HORIZON SCANNING FOR SCOTLAND'S FUTURES: THE NEXT 30 YEARS (AND BEYOND)

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"Increasing knowledge to help protect the environment and improve quality of life"

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Horizon Scanning for Scotland's Futures: the next 30 years (and beyond)

1. Introduction

This report collates and synthesises existing information on future scenarios and drivers of policy as well as indicating important areas of uncertainty that might benefit from further research. It is divided into this and five other sections.

Section 2 gives a brief outline on the current state of affairs in Scotland (population, demography, economic sectors, imports, exports etc.). Section 3 summarises the identified high-level trends operating at the global level which are likely to drive policy on environmental, marine and rural issues in Scotland (and elsewhere). These are:

- Globalisation, economic growth and natural resource consumption
- Social and political change and demographics
- Climate change
- Energy
- The influence of the concept of sustainability
- New technologies.

Section 4 brings the analysis closer to home, exploring the implications of these high-level trends for future Scotland in the following areas:

- Rural resources and economy
- Food production
- Biodiversity
- Marine resources and coastal management
- Water resources
- Health and wellbeing.
- Sustainable communities
- Transport
- Energy

For each of these trends, a boxed summary is offered of plausible future scenarios. These are not intended to be read as cast-iron predictions, but rather as illustrative of what could happen, extrapolating from current trends.

Section 5 concludes the review with a consideration of how Scotland might look in 20-30 years' time.

NB: The term 'Scottish Executive' is employed in this document to refer to those documents produced by Scotland's devolved administration *prior* to its name change at the beginning of September 2007. At all other times, the document deploys the term Scottish Government when referring to that institution.

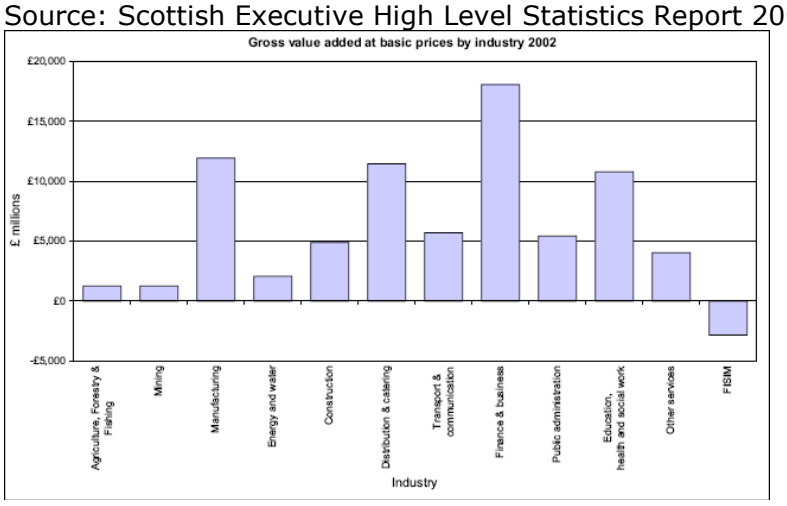
2. Scotland: State of the Nation[1]

According to the country's Rural Development Plan (2003), Scotland occupies 78,772km², with 974km² of fresh water lochs. To the west and north Scotland is surrounded by the Atlantic Ocean and on the east by the North Sea. The Southern border with England roughly follows the course of the Cheviot Hills.

In 2006, the recorded population of Scotland was almost 5.1 million people. Glasgow was the most densely-populated part of the country, with 3,298 people per square kilometre in 2005. The population is expected to increase up to 2019, partly as a result of an increase in the birth rate and partly due to projected migration patterns. Infant mortality stood at 5.2 in 2005, slightly above the UK average. A male baby born in 2004 could expect to live on average for 74.3 years, whilst a female baby for 79.4 years. As a Public Health Institute Scotland report has pointed out, this lags behind the rest of the UK and Europe more widely (2001). In 2006, 34% of households reported the presence of at least one person with a serious long-term illness, whilst 53% of adults thought they enjoyed good health. Thirty-two percent of Scottish households comprise one adult, whilst a further 33% consist of two adults.

In 2006, the Scottish economy grew by 2.3%. Growth in the third quarter of 2006 was in the order of 0.5 %. Scottish growth over the period 1975-2005 has been lower than that of the UK, averaging 1.8% per year as against the UK average of 2.3%. Over the same period the UK's service sector has average annual growth of 2.8%, compared to growth of 1.2% in production and 1.9% in construction. Figure 2.1 below illustrates the contribution to gross value added made by eleven broad industrial sectors in 2002 (at current basic prices). In the Confederation of Business and Industry's 2006 'Overview of UK Economic Trends', businesses in Scotland (as well as England) were found to be less optimistic about the general business situation than they had been six months earlier. Moreover, despite net rises in domestic and export orders, output, employment and prices, companies experienced dramatic falls in profit margins. This trend, the review estimated, was likely to continue into 2007

Figure 2.1
Source: Scottish Executive High Level Statistics Report 2006



[1]Sources (unless otherwise indicated): National Statistics office, http://www.statistics.gov.uk/cci/nugget.asp?id=1136; Scottish Executive Statistics online http://www.scottishexecutive.gov.uk/Topics/Statistics/Browse; Scottish Household Survey 2005-06, http://www.scotland.gov.uk/News/Releases/2007/08/02102730, Key trends for Scotland 2006, http://www.scottishexecutive.gov.uk/Resource/Doc/933/0031337.pdf

3. High-level trends and Scotland's futures

3.1 Globalisation, economic growth and natural resource consumption

In its 'Mapping the Future' document (2004), the US National Intelligence Council defines globalisation as "growing interconnectedness reflected in the expanded flows of information, technology, capital, goods, services, and people throughout the world". As a 'mega-trend', the Council considers globalisation a force so powerful that it will in large measure shape all other global trends by 2020. UNCTAD's World Investment Report 2004 traces the shifts in the global economy that characterise globalisation. Industrial output in the developed world is in continuing decline, whilst greater efficiency in the manufacturing sector is making labour more available to other sectors, notably services. Ever more manufacturing is shifting to developing countries, whilst richer countries have moved towards services, which are the target of ever greater quantities of foreign direct investment (FDI). In the early 1970s, only a quarter of FDI was channelled into services; by 2002, this figure has risen to 60%, calculated to be US$4 trillion.

A Scottish Government Trend Analysis Paper on globalisation (2006) notes that changes to Scotland's economic structure are consonant with those observed at the global level, with marked decreases in the manufacturing sectors contrasting with robust growth in the services (and in financial services in particular). Employment in manufacturing dropped between 1998 and 2004 by 27.8%; the service sector workforce grew by 17.6% over the same period.

Furthermore, the paper argues, the structure of Scotland's economy will continue to be shaped by the interdependence between countries that is at the core of globalisation processes. The paper goes on to identify a number of opportunities and challenges that it expects increasing interdependence between countries for their economic security to give rise to:

- The rapid economic growth of developing countries; especially China and India. China's economy is now larger than the UK's, whilst India's growth is forecast to exceed even China's by 2050. A relocation of some service sector jobs – i.e. to Indian call centres – is set to continue and indeed to increase. Moreover, both India and China are set, in terms of domestic production, to move up the value chain and provide increasing competition to Scottish producers.
- However, there will be greater opportunities for Scotland to prosper from the creation of and greater access to new markets, trade and investment flows. Moreover, current changes – such as manufacturing and some service jobs going overseas – do not appear to be harming Scottish employment rates, which are currently amongst the highest in the EU.

The paper argues that Scotland's future competitive advantage in a globalised economic age will increasingly derive from how far up the value chain it can climb. This will depend upon the extent to which it can adapt to and develop new technologies which is in turn dependent on the extent to which it develops as a knowledge economy, with high skill levels within the workforce and continual innovation. Scotland's Science and Innovation Strategy Progress report finds Scotland to be making good progress in producing world class research, competing well with both the rest of the UK and internationally. Moreover, an analysis of the numbers of published research papers and reviews, and their citations, found that, measured by the volume of citations, and the share of the top 1% of cited papers, the UK comes second only to the US. However, concerns have been expressed that whilst the excellence of the research base cannot be

doubted, it is less clear that it is being transformed into sufficient innovation. A recent article in *The Economist* argued that if prowess as a knowledge-based powerhouse is measured by the number of patents per head registered, the UK as a whole lags behind Japan, the US and Germany, and that the gap is widening[2].

In the Scottish context, there are, nonetheless, intriguing counter examples which suggest a healthier link between research capacity and industry innovation (though it is doubtful that they are sufficiently statistically significant to contradict the general point made in *The Economist* article). Scottish Enterprise commissioned a report in 2006 on research capacity for environmental goods and services. It concluded that Scotland had key research strengths in marine energy, energy distribution networks, carbon management and fuel cell technology (albeit "at various stages of commercial maturity). It also identified a number of partnerships between universities and industry in developing new technology and processes.

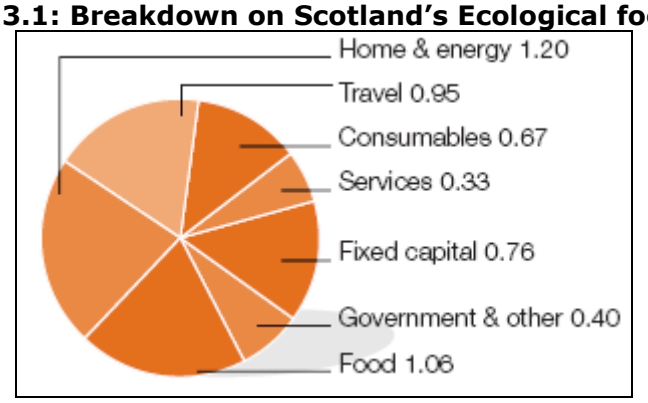
Whilst Scottish economists and politicians may closely watch the rise of emerging economies, viewed through the lens of poverty reduction, the overriding objective of the UN's Millennium Development Goals, the recent economic success of developing countries looks like good news. From 2001-2006, GDP per head amongst emerging economies has grown annually by 5.6%, on average (*The Economist*, 16th September 2006). However, if these rates of growth become a medium-long term trend, then the dilemma seen with regard to future energy policy is repeated here. Economic growth is bound up with natural resource consumption, and therefore with the overriding consideration of sustainability.

According to WWF's most recent Living Planet Report (2006), 2003 rates of consumption exceeded the planet's capacity to regenerate the resources we depend upon by 25%. Put simply, "humanity is no longer living off nature's interest, but drawing down its capital." Taking UN projections to postulate a 'business as usual' scenario of slow population and economic growth, WWF predicts that by 2050, human demand for resources will be double the earth's productive capacity. The toll taken on the planet's ecosystems under this scenario of 'ecological deficit' is grim: it could include the exhaustion of available ecological resources and ecosystem collapse. Indeed, even before the ultimate depletion of a given resource base has occurred, irreparable damage to its regenerative capacity can already have been done. Exceeding global biocapacity limits could lead to tensions between countries with or without resources such as drinking water, coal, oil or gas, which are necessary for survival, according to a 2003 Global Business Network publication (2003). WWF's 'ecological footprint' indicator (WWF 2006) suggests that the UK's resource consumption exceeds average global biocapacity – its capacity to process waste and make resources available for consumption – by a factor of three. In other words, if humankind consumed natural resources and emitted greenhouse gases at the UK rate, we would require three planets' worth of resources to sustain ourselves.

Work done by WWF Scotland suggests this to be the case in the Scottish context. It calculated that the country's 'ecological footprint' was 5.37 gha/cap, whereas in order to ensure 'one planet living' by reducing emissions by 60%, this figure would have to be reduced to approximately 2.15gha/cap. Figure 3.4.1 breaks Scotland's footprint down into its separate components.

[2] 'The good, the bad and the ugly' *The Economist, 4.8.07*

Figure 3.1: Breakdown on Scotland's Ecological footprint



Source: WWF Scotland 2006

The premise that carbon emissions reductions make economic as well as ecological sense has gained in credibility. Within the UK setting, the Stern Review ordered by the Treasury has been the highest-profile study to have made this case. Its author, Sir Nicolas Stern, argues that if the increase in greenhouse gas emissions continues at current levels, global economic output may be anywhere between 5% and 20% lower in the following two centuries than it would be otherwise. Stabilising greenhouse gas concentrations at 550 parts per million by 2050 would be likely, in contrast, to lead to a 1% reduction in global economic output.

Within this context of increasing calls for economic growth to be set on a sustainable basis, the conclusions of an Environmental Industries Mapping Study commissioned by Scottish Enterprise (2006) would appear to augur well. The study assembled a database of companies operating in Scotland which classified themselves within environmental industries, such as water management, air pollution control, environmental monitoring and instrumentation etc. It counted 833 in total, 65% of which had headquarters in Scotland. The broad level of combined turnover of these companies was estimated at £200 million p.a. and most industry sub-sectors forecast growth in revenues over the period to 2010 either through expansion of operations in Scotland or into international markets. It remained, though, beyond the remit of the study to calculate the contribution of such industries to the reduction of Scotland's carbon footprint.

3.2 Social and political change and demographics

Demographic trends are amongst those which most affect the shape of society, both globally and in the specific Scottish context. Globally, two established trends will continue to determine the core demographic phenomenon of population size. According to the UN World Population Prospects report (2006 revision), first, over the past three decades global fertility rates have declined and may well continue to do so. Second, overall population growth has continued: by 2050 it is thought likely that it will reach 9.2 billion people, an increase of 2.5 billion from 2007 levels. In developed countries, the population will most likely remain stable at around 1.2 billion people.

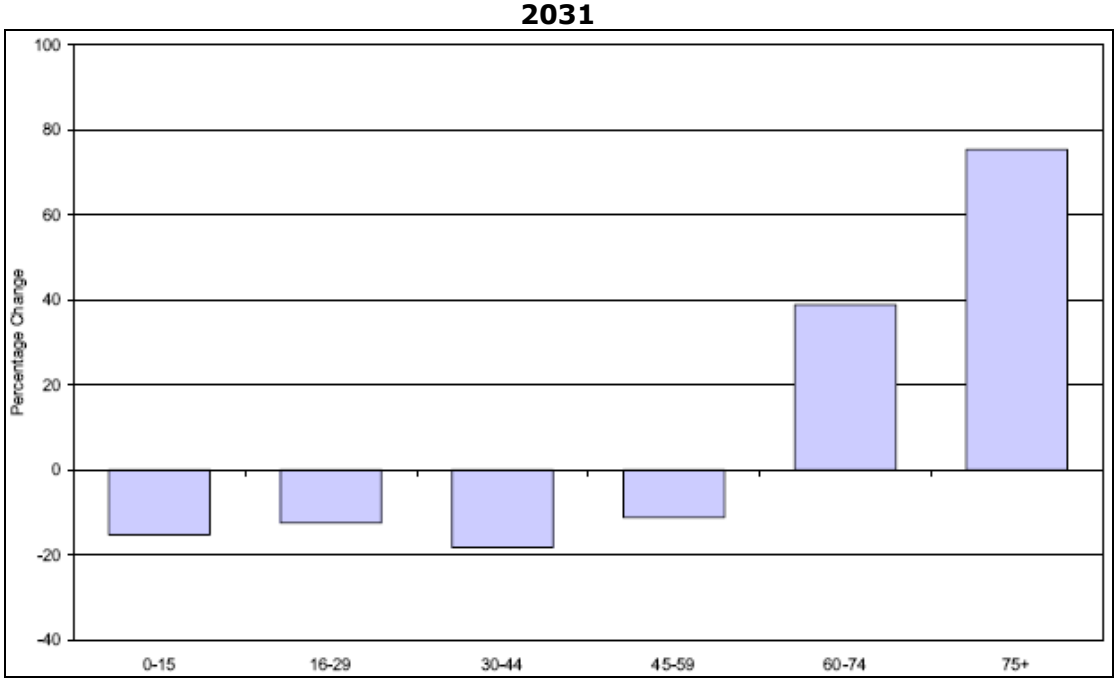
The Population Prospects report also reveals that in the UK, population levels are expected to rise, from 60,769 million people in 2007, to 65,190 million in 2025 and 68,717 million in 2050. The slight increase in fertility rates predicted from 1.76 in 2005 to 1.82 in 2050, will not account for this rise; rather, it is expected to happen as a consequence of net gains in migration flows. The Office for

National Statistics online estimated that in 2004, 223,000 more people migrated to the UK than migrated abroad, largely as a result of EU expansion in that year[3]. The annual average number that the UK is expected to receive between 2005 and 2050 is 130,000.

Scotland's experience fits these trends. According to Scottish Executive statistics (2006), the population has gradually declined since the mid-1970s, having peaked at 5.24 million in 1974. The population is currently projected to increase to 5.13 million by 2019, fall to 5.07 million by 2031, and fall beneath the 5 million mark by 2036. The General Register Office for Scotland Annual Report 2006 (2007) notes that migration patterns in Scotland have changed over time, from net out-migration between the 1960s and 1990s, to net in-migration in the twenty-first century. Between June 2005 and June 2006 around 42,000 people (including political asylum seekers) came from overseas to reside in Scotland, whilst 29,500 left Scotland to reside overseas, giving a net gain of 12,500 people[4]. However, whilst in-migration looks set to continue, a recent ESRC population study (Salt & Rees 2006) forecasts that the ethnic makeup of Scotland by 2020 will have changed little relative to 2001 levels. Whilst in 2001 97.99% of the population was white, 97.41% is expected to be white in 2020. The country's ethnic population is, nonetheless projected to increase, albeit at a lower rate than in other parts of the UK.

In developed countries, populations are ageing quite rapidly. The UN anticipates that in richer parts of the world, the population aged 60 or over could nearly double, from 245 million in 2005 to 406 million in 2050. In contrast, the amount of people under the age of 60 may well drop, from 971 million in 2005 to 839 million in 2050. According to Government Actuary statistics, between 2004 and 2030 the number of people in Scotland aged between 60 and 74 will grow by almost 40%; there will be close to 80% more people of 75 or over.

Figure 3.2 – projected changes to the age of Scotland's population 2004-2031



[3] http://www.statistics.gov.uk/cci/nugget.asp?id=1311

[4] These figures refer to international migrants who change their country of residence for 12 months or more and do not, the Annual Report clarifies, include short term seasonal migrants, such as those from southern eastern European countries who have recently become members of the EU.

One of the reasons why the population is ageing is because of a general increase in life expectancy. The General Register for Scotland anticipates that for children born in 2030-2031, life expectancy at birth will be 79.1 years for males, as opposed to 83.6 years for Europe. However, although people may live longer, they may not experience good health for the remaining time. Scots tend to have worse health than people living in similar circumstances and with similar income elsewhere. A Scottish Executive paper on the future of the life course in Scotland (2006) notes that the prevalence of chronic illnesses are on the increase both in Scotland and globally. Poor diet and the increasing prevalence of mental health problems can be caused or compounded by alcohol dependency. Alcohol-related deaths, according to NHS Scotland Alcohol Statistics, increased by 240% between 1980 and 2004.

Changes in social relationships are also in evidence. A paper on the 'life course' in Scotland observes that both the marriage and divorce rates have dropped over previous decades. This is in part because cohabitation has become a much more common experience, to the point where it is now considered a dominant family type. In 2001, 38% of the 163,434 non-married, cohabiting families in Scotland had dependent children, either from current or previous relationships. The paper anticipates that more children in future will experience some form of family transition. Another trend it notes is that greater numbers of people will live on their own, with subsequent policy implications in terms of community and social care, pensions, employment, health and an increased demand for housing.

Many of these changes are causally linked to the perceived rise in individualism. Another Scottish Executive futures paper discusses the effect in Scotland of the trend towards attitudes and values centred on individual wants and needs, as opposed to those of a broader community or Scottish society at large (2006). It argues that the future extent of this trend will depend on economic and political developments, whilst identifying three broad indicators of it:

1. Identities – with greater social freedom, people can more easily choose which groups they identify with or pertain to, and which values they live by.
2. Values – individuals relate more to single issues, and are less likely to align themselves with specific ideologies or large organisations.
3. Priorities – people have more consumer choice, and quality of life is determined by a wide range of factors (not just income).

The paper notes that ever greater numbers of Scots identify themselves as Scottish rather than British, and that the identities of being a parent and with being Scottish are stronger than class or gender-based concepts of identity. The paper also traces some of the consequences of individualistic attitudes, including falling membership of trades unions, political parties and religious organisations. However, although involvement in the local community is judged by the paper to have fallen, it points out that involvement in volunteering and other forms of issue based activities is quite common.

The rise in individualistic values, with its concomitant decrease in affiliation to political parties or identification with wider society, is connected to declining engagement with the political process, even as devolution has given Scotland greater decision making power over its political future. A SPICe briefing on the May 2007 elections to the Scottish Parliament reveals that although turnout increased by 2.3% on 2003 levels, it was 6.2% lower than the 1999 elections. Declines in Scottish turnout for general elections turnout are even sharper, falling

from 75.5% in 1992 to just 60.8% in 2005[5]. One reason for this phenomenon is that public trust in politicians has dropped dramatically: only 20% of British people trust a politician to be truthful[6].

These trends are likely to have an important bearing on one of the most central issues of the day: the question of Scottish independence. The election of the Scottish Nationalist Party (SNP) to government in the recent parliamentary elections, albeit by a slim margin, has greatly increased debate in the media and the public about the pros and cons of independence, and fostered speculation on the likelihood of it becoming a reality. The SNP recently launched a national conversation, setting out the options for future constitutional arrangements in Scotland, explaining its position in support of full independence and advocating that a referendum be put to the public to decide the matter. In the short term, the chances of Scotland gaining independence from the rest of the UK are not thought to be high. The SNP is not alone in advocating independence: the Scottish Socialist and Green Parties are also in favour. The Independence Convention and Independence First are both instances of civil society organisations lobbying for independence. However, 79 of the Scottish Parliament's 129 seats are held by parties who are against the division of the United Kingdom, making parliamentary cooperation unlikely on any initiatives which would seek to work towards independence or in some way favour it. Moreover, polls of public opinion on the subject are less than conclusive. For instance, whilst a *Scotsman* poll in November 2006 found a majority of Scots to be in favour, an ICM poll in February 2007 found 44% in favour, 42% against and 11% undecided[7]. When a poll in *The Times*[8] in April 2007 included the option of further devolution of power, but not full independence, support for full independence declined. Therefore, it does not seem wise to make predictions at present about the likelihood of independence coming to pass (nor appropriate within the brief of this report).

Nevertheless, it is worthwhile clarifying that a crucial factor that will affect Scotland's future is whether all powers are taken by a Scottish administration or whether some will remain reserved at Westminster. It is very difficult accurately to predict the future of an independent Scotland as opposed to the future of a Scotland within the UK, but an example may serve to illustrate the point. In a comment piece for *The Guardian*[9], MSP Chris Harvie argued that an independent Scottish government could use the remaining revenues from the North Sea Oil to invest in turning Scotland into the renewable energy hub of Europe. Whether or not an independent Scottish government would opt for this strategy will remain for the present a topic of pure conjecture, but it could not be opted for under the current arrangements, as energy policy is at present largely a reserved matter.

3.3 Climate change

There is greater scientific consensus than ever before regarding the extent to which global climate change is caused by human activity. The UN's Intergovernmental Panel on Climate Change Report posits a 70% rise in greenhouse gas emissions between 1970 and 2004, from 28.7 to 49 Gigatonnes of carbon dioxide equivalents (GtCOB2B-eq). In scenarios which assume that fossil fuels will maintain their dominant position in global energy generation until

[5] Source: www.elections.demon.co.uk
[6] Source: MORI Doctors Top Public Opinion Poll On Trustworthy Professions (2005), http://www.mori.com/polls/2005/bma.shtml
[7] cited by Independence First, http://www.independence1st.com/content/polls.shtml
[8] http://www.timesonline.co.uk/tol/news/politics/article1680124.ece
[9] Source, http://commentisfree.guardian.co.uk/christopher_harvie/2007/08/drop_the_dead_shark.html

at least 2030, COB2 from energy use is projected to grow 45-110% over that period. The IPCC's range of possible emission scenarios until 2050 is listed in table 3.1 below. They range from category AA, which assumes a rapid and effective global implementation of emission-reducing policy, to category E, which presupposes little to no action in the way of emissions mitigation.

Table 3.3 – Global warming scenarios

Category	Radiative Forcing (W/mP 2)	COB2B Concentration .39X (ppm)	COB2B-eq Concentration X 39X (ppm)	Global mean temp. increase (ºC)	Peaking year for COB2B emissionsF 40 F (year)	Change in global COB2B emissions in 2050 (% of 2000 emissions).
AA	2.5 – 3.0	350 – 400	445 – 490	2.0 – 2.4	2000 - 2015	-85 to -50
AB	3.0 – 3.5	400 – 440	490 – 535	2.4 – 2.8	2000 - 2020	-60 to -30
B	3.5 – 4.0	440 – 485	535 – 590	2.8 – 3.2	2010 - 2030	-30 to +5
C	4.0 – 5.0	485 – 570	590 – 710	3.2 – 4.0	2020 - 2060	+10 to +60
D	5.0 – 6.0	570 – 660	710 – 855	4.0 – 4.9	2050 - 2080	+25 to +85
E	6.0 – 7.5	660 – 790	855 – 1130	4.9 – 6.1	2060 - 2090	+90 to +140

Adapted from IPCC Fourth Assessment Report (2007)

Within the United Kingdom, the benchmark study on the potential impacts of climate change is that produced by the UK Climate Impact Programme, in collaboration with the Department for Environment, Food and Rural Affairs (Defra) and others (2002, soon to be followed by UKCIP08). Its key predictions are as follows:

- UK climate will become 2-3.5ºC warmer by the 2080s
- Summers will get hotter and dryer; winters wetter and less cold
- Sea levels will continue to rise around the UK
- Extreme sea level rises will become more frequent
- The Gulf Stream might weaken, inducing a drop in UK temperatures[10].

Even within the UK considerable regional variation is forecast. For instance, whilst in southeast England sea levels may rise by between 26 and 86cm, the range for western Scotland is between 2cm below to 58cm above current levels. According to Scottish Executive statistics (2006), temperatures in Scotland are predicted to increase by up to 3.5ºC during the summer months and around 2.5ºC during the winter by the turn of the century. There remains, though, considerable uncertainty regarding the potential consequences of climate change.

These projections find resonance with existing work on Scotland's climate over the past century. In 2006, SNIFFER produced the 'Handbook on climate trends in Scotland' (SNIFFER 2006). Among its key findings the following historical trends figure:

[10] The UKCIP02 report stressed, though, that potential changes to the gulf stream were still shrouded in uncertainty and that no available models predicted it to shut down entirely within the next 100 years.

- Measured since 1961, average spring, summer and winter temperatures have risen by more than 1°C
- Scotland has received 20% more rain since 1961, and by as much as almost 60% more in winter months in northern Scotland
- The snow season has decreased in length across Scotland since 1961
- A 25% reduction in frosty days has occurred since 1961.

Although the study does not determine whether the cause of change to Scotland's climate is anthropogenic, many, if not all, of the trends it charts are comparable with the UKCIP's future forecasts.

3.4 Energy

The production and consumption of energy presents a difficult conundrum, as the World Business Council for Sustainable Development (WBCSD) report on energy trends to 2050 points out. On the one hand, current methods of energy generation contribute enormously to greenhouse gas emissions. But on the other hand, the availability of energy is an essential part of global poverty reduction efforts. The WBCSD posits three future prosperity scenarios for 2050. The first is 'business as usual', in which energy requirements are constant with current levels, whilst the same proportion of people remain in poverty. In the other two, greater and lesser degrees of global prosperity are generated, requiring between a doubling and trebling of energy requirements. How to generate such prosperity whilst reducing emissions is a fundamental global challenge.

One oft-suggested way in which to go about reducing emissions and poverty simultaneously is to decouple economic growth from energy consumption. However, this experience is not wholly representative of broader international trends. The IPCC state that globally, the trend toward a declining carbon intensity of energy has been reversed since 2000. Nonetheless, evidence from the UK, the size of whose economy doubled between 1970 and 2003 (UK Government Energy White Paper 2003) but whose energy consumption increased only by 15%, might plausibly be used to suggest the feasibility of decoupling. Moreover, the UK is on course to reach the emissions targets of a 12% reduction for 2012 set out by the Kyoto Protocol. It is, though, unlikely that it will reach the UK Government's own target of a reduction of 20% in carbon emissions, in the view of a recent Institute for Public Policy Research report (2004).

According to Scottish Executive statistics (2006), Scotland's emissions in 2003 constituted 8% of the UK's total, which is roughly commensurate with the proportion of Scotland's population in relation to the total UK population. Under the Labour-Liberal Democrats coalition, the Government introduced the target of having 18% of electricity generated in Scotland coming from renewable sources by 2010, rising to 40% by 2020. Happily for Scotland, the renewable energy sector finds itself in rude health. Currently, 13% of the world's energy is supplied from renewable sources. This trend seems set to grow: solar photovoltaic power has grown by an average of 41% a year over the past three years; wind has grown by 18% a year (*The Economist*, 31st May 2007). Scotland's climate, especially with regard to wind and wave resources, makes it uncommonly well-placed to exploit the burgeoning opportunities offered by such developments. This point is explored further in section 1.4.

Another important trend relates to the consequences for the energy industry of the emergence of carbon as a tradable commodity. As the Shell Scenarios for 2025 report puts it, '2005 may well be remembered as the year when what is known as "the energy industry" became "the energy-and-carbon industry"' (2005). Shell note that putting a price on carbon emissions, with a view to

making the biggest emitters pay for the pollution they produce, is creating new markets and investment opportunities. The most notable instance of this is the European Emissions Trading Scheme (EETS), of which, via the UK, Scotland is a member.

3.5 The global influence of the concept of sustainability

The concept of sustainability has become extremely important in countless spheres of remarkably diverse human activity and in itself a global policy driver. A fuller account of its history is given in Newsham (2007); it is summarised here. Worries about the damage being done to the planet by production and consumption patterns ushered in by the industrial revolution were, by the 1950s and 1960s, focussing public attention on the idea that there were limits to economic growth imposed by environmental constraints. This proposition was taken up by a group of academics who founded, within the auspices of the UN, the Club of Rome. The work of the Club is epitomised by the *Limits to Growth* series (Meadows, Meadows & Randers 1972, 1992, 2004). From this focus on limits stems the quest to set human development on a sustainable trajectory. In 1972 Stockholm hosted the United Nations Conference on the Human Environment (UNHCE), at which the United Nations Environment Programme (UNEP) was established. In 1980 the IUCN (International Union for the Conservation of Nature), UNEP and WWF published the *World Conservation Strategy*, apparently the first document to make the call for 'sustainable development'. In 1987 The World Commission on Environment and Development (WCED), another UN body, released *Our Common Future*, which features the most frequently-cited definition of sustainable development: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The need to make development sustainable was cemented during the following decades, perhaps most notably at the 1992 and 2002 Earth Summits.

Governments the world over have long since signed up to the sustainable development agenda. The UK government and the devolved Scottish administrations are a case in point. The UK government has set out the strategy for sustainable development in the 2005 policy document *Securing the Future*, which takes as its starting point the WCED definition of sustainable development. Scotland has its own sustainable development strategy, as outlined in the *Choosing our Future* policy document of 2005. Both of these documents make abundantly clear the sheer reach of the concept of sustainability, which is applied to many different areas of public activity, including economic growth, transport, Scottish well-being, the built environment and food production and consumption.

Meadows, Meadows and Randers point out in 'The Limits to Growth: the 30 Year Update' (2004), however, that subscribing to a goal such as sustainable development in public does not necessarily lead to action or change. They contrast the influence of the concept of sustainability with that of free trade, both which started to become popular at the beginning of the 1970s. Free trade, they contend, has far outweighed considerations of sustainability in government decision-making processes.

3.6 New technologies

Merriam-Webster's dictionary defines technology as "the practical application of knowledge especially in a particular area". Perhaps the two technologies with the most scope to shape human development in the twenty-first century, both in the global and Scottish contexts, are biotechnology and nanotechnology. In 2006, the Institute for Prospective Technological Studies (IPTS) published a report entitled

'Consequences, opportunities and challenges of modern biotechnology for Europe'. It defines biotechnology as "use of cellular, molecular and genetic processes in production of goods and services". Medicine and health care is the biggest field of application for biotechnology. It is often credited, the IPTS report states, with the potential to make important reductions in the cost of health service provision. However, there is a lack of cost-effectiveness studies, making it hard to substantiate or refute this claim.

In primary production and agro-food, biotechnology applications are important in relation to the breeding and propagation of crops, livestock and fish to name but a few sectors. Perhaps the most well-known – and controversial – of these applications is the genetic modification of crops and livestock. The take-up of these applications within the EU has been low to date. For instance, the IPTS report shows that whilst 14% of maize grown globally in 2005 was genetically modified – a figure that rose to 52% in the case of the USA – in the EU the figure stood at less than 1%. Future uptake of this technology in the EU context and the Scottish one more specifically appears to be bound up intimately with public reception of these new technologies.

Biotechnology is in Scotland a well-established industry. According to the 'Scotland Official Online Gateway' website, it employs 20,000 people and is growing at 30% per year[11]. Nonetheless, as the IPTS report signals, challenges and concern within biotechnology remain, in relation to:

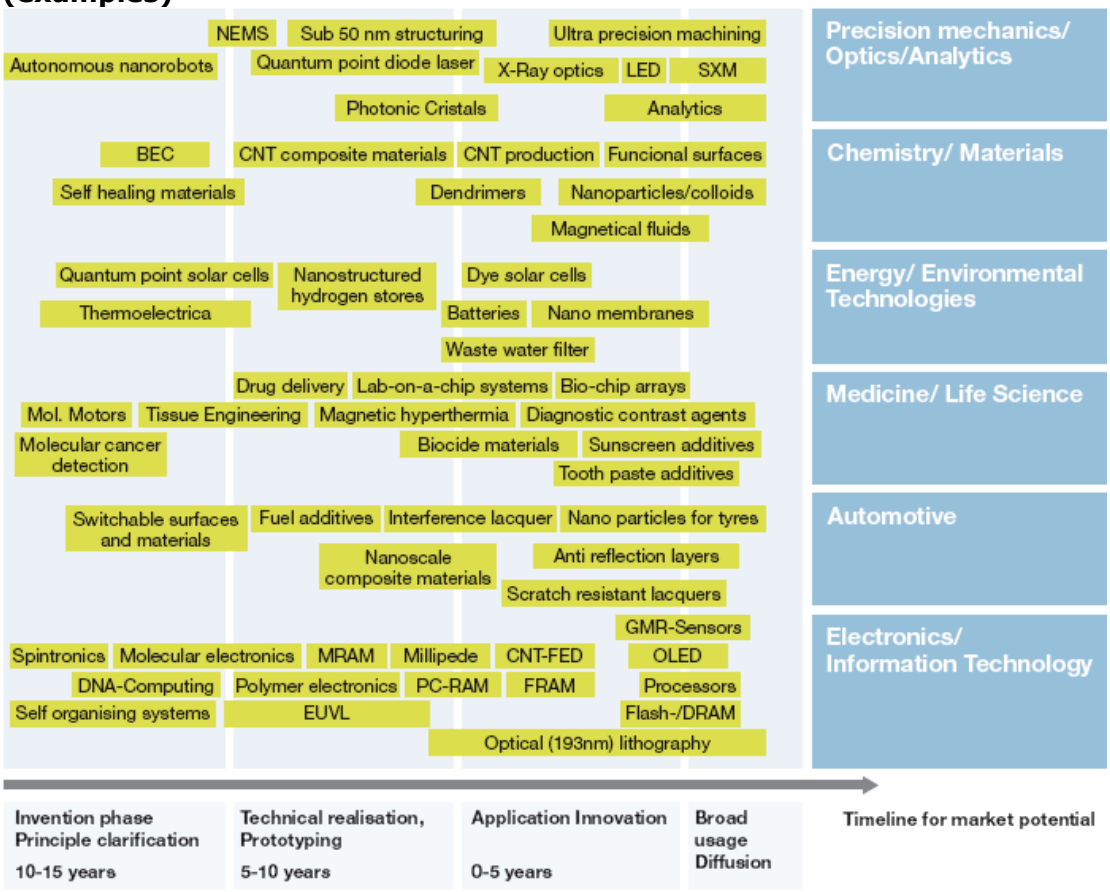
- human embryonic stem cells; use of genetic data for non-medical purposes;
- animal welfare in R&D and farming (see also section 1.4); and
- potential environmental risks of new applications.

Moreover, concerns are growing that the pace of developments in biotechnology is outstripping existing regulatory capacity. A recent article in the 'Nature Biotechnology' journal (2007) suggested that products from cloning technologies may enter the food chain – inadvertently or deliberately – before the public or regulatory bodies are prepared for it.

The International Risk Governance Council's (IRGC) 2006 white paper on nanotechnology defines it as "the development and application of structures, materials, devices and systems with fundamentally new properties and functions which derive from their size in the range of about 1 to 100 nanometers". Although in its infancy, it is thought to have remarkable economic potential. In 2000 the US National Science Foundation suggested that nanotechnology would find its way into key components of $1 trillion worth of products worldwide by 2015. It is already part and parcel of many sectors of industrial production. The IGRC has charted some of these and their potential trajectory over the next 10-15 years (see figure 3.6.1)

[11] url: http://www.scotland.org/about/innovation-and-creativity/features/business/b_biotech.html

Figure 3.6: Development Status and Application Fields in Nanotechnology (examples)



Source: IRGC 2006

Whilst there is much promise and many potential benefits to be had from increasing mastery of nanotechnology, there are also concerns, as the IRGC notes, that as with biotechnology the developments in the field may be outstripping monitoring and regulatory arrangements. This point is especially pertinent in view of potential risks from and continued uncertainty about nanotechnology.

Such concerns are as pertinent to Scotland as they are globally. Nonetheless, Scotland seems to be relatively well-placed to capitalise from developments within nanotechnology, with research and development facilities in Edinburgh and Glasgow universities, accompanying those at Stirling, home of the UK Institute of Nanotechnology. Furthermore, Scottish research outfits and companies can apply for funding under the UK-wide Micro- and Nanotechnology Initiative, started in 2003 by the DTI (now DBERR), which offers £90 million over the course of six years. That said, this investment pales in comparison with the sums of money being spent elsewhere. The (former) Department of Trade and Industry's 2002 UK Strategy for Nanotechnology notes that by 2005, the US government had earmarked spending of US$1,081 million for its National Nanotechnology Initiative, whilst Japan was set to spend US$950 million.

4 Trends for Scotland's futures – an overview of themes and sectors

4.1 Rural resources and economy

The state of rural Scotland
Rural areas constitute 89% of the Scottish land area, are home to 21% of the population and provide work for approximately 20% Scotland's working population ('Rural Scotland: Better Still, Naturally' Report 2007). Seventy-nine percent of Scotland's landmass is used for agricultural purposes, whilst 16% is currently reserved for forestry, a sector which has trebled in size since the 1950s (Rural Development Report 2003). The most significant industrial sectors in the rural economy are:

- Health and social work (13%)
- Retailing (10.6%)
- Agriculture (10.1%)
- Hotels and restaurants (7.4%)

The rural economic and employment base is undergoing diversification. Indeed, in a recent media release, Dr Richard Birnie of the Macaulay Institute argued that in-migration patterns had led to the emergence of two classes of rural area[12]. The first he refers to as "high amenity areas", with considerable in-migration and population growth, as well as healthy service industry economies. The second class consists of remoter, more isolated areas characterised by out-migration and largely reliant on primary industries.

In recent years, the population of both remote and accessible rural Scotland has increased slightly (by 3.9%), whilst the rest of Scotland has marginally declined. Population growth has not been a uniform experience across all of rural Scotland, but the forecast to 2018 indicates that population growth in rural areas will overall continue to exceed that of urban areas. Not only will Scotland's rural population grow, but it will also grow older, and again at higher rates than in urban areas, given that people in the 15-29 ages group tend to migrate to urban areas ('Rural Scotland: Better Still, Naturally' report).

As part of the Scottish Executive Environment and Rural Affairs Department (SEERAD) Strategic Research Strategy 2005-2010, a Research Needs and Priorities Review consultation was conducted in 2003. The report which summarised its findings saw the long-term viability of "fragile rural communities" as a future challenge for Scotland, one which spread beyond the consequences of changes to primary industries, also encompassing environmental, housing and social policy dimensions, and which would require further research.

Agriculture
Agriculture, a traditional mainstay of the rural economy, has to some extent bounced back from the massive slump caused by the UK-wide outbreak of foot and mouth disease, but in 2005 total income from farming decreased overall by 8.4% (Scottish Executive Statistics 2006). Two drivers of change looming over agricultural futures suggest that making a living is going to become harder, not easier, for farmers (future diversification into non-food crops notwithstanding). These are: changes taking place to subsidies currently received by farmers, and potential changes to agricultural productivity stemming from climate change.

The agricultural sector receives considerable subsidies under the EU Common Agricultural Policy (CAP). A key strand to reforms to the CAP in 2003 was the

[12] URL: http://www.macaulay.ac.uk/news/newsdetails.php?28/03/2007

decoupling of agricultural support from production, with a view to encouraging farmers to produce according to customer demand, as opposed to subsidy rules. The 2006 update of the 'Forward Strategy for Agriculture' sees decoupling as a vital part of ensuring that Scotland's agricultural production becomes profitable and self-sustaining. This is an especially important objective, given the likelihood of future reductions to CAP-related subsidies such as the Single Farm payment. July 2006 saw the collapse of the Doha trade negotiations (organised by the World Trade Organisation), leaving the future of agricultural subsidies in the EU in doubt. However, if they are revived, then 2013 would be the cut-off date for export subsidies in general, as the Forward Strategy for Agriculture observes. Participants in SEERAD's Research Needs and Priorities Review consultation pinpointed the need for research into ensuring economically and sustainable agricultural patterns driven by reform to the Common Agricultural Policy.

Government research has deemed the future impact of climate change upon Scottish agriculture an area in need of further research – not least Scotland-specific data on changes in organic carbon concentrations in organic rich semi-natural soils. According to a Scottish Executive review on the state of the country's soil resources (2006), this is the soil property most vulnerable to climate change. Any changes to its status could have huge impacts more broadly both for farmers and in terms of the extent to which the soil acts to store or release greenhouse gases. The review outlines some of the potential effects:

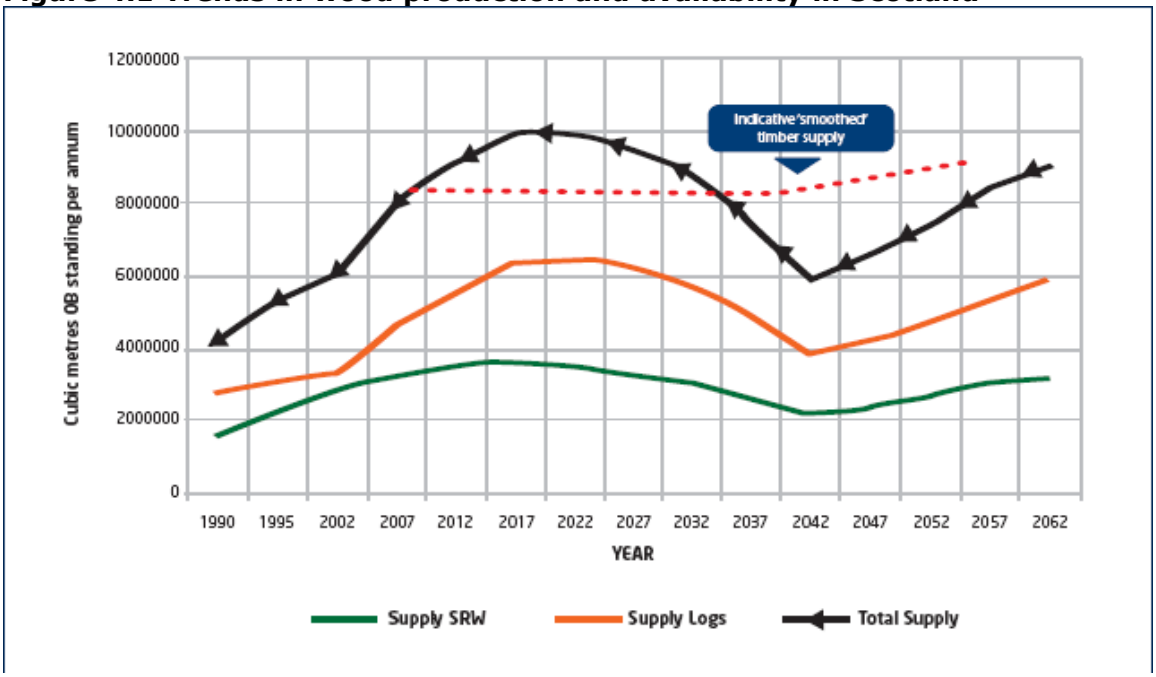
- Agricultural yields could be adversely affected, especially if decreases in summer rainfall increases in temperature combine to cause reductions in soil moisture content
- Land management practices like trafficability and soil workability may be compromised at crucial points in the year, potentially increasing the risk of compaction
- If storm events occur with greater frequency, the risk off erosion, subject to factors like crop cover and soil type, may rise concomitantly
- Some valued soils and habitats may be put at greater risk, for example machair (from increased flooding) and montane soils (from warming)
- There is, nonetheless, scope for mitigation strategies, through adopting different land management strategies.

At the UK level, the National Farmers' Union has produced a report on climate change and the possible impacts for agriculture, which features an extensive list of possible consequences (2005). These include (but are by no means limited to):

- Potential stimulated photosynthesis & yields (eg potatoes, wheat & forage)
- Increased/change in range of native/alien pest & disease problems(eg potato blight, Fusarium)
- Increased grazing opportunities in winter especially on freer draining soils
- Damaged crops (eg wheat, salad crops) at extreme temperatures
- Change in crops grown (diversification into sunflowers, navy beans, soya, lupins, borage, apricots, walnuts, peaches, grapevines & evening primrose, most notably in the SE), less frost damage
- Drop in some crop yields
- Increased irrigation needs and changes in methods (eg potatoes)
- Increased housing needed for livestock
- Change in agricultural markets, demand & competition
- Lack of grazing in drought events
- Erosion of land and salinisation of ground water (2005:4)

Forestry

Figure 4.1 Trends in wood production and availability in Scotland



Source: Scottish Forestry Strategy 2006

According to the Forest Commission Scotland, in 2006, 1.33 million hectares (13,300km^2) of woodland existed in Scotland. Sixty-five percent of this total was under the management of private owners, with the remainder in the hands of voluntary, charitable and public sector organisations (Forest Commission Scotland 2006). At the start of the twentieth century, only 5% of Scotland was forested, though this has now risen to 17%, and yet despite this steady growth trend, it remains a relatively sparsely forested country; for example in relation to the rest of Europe (Rural Development Report 2003).

The Forestry Commission Scotland has put together a Scottish Forestry Strategy, in an effort to foster sustainable forestry sector growth. One of its aims is to boost forest cover across Scotland from 17% to 25% by 2050. This target is in part an attempt to use forests to address climate change, through adaptation, mitigation, carbon sequestration and education. It is hoped that by 2020, through afforestation, using biomass as a renewable energy source, substituting building materials for wood products, a reduction of one million tonnes of carbon emissions can be brought about.

However, not all commentators are quite so optimistic. Tipper and McGhee (2005) have argued that at current rates of 8,000 ha per year of new woodlands planted, the 25% afforestation target is not likely to be met. The Forestry Strategy's own projections (above, in Figure 4.2.1) would appear to support this view.

Moreover, recent climate change modelling undertaken in the USA has cast doubt on the assumption that higher rates of afforestation will cause an aggregate cooling in temperatures. A recent journal article entitled 'Combined climate and carbon-cycle effects of large-scale deforestation' argued that total global deforestation would by 2100 leave the world 0.3ºC cooler as against a 'business as usual' scenario predicting a 6ºC temperature rise over the same period. The aim of the paper is not to argue the case for global deforestation, but rather to

draw attention to the fact forest cover, by dint of the sunlight that it absorbs, has warming as well as cooling effects. Therefore, whilst forestation for climate cooling makes sense in some parts of the world – especially tropical areas – it may even be counter-productive in other parts – such as Europe or North America. Any strategy in Scotland or the UK more broadly in the fight against climate change might want to establish the extent to which forests in Scotland have a net cooling or warming effect on the environment, and balance these off against the other benefits of forest cover.

Box 4.1 – Scotland's rural resources and economy in 2030

Rural Scotland is set to grow older, if not necessarily less populated. Buoyant rural centres are likely to continue to be a focus for migration patterns, but remoter parts will probably become less populated, especially if the decline in agricultural production continues.

Farming in Scotland seems likely to be a changed industry by 2030. Food production may well decline steadily, largely as a result of the demise of the Common Agricultural Policy. The number of farmers active in Scotland may shrink, whilst those remaining diversify into non-food crops or niche organic markets. Biotechnology will continue to play an important role in restructuring remaining food crop and livestock farming.

The forestry sector looks to be a (modest) growth sector. By 2030, annual timber production will experience a decrease on current projections but is expected to pick up. Although more of Scotland is forested than 50 years ago, the annual planting rate still needs to increase if the 2050 target of 25% is to be met.

4.2 Food production and challenges

Animal health and welfare

Animal health and welfare issues have come to receive greater prominence in recent years[13]. Much of this increased public profile stems from the outbreak of BSE and Foot and Mouth Disease epidemics – not least the Foot and Mouth outbreak in England of August 2007 and the first recorded UK outbreak of Blue Tongue in September 2007.

The most recent dedicated Scottish legislation relating to these issues is the Animal Health and Welfare (Scotland) Act, most of which came into force in October 2006. The legislation extends the Government's powers to organise large-scale slaughter programmes, grants inspectors access to farms at any time and makes extra provision for specialist testing, checking, seizures and slaughter and compensation in respect of Transmissible Spongiform Encephalopathies (BSE in cattle). These changes are likely to have implications for implementing both the Animal Health and Welfare Strategy for Great Britain (2005) and Scotland's Exotic Disease Communications Strategy (2005).

Three of the most important known drivers likely to influence animal health trends are:

1. EU policy and legislation
2. Consumer behaviour and preferences

[13] This section concentrates on farm animals, excluding an examination of the domestic animal situation on grounds on space constraints and relevance.

3. The rapid pace of developments in farm animal genomics.

The European Commission's 2002 report, 'Farm animal welfare: current research and future directions', elucidates some of the ramifications for member states of EU agricultural policy. Scotland will see itself affected, for instance, by legislation to be introduced in 2012, which will prohibit caging for hens that leaves each bird less than 750cm². Moreover, the Farm Animal Welfare report also singles out the Common Agricultural Policy for being widely associated with negative impacts on farm animal welfare.

The report also notes that farmers have expressed the fear that changing farming systems in order to accommodate animal welfare concerns may be cost-prohibitive. This observation brings out the interconnection between animal welfare and consumer behaviour and preferences, the second of the two drivers. Although the report signals that some methods of animal welfare improvement – such as bringing about reductions in hen-pecking amongst caged birds – are inexpensive, it also flags up an important tendency in consumer behaviour. And whilst consumers across the EU – and by extension in Scotland – express interest in paying more for animal-friendly products, their purchasing choices seem to suggest that value for money is the first priority.

Developments in farm animal genomics[14], the third driver of change in animal health and welfare, are explored by the Biotechnology and Biological Sciences Research Council in its 2005 Farm Animal Genomics Review Report. It states that genomics has transformed the way and the context in which research is conducted, and provides a powerful platform for strategic research the better to inform: sustainable land use applications, the animal breeding and health industries, as well as the food industry. Noting that SEERAD funds livestock genetics programmes to the tune of £4.8 million per year, it argues that farm animal genomics research should be a "very high priority" for the BBSRC. It identifies the following priorities for future research:

- Animal health: i.e. to understand better how livestock are susceptible to endemic and exotic diseases; and selecting genetic traits to increase disease and pest resistance
- Animal production: i.e. identifying and selecting genetic traits to improve the quality and efficiency of animal products
- Animal biology: i.e. making better use of available genomics tools to generate useful information about farm animal species
- Enabling tools and resources: if these priorities are to be realised, then generic molecular and numerical tools and skills – such as genomics technologies, GM technologies, bioinformatics and quantitative genetics – will require further development.

The Research Needs and Priorities Review consultation conducted for SEERAD's Strategic Research Strategy 2005-2010 also identifies priorities for future research in Scotland in this area. Participants in the consultation viewed infectious diseases in animals, as well as in humans and plants, as in need of greater research, with a view to ensuring the availability of sufficient capacity to respond effectively to emergent threats to animal, plant and human health. Concerns were raised about the potential for the overuse of antibiotics in animal treatment to become an issue for human health. Worries were also expressed

[14] The BBSRC defines 'farm animal genomics' as 'Science that promotes the understanding of genetics and gene function in livestock animals and the application of this knowledge to life sciences in general, in particular to farm animal health and welfare, product quality and efficiency, and human health'. http://www.bbsrc.ac.uk/about/pub/reports/fagr_11_10_05.pdf

about pesticides: although a reduction of these pending the introduction of new legislation would lead to new challenges for the agricultural sector, which would only be overcome through innovative new research.

A different type of concern was raised by the FABRE report on the future of sustainable farm animal breeding. It worried that "knowledge of technologies such as cloning or transgenesis (gene transfer) in farm animals is rapidly disappearing from Europe" (2006). It argued that Europe would be better advised to keep pace with international developments if it wanted to maintain control over whether or not to permit transgenic meat entering the market place.

The organic alternative?

Notwithstanding questions about the viability of food self-sufficiency for Scotland, one of the objectives of the Scottish Executive 'Choosing Our Future' document is to secure greater access to locally produced food. Moreover, the WWF Scotland report on moving towards a low carbon economy (2006) argues in favour of local production as a means through which to reduce Scotland's ecological footprint. It is not easy to see how to square these objectives with continuing reliance upon global food markets. But it is within this context that considerations of the future organic farming become significant.

In a recent article, the Soil Association contends that organic farming is the best solution to food security issues, both globally and in the UK. It argues that organic crop yields can be higher than those produced through conventional methods, and that the UK has sufficient agricultural potential for self-sufficiency. It concedes that such a shift would entail a drastic change in diet, but views this as a means through which to get the population to eat healthier, more nutritious food.

The Soil Association also gives optimistic forecasts about organic sales. It reported in November 2005 that UK organic sales were growing by £2.3 million each week[15]. The picture for Scotland, however, is less clear. A study conducted for the Scottish Executive on organic farming research needs in Scotland (2005) concluded that there was a lack of hard data specific to organic retail in Scotland, but that indications from interview data suggested expectations of slow or static sales growth. It also identified a lack of data on organic supply in Scotland across the supply chain. Finally, the study detailed a number of constraints that were likely to affect future growth in organic farming in Scotland, and about which more needed to be known, including :

- The viability of the Scottish organic processing sector
- Uncertainties over the health benefits of organic food
- Marketing assistance
- Uncertainty regarding why it is that more arable and horticulture farmers have not converted to organic farming
- The lack of abattoirs prepared to handle organic animals, and why this is the case.

Until uncertainty surrounding these (and other) constraints is lifted, it is hard to know what the role of organic farming in Scotland's future will be. At present whilst the organic premium appears to offer potential as a lucrative area into which farmers could diversify, it is less than clear that it represents an economically and politically viable alternative means of food production for Scotland.

[15] Soil Association Press Release 14.11.2005, http://www.soilassociation.org/web/sa/saweb.nsf/Library?OpenForm&Cat=_Press_releases_2005

Non-food crops and diversification
According to a BBSRC report into crop science research (2004), developing a new non-food crop portfolio will be critical to the economy in the coming 20 years. This is as a result, it suggests, of the imperative of finding alternatives to fossil fuels. The US Biomass Research and Development Technical Advisory Committee predicted that whilst oil supplies might be expended within 35-65 years, bio-fuels could achieve up to 10% of its potential market by 2010.

In the UK context, 'Prospecting Bioscience for the future of non-food uses of crops' a Defra-commissioned report, has argued that there is a clear 'policy-time window' within which action should be taken. This is partly due to the need to respond to the projected decline in the supply of fossil fuels, and partly to the fact that the UK was already playing 'catch-up' with respect to the development of a bio-economy in other countries. However, the report also argues that bioscience offers many opportunities for the UK to escape the risk of economic dependency on countries that have more fully developed bioscience technology. It lists a number of domains of application for bioscience involving non-food crops, including:

1. Energy
2. Industrial processing
3. Plant, microbial and fungal pharmaceuticals
4. Environmental amenity and bioremediation.

Considerations such as these have driven the production of a Biomass Action Plan for Scotland (2006). The plan ultimately seeks to kick-start a biomass industry in Scotland, envisaging the use of non-food crops for heat energy, electricity and bio-fuel production. These developments may come at a good time given that agriculture in Scotland is of necessity undergoing a process of diversification. According to the Macaulay Institute's 'State of Scotland's Farmed Environment 2005' report, Scotland's cereal production area fell in 2005 to 457,000ha, the lowest since 1973. Driving this decline is Common Agricultural Programme reform. Interestingly, the report anticipates that non food crops such as biodiesel and bioethanol are among the crops into which farmers are likely to diversify.

Non-food crops and food security
However, diversification into non-food crops might have implications for food security in Scotland. A report by the International Food Policy Research Institute (IFPR) into global food projections (2001) predicts that whilst global demand for cereals will grow by 1.32% between 1997 and 2020, cereal production is expected to increase only by 1.26%. Moreover, regional production increases will not, the report anticipates, match Asian cereal demand; in particular, East Asian demand is set to outpace production substantially. In the UK, meanwhile, a 2006 Defra paper on food security notes that the self-sufficiency ratio of domestic production to consumption has declined significantly since the mid 1990s. A report into sustainable farm animal breeding for the Farm Animal Breeding and Reproduction Technology Platform (FABRE) makes a similar point, arguing that relatively scarce agricultural land availability across Europe and Asia could in future lead to a "permanent risk of dependence upon the Americas" (2006). Would it be better, then, for Scotland to seek to achieve self-sufficiency in food, as opposed to witnessing a steady decline in its food production by way of addressing concerns about food security?

There is no easy answer to this question. However, observing that predictions of a new reality of high food prices and continuous shortages based on price fluctuations in the mid 1990s came by the turn of the century to look premature,

the IFPR report maintains that it is inexpedient to extrapolate long-term judgements about global food security from short term global market trends. Therefore, it may not be wise to jump to gloomy conclusions about a future characterised by mass starvation at home or abroad.

This sort of thinking seems to resonate with that of UK and Scottish Governments on food security. Having drawn out the long-term UK trend towards declining self-sufficiency in food production, the Defra paper on food security seeks to make a case for greater efficiency in food production. It argues that ever since the industrial revolution, food imports have been a central part of the UK's food supply, and that current self-sufficiency levels are not especially high in historical terms. It identifies the market as the solution to many food security issues, suggesting that the world food market functions well, that the UK has access to many stable sources of food and that the UK food supply has often proved resilient to shocks and disruptions to global food markets and supply chains. Moreover, it argues that self-sufficiency in food is dependent upon inputs, such as fertiliser and machinery, which also have to be imported, and that therefore even with increased domestic food production, a drop in output would not easily be avoided. Finally, it makes a similar point in relation to energy security, arguing that in an energy and oil-dependent economy, energy security should be a greater priority than food security.

The contention that the UK's wider integration into global trade networks renders food self-sufficiency an unrealistic objective is echoed by a publication written for the Executive on agriculture's contribution to Scottish society, economy and environment (2001). It argues that even if self-sufficiency was deemed an important goal for future agricultural policy, the bias in Scotland towards livestock production and a centralised food chain structure could impose limits on the size of potential increases in self-sufficiency. If this line of thinking were to continue to influence future Scottish Governments, then diversification into non-food crops would be likely to encounter little resistance; at least to the extent that it made Scottish agriculture more financially sustainable, one of the key objectives of the Forward Strategy for agriculture.

Box 4.2: Food Production in Scotland in 2030

Food security policy will, on current trends, continue to look to the international market as the solution, as opposed to fostering self-sufficiency; though a global food shortage by 2030 is a possibility. Scotland's food supply would then be dependent on the stability of its main suppliers, many of which are European (and thereby also subject to the consequences of CAP reform).

4.3 Biodiversity

In 2005, the devolved administration in Scotland set itself the ambitious objective of becoming the world's leading country in the conservation of the country's biodiversity. During the past 250 years, increasingly intensive agricultural land use, forestry, industry, urbanisation and population growth have combined to bring about substantial declines to Scotland's biodiversity. According to the (2005) UK Biodiversity Action Plan close to 32% of habitats and 18% of species identified were thought to be in decline in Scotland. However, roughly 32% of habitats and 39% of species remained stable or appeared to be in a state of recovery.

The Scottish Environment Protection Agency (SEPA) State of Scotland Report 2006 notes that the country plays host to myriad habitats of international importance, including 65 of the 159 conservation priority habitats listed in the European Habitats Directive, such as, heather moorland, upland blanket bogs and lowland raised bogs, Atlantic oak woods, machair grasslands, as well as freshwater and seawater lochs

The SEPA report also states that Scotland's location and its extensive coastline and wetlands makes it very important for migrating wildfowl and seabird breeding populations. In excess of 140 Special Protection Areas (SPAs) have been established under the EU Birds Directive to protect the breeding, feeding and roosting habitats of migrating bird species. Furthermore, Scotland has put in place a network of more than 1450 Sites of Special Scientific Interest, which cover 13% of Scotland.

In 2004, the Scottish Executive published a strategy for the conservation of biodiversity. Amongst other issues, the strategy addresses the potential future impacts of of climate change on biodiversity. It suggests that climate change may already be having an impact, citing the northward move of birds such as the kingfisher and nuthatch. In the future, it speculates that birch may become more prevalent in pinewoods, oak could become a more frequent sight around the margins, and also that tree-line is quite likely to be higher up than its current level of 650m. If arctic-alpine habitats were to disappear from mountain peaks, as seems possible given warming temperatures, then birds such as the dotterel and snow bunting would also be lost.

Within the marine context, the strategy notes, it seems likely that a number of southern species will move into Scottish waters, whilst other species, such as the sea-pen, the green sea urchin, and possibly the cod, could well significantly decline. Rising sea levels – which in some places could be as much as 70cm by 2080 – will inevitably impact upon coastal habitat, and conceivably at a rate too fast to allow some species to adapt. As the publication points out, adaptation to the effects of climate change will prove a key driver in determining the future health of Scotland’s biodiversity. If species manage to adapt, there will be less impact on biodiversity. However, shifts in habitat or even diet will prove more difficult for less mobile species. However, due to the sheer amount of recognised species in Scotland – over 90,000 – keeping track of adaptation trends across the board is difficult. Tracking the progress of particular species, as is being done through the 2005 UK Biodiversity Action Plan, is a useful and necessary heuristic, but one which nevertheless leaves room for considerable uncertainty. Indeed, the 2005 UK Biodiversity Action Plan reporting period identified a lack of sufficient data for 29% of habitat action plans and 32% of species action plans. However, this should be at least partially addressed by ongoing survey work.

Aside from climate change, the SEPA State of Scotland Report 2006 identifies a number of threats to the state of biodiversity in the future:

- Water quality – some flowering plants and algae regenerate rapidly with excess phosphorous and nitrogen nutrients from intensive agriculture. Large growth in these species growth may reduce the amount of oxygen and sunlight in the water, posing a potential threat to the survival of other plants, invertebrate and fish
- Water resources – if summer droughts are to become more frequent, affecting river quality level, then damaging consequences for fish and invertebrates may be encountered
- Rural land use – intensive agriculture has historically been one of the biggest threats to biodiversity and could continue to be so. However,

recent changes to farm funding provide incentives for sustainable biodiversity management, and the increasing rate of broad-leaf plantation also provides an opportunity to enrich Scotland's biodiversity profile

- Urbanisation – pressure for development to convert farmland and 'semi-natural' land into housing stock is high, and will be difficult to square with biodiversity conservation objectives. However, there is potential to mitigate some of this pressure through reclaiming land in former mining areas, to the benefit of both housing development and conservation objectives
- Air quality – Scotland is at present on course to continue meeting its air quality targets, and ground-level ozone concentrations rarely attain levels high enough to induce visible symptoms on leaves. There remains, nonetheless, scope for future damage to ecosystems from acidification and eutrophification processes. Acidification in particular, though relatively limited in its impact so far, could become a problem across large parts of upland Scotland, and continues to contribute to the decline of biodiversity in some areas.
- Nutrient enrichment of land and soils – the area in which nutrient enrichment reduced biodiversity by altering the competitive balance between species has fallen by roughly 17.5% over recent years. Although the potential for damage remains high in specific areas, this trend bodes well for the future

Another threat from an entirely different source can also be identified within the context of biodiversity conservation. A UK Parliament Science and Technology report has warned that the expertise in systematic biology – from which much knowledge on understanding how ecosystems function is derived – is being lost within the UK context. Grant-in-aid to major systematic biology institutions was found to have declined in real terms. On this basis, the report recommended a number of steps to be taken, including an increase in funding, collaborating and setting priorities, as well as digitising the systematic biology collections.

Box 4.3: Scottish biodiversity in 2030

Variations in climate look set to impact upon Scottish biodiversity by 2030, as seen through changes to the abundance of some species, such as an increase in the prevalence of birch, and the distribution of others, such as the northward migration of the kingfisher. However, Scotland seems likely to continue to maintain many of its habitats and species in a healthy state; although the rate of recovery of degraded areas will be determined not just by Scotland's progress in reducing greenhouse gases, but also global progress on this issue. Scotland protected area network will help offset some of the effects of climate change. Even outwith protected areas, anticipated reductions in agricultural activity, in tandem with the efforts to increase Scotland's forest cover would contribute to biodiversity objectives.

4.4 Marine resources and coastal management

The importance and state of Scotland's coasts

Increasing recognition is given to the importance of Scotland's coastlines, for the resources they offer – especially in terms of the fisheries and aquaculture industries – and for their contribution to the country's national heritage. The Scottish Coastal Forum notes that approximately 20% of the Scottish population lives within one kilometre of the coast, whilst 70% live within 10 kilometres (2006). Greater attention has recently been paid to the idea of integrated coastal zone management, which has led to the Strategy for Scotland's Coast and Inshore Waters (Scottish Coastal Forum 2006). Scotland's coasts are in good

shape when compared with other countries within the EU, with much less erosion than Spain or Ireland, for instance (EEA Coastal Briefing 2006). Although only 15% of the coastline has been developed, a Scottish Natural Heritage Coastal Futures publication notes that the coastal zone is subject to the potentially adverse effects of human activity such as waste disposal, fishing, aquaculture, land claim, shipping, energy generation, mineral extraction, etc. The Coast and Inshore Waters Strategy seeks to make coastal resource management sustainable by addressing the future ramifications of the following trends and issues:

- Declining fish stocks
- Making space for and integrating different forms of aquaculture
- The economic sustainability of coastal areas in view of declining production in North Sea oil and gas fields
- Integrating marine nature conservation into coastal zone planning
- Where to locate renewable energy installations on the coast or offshore, how and in what quantity
- The implications of sea level rise
- Navigation issues which arise from greater inshore waters utilisation
- Worries about population sizes in some rural coastal communities.

Fisheries

According to a recent Scottish Executive review, the overall outlook for Scotland's fisheries appears positive. One trend is increasing consumer demand for fish. In the Sustainable Framework for Scottish Sea Fisheries, this is seen as an opportunity not only to make Scottish eating habits healthier, but also to "position Scottish seafood as a high quality product on a global basis" (2006). According to the Sustainable Framework for Scottish Sea Fisheries, whilst fairly tight quota restrictions will continue to be necessary for the short to medium term, it is likely that over the longer term there will be scope for moderate pressure on fishing stocks. This cautiously optimistic forecast derives partly from the fact that current fish stocks are thought to be in reasonably good health (with some notable exceptions such as herring) and are being fished at sustainable levels.

However, the prognosis of the Royal Commission on Environmental Protection's (2006) report on the future of fisheries is rather gloomier. They estimate that half of all (recorded) fish landed in the UK are from unsustainable or borderline sources (though they do not extrapolate figures for Scotland). Northeast Atlantic fish stocks within safe biological limits reduced from 26% to 16% between 1996 and 2001. They have called for a Scottish Marine Act to replace what they view as a confusing legislative state of affairs (a call which has been heeded, with a Marine Bill shortly to go before Parliament), and have tabled the following recommendations for future policy:

- Establish a network of marine protected areas (MPAs) that closes off 30% of the UK's exclusive economic zone to commercial fishing
- Introduce a decommissioning scheme to ensure that the capacity of the UK fishing fleet is consonant with environmental limits
- Make funds available to assist the fishing industry in its transition and also for diversification activities for industry employees
- Introduce a ban on bottom trawling activities in UK waters
- Change from the current system of species quota for fisheries management to one of effort control, setting limits on the time that vessels can spend at sea
- Press the EU for fisheries reform along the lines suggested in the RCEP report.

Overall, the RCEP are of the view that there is much scope for ongoing research into ocean life more widely, on the basis that what is not known about oceans is greatly in excess of what is known.

Aquaculture

Aquaculture is a growth industry in Scotland. The SNH Coastal Futures report notes that the industry trend is moving towards a consolidation of fewer producers making use of more sites, and in particular offshore sites, by way of alleviating pressure on existing sites such as west-coast sea lochs. Cage technology has allowed this expansion into more exposed areas, but the SNH worry that not enough is known about the 'carrying capacity' of the locations being chosen for aquaculture activities. They also express concern about the future sustainability of the industry in view of its dependence on industrial fisheries for much of its food supply. The report does, though, acknowledge attempts to make, for instance, salmon farming more sustainable by restricting stocking densities and chemical discharges into surrounding waters. In future, cod and halibut seem likely to be farmed, and there exists potential to expand shellfish cultivation, the 'cleanest' form of aquaculture (at least in its current incarnation).

A report by the Fisheries Research Services anticipates that, according to current predictions, climate change trends are unlikely to impact on Scottish aquaculture to any significant extent over the course of the next decade (Gubbins, 2006). The outlook over the next 50 years may, though, be somewhat less rosy. Rising average water temperatures will entail quicker growth rates for species such as Atlantic salmon or mussels. However, longer periods of warmer summer temperatures may adversely affect cold water species such as cod and Atlantic halibut. Their culture at some sites may be limited or prevented, and welfare problems may arise, which could require temperature control for broodstock of some species. There may also, nonetheless, be opportunities from climate change patterns, to the extent that warmer waters allow aquaculture with species currently marginal in Scotland.

Aspects of marine biodiversity are mentioned in Section 1.4.3

Box 4.4: Scotland's coastal & marine environment and economy in 2030

Significant changes are projected for coastal economies. A decline in some areas seems inevitable, most notably in the oil and gas production industries, as a result of the decreasing capacity of North Sea reserves. Aquaculture, however, looks likely to continue its expansion. Mainly through rising levels of offshore aquaculture. Nevertheless, concerns about the rise in sea temperatures may generate a need for diversification into better-adapted species. Moreover, whilst the industry has become less polluting than at the start of the twenty-first century, environmentalists are still concerned by its continued dependence on industrial fisheries as the source of fish food. Scotland's fisheries could in future benefit from a more integrated approach to marine resource management, and the Marine Bill may aid the realisation of this objective. But the loss of some species such as herring and cod remains a distinct possibility.

Controversy may in future surround the issue of energy generation in coastal areas. Fossil fuel extraction from marine environments will continue to have implications for some sensitive areas. Tidal energy is set to expand significantly and will help Scotland to meet renewable energy targets, but the development of tidal power infrastructure could generate adverse environmental impacts.

4.5 Water resources / flooding

Current flooding dynamics in Scotland, as compared to the UK
As table 4.4.1 makes clear, much less damage is caused by flooding in Scotland than in England and Wales, and subsequently much less is spent on flood defences in Scotland. This much lower degree of flooding is partly due, according to an Scottish Natural Heritage report on trends in Scottish river channels and processes (2002), to the fact that effective flood defences, such as the drainage of wetlands and bank revetment, were already in place by the 1800s. Differing land use planning has also made Scotland less vulnerable to flooding. After World War II, efforts to drain wetlands and build up agricultural productivity were less widespread in Scotland than they were south of the border (Future Flooding Scotland report 2004).

Table 4.5.1: UK flood risks and flood-management costs in 2004

	Properties at risk	**Average annual damage (£m)**	**Flood management costs (£m)**
River & Coastal Flooding			
England & Wales	1,740,000	1,040	439
Scotland	180,000	32 (fluvial only)	14
Northern Ireland	45,000	16 (fluvial only)	11
Intra-urban flooding All UK	80,000	270,000	320
Total	**2,045,000**	**1,400**	**800**

Source: Office of Science and Technology Future Flooding Report 2004

In England, flood defences exist for 70% of houses at risk of flooding. The equivalent percentage in the Scottish context depends upon the numbers taken as the starting point for calculation. The Scotland Flooding Futures report puts the figure of houses at risk from fluvial flooding at 77,191, and calculates on that basis that less than 10%of them receive flooding protection. Furthermore,, the Future Flooding report for the UK (2004) states that 180,000 homes in Scotland are at risk of flooding*;* in which case the percentage of houses covered by some form of flood defence falls dramatically. However, new figures based on SEPA's recent flood maps anticipate that this figure will decrease because, although fluvial risk remains roughly the same, coastal risk has decreased significantly.

Possible impacts of climate change
Taking the UKCIP's (2002) scenario of a high level of climate change by the 2080s, the Future Flooding report for Scotland identifies five potential dangers.

1. It suggests that the north west, already wetter than the east, may receive up to 15% more rain, increasing the potential for flooding. There may be up to 25% more rain in the east also, and although the flooding risk may be lower than for the north west, a scenario in which a 25% rise in rainfall would almost certainly have consequences for flooding.
2. Whilst Scotland is less prone to the long-duration rainfall that caused flooding in 2000 (and more recently in June-July 2007) in England and Wales, it is vulnerable to high intensity rainfall in shorter bursts. In future,

extreme 48-hour rainfall is likely to increase, especially in winter, with ramifications for Scotland's drainage systems. Research into storms of short duration in the 2080s suggests that two-hour duration intense rainfall, currently a 1 in 30 year event, may increase in frequency by as much as 60% in Edinburgh. The capacity of urban drainage systems could subsequently be overwhelmed.

3. Impacts for Scottish agriculture will depend on related trends in EU subsidies and directives for sustainable flood protection planning. If climate trends continue, then flood damage to agricultural production and infrastructure is unlikely to remain the marginal phenomenon that it is at the start of the twenty-first century. If the intensification trend currently driving agriculture in eastern Scotland leads to the cultivation of what currently serve as floodplains, then the effects of future climate change would be exacerbated. If, however, if a reduction in EU farming subsidies, leading to less land being put under the plough, occurred in tandem with pressure to use the land more sustainably, then agricultural use of floodplains could lessen over the course of the century.
4. Regardless of the questions raised before concerning the role of forests in heating or cooling their surrounding environments, they are unquestionably an aid to Scotland's flooding planners. One of the aims of current policy, under the Scottish Forestry Strategy, is to replace trees more sensitive to flooding, such as conifers, with broad-leafed, water-tolerant species, with a view to recreating former floodplain forests (Forestry Commission Scotland 2005).
5. Some of the effects of a changing climate could be positive. For instance, the likelihood of fewer winter snows may lead to a drop in the occurrence of flooding caused or aggravated by snow melt. Wetlands such as lochs and fens would also benefit from increased flooding, in greater or smaller proportions.

Economic impacts of potential flooding

The Scottish Future Flooding report also makes tentative projections of likely changes to future costs of flooding, captured in Table 4.3.2.

Table 4.5.2 Inland flood risk in Scotland: residential and non-units (Average Annual Damages £ million)

Standard of Protection	2003	2020s	2050s	2080s
None	185.3	235.3	311.2	398.4
5	179.9	228.4	302.2	386.7
10	143.1	170.4	225.4	288.4
25	69.1	87.8	116.1	148.6
50	31.5	40.0	52.9	67.7
100	8.1	10.2	13.5	17.3
200	3.7	4.6	6.1	7.8

Standard of Protection refers to the level of flooding a defence will withstand i.e. up to flooding that that occurs on a five yearly basis, 50 yearly basis, 100 yearly basis and so on.

Source: Future Flooding Scotland report 2004

Areas for further research

The Scottish Future Flooding report identifies several areas about which more could usefully be known or done:

- There is a need for greater precision in the predictive modelling of precipitation increases up to the 2080s, as well as for the types of coastal

flooding that may become more frequent – especially on the west coast, which is likely to bear the brunt of rising sea levels
- Current drainage design needs to change
- The credibility of claims that wetlands and temporary floodplain storages can reduce downstream urban flood risks needs to be established
- There is a need for further research into the social costs of flooding.

Box 4.5: Flooding in Scotland in 2030

The strain of increased flooding in Scotland by 2030 may be starting to show. More will probably be done to increase protection for properties vulnerable to flooding. Moreover, any decrease in the cultivation of floodplains, in tandem with higher levels of forestation, will prove a boon for flooding planners.

Nonetheless, a sizeable quantity of property looks set to remain unprotected. The north west could struggle to adapt to heavier rainfall. The west coast may experience coastal flooding on a more frequent basis, owing to the incipient impacts of rising sea levels. Meanwhile, urban centres such as Edinburgh could find it difficult to cope if short but intense bursts of rain become more frequent. These have the potential to overwhelm the drainage system and for that reason possibly could become a bigger issue in local and national elections.

4.6 Health and well-being

Health and well-being are treated in the 'Choosing Our Future' document as essential parts of a sustainable future for the country. There are countless different factors that affect health and well-being, many of them subjective. There is not sufficient space in this report to survey them all, but recent work in a number of fields can be used to identify five important variables which will impact upon Scotland's health and well-being futures:

1. Income levels
2. The makeup and quality of urban environments
3. Mental health
4. Dietary habits
5. Climate change.

Income levels
The work of **Richard Layard** has explored well-being in terms of the happiness of a society, and makes some intriguing observations about the link between income and happiness. His starting point is that although Western societies have, over the course of the last 50-60 years, become considerably wealthier, levels of happiness have not increased in similar proportion. He argues that on average, once income in a given country rises above US$15,000 per head, happiness becomes increasingly independent of income. So too, he posits, does unhappiness: suicide rates, he notes, have increased since World War II in even the richest parts of the world. If Layard's work is applicable to Scotland's – and he thinks it applicable across the Western world – then wage increases in real terms are likely to contribute to the well-being of poorer sections of society, but are no guarantee of overall well-being rates. Layard suggests instead that increased job security – a major source of societal stress – secure families and communities, better provision for mental health, as well as personal and political freedom are key drivers for future happiness levels.

The makeup and quality of urban environments
The Royal Commission for Environmental Pollution (RCEP) released a report early in 2007 on the link between the urban environment and health and well-being. It

argues that whilst good quality urban environments can stimulate and offer opportunities not available elsewhere, they often have adverse impacts upon health and well-being, to the point of contributing to tens of thousands of deaths yearly. Air pollution, climate change, obesity, mental ill health, as well as high vehicle emissions, poor housing and lack of access to decent quality green space all feature heavily (if not exclusively) in the urban environment. In response, the RCEP advocates a number of measures to be taken by UK government and devolved administrations, including:

- a statutory framework for including Health Impact Assessments in the planning process
- further measures to reduce traffic levels in the air pollution hot spots of towns and cities, as well as tougher action towards the most polluting vehicles
- greater promotion of the concept of exposure reduction for reducing the overall health impacts of outdoor air pollutants
- greater recognition and protection in policy and legislation of the role played by urban natural ecosystems in improving towns and cities
- a strengthening of requirements for Local Transport Plans including statutory targets for a reduction in urban traffic by 2008
- more stringent requirements for sustainable build in planning policy

Future health and well-being gains are likely to be linked to the extent of uptake of such measures and the level of success in their implementation.

Mental health

'With Health in Mind', a Scottish Public Mental Health Alliance publication (2002), argues that mental health problems are on the increase in Scotland, and that they will become a greater focus than physical health in the public health sector as the twenty-first century progresses. The document surveys current trends in Scotland's mental health. Almost 30% of employees have mental health difficulties each year. Stress causes approximately half of all absence from work, costing UK employers an estimated £4 billion. Suicide among young men in Scotland rose by 50% between 1992 and 2002, and fourfold since 1977. Hospital admission rates for self-harm doubled between 1992 and 2002. A quarter of all registered patients consult a GP for anxiety and depression each year. However, to offset these concerning findings, it also notes that 70 – 80% of people diagnosed with severe mental illness recover.

Well Scotland identifies six priority areas vital for the future of mental health in Scotland:

- Improving infant mental health
- Improving the mental health of children and young people
- Improving mental health and wellbeing in employment and working life
- Improving mental health and wellbeing in later life
- Improving community mental health and well-being
- Improving the ability of public services to act in support of the promotion of mental health and the prevention of mental illness[16].

In a publication on mainstreaming mental health issues, the IPPR (2005) has set out a vision of what the future of mental health would ideally entail in 2025. It sees a society in which mental health is central to both policy makers and the wider public, no longer viewed as an issue for a stigmatised minority. Each community features a Community Health Care Centre, designed and delivered by

[16] url: http://www.wellscotland.info/priority-areas/

the local community. The centres offer people advice on all aspects of health, including mental health, and are staffed by access workers. Community-based support of this sort is credited with substantial reductions in anti-depressant prescriptions. People with mental health difficulties can choose between different kinds of (evidence-based treatments) and are given control over their medication. Crisis units for those in need of them remain, in the event of an emergency, offering a homely and therapeutic environment and focussed on the objective of making the stay as short as possible, in order to avoid people becoming institutionalised. The extent to which this scenario is realisable or indeed should be the direction of mental health intervention in future is unclear, but it may serve as a tool to aid thinking.

Dietary habits

Few would take issue with the proposition that Scotland's diet is not conducive to good health. The 1999 (Scottish) White Paper on Health found that diet is the second most important cause of poor health in the country. The average Scot, it concluded, eats too much in the way of confectionery, fatty meat products, sweet and salty snacks, cakes, and excessive amounts of sugary drinks and alcohol. In contrast, insufficient fruit, vegetables and cereals are consumed. Another Scottish Executive Report, 'Improving the Health & Nutrition of Scottish Children' (2006), revealed that in excess of 65% of Scottish men, 59% of women and 35% of schoolchildren are overweight.

What is becoming increasingly clear, however, is that not only is a poor diet bad for people, it is also harmful to the environment. 'The Footprint of Scotland's Diet', a report by the Stockholm Environment Institute, calculated the ecological footprint of the average Scottish diet to be 0.75 gha/cap and compared it with a number of other dietary arrangements. It found that simply eating healthily could reduce the footprint by 15%, whilst eating healthy, organic, vegetarian food grown locally might bring about a reduction of almost 40%. The relatively high footprint of the current Scottish average diet is explained largely by its high meat content. Meat production requires sizeable quantities of land for grazing animals and growing fodder, as well as significant energy processing and distribution inputs, relative to those needed for the production of other foods. Table 4.9.1 provides a ranking of diets according to its ecological footprint and net change in size of footprint.

Table 4.6: ranking of different dietary option by ecological footprint

Diet	Eco-footprint (gha/cap)	Net change
100% imports	1.23	+63%
Current Scottish average	0.75	Baseline
Healthy diet, standard	0.64	-15%
Healthy diet, 100% organic	0.63	-16%
Healthy diet, 100% local	0.53	-29%
Healthy diet vegetarian	0.50	-34%
Best diet (healthy, organic, vegetarian, local	0.46	-39%

Source: Frey & Barrett (2006) 'The Footprint of Scotland's Diet' (Stockholm Environment Institute

Research such as this would suggest that switching Scotland to a healthier diet could in future, then, generate not only health benefits but also environmental ones, which could lead to a greater overall well-being in society[17].

[17] For a broad overview of the global environmental consequences of livestock production, see Steinfield *et al* (2006), *'Livestock's Long Shadow'* (commissioned by LEAD/FAO), http://www.fao.org/docrep/010/a0701e/a0701e00.htm

Climate change
Whilst the potential environmental and economic ramifications of climate change are well-documented, rather less has been written on possible health impacts, even though these are intimately bound up with environmental and economic considerations. A post note for the (UK) Parliamentary Office of Science and Technology (2004) seeks to redress this balance somewhat with a concise but informative summary of the major health threats posed by anticipated variation in climate. It lists seven main impacts:

1. Temperature extremes – hotter summers could lead to 2,800 more heat related deaths per year; though milder winters could result in 20,000 fewer cold-related deaths
2. Flooding – severe coastal and river floods are likely to increase in frequency, possibly leading to subsequent rises in mental health problems amongst victims, due to economic loss and stress
3. Increased exposure to UV radiation could lead to an extra 5,000 cases of skin cancer and 2,000 of cataract per year by 2050
4. Vector-borne diseases such as Malaria might surge. Food poisoning from diseases like salmonella could increase by as much as 10,000 cases per year with warmer summers
5. Water-borne disease could be spread more easily, especially if levels of cryptosporidium and campylobacter in water increase
6. More frequent storms could produce greater personal injury levels
7. Adverse health effects from winter air pollution could be reduced if emissions of key pollutants, i.e. oxides of nitrogen and sulphur, drop

Areas for further research
With respect to food and health, the Biotechnology and Biological Sciences Research Council (BBSRC) has identified, in its 'High Level Food Research Strategy 2007-2012', a number of areas which could benefit from further research. These include:

1. The delivery of bioactive components in food that benefit health, i.e. understanding how the composition and structure of food influences human nutrition and physiology, with a view to allowing foods to be designed with precise nutritional and physiological properties (aka 'functional foods')
2. An improved understanding of what constitutes healthy food, i.e. how the physical properties of food effect the physiology of the gut
3. the effects of food and food components on human physiology, metabolism, health and behaviour
4. Nutrition, i.e. the effect of diet on mental performance
5. Food processing, i.e. assessment and improvement of existing food and feed technologies
6. Food quality and safety, i.e. exposure to food additives, flavourings, as well as 'migrants' which inhabit the packaging
7. Environmental impacts and total food chain, i.e. post market monitoring of GM food and feed

Proposals for BBSRC research for 2007-2012 may prove helpful to health and well-being policymakers. One example would be the proposal to establish more clearly the impact of diet on human development at critical stages. Little is presently known about how nutrition during fetal development or infancy affects health and cognitive functioning decades later on. Narrowing this knowledge gap may shed light on important issues for Scotland such as the long-term health of the population.

Box 4.6: health and well-being in 2030

It is hard to predict exactly what health and well-being levels will be experienced in Scotland in 2030. Even if Scotland continues to become ever more prosperous, higher incomes seem unlikely to produce a proportionate rise in overall well-being or health. Some current trends do not look encouraging: Scottish diet is poor and shows little sign of changing amongst adults; although efforts such as the 'Hungry for success' school dinners initiative could help change the eating habits of the next generation. A wholesale reduction in meat consumption and a shift toward local vegetable and cereal consumption could pay handsome health and environmental dividends, whose effects could by 2030 be starting to be felt. Mental health problems, meanwhile, are on the increase, which is a cause for concern; however, recovery from serious illness has risen and could help to offset a greater prevalence of mental ill health. If urban environments become cleaner, less congested places to live, then there will be positive consequences for health and well-being; but again there is the possibility that some of these could be offset by the effects of climate change. By 2030, these are likely to be more in evidence, although not as gravely as they are anticipated to be later on in the twenty-first century.

4.7 Sustainable Communities

Current thinking on sustainable communities
The concept of the sustainable community has been embraced by Scotland's devolved administration and the UK government. Following the Egan Review, the former Office of the Deputy Prime Minister (2003) identified the following requisites for a community to be considered sustainable:

- A healthy local economy
- Strong leadership
- Long-term participation by local people, civil society and business
- A safe, healthy, well-designed local environment of a size, scale and density to minimise use of local resources
- Good public transport, linked to urban, rural and regional centres
- Sustainably-built for resource use reduction and lower emissions
- A mix of decent homes for varied household sizes, ages and incomes
- Good quality local public services
- A diverse, vibrant, creative local culture for community cohesion
- Links with the wider regional, national and international community.

There is, too, a sizeable body of literature on making communities more sustainable. For instance, the Sustainable Development Commission has produced a report on sustainable communities and sustainable development (2005) and another on the challenges of sustainable building (2005). The devolved administration issued a policy statement on community regeneration (2002), in response to concerns about high rates of social exclusion and child poverty rates in Scotland. It has also set out the types of communities it wants to see in Scotland, in the Choosing Our Future report on sustainable development. Studies measuring the extent to which communities across Scotland are becoming more sustainable, in what ways and over what timeframe are, however, scarce or non-existent.

The National Planning Framework for Scotland (2005) document is one of a number of Scottish publications that puts an emphasis on community regeneration. In its vision of what needs to be done to achieve progress towards this objective by 2025, it sees improved access to jobs and opportunities as the

best way to help disadvantaged communities. It highlights the role of the planning system in promoting high quality neighbourhoods and environmental justice. It anticipates that social inclusion partnerships will function as a means by which to target regeneration funding more effectively and link economic opportunities with efforts in neighbourhoods to reduce unemployment rates. Furthermore, in relation to spatial planning, the Framework views two issues as crucial to the future of regeneration efforts:

1. formulating economic priorities to take account of the location of communities most in need of regeneration
2. investing in disadvantaged communities in such a way as to make available to hard-to-reach groups the jobs and opportunities already available to others.

Scottish policy on the sustainability of communities focuses on the concept of the mixed community. The '**People and Place'** document on community regeneration argues that if Scotland's most disadvantaged communities are to change, they need to become 'mixed communities'. That is, a mix of tenure arrangements needs to be available, in terms of possibilities to rent or buy locally, but also in terms of different sizes of property. People with good employment prospects are, the document states, less likely to move away from their community if they have the chance to move up the housing ladder and if there is access to good quality local schools, leisure and retail facilities.

Housing affordability

A Communities Scotland report on the affordability of Scotland's housing sector (2006) states that the national situation in 2005 was one in which the total need for additional houses was just over 8000 units per annum 'on central assumptions' (i.e. the middle one of three scenarios). This was related to the fact that recent prices in Scotland, and indeed in the rest of the UK, have been nearly 50% above long term trend values. There were serious affordability issues in some parts of Scotland – i.e. Edinburgh, where between 1995 and 2005 house prices increased by 2.7 times.

Looking forward, the following trends are anticipated between 2006 and 2021:

- Affordability may improve after 2006: the percentage of under-35 households in a position to buy could rise from 43% to 56% by 2021
- Annual net positive need may fall gradually, from 12,110 in 2006 to 7,770 in 2011, 3,485 in 2016, and 3,280 in 2021
- Housing surpluses could well increase significantly, from 5,635 in 2006 to 12,195 in 2021
- Homeless numbers are projected to decrease substantially: by 2021 they could be as low as 18,000 (compared with 38,000 in 2006).

Even if house prices do fall, an important component of efforts by Scottish policy makers to make communities more sustainable has to date been to ensure the provision of affordable housing. In its 'People and Place' policy statement on community regeneration (2006), it commits to a number of measures which are intended to make more affordable housing available in the future, including:

- Investing £1.2 billion by 2008, whilst securing sufficient private sector investment to provide 21,500 affordable homes
- Modernising the planning system, in particular with a view to speeding up applications for housing development
- Encouraging private sector developers and registered social landlords to build more housing for sale or rent in poorer areas.

Sustainable build
Climate Change Minister Stewart Stevenson announced in August 2007 that he wanted new-build housing in Scotland to adopt Scandinavian standards of efficiency in energy consumption[18]. Observing that whilst Scottish planning policy already required low or zero carbon equipment in new developments, he argued more could still be done. To that end, he has convened an expert panel to devise a strategy for increasing the energy efficiency of new build and for ensuring that more buildings generate their own energy.

Whilst this announcement seems likely to be welcomed by environmental campaigners, the Sustainable Development Commission argues that the focus needs to be on how to make the existing housing stock more energy efficient. In 'Sustainable buildings – the challenge of existing stock' (2005), it points out that at the current rate of new build in the UK of 1% of the total stock per year, the 99% of building stock already in existence will be a far bigger determinant of carbon emissions over the next 50 years. Domestic buildings are responsible for 25% of UK greenhouse emissions, more than 50% of water consumption and 8% of waste generation. Although the report does not make Scotland-specific recommendations, those that it does list it perceives to be of UK-wide relevance. Its three core recommendations are:

- Prioritise the optimal use of existing buildings above approving construction of new build
- Focus on minimising energy and resource use more generally within existing buildings
- Devise ways of communicating to homebuyers the benefits, economic and otherwise, of environmentally friendly housing.

Social exclusion amongst older people
Another report for the Communities and Local Government department has examined in the English context the increasing rates of social exclusion amongst the elderly population (2006). The incidence of this phenomenon is on the increase, in line with the tendency for Britain's population to become older. The report identified seven dimensions of social exclusion:

- social relationships;
- cultural activities;
- civic activities;
- access to basic services;
- neighbourhood exclusion;
- financial products; and
- material goods.

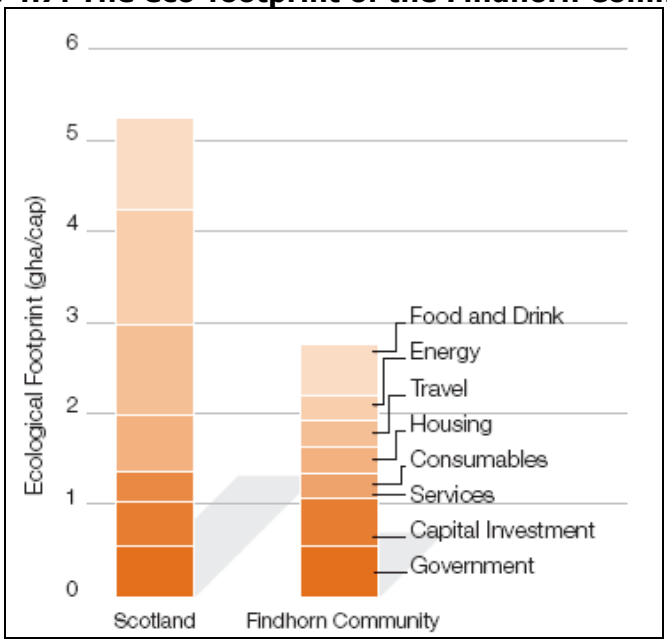
It found that 29% of older people count as excluded in terms of one of these dimensions, 13% in terms of two dimensions and 7% in terms of three or more dimensions. Older women are at even greater risk of social exclusion. By 2011 their numbers will increase by 69,000; and by 2021 they may number as many as 355,000. No comparable study for Scotland was found during the literature search for this document, but the themes it explores are likely to be as relevant north of the border as they are south of it.

Findhorn: an existing instance of a sustainable community in Scotland
WWF Scotland's 'Low footprint Scotland' report in 2006 cited Findhorn community as a prime example of the potential for sustainable living, with one of the lowest 'ecological footprints' of any community anywhere in the UK. At 2.7gha/capita, a

[18]See Scottish Executive News http://www.scotland.gov.uk/News/Releases/2007/08/20080754, 20.8.2007

Findhorn resident's 'ecological footprint' is, on aggregate, 50% less than that of the average Scottish resident. Because of the prevalence of a diet which is low in animal products and high in local organic food, the food footprint is 60% below the Scottish average. Much of the community's energy needs are provided by renewable sources, such as the site's four wind turbines. People at Findhorn also travel less – and when they do travel, tend to do so via car-pool schemes or other, more efficient means.

Figure 4.7: The eco-footprint of the Findhorn Community



Source: WWF Scotland (2006)

Jonathon Dawson notes that one of the defining characteristics of eco villages like Findhorn is communal living (2006). Many activities, i.e. eating, occur in communal settings and possessions are often shared. Both of these tendencies exploit 'efficiencies of scale', whilst, Dawson argues, breaking the link between consumption and well-being. Although there are interesting lessons to be learned from the eco-village experience, studies on the feasibility or likelihood of making communities more sustainable along the lines of models like that provided by Findhorn would appear to be thin on the ground.

Box 4.7: Sustainable communities in 2030

Uncertainty remains around the future of sustainable communities. The concept does not appear to have experienced as much uptake in Scotland, where the emphasis continues to be on community regeneration, as it has in other parts of the UK. The sustainability of Scotland's communities is likely to remain bound up with the extent of regeneration that can be fostered. It will also be affected by factors such as social exclusion, changes in demographic trends, housing affordability and the future implications of reform to the planning system. There is a lack of research evaluating the impacts of these dynamics on communities.

The emphasis in Scottish policy on bringing down household greenhouse gas emissions through stricter building standards would appear to augur well for lowering Scotland's carbon footprint by 2030. However, existing housing stock will over the next 20-50 years continue to comprise the majority of available housing. Efficiency gains provided by new build may well continue to look insignificant in comparison with the inefficiency of existing buildings.

4.8 Transport and travel

Current transport trends for the UK and Scotland

This section splits its focus evenly between Scotland and the UK, on the proviso that transport across the UK is interlinked, and that Scotland will find itself affected significantly by the outcomes of decisions made about transport and travel policy made across the UK. The Department for Transport's 'Transport Trends 2006' offers the following picture of the recent trends in transport usage. Total road traffic grew by 82% between 1980 and 2005, driven by trends in affordable fuel prices, economic growth, as well as increases in both the number of cars and drivers per household. There are now more households with two cars than there are households without access to one. Bus journeys have, in contrast, declined overall since the mid 1980s, whilst travel by rail has increased significantly, by 40%, largely, the study suggests, as a result of privatisation. To put this finding in perspective, though, an overview of future trends by Transport Visions reckoned that in 2002, rail journeys constituted 6% of all passenger kilometres travelled in the UK. In 1980, 18 million visits were made overseas on a plane or a boat by UK residents; by 2005 this number had swelled to 66 million, with most of the increase accounted for by plane journeys. Visits to the UK from abroad increased from 12 million to 30 million over the same period. Meanwhile, walking and cycling for the purposes of travelling have experienced a sharp decline over the previous 10 years, in the face of a 52% rise in carbon dioxide emissions from domestic transport services between 1980 and 2005.

According to Scottish Transport Statistics 2006, overall trends in Scotland are similar to those found in the UK more widely. The total volume of traffic for Scotland was 43 billion vehicle kilometres, 16% higher than in 1995. The estimate for traffic on major roads has more than doubled since 1975, up from approximately 9.3 billion vehicle kilometres in that year to 22 billion vehicle kilometres in recent years. Less traffic is found on motorways and more on A roads in Scotland than in the rest of the UK per head of population; although taking all roads together, there is less traffic in Scotland than the rest of the UK.

The Scottish Transport Statistics also offers plentiful data on public transport trends. It finds that 2005-2006 saw a 0.4% drop in passenger journeys to 477 million, down 6% on 1995-1996 figures. These figures are consonant with a historic decline: buses accounted for almost 1.7 billion passenger journeys in 1960. Bus use remains, however, higher in Scotland than in the rest of the UK. Uptake in rail use – at least on ScotRail – has been somewhat higher than the UK average: there has been a 48% increase since 1995-1996, and a 9% increase in 2005-2006 on the previous financial year, with 75.1 million ScotRail passenger journeys taking place. The report expected that figure to reach 80 million by the following year.

The Scottish Transport Statistics report also reveals the car to be king of commuting. In 2005, roughly two-thirds of commuters travelled by car or van (most of them as drivers rather than as passengers), 13% walked, 12% took the bus, 4% the train, 2% cycled and 2% arrived to work by other means of transport. The 2004 White Paper, 'Scotland's Transport Future', notes that car dominance in commuting journeys is a result of falls in real motoring costs over a period when public transport users have experienced price increases in real terms. It also argues that the vision held by previous governments for the transport sector in Scotland has been too car-focussed.

Concerns about upward trends in road transport usage

In their 2003 publication, 'Putting the breaks on climate change', the IPPR posited that road transport could by 2020 account for almost 29% of the UK's total CO2

emissions, exceeding the domestic, industry and service sectors. They argue that the UK may well miss its 2010 target of reducing greenhouse gas emissions by 20% precisely because of this rising trend. By 2020, they worry, the increases from road transport could cancel out the gains made from cleaner cars, greater overall energy efficiency and greater availability of renewable energy sources, and could even lead to a raise in overall CO2 emissions for the UK. Table 4.6.1 lists anticipated emissions rises from road transport, along with expected trends for other sectors.

Table 4.8.1: Projected UK CO2 emissions by sector (million of tonnes of carbon MtC)

	Climate Change Programme baseline	DfT NTM baseline			% change 2000 -2020
	1990	**2000**	**2010**	**2020**	
Industry	49.8	40.1	32.7	29.1	-27.4%
Domestic	42.6	39.8	33.6	33.1	-16.8%
Services	23.3	22.8	19.1	21.3	-6.6%
Road transport	**33.3**	**34.5**	**37.0**	**39.6**	**+14.8%**
Other transport*	4.3	4.4	4.8	5.1	+15.9%
Other	14.7	13.0	9.2	8.9	-31.5%
Total	168	154.6	136.4	137.1	-11.3%
Road transport as % of total	**19.2%**	**22.3%**	**27.1%**	**28.9%**	
Transport as % of total	22.4%	25.2%	30.6%	32.6%	

Source: IPPR (2003), 'Putting the breaks on climate change'

It is stated in a number of Government documents (i.e. the 2004 Transport White Paper) that overall road usage in Scotland is expected to increase by 27% by 2021 if no action is taken, leading not only to increased CO2 emissions but also to more severe congestion. Table 4.6.2 offers a breakdown of anticipated traffic increases in Scotland assuming a 'business as usual' scenario.

Table 4.8.2: Projected traffic growth in Scotland (overall and in 4 major urban areas)

	Projected growth without targets (vehicle km)		
	2006	2011	2021
National Average	9%	16%	27%
City of Edinburgh Council	12%	18%	30%
Glasgow City Council	8%	15%	24%
Aberdeen City Council	10%	19%	34%
Dundee City Council	6%	12%	22%

Source: 'Scotland's Transport: Delivering Improvements' (2002)

The IPPR, amongst a number of other organisations, has argued that road pricing measures such as congestion charging on a revenue raising basis should be introduced by government as a means to stem traffic growth, increase public transport use and stimulate walking and cycling as means of getting to work. They speculate that if such a charge were introduced in England in 2010, it could reduce congestion by 7% and CO2 emissions by 8%. In Scotland, ministers have backed road pricing with some enthusiasm suggesting that it could in future become a key driver of road traffic and C02 emissions rates. However, Edinburgh's experience with a referendum in which the city's inhabitants voted overwhelmingly against the introduction of a congestion charge highlights the main challenge identified by the IPPR for politicians who do favour road pricing: convincing motorists that it is after all in their interests.

Aviation

A review carried out for the Scottish Executive on the future of Scottish airports (2003) takes the commonly-held view that air travel makes an important contribution to Scotland's economy and to social welfare. As the quickest way to reach both international and UK destinations, flying is a mode of transport whose popularity is rapidly increasing. According to Scottish Transport Statistics, 23.8 million passengers passed through Scottish airports in 2005, 93% more than in 1995. In 1960, only 1.2 million passengers passed through Scottish airports, a figure which gives an indication of how much more popular air travel has become over the past five decades. The (UK) Department for Transport's White Paper (2004) forecasts a rise in passenger numbers to 50 million by 2030, with much of the increased numbers passing through central belt airports. This compares with forecast increases for the UK from current demand of 180 million passengers per year to 500 million passengers per year by 2030, according to DfT forecasts. The DfT also found that freight in the UK doubled between 1989 and 1999, and is expected to grow even more rapidly in the period to 2015. On this basis, the White Paper recommended a significant expansion of Scotland's airport structures, including a new runway at Edinburgh International Airport and a doubling of capacity at Glasgow International Airport.

The increasing centrality of aviation to Scotland's economy may, however, prove difficult to reconcile with the target of reducing greenhouse gas emissions by 60% by 2050. A report for Friends of the Earth Scotland by the Tyndall Centre for Climate Change (2005) studied carbon emissions from aviation at the UK and EU level (used here as forecasts specific to Scotland were not available). Its principal argument was that permitting the aviation industry to grow at its current rate of 3.3% per year would make it much harder for the UK to reach its 60% emissions reduction target by 2050. This is largely because aviation emissions will comprise an increasingly higher proportion of total emissions for the UK over time. Assuming little or no constraint on growth in the aviation sector and assuming also that Britain is on target to reduce greenhouse gas emissions to 550ppmv, the report predicts that aviation emissions will be 17% of the UK total by 2030. On this model, that proportion would rise to 50% by 2050. This level of growth would have drastic implications for all other sorts of greenhouse gas emitting types of activity, and would entail much bigger switches to nuclear and renewable energy sources over a quicker timescale than is currently envisaged. The report concludes that such a response is unlikely, adding that even purchasing permits on the EU Emissions Trading Scheme would not be sufficient to compensate.

Box 4.8: Travel and transport in Scotland in 2030

Current trends in transport and travelling do not look easy to change. Promising though the increase in rail travel in Scotland and the UK may be, it is dwarfed by the rise in air travel. People and government at the Scotland and UK levels alike will not, it would appear, easily be persuaded to cut back on road vehicle use or dissuaded from fostering the growth of the aviation industry. Perhaps the 'worst case' scenario suggested by, for instance, the Tyndall research on aviation, will not quite come to pass: there is the possibility that pressure on government, be it public or from environmental lobby groups, will to some extent limit airport expansion in Scotland and the UK more widely. However, if habits do not change by 2030, then the UK's current reductions in greenhouse gas emissions could be reversed, and will be increasingly dependent on the introduction and uptake of cleaner technologies both in car and aeroplanes.

4.9 Energy – electricity, renewables and efficiency

The current state of play in Scottish electricity generation

The Key Scottish Environment Statistics report of 2006 calculates that, in 2004, 50,972 GigaWatt hours of electricity was generated in Scotland, 550 GWh (1%) more than in 2000. The proportion of coal-generated electricity fell from 33% in 2000 to 26% in 2004, whilst gas and oil-generated electricity grew from 22% to 26% over the same period. Nuclear power provided a further 35% of total electricity, and renewable sources 11.5% (see also table 4.5.1 below). Hydroelectric accounted for most of this total; although renewable energy from other sources increased from 0.6% in 2000 to 2.6% in 2004.

Table 4.9.1: energy generation in Scotland by source

GigaWatt hours

	2000	2001	2002	2003	2004
Other renewables[3]	306	465	643	834	1,308
Hydroelectric (pumped storage)[4]	613	534	622	670	786
Hydroelectric (natural flow)	4,665	3,738	4,458	2,984	4,546
Gas and Oil	11,283	10,898	13,210	12,059	13,265
Coal	16,624	15,408	14,826	14,554	13,054
Nuclear	16,918	18,052	15,863	18,394	18,013

Source: Key Scottish Environment Statistics 2006

There are two principal drivers that will determine whether, over the next 20-30 years, Scotland's electricity generation will successfully play its part in ensuring that the UK-wide goal of a 60% reduction of overall greenhouse gas emissions by 2050 is reached. These are:

- The extent to which savings from possible from greater energy efficiency become a way of life for Scotland
- The magnitude of increases in the proportion of electricity generated from renewable sources.

Energy efficiency

The most cost effective way to lower carbon emissions is to improve energy efficiency. In the UK Government's (2003) Energy White Paper, up to half of

emissions reductions are expected to be achieved through energy efficiency gains. In Scotland, projected efficiency improvements could help to save up to 13TWh in 2020 (RSPB, WWF Scotland & FoE 2006); although these savings will also be determined by the extent to which demand for energy increases. Nonetheless, a reduction in domestic energy use in the order of 37% is thought realistic by some (ibid). According to the IPPR (2004), domestic energy efficiency initiatives such as Warm Front and the Energy Efficiency Commitment, are meeting their targets. However, they call for better monitoring arrangements to gauge more precisely the levels of saving being made.

Renewable energy sources

A 2006 briefing, 'The Power of Scotland', by the RSPB, WWF Scotland and Friends of the Earth Scotland, observes that Scotland commands approximately 23% of Europe's on- and off-shore wind energy resource, a sizeable chunk of UK marine energy, forestry biomass and untapped hydro resources. For this reason, expectations about renewable electricity generation in Scotland are quite high. By 2010, in accordance with the Climate Change Programme, the Government wanted 18% of energy generated in Scotland to come from renewable sources. In fact, the 2010 target has already been met, in 2007, according to a Scottish Renewables Forum report (2007) on Scotland's renewable energy futures. Onshore wind and also hydro electric constitute the bulk of this provision, with the contribution from other renewables yet to figure prominently.

By 2020, the national target is for 40% of electricity to be generated from renewable sources. This leaves a further 3GW on top of current of renewables capacity to be developed over the course of a decade in order to reach the 2020 target. The Scotland Renewables Forum, however, views this as wholly feasible: its 2007 report suggests that Scotland could be producing 54% of its electricity from renewables by that date. However, it warns that the 40% target, which is currently aspirational could be missed if it is not given a statutory basis. By this point, sources other than wind and hydro are expected to figure more prominently. A publication by Forum for Renewable Energy Development in Scotland Forum in 2004 anticipated that wave and tidal stream energy capacity energy alone could provide 1.3GW by 2020.

Notwithstanding the potential of renewable energy, the 'Power of Scotland' briefing draws attention to possible gaps in the energy supply up to 2020, as a result of decommissioning of existing power plants. The scale of decommissioning, in the worst case scenario, could leave an energy gap of up to 20TWh by 2020, even if the 40% renewables target is met. One solution to this worry is to invest in nuclear energy. Tony Blair's government looked favourably upon this option. However, devolved government in Scotland under Labour did not share Westminster's enthusiasm for nuclear; the current SNP administration seems even less likely to favour it. Against this changed political background, a study commissioned by the Scottish Executive in 2001, looking at the potential for renewable energy to power the country, becomes especially pertinent (see table 4.5.2 below).

Table 4.9.2: Scotland's resource potential[19]

Technology	Capacity (GW)	Energy (TWh)
Offshore wind	25.00	82
Onshore wind	11.50	45
Wave	14.00	45.7
Tidal stream	7.50	33.5
Small hydro	0.30	1
Energy Crops	0.14	1
Agricultural Wastes	0.40	3.5
Forestry residues[23]	0.4	3.1
Landfill gas	0.07	0.6
TOTAL	**59.0**	**215.1**

Source: Scottish Executive 2001, cited in RSPB, WWF Scotland & FoE Scotland 2006.

The 'Power of Scotland' briefing estimates that by 2020, Scotland will need to produce 45TWh, roughly 21% of the total potential for renewable energy generation calculated by the 'Scotland's Renewable Resource' study.

It is important to clarify, however, as does the Scottish Renewables Forum 2007 report, that whilst renewable sources show much promise for the generation of electricity, their contribution to heating – which accounts for more than half of Scotland's energy consumption – is insignificant. Nevertheless it may, by 2020, provide 10% of heating energy needs.

The Scottish Renewables Forum 2007 report is reluctant to make cast iron predictions about how likely Scotland is to meet the RCEP target of a 60% reduction in carbon emissions by 2050. However, it suggests that if Scottish energy policy permits the gradual evolution of support for renewable energy sources, encouraging new technologies and markets to emerge in line with developments that have been made to date, then the country could stand a good chance of hitting the target.

Personal Carbon trading

Personal carbon trading is a recent concept, taking its cue from initiatives such as the European Union Carbon Trading Scheme. A recent Centre for Sustainable Energy Report (2006) written for DEFRA, sets out the basic idea: each person in a given community or society is allocated a carbon allowance (the amount of carbon it is permissible for them to emit). S/he can only exceed this amount by purchasing carbon credits from other individuals who have not used their quota. In theory, this would lead to a wholesale reduction in individual emissions in the domestic by between 40-50% wholly along the lines of the 'polluter pays' principle, one which it finds to be fair, egalitarian and economically efficient.

There are different approaches to personal carbon trading – such as the Tradeable Energy Quotas or the Tyndall Centre's Domestic Tradable Quotas (see Starkey and Anderson 2005) – which give an indication of the enthusiasm that exists for the idea. However, even its advocates are not without reservations. The 2006 Centre for Sustainable Energy report for Defra on personal carbon trading noted that the viability of the scheme would be dependent on the extent to which government could enforce its rules and penalise transgressors. Another report for

[19] These figures assume that the difficulties entailed in hooking up these energy sources to the national grid have been overcome.

DEFRA by the Centre for Sustainable Energy Report (2007) identified drawbacks and caveats. It noted a lack of evidence to support the notion that 'community initiative' mechanisms for implementing the system were capable of bringing about change in individual behaviour. It speculated that significant government intervention from government would probably be necessary in order to get communities to prioritise climate change sufficiently to take seriously personal carbon trading.

In the Scottish context, little policy work has as yet been done on personal carbon trading, as a recent SPICe briefing on the concept points out. The briefing also raises the question of whether or not any potential personal carbon trading scheme would be reserved by the UK government or devolved to the Scottish Government. It points out that personal carbon trading would fall into the grey area of what in energy policy is reserved and what devolved, and concludes it to be a matter for further and deeper legal analysis.

Box 4.9: Scotland's energy generation in 2030

Scotland has a good chance of meeting the 2020 target for the provision of 40% of electricity by 2020 and by 2030 to raise that level to over 50%. But critical uncertainties will remain. Perhaps the biggest of these is the 'nuclear question', and which government will decide it. Nuclear capacity could help to make much more of Scotland's heat generation carbon neutral, but Scotland's politicians seem more resistant to expansion of nuclear power than do Westminster counterparts. Energy policy may therefore depend upon changes (or lack of therein) to Scotland's constitutional arrangements.

Although more efficient technologies seem set to reduce many aspects of electricity consumption, overall consumption is likely to be greater by 2030 than it is today.

5. Conclusion: how Scotland might look in 20-30 years' time

Over the next 20-30 years, Scotland is set to experience significant changes on a number of fronts. Scotland will, on current forecasts, see its population rise from current numbers in the years up to 2020, but then fall over the following 20 years. It will also be inhabited by an older population: by 2030 the number of people in Scotland aged between 60 and 74 may grow by almost 40%. A resurgence of people living in rural centres is likely to continue, whilst remoter parts of rural Scotland could experience higher rates of depopulation. What is less clear is the extent to which Scotland's communities, be they rural or urban, will become more sustainable. Anticipated changes to regulations governing the energy efficiency of new buildings should help reduce Scotland's domestic energy consumption. However, over the next 20-30 years, energy consumption levels will be more affected by existing stock than by new build, the gains from which may only be felt in the long term.

Although Scotland does not have as much to fear from global warming as do, say, Bangladesh or the Maldives (and certainly not over the next 20-30 years), the potential effects are not to be underestimated. Temperatures in Scotland are predicted to increase by up to 3.5ºC during the summer months and around 2.5ºC during the winter by the turn of the century. These changes are likely to have adverse consequences in terms of increased flood risk, and to impact upon on water resources, biodiversity, agriculture and possibly aquaculture. There remains, though, considerable uncertainty regarding the potential consequences of climate change. For instance, the shutting down of the Gulf Stream is a possibility in the twenty-second century, but the uncertainty inherent in such predictions is so great that it is difficult to trace the policy implications.

Worries about climate change notwithstanding, the future prospects for Scotland's biodiversity appear to be, on balance, relatively healthy. Although some habitats and species will continue to experience decline, many others will continue to recover from the effects of processes such as industrialisation or the modernisation and intensification of agricultural production. Efforts to reforest Scotland are proving helpful to biodiversity objectives, and will also contribute to mitigating future flood damage, even if the target of increasing woodland coverage to 25% by 2050 is missed (as seems likely on current information). Nonetheless, the crucial variable which will determine the fate of much of Scotland's biodiversity is the rate of adaptation to climate change. Whilst it may broadly be said, for instance, that more mobile species are likely to fare better, it is difficult to make specific predictions in the face of continuing uncertainty over rates of climate change.

Farming in Scotland can be expected to change significantly in the coming 20-30 years. Food production seems set to decline steadily, especially insomuch as its future remains closely linked to the fate of the Common Agricultural Policy. There may well be fewer farmers in Scotland, and those that do remain could find themselves diversifying into non-food crops or niche organic markets. Biotechnology is likely to become more central to remaining food crop and livestock farming activities, and given global trends, genetically modified products such as cloned animals are likely to be part and parcel of the food chain.

Significant changes may also be witnessed in the coastal and marine sectors. A decline seems inevitable in the oil and gas production industries, due to the decreasing capacity of North Sea reserves. Other sectors, such as aquaculture, look likely to continue to grow, principally through rising levels of offshore aquaculture. If sea temperatures rise over the coming decades, there may be a need for diversification into better-adapted species.

Scotland appears well-placed to take advantage of developments in the fields of bio- and nanotechnology. Both are comparatively well-established in the country and could potentially deliver important economic and environmental dividends. However, much public debate remains to be had in relation to issues in both fields, such as introducing genetically-modified animals into the food chain or concerns about health risks from nano-applications. Uncertainty remains, though, over the extent of public reaction to developments in either field. Moreover, in relation to nanotechnology in particular, the magnitude of risks, for instance to human health, are not yet well known and remain a cause for concern.

With 23% of Europe's wind and wave resources, Scotland could slash its energy emissions rates. Scotland is in a good position to hit the 2020 target for the provision of 40% of electricity by 2020. Renewable sources of energy will be indispensable to lowering Scotland's carbon emissions by 60% by 2050. The Scottish Renewables Forum think that they could make the 60% target realistic (under the right circumstances). But their future is linked to questions of how to power Scotland and the UK more widely. The debate over whether to include nuclear sources in future plans has a different character in Scotland and England: both Labour in Scotland and the SNP express greater doubts about nuclear energy than does the UK Labour party. However, although Scottish ministers can set renewable energy targets, overall energy policy remains an issue reserved by Westminster.

Despite the potential for clean energy in Scotland, current emissions levels are considerably more than double the posited sustainable limit, going on WWF data. The UK ranks as having the 14th highest ecological footprint in the world; and Scotland's emissions are slightly higher than the UK average. Although Scotland, along with the rest of the UK, is steadily reducing its greenhouse gas emissions and is on target to meet its obligations for 2010 under the Kyoto Protocol, consumption levels in Scotland will continue to require far more resources than the country produces, or than the world can regenerate for decades to come.

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