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BEST PRACTICE PROGRAMME

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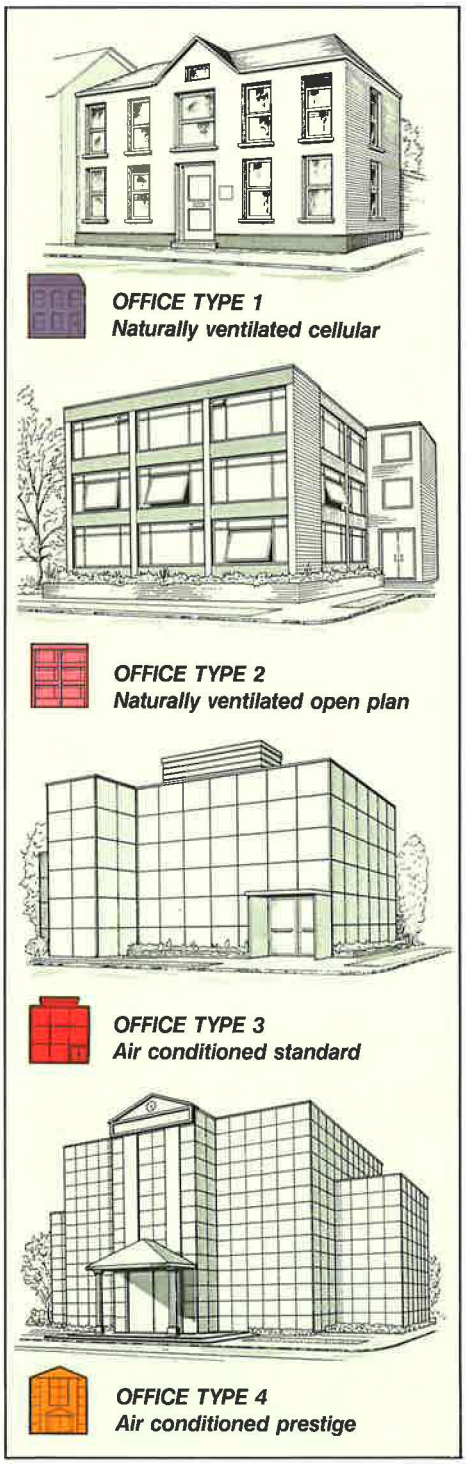
Energy Consumption Guide

ENERGY EFFICIENCY IN OFFICES

A technical Guide for owners and single tenants



OFFICE TYPE 1
Naturally ventilated cellular

OFFICE TYPE 2
Naturally ventilated open plan

OFFICE TYPE 3
Air conditioned standard

OFFICE TYPE 4
Air conditioned prestige

This Guide is intended for technical people in owner occupier and head tenant organisations which manage entire office buildings and pay all their energy costs directly.

The information in this Guide is based upon data collected from some 200 office buildings which were considered for inclusion in the Energy Efficiency Office (EEO) series of Good Practice Case Studies, and another 200 buildings from which energy survey information was available.

Annual delivered energy consumption can range from under 100 to over 1000 kWh/m^2 of treated floor area, costing from £4/m^2 to £40/m^2 or more at 1990 prices. Of this, fossil fuel (normally gas) averages 200-250 kWh/m^2 and £3/m^2 (table 1).

In contrast to fossil fuel use, electricity use varies more widely, the most significant influences being:

- Open plan designs, which normally make more use of artificial lighting.
- Air conditioning: fans and pumps usually need almost twice as much as refrigeration.
- Mainframe computer rooms and their air conditioning.

Energy use by general office equipment is significant, but seldom as high as people expect, and never as high as the load specified on the actual equipment.

Larger offices often contain more equipment and operate for longer hours, adding to energy use. However, their higher consumption and better load factors can give them more advantageous tariffs which lower their unit fuel costs.

Ideally each office would have its individual energy consumption and cost target, but that is beyond the scope of this Guide. Instead average and good practice patterns of energy use and cost are outlined for the four typical office types sketched in the adjoining column:

1 Naturally ventilated, largely cellular.
2 Naturally ventilated, largely open plan.
3 Air conditioned, largely open plan.
4 Prestige air conditioned with computer suite, restaurant etc.

Energy costs in Good Practice offices are usually 30-50% below average levels, as Case Studies and other publications in the EEO Best Practice programme demonstrate (Fig 1). Many savings measures are proven and cost effective when undertaken as part of ongoing new construction, refurbishment and alteration work. Some of them, and particularly improvements to lighting, controls and management, are also often viable in their own right.

Energy Efficiency Office
DEPARTMENT OF ENERGY

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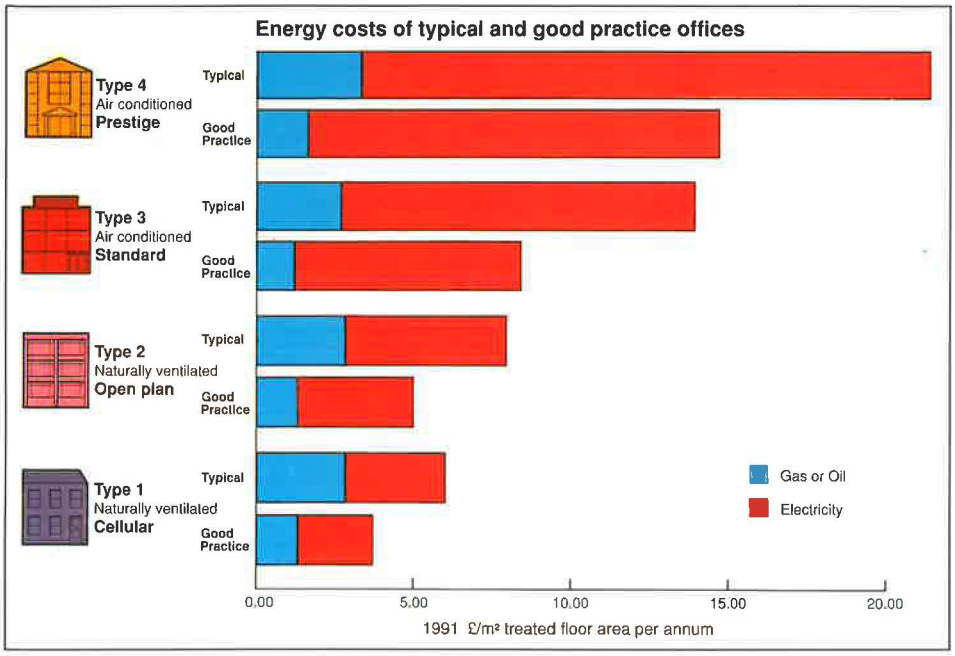

Fig. 1 Average and good practice energy costs for the four different offices

The four different office types

The patterns of energy use and cost in the four types of office give some reference points against which you can judge your own buildings.

Individual offices may contain features of more than one of the four typical examples; in this case, comparisons can be made against a combination of figures from the different office types.

Annual electricity and fossil fuel use and costs are shown for:

- a "typical" example near the middle of the consumption range for the national office stock as a whole, and
- a "good current practice" building, well managed and using simple, readily available and proven technologies and design features.

The values given for "good current practice" are drawn from energy consumption data in Case Studies of energy efficient offices. The buildings and refurbishments featured in the Case Studies, published under the EEO Best Practice programme, are already several years old and would perform even better with today's plant, lights and controls. The examples do not deal explicitly with all-electric offices which, like for like, usually have rather lower annual energy consumptions but higher energy costs.

Savings are not only possible within a given building type: in favourable circumstances one may also be able to achieve a less energy-dependent design. The Case Studies of Refuge House, NFU Mutual and Avon Group, and Hereford and Worcester County Hall (EEO Good Practice Case Study numbers 20, 13 and 17 respectively) demonstrate this by reducing the need for electric lighting and air conditioning in what could have been a fully air conditioned design, whilst still offering prestige offices. Instead, use of air conditioning and electric lighting is minimised through a 'mixed mode' approach, which uses natural ventilation and daylight when and where possible, with much of the building using full air conditioning only for limited periods of the year.

THE DIFFERENT OFFICES

OFFICE TYPE 1
Naturally ventilated cellular

A fairly small, simple building with largely individual offices, and perhaps a few group spaces. Daylight is good while artificial lighting is usually less intense than in the other three office types, and easily controlled by individual switches by the doors. There are few common facilities and catering is usually restricted to the odd sink and kettle.

OFFICE TYPE 2
Naturally ventilated open plan

Largely open planned but with some cellular offices and special areas such as conference rooms. Light levels and lighting power tend to be higher, and with deeper plans daylight is less available. Lights also tend to be switched in large groups. There is often more office equipment, vending machines etc..

OFFICE TYPE 3
Air conditioned

Similar in occupancy and planning to Type 2, but usually larger and with a deeper floor plan and tinted or shaded windows which reduce the availability and use of daylight still further. The air conditioning system may be either all-air (for example variable air volume) or air/water (for example induction units or fan-coils).

OFFICE TYPE 4
Prestige air conditioned

Larger still, and often a national or regional head office, with a computer suite, a restaurant serving hot lunches for at least half the staff, and a generally higher level of equipment, facilities and information technology. Hours of use are also extended owing to the more diverse pattern of occupation.

Note on hours of use

Energy use is sometimes also standardised for hours of occupancy or plant operation, but linear corrections tend to introduce more discrepancies than they resolve. Most offices are intensively occupied for about ten hours a day, five days per week, with another hour or two at the beginning or end of the day for cleaning. At other times, only a few people remain (except perhaps in special areas such as data processing) and only local heating and lighting should be required. If everything stays on, that is a problem to be exposed, not concealed by increasing the energy target. It is often more instructive to state the reasons why the intensity of use is high (eg: regular Saturday or multi-shift operation) or low (eg: if the building is partly empty), than to make arithmetical corrections.

NFU Mutual and Avon Group Head Office designed to avoid air conditioning in most areas

Notes on floor area

To compare buildings, it is convenient to standardise annual consumptions in terms of energy use per unit floor area. Here we use treated area (see below). A paper on floor area measurements and definitions is available from BRECSU upon request.

As simple working rules and excluding car parks, attics, and large stores, ratios of treated to gross and nett lettable area for reasonably space efficient offices will be in the region of:

	Treated to gross	Nett to treated	Nett to gross
Type 1	95%	80%	76%
Type 2	95%	80%	76%
Type 3	90%	80%	72%
Type 4	85%	80%	68%

These figures should be used for initial checks only: for more detailed comparisons measurement of your own buildings is recommended: individual offices can easily deviate by ±5% from these norms, and areas obtained from files or colleagues are often inaccurate.

Short Notes on the Measurement of Floor Area

Gross	Total building area measured inside external walls
Nett	Gross area less common areas and ancillary spaces. Agent's lettable floor area.
Treated	Gross area less plant rooms and other areas (eg stores, covered car parking and roof spaces) not directly heated.

What can I do?

Understanding how energy is used in your building is the first major step to achieving energy savings.

- Collect your energy use and cost data for the past year or more.
- Obtain or measure the floor area of your buildings. If only gross or nett areas are available, use the conversion factors on page 2 for initial estimates.
- Consider how the overall annual electricity and fossil fuel use relates to the examples given, and if the monthly energy consumption pattern relates sensibly to the weather and to the pattern of use.
- Try to understand features of your buildings which might cause the consumption levels to be particularly high or low. If your electricity is on a DAY/NIGHT tariff the information can be invaluable in helping to estimate night-time loads such as in computer suites.
- Concentrate at first on the buildings or features which are particularly high energy consumers or offer the greatest potential for energy saving.
- If necessary, install and read meters to check the amount and pattern of energy consumption by major individual items, such as computer rooms, computer air conditioning, kitchens, chillers and large fans.
- Regularly review the information provided by meters.
- Prioritise the measures. Simple, highly cost effective measures can sometimes create cash reserves from utility budgets to help finance subsequent projects.
- Make use of opportunities. The best time to implement energy saving measures is on the back of an essential project, for example maintenance, alteration, re-equipment and refurbishment. Don't miss the chance.
- Keep it simple. Don't use any more, or more complex, technology than necessary to solve the problem effectively. Don't create unnecessary maintenance or management burdens.
- Refer to other Good Practice Guides as necessary.
- Carry out a full energy audit and survey. Refer to the CIBSE Applications Manual on Energy Audits and Surveys for guidance. The Manual is described further in Good Practice Guides 27 and 28.
- Seek professional advice if you require it.

Summary

Energy efficiency in offices is not only — or even mainly — about heating: electricity costs usually predominate, and offer good scope for cost effective energy savings.

Heating

For heating itself, better insulation is not the whole story. Many buildings, including well insulated ones, cost more to heat than they should owing to inefficiencies in plant, control and management. The situation is often worsened by oversized boiler plant, particularly when it runs poorly controlled in summer to make small amounts of hot tap water.

Air Conditioning

In air conditioned offices, people often regard chiller efficiency as paramount. However, with all-air systems the fans usually cost more to run, and attention to fan power and control can be more rewarding. Excess running hours often lead to unseen — and often undetected — waste. Hours-run meters on important items of plant can be helpful and parts of the office which are regularly used outside normal hours should be separately zoned and controlled.

Lighting

Lighting is often the largest individual item of energy cost, varying over a wide range depending upon installed power and hours of operation. In cellular offices people can easily use available daylight — as they do at home — and should be encouraged to do so. In open plan offices the situation is more complex and the lights often tend to stay on all day, whether or not they are required. New lamps, reflectors and controls can often give major savings, particularly for the lights which burn for the longest hours.

Computer Suites

Mainframe computer suites can sometimes account for more than half the entire energy bill. Their air conditioning often runs inefficiently and offers scope for substantial savings through improved control and management. If possible, power supplies to the computer and its air conditioning should be separately metered and regularly monitored: if the ratio of air conditioning to computer consumption is more than 0.6, there may well be scope for improvement. Unified control should be considered for installations made up from independent packaged units.

Office Equipment

Although office equipment often uses less energy than people expect, averaging perhaps one-third of the labels on the back, leaving it on unnecessarily — and particularly overnight — should be discouraged. Purchasing decisions should take account of energy requirements: some brands and types of equipment are considerably more energy efficient than others, and their lower heat output also helps to reduce both the need for air conditioning and the cooling loads it has to serve.

Good Management

Good management is essential. Energy efficiency is not an end in itself, but a reward for meeting the organisational and user needs in an effective and professional manner. Important aspects include:

- Matching performance standards and operating hours to user needs.
- Regular checking of control functions.
- Regular reviews of fuel bills and sub-meter readings.
- Good maintenance of plant.
- Attempting to site office equipment with high heat outputs in places where it does not unnecessarily increase cooling loads or the need for air conditioning, for example in areas with separate local air extract systems.

Building Energy Management Systems

When considering advanced electronic controls and Building Energy Management Systems (BEMS), don't take them for granted: the systems are an aid to good management, not a substitute for it.

Tariffs

Finally, you may be paying more for your fuel, and particularly your electricity, than you should. More economical tariffs may be available (for example DAY/NIGHT if you have a large night-time computer room load). You may also be able to take steps to improve power factors or maximum demand profiles.

This is the first time that yardsticks for detailed energy uses in offices have been presented in the present form. It is possible that ongoing studies of further Good Practice Case Studies, combined with trends in office building, will lead to future revisions of the yardsticks for both typical and "good practice" offices.

DATA SHEET — TABLE 1

Annual Delivered Energy Consumption of Typical and Good Practice Offices for the four office types (kWh/m² treated area)

	Type 1		Type 2		Type 3		Type 4	
End Use	Typical	Good Practice	Typical	Good Practice	Typical	Good Practice	Typical	Good Practice
Heating + Hot Water — gas or oil	200	95	200	95	222	100	259	124
Catering gas	0	0	0	0	0	0	14	8
Catering electricity	3	3	5	4	7	7	14	12
Refrigeration	0	0	0	0	33	17	41	24
Fans, pumps, controls	3	3	6	5	61	39	71	47
Lights	26	16	53	32	67	39	82	47
Office equipment (variable)	11	11	16	16	22	22	29	29
Computer room (variable)	0	0	0	0	0	0	106	88
Other	5	4	5	4	11	9	18	14
Total gas or oil	200	95	200	95	222	100	273	132
Total electricity	48	36	85	61	202	132	361	261
Total delivered energy consumption	248	131	285	156	424	232	634	393

Annual Energy Costs (1990-91 £/m² treated area)

	Type 1		Type 2		Type 3		Type 4	
End Use	Typical	Good Practice	Typical	Good Practice	Typical	Good Practice	Typical	Good Practice
Heating + Hot Water — gas or oil	£2.80	£1.33	£2.80	£1.33	£2.67	£1.20	£3.11	£1.48
Catering gas	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.17	£0.10
Catering electricity	£0.21	£0.17	£0.32	£0.25	£0.43	£0.37	£0.71	£0.59
Refrigeration	£0.00	£0.00	£0.00	£0.00	£1.83	£0.92	£2.06	£1.18
Fans, pumps, controls	£0.21	£0.17	£0.38	£0.32	£3.36	£2.14	£3.53	£2.35
Lights	£1.71	£1.03	£3.16	£1.89	£3.67	£2.14	£4.12	£2.35
Office equipment (variable)	£0.68	£0.68	£0.95	£0.95	£1.22	£1.22	£1.47	£1.47
Computer room (variable)	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£5.29	£4.41
Other	£0.34	£0.27	£0.32	£0.25	£0.61	£0.49	£0.88	£0.71
Total gas or oil	£2.80	£1.33	£2.80	£1.33	£2.67	£1.20	£3.28	£1.58
Total electricity	£3.15	£2.33	£5.12	£3.66	£11.12	£7.27	£18.06	£13.06
Total energy cost	£5.95	£3.66	£7.92	£4.99	£13.79	£8.47	£21.34	£14.64

Further information on this or other buildings-related projects, please contact: Enquiries Bureau, Building Research Energy Conservation Support Unit (BRECSU), Building Research Establishment, Garston, Watford, WD2 7JR. Tel No. 0923 664258. Fax No. 0923 664097.

For further information on industrial projects, please contact the Energy Efficiency Enquiries Bureau, Energy Technology Support Unit (ETSU), Building 156, Harwell Laboratory, Oxon OX11 0RA. Tel No: 0235 436747. Telex No: 83135 . Fax No: 0235 432923.

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