Notice of Copyright

Multiple Benefits of Industrial Energy Efficiency - Lessons Learned and New Initiatives

BRUCE LUNG
SACHIN NIMBALKAR
THOMAS WENNING

ABSTRACT

Past research has shown that energy efficiency implementation in manufacturing can yield additional, quantifiable benefits in areas such as maintenance, production and environmental performance. However, these types of benefits don't often get identified or estimated during energy efficiency assessments on industrial plants or systems. In addition, these types of benefits are often omitted from conventional performance metrics, leading to overly modest payback calculations and an imperfect understanding of the impact of energy efficiency in manufacturing. If the non-energy related or multiple benefits of energy efficiency measures were to be estimated with good certainty in industrial energy assessments, the true magnitude of energy efficiency measures could be understood, leading to better and more accurate return on investment estimates for energy efficiency projects. According to the IEA report "Capturing the Multiple Benefits of Energy Efficiency (2014)," the monetary value of non-energy benefits stemming from industrial energy efficiency implementation could be in the range of 40% to 50% of the value of energy savings per measure, which could lower energy-efficiency project paybacks by more than half.

In order to integrate the potential multiple benefits of energy-efficiency investments in energy efficiency assessments, these benefits need to be identified and quantified during energy efficiency assessments. To help achieve this an effort is under way to develop a training platform to enable companies and individuals who perform energy assessments to include multiple benefits of energy efficiency in project evaluations. This platform will include tools to analyze energy-saving projects, training workshops and communications techniques and materials to provide the knowledge base to effectively integrate multiple benefits in the investment evaluations of energy efficiency measures. By integrating multiple benefit analyses in the energy assessments and assessment reports it is expected that the business case for energy efficiency will be bolstered leading to greater implementation of energy efficiency projects in manufacturing. This paper will discuss previous research showing the multiple benefits of energy efficiency in manufacturing and the analytical and communications framework that will enable integration of multiple benefits in energy efficiency assessments.

INTRODUCTION

Multiple or non-energy benefits of industrial energy efficiency projects have been estimated by various analysts and energy efficiency advocates for approximately 20 years. The main problem is that these estimates have usually occurred after the energy assessments and subsequent implementation of energy saving measures were performed. In some cases the estimates were derived using large data sets of industrial energy saving projects. In the vast majority of cases, the Return on Investment (ROI) metrics, e.g. simple payback, internal rate of return, net present value, etc., were significantly better once the quantifiable multiple benefits were included in these types of calculations. If multiple benefits, which can come in many different forms – cost savings in areas other than energy such as maintenance or purchases of treatment chemicals, better/greater output, reduced labor hours – can be quantified during energy assessments and integrated into the ROIs, a more realistic impact of the energy saving measures can be provided to the organizations receiving the assessments.

However, the significance of integrating multiple benefits of energy efficiency measures goes far beyond improving the ROI of a given energy-saving measure. Many types of organizations receive internal and external suggestions for improvement. As with projects intended to improve productivity, safety, environmental performance and other areas, energy projects compete for internal capital funding. Because manufacturers have limited amounts of capital to allocate, projects having worse ROIs, e.g. longer simple paybacks, tend to get lower priority for implementation. Therefore, projects that are evaluated based only on their energy savings can be disadvantaged when compared with other projects. By including multiple benefits in energy efficiency

measures, these types of projects can compete more effectively for corporate project funding.

In 2017, an effort was started in the European Union to develop tools, training and other resources to enable that can enable professional energy consultants and staffs at industrial companies to integrate multiple benefits of energy efficiency into the energy assessments that they conduct. The intention is to develop a platform of resources that can enable the determination and quantification of multiple benefits across the full spectrum of manufacturing plants. Entitled "Horizon 2020" this project, once completed, could provide a blueprint for estimating multiple benefits of industrial energy efficiency measures throughout the world. This paper will discuss the research leading up to Horizon 2020, the progress that Horizon 2020 has achieved so far and the expected benefits once the project is completed.

LITERATURE REVIEW

Research into multiple benefits and their impacts have been ongoing for at least two decades. Beginning with McKane and Pye (1999), Worrel et al. (2003), Lung (2005) and Laitner (2009) along with many other observers, multiple reports and assessments of industrial energy efficiency projects identified and quantified non-energy benefits that were derived when energy efficiency was implemented. Some reports indicated that the value of multiple benefits can be in the range of 40-50% of the value of energy savings per measure or as much as 2.5 times the value of energy savings (Lilly, P. and D. Pearson, 1999; Pearson and Skumatz, 2002).

Generally, non-energy or multiple benefits identified by these and other studies can be grouped in several categories across numerous sectors:

- Production (for example, increased production and production reliability, improved product quality, increased equipment life, shorter process cycle time, reduced raw materials use);
- Operation and maintenance (for instance, reduced maintenance, lower cooling requirements, reduced labor requirements, reduced need for engineering controls);
- Working environment (for instance, increased worker safety, reduced noise, improved air quality, improved temperature control, improved lighting);
- Waste (for instance, reduced waste water, reduced hazardous waste, use of waste fuel, heat, gas, materials reduction);
- Emissions (for instance, reduced CO, CO2, NOx, SOx emissions);

Operations and Maintenance	Production
Reduced maintenance costs	Reduced product waste
Reduced purchases of ancillary materials	Increased Production
Reduced water consumption	Improved product quality
Lower cooling requirements	Increased production reliability
Reduced labor costs	Shorter process/cycle time
Lower costs of treatment chemicals	
Work Environment	**Environmental**
Increased worker safety	Reduced hazardous waste
Reduced noise levels	Reduced dust emissions
Improved workstation air quality	Reduced waste water output
	Reduced CO, CO_2, NO_x, SO_x emissions
Other	
Achieved rebate/incentive (one-time)	
Reduced/eliminated demand charges	
Reduced/eliminated rental equipment costs	
Avoided/delayed costs (one-time)	

- Other (improved public/corporate image, improved worker morale, increased sales level).

The table below provides a compendium of multiple benefits grouped into several categories:

The underlying conclusion in each of these research efforts is that the impacts of energy efficiency are not fully understood and are understated when multiple benefits do not get captured. This minimizes the significance of energy efficiency and can also lead to inaccurate understandings of an organization's overall performance.

In 2014 the International Energy Agency (IEA) convened a round table with experts in the topic of multiple benefits to identify relevant evaluation frameworks for multiple benefits and support the development of any reports or tools that could help integrate multiple benefits of energy efficiency into programmatic and policy initiatives.

The goals of IEA's round table on multiple benefits in the industrial sector were to:

- Confirm that non-energy benefits related to industrial energy efficiency are quantifiable
- Confirm that there is value for stakeholders in collecting data on non-energy benefits, and including them in assessment of energy efficiency investments and programs.
- Provide guidance on the types of benefits that could be of relevance
- Provide guidance on possible approaches to quantifying non-energy benefits and using

quantified values in assessment of energy efficiency measures and programs

- Explore whether multipliers could be developed to calculate expected benefits or if a project by project approach is the only realistic option.

The outcome of the meeting yielded some important action items for IEA. First was to develop a comprehensive report on multiple benefits that would include the definition of multiple benefits, types of benefits that can be result from energy efficiency implementation, potential metrics that could be used to quantify them as well as potential macroeconomic, policy and health impacts that such benefits can have in sector models. A second action item was to establish a capacity-building module to educate experts, end users and other stakeholders into how to identify and assess multiple benefits of energy efficiency during the energy assessment phase or before implementation of energy-saving project.

The report integrated input from more than 300 experts from 27 countries and more than 60 organizations and was produced at the end of 2014. Entitled "Capturing the Multiple Benefits of Energy Efficiency," the report is intended to assist a wide variety of stakeholders including policy makers, program administrators, energy experts and end users to understand the full range of impacts of energy efficiency optimization efforts. The expectation is that it would build confidence in capturing multiple benefits and elevate the priority of energy efficiency projects/practices within society.

The report contains a chapter on industrial energy efficiency and multiple benefits. The overriding conclusion was that industrial energy efficiency measures deliver substantial benefits in addition to energy and energy cost savings. The report found that in manufacturing energy efficiency could enhance competitiveness, improve profitability, productivity and product quality. Energy efficiency can also improve safety of the work environment, reduce maintenance and raw materials costs as well as costs of environmental compliance. The report found that capturing multiple benefits in an industrial context can serve to align energy management with strategic business priorities and strengthen the business case for energy efficiency investments in comparison with other potential investments that manufacturing companies can undertake. The value of the productivity and other benefits derived from energy efficiency project implementation was found to be up to 2.5 times (250%) the value of energy savings. The report concluded that including such productivity outcomes in financial cost assessment frameworks can substantially reduce the payback period for energy efficiency investment, in some cases from four years to one year.

The IEA report also found that there is a lack of consensus on how to characterize and quantify multiple benefits. The report recommends gathering data and developing generally accepted methodologies for quantifying such benefits in order to have uniform and systematic approaches. Another insight from the report is that it is important to understand how investment decisions are made within industrial companies. Currently, most firms view energy efficiency as a cost-reducing effort. If it can be shown that energy efficiency can also increase value or mitigate risk, it can be seen as a more strategic endeavor the arguments for implementation could be more powerful for key constituencies within manufacturing organizations. In addition, different types of non-energy benefits can have greater importance depending on the industry sector, type of company and company priorities. Because some energy-saving projects can provide better process control they can also improve reliability and raw material consumption, which would be important for process industries such as chemicals, petroleum refining and pulp & paper production. To establish a systematic approach to quantifying multiple benefits the report suggests that more data be collected and that more methodologies be analyzed to understand causal relationships between energy consumption and other resource use in manufacturing.

Finally, the IAE report discussed the policy aspect and what role policy makers have with respect to multiple benefits. The prime conclusion is that policy makers have an important role in communicating non-energy benefits and educating industrial energy end users about them. For some industrial stakeholders, multiple benefits from energy efficiency efforts is either new or not easily understood. Effective communication and even educating employees in industrial organizations by an impartial public agency can be an important activity that could raise awareness and facilitate concurrence from industry.

The IAE report's overall conclusion is that the full scope of energy efficiency benefits is understated when only energy savings are considered in the decision-making process. Capturing and identifying non-energy benefits that could result from energy efficiency measures would lead to a truer understanding of the potential value from such efforts. Better data collection and methodologies for identifying non-energy benefits are needed. In addition, there needs to be some educating of managers and policymakers in order to integrate such

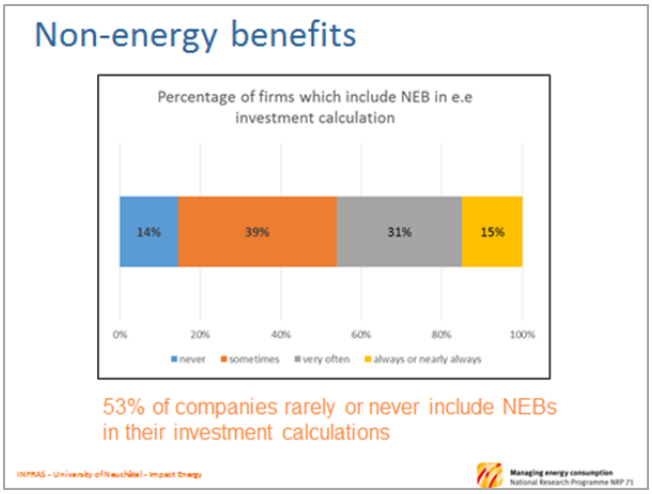
benefits into corporate decision-making and calculation related to energy efficiency investments. .

MULTIPLE BENEFITS OF ENERGY EFFICIENCY

Following the IEA report a group of stakeholders in Europe decided to generate a set of materials that could help account for and integrate non-energy benefits into corporate decision-making on energy efficiency. With a grant from the European Union (EU) and led by the Fraunhofer Institute, a project entitled "Including Multiple Benefits of Energy Efficiency in Investment Calculations," was started. The project team leveraged the conclusions of not only the IAE report, but conclusions by numerous experts in energy. Their initial finding is that there exists a lack of investment in energy-efficiency across many countries and sectors. Additionally, efforts initiated by various policymakers to improve energy efficiency and reduce greenhouse gas emissions have met inadequate results, which signifies that there is still significant potential to optimize energy consumption in many sectors of the economy.

The project team assessed common practices in the market and found some barriers to energy efficiency that they felt could be overcome if multiple benefits of energy efficiency were better understood. The biggest barrier is that most companies do not consider that using less energy or optimizing energy consumption contributes to their competitive advantage. As a result, there is not the same urgency that exists for productivity enhancements. Also, because firms have limited amounts of capital to allocate, energy efficiency investments compete with other possible investments within firms. Investments in projects that contribute more to what are seen as the core business tend to be selected more often. One disadvantage of energy efficiency investments is that they are usually only evaluated based on their energy-saving potential, which is not viewed as contributing to productivity of core practice areas. As a result they face highly stringent financial criteria such as rapid payback periods of less than 2 years, which tends to exclude many capital-intensive energy-saving projects.

Another assertion by the project team is that in many firms energy efficiency projects yield multiple benefits that support or enhance many of the core business practices. For manufacturing organizations, this includes productivity benefits such as better product quality, faster line speed, reductions in unplanned downtime, and lower rates of production waste. One important element of multiple benefits is the ability to quantify them so that they can factor into firms'' ROI calculations. According to the IEA's literature review, the monetary value of multiple benefits was found to be as much as 40% to 50% of the value of the energy savings per measure. This means that they could reduce paybacks of energy-efficiency projects by as much as half. The project team found, based on survey data that integrating multiple benefits does not often occur. This is largely because of lack of knowledge and ability to quantify multiple benefits and integrate them into ROI calculations.



PROJECT MISSION & GOALS

To overcome these gaps and improve the chances for energy-efficiency investments to be selected, the project team identified three goals that would need to be accomplished:

1) Methodology - a methodology would need to be established that appropriately categorizes multiple benefits in ways that are clear and convincing so that firms will want to assess them ex ante, during energy assessments, or at least before energy-saving projects are undertaken. The categorization can have different perspectives such as technical, operational and financial. In addition, the methodology needs to be able to take into account the time variations and measurability requirements of multiple benefits.

2) Data – in order to inform practitioners who perform energy assessments as well as personnel on the ground and corporate decision-makers, reliable data on multiple benefits must be identified and collected. Part of this effort includes identifying the appropriate, uniform metrics for the data and establishing data collection protocols. In addition, the collected data should be made available in a database after removing proprietary/sensitive information.

3) Training/communication – in order to get buy in from the market a convincing way to communicate about multiple benefits towards a wide range stakeholders needs to be developed. In addition, training for both energy experts and personnel within manufacturing and other organizations on how to identify and integrate multiple benefits needs to be provided.

IMPLEMENTATION & RESOURCES

To accomplish these goals the project team decided to develop a set of resources that will be delivered at the conclusion of the project. The first of these resources is a toolkit that will include several tools and templates to help assess, analyze and communicate multiple benefits. The toolkit will be based on an integrated approach of analysis (Cooremans 2015). This approach consists of linking energy, operational, strategic and financial analyses to fully evaluate the attractiveness of energy-efficiency investments.

One resource of the toolkit is an analytical tool to be used during energy assessments or prior to the start of implementation of energy-efficiency projects. The analytical tool will be used to identify and assess the potential multiple benefits. It will also include modules to identify and quantify significant multiple benefits that get uncovered during energy assessments. Another resource will be a communications tool to help present multiple benefits in a uniform and convincing manner. The communications tool is intended for use by employees of organizations, consultants as well as external program staffs. Another resource in the toolkit will be a spreadsheet tool that has financial calculators to integrate multiple benefits with energy savings in various corporate ROI formulae. Finally, there will also be a user's manual to facilitate understanding and use of the toolkit by the end users whether they are outside practitioners, e.g. engineers performing assessments, or internal staffs of the organizations under assessment.

The next resource to be developed is a multiple benefits database, which will contain data collected in the participating countries, organized by business activity, energy-efficiency measure type and geographical location. To create this resource the project team will undertake the following action items:

- Develop a survey tool to collect uniform data from different organizations in different countries.
- Establish a network of experts to collect robust multiple benefits data (based on actual examples in the field, best practices and metrics).
- Design and launch of a database of multiple benefits. The database will be organized by business activity/industry sector, energy-efficiency measure type and geographical location to enable easy searching. In addition, the database will be able to link to other similar databases within the EU and UN.

The next resource of the toolkit is on training and competence of personnel who will collect and apply multiple benefits. The prime audiences to receive the training are the engineers and consulting organizations including ESCOs that perform energy audits. This group is expected to be able to contribute to case studies and the multiple benefits database. The training will be delivered via in-person workshops, webinars and online courses to all engineers in charge of energy audits and of energy-efficiency projects in all participating countries of the EU. The training materials will include a "User Manual" to facilitate comprehension and use of the training tools by practitioners and a "Serious Game M-BENEFITS". Building on the very successful experience in the field of energy management, M-BENEFITS Serious Game will be developed as one of the main project's tools. A serious game is a game designed for a primary purpose other than pure entertainment. Based on a mix of virtual activities (simulation) and real activities (presentations and exchanges), this powerful educational tool explicitly emphasizes the added pedagogical value of fun and competition. Serious games develop participants' capacity to take on a complex problem in a global and systemic manner and high levels of competence in analysis, synthesis and evaluation.

Another resource involves the communications materials and their dissemination into the market. Throughout the project, dissemination activities will be performed such as communicating multiple benefits of energy efficiency as well as the contributions that such benefits can have. This effort is intended not only for engineers and personnel in manufacturing or other organizations, but also to academia, financial stakeholders, and the community of policymakers and energy-related program staffs to help them understand the potential that energy-saving measures can have on individual firms, but also on a national scale.

Communications materials include the main website, along with newsletters, case studies (digital and in print), webinars and social media content. Another feature of these materials will include a decision-making map, which will enable engineers and energy experts who perform energy assessments to consider key aspects of the decisional context when conceiving and planning their energy-efficiency projects. In addition, the project team intends to maintain a library of project reports and outputs including training materials and webinars.

Lastly, and one of the most important elements, are the pilot assessments that will implement the Toolkit. This will be accomplished by testing the Multiple Benefits Toolkit in multiple facilities that voluntarily agree to receive an energy assessment in which multiple benefits will also be estimated. These pilot assessments will be used to both refine the tools and resources in the Toolkit and to collect data. The facilities that participate will derive value from getting an energy assessment that also provides training on how to estimate multiple benefits by using the analytical tools and methods in the toolkit. The training will be given to both practitioners and facility personnel. The objectives of the pilot assessments including getting feedback on how well the resources work are to identify any gaps as well as develop a strategic understanding of how companies and organizations benefit from the analysis. Of particular interest is whether the organizations intend to continue to use and replicate the analysis in other projects. To accomplish this task the project team will solicit partners across multiple industry/market segments that are willing to test the Toolkit during an assessment. Also, these assessments will be turned into case studies to help generate interest in the topic. The project team intends to perform a minimum of 50 pilot projects that would train at least 300 people.

PILOT ASSESSMENTS

The assessment process will be undertaken to ensure that a broad network of stakeholders is actively involved in the project. This is to both benefit from the assessment and to provide feedback on the toolkit and the experience of integrating multiple benefits. Each assessment will be done in such a way to minimize the time burden on the stakeholders. The assessment team will encourage dialogue and exchange of views rather than a formal, structured audit process. This is expected to enable stakeholders to gain direct access to the ongoing lessons from the pilot assessments.

The first stage of the assessment process includes generating and sharing a summary description of the assessment, its aims and objectives, and the reason for seeking stakeholder input. Next, the assessment team will determine whether or not stakeholders already include non-energy benefits in their decision-making processes or in their negotiations with clients (for agents such as ESCOs of energy auditors). This will yield a brief report of current practice. Then, once the assessment is completed, the team will shift to a communication of a “best practice” approach for inclusion of multiple benefits in economic appraisals, derived from the evidence base generated in the assessment and leveraging lessons learned from other pilots. Once final results from the pilots become available, we will feed back key learnings and conclusions to stakeholders and validate them against their own experience and situation. The insight from stakeholders will be used to refine the final version of the toolkit.

Following a number of assessments in different sectors, communication strategies and dissemination approaches will be developed for each target audience and key stakeholder group. These strategies will describe specific audience/stakeholder communication objectives, tailored content to be developed, channels and channel development.

The main target group of the multiple benefits project is the companies potentially willing to invest in energy efficiency because the non-energy benefits evaluated by it. The companies may belong to a wide range of sectors including less energy-intensive sectors due to the focus on multiple benefits in different areas apart from energy efficiency.

The potential company can be addressed using national or EU-level policy for the implementation and support of energy-efficiency measures. The results can be used for the promotion of funding instruments to a broader range of companies like special credit lines by development banks or direct grants for energy-efficiency measures. As of the end of 2017, twenty-seven companies and other implementers, as well as nine policy makers and thirteen other stakeholders from the main target group have already signed a letter of intent stating their interest in the project results.

Another major target group are policy makers who have the ability to support and expand incentive programs for energy efficiency. Among those policy makers are members of the EU, national, regional and local administration as well as NGOs and other associations active in this field. They can benefit for the promotion of their activities with the use of a more in-depth scientific evidence base that acknowledges the multiple benefits of their promoted measures. The target group will be addressed using the project website and newsletter, as well as the

respective offerings of the project partners and their various communication channels from previous work. Furthermore the project can draw on the high visibility of European Council for an Energy Efficient Economy (ECEEE) and their stakeholder/partner events or workshops in concert with their conferences in 2018 and 2019.

Lastly, the project will target the general public. All publications that have not been marked as confidential will be provided free of charge on the project website. The scientific publications will be published under open access conditions, when the journals allow this.

A follow on project of this task is to apply the multiple benefits and integrate them into the data collection approach and survey tool in the toolkit. As a part of this task the energy, technical, operational, strategic and financial aspects of the energy efficiency projects uncovered in the assessments will be evaluated. For this purpose key parameters, input data and metrics will be collected, measured or estimated. These include metrics for energy services, process data, product quality, working environment, market information and user-need requirements. Correlations will be applied to translate the identified relevant multiple benefits into concrete monetized savings, where possible. The expected outcomes of this task are to create comprehensive financial evaluations of the energy efficiency projects uncovered in the pilot assessments that include the assessed multiple benefits. These outcomes will be also transferred to the evidence-base data collection. The specific materials and content to be produced will include:

- folders/brochures describing the value proposition for key industry and business audiences/stakeholders, including companies targeted for pilots and trainings
- posters for conferences/events highlighting project objectives, findings/key information, partner logos and link to the website etc.
- web/digital summaries of progress, deliverables/reports, key findings and tools produced across all work packages
- news releases/promotions (digital) to market new products/tools developed, trainings/webinars and events.

CONCLUSION

The exclusion of non-energy or multiple benefits from energy efficiency measures and discrete projects leads to an under appreciation of the impacts of energy efficiency and misallocation of resources when the return on investments from energy savings only are integrated into corporate financial models used to justify investments. While numerous observers have found a wide array of multiple benefits that result from energy efficiency projects the systematic identification and integration of multiple benefits has lagged. This effort by the multiple benefits team should meet an important gap in the market by implementing energy assessments in which potential energy and non-energy benefits will also evaluated. In addition, this effort seeks to train a wide range of stakeholders including energy end use companies/organizations, consulting organizations, energy utilities, policymakers and other stakeholders to seek, identify and quantify non-energy benefits during energy assessments or before energy-saving projects are implemented. Doing this should not only enhance the payback or returns of energy-saving projects, but also help outside experts as well as employees in organizations that receive energy assessments to appreciate the full impacts of the energy-saving measures they uncover. If this approach can be generalized in the market, then it's possible that energy efficiency projects could be more compelling and could be implemented at higher rates due to the increased attractiveness based on the improved business cases that multiple benefits can generate.

Future work could focus on the impact of energy efficiency on economic growth or productivity using production/growth models. Without the integration of multiple benefits, such models can lack the precision that enables good decision-making, whether at the level of a firm or a state, which can have important repercussions for forecasts of a firm's output to GDP growth and economic policy. Productivity and growth models that take account of energy savings resulting from productivity improvements can become more properly characterized and can therefore, provide more exact and robust estimates of energy production and consumption. By taking into account energy savings from productivity improvements, truer impacts of energy efficiency and productivity projects should be enabled.

REFERENCES

1. Capturing the Multiple Benefits of Energy Efficiency, International Energy Agency, 2014.
2. Cooremans, Catherine and Barbara Schloman "M-BENEFITS: Valuing and communicating the multiple benefits of energy efficiency projects," Brussels, Belgium, 2018.
3. Imbierowicz, Karen, Lisa Skumatz and John Gardner. "Net NEB Multipliers for Economic Impacts: Detailed Analysis of Differences by Program and State." In: Proceedings 2006 Summer Study on Energy Efficiency in Buildings. Monterey, CA. American Council for an Energy Efficient Economy, 2006.
4. Laitner, John A. et al. "Room for Improvement: Increasing the Value of Energy Modeling for Policy Analysis." Utilities Policy, 2003.
5. Lung, Robert B. et al. "Ancillary Savings and Production Benefits in the Evaluation of Industrial Energy Efficiency Measures." In: Proceedings 2005 Summer Study on Energy Efficiency in Industry. West Point, NY: American Council for an Energy Efficient Economy; 2005, 193-203.
6. McKane A, Pye, Myriam. "Enhancing Shareholder Value, Making a More Compelling Energy Efficiency Case to Industry by Quantifying Non-Energy Benefits." In: Proceedings 1999 Summer Study on Energy Efficiency in Industry. Washington D.C.: American Council for an Energy Efficient Economy; 1999, 325-36.
7. Worrell, Ernst, John A. Laitner, Michael Ruth & Hodayah Finman. Productivity Benefits of Industrial Energy Efficiency Measures. Energy 11 28 pp.1081-1098 (2003).