PRACTITIONERS' DIALOGUE ON CLIMATE INVESTMENTS

ENABLING INITIATIVES TOWARDS MAINSTREAMING AND UPSCALING THE APPLICATION OF ENERGY- EFFICIENT TECHNOLOGY IN INDUSTRIES

Report for the Practitioners' Dialogue on Climate Investments (PDCI

Federal Ministry for Economic Cooperation and Development

implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Title:	Enabling Initiatives Towards Mainstreaming and Upscaling the Application of Energy-Efficient Technology in Industries
Date:	September 30, 2016
Commissioned by:	The Practitioners' Dialogue on Climate Investments (PDCI) Deutsche Gesellschaft für Internationale Zusammenarbeit (GTZ) GmbH.
Author:	Corazon D. Conde **,** Group Head, ADFIAP Consulting
Organisation:	Association of Development Financing Institutions in Asia and the Pacific (ADFIAP)
Contact:	aconsulting@adfiap.org

Federal Ministry for Economic Cooperation and Development

implemented by
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Content

Abbreviations

BTU	British Thermal Units equal to 1055 joules
CO2	Carbon Dioxide
COP 21	Paris Climate Conference
DFI	Development Finance Institution
ECOFIN	Environmental Consultation and Financing Unit
EJ	Exajoule or one quintillion joules
ESCO	Energy Service Company
GHG	Greenhouse Gas
GIZ	Gesellschaft für Internationale Zusammenarbeit
GRR	Grid Rotor Resistance
GT	Gigaton or Billion Tons
GWH	Gigawatt Hour equal to one billion watt hours, one thousand megawatt Hours, 3.6 terajoules or 3.42 billion British Thermal Units
HVAC	Heating, Venting and Cooling
IEA	International Energy Agency
IEC	International Electrotechnical Commission
J	Joule or energy transferred to an object
KWh	Kilowatt hour equal to 3.6 megajoules
MMBtu	One million British Thermal Units euqal to 1.06 joules
MV VFD	Medium Voltage Variable Frequency Drives
PCSIR	Pakistan Council of Scientific and Industrial Research

Acknowledgements

The completion of this undertaking could not have been possible without the valuable inputs and guidance of the members of Working Group 4 ("Supporting Energy-Efficiency Improvements in Industrial Production") composed of **Prototype Developers**, Ms. Rafaelita Aldaba of the Department of Trade & Industry-Board of Investments, Philippines; Mr. Vicente Co, Vice of the Philippine Plastics Industry Association; Mr. Kabil Dahman, of the Ministry of Finance-Tunisia; Ms. Iffat Farooq of the Energy Department Punjab; Mr. Churchill Norbert of the Department of Energy – Antigua and Barbuda; Mr. Alejandro Velasco of Quality Energy Solutions-Columbia; Mr. Manfred Kopper, of the Entrepreneurial Association for Development, Costa Rica; **Advisors** Mr. Venkatagiri Kramadhati Sivaramakrishnan, Executive Director Designate of the Confederation of Indian Industry; Mr. Kishan Kumar Chakarvarti, Senior Advisor of the Institute for Industry Productivity, India; Mr. Steve Piro, Founder and CEO of Synergy Efficiency Solutions, Indonesia; and **Policy Author** Mr. Victor Abainza of the Association of Development Financing Institutions in Asia and the Pacific. Their contributions are sincerely appreciated and gratefully acknowledged.

I would also like to acknowledge with thanks the commendable initiatives, kind patronage, encouragement and all-out support of Mr. Mirko Zuerker, Working Group 4 Moderator and Senior Project Manager, Adelphi; and Mr. Frederic Wils, Ms. Denise Engel, Ms. Isabel von Griesheim and Ms. Ekaterina Parfenova of GIZ GmbH.

Lastly, thank you to all the participants of the Practitioners Dialogue on Climate Investments (PDCI) for the information sharing, exchange of experiences and best practices and productive networking. The PDCI has indeed been an effective platform that facilitated the exchange of ideas towards the design of innovative prototype policy instruments and other solutions to scale up financial flows in low-emission development and encourage private sector investments in climate-resilience measures.

Executive Summary

This Policy Brief presents enabling initiatives proposed to be undertaken by major stakeholders to promote the culture change needed to mainstream and upscale the application of energy-efficient technology in industries for industrial energy efficiency to be realized and sustained over time.

Based on studies, industry consumes almost 40% of global energy, with Chemicals and Petrochemicals; Aluminum and Steel; Cement; and Pulp and Paper responsible for about 45% of all business and public sector greenhouse gas emissions. Accelerating improvements in energy efficiency of industrial production, particularly in these sectors, should, therefore, be prioritized to achieve the less than 2 degrees Celsius global temperature agreed upon by 195 countries at the Paris Climate Conference (COP21) in December 2015.

Analysis of industry shows that the application of proven technologies and best practices on a global scale could save between 25EJ and 37 EJ per year, which represents between 18% and 26% of current primary energy use in industry. The associated CO2 emissions savings are 1.9 Gt CO2 to 3.2 Gt CO2 per year.

Resource-efficient technologies and measures that can substantially reduce the ecological footprint of energy-intensive industries already exist, but they fall short of full deployment for a number of reasons. The most common of these reasons are challenges or barriers falling under the categories of Management, Knowledge and Information, Financing, Policy and Technology and Skills.

It is recommended that Industries develop new management approaches in order to fully exploit opportunities for increased energy efficiency, especially by increasing awareness of their energy consumption and savings in the long term and instilling energy efficiency as an intrinsic value within their corporate culture. Governments need to create an environment that rewards energy efficient choices and encourages innovation through economic and financial incentives. Financial Institutions should think and act “out-of-the box” and take a pro-active stance in developing and adopting new financing structures and schemes. Collaboration amongst the various stakeholders such as industry associations and chambers, international agencies, academe, technical experts and government should be strengthened and rationalized through the designation of a pro-active umbrella agency that would act as a coordinating body to broaden coalition, trigger synergies that foster technology improvements and knowledge sharing and harmonize all environment-related policies and regulations.

The concerted effort and genuine commitment from both the public and private sectors is imperative to mainstream and upscale the application of energy-efficient technolog in industries.

1. Introduction to the Policy Brief

The industrial sector represents more than one third of both global primary energy use and energy-related carbon dioxide emissions. In developing countries, the portion of the energy supply consumed by the industrial sector is often in excess of 50%. Therefore, countries with an emerging and rapidly expanding industrial infrastructure have the opportunity to increase their competitiveness by applying energy-efficient best practices in new as well as existing industrial facilities. Despite this potential and the need to accelerate improvements in energy efficiency to achieve the less than 2 degrees Celsius global temperature agreed upon by 195 countries at the Paris Climate Conference (COP21) in December 2015, policymakers frequently overlook the opportunities presented by industrial energy efficiency to have a significant impact on climate change mitigation, security of energy supply and sustainability.

Energy efficiency offers a wide, low-cost energy resource for the industrial sector - but only if there would be a comprehensive and innovative approach to unlock it. Notable challenges and barriers have to be addressed at multiple levels to create traction and sustain demand for energy efficiency and promote and manage its delivery across the industrial sector, specifically to top energy-intensive industries such as chemicals and petrochemicals, aluminum and steel, cement, and pulp and paper which are responsible for about 45% of all business and public sector greenhouse gas emissions.

Resource-efficient technologies and measures that can substantially reduce the ecological footprint of energy-intensive industries already exist. They fall short of full deployment for a number of reasons. It is essential for policy makers to mainstream these technologies in policies with implementable guidelines that include a green mandate. The implementation process should be strengthened to include interventions such as technical capacity building, ensuring access to adequate financing, and establishing accountability and monitoring mechanisms. This Policy Brief presents a portfolio of enabling initiatives aimed at mainstreaming and up-scaling energy efficiency in industrial production.

Background

The industry sector covers the manufacture of finished goods and products, mining and quarrying of raw materials and construction. Industry uses almost 40% of worldwide energy. It contributes about 37% of the global greenhouse gas emissions (GHG), of which over 80% is from energy use. Total energy-related emissions, which were 9.9 GtCo2 in 2004, have grown by 65% since 1971. Energy efficiency is potentially the most important and cost-effective means for mitigating GHG from industry.

Analysis of industry shows that the application of proven technologies and best practices on a global scale could save between 25EJ and 37 EJ per year, which represents between 18% to 26% technical savings potential. The associated CO2 emissions savings are 1.9 Gt CO2 to 3.2 Gt CO2 per year, representing 19% to 32% technical savings potential. ANNEX A shows the savings from adoption of best practice commercial technologies of some energy intensive industries which are among those covered in this policy brief.

Opportunities to improve energy efficiency are found throughout the industrial sector. Assessments of cost-effective efficiency improvement opportunities in energy-intensive industries in the United States, such as cement and paper manufacturing, found cost-effective savings of 16% to 18%; even greater savings can often be realized in developing countries where old, inefficient technologies have continued to be used to meet growing material demands.

Improved energy system efficiency can also contribute to a company's bottom line by increased production through better utilization of equipment assets, greater reliability and reduced maintenance costs. Payback periods for system optimization projects are typically short – from a few months to three years – and involve commercially available products and accepted engineering practices.

2. Case Studies on Good Energy Efficiency Practices

Discussed below are top energy-intensive sectors/industries and case studies on good energy efficiency practices that may be replicated:

Box 1: Plastic

Part of the **Chemical and Petrochemical Sector** where energy use was 34 EJ in 2005, making it the *largest industrial consumer of energy*, is the **plastic industry** which manufactures polymer materials and offers services in plastics important to a range of industries, including packaging, building and construction, electronics, aerospace and transportation. The plastic industry can save money in all areas of operations by investing in energy efficiency. Technology makes it possible to re-equip a factory for lower operating costs. Potential areas for investment to reduce energy use and costs include all electric injection moulding machines; cooling water treatment; polymer drying; polymer transport and conveying; lighting schemes and controls; compressors and controls. These are all projects where current technology has proven energy saving benefits. Typical projects have paybacks ranging from under 4 years and often as low as 9 months.

Case Study: *Superfos Packaging*, one of the largest plastic packaging specialists in Europe, develops and produces injection-moulded rigid containers with open tops. Energy costs at the plant in Cumberland, Maryland total to about $760,000 annually, most of which is for electricity and the remainder for natural gas. By putting into practice energy audit recommendations of the West Virginia University's Industrial Assessment Center's recommendations, electricity consumption was reduced by 2.3 million kWh or 7.950 MMBtu translating to cost savings of nearly $100,000 per year. Furthermore, the company's actions improved environmental performance, reducing CO2 emissions by more than 5 million pounds per year. The implemented recommendations are shown in ANNEX B.

Box 2: Fan

Fan industrial production is part of the **Aluminum and Steel Sector** where it sources its raw materials of electric steel sheets, aluminum, aluminum blades, and steel rod. Said sector is the *second largest industrial user of energy,* consuming 23 EJ in 2005 and the largest industrial source of CO2 emissions. Fans use approximately 40% of all electricity in Heating, Venting and Cooling (HVAC) systems, hence, on the average, have a huge energy improvement potential. Up to 50% of electricity for fans could be saved just by designing and installing more energy efficient fans and introducing better control strategies.

Case Study: *Pakistan Electric Fan Industry* - Pakistan is one of the major fans producing countries. The production of Pakistan fan industry is 10 million domestic fans per annum with an estimated value of Rs 18 billion, utilizing only 50% efficiency. The global demand for domestic fans is well in excess of the US$4 billion per year. However, Pakistan only exports US$ 40 million per year that is only a fraction of 1%. The electric fan industry of Pakistan is faced with multiple problems such as non-compliance with International Electrotechnical Commission (IEC) standards; non-availability of quality materials and components; inadequate technology upgrade; and shortage of skilled staff. While the Pakistan Council of Scientific and Industrial Research (PCSIR) testing facilities are equipped with the state of the art equipment, the capacity of PCSIR needs to be enhanced through technical and financial assistance for laboratory infrastructure, additional test equipment and training of laboratory staff.

Box 2: Fan (cont.)

Electric fans of inferior quality consume 150-160 watts, whereas efficient fans consume only 80 watts. Potential of energy conservation in Pakistan for fans by 2019 is 3000 GWH. ENERCON survey suggested in 2010 that if fan manufacturers improve only 10% efficiency, then power consumption will be reduced from 6500 GWH to 3500n GWH with a net savings of 3000 GWH.

The Energy Department Punjab is proposing the establishment of a modern and organized common facility center for fan testing, labeling, stamping press, hydraulic press slitting lines, engraving and boring services for the Pakistan Electric Fan Industry. This aims to address the multiple problems mentioned above and address the gaps faced by the PCSIR to support energy efficiency and promote a conducive investment climate for fan industrial production. The proposed laboratory will also be used as a research and training center for fan manufacturers to ensure high quality and low energy fan production. Coupled with energy efficiency improvement in fan production, the proposed project will boost exports of the fan industry leading to increased global market share and increased foreign exchange revenues, which is a win-win situation from the economic, environmental and social viewpoints.

Box 3: Cement

The **cement industry** uses about 8 EJ of energy per year and is the *third largest industrial consumer of energy*. The production of cement is very energy and carbon intensive. Dry, semi-dry, semi-wet and wet processes are the four main process routes that are used for the production of cement. Dry processes are considerably more energy efficient than the wet processes since under the latter, water is evaporated from the mixture of limestone and clay and this step in the production requires significant amounts of energy compared to the former where raw materials are mixed without water, therefore, the evaporation process can be omitted. The International Energy Agency (IEA) (2007) estimates that the global cement industry could save between 28 and 33% of total energy use and a CO2 savings of 210 Mt by the adoption of best practice commercial technologies. The largest opportunities for improving energy efficiency and reducing CO2 emissions can be achieved by improving the cement manufacturing and production processes which would entail changing energy management and by investing in new equipment and/or upgrades.

ANNEX C indicates energy efficiency measures in dry process cement plants based on the average performance of the U.S. cement industry.

Case Study: *Mangalam Cement* located at Morak Dist. Kota, Rajasthan installed Medium Voltage Variable Frequency Drives (MV VFD) in place of Grid Rotor Resistance (GRR) for Line-1 Kiln hybrid bag house fan and achieved 160 kW savings in power consumption. The details of savings and investment are as follows:

Description	Before (with GRR)	After (With VFD)
Average power consumption	290 kW	130 kW
Savings in power	160 kW	
Annual Savings	Rs.6.97 Million	
Investment	Rs. 6.0 Million	
Simple Payback Period	10 months	

Box 4: Pulp and Paper

The **pulp and paper industry** is the *fourth largest industrial user of energy*, consuming 6.4 EJ in 2005 and accounted for 5% of industrial CO2 equivalent emissions in 2010. Approximately two-thirds of final energy consumption is fuel that is used to produce heat, while the remaining third is electricity, either from the grid or produced on-site. Energy consumption could be reduced by 15% to 18% by adopting the best practice commercial technologies in ANNEX D

Case Study: *International Paper*'s manufacturing processes generate and consume large amounts of energy. For well over a decade, said firm based in Memphis, Tennessee, has been focused on improving its energy efficiency. During the past five years, it has invested $424 million to reduce its annual energy purchases by 14 trillion British Thermal Units (BTUs). This energy reduction is equal to 4,500 rail cars of coal or the energy to heat a Midwestern town of 125,000 people for a year. International Paper employs the kraft pulping process which cooks wood in an alkaline solution and separates the wood fiber from the natural glues and sugars that hold the tree together. Paper is then made from the fibers and the separated sugars are used as a biofuel burned to create energy.

Its energy production uses additional biomass-based energy sources such as forest residuals like bark. This efficient use of resources enables its mills to be about 72% fueled by renewable carbon-neutral biomass. The same trees that provide the wood fiber for its products also efficiently provide the majority of the energy to make the products themselves. The company purchases fuels and electricity for the remaining 28% energy needed to power its mills. In 2014, energy efficiency in its mills improved by 6.1% compared with its 2010 baseline.

3. Key Challenges

Despite the existence of cost-effective industrial energy efficiency technologies and measures, studies indicate that these measures are not always implemented due to the prevalence of critical limiting factors. The following categories of challenges or barriers to energy efficiency have been identified as the most common:

CATEGORIES	INDICATORS
Management	• Lack of awareness at company top management level of energy efficiency which is the root cause of other barriers such as: - Management finds production more important; - Management is concerned about investment costs of energy efficiency measures; - Lack of policies, systems, energy/environment managers within companies; - Lack of integration of energy into core business management and reporting.
Knowledge and Information	This challenge covers the following: • Limited access to and availability of technical information; • Limited technical knowledge at company level and facilitating organizations; • Limited appreciation of the link between energy efficiency, cost savings, improved productivity; among industries as well as industrial energy efficiency programs of government; • Absence of harmonized regional standards.
Financing	Almost all companies are faced with the following financial limitations in implementing energy efficiency options:

	• Difficulty in obtaining external financing for energy efficiency projects due to perceived risk in financing such projects stemmingfrom the banks' lack of understanding and technical/financial skills to undertake risk-based appraisal thereof; • Limited information and awareness about the financial or qualitative benefits of energy efficiency investments and technologies and lack of familiarity with energy efficient products; • Lack of credit history or collateral as well as lack of experience in preparing project and loan request documents.
Policy	While companies hold the key to reducing their energy consumption, government policy certainly has a big influence. Identified as challenges relative thereto are the following: • Weak legislation resulting to non-alignment of policy with implementing guidelines; • Limited financial incentives by government for energy efficiency; • Irrational (subsidized) energy pricing policies; • Weak contract enforcement leading to increased perceived risk by financial institutions, manufacturers and service providers; • Timeliness of policy formulation and political will on enforcement
Technology and Skills	The following challenges deter the implementation of energy efficiency improvements: • Inadequate skills to implement energy use reduction measures; • Limited technical capacity among government agencies tasked to implement and monitor policies and programs on industrial energy efficiency; • Limited access to systems and skills for the measurement, monitoring and verification of reduced energy use; • Absence of supportive enabling environment for technology transfer, including opposition from "vested interests"/lobby groups.

4. Key Recommendations

To effectively address the aforementioned challenges, the concerted effort and genuine commitment from both the public and private sectors towards the pursuance of energy efficiency improvements is imperative. Governments need to create an environment that rewards energy efficient choices and encourages innovation. Industries and financing institutions should think and act "out-of-the box" and take a pro-active stance in developing and adopting new management approaches and financing schemes, respectively. Hereunder are some enabling initiatives proposed to be undertaken by major stakeholders to upscale the application of energy-efficient technology in industries:

CATEGORIES	INITIATORS/PLAYERS	ENABLING INITIATIVES
Management	A "Green Champion" from the Board or top management	• Adopt Energy Efficiency Awareness Program - Assemble a Green Team - Establish baseline of energy consumption - Formulate objectives - Develop communication plan - Give recognition and awards to encourage staff participation - Implement program activities - Evaluate program, track results, adapt approach to changing needs - Celebrate and share success to sustain energy-use reduction momentum • Identify Energy Efficiency Opportunities in Infrastructures and Operations - Integrate energy efficiency in business practices - Consider new business approach to make it possible to invest in energy savings • Instill energy efficiency as an intrinsic value within the corporate culture and give recognition & awards to encourage organization-wide participation
Knowledge and Information	Collaboration amongst the company, industry associations and chambers, international agencies and government	• International cooperation on energy efficiency policies can trigger synergies that foster technology improvements through removal of barriers in the deployment of technologies in the marketplace • Adopt benchmarking and comparative analysis that provide valuable indicators in energy efficiencies, operating expenses, manufacturing costs and return on investments • Create an enabling framework for use of existing efficient technologies, development of innovative technologies and deployment of said technologies
Financing	Development Finance Institutions (DFIs), private banks, multilateral and bilateral funding agencies and government	• Create an Environmental Consultation and Financing Unit (ECOFIN) in DFIs and private banks to provide advisory and consultation services to SMEs with green projects and offer demand-driven green financing products and services and provide financing to green projects • Leverage private finance through co-

		financing or loan syndications, provision of loan guarantees, energy savings insurance, revolving fund and partnership with Energy Service Companies (ESCOs) • Source green funds with technical assistance/grant components from multilateral and bilateral funding agencies backed up by government guarantee bearing low interest rate and longer repayment term for on-lending to private banks or direct lending to green projects. Using the technical assistance/grant component of said funds, help clean technology start ups and business incubators understand the market potential of energy efficiency solutions through energy efficiency accelerator programs and build their capacities to develop bankable projects for financing
Policy	Government and other stakeholders	• Designate a pro-active umbrella agency that would act as a coordinating body to broaden coalition to include other stakeholders such as civil society, business associations and chambers, academe, guilds, and local government units that would harmonize all environment-related policies and regulations, be responsible for their strict enforcement as well as the monitoring of compliance thereto. • Develop policy incentives and innovative market mechanisms to reinforce the market for energy efficiency: - Appropriate energy pricing - Enhanced economic incentives - Public technical support to promote energy efficient industrial systems - Labels and Certificates to stimulate market adoption of energy efficient technologies - Voluntary Agreements and Public Private Partnerships as mechanisms for promoting energy efficiency within the industrial sector - Set Energy Management Standards (ISO 50001) to provide guidance for industrial facilities to integrate energy efficiency into their management practices and production processes and to serve as tool to keep the continued improvement of energy efficiency on track.

Technology and Skills	Collaboration amongst the company, industry associations and chambers, technical experts and government	• Provide intensive technical training to build capacities and create a cadre of highly skilled system optimization experts • Establish common laboratory facilities that will serve as training centre for dissemination of knowledge and research, project incubator and provide testing, labeling and certification of energy performance

5. Conclusion

- Industry accounts for about one quarter of total global energy consumption. Energy efficiency in this sector is, therefore, a fundamental element in the progression towards a future low-carbon economy.

- There is a strong business case for energy efficiency. It enables companies to save costs, improve their competitiveness and overall productivity. Energy management and existing technology provide a huge savings potential with short payback periods. Yet, there remains a gap between the available energy efficiency measures and those actually undertaken by companies.

- Businesses should develop new management approaches in order to fully exploit opportunities for increased energy efficiency, especially by increasing awareness of their energy consumption and savings in the long term and instilling energy efficiency as an intrinsic value within their corporate culture.

- Government needs to create a conducive policy environment that encourages energy-efficient choices and innovation. Economic and financial initiatives such as appropriate energy pricing and enhanced incentives, government support for technical assistance, energy management standards, professional training and consulting, research, development, and reinforcing international cooperation to enhance knowledge and information are initial steps.

- Financial Institutions should think and act “out-of-the box” and take a pro-active stance in developing and adopting new financing structures and schemes.

- Reinforcing the market for energy efficiency through innovative mechanisms, such as voluntary agreements, standards, labels, public-private partnerships, energy performance contracting and availability of various financing schemes can lead to increased certainty and demand for energy efficiency which will foster private sector initiatives.

- There is a need by Government to designate a pro-active umbrella agency that would act as a coordinating body among the different ministries involved in environmental protection and related activities to broaden coalition, trigger synergies that foster technology improvements and knowledge sharing and harmonize all environment-related policies and regulations and ensure strict enforcement and monitoring of compliance thereto.

- The successful mainstreaming and up-scaling of the application of energy efficient technology in industries requires the concerted effort of the private sector and government in introducing enabling initiatives to promote the culture change needed for industrial energy efficiency to be realized and sustained over time.

6. Annex

ANNEX A

Savings From Adoption of Best Practice Commercial Technologies of Energy Intensive Industries

	Low-High Estimates of Technical Savings Potential	
Sectoral Improvements	**Mtoe/year**	**MtCo2/year**
Chemicals/petrochemicals	120-155	370-470
Iron and Steel	55-108	220-360
Cement	60-72	480-520
Pulp and paper	31-36	52-105
Aluminum	7-10	20-30
Other non-metallic minerals & non-ferrous	12-24	40-70
System/life cycle Improvements		
Motor systems	143-191	340-750
Combined heat and power	48-72	110-170
Steam systems	36-60	110-180
Process integration	24-60	70-180
Increased recycling	36-60	80-210
Energy recovery	36-55	80-190
Total	600-900	1,900-3,200
Global improvement potential – share of industrial energy use end CO2 emissions	18-26%	19-32%
Global improvement potential – share of total energy use and CO2 emissions	5.4-8.0%	7.4-12.4%

Source: IEA 2007. Tracking Industrial Energy Efficiency and Co2 Emissions

ANNEX B

CASE STUDY: SUPERFOS PACKAGING - RECOMMENDATIONS THAT IMPROVED ENVIRONMENTAL PERFORMANCE

Project Category/ Recommendation	Annual Resources Savings	Annual Cost Savings	Implementation Cost	Payback Period
Process Insulate molding machine surfaces	5,464 MMBtu	$76,401	$2,253	1.2 mos.
Motor Implement motor management system	1,500 MMBtu	$8,388	$480	1.2 mos.
Compressed Air System - Reduce compressor air pressure - Repair compressed air leaks	484 MMBtu 245 MMBtu	$6,764 $3,425	$128 $250	1.2 mos. 1.2 mos.
Lighting - Replace 400-W metal halide bulbs with 360W - Install occupancy sensors	197 MMBtu 60 MMBtu	$6,764 $839	0 $800	Immediate 1 year
Total	**7,950 MMBtu/yr**	**$98,542**	**$3,911**	

ANNEX C

ENERGY EFFICIENCY MEASURES IN DRY PROCESS CEMENT PLANTS BASED ON THE AVERAGE PERFORMANCE OF THE U.S. CEMENT INDUSTRY

Energy Efficiency Measure	Specific Fuel Savings (MBtu/ton cement)	Specific Electricity Savings (kWh/ton cement)	Estimated Payback Period (1) (years)
Raw Materials Preparation			
Efficient Transport System	-	3.2	> 10 (1)
Raw Meal Blending	-	1.5 – 3.9	N/A (1)
Process Control Vertical Mill	-	0.8 – 1.0	1
High-Efficiency Roller Mill	-	10.2 – 11.9	> 10 (1)
High-Efficiency Classifiers	-	4.3 – 5.8	> 10 (1)
Fuel Preparation: Roller Mills	-	0.7 – 1.1	N/A (1)
Clinker Making			
Energy Management & Control Systems	0.10 – 0.20	1.2 – 2.6	1 – 3
Seal Replacement	0.02	-	< 1
Combustion System Improvement	0.10 – 0.39	-	2 – 3
Indirect Firing	0.13 – 0.19	-	N/A
Shell Heat Loss Reduction	0.09 – 0.31	-	1
Optimize Grate Cooler	0.06- 0.12	0 - -1.8	1 – 2
Conversion to Grate Cooler	0.23	-2.4	1 – 2
Heat Recovery for Power Generation	-	18	3
Low-pressure Drop Suspension Preheaters	-	0.5 – 3.5	> 10 (1)
Addition of Precalciner or Upgrade	0.12 – 0.54	-	5 (1)
Conversion of Long Dry Kiln to Preheater		0.36 – 0.73	> 10 (1)
Conversion of Long Dry Kiln to Precalciner		0.55 - 1.10	> 10 (1)
Efficient Mill Drives	-	0.8 – 3.2	1
Use of Secondary Fuels	> 0.5	-	1
Finish Grinding			
Energy Management & Process Control	-	1.6	< 1
Improved Grinding Media in Ball Mills	-	1.8	8 (1)
High Pressure Roller Press	-	7 – 25	> 10 (1)
High-Efficiency Classifiers	-	1.7 – 6.0	> 10 (1)
Plant Wide Measures			
Preventative Maintenance	0.04	0 – 5	< 1
High Efficiency Motors	-	0 – 5	< 1
Adjustable Speed Drives	-	5.5 – 7.0	2- 3
Optimization of Compressed Air Systems	-	0 – 2	< 3
Efficient Lighting	-	0 – 0.5	N/A
Product Change			
Blended Cement	1.21	-15	< 1
Limestone Portland Cement	0.30	3.0	< 1
Use of Steel Slag in Clinker (CemStar)	0.16	-	< 2
Low Alkali Cement	0.16 – 0.4	N/A	Immediate
Reduced Fineness of Cement for Selected Uses	-	0 – 14	Immediate

Source: Energy Efficiency Improvement and Cost Saving Saving Opportunities for Cement Making, Ernst Worrel and Christina Galitsky, Berkley Lab, March 2008

ANNEX D

BEST PRACTICE COMMERCIAL TECHNOLOGIES FOR PULP & PAPER INDUSTRY

Sector	Energy Efficiency Opportunities
Pulp and paper – raw materials preparation	• Cradle debarkers • Automatic chip handling and screening • Replace pneumatic chip conveyors with belt conveyors • Bar-type chip screening • Use secondary heat instead of steam in de-barking • Chip conditioning
Chemical pulping - pulping	• Use of pulping aids to increase yields • Digester blow/flash heat recovery • Optimize the dilution factor control • Heat recovery from bleach plant effluents • Continuous digester control system • Improved brownstock washing • Digester improvement • Chlorine dioxide heat exchange
Chemical pulping - bleaching	• Heat recovery from bleach plan effluents • Chlorine dioxide heat exchange • Improved brownstock washing
Chemical pulping – chemical recovery	• Lime kiln oxygen enrichment • Improved composite tubes for recovery boiler • Lime kiln modification • Recovery boiler deposition monitoring • Lime kiln electrostatic precipitation • Quaternary air injection • Black liquor solids concentration
Mechanical pulping	• Refiner improvements • Increase use of recycle pulp • Refiner optimization for overall energy use • Heat recovery from de-inking plant • Pressurized groundwood • Fractionation of recycled fibers • Continuous repulping • Thermopulping • Efficient repulping rotors • Drum pulpers • Heat recovery in thermomechanical pulp
Paper making	• Advanced dryer controls • Waste heat recovery • Conrol of dew point • Vacuum nip press • Energy-efficient dewatering-rewetting • Shoe (extended nip) press • Dryers bars and stationary siphons • Reduction of blow through losses • Belt drying • Reduction air requirements • Air impingement drying • Optimizing pocket ventilation temperature

ANNEX E

DETAILED RECOMMENDATIONS TO ADDRESS THE CHALLENGES FOR MAINSTREAMING AND UPSCALING ENERGY EFFICIENCY IN INDUSTRIAL PRODUCTION

To effectively address the aforementioned challenges, the concerted effort and genuine commitment from both the public and private sectors towards the pursuance of energy efficiency improvements is imperative. Governments need to create an environment that rewards energy efficient choices and encourages innovation. Industries and financing institutions should think and act "out-of-the box" and take a pro-active stance in developing and adopting new management approaches and financing schemes, respectively. Hereunder are some enabling initiatives proposed to be undertaken by major stakeholders towards upscaling the application of energy-efficient technology in industries:

Management

To address the challenge on lack of awareness on energy efficiency at industry/company top management level, critical would be the presence of a leader, preferably from the Board or top management who would champion the cause and initiate new management approaches such as the following:

- ***Energy Efficiency Awareness Program***
  A basic solution to address the lack of awareness by Management of the importance of energy efficiency as a means of achieving and sustaining productivity and competitiveness in the global markets is the adoption of an *Energy Efficiency Awareness Program* that will support and reinforce the company's overall energy efficiency objectives through top management commitment and engagement. To become truly energy-efficient, the company, at the instance of top management, must make basic changes in the way the employees behave, in the technologies adopted and in internal policies and procedures. These changes do not have to be drastic or costly, but no single change can deliver maximum savings. Benefits are maximized when a combination of technological, behavioural and organizational changes are implemented simultaneously with support from top management. To achieve these changes, the program should become part of the organization's management best practices. As such, it will become an integrated company-wide effort that involves making business decisions about equipment, establishing procedures that ensure greater energy and process efficiency and encouraging behaviours that save energy and money. The steps towards this goal are as follows: (1) *Assemble a Green Team* with top management commitment and appointment of an energy efficiency champion and a program leader; (2) *Establish baseline* of energy consumption for setting objectives and baseline of energy efficiency awareness to evaluate the success of the program using survey/questionnaire as tool; (3) *Formulate objectives* amongst the Green Team and top management agreeing on a set of indicators and establish awareness and communications objectives such as: generate energy efficiency ideas that lead to reductions in energy consumption; shift the organizational culture toward energy efficiency; help employees understand the benefits of working in an energy-efficient workplace; reward employees with improved benefits or awards for energy-efficient actions; (4) *Develop a Communications Plan*, identifying the tools that will deliver the message in the most effective way, the target audience, and the impact-full message to be conveyed; (5) *Give recognition* and awards to encourage staff to participate, build momentum, generate interest and motivate behavioural change; (6) *Implement* program activities considering the timing, venue, target participants and rollout cost; (7) Evaluate the program, track results, adapt approach to changing needs and celebrate and share successes to sustain energy-use reduction momentum.

  Example: *Lower Mainland Health Authorities (British Columbia)* created an Environmental Sustainability Policy that applies to all employees, volunteers, physicians and contract workers. The Energy and Environmental Sustainability (EES) Team, housed in the Facilities Management Department, is responsible for rolling out a strategy to implement the policy. Under the "Green Care" umbrella, the strategy includes a variety of initiatives including the

Green+Leaders program which implemented several successful energy reduction campaigns to encourage staff to turn off equipment. Some departments have reported up to an 80% improvement in "turn-it-off" behaviour. Furthermore, Green+Leaders also identified other opportunities to reduce energy use such as decommissioning and consolidating office and medical equipment no longer in use as well as facilitating the installation of motion sensors in their units. The EES team has a designated group of Energy Managers and Energy specialists who work specifically on infrastructure upgrades to ensure facilities are maximizing opportunities to reduce energy.

- ***Identify Energy Efficiency Opportunities in Infrastructures and Operations***
  A growing number of companies have integrated energy efficiency into business practices, e.g. in investment and procurement processes. A new business approach consists in changing the rules to invest in energy savings by changing the analyses of the life cycle costs of energy efficiency investments, identifying lower discounts rates for energy efficiency investments, taking into consideration future energy prices and identifying the multiple benefits from energy efficiency investments.

  Example: *Roche,* a research-focused healthcare company, doubled its energy efficiency, saving money as well as reducing the intensity of its environmental impact. In 2005, it set itself a new goal of reducing energy consumption by a further 10% over the next 5 years on a per employee basis. But energy managers had already attacked the "low hanging fruit" of low-cost, no-cost and quick to pay-back energy efficiency opportunities. In competing for limited capital, they were beginning to come up against investment hurdles that made it difficult to demonstrate the feasibility of energy conservation investments. The problem they faced was that simple payback and return on investment calculations tend to underestimate the cost savings from energy efficiency investments. Then they decided to take into account these savings, as well as other benefits such as lower emissions, reduced exposure to energy price fluctuation, increased staff comfort and better public relations. So Roche changed the rules by which it assessed the net present value of energy conservation measures in order to capture the true balance of costs and benefits of energy efficiency investments: (1) lower discount rates – energy efficiency investments are less risky than normal pharmaceutical investments, thus requiring lower discount rates; (2) future energy savings – future energy costs will keep rising, which makes future energy savings more valuable; (3) multiple benefits result from energy efficiency investments such as increased comfort, productivity, environmental benefits, utility rebates from energy providers and government grants; (4) a full life-cycle analysis enables to take into account the impacts of energy and all other costs over the expected life of the asset in the balance between present costs and future savings. This methodology allows Roche to compare different design alternatives and select the most profitable, which will also be the most energy efficient because of the strong emphasis on future costs. In the 2 years since this methodology was introduced, Roche has managed to reduce energy use per employee by 8%, despite growing the business and incorporating new enterprises.

- ***Instill Energy Efficiency as an Intrinsic Value Within the Corporate Culture and Give Recognition and Awards to Encourage Organization-Wide Participation***
  Actions towards this end can include: (1) establishing multi-level energy teams that include senior staff with corporate level access; (2) making performance data visible to senior management to clearly show progress, i.e. energy use dashboards; (3) establishing clear accountability for energy efficiency at every level, possibly linking energy efficiency into individual performance reviews; (4) give recognition and awards to best performers in different categories; (5) promote the good citizenship values associated with being energy efficient; (6) set aggressive cost cutting goals relative to energy efficiency measures to help encourage innovative "out of the box" thinking; and (7) implement change management processes that ensure that new energy efficient practices become a part of company culture.

  Example: *3M – Integrating Energy Efficiency Into The Company Culture* - 3M met its first goal to improve energy intensity by 25% over 9 years across 111 facilities. They now have a new goal to improve energy intensity by another 30% over the next 10 years. 3M established an Energy Recognition Program in 2003 to boost employee participation in energy efficiency and as part of that they introduced the Plant Energy Awards to reward individuals. These programs have motivated staff and driven commitment to energy efficiency helping identify new projects and follow best practice.

Knowledge and Information

Reinforce cooperation between the public and private sectors, among industry associations/industry chambers across countries to enhance knowledge and information through the following:

- ***International cooperation to promote harmonized policies and mutual recognition***
  International cooperation on energy efficiency policies can trigger synergies that foster technology improvements, mainly through the removal of barriers in the deployment of technologies in the market place. Coordinated policies and standards are critical for enhancing global trade. The mutual recognition of energy labels should be encouraged.

  Example: The US and the EU signed an agreement in 2000 to coordinate energy efficiency labeling programmes for office equipment through the common use of the Energy star programme logo and specifications. The *International Partnership for Energy Efficiency Cooperation (IPEEC)* was launched in May 2009 between G-8 countries and emerging countries with the objective of undertaking an inventory of national energy efficiency policies, to share best practices on programme development, public procurement, industrial plant audits, training, public awareness efforts, and to identify areas of joint actions to facilitate energy efficiency improvement.

- ***Transparency and comparative information***
  Benchmarking provides valuable indicators in energy efficiencies, operating expenses, manufacturing costs and return on investment. Comparative analysis of energy and carbon emissions performances of industries across countries can help value best practices and set common indicators and targets.

  Example: In Europe the *ODYSSEE project* aims to establish and produce energy efficiency indicators for the various sectors of the economy with a detailed breakdown by usage. The aim is to set up a permanent technical structure to monitor annual progress in energy efficiency and carbon emissions, nationally and at the European level. Each national team is in charge of providing the best data available. In the US, the Green Grid, a global consortium dedicated to data centre efficiency, working towards new operating standards and best practices, has attracted support from industry. The Green Grid does not endorse any vendor-specific products or solutions and seeks to provide industry-wide recommendations on best practices, metrics and technologies that will improve overall data centre energy efficiencies.

- ***Technology Development and Deployment***
  Significant opportunities exist to enhance the use of existing efficient technologies. Oftentimes, technology development and deployment are inhibited by lack of an appropriate enabling framework. Much effort has to be exerted to drive increased development and deployment of more efficient technologies and provide broader markets for innovative technologies in the future.

  Example: Japan established the *"Japanese Business Alliance for Smart Energy Worldwide (JASE-World) "* in 2008 aiming to promote technology and know-how on energy conservation globally as well as to build a system for advancing the spread of energy efficiency businesses. JASE-World is a government-business partnership and consists of 57 companies, 19 business organizations, financial institutions and Japanese ministries and published Japanese State-of-the art Smart Energy Products & Technologies to introduce energy efficient technologies.

Financing

To address the financing gap, there must be a green champion that would demonstrate, establish and market green investments as a business case not only for industries but also for financial institutions. Development Financial Institutions (DFIs), are the best "Green Finance Champions" in their respective countries, being a form of government intervention in the financial system with the aim of addressing market failures in the provision of finance. They provide finance to those market segments that are not well-served by the financial system, such as environmental projects which are more developmental/social than commercial in nature; need long-term financing; and viewed as risky ventures due to new technologies. Among the initiatives to promote green financing are the following:

- ***Creation of Environmental Consultation and Financing Units (ECOFIN) in DFIs***
  The ECOFIN units in DFIs will have two environmental desks: (1) Environmental Consultation Desk which will provide advisory and consultation services to SMEs with green projects on how these can meet the environmental and credit standards of banks to pave the way for access to finance; and (2) Environmental Financing Desk which will craft demand-driven green financing products and services, come up with guidelines on green financing, evaluate SME project proposals and provide financing for green projects. Capacity building programs will be implemented for DFIs to strengthen their ECOFIN Units with the objective of facilitating SME access to finance for green investments.

  Example: *Development Bank of the Philippines (DBP)* – one of the first Philippine banks to integrate environmental considerations in all aspects of its operations to prove its commitment to environmental protection and sustainable development. It provides financing as well as technical assistance to green projects and plays an active role in encouraging clients and participating financial institutions under its wholesale lending program, to include green considerations in their businesses and thrusts. The bank's Development Banking Sector houses its ECOFIN department named "Financing, Infrastructure, Environmental and Logistics Development" which manages its Green Financing Program designed to assist strategic sectors, industries and local government units in adapting environment-friendly processes and technologies and incorporating climate change adaptation and mitigation and disaster risk reduction measures by providing financing and technical assistance.

- ***Leverage Private Finance***
  As Green Champions, DFIs can take the lead in undertaking new innovative financial schemes and encouraging the participation of private banks through co-financing or loan syndications. New innovative financial schemes have been recently designed to attract private funds into energy efficiency programmes. These innovative funds use tools traditionally used by the private sector (e.g. debt and project financing, equity participation, venture capital, bonds) and seek a partnership between public institutions and private investors, such as banks or Energy Service Companies (ESCOs). These funds which prioritize operations with high investment cost should help develop a market for energy efficiency that would be self-sustaining without public intervention. Risk sharing mechanisms initiated by DFIs such as co-financing, loan guarantee, insurance and revolving funds are examples of innovative approaches that have been developed in different parts of the world.

  Example: *Thai Energy Efficiency Revolving Fund (EERF)* – launched by the Government of Thailand in 2003 as part of its Energy Conservation Programme, the EERF works to overcome barriers within the Thai financial sector to stimulate adequate financing for energy efficiency and reduce the country's greenhouse gas emissions. Some of these key barriers included a general lack of interest and experience in energy efficiency financing among banks as well as corresponding high perceived risks. The stated objective of the EERF is to support clients for investment in machinery and equipment in relation to energy efficiency projects through the provision of low-interest loans to banks, which then finance energy efficiency projects through loans with favorable interest rates. Because of its success in leveraging private capital with government financing, the EERF can be considered a model financial support mechanism for jump-starting investments in energy efficiency.

- ***Source Green Funds with Technical Assistance/Grant Components***
  DFIs have the capability to source environmental funds from multilateral and bilateral funding agencies like the World Bank, Asian Development Bank, KFW of Germany and Japan Bank for International Cooperation, among others, backed up by government guarantee which the DFIs can either lend directly to green projects or channel to accredited private banks for on-lending to green projects. Said green funds normally have concessional interest rates and long repayment terms which are ideal for green investments. They also have technical assistance/grant components intended for capacity building of the staff of the DFIs/participating private banks on risk-based lending and appraisal of green projects. The technical assistance/grants can also be directed to help clean technology start ups and business incubators understand the market potential of energy efficiency solutions through energy efficiency accelerator programs and build their capacities to develop bankable projects that can be presented to DFIs/participating private banks for financing.

  Example: *Landbank of the Philippines* sourced environmental funds from KFW of Germany for its “Credit Line for Energy Efficiency and Climate Protection“ or CLEECP program directed to private sector businesses, local government units, and national government agencies for all types of investments that would directly reduce primary energy consumption and/or direct greenhouse gas emissions, such as replacement or retrofitting or energy efficient modernization of CDC,HFC and HFC chillers; installation or energy efficient modernization of biomass cogeneration facilities; replacement o energy efficient modernization of machinery and equipment powered by primary energy sources and replacement of diesel generators or kerosene lamps by solar panels, mini-hydros or other renewable energy facilities. Maximum loanable amount is the P200M or about $4.2M with concessional interest rate and maximum term of 10 years.

Policy

Government plays a major role in promoting energy efficiency through enforceable policies and regulations. While in most countries there are several government agencies responsible for environmental concerns and initiatives, it is imperative to designate a pro-active government umbrella agency that would act as a coordinating body to broaden coalition to include other stakeholders such as civil society, business associations and chambers, academe, guilds, and local government units that would harmonize all environment-related policies and regulations, be responsible for their strict enforcement as well as the monitoring of compliance thereto.

Among the tasks of this umbrella agency is to develop government policy incentives and innovative market mechanisms, such as the following, to reinforce the market for energy efficiency:

- ***Appropriate Energy Pricing***
  Adequate pricing is a necessary condition for promoting energy efficiency. The first step of any energy efficiency policy should be to adjust energy prices in order to give correct signals to consumers, thereby providing incentives for behaviour changes or to acquire energy efficient equipment and technologies.

  Example: *Japan* has increased the cost of energy at higher consumption levels (e.g. increasing electricity rates for residential customers) as a way to encourage lower energy consumption.

- ***Enhanced Incentives***
  Economic incentives have proven very helpful in making investments in energy efficiency more attractive. A course of action consists in reforming utility company incentives to

reward energy efficiency rather than solely volume supplied. Power utilities are traditionally tied to the volume of electricity they deliver, encouraging growth in electricity consumption rather than encouraging efficient use. Instead, regulators could reward utilities for promoting energy efficiency and reducing energy consumption in society as a whole.

Example: The state of *California* has an incentive program that rewards and penalizes the state's privately owned utilities by up to plus or minus $450 million depending on their energy efficiency performance.

- ***Technical support***
  Programmes to promote energy efficient industrial systems can be highly cost effective. Public technical assistance is therefore very valuable.

  Example: The *European Commission* offers technical assistance to companies seeking to improve the energy efficiency of their electric motor driven systems through the Motor Challenge Programme. China has also begun offering technical support to improve energy efficiency at its 1000 most energy-intensive plants as part of a national effort to reduce energy consumption per unit of GDP by 20% by 2010.

- ***Labels and Certificates***
  Information on energy performance may enable consumers to obtain information about the energy consumption of the product they buy and stimulate the introduction of new, more efficient models. The US Energy Star Program has improved the energy efficiency of products such as refrigerators and copier machines. White certificate schemes which certify that a certain reduction of energy consumption has been attained, can also provide transparency and stimulate market adoption.

  Example: The *United Kingdom* was the first EU country to introduce such a scheme, combining its obligations on suppliers to save energy with the possibility of trading those obligations and the certificates. White certificates are an example of how to link public policies with targets and timelines (e.g. the European Commission's target of cutting energy consumption by 20% by 2020) and market incentives) rewards towards energy efficiency targets).

- ***Voluntary Agreements (VA) and Public Private Partnership (PPP)***
  VA has been used by a number of governments as a mechanism for promoting energy efficiency within the industrial sector. International best practice calls for the establishment of a coordinated set of policies that provide strong economic incentives as well as technical and financial support to participating industries. Effective target-setting agreement programmes are based on signed, legally-binding agreements with realistic long-term (typically 5-10 years) targets, require facility or company level implementation plans for reaching the targets, require annual monitoring and reporting of progress towards the targets, include a real threat of increased government regulation or energy/GHG taxes if targets are not achieved, and provides effective supporting programmes to assist industry in reaching the goals outlined in the agreements. Key elements of a target-setting programme are: (1) target-setting process; (2) identifying energy-saving technologies and measures; (3) benchmarking current energy efficiency practices; (4) establishing an energy management plan; conducting energy efficiency audits; (5) developing an energy savings action plan; (6) developing incentives and supporting policies; measuring and monitoring progress toward targets; and (7) programme evaluation.

  Example: In 2005, the *Chinese government* announced an ambitious goal of reducing energy consumption per unit of GDP by 20% between 2005 and 2010. One of the key programmes for attaining this goal is the Top 1,000 Energy Consuming Enterprises Programme. The energy consumption of these 1,000 enterprises accounted for 33% of national and 47% of industrial energy usage in 2004. Activities undertaken included benchmarking, energy audits, energy saving action.

- ***ISO 50001 - Energy Management Standards (EMS)***
  EMS is aimed at providing guidance for industrial facilities to integrate energy efficiency into their management practices, including fine-tuning production processes and improving the energy efficiency of industrial systems. Government efficiency standard have been shown to be an effective, low cost way to coordinate a transition to more efficient products. With the implementation of such standards, production volumes increase and economies of scale emerge so that prices for energy efficient products decline to a level of the old, less efficient products. Rather than regulating the use of specific technologies, standards are more effective if they set targets for overall efficiency and leave room for company innovation in ways to meet the target. Typical features of an energy management standard include: (1) a strategic plan that requires measurement, management and documentation for continuous improvement for energy efficiency; (2) a cross-divisional management team led by an energy coordinator who reports directly to management and is responsible for overseeing the implementation of the strategic plan; (3) policies and procedures to address all aspects of energy purchase, use and disposal; (4) projects to demonstrate continuous improvement in energy efficiency; (5) creation of an Energy Manual, a living document that evolves over time as additional energy saving projects and policies are undertaken and documented; (6) identification of key performance indicators, unique to the company that are tracked to measure progress; and (7) periodic reporting of progress to management based on these measurements. Countries that have EMS include Denmark, Ireland, Netherlands, Sweden, United States, Spain, Thailand, Brazil, Korea and China. Their EMS are designed to be applicable to all types and sizes of companies; however, in each instance, the largest, most energy intensive industries are the focus of additional programmes and initiatives. By concentrating efforts on these large energy users, policymakers seek the greatest reduction in industrial energy consumption and overall GHG emissions. The proportionally greatest impact on industrial energy consumption has been in Denmark which has had financial incentives since 1992 in the form of a CO_2 tax rebate, coupled with target-setting agreements and as of 2001, EMS. The coupling of target-setting agreements with an EMS seems to be particularly effective.

  Example: The *Danish Malting Group* A/S owned by Carlsberg Breweries, has one of the largest and most modern malt houses in Europe that produces 115,000-120,000 tons of pilsner malt each year. The company joined the voluntary agreement scheme from the beginning in 1996. Year by year, they have continued to improve all significant areas of energy consumption in the facility. The energy management standards DS2403, EN16001 and now ISO50001 have been the tool to keep the continued improvement of energy efficiency on track. This has led to a significant reduction of operating costs. The company's electricity consumption has been reduced by more than 40% and the consumption of natural gas has been reduced by more than 25% in the period 1997-2011. The improvements in Danish Malting Group A/S demonstrate that a continual effort gains improvements year after year as new insights and experiences are gained via systematic effort.

Technology and Skills

The formulation and implementation of energy efficiency programmes require technical and managerial skills of a high order. Among the initiatives towards this end are the following:

- ***Building Technical Capacity*** to create a cadre of highly skilled system optimization experts. Careful selection is needed of individuals with prior training in mechanical or electrical engineering, who have an interest and the opportunity to apply their training to develop projects. Training is intensive and system-specific and includes both classroom and hands-on-measurement and system assessment instruction. The resulting system experts are prepared to evaluate and optimize one or more industrial motor-driven systems or steam systems. Ideally, the completion of the intensive training programme is coupled with practical testing of competency and a certificate of recognition for the trained local experts. The trained local experts are also prepared to offer awareness level training to factory operating personnel on how to recognize system optimization opportunities. This awareness training can be used to build interest in and a market for the local experts' system optimization services. In addition, awareness training can provide a basic understanding of system optimization for factory operating personnel to apply in identifying energy efficiency project opportunities.

Example: *Quality Energy Solutions'* Efficiency Management 2.0 (EM 2.0) aims to increase the capacities of decision makers with regards to total site energy management; create energy profiles in the industry to identify potentials in energy efficiency; and minimize barriers for private investments and energy performance contracts through on-site and on-line trainings using practical tools for measurement, monitoring, visualization, modeling and analysis of material and energy flows in a systematic and holistic manner. For maximum effectiveness, the training is directed to energy managers, process engineers, production managers of energy intensive industries and energy consultants. Concurrent with experts training, training will be conducted to introduce equipment suppliers, manufacturers' representatives and vendors to system optimization techniques.

- ***Common Laboratory Facilities*** that will serve as training centre for dissemination of knowledge and research, project incubator and provide testing, labeling and certification of energy performance. Establishing a model for the laboratory provides an independent baseline for future energy management actions. It also provides a basis for targeting and monitoring energy savings at the facility, department or equipment level. Most importantly, lab behavior can be monitored and unwarranted increases in energy consumption can be identified, which may have otherwise gone unnoticed.

  Example: *Riverside Energy Efficiency Laboratory* (REEL) was established as a test and research facility for the heating, ventilation and air condition industry. This independent laboratory at the Texas A&M University Riverside Campus has served air conditioning and ventilation manufacturers globally. The laboratory is ISO 17025 (Laboratory Quality) accredited and is also an approved testing laboratory for the Home Ventilating Institute and the California Energy Commission Appliance Efficiency Program. Additionally, REEL provides certified air conditioning and heat pump testing for the Energy Star Program. REEL's mission is to provide accurate and repeatable testing and research results, whether it is from a standard test/research procedure developed for specific equipment requirements. REEL strives to accomplish these activities with the highest quality, accountability and ethical practice.

7. References

- Barriers and Solutions to Corporate Energy Efficiency, PEW Center Global Climate Change, August 2010
- Barriers to Energy Efficiency in Industry in Asia – Review and Policy Guidance, UNDP, June 2006
- Best Practices and Case Studies for Industrial Energy Efficiency Improvement – An Introduction for Policy Makers; Steven Fawkes, Kit Oung, David Thorpe, February 2016
- Breaking Down Barriers to Energy Efficiency, EDF Climate Corps, 2011
- Case Study Booklet on Energy Efficient Technologies in Cement Industry; CII, 2015
- De Beer et al., 2001
- European Climate Change Programme (ECCP), 2001
- Energy-Intensive Industry and Climate Change, Friends of the Earth, September 2011
- Energy Efficiency (2009) 2:109-123
- Energy Efficiency Improvement and Cost Saving Saving Opportunities for Cement Making, Ernst Worrel and Christina Galitsky, Berkley Lab, March 2008
- Energy Efficiency in Plastics Processing; Tangram Technology Ltd.
- Energy Efficiency with Case Studies, ICC Commissions on Environment and Energy, Docu ment No. 213/75, 19 November 2009
- Energy Policy Toolkit on Energy efficiency in Industries, Experiences from Denmark
- Financing Energy Efficiency: Forging the Link Between Financing and Project Implementation, European Commission, 2010
- Financing mechanism for energy efficiency projects and programmes, PWC, 2011
- IEA 2007. Tracking Industrial Energy Efficiency and Co2 Emissions
- Intergovernmental Panel on Climate Change (IPCC), 2001, IEA 2007
- Martin et al., 1999,2000a; Worrell, et al. 2001
- National Climate Finance Institutions Support Programme Case Study: The Thai Energy Efficiency Revolving Fund; Frankfurt School of Finance & Management gGmbH 2012.
- Policies and Measures to realize Indusrial Energy Efficiency and Mitigate Climate Change, UN Energy 2009
- Policies for promoting industrial energy efficiency in developing countries and transition economies, UNIDO, 2008
- Price and Wang, 2007
- Price et al., 1999; 2002; 2006
- Public Finance Mechanisms to Increase Investment in Energy Efficiency, BASE and UNEP, 2006
- REFINe www.worldbank.org/energy/refine
- Rohdin et al., 2007
- Schumacher and Sathaye, 1999
- World Environment Center (WEC), 2004
- Worldwide Trends in Energy Use and Efficiency, Key Insights from IEA Indicator Analysis)
- Worldwide Trends in Energy Use and Efficiency: Key Insights from IEA Indicator Analysis, OECD/IEA, 2008