Energy Monitoring and Targeting in the UK Brewing Industry

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ABSTRACT

In an effort to reduce the cost of energy and utilities services within the brewing process, energy and utilities monitoring and targeting techniques have been developed within the UK brewing industry. The technique encompasses the recognition of energy and utilities as production-related resources and identifies the steps to improve the operational and financial management of those resources. The steps involve the design and installation of usage data collection, feedback and analysis systems which facilitate better appreciation of usage patterns and the setting of practical usage reduction targets. Practical experience in the UK has indicated a cost saving potential of 5% of brewery annual energy and utilities costs.

In my presentation I would like to introduce you to the UK Brewing Industry, explain why M&T has been introduced, outline the concept of M&T and some case studies, comment on M&T systems and equipment selection and conclude with recommendations.

The UK Brewing Industry today is one of the major UK industries, it directly employs 600,000 personnel and a further 200,000 (ranging from farmers to can making machinery suppliers) are industry dependent.

The brewing industry accounts for $9 billion of goods and services purchased annually. It directly contributes $3.6 billion in beer excise duty to the Chancellor and the total taxation benefit created for the Government via pubs, clubs, etc. is of the order of $11.4 billion. You will appreciate that a successful brewing industry is vital to the development of the UK economy.

The industry has endeavored to improve its performance over the last decade.

However, total UK beer production output is not impressive when compared with other countries worldwide. (Ref. Appendix 1)

Overall, the world brewing scene is active and the global trends point to expansion in brewing. The North American Brewing Industry continues to dominate world production levels and is strong and vibrant. The Asian brewing scene is one of great potential. Within the European Union Brewing Industry, beer production is flat.

In the case of the UK, beer production is in decline. (Ref. Appendix 2)

SÍNTESIS

En un esfuerzo para disminuir los costos de energía y servicios en el proceso cervecero, se han desarrollado técnicas para monitoreo e identificación en la industria cervecera británica. La técnica comprende el reconocimiento de energía y servicios como recursos vinculados al proceso de producción e identifica los pasos para mejorar la administración operacional y financiera de estos recursos. Los pasos comprenden el diseño e instalación de colectores de información, sistemas de análisis y retroalimentación que facilitan la apreciación de variaciones de uso y la implementación de objetivos prácticos para la disminución del consumo de energía. La experiencia práctica en el Reino Unido ha indicado que hay el potencial de un ahorro del 5% en los índices de consumo anual de energía y costos de servicios.

The brewing industry is endeavoring to survive in an ever-increasingly competitive market place, whilst at the same time complying with the increasing pressures of unfair Government taxation policies, regulation and environmental improvement.

The industry is having to comply with a variety of strict regulations covering water usage, health and safety, pressure systems, effluent treatment and disposal, and packaging waste. Such legislation imposes severe financial burdens on the breweries.

Within the brewing process, environmental issues and energy issues are inextricably linked. Utilities used within the process directly relate to the environmental impact of the process. Within the UK Brewing Industry, the emergence of corporate environmental policies and environmental management systems is resulting in a repositioning of energy efficiency issues. Corporate environmental policies are raising the profile of energy efficiency issues linked to steps to improve the environmental friendliness of the brewing process.

Faced with the overall declining beer market, the UK Brewing Industry, over the last decade, has focused systematically on improving process efficiency as part of the strategy towards achieving competitive advantage and environmental compliance. It is recognized that energy is a controllable cost of strategic importance. We have appreciated the need to systematically appraise all available opportunities towards achieving best practice energy and environmental management. The best in class philosophy is helping the drive towards the uptake of energy efficiency and environmental friendliness improvements.
In the drive towards cost reduction and best practices in environmental and energy management, the UK brewing industry has been developing a technique known as monitoring and target setting, which can reduce the cost of energy and utility services - such as water and process gases, encourage wider participation in environmental and energy management, and provide a greater understanding of the brewing process and plant performance. (Ref. Appendix 3)

M&T is a development based on the premise of a shared system of resource management. It requires the setting up of a linked method of information feedback covering all the major aspects of a brewing operation energy usage. Dynamic, continuous feedback is established such that accurate monitoring of the actual consumption of utilities within the process is achieved. (Ref. Appendix 4)

The information gathered is compared against derived standards for a particular brewing process. Action to correct deviation from the standard can be evaluated. By benchmarking against standards, measures to correct deviations/implement energy saving measures can be actioned.

As a result of being able to accurately collect factual data, the effective use of a M&T system can assist in achieving the overall objectives set for M&T which are:

- Improve understanding of the brewing process in terms of utilities consumption and environmental impact.
- Facilitate the development of a general brewing model.
- Determine minimum energy requirements.
- Optimize production scheduling.
- Identify areas for energy cost savings and environmental performance improvements.
- Focus on cost reduction linked to environmental improvements.

This technique can be applied universally within the industry to breweries of any size to further improve the efficient use of energy, minimize resource costs, improve environmental friendliness and maximize total profitability. The monitoring and target setting principle can be particularly attractive for small and medium-sized breweries, as many projects can be carried out at no cost or minimum capital expenditure with annual cost savings likely to be in the order of 5% or higher. Production events can be directly related to energy and utilities consumption and, in addition, alarms fitted to monitoring equipment can provide further quantifiable cost savings by identifying equipment and operating faults - a potentially crucial factor for the profitability of a small- or medium-sized brewery.

In essence, M&T involves a shift in the accountability for the use of energy and utilities and an increased awareness of their cost and pattern of use. Accountability for use and cost must involve commitment from all personnel involved in the particular industrial process.

Monitoring and target setting (M&T) is not a new concept, although it is not yet widely applied in UK industry. Where the concept has been introduced in a number of UK industrial sectors, it has shown energy cost savings of between 4% and 18%. Although developed for the management of energy use initially, M&T techniques can also be applied to utilities services as already mentioned. (Ref. Appendix 5)

The current cost of energy to the UK brewing industry is approximately £84 million which represents approximately 3% of production costs. Similarly, the cost of utilities such as water and process gases is also £84 million, and represents another 3% of production costs. (Ref. Appendix 6)

The UK brewing industry is highly conscious of the need for energy conservation. Good housekeeping has been reflected in significant improvements in energy efficiency brought about by the UK brewing companies adopting best practice energy usage over the last decade.

The brewing process is sufficiently standardized to have enabled valid benchmarking of energy efficiency against an industry standard. (Ref. Appendix 7)

Shown here is the BLRA compiled industry average energy consumption for the period 1976-1994. As can be seen, total energy consumption to produce a hectolitre of product has decreased on average from 303 megajoules in 1976 to 162.3 megajoules in 1994, a reduction of 46.44% over the period.

Energy and utilities are traditionally managed by a company’s engineering and maintenance management staff. Although engineering management is responsible for the efficient supply of such resources, their efficient use and rate of consumption is principally a production responsibility.

Until now, the cost of such services has often tended to be regarded as an overhead. In some instances, monitoring systems has been set up with the intention of transferring internal costs, but difficulties have been experienced with their allocation, inaccurate and infrequent consumption information and the extent of administrative management effort involved.

The fundamental principal of M&T is that:

- Energy and utilities should be considered production-related resources which must be paid for in the same way as labor and materials. Responsibility for controlling the use and cost of such resources and, hence, the results, should, therefore, be shared between:
  - those who supply it, and;
  - those who use it
- That is, the managers of both engineering and end-user production functions.

Monitoring and target setting should be regarded as a shared system of resource management.

The end purpose of M&T is to provide a common base - expressed in financial terms - which everyone, from accountant to end-user, can understand the information reporting and analysis of resource use.

To do this, the basic steps required to establish an M&T system are as follows:

STEP 1 Install effective monitoring of process systems via efficient metering and out-stations, with information feedback to one or more central locations together with a capability for analyzing all resources used.

STEP 2 Identify Energy Accountable Centers (known as EACs). That is done by dividing the company into those departments or areas which use and supply energy and utilities services. An EAC would normally correspond to an existing management accounting center, taking into account the configuration of services, the ease of monitoring, large users of energy utilities and opportunities for potential cost savings.

STEP 3 Monitor the energy and utilities services in each EAC and present it as part of the management accounts.

STEP 4 Set standards by establishing energy and utilities consumption in each EAC and compare actual use with the standards set.

STEP 5 Report and review consumption, costs and expected
variations, learn from experience and motivate all engineering and production personnel to be energy conscious.

STEP 6 Target future potential reductions in energy and utilities consumption. This would be via a combined engineering and production management initiative, based on progressive experience of the M&T system and identification of further cost-effective efficiency products which could be carried out.

To summarize, in addition to permitting direct cost accounting, the monitoring of energy and utilities and other production variables in an EAC will highlight deviations from established standards. Action can then be taken by production managers to prevent further waste. The application of the technique will also identify areas of high consumption which could be targeted for reduction by investment in further efficiency measures.

At this point I would like to outline the M&T Pilot Study carried out in a number of UK breweries.

The Brewers Society carried out a Pilot Study during the period September 1987 to October 1989, followed by a further period of information gathering and preparation of an overall report.

The total cost of energy and utilities in the breweries at the start of the project was $12.6 million. The total capital investment made during, or as a result of, the project were approximately $480,000.

The reported benefits included:
1. Unexpected variations in boilerhouse efficiency identified.
2. Confirmation of production plant being turned on too early or off too late.
3. Unusually high space heating was detected.
4. One brewery saved 15% of its annual fuel costs, inspired by M&T and worth $207,000. At the same time, brewhouse energy savings were made possible by changing the pattern of operation - again this was due to the introduction of the M&T technique.

Since the Pilot Study, savings of $6.45 million have been identified from projects at 19 breweries, with investment payback periods ranging from 2 - 5 years. These savings average out at over $300,000 per brewery. Over 30% of the projects were carried out at no cost or low cost capital expenditure.

One specific case study is that of the M&T system installed at Scottish & Newcastle's Fountain Brewery in Edinburgh.

The Fountain M&T system consists of 62 remote electronic flow meters and totalizers monitoring the usage of utilities on site.

The conditions monitored are:
- Ambient temperature
- Electrical power
- Steam
- Water
- Oil
- Natural gas
- Carbon dioxide
- Nitrogen
- Caustic

Fifty-one of the flow meters were installed in 1989 as the first phase of the M&T project at a cost of $150,000 and 11 additional flow meters have recently been installed in the current year.

Considering the M&T hardware and software in use at Fountain Brewery (Ref. Appendix 8):
One spectacular success in resource cost savings which has been achieved is at a small brewery in England, the success of which can be contributed solely to the introduction of the M&T technique.

The brewery has been in existence since 1876. In 1976, the company’s centenary year, operations were moved to a purpose built brewery.

Efficient use of energy and utilities had been of prime importance from the concept of the new brewery. In 1985, an Energy Manager was appointed to improve efficiency, both in the brewery and in the company’s pubs. Initially, good housekeeping measures (such as repair of steam and water leaks, insulation of pipes, etc.) were carried out, closely followed by the development of M&T in 1987 – which was motivated by the ever-pressing needs of the brewery to maintain a competitive edge in the market by tight control of year-by-year energy and utilities costs.

The M&T system encompassed a total investment for 50 metering stations and data collection mules at a cost of $76,500. Annual system operating costs have been negligible. Maintenance, consisting of checking and, if necessary, repair and/or calibration of meters has cost $1,800 per year.

The overall installation and operating cost of the project from 1987 to 1992 amounted to $87,300. In the first 12 months of M&T operation, energy savings were estimated at $36,990 plus a further $22,784 in water savings making a total saving of $59,774 – thus achieving an actual payback period of 5 months. (Ref Appendix 15)

Energy savings for the whole of period 1987 to 1992 were estimated to be worth $450,798. Estimated water savings for the same period amounted to $354,953. This gives a total estimated saving for the 5 years of $805,751. Compared with the UK Brewing Industry averages for consumption, this is an impressive performance – even allowing for the fact that the UK brewing industry is already considered to be highly cost conscious and efficient. On a total capital investment of $87,300 this gives an overall payback of just one month including the annual maintenance costs.

CO2 and nitrogen have also seen a drop in consumption rates even though CO2 use at this particular brewery is higher than the industry average due to a high diversity of product types and packaging, of which a high proportion are brewery conditioned and in small packs.

The M&T installation costs of the project were kept to a minimum by using in-house labor wherever possible. It is estimated that, at today’s prices, replication of the M&T system at a similar sized brewery would require investment of around $112,500 over a 5-year period.

What happened at this particular small brewery is a classic example of how considerable effort and dedication by the owners and managers of breweries can use a modest investment and an in-house workforce to achieve significant savings in their energy costs and improvements in their environmental impact. I would like to provide a very brief overview of the type of equipment and methods of information reporting best suited to the application of M&T techniques.

Considering the optimum levels of M&T equipment and information reporting, particularly in the context of small- and medium-sized breweries . . . Ref Appendix 16:

Too great a level of M&T sophistication of coverage will be self-defeating in terms of capital expenditure and resource management as they will either be costly to operate or costly to install. Similarly a minimal project approach might not produce the best level of coverage or sophistication. Pilot schemes may be designed to produce sophisticated results, but with a very limited level of coverage. Economic analysis and good engineering judgement should aim for a target zone midway between high sophistication and total coverage. (Ref Appendix 17)

Having installed the best buy M&T system, the question then arises of setting standards and targets. Where the pattern of resource use indicates loose control, the standards or targets not being met, the reasons should be investigated and action taken with the aim of achieving future performance based on the best 50% of results obtained to date. (Ref Appendix 18)

With a tightly controlled pattern of resource use, the results should match the standards and targets which have been set. The only action then required being ongoing monitoring of the system.

Turning to the metering aspect of M&T.

Bad information is a liability. You should not compromise on meter quality. If there is insufficient money to do the job properly, the scope of the scheme should be reduced.

What services should be metered and how they should be ranked in order of priority? Large users of energy and utility services should be included together with multi-users of services, and those users with poor control over resource use. In the brewing process, the obvious first choice priorities are refrigeration, the brewhouse and maturation facilities. You would need to identify in your own breweries which would be the listing of your priorities.

The selection of services to be metered should be based on the annual bought in costs of each service to a specific area or a high energy or utilities using item of plant. The value of the information to be gained from a metering location should be compared with the marginal cost of installing the meter. A useful guideline on meter location would be to calculate the savings required to achieve a 2-year payback period for the cost of the meter. In the final analysis, economics combined with good engineering judgement will invariably provide the answers to such problems.

There are a large range of meters available for data gathering, selection of which will be dependent upon the type of information required, e.g. hourly/daily/weekly/monthly, summary reporting or 24-hour production related live usage, or the ability to generate alarm conditions or a combination.

Normal optical meters are not efficient and will not facilitate live monitoring of alarm situations which could cause environmental damage.

Pulsed output electronic metering is to be recommended, using meters with alarm condition facilities so as to allow rapid investigation or corrective action to be taken when over-usage, faults or leaks occur.

Summarizing, practical experience in the UK Brewing Industry has proven that M&T can significantly impact on energy costs, achieve waste minimization and improve the environmental friendliness of the brewing process.

In the small brewery example I outlined the phased, step-by-step approach to M&T installation which was deliberate management strategy. Capital investment for each stage of the work was recovered in resource cost savings before the next injection of money was made available. M&T development became an almost self-funding exercise.

No more than $22,500 (the cost of a mid-range motor car) was spent in any one year of the 5-year project. Even in the first
year the payback period on the investment was as low as 5 months.

The total investment of $87,300 achieved savings in energy and water costs over the full 5-year period of $805,751, a payback period of just over one month. An impressive performance, even when compared with the UK Brewing Industry averages for consumption.

CONCLUSION

In conclusion, all the energy cost reduction/avoidance benefits that have been referred to are advantageous to the profitability of breweries, where sometimes a fine line can frequently divide continued existence or rationalization which often leads to closure. M&T can be truly effective and large capital investment is not necessary to obtain results.

The UK Brewing Industry policy objectives include compliance with environmental legislation and energy and waste reduction. The latter two objectives are seen as no-regrets objectives, their successful implementation will bring business benefits in the form of cost savings as well as environmental benefits.

Within the UK Brewing Industry, energy management is being integrated into corporate environmental management strategies and we anticipate that as a consequence energy use and reduction targets will be incorporated into environmental planning activities.

Although it might not always be possible to achieve the full extent of the benefits described, we in the UK Brewing Industry wholeheartedly endorse the M&T technique as a means of cost effectiveness which can galvanize the advance towards environmental improvements, advance our knowledge of the brewing process, and contribute to the continued existence and prosperity of brewing companies worldwide.

ACKNOWLEDGEMENTS

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   London.
2. Scottish Courage Brewing Ltd.

APPENDIX 2 - UK BEER PRODUCTION 1970 - 1993

**Millions Hectolitres**

![Graph](image)

APPENDIX 1


NORTH AMERICA, EUROPEAN UNION & ASIA

- North America & European Union: Brewing Industry
  Flat - Consolidating Home Production
- Asian Demand Increasing
- Pro-Active Response To Opportunities In Chinese Brewing Industry By European/North American/Australasian Companies

**Production Units: Million Hectolitres**

![Graph](image)
APPENDIX 3 - MONITORING & TARGET SETTING

A Shared System of Resource Management

APPENDIX 4 - MONITORING & TARGET CONCEPT
APPENDIX 5 - TYPICAL UK BREWING - INDUSTRY RESOURCE COSTS

Energy: $84 Million
3% Beer Production Costs

Utilities: $84 Million
3% Beer Production Costs

Mj/hl of Beer

Best Practice Energy Usage %’s

*1994 Results provisional
APPENDIX 7 - TYPICAL UK BREWING ENERGY - CONSUMPTION 1976 - 1994

Mj/hl of Beer

46.44% Reduction over the Period!!!

APPENDIX 8 - FOUNTAIN MONITORING AND TARGETING SYSTEM

DEC - VAX
Site Distribution
APPENDIX 9 - FOUNTAIN BREWERY - M & T SYSTEM

STARK RT-WINDOWS V5.3 - MAIN FEATURES:

- Security - defines authorised users of the system
- Outstations - defines the details of each physical outstation
- Channels - defines the details of each meter/sensor
- Maintain Data - is used to manually enter, or amend, data values
- Reports - is used to select for analysis the data stored for a given period and then to manipulate and display the data
- Constraints - defines and stores system-wide numbers for use in analysis

APPENDIX 10 - FOUNTAIN BREWERY - M & T SYSTEM

- Groups - ties several related channels and constants together as a single entity which can be slotted into a report
- Calendar - instructs Auto Analysis to run reports at a specified date and time
- Schedules - instructs Auto Analysis to run specified reports at regular intervals
- Auto Analysis - controls the automatic running of reports at regular intervals

APPENDIX 11 - COMPLEX ELECTRICITY

Diagram showing the connections between M&T, Refrigeration, FV Services, and MV 1.
APPENDIX 12 · SITE UTILITIES MANAGEMENT · TEAM STRUCTURE PROPOSAL

PRODUCTION DIRECTOR

Site Utilities Management Team(s)

CHAIRMAN
(Production Manager)

Brewing
Process
Packaging
Engineering

Engineering

Laboratory

Project
Brewing

Production

Management
Accounts

APPENDIX 13 · COST SAVING IDEAS

▲ Review of Copper boiling operations
▲ Review of Glycol cooling temperatures
▲ Replacement of Hot by Cold CIP in FMV’s
▲ Reduced air usage on site
▲ Review of CIP flushing volumes / Temperatures
▲ Reduced site steam usage
▲ Review of keg racker heat recover efficiency
▲ Review of ventilation requirements
▲ Audits of housekeeping standards
APPENDIX 14 - COST SAVING IDEAS

- CO₂ usage reduction
- N₂ usage reduction
- Revised effluent consent volumes
- Reduced maximum demand on electricity
- Reduced condenser cooling water overflows
- Replacement of CO₂ by N₂ in MV’s
- Load scheduling of operations
- Reduced cooling loads
- Reduced water wastage on site
- Review of site lighting levels

APPENDIX 15: CUMULATIVE TOTAL ENERGY & WATER COST SAVINGS

(Compared With BRLA “Industry Average”)

Energy Cost Savings
1987-1992: $450,798

Water Cost Savings

$87,300 Total Capital Investment = 1 Month Payback Period
APPENDIX 18 - OPTIMUM LEVELS OF M&T EQUIPMENT AND INFORMATION GATHERING

Target Zone

VERY HIGH

Level of M&T Sophistication

LOW

Extent of M&T

VERY HIGH

Pilot Schemes

Minimal

Target Zone

Costly to install

Costly to Operate

APPENDIX 17 - OPTIMUM LEVELS OF M&T EQUIPMENT AND INFORMATION-GATHERING

Lose Control

Resource Use Consumption

Weekly Production Rate (Days 1-7)

Action: Investigate Base TARGET On Best 50% Results
APPENDIX 18 - OPTIMUM LEVELS OF M&T EQUIPMENT AND INFORMATION-GATHERING

Tightly Controlled

Resource Use Consumption

Standard & Target

Action: Ongoing MONITORING

Weekly Production Rate (Days 1-7)