the dti
Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

energy
Department:
Energy
REPUBLIC OF SOUTH AFRICA

UNIDO

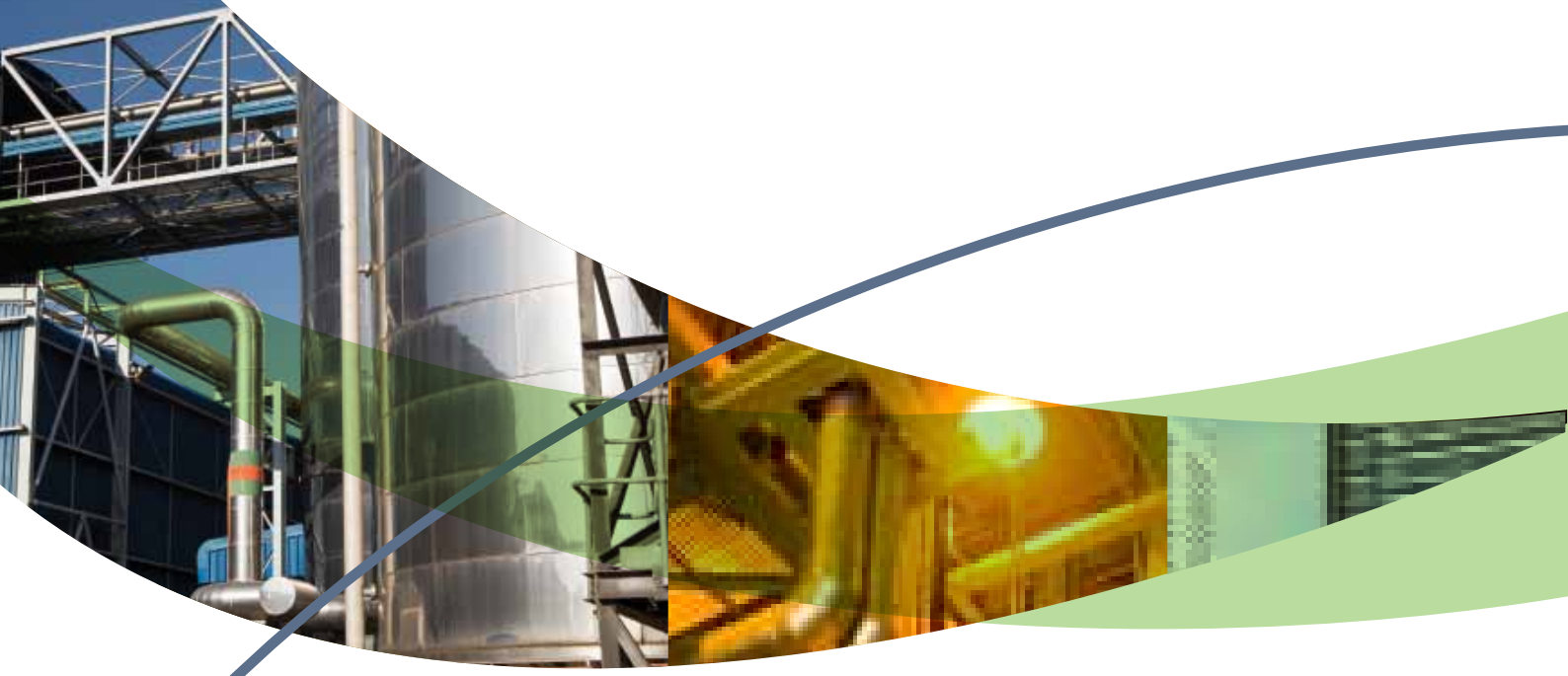
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs FDEA
State Secretariat for Economic Affairs SECO

UKaid
from the Department for International Development

Industrial Energy Efficiency Improvement Project in South Africa



Introduction and Implementation of an Energy Management System and Energy Systems Optimization Measures

CASE STUDY: TOYOTA SOUTH AFRICA

THE ISSUE AND MAIN FINDINGS

In a nation where the electricity supply reserve margin is low and energy costs rapidly increasing, it is not only good corporate citizenry to reduce energy consumption but it makes good business-sense as well.

The implementation of an Energy Management System (EnMS)[1] at Toyota SA resulted in a reduction in electricity usage which has translated into cost-savings of more than R4.8 million over a two-year period (2010/11). A total of 55 Energy Systems Optimization (ESO) initiatives have been implemented since 2010. 25 projects were started in 2010 and continued over 2011, during which an additional 30 new projects were also initiated.

Toyota improvements 2010 - 2011	
Total No. of Projects	55
Gross Monetary Savings	R4,847,000
Energy Savings	GWh 8.15
Total Investment	R3,350,000
Overall Payback Period (in years)	1.09
GHG Emissions Reduction[2]	ton CO_2 7,804[3]

Toyota's company policy is to consider all energy initiatives that show a payback period of less than two years. The optimization projects identified and implemented have an overall average payback period of 1.09 years. The table below shows the profitability index (ROI) of the investments undertaken by Toyota SA to implement EnMS and ESO measures in the 14 plants within Toyota SA. The investments were fully recovered within the project implementation period of 2 years (2010/11). In addition, assuming no further investments to improve energy efficiency are undertaken by the company, the 2010 and 2011 investments will be recovered 4.14 times within 5 years' time and 7.04 times within 10 years' time. The hurdle rate[4] used for this analysis is fairly conservative and equal to 12%.

The Net Present Value[5] (NPV) indicates that the discounted savings after 5 years will account for roughly ZAR 10 million and are expected to reach ZAR 17 million after 10 years, assuming that all assumptions are kept constant. This shows that improvements in energy efficiency through EnMS and ESO initiatives not only do not negatively impact productivity, but also represents a profitable investment for the company.

Profitability Index (2 years)	1.43
Profitability Index (5 years)	4.14
Profitability Index (10 years)	7.04

NPV (5 years)	R9,748,571
NPV (10 years)	R17,333,261

THE GROUNDING STRATEGY

In 2008, Toyota SA (Durban) identified energy saving as one of its priority focus areas. A representative from each of the 14 Toyota SA plants was called to be part of a working group tasked with identifying areas for possible energy consumption reduction. In April 2012 the company set up a dedicated Energy Management Department consisting of a senior manager and four engineers, each dedicated to a particular cluster of plants within Toyota Durban, namely:

- Paint and utilities plants;
- Vehicle and component assembly plants, and assembly parts warehouses;
- Welding plants; and
- Non-production areas (administrative areas).

[1] Energy Management System (EnMS) is a systematic approach towards achieving continual improvement of energy performance, energy efficiency and energy conservation. It addresses energy supply, measurement, documentation and reporting of energy use and procurement, as well as design practices for energy using equipment, systems and processes. [based on ISO 50001]. *Note: An EnMS is a management system and not a technical system.*

[2] SA Grid kWh to CO_2 Conversion Factor set at 0.957 as per the 'Journal of Energy in South Africa' – Vol 22 No 4; November 2011.

[3] 7 803 542 Kg CO_2 Emission Reduction equates to roughly 7 804 ton CO_2.

[4] 'Hurdle rate' is defined as the actualization rate used to discount cash-flows. In business terms, it represents the interest rate that a company would get if it deposited the money in the bank rather than investing.

[5] The Net Present Value is given by the sum of cash-flows discounted back to present time and it therefore indicates the company's discounted savings over a specific period of time.

In August 2010 Toyota SA signed up as a Host Plant[6] for the Industrial Energy Efficiency Improvement in South Africa Project (IEE Project). All relevant Toyota personnel enrolled for the user-level EnMS and ESO training programme offered by the IEE Project, with two candidates successfully completing the first expert-level EnMS training course and one graduating from the Pump Systems expert-level course in 2012.

IMPLEMENTING AN ENERGY MANAGEMENT SYSTEM

After signing up as a Host Plant, an EnMS was introduced, along with 55 ESO and Energy Efficiency projects across various operational areas in the Toyota SA plants.

Toyota SA set up a Plan-Do-Check-Act (PDCA) process to ensure effective implementation of the EnMS, including regular and accurate monitoring. The following steps were then taken:

- An energy policy was developed for Toyota SA, with commitment to continuous improvement;
- Energy audits were conducted and significant energy users identified;
- An automated real-time energy measurement system was implemented for all plants at Toyota SA;
- Energy Performance Indicators (EnPIs), namely GJ/vehicle, were developed;
- Objectives and targets were set and action plans developed to achieve them;
- The plant personnel in all the identified projects were engaged to encourage the necessary support and behavioural change in employees, e.g. switching off equipment during non-production times, such as between shifts and over weekends;
- The energy reduction projects identified and agreed upon were implemented, including the following:
    - Occupancy sensors were placed in some of the larger offices;
    - Some of the larger, mostly inefficient overhead ventilation systems, were replaced with smaller localised systems;
    - Solar water heating was installed in two ablution systems;
    - All mercury vapour lighting systems were replaced with energy efficient fluorescent lighting.
- After project implementation, energy-saving results were verified through accurate measurement[7].

Throughout the process, feedback was given to senior management on a bi-monthly basis, with demonstration of performance improvement against targets.

[6] The IEE Project defines a Host Plant as any South African industrial plant that agrees to accommodate project related events at its facilities.

[7] Measurement and Verification is defined as he process of quantifying energy savings or its impact by determining the actual consumption and relative energy governing factors and to develop baselines and baseline adjustments. [based on SATS 50010:2010]

SELECTED INTERVENTIONS: ENERGY SYSTEMS OPTIMIZATION

As part of the implementation of an EnMS at Toyota South Africa in Durban, energy audits were conducted at all 14 of its plants to identify significant energy users.

As mentioned earlier, Toyota SA follows the PDCA (Plan, Do, Check, Act) principle in all energy-related initiatives. Results are verified by means of accurate measurements before and after completion of interventions, and performance standards are set and carried over to similar plants within the company. Both top and plant management is provided with regular feedback on progress against energy targets, and support is requested for the removal of potential barriers.

The interventions below have shown particular success in energy reduction and represent a sample of the 55 different systems optimization and energy efficiency projects implemented over 2010/11 within the Toyota plants in South Africa.

PUMP SYSTEM OPTIMIZATION

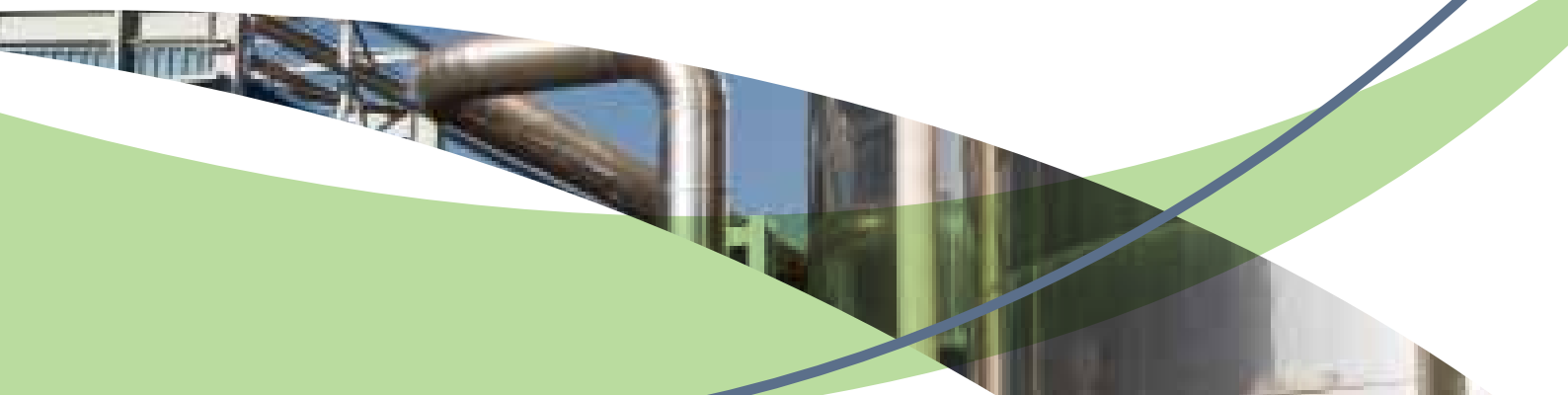
The objective was to optimize the energy use for cooling water pumping in the welding plant whilst still maintaining a flow rate of 487 m³/h. The resultant solution reduced the number of pumps required from three to two, without compromising the required flow rate. The intervention involved changing the configuration of the pipes, as shown in figure one.

Summary of initiatives	
Process	Cooling water pumps
Plant	Welding plant
Energy Source	Electricity
Objective	Reduce from 3 to 2 pumps and maintain a flow rate of 487 m^3/h
How	Changed pipe configuration after the supply pumps
Status	Objective successfully achieved

Cooling Water Pumps Savings	
Monetary savings/year	R167,700
Energy savings/year	322,500 kWh
Cost of initiative	R38,000
Payback period	3 months
kg CO_2 savings/year	308,955 kg CO_2

Figure 1: *Cooling Water Pumps Configuration*

BEFORE ***AFTER***

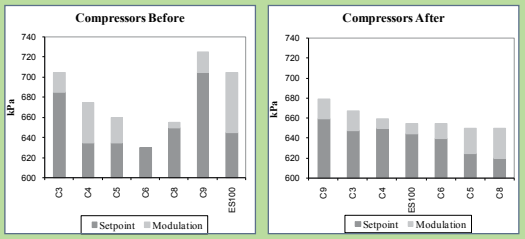


COMPRESSED AIR SYSTEM OPTIMIZATION

Prior to this intervention, compressors at the utilities plant were not synchronised and compressor motors would run loaded constantly with blow-off valves being open. The project involved resetting the compressors and reducing pressure over down times. It did not involve any costs and the objective was achieved with immediate effect.

Summary of initiatives	
Process	Main compressors
Plant	Utilities
Energy Source	Electricity
Objective	Optimize compressors to run only when required
How	Set up sequence of compressors to load and unload according to the air demand from the plants
Status	Objective successfully achieved with immediate effect

Figure 2: Compressor Pressure



COMPRESSOR SET POINT (650 kPa)

Compressor savings	
Monetary savings/year	R402,000
Energy savings / year	774, 000 kWh
Cost of project	R0
Payback period	0
kg CO_2 savings/year	741,492 kg CO_2

DAYLIGHT HARVESTING

Summary of initiatives	
Process	Warehouse lighting
Plant	Imported parts warehouse
Energy Source	Electricity
Objective	Reduce lighting during the day
How	Improvement of natural lighting levels by fitting strategically placed clear roof sheets to allow in natural light; and better management of the artificial lighting consumption
Status	Objective successfully achieved

This project was aimed at allowing more daylight into the imported parts warehouse to reduce the dependency on artificial, energy-consuming lighting. After a 14-month implementation process all lights are now switched off during the day.

Daylight harvesting savings	
Cost savings/year	R54,732
Energy savings/year	105, 254 kWh
Cost of project	R67,000
Payback period	14 months
kg CO_2 savings/year	100,829 kg CO_2

***Figure 3:** Daylight harvesting in Imported Parts Warehouse*

BEFORE

AFTER

ASSEMBLY PLANT LIGHTING REDUCTION

This project involved the removal of 50% (or every second row) of the artificial lights, replacement of the remaining fluorescent tubes with more energy efficient ones and installation of reflectors to each fitting within the assembly plant. The project entailed a significant investment but has achieved it's objective within a 20 month payback period.

Summary of initiatives	
Process	Assembly line lighting
Plant	Assembly plant
Energy Source	Electricity
Objective	Maintain lighting level above requirements with a reduced number of lights
How	Removed 50% of lights in the plant; introduce automation of the switches; installation of EE tubes
Status	Objective successfully achieved

Lighting reduction savings	
Cost savings/year	R120,264
Energy savings / year	231, 273 kWh
Cost of initiative	R 222,000
Payback period	20 months
kg CO_2 savings/year	221,560 kg CO_2

Figure 4: *Assembly Line Lighting Reduction*

BEFORE

AFTER

LIGHTING AND VENTILATION AUTOMATION

This project at the chassis plant achieved energy savings by introducing an automatic switch that switches the lighting and ventilation off automatically during non-production periods.

Results achieved

- The majority of plant lights and ventilation systems are switched off automatically during non-production times
- Plant load has been reduced during non-production times.
- The objective was achieved within a 12-month payback period.

Summary of initiatives	
Process	Welding plant lighting and ventilation
Plant	Chassis Plant
Energy Source	Electricity
Objective	Automatically switch off lights and ventilation during non-production times
How	Installation of automation switches; reduced plant loads during non-production times
Status	Objective successfully achieved

Lighting and ventilation automation savings	
Cost savings/year	R630,240 / year
Energy savings / year	1, 212, 000 kWh
Cost of project	R590,000
Payback period	12 months
kg CO_2 savings/year	1,160,329 kg CO_2

Figure 5: *Chassis Plant Energy Load Profile*

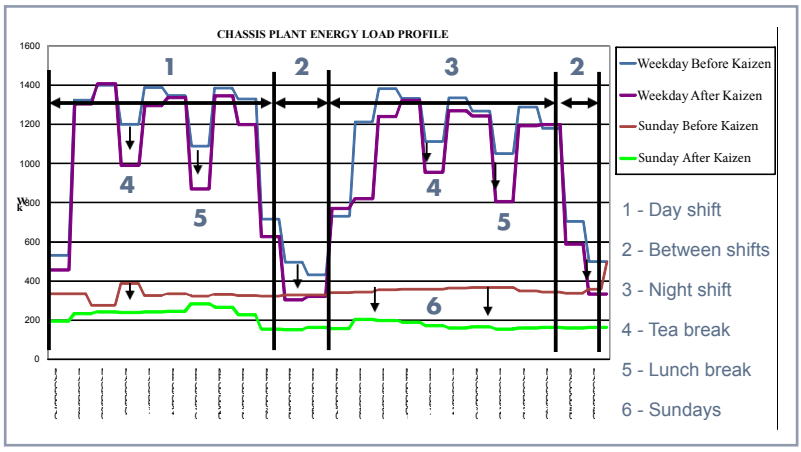
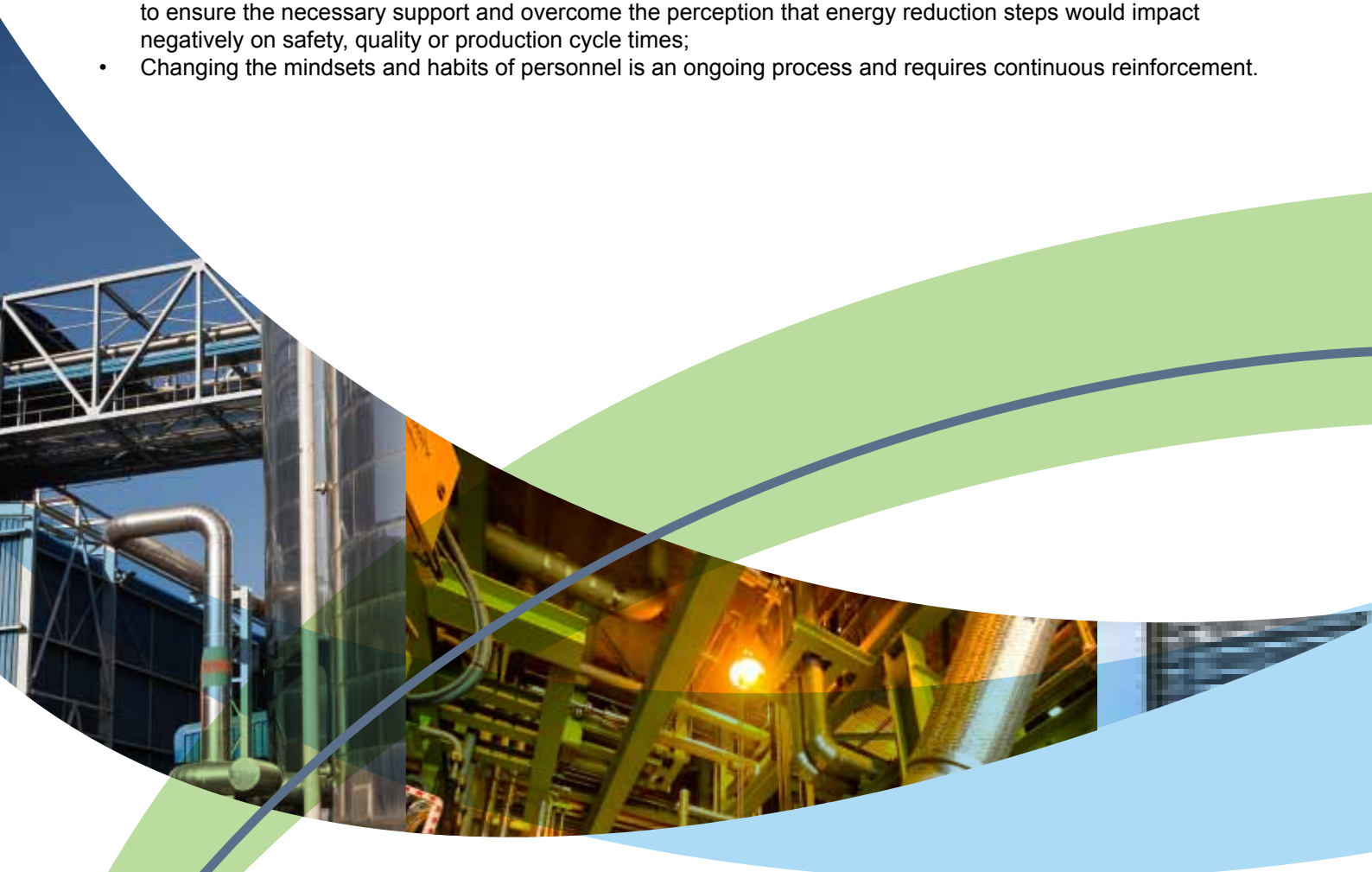


Figure 5 shows the impact of the lighting and ventilation automation intervention. It particularly highlights the reduction in power consumption within the Chassis Plant during certain time periods of the day as a result of a Kaizen (Japanese word for “improvement” or “change for the better”) activity.

LESSONS LEARNED FROM TOYOTA’S EE EXPERIENCE

- An important grounding for the success of the EnMS and ESO initiatives at Toyota SA has been the support of both top management and among the managers of the plants concerned;
- Plant personnel in all targeted areas have to be engaged throughout the planning and implementation stages to ensure the necessary support and overcome the perception that energy reduction steps would impact negatively on safety, quality or production cycle times;
- Changing the mindsets and habits of personnel is an ongoing process and requires continuous reinforcement.



The Industrial Energy Efficiency (IEE) Improvement Project was introduced in South Africa by the United Nations Industrial Development Organization (UNIDO) after rolling blackouts in 2008 exposed the country's acute shortage of electricity generation capacity. It is a collaborative initiative between the South African government through the Department of Trade and Industry (the dti), the Department of Energy (DoE), the Swiss State Secretariat for Economic Affairs (SECO) and the UK Department for International Development (DFID). The Project is implemented by UNIDO and is hosted by the National Cleaner Production Centre of South Africa (NCPC-SA) at the Council for Scientific and Industrial Research (CSIR).

The IEE Project contributes to the sustainable transformation of energy usage practices in South African industry and aims to enhance national energy security, contribute to job creation and the reduction of carbon dioxide emissions. The project facilitates the implementation of the new South African Energy Management Standard under the framework of the recently released international Energy Management Standard ISO50001, and builds the capacity to introduce energy systems optimization with a holistic approach in industry in South Africa.

The IEE Project currently focuses on five key industry sectors which have the potential to bring about significant reductions in the overall energy consumption of the country. These are agro-processing, chemicals and liquid fuels, metals processing and engineering, automotives, and mining. The objective is to contribute to the national energy demand reduction target of 15% by the year 2015 for mining and industry, and 12% for the country as a whole.

the dti
Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

energy
Department:
Energy
REPUBLIC OF SOUTH AFRICA

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs FDEA
State Secretariat for Economic Affairs SECO

UKaid
from the Department for International Development

UNIDO

ENQUIRIES

NCPC
NATIONAL CLEANER PRODUCTION CENTRE
SOUTH AFRICA

For more information about the training workshops and participation opportunities:

www.iee-sa.co.za | Tel: 012 841 2768 (Pretoria), 021 658 3983 (Cape Town)
or 031 242 2365 (Durban)

For more information about partnership opportunities:

www.unido.org | Tel: 012 394 1567 (Pretoria)