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Energy Conversion and Management 44 (2003) 945–959

ENERGY CONVERSION & MANAGEMENT

www.elsevier.com/locate/enconman

Energy management practices in SME—case study of a bakery in Germany

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Received 20 October 2001; accepted 20 March 2002

Abstract

The role of energy management has greatly expanded in industries. Major industries are contracting with energy service providers to implement energy management practices to improve efficiency. The effort to introduce energy management in small and medium scale enterprises (SME) is very limited due to the lack of initiation, expertise and financial limitations. In manufacturing, energy cost is usually a small portion of the total production cost, and therefore, energy cost receives relatively little attention. Another problem is lack of knowledge about the underlying principles involved in energy management. There is a well-recognized need to target SME with information on energy management concepts and practises. This paper aims to provide a guideline for entrepreneurs in implementing energy management. It reviews the methodology of energy management that was introduced in a German bakery with a clear and consistent path toward introducing energy management. The methodology, tools used, results and difficulties encountered during the study are discussed.

Keywords: Energy management; Energy efficiency; SME; Germany; Bakery; Carbon dioxide

1. Introduction

Today, the Kyoto Protocol can be seen in the light of several recently launched energy programmes in Germany. Energy management approaches can be one answer to these obligations.

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0196-8904/02/$ - see front matter
PII: S0196-8904(02)00079-1

Energy management becomes a dynamic process where new ideas and knowledge are generated, which, in turn, produce additional energy efficiency gains. As we enter the new millennium, the role of energy management has greatly expanded in industries [1]. German large industries are contracting with energy service providers to implement energy management practices to improve efficiency and conserve energy [2]. In Germany, small and medium scale enterprises (SME) play a crucial role by creating employment and contributing towards gross domestic product. They account for 99% of the total enterprises and 31% of the industrial production [3]. In the manufacturing sector, SME is defined as enterprises employing less than 500 employees and with annual turnover of less than 100 million Deutsche Mark (DM). The European Commission considered the SME sector as an important target, as they account for a considerable share of the energy balance [4]. It was identified that there is a potential to save about 20% of energy consumption in German SME [5].

In the SME, energy cost is usually a small portion of the total production cost, and therefore, energy cost is receiving relatively little attention from the financial point of view. Besides, barriers in introducing energy management in the SME are lack of initiation, information availability and expertise of the entrepreneurs [2]. Nevertheless, the SME cannot afford to appoint a dedicated (energy) manager to look into the energy related activities (Box 1). Another problem is lack of knowledge about the underlying principles involved in energy management. There is a well-recognized need to target the SME with information on concepts and practises of energy management [4,6]. On the other hand, the SME are considered as a sector that is often 'difficult' to reach [4]. An energy management study in a German bakery was conducted, and this case study is described to show how the energy management principles could be implemented in the SME.

Box 1. Can SME afford an energy manger?

In Germany, manpower cost is very high and energy is relatively cheap. For example, if a SME deputes an energy manager with technical qualification (a master craftsman or a technician) to look into energy related activities, the annual manpower cost (salary) will be about 60,000 DM. If the accrued savings is about 10%, and if the energy manager should be paid from the energy savings, then the annual energy cost of the SME must be more than 600,000 DM. For such an energy cost, the annual energy consumption would be in a range of 4–10 GWh, but, the energy consumption of most SME are less than 2 GWh per year. Under this circumstance, the energy saving alone would not pay-off a 'dedicated' energy manager. This cost factor hampers the adoption of an energy saving campaign in the SME.

Energy management is the judicious and effective use of energy to maximise profits and to enhance competitive positions through organisational measures and optimisation of energy efficiency in the process [7]. A comprehensive energy management programme is not purely technical, and its introduction also implies a new management discipline. It is multidisciplinary in nature, and it combines the skills of engineering, management and housekeeping [8]. Energy management in any industry is desirable for financial, social and environmental reasons. The financial reasons focus on the profitability and potential growth of the enterprises, whereas the social and environmental reasons focus on the benefits that the enterprises, their workers and the society get from an energy management programme. Fig. 1 illustrates the structure of an energy management programme.

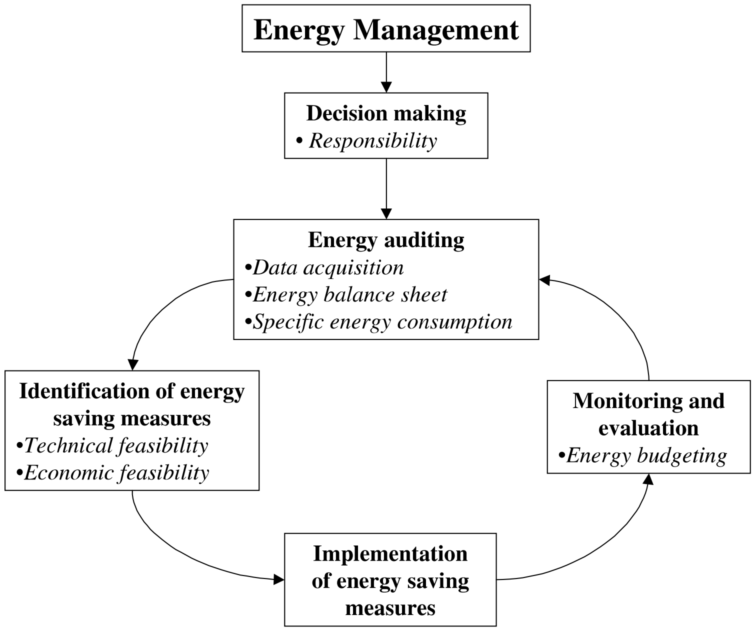

Fig. 1. Structure of energy management programme.

For the energy management programme to be successful, initially, a firm commitment by the top management is essential. Right from the beginning, it should be made clear that energy management is a permanent activity, as compared to an energy saving campaign. For implementation, the enterprise should introduce an organisational structure in which at least one person (Energy Manager), who has the technical know-how on the production process, should be made responsible for the overall energy related activities. To minimize the personnel cost on a 'dedicated' energy manager, the production manager or plant supervisor could be made responsible for energy related (conservation) activities. However, he should be paid in addition to his normal pay, depending on the energy saving achieved. The new organizational structure and delegated responsibilities will generate a wider interest and commitment to the energy saving effort.

1.1. Background of the case study

The bakery industry is one of the major food processing industries in Germany, and it is an energy intensive industry. Most of the bakeries in Germany are small scale industries and more than 70% of the total bakery products are produced from craftsman bakeries (*Handwerkliche Bäckereien*) [9]. In 2000, about 20,600 craftsman bakeries, 1200 small and 11 big industrial units were operating in this sector [10]. In bakeries, about 80% of the total energy requirement is thermal energy at 180–360 °C for baking. "*Der Grundhofer Vollkornbäcker—Peter Thaysen*" is a craftsman bakery in the state of Schleswig-Holstein, Germany. The bakery was certified under

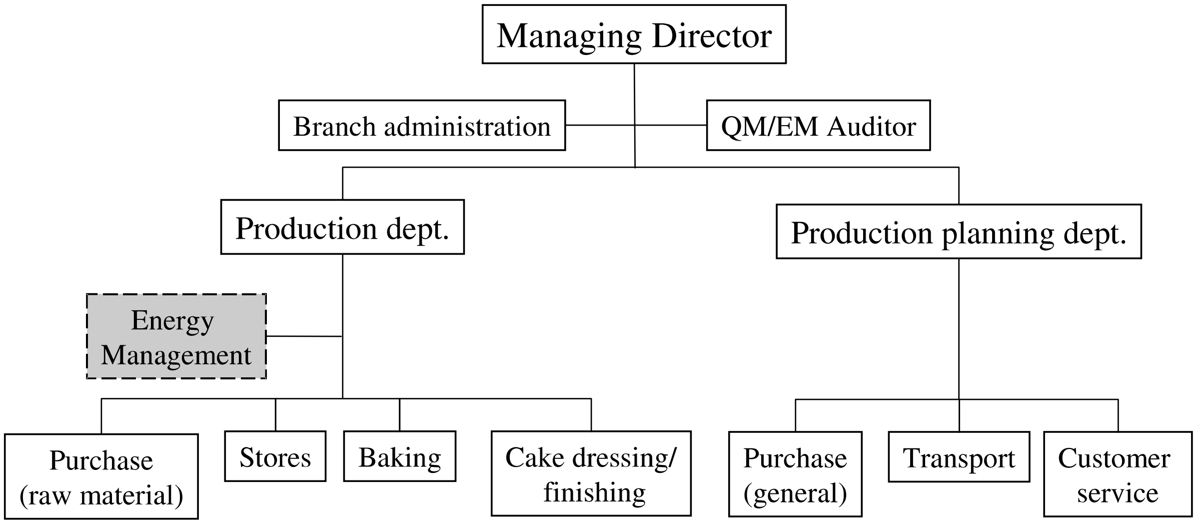

Fig. 2. Organisation structure shows the energy management in the bakery.

ISO 9002, and it is the first craftsman bakery in Germany to have an environmental audit (EG-Öko-Audit-Verordnung no. 1836/93) [11]. Its 950 m^2 modern production unit processed daily about 2 tons of flour for bread, buns, rolls, cakes and pastries. The bakery consumed annually about 225 MWh electricity and 57,700 l of furnace oil, and the annual energy bill was 68,300 DM.

Energy management in the bakery began with a discussion with the owner of the bakery to explain the aim and benefits of energy management. Though the bakery had an energy conservation initiation as part of its environmental audit, the management agreed to have energy management at the production unit to improve their marketing strategy, since it was serving for the *eco-product* market. It was decided to include energy management in their organisational structure and bring the responsibility of energy management under the production manager's control, so that it would be easier to make any modification in the production schedule or machines as and when required. Fig. 2 shows the position of energy management in the bakery's organizational structure.

2. Energy auditing

Once the decision to conduct an energy management programme was taken, energy audit is the next step. It plays an important role in identifying energy saving possibilities of the enterprise. The aim of an energy audit is to scan areas for possible energy savings or analysing individual energy saving measures [1]. An energy audit may be considered as similar to the monthly closing statement of an accounting system. One series of entries consist of the amounts of energy that were consumed during a period, and a second series lists how the energy was used. How much for heating, cooling and lighting? How much for each process/operation? The outcome of an energy audit provides information about the present energy use of the enterprise. The energy audit should be conducted accurately enough to identify and quantify the energy savings that are likely to be realised. The various steps involved in energy auditing are described below:

2.1. Data acquisition

The data needed for energy auditing are: amounts of energy consumed, their end uses, types of fuel and volume of production.

For example, the bakery was using electricity and furnace oil as a source of energy. Electricity was used for machinery, bake oven, absorption cooling system and lighting, while furnace oil was used for bake ovens and boilers. The electricity bills during the past four years were noted and found to be 225 MWh per year with a connected load of 125 kW. The annual electricity cost was 43,000 DM.

Fuel oil bills during the past many years were not available, and the annual furnace oil consumption was estimated from the available bills as 57,000 l per year having a monetary value of 24,600 DM. The total energy consumption was then calculated by considering both electricity and oil consumption. This amounted to about 800 MWh per year, and the total energy cost was 67,600 DM. About 72% of the total energy requirement was met by oil, while 28% was met by electricity.

2.2. Energy balance sheet

The data on energy use was then used to prepare an energy balance sheet. The energy balance sheet itemises all relevant input and output energy forms and shows the breakdown of energy used in various processes. The energy balance sheet is used to identify the 'energy centres', which may then be analysed to see an area for energy saving potential. To prepare the bakery's energy balance sheet, a continuous on-site study was conducted at the production unit, and a process and energy flow diagram was developed as shown in Fig. 3.

2.2.1. Production process

Flour was milled in the bakery and stored in the silo. Flour from the silo was transported to the kneading machine pneumatically. Flour, fermented broth and other ingredients were mixed in the kneading machine to make dough for bread/bun/rolls, while the mixer was used to make cake batter. Dough was moulded into bread/bun/rolls by machineries. The moulded breads were fermented in the fermentor and baked at 180–300 °C, depending on the type of bread. A portion of the bread dough was baked partially and frozen by blowing cold air at −38 °C (shock freezer) and stored in the freezer at −23 °C. The bread moulds and baking trays were washed in hot water at 40 °C.

Moulded bun dough was loaded in the auto-fermentor, which is a storage room cum fermentor where the temperature is automatically controlled between −23 and 40 °C. While loading dough in the auto-fermentor, the temperature was −23 °C and was gradually increased to 40 °C over 16 h time during which period fermentation took place. Then the auto-fermentor was cooled to −23 °C for the next loading of bun dough. The fermented bun dough was baked at 200–260 °C. A small portion of the bun dough was delivered to their retail outlets, where they were baked.

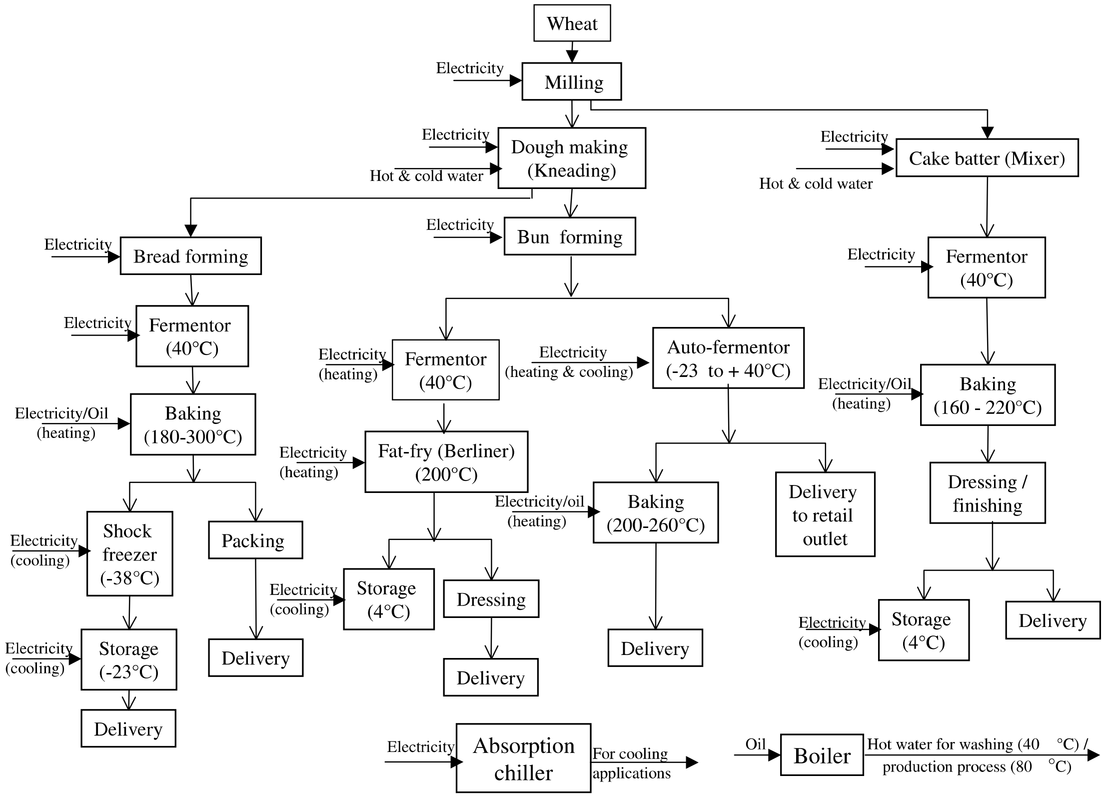

Fig. 3. Production process diagram of the bakery.

Besides, some bun dough was baked in fat at 200 °C (*Berliner*). Part of the baked goods were stored in the cold storage room at 4 °C or −23 °C depending on the storage period.

All machineries in the production unit were listed including the equipments indirectly involved in the production process, such as lighting, controller, ventilator etc. The major machineries were the miller, mixer/kneedding machine, bun and bread former (divider), fermentor (proofing oven), bake ovens, cold storage unit and boilers. At the beginning of the energy management programme, seven bake ovens (six oil fired and one electrical) were used. Later, three oil fired bake ovens were replaced by four electrical ovens, which were planned before this energy management programme. During the audit, eight bake ovens (three oil fired and five electrical) were in operation. Two boilers supplied hot water to the production process and space heating. The hot water (40–50 °C) was mainly used for washing the baking plates, moulds and trays. The hot water requirement of the owner's residence was also supplied from the boiler, but there was no data available to quantify the consumption. The cold storage room, freezer and auto-fermentor were cooled by a central absorption chiller. Two cold water systems were also in operation.

Based on the rated power of the equipment and their number of operating hours, the total energy consumption was calculated. The number of operating hours was estimated based on observation and discussion with operators and managers. The difficulties encountered during the determination of the number of operating hours were: some machineries were running at different time intervals or vary from day to day and some were operated by controllers. The bakery was operating on a single 8 h shift, and the major production (baking) was in the early morning hours. It was estimated that the production hall operated annually for about 4575 h.

The calculated total energy consumption was 813 MWh, which agreed well with the actual energy consumption of 800 MWh. A breakdown of the energy used for various processes and end applications is shown in Figs. 4–7. About 73% of the total energy was consumed in baking, while fermentation and cleaning accounted for 6% each. About 85% of the total energy was used for heating, while lighting, machinery and cooling accounted for 5% each.

2.3. Specific energy consumption

Specific energy consumption was estimated in terms of kWh per kg of product. In the bakery, the energy consumption could not be directly related to production volume because the output products did not have any fixed weight or volume. Therefore, the specific energy consumption was estimated in kWh per kg of processed flour.

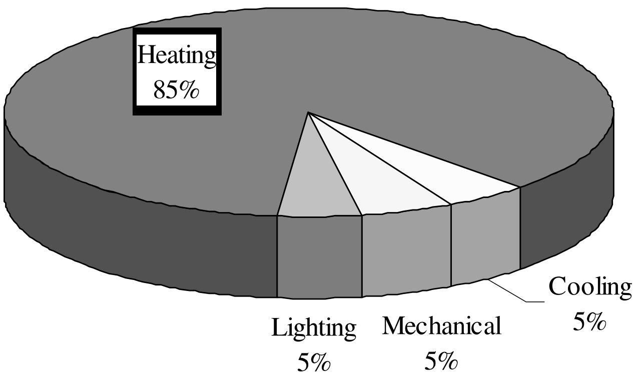

Fig. 4. Energy use for various end applications.

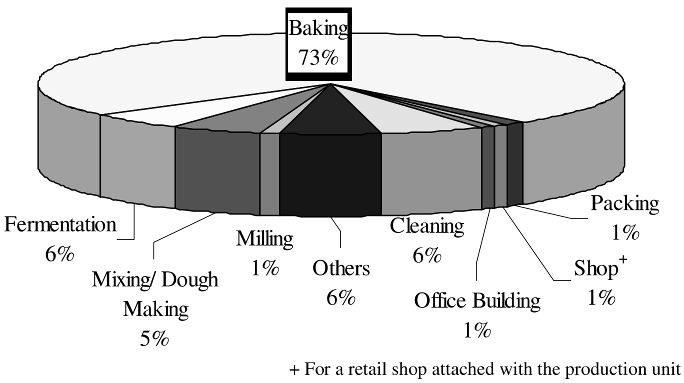

Fig. 5. Energy use for various processes.

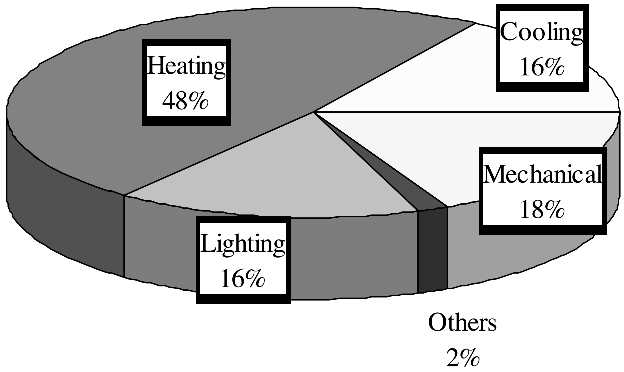

Fig. 6. Electricity use for various end applications.

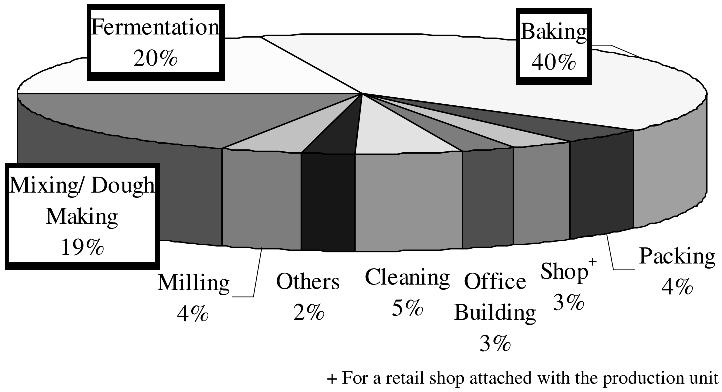

Fig. 7. Electricity use for various processes.

$$\text{Specific energy consumption} = \frac{\text{Total energy consumption per year}}{\text{Total processed flour per year}} \tag{1}$$

It was estimated that the bakery processed about 585 tons of flour annually, and the specific energy consumption was 1.37 kWh/kg of processed flour (Table 1). The specific energy cost was 0.11 DM per kg of processed flour. Since the bakery was serving for an eco-product market, carbon dioxide (CO_2) emission was also estimated. The CO_2 emission factors for German electricity generation [12] and oil production [13] were used for the CO_2 emission calculation, and the specific CO_2 emission was about 500 gm per kg of processed flour.

Based on literature and bakery machinery manufacturers data, the estimated specific energy consumption could be in the range of 1.27–1.89 kWh/kg of processed flour depending upon the type of fuel used in the bake ovens [14–16] (Table 2). However, it varies with the type of bread baked, size of the bakery and number of shifts. Conventionally, the total specific energy consumption is estimated by adding the specific thermal energy consumption and the specific electrical energy consumption. In such estimates, the efficiency of electric power generation is not considered. Hence, the specific primary consumption and the specific CO_2 emissions were calculated.

Table 1
Estimated specific energy consumption, cost and CO_2 emission of the audited bakery

Energy source	Energy consumption (kWh)	Processed flour (kg)	Specific energy consumption (kWh/kg[a])	Average energy price (DM/kWh)	Specific energy cost (DM/kg)	Specific CO_2 emission (gm/kg[a])
Electricity	225,160		0.383	0.19[b]	0.07	240 [12]
Oil	577,810	587,400	0.984	0.04	0.04	256 [13]
Total	802,970		1.367		0.11	496

[a] kg of processed flour.
[b] Including demand charge.

Table 2
Summary of specific energy consumption and specific primary energy consumption

Energy source for bake oven	Specific energy consumption (kWh/kg[a])	Specific primary energy consumption (kWh/kg[a])	Specific CO_2 emission [12,13] (gm/kg[a])
Electricity [14]	1.27	3.18	796
Gas [14]	1.84	2.58	578
Oil [14]	1.89	2.64	675
Oil [16]	1.47–1.56	2.21–2.3	564–588
NA [15]	1.30	–	–
NA [15]	0.976[b]	–	–

NA: not available.
[a] kg of processed flour.
[b] Only for baking and hot water.

3. Identification of energy saving measures

3.1. Technical and economic feasibility

From the energy balance sheet, areas of high energy consumption 'energy centres' were considered as potential areas for energy saving. However, other areas could also be considered to improve the overall energy utilization. There may be many options to reduce energy consumption. For example, better housekeeping, behavioural changes, preventive maintenance, installation of energy efficient equipments etc. are a few of the options available. The next section briefs selected energy saving measures recommended for the bakery.

3.2. Energy saving measures for the bakery

Though the specific energy consumption of the bakery (1.37 kWh/kg of processed flour) agreed with the literature, there was some further scope to save energy. Since baking was consuming the major share of energy (Fig. 5), it became the first focus area for energy saving measures. Since the management had a plan to replace the rest of the oil fired bake ovens by electric bake ovens in the next two years, the oil fired bake ovens were not considered for an investment oriented conservation measure. Nevertheless, it was recommended that some housekeeping practices should lead to reduced energy consumption.

3.3. Conservation in bake ovens

The load in the bake oven has a significant influence on energy consumption. If the load is 75%, the specific energy consumption will increase by 5%, while it will increase by 16% at 50% load [15]. It was observed in the bakery that most of the baking is done in batches, and the bake ovens were normally partially loaded, which could be avoided by scheduled baking. Though there were some variations in daily production, they were mostly stable for a particular season. Hence, 4–5 bake ovens could be used for regular production, and these ovens could be operated on full load. Also, very often, the bake ovens were not loaded, either due to unsuitable (low or high) temperature in the ovens or other reasons. This could be avoided by a clear baking plan. Dough requiring high temperature should be baked first, followed by low temperature dough. This would not only reduce the lead time but also facilitate the use of sensible heat in the ovens. Creating an awareness among the operators and organizing a scheduled baking plan should easily achieve a considerable saving. Even a 5% energy saving was estimated to save annually about 4200 kWh of electricity and 2500 l of oil.

The flue gas from the bake oven can be used for hot water generation. The flue gas from a 10 m^2 bake oven could heat 300 l of water to 70 °C daily, and this could improve the energy utilization by 10–15% [15,17].

In oil fired bake ovens, cold ambient air was directly used as combustion air, and due the to high moisture of ambient air, tar build-up was noticed at the burners. Instead of using ambient air directly, it could be preheated by the flue gas. This would save energy as well as reduce maintenance cost of the oil fired bake ovens.

Selection of a new bake oven: The management had a plan to replace the remaining oil fired bake ovens by electric ovens. It was recommended that before replacing the oil fired bake ovens, the management should look at the energy efficiency of the proposed new oven. The selection should be based only on how to use energy more efficiently, but also lead to economic benefits. A life cycle cost analysis was made for oil fired, gas fired and electric bake ovens, and the life cycle CO_2 emission was also estimated. In an economic point of view, the oil fired oven would be the cheapest, while on an ecological aspect, the gas fired oven would be the best. Though the initial investment on an electrical oven was low, it was found to have the highest annual cost and leads to high CO_2 emissions unless the electricity is produced from renewable energy sources (green power). The additional investments on the oil and gas fired bake ovens would be paid off in 1.2 and 2.7 years respectively, and their CO_2 emissions would be less by 13% and 33%, respectively, compared to the electrical oven. Liquefied petroleum gas was available at the bakery location, and it was also found that the local utility proposed to supply natural gas by pipeline. Hence, it was recommended for the gas fired bake ovens.

3.4. Lighting

About 16% of the electrical energy consumed was for lighting (Fig. 6). For lighting, mostly 58 W fluorescent tube lamps were used with conventional induction choke (ballast). It was proposed to replace the induction choke by electronic ballast that would save about 3800 kWh. Though it was technically feasible, the pay back of such investment was about 14 years. Hence, it was recommended to use electronic ballast only for new installations.

Because of centralized switches for lighting in the bakery, some lights in unoccupied rooms were left on. For example:

- The tube lights in the smoking room were needed only for a short interval, but the lights were on throughout the day. By installing individual switches (decentralized), considerable energy could be saved. Since the light requirement in the smoking room was for very short time intervals, a 12 W compact florescent lamps was found to be sufficient. It would save 270 kWh annually, and the pay back period of the investment was less than two years.
- In the milling room, there was no need for continuous lighting from four lamps since the motors are operated by controllers. Leaving only one lamp on (instead of four lamps), especially when not required by operators, was estimated to save 840 kWh annually.
- Tube lights in the packing hall, washing section and logistic station could be switched off whenever sufficient daylight was available. Here also, individual light switches were recommended to switch off the lights when necessary. A reduction of 3 h per day during the three summer months itself saves about 700 kWh/year.

Installing individual switches and creating awareness among the operators could achieve these savings.

It was recommended to relocate the two lamps over the new electric oven, since the ovens blocked the light from these lamps. Because of the moist exhaust from the oven, the lamps were deposited with dirt and were yellowish. A periodical cleaning of lamps was recommended that would improve the light quality and life time of the lamps.

3.5. Hot water usage

It was observed that cold water at 4 °C and hot water at 80 °C were mixed for general use (45 °C) because there was no provision for pipe water in the production hall. This was especially practiced while washing the machineries and floors. Instead of mixing cold water, pipe water (13 °C) could be used to make hot water for general use. It was estimated that an annual saving of 450 l of oil (in the boiler) and 5400 kWh of electricity (in the cold water system) could be achieved without any investment.

3.6. Insulation of pipes

The cold and hot water pipelines were not insulated in the sub-distribution network. Extending the insulation to the end of the distribution network would reduce energy loss and, therefore, save energy.

3.7. Recalibration of thermostat

In dough making (in kneedding machine), water was used between 4 and 80 °C and water was discharged by a thermostat controlled pump. It was measured that there were large variations in water temperatures. For example, for the 4 °C temperature setting, cold water was discharged at 2.7 °C while for 36 °C temperature settings the hot water discharge was at 42 ° C. Recalibration of the thermostat also will lead to energy saving. The calibration should be performed periodically.

4. Implementation of energy saving measures

Once a choice for the energy saving measures was made based on their technical and economic feasibility, steps were needed to implement the chosen options into practice and to monitor the results. The implementation phase needs to be planned first, and this required additional information. Employee awareness on energy conservation was given high priority before implementing any energy saving measures.

In the case of this bakery, most of the recommendations were tightening of operations and housekeeping practices. Instead of making the housekeeping a special task, it was integrated into the routine operational practice. If the energy saving measures could be implemented, the specific energy consumption would be reduced to 1.28 kWh/kg of processed flour from 1.36 kWh/kg of processed flour. An annual saving of about 12,000 kWh of electricity and 35,000 l of furnace oil was expected, accounting for 4000 DM per year (6% of the total energy cost).

5. Monitoring and evaluation

Monitoring facilitates keeping track of the energy consumption of the enterprise, and evaluation over a period of time gives an indication of the success or failure of the energy saving measures. It helps to judge whether the predicted energy savings are actually being achieved or not. It will also assist in identifying alternate adjustments and new possibilities. Periodic monitoring requires some measuring equipment and maintaining an energy record.

Evaluation shows whether the energy saving measures are progressing according to plan or whether there have been any deviations. An evaluation should also reflect the following: Are the measures still on course as far as original objectives are concerned? Did the measures have an impact on other processes? In short, evaluation is recoding the experiences, whether there are benefits or problems, along with possible solutions. Repeating the energy audit shall facilitate the evaluation. Repetitions of the energy audit shall lead to further identification of energy saving measures. Once again, these need implementation of such measures and need monitoring and evaluation. Hence, an energy management programme is a cyclic process that requires support from all levels.

In the case of the bakery, it was recommended that annual energy audits be conducted to monitor the new developments in energy consumption and to review the energy consumption figures with an emphasis on the energy intensity. Also, it was suggested to set a target for the new energy consumption, and more attention shall be given to find methods of improving utilisation of the waste heat from the ovens and to seek more ways to conserve electricity in lighting.

5.1. Energy budgeting

Another important feature of energy management is planning for future energy demand. Energy budgeting is an estimate of future energy demand in terms of fuel quantity, cost and environmental impacts (pollutants) caused by the energy related activities. After considering various energy saving measures and new energy saving projects, the expected saving can be estimated. With such estimations and the earlier energy consumption pattern, an expected energy consumption for the following years can be determined.

For this bakery, an energy budget was prepared (Table 3) based on the estimated energy consumption of the newly installed electrical ovens and the expected savings from energy conservation measures. Since the bakery proposed to increase production by 10%, three oil fired bake ovens were replaced by four electrical bake ovens. This would double the electricity consumption, whereas the oil consumption would decrease by 40%. However, the specific energy consumption could be reduced by 6.5% due to the new energy saving measures. The projected energy consumption for the next year was about 460 MWh electricity and 34,800 l of furnace oil, while the energy cost was 105,000 DM. The specific CO_2 emission was expected to increase from 496 to 592 g per kg of process flour because the electricity was generated by fossil based power plants.

6. Constraints in implementation of energy management practices

At the beginning, the administrative personnel felt that finding the past energy bill and equipment manuals was extra work. If the future data (bill) on electricity and oil is obtained from normal administrative work (reporting), this could not be the case.

During the energy auditing, when observing housekeeping practices, the operators felt that they were being observed all the time, and it caused fear/resentment among the operators. This could be overcome by giving adequate training, and awareness should be created with dedicated support of top management. Besides, additional incentives would motivate them to conserve energy.

Only limited energy consumption data/standards/benchmarks were available for the bakery process. To establish energy consumption standards/benchmarks, a data sheet was sent to all bakeries in the region. There was only one response, though the data sheet was sent through the bakery association. This shows that there is a lack of interest and awareness regarding energy conservation.

Though this energy management methodology was developed for entrepreneurs, it was observed that it might be difficult for the entrepreneurs to conduct the energy audit by themselves and to identify the energy conservation measures. Though their experience and knowledge in the production process is an added advantage, on the other hand, it is biased when it comes to housekeeping practices or production processes. The resistance to change in suggested practices is known as '*attitude change*'. Besides, energy management is felt as an extra workload that may be delaying further progress. So, it would be better to conduct the energy audit, at the initiation stage, by an external consultant or an energy expert, who could also bring more experience from

Table 3
Energy budget of the audited bakery

Descriptions	Projected for 2001	Actual in 2000	Changes (%)
Production (in tons)			
Quantity of processed flour	650	587	+10.7
Electricity (in kWh)			
Present consumption	225,049	225,160	
Add electricity consumption for newly installed bake ovens (estimated)	269,428	–	
Sub-total	494,477	225,160	
Less expected savings	25,858	–	
Total (A)	468,619	225,160	+108.13
Furnace oil			
Present consumption	588,307	577,810	
Less oil consumption of replaced bake ovens (estimated)	214,812	–	
Sub-total	373,495	577,810	
Less expected savings	25,198	–	
Total (B)	348,297	577,810	−39.72
Total energy consumption (A + B)	816,916	802,970	+1.74
Energy cost (in DM)			
Electricity	91,006	43,726	
Furnace oil	14,837	24,615	
Total energy cost	105,843	68,341	+54.88
CO_2 emissions (in tons)			
CO_2 emission from electricity use [12]	294	141	
CO_2 emission from furnace oil use [13]	91	150	
Total CO_2 emission	385	291	+32.30
Summary			
Specific energy consumption (kWh per kg of processed flour)	1.257	1.367	−8.04
Specific energy cost (DM per kg of processed flour)	0.16	0.11	+45.45
Specific CO_2 emission (gm per kg of processed flour)	592	496	+19.35

other industrial practices. However, the entrepreneur should get involved, so that the energy manager could do the evaluation process in a better way.

7. Conclusion

As a result of introduction of energy management in the bakery, a reduction of 6.5% on total energy consumption was expected. Though the bakery had some energy conservation programme, this 6.5% energy saving is to be achieved without much investment. It indicates that there could be a significant potential to save energy in other bakeries where no energy conservation campaign/saving measures have been taken. Hence, the energy management approach can be one answer to reduce energy consumption and meet CO_2 emission mitigation obligations.

Acknowledgements

The authors would like to acknowledge the financial support given by the German Academic Exchange Service (DAAD) to conduct this research study. This work was performed as a part of the corresponding author's research study towards his Master's thesis under the guidance of the co-author.

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