# *ISO 14001 as an Instrument to Reduce Carbon Emissions*
# *A Case Study from an Electronics Manufacturer*

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**Abstract**
The concern over climate change and its impact on society is steadily increasing with specific warnings from the IPCC about global warming and the need to reduce greenhouse gas emissions globally. To achieve the targets of Kyoto Protocol, governments and organisations have aspired to adopt more sustainable business models and promote low Carbon economies. The Low Carbon KEEP Programme provides funding to support East of England businesses to innovate and grow through University partnerships by improving internal capabilities and implementing a low carbon approach to business through academic guidance.

This article reports on a case study of a project undertaken in a leading Contract Electronics Manufacturer in association with the School of Engineering and Technology of the University of Hertfordshire through the Low Carbon KEEP Programme. The project's objectives were to introduce an ISO 14001 compliant Environmental Management System, integral to the company's accredited Quality Management System, and to reduce the company's resource consumption, carbon footprint and the overall overhead costs.

A framework for setting up an effective environmental management system with specific environmental targets was developed. This was utilised for planning and managing the implementation of new environmental projects. As a direct result of the project, the company acquired a Building Management System, and took specific measures to improve energy performance. Moreover, an awareness campaign to improve the environmental attitude and behaviour of the employees was undertaken to enhance stakeholder participation. The certification of the Environmental Management System was completed in summer 2014.

Keywords: Environmental Management, ISO 14001, $CO_2$ Emissions, Energy Efficiency, Electronics Manufacturing

# 1. Introduction

## 1.1. Low Carbon Keep Programme

Advances in scientific knowledge highlight clearly the dangers of global warming, and the climate change is at least in part responsible for certain natural disasters and their substantial economic impact (Boiral, 2006).

It is imperative that all companies, especially those industries which are responsible for significant Greenhouse Gas (GHG) emission, should verify their organisation's GHG emissions sources, and determine the most efficient options for reducing these emissions (Boiral, 2006).

Organisations who adopt a proactive strategy, find it easier to implement standards or regulations to govern their environmental performance and reduce the environmental impact of their activities. They also avoid the barriers to markets that not having these measures in place represent (Boiral, 2006).

The main objective of the Low Carbon KEEP Programme is to actively encourage the development of a low carbon economy in the East of England. The programme provides funding for projects where maximum benefit from knowledge transfer will arise through flexible university-employer partnerships for all types of Small and Medium Enterprise (SME) that meet the conditions of the Programme (Anglia Ruskin University, 2014).

By implementing Low Carbon improvements, businesses will either reduce their carbon emissions, those of their customers or their supply chain. Low carbon improvements can take the form of energy savings, design improvements, new products or processes, waste reduction or general resource efficiency. Most actions which reduce the consumption of resources will reduce carbon emissions and also lead to financial savings (Anglia Ruskin University, 2014).

## 1.2. Project Partners

This Low Carbon KEEP project was undertaken in a leading Contract Electronics Manufacturer in association with the School of Engineering and Technology of the University of Hertfordshire. The company, Nemco Ltd, produces mainly Printed Circuit Boards and General Assembly Products and provides a complete product manufacturing, logistics and repair service to customers. They service a variety of Commercial, Automotive, Aerospace and Defence Markets, with their knowledge of Digital, Analogue, RF and Mechanical Disciplines. Technically advanced and complex products are manufactured, tested, configured then packaged and shipped worldwide from their facility in Stevenage. The university partner supported the project by providing technical supervision.

The aim of this project was to introduce an ISO 14001 compliant Environmental Management System, integral to the company's accredited Quality Management System, and to develop resource monitoring and control systems, focusing primarily

on energy. This would reduce the company's resource consumption, carbon footprint and overall overhead costs, providing increased competitiveness. The certification of the Environmental Management System was completed by the BSI in summer 2014.

### 1.3. ISO 14001

ISO 14001 sets out the criteria for an Environmental Management System (EMS), by mapping out a framework that a company or an organisation can adopt in order to set up an effective system for managing their environmental impact (ISO, 2004).

The standard can be applied to a variety of levels in the business, from organisational level, right down to the product and service level; highlighting what an organisation needs to do to meet their goals, rather than focusing on exact measures and goals of the environmental performance (ISO, 2004).

ISO 14001, as with other ISO 14000 standards, is voluntary, primarily aiming to assist companies to continually improve their environmental performance, while complying with any applicable legislation. Organisations are responsible for setting their own targets and performance measures, with the standard assisting them to meet their objectives and goals and subsequently monitor their performance (ISO, 2004).

The number of UK organisations with a certified ISO 14001 environmental management system is relatively small; reported to have been 4985 in 2009 (Sammalisto & Brorson, 2008).

It does not state any requirements for environmental performance, nor methods of improving resource efficiency, reducing waste or the operations' costs (ISO 2004).

However, organisations with a certified EMS already in place have the processes that may form the basis for GHG accounting and management. Environmental management standard ISO 14001 supports the measurement and reporting of GHG emissions [4]. It applies the "Plan-Do-Check-Act" model based on the Denin Cycle [ see Figure …], which provides a framework for monitoring, collecting data, setting targets and reducing Greenhouse-Gas (GHG) emissions (Suff, 2011).

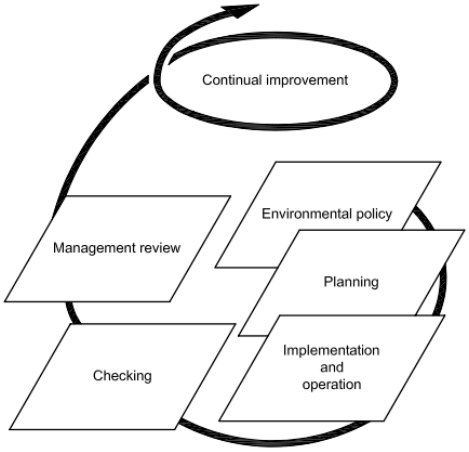


*Figure1: The Denin Cycle*

ISO sets out how Denin should be applied to management systems ensuring the continual improvement of the system.

***Plan Section*** of 14001 focuses specifically on objectives, targets and implementation plans. GHG emissions can be included in the environmental aspects and impacts register that is required by the standard. These are drawn up following the assessment of how the organisation interacts with the environment, identifying those aspects that are significant. Reduction targets and objectives can be set for aspects of operations and activities that contribute to atmospheric emissions (Suff, 2011).

***Do Section*** deals with the implementation of the environmental management programmes to meet objectives and targets; raising awareness among employees of the environmental policy, and specifically the GHG reduction goals; train relevant personnel to raise their competence. Operational controls, such as standard operating procedures, will ensure current emissions are under control (Suff, 2011).

***Check Section*** focuses on regularly monitoring and measuring GHG emissions, tracking progress towards targets and helping to manage energy and emissions reduction. Records will demonstrate that procedures are being performed effectively. Periodic reviews of targets and objectives will determine whether they are sufficient or need altering in some way (Suff, 2011).

***Act Section*** determines changes to management programmes, processes and procedures that are required to deliver improved results and meet changing targets and objectives (Suff, 2011).

## 2. Project Plan

The project targeted a number of challenges: i) allocating appropriate internal support resource and setting timescales; ii) identifying specific improvements to be implemented; and iii) instigating and realising behavioural changes.

Initially an environmental review of the company's activities was undertaken focusing on: I) identifying and understanding existing procedures; II) collecting and understanding existing environmental data and performance; III) identifying monitoring needs; IV) examining the existing Quality Management System (QMS); V) and identifying the environmental aspects and impacts.

The environmental review included meetings with the management team and an audit of the site; to develop a precise understanding of the production procedures and products, people in charge of each production procedure, the background of the company and its customers. The review also collected data regarding electricity, gas, and water consumption and the waste produced by the company.

The company had already measures in place to manage certain environmental aspects. However, it was imperative to develop comprehensive documented procedures in order to ensure consistency of approach by all involved.

The quality management system established some work instructions with relevance to the environmental management (equipment maintenance) and had in place procedures to manage documents and records that could be partially adopted by the environmental management system (EMS). Different type of waste was being separated and collected by different companies for treatment. A Waste Management Table was created to collate comprehensive data to improve the provision of waste management, to define the baseline and to develop Key Performance Indicators (KPIs).

Data was gathered for a range of environmental dimensions. However, the project focused primarily on electricity, gas and water consumption and waste. The initial assessment ascertained the ratio of turnover for a unit of electricity (kWh) used, which also highlighted seasonal variations in productivity.

In the preceding year, the company used approximately 638 000 kWh of electricity which meant that approximately 315 tonnes of $CO_2$ were emitted to the atmosphere as a result of the electricity production, transport and distribution; whilst the gas consumption for the same year amounted to approximately 696 000 kWh representing approximately 129 tonnes of emitted CO2 (DEFRA, 2012, 2013).

The initial environmental review was also used to identify the need for additional monitoring equipment. One of the ovens on-site, responsible for significant electricity consumption, had been continuously monitored for over one year. The analysis of the metered data enabled estimation of the overall consumption of all the ovens. Clamp meters were used to ascertain the consumption of other industrial equipment within the company.

The processes of the quality management system were analysed and a matrix for gap analysis was developed. The matrix compared the existing processes of the quality management system with the processes that needed to be developed for the environmental management system, looking for similar processes that might be adapted by the new EMS. The matrix listed the requirements of the environmental management system, compared them with the existing system and identified the processes and documents that would need to be developed or changed.

A comprehensive register of all the environmental aspects associated with every activity within the company, the equipment and the installations was generated. The environmental impacts of each environmental aspect were also identified in this document. Table 1 indicates a typical entry for one activity.

*Table 1: An Illustrative Environmental Aspect Identification*

| Process | Activity | Aspect | Impact |
|---|---|---|---|
| General assembly | Hand soldering | Electricity consumption | Production impacts (ex: greenhouse effect) |
| | | Non renewable resource consumption | Depletion of non renewablee resurces |
| | | Solid waste | Waste elimination impacts |
| | | Polluting fumes | Air pollution |

## 3. Project Objectives

The primary objective of the project was to achieve ISO 14001 Certification; through the implementation of an environmental management system and the required procedures identified at the project planning phase. The total number of procedures that the EMS required and those that could be adapted from the quality management system after reviewing were identified (see Table 2).

*Table 2: Number of Procedures Required by the Environmental Management System*

| ISO 14001 Requirements | |
|---|---|
| **Procedures** | |
| Needed | 21 |
| Existing from QMS | 12 |
| Need Reviewing | all |

Furthermore, the project aimed to reduce resource use and $CO_2$ emission; requiring the setting of Environmental Objectives. The Environmental Policy established the commitment to setting environmental objectives and the priorities were identified as i) reducing electricity consumption, ii) reducing gas consumption, iii) improving waste separation and reducing collection frequency, iv) providing environmental training and improving awareness, and v) improving employees' participation. The objectives, as well as appropriate actions/control measures, were established by the top management in the environmental programme with the assistance of the project team; see Figure 2 for a schematic representation of the aspects of each objective as recorded in the aforementioned table.

| Objectives | Initial Status | Final Status | Targets | Actions | Person in Charge | Resources | Deadline |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |

*Figure 2: Schematic Representation of Objectives' Aspects*

Periodically, the status of each action and environmental objective was updated on the environmental programme and/or additional actions and objectives were set, following the "Plan-Do-Check-Act" model. Figure 1 depicts the continuous cycle of setting the policy, identifying objectives and targets, deciding on actions to be taken and the control measures to be implemented, monitoring the results and consequently updating the policy once again.

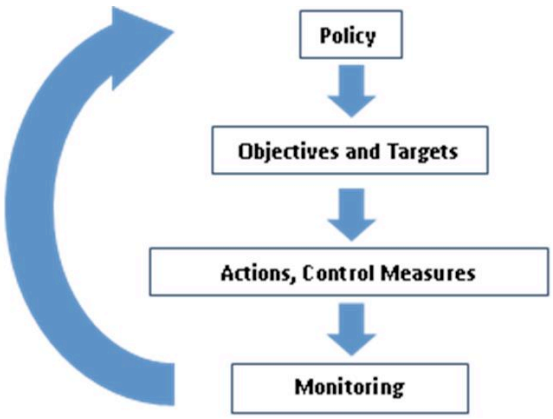


*Figure3: Policy Setting and Implementation Cycle*

## 4. Implementation

### 4.1. Environmental Management System (EMS);

The company's existing environmental policy was reviewed and revised to incorporate the requirements of the ISO14001. The updated approved version was made available to all members of staff.

The matrix of environmental aspects was scrutinised and the significance of each aspect ascertained. The threshold for the level of significance was determined.

Key Performance Indicators (KPI) representative of the company's environmental performance were defined. These were subsequently monitored according to an established plan to assess the company's performance.

An environmental process was developed for managing all the waste in the company in a standardised way.

The environmental requirements that applied to the company (legal and others) were gathered and the company's compliance was assessed. A new process was established to periodically update the environmental requirements and review compliance.

The Environmental Processes that were developed for the EMS used the same template that was used for the Quality Procedures to ensure integration of the two systems would be straightforward. In addition, Environmental Work Instructions and Emergency Procedures were also created. All the procedures were methodically documented for ease of referencing. Table 3 enlists the number of processes, procedures, and work instructions as well as documents that were created by the end of the project.

*Table 3: Overview of the Documented Procedures (June 2014)*

| Environmental Management System |
|---|
| **Processes** |
| 12 |
| **Procedures + Work Instructions** |
| 8 |
| **Other Documents and Tables** |
| 22 |

### 4.2. Building Management System (BMS);

The company implemented a state-of-the-art Building Management System (BMS) with an aim to monitor and control certain aspects of their operation which have a significant environmental impact, and to improve their environmental performance. The implemented System measures electricity, water and gas consumption, improves control over electricity and gas consumption and highlights potential new actions for further improvement in the future.

The BMS provides specific electricity consumption figures for the main equipment within each installation at Nemco. It also provides additional data such as operating hours and consumption cycles of the main equipment. This allows for detailed study of the equipment and identifying further improvement projects.

The BMS also measures gas consumption and, by measuring the temperature inside and outside the building, allows for automatic regulation of the temperature indoors. It makes it possible to differentiate between gas used directly for space heating in the industrial area and for heating up water (toilets and office heating) usage.

### 4.3. Energy and Carbon Emissions Reduction

A number of projects were identified to reduce energy and carbon emission in the company and to improve employees' awareness

#### 4.3.1. Efficient Lighting;

The analysis indicated that changing the existing lights in the warehouse for more efficient variants would accomplish savings, while achieving improved lighting quality with a 3-year payback. An action plan was devised, resources and manpower were committed to the scheme and a deadline was set. The forecast savings in electricity and carbon-dioxide are listed in Table 4.

*Table 4: Forecast Savings*

| | Before | After |
|---|---|---|
| Lights | 465 W | 320/216/160 W |
| kWh/year | 38 000 | 18 500 |
| tCO2 | 20 | 10 |
| £/year | 4 000 | 2 000 |

#### 4.3.2. Automatic Computer Shutdown;

The company uses approximately 100 computers that had to stay on after work to finish the anti-virus scan and would remain on afterwards. However it was noted that the period could be shortened if the automatic shut down of the computers immediately after the anti-virus was implemented. The power consumption of each machine was measured and IT department implemented the automatic shutdown. This is projected to lead to savings of up to 17000 kWh/year, which accounts for 7.6 tCO2 emissions/year (DEFRA, 2013, 2014).

#### 4.3.3. Energy Efficient Equipment;

Replacement of other inefficient practices provided further energy savings and hence carbon emissions reductions as well as cost savings. One example was discontinuing the use of paper towels (est. £1500/year) and replacing inefficient dryers (2450 W) by energy efficient (1600 W) hand dryers that delivered faster drying action and allowed for cost reductions, with a payback period of less than three years.

#### 4.3.4. Waste Collection Reduction

The frequency of the collection of some recyclables (paper, plastic, cans, and cardboard) was reduced by 50%. This was achieved by rationalising the collection of paper, plastics and cans, and by utilising a larger container for cardboard. This led to a reduction in fuel consumption for the two recycling companies responsible for collecting the waste and lower levels of $CO_2$ emissions.

### 4.4. Environmental Training

According to Roninelli and Vastag (2000), one of the strongest impacts of ISO 14001 certification and the adoption of a strengthened Environmental Management System in their case study was behavioural. Managers at the plant in their case study noted that the ISO 14001 certification increased awareness of environmental aspects.

Kitazawa and Sarkis (2000) reported the important role of people (employees, managers) in making the source reduction linkage to the ISO 14001 (EMS) standards stronger and they also refer to other environmental and sustainability management studies that have also shown how critical the “people” dimension is because it goes beyond just product and process dimensions.

In order to increase employee awareness and participation at Nemco, a training programme was devised and delivered to all members of staff divided into small groups. Prior to the training, the general knowledge and attitude of the employees towards a range of environmental issues, as well their role in reducing environmental impacts at the company, was scrutinised though a self-completing questionnaire. One question specifically enquired whether they would like to receive any environmental information and their preferred method of delivery. They were also asked for suggestions that, in their opinion, would improve environmental management in the company.

The results informed the content and method of delivery of the subsequent training provided. The shift in the general environmental knowledge, and their awareness relating to the environmental management in the company, their environmental attitude in general, and their attitude towards environmental management in the company was assessed through a second questionnaire following the training session.

Overall, the training was received favourably by the staff and the initial analysis of the data indicates significant positive results with respect to enhanced knowledge and improved attitude amongst the staff.

The improvement in Nemco's environmental performance could be in part attributed to the raised awareness of the staff.

## 5. Certification Process

The importance of the certification for the environmental performance of the organisation has been shown by Potoski and Prakash (2005). In their study, they compared ISO 14001 certification with Responsible Care. They state that while Responsible Care – a covenant without a sanctioning mechanism – did not improve participants' environmental performance, their study found that ISO 14001, a covenant with a weak monitoring and sanctioning mechanism, improved participants' environmental performance. The discriminating variable in the design of the two programmes is third-party audits. Their paper concludes that monitoring and sanctioning is necessary for a voluntary programme to improve participants' environmental performance.

The award of the ISO14001 standard is subsequent to an external audit by a 3rd party awarding body. In our case study, we approached the British Standard Institute (BSI), and arranged a pre-certification audit (not a mandatory part of the certification process) to highlight any areas that required further improvements. Subsequently, the certification audit was conducted by BSI, in two stages. The first stage assessed the general implementation of the system and if it was ready for the second stage. The second stage assessed in detail if the requirements of the standard were being met by the environmental system. The certification process was conducted successfully, concluding that the Environmental Management System had been properly implemented and, accordingly, Nemco was awarded the ISO14001 Standard Certification.

## 6. Conclusion

The Low Carbon Keep partnership proved successful through an effective mechanism for a partnership between an SME and a knowledge institution, and provided part-funding for the project and for investment in the energy reducing equipment. The partnership between Nemco, a forward-thinking company, and the University of Hertfordshire, an established engineering knowledge and training base, led to the successful implementation and certification of an Environmental Management System compliant with ISO 14001.

The process leading to the ISO 14001 certification was utilised as an effective tool, to establish an Environmental Management System that successfully accomplished the implementation of effective schemes to achieve a significant reduction in energy use and CO2 emissions. The recorded results indicated a 7% reduction in electricity consumption over the 12 month period of the project compared to the preceding year. Furthermore, the calculated CO2 emission over the same period of time showed an 18% reduction. This represents a considerable achievement and clearly proves the success of the project and the partnership between the industry and the knowledge institute. The project also led to improved environmental awareness of the employees in the company.

It is fully anticipated that the company's resource use and energy consumption will be further reduced in the coming year once the implemented systems are fully imbedded in the company's procedures and culture.

## 7. Acknowledgements

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