Office of the Comptroller and Auditor General

Report on Value for Money Examination

Department of Health

Energy Management in the Health Service

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Report of the Comptroller and Auditor General

Department of Health
Energy Management in the Health Service

I have, in accordance with the provisions of Section 9 of the Comptroller and Auditor General (Amendment) Act, 1993, carried out a value for money examination of energy management in the health service.

I hereby submit my report of the above examination for presentation to Dáil Éireann pursuant to Section 11 of the said Act.

John Purcell
Comptroller and Auditor General

28 April 1995

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Summary of Findings

1 This examination set out to review the management of energy by health boards and voluntary hospitals.

2 Health boards and publicly-funded hospitals spent £21.9m on fuels and other energy sources in 1993 (the latest year for which figures are available). *(Paragraph 1.6)*

3 Boards have been generally successful in reducing the cost of energy in recent years. Energy costs peaked in 1985 but decreased until 1989 when they began to rise again. However, in aggregate, they have still not surpassed the 1985 levels. *(Paragraph 1.7)*

4 Energy management practices of the boards and a sample of hospitals and homes were examined to gauge the success of the measures they have taken

- to minimise the price of fuels or to substitute cheaper inputs and
- to control consumption by eliminating energy waste and improving the efficiency of energy utilisation.

Procurement and Price

5 The performance of health boards, hospitals and homes in procuring energy varied. Expenditure reductions occurred over the period 1984 to 1993 in five boards while costs have remained at or exceeded 1984 levels in the other three boards. *(Paragraph 1.8)*

Fuel Substitution

6 The main reason for the reduction in expenditure on energy by certain boards was the substitution of natural gas and heavy fuel oil for other more expensive fuels. Natural gas now provides 28 per cent of all energy utilised by boards and hospitals, with heavy fuel oil accounting for about 8 per cent. *(Paragraph 2.1)*

7 While hospitals and homes have access to natural gas in only five of the boards, initiatives are also possible in other areas to improve the situation. Substitution of heavier grade oils can yield savings sufficient to recoup the initial capital outlay inside 12 months. *(Table 3.9)*

Purchase Price of Fuels

8 The examination established that the prices paid for the main forms of energy used varied. The average fuel cost per kilowatt hour of energy used ranged from under 1p where it was produced from natural gas or heavier grades of fuel oil, to over 6p for

electricity. Electricity is a relatively expensive source of energy. While it supplied 12 per cent of energy output in 1993, it accounted for 42 per cent of energy costs.
(Paragraphs 2.1 to 2.3)

Centralised Purchasing of Fuels

9 There have been some central procurement initiatives.

- A natural gas supply agreement covering the period 1992 to 1996 was introduced which, while not fixing the absolute price of gas, established a pricing structure which related prices to oil costs. *(Paragraph 2.12)*

- A recent initiative has been taken by the health boards to provide for central negotiation of oil prices. *(Paragraphs 2.21 and 2.22)*

10 The natural gas agreement did not necessarily reduce costs for all boards. For instance, in the South Eastern Health Board area, hospitals and homes were able to buy gas at lower prices under locally negotiated contracts which were valid until late 1993 or early 1994.

11 Some boards have maintained dual facilities in hospitals and homes to preserve their purchasing power. Despite the availability of natural gas under centrally negotiated agreements, heavy fuel oil is used in some such facilities where it has been established that it is more economic to do so. *(Paragraph 2.15)*

12 In view of the variations between boards in the unit prices paid for fuel oils and the obvious purchasing power of the sector, there certainly appears to be scope for savings. For instance, it is estimated that central procurement arrangements for fuel oils will generate annual savings of £114,000 for the North Western Health Board.
(Paragraph 2.22)

Use and Control of Energy

13 In the course of the examination we measured energy consumption rates in respect of 187 hospitals and homes. The rates were adjusted for factors which influence consumption including degree of exposure of buildings and variations in local climatic temperature. This produced an indicator which could be used to compare energy use in individual hospitals and homes. It cannot, however, take into account the effectiveness of the building fabric and the special energy demands which arise where, for example, hospitals and homes provide kitchen and laundry services on behalf of neighbouring premises. *(Paragraphs 3.2 to 3.4)*

Energy Use

14 The main trends observed were:

- Consumption of energy varied widely with some hospitals and homes using seven times more energy than others for each cubic metre of buildings in use. *(Table 3.1)*

- Considerable regional variation in energy use was evident when health boards were compared. The highest average use was 30 per cent greater than the lowest. *(Table 3.2)*

- Energy use per bed varied substantially in geriatric hospitals and homes with those in the North Western Health Board and the Eastern Health Board consuming well above average. *(Table 3.4)*

- On average, geriatric hospitals and homes in the North Western Health Board had the highest rates of electricity consumption. *(Table 3.6)*

Savings on Energy Expenditure

15 To establish the reasons for the performance suggested by the indicators, we engaged engineering consultants to survey a selected number of hospitals and homes and to identify measures with potential for savings on energy expenditure.

16 In the 16 health board hospitals and homes examined, the consultants identified:

- a set of initiatives involving minor outlay which would produce savings estimated at 3.8 per cent of energy running costs and

- a set of initiatives which would involve capital outlays on equipment and installation costing £0.76m, but which would produce savings estimated at £0.28m per year for at least 10 years. *(Tables 3.8 and 3.9)*

17 The potential for savings was much less in the four voluntary hospitals examined. In general, it was noted that considerable progress had been made already by the voluntary hospitals in exploiting such opportunities. *(Tables 3.8 and 3.9)*

18 Because of the limited number of hospitals and homes visited in each health board area, it is not appropriate simply to extrapolate the potential savings identified over the full range of hospitals and homes. At the same time, there is no reason to believe that the hospitals and homes visited are significantly less economical or efficient consumers of energy than are others.

19 It is worthwhile to consider the potential overall savings which would accrue if the rate of savings identified in the health board hospitals and homes visited was achieved throughout the health board system. On that basis:

- low cost initiatives would generate annual savings of around £0.5m

- further annual savings of £2.2m, for at least 10 years, could be generated by initiatives involving a once-off capital outlay of around £6m. *(Paragraph 3.27)*

20 Whatever the scale of potential overall savings on health board expenditure, it should be borne in mind that the same potential for savings does not exist in all health boards since some boards have already implemented extensive energy cost-saving programmes.

21 Other points to emerge from the engineering examination were:

- Energy management performance varied from poor to very good. *(Table 3.7)*

- Worthwhile savings could be achieved by regular efficiency testing of all boilers. *(Paragraphs 3.29 to 3.35)*

- Instances of inoperative or inaccurate control systems were noted. Control systems typically have shorter lives than the equipment they control and consideration should be given to up-grading them. *(Paragraphs 3.36 to 3.38)*

- Instances were noted where the cost of space heating could be reduced by restricting heating services at times when certain areas are not in use. *(Paragraphs 3.39 to 3.42)*

- Programmes are in place to replace tungsten filament installations with fluorescent sources. This should yield savings given the high use of lighting in hospitals. *(Paragraph 3.59)*

- Areas were noted which were unoccupied for large parts of the day or night but lighting remained switched on. In instances where lighting management systems may not be appropriate the matter might be addressed by means of instructions to staff and posting of notices. *(Paragraphs 3.55 and 3.56)*

- Most boards have installed Building Management Systems (BMS) which make use of computer technology to control and monitor energy use. With a pro-active approach on the part of the boards, these systems have the potential to further reduce running costs and therefore a progressive and phased up-grade to a full monitoring and reporting BMS should be incorporated into all medium term energy management plans. *(Paragraphs 3.43 to 3.46)*

- Boards should adopt a preventative maintenance approach. *(Paragraph 3.32)*

- Laundries, kitchens and operating theatres are heavy users of electricity. They merit separate monitoring to enable their efficiency to be evaluated. Separate metering is required to facilitate this. *(Paragraphs 4.47 to 4.50)*

Organisation

22 Health boards do not have stated policies in respect of energy management. There is, however, an evident acceptance of good practice. *(Paragraphs 4.2 and 4.3)*

23 The general responsibility for energy management rests with Technical Services Officers (TSOs) who are also responsible for a range of other engineering services.

24 In order to focus energy initiatives, there is a need for:

- central guidance by the Department of Health on key issues and
- a structured consultation forum involving the TSOs.

(Paragraph 4.22)

Reporting of Energy Performance

25 There is a need to introduce formal accountability for energy management. The annual compilation of performance indicators on the lines of those used in Appendix B of this report and their presentation to boards would provide a useful source of information which should facilitate review and any necessary decision-making. *(Paragraphs 4.14 to 4.16)*

Energy Saving Initiatives

26 In the course of the examination many achievements were noted and the following good practice opportunities were identified:

- setting targets to focus the initial drive for conservation
- establishing local energy committees
- central or regional negotiation of procurement contracts

- substituting heavier grades of oil for gas oil
- decentralisation of boiler systems
- using BMS equipment to control and monitor consumption
- ensuring electricity is purchased under the most favourable tariff arrangement
- minimising the use of electricity, for example by using steam to power autoclaves or gas to power kitchen equipment and
- re-scheduling work or peak-lopping to manage maximum demand which is a critical factor in the determination of electricity costs.

Combined Heat and Power

27 Hospitals and homes, being consumers of energy for 24 hours each day, are possible sites for combined heat and power (CHP) plants. This technology supplies heating needs while generating part of the electricity requirement and is worthy of consideration for all medium and large hospitals and homes in the natural gas area. There is a proposal to install a liquid petroleum gas-fired CHP unit at Letterkenny General Hospital. If this proceeds, it will provide information about the efficiency of such systems as an energy-saving option outside natural gas areas.
(Paragraphs 4.32 to 4.42)

Contract Energy Management

28 Our review examined the possible contribution that could be made by contracting out energy management to private sector specialists who operate in this area. We concluded that it may be worth considering for certain aspects of energy management in view of the claimed savings and the guarantee of continuing efficient operation. It is unlikely, however, that entire energy management operations at hospitals and homes would lend themselves to this approach. *(Paragraphs 4.43 to 4.46)*

Incineration

29 We noted that in the cases of incineration plants examined, no waste heat recovery mechanisms were installed. However, it is proposed to de-commission all existing plant for environmental reasons, so expenditure on the modifications necessary for heat recovery would not be justified. *(Paragraphs 4.51 and 4.52)*

Appraisal and Funding of Initiatives

30 A key element in deciding on which energy-saving initiatives to implement is a system of appraisal. There is a need to issue guidance on techniques for ranking proposed initiatives and to establish formal structures at board level to consider them.

31 Progress can be hampered by the present system of funding. All funds for energy are included in current budgets. Consideration needs to be given to introducing some assignment of funds for capital purposes. Alternatively, where initiatives to achieve medium and long term savings in energy running costs have been identified and duly appraised, there may be merit in borrowing for projects with short payback periods. *(Paragraphs 4.23 to 4.26)*

Part 1 : Introduction

General Background

1.1 There are eight health boards established under the Health Act, 1970. The boards have the function of seeking to improve the health of the people in their areas by:

- promoting healthier life styles
- preventing and diagnosing ill health
- caring for those suffering from long term illnesses and disabilities and
- providing social services to individuals and families at risk.

1.2 In order to discharge these functions, boards are organised into the following services:

- general hospital care
- special hospital care and
- community care.

1.3 State funding of hospitals and homes amounted to £1,743m in 1993. Almost 90 per cent of health board activity is State-funded.

1.4 The boards are responsible for over 160 hospitals, welfare homes and other residential institutions.

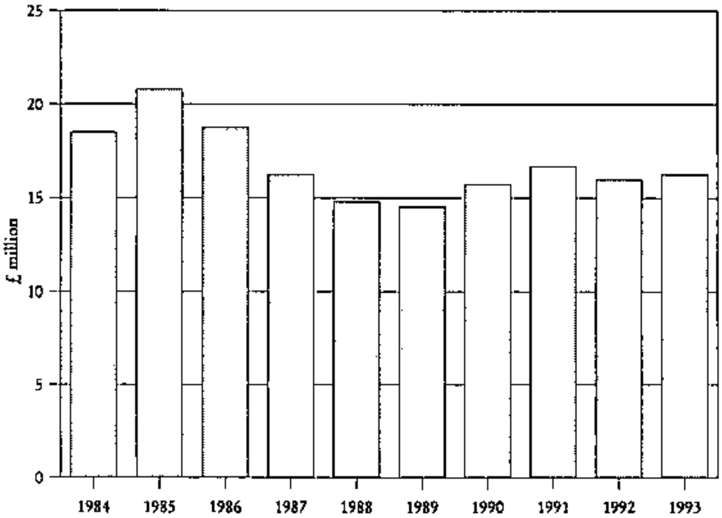
1.5 There are, in addition, 30 public voluntary hospitals which, while independent of the boards, in effect, provide services on their behalf. There are also two major Dublin hospitals administered by joint hospital boards. This report refers to all these hospitals as voluntary hospitals. State funding for voluntary hospitals is provided directly by the Department of Health.

Expenditure on Energy

1.6 The health sector is a considerable user of energy. Energy costs in State-funded hospitals and homes amounted to some £21.9m in 1993 (the latest year for which figures are available) of which £16.2m was incurred by health board hospitals and homes. The remaining £5.7m was incurred by voluntary hospitals.

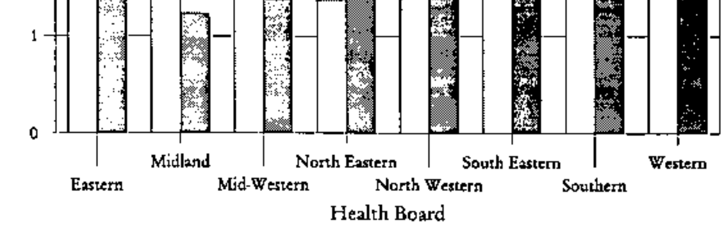
1.7 Changes in energy expenditure over the past ten years are illustrated in Figure 1.1. Expenditure on energy by the boards peaked in 1985 and then decreased each year until 1989, when it began to rise again. Expenditure on energy in 1993 was 88 per cent of the 1984 level.

Figure 1.1
Expenditure on energy by health boards, 1984 to 1993



1.8 Expenditure on energy did not decrease in every health board between 1984 and 1993. Five of the eight boards showed a reduction while expenditure increased in two boards and remained at around 1984 levels in one. Figure 1.2 shows how expenditure changed in each health board between 1984 and 1993.

Figure 1.2
Comparison of expenditure on energy, by board, 1984 and 1993



1.9 Some of the factors which determined this pattern of change in expenditure on energy were:

- changes in the prices for fuels
- the availability of natural gas in some of the boards
- changes in the level and nature of activity in hospitals and homes and
- initiatives taken in some boards to reduce energy consumption.

Changes in Fuel Prices

1.10 Prices for individual fuels changed in different ways over the period 1984 to 1993, as shown in Table 1.1. The impact of price changes on individual health boards' expenditures on energy cannot be isolated because:

- each health board uses a different mix of fuels and
- the mix of fuels used in most boards changed over the period 1984 to 1993.

Table 1.1
Changes in unit prices for selected fuels, 1984 to 1993

	% change in unit price 1984 to 1993 [a]
Natural gas [b]	- 23%
Heavy fuel oil	- 21%
Gas oil	- 7%
Liquid petroleum gas (LPG)	- 4%
Electricity [b]	+7%
Peat brickeens	+23%
Machine turf	+40%

Source: Forbairt

[a] *Based on October list prices in each year. For most fuels purchased in large quantities, variable discounts and rebates may be available.*

[b] *Standing charges are not included.*

Changes in Level and Nature of Hospital Activity

1.11 Significant changes have occurred since 1984 in the way in which health services are delivered. These have involved:

- the treatment on a day-attendance basis of conditions which were previously treated on an in-patient basis

- consequent reductions in the number of in-patient beds

- construction of new hospitals and homes and of new buildings in existing hospitals and homes

- rationalisation of services involving closure of a number of older hospitals and homes and

- a shift in delivery of services for mentally-ill patients and for frail elderly persons from institutional to community-based care.

1.12 The extent to which these factors affected energy use varied from health board to health board.

- Total energy cost for each region is affected by the structure of health services in the area. For example, most publicly-funded acute services in the Eastern Health Board area are delivered by voluntary hospitals, while some other boards provide all the acute services in their areas.

- Despite an overall reduction in the total area of health sector buildings in use, the total area in use increased in some health boards. For example:

  - Cavan General Hospital was brought into service in 1989 without any major reduction in the capacity of other hospitals in the North Eastern Health Board region.

  - Sligo General Hospital more than doubled in size to almost 29,000m^2 in 1990.

Energy Cost per Bed

1.13 A survey of energy use in hospitals and homes in 1993 was undertaken as part of this study (see Appendix A). This revealed that the cost of energy per bed varied between the different kinds of hospitals and homes, as shown in Table 1.2. Average energy cost per bed in 1993 was highest in acute hospitals (£841) and lowest in geriatric hospitals and homes (£395).

Table 1.2
Energy cost per bed, by category of hospital/home, 1993

Category of hospital/home [a]	Number	Average cost per bed	Range of cost per bed
Acute	46	£841	£310 - £1,399
Geriatric	95	£395	£198 - £1,061 [b]
Psychiatric/mental handicap	36	£606	£357 - £1,189 [c]
Other	14	£724	£429 - £1,304
All	191	£632	£198 - £1,399

[a] *Categories of hospital/home are explained in Appendix B.*
[b] *94 per cent of geriatric hospitals/homes had energy costs per bed of less than £680.*
[c] *89 per cent of psychiatric hospitals/homes had energy costs per bed less than £875.*

1.14 The cost of energy per bed for each hospital and home surveyed is shown in Appendix B.

Purpose and Scope of Examination

1.15 The study set out to examine whether health boards:

- procured energy products economically and
- efficiently converted them into energy output.

1.16 The examination consequently extended to the following matters:

- procurement practices and price of energy products
- the management and control by boards of energy consumption and
- the organisation of the energy management function at board level.

1.17 In addition, the examination compared practices in voluntary hospitals with those of the health boards and looked at the environment in which energy management in the health service operates.

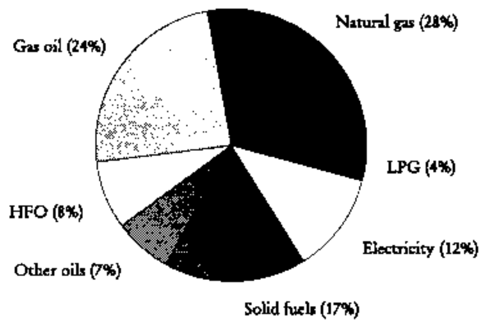
1.18 In the course of the examination, the performance of 191 hospitals and homes were examined and detailed surveys were carried out on 16 health board hospitals and homes and on four voluntary hospitals. No private hospitals were surveyed because the Comptroller and Auditor General has no function in that area.

Part 2 : Procurement of Energy

Energy Sources

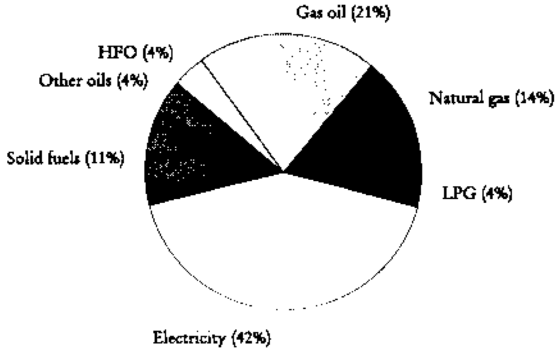
2.1 Health boards use a variety of fuels and energy sources. Over half the energy consumed in health board hospitals and homes in 1993 was provided by natural gas and gas oil. (See Figure 2.1.) Solid fuels (coal and peat) and other oils (like heavy fuel oil - HFO) provide over 30 per cent of the energy consumed.

Figure 2.1
Source of energy used in health board hospitals and homes in 1993



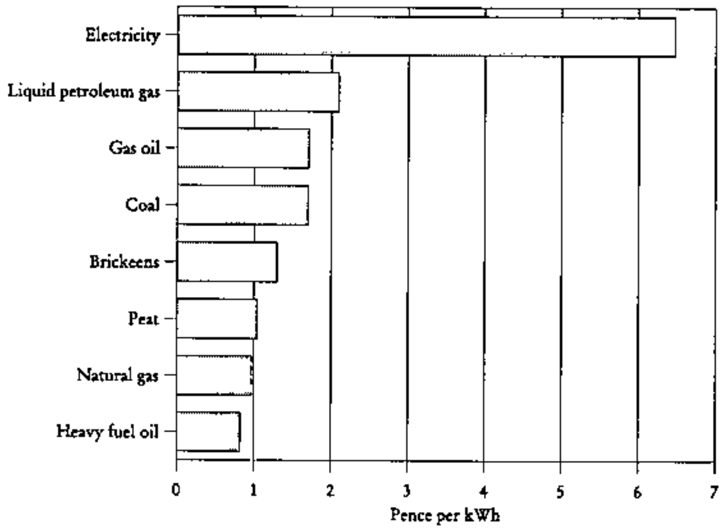
2.2 While electricity supplied only 12 per cent of the total energy consumed, it accounted for 42 per cent of the total expenditure. (See Figure 2.2.)

Figure 2.2
Expenditure on energy used in health board hospitals and homes in 1993



2.3 Expressing each energy source used in health board hospitals and homes in terms of cost per kilowatt hour (kWh), Figure 2.3 depicts the average unit cost of each energy source procured.

Figure 2.3
Average cost (inclusive of VAT) per kWh for each fuel type[1], 1993



2.4 Because some fuels are much cheaper than others, the following good practice options are appropriate:

- minimising the use of electricity where possible, for example by using steam to power autoclaves
- maximising non-electricity output in laundry hot water systems
- using heavier fuel oil where possible
- using natural gas in substitution for gas oil and
- substituting gas for electricity to power kitchen equipment.

2.5 The extent to which boards can avail of these options depends on local circumstances, for example availability of natural gas. However, instances of these good practices were noted in the course of examinations at a selection of hospitals and homes.

Purchase Price of Fuels

2.6 On examination of the unit prices paid by individual health boards for the various types of fuel considerable variation was noted.

Electricity

2.7 Electricity tariffs are structured so that, in general, larger consumers pay a lower unit price than smaller consumers. The unit cost paid for electricity used in health board

[1] *Solid fuels have associated handling costs which can increase the cost of each unit of energy output by over 100 per cent and certain oil-fired steam boilers also require a permanent presence.*

hospitals and homes in 1993 varied from an average of 10.5p per kWh for small quantities bought, to an average of 6.2p per kWh for quantities in excess of 400,000 kWh per year.

2.8 These prices are determined to a large extent by the consumers' ESB tariffs. The ESB advise that hospitals and homes using over 60,000 kWh per year should consider the cost-effectiveness of the maximum demand tariff and it provides a free advisory service on energy efficiency in the course of which they advise consumers on the most appropriate tariff structure.

2.9 We noted that 33 hospitals and homes using more than 60,000 kWh had electricity costs in 1993 in the range of 8.5p to 11.9p per unit. There may be scope for adjustment of the tariff structure in these cases.

Gas Oil

2.10 Prices paid for gas oil varied within and between health boards, as indicated in Table 2.1. The lowest price paid for gas oil was 14.4p per litre by one hospital in the South Eastern Health Board area. The average price per litre paid by hospitals and homes in the Southern Health Board area was lower than that in any other region. The highest average unit price was paid in the North Western Health Board region (21p per litre), about 24 per cent higher than in the Southern Health Board region.

Table 2.1
Gas oil - unit price paid by health boards and voluntary hospitals, 1993

	Number of hospitals/ homes using gas oil	Unit price (pence per litre) [a]		
		Average	Minimum	Maximum
Eastern	7	17.5	17.4	17.7
Midland	15	17.9	16.9	18.1
Mid-Western	13	17.9	17.6	18.0
North Eastern	12	17.6	15.5	18.1
North Western [b]	17	21.0	-	-
South Eastern	23	17.3	14.4	18.3
Southern	27	17.0	14.8	19.3
Western	23	18.5	17.8	20.3
All boards	137	18.1	14.4	20.3
Voluntary hospitals	11	18.2	15.7	22.0

[a] *All prices are inclusive of VAT.*

[b] *The North Western Health Board had a common contract for all its hospitals and homes. The price quoted represents the average price paid for the year.*

Natural Gas

2.11 Natural gas is available in only five of the eight health board regions, and within those regions, it is not available to all hospitals and homes. In the Eastern Health Board region, 11 of the 17 hospitals and homes surveyed use this fuel. By contrast, only one hospital in the North Eastern region has access to natural gas. In total, 33 of the health board hospitals and homes surveyed use natural gas. Most of the voluntary hospitals surveyed also use natural gas.

2.12 In June 1992, the Department of Health agreed a centralised price structure with Bord Gáis Éireann (BGÉ) for natural gas supplies to publicly-funded hospitals and homes and health board offices during the period 1 January 1992 to 31 December 1996. While not fixing prices in absolute terms, this agreement provided for:

- supplies to be made available to hospitals under agreed pricing mechanisms, as individual hospitals reached the end of existing contracts
- separate pricing mechanisms to apply to premises where annual consumption of gas is below 150,000 therms, and those where 150,000 therms or more are used and
- prices to be related to the cost of oil.

2.13 Table 2.2 sets out the range of unit prices paid for natural gas.

Table 2.2
Natural gas - range of prices paid by health boards and voluntary hospitals, 1993

	Unit price (pence per therm) [a]	
	Minimum	**Maximum**
Purchasing up to 150,000 therms per year		
South Eastern Health Board hospitals/homes	23.7	25.4
Other health board hospitals/homes	39.7	48.3
Voluntary hospitals	43.0	53.4
Purchasing more than 150,000 therms per year		
South Eastern Health Board hospitals/homes	23.7	25.4
Other health board hospitals/homes	24.7	28.3
Voluntary hospitals	22.5	30.2

[a] *All prices are inclusive of VAT.*

2.14 Most health board hospitals and homes using natural gas in 1993 had contracted for supplies under central supply agreement terms. While it is not possible to determine what price levels might have been set under locally negotiated agreements, the agreement negotiated centrally did not reduce costs for all boards. For instance, in the South Eastern Health Board area, hospitals and homes were able to buy gas more cheaply under local contracts which were valid until late 1993 or early 1994. Thereafter, supplies were bought under central supply agreement terms.

2.15 Some boards have maintained dual facilities in hospitals and homes to preserve their purchasing power. Despite the availability of natural gas under centrally negotiated agreements, heavy fuel oil is used in some facilities where it has been established that it is more economic to do so.

Liquid Petroleum Gas (LPG)

2.16 127 hospitals and homes (in all board areas except the Eastern) use bulk supplies of LPG as a heating and cooking fuel. (See Table 2.3.) The lowest average price for LPG is paid by the Mid-Western Health Board (13.6p per litre). The highest average price, paid by the Western Health Board, is 16.7p per litre, 23 per cent higher than paid by the Mid-Western Health Board.

Table 2.3
Bulk LPG - unit price paid by health boards and voluntary hospitals, 1993

	Number of hospitals/ homes using LPG	Unit price (pence per litre) [a]		
		Average	Minimum	Maximum
Eastern	-	-	-	-
Midland	14	14.7	14.1	15.1
Mid-Western	12	13.6	13.6	14.5
North Eastern	12	15.1	14.0	18.4
North Western [b]	16	15.0	-	-
South Eastern	23	15.5	15.0	17.4
Southern	27	14.7	13.7	15.2
Western	23	16.7	15.4	21.3
All boards	127	14.9	13.6	21.3
Voluntary hospitals	2	27.0	19.4	28.3

[a] *All prices are inclusive of VAT.*
[b] *The North Western Health Board had a common contract for all its hospitals and homes. The price quoted represents the average price paid for the year.*

Other Fuels

2.17 Other fuels like peat, peat-brickeens and heavy fuel oils are used far less widely. Although they account for significant levels of expenditure (see Table 2.4), it is difficult to discern any particular patterns in prices for these fuels because of the limited number of hospitals and homes where they are used.

Table 2.4
Other fuels - unit price paid by health boards, 1993

	Other oils [a]	Peat	Brickeens
Number of hospitals/homes	20	8	8
Amount spent (£'000)	976	444	1,014
Average unit price [b]	10.6p/litre	£41.64/tonne	£ 69.54/tonne
Minimum unit price [b]	8.7p/litre	£38.51/tonne	£ 66.16/tonne
Maximum unit price [b]	18.3p/litre	£69.10/tonne	£100.25/tonne

[a] *Oils other than gas oil. Unit cost of such oils may vary because of differences in blend.*
[b] *All prices are inclusive of VAT.*

2.18 Historically, health boards were encouraged to use native solid fuels like peat. Where these were used, it was usual to site boilerhouses at a distance from hospital buildings to eliminate dust, smoke and noise. This resulted in long pipe runs and consequent distribution losses of energy.

2.19 The policy on fuel sources has more recently been relaxed. As a result, much current investment in energy systems has concentrated on boiler replacement as boards converted solid fuel systems to systems using oil or gas sources. Some boards have also engaged in programmes to distribute boilers around the hospital complexes and thus reduce losses in distribution. Substantial manpower savings have also accrued. For instance, the Eastern Health Board has reported estimated savings of £700,000 a year by eliminating boilermen posts and reducing maintenance charges on solid fuel boiler plant.

Procurement Procedures

2.20 The extent of variation in fuel prices between health boards suggests that there may be scope for reduction in expenditure on energy by improving procurement procedures.

2.21 In 1992, the Chief Executive Officers (CEOs) of the health boards established a central purchasing group, with the support of the Department of Health. The group is chaired by the CEO of the Eastern Health Board and the membership includes a representative of each of the other boards. An Eastern Health Board buyer works three days a week for the group as a Procurement Co-ordinator. The Department provides for the associated costs in its annual grant to the Eastern Health Board.

2.22 The remit of the group was extended in 1994 to include the procurement of fuel oils, both for motor vehicles and for heating. Contracts have been placed following recommendations by the group. It is envisaged that worthwhile savings will be achieved from the centralised procurement processes. For instance, it is estimated that annual savings of £114,000 will accrue to the North Western Health Board which, as shown in Table 2.1, paid the highest average unit cost for gas oil in 1993.

Part 3 : Use and Control of Energy

3.1 Hospitals and homes are heavy users of energy since they run on a 24-hour basis all year round. Good energy management practice requires that in addition to minimising procurement costs, whether by substitution of cheaper inputs or price negotiation, measures be taken to get the best value from output. This entails managing consumption so that desired standards of patient comfort are achieved at the least cost. The average target established for the hospitals and homes surveyed in respect of heating continuously occupied spaces was 20° celsius.

Energy Consumption Patterns

3.2 Energy consumption was calculated for the hospitals and homes surveyed and related to the cubic capacity of their serviced area. Average energy consumption and the consumption range in respect of the various categories of premises are shown in Table 3.1.

Table 3.1
Total energy consumption by category of hospital/home, 1993

Category of hospital/home [a]	Number [b]	Energy consumption rate	
		Average GJ/100m^3	Range GJ/100m^3
Acute	43	61	18 - 101
Geriatric	95	63	27 - 128
Psychiatric/mental handicap	36	56	29 - 96
Other	13	57	26 - 114
All	187	60	18 - 128

a *Categories of hospital/home are explained in Appendix B.*
b *Four small voluntary hospitals did not provide data about building area or volume and consequently, consumption rates could not be calculated.*

Energy Efficiency

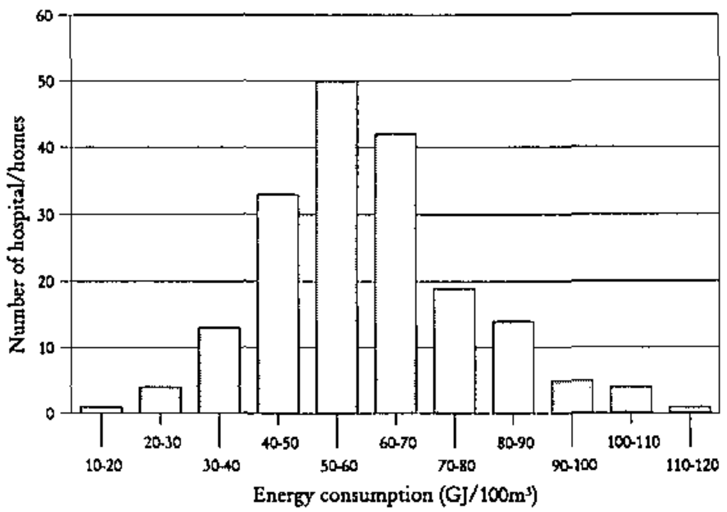
3.3 Consumption alone is not a true measure of the efficiency of energy management since the amount of energy consumed in a building depends on a variety of factors including climatic temperature and the degree of exposure of the building to weather. For comparison between hospitals and homes, the consumption measure was adjusted for local temperature and exposure to derive a performance indicator. The indicator was compiled based on a methodology recommended by Forbairt conforming to that used in similar UK studies. (See Appendix A.)

3.4 While this indicator is valuable in assessing the relative performance of the energy conversion and distribution processes, it must be interpreted with caution because:

- the amount of energy consumed is affected by the quality of the building fabric
- comparability is distorted where laundry or kitchen services are provided on one site on behalf of neighbouring institutions
- the differing functions of hospitals or homes result in differing demands for energy.

3.5 The relative performance of hospitals/homes (having adjusted for exposure of buildings and weather variations) is depicted in Figure 3.1.

Figure 3.1
Distribution of energy consumption levels in hospitals and homes, 1993



3.6 Relatively little variation was found in the patterns of energy consumption between the main categories of hospital i.e. acute, geriatric, psychiatric/mental handicap. By contrast, significant variation was noted in consumption rates when health boards are compared, as indicated in Table 3.2. Average consumption in the South Eastern Health Board region was 50 GJ/100m^3, compared to an average of 65 GJ/100m^3 in the Southern Health Board region.

Table 3.2
Total energy consumption[a] by health board, 1993

	Number of hospitals/homes	Energy consumption rate	
		Average GJ/100m³	Range GJ/100m³
Eastern	17	60	38 - 73
Midland	15	58	39 - 101
Mid-Western	16	64	38 - 86
North Eastern	14	63	28 - 119
North Western	21	64	27 - 103
South Eastern	25	50	35 - 71
Southern	33	65	34 - 108
Western	25	62	28 - 84
All health boards	166	61	27 - 119
Voluntary hospitals [b]	21	57	18 - 72

[a] *Adjusted for exposure of buildings and weather variations.*

[b] *Four small voluntary hospitals did not provide data about building area or volume and consequently, consumption rates could not be calculated.*

Consumption Relative to Bed Numbers

3.7 The utilisation of energy can also be considered from the point of view of consumption per bed. Buildings with a low number of beds relative to total floor area, or where the utilisation of available beds is low, generally have to be heated to the same standard with consequent higher energy costs per bed. As a result, this indicator informs us about the efficiency of use of the serviced building space.

3.8 Consumption of energy per bed varies by category of hospital/home, as shown in Table 3.3. Acute hospitals were found to use more energy per bed, since they include more ancillary space such as out-patient departments, treatment units, laboratories and lecture rooms.

3.9 Comparison of costs per bed for each board can only be meaningful when similar categories of hospitals and homes are being examined. Only in the case of geriatric hospitals and homes did the survey contain sufficient records to permit comparisons between boards.

3.10 Considerable variation was noted between health boards in the level of energy consumption per bed in geriatric hospitals and homes. (See Table 3.4.) In the North Western Health Board, average consumption, at 79 GJ per bed, was over 50 per cent higher than in the South Eastern Health Board.

Table 3.3
Total energy consumption per bed, by category of hospital/home, 1993

Category of hospital/home [a]	Number	Energy consumption rate	
		Average GJ/bed	Range GJ/bed
Acute	46	157	74 - 285
Geriatric	95	66	26 - 124
Psychiatric/mental handicap	36	125	51 - 213
Other	14	136	62 - 303
All	191	118	26 - 303

[a] *Categories of hospital/home are explained in Appendix B.*

Table 3.4
Total energy consumption per geriatric bed, by health board, 1993

	Number of hospitals/ homes	Energy consumption per geriatric bed	
		Average GJ/bed	Range GJ/bed
Eastern	8	74	52 - 99
Midland	7	64	44 - 70
Mid-Western	9	64	26 - 90
North Eastern	8	63	45 - 123
North Western	14	79	38 - 124
South Eastern	13	52	33 - 73
Southern	19	67	36 - 110
Western	16	58	30 - 108
All	94 [a]	66	26 - 124

[a] *Total in other tables includes one voluntary geriatric hospital.*

3.11 The North Western Health Board have pointed out that comparison of energy consumption by category of hospital/home may not be valid in every case since the type of activity undertaken varies considerably even within categories. For example, in Dungloe District Hospital, a small geriatric hospital, almost half of the hospital area is used for community care services, out-patient services and acute day-bed care.

Consumption of Electrical Energy

3.12 About 12 per cent of the energy consumed in health board hospitals is provided by electricity and is used to provide power for lighting, equipment and some space heating. Because electricity is relatively expensive, accounting for 42 per cent of expenditure, it is of interest to consider separately the rate of consumption of electrical energy.

3.13 Electrical energy consumption was, on average, significantly higher in acute hospitals than in other categories of hospitals and homes. (See Table 3.5.) This conforms to the expected trend given the relatively greater use of electrically-powered equipment for medical treatment in acute hospitals.

Table 3.5
Electrical energy consumption by category of hospital/home, 1993

Category of hospital/home [a]	Number	Electrical energy consumption rate [b]	
		Average kWh/m²	Range kWh/m²
Acute	43	95	37 - 180
Geriatric	95	62	6 - 179
Psychiatric/mental handicap	36	51	20 - 98
Other	13	80	33 - 140
All	187[c]	76	6 - 179

a *Categories of hospital/home are explained in Appendix B.*

b *Since electricity is not generally used for space heating, it is considered more appropriate to relate electrical energy consumption to floor area than to building volume.*

c *Four small voluntary hospitals did not supply data about floor area and consequently, consumption rates could not be calculated.*

3.14 The rate of electrical energy consumption varies widely for each category of hospital/home and particularly for geriatric hospitals and homes. Within the group of geriatric hospitals and homes, there was significant variation between health boards in the rate of use of electricity, as shown in Table 3.6.

Table 3.6
Electrical energy consumption in geriatric hospitals and homes, by health board, 1993

	Number of hospitals/homes	Electrical energy consumption in geriatric hospitals/homes	
		Average kWh/m^2	Range kWh/m^2
Eastern	8	68	52 - 89
Midland	7	64	42 - 115
Mid-Western	9	64	21 - 88
North Eastern	8	63	43 - 91
North Western	14	75	6 - 179
South Eastern	13	55	39 - 75
Southern	19	68	27 - 101
Western	16	43	19 - 69
All geriatric hospitals/homes[a]	94	62	6 - 179

[a] *Excludes one voluntary geriatric hospital.*

Detailed Examinations

3.15 While the figures reported above give an indication of the relative performance of the boards' energy management activity, 16 health board hospitals and homes were examined on our behalf by a firm of consulting engineers. Four voluntary hospitals were also examined for comparative purposes.

3.16 The conclusion from the examinations was that the performance indicators were generally accurate. The examinations then sought to explain the performance and to isolate factors which contributed to it. Factors such as heavy demand from kitchens and laundries were taken into account in arriving at an overall assessment.

3.17 A detailed report containing recommendations was prepared in respect of each hospital and home examined. These reports together with a list of measures identified, which were projected to yield savings, were reported to the relevant authorities.

3.18 The hospitals and homes examined and the performance ratings given by the consulting engineers are set out in Table 3.7.

Table 3.7
Performance rating of hospitals/homes examined

Hospital/home	Energy use GJ/100m³	Initial C&AG rating [a]	Rating after detailed examination [b]
Acute hospitals			
Health board hospitals			
Louth County Hospital, Dundalk	59	Good	Very good
County Hospital, Roscommon	60	Good	Good
General Hospital, Letterkenny	62	Good	Good
General Hospital, Tullamore	68	Good	Good
James Connolly Memorial, Blanchardstown	69	Good	Fair - good
General Hospital, Cavan	70	Fair	Fair - good
Voluntary hospitals			
Our Lady's Hospital for Sick Children, Crumlin	59	Good	Very good
St. Vincent's Hospital, Elm Park	60	Good	Very good
Beaumont Hospital, Dublin	65	Good	Good
St. James's Hospital, James's St.	69	Good	Good
Geriatric hospitals/homes			
District Hospital, Clogheen	35	Good	Very good
Plunkett Home for the Aged, Boyle	62	Fair	Fair - good
St. Joseph's Hospital, Ennis	67	Fair	Fair - good
St. Vincent's Hospital, Athy	73	Poor	Poor
District Hospital, Skibbereen	75	Poor	Good
District Hospital, Birr	82	Poor	Fair - good
Psychiatric/mental handicap hospitals/homes			
St. Columba's Hospital, Sligo	52	Good	Good
Heatherside Hospital, Buttevant	54	Good	Good
St. Luke's Hospital, Clonmel	64	Fair	Very good
St. Anne's Psychiatric Unit, Skibbereen	83	Poor	Good

[a] *For the purpose of rating performance, hospitals and homes were categorised based on a Forbairt-approved methodology. Different standards of performance apply to different categories of hospital/home (small acute, large acute, geriatric, psychiatric/mental handicap).*

[b] *These ratings represent the opinion of the consulting engineers on the performance of the energy management function after taking into account the engineering services performance within the constraints of the building fabric (see paragraphs 4.29 to 4.31) and any particular demands of special services such as laundries and kitchens (see paragraphs 4.47 to 4.50).*

Opportunities for Savings on Energy Expenditure

3.19 Notwithstanding the relative good performance reported for the hospitals and homes visited, detailed examination indicated a number of areas where improvement was possible and savings could be achieved. The consulting engineers grouped their suggested improvements as follows:

- low cost initiatives and
- initiatives involving capital outlay.

Low Cost Initiatives

3.20 These initiatives are capable of being met from current budgets. Five kinds of initiatives in this category were identified which, with minor initial cost, would be likely to result in recurring savings in expenditure on energy in the hospitals and homes examined. These were:

- optimisation of boiler efficiency
- re-commissioning or up-grading of controlling equipment.
- introduction of zone controls
- improvement of lighting efficiency and
- improvement of light switching.

3.21 Table 3.8 sets out the level of annual savings which, it is estimated, could be achieved by undertaking the suggested initiatives in the hospitals and homes visited during this examination. Annual savings, as a percentage of 1993 expenditure on fuels by the hospitals and homes concerned, are estimated at 3.8 per cent for the health board hospitals and homes and around 1 per cent for the voluntary hospitals.

Initiatives involving Capital Outlay

3.22 The consulting engineers also identified a number of initiatives which would involve capital costs but would also generate significant recurring annual savings in expenditure on fuels. These initiatives were:

- replacement of control systems
- installation of building management systems (BMS)
- installation of combined heat and power (CHP) systems
- alternative fuel selection and
- synchronised generator operation.

Table 3.8
Estimated annual savings arising from low cost initiatives in selected hospitals/homes

Initiative	Health board hospitals/ homes	Voluntary hospitals
	£	£
Optimisation of boiler efficiency	25,400	10,000
Re-commissioning/up-grading of controlling equipment	16,100	-
Introduction of zone controls	8,000	1,500
Improvement of lighting efficiency	13,450	4,000
Improvement of light switching	3,000	2,000
All low or no cost initiatives	65,950	17,500
Expenditure on fuels in 1993 by hospitals/homes surveyed	£1.7m	£2.0m
Savings as a percentage of 1993 expenditure	3.8%	0.9%
Number of hospitals/homes examined	16	4

3.23 The engineers concluded that one or more of the initiatives involving capital outlay could usefully be introduced in most of the hospitals and homes visited. Table 3.9 sets out the estimated cost and savings associated with the initiatives.

Table 3.9
Estimated savings arising from initiatives involving capital outlay

Initiative	Life of initiative	Health board hospitals/homes		Voluntary hospitals	
		Capital cost	Annual savings	Capital cost	Annual savings
	Years	£'000	£'000	£'000	£'000
Replacement of control system	10	6	3	80	15
Installation of BMS	10	251	55	875	157
Installation of CHP	15	380	89	2,250	390
Alternative fuel selection	20	83	112	-	-
Synchronised generator operation	20	45	25	-	-
All initiatives		765	284	3,205	562

3.24 The various initiatives involving capital expenditure generate different levels of savings which makes it difficult to compare them in a meaningful way. Two useful summary measures for comparison are:

- payback period - the number of years it takes for recurring annual savings from an initiative to repay the initial capital expenditure incurred and

- net present value (NPV) - the value now, using a discount rate of 5 per cent[2], of savings generated over the useful life of the equipment installed, after taking the initial outlay into account.

3.25 Table 3.10 sets out the payback period and NPV for each of the initiatives. After taking capital outlays into account, the NPV of all savings identified is of the order of £2.3m for health board hospitals/homes and £2.2m for voluntary hospitals over the lifetime of the related equipment.

Table 3.10
Comparison of returns on initiatives involving capital outlay

Initiative	Payback period (years)		Net present value (£m)	
	Health board hospitals/ homes	Voluntary hospitals	Health board hospitals/ homes	Voluntary hospitals
Replacement of control systems	2.0	5.3	*[a]	*[a]
Installation of BMS	4.6	5.6	0.2	0.4
Installation of CHP	4.3	5.8	0.5	1.8
Alternative fuel selection	0.7	-	1.3	-
Synchronised generator operation	1.8	-	0.3	-
All initiatives	2.7	5.7	2.3	2.2

[a] *In these cases, the NPV is less than £50,000.*

Potential Overall Savings

3.26 Because of the limited number of hospitals and homes visited in each health board area, it is not appropriate simply to extrapolate the potential savings identified above over the full range of hospitals and homes. At the same time, there is no reason to

[2] *Savings are discounted to reflect the fact that a sum of money payable in the future is not worth as much as the sum payable now, even when inflation has been taken into account. The Department of Finance recommends that a discount rate of 5 per cent (after inflation) should be used.*

believe that the hospitals and homes visited are significantly less economical or efficient consumers of energy than are others.

3.27 It is worthwhile to consider the potential overall savings which would accrue if the rate of savings identified in the health board hospitals and homes visited was achieved throughout the health board system. On that basis:

- low cost initiatives would generate annual savings of around £0.5m and
- further annual savings of £2.2m, for at least 10 years, could be generated by initiatives involving once-off capital outlay of around £6m.

3.28 Whatever the scale of potential overall savings on health board expenditure, it should be borne in mind that the same potential for savings does not exist in all health boards since some boards have already implemented extensive energy cost-saving programmes.

Specific Findings

Optimisation of Boiler Efficiency

3.29 In any heating system, the efficiency of the boiler plant is vital since that is where primary energy is converted to output. It was noted that the health boards operate a large number of diverse boiler plants of varying age, type, size and fuel system. The examination covered approximately sixty boilers. An idea of the scale of activity can be gauged from the fact that the South Eastern Health Board alone operates over 300 boilers.

3.30 Boiler efficiency impacts directly on cost and savings can be achieved by introducing more efficient plant. For instance, new plant installed in Roscommon County Hospital is projected to raise efficiency by as much as 12 per cent, which should impact on cost to a similar degree. This is being done as part of a change to heavier grade fuel oil.

3.31 Regular efficiency testing was found to be carried out in some cases, particularly with the larger boilers. Further worthwhile savings could be achieved by extending efficiency testing to all operating boiler plant.

3.32 While health boards have achieved high standards of plant availability under their existing maintenance approach, it is likely that greater efficiency could be achieved by introducing routine maintenance.

3.33 Using their current resources it would be quite difficult for the boards to optimise efficiency on so many diverse types of plant.

3.34 A possible approach to achieving optimum maintenance cycles on such large numbers of plant could be by competitive tendering organised by a central unit or by an energy consultant who would prepare the tender documentation and supervise implementation.

3.35 It is suggested that the boiler plant at each location be examined in respect of:

- suitability of boiler time control including consideration of optimum start/stop settings
- boiler efficiency at high and low-firing rates
- elimination of wasted output in multiple boiler installations and
- establishment of economic viability of operational but semi-obsolete plant.

Control Instrumentation

3.36 Control systems, typically, have a shorter life than the equipment they control. Consequently, consideration should be given during the life of most mechanical plant to the up-grading of their controls to a more effective level.

3.37 In the course of the examinations, a number of control components were found to be installed but inoperative or operating inaccurately. This is not an infrequent occurrence and can usually be rectified by replacement of a valve motor or air damper motor and its controller.

3.38 Examples noted included the need to replace control systems in one unit at St. Columba's Hospital, Sligo and to install controls capable of adjusting output to demand in units of Heatherside Hospital, Buttevant.

Distribution of Output and Zone Control

3.39 The mechanisms for distributing the heat output were found to be generally satisfactory. It was noted, however, that some hospitals and homes had areas where their usage times were not reflected in the zone control regime of the heating system. Additional zone control systems are effective in achieving energy conservation and should be considered in such cases.

3.40 However, careful evaluation of each system is always necessary since pipework in many instances does not permit a simple introduction of a zone valve. Nonetheless, this is a valid technique for energy conservation and the study identified potential applications which were notified to the relevant authorities in the hospitals and homes. These relate to areas used only during certain periods with the possibility of switching off during the unoccupied period.

3.41 Inefficient zoning was also noted in St. Vincent's Hospital, Athy and in the case of St. Luke's Hospital, Clonmel. Although a significant amount of piping would be required, there appeared to be scope to increase control in the main hospital at St. Luke's by:

- zoning of wards and
- zoning of resource area.

3.42 In St. Anne's Psychiatric Unit, Skibbereen, the therapy area could be zoned off at night. In the District Hospital, Skibbereen, the former convent area should be zoned off when it is being converted to community care use since this is confined to the daytime. There also appeared to be scope for additional zone control valves.

Building Management Systems

3.43 Building Management Systems (BMS) can be utilised to monitor and control energy use at one or more locations by means of a link to a central computerised control. Features of a typical BMS include:

- control of temperatures
- instant reporting of plant failure
- automatic computation of energy consumption by cost centre and
- scheduling of maintenance.

3.44 Significant overall advantages can accrue from the operation of such a system including increased energy efficiency, increased plant up-time, reduced running costs and increased efficiency in the deployment of human resources.

3.45 A BMS of one type or another monitors energy performance at 32 sites throughout the health boards. It was noted in the cases examined that the value derived from such systems varied and that scope existed for a more effective application of their potential. In our opinion, such systems should be constantly developed and their functions extended gradually both within and between institutions.

3.46 Examples of instances noted where a BMS could be cost effective were:

- Cavan General Hospital, a large institution of relatively new construction, operating with an inappropriate control system. A BMS should be introduced in this building as a priority.

- St. Luke's Hospital, Clonmel has an operational BMS but would benefit from an extension of the system to control all areas and to extend its range of functions.

- St. Vincent's Hospital, Athy, which is a large geriatric unit of very old building stock is in urgent need of an adequate BMS to effect proper control.

Electricity

3.47 In addition to being a costly source of energy, the consumption of electricity has been increasing. A survey of six larger Dublin hospitals indicated an increase of 2.2 per cent in 1994 over 1993 consumption levels. With increasing use of electrically-powered medical equipment, this trend may be irreversible. Accordingly, attention must focus primarily on managing the demand cost effectively. In order to optimise the overall energy cost from the boards' point of view, important steps are:

- ensuring the institution has opted for the correct ESB tariff

- minimising loads at peak periods either by peak-lopping or re-scheduling work

- monitoring the purchase and installation of new electrical equipment above a certain size and

- accurate monitoring of total consumption and that of key units within hospitals and homes.

ESB Tariffs

3.48 Our review found that hospitals and homes were on appropriate tariff arrangements with most hospitals on the ESB maximum demand tariff. However, any inability to reduce peak ESB demand can impact unfavourably on cost where hospitals and homes have opted for this tariff.

3.49 The maximum demand tariff relates costs to the maximum load drawn from the system. It is particularly relevant in the winter (November-February) period where bills are calculated by reference to the demand in a key two-hour period (5 p.m. — 7 p.m. each day). Demand is calculated in 15-minute intervals, with the maximum drawn in any reckonable interval of the billing period determining a key component of the bill known as the demand charge. The consumer pays a two-monthly demand charge based on the maximum demand. Consequently, when this demand is managed efficiently, electricity costs can be controlled.

Using Generators for Peak-Lopping

3.50 Our review indicated that peak-lopping using generators was, in many hospitals and homes, not regarded as a suitable method of minimising peak demand. Such a process would involve using generators to meet demand at peak times, thus achieving economies under the regime of tariffs operated by the ESB.

3.51 We noted that peak-lopping by using generators had been discontinued in some hospitals. In James Connolly Memorial Hospital, Blanchardstown such use was discontinued in 1994. As a result, slightly lower consumption of electricity in November-December 1994 cost 22.5 per cent more than in November-December 1993.

Table 3.11
Electricity consumption in James Connolly Memorial Hospital, Blanchardstown, November-December 1993 and 1994

Billing period	Consumption '000 kwh	Maximum demand	Cost (before VAT)
November-December 1993	324	79	£11,708
November-December 1994	322	251	£14,338

3.52 In general, we found that the use of generators to achieve demand reduction at peak times was restricted because of fears of loss of power to electromedical devices caused by simple switching of plant. The successful application of this procedure depends on the availability of synchronised switching devices. Our study noted that this technique had worked effectively in at least one major hospital and should on that basis be considered in other cases. However, in order to clear up any doubts on the matter, there is a need for a definitive study to determine the actual risks, the possible implications for overtime payments and the length of the payback period involved.

Re-scheduling Electricity Demand

3.53 The scope for re-scheduling of activity so as to reduce peak demand was found to be limited especially in smaller premises where extra overtime costs might outweigh any savings. However, some opportunities exist. For example, the use of autoclaves during off-peak periods works successfully in Letterkenny General Hospital and we suggest that it should be adopted in Louth County Hospital.

3.54 Instances of good practice opportunities noted were:

- introduction of maximum demand tariffs where cost-effective, and maximising the gain from the ESB's winter demand reduction incentive scheme
- re-scheduling of work to reduce maximum demand
- maximising output from other energy sources and thereby reducing the use of electricity in laundries
- use of steam instead of electricity for autoclaves
- use of generators with synchronised switching technology to reduce maximum demand and
- use of LPG or natural gas instead of electricity in kitchens.

Control of Electrical Consumption

3.55 In the course of our examination, areas were noted which were unoccupied for a large part of the day or night but where lighting was not switched off. This is essentially a management function which should be promoted within normal operational procedures.

3.56 We concluded that for the vast majority of hospitals and homes, lighting management systems are not a practical option. Prominent instruction on exits from these areas, with corresponding staff instruction, could be effective in achieving savings.

3.57 It is clear that savings can be effected by active management. For instance, we noted that in Letterkenny General Hospital, which was a reasonably heavy user of electricity in 1993, considerable progress had been made in reducing both consumption and cost. The reductions for the first eight months of 1994 were:

- consumption 8.4%
- cost 11.8%

3.58 This is attributed to an active Energy Committee which has taken the following initiatives:

- improved 'housekeeping' procedures
- installation of efficient light fittings and
- re-scheduling of loads outside maximum demand periods.

Lighting Efficiency

3.59 Hospitals and homes tend to have a high relative use of lighting in comparison with commercial, industrial or educational premises. Using high-efficiency lighting is therefore more important in hospitals and homes. We found, generally, that programmes are in place to replace the residual stock of tungsten filament lamps with fluorescent sources. We recommend this policy should be encouraged and accelerated where possible.

Part 4 : Organisation and General Issues

Approach to Energy Management

4.1 Good energy management depends to a large extent on:

- active commitment of the organisation
- investment policies to achieve savings
- accountability, including responsibility for review of outturn and follow-up action and
- encouragement to users to save energy.

We examined practices in each of the health boards under these criteria.

Energy Management Organisation

4.2 Our review noted that energy was not the subject of policy statements at board level.

4.3 While at management level there was an obvious commitment to good practice, boards should set out their approach to energy management and give consideration to introducing a suitable policy to guide management in their operations. In order to focus energy initiatives and management, performance targets should be established. While targeting and measurement, of itself, cannot guarantee savings it is notable that where this has been done, considerable progress has been achieved. For instance, it was noted that the Mid-Western Health Board had reduced its expenditure by over one-third during the period 1984 to 1993.

4.4 Responsibility for energy management is assigned in a variety of ways by boards. The general responsibility in each board rests with a Technical Services Officer (TSO). In five of the boards, the TSO shares the brief with an Energy Officer. In the other three, the TSO carries the brief with varying degrees of involvement.

4.5 Energy management is just one of a wide range of engineering services for which TSOs are responsible.

4.6 The TSO and the Energy Officer (where one had been appointed) are responsible for identification of initiatives and the supervision of their implementation. The human resources available to TSOs for energy management are set out in Table 4.1. They do not, however, have responsibility for the related budgets. Financial responsibility rests with hospital administrators.

Table 4.1
Energy management personnel, by health board, 1994

	Energy officers	Engineering officers	Maintenance officers [a]
Eastern [b]	1	3	9
Midland	1	-	10
Mid-Western	-	2	5 [c]
North Eastern	-	-	5
North Western	1	1	8
South Eastern	1 [d]	1	5
Southern	1 [d]	4	8
Western	- [e]	3	9

a *In general, maintenance officers and their staff do not come under the direct control of TSOs.*

b *Neither engineering officers nor maintenance officers come under the direct control of the TSO in the Eastern Health Board.*

c *Maintenance officers in the Mid-Western Health Board are called Technical Services Supervisors and come under the direct control of the TSO.*

d *Part-time function.*

e *In the Western Health Board, two Assistant TSOs and a Staff Officer have roles in energy management.*

4.7 Voluntary hospitals have more manpower resources than health board premises for management and maintenance. Five large health board hospitals surveyed had one maintenance person for every 25 beds while four selected voluntary hospitals had a ratio of 1:15. Management in voluntary hospitals regarded these as the minimum essential resources. However, it should be emphasised that the good management of energy in an era of computerised controls is concerned more with the type of support and response staff than with their numbers. This should be examined by each board in the light of its circumstances.

Investment in Energy Efficiency

4.8 Investment in energy efficiency is one of the few initiatives a health board can take which yields a financial return in future years. The critical factors which underpin successful initiatives are:

- the availability of funding and
- the effective appraisal of options.

4.9 The boards' budgets for energy are treated as recurrent in nature leading to a general attitude that a one-year horizon is all that can be contemplated. Many initiatives have payback periods extending beyond this horizon. Decision makers, given the annual funding basis, have tended to accept higher current outgoings on energy because the seed funding for measures to staunch the waste is not available.

4.10 The labelling of grant moneys as recurrent should not deter boards from allocating resources for such works. Where this is not possible some form of borrowing might be considered.

4.11 Our examination noted that boards were weak in formal appraisal of initiatives. However, instances of good practice were noted. For example, the Western Health Board has comprehensively set out its proposed initiatives and the Mid-Western Health Board has also demonstrated a particularly pro-active approach. Appraisal should be addressed by introducing practices to identify and rank initiatives based on simple payback calculations or discounted cash flows. Major initiatives should be reviewed by boards.

4.12 In the initial drive for energy conservation it is useful to establish targets, and this has been done successfully in some instances. As health boards move into the next phase of their strategy it may be necessary to conduct formal audits or surveys in order to identify energy-saving possibilities. In the past, some boards have engaged consulting engineers to perform energy audits on hospitals and homes in their areas. However, most TSOs have preferred to perform their own reviews as part of ongoing monitoring and maintenance. The Energy Audit Grant Scheme operated through the Irish Energy Centre should be availed of by boards to the maximum extent.

4.13 The Department of Energy informed us that the Irish Energy Centre will have a key role in following up on good practice opportunities identified in the course of this examination. It will have a particularly important role in the provision of information and advice and in administering the Energy Audit Grant Scheme. The Department of Energy emphasised, however, that conducting energy audits must not be seen as an end in itself but as a feasibility stage in the process of investment in energy efficiency. Accordingly, where the feasibility study so indicates, energy audits should be followed up by investment. Grant aid by way of support for such investment will be available under an Energy Efficiency Investment Support Scheme which will also be administered by the Irish Energy Centre.

Accountability

4.14 Our review indicates that greater monitoring can be cost-effective. However, monitoring at executive level alone will not achieve savings. Critical scrutiny of outturn in periodic board reviews of performance would introduce a measure of accountability. The generation of indicators and their reporting to the board in a suitable format would underpin the effort to achieve good energy management. Indicators such as those reported in Appendix B might be considered for this purpose.

4.15 The approach to the assessment of energy consumption differs from one health board to another. In all of the health boards, excluding the North Eastern and North Western, energy performance by fuel type is analysed periodically. Performance reporting in the North Eastern and North Western Health Boards is confined to analysis of total monthly energy cost per hospital. The performance of each of the regions' health institutions is assessed by the relevant health board as set out in Table 4.2. Reports are mainly routed to senior management. Reporting to board level does not occur in any routine fashion.

4.16 While at present the administrators of health board hospitals and homes receive monthly accounts of running costs, including energy costs and energy performance information to the extent set out in Table 4.2, there is merit in supplying periodic energy performance reports to all administrators.

User Encouragement

4.17 Given the management structure of hospitals and homes whereby aspects of energy accountability vests in both the administrator and the TSO, there is a clear need for some co-ordinating function. This might be supplied either by a committee as in Letterkenny General Hospital or by assigning responsibility to particular individuals.

4.18 Opportunities to save energy exist even at the level of good housekeeping. These include:

- switching off lights in unused areas
- keeping windows and doors closed when heating is on and
- switching off electrical equipment when not in use.

Busy staff are unlikely to have this at the top of their agenda but management should consider some form of publicity to encourage staff awareness and, where possible, assign responsibility. Comprehensive checklists of such measures have been published in respect of the UK national health services. These cover all areas of hospital operation and could be adopted by Irish institutions.

Table 4.2
Assessment by health boards of energy performance

	Reports produced [a]	Circulation of reports
Eastern	Periodic cost and consumption of each fuel. Annual cost per square metre for each fuel. Annual consumption per square metre.	An annual report under each category is submitted to the management team for information.
Midland	Periodic cost and consumption of each fuel with a three-year comparison.	Circulated every four months to the hospital administrators and the maintenance supervisors. An annual report is submitted to the management team.
Mid-Western	Periodic cost and consumption of each fuel.	Circulated monthly to the Chief Executive Officer, the management team and the administrators.
North Eastern	Periodic energy costs per hospital.	Circulated monthly to the management team.
North Western	Periodic energy costs per hospital.	Circulated monthly to the management team.
South Eastern	Periodic cost and consumption of each fuel. Annual cost per bed. Annual consumption per square metre and cubic metre.	An annual summary is presented to the management team, with particular reference to envisaged projects.
Southern	Periodic comparison with previous year of costs and consumption for each fuel.	Annual summary to management team and Board with reference to projects completed and envisaged.
Western	Periodic cost and consumption of each fuel. Annual cost and consumption per bed and per square metre, with a three-year comparison.	Circulated annually to the programme managers and the administrators.

[a] *Where a reference is made to periodic costs and consumption, it should be taken to mean the regular fuel billing periods, e.g. bi-monthly electricity bills and monthly gas bills.*

Achievements

4.19 Boards have achieved considerable success in managing the energy function and driving down energy cost. Some notable examples are:

- Many boards have installed distributed systems (smaller boilers spread throughout hospital complexes) in replacement of less efficient central systems. This was usually accompanied by boards taking the opportunity to switch fuels and to replace pipework and insulation. Savings have been significant. For example:

  - At St. Stephen's Hospital, Sarsfield Court, Cork, annual energy consumption was reduced by 58 per cent by installing a distributed system in 1986. The replacement of turf by LPG also realised a substantial saving in the labour cost of boilerhouse staff.

  - When the heating system was decentralised in St. Loman's, Mullingar, the 25-year old pipework and insulation were replaced and a BMS was installed. Savings in energy consumption of 36 per cent were achieved.

  - At James Connolly Memorial Hospital, Blanchardstown, energy consumption reduced by 37 per cent as a result of the decentralisation of the heating system.

- The Midland Health Board has installed a BMS which is capable of controlling and monitoring the heating services at five of its main hospitals by means of a remote computer terminal located in its head office at Tullamore.

- The Mid-Western Health Board has cut the cost of energy by over £1m since 1985. The principle features of its strategy were:

  - establishment of energy saving targets
  - monitoring energy utilisation
  - substitution of cheaper energy sources (natural gas and heavier grade oils)
  - opting for and managing maximum demand tariffs
  - decentralisation of boiler plant
  - rationalisation of existing heating systems and
  - reducing the use of and pressure of steam where possible.

- The Western Health Board is engaged in a series of initiatives at nine sites involving:

  - the installation of distributed systems and
  - alternative fuel selection (using heavier grade oils).

The combined effect of the Western Health Board initiatives is projected to yield substantial annual savings and the Board has estimated that further annual savings of £100,000 can be achieved for outlays of the order of £150,000.

Issues for Central Government

Central Guidance

4.20 No explicit statement of policy has been issued by the Department of Health in the area of energy management. The Department did however, issue a report drawn up in 1983 by a group who considered the use and control of energy.

4.21 The principal recommendations of the group, together with a comment on the implementation to date of each recommendation, were:

• Assign responsibility for recording and control of energy use to a designated officer in each hospital and home.	*The recommendation has been implemented in part with the appointment of Energy Officers in five boards and with corresponding officers in voluntary hospitals.*
• Energy consumption should be analysed.	*This is being done in six boards.*
• Microprocessor based control and monitoring systems should be assessed.	*This has been done and successful Building Management Systems operate at a number of sites.*
• Energy-saving measures should be financed from specific capital funds and consideration should be given to borrowing for attractive measures.	*Little progress has been made in this area.*

4.22 Progress on the report's recommendations has occurred at a steady rate in the past 12 years. However, more could be achieved with greater co-ordination. An initial worthwhile step would be the provision of a Department-chaired forum, with technical representation from the Irish Energy Centre. This would provide an opportunity for TSOs to address energy conservation issues in a structured way and to disseminate good practice guidance.

Funding of Energy Initiatives

4.23 Funding of boards is by way of block grants for recurrent expenditure with capital grants only for major works. In addition boards may borrow with the approval of the Minister for Finance. The problems which arise at health board level in obtaining an appropriate funding source for attractive initiatives spring to some extent from the rigidities perceived to attach to the existing mechanisms.

4.24 In order to free the boards to take desirable cost-effective initiatives, consideration should be given to one or more of the following:

- encouraging boards to allocate a portion of their annual budgets for capital works with paybacks of less than five years
- provision of specific grants for minor capital works including energy measures
- Department-sponsored borrowing for initiatives approved by the boards where short term paybacks are projected
- third-party financing of measures with specific Department approvals.

4.25 Third-party financing has been used in two cases:

- a loan of £314,000 was undertaken by the Southern Health Board to fund a combined heat and power (CHP) plant at Cork University Hospital and
- borrowing of £100,000 was organised by the Eastern Health Board to finance the installation of a CHP plant at St. Mary's Hospital, Phoenix Park.

4.26 While there is merit in discouraging borrowing for running costs, the funding of energy efficiency measures is almost invariably justified in circumstances where the initial investment is repaid in less than five years and savings continue to accrue over the remaining life of the measures.

Energy Implications of Condition of Buildings

New Buildings

4.27 Good design features are essential in guaranteeing energy efficiency at the operational stage. The principal features which need consideration are:

- layout and orientation of the building on site
- good thermal standards and
- efficient design and standards of plant and controls.

4.28 The Department of Health has an implicit policy to promote energy efficiency in new hospital buildings. As an example of this, the design specification for a recent project included the instructions set out in Table 4.3.

Table 4.3
Extract from design specification for a hospital building project

The efficiency of the design in regard to energy economy must achieve the following objectives:

- Provide adequate thermal comfort
- Reduce heat transmission through fabric and openings
- Reduce heat loss due to ventilation and infiltration
- Control and optimise the distribution of heat within buildings by heating installations, by ventilation and by transmission through fabric
- Maximise the use of solar and casual heat gains while controlling overheating
- Optimise the relationship between patterns of occupancy, thermal response of building fabric and thermal response of heating installation
- Select suitable energy sources, improve the efficiency of fuel conversion (to heat, light, etc.) and reduce flue and other losses
- Provide occupants with appropriate controls and ensure that they understand what should be done to achieve economical operation
- Make allowance for future changes
- Ensure adequate standards of workmanship, plant installation and commissioning
- Ensure that the need for maintenance and monitoring is understood and that guidelines are provided.

Source: Department of Health

Existing Buildings

4.29 A wide variety of buildings was surveyed by the consulting engineers during their examination of selected hospitals and homes. Buildings ranged from those built around 1840 to those of very recent construction. In general, fabric varied from building to building with construction based on stone, mass concrete or cavity walls, depending on the construction period. Evidence of dampness was noted in two buildings. Investment in up-grading the thermal performance of older stock has centred on roof insulation, where possible, and phased replacement of windows.

4.30 Great emphasis should be placed on draught control at external doors but, in view of the type of traffic involved, this is a problem with no easy universal solution. In the case of the buildings examined, it is unlikely that significant improvement can be made to the thermal performance of walls and floors at reasonable cost.

4.31 Age and condition of the building is a significant factor in assessing the efficiency of performance. The continued use of very poorly insulated buildings may result in poor performance being indicated despite efficient operation of plant and distribution systems. Improvement of the performance of such buildings will demand radical appraisal which in some cases should include questioning the validity of their continued use.

Energy Management Initiatives

Combined Heat and Power

4.32 A combined heat and power (CHP) plant generates both heat and electricity. Although such plants have been used in industry for decades, the technology has only gained momentum in Ireland in recent years, mainly because:

- it is now being actively promoted by the ESB
- competitively-priced natural gas is available and
- smaller off-the-shelf CHP packages are available.

4.33 At its most basic, a CHP plant consists of a turbine or engine which drives a generator to supply electricity to a building. Waste heat from the generation process, which would normally be dumped, is recovered and used to heat the building. Due to the heat recovery process, a higher thermal efficiency is achieved than is usual in electricity generation alone, making the technology financially attractive in appropriate buildings.

4.34 There are however, several technical and financial constraints in deciding whether the technology is appropriate for a particular site:

- Turbines, whether gas or steam, are suited to large installations with base electrical loads of a minimum of 1 megawatt and where the ratio of heating load to electrical load is higher than normal. As such, they would be considered for the very largest of hospitals and only then, when piston engines are not feasible. In practice, there are few situations in Ireland where turbines would be appropriate.

- Piston-engined installations are of two types, diesel and spark-ignition gas. Diesel engines have proven technically unsatisfactory in recent trials for several reasons, in particular due to the long running hours, typically over 5,000 hours per annum.

- Gas-fired engines fall into two types, those firing natural gas and those firing liquid petroleum gas (LPG). The technical characteristics of both types of installation are basically the same.

Natural Gas-fired CHP

4.35 Natural gas-fired CHP installations are commercially available and several have been installed in hospitals and other buildings in Ireland. The hospital installations include:

- Cork University Hospital
- NMRC, Dún Laoghaire
- St. Mary's Hospital, Phoenix Park
- Our Lady's Hospital, Crumlin.

4.36 Consideration is being given to installation of CHP plants at:

- Beaumont Hospital
- St. Vincent's, Elm Park
- St. James's, James's Street
- Mater Misericordiae, Eccles Street.
- Louth County Hospital, Dundalk
- Regional Maternity Hospital, Limerick
- St. Luke's Hospital, Clonmel

4.37 Units with natural gas-fired engines are generally suitable for buildings with minimum base loads of 38kW electrical and 70kW thermal. The amount of electricity generated by such plants is determined almost totally by the heating demand. Payback periods of 3 to 4.5 years are achievable, depending on site considerations and the scale of the installation. EU funding of up to 35 per cent grant aid has heretofore been available under the THERMIE fund, but continued availability is in question.

LPG-fired CHP

4.38 LPG-fired installations are also technically feasible, but there are two further considerations which impact adversely on the payback period:

- Engines firing LPG cannot produce the same power output as when firing natural gas. Consequently, larger engines are required to produce a given energy output using LPG, resulting in a higher capital cost per plant.

- LPG is considerably more expensive to purchase than natural gas.

4.39 It has been the generally-held view therefore that such installations are not financially attractive and there is no such installation in operation in the State at present. Two such installations were implemented and subsequently de-commissioned over a decade ago. However, it is also accepted that newer generation engines have solved the technical problems.

4.40 There is an active proposal for the installation of an LPG-fired CHP unit at Letterkenny General Hospital. The outcome of this development, should it proceed, must be awaited before re-assessing the state-of-the-art concerning LPG-fired CHP plant in the State.

Impact of CHP

4.41 CHP plants can impact substantially on electricity demand from ESB sources:

- A plant at Our Lady's Hospital for Sick Children in Crumlin came into operation in 1994. This has led to a decrease in the consumption of electricity from the ESB. The reductions achieved varied with the billing period. The largest periodic reduction over the corresponding 1993 period has been 41 per cent in the November-December 1994 period. Larger reductions occur in winter since the demand for hot water output is greater. Preliminary indications are that this plant is achieving its target savings.

- A natural gas-fired CHP plant installed in Cork University Hospital in November 1994 has achieved a reduction of 80 per cent in consumption of electricity from the ESB for the first three months of operation. The actual cost savings during this initial period was £24,000.

4.42 CHP technology is worthy of consideration in all medium and large hospital sites in the natural gas area. For sites outside the natural gas area, the outcome of the Letterkenny project is clearly the key factor before the feasibility of LPG-fired CHP installations can be evaluated. Oil-fired projects are considered to be unproven due to serious reliability questions and the unavailability of commercially-marketed packaged systems.

Contract Energy Management

4.43 Contract energy management (CEM) consists of the provision by an external contractor of a combination of financial, engineering and management services appropriate to implementing an energy saving project. CEM may be structured so that the contractor:

- conducts an energy survey
- finances the supply of energy efficient equipment and
- operates the equipment.

4.44 The financial terms may vary as follows:

- a heat services contract under the terms of which the CEM contractor provides heat energy at a charge

- a shared saving contract where the CEM company shares the savings achieved with the user

- a fixed fee contract for a specified level of service.

4.45 A claimed advantage of such arrangements is the guaranteed efficient operation of plant. It has been adopted in Europe to a limited extent and some very substantial energy reductions have been claimed.

4.46 The technique, while superficially attractive, does not appear directly applicable to hospitals and homes. However, it is possible that aspects of energy management within the hospitals and homes could lend themselves to CEM, in particular the installation, funding and operation of high quality BMS where both cost and risk factors were eliminated or reduced from a board's perspective.

Metering of Kitchens, Laundries and Operating Theatres

4.47 Kitchens and laundries included in the examination frequently act as central facilities for outlying units. For instance, the laundry at St. Luke's Hospital, Clonmel also services four other hospitals in the area, while the kitchen also caters for one other hospital. Modern cook-chill procedures tend to lead to centralisation of kitchen operations.

4.48 Operating theatres have a high volume of air changes per hour with space temperature and humidity controlled within very clearly defined limits using heating and cooling energy sources.

4.49 The energy consumed by these functions is substantial and it is desirable to isolate these demands to evaluate their performance in a meaningful way. Accordingly, we recommend the installation of sub-meters on these thermal and electrical loads for recording of total energy use.

4.50 In addition, since laundries require a heavy energy load it is preferable for administrators to be in a position to determine the best way of delivering this service, whether in-house or by service contract. This can only be done if the costs can be identified and made available to assist in any examinations of the economics of the in-house functions.

Environmental Considerations

Incineration

4.51 Incinerators for hospital waste are installed in the following hospitals which we examined:

- District Hospital, Skibbereen
- General Hospital, Cavan
- St. Columba's Hospital, Sligo
- County Hospital, Roscommon
- Heatherside Hospital, Buttevant.

4.52 Incineration is a highly contentious issue. The Department is currently actively considering alternative de-contamination techniques such as sterilisation and irradiation to reduce most waste to landfill quality, with the remainder being exported to waste disposal plant abroad. Waste heat recovery mechanisms were not installed in any of the incinerators surveyed. However, since it is proposed to de-commission all existing plant, expenditure on heat recovery modifications would not be justified.

Air Pollution

4.53 In future, emissions from hospitals may be monitored and controlled by regulatory authorities, such as the Environmental Protection Agency, with implications for fuel source choices. Consequently, in developing and modifying practices in the hospital sector, environmental considerations must be given proper emphasis. Key considerations in this regard are:

- choice of primary fuel and
- efficiency of use.

4.54 The more serious pollutants generated by the burning of fuels are carbon dioxide and oxides of sulphur and nitrogen. In general the cleanest fuel is natural gas and, where that is not available, low sulphur fuel oils (e.g. diesel or less than 1 per cent sulphur heavy fuel oil) generate the least amount of air pollutants.

4.55 The efficient conversion and use of energy is, in itself, an important contribution to conservation of non-renewable primary energy sources and to the limiting of damage to the environment including air pollution.

Glossary

Autoclave	A fabric and instrument steriliser.
Base load	The heating or electrical load below which the demand rarely reduces.
BMS - Building Management Systems	An energy control and management system which allows a computer to control heating, ventilation and other electrical systems in response to changes in its surroundings within the limits of pre-set parameters. A BMS can be installed to a high specification depending on the number of heating circuits, the number of meters required, the complexity of the required information system and the finance available. A BMS, from a central base, can control more than one site.
Brickeens	Solid fuel in the form of broken briquettes.
CHP - Combined Heat and Power	Combined heat and power, also known as co-generation is a process where both heat energy and electrical power are produced simultaneously by a specially designed unit. A CHP unit is similar to a conventional generator, with the exception that the waste heat is not rejected through a radiator into the atmosphere but is utilised for a process load, such as domestic hot water production and space heating. In a CHP plant, up to 90 per cent of the total heat produced by the fuel (which may be oil but is more usually gas) can be recovered for use, typically 40 per cent to generate electricity and 60 per cent to direct heating. In order to achieve optimum energy cost savings, a simultaneous demand for hot water and electricity should exist. In most cases this should exceed CHP capacity and extend for a substantial period.
Cook-chill	A relatively new departure in catering whereby a large quantity of similar foods are prepared at the same time in a clean kitchen environment. The food is kept in refrigerated storage. As needed, it is taken in smaller quantities to the point-of-use, i.e. the hospital ward,

	where it is heated by re-generation to the required serving temperature.
CEM - Contract Energy Management	An arrangement with a third party whereby the third party installs energy-saving measures at no cost to the user. The savings generated by the installation are divided between the two parties for a pre-determined period, from which time all savings accrue to the user. The third party may, under some contracts, assume responsibility for the ongoing monitoring of the installation.
GJ - gigajoule	A measure of energy (10^9 joules). An alternative unit of energy is the kiloWatt hour (kWh). A table of their relationships to the common measurement units for each energy source is set out in Table A.1 of Appendix A.
HFO - Heavy Fuel Oil	A fuel normally used in larger boilers.
kW - kilowatt	A measure of the rate of using energy (1 kW = 1,000 watts, 1 watt = 1 joule per second).
kW thermal	A measure of thermal energy.
kWe - kiloWatt of electrical power	A measure of electrical power generating capacity of a CHP unit, to distinguish from kW thermal.
kWh - kiloWatt hour	A unit of energy, either electrical, thermal or mechanical.
Load-shedding	Selective reduction in non-essential electrical loads for a period to reduce maximum electrical demand.
LPG - Liquid Petroleum Gas	Liquified hydrocarbon gas, consisting mostly of propane, available in bulk or in pressurised cylinders.
Peak-lopping	The distribution of an electricity load from the period of the day of greatest demand to less busy times.
THERMIE	An EU grant scheme for funding selected energy-saving projects.

Therm	A traditional unit of thermal energy (1 therm = 100,000 British thermal units).
TPF - Third Party Financing	The provision of funding by a third party, such as a financial institution or the ESB, to be repaid with interest over a fixed period.
TSO - Technical Services Officer	An officer with responsibility for technical matters in each of the health boards.
Zone Control	Zone control involves the installation of supply circuits (e.g. heating, electricity) which can be identified and activated independently of any other circuit.

Appendices

Appendix A

Audit Methodology

The examination was conducted in two main stages:

- the compilation of energy consumption performance indicators for hospitals and homes based on a survey of health boards and voluntary hospitals and

- the detailed examination by a firm of consulting engineers (MacArdle McSweeney Associates) of the energy management and related functions in a sample of hospitals and homes.

Survey of hospitals

Questionnaire

A postal survey of hospitals and homes was undertaken to provide basic data concerning costs and consumption of energy. The questionnaire used in the survey included questions in relation to:

- category of hospital/home
- number of beds
- bed days used
- type and cost of energy used in 1993
- volume and area of buildings in use
- date of construction of buildings
- layout of buildings
- exposure of buildings
- laundry and catering facilities
- energy management.

Questionnaires were sent at the end of May 1994 to the health board Technical Services Officers (TSOs). A questionnaire was also sent to the Secretary/Manager of each of 29 voluntary hospitals.

Response Rate

Questionnaires in relation to 166 health board hospitals and homes with 25 or more beds were returned. 25 voluntary hospitals also responded.

Most questions were answered by all respondents, but some questions (e.g. in relation to hot water usage in laundries) had to be disregarded because of low response rates. Four of the smaller voluntary hospitals did not provide data relating to building volume or area.

Validation of Data

A number of procedures were adopted to validate the data submitted in questionnaires.

- Print-outs of relevant parts of the database were sent to each health board with a request that these be checked by internal audit staff. Six health boards complied with this request.

- Where internal audit checks were not undertaken, staff of this Office visited the health board offices and examined records and the procedures used to generate the questionnaire responses.

- Tests of the data for internal consistency and reasonableness were run. Outlying or unlikely values were noted and each such value was queried with the relevant TSO or individual hospital management.

The validation procedures used resulted in significant changes being made to the data base. While we are reasonably satisfied with the quality of the data collected, it is clear that the procedures and systems in some health boards for generating and recording management information about energy usage need to be considerably improved.

Energy Consumption/Performance Indicator

The main indicator of performance used is energy consumption per 100 cubic metres expressed in gigajoules (GJ/100m^3) adjusted in respect of local temperature and exposure. This indicator was compiled using a methodology approved by Forbairt.

The performance indicator is based on energy consumed using the factors in Table A.1 to convert the quantity of fuel used to gigajoules of energy consumed.

Electricity was apportioned between that used for heating and that for power.

Exposure of Buildings

Buildings vary in the extent to which they are exposed to weather. The following adjustment factors were applied in estimating performance indicators.

Weather Correction Factors

The performance of each hospital and home was adjusted to take into account variations in local temperature from the national average.

Table A.1
Energy conversion factors for selected fuels

Fuel	Normal Measurement	Conversion factor [a]	
		to kWh	to GJ
Natural gas	Therm	29.31	0.1055
Gas oil	Litre	10.60	0.0382
Heavy fuel oil	Litre	11.40	0.0410
Medium fuel oil	Litre	11.30	0.0407
Light fuel oil	Litre	11.20	0.0403
Coal	Tonne	7,600.00	27.3600
Peat	Tonne	4,002.60	14.4094
Brickeens	Tonne	5,362.50	19.3050
Liquid petroleum gas (LPG)	Litre	7.09	0.0255

[a] *To convert a quantity expressed in the normal measurement for a fuel to kWh or GJ, multiply by the relevant conversion factor.*

Table A.2
Adjustment factor for degree of exposure of building

Condition	Description	Adjustment Factor
Sheltered	A building in a built-up area with other buildings of similar or greater height surrounding, e.g. most city centre locations.	1.1
Average	A building on level ground in urban and rural surroundings with adjacent trees or buildings.	1.0
Exposed	A building on a coastal or hilly site with no adjacent screening.	0.9

Local Inspections

The principal matters examined by the consulting engineers were:

- personnel
- energy consumption by fuel
- energy consumption by function
- pattern of use
- types of control
- temperature maintained
- plant and equipment
- building efficiencies
- energy monitoring
- space heating
- electricity/lighting
- performance rating.

The results of the detailed examination have been separately transmitted to the institutions. A summary of the findings is contained in this report.

Appendix B

Energy Use in Public Sector Hospitals and Homes, 1993

The following tables set out selected results of the analysis of the survey data collected. Each of the Tables B.1 to B.8 deals with hospitals and homes within a single health board area. Table B.9 presents results relating to the voluntary hospitals included in the survey.

Hospitals and homes are listed under four categories, on the basis of the predominant type of care given. These are:

- acute hospitals (which includes general and paediatric hospitals)
- geriatric hospitals and homes (where predominantly long-stay care is provided)
- psychiatric and mental handicap hospitals and homes and
- other hospitals and homes (which includes maternity and orthopaedic hospitals, and hospitals which predominantly provide specialist treatments, e.g. oncology and rehabilitation).

Table B.1
Energy use in Eastern Health Board hospitals and homes, 1993

Hospital/home	**Total energy use GJ/100m³**	**Beds**	**Energy cost per bed £**	**Energy use per bed GJ/bed**
Acute hospitals				
General Hospital, Naas	51	123	753	110
St. Columcille's Hospital, Loughlinstown	54	150	758	106
James Connolly Memorial, Blanchardstown	69	336	545	153
Geriatric hospitals and homes				
St. Clare's Home, Griffith Avenue	43	85	313	52
St. Mary's Hospital, Phoenix Park	48	345	419	99
Brú Chaoimhin, Cork Street	51	182	334	60
St. Colman's Hospital, Rathdrum	63	142	425	60
District Hospital, Baltinglass	67	95	431	70
St. Brigid's Hospital, Crooksling	67	150	554	80
St. Vincent's Hospital, Athy	73	272	382	59
Vergemount Hospital, Clonskeagh	73	205	457	79
Psychiatric and mental handicap hospitals and homes				
St. Brendan's Hospital, Grangegorman	38	300	609	126
Central Mental Hospital, Dundrum	51	86	1,189	179
St. Loman's Hospital, Palmerstown	62	153	719	117
Newcastle Hospital, Greystones	63	102	1,076	172
St. Ita's Hospital, Portrane	80	735	559	141
Other hospitals and homes				
Cherry Orchard, Dublin	48	280	429	97

Table B.2
Energy use in Midland Health Board hospitals and homes, 1993

Hospital/home	Total energy use GJ/100m³	Beds	Energy cost per bed £	Energy use per bed GJ/bed
Acute hospitals				
District Hospital, Athlone	41	81	486	74
St. Mary's & General Hospital, Mullingar	54	339	600	103
District Hospital, Abbeyleix	57	50	450	75
General Hospital, Tullamore	68	226	639	120
General Hospital, Portlaoise	87	140	795	129
Geriatric hospitals and homes				
St. Brigid's, Shaen	50	58	454	65
Riada House, Tullamore	59	40	397	44
St. Joseph's, Longford	61	201	466	70
St. Vincent's, Mountmellick	69	187	270	64
Welfare Home, Athlone	73	40	377	50
District Hospital, Birr	82	70	441	68
Welfare Home, Edenderry	101	40	413	61
Psychiatric and mental handicap hospitals and homes				
St. Peter's, Castlepollard	39	93	591	89
St. Fintan's, Portlaoise	46	212	549	138
St. Loman's, Mullingar	56	367	679	140

Table B.3
Energy use in Mid-Western Health Board hospitals and homes, 1993

Hospital/home	Total energy use $GJ/100m^3$	Beds	Energy cost per bed £	Energy use per bed GJ/bed
Acute hospitals				
Regional Hospital, Dooradoyle	60	345	568	104
General Hospital, Ennis	66	84	711	109
General Hospital, Nenagh	81	60	1,240	206
Geriatric hospitals and homes				
Regina House, Kilrush	38	40	198	27
District Hospital, Raheen	49	36	319	42
Assumption Hospital, Thurles	54	156	401	57
Welfare Home, Roscrea	54	40	262	37
St. Ita's, Newcastle West	58	160	376	57
Welfare Home, Nenagh	63	40	239	35
St. Joseph's, Ennis	67	265	352	59
St. Camillus's, Limerick	75	305	427	90
District Hospital, Ennistymon	86	33	478	75
Psychiatric and mental handicap hospitals and homes				
St. Joseph's, Limerick	55	247	527	114
Our Lady's, Ennis	58	242	509	108
Other hospitals and homes				
Regional Maternity Hospital, Limerick	55	96	608	98
St. Nessan's Orthopaedic, Croom	70	83	890	126

Table B.4
Energy use in North Eastern Health Board hospitals and homes, 1993

Hospital/home	Total energy use GJ/100m³	Beds	Energy cost per bed £	Energy use per bed GJ/bed
Acute hospitals				
Louth County Hospital, Dundalk	59	293	423	94
General Hospital, Cavan	70	239	1,143	170
Our Lady's, Navan	78	177	784	141
General Hospital, Monaghan	94	136	651	106
Geriatric hospitals and homes				
St. Felim's, Cavan	28	213	331	53
St. Joseph's, Ardee	38	46	504	53
Welfare Home, Cavan	55	40	457	56
St. Joseph's, Trim	57	244	377	49
St. Mary's, Drogheda	59	46	604	45
Cottage Hospital, Drogheda	77	44	775	123
Boyne View House	105	38	460	68
St. Mary's, Castleblaney	119	204	389	86
Psychiatric and mental handicap hospitals and homes				
St. Brigid's, Ardee	53	185	457	111
St. Davnet's, Monaghan	64	278	776	192

Table B.5
Energy use in North Western Health Board hospitals and homes, 1993

Hospital/home	Total energy use GJ/100m³	Beds	Energy cost per bed £	Energy use per bed GJ/bed
Acute hospitals				
General Hospital, Sligo	58	326	1,008	162
General Hospital, Letterkenny	62	309	1,023	131
Our Lady's, Manorhamilton	81	60	1,007	128
Geriatric hospitals and homes				
Rock Welfare Home, Ballyshannon	27	35	514	42
District Hospital, Carndonagh	42	38	487	79
Sheil Hospital, Ballyshannon	46	51	500	59
Arus Breffni, Manorhamilton	48	40	379	38
District Hospital, Donegal	52	29	1,061	124
District Hospital, Dungloe	57	48	749	92
St. Patrick's, Carrick-on-Shannon	68	118	525	69
Arus Carolan, Mohill	68	40	395	56
Community Nursing Unit, Falcarragh	78	35	705	91
St. John's, Ballytivnan, Sligo	81	270	394	75
District Hospital, Lifford	91	40	677	80
Community Nursing Unit, Buncrana	93	45	924	120
St. Joseph's, Stranorlar	97	189	397	90
Community Nursing Unit, Ramelton	103	38	836	107
Psychiatric and mental handicap hospitals and homes				
Cloonamahon Centre	40	100	412	53
James Connolly Memorial, Carndonagh	45	28	641	78
St. Columba's, Sligo	52	175	510	79
St. Conal's, Letterkenny	54	197	1,074	213

Table B.6
Energy use in South Eastern Health Board hospitals and homes, 1993

Hospital/home	Total energy use GJ/100m³	Beds	Energy cost per bed £	Energy use per bed GJ/bed
Acute hospitals				
Ardkeen, Waterford	44	337	1,040	217
St. Joseph's, Clonmel	44	177	399	95
General Hospital, Wexford	50	205	999	146
St. Luke's, Kilkenny	52	179	705	117
District Hospital, Carlow	64	26	310	86
Our Lady's, Cashel	67	77	899	140
Geriatric hospitals and homes				
St. Joseph's, Dungarvan	35	111	391	51
St. Columba's, Thomastown	40	154	321	45
District Hospital, Gorey	47	26	492	73
New Houghton Hospital	48	66	350	50
Welfare Home, Tipperary	48	40	270	33
St. Patrick's, Waterford	51	121	222	50
District Hospital, Castlecomer	56	29	346	49
St. Patrick's Hospital, Cashel	56	184	315	49
Welfare Home, Carlow	58	38	344	42
District Hospital, Dungarvan	59	30	326	37
Sacred Heart Home, Carlow	66	102	257	71
Welfare Home, Dungarvan	67	40	289	43
St. John's, Enniscorthy	71	196	270	58
Psychiatric and mental handicap hospitals and homes				
St. Canice's, Kilkenny	39	164	485	127
St. Senan's, Enniscorthy	45	227	424	96
St. Otteran's, Waterford	51	158	635	138
St. Luke's, Clonmel	64	313	492	110
St. Dympna's, Carlow	64	171	654	166
Other hospitals and homes				
Orthopaedic, Kilkreene	70	60	884	186

Table B.7
Energy use in Southern Health Board hospitals and homes, 1993

Hospital/home	Total energy use GJ/100m³	Beds	Energy cost per bed £	Energy use per bed GJ/bed
Acute hospitals				
General Hospital, Mallow	34	69	1,138	172
Cork University Hospital	66	566	737	139
General Hospital, Bantry	67	92	728	115
General Hospital, Tralee	80	354	658	150
Geriatric hospitals and homes				
District Hospital, Dingle	38	47	435	52
District Hospital, Fermoy	42	80	442	47
District Hospital, Cahirciveen	43	49	379	45
Our Lady of Lourdes, Midleton	45	90	524	61
District Hospital, Youghal	52	35	439	57
District Hospital, Killarney	53	42	379	47
Welfare Home, Fermoy	57	28	355	43
District Hospital, Kenmare	58	26	379	49
District Hospital, Listowel	59	64	449	56
Mount Carmel, Clonakilty	61	197	289	50
District Hospital, Kinsale	66	40	360	64
District Hospital, Kanturk	68	52	363	58
County Home, Killarney	69	240	257	45
Welfare Home, Youghal	72	39	254	38
District Hospital, Castletownbere	74	33	316	49
District Hospital, Skibbereen	75	40	328	42
St. Finbarr's, Cork	79	443	467	110
District Hospital, Macroom	82	38	276	36
District Hospital, Millstreet	87	26	422	68
Psychiatric and mental handicap hospitals and homes				
St. Stephen's, Glanmire	49	311	572	80
Our Lady's Hospital, Cork	49	213	568	118
Heatherside Hospital, Buttevant	54	115	489	69
St. Finan's, Killarney	54	300	372	90
Mount Alvernia Hospital	63	118	377	58
St. Raphael's, Youghal	83	212	368	72
St. Anne's Psychiatric Unit, Skibbereen	83	28	378	59
County Hospital, Midleton	95	40	373	51
Other hospitals and homes				
Erinville Hospital, Cork	63	73	609	89
St. Mary's, Gurranebraher	108	164	693	194

Table B.8
Energy use in Western Health Board hospitals and homes, 1993

Hospital/home	Total energy use GJ/100m³	Beds	Energy cost per bed £	Energy use per bed GJ/bed
Acute hospitals				
County Hospital, Roscommon	60	116	791	109
University College Hospital, Galway	60	486	719	174
Regional Hospital, Merlin Park	63	319	935	202
General Hospital, Castlebar	80	226	966	190
Geriatric hospitals and homes				
Arus Deirbhle & District, Belmullet	33	82	374	54
Home for the Aged, Claremorris	37	40	289	30
Home for the Aged, Tuam	40	25	375	50
Home for the Aged, Newcastle	46	40	341	46
Home for the Aged, Clifden	46	38	310	50
Home for the Aged, Carraroe	47	40	338	46
District Hospital, Clifden	51	30	391	60
Home for the Aged, Westport	57	40	331	42
Home for the Aged, Ballina	57	40	287	40
Home for the Aged, Boyle	62	60	650	83
St. Brendan's Home, Loughrea	63	260	324	51
Home for the Aged, Castlerea	65	40	436	58
District Hospital, Swinford	67	40	627	95
Sacred Heart Home, Roscommon	71	230	354	57
District Hospital, Ballina	72	60	662	108
Sacred Heart Home, Castlebar	84	300	286	61
Psychiatric and mental handicap hospitals and homes				
Toghermore Training Centre, Tuam	28	38	625	63
Arus Attracta, Swinford	42	186	771	136
St. Patrick's, Castlerea	45	90	1,092	183
St. Mary's, Castlebar	58	344	666	150
St. Brigid's, Ballinasloe	59	600	694	152

Table B.9
Energy use in voluntary hospitals, 1993

Hospital/home	Total energy use GJ/100m³	Beds	Energy cost per bed £	Energy use per bed GJ/bed
Acute hospitals				
National Children's Hospital, Harcourt St.	n.a.	70	799	123
St. Michael's Hospital, Dún Laoghaire	n.a.	105	809	119
The Children's Hospital, Temple St.	n.a.	128	1,095	246
Adelaide Hospital, Dublin	18	180	930	87
South Infirmary-Victoria Hospital, Cork	22	191	626	76
Portiuncula Hospital, Ballinasloe	41	210	908	116
St. John's Hospital, Limerick	51	104	663	84
Our Lady's Hospital, Crumlin	59	257	875	188
St. Vincent's Hospital, Elm Park	60	482	993	213
Beaumont Hospital, Dublin	65	630	834	162
The Mercy Hospital, Cork	66	255	423	90
Our Lady of Lourdes, Drogheda	69	367	748	145
St. James's Hospital, James's St.	69	588	1,318	264
Mater Misericordiae Hospital, Eccles St.	72	489	1,399	285
Geriatric hospitals and homes				
Royal Hospital, Donnybrook	61	224	466	75
Psychiatric and mental handicap hospitals and homes				
St. Mary's Hospital, Baldoyle	42	93	357	89
St. Vincent's Hospital, Fairview	45	94	872	132
Other hospitals and homes				
NMRC, Dún Laoghaire	n.a.	125	964	121
Skin and Cancer Hospital, Hume Street	25	30	901	131
Rotunda Hospital, Dublin	33	194	683	137
National Maternity Hospital, Holles Street	40	206	749	62
Royal Victoria Eye and Ear, Dublin	43	80	1,304	154
St. Mary's Orthopaedic Hospital, Cappagh	52	120	879	220
Coombe Women's Hospital, Dublin	56	237	503	109
St. Luke's Hospital, Rathgar	67	110	1,070	303