1 The NHS spends over £225 million a year on energy which represents about £1 million for each district health authority. But fuel prices can change rapidly as has been demonstrated by the recent Gulf crisis and future expenditure trends cannot be accurately predicted.

2 In the last 10 years, cumulative savings of £379 million have been made on energy expenditure. The savings are a reflection of lower fuel prices, rationalisation of the estate and reduced consumption. Reduced consumption of energy may be fortuitous i.e. as a result of the recent mild winters or be due to an energy conservation programme. Whilst consumption of fossil fuel has reduced, the consumption of electricity (which is a relatively expensive fuel) continues to increase. The Department of Health has recently set health authorities in England a target of a 15% reduction in energy consumption over the next 5 years.

3 The energy consumption of 450 hospitals in England and Wales has been measured using a normalised performance indicator developed by the Audit Commission. This has demonstrated a wide range of performance between similar types of hospitals and indicates considerable scope for saving energy in most health authorities.

4 More attention needs to be given to energy management. Reducing expenditure on energy releases resources for patient care, and helps to reduce carbon dioxide emissions which contribute to the "greenhouse effect".

5 The arrangements for managing energy in this report relate primarily to health authorities in England but the study covered all parts of the United Kingdom to see what lessons can be learned. Visits were also made to France and Germany and the problems of controlling energy consumption were similar, but in Germany the application of energy management systems was far in advance of that in the United Kingdom.

6 The five factors which are inhibiting progress towards greater savings in energy consumption in the NHS are:-

   — Inadequate management of energy
   — Inadequate monitoring and targeting
   — Inappropriate use of technology
7 The National Health Service and Community Care Act 1990 will devolve energy management from District to hospital level. This report suggests some of the solutions to the problems of energy management in the reformed NHS. These include:

- Commitment to energy conservation and the development of energy efficiency policies;
- Better management of energy;
- Further investment in energy efficiency measures;
- Introducing effective energy management systems;
- Creating incentives for saving energy.

The Commission recognises that at a time when there are many other problems clamouring for management attention, energy conservation can seem a low priority. But if the steps recommended in this report are taken, the Department of Health's target of a 15% reduction in energy consumption, (£30 million per annum at 1987/88 prices) can be achieved. About ¼ of this sum (£7.5 million) can be realised within 12 months without any capital expenditure at all but the remaining savings will require further investment. These savings will arise mainly from a reduction in fossil fuel consumption. The problem of controlling electricity also needs to be addressed.

1 In 1987/1988, health authorities in England consumed 54 million gigajoules of energy which cost £227 million*. The National Health Service is one of the largest energy users in the United Kingdom, with expenditure on energy representing about 1.6% of total national energy usage. On average, health authorities spend about £1 million on energy of which over £400,000 is spent on electricity.

2 In relation to energy, both expenditure and consumption are important because expenditure can fluctuate significantly as a result of changes in energy prices without any changes in consumption levels. For example, in England, electricity represents only 13% of consumption but 42% of expenditure, (Exhibit 1).

3 Whilst the consumption of fossil fuel in the NHS has decreased in the last 10 years, electricity consumption has continued to rise as newer buildings containing more electrically driven plant replace older buildings and as the amount of equipment in hospitals has rapidly increased, (Exhibit 2 overleaf).

4 Increasing attention is being given to the need to protect the environment. In April 1990, the Department of Health launched a campaign, "Towards a Greener NHS" which encouraged NHS hospitals to pay more attention to energy conservation. The Department of the Environment has recently published a White Paper, "This Common Inheritance" which proposes to return emissions of carbon dioxide to 1990 levels by the year 2005. As a major user of energy, the NHS can help to reduce carbon dioxide emissions and so contribute to the achievement of that target. This report shows that savings in energy consumption which at

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**Exhibit 1**

**ENERGY CONSUMPTION AND EXPENDITURE**

Electricity represents only 13% of consumption but 42% of expenditure.

![Energy Consumption vs. Expenditure Graph](image-url)

*Source – Department of Health Data 1987-88*

* based on the latest complete set of data available to the Department of Health at the date of publication of this report.
Exhibit 2
FUEL CONSUMPTION
The consumption of fossil fuel has reduced but electricity consumption continues to rise.

Source – Department of Health

current prices would save some £30 million per annum are possible over the next few years.

5 An incineration plant coupled to a waste heat boiler can produce energy from clinical waste and general hospital refuse. This could be a significant source of energy for the NHS but the incinerators currently installed on hospital sites will not all be capable of meeting the future EC requirements on the control of pollution and environmental standards. Waste burning boilers are a more recent development and have a higher efficiency than a waste heat boiler. They are currently being piloted at a few health authorities and the results are still awaited.

6 Many managers in the NHS have long been conscious of the need to save energy. The Department of Health estimates that £379 million has been saved in the NHS in the last 10 years due to reductions in energy consumption, changes in fuel prices and rationalisation of the estate. At present an annually recurring saving of £68 million is being achieved. Following the National Audit Office report to the Public Accounts Committee in 1985, the Department of Health adopted a policy which required health authorities to achieve savings of 1.5% per annum in the energy bill. In August 1990, the target was increased to a 15% reduction in energy consumption over the next five years. The Commission believes that this new target can be achieved if the steps recommended in this report are taken.

7 The Commission has developed performance indicators for energy (see paragraph 18). Using these performance indicators a feasibility study was undertaken at a sample of health authorities. The results show both a wide range of performance and significant opportunities for savings. (Exhibit 3 overleaf).

8 A study team was established under the overall direction of Ken Sneath, formerly Assistant Director of Audit at the Department of Health (now Associate Director of the Audit Commission). The Project Manager was Graham Cuthbert, assisted by Geoffrey Rendle and technical advice was provided by Ian Jackson and Ian Hargreaves who have both recently been energy managers in the NHS and Peter Harris, an independent consultant. The team has been helped by many people in the Department of Health (in particular Brian Oliver who has responsibility for energy efficiency policy and green issues), the Energy Efficiency Office and other independent consultants.

9 Studies were carried out at health authorities in England based on an Audit Guide* and data on performance has been obtained from 450 hospitals. This Guide has also been used to carry out similar studies in Wales, Scotland, Northern Ireland and France (see paragraphs 10 to 13 below). Separate reports for these countries are being produced but the lessons learned have influenced this report.

INTERNATIONAL EXPERIENCE

10 A review of energy management in French and German hospitals was carried out in order to compare practices with those in England and Wales and to identify good practices which might be implemented in the NHS. In France a study was carried

Exhibit 3

NPI DISTRIBUTION

Consumption of energy varies considerably in broadly similar types of hospital.

LARGER ACUTE HOSPITALS

![Chart 1: NPI Distribution for Larger Acute Hospitals]

SMALLER ACUTE HOSPITALS

![Chart 2: NPI Distribution for Smaller Acute Hospitals]

LONG STAY, GERIATRIC AND MENTAL HOSPITALS

![Chart 3: NPI Distribution for Long Stay, Geriatric and Mental Hospitals]

Source – Audit Returns

out in conjunction with the Inspection Generale des Affaires Sociale. The Audit Commission Energy Guide was used as the basis for the study which covered 14 hospitals of different sizes and types throughout France.

11 It was immediately apparent that French hospitals faced similar problems. Although there had been considerable investment in energy saving measures, the main problem was the failure to manage the use of energy properly. Of particular interest, in view of the move towards contract energy management in the NHS, was the general failure to control such schemes in France. Undue reliance was placed on energy management contractors with little or no monitoring of their contracts. Essential information on energy consumption was frequently not available to the hospitals and overpayments were made to the companies.

12 Problems identified in France which were similar to those found in the NHS included:-

- responsibility for the management of energy not clearly defined;
- no energy policy statements;
- no management reports on performance;
- lack of staff awareness of energy conservation and lack of incentives;
- lack of meters which led to inadequate monitoring of energy consumption and expenditure;
- the need to renegotiate supply contracts;
- inadequate consideration of investment options;
- lack of appropriate technical expertise at hospital level.

13 The German experience showed that significant progress in solving the
problems of energy management had been made. Reliance was placed on technology, particularly the application of energy management systems which were far in advance of those seen in either the NHS or France (see paragraph 58).

THE NATIONAL HEALTH SERVICE AND COMMUNITY CARE ACT (1990)

14 Until the National Health Service and Community Care Act 1990, District Health Authorities (DHAs) were responsible for energy management. The use of energy was managed either by a designated energy officer or was part of the job description of a member of the District Estates Department. DHAs were monitored by Regions, who were responsible together with the Department of Health for the planning of new hospitals, alterations and additions to existing sites. The Estate Directorate of the Department of Health had an overall advisory role and maintained regular contact with Regional and District Health Authorities through field visits.

15 The Government's proposed new arrangements for the NHS will necessitate new systems for ensuring that the NHS obtains maximum efficiency in its use of energy. The creation of NHS Trusts and directly managed units as providers of services and District Health Authorities as purchasers of services will move the actual management of energy down from the District to the Unit level.

16 Some Units will be large enough to warrant the employment of their own energy conservation expertise; others will be too small and may well need to buy in the service from a neighbouring unit or from some other source. Other possibilities include the private supply of advice from commercial sources, or contracting of energy management as is done in the private sector. Experience of contract energy management schemes in the NHS is limited to few sites at present. Experience of contract energy management schemes in France suggests that such arrangements need to be closely controlled and monitored.

2. RESULTS

17 The Commission's Normalised Performance Indicator (NPI) is a measure of energy consumption and is expressed in gigajoules per 100 cubic meters per annum. The indicator is normalised to take account of:

H1 Local Weather
H2 Site Exposure
H3 The number of Hours of use

(Exhibit 4)

Exhibit 4
DEVELOPING PERFORMANCE INDICATORS
NPIs have been developed to take into account local and environmental factors

Exhibit 5
YARDSTICKS
Yardsticks of performance have been calculated by the Audit Commission.

Source – Audit Returns
NPIs HAVE BEEN CALCULATED FOR 450 HOSPITALS

NPIs calculated for 450 hospitals showed a broadly similar pattern regardless of type.

SMALLER ACUTE/PARTLY ACUTE HOSPITALS (CAT 1)

LARGER ACUTE/PARTLY ACUTE HOSPITALS (CAT 2)

LONG STAY GERIATRIC AND MENTALLY ILL HOSPITALS (CAT 3)

Source – Audit Returns

From this NPI separate performance indicators for boiler fuel and electricity can be calculated.

18 Validated performance indicators were collected from 200 hospital sites in England and Wales and yardsticks of performance for both boiler fuel and electricity were produced. Yardsticks were developed for three main categories of hospital which account for the major part of NHS expenditure on energy:

H1 Smaller acute hospitals
H2 Larger acute hospitals
H3 Long stay, geriatric, and mental hospitals (Exhibit 5)

19 Normalised Performance Indicators calculated from 450 hospitals in England and Wales, which represents more than 20% of all hospitals are given below. They show a wide range of performance, (Exhibit 6) with the most energy-efficient hospitals in each category outperforming the worst by a factor of two or more.

20 The NPI consists of two elements, boiler fuel and electricity. In order to improve the overall NPI, energy conservation measures have to be applied to both types of consumption. When the consumption of boiler fuel is plotted with electricity for each of the 450 sites it shows that in general, more progress has been made in larger acute hospitals than in other types, (Exhibit 7 overleaf). However it is clear that there is considerable scope for saving energy in nearly all hospitals. Energy consumption can be reduced even in hospitals with a "Good" NPI.

21 Why is there such a wide variation in the range of performance of similar types of hospital after adjustment for the major variables such as geographical location and exposure of the site? Some of the variation can be explained by the fabric and design of the hospital or by the extent of air conditioning present. But the main characteristics of poor performing hospitals are lack of commitment to more efficient use of energy, inadequate management of energy and inappropriate technology.

LACK OF COMMITMENT

22 Throughout the study, energy...
Although more progress has been made in larger acute hospitals, most hospitals can make further energy savings.

**SMALLER ACUTE/PARTLY ACUTE HOSPITALS (CAT 1)**

Managers frequently alleged that there was a lack of commitment by senior management to achieve greater efficiency in the use of energy. They claimed to have identified many opportunities for saving energy which required the investment of capital funds but competing demands for investment and the failure to give high priority to energy efficiency meant that these schemes were often not adopted. The audits found evidence of lack of commitment. Many health authorities did not have documented energy policy statements, (see appendix A) and very few produced an annual report on progress on the introduction of energy efficiency measures and savings achieved. Advantage was not always taken of all sources of available funding for energy efficiency measures.

**NEW HOSPITALS**

Energy efficiency is not being given proper consideration at the planning stage of new hospital buildings. Examples were noted where either energy efficiency schemes were eliminated due to cost constraints or had not been included in the initial specification. This resulted in great variation in the extent to which energy efficiency measures were included in recently constructed buildings. Typical examples of energy efficiency measures include heat recovery systems installed in ventilation plants, energy management systems, double glazing, highly insulated building fabric, low energy lighting, sub metering and automatic doors. The extent of the inclusion of the above aspects varied from, in one case a hospital built in 1985 which included the majority of these features...
to one which was constructed in 1989 which included none of them. A similar situation was found in two other hospitals in different parts of the country which had been built within months of each other both to the NUCLEUS design but which varied significantly in the energy efficiency measures included. A visit to two hospitals in West Germany revealed a marked contrast in attitude where both hospitals had advanced energy management systems, sub metering, heat recovery, double glazing and automatic doors.

EXISTING HOSPITALS

24 The pursuit of energy efficiency in older buildings is subject to a different set of considerations. Management frequently gave "the limited life of the building" as the reason for failure to take action. These claims were sometimes justified but in other cases the "imminent" or "threatened" closure of the site failed to materialise due to planning changes. Contract energy management is a possible solution for a hospital site with a limited life but the experience of hospitals in France (see paragraphs 10 to 13 above) is a reminder of the need for effective control of such arrangements. Clearly, where it has been firmly established that the future of a site is limited, then energy conservation measures need to reflect the scope for payback of the investment.

25 Health authority staff frequently said, "We have done all the easy things, we now need some more funds". In all cases, areas where savings could be made often without further investment were readily identified. The boilers at 30 hospitals were measured using a fuel efficiency monitor and a third of the boilers at these sites were found to be inefficient. The extra costs of fuel varies depending on the size of the boiler, the firing rate and the length of the period between maintenance but is in the range from £10,000 - £40,000 per annum for each site. In nearly half of the sites the equipment that had been installed to monitor boiler efficiency was found to be faulty.

26 The provision of standby arrangements in the 30 hospital sites varied widely, with some hospitals operating standby boilers at all times and producing a capacity far in excess of potential requirements. On a hot summer day during the study, one hospital had 3 boilers on hot standby' in addition to the two boilers which were fired. Professional advice suggests that savings of from £10,000 to £25,000 per annum can be achieved by reducing boiler standby arrangements to an appropriate level at some hospital sites.

27 There was often an excessive supply of boiler capacity, giving rise to large standing losses. Steam and condense leaks were found including evidence of long term leaks and flooded plant rooms. Many hospitals had poor standards of insulation and in some cases parts of the plant were not insulated at all. Energy management systems were not always used effectively and in some cases were bypassed altogether. Ward and department temperatures were often considerably in excess of both Department of Health standards and the needs of patients and staff. Partially used areas were frequently heated for twenty four hours a day, seven days a week. Air conditioning and ventilation systems were used excessively and heat recovery systems not operated to full efficiency.

28 One hospital which claimed that lack of funds was inhibiting progress had no strategic plan, no annual energy report to management, no monitoring and targeting system and no energy management system. A survey of the site revealed a number of initiatives which could be taken which had paybacks of less than 12 months i.e. energy saving measures which could therefore be financed from revenue funds. These included:-

— replacement of insulation which had been removed for maintenance purposes;

— simple time controls to switch off continuously running ventilation plant serving significant areas of the site which were used for less than 50 hours a week;

— modifications to the existing heat recovery system to ensure efficient operation;

— installation of lagging jackets to valves and fittings.

These measures will yield annual savings of approximately £70,000. This was no isolated example. A one day visit to another health authority revealed measures that could be taken immediately without investment which would save £21,000 per annum. The study also identified scope for investment in energy management systems, certain combined heat and power systems (see paragraphs 57 and 58) and heat recovery systems with
payback periods of 2–3 years which had not been made due to "lack of funds".

29 Some authorities had taken advantage of local or regional "brokerage schemes" where energy savings were returned to the pool to support further investment, but many had not even begun to consider the establishment of such schemes. Larger energy investment schemes involving partnership with the private sector and an agreed sharing of profits were rare. Some of the more progressive authorities were beginning to pursue this avenue for large scale assistance with energy saving schemes such as combined heat and power plants.

INADEQUATE MANAGEMENT OF ENERGY
30 The amount of time devoted to energy management in the NHS varies considerably. There is a direct correlation between the profile of energy management and the degree and number of opportunities for savings and efficiency identified and taken. In the reformed NHS, the Business Plan for each unit should provide for adequate manpower resources to be devoted to the management of the energy programme. This can be achieved in various ways, (see Paragraph 46 below) but whatever local arrangements are adopted management must ensure that up to date technical advice is obtained, comparative reviews of performance are undertaken, and systems to obtain accurate data are introduced.

MANAGEMENT INFORMATION
31 The quality of management information is generally poor. The main unit of measure for energy consumption in the NHS is heated cubic volume and the majority of health authorities have not accurately measured their sites. One striking example was a major London Teaching Hospital which apparently had an NPI of 62 (ie good performance). However, using the methodology set out in the Audit Guide, the heated volume of the site was assessed in less than one man week. This revealed that the reported heated volume was grossly inaccurate and that the NPI was in fact close to 120 ie extremely poor performance. The volume data for this hospital which had been submitted to the Department of Health for a number of years was not based on a proper survey of the site. As a result, information used for monitoring energy consumption by both local management and the Department of Health in its publications contains serious inaccuracies.

BUDGETS
32 Energy budgets at health authorities were usually based on the previous year’s expenditure plus an allowance for inflation and known developments. Some hospitals had set targets for energy consumption which had also been related to degree days, but budgets were not based on these targets. The result of such budgetary arrangements is that there is no incentive to save energy. Savings made on energy expenditure are not necessarily returned to the energy budget holder.

COMPUTER ASSISTED TECHNIQUES
33 A reference code for Energy efficiency (ENCODE) was developed by the Estates Directorate within the Department of Health. It contains guidance on energy surveys, monitoring and targeting and technical aspects of energy efficiency. The Encode initiative includes a number of computer aids which have been developed to support the methods and techniques set out in the Encode manual. They include Enplant, Enbuild, Enaudit, Encomp and Enmats. Enmats is designed to assist Engineers and Energy Managers to monitor the consumption and costs of fuel in hospitals and to provide consumption targets based on past data. It is intended to be a replacement for the WIMS energy module.

34 A sample of 14 health authorities was selected in order to determine the extent to which Encode and the related software was being used. There is no reason to suppose that the sample of authorities reviewed was unrepresentative and the results indicated that nearly half of the health authorities (6) did not use Encode at all. The material was considered to be "cumbersome, unwieldy and time consuming". Only one health authority out of the 14 claimed to use Enbuild, Encomp or Enmats and none of the sections of Encode was used by more than three authorities. Eight authorities purchased alternative software packages from various companies.

ELECTRICITY
35 Although electricity represents only 13% of consumption it is a relatively expensive fuel and in 1987/88 represented 42% of energy costs. Since 1977/78, electricity consumption in the NHS has been increasing by nearly 5% per annum.
The Audit Commission has produced yardsticks of performance for electricity and the results of the audit show a wide range of performance between health authorities (see paragraph 19). A major part of electricity consumption (variously estimated between 35 and 60 per cent) relates to lighting and most of the remainder represents energy for equipment in the wards and departments.

36 Some authorities have reduced lighting costs by installing low energy light bulbs or by the use of high efficiency reflectors which can also reduce the number of bulbs or tubes fitted. Some schemes have demonstrable pay backs of under 2 years. One hospital reduced its electricity bill by 15% per annum as a result of fitting a reflector system to more than one thousand fluorescent luminaries. More can be done in many authorities in these and other ways but it is recognised that economy in the use of lighting systems in hospitals is complicated by the fact that in many areas of a hospital, for various reasons including security, some form of continuous illumination is required.

37 Very few authorities give consideration to the likely consumption of electricity when items of equipment (such as sterilisers, food vending machines etc) are purchased. Not only is this an important aspect of control, but ignoring an important element of costs leads to poor purchasing decisions.

38 Many relatively modern hospitals have some degree of air conditioning. The cost of electricity used to drive the chillers, heaters and fans is directly related to the size of the system and the extent to which it is used. High electricity consumption due to air conditioning will significantly affect the NPI of a hospital (e.g. the size of the chiller on the air conditioning plant in a large hospital in Belfast was equal to one megawatt of electricity).

39 Air conditioning systems are expensive to run. Given the competing demands for revenue funds, more consideration needs to be given to the design of air conditioning plant. Some hospitals use the air conditioning systems to a greater extent than others. Air conditioning is sometimes switched off in non-critical areas in order to secure economies but the review team also found cases where air conditioning was being used excessively e.g. the plant turned on 24 hours a day in all parts of the hospital including all corridors, common areas and emergency stairs.

INAPPROPRIATE TECHNOLOGY

40 At its inception the NHS inherited hospital buildings served by steam boiler houses. This tradition has remained virtually unchanged to the present day. New hospitals have sometimes been built with high temperature or medium temperature hot water boiler plant but most new hospitals have continued with the existing steam technology. Many engineers in the NHS allege that the reasons for this tradition are the marine background of many NHS engineers and the former practice of hospitals having their own laundry. The approach in West Germany, (see Appendix C) was very different; the concept was of a heat production centre. Apart from certain small dedicated steam production plants for laundry, catering and sterile services where appropriate, the heat production plant was of the low temperature hot water type which utilised:

— Ground water via a heat pump;
— Thermal storage;
— High efficiency boilers.

41 Few health authorities have installed Combined Heat and Power (CHP) systems. Furthermore those systems that have been installed have not always optimised the outputs of electricity and heat in relation to site requirements which has resulted in poor utilisation of the equipment. Early installations suffered from mechanical failure or a lack of provided servicing but recent installations appear to be more successful. The performance of these systems should be monitored and the results published.

42 Energy management systems were found in the NHS where the operators were unfamiliar with the extent of sophistication of the equipment under their direct control. In several cases, staff were unable to interrogate the energy management system and obtain basic reports i.e. temperature. Other weaknesses in the operation of energy management systems included:

— energy management systems that were capable of being used for controlling energy but which were only being used for monitoring purposes;
— more than one type of energy
management system in use but no effective interface;
— an energy management system producing good monitoring information which was being constantly ignored or consciously overridden.

43 Most health authorities did not have an incineration plant linked to a waste heat boiler. The study team visited several sites which had such plant and found:—

— Plant was not always used to its full potential.
— Not all health authorities had explored the possibility of using the spare capacity to incinerate waste for third parties. This would both produce "free energy" and additional income.
— The amount of energy produced by waste heat boilers ranged from minimal amounts to a significant contribution to the total site energy requirements.
— The national information system failed to take account of energy produced by incineration until after the start of the study.

3. PROBLEMS AND SOLUTIONS

44 The solutions to these problems and the ways of achieving better performance are:—

* Better energy management
* Improved monitoring and targeting
* More appropriate use of technology
* More investment
* Creation of incentives

These solutions to managing energy have all been adopted at Newcastle Health Authority which has achieved annual recurring savings of £1 million over the last 11 years, (see Appendix B).

BEETTER ENERGY MANAGEMENT

45 The morale of many energy efficiency officers in the NHS is low. They are often relatively lowly graded officers without sufficient authority and not close to key decision makers. Their recommendations to improve energy efficiency are frequently not implemented and schemes are not always included in capital plans. In short, the message of energy efficiency is not always getting across. However, despite the difficulties the NHS has several outstanding energy officers who have made significant reductions in energy consumption in their authorities.

46 The National Health Service and Community Care Act 1990 transfers management responsibility of health services from District Health Authorities to NHS Trusts and Directly Managed Units. This will affect the management of energy which is usually managed by "District" officers. Units are much smaller than Districts and although some will justify the employment of a full time energy officer alternative management models will need to be considered. These include:—

— buying in energy expertise from the private sector;
— consortium arrangements with neighbouring units;
— partnership and profit sharing arrangements for the entire estate management function;
— management buyouts.

47 Whichever arrangements are adopted, it is essential that the need for energy efficiency has a high profile in each health authority. This will need the commitment of senior management and should lead to:—

— An energy policy statement being prepared for each major hospital, (an example of an energy policy statement is set out in Appendix A).
— An annual energy management report setting out progress on the introduction of energy efficiency measures and savings achieved.

IMPROVED MONITORING AND TARGETING

48 Monitoring and targeting systems in most health authorities were not sufficiently developed to provide detailed information to enable managers to control energy consumption properly. The following steps need to be taken:—

— Accurate information systems on energy use should be introduced.
— Energy budgets should be based on consumption, but each budget holder should also be made aware of the costs of energy consumed.
— Realistic targets for energy consumption should be set.
The Normalised Performance Indicators and yardsticks developed by the Audit Commission provide a useful monitoring tool whereby hospitals can compare their performance with other hospitals of a similar type and with "good performance" targets. As the indicators are based on consumption rather than price, hospitals can compare their performance over time. Details of the methodology are explained in the Audit Guide. However, it is essential that performance indicators are calculated on the basis of valid data. The major problem that health authorities face is obtaining a reasonably accurate assessment of the site and updating this measure to take account of changes.

The Audit Guide sets out one methodology by which authorities can estimate the heated cubic capacity of their sites without incurring prohibitive costs. This method was used during the study and the results set out in this report are based upon validated data. The Department of Health has recognised the need to collect more accurate data on energy use in the NHS and during the study it has introduced improvements to its management information systems.

In association with Cheriton Technology Management Ltd the Audit Commission has developed the application of a statistical technique known as "Cusum" to the problems of monitoring energy consumption in the NHS. Cusum gives management three key pieces of information:

- It quantifies the savings achieved from the measures introduced.
- It identifies time periods between one change in pattern and another so that the impact of an energy saving measure on consumption can be resolved.
- It establishes the time from which the current energy pattern began.

Cusum enables managers to see directly the effects of their actions. Because Cusum measures savings in consumption on a cumulative basis against a previous line of commitment, the savings measured are a direct reflection of the changes made. The graphical format enables the effect of events to be pin-pointed by a fall in the Cusum line. This means that evidence of the original investment return forecasted can be obtained. This enables the future cases for investment in energy saving measures to be more accurately forecasted and subsequently confirmed. For operational managers of energy, Cusum measures "the bottom line".

The potential of technology to save energy is not being fully exploited:

- the production of energy is traditionally by steam systems;
- few health authorities have installed CHP systems;
- the potential of energy management systems to save energy is not being realised;
- the development of 'green' technology is minimal.

Boiler Houses

Steam boilers which are traditional in NHS hospitals are not always the most efficient option for a modern hospital site. Today, the disadvantages of steam boilers include:

- high distribution losses;
- greater maintenance costs;
- the cost of water treatment;
- condense related problems.

More consideration needs to be given to the design of heat production plant in the future. This will include:

- the temperature requirements of the heating medium;
- sources of equipment available;
- types of equipment available;
- the possible integration of different types of heat producing units.

Combined Heat and Power

The 1983 Energy Act allowed much greater freedom for the private generation of electricity. Combined Heat and Power (CHP) is particularly well placed to take advantage of this freedom. The subsequent restructuring of the electricity supply industry has also stimulated further interest in CHP. The Government has now made available its report on the United Nations based Intergovernmental Panel on Climate Change which outlines the contribution that CHP can make to savings in fossil fuel burn and thus reducing CO2 emissions. The report suggests that the take up of CHP in the commercial and public sector (including hospitals) is modest and that there is a realistic potential of increasing CHP capacity eightfold in
that sector in the 1990s. The study confirmed the findings of the report that few health authorities have installed CHP systems.

56 CHP is a process where both heat energy and electrical power are produced simultaneously by a specially designed unit. The production of heat from fuel sources is a relatively efficient process. Many modern boilers can achieve efficiencies of around 70-80 per cent and some condensing boilers can reach over 85 per cent. The generation of electricity from fuel is a less efficient process - even the most efficient plants reject at least 50 per cent of their fuel input energy as waste heat. When transmission and distribution losses have been taken into account conventional power stations only achieve efficiencies of around 30-35 per cent. By producing usable heat as well as electricity, CHP can increase the overall efficiency of fuel utilisation to around 70-90 per cent.

57 When CHP plants are installed it is essential that a comprehensive option appraisal is prepared. This should take account of the size and suitability of the plant for the application, the availability of fuel supply, reliability and maintenance costs, (Exhibit 8). Paybacks on CHP systems have been found to be in the range of 2½ to six years. A number of health authorities were considering the installation of CHP systems but the two major constraints were lack of availability of finance and a cautious approach to the introduction of advanced technology in the NHS environment. Greater acceptance of such schemes should follow the successful implementation of CHP at other sites. The study found two hospitals which had recently installed CHP apparently with success. Progress needs to be closely monitored and the Department of Health should take the lead in giving publicity to these schemes.

ENERGY MANAGEMENT SYSTEMS

58 An energy management system is used to supervise and control the technical installations in hospitals, such as heating, ventilation, air conditioning plant and (in some instances) lighting and process steam to laundries. An energy management system is also essentially a management tool, to be used to:

— reduce energy consumption;
— evaluate and produce reports;
— provide information concerning the status of the system (e.g. ward temperatures, working conditions of boilers);

Exhibit 8

INSTALLING CHP

There are a number of essential factors to consider when installing a CHP plant.

— provide comfortable conditions for patients and staff at minimum cost.

Many health authorities that have made significant reductions in energy consumption have an energy management system. The cost and complexity of energy management system installations varies from an information gathering tool costing perhaps £25,000 to a very elaborate system such as that found in West Germany (see Appendix C) costing in excess of half a million pounds. Systems in operation in the NHS were usually in the middle of the range and the bulk of potential savings in energy can be achieved by the correct use of such a system. Typically paybacks on such systems are of the order of 2½ to 3 years. The most comprehensive systems have longer paybacks but authorities should not be discouraged from investing in such systems as further savings in energy can be made.

GREEN TECHNOLOGY

59 “Green” technology is likely to include alternative sources of energy such as wind and solar power. These are areas yet to be introduced in the NHS with the exception of the proposal to install a wind generator at the second low energy hospital at Ashington. When this technology is proven and more widely available this will be a major challenge for the future. However, in the meantime much more progress could be made by the more widespread introduction of existing technology which will contribute to a reduction in energy consumption and thus reduce carbon dioxide emissions into the atmosphere.
INVESTMENT

The Secretary of State for Energy recently stated that the single most cost effective response to the battle against global warming is energy efficiency. A key measure of whether or not this battle is being won is the amount of energy efficiency investment taking place. How does the NHS measure up to this challenge? The response is variable; some health authorities have plans for significant investment in energy efficiency but in many authorities investment is insufficient. The factors that appear to influence the level of investment are:

— availability of funds;
— the priority given to energy efficiency by senior managers.

Energy needs to be given high priority by management as investment in energy saving measures produces revenue savings rather than further revenue expenditure. Energy is already one of the largest items of non pay expenditure and the future of energy prices is uncertain. At the time of writing the escalation in oil prices due to the Gulf Crisis and the imposition of VAT on fuel prices means that the cost of energy in the current year (1990/91) will be considerably higher than in 1989/90.

There will always be competing demands for funds in the NHS. Given limited funds, management at health authorities with low levels of investment need to follow the practices of the more innovative authorities including profit sharing schemes with the private sector and contract energy management. Authorities should not ignore "good housekeeping" and small investment schemes which produce savings and thus release funds for further investment.

NHS Trusts and directly managed units should set specific targets for a reduction in energy consumption and should adopt a realistic investment strategy to achieve them. Investment in energy efficiency measures should be made in each of the following three areas:

— that which can be financed from existing expenditure levels by a more efficient use of plant and equipment currently in use;
— small scale investment which shows a quick return on local investment schemes;
— large scale investment of funds with probably longer payback periods.

Most investment in energy conservation has been directed towards saving boiler fuel. However, the growth of electricity in the NHS has not been effectively addressed, and if performance is to be improved, there is a need for investment in measures that will reduce the consumption of both types of fuel. (Exhibit 9).

A systematic method of selecting investment schemes which will be of most benefit to health authorities is vital to a successful energy efficiency programme. Methods for selecting schemes can crudely be divided between discounted cash flow and payback methods. Although payback is widely used, the Treasury recommends that a present value approach with a real discount rate of 6% should be used. The Audit Commission’s report, Saving energy in Local Government Buildings' demonstrates that for a typical energy saving project with a four year payback or better, the 6% real return is exceeded.

Action should be taken to reduce the extent to which energy efficiency measures are eliminated from the specifications of new hospitals because of cost constraints. The pay back period of some schemes can be as low as two years and the abandonment of

Exhibit 9
SAVINGS VECTORS
To improve overall performance, both electricity and boiler fuel consumption must be reduced.
these measures from new hospitals costs rather than saves money. The Commission has noted the Department’s recent initiative to build “low energy” hospitals at Ashington and Newport, Isle of Wight. It is too early to evaluate whether the concepts enshrined in these sites provide an adequate approach to the problems of conserving energy in the NHS. This will be monitored by a research project at Bath University over the next three years.

INCENTIVES

There are few real incentives to save energy in the NHS. Budgets may be devolved to user departments but the energy component is nearly always based on an estimation rather than the actual amount of energy consumed. The general failure to introduce sub metering arrangements for space heating means that nobody knows how much energy is used at each cost centre. As shown earlier, the use of electricity is increasing significantly and although it can more easily be metered, budget holders are not being made to account for its use. Until the consumption of fuel in wards and departments is identified, incentives can only operate at hospital level. A very few health authorities have included energy targets in the performance criteria of unit managers and this has succeeded in raising the profile of the use of energy. Incentives need to be devolved if energy is ultimately to be more effectively controlled.

The role of the Department of Health also needs to change. Following the first energy crisis in the early 1970’s, a small section of professional staff was set up within the Estates Directorate of the Department of Health to monitor and advise the NHS on energy conservation issues. The development of ENCODE, a reference code for energy efficiency, and its associated computer assisted techniques (see paragraph 33 above) raised the profile of energy efficiency in the NHS. But the limited resources available to the Department of Health to undertake such development work itself and the alternative software packages available in the private sector demands that it should reconsider its role.

NHS fuel purchasing has been carried out centrally since 1983 and in 1988 the Department of Health expanded the role of its Procurement Directorate to include this responsibility. The Directorate arranges fuel supply agreements for oil, coal, gas and electricity. Health authorities can undertake this task for themselves but the Directorate considers that by acting collectively on behalf of authorities, it has secured significant savings in fuel costs which far outweigh the cost of the service.

This should be tested in the market place by requiring the Procurement Directorate to charge for its services. NHS Trusts and Directly Managed Units should be at liberty to decide whether to purchase this service. The study has shown that some health authorities had already acted independently of the Directorate and made spot purchases of heavy fuel oil prior to the current uncertainty with regard to future oil prices. The forthcoming privatisation of the

THE SAVINGS HILL

Reducing energy consumption is easiest at the beginning of an energy saving programme and hardest at the end.
electricity industry has meant that the Procurement Directorate has been unable to obtain any beneficial contracts for electricity. Health authorities are negotiating their own arrangements.

5. THE WAY FORWARD

71 Within a constrained budget saving energy is one way of releasing more resources for patients. Apart from staff pay, energy is one of the largest items of expenditure in the hospital’s budget. If the recommendations in this report are implemented at least £30 million will become available for further service development.

72 Reducing energy consumption is easiest at the beginning of an energy saving programme and hardest at the end, (Exhibit 10). Large savings can be made merely by changing the approach and raising the profile of energy management; significant savings can be made by major technological changes such as changing the distribution system and investing in energy management systems. Finally, a considerable contribution to energy savings can be made by further investment in high technology such as combined heat and power, heat recovery systems, variable speed motors etc.

73 Saving energy is everybody’s business. From the policy makers through the managers to all users in wards and departments. All are faced with a challenge to save money for the NHS and make a significant contribution to the preservation and protection of the environment. There are of course many other demands on management time, particularly now the reform programme is moving ahead rapidly. But energy conservation can release resources to ease the progress of other measures and cannot be ignored. The Audit Commission and its auditors will monitor local management’s success in this area in the future.
APPENDIX A

ENERGY POLICY STATEMENT

The following key areas should be addressed. Objectives and methods of achieving them should wherever possible be included.

EXAMPLES

ENERGY CONSUMPTION: The intention is to reduce energy consumption by ... % over the next ... years.

ENERGY COST: All fuel will be purchased at the most advantageous prices by participation in the... purchasing organisation.

PROVISION OF FINANCE: An amount of £..., will be allocated to the energy efficiency investment programme for the next ... years.

SELECTION/APPRaisal CRITERIA: A simple payback of ... years will be used to shortlist minor energy efficiency measures. Present value appraisal methods should be used for larger schemes.

REVENUE SAVINGS: ... % of the revenue savings will be used to finance further energy efficiency work.

ORGANISATION: The energy management unit within the ... department will be responsible for:

— The monitoring and targeting of energy consumption
— Managing the energy efficiency investment programme

MONITORING AND TARGETING: The existing manual Monitoring and Targeting system will be computerised and extended to cover ...% of the building.

MAINTENANCE: All maintenance work that is causing energy to be wasted will be carried out within ... days of notification.

NEW BUILD: Energy efficient design and submetering to ward or department level will be the norm for new build projects.

USE OF BUILDINGS: In planning the use of buildings or considering a change of use of buildings the energy implications will be taken into account.

TRAINING: Training courses will be given to the staff at regular intervals and an energy module will be included in the new staff induction course.

PUBLICITY: The in-house newspaper will feature energy matters at regular intervals.
APPENDIX B

Newcastle Health Authority currently spends £2.8 million per annum on energy but has achieved annual recurring savings of £1 million from energy conservation measures taken over the last 11 years.

These initiatives include:

— In 1979 an energy conservation policy was prepared which identified potential savings of 5% of the fuel, light and power budget through good housekeeping measures. A full time energy conservation officer was appointed the following year.

— A targeting and monitoring system was introduced throughout the district which called for formal reports on energy performance and progress on energy saving measures on a quarterly basis. These reports were circulated to senior management and to authority members including the Chairman.

— The concept of electronic energy management systems was accepted by the Authority and the first system installed at the Royal Victoria Infirmary in 1982/83. Further management systems were installed at all major sites in Newcastle between 1983 and 1987, after the successful performance of the first system.

— A policy of boiler decentralisation was commenced in 1986 on non-acute sites, utilising high efficiency and condensing boiler plants.

— Insulation was reviewed and upgraded to the maximum economic thickness.

— A programme of cavity wall insulation was introduced on several sites.

— Easi-fit mattresses to valves, flanges and fittings were extensively used.

— Ventilation plant heat recovery systems were installed at appropriate locations.

— The Authority undertook a programme of low energy lighting schemes in selected areas.

— Oxygen trim systems were installed on lead boilers in order to optimise the thermal efficiency.

— Microprocessor optimiser/compensators were installed in clinics and health centres.

— A procedure was developed for the automatic switching off of the operating theatre ventilation plant for twenty of the more modern theatres in Newcastle when not in use.

This policy has been followed for the last four years without any problems and has resulted in annual savings of a sum in excess of £30,000 (at 1990 prices).

Electrical tariff analysis was carried out for all hospital sites and other major health buildings and as a result optimum tariffs were selected.

Cumulative savings made at the Royal Victoria Hospital, Newcastle, over the 9 year period to 1989/90 have been measured using Cusum, (Exhibit B-1). Further details of the action taken to obtain the savings can be found in the Audit Guide.

The NPI for the major sites in the District has fallen from over 100 to 72 in 1989/90. This has taken the indicator from "Extra Poor" to "Fair" (Range - type H2 70-80). This suggests that despite the substantial savings achieved still more can be done. Measures currently under consideration include combined heat and power and variable speed motors.

Exhibit B-1

ROYAL VICTORIA INFIRMARY

Savings and expenditure.

Source – Audit Returns
A visit was made to a hospital in West Germany which had 244 acute beds and a further 550 psychiatric and long stay beds on the site. There were approximately 50 separate buildings on the site and each building was separately metered for each fuel and utility. The approach to the provision of energy to the hospital was very different from that currently found in the NHS. The hospital was designed to have maximum flexibility in the use of sources of energy. This ranged from renewable energy (eg ground water) to conventional fossil fuels. The hospital had a very extensive energy management system which included:

- 65 intelligent outstations.

- Full digital control of all air conditioning plant operation, including heating, cooling, relative humidity, ventilation rate and user demand.

- All submetering to individual departments was interfaced with the energy management systems. This included space heating, domestic hot water, electricity and gas and the subsequent accounting to departments in respect of usage for budgetary control purposes.

- Optimisation of the operation of the multifuel heat generating plant to allow advantage to be taken of the most economic tariff periods for each fuel. The heat generating plant included a large (3000 kW) electrically powered heat pump; high efficiency duel fuel gas and oil boilers coupled to thermal storage facilities.

- All lighting installed in non-critical areas was coupled to the energy management system and was pulsed every hour or half hour with manual reset.

- Operating theatres were switched automatically to background conditions after two hours and had to be manually reset.

- An electrical maximum demand programme which introduced load shedding of certain areas when required eg air conditioning systems serving kitchens and laundry.