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Curbing the growth in UK commercial energy consumption

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The rate of growth in UK commercial energy consumption since the early 1970s has been approximately three times greater than in the domestic sector. Consumption is projected to continue growing faster than in all other sectors except transport. Increasing floor space has been accompanied by rising energy intensity in many commercial buildings. In the office sector, demand for air conditioning has grown rapidly, and this is associated with a dramatic increase in CO_2 emissions. Significant cost-effective CO_2 savings have been identified in the sector, using readily available technologies. The Climate Change Levy, and questions of comfort, health and productivity among workers, are pushing energy issues up the agenda for many businesses. However positive action is impeded by barriers in the commercial property sector, such as conflicts of interest between landlords and tenants, poor information and professional conservatism. These barriers act to limit energy efficiency investment, to the detriment of building occupants and wider society for generations to come. These problems will limit the efficacy of existing initiatives that aim to curb commercial sector energy use. The Association for the Conservation of Energy considers that new legislation is needed. This would require freeholders to improve the energy efficiency of their new and existing buildings, in consultation with occupiers and/or unions. Further research is needed on options for sharing the costs and benefits with occupiers and/or energy service companies.

Keywords: air conditioning, building stock, climate change, energy consumption, energy efficiency, offices, regulations, sustainability, UK

Depuis le début des années 1970, le taux de croissance de la consommation énergétique commerciale au Royaume-Uni a été près de trois fois supérieure à celui de la consommation du secteur domestique. Il devrait continuer à croître plus vite que dans tous les autres secteurs, à l'exception des transports. L'augmentation de la surface utile par personne s'est accompagnée d'un accroissement de l'intensité énergétique dans de nombreux bâtiments commerciaux. Dans le secteur des immeubles de bureaux, la demande en climatisation s'est accélérée et s'est donc traduite par une augmentation spectaculaire des émissions de CO_2. Les technologies existantes permettent de lutter avec efficacité et à moindre coût contre ces émissions. Le problème des changements climatiques, ainsi que les questions de confort, d'hygiène et de productivité chez les travailleurs, mettent en avant les questions d'énergie dans de nombreuses entreprises. Or, des actions positives sont confrontées à des obstacles dans le secteur de la propriété commerciale; c'est le cas des conflits d'intérêts entre propriétaires et locataires, de la médiocrité de l'information et du conservatisme professionnel. Ces obstacles gênent les investissements axés sur une amélioration du rendement énergétique, au détriment des occupants des bâtiments et d'une plus grande société pour les générations à venir. Ils iront à l'encontre des initiatives existantes dont l'objectif est de freiner la consommation de l'énergie dans le secteur commercial. L'Association pour la Conservation de l'Énergie estime que cette nouvelle législation est nécessaire. Il faudrait pour cela que les propriétaires fonciers améliorent l'efficacité énergétique de leurs bâtiments, anciens et nouveaux, en concertation avec les occupants et/ou leurs syndicats. Il faut conduire d'autres recherches sur les options concernant le partage des coûts et des bénéfices avec les occupants et (ou) avec les entreprises de services énergétiques.

Mots clés: climatisation, stocks pour le bâtiment, changement climatique, consommation énergétique, efficacité énergétique, bureaux, règlements, durabilité, Royaume-Uni

Introduction

Rapidly increasing energy consumption in the UK commercial sector has been neglected in official statistics and in the application of energy efficiency policies and programmes. The rate of growth in final energy demand in the commercial sector from 1973–1996 was approxi-

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mately three times greater than in the domestic sector (DTI, 1997) and consumption is projected to continue growing faster than in all other sectors except transport (DTI, 2000). The rate of increase equals or exceeds growth in the contribution the sector makes to the UK economy (DTI, 1997; EC, 1997). Due to heavy dependence on electricity, for air conditioning, lighting, IT equipment (and even for space heating in the retail sector), the sector is an inefficient energy consumer in terms of natural resources. In official statistics, which combine private and public services, CO_2 emissions have been kept in check by changes in the electricity supply sector, but this good fortune is expected to end within 10 years.

Growth in energy consumption is partly explained by rapid expansion in floor space, with offices, for example, occupying almost twice as much floor space in 1994 as in 1970 (Pout *et al.*, 1998). There has also been an increase in specific energy demand in some types of commercial premises. Demand for air conditioning has grown rapidly, and this is associated with a dramatic increase in CO_2 emissions (DETR, 2000a). Significant cost effective CO_2 savings have been identified in the commercial sector, using readily available technologies (BRE, 1996a, b).

Barriers exist to energy efficient construction and retrofitting in the commercial sector. In offices, energy costs represent a significant proportion of service charges, but occupiers are overwhelmingly tenants and pay on the basis of occupied area. They are therefore not *aware* of their energy consumption. Furthermore, almost half of the UK commercial property stock is owned by large institutional investors (Callender and Key, 1997) who take a 'hands-off' approach to managing their assets (Gibson and Lizieri, 1999). They have been unconcerned about energy consumption in their properties, because they simply pass the cost on to the occupiers. The benefits of investing in energy efficiency can include healthier, more comfortable and more productive workforces (Fisk and Rosenfeld, 1998; Leaman and Bordass, 1999) lower occupancy costs and a reduced contribution to climate change. These benefits are intangible, or pooorly understood, by commercial property investors, owners and professionals.

Therefore the Association for the Conservation of Energy proposes legislation that would require major property freeholders (insurance companies, pension funds and others) to improve the energy efficiency of their buildings. Every 5 years or at the time of rent review (every 5 years normally), sale or re-letting, an energy audit should be required, with the stipulation that the energy performance of the building is to be brought up to an acceptable standard within a fixed time-frame. Consultation with occupiers and/or unions should be required. Options for sharing the costs and financial benefits with occupiers and/or energy service companies are a subject for further research. The insurance industry might be expected to take a lead in backing such a proposal, given their frequently expressed concern over the impacts of weather related insurance claims, and their stated commitment to helping combat climate change (UNEP, 1995, 1996).

The scale of the problem

Energy efficiency policies and programmes in the UK have focussed on the domestic and industrial sectors, and have tended to overlook the service sector. This lack of specific interest in the sector is reflected in the way energy consumption data are compiled by the Department of Trade and Industry (DTI).[1] In the annual Digest of UK Energy Statistics (DTI, 1999) the commercial sector is included in 'other final users', along with public administration and agriculture.

Energy consumption by these 'other final users' has *not* been increasing rapidly compared to other sectors. From 1973–1998 there was a 16.6% increase in final energy consumption, compared to 22.5% growth in the domestic sector and 62.5% growth in the transport sector. Energy consumption in the industrial sector fell by 46.3% over the same period (DTI, 1999). However, this aggregation of 'other final users' masks the fact that virtually all of the increase in this sector has been in *commercial* services (private offices, retail, leisure, hospitality and warehouses).

Growth in energy consumption

In commercial services final energy consumption grew by 65% from 1973 to 1996, compared to only 1% growth in public sector services energy consumption (DTI, 1997). Table 1 breaks down the growth in 'other final users' into public services, commercial services and agriculture, and apportions the growth to increased output in each sector in excess of gains in energy intensity (arising from improved efficiency and structural change). This rapid growth in commercial sector energy consumption reflects expansion in floor space, and increased heating, lighting, IT and air conditioning (AC) loads in individual buildings. These factors are examined in more detail below.

Growth in service sector energy consumption has been particularly marked in the 1990s. Table 2 compares annual growth in final energy consumption in major sectors in the UK, with projections to 2010 as prepared by the European Commission (EC) Directorate General (DG) for Energy (EC, 1997) and the DTI (2000). While the EC expects the service sector to have by far the most rapid growth of any sector, the DTI expects it to be second only to the transport sector.

Most critically, there has been no improvement in sectoral energy intensity (delivered energy consumption divided by contribution to GDP) in the UK service sector since the late 1980s (DTI, 1997). This is to say that despite the rapid growth in economic output from the service sector, energy consumption has increased just as rapidly. According to the EC DG for Energy there has actually been a

Table 1 Factors affecting service sector final energy consumption 1973 to 1996

	PJ		
	Commercial services	**Public services[a]**	**Agriculture**
1973 consumption	314.0	372.6	92.1
1996 consumption	519.2	376.8	58.6
Change due to increase in output	+309.8	+96.3	+33.5
Change due to efficiency improvement and structural change	−104.7	−92.1	−67.0
Net change	+205.2	+4.2	−33.5
Change 73-96	+65%	+1%	−36%

[a]In the original table this is labelled 'private services' but the text makes it clear that this is a misprint.
Source: DTI (1997) (adapted from Table 8.6).

Table 2 Annual growth in final energy demand by sector in the UK, 1990 to 2010

	EC 1990–2000	EC 1990–2010	DTI 1995–2010
Services	5.5%	3.7%	1.4%
Industry	0.2%	0.8%	0.5%
Residential	0.4%	0.4%	0.8%
Transport	1.0%	1.3%	1.9%

Source: EC (1997), DTI (2000).

Table 3 Percentage energy conversion losses by sector in 1996

Sector	Conversion losses (%)
Services	43.3
Industry	37.8
Domestic	33.0
Transport	11.8

Source: DTI (1997).

significant deterioration in the energy intensity of the UK tertiary sector. In 1995 it consumed 30% more energy per unit of value added to the economy than in 1990. By 2005 38% more energy will be consumed per unit of value added than in 1990 (EC, 1997). This is partially explained by a rapid fall in value added in the public sector, but also reflects rising energy intensity in some private commercial sector buildings.

Perhaps the most worrying trend is the rate of increase in electricity consumption in the service sector. While *total* energy use in the sector defined as 'other final users' by the DTI (i.e. public plus private services and agriculture) increased by 16.6% from 1973 to 1998, *electricity* use more than doubled (DTI, 1999). This reflects growing demand for high levels of illumination, heating and cooling, and increased use of IT equipment. Because of the high electricity use in the sector, conversion losses are higher in the services sector than in any other. This is demonstrated in Table 3.

This means that the sector is wasteful in terms of natural resources, and which has ramifications for CO_2 emissions from the sector. Growth in CO_2 emissions from the service sector (public plus private) have been kept in check by fuel switching from coal to gas in buildings and in the electricity generation sector. The DTI now projects total emissions from power generation will be 4% lower in 2010 than 2000, and will then increase slowly from 2010 (DTI, 2000). This contrasts with the predictions made in 1995, for an 11% increase in emissions in the period 2000 to 2010, followed by a 19% increase in the subsequent decade to 2020 (DTI, 1995). The more optimistic current projections reflect a return to the 'dash for gas' seen in the 1990s, a heroic threefold increase in power generation from renewables, and a significant ongoing role for nuclear power in the next 10 years.

If there is reason to question these assumptions on the fuel mix in electricity generation, then there is immediate cause for concern. Furthermore, from 2010 emissions are set to rise even under these assumptions, and they will rise particularly quickly in the rapidly expanding (and electricity intensive) *private* commercial sector.

Growth in floor space

Figure 1 demonstrates the rapid growth in commercial floor space since the early 1970s in England and Wales. From 1970–1994 retail floor space increased by 54%, office floor space almost doubled, and warehouse space increased by a massive 114% (Pout *et al.*, 1998).

Offices, retail outlets and warehouses are the focus of attention here, though similar trends are evident in hotels/

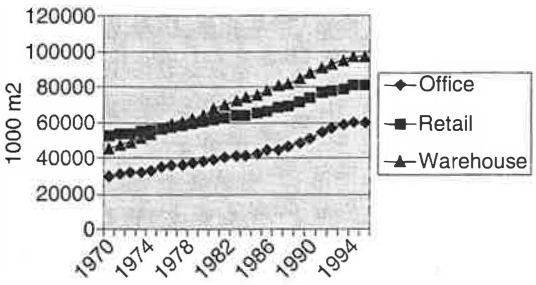

Figure 1 Growth in commercial office, retail and warehouse floor space in England and Wales 1970 to 1994 (data from Pout *et al.*, 1998)

leisure, communications and sports/entertainment subsectors. Hotels are excluded from further analysis because the leisure industry has recently signed a voluntary energy efficiency agreement, in exchange for relief on taxation under the government's Climate Change Levy (EIBI, 2000). This was noteworthy for being the first voluntary agreement to relate directly to energy saving in buildings, rather than in industry. Furthermore, 90% of leisure businesses are small and medium sized pubs, restaurants and hotels, whereas the focus here is on barriers to energy efficiency that exist in properties owned primarily as investment assets. Communications and sports/entertainment are relatively minor energy users.

Breakdown of energy consumption and CO_2 emissions

Recent DETR funded research on energy use in non-domestic buildings (Pout *et al.*, 1998) provides a breakdown of energy use and CO_2 emissions by type of occupier, end use and fuel type. Data for commercial offices, retail outlets and warehouses are presented in Table 4. Table 5 presents the proportion of total CO_2 emissions by end use in each sector. These estimates for 1994 are based on extensive energy audits and national building stock data from the Valuation Office, and are therefore quite reliable and complete. Note that CO_2 data include emissions from power stations.

Table 4 demonstrates that the combined CO_2 emissions from these three categories of non-domestic buildings amount to over 33 million tonnes per annum. This is equivalent to 9 million tonnes of carbon (MtC). For reference, total UK CO_2 emissions in 1990 amounted to 168 MtC (DETR, 2000b). *Total* commercial sector emissions in 1993 were 15.5 MtC (BRE, 1996a). The CO_2 emissions from the retail sector are particularly high. The large electricity demand for lighting in shops, and surprisingly large electricity demand for heating, account for these high emissions. Use of electricity for space heating is highly inefficient in terms of primary energy consumption and emissions.

Energy consumption for cooling is particularly high in offices. Again this is powered by electricity, resulting in high CO_2 emissions. Electricity demand for cooling is expected to increase rapidly in coming years. According to Pout *et al.* (1998):

> Only a small proportion of service sector floor area currently has air conditioning plant fitted and ... newer premises are more likely to be air conditioned. These factors indicate that cooling energy use may increase substantially in the future (p. 63).

This issue is discussed in detail below.

Table 4 Energy consumption and CO_2 emissions in the UK commercial office, retail and warehouse building stock in 1994

	Commercial offices			**Retail**			**Warehouses**		
	Fossil fuels (PJ)	**Electricity (PJ)**	**CO_2 (kT)**	**Fossil fuels (PJ)**	**Electricity (PJ)**	**CO_2 (kT)**	**Fossil fuels (PJ)**	**Electricity (PJ)**	**CO_2 (kT)**
Heating	46	5	3680	46	15	4667	18	2	2931
Light	–	16	2238	–	44	5373	–	15	3071
Cooling	–	11	1319	–	4	721	–	22	658
IT	–	12	1031	–	3	390	–	2	459
Hot water	5.0	0	469	7	2	610	3	0.6	109
Catering	3.0	3	370	3	5	1957	–	1	285
Small power	–	2	250	–	5	643	0.1	2	335
Process	–	3	7	–	3	352	0.6	6	665
Other	–	2	184	–	2	378	–	–	1
Unknown	–	0.3	121	–	1	77	–	–	–
Total	**54.0**	**56**	**9669**	**55**	**82**	**1523**	**22**	**50**	**8515**

Source: Pout *et al.* (1998) (adapted from Tables 15 and 16).

Table 5 CO_2 emissions by end use in commercial buildings

	% of total CO_2 emissions		
	Commercial offices	**Retail**	**Warehouses**
Heating	38	31	34
Light	23	35	36
Cooling	14	5	8
IT	11	3	5
Hot water	5	4	1
Catering	4	13	3
Small power	3	4	4
Process	0	2	8
Other	2	2	0
Unknown	1	0	0
Total	**100**	**100**	**100**
	(9669 kT CO_2)	**(15 237 kT CO_2)**	**(8515 kT CO_2)**

Source: Pout *et al.* (1998) (adapted from Tables 15 and 16).

Cost effective CO_2 savings

Using readily available and cost effective technologies to save energy in commercial buildings in the UK would save 1.2 to 2.5 MtC per annum (8 to 16% of the total commercial sector CO_2 emissions) (BRE, 1996a). The higher figure assumes that electricity is generated from coal, and the lower figure assumes efficient gas fired generation. Discount rates of 8 or 15% were applied. The measures include the following:

- Condensing natural gas boilers
- Compact fluorescent lamps
- Low energy computing equipment and accessories
- Thermostatically controlled radiator valves
- Improved design and use of air conditioning systems
- Replace electric room heaters with natural gas room heaters
- Loft insulation
- Cavity wall insulation
- Hot water tank lagging
- Use of night blinds and motor controllers in commercial refrigeration.

A further 0.9 to 3.4 MtC per annum could be saved in commercial/public sector buildings through cost-effective use of small scale combined heat and power (CHP) (BRE, 1996b). The range reflects assumptions as to how displaced electricity is generated (coal or gas) and choice of discount rate (8 or 15%).

It should be stressed that much greater carbon savings are technically possible, but these estimates refer only to options that save businesses money and are readily available.

Energy use in offices

In the economy as a whole it is generally the case that new investments will be more energy efficient than whatever they replace. Boilers, car engines, industrial machinery, houses and household appliances have all followed this pattern. Many new office buildings go against this trend, primarily because of the rising use of AC, plus demand for higher levels of heating and illumination.

The Department of the Environment, Transport and the Regions' Energy Efficiency Best Practice Programme has studied typical and good practice energy consumption in four types of offices (DETR, 2000a). The office types are as follows:

(1) Naturally ventilated cellular

(2) Naturally ventilated open-plan

(3) Air-conditioned, standard

(4) Air-conditioned, prestige

Table 6 presents good practice and typical energy consumption for these office types and demonstrates the following:

- A typical prestige office consumes 2.8 times more energy per unit of floor area than a typical naturally ventilated cellular building.[2]
- AC offices use substantially more energy than non-AC offices for equivalent services, e.g. lighting, heating and ventilation.

Table 6 Typical and good practice energy consumption in offices in the UK (MJ/m^2 treated floor area)

	Type 1		Type 2		Type 3		Type 4	
	Good practice	**Typical**	**Good practice**	**Typical**	**Good practice**	**Typical**	**Good practice**	**Typical**
Heating & hot water	284.0	543.6	284.0	543.6	349.2	640.8	358.2	723.6
Cooling	0	0	3.6	7.2	50.4	111.6	75.2	147.6
Fans, pumps and controls	7.2	21.6	14.4	28.8	108.0	216.0	129.6	214.2
Humidification	0	0	0	0	28.8	64.8	43.2	82.8
Lighting	50.4	82.8	79.2	136.8	97.2	194.4	104.4	216.0
Office equipment	43.2	64.8	72.0	97.2	82.8	111.6	82.8	115.2
Catering	7.2	10.8	10.8	18.0	18.0	21.6	72.0	86.4
Other electricity	10.8	14.4	14.4	18.0	25.2	28.8	46.8	54.0
Computer room[a]	0	0	0	0	50.4	64.8	313.2	318.6
Total	**403.2**	**738.0**	**478.8**	**849.6**	**810.0**	**1454.4**	**1252.8**	**2044.8**
Electricity as % of total	29%	26%	41%	36%	57%	56%	67%	63%

[a]Where appropriate. See endnotes 2 and 3.
Source: DETR (2000a).

- Typical offices use 60% to 90% more energy than offices using good practice.

Furthermore energy consumed for cooling, fans, computer rooms, humidification, pumps and controls all tends to be electricity. Therefore the CO_2 emissions are even more divergent between AC and naturally ventilated buildings. A typical prestige AC office emits almost 3–4 times as much CO_2 per unit of floor area as a typical naturally ventilated office.[3] Table 7 demonstrates that the difference between good practice and actual CO_2 emissions in AC offices is of roughly equal magnitude to *total* CO_2 emissions in a *typical* naturally ventilated office. Therefore if one is aiming to reduce total CO_2 emissions from the office sector, much greater savings are possible in AC offices than in traditionally ventilated buildings.

These observations are particularly pertinent given the rapid switch to air conditioning in new offices. Over half of new offices and a third of new retail premises built in the 1990s had AC. In the 1980s these proportions were 43% and 25%, and in the 1970s 36% and 22% (Pout *et al.*, 1998). If this trend continues, coupled with the rapid increase in floor area discussed earlier, energy consumption will continue on its rapid upward trajectory, outstripping growth in the contribution the sector makes to the economy.

Interestingly it appears that the public sector has been particularly influential in the shift towards air conditioning in office buildings. In the 1960s and 1970s, when AC was taking off in the UK, the public sector was perceived as a reliable source of tenants even during recessions, and

Table 7 CO_2 emissions per unit of floor area for four office types

	kgC/m^2–treated floor area							
	Type 1		**Type 2**		**Type 3**		**Type 4**	
	Good practice	**Typical**	**Good practice**	**Typical**	**Good practice**	**Typical**	**Good practice**	**Typcial**
Cooling, fans, pumps, controls & humidification	0.3	0.8	0.6	1.3	6.6	13.8	8.8	16.6
Heating & hot water	4.1	7.9	4.1	7.9	5.0	9.3	5.6	10.5
Lighting	1.8	2.9	2.8	4.8	3.4	6.9	3.7	7.6
Other[a]	2.2	3.2	3.4	4.6	6.2	8.0	17.7	21.7
Total	**8.3**	**14.8**	**11.0**	**18.7**	**21.3**	**38.0**	**36.8**	**56.4**

[a]Office equipment, catering, computer room (Types 3 and 4 only) and 'other'.
Source: DETR (2000a).

AC was seen as necessary to attract the public sector. At this time 'developing non-air-conditioned space seemed commercial suicide' (Guy, 1998, p. 269). This situation has since reversed, with the Department of the Environment, Transport and the Regions specifying stringent energy conservation and the avoidance of air-conditioning wherever possible within the civil estate. Hopefully this will encourage property developers to recognize the commercial potential of efficient, non-air-conditioned space (Guy, 1998).

Comfort, health and productivity

In manufacturing industry there is mounting evidence of a significant positive correlation between productivity and energy efficiency (Boyd and Pang, 2000). In the services sector, productivity in terms of worker output is a difficult concept to measure empirically. This has been overcome by measuring workers' perceptions of their own productivity, as it relates to their working environment. The first study of this kind, in 1987, reported on the causes of 'building sickness' (Wilson and Hedge, 1987), also known as 'sick building syndrome' or 'building related sickness'. Using a questionnaire survey of over 4000 workers in 46 buildings, the report found that 80% of workers experienced symptoms which they associated with being in their place of work. They found that 'air-conditioned buildings had consistently higher rates of sickness than buildings with either natural or mechanical systems of ventilation' (p. 3). Furthermore, perceptions of comfort were no greater in air-conditioned buildings. A lack of perceived control over one's local environment, plus an oppressive feeling of exclusion from the outside world which is associated with the deep plan structures that air conditioning facilitates, added to the dissatisfaction and perceived reduction in work productivity.

Leaman and Bordass (1999) have carried out subsequent surveys, which have confirmed and extended these conclusions. They warn that it is very difficult to isolate causes and effects in buildings:

> There is no such thing as an independent variable in a building! (p. 8)

Nonetheless,

> There is a consensus that indoor environment factors improve output, as well as a lot of evidence to show associations with a cluster of related factors such as perceived health, comfort and satisfaction. There are also data to show that some of the management, design and use characteristics which improve perceptions of individual welfare also contribute towards better energy efficiency, thereby closing the loop on a potential 'virtuous' circle. (p. 7)

Leaman and Bordass (1999) identify four clusters of building-related variables which affect worker productivity: personal control over the work environment; responsiveness to problems as they arise; building depth; and size of workgroups. Air-conditioned buildings often perform badly in all respects. By allowing building depths greater than 15 metres, and reducing options to control personal environments (by opening windows, for example) workers often find themselves in large, deep, open-plan spaces with large workgroups. Dependence on sophisticated technology to control the interior environment creates problems where building management is unresponsive or incompetent when problems arise. Lack or perceived control significantly increases intolerance of discomfort. Though air conditioning is not *necessarily* a cause of low worker productivity, it is clearly implicated.

US research confirms the importance of indoor environments in the workplace for health and productivity (Fisk and Rosenfeld, 1998; Heerwagen, 2000) and that 'numerous building technologies and practices have the potential to simultaneously increase productivity and save energy' (Fisk and Rosenfeld, 1998, p. 93). Since these relationships have been known for over a decade, why do we continue to build unpopular and unhealthy office accommodation?

Barriers

Just as in there are no independent variables in buildings, there are also no exogenous, insurmountable 'barriers' to improving energy efficiency. Nonetheless there are factors that contribute to the problem and need to be considered when proposing solutions.

Problems begin at the design stage, with clients rarely demanding energy efficient buildings, and architects rarely forcing it on to the agenda (this may improve now that sustainability considerations are a requirement in all British architecture degree course design projects). Designers will also be influenced by letting agents, who tend to recommend that air-conditioning (and marble lift lobbies, for example) are necessary for the building to be attractive to tenants. This raises construction and occupancy costs (and letting agents' commissions).[4]

Environmental engineers are then called in to design building services to overcome the effects of inappropriate building design (Bordass, 1993). The result may be an inefficient, uncomfortable and unhealthy building, but this will not necessarily be reflected in its valuation if it is otherwise of 'investment qualilty'. Indeed, the opposite situation is more likely: when confronted with a non-standard product (such as a highly energy-efficient building) UK valuers actively mark prices down (Gibson and Lizieri, 1998). Conservatism and vested interests across the property professions inhibit provision of the kinds of workplaces occupiers actually want. So why do the occupiers not press for change? Lack of information on energy costs and non-ownership of buildings appear to be the main barriers.

One commonly cited reason for the lack of investment in energy efficiency in buildings is that energy represents a small percentage of total occupancy costs, and therefore it is given little attention. However, in offices this is not the case. It may be that tenants are not *aware* of the energy component of their service charge, but energy (and air conditioning) comprise a significant proportion.

In 1998 AC office buildings had an average annual service charge of £57.36 per m^2, compared to £40.26 for non-AC buildings (Jones Lang LaSalle, 1999). Table 8 breaks these service charges down by components. In AC offices energy itself represents 18% of total service charges; including maintenance of heating and AC systems brings the proportion to 35%. These are significant proportions and therefore one could expect that tenants would be interested in lowering energy consumption in their premises.

'Conservation and vested interests ... inhibit provision of the kinds of workplaces occupiers actually want.'

Unfortunately this is not often an option. In the commercial sector almost half of the stock (by value) is owned by institutional investors (Callender and Key, 1997). In 1990 52% of offices and 35% of retail outlets were owned by institutional investors (Scott, 1996). Total UK commercial property stock had a value of £265 billion (bn) in 1995 (Callender and Key, 1997). The largest investors are long term insurance companies, with £36.4 bn worth of assets 14% of total UK commercial property stock). The other large investors are UK quoted property companies (£28.2 bn, 11% of total stock), pension funds (£24.3 bn, 9%) and foreign investors (£12–15 bn, approximately 5%). Other insurance interests, property unit trusts and investment trusts hold a further £4.1 bn (1.6%) of the UK assets. Traditional landowners, such as the Crown Estate, Church Commissioners, Oxbridge colleges and urban estates such as the Grosvenor and Bedford, own a further £8 bn worth of commercial property assets. Institutional investors dominate in the prestige and AC end of the market, where buildings are considered to be of 'investment quality'.

Table 8 Service charges in UK offices by component percentages in 1998

	A/C	Non A/C
Energy	18%	11%
Heating and A/C maintenance	17%	9%
Other	65%	80%

(Jones Lang LaSalle, 1999)

Just 10% of offices are occupied by the freeholder, and 70% of offices are multi-tenanted (Herring *et al.*, 1988). Thus we have a classic landlord/tenant barrier to improving energy efficiency: tenants are unable or unwilling to invest in improving the efficiency of buildings owned by another party, and the owners are happy to pass on the fuel costs to the tenants. An extended quote from Gibson and Lizieri (1999) illustrates the problem. Their research focuses on the mismatch between office space provision and the needs of businesses, but the arguments apply equally to the provision of energy services in commercial buildings:

> The major financial institutions, defined as both institutional investors, pension funds and life assurance companies, and property companies, continue to dominated the UK property market. With properties viewed purely as an investment asset, such firms have been unwilling to act as providers of product and service to occupiers. The cost and time involved in 'management' of the property investment are seen as a disadvantage for property investment when compared to other asset classes .... Many financial institutions thus outsource the management of their investment portfolios to property consultants who see it purely as an administrative function. Their measures of performance are related to minimizing voids, keeping management costs down and ensuring that tenants are paying promptly and meeting their obligations. The client is the financial institution, not the tenant, who has little power or influence.
>
> This arm's length attitude to space provision contributed to the developement of the UK institutional lease with its long term, onerous conditions and FRI (full repairing and insuring) provisions ... This lease structure minimises the involvement of the landlord and maximizes the input of the tenant ...
>
> As well as controlling much of the current stock, financial institutions provide much of the capital for developers to build new space .... Consequently ... the specification has been driven by what the investor felt was appropriate, not what the occupier actually needed. This, it has been asserted, led to considerable over-specification from the occupiers' perspective and additional cost which ultimately would have to be borne by the tenants. (p. 210)

Thus it appears that we have a situation in the UK whereby commercial property development and ownership is dominated by institutional investors who have pushed the market towards the prestige, energy-inefficient end of the spectrum. There is substantial evidence that this is at the expense of the profitability and even comfort of tenants.

The proposed solution

The Climate Change Levy will send a small but positive signal to businesses about the need to conserve energy (despite the fact that recycling of the revenue into a reduction in National Insurance permiums will mean that many service sector businesses will make a net financial gain). The government's Energy Efficiency Best Practice Programme also disseminates useful information on ways to save energy (e.g. DETR, 2000a). This fiscal encouragement and information provision are positive steps, but there is a limit to the extent to which tenants can be expected to take the initiative and improve the energy performance of buildings own by others.

'... commercial property development and ownership ... have pushed the market towards the prestige, energy inefficient ...'

However, freeholders have little incentive to invest in energy efficiency in their property stock, as they are more concerned by annual profits and losses than long term savings (which would accrue to their tenants). Another quote from Gibson and Lizieri (1999) underlines this point:

> The barriers to change reflect the dominate position held by institutional investors and financially oriented property companies as landlords in the UK market. These landlords, seeing property as purely an investment asset, are unwilling to become closely involved in the management of the property or act as service providers. (p. 215)

Therefore the Association for the Conservation of Energy considers that an obligation should be placed upon the freeholders of commercial properties to ensure that their buildings meet minimum energy efficiency performance standards. The obligation to undertake an energy audit and improve energy efficiency should be enacted every 5 years, or whenever a building is sold, re-let or subject to a rent review. There should be a requirement for consultation with building occupants and/or unions before detailed refurbishment plans are drawn up. Options for sharing the burden of costs and benefits of energy efficiency refurbishment with tenants and/or energy service companies (ESCOs) require detailed consideration which is beyond the scope of this paper.

Requiring energy audits at each rent review would fulfil the UK's obligation under Article 2 of SAVE Directive 93/76. This directive should be implemented and extended to ensure work is undertaken to improve energy performance where it is unsatisfactory.

An energy audit and improvement should be undertaken every 5 years ...

The policy should also be framed so that it sends a clear signal to those developing new properties that prevention is better than cure: i.e. they should design for low energy consumption from the outset. Low energy or 'green' buildings do not typically cost more to construct than more wasteful designs, though expenditure will be in different areas, e.g. more on design costs and less on equipment such as AC (Cole, 2000). Passive cooling systems depend on the building form, and are therefore expected to operate for the lifetime of the building. It should be noted that the performance of passive and other low-energy cooling systems is very sensitive to climate (Hulme *et al.*, 1992), and therefore consideration must be given to the expected warming due to the enhanced greenhouse effect over the building's lifetime. This approach would break the positive feedback loop between a warming climate and increased demand for AC.

The insurance industry, which owns almost £40 billion worth of commercial property assets in the UK (15% of the total value) (Callender and Key, 1997) might be expected to take a lead in improving energy efficiency in its property stock. Prudential Property Portfolio has called for legislation to ensure that every commercial building is audited every 5 years, with recommendations to be implemented before the next audit (EIBI, 1999). Furthermore, Prudential has already taken steps to assist its tenants to save energy, in particular by making efforts to ensure that all tenants receive individual bills based on their energy consumption rather than on floor area alone. Individual metering and billing is required under Article 3 of the EC SAVE Directive 93/76. Enforcing compliance with this regulation would be a positive step, but a limited amount can be saved before attention must be turned to the building fabric, heating and cooling systems. Improvements here should be the responsibility of the freeholder.

The insurance industry is concerned about the impacts of climate change, particularly in terms of extreme weather events which could lead to heavy claims. In a United Nations Environment Programme 'Insurance industry position paper on climate change' (UNEP, 1996) it states:

> Man made climate change will lead to shifts in atmospheric and oceanic circulation patterns. This will probably increase the likelihood of extreme weather events in certain areas. Such effects carry the risk of dramatically increased property damage,

with serious implications for property insurers. (Para. 2.1.2)

It is anticipated that structural changes in energy intensive industries in response to measures to control greenhouse gas emissions will result in opportunities and challenges for the investment community, including for example alternative energy, efficiency programmes and public transit systems. *However, without political initiatives, market forces alone may not result in the efficient use of investment potential.* (Para 1.5, emphasis added)

'Improvements ... should be the responsibility of the freeholder.'

The challenge is for the investment community to see that the same opportunities, and need for legislation, apply in the commercial sector building stock. Over 60 insurance companies from 23 countries are now signatories to a United Nations Environment Programme 'Statement of Environmental Commitment by the Insurance Industry' (UNEP, 1995). This calls for precautionary action to reduce greenhouse gas emissions, and states:

The insurance industry recognizes that economic development needs to be compatible with human welfare and a healthy environment. To ignore this is to risk increasing social, environmental and financial costs. Our industry plays an important role in managing and reducing environmental risk, in conjuction with governments, individuals and organizations. We are committed ot work together to address key issues such as pollution reduction, the efficient use of resourses, and climate change. We endeavour to identify realistic, sustainable solutions. (Preamble)

Life and health insurance companies should carefully examine the dividends in terms of loss prevention afforded by investing in healthier, more energy efficient real estate. Mills (1997) has identified 33 energy efficiency measures which can contribute to eight categories of insurance loss mitigation. There are positive signs:

We are committed to manage internal operations and physical assets under our control in a manner that reflects environmental considerations. (UNEP, 1995, Para. 2.2)

At best this presently appears only to mean gestures to help tenants reduce their consumption, at no cost to the freeholder. Meanwhile the Climate Change Levy will impact only on the occupier, who is not in a position to make the changes needed for really significant energy savings. As demonstrated in this paper, inefficient use of energy is worst in the newer, more prestige premises, which are precisely those owned by large institutional investors. Price incentives and best practice advice will have little effect here, since costs are simply passed on to occupants.

Therefore the Association for the Conservation of Energy proposes legislation obliging property owners to build energy efficient premises and retrofit existing properties to bring their energy performance up to an acceptable level.

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Endnotes

[1] Also, at the time of writing it was impossible to obtain annual time series data for energy consumption or CO_2 emissions from the private services sector.

[2] It should be noted that prestige buildings may perform more functions than others, and this accounts for some of the higher energy consumption. In these figures computer room energy represents a large energy load, and is in effect process energy. If one disregards this energy use, the prestige AC offices still consume over twice as much energy per unit of floor area than non-AC buildings.

[3] Omitting process energy for computer rooms in prestige AC offices would mean that these offices emit 2.3 to 3 times as much CO_2 per m^2 as naturally ventilated offices.

[4] Individual metering of tenants' energy consumption, with bills paid separately from rent, would eliminate this incentive for letting agents to encourage the use of AC in new buildings. More generally, measures are needed to remove the financial incentives for property professionals to push up construction and occupancy costs in new buildings.