SUPPLY CHAIN
ENERGY EFFICIENCY

Engaging Small & Medium Entities in Global Production Systems

// AUGUST 2013 //
New governmental incentives are pushing for increased industrial energy efficiency, most specifically China and its explicit mandate to extend energy efficiency much deeper into supply chains. An increase in corporate responsibility has meant that large downstream customer firms are formalizing energy management and carbon reduction incentives and pushing these activities upstream. Finally, growing customer awareness about climate change and corporate supply chains underpins both increasing corporate responsibility and new governmental incentives, necessitating further transparency and standardization.

These conditions suggest that supply chains may hold key opportunities for promoting energy efficiency, reducing costs and decreasing the environmental footprint of consumer goods. Even though the promise is strong, the benefits still prove to be elusive for most companies. Scale and efficiency are difficult to unlock, as is the coordination of multiple organizations spanning complex geographies. Nowhere is this truer than for small and medium enterprises across the globe. However, many organizations across the energy efficiency supply chain are beginning to make progress. Financial institutions, utilities, energy service companies, brand owners, retail giants and factories are all beginning to connect the dots and understand how clear communication, innovative finance models and improved transparency can lead to streamlined supplier relations, smaller carbon footprints and lower cost of goods.

The Supply Chain Coordination and Energy Efficiency Symposium brought together key leaders and innovators across the energy efficiency supply chain to discuss these key drivers and opportunities. We focused on how to accelerate industrial energy efficiency initiatives in small and medium enterprises, sharing lessons learned about obstacles encountered, success achieved and innovations in the works to unlock the full potential of supply chain efficiency. Emerging from the symposium is this report outlining a systemic perspective on the role supply chain actors can play (both in commercial and energy efficiency supply chains) in improving industrial energy efficiency, along with four key recommendations based on participant discussions. These recommendations include:

1. Engage leading companies (manufacturer/retail brand owners) to identify high-quality suppliers for pilot supply chain energy efficiency improvements.
2. Create one or more sector-based collaborations for improving supply chain energy efficiency by assembling groups of peer manufacturers within a supply chain...
and using benchmarking, process capability analysis and best practice sharing to identify and improve energy efficiency and industry competitiveness.

3. Increase transparency and standardization of energy use, audits and supply chain information.

4. Create finance and credit risk approaches and models for portfolio-level energy efficiency and energy management projects.

Although the recommendations coming out of the Supply Chain Coordination and Energy Efficiency Symposium are ambitious, their attainment is critical to unlocking the full carbon savings and investment potential embedded in current industrial energy systems. As the following report describes, large leading companies can provide motivation and resources upstream to their suppliers for energy efficiency improvements. More information, transparency and standardization can reduce the high transaction costs that exist in current energy efficiency financing and investments. As the world wrestles with the upcoming global environmental challenges in the 21st century, we suspect that a more comprehensive view of current and potential efforts targeting supply chain energy efficiency will illuminate very different paths forward. These paths must focus on collaborative, transparent and creative solutions for progressing global industrial energy efficiency.

Sincerely,

TIM SMITH
NorthStar Initiative for Sustainable Enterprise

ANDREW HUTSON
Environmental Defense Fund

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The authors of this report are Jennifer Schmitt (NorthStar Initiative for Sustainable Enterprise - NiSE) and Timothy M. Smith (NiSE). This report was edited by Samantha Steinbring (NiSE) and benefitted from the initial work of previous NiSE staff including Miriam Fischlein, Terry Foecke, and Cindy McComas. The graphics and layout were designed by Sarah Karnas (Institute on the Environment).

SYMPOSIUM

THE SUPPLY CHAIN COORDINATION AND ENERGY EFFICIENCY SYMPOSIUM occurred October 22–24, 2012 in Racine, Wis. Thirty-one participants representing key actors of the industrial energy efficiency supply chain, from product development companies and manufacturers to energy service companies, financing institutions, insurance providers, retailers, nongovernmental organizations, government and academia, came together to discuss the state of the art of global energy efficiency implementation, barriers associated with engaging small and medium enterprises and the role of large downstream brand owners in incentivizing and enhancing upstream energy efficiency.

This symposium is part of a broader research project aimed at better understanding the role of demand-side management in sustainable energy systems. The research is funded through a grant from the Institute on the Environment and the Initiative for Renewable Energy and the Environment at the University of Minnesota. Supplemental funding for this symposium was provided by the Environmental Defense Fund, along with in-kind support from the Johnson Foundation at Wingspread.

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INTRODUCTION

RISING ENERGY PRICES, new governmental regulations and incentives, increases in corporate environmental responsibility and customers’ increasing ecological awareness have pushed energy-efficient manufacturing and production into the spotlight. Industrial energy plays an important role in a government’s national carbon dioxide emissions as well as a product’s supply chain carbon dioxide emissions; thus, both governments and companies are striving to identify the most effective measures to increase industrial energy efficiency. The industrial sector is one of the main consumers of energy and emitters of carbon dioxide, consuming nearly one-third of total global primary energy supply and causing 36% of energy-related carbon dioxide emissions (IEA 2009). Opportunities for improved efficiencies are substantial. It is estimated that potential primary energy savings in the industrial sector, through the adoption of available best-practice commercial technologies, could reach 18–26% of industrial consumption or 5.4–8.0% of total global energy consumption (IEA 2007).

From an individual firm perspective, these energy efficiency investments are often a no- or low-cost proposition. Particularly in the industrial and commercial sectors, many energy efficiency projects carry the promise of substantial financial returns within only a few years. Overall, McKinsey and Company estimate the global investment potential for energy efficiency at $170 billion annually through 2020 with average annual returns of 17% (Farrell et al. 2008). In addition, incentive programs to increase adoption of energy efficiency practices are numerous, with most government funded or run by utilities in the context of demand-side management. Following the 2008 financial crisis, a proportion of stimulus funds across the world was aimed at jump-starting the green economy; 30% of these green stimulus funds went toward energy efficiency, for a total of $56 billion (UNEP 2010).

Yet these programs and funds have not provided sufficient incentive for companies to take action on energy efficiency investments at a seemingly justifiable scale. It is estimated that energy use can vary by a factor of two to three between the most and least energy efficient firms in a sector (de Beer 2000) and that the average firm implements less than two-thirds of recommended and economically viable projects (Anderson & Newell 2004; DeWahl et al. 2010). Although $43 billion was spent on energy efficiency improvements in the United States alone in 2004, amounting to 1.7 quads of energy savings (Ehrhardt-Martinez & Laitner 2008), the market potential is much larger, according to analysts. Energy cost savings could amount to $900 billion by the year 2020. Therefore, much of the literature on energy efficiency has sought to understand decision-making, and, at the risk of oversimplification, identify the degree to which market and behavioral failures lead to suboptimal adoption rates and where policy interventions might correct them (Gillingham et al. 2009).

While this body of work has done much to illuminate what has come to be known as the “energy efficiency gap,” scant research is available addressing the interorganizational supply chain responsible for a “saved kilowatt hour” or the emerging role of large downstream customers and creative financial approaches in bundling and commoditizing global energy efficiency assets across small-to medium-size enterprises (SMEs). Only recently have management and policy scholars begun to evaluate the role of private sector companies in delivering cost-effective energy savings to end users across the supply chain (Satchwell et al. 2010). As such, energy service companies (ESCOs) are devising innovative methods to deliver complete packages of technologies, operational support and financing to clients. Financial institutions, in search of new markets, are beginning to explore financial mechanisms targeting energy efficiency. Large
manufacturing and retail brand owners (Walmart, Ikea, Tesco, Herman Miller, Pepsi, etc.) are investing in supply-chain energy efficiency programs both within their own operations and in upstream suppliers to address corporate-level sustainability targets. Non-governmental organizations, or NGOs [Environmental Defense Fund (EDF), World Resources Institute (WRI), CDP (formally Carbon Disclosure Project), etc.] and transnational organizations (the United Nations, World Bank, International Finance Corporation, etc.) are increasingly engaging industrial energy efficiency implementation and financing among smaller, less sophisticated and less capital-ized enterprises. Furthermore, governments are focusing new energy efficiency policies at SMEs. Achieving national or corporate environmental and energy targets must include SMEs, and large, enlightened, supply chain actors might be an effective lever toward motivating and scaling SME energy efficiency projects.

While the size of the problem and the importance of reaching further upstream into industrial supply chains have sparked countless pilot projects and experimental programs, little evidence of successful outcomes has been found to exist – leaving companies, governments and NGOs with little knowledge toward effective strategies or policies for supply chain energy efficiency targeting SMEs. A recent Institute for Industrial Productivity (IIP) report summarizes the on-the-ground energy efficiency landscape in China largely as “an interconnected web of barriers” (Dreessen & Wang 2012). Structuring efficiency projects is difficult and unconventional, as no generally accepted measurement and verification standard exists for energy savings; energy efficiency projects are often small and scattered; financial institutions do not understand energy-saving technologies or trust savings projections; banks are risk-averse and reluctant to change their existing procedural frameworks for energy efficiency projects; ESCOs are themselves often small with limited technical and credit histories and host enterprises in rapidly growing economies prioritize sales growth over cost/
energy efficiency. In short, success, where it has emerged, has largely been concentrated in a very limited number of credible large clients.

Yet, the local and greenhouse gas (GHG) emissions reductions associated with overcoming these obstacles in the very near term are tremendous. In China alone, energy efficiency investment to meet new policies implemented under the 12th Five Year Plan (FYP) (2011–2016), expanding objectives beyond the largest energy users to the top 10,000 emitters, is estimated at nearly $189 billion with resulting energy savings of 400 mtce\(^1\) (Dreessen & Wang 2012) – roughly the total electricity and natural gas consumption of California over the same five years. The total potential for GHG emission mitigation in the global industrial sector by 2030 is estimated to be 9–37% \((1,500-6,100 \text{ MtCO}_2\text{-eq/year})^2\) (Worrell et al. 2009).

In an attempt to surface vital enablers for increased supply chain energy efficiency implementation, the Supply Chain Coordination and Energy Efficiency Symposium was held to obtain expert opinion on a set of key questions:

1. How might the inclusion of SMEs alter approaches taken by governments and companies working toward energy efficiency investments?
2. What additional risks and opportunities exist for governments and supply chains by increasing focus on SME energy efficiency?
3. How might increased supply chain coordination facilitate energy efficiency improvements in SMEs?
4. How does the development and effectiveness of the energy efficiency supply chain impact the stability of material / product supply relationships?
5. Where do leverage points exist in the industrial energy efficiency system, if new information from coordinated research, data infrastructure and demonstration were available?

This document summarizes a select subset of the energy efficiency literature in an effort to provide context to the findings emanating from the multistakeholder discussions at the symposium. It suggests that a more comprehensive view of current and potential efforts targeting supply chain energy efficiency may illuminate very different paths forward from the largely facility-level adoption or sector-level energy savings opportunity studies so pervasive in the literature.

Specifically, recommendations emanating from the symposium are as follows:

1. Engage leading companies (manufacturer/retail brand owners) to identify high-quality suppliers to pilot supply chain energy efficiency improvements.
2. Create one or more sector-based collaborations for improving supply chain energy efficiency by assembling groups of peer manufacturers within a supply chain and using benchmarking, process capability analysis and best practice sharing to identify and improve energy efficiency and industry competitiveness.
3. Increase transparency and standardization of energy use, audits and supply chain information.
4. Create finance and credit risk approaches and models for portfolio-level energy efficiency and energy management projects.

Accomplishing greater rates of adoption of energy efficiency technologies among SMEs is a difficult, but attainable, challenge. This report provides initial insight into the role of large leading companies near the end of supply chains in providing motivation and resources to upstream SME supply chain partners. It lays out a framework toward the development of, and resources required for, lowering the high transaction costs of performance-based energy efficiency implementation approaches (audits, savings calculations, opportunity identification, technology assessment, financing, etc.). The discussion and approach for implementing supply chain energy efficiency is based on a systemic perspective (Figure 1) with the four recommendations emanating from the expert panel convened at the Supply Chain Coordination and Energy Efficiency Symposium in October 2012. Each of the following four sections corresponds to the four high-level systemic areas (Figure 1), providing background, key information and when relevant to our symposium discussions, recommendations. These recommendations require an unprecedented ability to characterize and benchmark sector-level and facility-level energy savings opportunities, share knowledge in ways that allow for the flexible application of technological and organizational information in a supply chain environment, and coordinate resources across regions and across public and private actors.

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\(^1\) Mtce (metric tons of standard coal equivalent) is an energy equivalency metric.

\(^2\) MtCO₂-eq (metric tons of carbon dioxide equivalent) is a global warming potential metric.
or should a price be put on carbon (due to governmental policies) the returns for energy efficiency will change.

Within these global energy systems and markets, many actors play a role in the creation of a “saved kilowatt hour” (Table 1). Improved integration of these actors (financial institutions, utilities, energy service companies, large leading companies, etc.) provide new and potentially fruitful avenues for aggregation and commoditization of energy efficiency assets deployed at SME facilities. Supply chains necessary for the creation of a “saved kilowatt hour” must not, however, decrease the robustness or resiliency of the material (or product) supply chains associated with large, enlightened brand owners. Understanding this tension between short-term stress to the material supply chain and long-term resiliency and advantage of less environmentally and socially impactful supply chains is paramount — ultimately changing the optimization function from cost reduction or profit maximization to a multi-criteria approach.

At the heart of a “saved kilowatt hour” are the industrial facilities using energy to meet the consumption demands of almost 7 billion people. The industrial sector is the world’s largest energy consumer, using about 37% of delivered energy worldwide (Abdelaziz et al. 2011). At the base of the industrial sector are primarily SMEs. For example, 93.5% of the suppliers in the Korean automobile industry are SMEs (Choi 2003), and China’s 2.4 million SMEs make up 99% of all enterprises in that country, accounting for more than half of all of China’s GHG emissions and pollutants (Teng & Gu 2007). Efforts to achieve national or corporate environmental targets must include SME suppliers (Holt et al. 2001).

Substantial informational, financial and organizational barriers challenge SMEs — and these challenges vary across sector, region and organizational size. Major barriers include lack of time, other priorities for capital investments, lack of access to capital, lack of budget funding, cost of production disruption and inconvenience, technical risk of future production disruptions, and difficulty of obtaining information on the energy use of purchased equipment (Painuly et al. 2003; Sardianou 2008; Shi et al. 2008; Trianni & Cagno 2011).

While SMEs pose some challenges to increasing global energy efficiency, energy savings and management opportunities may actually be considerably easier for SMEs than other enterprises to benefit from because many SMEs have yet to engage in significant energy efficiency, demand side management or distributed generation activities. However, without adequate visibility into energy use information, along with properly aligned incentives, these opportunities are largely unattainable.

### TABLE 1 // FRAMES AND POTENTIAL ROLES FOR ENERGY EFFICIENCY SUPPLY CHAIN COORDINATION (expanded upon Fischlein et al. 2011)

<table>
<thead>
<tr>
<th>SUPPLY CHAIN ACTOR</th>
<th>POTENTIAL ROLE IN AGGREGATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governments</td>
<td>Governments can match investors and clients for loan programs and provide loan guarantees. They can develop standard contracts.</td>
</tr>
<tr>
<td>Electric utilities</td>
<td>Utilities can utilize existing relationships with industrial customers and knowledge of their energy use profile; identify those offering the best opportunities for load-shifting. Given the right financial incentives (decoupled rates, time of day pricing, energy efficiency performance standards) utilities can bring together similar companies.</td>
</tr>
<tr>
<td>Insurance industry</td>
<td>Insurance providers can offer standardized insurance for energy performance contracts. The insurance industry can lower the transaction costs and risk of energy efficiency investments by offering loss prevention insurance. They also have a role to play as institutional investors interested in annuity style investments.</td>
</tr>
<tr>
<td>Financial industry (e.g. banks, pension funds, equity investors, the International Financial Corporation)</td>
<td>The financial industry can build on the experience with securitization of credit card and other assets to develop rules for energy efficiency investments. It also can build on the experience with metrics and financial risk indices to develop a yardstick for evaluating energy efficiency investments.</td>
</tr>
<tr>
<td>Energy service companies (ESCOs)</td>
<td>ESCOs could expand their business into the small business sector and develop methodologies to streamline contracts for firms with similar characteristics.</td>
</tr>
<tr>
<td>Large leading companies (Walmart, Nike, Levi Strauss, Herman Miller, Best Buy, etc.)</td>
<td>Retailers and brand owners can aggregate along their supply chain, facilitating energy efficiency investments in their suppliers through supplier incentives, supplier preference and retention, contract guarantees, etc.</td>
</tr>
<tr>
<td>Supply chain management companies (e.g. PCH International)</td>
<td>Supply chain management companies can incorporate energy efficiency into their supplier development and selection criteria.</td>
</tr>
</tbody>
</table>
SUPPLY CHAIN ENERGY MANAGEMENT: A nested energy services network

FOR MUCH OF the past three decades, the imperatives of cost efficiency and customer responsiveness have resulted in the pervasive pursuit of two basic business strategies, globalization and time-based competition (Bhatnagar & Viswanathan 2007). Globalization—motivated by cost minimization, access to new markets, economies of scale, etc.—has led to the emergence of borderless organizations with globally located suppliers and substantial, unanticipated additional costs stemming from reputational to natural hazards (Geary et al. 2006; Halldórsson & Kovács 2010). Many of these risks are exacerbated by the increasing geographic scope of firms’ supply chains that expose supply chains to a variety of cultural, legal, administrative, linguistic and political issues (Branch 2008; Mentzer et al. 2001). Thus, from a supply chain resiliency perspective, the wisdom of adopting a number of publicly proclaimed “best practices” comes into question—including supply base reduction, global and supply cluster sourcing, and the broad implementation of lean production systems (e.g., reduced inventory, shipment sizes, production batches; frequent just-in-time delivery; rapid-response logistics; central warehousing; mass customization). This has fueled interest in green supply chain management; many organizations are recognizing the need to influence operations that fall outside the direct control of a single business unit or manufacturing facility, and taking a full life cycle approach to improve the environmental impact of their products and services. In the case of GHGs, companies seeking to reduce policy or reputational risks associated with these emissions often find that their direct emissions are dwarfed by the emissions in their supply chains (Palmbeck 2012). In fact, across industries, companies’ direct GHG emissions average only 14% of their supply chain cradle-to-gate emissions (Matthews et al. 2008).

By far the most documented case of corporate efforts to reduce environmental impacts in its supply chain is that of Walmart (Humes 2011). Walmart is widely cited in the academic and popular press as profiting from its actions to reduce GHG emissions (and increasingly water use) in its own operations and its supply chain. Walmart has been successful in capturing cost reductions (energy efficiency being a central strategy), new sources of revenue, improved employee motivation, enhanced public relations and increased voice with policy makers through this strategy (Palmbeck 2012). Efforts to manage upstream energy and carbon impact are not, however, restricted to Walmart. Dell, Ford, Unilever, Pepsi, Best Buy and countless others, often in conjunction with NGO partners such as CDP, EDF and WRI, have put in place reduction targets and initiatives focused on upstream and downstream supply chain impacts. Despite the growing interest by leading companies in their supply chains, there has not been a significant uptick in the number of energy efficiency projects implemented by suppliers. This phenomenon is borne out of data on 2,415 suppliers that shows only 27% invested in GHG emission-reducing activities in 2011 (CDP 2012). Furthermore, this number has been steady for several years even though 69% of these suppliers’ customers were investing in emission-reducing activities in 2011, up from 39% in 2010.

Despite lack of universal success, there is still great opportunity for supply chains to act...
RECOMMENDATION | GOAL | BARRIERS TO IMPLEMENTATION
--- | --- | ---
Engage leading companies to identify high quality suppliers to pilot supply chain energy efficiency improvements | Create a demonstration project of multiple leading companies willing to actively engage and assist their suppliers with energy efficiency improvements. This would include involvement from the CEO/CFO, supplier incentives and willingness of the leading company to put forth time, money, effort or reputation in the process. | • Identifying corporate leaders
• Hesitation of leading companies to put time, money, effort or reputation in the process
• Leading companies may have great energy efficiency intentions, but they may lack knowledge about the actual energy processes and technologies

MEASUREMENT & METRICS | POTENTIAL STRATEGIES & NEXT STEPS
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The demonstration project will measure: | • Identify an influential CEO willing to be the “high profile messenger”
• Identify the five companies in the top 100 whose CEO/CFO may be interested in this space. Look into highly energy intensive industries
• Focus on leading companies’ motivations including: preserving or improving reputation, competition, profit, corporate values, customer preferences and correlations to better business health
• Number of energy efficiency projects implemented
• Project costs
• Project paybacks
• Project energy and cost savings
• CO₂ reduction benefits
• Willingness of companies to place a stake in the process, including: multi-year purchase agreements, investment into a project finance vehicle, backstopping loans, etc.
• Widespread dispersion of “success stories”

### TABLE 2 // SYMPOSIUM RECOMMENDATION #1 - ENGAGING LEADING COMPANIES IN THE SUPPLY CHAIN

as aggregators of SMEs and facilitate implementation of energy efficiency projects. The recommendation coming from the Supply Chain Coordination and Energy Efficiency Symposium to increase leading companies’ role in their supply chain energy efficiency implementation is to engage leading companies in a demonstration project to pilot supply chain energy efficiency improvements. Key to the success of this demonstration project would be the buy-in of a major CEO to be a “high profile messenger” to bring in other CEOs and CFOs and thus a handful of top 100 companies interested in collaborating in this space. Indicators of success would be an increase in the number of energy efficiency projects implemented, widespread sharing of success stories, and a willingness of leading companies to put forth time, money, effort or reputation to assist their suppliers with energy efficiency implementation.

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Environmental Defense Fund (EDF) has worked with leading companies such as Walmart, Tesco, Levi Strauss & Co, and the London based investment bank, Sustainable Development Capital LLP (SDCL), to drive energy efficiencies in supply chains in China and, in some cases, to identify financing solutions to support implementation. These leading companies agreed to support energy audits of hundreds of their Chinese factory suppliers. EDF provided technical support for these audits, which identified many low-cost energy saving opportunities. Suppliers of Levi Strauss & Co also participated in this program which yielded important learnings on project design to engage upstream supply chain actors in collaborative energy efficiency projects. Through its corporate partnership work, EDF has been able to effectively link environmental gains with bottom line efficiencies. Building upon this example, the recommendation that emerged from the symposium suggests identifying a major CEO to act as a “high profile messenger” to lead the charge in bringing together influencers for a pilot project to improve supply chain efficiency. The recommendation also emphasizes continued and increased concrete commitment by leading companies on how they will put forth time, money, effort or reputation to promote energy efficiency improvements in their suppliers.

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1 Cradle-to-gate refers to a partial lifecycle analysis of the company’s greenhouse gas emissions; accounting for emissions not only produced by a company, but all those emissions associated with creating the products the company sells and the emissions associated with the power generation for the heat and electricity. The emissions associated with the company’s product uses and disposal are not considered.
Improvement measures

**ENERGY AUDITS OF FACILITIES** provide invaluable data on energy performance and are increasingly being demanded by downstream customers, upstream financiers and insurance providers. Although numerous energy efficiency assessment data tools and approaches have been developed to meet this demand, the intensity and specificity of process data varies, making it difficult for financial professionals to assess medium-term energy efficiency contracts subject to operational and environmental risks. Multiple studies have pointed to the chasm between the types of data required by financial actors for project financing and those data most relevant and familiar to process engineers (Pye 2000; Simpson 1987; Tanaka 2008). In addition, data collection for baselines as well as measurement and verification following installation costs money and time. Standardizing energy audits can decrease transaction costs for SMEs through the creation of commonly shared rules and procedures on the type and amount of information needed to justify project funding. Use of standard contract language will also help close the communication gap between process engineers and the financial community.

Along with standardizing energy audits, making facility-level data more transparent could facilitate industry-wide benchmarking. Large companies, particularly in energy-intensive industries like steel, cement and the glass industry, have benefitted from U.S. Department of Energy (DOE) and Environmental Protection Agency programs like the Energy Star Focus Industry program (Energy Star 2013), which includes communities of practice, industry-specific energy guides (Hasanbeigi 2010) and plant energy performance indicator benchmarking (Boyd 2005). There have also been detailed studies of theoretical potentials in selected industries to guide best-in-class energy efficiency improvements over the longer term (Energetics 2004). Large companies also benefit from national recognition programs, such as the U.S. DOE Better Buildings Challenge (DOE 2013), in which manufacturing companies are recognized for making commitments and achieving a 25% energy intensity improvement over 10 years. Unfortunately, these resources have not generally been as accessible to SMEs, and without sector benchmarking, facilities that are managing their energy have a difficult time evaluating their efficiency efforts.

Collected energy data is a prerequisite to understanding how energy savings at the factory level aggregates up to produce energy savings for an entire supply chain. It is also an imperative for supply chain, country-level and global-level energy mapping, and a requisite to managing energy on a systemic scale and substantially increasing possibilities of demand-side management. To date, many facilities are hesitant to share their energy data with customers because of concerns over pricing; they see a request for information about energy efficiency improvements as a way for leading companies to request cheaper product prices from the energy cost savings (Goldberg et al. 2012). Furthermore, standardized transparent data is often not required. Of the 38 implemented measures for identifying energy efficiency opportunities in International Energy Agency member countries, the European Union and China, as outlined by Tanaka (2011), only seven used data collection/reporting, and only two programs made this reporting mandatory.

While there are a definite number of important sources for energy data and best practices (Industrial Assessment Centers, the World Bank Sustainable Energy for All initiative, Energy Star Industries in Focus, the U.S. Government Green Button program and the Institute on Industrial Productivity best practice database, to name a few), a repository for global supply chain energy data has not been developed. The recommendation from the Supply Chain Coordination and Energy Efficiency Symposium stresses the need to create an information platform for sector-level benchmarking and sharing of best practices. This platform could be housed by a neutral third party, such as a university institute or accounting firm, and become the central agency for reporting, data aggregation and analysis. This would allow suppliers to securely share their data and reap the benefits of sector- and supply chain-level analyses of best practices.
Create one or more sector-based collaborations for improving supply chain energy efficiency, by assembling groups of peer manufacturers within a supply chain and using benchmarking, process capability analysis and best practice sharing to identify and improve energy efficiency and industry competitiveness.

Target tier 2 and tier 3 suppliers providing inputs to a variety of industries that are medium to high in energy-intensity and that have common enough product characteristics to allow peer, plant-level benchmarking and process capability analysis. Aggregate sector benchmarking across supply chains at the industry sector level and for individual supply networks.

- Globally dispersed production systems
- Coordination across multiple governmental policy and finance programs
- Potential incongruence between cost/benefit to global, private supply chain actors and nation-based, public actors

Key benchmarking and capability analyses will include:
- Efficiency of current facilities/processes
- Potential opportunity for improvement
- Identification of facilities/processes for best practice
- Prioritization of improvement opportunities across supply chain

- Develop anonymous benchmarking/capability analysis through an accounting firm or university institute to manage data collection, analysis and reporting
- Coordinate NGO and industry sponsors, host initial meetings, invite suppliers to share knowledge/expertise
- A reference operational model for this is the Energy Star Focus Industry program

### TABLE 3 // SYMPOSIUM RECOMMENDATION #2 - SECTOR BASED COLLABORATIONS TO IMPROVE DATA, METRICS & ANALYTICS

### REGIONAL COLLABORATION & IMPLEMENTATION

Global policy and financing

**NATIONAL GOVERNMENTS** and programs facilitated by transnational organizations have increasingly implemented programs addressing energy efficiency finance. Subsidies and funding schemes are widely used across the globe. Many, though not all, of these programs target SMEs and are typically used to pay for technical actions such as audits, energy management, equipment investment and research and development (R&D) (Tanaka 2011). One of the most documented programs is the U.S. DOE’s Industrial Assessment Centers (IAC) program, which has provided no-cost energy audits to small and medium-size manufacturers since 1976. A review of nearly 40,000 individual projects across more than 9,000 U.S. facilities participating in the program yielded mixed results in terms of energy efficiency adoption (Anderson & Newell 2004). Although more than half of recommended projects were adopted, only the lowest hanging opportunities (i.e., those that are easily achievable and do not require a lot of money or effort) were pursued—projects with average investments of less than $5,000 and simple paybacks of 1.02 years. The same study suggests that SMEs are about 40% more responsive to investment costs than to energy savings, suggesting that policies to reduce implementation costs may be somewhat more effective than various mechanisms that raise energy prices (Anderson & Newell 2004). Also in the United States, the mandate provided by Title XVII of the Energy Policy Act of 2005 allowed the U.S. DOE to invite pre-applications for up to $2 billion in loan guarantees.

Germany’s Special Fund for Energy Efficiency in SMEs provides SMEs with low-interest loans for energy conservation. In Japan, a government-affiliated financial institution provides low-interest loans for energy conservation systems. In the United Kingdom, the Carbon Trust runs an interest-free loan scheme for energy efficiency investment of SMEs, with loans ranging from £5,000–400,000, depending on technology and region. In France, a loan guarantee fund with a budget of approximately €18 million for energy efficiency investment of SMEs (FOGIME) was created with the ability to guarantee up to €244 million in loans to the private sector. China has perhaps some
of the most significant government involvement in energy efficiency. China’s 12th FYP (2011–2015) builds directly on previous efforts targeting large (predominantly state-owned) enterprises, extending the scope of the Top-1,000 Energy-Consuming Enterprises program to a Top-10,000 program. The plan sets a new national target to reduce energy intensity by an additional 16% by 2015 and requires enterprises to invest in efficiency-improving measures, develop energy reporting and auditing systems and report results quarterly to the National Bureau of Statistics. This policy environment, paired with the scale of China’s manufacturing sector, has resulted in an explosion in the ESCO industry, supported by NGO and transnational organizational programs. A comprehensive analysis of global energy efficiency policies can be found at (Tanaka 2011).

In 2010, the U.S. government (through federal, state and local levels) spent approximately $1.1 billion5 on industrial energy efficiency programs (Chittum & Nowak 2012). In 2011 utilities spent almost $7 billion on energy efficiency programs ($5.9 billion on programs for electricity efficiency and an additional $1.1 billion for natural gas efficiency programs), saving an estimated 18 million MWh in 2010, the most recent year for which data are available (ACEEE Energy efficiency scorecard 2012). These investments are projected to increase to $10–16 billion per year by 2025 (ACEEE Energy efficiency scorecard 2012). However,

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5 This includes $228 million in federal American Recovery and Reinvestment Act of 2009 funds specifically targeted toward industrial energy efficiency.
assessing and evaluating which programs, technologies and applications are most effective is often stymied by lack of energy use data. Energy efficiency investments are generally considered to be “money well spent” (Chittum & Nowak 2012), when in reality empirical evaluations of cost-effectiveness of programs often do not exist (Gillingham et al. 2006).

The lack of energy use data, program evaluations, standardizations and transparency poses a significant barrier to improving energy efficiency improvements worldwide. The recommendation coming out of the Supply Chain Coordination and Energy Efficiency Symposium is to increase transparency and standardization of energy use, audits and performance information to create a data infrastructure that can be used to evaluate public and private investment in energy efficiency. To achieve this, the symposium participants suggested the formation of public-private partnerships that could subsidize auditing and information programs and develop reporting guidelines for best practices.

### Table 4 // Symposium Recommendation #3 - Increasing Transparency and Standardization to Evaluate Investments in Energy Efficiency

<table>
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<tr>
<th>Recommendation</th>
<th>Goal</th>
<th>Barriers to Implementation</th>
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| Increase transparency and standardization of energy use, audits and supply chain information | Create critical data infrastructure associated with supply chain energy use, capable of: 1. evaluating public and private investment in energy efficiency; and, 2. facilitating the integration of future “behind meter” demand resources such as distributed generation and demand response. | • Link between energy use and proprietary processes may restrict access to some information  
• Standards do not exist for auditing or reporting energy efficiency opportunities or implementation  
• Geographic differences complicate expected value and impact assessment |

### Measurement & Metrics

While a significant component of this recommendation is to determine appropriate and comparable metrics at facility, sector and supply chain levels, metrics would likely include:

- Energy (costs; savings)/operating costs
- Energy (costs; savings)/production output
- Energy (costs; savings)/budget (operating) risk
- Ancillary benefits/costs: quality, throughput, waste, labor, etc.

### Potential Strategies & Next Steps

- Create partnerships across governamental and NGO-based programs facilitating and subsidizing EE auditing and information programs (World Bank, IFC, IIP, DOE/ EPA, EDF, etc.)
- Develop anonymous reporting guidelines for best practice and participation in subsidized programs
- Create a demonstration project with the support of industry/retail participation for application of database to supply chain level

While governments are investing widely in energy efficiency, the financial community has become increasingly interested in capitalizing on energy efficiency. However, significant interest in energy efficiency financing has been hampered by equally significant barriers to efficiency project financing. To date, the bulk of energy efficiency finance depends in one form or another on performance-based contracts. Energy performance-based contracts can be generally classified into three types: shared savings contracts; guaranteed energy savings contracts; and outsourced contracts (Xiaoliang et al. 2011). In shared savings contracts, assets created by the project are generally owned by the ESCO, with the contract specifying payments to the ESCO based on an agreed percentage share of an estimated minimum cost savings scenario at normal asset operation. With guaranteed energy savings contracts, assets typically belong to the client, but the project is designed and implemented by the ESCO under financial guarantees for performance. Finally, outsourced contracts allow for the direct sale of heat, electricity and energy services from assets owned or acquired by an ESCO over an extended period of time. While useful for discussion purposes, it is important to note that great variation exists, making it difficult to compare types across countries,
and a variety of hybrid approaches have been developed. In nearly all cases, an ESCO establishes the overall project design, manages most project implementation aspects, and guarantees energy savings performance, but financing, contract, asset ownership and risk-sharing arrangements vary. Of course, where clients have specific needs or concerns, ESCOs often will vary contractual arrangements. However, if ESCOs are looking to banks or other financial institutions for project loan financing, it is important for project payment regimes to be as fixed and predictable as possible.

On the global stage, China is emerging as an important arena in the development of energy efficiency implementation and finance. With energy performance contracting investment in 2010 totaling more than $4.24 billion, the business volumes of China’s industry are now on par with those of the ESCO industry in the United States. China’s energy performance contracting business has grown remarkably fast over the past decade, developing contractual practices, business models and market approaches that are distinctly adapted to the Chinese market, where almost three-quarters of energy performance contracting investment occurs in industrial sector projects.

The ESCO model of energy efficiency financing and project implementation has played a critical role in industrial energy efficiency improvements to date. One aspect of this model going forward that was mentioned as important, but not further discussed at the Supply Chain Coordination and Energy Efficiency Symposium, was ensuring quality of ESCO providers as the number of ESCOs continues to proliferate. Another aspect participants mentioned and spent substantial time discussing was how banks and equity investors could play a larger role in energy efficiency financing, especially as projects move into SMEs.

Financing barriers are significant for SME energy efficiency projects and include issues of information asymmetries, transaction costs, perceptions of risk and limited capacity and knowledge of financial markets by small ESCOs or industrial process efficiencies by loan officers and risk managers (Figure 2). Central to these barriers is the perspective of banks on energy efficiency projects. Banks view loans for energy efficiency improvements as nonrecourse, meaning in the event of default, the banks can lay claim to the collateral (i.e., the equipment put into place for the energy efficiency improvement), but cannot take further legal action. Such loans are more risky for banks due to their limited opportunity for ensuring repayment. In the case of energy efficiency improvements, the risk is even greater because the transaction costs of getting the equipment out of the factory (e.g., removing an integrated HVAC system from a building) are high, so the bank sees no collateral value in the equipment itself.

If banks do not value the equipment, factories have no collateral with which they can use to secure a loan. The value of energy efficiency improvements stems from the future stream of cost savings that will occur when the energy bills of the factory decrease from the increased energy efficiency of the new equipment.

**FIGURE 2 // FINANCING BARRIERS TO INDUSTRIAL ENERGY EFFICIENCY**

Xiaoliang et al. (2011)

**CREDIT RISK AND PORTFOLIO MANAGEMENT // INTERNATIONAL FINANCE CORPORATION**

The International Finance Corporation (IFC), a World Bank Group, has been working to stimulate energy efficiency investments since 2006. Their China Utility-Based Energy Efficiency Finance Program (CHUEE) provides bank guarantees for energy efficiency loans and technical assistance to market players, including utilities, equipment vendors, and energy service companies, to help implement energy efficiency projects. As of end-2011, the CHUEE program’s participating banks have provided loans totaling close to $700 million, far exceeding the target of around $500 million. The original expectation was that 60% of the guaranteed loans would be small (about $0.2 million). However, by mid-2009, the average loan was $5.7 million, and loans of $0.2 million or less constituted less than 10% of the actual portfolio. Given the project success, coupled with a predominance of larger companies in the CHUEE program, IFC is expanding their effort to assist SMEs and is setting aside $200 million for SME energy efficiency financing, while also giving more focus to cooperating with smaller banks. IFC’s work has improved financing for energy efficiency in China and could provide some baseline data for how alternative credit risk models and portfolio financing could work globally.
ESCOs may have information about the technology, its effectiveness, payback period, etc., but this information is not relevant to a bank's decision to loan money. Investors need new credit/risk models to enable the financial community to capture the extensive potential of energy efficiency investments for small and medium enterprises. The recommendation from the Supply Chain Coordination and Energy Efficiency Symposium for new credit / risk models centers on creating ways to assess credit risk to a portfolio of projects. Investment disparity poses a challenge to this task. A typical project at an existing facility can cost in the range of $50,000 to $5 million, while $100 million is the typical scale for a level of interest for aggregated investment in such projects (Kapur et al. 2011; Taylor et al. 2008). This disconnect in scale thus requires aggregation of many small projects into a portfolio approach to financing. The participant discussion identified four essential requirements for this portfolio approach to be successful: homogeneous products (e.g., the portfolio needs to be only industrial, with no mixing with municipals or residential), a two-year or less payback, consistent quality and a mechanism for determining the portfolio credit rating. The first two criteria can currently be met (i.e., banks can require homogeneous projects, and information is available to estimate paybacks); however, the third and fourth criteria remain areas of key unknowns. The symposium recommendation centers around the fourth issue of portfolio credit ratings.

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<th>RECOMMENDATION</th>
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<th>BARRIERS TO IMPLEMENTATION</th>
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<tr>
<td>Create finance and credit risk approaches and models for portfolio-level energy efficiency and energy management projects</td>
<td>Develop the application of existing models to quantify credit risk of supply chain and/or SME energy efficiency portfolios: with application in control of risk concentration, evaluation of return on capital at the supply-chain level, and active management of credit portfolios.</td>
<td>• Small size of individual projects and possibly small size of portfolios (est. 50-100 projects for a $20MM fund) • High transaction costs associated with education and informational costs of project identification, technology selection, and savings calculations • Potential low returns of individual projects (~10% under current transaction costs) reduces attractiveness of portfolio</td>
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<tr>
<th>MEASUREMENT &amp; METRICS</th>
<th>POTENTIAL STRATEGIES &amp; NEXT STEPS</th>
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<td>Measures of credit risk similar to influential benchmarks common to the pricing of a wide range of asset types used in energy efficiency finance (i.e. private equity, loans and bond-like instruments): • Default Risk • Value-at-Risk (Var)</td>
<td>• Convene key practitioner and academic experts to identify specific barriers and opportunities for energy/resource efficiency risk portfolio management products • Explore the creation of a community of practice for sharing knowledge and best practice</td>
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**TABLE 5 // SYMPOSIUM RECOMMENDATION #4 - ASSESSING CREDIT RISKS AND CREATING PORTFOLIOS OF ENERGY EFFICIENCY PROJECTS**
CONCLUSIONS

THE PERSISTENT GAP between economically justifiable and implemented energy efficiency investments has puzzled researchers and practitioners for over four decades. Economists have characterized this gap as market failure, while behaviorists believe it is caused by individual, interpersonal, organizational or cultural factors. The gap between potential and actual savings is exacerbated among SMEs. This report provides initial insight into the potential role of large companies near the end of supply chains in providing motivation to upstream, and often smaller, supply chain partners and resources toward lowering the high transaction costs of performance-based energy efficiency implementation approaches (audits, savings calculations, opportunity identification, technology assessment, financing, etc.). The information and recommendations provided are based on expert opinion obtained through a workshop of influential stakeholders and relatively limited literature focused on supply chain energy efficiency.

At the heart of this report resides the assumption that the benefits of energy efficiency investments and related sustainability co-benefits (carbon reductions, local GHG emissions reductions, process performance efficiencies, etc.), are created by, and shared between, complex configurations of supply-chain actors involved in designing, planning, executing, controlling and monitoring the ultimate provision of net value to end customers. Therefore, the goals, measures and metrics, and suggested next steps are largely focused on the development of institutional infrastructure and shared informational assets facilitating implementation. Specific recommendations surfaced are:

1. Engage leading companies (manufacturer/retail brand owners) to identify high-quality suppliers to pilot supply chain energy efficiency improvements.
2. Create one or more sector-based collaborations for improving supply chain energy efficiency by assembling groups of peer manufacturers within a supply chain and using benchmarking, process capability analysis and best practice sharing to identify and improve energy efficiency and industry competitiveness.
3. Increase transparency and standardization of energy use, audits and supply chain information.
4. Create finance and credit risk approaches and models for portfolio-level energy efficiency and energy management projects.
5. Accomplishing high penetration of energy efficiency technologies in global SMEs represents a daunting, though attainable, challenge.

Meeting energy and environmental goals will require an unprecedented ability to characterize and benchmark sector- and facility-level energy savings opportunities, share knowledge in ways that allow for the flexible application of technological and organizational information in a supply chain environment, and coordinate resources across regions and across public and private actors. From a technical perspective, success will demand accurate, reliable and consistent computations and measurements across an expansive range of technologies, supply chain configurations and financial mechanisms. From a development perspective, resources from key actors – namely, large leading companies in supply chains, national governments, transnational organizations, and technically adept NGOs – will be required to create fundamental pre-competitive infrastructure and demonstration projects to further prove the concept.

The information and recommendations in this report represent incipient thoughts of stakeholders and experts within the global energy efficiency and research communities; advancement beyond this initial stage will require more detailed documentation and long range planning. Nevertheless, identifying these key barriers and brainstorming ways for overcoming them is imperative for maximizing supply chain energy efficiency.
REFERENCES


