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This study presents the first international comparison of energy use and structure in the service sector of major OECD countries. This sector includes offices, hospitals, schools, stores, and other buildings commonly referred to as "commercial buildings". We separate service sector energy use from other sectors, examine differences in fuel mix, energy intensity, electricity use, and conservation experience, as well as fundamental differences in the extent and make-up of the building stock and the climate. We show that most countries have reduced energy intensity since 1973; all have reduced the share of heating oil and increased the use of electricity, both for space conditioning as well as for other building services. We find that energy intensity in U.S. commercial and institutional buildings is among the highest in the OECD, while electricity intensities in Norway, Canada, the U.S. and Sweden are well above those in other countries.

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Energy Use in the Service Sector:
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1 INTRODUCTION

In the last decade, there has been considerable progress toward understanding changes in energy consumption in the residential, industrial, and transportation sectors of the OECD countries. Much less work has been done on the service sector. This has probably been due in part to lack of interest, the service sector being the smallest energy consumer of the four main end-use sectors. Yet output in the service sector of most OECD countries has grown rapidly in recent decades; in many countries energy (or electricity) use growth in this sector led all sectors. But the lack of adequate data on energy use in the service sector has also stymied efforts to better understand the changes taking place in that area. In the energy statistics of most countries, energy sales not accounted for by transportation or industrial uses are usually lumped together into the "residential/commercial" sector. Because of the considerable differences among the various energy users included in such a grouping, meaningful analysis with such data is difficult.

In recent years, data have begun to become available from a number of countries that allow study of the service sector on its own. This paper reports on our efforts to collect and compare data on service sector energy use in eight OECD countries: Canada, Denmark, France, Germany, Norway, Sweden, the United Kingdom (UK), and the United States (US). We focus on consumption at the national level, disaggregated, where data permit, by sub-sector. Although data limitations have impeded some of the analysis we would like to do, we are able to shed new light on the structure of energy use in the service sector and its recent evolution.

Our work has the following goals:

- To quantify service sector energy use in OECD countries, separate from residential and other uses with which the service sector is commonly classified;

- To examine differences among countries in the structure of the service sector (the mix of building types, vintage, heating fuels);

- To investigate differences in service-sector energy consumption among countries;

- To explore signs of energy conservation;

- To study changes in the use of individual fuels, particularly electricity and oil.

This paper reports on our progress to date. It is an introduction to and overview of the data we have assembled. We hope that this presentation of initial findings will stimulate discussion of service sector energy use as well as contributions of data as yet unknown to us.

1.1 What is the Service Sector?*

Generally speaking, the service sector corresponds to the provision of services by public and private entities (in contrast to the production of goods or transportation of people and goods). It follows from this that a wide array of activities are lumped together in the service sector. "Service" activities range from caring for the sick to treatment of sewage. This stands in contrast to the residential sector, which is comparatively homogeneous. A reasonable definition of service activities includes activities in the following Standard Industrial Classification (SIC) divisions: Wholesale trade; Retail trade; Finance, insurance, and real estate; Services (includes lodging, personal, business, health, legal, educational, and social services); Public administration; and Transportation, communication, electricity, gas, and sanitary services. In most countries, the service sector is defined to include these activities, but there is some variation in what is or is not included.

What we refer to as service-sector *energy* consumption consists of energy consumed by these activities, with the exclusion of energy consumed in transportation and in electricity and gas production. The great majority of energy consumption in the service sector is associated with building functions: heating and cooling, ventilation, lighting, and other electrical operations. It should be kept in mind, however, that services like street lighting and water works are also part of the service sector.

1.2 Studying Energy Use in the Service Sector

Perhaps the most serious barrier to understanding the service sector is the heterogeneity of its constituents. Different kinds of service enterprises may have quite different energy use patterns and may also undergo different rates of physical growth. This situation argues for a more detailed breakdown of the service sector into sub-sectors. Such a breakdown involves "bottom-up" data from surveys. With such data we are able to characterize the changing physical *structure* of the service sector -- in terms of the kinds of operations that are occurring and the type of energy-using equipment in place -- and changes in *energy use* at the sub-sectoral level. We present data and discussion on structure in Section 2. From this vantage point, we can then examine data on energy consumption. In Section 3, we explore differences among countries in total service-sector energy consumption, and present disaggregated data as well. In Section 4, we look at changes in service-sector energy consumption over time, paying particular attention to changes in energy intensity (energy consumption per square meter or per employee).

Our data sources, which we describe in the Appendix, are primarily government statistics-gathering agencies. The Appendix also presents time-series data on the sales of the various energy products to service-sector customers, and data on consumption by sub-sectors. Except where we make specific references, all of our quantitative observations are based on the data presented in the Appendix tables, or on other data from the same sources.

* Also known as the "commercial" or "tertiary" sector. We have chosen to use the term "service sector" because it is the most accurate description of the activities that comprise the sector. In the statistics of some countries, a distinction is made between the "commercial" sector and "public administration." The term "service sector" comfortably includes both.

2 THE STRUCTURE OF THE SERVICE SECTOR

Service-sector energy use is shaped by particular physical and economic attributes: floor area, the sector's composition in terms of the kind of activities that take place within it, the age structure of the building stock, and the type of fuels used to support service-sector activities. These attributes, which collectively we call "structure," change over time and shape the evolution of energy consumption.

2.1 Floor Area

A basic structural indicator for the service sector is building floor area. Five of the eight countries have conducted at least one survey of the service-sector building stock. The historical evolution of service-sector floor area is estimated in most cases. In most countries, service-sector floor area grew rapidly between 1960 and the mid-1970s. There has been a marked slowdown since then in Scandinavia, and, to a lesser extent, in the US.

Heated area is always less than total enclosed area. Some categories of service-sector buildings (train stations, markets) are typically not conditioned, while others may not be conditioned during the whole year, or may only be conditioned during certain hours of the day. A higher penetration of space conditioning over time increases overall sector energy intensity. The penetration of cooling is an important factor in the US; it is growing in Europe but is now generally under 10% of total floor space.

Most of the countries for which we have data have between 15 and 17 square meters of service-sector floor area per capita (Table 1). France and Norway are significantly lower, while the US is slightly higher at 17.4. The amount of floor area per employee is in the range of 40-50 sq meters in Europe, and about 65 sq meters in the US. According to estimates of changes in total sector floor area, this indicator has grown in Denmark and France, remained about the same in Sweden and the US, and apparently fallen in Norway.

2.2 Activity Composition of the Service Sector

As mentioned above, the service sector consists of many different kinds of activities. Although in general all of the industrial countries have the same basic service activities, the mix of those activities varies from one country to the next. Where we have data, the percentage of floor area accounted for by different building categories is shown in the Appendix tables. It is difficult to make comparisons, because the categories used are different from one country to the next. There are some evident differences, however: the share of total area for schools and hospitals in Sweden, for example, is significantly higher than in the US (although their absolute levels, per capita, are close). Educational facilities form the largest sub-sector in the Scandanavian countries. Office buildings account for a smaller share of total service-sector floor space (15-17%) than one might expect.

It is important to know the rates at which the various sub-sectors are growing, since they have different characteristic energy intensities or fuel mix patterns. For the most part, such data are scarce. We have found estimates of the growth in floor area of the service sub-sectors during the 1970s for France and the US. In France, there are considerable differences among the sub-sectors (see Table 2). This is less evident in the US.

2.3 Vintage

The age distribution or vintage of the service-sector building stock differs among countries. In Sweden, for example, 63% of the heated service-sector building space existing in 1981 was built after 1960; only 21% dates before 1940. German and Norwegian buildings have a similar age distribution. In the US, the comparable figures (in 1979) were 42% and 38% (through 1945). Denmark is similar to this. The relative newness of the Swedish stock is important, since buildings constructed after 1960 tend to have the lowest energy intensity. In the US, gas-heated buildings built after 1973 consumed 30% less gas per square foot than those built between 1961 and 1973. Overall electricity intensity, on the other hand, is slightly higher among post-1973 US buildings than among the 1961 to 1973 group. (For both gas and electricity, the effects of the geographical distribution of buildings must be taken into account before any definitive statements can be made. The increase in electricity intensity could be due to more use of electric heat or greater location of buildings in areas where air conditioning needs are high.)

The age distribution differs among service sub-sectors. One reason for this is that construction of different kinds of buildings was concentrated in different economic booms: schools following the "baby boom", hospitals and other public services during the 1960s expansion of the public sector, hotels and restaurants during recent years, as travel for business and pleasure expanded.

2.4 Heating Fuel

The energy-using equipment installed in buildings is another important structural factor. Since space heating is the most significant end-use, and also the one for which users have the most choice with respect to fuels, it is important to know about heating equipment. We found data on the heating fuels in use in service-sector buildings for Denmark, France, Norway, Sweden, and the US (Table 3). Denmark and Sweden have a similar structure: oil heat accounts for nearly half of the floor area, and district heat most of the rest. France (in 1984) had 56% of its space heated with oil, with gas accounting for the next largest share at 21%. In the US, gas heating (at 49% of floor area) and electric heating (at 19% of floor area) are more prominent. Norway, with inexpensive hydroelectricity, has a very high penetration of electric heating: 24% of the floor area (in 1977) was heated only by electricity, and an additional 54% by electricity and oil. Since 1977, the share of electricity has reportedly risen significantly in every country, even in Norway.

The choice of heating fuels in the service sector differs from that in the residential sector. In Denmark and Sweden, electric space heating has a significantly higher penetration in the residential sector than in the service sector. Heating fuels in multi-family buildings more closely resemble those of service-sector buildings. The market share of fuels depends on building vintage. Oil is found in the oldest buildings everywhere, electricity in the newest (or in old buildings where primitive heating systems were recently replaced), and district heating principally in buildings of post-1960 vintage.

2.5 Geographical Distribution

Changing geographical distribution of service-sector buildings within a country can affect energy consumption if there are significant climatic variations from one region to the next. For our study countries, internal climate variations are very important only in France and the US, much less important in Canada, Norway, and Sweden (because the populations are packed into the southern areas), and almost insignificant in Denmark, Germany, and the UK. In the US and France, a significant part of the

population lives in areas with little need for space heating but great potential (or actual) cooling needs. For the US, estimates by the Department of Energy of changes in service-sector floorspace between 1970 and 1980 show an increased share of total floorspace in the South (28.0% to 30.1%) and the West (13.3% to 14.7%).[1] (Oil-heated buildings in the US are concentrated in the Northeast, electrically-heated ones in the South and West.)

3 ENERGY CONSUMPTION IN THE SERVICE SECTOR

3.1 Data on the Service Sector

It is difficult to know the extent to which reported data on energy consumption in the service sector correspond to actual energy consumption among the consumers who are properly part of the sector. Large apartment buildings are often grouped into the "commercial" category. A certain number of residences, usually 2-3% of the entire stock, lie in buildings whose purposes are otherwise non-residential, and this consumption is usually lost in the service sector data. The reverse effect -- service activities (small stores, clinics, etc.) in buildings whose purposes are predominantly residential -- also occurs. Records on oil sales often do not make a clear distinction between service-sector and other customers. A further complication is that data on annual oil sales/deliveries may not match annual consumption due to stocking at the building site, particularly in 1973-74 and 1979.[2]

Our approach is to take data on service sector energy consumption from in-country sources, and, when necessary and possible, to make modifications so that they more closely correspond to what we have defined as the service sector. (The Appendix contains descriptions of the data for each country and of our manipulations of them.) Some of the data in this section come from government statistics on product deliveries, but the majority are from national surveys of service-sector buildings.

3.2 Service Sector Energy Use in Context

Service-sector energy consumption is smaller than that of the other major sectors. Compared to residential energy consumption, energy consumption in the service sector ranges from 40-45% (in the European countries) to about 60% (in Canada and the US) of residential consumption (Table 4). The market shares of the various fuels are also different in the service sector, where electricity is generally much more prominent (Table 5). Excepting Norway, its use accounts for 26% (Germany and the United Kingdom) to 38% (Sweden) of total delivered* energy consumption, compared with 15% to 29% in the residential sector. The share of oil is generally less in the service sector, while gas tends to have about the same share in both sectors. (The UK is an exception to both of these statements.) Use of solid fuels is less common in the service sector. The lower share of oil and solid fuels, which are almost exclusively used for heating, is due in part to heating being relatively less important than in the residential sector.

* "Delivered" energy refers to quantities reported as sold to consumers. This quantity does not include losses in production and transmission.

3.3 Differences Among Countries

On a per capita basis, energy consumption (delivered) in service-sector buildings* in Europe ranges between 10 GJ (France) and 18 GJ (Sweden) (Table 6). Considering climate differences, these values converge fairly closely. Per capita consumption is much higher in the US (25 GJ) and Canada (30 GJ). Taking into account differences in the amount of floor area per capita, energy use per square meter remains considerably higher in the US and Canada. The US (in 1979) was over 60% higher than France (in 1983), which has a somewhat warmer climate, and 18% above much colder Sweden (1982). The higher consumption in the US is attributable in part to the nearly universal use of air conditioning, which Jackson *et al.* estimated to account for 13% of service-sector delivered energy consumption in 1975.[3] Energy use per square meter of floor area is some 50% higher in Canada than in the US, but the Canadian climate is also much colder (the long-term average number of heating degree-days in Canada is 75% higher than in the US).

Taking into account the effects of climate differences among countries is more difficult to do with service-sector data than with residential. Because of building internal loads, consumption for space heating does not vary proportionally with outdoor climate. Further, the amount of total consumption that should be adjusted for climate (the shares of space heating and air conditioning) is less well known in the service sector. To get around this problem, a first adjustment can be made with non-electric energy consumption, since petroleum products, gas, and district heat are primarily used for space heating. When we divide non-electric energy consumption per square meter by each country's number of heating degree-days (adjusted to a common basis), the US and Canada come out 40-60% above the European countries (Table 7).* With the exception of Norway (which is not comparable due to the high degree of electric heating) the European countries fall in the range of 131 to 156 kJ per square meter per degree-day, while the US and Canada are above 200 kJ. Since the data are for different years (note that the US value is for 1979 while for the other countries the year is 1981 or 1982 or 1983; given the evolution of energy prices, the US value was no doubt lower by 1981 or 1982), and the data on floor area are somewhat uncertain, the comparison should not be taken too far. But the numbers are good enough to substantiate a major difference between Europe and North America in energy intensity for heating.

The value for the US fuel intensity is complicated by the more prevalent use of electricity for space heating (19% of floor area vs. 8% or less in most of Europe). If more of the US floor area were heated by non-electric means, the US fuel intensity would of course be higher.

The above values include varying amounts of energy consumption for hot water and cooking, and this could explain a small part of the differences seen above. That is, US and Canadian buildings could have greater use of hot water. Buildings with the greatest use of fuels for hot water and cooking are hospitals, restaurants, and hotels. Since there are not major differences among countries in area per capita devoted to these activities, it seems unlikely that hot water (or cooking) is a major cause of the higher fuel intensity in the US and Canada.

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* In order to make countries more comparable, we have tried to use data that reflect energy consumption for building purposes only. This helps to correct for differences in what countries may include in their service sector data. Since there are likely still some differences among countries as to what is being counted, the numbers should not be taken too exactly. Note also that the US value is for 1979, while observations for the other countries are after the 1979/80 price increases.

* We have also adjusted the data to approximate "useful" energy consumption in order to account for the high share of district heat (which has minimal losses at the building boundary) in several countries. In this adjustment, fuels were counted with 66% conversion efficiency, district heat and electricity at 100% efficiency. The fact that we have divided total fuel consumption, and not just that for space heating, by degree-days means that we have overcompensated for the effect of climate. This procedure lowers the intensity for the countries with very cold climate more than those with warm climate.

American and Canadian buildings stand out even more with respect to electricity intensity. Electricity consumption per square meter is two to three times higher in North America than in Denmark, France, or Germany (Table 7). Sweden, which has 6% of its floor area with electric heating, is midway between these extremes. The high electric intensity in the US, Canada, and Sweden is caused in part by electric heating, and, for the US and Canada, by air conditioning. (Jackson *et al.* estimated that in 1975, air conditioning accounted for 36% of total US service-sector electricity consumption.)[3] When we remove buildings with electric heating from the Swedish data, the intensity of the remaining stock falls to 390 MJ/sq m (for 1981).* For the US, the electricity intensity of the non-electrically-heated stock in 1979 was 462 MJ/sq m (the intensity for those with electric heat was 660 MJ/sq m). Air conditioning in the US is probably substantial enough to account for this difference, leading to the somewhat surprising conclusion that US and Swedish electricity intensity for non-space-conditioning purposes is at a comparable level.

The very high intensity in Norway is due to the large share of full or supplementary electric heating. In buildings without electric heating, however, electricity intensity (in 1977) was still 587 MJ/sq m, close to the overall electricity intensity in Canada (in 1981). For Canada, we have no estimate of electric heating penetration, but it is probably between that of Sweden and the US. The extremely cold Canadian winters are contrasted by short but hot and humid summers, so air conditioning is also important. It is unclear why the Norwegian electricity intensity should be so high, though low electricity prices no doubt play a role. Norway, Canada and Sweden have historically had considerably lower electricity prices than the US.

Because of the complications caused by electric space heating and air conditioning, interpretation of the data on electricity intensity is difficult. Clearly, the presence of electric heating, whether alone or in combination with other fuels, appears as an important factor that raises overall electricity intensity. The very much higher level of US and Canadian intensity suggests a considerable difference independent of space conditioning effects, but further work is needed to separate out the effect of the various factors.

3.4 Disaggregating the Service Sector

In the residential sector, it is important to look separately at the two main classes of dwellings, single-family houses and apartments. Disaggregation is even more important in the service sector, where the energy use patterns can be quite different from one sub-sector to the next. We found data allowing disaggregation of service-sector energy consumption into sub-sectors for most countries (Table 8). As with floorspace, the shares of different sub-sectors vary among the countries, but differences in sub-sector definition make comparison difficult. The sub-sector shares are different for different fuels. Offices, for example, account for a relatively small share of oil or gas consumption, but a very high share of electricity consumption.

Not surprisingly, the sub-sectors have considerably different energy intensities. Table 9 shows oil consumption per square meter (for space and water heating) in different sub-sectors in Denmark and Sweden. In both cases, health care facilities have the highest or nearly highest oil intensity. The Danish sub-sectors exhibit a wider range of average intensity than do the Swedish ones. Table 10 shows total energy consumption per square meter in different sub-sectors in France and the US. The US sub-sectors an exceptionally wide range of energy intensities -- from 930 MJ per square meter for assembly buildings to 2975 MJ per square meter for health care facilities. Variation in intensity means that a significant

* Supplementary electric heating is commmon in Sweden. It probably accounts for an average of 40-50 MJ/sq m.

difference in the kinds of buildings among countries could cause observable variation in total service sector energy intensity.

One of the reasons for disaggregating the service sector is that the penetration of fuels varies among sub-sectors. This may be caused by the different vintages of each building type, different locations (closer or further from gas and district heating), or the differing importance of space heating vis a vis other end uses. The result is that variable physical growth among the sub-sectors will affect different energy products in different ways. In Table 11, we show the electric share of delivered energy consumption for several different building types. (We have included survey data from Japan for comparison.) Electricity's share is highest in offices and/or retail stores in all countries, lowest in schools, and intermediate in hotels/restaurants and hospitals.

As with the aggregate sector data discussed above, the energy intensity of the service sub-sectors can be quite different from one country to the next. Table 12 shows electricity intensity for several sub-sectors for which the data are reasonably comparable among countries. The US sub-sectors are considerably more electricity-intensive in all cases, even more so than those buildings in Norway without electric heat. Without accounting for the presence of air conditioning, however, this fact is difficult to interpret.

3.5 End-Uses in the Service Sector

The distribution of energy consumption among the various end-uses is more difficult to determine in the service sector than in the residential. Estimates have been made in several countries, but their accuracy is open to question. The estimates we have collected suggest that space heating accounts for 60-65% of total delivered energy consumption in service-sector buildings in central Europe and the US (see Table 13). In the US, the space heating share of 65% was estimated for 1975. It has likely fallen since then, and would be lower still if the space heating intensity in the US were not so much higher than in other countries.

Only in the US is air conditioning significant (at 13%). Lighting accounts for an estimated 12% in the US, 9% in Germany, and 12% in the UK. The lighting shares imply an intensity of about 70 MJ/m^2 for Germany but nearly 170 MJ/m^2 for the US. In general, the shares of the end-uses will change as conservation or other changes influence one end-use or another.

4 CHANGES IN SERVICE SECTOR ENERGY USE OVER TIME

The time-series of service sector energy consumption that we have assembled (see Appendix tables) are mostly based on government-collected statistics. Interpreting the trends exhibited by such data is complicated by several factors. One is sector definition: how well the statistics reflect service-sector energy consumption, and whether this coverage has changed over time. The various data series differ somewhat in the extent to which they reflect only service-sector energy consumption. In Sweden and Denmark, the data sources attempt to exclude non-building uses such as construction, light manufacturing, agriculture, and utilities. The German time-series data, on the other hand, include a considerable amount of consumption in non-service-sector categories. For the US, the Department of Energy time-series value is 11% higher than service-sector buildings energy consumption as indicated by the 1979 NBECS survey. Most of this is probably non-buildings service-sector consumption. For Canada, the government data have historically included a large amount of consumption in mass-metered apartments (which we have

attempted to remove from gas and electricity consumption). In other countries, the degree of exclusion of non-service-sector consumption is uncertain.

The various series appear to be reasonably consistent over time within each country. There may be a small effect from the tendency of some statistics-gathering agencies to gain more accurate reporting from energy suppliers with respect to consumer categories.

4.1 Historical Trends in Energy Consumption

Delivered energy consumption in the service sector has either declined or grown slowly since 1971-72 in all of the countries except Norway (Table 14). Denmark and France have had negative growth, Germany no growth, while in other countries growth averaged less than 1% per year. Delivered energy consumption *per capita* has fallen significantly in most countries, stayed about the same in Germany and the UK, and risen only in Norway. Denmark and France have seen the largest decline in this indicator.

Part of the decline in delivered energy consumption may be attributable to greater use of fuels that have lower losses associated with their use at the building site (district heat and electricity). Counting primary energy shows all of the energy resources that go into district heat and electricity production. Since electricity production in particular has high energy losses, increasing use of electricity in the service sector (see below) has led to growth in primary energy consumption ranging from 0.9% per year in Canada to 2.4% per year in Sweden and 4.5% per year in heavily-electrified Norway. (We multiply electricity consumption by 2.89, district heat by 1.33 to account for production and transmission losses.)

4.2 Historic Trends: Specific Fuels

Although overall energy consumption has been more or less stable, there has been considerable difference in the evolution of consumption of different fuels. *Petroleum products* consumption has fallen considerably in all of the countries. By 1982, it had fallen to 55% of its 1973 level in Canada, to 58% of its 1974 level in France, to 62% of its 1972 level in Denmark, to 63% of its 1971 level in Germany, to 67% of its 1972 level in Sweden, to 72% of its 1972 level in the UK, and to 67% of its 1971 level in the US.* In all cases, the largest part of the decline occurred after 1979 (see Appendix tables).

Electricity on the other hand has seen strong growth: an average of 5-6% per year for most of the European countries, just over 4% per year in the US, and around 3% per year in Canada and the UK. The result has been a near-doubling in electricity demand in many countries since the early 1970s. Most of this growth was caused either by increased penetration or usage of air conditioning, lighting, machines, and ventilation), but some may have been caused by new electricity uses (electronics) or by penetration of electricity into space heating, water heating, and cooking.

Gas consumption has grown substantially in France, Germany, and the UK, and grew in Canada as well. In the US it has remained essentially stable. *District heat,* which is significant only in Denmark and Sweden, has seen substantial growth in Sweden but remained at the same level in Denmark.

* Years were chosen for reasons of climate comparability.

4.3 Changing Fuel Shares

The result of differing growth rates has been considerable shift in the shares of the fuels used in the service sector. In Europe, *oil* accounted for between 48% (UK) and 72% (France) of total delivered energy consumption in the early 1970s (Table 15). By 1982, the oil share had fallen to between 33% (UK) and 43% (France and Germany). In Canada and the US, where the oil share in the early 1970s was 40% and 25% respectively, substantial drops occurred as well (to 22% and 16%).

The *electricity* share of total delivered energy consumption has grown to over 25% in all of the countries: from 16% to 34% in Denmark, from 16% to 31% in France, from 14% to 26% in Germany, from 25% to 38% in Sweden, from 20% to 26% in the UK, from 25% to 36% in the US, and from 30% to 32% in Canada. Norway saw a near-doubling of electricity's share from 37% to 65%. *Gas* consumption has taken on a major share of total delivered energy consumption in France (24% in 1982), Germany (21%), and the UK (32%), and has risen to nearly half of total consumption in Canada and stayed at that level in the US.

4.4 Energy Intensity and Conservation

The stability or decline in total energy consumption is not a consequence of lack of growth in energy-demanding activities, as the service sector has grown in all of the countries in our study. Two measures for the growth of the service sector are floor area and the number of employees. Indicators of overall service-sector energy intensity can be obtained by dividing total energy consumption by these values. Floor area reflects actual physical growth, but historical data tend to be either non-existent or roughly estimated. Decrease in delivered energy consumption per square meter of floor area is nonetheless evident. The data show a decline of 27% between 1972 and 1982 in Denmark, of 31% between 1973 and 1980 in France, of 17% between 1972 and 1982 in Sweden, and of 18% between 1970 and 1980 in the US. (The years chosen had comparable weather.)

Delivered energy consumption per employee is easier to establish and compare, since statistics on employees are assembled in a uniform fashion. Between 1970 and 1982, this indicator fell by 27% in Canada, by 12% in Germany and the UK, by 13% in Norway, by 15% in Sweden, and by 24% in the US. Denmark saw a 19% drop between 1972 and 1982, France a 17% drop between 1973 and 1982 (Table 16). Consumption per employee fell slower than consumption per square meter in Denmark and France (reflecting the increase in number of square meters per employee), at about the same rate in Sweden and the US, and faster in Norway.

Part of the decline in energy intensity could in principle be caused by changes in the mix of buildings. As we showed above, intensity varies by more than a factor of two across building types. The effect of the building mix depends upon the growth rate of the various sub-sectors. In France, the sub-sectors with the highest energy intensity (transport, health, and large commerce) all grew faster than the entire stock during the 1970s, according to estimates. This may have placed some upward pressure on total sector energy intensity, which makes the decline in consumption in France all the more noteworthy. In general, however, the time period of the last ten years is too short to expect any major effect from variable sub-sector growth rates.

Declining energy intensity is a signal of energy conservation. In some countries, we can measure the changes in more detail. In Germany, the major oil companies have measured oil intensity in a panel of service-sector buildings using oil for heat (and a small amount of hot water) on a monthly basis from 1968 to the present).[2] Oil intensity was around 1380 MJ/sq m between 1970 and 1973, fell to 1190-1250 MJ/sq

m between 1975 and 1978, then fell to 850 MJ/sq m in 1981-83 (Table 17). Similar trends have been observed in Denmark, oil intensity has been falling nearly continuously since 1973 (Table 17).[4] The 1983 level of 770 MJ/sq m was nearly half as much as the early 1970s level of 1350 MJ/sq m. Among buildings that had used the government's Heat Consultant Program, oil intensity in 1983 was close to 500 MJ/sq m. The drop in buildings with district heat was somewhat smaller than that for oil.

Swedish surveys[5] conducted since 1977 present the most detail, giving data on oil and district heating intensity by sub-sector (Table 18). Despite the shortness of the period covered, changes are evident. The total oil-heated stock consumed 1120 MJ/sq m in 1977; this had fallen by 24% to 850 MJ/sq m by 1983. Changes varied considerably among the sub-sectors, with hospitals exhibiting the largest decline, but some drop occurred in nearly every building type and vintage. A somewhat less steep decline -- from 815 MJ/sq m in 1977 to 695 MJ/sq m in 1983 -- occurred in buildings using district heat.*

Although there is no question that the drop in oil or district heating intensity in these three countries is real, interpretation of trends can be complicated by conversions of buildings from one heating fuel to another. For example, the many conversions from oil to district heating in Sweden reduced the stock-wide effect of conservation in district-heated buildings by introducing many older, more energy-intensive buildings into the district-heated stock.

Conservation of gas is difficult to measure because of the strong growth in its use. Since many oil-heated buildings in France and Germany have been converted to gas, and since these buildings tend to be old, their entrance into the gas-heated stock would tend to increase overall heating intensity. Conversely, the appearance of many new (and presumably more efficient) buildings obscures the decline in gas consumption in existing gas-heated buildings. Since gas consumption increased substantially in both these countries, it is impossible to pinpoint the magnitude of gas conservation. In the US, 19% of the 1979 stock of buildings using gas for heating was built between 1971 and 1979, implying significant increase in the total floor area of buildings using gas for heating. Since it is plausible that other buildings built before 1971 converted to gas from oil during this period in great enough numbers to offset removals or conversions away from gas, it is likely that a 23% increase in the area heated by gas is a lower limit. Total service sector gas consumption during the same period increased by 15% between 1971 and 1979 (years with comparable weather). This indicates a reduction in consumption per square meter of at least 7%.

Electricity consumption per square meter has risen in all countries, particularly in Denmark, Norway, and Sweden (Table 16). In the US, the increase was on the order of 20% between 1970 and 1980. Electricity consumption per employee has also risen, though in a few countries (Canada, Denmark, the UK and the US) there has been a decline or levelling off in recent years. Between 1970 and 1982, this indicator grew by 67% in Germany, by 84% in Norway, by 61% in Sweden, by 24% in the UK, and by 23% in the US, and by only 9% in Canada. Denmark saw a 64% increase between 1972 and 1982, France a 52% increase between 1973 and 1982.

Electricity intensity is more complicated to analyze because of the multiplicity of uses other than for climate conditioning. Growth in overall intensity obscures the effect of better energy management and more efficient appliances. Data from all Swedish buildings with electric heat, for example, show a decline of about 15% from 1977 to 1982 in electricity consumption per square meter. In this same period,

* The drop was less in part because many older, relatively leaky buildings converted to district heating, increasing the average intensity and probably accounting for the upturn in 1983. Also, improvements in the oil combustion efficiency are recorded in these statistics; improvements in district heating centrals do not show up in the data, so the changes in oil-heated buildings can easily be greater than in those with district heat.

electricity intensity over the entire stock of buildings grew by some 10%.

4.5 Service-Sector Energy Use in the Future

Service-sector energy demand is being shaped by growth of the overall building stock and of particular sub-sectors, the mix of heating fuels, and the energy intensity of each individual process that occurs in a building (as well as their interaction in changing heating or cooling needs). The transfer of residential activity to the service sector -- increased use of hotels, restaurants, care for the elderly --- is one cause of increased service-sector energy consumption. Care for the aged, for example, accounted for 3% of service sector fuel and electricity consumption in Sweden in 1982. A potential trend in the opposite direction is increasing use of homes for commercial activity, facilitated by home computers.

Energy conservation will play an important role in shaping overall demand. Reduction in heating intensity is the most likely cause of the observed drops in energy intensity to date. The potential for reduction in this area is far from exhausted; indeed, buildings with virtually no space heating demands (the Ontario Hydro Building, in Toronto, is an example) are feasible and economic today. Electricity savings will be more dependent upon equipment renewal. Higher electricity prices have stimulated great interest in achieving more efficiency in space conditioning, lighting, and other equipment. While there is potential for increased use of electricity for computers and other electronics, there are far greater potential savings from more energy-efficient climate conditioning, lighting, and other uses.

It is likely that overall service sector energy intensity (in terms of delivered energy) will continue to move downward. If growth in the building stock accelerates after the recent slowdown, more efficient buildings and systems can enter the stock, reducing average energy intensity. Total energy consumption may increase, but at a slower rate than total floor area. The pace and extent of retrofitting of existing buildings, driven by energy prices, policies, and the availability of new technologies and services, will be extremely important in determining the future energy intensity of the service sector.

5 CONCLUSIONS AND ISSUES

While we are only midway in our analysis of service sector energy consumption, we have reached several important conclusions. First, we have seen that there are large differences in per-capita service-sector energy consumption between Europe and the US. Accounting for differences in climate, American buildings appear to have a heating intensity some 20-30% above European levels. The US and Canada also exhibit very much higher electricity intensity than most of Europe, in part due to the widespread use of air conditioning. Electricity intensity increases with decreasing electricity prices, reflecting the importance of this determinant of consumption. Other factors that shape the differences in the level of consumption among countries include the mix of fuels, the mix of building types, and building vintage.

We found definite signs of energy conservation, measured as a reduction in energy intensity, between 1972-73 and 1982. This decrease has occurred across most sectors and most fuels used for heating. Decline in oil intensity has led this overall drop. Gas and district heating have been the most common substitutes for oil. Overall electricity intensity has increased substantially in all countries, although in every country, gains in electricity efficiency are reported in HVAC systems as well as in lighting. Direct substitution of electricity for fuels is apparent mainly in Norway and Sweden. What is as yet unclear is the permanency of the decline in energy intensity, whether the changes were caused by new technology or

by adjustments to existing systems and reductions in comfort. We need more information on actions by building owners and managers to deal with this question.

In general, much more information needs to be gathered in order to make better sense of the changes in service-sector energy demand. A better understanding of the end-use structure of demand is needed. We need to quantify changes over time at the sub-sectoral level (as Sweden has begun to do), and look more at the different evolution of the sub-sectors. Information on conservation activity (as in the U.S. Department of Energy's NBECS survey),[6] can then be connected to data on changes in energy intensity. The U.S. survey is the only comprehensive national survey of virtually all energy products and building types. The French surveys appear to contain similar data, while a new survey is planned for Norway. No such surveys that include both energy consumption and building equipment characteristics have yet been undertaken in Canada, Denmark, or Germany.

Energy growth in the service sector, particularly for electricity, has outpaced that in homes and in some countries even that of industrial energy uses, suggesting that an understanding of this sector should be a high research priority. Yet it seems that many countries lack the kind of information that would guide policy and research decisions. Many tasks remain to be done if we are to increase our understanding of energy consumption in the service sector and how it is changing in response to energy prices. What we have presented here is a starting point. Better treatment of the service sector in surveys and other studies, including definition of its boundaries, would go a long way towards clearing up more of the mystery that has always shrouded energy consumption in this sector.

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Table 1

SERVICE SECTOR FLOOR AREA

	CANADA 1981	DENMARK 1982	FRANCE 1983	GERMANY 1982	NORWAY 1982	SWEDEN 1982	USA 1980
TOTAL AREA (E6 sq m)	380	80	689	1030	50	134	3955
AREA PER CAPITA (sq m)	15.6	15.6	12.7	16.7	12.7	16.1	17.4
HEATED AREA (E6 sq m)	-	-	495	-	-	134	-

Data on total area refer to utilized, enclosed floor area. Residential area has been removed from US data. Swedish data are for heated area.

Table 2
GROWTH IN FLOOR AREA OF SERVICE SUBSECTORS
AVERAGE ANNUAL GROWTH RATES (%)

*FRANCE 1978-80**	
EDUCATION	3.4
OFFICE	4.0
RETAIL/ARTISANS	3.2
HOTELS/RESTAURANTS	1.5
LARGE COMMERCE	12.4
HEALTH	5.5
GROUP FACILITIES	0.5
SPORTS/CULTURE	5.8
TRANSPORT	8.5
ALL SECTORS	4.5
*UNITED STATES 1970-80***	
OFFICE	2.8
RETAIL/WHOLESALE	3.4
WAREHOUSE	2.6
LODGING	2.8
INSTITUTIONAL	3.4
MISCELLANEOUS	2.0
ALL SECTORS	2.8

* Based on estimates.

** Based on a 1979 survey.

Table 3
HEATING FUELS IN THE SERVICE SECTOR
% OF TOTAL FLOOR AREA

	DENMARK 1980	FRANCE** 1984	NORWAY 1978	SWEDEN 1981	USA 1979
OIL	45	57	20+54*	44	17
DISTRICT HEAT	38	14	-	42	-
ELECTRICITY	2	8	24+54*	6	19
GAS	..	21	..	..	49

* First figure gives share using only that fuel; the second gives combinations of electricity and oil.
** 10% of the heated surface was excluded from the survey.
District heat includes solids and other sources.

Table 4
ENERGY CONSUMPTION IN THE SERVICE AND RESIDENTIAL SECTORS, 1982
DELIVERED ENERGY

	CANADA	DENMARK	FRANCE	GERMANY	NORWAY	SWEDEN	UK	US
TOTAL (PJ)								
SERVICE	743	69	535	765	64	150	719	5970
RESIDENTIAL	1230	177	1425	1880	129	336	1645	10255
IEA "OTHER"*	2173	327	1957	3012	215	559	2287	18640
PER CAPITA (GJ)								
SERVICE	30	14	10	12	16	18	13	26
RESIDENTIAL	50	35	26	30	31	40	29	44

Service sector consumption is for building uses only for Sweden. Estimated residential consumption has been removed from US service sector data. Source for residential consumption is the LBL OECD Residential Data Base.

* From *Energy Balances of OECD Countries 1970/82.*

Table 5
SERVICE AND RESIDENTIAL SECTORS
SHARES OF DELIVERED ENERGY CONSUMPTION, 1982 (%)

	OIL	GAS	DISTRICT HEAT	ELECTRICITY	SOLIDS
CANADA					
SERVICE	21	46	..	33	..
RESIDENTIAL	27	41	..	29	3
DENMARK					
SERVICE	37	1	28	34	..
RESIDENTIAL	55	2	22	15	6
FRANCE					
SERVICE	43	24	[6]*	31	2
RESIDENTIAL	48	23	3	16	10
GERMANY					
SERVICE	42	22	9	25	2
RESIDENTIAL	48	24	3	16	9
NORWAY					
SERVICE	35**	..	..	65	..
RESIDENTIAL	18	..	..	68	14
SWEDEN					
SERVICE	39	..	23	38	..
RESIDENTIAL	41	..	18	29	11
UNITED KINGDOM					
SERVICE	33	32	..	26	9
RESIDENTIAL	6	56	..	18	20
UNITED STATES					
SERVICE	17	44	3	34	2
RESIDENTIAL	15	49	..	26	9

Service sector consumption is for building uses only for Sweden. Source for residential consumption is the LBL OECD Residential Data Base.

* Fuel inputs for district heat are included under each fuel. These amounted to 6% of total consumption in 1978.

** Includes small amounts of other fuels.

Table 6
SERVICE BUILDINGS ENERGY CONSUMPTION*

	CANADA	DENMARK	FRANCE	GERMANY	NORWAY	SWEDEN	UK	USA
	1982	1982	1983	1982	1982	1982	1980	1979
DELIVERED ENERGY								
TOTAL (PJ)	743	69	547	765	64	150	706	5540
PER CAPITA (GJ)	30	14	10	12	16	18	13	25
PER SQ M. (MJ)	1895**	870	793	765	1290	1120	-	1325
PRIMARY ENERGY								
TOTAL (PJ)	1197	120	893	1155	144	270	1209	9620
PER CAPITA (GJ)	48	23	16	19	35	32	22	43
PER SQ M. (MJ)	3024**	1500	1295	1120	2870	2015	-	2300
CLIMATE INDEX	107.8	94.8	99.1	95.8	98.2	100.7	99.8	102.7
DD NORMAL (18C)	4581	3122	2450	3116	4069	4010	2917	2600

* Probably includes some non-buildings energy consumption in Canada, Denmark, and Germany. Residential consumption has been removed from US data.
** 1981

Table 7
SERVICE BUILDINGS
FUEL AND ELECTRICITY INTENSITY

	CANADA 1981	DENMARK 1981	FRANCE 1983	GERMANY 1982	NORWAY 1982	SWEDEN 1982	USA 1979
OIL/GAS/DH							
TOTAL (PJ)	493	48	364	571	23	92	3420
PER SQ M. (MJ)	1277	610	528	570	450	689	865
PER SQ M. AND DEG-DAY (KJ)	300	196	216	190	113	172	324
USEFUL ENERGY*							
PER SQ M. (MJ)	874	486	373	390	297	542	571
PER SQ M. AND DEG-DAY (KJ)	202	156	152	131	74	135	214
ELECTRICITY							
TOTAL (PJ)	227	22	183	194	42	58	2120
PER SQ M. (MJ)	597	280	265	188	838**	433	536
CLIMATE INDEX	94.5	100	99.1	95.8	98.2	100.7	102.7
DD NORMAL	4581	3122	2450	3116	4069	4010	2600

* Useful energy was calculated by assuming fuels were converted to heat with an efficiency of 66%, district heating with 100%.

** Electric intensity is 587 MJ/sq m in buildings without electric heat.

Table 8a
SERVICE BUILDINGS
SHARES OF DELIVERED ENERGY CONSUMPTION (% of column)

	OIL	ELECTRICITY	TOTAL ENERGY
FRANCE 1980			
OFFICES	8	21	11
LARGE COMMERCE	15	15	19
RETAIL/ARTISANS	23	21	19
TRANSPORT	5	6	5
HOTELS/RESTAURANTS	11	8	10
HEALTH	11	5	10
EDUCATION	19	5	15
SPORTS/CULTURE	4	13	6
GROUP FACILITIES	5	5	4
	100	100	100
GERMANY 1982			
GOVERNMENT	7	25	13
RETAIL	22	20	21
BANKS/INSURANCE	2	3	3
WORK SHOPS	12	9	9
LAUNDRIES	7	3	4
HOTELS/RESTAURANTS	11	9	11
HEALTH CARE	11	10	12
EDUCATION	12	4	13
POOLS/BATHS	2	3	4
OTHER SERVICES	13	13	10
	100	100	100

Note: See the "B" series in the Appendix for complete breakdowns of fuels by sector for these countries.

Table 8b
SERVICE BUILDINGS
SHARES OF DELIVERED ENERGY CONSUMPTION (% of column)
UNITED KINGDOM: 1980

	OIL	GAS	ELECTRICITY	TOTAL ENERGY
COMML OFFICES	9	15	19	13
GOVERNMENT	31	13	11	19
SHOPS	10	9	22	14
HEALTH	20	13	7	16
EDUCATION	19	20	8	17
OTHER	12	31	22	20
	100	100	100	100

Table 8c
SERVICE BUILDINGS
SHARES OF DELIVERED ENERGY CONSUMPTION (% of column)
USA: 1979

	GAS	ELECTRICITY	TOTAL ENERGY
OFFICE	16	24	19
RETAIL/SERVICES	14	15	12
STORAGE	14	13	12
AUTO SALES/SERVICE	5	3	4
FOOD SALES	6	9	6
LODGING	5	6	5
HEALTH CARE	8	6	8
EDUCATION	10	8	9
ASSEMBLY	9	6	8
OTHER	13	10	11
	100	100	100

Note: See the "B" series in the Appendix for complete breakdowns of fuels by sector for these countries.

Table 8d
SERVICE BUILDINGS
SHARES OF OIL CONSUMPTION (% of column)

DENMARK 1977

PRIVATE OFFICES	5
GOVERNMENT	2
RETAIL	6
WHOLESALE	37
OTHER SERVICES/TRANSPORT	6
SCHOOLS	14
HEALTH CARE	16
DAY INSTITUTIONS	1
OTHER INSTITUTIONS	9
SPORTS	3
	100

SWEDEN 1981

STORES/STORAGE	5
BANKS/INSURANCE	1
OTHER OFFICES	8
LODGING	4
COMMUNICATION	9
HEALTH CARE	25
EDUCATION	22
SPORTS	5
OTHER	11
	100

Note: See the "B" series in the Appendix for complete breakdowns of fuels by sector for these countries.

Table 9
SERVICE BUILDINGS
OIL INTENSITY BY BUILDING TYPE*
(MJ PER SQ METER)

DENMARK 1977

HEALTH CARE	1530
RETAIL/PRIV SERVICES	1330
SPORTS/LEISURE	1170
MISC INSTITUTIONS	1090
SCHOOLS	780
DAY CARE	735
GOVT/PUBL SERVICES	660
LODGING/OTHER SERVICES	605

SWEDEN 1977

THEATERS	1360
HOSPITALS	1290
OTHER CARE	1250
LODGING	1215
RELIGIOUS	1140
SCHOOLS	1140
OTHER ASSEMBLY	1140
OTHER OFFICE	1065
RETAIL/WHOLESALE	1065
BANKS/INSURANCE	1030
ALL	1140

* Refers only to buildings using oil for heating.

Table 10
ENERGY INTENSITY BY SERVICE SUB-SECTOR:
(TOTAL DELIVERED ENERGY (MJ) PER SQ METER)

*FRANCE 1980**

TRANSPORT	1186
HEALTH	1150
LARGE COMMERCE	1150
HOTELS/RESTAURANTS	837
RETAIL/ARTISANS	831
OFFICES	807
EDUCATION	716
SPORTS/CULTURE	509
GROUP FACILITIES	496
ALL	832

*UNITED STATES 1979***

HEALTH CARE	2975
FOOD SALES	2120
LODGING	1520
OFFICE	1410
AUTO SALES/SERVICE	1385
WAREHOUSE/STORAGE	1225
RETAIL/SERVICES	985
EDUCATION	985
ASSEMBLY	930
ALL	1305

* Based on estimates of total consumption and area.

** Based on survey.

Table 11
SERVICE BUILDINGS
ELECTRICITY SHARE OF ENERGY CONSUMPTION
(% OF DELIVERED ENERGY IN EACH CATEGORY)

	FRANCE 1980	GERMANY 1982	JAPAN 1976	NORWAY 1977	SWEDEN 1981	UK 1980	US 1979
OFFICES	44	-	55	-	52	-	48
PRIVATE	-	-	-	-	-	37	-
PUBLIC	-	51	-	50-60	-	15	-
RETAIL	25	23	65	66	52	53	44
HOTELS/RESTAURANTS	18	21	20/30	64	-	-	43*
SCHOOLS	8	8	19	45	19	13	32
HOSPITALS	11	18	20	45	34	12	26

* Hotels only; "Food sales," which includes grocery stores, has a 53% electricity share.

Table 12
SERVICE BUILDINGS
ELECTRICITY INTENSITY BY BUILDING TYPE
(MJ PER SQ METER)

	FRANCE 1980	GERMANY 1982	JAPAN 1976	NORWAY* 1977	SWEDEN 1982	US 1979
OFFICES	353	-	188	328/225	336	670
RETAIL	206	-	272	383/212	-	431
HOTELS/RESTAURANT	149	-	84	375/252	-	647**
SCHOOLS	57	108***	80	320/129+	173	318
HOSPITALS	126	224***	84	320/129+	247	783

* First figure is for buildings with electric heating, second for those without.
** Hotels only; "food sales", which include grocery stores, have a 53% electricity share.
*** Based on uncertain estimates of floor area.
+ Schools and Hospitals are not disaggregated.

Table 13
SERVICE BUILDINGS ENERGY CONSUMPTION BY END-USE
(PERCENTAGE OF TOTAL DELIVERED ENERGY)

	FRANCE 1983	GERMANY 1982	UK 1980	US 1975
SPACE HEATING	60	60	64	65
WATER HEATING	16*	16	11	3
COOKING	-	2	9	**
LIGHTING	**	9	12	12
AIR CONDITIONING	**	4	2	13
OTHER	24	9	2	7

* Includes cooking
** Included in "Other"

Table 14
SERVICE SECTOR ENERGY CONSUMPTION
AVERAGE ANNUAL GROWTH RATES (%)

	CANADA 1973-81	DENMARK 1972-82	FRANCE 1974-82	GERMANY 1971-83	NORWAY 1972-82	SWEDEN 1972-82	UK 1970-80	USA 1971-82
DELIVERED ENERGY								
TOTAL	0.6	-0.9	-0.9	0.0	1.8	0.7	0.3	0.4
PER CAPITA	-0.7	-1.1	-1.3	0.0	1.4	-0.4	0.2	-0.6
PRIMARY ENERGY								
TOTAL	0.9	1.3	1.4	1.5	4.5	2.4	1.2	1.8
PER CAPITA	-0.4	1.0	0.9	1.5	4.1	2.2	1.1	0.8

First and last years had roughly similar climate.

Table 15
SERVICE SECTOR ENERGY CONSUMPTION
SHARES OF TOTAL DELIVERED ENERGY (%)

	CANADA	DENMARK	FRANCE	GERMANY*	NORWAY	SWEDEN	UK	USA
OIL								
1971-73	40	55	72	68	63	62	48	25
1982	22	37	43	43	35	39	33	16
ELECTRICITY								
1971-73	30	16	16	14	37	25	20	25
1982	32	34	31	26	65	38	26	36
DISTRICT HEAT								
1971-73	-	27	-	3	-	13	-	-
1982	-	28	-	7	-	23	-	3
GAS								
1971-73	31	1	9	8	-	..	15	47
1982	45	1	24	21	-	..	32	46

* 20-25% of the German consumption is for non-commercial purposes.

Table 16
COMMERCIAL SECTOR ENERGY AND ELECTRICITY INTENSITY
(GJ PER SERVICE SECTOR EMPLOYEE)

	CANADA	DENMARK	FRANCE	GERMANY	NORWAY	SWEDEN	UK	US
				DELIVERED ENERGY				
1970	139	-	-	84	61*	65	56*	118
1971	137*	-	-	85*	66*	64*	52	117*
1972	150	57	-	91	61*	65	52*	116
1973	125	-	58*	94	55*	66*	51*	115
1974	122	-	56*	87	54*	60	48	108
1975	109*	49	50*	87	53*	62	47	103
1976	119	57*	51*	91*	54*	68	49	107
1977	117*	56	52*	87	55*	66*	51	102*
1978	115	54*	53*	92	53*	66	51*	100
1979	109*	54	52*	94	55*	65	52	99
1980	103	49	50*	84	53*	62	49	94*
1981	99	47*	49*	79*	54*	58	49	90
1982	102	46	48*	74	53*	55*	49	90*
				ELECTRICITY				
1970	30.2	-	-	11.5	18.7*	13.2	10.3*	26.4
1971	31.2*	-	-	12.1*	21.9*	14.8*	10.5	27.4*
1972	35.1	9.4	-	13.3	22.5*	16.2	10.7*	28.7
1973	36.5	-	9.2*	14.0	23.2*	17.1*	11.2*	30.0
1974	36.1	-	9.7*	14.4	26.5*	16.1	10.1	28.8
1975	34.7*	10.5	10.1*	15.1	26.3*	17.1	10.7	30.0
1976	36.9	12.0*	10.8*	16.2*	26.5*	18.7	11.0	30.5
1977	38.8*	12.9	11.4*	17.0	28.0*	18.8*	11.6	30.7*
1978	33.5	14.5*	12.1*	17.9	27.6*	19.7	12.1*	30.6
1979	34.3*	15.7	12.5*	18.2	29.8*	19.8	12.5	30.4
1980	32.8	14.8	12.9*	18.1	30.0*	20.5	12.4	30.7*
1981	31.1	14.7*	13.5*	18.9*	32.4*	20.3	12.8	32.2
1982	33.0	15.4	14.0*	19.2	34.5*	21.3*	12.8	32.4*

Source for employees: OECD Labour Force Statistics (Services includes major divisions 6-9 and 0 of the ISIC.)

* Years of weather within 2 index points of heating degree-day normal. (French and Norwegian consumption data were weather-nomalized by the source.) Annual fluctuations in cooling degree-days affect Canadian and US electricity data.

Table 17
SERVICE BUILDINGS ENERGY INTENSITY: SURVEY DATA*
(MJ per square meter, corrected to normal climate)

Building Heating Fuel	1970-73	1975	1977	1978	1979	1980	1981	1982	1983
OIL									
DENMARK	1350	1180	1190	1070	1050	900	810	800	770
GERMANY	1375	1192	1296	1200	1096	787	872	869	851
SWEDEN	-	-	1100	1100	1115	1094	956	882	850**
DISTRICT HEAT									
SWEDEN	-	-	815	770	651	634	697	684	695**

* Consumption shown is of the heating fuel only.
** 1983 values are preliminary.

Table 18

ENERGY INTENSITY FOR HEATING AND HOT WATER BY BUILDING TYPE IN SWEDEN

(Indicated units per sq meter heated floor area)

	YEAR	OIL (liters)			DISTRICT HEAT (kWh)		
		All Bldgs	Pre-1940 Bldgs	Post-1960 Bldgs	All Bldgs	Pre-1940 Bldgs	Post-1960 Bldgs
ACCOMODATIONS	1977	33	28	37	224	161	273
	1981	33	27	41	243	340	219
POST/TELE	1977	27	25	30	190	-	176
	1981	19	21	16	233	144	246
BANKS/INSUR	1977	28	26	29	272	348	270
	1981	32	26	33	149	247	147
OTHER OFFICE	1977	29	28	30	179	182	170
	1981	23	23	20	201	207	195
STORES/STORAGE	1977	29	32	26	186	167	190
	1981	21	23	19	200	211	193
HOSPITALS	1977	35	36	34	245	295	244
	1981	22	27	19	181	216	159
OTHER CARE	1977	34	27	37	283	-	275
	1981	29	30	29	209	159	208
SCHOOLS	1977	31	29	32	255	335	222
	1981	25	24	25	201	182	208
RELIGIOUS	1977	31	30	27	236	337	-
	1981	26	26	26	181	192	155
THEATERS	1977	37	34	49	188	226	-
	1981	35	34	22	250	244	227
OTHER ASSEMBLY	1977	31	35	28	227	219	240
	1981	25	28	20	198	196	194
SPORTS	1977						
	1981	31	27	31	269	303	254
OTHER	1977	31	31	31	174	281	154
	1981	31	18	36	238	236	187
TOTAL	1977	31	30	32	229	240	227
	1981	25	25	24	201	204	186

Appendix
Data on Energy and the Service Sector

This appendix describes the sources of the data that we have collected on energy use and structure in the service sector of various OECD countries, and discusses the status of data on the service sector in each country. Following the discussion are tables of time-series data on service sector energy consumption and tables presenting a disaggregation of service-sector energy consumption for a single year.

There are three kinds of data sources for each country. The first kind consists of time-series of energy deliveries to the service sector. We found time-series of one kind or another for every country since 1973, and for most countries since 1970-72. Although they are generally consistent over time, there are problems with respect to sector definition, as well as the problems associated with tertiary stocking of fuels. The various time-series contain different customers from one country to the next. We use these data to characterize overall trends. Data are given in the "A" tables.

The second kind of data are those arising from surveys of fuel use by building type and area. These are repeated at varying intervals in Sweden and the US, made occasionally in France, while in other countries there are estimates of energy consumption by building type made for one year. Some country studies also estimated the fraction of energy consumption (by fuel) going to each end-use. This procedure is relatively easy for oil, solids, and district heating, for which heating dominates, but more difficult for gas and extremely difficult for electricity. Snapshots for one year of each of 8 countries are shown in the "B" series.

The third kind of data are those characterizing the building stock. We found only a few reliable disaggregated time-series estimates (Denmark and Sweden from 1977), but reasonable estimates of overall floor area growth since the early 1970s for every country but Canada, Germany and the UK. The "C" series gives the building stock breakdowns for one year for each of eight countries.

The descriptions below do not exhaust the available information on energy use in the service sector, although they do give the main sources. By the same token, the data presented in this appendix represent only part of what we have collected. Other data describe floor area and heating fuels by sub-sector, and give further estimates of energy consumption by end-use. We also have micro-level data on results of energy conservation efforts.

Data on the service sector is beginning to become available for OECD countries other than the eight we present here. Data gathering efforts may be undertaken in Belgium and the Netherlands. We hope to include information from these surveys, as well as more data from Japan, in future work.

1 Canada

1.1 Energy Consumption

Data on energy consumption in the Canadian service sector are relatively sparse. Statistics on deliveries of the various energy products are published by Statistics Canada.[1] The category "Commercial" was split into "Commercial and other institutional" and "Public administration" beginning in 1978. With the exception of mass-metered apartment buildings, the category does not seem to include very much consumption that should be in a different category. In the data series we have assembled (Table A1), we have removed some gas and electricity consumption to account for the presence of mass-metered apartments in the Statistics Canada data. The amount removed in each year was based on estimates by Shell Canada of what residential sector energy consumption would be if such buildings were included in the statistics. There are to our knowledge no data

that allow disaggregation of Canadian service energy consumption.

1.2 Structure

Data on structure for the Canadian service sector are also relatively sparse. An estimate of total floor area and its composition by building type exists for 1981 only. This was provided by Chas. Ficner of the Ministry of Energy, Mines, and Resources, Ottawa. The amount of floor space, when expressed on a per capita basis, lies between that of the US and the European countries.

2 Denmark

2.1 Energy Consumption

Total energy deliveries to the Danish service sector ("handel og service") are not well-quantified. The Danish Boiler Federation (DKF) provides some estimates in their reviews of Danish energy use between 1972 and 1979, [2] as do the quarterly reports of the Energistyrelsen (National Energy Board), but the categories used make these sources not particularly useful. Data on district heating are poor, and city gas data only describe broad categories of customers. None contain detail at the national level. National electric power data contain some breakdown by building economic sector, and data compiled by DEFU, the research arm of the Danish Electricity Federation, show increasing detail of electricity sales after 1977. This is also true for the data from the Federation itself, though it is not possible to know how much the definitions of subsectors vary from utility to utility. In particular, the category "other" varies by $\pm$ 50% from year to year, suggesting it is really a residual. Furthermore, the sector "public consumption" contains buildings, assembly structures (including swimming pools), and waste treatment plants, among others, making this category difficult to use for analysis.

Recently, Energistyrelsen (The National Energy Authority) and the Ministry of Energy communicated to us many unpublished time series estimates of energy consumption and floor area.[3] Copenhagen: Energistyrelsen. The data series presented in Table A2 was assembled for us by Peter Hoffman of the Board of Energy. He estimated the service-sector share of oil and district heating consumption by taking a constant proportion of combined service/residential use. (This division is probably justified, given the nearly constant proportions of residential and non-residential space heated by these two fuels.) For electricity, he estimated sales for retail, wholesale, services, public, and other from Danish Utility Association data (after 1978), and extrapolated to earlier years (there being essentially no national data on residential or service-sector electricity consumption from before 1976).

There has been one study of energy consumption in the service sector: the "Fase Et" (Phase One) study of the Teknologisk Institut.[4] The researchers surveyed several hundred buildings and recorded oil or district heating consumption for the years 1975-1979. This is the only work that portions out oil or district heating use by building type. We used the totals, extrapolated for the entire stock, to show the breakdown of sectoral consumption for the year 1977 (Table B1). The totals are lower than Hoffman's estimates.

There are several excellent studies of individual building types that can be used to extend the "Fase Et" data to study energy use before and after conservation measures were taken.[5] There are also recent studies of buildings that have been retrofit after inspection by "Varmekonsulenter" (heat consultants). In 1984 an evaluation of the Heat Consultant program was begun by Statens Bygeforsknings Institut. The reports should

show how oil used has changed in major institutional buildings.

2.2 Structure

Statistics on the physical characteristics of the service-sector building stock have been gathered annually since 1980 (also in 1977) by the Bygning og Bolig Register (BBR). Characteristics include outer wall and roof material, size and shape (including volume), heating fuel, and number of units. Table C gives the distribution of floor area over building type for 1981.

Unfortunately, the BBR series is not actually run out anymore, so only the 1981 estimates by type, vintage, and heating fuel are available. The yearly "Energioversigt" of the Energistyrelsen now contains indicators that extrapolate total non-residential building space, excluding that for industrial and farm buildings.

3 France

3.1 Energy Consumption

Energy demand data for the service sector ("tertiare") have been estimated since 1970 by the CEREN (Centre d'Etudes et Recherches sur l'Energie), a private institution funded by various government agencies and utilities (including Electricitè de France - EDF). More systematic studies have been conducted since 1980 by the CEREN, and specific surveys conducted on the subsectors of Large Commerce (1980) and Health (1982).

Data on service sector energy consumption are published in aggregated form by the AFME[6] (Agence Francaise pour la Maitrise de l'Energie), and lately by the Observatoire de l'Energie.[7] These publications present energy consumption of various energy products in the "Tertiare" sector from 1973 to 1982, adjusted for annual climate variation. Disaggregation by end-uses is also given, splitting "space heating", "water heating and cooking", "public lighting", and "other electric appliances". The definition of the sector is not obvious, and might include some residual consumption from other sectors, or consider different definitions of the sector itself (accounting or not for transportation activities). Herein lay most of the differences between CEREN, EDF, and AFME estimates.

A complete disaggregation of French service-sector energy consumption by sub-sectors in 1980 (Table B2) is possible thanks to a study by EDF.[8] The consumption for 1980 is given in detail by fuel for 9 main subsectors, as well as estimates of the variation from the 1973 levels.

3.2 Structure

The EDF study also presents 1980 estimates on building stocks, and total and heated area of service-sector buildings, with a disaggregation into 16 sub-sectors (energy is split into 9). This allows consistent indicators for 1980, but doesn't permit the understanding of the evolution in the last ten years.

For previous years, estimates of service-sector building heated area in various categories have been made by BIPE (Bureau d'Information et de Prèvisions Economiques) for 1965, 1970, 1975, and 1980, giving an understanding of the general evolution of the stock. However, the 1980 BIPE estimate is 14% below the EDF value. This BIPE estimate of surveys has been used by CEREN for developing 1980 indicators per square

meter, giving results considerably higher than the EDF study.

The BIPE has more recently conducted two very reliable surveys, in 1983 and 1984, on the areas of the eight major subsectors (excluding Religious, Car Repairs, and Transportation), dividing them into 18 building categories. The 1984 survey[9] includes data on heated area and heating fuel used for each of the categories surveyed. Unfortunately, no energy consumption data is yet available at this level of detail for those recent years. We show the detail of the 1983 structure in Table C, and give the 1980 structure in Table B2.

4 Germany

4.1 Energy Consumption

Data on the German service sector are complicated by the fact that the statistical category "Kleinverbraucher" (small consumers) includes a number of consumer categories (such as construction, agriculture, and small industrial operations) that are not part of the service sector. Thus, the annual energy consumption data published by the energy statistics organization Arbeitsgemeinscaft Energiebilanzen do not accurately portray the service sector. We have nonetheless used these data to characterize historical trends for Germany. The oil consumption time series (Table 17 in the main text) from an industry panel covers an unspecified mix of buildings, but the panel is considered a representative barometer of average consumption (K.F. Holm, Deutsche Esso AG, priv. comm.)

Disaggregated estimates of service sector energy consumption have been made by the Energiewirtschaftliches Institut of the University of Koeln for 1978[10] and by Prognos AG for 1982.[11] The former work, carried out by Suding, surveyed several thousand firms and recorded actual energy use as well as many characteristics of buildings, but did not publish building area. We have used the latter work to characterize recent service sector energy consumption in Germany. Unfortunately, there are some inconsistencies between these studies.

4.2 Structure

There has never been a complete building census in Germany. Building removals and conversions to/from residential buildings cloud attempts to estimate building areas from construction statistics. The only data we found on the structure of the German service sector are estimates for 1982/83 of the floor area in four building categories.[12] The categories include the relatively homogeneous subsectors of health and education, as well as other, less well defined sectors. These are shown in Table C. "Hospitals include hotels and other "residence-like" buildings.

5 Japan

5.1 Energy

Energy consumption data are not officially disaggregated into the residential and services sectors. However, the Japan Institute for Energy Economics (IEE) surveyed the services sector in 1976 and reported its work in detail.[13] They report use of gas, oil, and electricity; traditionally gas includes LPG use, which may be significant, but it is not reported separately by sub-sector. IEE report about 78PJ of LPG, out of 120 PJ of gas. We give total energy use in Table B4, and we include several important facets of Japanese data in the text. IEE also report 1979 consumption data, but not floor area. Consumption in that year was 903PJ, about 10.5% higher than in 1976, and the increase was about the same across all fuels but not across all sectors. We give the 1979 total consumption in Table B4. Further treatment of Japanese data awaits the 1984 survey that was conducted by IEE.

5.2 Structure

The IEE study divided the stock into two groups. The first contains restaurants, small stores, places of entertainment, and personal services like barbers and laundries. For these the number of employees was counted and energy/employee surveyed; in this way total energy by fuel was obtained, but no estimates of areas were given. In these classes of buildings, 9.14×10^6 people worked in 1976. For other buildings, IEE surveyed building area, and reported on the categories shown in Table B4 and C.

6 Norway

6.1 Energy Consumption

Data on Norwegian service sector energy consumption come from several sources. The Central Bureau of Statistics (SSB) maintains a model that follows demand closely. Jon Sagen of the CBS provided us with an unpublished time series of total consumption (Table A5), with electricity shown separately (and oil accounting for practically all other consumption). [14] Other data sources include annual energy sales reports, which are detailed for the case of electricity.

A major survey of the sector (excluding public administration) was carried out in 1977 by the SSB.[15] The survey divided buildings (actually "bedrifter", or businesses) into three size classes, depending on the level of employment. Floor area, heated floor area, intensity, and consumption are tabulated according to whether the building used only electricity, only oil, or both fuels for space heating, allowing an estimate of electricity intensity for heating and for non-heating purposes. The survey was expanded to the entire population using the ratio of employment in the surveyed businesses to that in the entire country for the class of business/building. We show some results of Foyn's survey, aggregated up to the entire country, in Table B5, with a large unallocated term calculated as the difference between Foyn's data and those in Table A5.

As for evidence of energy conservation, Moen[16] reports the results of a detailed survey carried out by Oslo Lysvaerker (Oslo City Light) that measured energy use in a sample of buildings before and after conservation measures were applied.

6.2 Structure

Disaggregated data on floor area and heating fuel are available for 1977 from the SSB survey. We show the most important categories in Table C.

7 Sweden

7.1 Energy Consumption

Data on Swedish service sector ("lokaler") energy consumption are of mixed quality. There is an excellent record of electricity sales by economic subsector. The data on oil, gas, and district heating are poor until 1977, when a survey of the use of these fuels in service-sector buildings was begun by the Central Bureau of Statistics (SCB).[17] That survey, which has continued annually, formed the basis of a complete review and statistical reconstruction of the buildings sector by Carlsson.[18] We use his estimates of oil, gas, and district heat consumption back to 1970 in Table A6.

The SCB surveys allow a disaggregation of service-sector buildings oil and district heat consumption by nearly 20 building types (Table B6). Since data on floor area were also collected, changes in energy intensity in each sub-sector can be seen. The use of electricity for non-heating purposes in buildings heated by oil or district heat is not documented by the SCB survey (although the data appear to be collected). We added SCB electric power and gas sales statistics to the data from the building survey, but the categories do not match completely.

In 1984, a major study of energy use in all buildings was carried out as part of the evaluation of the national energy conservation program. Among the contributions to this study were Carlsson's, an evaluation of service-sector building stock in recent years, and an energy model that traced service-sector energy use from 1970 to 1982 (based on work initially done at LBL). Hence the picture of energy use in the service sector in Sweden is very complete, and almost as detailed as that provided for the US for 1979. As a time series, the Swedish data after 1977 are the best we encountered, in spite of the small uncertainties over electricity.

7.2 Structure

The SCB surveys, which use a sample of 4000 properties, cover many important physical aspects of buildings. The building stock is broken down by nearly 20 types, three vintages, four climate zones, and several heating fuels. Results for 1981 are given in Table C.

8 United Kingdom

8.1 Energy Consumption

Annual statistics on energy consumption in the "Public Administration" and "Miscellaneuos" categories are published annually by the Dept. of Energy (Table A7).[19] The "Miscellaneous" category is primarily private commercial customers (it does not include agriculture). The Dept. of Energy also publishes statistics on sub-sectoral consumption of diesel fuel and fuel oil (since 1981), gas (since 1978), and electricity (since the 1960s); the categories are different in each case. A disaggregation of energy supplied to the service sector using common categories exists for 1979 and 1980. The latter work, done by the government's Energy

Technology Support Unit,[20] estimates consumption of solids, liquids, gases, and electricity in seven end-use categories for six sub-sectors (Table B7). The breakdown by end-use makes this work unique among the studies we have seen.

8.2 Structure

We have found two estimates of floor area, but in both cases the area referred to is "ratable" (taxable) area, which is apparently less than heated or total area. These estimates result in a level of per capita floor area that is about half that found in the other European countries. In Table C we give the distribution of building types according to share of rateable area, but we give the total utilized area as well. Results of a survey from ETSU should be made available in late 1985.

9 United States

9.1 Energy Consumption

Statistics on deliveries of the various energy products to the service sector are published by the Energy Information Administration (EIA) in the annual State Energy Data Report(Table A8). [21] The EIA service sector definition includes energy consumed at non-manufacturing business establishments; health, social, and educational institutions; and government entities. The statistics include some master-metered residential usage (a considerable amount in the case of oil) and agricultural use of natural gas. There is also a small amount of motor gasoline, which we have removed. The statistics do not include consumption of steam.

EIA's *Nonresidential Buildings Energy Consumption Survey* (NBECS), conducted in 1979, is a wealth of data for disaggregating the service sector.[22-24] The data presented in Table B8 are only the tip of the iceberg. Results of the 1983 repeat survey will be available in June 1985 (for structural characteristics), but not until 1986 for consumption characteristics.

9.2 Structure

The NBECS data also provide considerable information on the structure of the service sector as of 1979. There are no comparable data for other years, but EIA has made national and regional estimates of the floor area of various building categories in the 1970-80 period for their Commercial Sector Energy Model.[25] These estimates were made using NBECS data. The share of area in various building types is shown in Table C.

Data Sources

1. Statistics Canada, *Detailed Energy Supply and Demand in Canada* (various years). Ottawa.

2. Danmarks Kedel Foreningen, 1974-79. *Danmarks Energibalancer.* Copenhagen: Danmarks Kedel Forening.

3. See for example Anon., 1984. *Energioversigt.* 2 Kvartal 1984.

4. Christensen, F., and Ljungmark, P., 1981. *Existerende Bygningers Energimaessige Tilstand.* Taastrup: Teknologisk Institut.

5. Statens Bygeforskningsinstitut, 1980, 1981. Reports 106 and 116. Hørsholm.

6. AFME (previously AEE), 1980 - 82. *Les consommations et les èconomies d'ènergie du secteur rèsidentiel et tertiare, edition 1980, 1981, 1982.*

7. Ministère de L'Industrie et de la Recherche, 1984. *L'Energie dans les Secteurs Economiques, donnees receuillies par l'Observatoire de l'Energie.*

8. Electricite de France - SEPAC, 1983. Observatoire Tertiaire - Fiches de Synthèse.

9. BIPE (Bureau d'Informations et de Prèvisions Economiques), 1985. *Analyse Règionale des Modes de Chauffage dans les Bâtiments Tertiaires.* Paris.

10. Suding, P., 1982. *Detaillierung des Energieverbrauchs in der Bundesrepublik Deutschland.* Energiewirtschaftliches Institut an der Universitaet Koeln, Koeln.

11. Prognos AG, 1984. *Die Entwicklung des Energieverbrauchs in der Bundesrepublik Deutschland* und seine Deckung bis zum Jahr 2000. Basel.

12. Rudolph, R. 1984. *Struktur der Gebauede und Heizungssysteme in der Bundesrepublik Deutschland.* GEWIPLAN, Frankfurt am Main.

13. I. E. E., 1980. *National Living Standards and Energy Demand* (Summarized by IEE in English) Report IEE-SR129 (80-10). Tokyo: Japan Inst. of Energy Economics.

14. Sagen, J., 1985. Material prepared for the workshop "Electricity Use in the Services Sector", Electric Power Research Institute, Palo Alto, Ca., March 1985.

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"Electricity Use in the Services Sector", Electric Power Research Institute, Palo Alto, Ca., March 1985.

17. Bjoerck, G. 1978-. *Energistatistik foer Lokaler.* Oerebro: Central Bureau of Statistics.

18. Carlsson, L.G. 1984. *Energi Anvaendning i Bostaeder och Lokaler.* R131:84. Stockholm: Sw. Council for Building Research.

19. Department of Energy (various years). *Digest of United Kingdom Energy Statistics.* London.

20. Energy Technology Support Unit (1984). *Energy Consumption in the United Kindgom in 1980.*

21. Energy Information Administration, 1984. *State Energy Data Report. Washington:* U.S. Dept. of Energy.

22. Energy Information Administration, 1981. *Nonresidential Buildings Energy Consumption Survey: Fuel Characteristics and Conservation Practices.* Washington, D.C.: U.S. Dept. of Energy.

23. Energy Information Administration, 1983. *Nonresidential Buildings Energy Consumption Survey: 1979 Consumption and Expenditures. Part 1: Natural Gas and Electricity.* Washington, D.C.: U.S. Dept. of Energy.

24. Energy Information Administration, 1983. *Nonresidential Buildings Energy Consumption Survey: 1979 Consumption and Expenditures. Part 2: Steam, Fuel Oil, LPG and All Fuels.* Washington, D.C.: U.S. Dept. of Energy.

25. Energy Information Administration (1984). *Model Documentation: Commercial Sector Energy Model.* Washington, D.C.: U.S. Dept. of Energy.

General Notes for Data Tables

[1] LPG is included under "Oil" except in the case of Germany, where it is aggregated under "Gas".

[2] In estimating primary energy consumption, we have used the same factors for all countries: 1.33 times delivered district heat consumption, 2.89 times delivered electricity consumption.

[3] The time-series and survey data are not adjusted for annual climate differences, except in the case of France and Norway, where the original data were so adjusted.

[4] Notation: .. signifies a small quantity; a dash or blank space signifies that data are unavailable.

Table A1
SERVICE SECTOR ENERGY CONSUMPTION
COUNTRY: CANADA
Energy units: PJ

YEAR	OIL	GAS	SOLIDS	DH	ELEC	TOTAL DELIVERED	TOTAL PRIMARY	DEG-DAY INDEX	AREA E6m^2
1970	360	203/155	12	-	159/147	734/674	/952	103.5	
1971	346	232/180	8	-	172/157	758/691	/988	101.5	
1972	374	281/222	5	-	203/184	863/785	/1133	108.7	
1973	277	269/208	2	-	222/201	770/688	/1068	96.1	
1974	265	300/232	1	-	234/208	800/706	/1099	102.1	
1975	209	308/238	-	-	237/208	754/655	/1048	99.6	
1976	248	331/256	-	-	257/225	836/729	/1154	104.1	
1977	220	353/276	-	-	278/245	851/741	/1204	98.9	
1978	237	339/294	2	-	245/219	823/752	/1166	106.3	
1979	207	348/300	1	1	259/233	816/742	/1182	100.9	
1980	199	333/292	1	1	261/232	795/725	/1163	104.1	
1981	184	356/308	1	..	270/227	811/720	/1149	94.7	380
1982	167	393/334	1	1	279/240	841/743	1197	105.0	
1983	152	387/(337)	1	1	291/(251)	832/742	/1216	96.5	

Source: Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada,* various years, *Detailed Energy Supply and Demand in Canada,* various years. *Sector definition*: "Public administration" and "Commercial and other institutional" after 1977; "Commercial" for 1977 and before. For gas, electricity and total, the first number is as reported by Statistics Canada; the second number is after residential consumption (mass-metered apartments) as estimated by Shell Canada has been removed. Before 1973, oil may include some non-commercial energy consumption. Degree-day normal: 4581 (18°C). Area: estimate from Ministry of Energy, Mines, and Resources (C. Ficner)

Other notes: Oil includes light and heavy fuel oil, kerosene, and gas plant LPGs (estimated before 1979). Sectoral breakdown of refinery LPGs was not given. Excluded are motor gasoline, diesel fuel oil, aviation gasoline, and aviation turbo fuel (these are included for some years in the Statistics Canada tabulations).

Table A2
SERVICE SECTOR ENERGY CONSUMPTION
COUNTRY: DENMARK
Energy units: PJ

YEAR	OIL	GAS	SOLIDS	DH	ELEC	TOTAL DELIVERED	TOTAL PRIMARY	DEG DAYS INDEX	AREA $E6m^2$
1972	41.8	1.0	..	20.4	12.4	75.6	105.8	95.5	63
1975	34.1	0.9	..	17.6	14.4	67.0	100.0	90.1	69
1976	40.6	0.8	..	19.3	16.1	76.8	113.6	99.4	70
1977	38.8	0.8	..	19.7	17.8	77.1	117.2	94.3	72
1978	34.9	0.7	..	20.0	20.4	76.0	121.2	99.4	74
1979	34.2	0.7	..	21.1	23.0	79.0	129.4	108.6	75
1980	32.0	0.7	..	19.9	22.8	75.4	125.1	103.2	77
1981	28.3	0.6	..	19.3	22.0	70.2	118.1	100.0	79
1982	25.9	0.6	..	19.6	23.3	69.4	119.9	94.8	80
1983	23.5	0.5	..	19.6	23.7	67.3	118.6	92.3	82

Source: Peter Hoffmann, Energistyrelsen (ENS). Tables assembled for LBL from Energistyrlsen Quarterly and Yearly Reports. City gas is estimated herein, as it is not provided by ENS; there was no reported natural gas use through 1983.

Sector definition: "Handel og Service" (business and services). Includes virtually all non-residential buildings except those for agriculture and greenhouses. Electric power statistics also include electricity consumed by publicly owned enterprises such as electric, gas, and water utilities and street lighting.

Degree-day normal: 3122 (18C), calculated from the ENS defined shadow/sun average value of 2691 by adding 431 DD/yr to the ENS value.

Area: includes all non-residential buildings; from BBR after 1977 and estimated by ENS and others for 1972-1977.

Table A3
SERVICE SECTOR ENERGY CONSUMPTION
(Consumption *corrected* for climate)
COUNTRY: FRANCE
Energy units: PJ

YEAR	OIL	GAS	SOLIDS	DH*	ELEC	TOTAL DELIVERED	TOTAL PRIMARY	DEG-DAY INDEX	AREA $E6m^2$
1973	423.6	55.4	14.0	-	93.4	586.4	762.9	104	484
1974	398.5	61.2	14.0	-	101.2	574.9	766.2	96	
1975	335.7	67.3	14.0	-	106.8	523.8	725.7	100	
1976	348.3	74.5	11.2	-	117.0	551.0	772.1	99	
1977	348.3	88.2	11.2	-	127.5	575.2	816.2	95	
1978	344.1	105.5	8.4	[47.7]*	137.6	595.6	855.7	101	
1979	327.3	107.6	5.6	-	145.0	585.5	859.6	101	
1980	281.3	114.5	5.6	-	151.3	552.7	838.7	104	663
1981	239.4	122.8	8.4	-	158.9	529.5	829.8	97	
1982	231.1	127.4	8.4	-	168.4	535.3	853.6	94	
1983	218.5	134.3	11.3	-	183.1	547.2	893.3	99	689

Sources: Observatoire de l'Energie - Ministere de l'Industrie et de la Recherche; AFME - Agence Francaise pour la Maitrise de l'Energie; CEREN - Centre d'Etudes et de Recherches Economiques sur l'Energie; CDF - Charbonage de France; CPDP - Comite Professionnel du Petrole; EDF - Electricite de France; GDF - Gaz de France.

Sector definition: "Tertiaire"; agriculture use in the electricity consumption data has been removed. Degree-day normal: 2450 DD (base 18C). Area: 1973 and 1980, estimates from EDF; 1983, from BIPE survey.

* Energy used in district heating is included in values for oil, gas, and coal. Breakdown is available for 1978 only: 28.9 PJ of oil, 4.2 PJ of gas, and 14.6 PJ of coal and other fuels.

Table A4
SERVICE SECTOR ENERGY CONSUMPTION
COUNTRY: W. GERMANY
Energy units: PJ

YEAR	OIL	GAS	COAL	DH	ELEC	TOTAL DELIVERED	TOTAL PRIMARY	DEG-DAY INDEX	AREA E6m^2
1970	612	64	100	35	129	940	1195	106.2	
1971	665	76	67	32	138	978	1248	98.8	
1972	703	108	56	38	155	1060	1365	105.6	
1973	721	129	62	38	167	1117	1444	103.0	
1974	633	144	59	38	173	1047	1386	91.5	
1975	636	147	44	38	182	1047	1401	96.4	
1976	645	182	35	44	196	1102	1488	101.1	
1977	612	179	29	41	208	1069	1477	93.7	
1978	671	176	26	50	223	1146	1582	102.8	
1979	689	185	38	56	231	1199	1655	103.4	
1980	551	202	35	62	234	1084	1547	104.3	
1981	481	214	26	64	246	1031	1518	99.2	
1982	416	205	26	64	249	960	1453	95.8	
1983	410	220	26	64	258	978	1488	98.3	1030

Source: Arbeitsgemeinschaft Energiebilanzen (original units: million tons of coal equivalent = 29.3 PJ)

Sector definition: "Kleinverbraucher"; includes agriculture (including greenhouses), construction, and small industrial operations. We have removed gasoline and diesel from the original data, thus removing some of the consumption in non-buildings categories. For 1978, consumption in the non-commercial categories (not including small industry) was: total site - 5.8, oil - 4.2, gas - 0.6, coal - 0.3, dh - 0.1, electricity - 1.1. For 1982, consumption in the non-commercial categories (including small industry) was: total site - 6.9, oil - 3.3, gas - 1.2, coal - 0.5, dh - 0.0, electricity - 1.9. Degree-day normal: 3074 (base 18 ° C), 1970-83 average Area: Total used area; from Rudolph (1984).

Table A5.
SERVICE SECTOR ENERGY CONSUMPTION
COUNTRY: NORWAY
Energy units: PJ (weather normalized)

YEAR	OIL	GAS	SOLIDS	DH	ELEC	TOTAL DELIVERED	TOTAL PRIMARY	DEG DAYS INDEX	AREA E6m^2
1970					13.7	44.3	70.2	105.9	37.9
1971					16.4	49.7	80.7	100.0	38.7
1972					19.9	53.7	91.3	98.2	39.8
1973					21.0	50.1	89.8	98.9	40.7
1974					24.3	49.7	95.6	90.0	41.6
1975					25.3	50.7	98.5	92.6	42.7
1976					27.2	55.6	107.0	104.0	43.9
1977					29.9	58.6	115.1	102.0	45.0
1978					30.5	58.7	116.3	105.4	46.0
1979					34.2	63.3	127.9	108.5	47.2
1980					35.4	63.2	130.1	106.1	48.0
1981					38.6	64.3	137.3	105.6	49.0
1982					41.9	64.4	143.6	98.2	50.0
1983					42.3	64.1	144.0	93.6	51.2

Source: Jon Sagen, Central Bureau of Statistics

Sector definition: Probably mostly buildings. Area: estimated based on a 1977 survey (Foyn) and data on new construction. The total includes electricity and a residual which is mostly oil, but a small amount of city gas (<1 PJ before 1973) and wood (probably less than 2PJ during the entire period), which is not included in the totals, was also consumed.

Table A6
SERVICE SECTOR ENERGY CONSUMPTION
COUNTRY: SWEDEN
Energy units: PJ

YEAR	OIL	GAS	COAL	DH	ELEC	TOTAL DELIVERED	TOTAL PRIMARY	DEG-DAY INDEX	AREA E6m^2
1970	91.4	0.4	1.4	14.0	27.1	134.4	190.1	112.3	98
1971	86.8	0.4	0.7	16.2	31.2	135.3	199.6	98.3	
1972	86.8	0.4	0.4	18.0	34.9	140.4	212.2	97.4	-
1973	87.8	0.3	0.4	18.0	37.1	143.7	219.7	99.5	
1974	80.6	0.3	0.3	16.6	35.9	133.7	207.0	89.3	
1975	83.5	0.3	0.1	19.4	39.7	143.0	224.4	88.5	115
1976	91.8	0.3	..	24.8	44.6	161.6	254.0	106.7	
1977	87.8	0.3	..	27.0	45.9	161.1	256.7	102.0	-
1978	85.0	0.3	..	29.5	49.2	164.0	266.7	108.8	124
1979	85.0	0.3	..	31.3	51.1	167.8	274.6	111.9	
1980	76.3	0.3	..	32.8	53.9	163.4	276.0	111.6	
1981	64.8	0.3	..	34.2	54.1	153.4	266.9	107.9	-
1982	57.8	0.3	..	34.2	57.6	150.0	270.2	100.7	134
1983	46.8	0.3	0.1	33.9	60.4	141.4	266.8	95.6	-

Source: Carlsson (1984) (oil/gas/coal/DH); Statens Vattenfall (C. Hedenstroem, priv. comm.) (electricity) Sector definition: Buildings only. Degree-day normal: 4010 (base 18C). Area: estimates by Carlsson (1984).

Other notes: Wood used for heating and hot water is included in gas. City gas used for cooking and other purposes (estimated at 1.0 PJ in 1970, falling to 0.2 PJ in 1982) is not included.

Table A7
SERVICE SECTOR ENERGY CONSUMPTION
COUNTRY: UNITED KINGDOM
Energy units: PJ

YEAR	OIL	GAS	SOLIDS	DH	ELEC	TOTAL DELIVERED	TOTAL PRIMARY	DEG DAYS	AREA E6m^2
1970	319	80	176	-	130	705	951	98.5	
1971	320	91	126	-	135	672	927	93.7	
1972	326	105	111	-	139	681	944	99.3	
1973	327	114	101	-	151	693	978	98.2	
1974	290	134	97	-	138	659	920	95.4	
1975	291	142	73	-	150	656	940	96.0	
1976	304	160	70	-	155	689	982	97.5	
1977	322	167	74	-	164	727	1037	96.9	
1978	305	184	70	-	173	732	1059	98.5	
1979	306	208	69	-	183	766	1112	107.9	
1980	263	217	62	-	185	727	1077	99.8	
1981	253	223	60	-	188	724	1079		
1982	236	230	63	-	190	719	1078		
1983	224	238	62	-	200	724	1102		

Source: Digest of United Kingdom Energy Statistics Sector definition: Public Administration and Miscellaneous. (Misc. does not include agriculture). Degree-day normal: 2380 (15.5 C).

Other notes: Estimates of commercial building floor area by the Central Electricity Generating Board and J. Wilson of The Energy Technology Support Unit, Atomic Energy Research Establishment, Harewell, for 1979 are 369 and 402 million sq meters, respectively. These values refer to taxable, heated area. The resulting value for area per capita (6.6-7.2 sq m) is well below similar values for other countries.

Table A8
SERVICE SECTOR ENERGY CONSUMPTION
COUNTRY: USA
Energy Units: PJ

YEAR	OIL	GAS	COAL	STEAM	ELEC	TOTAL DELIVERED	TOTAL PRIMARY	DEG-DAY INDEX	AREA $E6m^2$
1970	1545	2609	228	-	1269	5652	8050	102.6	3129
1971	1504	2729	214	-	1361	5808	8380	99.5	3266
1972	1522	2825	165	-	1486	5999	8807	103.4	3411
1973	1559	2794	158	-	1602	6114	9142	93.6	3504
1974	1414	2761	161	-	1584	5920	8915	96.0	3654
1975	1288	2698	132	-	1686	5803	8989	96.7	3776
1976	1439	2867	128	-	1769	6204	9546	102.4	3897
1977	1487	2688	129	-	1850	6155	9651	99.4	4005
1978	1417	2788	137	-	1914	6254	9871	106.8	4108
1979	1297	2992	121	(215)*	1956	6366	10062	102.7	4173
1980	1245	2816	93	-	2012	6166	9967	100.9	4159
1981	1053	2727	105	-	2145	6026	10082	96.7	-
1982	970	2820	120	-	2191	6102	10243	98.8	-
1983	~ 800	2633	(100)	-	2246	5779	10024	98.8	

Source: U.S. Dept. of Energy (1984), *State Energy Data Report* (SEDS) (original units: trillion Btu = 1.055 PJ); Petroleum Supply Annual 1983; Natural Gas Annual 1983; Electric Power Annual 1983

* - From NBECS; value not included in totals.

Sector definition: Energy consumed at non-manufacturing business establishments; health, social, and educational institutions; and government entities. SEDS includes some residential consumption in large apartment buildings (a considerable amount in the case of oil) and agricultural use of natural gas. Consumption of motor gasoline has been removed from SEDS data. Degree-day normal: 2600 (base 18C) (1970-82 average). Area: estimates by EIA based on NBECS survey data (Energy Information Administration, 1984).

Table B1

DENMARK: ENERGY CONSUMPTION AND AREA BY BUILDING TYPE, PJ (1977).

	TOTAL DELIVERED	OIL	LPG	GAS	COAL	DH	ELEC.	AREA* %
CATEGORY:								
Private Offices	-	1.76	-	-	-	1.09	-	
Public Administration	-	0.80	-	-	-	0.50	-	
Retail, Wholesale	-	14.31	-	-	-	8.75	-	
Other Service/Transport	-	2.05	-	-	-	0.84	-	
Education	-	4.65	-	-	-	4.02	-	18.9
Hospitals	-	3.43	-	-	-	1.21	-	8.4
Day Care	-	2.05	-	-	-	1.63	-	1.8
Other Institutions	-	2.85	-	-	-	1.17	-	3.9
Sports/Leisure	-	1.21	-	-	-	0.46	-	4.4
Other/Unallocated	-	5.7	<-	1	0	2.7	0.6	33.3
TOTAL	-	33.8	1.0	-	-	19.7	17.8	66.3**

Source: Teknologisk Institut (1981) for detailed breakdowns, Energistyrelsen for totals, Bolig og Bygning Register (BBR) for stock data. Category definitions: "Hospitals" includes hospitals and resthomes ("dogninstitutioner"). "Day care" ("dagsinstitutioner") includes child care and day facilities for retired people. "Education" includes educational and research buildings. "Other institutions" includes jails and military barracks. "Sports and leisure" includes hostels, sports halls, and resorts.

Table B2
FRANCE: ENERGY CONSUMPTION AND AREA BY BUILDING TYPE, PJ (1980).

	TOTAL (DELIVERED)	OIL/OTHER	GAS	ELEC.	AREA %
CATEGORY:					
Hotels/Restaurants	57.7	34.8	12.7	10.26	14
Group Facilities	23.6	15.9	1.8	5.86	6
Health	57.5	32.2	19.0	6.28	10
Education	81.3	56.9	17.8	6.53	23
Sports, Culture	35.8	11.7*	8.63	15.5*	10
Offices	58.9	23.5	9.67	25.8	15
Large Commerce	106.5	46.1	42.1	18.3	5
Retail, Artisans	102.8	69.1	8.29	25.5	16
Transport	27.5	15.5**	5.15**	6.87	2
TOTAL	551.7	305.6	125.2	120.8	663***

Source: Electricite de France. Category definition: Hotels/Restaurants includes cafeterias and bars. Group Accomodations ("Habitats Communautaires") includes army barracks, prisons, religious communities, vacation resorts, union halls. Health includes public and private facilities. Education includes research facilities. Sports & Culture includes some vacation centers, entertainment, museums, libraries, zoos, assembly buildings, churches. Offices includes public and private. Large Commerce includes supermarkets, large stores and markets, wholesale commerce. Retail & Artisans includes small commerce, garages. Transport includes air, rail, and other buildings.

Area refers to estimated total area. Heated area is much less in the categories Group Facilities, Sports & Culture, Large Commerce, Retail & Artisans, and Transport,

* Public lighting accounted for 9.5PJ.
** Heating only.
*** Million sq meters.

Table B3
W. GERMANY: ENERGY CONSUMPTION AND AREA BY BUILDING TYPE, PJ (1980).

	TOTAL DELIVERED	OIL	GAS	COAL	DH	ELEC.	AREA $10^6 m^2$
CATEGORY:							
Work shops	69.2	39.4	7.9	4.2	0.2	17.4	
Retail	163.9	70.1	43.9	3.2	8.6	38.0	
Banks/insurance	25.8	7.4	10.8	0	1	6.6	
Laundries	30.8	23.4	1.7	0	0	5.6	
Lodging/restaurants	85.6	36.0	29.9	0.5	1.4	17.8	
Private health care	15.2	6.3	2.7	0	5.7	6.1	
Hospitals	72.8	27.0	12.7	0.4	19.7	12.9	110
Schools	101.6	39.5	24.1	3.1	26.3	5.6	80
Pools/baths	27.1	6.6	88	0	5.1	6.6	
Other services*	76.7	41.6	8.5	0	1.2	25.1	
Govt. buildings	96.5	20.6	20.5	4.1	2.1	49.0	
TOTAL	765.3	317.8	171.7	15.6	71.4	194.0	1030

Source: Prognos AG (1984), based on Suding 1982. Gasoline and diesel ("Uebrige mineraloelprodukte") have been removed. Gas includes LPG.

* Private and public.

Table B4

JAPAN: ENERGY CONSUMPTION AND AREA BY BUILDING TYPE, PJ, (1976 and 1979).

	TOTAL DELIVERED	OIL	GAS*	ELEC.	AREA* %	1979 Consumption
CATEGORY:						
Wholesale/Retail	124.8	28.0	11.22	72.9	**	124
Restaurants	72.63	18.6	32.7	21.8	**	82.4
Laundry, Barber, Bath	69.9	34.48	20.68	13.6	**	72.6
Entertainment	8.84	3.45	1.0	4.45	**	10.2
SUB-TOTAL	262.6	84.2	65.5	112.9	**	289.2
Offices	207.7	72.66	15.71	108.0	234.5	224.1
Dept. Stores, Supermkts	32.3	6.46	4.85	21.0	25.92	38.9
Hotels	104.7	76.43	7.33	20.94	50.01	115.3
Theaters, movie	16.4	7.87	1.0	7.54	17.03	16.6
Education	96.0	63.3	14.4	18.23	269.64	102.6
Hospitals	110.35	77.2	11.0	22.07	58.57	116.9
SUB-TOTAL	556.1	304.0	54.3	197.8	655.5	612.6
GRAND TOTAL	818.1	388.2	119.0	310.7	..	903.0

Source: Survey by the Japan Institute of Energy Economics (IEE). IEE does not give any other fuels, although "Gas" includes 78.6 PJ of LPG. IEE does give energy (but not area) for 1979, which we give in the last column.

* Million sq. meters. ** IEE gives data for employees only. Total for the first four sectors was 9.14×10^6 employees.

The categories in the first group refer mainly to small establishments particularly stores. Many of these are in malls or other space the area of which is shared by many establishments. "Theaters and movie" probably includes assembly (sports, worship, etc.).

Table B5
NORWAY: ENERGY CONSUMPTION AND AREA BY BUILDING TYPE, PJ (1977).

	TOTAL DELIVERED	OIL	GAS	SOLIDS	DH	ELEC.	AREA $10^6 m^2$
Retail and Wholesale	10.8	6.48	0	..	0	10.3	11.26
Hotels, Restaurants	4.5	1.62	0	..	0	2.87	2.53
Transport, Warehousing	0.83	0.22	0	..	0	0.61	0.34
Banks and Insurance	2.55	1.08	0	..	0	1.47	1.62
Health, Education, other*	4.11	2.27	0	..	0	1.84	2.42
Assembly	0.15	(0)	0	..	0	0.15	0.22
Other Private**	3.96	2.92	0	..	..	1.04	1.40
Govt/Administration***	25.8	14.1	0	..	0	11.7	
TOTAL	58.6	28.7	0	..	0	29.9	46.3

Data for the first six categories are from Foyn, Central Bureau of Statistics, and cover SN categories 6, 7116, 7123, 7132, 719, 8 (ex 8311), and 9 (except 91). Totals and residual from Statistiska Sentralbyraa, Jon Sagen (priv. comm.). We have no information on solid fuel used, but there is probably some consumption (at most a few PJ), judging by the continued use of wood in the residential sector. City gas use was very low by this time, at most 0.3PJ.

* Public schools and hospitals are excluded from "Health, Education" and appear instead under "Govt/Admin".

** "Other private" includes laundries and repair and other private services from SN 90.

*** All buildings owned by national and local authorities, including public administration, schools, hospitals, etc. Calculated as the residual obtained by comparing the first six categories with the data for 1977 in Table A6.

Table B6
SWEDEN: ENERGY CONSUMPTION AND AREA BY BUILDING TYPE, PJ, (1981).

	TOTAL DELIVERED	OIL	GAS	COAL	DH	ELEC.	AREA %
CATEGORY:							
Stores/Storage	-	9.00	..	0	2.50	12.64	7.7
Restaurants/Hotels	-	2.60	-	-	1.09	-	4.05
Bank/Insurance	-	0.35	..	0	2.14	1.22	3.7
Other Offices	-	4.82	..	0	6.23	3.46*	13.2
Post/Tele	-	5.60	..	0	0.12	-	0.8
Hospitals	-	11.10	..	0	7.80	7.16	18.9
Other Care	-	3.80	..	0	1.00	^	5.4
Schools	-	13.50	..	0	8.38	5.15	24.0
Religious	-	1.06	..	0	0.09	-	1.9
Cultural	-	0.16	..	0	0.29	-	0.5
Other Meeting	-	1.68	..	0	0.76	-	3.5
Sports	-	3.12	..	0	2.66	-	5.6
Residences	-	2.80	..	0	1.57	-	4.4
Other Buildings	-	3.69	..	0	2.72	14.12	7.1
(Common Areas)						7.78	
TOTAL	160.5	65.78**	0.82***	0.5	37.35	56.09	121.7&

Sources: *Energistatistik foer Lokaler* (oil and DH); Central Bureau of Statistics (city gas, solids); Swedish State Power Board (electricity) There is some kerosene, coal, and wood use, probably at most 2PJ for the entire sector, according to Carlsson (1984). The categories for these two data surveys do not overlap exactly. We follow categories from *Energistatistik foer Lokaler* and lump any undefined electricity into "Other Buildings".

Residential electricity use in non-residential buildings is not counted separately by the State Power Board, but a small part is contained under "Common Areas," and an additional 0.23 PJ were used in residential space heated with electricity. "Other Buildings" includes 2.56 PJ of electricity in "other communications", 2.41 PJ of electricity in "other social services" and 9.14 PJ in "other services", as defined by the Electric Power Statistics. "Other Communications" includes activities related to transport (besides trains and streetcars,), post office and telegraph (counted separately in the heat statistics); "other social services" includes sanitary services besides waterworks and sewage, private interest organizations (lodges, etc.), recreation. "Other services" includes hotels and restaurants, business services (renting of machines, etc.), repair, laundries, domestic servies, some recreation services. Under "Common Areas," the value represents 75% of "Fastighetsfoervalting", the collective billing of electricity for common areas in non-residential buildings. This is often counted as "other buildings", although it is consumed in every sector.

* Value for "Other Offices" includes the public buildings for electricity supply, but "other offices" for heating.
** Includes estimated 2.5 PJ consumed in "heating centrals" that heat several buildings (4% of the total).
*** 0.31 PJ to public buildings and the rest to private buildings. No other breakdown was available.

& Million sq meters

Table B7

UNITED KINGDOM: ENERGY CONSUMPTION AND AREA BY BUILDING TYPE, PJ (1980).

	TOTAL DELIVERED	OIL	GAS	COAL	DH	ELEC.	AREA $10^6 m^2$
CATEGORY:							
Education	119.6	44.8	42.4	17.2	-	15.2	110
Government	132.9	74.4	28.7	9.8	-	20.0	
Health	113.1	49.5	28.9	21.6	-	13.1	40
Comml Offices	91.2	20.8	32.0	3.9	-	34.5	
Shops	99.6	24.3	19.2	3.4	-	52.7	
Other Premises	141.1	28.3	66.2	5.6	-	41.0	
TOTAL	705.8	242.1	217.4	61.5	-	184.8	590

Source: Energy Technology Support Unit (1984)

Other notes: Comml Offices includes wholesale warehouses. Shops includes public houses and clubs. Other Premises includes restaurants and hotels. The area breakdown according to taxed area is shown in Table C. The total area given here is a provisional estimate provided by ETSU.

Table B8
USA: ENERGY CONSUMPTION AND AREA BY BUILDING TYPE, PJ (1979).

	TOTAL DELIVERED	OIL	LPG	GAS	COAL	STEAM	ELEC.	AREA %
CATEGORY:								
Assembly	435	61	7.4	218	0	0	129	10.5
Auto Sales/Service	234	47	0	116	0	0	63	3.8
Education	537	112	2.1	223	0	0	171	12.3
Food Sales	367	15	8.4	145	0	0	195	3.9
Health Care	465	100	0	195	0	0	122	3.5
Lodging	284	20	0	115	0	0	122	4.2
Office	1070	130	3.2	373.5	0	0	513	17.2
Retail/Services	698	56	7.4	320	0	0	308	16.0
Warehouse/Storage	684	108	0	318	0	0	276	12.7
Other	606	80	2.1	300	0	0	206	6.6
Vacant	86	15	0	31	0	0	36	2.7
Residential*	290	91	0	134	0	0	63	6.5
TOTAL	5757	835	55.9	2483	0	215	2168	4430**

Source: Energy Information Administration (1983), *Nonresidential Buildings Energy Consumption Survey*

Data may not sum to totals due to rounding.

* Includes buildings with predominantly residential but also commercial activity.

** million sq meters

Table C.
COMMERCIAL BUILDINGS FLOOR AREA BY BUILDING TYPE

DENMARK, 1981 (Total Used Area $79x10^6m^2$)	Percent
HEALTH/CARE	11
EDUCATION	19
HOTELS/RESTAURANTS	6
SPORTS/CULTURE	5
GOVT/PUBLIC SERVICES	46
TRANSPORT	5
OTHER	8
FRANCE, 1983 (Total Heated area $689x10^6m^2$)	
HEALTH	6
EDUCATION	16
HOTELS/RESTAURANTS	7
SPORTS/CULTURE	10
OFFICE	11
RETAIL/ARTISANS	22
GROUP FACILITIES	9
LARGE COMMERCE	15
TRANSPORT	4
GERMANY, 1983 (Total Useful area $1030x10^6m^2$)	
HEALTH/HOTELS	23.4
EDUCATION	21.7
OFFICES, ADMIN.	32.8
RETAIL/REST.	11.5
ASSEMBLY	10.6

Table C (cont.)
COMMERCIAL BUILDINGS FLOOR AREA BY BUILDING TYPE

JAPAN, 1976 (Area of Types considered $655 \times 10^6 m^2$)	Percent
Offices	35.8
Large Stores	3.9
Hotels	7.6
Movies, Theaters	2.6
Education	41.1
Hospitals	8.9

Other types not included herein include smaller stores, restaurants, laundry, baths, entertainment.

NORWAY, 1977 (Total Useful area $46.3 \times 10^6 m^2$)	
HEALTH	14.3
EDUCATION	23.7
HOTELS/RESTAURANTS	5.7
RETAIL	27
TRANSPORT/WAREHOUSES	8
POST/COMMUNICATIONS	2.2
BANKS/INSURANCE	2.0
OTHER OFFICES	1.7
PUB. ADMINISTRATION	7.0
OTHER SERVICES	8.9

SWEDEN, 1981 (Total Heated area $122 \times 10^6 m^2$)	
HEALTH	24
EDUCATION	24
HOTELS	3
SPORTS	6
OFFICE	17
STORES/STORAGE	8
RELIGIOUS	2
RESIDENTIAL	4

Table C (cont.)
COMMERCIAL BUILDINGS FLOOR AREA BY BUILDING TYPE

UNITED KINGDOM, 1980 (Total 590 x$10^6 m^2$*)	Percent
EDUCATION	19.0
HEALTH	9.2
OFFICES	13.6
ARMED FORCES	2.2
GOVERNMENT	12.2
SHOPS	23.8
OTHER	12.5
PUBS, RESTAURANTS	(6.0)
HOTELS	(6.0)

U.K Breadown is for taxable area, according to ETSU.

UNITED STATES, 1979 (Total 4430x$10^6 m^2$)	
HEALTH	4
EDUCATION	12
FOOD SALES	4
ASSEMBLY	11
OFFICE	17
RETAIL/SERVICES	16
WAREHOUSE/STORAGE	13
LODGING	4
AUTO SALES/SERVICE	4
RESIDENTIAL	7

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