This is a working paper for the purpose of evaluating alternative scenarios for 2050 and as such does not represent Government policy.

Energy Efficiency: DEFRA Paper on Energy Projections for the Service Sector

Introduction

Projections of service sector energy demand have been made to 2050 under 'Business-as-Usual' and four alternate scenarios, World Markets, Provincial Enterprise, Global Sustainability and Local Stewardship, based on those developed by the Foresight Programme.

Methodology

The approach to projecting service energy demand has been to identify six principal end-uses and make forecasts for each under the different scenarios. These end-uses are:

- Space heating
- Water heating
- Space cooling
- Lights
- Cooking
- Other electrical

For each end use, the overall growth in energy demand (ΔE) in 2050 compared to 2000 is broken into two components:

- change in the demand for energy services (ΔSI)
- change in the efficiency with which these services are provided (ΔEI)

For small changes this leads to

$$\Delta E/E = \Delta EI/EI \times \Delta SI/SI$$

Changes in the demand for energy services

Space heating

The demand for space heating services is assumed to increase in line with floor area. This is in line with the approach suggested by the IEA (Workshop on indicators of service sector activity, 28-30 June 2000) and is also the methodology used by BRE and the PIU. Future trends in floor area (FA) have been derived based on a methodology suggested by the PIU, which links changes in floor area to changes in service sector growth (SSG) and number of employees (Emp) as follows:[1]

$$\Delta FA/FA = \alpha\,(\Delta SSG/SSG) + \beta\,(\Delta Emp/Emp)$$

where α and β have the values of 0.09 and 0.99 respectively and were determined by analysing BRE forecasts of service sector demand to 2020.

The growth in service sector output under each scenario is taken from estimates made by the DTI and is BaU 2.49 %, WM 3.25 %, PE 1.75 %, GS 2.36 % and LS 1.25 %. Assumptions for the growth of employment in the service sector are described under water heating below.

[1] In the PIU work the parameters are actually overall GDP and population.

Water heating
The demand for water heating services is linked to the number of employees in the service sector, again as suggested by the IEA. The change in employment levels is calculated from the service sector growth rates under each scenario and forecasts of the productivity per employee based on an analysis of historical trends.

Air conditioning
Projections for changes in useful energy demand for air conditioning are based on work by BRE. This work suggests that under 'business-as-usual' over the period 2000 to 2020 useful energy demand will increase by just over three times. However, this level of increase will not be sustainable in the longer term and saturation effects are likely to set in. The BRE work has been used as the basis for the BaU scenario projections, with higher estimates taken for WM reflecting both greater floor area and increased wealth and lower estimates for PE, GS and LS (as both floor area and GDP are lower under these scenarios).

Cooking demand
The useful demand for cooking is linked to the number of employees in the service sector (see water heating).

Lighting demand
The useful demand for lighting is linked to floor area (see space heating).

Other electrical
Other electrical includes all process and appliance use of computers in the service sector (e.g. IT equipment, motors, medical equipment) etc. Currently this component of demand accounts for 8 % of total energy demand and, because of its diverse nature, it is the hardest to project. For this reason it has been assumed that the change in useful energy demand for other electrical is the simple average of the changes observed for the other end-uses in the service sector. This approach leads to projections of changes that are slightly higher than most of the other components, which would appear reasonable.

Changes in energy intensity
Changes in energy intensity ($\Delta EI/EI$) for each end use sector have been estimated from a recent BRE cost-abatement report[2]. This report considers the cost-effectiveness of a wide range of measures in 2000 and 2010 at different discount rates. These include conventional energy efficiency measures that are cost-effective today, such as efficient lighting and insulation, as well as more advanced solutions like Building Energy Management Systems that offer greater savings at much higher cost.

The following assumptions have been made to give an initial estimate of the likely take-up of energy efficiency measures by 2050:

- Baseline: All currently cost-effective measures (at 25% discount rate) + 50% of currently non-cost-effective measures (at 25% discount rate)
- WM: All cost-effective measures + 25% of non-cost-effective measures
- PE: All cost-effective measures only
- GS: All cost-effective measures + all non-cost-effective measures
- LS: All cost-effective measures + 75% of non-cost-effective measures

[2] "Cost Abatement Analysis for the Non-Domestic Building Stock" BRE Draft Report 205186 June 2001

It is reasonable to expect some measures that are not currently cost-effective to become so over 50 years, due to improved technologies and lower manufacturing costs. The scenario differences can be explained by differences in the speed of technological development (highest in WM and GS) and the willingness of companies to adopt energy saving measures (highest in GS and LS).

This is a simplified approach which does not take account of the emergence of new energy efficiency technologies or possible structural changes in the services sector. However, the baseline result of 78% (energy intensity in 2050 compared to 2000) agrees with the historical trend of -0.5% p.a. (equal to 78% in 50 years). It is also comparable with the 80% estimated by Jake Chapman in his initial service sector paper for the PIU.

The total energy demand by fuel for 2000, and the split between electricity and fossil fuel has been taken from DUKES 2001. The split of energy demand by end use has been taken from BRE data for 1997, which is the latest available data. This will slightly underestimate the contributions of cooling and other electrical, which are the fastest growing end use sectors.

Results

The following tables show the results of this analysis. Table 1 shows changes in the demand for energy services by end use, Table 2 shows changes in the efficiency (energy intensity) of meeting this demand and Tables 3 and 4 show the overall effect on energy demand in the service sector. Table 5 shows how this energy demand is expected to be split by fossil fuel and electricity.

Table 1: Changes in demand for energy services 2000 to 2050 (DSI/SI)

Scenario	Space heating	Water heating	Lights	Other electrical	Catering	Space cooling	Total
BaU	1.39	1.27	1.39	1.90	1.27	4.17	1.49
WM	1.54	1.33	1.54	2.20	1.33	5.28	1.66
PE	1.28	1.10	1.28	1.64	1.10	3.46	1.34
GS	1.33	1.19	1.33	1.64	1.19	3.17	1.38
LS	1.20	1.07	1.20	1.48	1.07	2.84	1.24

Table 2: Changes in energy efficiency 2000 to 2050 (DEI/EI)

Scenario	Space heating	Water heating	Lights	Other electrical	Catering	Space cooling	Total
BaU	0.75	0.84	0.63	0.89	0.97	0.81	0.78
WM	0.81	0.87	0.65	0.89	0.97	0.81	0.82
PE	0.87	0.89	0.68	0.89	0.97	0.81	0.86
GS	0.63	0.80	0.57	0.88	0.96	0.81	0.69
LS	0.69	0.82	0.60	0.88	0.96	0.81	0.73

Table 3: Overall changes in energy demand 2000 to 2050 (DE/E)

Scenario	Space heating	Water heating	Lights	Other electrical	Catering	Space cooling	Total
BaU	1.03	1.15	0.87	1.68	1.23	3.37	1.15
WM	1.23	1.31	1.01	1.95	1.28	4.26	1.35
PE	1.10	1.11	0.87	1.46	1.07	2.79	1.14
GS	0.83	1.05	0.76	1.45	1.15	2.56	0.96
LS	0.82	0.96	0.71	1.30	1.03	2.30	0.91

Table 4: Service sector energy demand in 2000 to 2050 (Mtoe)

	2000	2050				
		BaU	WM	PE	GS	LS
Space heating	12.4	12.8	15.2	13.6	10.3	10.1
Water heating	1.9	2.2	2.5	2.1	2.0	1.9
Lighting	3.1	2.7	3.2	2.7	2.4	2.2
Other electrical	1.7	2.8	3.3	2.5	2.5	2.2
Catering	2.1	2.5	2.7	2.2	2.4	2.1
Space cooling	0.6	2.1	2.7	1.8	1.6	1.5
Total	**21.8**	**25.3**	**29.6**	**24.9**	**21.2**	**20.0**

Table 5: Services energy demand split by fossil fuel and electricity (Mtoe)

	2000	2050				
		BaU	WM	PE	GS	LS
Electricity	8.1	10.6	12.4	9.7	9.1	8.3
Fossil	13.7	14.6	17.2	15.2	12.1	11.7
Total	**21.8**	**25.3**	**29.6**	**24.9**	**21.2**	**20.0**