

South West of England Regional Development Agency
**Use of the REEIO Model to Assess
Environmental Implications of Business Energy Efficiency
Paper 2: Business Energy Consumption Scenarios**

The South West SCPNet Technical Group discussed the testing of a number of scenarios put forward by the Policy User Group using the REEIO model in order for the group to gain a better understanding of the model and insight into potential policy uses of the model by regional partners in the future.

The scenarios proposed, prompted by the current work on developing an energy efficiency strategy for the region, were:

- (i) Domestic energy use, looking at the effect of a 50% reduction in pupil transport miles;
- (ii) Business energy efficiency, assessing what means might be required in different sectors to achieve a 20% reduction in CO₂;
- (iii) Sustainable construction, assessing ways in which zero CO₂ emissions from sustainable construction might be achieved.

Further discussions with the Technical Group identified that further work, including possibly additional data collection, outside REEIO would be required in order to develop Scenario 1 into a meaningful REEIO run.

In terms of business energy efficiency, it was decided to look at the business energy consumption assumptions within REEIO and assesses the impact that changes to industrial energy consumption patterns might have.

1. Baseline Scenario

1.1 Economic Assumptions

The economic module of the REEIO model is based on the Cambridge Econometrics Local Economy Forecasting Model (LEFM), assuming an average growth of 2.5% per annum in GVA but 0.75% growth per annum in population. However it was agreed this should be amended to reflect the projected growth scenarios outlined in the recently reviewed Regional Economic Strategy. These are:

- 2.8% per annum increase in GVA, 2006-2015, maintaining the sector distribution predicted by the LEFM
- 0.65% increase in population per annum, 2006-2015, maintaining the age distribution predicted by the LEFM

This growth scenario is considered by HM Treasury and others in central government to be a realistic outcome for the South West region and therefore has been adopted as the Baseline Economic Scenario.

1.2 Baseline Business Energy Consumption Assumptions

The baseline model, against which business energy consumption scenarios will be compared, is based on assumptions about

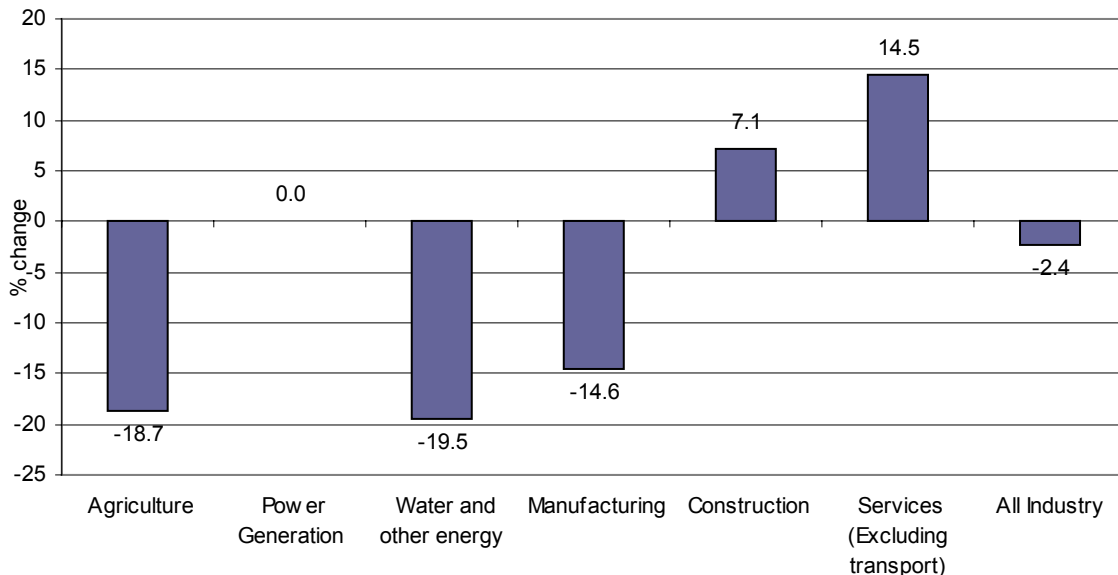
- Amount of energy used per unit of gross economic output for each of 38 industrial sectors (not including power generation). Assumptions have been made about how this will change over time based on past trends in energy use and energy policy implementation
- Fuel use pattern – share of energy by fuel type for each of the above sectors

Other assumptions around power generation are also available but have not been considered within this analysis. For the purpose of this analysis, the broad industrial or business sector has been defined as including agriculture, power generation, manufacturing, construction and services.

The REEIO model baseline scenario indicates that the industrial sector accounts for about 36% of total energy consumption in the South West in 2005, but will decrease to 31% in 2015. The remaining energy consumption is split between the domestic sector (29% in 2005 and 2015) and transport (36% to 41%).

Figure 1 below shows the projected change in the baseline scenario in energy consumption of the industrial sectors, which is predicted to decrease slightly between 2005 and 2015, compared to a relatively large increase of 14% in the total regional consumption.

Figure 1: Change in Energy Consumption, 2005-2015



It also shows the pattern of change varying across the broad sector groups, with large declines consumption in agriculture, utilities and manufacturing, and large increases in services and construction.

2.0 Projected Future Scenarios

Three sets of sectors were selected to test the effect of targeting business energy efficiency improvements in different ways. These are as follows:

- Sectors that use the most energy
- Sectors that are most intensive in energy use
- Sectors that are predicted to have the greatest increase in energy consumption

Identification of sectors to be targeted by each scenario was carried out as follows:

2.1. Scenario #1: Top 10 consumers

Table 1 below lists the top 10 industrial energy consumers in 2005 in the baseline scenario, which remain largely unchanged through to 2015 with “rubber and plastics” being replaced by “miscellaneous services and the ranking changing slightly.

Power generation, although by far the largest consumer, accounting for 28% of business energy use and around 10% of all energy consumption, has been excluded to simplify this analysis because of the complexities in determining the affects of increasing energy efficiency or indeed increasing production of renewable energy in this sector.

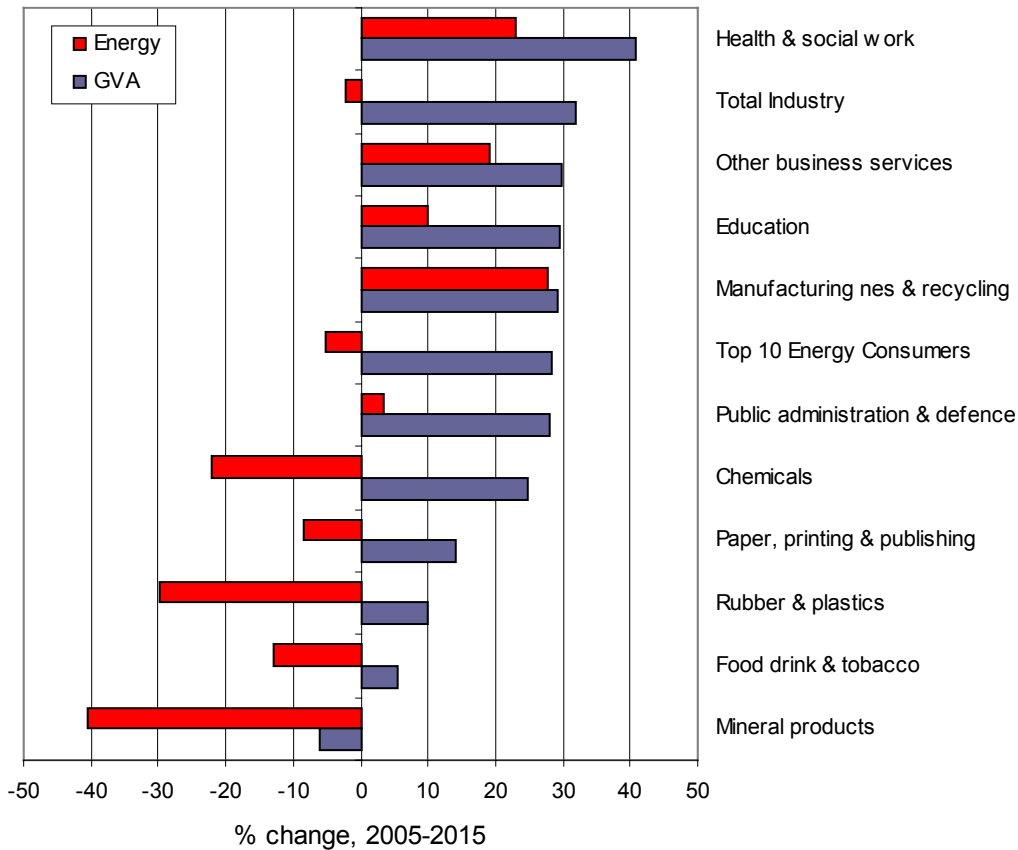
The top 10 consumers in 2005 account for 39% of energy consumption by industry, broadly in line with the share of economic output, measured as GVA (34%). This situation is predicted to change only slightly by 2015, to 41% for energy consumption and 33% in relation to GVA.

Table 1: Total Energy Consumption - Top 10 Sectors

2005 Rank	Sector	2005			2015			Change in Rank 2005-2015
		Energy consumption (million toe)	% of Industry Energy	% of GVA	Energy consumption (million toe)	% of Industry Energy	% of GVA	
1	Food drink & tobacco	0.26	5.9	2.4	0.23	5.3	1.9	-1
2	Chemicals	0.24	5.4	0.6	0.19	4.4	0.5	-2
3	Mineral products	0.23	5.2	0.5	0.14	3.2	0.4	-5
4	Health & social work	0.22	5.0	8.3	0.28	6.5	8.8	+3
5	Public administration & defence	0.20	4.5	8.4	0.21	4.9	8.2	+2
6	Paper, printing & publishing	0.17	3.8	1.7	0.16	3.7	1.5	-1
7	Education	0.15	3.4	7.0	0.17	3.9	6.8	+2
8	Manufacturing nes & recycling	0.13	2.9	1.0	0.17	3.9	1.0	+2
9	Other business services	0.11	2.5	2.8	0.13	3.0	2.7	-
10	Rubber & plastics	0.10	0.1	1.0	0.07	1.6	0.8	-7
	Sum of top 10 consumers	1.82	38.7	33.7	1.73	40.5	32.8	
	All Industry	4.43	100	100	4.33	100	100	

Figure 2 below shows the predicted change in energy consumption and GVA between 2005 and 2015 for each of the top 10 consumers. It indicates the service sectors in the top 10 growing the fastest and the manufacturing sectors the slowest in terms of GVA.

Figure 2: Change in Energy & GVA - Top 10 Energy Users



Those sectors showing the largest increase in GVA also show large increases in energy consumption. Health, manufacturing and recycling, other businesses, and education all show increases well above the industry average of a 2.4% decline.

Those with the slowest growth or decline in GVA have lowest increases or declines in energy consumption. The reasons for this will vary by sector. Manufacturing sectors are under increased pressure to minimise energy costs in order to be internationally competitive, as well as to comply with emissions legislation. In addition, manufacturing will be more energy intensive than for service sectors - a decrease in GVA may result in a disproportionate decrease in energy consumption. This is particularly notable for the mineral products sector which is highly energy intensive.

2.2 Scenario #2: Top 10 Energy Intensive Consumers

Table 2 shows the top 10 most intensive industrial energy consumers. Not surprisingly this list is dominated by production industries and unlike the top 10 consumers, no service sectors appear.

Six sectors appear on both lists, mineral products; chemicals; paper, printing and publishing; manufacturing and recycling; rubber and plastics; and food and drink. Although ranking very highly in terms of energy intensity of production, textiles and pharmaceuticals, rank lowly (26th and 31st, respectively) in terms of total consumption.

Table 2: Energy Intensity of Consumption - Top 10 Sectors

Rank	Sector	Energy Intensity per Unit Gross Output			Rank in Total Consumption (2005)
		2005	2015	% change	
1	Mineral products	0.308	0.187	-39.4	3
2	Basic metals	0.217	0.155	-28.5	11
3	Chemicals	0.193	0.129	-33.2	2
4	Paper, printing & publishing	0.097	0.074	-23.2	6
5	Manufacturing nes & recycling	0.095	0.095	0.0	8
6	Textiles clothing & leather	0.075	0.057	-23.2	26
7	Pharmaceuticuals	0.073	0.049	-33.2	31
8	Rubber & plastics	0.069	0.042	-39.3	10
9	Food drink & tobacco	0.062	0.047	-23.3	1
10	Wood & wood products	0.061	0.047	-23.2	17

Figure 3 shows the expected change in energy intensity, energy consumption and GVA for these sectors. Energy intensity is expected to decline across all sectors except manufacturing and recycling. The reason for this is unclear. As above, energy consumption broadly declines most in those sectors with the lowest growth in GVA.

Figure 3: Change in Energy, Intensity & GVA - Top 10 by Intensity

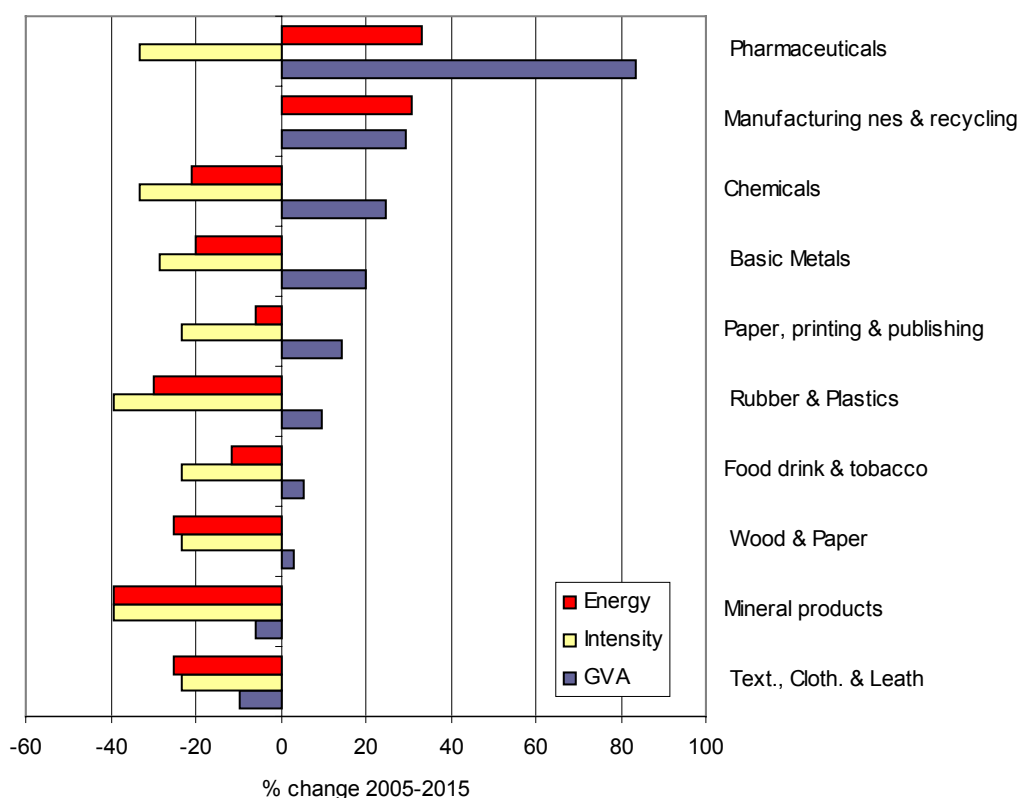


Table 3 below indicates the energy consumption and economic output of the most intensive sectors. These are estimated to account for 31% of industry energy consumption in 2005 but unlike the top 10 consumers, the relative share of GVA is low (only 8%). These figures are shown to have little change by 2015 (27% of energy vs. 7% of GVA).

Table 3: Energy Consumption and Economic Output of Most Intensive Users

	Energy Consumption (million toe)				GVA			
	Million toe		Share (%)		£ million		Share (%)	
	2005	2015	2005	2015	2005	2015	2005	2015
Mineral products	0.23	0.14	5.19	3.24	333	312	0.52	0.37
Basic metals	0.10	0.08	2.26	1.85	121	145	0.19	0.17
Chemicals	0.24	0.19	5.42	4.39	367	457	0.57	0.54
Paper, printing & publishing	0.17	0.16	3.84	3.70	299	548	0.47	0.65
Manufacturing nes & recycling	0.13	0.17	2.93	3.93	658	851	1.03	1.01
Textiles clothing & leather	0.04	0.03	0.90	0.69	266	240	0.42	0.29
Pharmaceuticals	0.03	0.04	0.68	0.92	299	548	0.47	0.65
Rubber & plastics	0.10	0.07	2.26	1.62	638	701	1.00	0.83
Food drink & tobacco	0.26	0.23	5.87	5.32	1,553	1,638	2.43	1.95
Wood & wood products	0.08	0.06	1.81	1.39	508	523	0.80	0.62
Total top 10	1.38	1.17	31.14	27.04	5,042	5,965	7.90	7.08
Total	4.43	4.33	100.00	100.00	63,827	84,213	100.00	100.00

2.3 Scenario #3: Sectors with Highest Energy Consumption Increase

Table 4 shows the twelve sectors for which energy consumption in the baseline scenario increases by more than 10% between 2005 and 2015. The list is predominated by service sectors and relatively high tech manufacturing sectors.

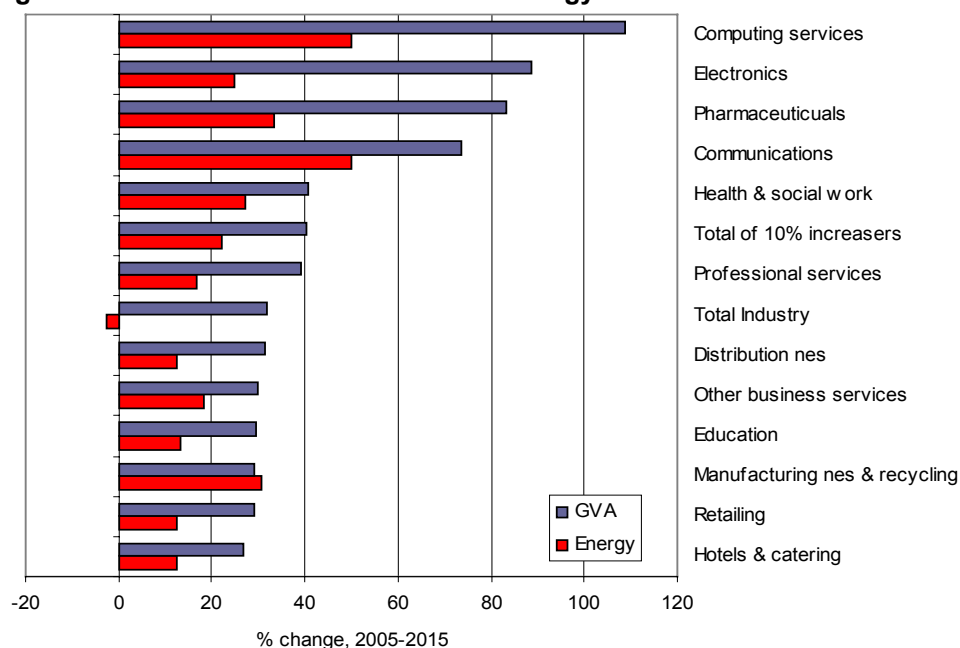
On average these are sectors predicted to grow relatively quickly over the next ten years, with growth in GVA is predicted to be 40% for the 12 sectors, compared to 31% for all industry sectors. These sectors' share of GVA is expected to increase from 55% to 59%, with their share of energy consumption, however, being comparatively low at 23%, rising to 29%.

Table 4: Identification of Sectors With 10%+ Increase in Energy Consumption, 2005-2015

	Energy Consumption (toe)					GVA				
	2005		2015		%	2005		2015		%
	Total	% share	Total	% share		Total	% share	Total	% share	
Communications	0.04	0.9	0.06	1.4	50.0	1,971	2.9	3,421	3.9	73.5
Computing services	0.02	0.5	0.03	0.7	50.0	1,622	2.4	3,388	3.8	108.8
Pharmaceuticals	0.03	0.7	0.04	0.9	33.3	299	0.4	548	0.6	83.4
Manufacturing nes & recycling	0.13	2.9	0.17	3.9	30.8	658	1.0	851	1.0	29.2
Health & social work	0.22	5.0	0.28	6.5	27.3	5,272	7.9	7,426	8.4	40.8
Electronics	0.04	0.9	0.05	1.2	25.0	765	1.1	1,443	1.6	88.6
Other business services	0.11	2.5	0.13	3.0	18.2	1,782	2.7	2,312	2.6	29.8
Professional services	0.06	1.4	0.07	1.6	16.7	6,830	10.2	9,502	10.8	39.1
Education	0.15	3.4	0.17	3.9	13.3	4,449	6.6	5,760	6.5	29.5
Retailing	0.08	1.8	0.09	2.1	12.5	5,045	7.5	6,505	7.4	28.9
Distribution nes	0.08	1.8	0.09	2.1	12.5	5,040	7.5	6,632	7.5	31.6
Hotels & catering	0.08	1.8	0.09	2.1	12.5	3,175	4.7	4,032	4.6	27.0
Total of 10% increasers	1.04	23.5	1.27	29.4	22.1	36,909	55.1	51,818	58.8	40.4
Total Industry	4.43	100.0	4.32	100.0	-2.5	66,975	100.0	88,171	100.0	31.6

Figure 4 below shows change in energy consumption and GVA between 2005 and 2015. Four of these sectors are showing above average increases in consumption but below average increases in economic output (computing services, electronics, pharmaceuticals and communications).

Figure 4: Sectors With 10%+ Increase in Energy Use



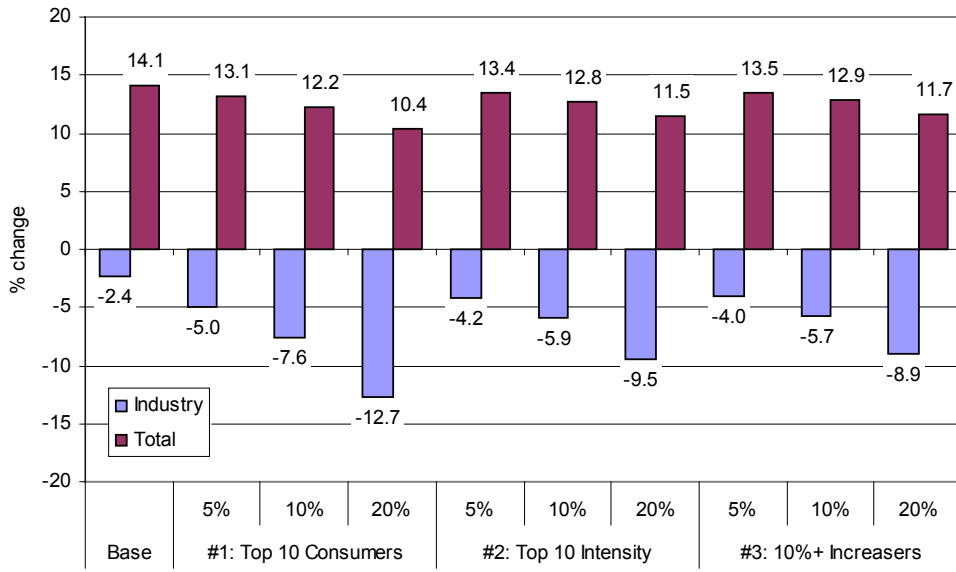
3.0 Scenario Assumptions

For each of the scenario sectors above (top 10 consumers, top 10 intensity and 10%+ increasers), energy intensity (thereby energy consumption) was decreased between 2005 and 2015 by an additional 5%, 10% or 20% from levels predicted by the baseline model. The output of these scenarios in terms of energy consumption and emissions is considered below.

4. Environmental Outputs

4.1. Changes in Energy consumption Figure 5 shows the change in energy consumption predicted under each scenario.

Figure 5: Change in Energy Consumption, 2005-2015



Unsurprisingly, targeting those sectors that use the most energy (scenario #1) was more effective than targeting those that use energy most intensively (scenario #2). The share of total industrial energy consumption of the top 10 consumers was 39%, compared to 31% for the top 10 in terms of intensity. Scenario #3 targeting the sectors expected to increase energy consumption over the next decade had the least effect – these sectors' share of industrial energy use was only 23% in 2005.

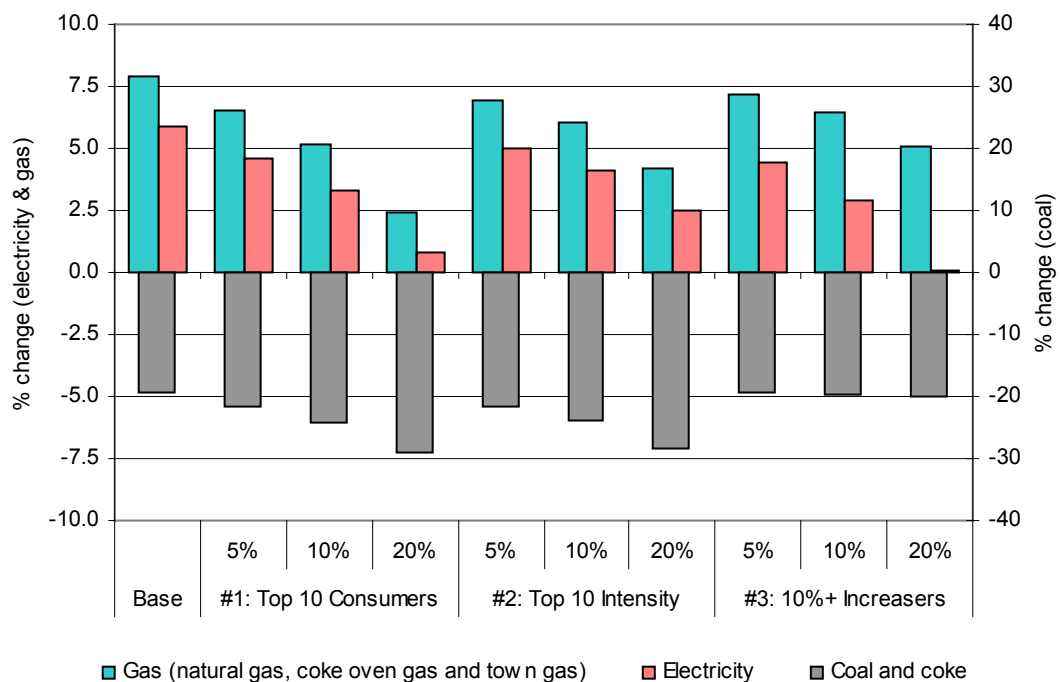
Whilst the decline in industrial energy use was increased by between 3.5 and 5-fold across the three scenarios at 20% change level, the effect on total energy consumption was much smaller, reducing from 14% to between 10% and 12%.

4.2 Changes in Fuel Use

Figure 6 shows changes in consumption of three of the major fuels used by industry – coal, electricity and gas. The figures show totals for all of the South West, not just industry. Nonetheless, there are clear differences between the scenarios, determined by the different fuel shares of the three subsets of sectors.

Coal consumption is expected to decline considerably over the next ten years, by 19% according in the baseline scenario. Scenario #1 targeting large users, and scenario #2, targeting intensive users of energy, both had similar effects, perhaps explained by the fuel use patterns of some of the large sectors shared by both of these subsets. Consumption is decreased by a further 10% at the 20% scenario level. Those sectors expected to increase in consumption appear to be less dependent upon coal and very little change is seen relative to the baseline scenario.

Figure 6: Change in Energy Consumption by Fuel, 2005-2015



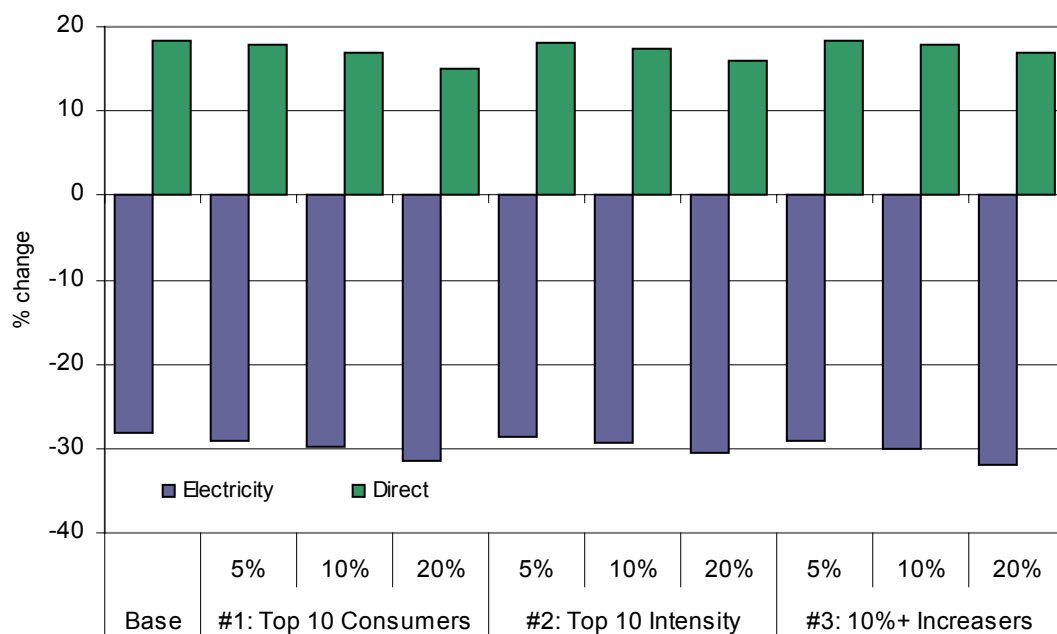
The greatest effect on gas consumption is seen in the scenarios targeting the top 10 largest consumers, with the expected increase (20% level) at around one third of the baseline level. The other two sets of scenarios show a less marked effect, presumably due to their lower shares of overall gas consumption.

The most marked effect on consumption of electricity is in Scenario 3 which targets those sectors expected to increase in energy consumption. The scenario assumptions almost negate the expected increase in electricity over the next ten years. This is primarily explained by the presence of large service sectors in the subset of sectors considered by these scenarios. Education and health accounted for 8.4% of industrial energy consumption in 2005, set to increase to 10.4% in 2015.

6.3 Carbon Dioxide Emissions

Figure 7 shows the effect of the different scenarios on total regional carbon dioxide emissions (including domestic and transport). Direct emissions do not include figures on emissions from generation of electricity outside of the region but electricity emissions are included from power generation inside and outside of the region.

Figure 7: Change in Carbon Dioxide Emissions, 2005-2015



While the main purpose of this analysis was to investigate the effect of the scenarios on industrial energy consumption, the assumptions also mimic in part the effect of replacing energy that has associated emissions with emission-free energy, i.e. renewables.

The greatest effect on direct emissions is seen with Scenario 1 as the sectors targeted here consume the most energy. However overall, only a small impact on total carbon dioxide emissions is indicated, changing from an 18% decrease in the baseline to a 15% increase under Scenario 1 at the 20% level.

The REEIO model also calculates the emissions from the power generation associated with electricity consumed in the region. It indicates that electricity emissions will decrease by about 30% over the next ten years, for the baseline scenario.

Scenario 3, which looked at sectors set to increase in energy consumption over the next 10 years, has the greatest effect, although only marginally better than the other two scenarios.

5.0 Economic Outputs

All three scenario sets were generated by altering only the REEIO assumptions on energy consumption per unit output. While the model depends on economic output values in order to calculate energy use by sector, no economic parameters were altered by changing the energy assumptions. Thus the scenarios are economically neutral.

The assumptions therefore are rather simplistic. Any measures that increase energy efficiency are likely to have economic benefits, thereby increasing output and productivity. These benefits would in turn have a cascading effect throughout other sectors of the economy (including the domestic sector), and consequently on environmental resource use and impact.

6.0 Summary

Three sets of scenarios were constructed to look at business energy efficiency. These scenarios targeted different subsets of industrial sectors – the largest consumers, the most intense consumers, and those predicted to change substantially over the next decade. For each scenario a set of assumptions looking at 5%, 10% and 20% reduction in energy consumption were tested.

All three scenarios produced an effect on energy consumption and emissions. Targeting the largest consumers was overall the most effective scenario, although there were variations in consumption of different fuel, dictated by the fuel use patterns of the three sector sub-sets.

The greatest effect on gas consumption is seen in the scenarios targeting the top 10 largest consumers, with the expected increase (20% level) at around one third of the baseline level. The other two sets of scenarios show a less marked effect, presumably due to their lower shares of overall gas consumption.

The most marked effect on consumption of electricity was the scenario targeting those sectors expected to increase in energy consumption which almost negated the expected increase in electricity over the next ten years. It may therefore be worth targeting these specific sectors to encourage energy efficiency measures.

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16th May 2006*