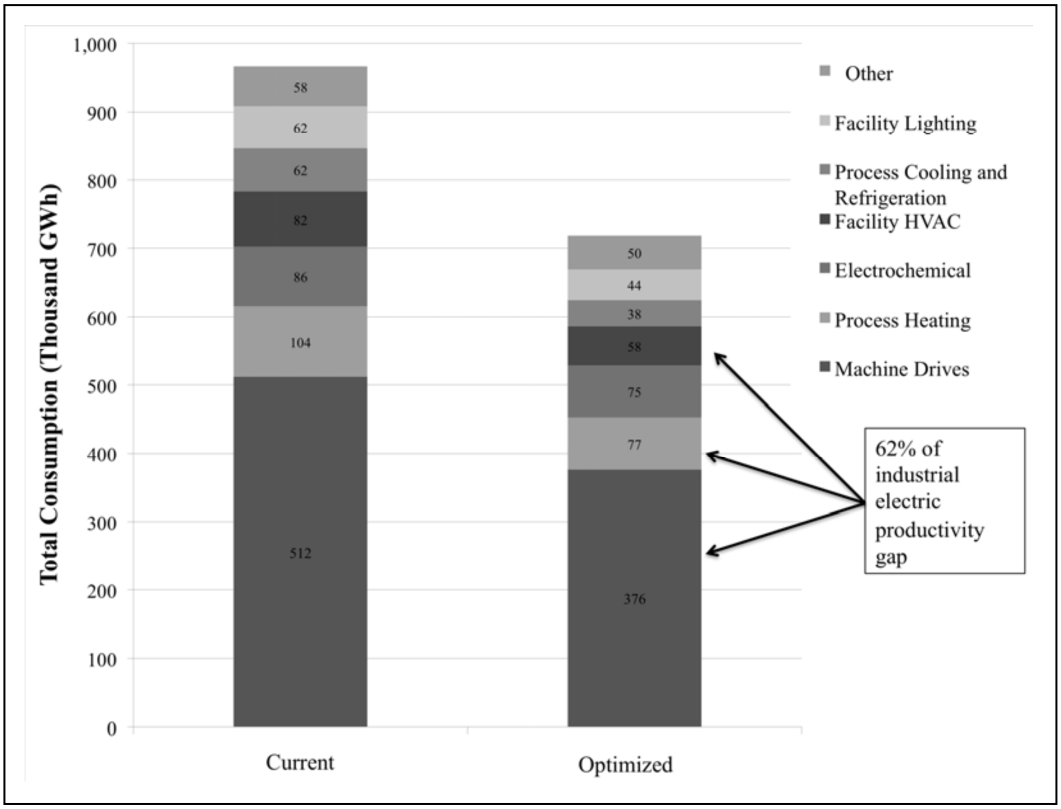
Figure 1 ranks industrial electric productivity (IEP) by state and indicates that the existing industrial sector could save 300,000 GWh, or eight percent of all electric retail sales in the U.S.

Figure 1. Industrial Electric Productivity State Rankings after Adjustments



In Figure 2 we show that improving the efficiency in three of the largest electricity end uses (machine drives, process heating and facility HVAC), would tackle 62% of the industrial electric productivity opportunity. This is the equivalent of over 7 % of total U.S. electricity use. However, because these end use efficiency measures are well known opportunities, it is important to assess why the gap exists between states and to determine what approaches can help close it.

Figure 2. Estimated Savings by End-use for Existing Manufacturing Facilities



Sources: ACEEE 2009; IWG 2000; Optimal Energy 2003; SWEEP 2002; RMI Analysis 2009

Exogenous Factors: A Critical Role in Closing the Gap?

In general, RMI believes that exogenous factors can affect electric productivity. However, because industry has an economic benefit from efficiency, these exogenous factors only play a part in both creating and closing the gap. Consider the following three factors:

- **Energy efficiency programs and incentives:** There are over 700 U.S. programs that provide incentives for industrial efficiency, but the top performing IEP states do not, in general, have more efficiency programs than lower performing IEP states.
- **Energy intensive industrial sectors:** While it would be rational to assume that states that have a higher proportion of electric intensive industries would suffer a "productivity penalty," our analysis shows that this is not true. Many of the top performing IEP states have above average amounts of electric intensive industry as compared to the U.S. average, as shown in Figure 3. For example, both New York and Connecticut have higher quantities of intensive industry than the national average, but rank in the top 10 states for IEP.

- **Industrial Electricity Price:** It comes as no surprise that there is a correlation between electrical productivity and the price of electricity, but as shown in Figure 4, there is dispersion in the data; still, states with similar prices can have varying productivities. The fact that productivity can vary widely despite similar pricing illustrates that states can achieve relatively high industrial electricity pricing despite low electricity rates. Given the record of what some states, utilities, and industries have been able to achieve, we strongly believe that improving productivity is possible without large rate increases.

Figure 3. Comparison of Industrial Electricity Composition for Top Performing States and the National Average

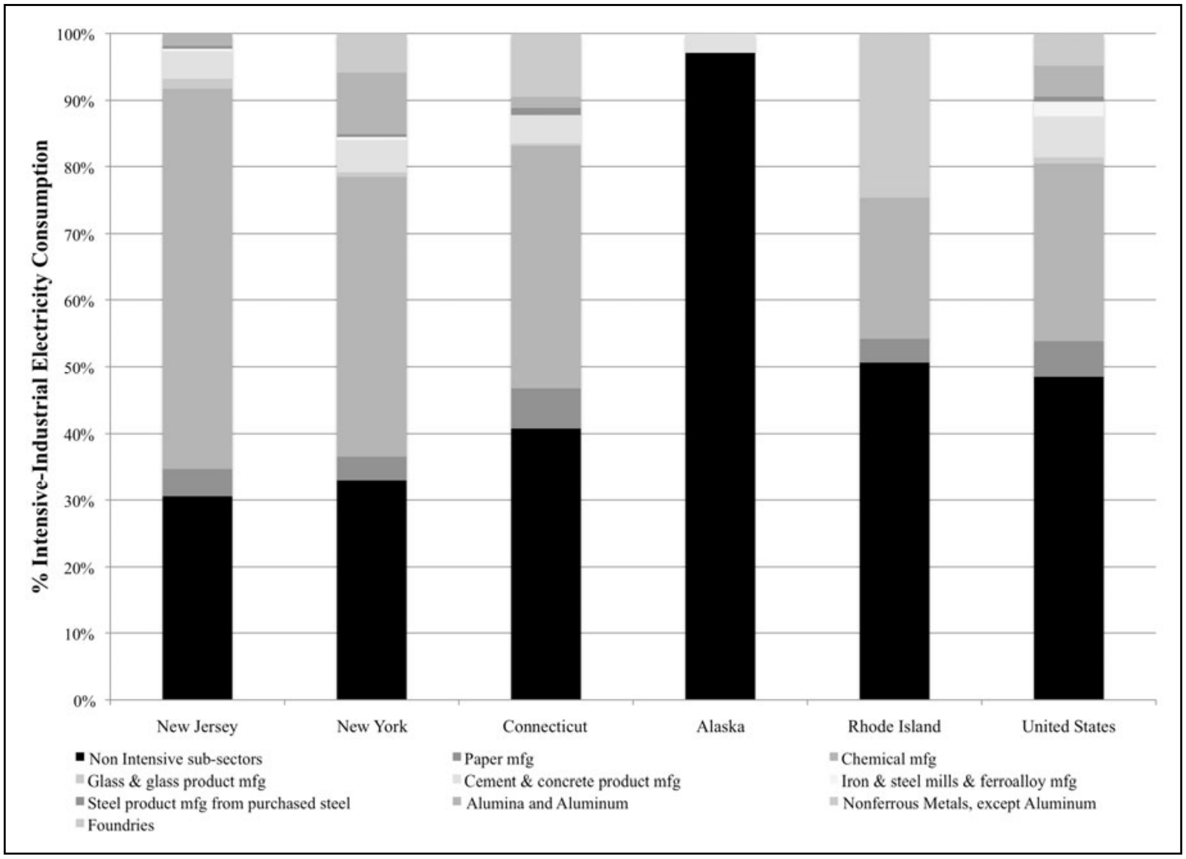
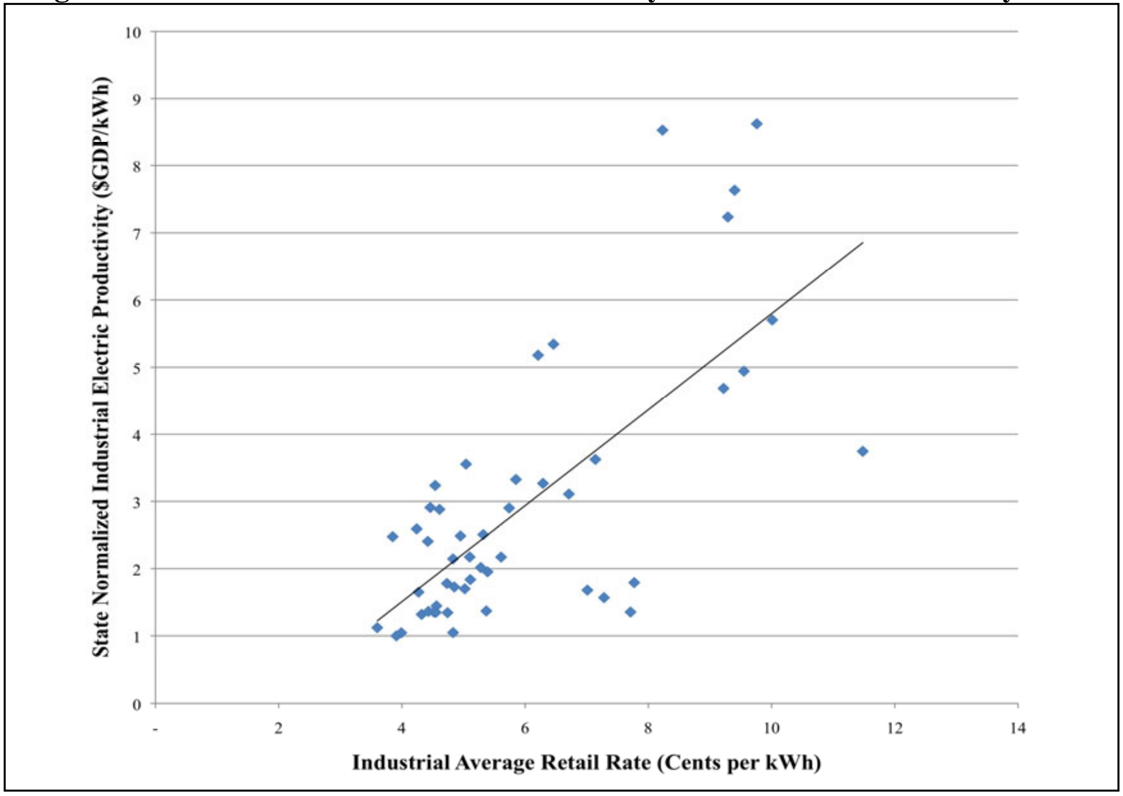


Figure 4. State Industrial Electric Productivity and Industrial Electricity Price



Endogenous Factors: Internal Barriers to Industrial Efficiency

While we do believe that factors exogenous to industry play a role in shaping electricity productivity, RMI believes it is more important to identify key and common barriers that constrain business' ability to economically improve electric efficiency. Doing so can have multiple and potentially compounding affects:

- Once the barriers are identified, tailored approaches to overcome root causes can be implemented by individual businesses;
- States can create supporting and enabling programs to specifically aid businesses in addressing the barriers;
- Where barriers are widespread and common, it may be possible to efficiently scale the solutions across sectors.

Through RMI's extensive work on energy and process efficiency in a variety of industries, we have identified barriers we commonly encounter in both existing and new facilities.

Common Barriers to Industrial Efficiency for Greenfield Sites

- **Poor understanding of the efficiency potential**: In numerous instances we have found that businesses begin to design a new process and facility without a clear understanding of the gap between current energy requirements and those that are theoretically and technically possible. This situation arises for several reasons including: mindset ("why bother to size a theoretical gap since we must deal with reality?"); lack of interest ("it won't make much difference anyway…"); time pressure ("we have to meet time and budget targets"); and lack of skill ("the problem is far too messy").

- **Lack of clear targets and incentives:** All too often we find that companies have clear targets for costs, timelines, process specifications, but have failed to apply the same rigor to energy and resource efficiency. This often arises because companies have not sized the potential as described above. If targets were established, the company would have a credible basis upon which to task internal resources, and external design and build firms, to meet challenging reductions in energy use at economically attractive costs.
- **Fossilized design paradigms:** Unless senior managers are armed with a gap analysis and credible targets, pushing their internal and external designers to achieve truly innovative designs will likely be difficult. Typically, there is a tendency to dust off proven approaches and tailor them to the new assignment. This natural tendency to make incremental improvements arises from a combination of time and cost pressures and an aversion to the perceived risks associated with real innovation.
- **Piecemeal solutions:** While the world is full of those who talk about "system solutions," in reality, complex projects are rapidly broken into smaller parts and assigned to experts in respective areas. In principle, the pieces are meant to be knit back together to create an optimized solution. In practice, we have found that far too little time is allocated for a "whole system view" in which multiple iterations between design teams allows for real system optimization. When such exercises do occur they are often hampered by fossilized design paradigms as teams struggle to create new solutions under tight deadlines.
- **Capital Constraints:** Companies can encounter several pitfalls as they consider capital allocations for new facilities. They may take a "first cost" view that eliminates efficiency opportunities that have substantial long-term returns. Even when fully accounting for near and long term cost ("levelized costs"), the project may run into financial difficulties depending on how the company manages its debt and cash flows. In addition, even companies with a long-term commitment to efficiency may "value-engineer" out the cost-effective efficiency measures during the detailed design and build phases to meet near term budget pressures.
- **Split Incentives:** Even when companies do design for efficiency, they can still be let down by their major equipment suppliers who are also trying to meet their own cost and time targets. Unless specifically tasked to do so, suppliers often do not build equipment to provide the lowest levelized costs as they are only responsible for meeting process specifications and capital budgets.

Additional Barriers to Industrial Efficiency in Existing Facilities

The barriers outlined above also plague the retrofit of existing facilities, but the challenges are heightened by several factors:

- Existing equipment and facilities may need to be scrapped or significantly redesigned while they still have useful operating life. Doing so may impose untenable costs to goods or services.

- Major retrofits may reduce the facility's productivity, thereby reducing margins and potentially jeopardizing customer relationships.
- Focusing on current operations may prevent the appropriate allocation of skilled resources to tackle longer-term efficiency opportunities.
- Compartmentalized functions in a facility may hamper the ability to capture opportunities requiring the interaction and agreement of multiple stakeholder groups.

Our experience suggests that these barriers are widespread and cross sector boundaries. In the next section, we illustrate their impact and outline solutions that have allowed companies to capture significant value while reducing their electrical, general energy and resource needs.

Capturing the Opportunity: Case Studies in Diverse Sectors

While it is important to understand the generic barriers that prevent companies from enjoying the competitive benefits of electrical efficiency, we have found that a powerful catalyst for change is to tackle these barriers in "field tests" with real companies. Below, we outline three case studies to provide details about how diverse industrial companies-—high technology, oil and gas, and food production and distribution—have recognized and captured large efficiency opportunities.

High Technology Companies

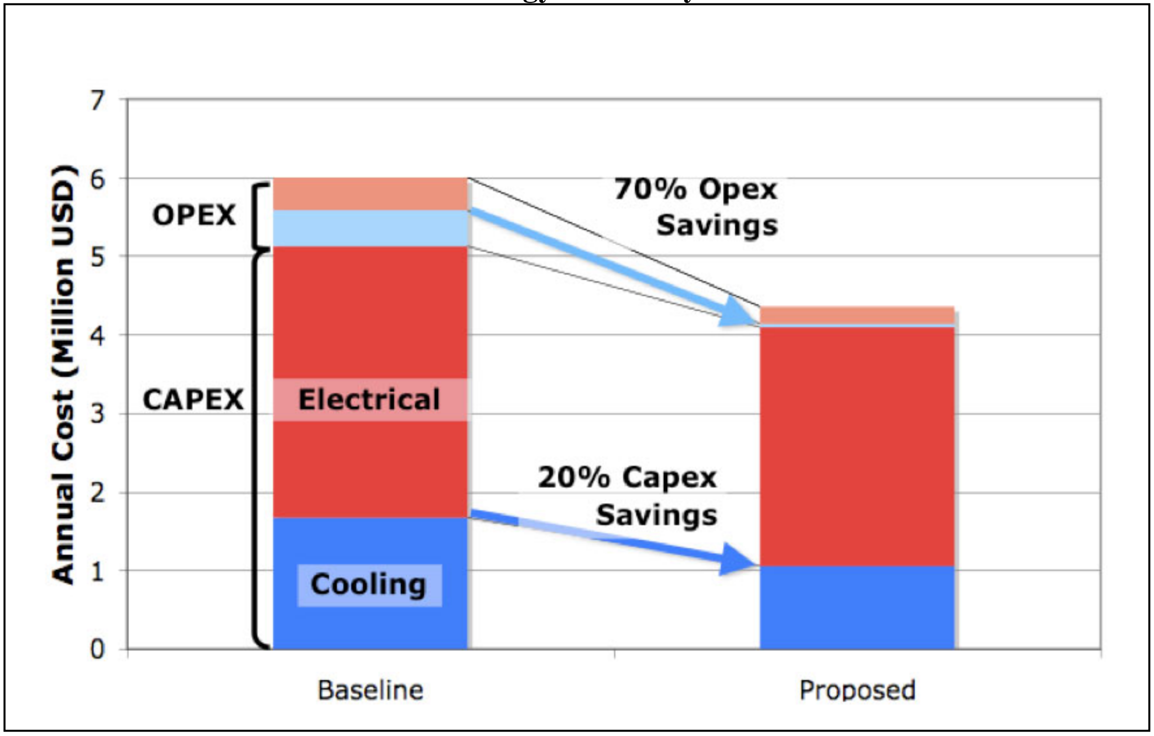
Data centers have become critically important as society becomes ever more dependent on large streams of data and information produced and conveyed by the Internet. From an electricity point of view, data centers account for nearly two percent of electricity consumption in the United States, a number that is projected to double from 2006 to 2011. RMI's work in data services (Eubank & Swisher 2003) identified energy efficiency opportunities that can address rising energy costs, constrained data capacity, and the need for expensive new facilities. In that work we showed that typical data centers consume as much power to cool and support the servers as the servers themselves consume. Furthermore, only a small fraction of the power used by servers ultimately supports the value-add computing - most power is lost in power conversion, fans, and other support equipment.

RMI's recent work with a leading data service company has demonstrated that tackling key barriers to efficiency can reduce costs, increase capacity and reduce carbon dioxide emissions. Though most efficiency measures were widely known best practices - efficient hardware, virtualization, and cooling distribution optimization - opportunities had not been widely addressed. Common barriers of split incentives, risk adversity, and one-year payback requirements can prevent efficiency measures from being implemented.

The team looked at multiple scenarios that could provide increased server capacity and reduce energy use in the data centers. Analysis of these scenarios revealed that aggressive efficiency programs could provide years of additional capacity in existing facilities while delaying expensive capital outlays.

In a second study RMI helped design a new data center with significantly reduced operating and capital costs, and a much reduced carbon footprint per unit of service, as shown in Figure 5.

Figure 5. Capital and Operating Expense Reductions in Data Center Design through Energy Efficiency



Oil and Gas

Increasing awareness of climate change has created additional concerns about large capital investments in the oil and gas industries. Taking an approach that combines highly efficient system design with minimum resource requirements can ameliorate those concerns while reducing the large carbon footprint associated with production in these industries. The challenge is to achieve breakthrough levels of innovation by replacing the current design paradigm in these industries.

In RMI's work in this sector, we have been able to help companies address a number of the barriers outlined above. For example, the team was challenged to address the vast pumping needs of a complex facility. Taking an approach that began with understanding the theoretical minimum, they were able to show that 85% of pumping energy was associated with frictional losses arising from convoluted piping designs and control schemes.

Food Production and Distribution

In food production and sales, manufacturers energy consumption can represent less than 1% of overall operating expenditures. Despite this low percentage of total costs, energy consumption costs can still represent more than half a company's profit margin. While food producers are generally well aware of the financial opportunity in efficiency and had made great progress reducing kWh/square foot, it is clear that are still opportunities for the savings from efficiency.

RMI's work with a large U.S. food production and distribution company has shown efficiency opportunities from improving existing facility design can yield a 35-40% energy reduction in kWh/square foot, and 40-50% energy reduction in kWh/square foot savings in new facilities. For example, drastically increasing building insulation can allow the company to decrease the size of its cooling units, also driving down the capital necessary to make the investment. In another example, field results have shown that recommissioning can yield cost effective energy savings of 5-20% with a typical payback (Thorne & Nadel 2003).

The financial implications are large as that work showed that for every $1 of cost savings from efficiency, the company would have to increase revenues by $40-60 to have the same bottom line impact.

Implications for Policymakers

It is necessary, but not sufficient for industry to shift the way that it thinks about energy efficiency; policymakers must also re-evaluate how to best enable industrial energy efficiency. Industrial facilities mangers are likely aware of the types of savings identified in this paper, but may not have the interest, or capital to act. Policy incentives and state leadership on industrial energy efficiency can overcome these barriers. In particular, policy can be used to assist companies that already support energy efficiency, but only invest in measures that maximize NPV rather than achieve all measures that as a package yield an NPV neutral result.

Access to low cost capital may encourage industry to invest in efficiency measures that offer the most benefits on a societal level. Many states already offer some type of industrial financing mechanism, however, none of the policies encourage a holistic approach where companies finance the NPV positive measures while the state subsidizes low-cost financing for NPV neutral measures.

An additional tool that policymakers could offer is education and training to address the real lack of skills that are required to holistically address industrial energy efficiency opportunities. Education and training is needed both within the companies themselves, and with the external contractors that industries work with.

Conclusion

A 300,000 GWh gap exists in state electric productivity that is worth billions of dollars, particularly for private companies that work to increase their industrial efficiency. Increasing industrial electric productivity is a significant near-term opportunity that can reduce electricity costs, carbon dioxide emissions per unit of output, and increase profits, and the best companies are employing strategies that will drastically reduce their energy consumption. Diverse industrial companies—high technology, oil and gas, and food production and distribution—have recognized and captured large efficiency opportunities despite the barriers that exist for efficiency in new facility design as well as retrofits.

Nevertheless, even the most aggressive companies will have a difficult time justifying the level of investment that offers the most societal benefits. Thus, society must re-think how industrial energy efficiency is valued, and what the appropriate incentives should be. To drive the market transformation and accelerate the adoption of energy efficiency, policy will have to play an important role—providing the incentives that currently are lacking for industry to move far beyond current levels of efficiency.

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