FUELLING A FOOD CRISIS

The impact of peak oil on food security

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The Greens | European Free Alliance
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BLACK GOLD

Petroleum has become the lifeblood of both industrialised and developing economies. It would be difficult to find a single product available to us in the UK that has not consumed crude oil derivatives (as well as natural gas or coal) during its production, distribution and retail. Yet there is increasing evidence that the days of easy access to cheap oil are fast running out.

The study of 'peak oil' – the point at which half of the total oil known to exist has been consumed, and beyond which extraction goes into irreversible decline – is beginning to be taken much more seriously. According to a recent report for the US government, and prepared by the US office of petroleum reserves, "world oil reserves are being depleted three times as fast as they are being discovered. Oil is being produced from past discoveries, but they are not being replaced. The disparity between increasing production and declining discoveries can only have one outcome: a practical supply limit will be reached and future supply to meet conventional oil demand will not be available."

While there is no consensus on how soon global oil production will peak, many expect it to occur well before 2020 – some believe we may already have passed the point of maximum production.

The implications of this are vast. Since the first oil crisis of 1973, some of the inevitable consequences of addiction to fossil fuels have been well documented, particularly in terms of its impact on our transport systems. What has been much less analysed, however, is the impact of higher oil prices on our increasingly industrialised food system. This report aims to help address that question, by highlighting the extraordinary dependence of existing food and agriculture policy on cheap oil, and by demonstrating why this will have to change.

In my work as an MEP, I have long argued that the European Union's policies of ever greater free trade and more open markets must change, since they destroy the livelihoods of small and medium sized farmers, jeopardising food security, and increasing our dependence on imports. They also adversely affect the environment, as agricultural commodities are transported ever longer distances, and are processed and packaged to survive the journey. To these social and environmental problems must be added a new imperative – weaning the industrialised food production system itself off its high-energy use.

The priorities are clear. The Common Agricultural Policy must be replaced by a policy framework that minimises fossil-fuel use through the prioritisation of self-reliance, so that Europe can meet this new challenge head on, delivering food security into the future. The current emphasis on ever increasing international trade needs to be replaced by polices to relocalise our food systems. Finally, the EU must urgently refocus its development policies, so that poorer countries can put food security before exports, and replace their dependence on Western markets by much greater national and regional self-reliance. These are ambitious goals. The purpose of this report is to demonstrate why they are so urgently needed.

Caroline Lucas MEP
December 2006

INTRODUCTION

"When the price of oil climbed above $50/barrel in late 2004, public attention began to focus on the adequacy of world oil supplies – and specifically on when production would peak and begin to decline. Analysts are far from a consensus on this issue, but several prominent ones now believe that the oil peak is imminent." [1]

US Department of Energy, 2005

Over recent months, there has been much speculation about the causes of higher oil prices, and over the likelihood of whether or not they will continue. Commentary has focused on the geopolitical instability in the Middle East; increasing dependence on Russia; governments in Latin America retaking control of their oil industries; and supply bottle necks such as refining capacity.

The geological constraints on future energy supply, known as peak oil - the point at which oil production stops rising and begins its inevitable long-term decline – have received much less attention, however. Yet while the majority of constraints on access to oil could potentially be overcome through political or economic means, the geological reality of ever-dwindling fossil-fuel supplies is non-negotiable.

While it has taken 145 years to consume half of the 2-2.5 trillion barrels of conventional oil supplies generally regarded as the total available, it is likely that, given the huge increases of demand from China and India in particular, the other half will be largely consumed within the next 40 years. Some 98% of global crude oil comes from 45 nations, over half of which may already have peaked in oil production, including seven of the 11 OPEC nations. Major oil field discoveries fell to zero for the first time in 2003, while the excess capacity held by OPEC nations has dwindled, from an average of 30% to about 1% of global demand today.[2] World oil and gas production is declining at an average of 4-6% a year, while demand is growing at 2-3% a year.

The implications of this, for every aspect of our lives today, are overwhelming. Some analysis has begun on the impacts on our transport systems, and on how we heat our homes. Very little has so far focused on the implications for our food systems. This report makes the case that, unless we take urgent action, as oil security deteriorates, so too will food security. It is fast becoming the case that decisions made by government departments of energy, on whether to continue promoting fossil fuels or to shift to renewable energy sources, could have a greater effect on long-term food security than any actions taken by departments of agriculture.

The amount of energy is concentrated in even a small amount of oil or gas is extraordinary. A barrel of oil contains the energy-equivalent of almost 25,000 hours of human labour. A single gallon of petrol contains the energy-equivalent of 500 hours of human labour. And across the world, food production systems make use of this stored energy from fossil fuels on a massive scale.

The industrialisation of farming accelerated dramatically in industrialised countries after World War Two, and began in many poorer countries as a result of the Green Revolution of the 1950s and 1960s. These trends transformed food production around the globe, with world grain harvests increasing by 250%. Yet this reliance on fossil fuels - in the form of fertilisers (which accounts for around a third of agricultural energy consumption), pesticides, and hydrocarbon-fuelled farm machinery and irrigation systems – means that industrialised farming consumes 50 times the energy input of traditional agriculture; in the most extreme cases, energy consumption by agriculture has increased 100 fold or more. It has been estimated, for example, that 95% of all of our food products require the use of oil.[3] Just to farm a single cow and deliver it to market requires 6 barrels of oil, enough to drive a car from New York to Los Angeles.[4]

This report details the extent to which 21st century food systems are dependent on intensive energy use, and examines why they are particularly vulnerable to the impact of high energy prices on the fertilisers, pesticides, plastics, aviation fuel, 'warehousing on wheels' and 'just in time delivery' systems, central to the UK's supermarket dominated food system. We caught a glimpse of just how dependent the supply of even the most basic foods have become on petroleum during the blockades at oil refineries and distribution depots in September 2000, when the protest by farmers and road hauliers against higher fuel taxes triggered a national "fuel crisis." Within days, the supermarkets began to ration sales of bread, milk and sugar. The chief executive of Sainsbury's, one of the largest retailers in the UK, wrote to the Prime Minister to warn that the petrol crisis was threatening Britain's food stocks and that stores were likely to be out of food in "days rather than weeks."[5]

Much of our food system is staggeringly inefficient: overall – including energy costs for farm machinery, transportation, processing and feedstocks for agricultural chemicals – the modern food system consumes roughly ten calories of fossil-fuel energy for every calorie of food energy produced.[6] Processing is particularly energy-dependent. Next time you reach for a typical 450 gram box of breakfast cereal, for example, you might pause to consider that it could have required over 7000 kilocalories of energy for processing, while the cereal itself provides only 1,100 kilocalories of food energy.[7]

The UK's dependence on food imports makes us particularly vulnerable to rising energy prices. We currently rely on imports to provide almost one third of the food consumed in the UK, and have one of the lowest self-sufficiency ratios in the EU.[8] Although the UK has been a net importer of food for a long time, imports are currently growing at a significant rate. DEFRA figures show that imports in tonnes increased by 38% from 1988 to 2002. For some types of food, the increase has been even more dramatic. Imports of fruit have doubled, for example, while imports of vegetables have tripled. Half of all vegetables and 95% of all fruit consumed in the UK now come from overseas.[9]

Our report examines the reality of our energy intensive food system through case studies to examine how a range of increased oil and natural gas costs will affect the price of some of the most basic everyday food commodities. We demonstrate how a £3 whole chicken could almost double in price, or treble, if the costs of shopping by car, storage and cooking in the home are included. For the ingredients of a typical stir-fry, the transport costs associated with the ingredients alone would increase by between £1.70 and £3.95.

The effect of rising oil prices on food production is only half the story, however. Its effect on the demand for food commodities is also extremely significant. Since virtually all the crops we currently grow for food can also be converted into automobile fuel, either in ethanol distilleries or bio-diesel refineries, high oil prices will open a vast new market for farm products. Those buying commodities for fuel producers will be competing directly with food processors for supplies of wheat, corn, soybean, sugarcane, and other key crops. As Lester Brown has observed, the price of oil is setting the price for food simply because if the fuel value of a commodity exceeds its value as food, it will be converted into fuel - "in effect, supermarkets and service stations are now competing for the same commodities."[10]

The implications of this are even graver, considering we are already facing a world of potential grain shortages. In China, for example, the grain harvest fell by 34 million tons, or 9%, between 1998 and 2005. There is a real risk that a combination of China's increasing reliance on world markets for major imports, together with a growing diversion of farm commodities to biofuels, will result in grain prices being driven so high that many low-income developing countries will simply not be able to import enough grain.[11] This in turn could lead to escalating food prices and political instability on a global scale. In a world which faces the annual addition of more than 70 million people to a world population of over 6 billion, at a time when water tables are falling, temperatures are rising as a result of climate change, and oil supplies will soon be shrinking, the need for decisive action could not be more urgent.

The report ends by outlining the comprehensive changes necessary to ensure that the food needs of each and every nation are fully met. This will involve a radical shift to a low energy, low input, increasingly organic and localised food and agricultural system, and will demand fundamental changes in energy policy and in the rules of world trade. For the EU, it will also require a radical change in the direction and scope of the Common Agricultural Policy and the Single Market, which currently prioritise international competitiveness over national food security. One of the key elements of the EU's energy security strategy, the large-scale development of biofuels, will also need to be reviewed, since ironically this strategy could itself also pose a threat to food security, as land is transferred out of food production in order to grow crops for fuel. Finally, in the UK, we are calling for a Royal Commission on Food Security, in order to raise much greater political awareness of the urgent need to decouple our food system from dependence on fossil fuels. These are ambitious demands. Yet the scale of the crisis we face requires no less.

OIL AND FOOD – OUR ADDICTION

"From farm to plate, the modern food system relies heavily on cheap oil. Threats to our oil supply are also threats to our food supply. As food undergoes more processing and travels farther, the food system consumes ever more energy each year." [12]

Danielle Murray, *Oil and Food: A Rising Security Challenge*, 2005

There have been dramatic changes in how food is produced, processed and distributed over the last fifty years. The most significant changes include:

- The mechanisation of agriculture and an increased reliance on external supplements, such as synthetic fertiliser, pesticide, feed, plastics, energy and fuel;
- A major shift to highly processed and packaged food;
- The globalisation of the food industry, characterized by an increase in food trade (imports and exports) and wider sourcing of food within the UK and overseas. Of particular note is the rise in imports of fresh fruit and vegetables, with more produce sourced from further a field, such as Africa, Asia and the Far East;
- Supermarkets emerging as sales leaders, accompanied by the loss of small shops, markets and wholesalers. Running parallel to this trend is the concentration of the supply base into the hands of fewer, larger suppliers, partly to meet supermarket preferences for bulk year-round supply of uniform produce;
- Major changes in delivery patterns, with most goods now routed through supermarket regional distribution centres, a trend towards use of larger Heavy Goods Vehicles (HGVs) and just-in-time delivery, sometimes referred to as 'warehouses on wheels';
- A switch from frequent food shopping on foot at small local shops, to shopping by car at large out of town supermarkets.

Food supply in the UK now accounts for 21% of total UK energy use. As Table One, below, shows, agriculture and food processing are responsible for a significant proportion of this food-related energy consumption, with food transportation answerable for almost a fifth (18.5%) of the total. Despite the energy intensity of UK agriculture, self-sufficiency in food has fallen to around two-thirds.[13]

UK	TJ (ii)	%	Energy Per Household (GJ)	Energy Per Capita (GJ)
Retailing	97,925	6.4	3.95	1.65
Packaging	115,000	7.6	4.64	1.93
Catering	151,000	9.9	6.09	2.54
Food transport and Distribution Centres	282,060	18.5	11.38	4.74
Home preparation	350,000	23.0	14.12	5.89
Agriculture and food processing	525,000	34.5	21.19	8.83
Total	**1,520,985**	**100.0**	**61.38**	**25.58**
Total UK final energy consumption	*7,214,410*		*291.15*	*121.31*

Table One - Annual energy use associated with UK food supplies[14]

The energy currently used to supply food in the UK is represented in oil equivalent terms in Table Two. It shows that, on average, food supply to each UK household currently requires the equivalent of almost 10 barrels (1860 litres) of crude oil each year. Of course, the energy used to produce, package, process, distribute, store and cook food comes from several sources, not just from oil. Food distribution is totally dependent on petroleum products, whereas food processing consumes coal, natural gas and electricity as well as crude oil. Throughout each and every stage of the food chain, the use of renewable energy is currently at very low levels.

UK	UK Total (barrels of oil equivalent)	Per Capita (barrels of oil equivalent)	Per Household (barrels of oil equivalent)
Retailing	16,003,432	0.27	0.64
Packaging	18,793,921	0.32	0.75
Catering	24,677,235	0.41	0.99
Food transport and Distribution Centres	46,095,723	0.78	1.84
Home preparation	57,198,889	0.96	2.29
Agriculture and food processing	85,798,333	1.44	3.43
Total	**248,567,532**	**4.18**	**9.94**

Table Two - Annual energy use to supply food in the UK[15]

About half of the energy used to transport food is consumed in the UK. The other half is associated with transport in the countries that export foodstuffs to the UK and the international transportation by road, sea and plane for these UK food imports. In terms of the energy used to produce food on farms and in market gardens, and for food processing and packaging about a third will be in countries that export food products to the UK, as UK self-sufficiency in food has fallen to around two-thirds.

FERTILISER

The manufacture of synthetic fertilizers is particularly energy intensive, and accounts for around one third of the UK's agricultural energy consumption. It has been estimated that 40% of world food protein production now relies on synthetic nitrogen fertilizers.

Although synthetic fertilisers have only been used on a large scale since the 1950s, consumption in that period has increased dramatically. World fertiliser consumption increased from 70 million tonnes in 1970 to 138 million tonnes in 2000 and is expected to rise to 200 million tonnes by 2030. China now consumes the most fertiliser, at 40 million tonnes in 2004.

The fertiliser industry accounts for around 2% of world energy consumption, with a large proportion of this used in the production of nitrogen fertilizer. Table Three below shows that producing a kilogram of synthetic nitrogen fertiliser requires the energy equivalent of 2 litres of diesel, and phosphate fertiliser, almost half a litre of diesel.

Nutrient		Production	Packaging	Transportation	Application	Total	Litres diesel equivalent/kg
N	Nitrogen	69.5	2.6	4.5	1.6	**78.2**	2.03
P_2O_5	Phosphate	7.7	2.6	5.7	1.5	**17.5**	0.45
K_2O	Potash	6.4	1.8	4.6	1.0	**13.8**	0.36

Table Three – Energy Requirements for synthetic nitrogen, phosphate, potash (MJ/kg)

The energy consumed during fertiliser manufacture was equivalent to 191 billion litres of diesel in 2000, which is projected to rise to 277 billion litres in 2030 (Table Four).

	2000		2030	
Fertiliser	Consumption (tonnes)	Energy Use (litres of diesel equivalent)	Consumption (tonnes)	Energy Use (litres of diesel equivalent)
Nitrogen, N	83,000,000	168,490,000,000	120,289,855	244,188,405,797
Phosphate, P_2O_5	33,000,000	14,850,000,000	47,826,087	21,521,739,130
Potash, K_2O	22,000,000	7,920,000,000	31,884,058	11,478,260,870
TOTAL	**138,000,000**	**191,260,000,000**	**200,000,000**	**277,188,405,797**

Table Four - Global consumption and energy requirements
for nitrogen, phosphate, and potash fertilisers in 2000 and 2030

Higher energy and fuel prices will be a triple blow for the synthetic fertiliser industry, and for those farmers that have become dependent on this quick fix and are unwilling to consider the alternatives. Firstly, because of the large amount of energy required to extract ores and consumed during the manufacturing process; secondly, the use of natural gas as a feedstock, and thirdly, the costs of the fuel required to transport these bulk commodities. The export of fertilisers and their raw materials are a significant constituent of sea-borne bulk trade: the fourth most traded bulk commodity in world shipping trade after iron ore, coal and cereals.

Initially, the energy required to produce nitrogen fertilizer was provided by cheap electricity and derivatives of coal, inputs that were mostly available only in industrialised countries. Trade in fertilisers has increased because the fertiliser industry has gradually relocated plants to countries that have low electricity prices as well as the required natural gas feedstock. These include the former Soviet Union, Eastern Europe, the Middle East and Venezuela. The need to access raw materials for other fertilizers has seen the industry also move into areas that have extensive natural reserves, including Africa, China, the US, and Morocco. Worldwide demand for fertiliser has necessitated significant levels of international trade. Shipping costs are relatively high for these low-value bulk commodities: the lower the value of the shipped material, the greater the incidence of transport in the landed cost.

The fertiliser industry does not see peak oil and natural gas as being a problem for fertiliser producers. According to the International Fertiliser Industry Association"…processes for ammonia production can use a wide range of energy sources. Thus, even when oil and gas supplies eventually dwindle, very large reserves of coal are likely to remain. Coal reserves are sufficient for well over 200 years at current production levels, and their location is geographically diverse. 60% of China's nitrogen fertiliser production is currently based on coal."[16]

The consequences in terms of climate change, however, would be catastrophic. Additionally, production of ammonia from coal is 70% more energy intensive than production from natural gas.

Given the high energy input required to produce nitrogen fertiliser, it is inevitable that manufacturing costs have risen as oil and gas prices worldwide have increased. Since 2003, ammonium nitrate costs, for example, have risen from £90 per tonne to over £170 per tonne in early 2006.

PLASTICS

The global food packaging industry is now worth $100bn-a-year and is expanding at a rate of 10-15% each year. Consumption of polymers for plastics applications in Western Europe amounted to 39,706,000 tonnes in 2003, which equates to almost 100 kilograms per person each year. Half of all goods consumed in Europe are now packed in plastic, with food and non-food packaging representing the largest end-use, accounting for 37.2% of all plastics consumed. Packaging represents the largest single use of plastic - more than is used in the building and construction, automotive, electrical and electronics industries combined. Plastics have replaced more traditional food packaging materials because they are lightweight, flexible, durable and, until recently, prices have been low.

In the UK, the packaging of food and drink now accounts for two-thirds of all packaging of consumer goods, a total of 130kg per household per year. Food packaging consumes 4.6 GJ of energy per household per year. The increase in food packaging, particularly plastic, is linked inextricably with the rise in processed food, which now accounts for three-quarters of total world food sales. Food processing is extremely energy intensive, while the packaging, which is often difficult to separate and recycle, also requires large amounts of energy and raw materials to produce.

The use of plastic in the food system demonstrates how complicated food supply chains have become. Most visible to the consumer are the plastic bags and the over-wrapped groceries, symbols of the profligate use of resources that characterises current food production. Yet a closer examination of the entire food chain reveals a widespread use of plastics, and enables a better appreciation of just how dependent the food system has become on finite fossil fuels.

For example, in Europe in 2003, three-quarters of a million tonnes of agricultural plastics were consumed for fertiliser and feed bags, to cover silage and for irrigation and drainage systems. The distribution of food involves plastic crates, shrink-wrap and secondary packaging. Plastic is also used for parts for tractors and other farm machinery and equipment. Table Five, below, gives an overview of the range of plastics and how they are used through the food system, demonstrating the extent of the dependence of today's food system on the ready availability of plastic.

High density polyethylene (HDPE)	Milk, juice, water and food containers, house wares, food wrapping and film, Household and kitchenware, carrier bags.
Low density polyethylene (LDPE)	Shrink and stretch film for pallets and agricultural film, bags, coatings (e.g. drinks cartons), containers, squeeze bottles.
Polyethylene terephthalate (PET)	Bottles, film for food packaging.
Polypropylene (PP)	Microwave-proof containers, crates, automotive parts, caps and lids for bottles and containers, electrical components, flexible and rigid packaging containers (e.g. for yoghurt, ketchup and syrup).
Polystyrene (PS & EPS)	Rigid packaging such as meat trays and egg cartons, vending cups, yoghurt pots, refrigerator trays and linings, and electrical appliances.
Polyvinyl chloride (PVC)	Bottles, cling film, packing for meat and fish.
Polyamide (PA)	Films for packaging of foods such as oil, cheese and boil-in-the-bag products.

Table Five - Use of plastics in the food system

FOOD MILES

Transport, because of its almost complete dependence on fuels derived from crude oil, is particularly vulnerable to a decline in the availability of cheap oil. Food miles and the impact of the increasing transportation associated with today's food supply chain have been seen as key to the sustainability agenda for over a decade.

Food transportation has increased significantly in recent decades. For example, the distribution of food now accounts for at least 30% of all road freight within the UK. In other words, one in every three of the lorries on motorways and in town and city centres contains food and drink. Vehicles and vessels travelled a cumulative distance of 30 billion kilometres moving food products to and within the UK in 2002.

Shopping trips for food by car have also increased, in terms of journey length and frequency, due largely to the replacement of local shops by out of town supermarkets.

As the price of fuel rises, of course, so do the costs of transport. In the UK, the retail price of diesel increased from 42p a litre in 1990, to 65p in 1998, and 87p in 2005. In 2006, the price of both diesel and petrol reached just below the milestone of £1 a litre in the summer. In the year to mid March 2006, petrol and diesel increased in price by 8.1 pence (10%) and 7.8 pence (9%) per litre respectively. The prices have since dropped somewhat but are expected to stay higher than has been the case since the early 1980s.

AIRFREIGHT

Whilst exports of food from the UK have increased significantly since 1961, from 2 million tonnes to 15 million tonnes in 2000, the value of these exports is declining. And the UK still imports almost twice the amount of food that it exports, with imports growing significantly in value and weight. In 1980 the UK trade gap in food, feed and drink was £3.5 billion. This increased to £5.9 billion in 1990, £8.3 billion in 1999, £10 billion in 2002 and £12.2 billion in 2004. Recently the trade gap widened by 11 per cent in just 12 months.[17]

Although airfreight currently accounts for only a small fraction of food imports, it has a much greater impact when energy use, greenhouse gas are considered. A recent report for DEFRA concluded that "Transport of food by air has the highest CO2 emissions per tonne, and is the fastest growing mode. Although air freight of food accounts for only 1% of food tonne kilometres and 0.1% of vehicle kilometres, it produces 11% of the food transport CO2 equivalent emissions."

At present, imports by plane consist mainly of perishable goods such as seafood, fruit and vegetables. Several years ago, a large proportion of this cargo was carried as belly freight on passenger planes. However, there has been a trend towards the use of dedicated air freighters and now most food freight is carried on specialised aircraft, because this allows for easier handling of pre-packed containers and customized storage requirements such as refrigeration and freezing.

Diagram One below provides a breakdown of UK airfreight of food and drink products, both imports and exports. The largest category is vegetables from Africa (green beans, baby corn, mangetout), mainly from Kenya, Gambia, Egypt and South Africa. Vegetable imports account for 40% of food airfreight in or out of the UK, fruit imports for 21% and fish imports for 7%.

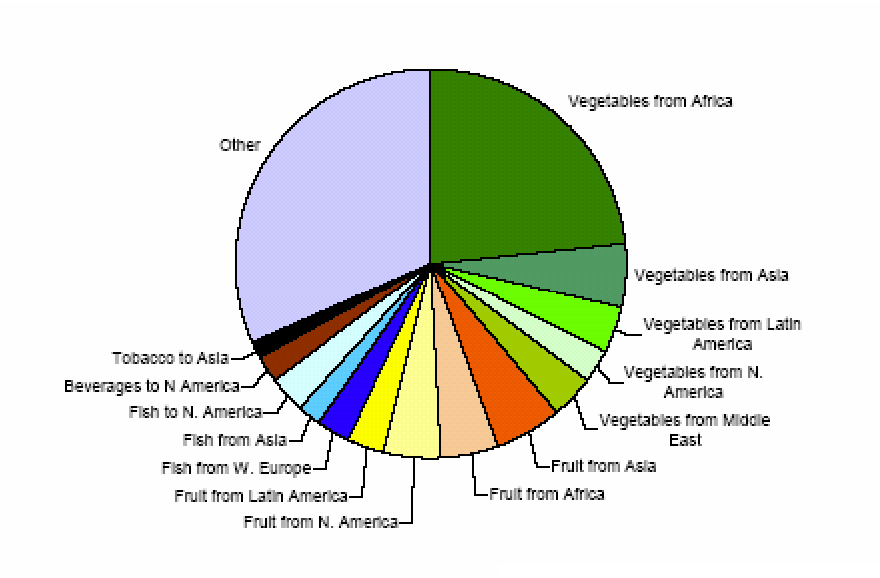

Diagram One - UK Air Freight – food and drink by commodity

Until recently aviation fuel has been very cheap when compared to petrol and diesel for road vehicles - in 2000 aviation fuel was a sixth of the price of diesel. Yet in the last 3 years, the cost of jet fuel has risen significantly and in line with the increased cost of crude oil, as shown in Diagram Two. This has resulted in increased costs for airlines in the first half of 2006 of $22 billion.

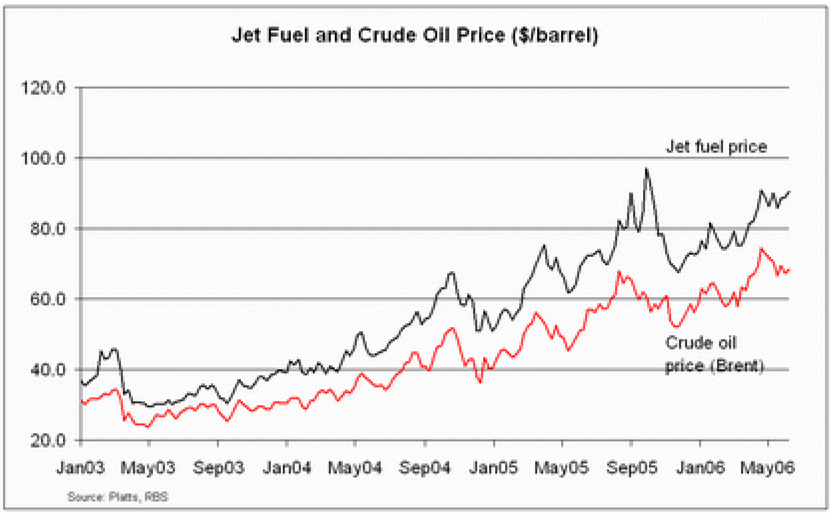

Diagram Two – Jet Fuel and Crude Oil Price

Airfreight is likely to be one of the first aspects of current food sourcing and distribution systems to be hit if oil prices continue to rise overall. Importing produce by air will be less likely to be a viable option, particularly for food products that could be sourced in the UK or transported by sea. For the farm owners and farm workers from poorer nations in Asia, Africa and Latin America that have shifted to, and become dependent upon production for export by air, this is likely to result in economic difficulties. Since the price of aviation is likely to increase in any case (eg via the European Commission's proposals to include aviation in its Emissions Trading System), support should urgently be given to enable poorer countries to diversify away from such dependence.

ENERGY SECURITY VERSUS FOOD SECURITY

Food security in a fossil-fuel constrained world will take on increasing significance, particularly for those countries which have become heavily dependent on food imports, like the UK. We currently rely on imports to provide almost one third of the food consumed in the UK, and have one of the lowest self-sufficiency ratios in the EU.[18]

Although the UK has been a net importer of food for a long time, imports are currently growing at a significant rate. DEFRA figures show that imports in tonnes increased by 38% between 1988 and 2002. For some types of food, the increase has been even more dramatic. Imports of fruit have doubled, for example, while imports of vegetables have tripled. Half of all vegetables and 95% of all fruit consumed in the UK now come from overseas. [19]

Although consumer demand for exotic or out of season foods is one of the drivers for increasing imports, it's worth noting that over half of the food imported in 2002 was indigenous produce – in other words, at the time when it was imported, it could have been grown in the UK's temperate climate, and therefore sourced from the UK.

It's true that there are some cases where, in energy terms, it is currently more efficient to import non-indigenous produce or out of season produce than to grow it in the UK. For example, a recent study suggested that the energy used for growing tomatoes in heated greenhouses in the UK outweighs the energy used in importing tomatoes grown outdoors in Spain. With rising oil and gas prices, however, neither option is likely to be an economic option for a majority.

The implications of import dependence for some developing countries are even more serious, since we are already facing a world of potential grain shortages. In China, for example, the grain harvest fell by 34 million tons, or 9%, between 1998 and 2005. There is a real risk that a combination of China's increasing reliance on world markets for major imports, together with a growing diversion of farm commodities to biofuels, will result in grain prices being driven so high that many low-income developing countries will simply not be able to import enough grain.[20] This in turn could lead to escalating food prices and political instability on a global scale.

It would be complacent to imagine that Europe would be unaffected by these trends. Indeed, there is potential for supplies of food on global export markets to be so tight that the UK, for example, is unable to source sufficient imports to meet its needs. World grain stocks are now at their lowest levels in 34 years and, according to Lester Brown, world trade in food may now be moving into a period dominated not by food surpluses but by shortages.[21] The emphasis of global food policy is therefore likely to shift from exporters' access to markets, to importers' access to supplies.

THE RISE OF BIOFUELS

"Road transport in the UK consumes 37.5m tonnes of petroleum products a year. The most productive oil crop that can be grown in this country is rape. The average yield is 3-3.5 tonnes per hectare. One tonne of rapeseed produces 415kg of biodiesel. So every hectare of arable land could provide 1.45 tonnes of transport fuel. To run our cars and busses and lorries on biodiesel, in other words, would require 25.9m hectares. There are 5.7m in the UK. Even the EU's more modest target of 20% by 2020 would consume almost all our cropland".[22]

George Monbiot, *The Guardian*, 2004

This trend will be exacerbated both by climate change, with its potential to significantly reduce harvests and, indeed, some of the current policy responses to it - including the mass development of biofuels.

A large scale switch from growing crops for food to growing crops for fuel is beginning to take place. Bioethanol and biodiesel can be produced from crops such as corn and soya. Biofuels are also made from plant oils, crop wastes or wood, and can be used to run cars, buses and lorries. Switching from fossil fuels to biodiesel and bioalcohol is currently being promoted as one of the major solutions to climate change and could soon see its economics improve dramatically because of the effects of peak oil.

As Lester Brown observes, cars, not people, will already claim most of the increase in world grain consumption this year.[23] The US Department of Agriculture projects that world grain use will grow by 20 million tonnes in 2006. Of this, 14 million tonnes will be used to produce fuel for cars in the US, leaving only 6 million tonnes to satisfy the world's growing food needs.

Brown points out that the world appetite for automotive fuel is insatiable: the grain required to fill a 25 gallon SUV gas tank with ethanol could feed one person for a year. The amount of corn used in US ethanol distilleries has tripled in five years, jumping from 18 million tonnes in 2001 to an estimated 55 million tonnes from the 2006 crop. In South Dakota, a top-ten corn-growing state, ethanol distilleries are already claiming over half of the corn harvest.

With so many distilleries being built, livestock and poultry producers fear there may not be enough corn to produce meat, milk, and eggs. According to Brown, since the US supplies 70% of world corn exports, corn-importing countries are understandably worried about their supply.

And where the US goes, the EU is trying to follow, with ambitious plans not only for a 2010 target of 5.75% market share of biofuels in the overall transport fuel supply, but for much greater growth thereafter. Last year, the EU produced 1.6 billion gallons of biofuels. Of this, 858 million gallons were biodiesel, produced from vegetable oil, mostly in Germany and France, and 718 million gallons were ethanol, most of it distilled from grain in France, Spain and Germany. Already margerine manufacturers, struggling to compete with subsidized biodiesel refineries, have been asking for help as a result.[24]

It's been calculated that meeting the EU's target for 20% of transport fuel to come from biodiesel by 2020 would consume almost all of Britain's cropland. Environmentalist George Monbiot has concluded that if this were attempted worldwide, then most of the arable surface of the planet will be deployed to produce food for cars, not people. It's clear, then, that food security – already at risk as a result of peak oil – must not be further jeopardised by committing vast areas of land for the production of fuel rather than food.

A year ago, the UK's vulnerability to disruptions in energy imports became extremely clear, when Russia tweaked the spigot on gas supplies to Europe and catapulted energy security to the top of the agenda. The arrival of large importers like China on the world food market, together with the growing effects of higher energy costs and climate change on global food production, means that a similar vulnerability to sufficent supplies of food imports to the UK and Europe is a possibility. Therefore, as a matter of urgency, this report calls for a Royal Commission on Food Security to give serious consideration to these issues.

THE COST OF OUR ADDICTION

"The last energy crisis in 1978-1981 resulted in panic and widespread fears of a depression. But at the time there was plenty of spare capacity, large stockpiles and more oil to come from the North Sea and elsewhere, so the crisis did not last. None of those escape clauses apply today." [25]

Jeremy Leggett, *Half Gone, 2006*

In the past few years, energy prices have escalated and global foreign policy has been dictated even more than usual by the desire to secure access to ever dwindling sources of oil and gas. As demand for oil continues to grow, particularly in countries such as China, India and Brazil, and as global production peaks, high energy prices will stay the norm.

THE ERA OF HIGH ENERGY PRICES IS HERE TO STAY

"Without timely mitigation, world supply/demand balance will be achieved through massive demand destruction (shortages), accompanied by huge oil price increases, both of which would create a long period of significant economic hardship worldwide.... World oil peaking represents a problem like none other. The political, economic, and social stakes are enormous. Prudent risk management demands urgent attention and early action." [26]

Dr. Robert L. Hirsch, *The Mitigation of the Peaking of World Oil Production Summary of an Analysis by the US Department of Energy,* 2005

REASONS FOR THE RECENT RISE IN ENERGY PRICES

Previous oil shocks have resulted in the price of crude tripling or quadrupling over the period of a few months or a few years. During the last few years, oil price has risen above the levels experienced during the 1973 crisis in both nominal and inflation-adjusted terms. Whereas in the 1973 and 1979 crises, oil prices trebled or quadrupled, between 1999 and 2006 prices increased 7-fold: from $10 in 1999 to reach the $70-$75 level experienced during April and May 2006.

There are several possible reasons for these recent price rises. A sharp increase in demand in countries whose economies are expanding rapidly, such as China and India, is part of the answer. Temporary reductions, and the threat of disruptions in supplies, are also a factor. One of the most important is growing turbulence in the Middle East, the world's largest oil producing region with about 50% of the remaining known world oil reserves.

Outside the Middle East, the situation in several of the major oil exporting countries, such as Venezuela and Nigeria, has also caused concern for oil traders, fuelling speculation and a rise in prices. These include strikes in Venezuela and the worsening relationship between the USA and President Chavez, as well as attacks on oil installations and foreign oil workers being kidnapped in Nigeria.

Whilst it could be potentially possible, eventually, to overcome most of these problems through political and economic means, the geological reality of peak oil is non-negotiable.

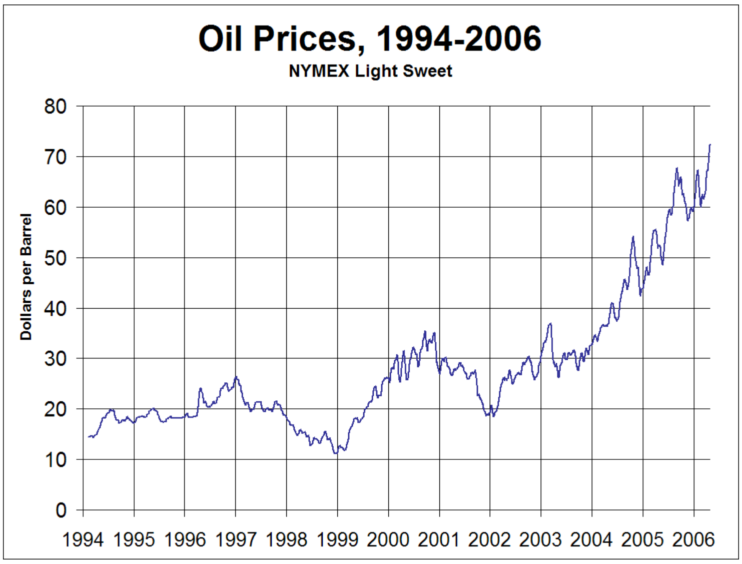

Diagram Three - Oil Prices, 1994-2006 (not adjusted for inflation)[1]

PRICES COULD DROP EVEN GIVEN PEAK OIL- BUT ONLY FOR A TIME

Of course a future of high energy prices overall does not mean that prices won't occasionally fall, sometimes quite significantly. Once the markets fully absorb the facts of peak oil and the impossibility of returning to very cheap energy prices, there is likely to be considerable loss of confidence in global stock markets. This will be based on concerns about the effect that rising prices, rising inflation, and the end of the era of extremely low interest rates, might have on consumer demand. A decline in demand will lead to rising unemployment and a downward cycle that will adversely affect company profits and the tax take needed to fund social infrastructure. This is likely to result in a considerable fall in energy demand at a time when, because of recent high prices, producers are pumping out as much oil and gas as they can to maximise returns. In the short term, then, energy prices may fall.

However, once this fall is registered by the economic system, demand in the future is likely to rise. This will then mean that the prices will rebound upwards again, because of the inherent geological constraints on future supply. In short, peak oil means that, overall, every time demand grows the price of oil (and gas, whose price is linked to it) will rise, and will do so ever more steeply as supply constraints increase.

THE CASE FOR PEAK OIL

"On top of concerns about high oil prices comes the fear that we have reached 'peak oil' and that global oil output will start to decline... If oil has peaked, do we face a future of growing energy shortages, rising prices and international conflict for supplies? No one should underestimate the energy challenge... My view is that 'easy' oil has probably passed its peak..."[27]

Jeroen van der Veer, Chief Executive Royal Dutch Shell, 2006

Peak oil will occur when the world reaches the point at which half our oil reserves are used up. There is considerable controversy as to when that will actually be. Whether it has already taken place or whether it is about to be experienced, the world will soon be entering the transition from a century and a half of annual growth of oil, to a future of declining annual supplies. Indeed it is relatively unimportant whether the actual peak arrives this year or in a few years time, since the reality is that it won't appear as a sudden high isolated pinnacle, but will be the highpoint of a gentle curve.[28] At this point, although there will be roughly one trillion barrels of oil left, ie about as much as has been extracted so far, much of it will be of a lower quality or more difficult, and hence more expensive, to extract.[29]

The concept of 'peak oil' reached a wider audience following the Shell reserves fiasco in January 2004, when the company admitted to overstating its proven reserves by 20%. Yet there are several far more fundamental geological factors that point to its likely imminence:

FALLING GLOBAL RATES OF OIL PRODUCTION

According to Chevron Texaco, 33 of the 48 significant oil producing nations are already experiencing declining production.[30] UK oil and gas production in the North Sea, for example, is in steep decline. The Department of Trade and Industry predicts that most UK reserves will be all but depleted by 2020 or earlier. The UK became a net importer of gas in 2004, and the same situation will be reached over the next couple of years for oil, both ahead of forecasts. Global rates of oil discoveries have been in decline since the 1960s, with over 60% of oil-producing countries now at, or past, the peak of their production.[31]

FALLING GLOBAL RATES OF OIL DISCOVERY

Global rates of oil discovery have been falling since the early 60s.[32] In 2005 it was estimated that about 5 billion barrels of oil were discovered in new fields, compared with the 31 billion extracted and used worldwide.[33] The global oil industry has been able to disguise this to a considerable degree by re-estimating of the size of recovery from existing fields. The Royal Swedish Academy of Science has asserted that in the last 10-15 years, two-thirds of the increases in reserves have been based on increased estimates of recovery from existing fields, compared with only one third based on discoveries of new fields.[34] However the technological improvements used to stretch reserves are only relevant for old existing fields - see technology section below - and future supplies will increasingly have to come from new fields.

NO NEW 'GIANT' OILFIELDS

The recent rate of discovery of "giant" oil-fields, of more than 500 million barrels, is on a dramatic downward curve: in 2000 there were 16 discoveries, in 2001 nine, in 2002 just two, and in 2003 none.[35] It takes around six years from the discovery of an oil-field for the first oil to come to market. If they're called "giant", they still represent less than a week's global supply at current demand rate. Of the 100 or so giant oil fields that supply about half of current world production, almost all are more than 25 years old. The world's biggest oil-fields, the giants of Saudi Arabia and Kuwait, were discovered in the 1930s and 1940s. The last time a major oil province was discovered was in the 1970s. Perhaps most ominously, the last time more oil was discovered in a year than was used was a quarter of a century ago.[36]

OPEC'S EXAGGERATED CLAIMS

The Middle Eastern members of the Organisation of Oil and Petroleum Exporting Countries (OPEC) are generally thought to have huge proven reserves, yet they have been exaggerating these reserves for almost two decades. A growing number of oil industry insiders claim that they have been inflating their statements of reserves ever since OPEC agreed a quota system for production based on the size of national reserves. A former energy advisor to the Bush administration, the investment banker Matthew Simmons, has studied technical papers from the Society of Petroleum Engineers, and has concluded that the oil production of the nation with the largest reserves in the world, Saudi

Arabia, could be close to its maximum, and that world oil production is also therefore close to its peak.[37]

FALSE HOPES OF TECHNOLOGICAL FIXES

Enhancing reserves through the use of advanced drilling technology to boost production is commonly put forward as a solution to peak oil. Techniques, such as steam injection and horizontal drilling, do enhance flows from oil-fields, but they tend only to be useful in the older fields, as newer fields are developed to higher efficiency standards from the outset. Technological fixes are not going to be enough to close the gap between shrinking supply and growing demand.

NO REALISTIC 'UNCONVENTIONAL' OIL ALTERNATIVES

Making up the gap by exploiting "unconventional" oil is also not a realistic option. Unconventional oil exists in huge quantities in several big deposits, notably Canada's tar sands and Venezuela's Orinoco oil belt. Tar sands have to be mined, not drilled, and heavy oil is very difficult to pump and refine. In Canada, for example, large scale use of this process would require such high resource and energy inputs as to render it virtually worthless in terms of resulting net energy. There are also serious environmental costs, including the water intensivity of the extraction process and the resulting pollution, plus the huge amounts of natural gas required to extract deeper reserves and to process the crude oil. The present plan is to build a 1400km pipeline to transport the natural gas needed from the Artic to Alberta, with major environmental threats to permafrost and fragile ecosystems.[38] One estimate is that the amount of gas needed to extract all the Canadian oil reserves is two to three times Canada's total gas reserves.[39]

Even if unconventional oil reserves are fully exploited, the International Energy Agency expects only 10 million barrels a day by 2030 from such sources. That doesn't come close to bridging the gap between supply and anticipated demand of millions of barrels a day.

WHAT IF PEAK OIL ISN'T SO IMMINENT?

"… It is quite likely that the time interval before the global peak occurs will be briefer than the period required for societies to adapt themselves painlessly to a different energy regime." [40]

Richard Heinberg, *The Oil Depletion Protocol*, 2006

Of course not all commentators agree that peak oil will occur in the near future. Oil company spokesmen such as BP's CEO Lord Browne sanguinely assert that it won't happen any time soon: "There is no physical shortage…at present consumption rates (oil found but not yet produced), that's 40 years of oil supply and 60 years of gas."[41] When Der Speigel tried to draw him on a date for peak oil, he sidestepped the question, answering "We don't have to be worried. There are still sufficient reserves out there. Technological advances enable us to pump far more oil from a field than in the past."[42] Yet BP's own exploration consultant, Francis Harper, has estimated that total usable oil reserves would peak between 2010 and 2020, while Browne's complacency has been criticised by geologists and energy commentators alike, including by members of the Association for the Study of Peak Oil.[43]

Regardless of the actual date of peak oil, however, the disruptions that will be caused by the permanent end of cheap oil are so huge and will impact so many sectors of agriculture and industry, as well as having such far reaching economic implications, that efforts to mitigate the effects must begin immediately. A shift away from oil will not only make weathering the peak oil storm less economically damaging, it will also help tackle the other major challenge facing human kind – climate change. Such a shift in energy use will, of course, have considerable implications, especially for the cost of UK food. Perhaps, most seriously, it will also adversely affect the global availability of food exports, which in turn could have serious implications for the UK's future food security.

CASE STUDIES

The food system has become a huge machine that consumes energy in vast quantities. The case studies below examine how rising energy costs could affect the price of some everyday foods – a burger, a chicken, and strawberries. In order to understand the impact of increasing transport costs in particular, we also examine the costs associated with a typical stir-fry in more detail.

As we have seen, the food system uses oil and gas and their derivatives in many ways: for example, diesel, fuel oil and aviation fuel during food distribution; natural gas as an input in synthetic nitrogen fertiliser manufacture; petrochemicals derived from oil as feedstock for pesticides and plastics; electricity to power irrigation systems, and gas to produce steam and heat during food processing and cooking.

The prices of oil and gas are related, and since gas is a major energy source in power generation, electricity costs are also to some extent correlated to oil prices.

The case studies draw on five energy price scenarios, which are detailed in Table Six below, with the assumptions behind them set out in Appendix One.

Price	*Represents*
1	Lowest price over the last few years
2	Current or recent prices
3	An increase of up to 2-fold on current prices
4	An increase of up to 3-fold on current prices
5	An increase of up to 4-fold on current prices

Table Six - Energy price scenarios

FOOD MILES

In 1992 food travelled a total of 27 billion vehicle kilometres to reach UK consumers. By 1996 this figure had increased to 29 billion vehicle kilometres, and to 30 billion vehicle kilometres by 2002. In terms of the fuel used, this currently amounts to a cost of £203 per UK household per year, or around £4 per week – see Appendix Three. However, if diesel and petrol costs continue to rise as predicted, the share of the food bill associated with transport will also increase. For example, if transport fuel costs double, the financial cost to each household will rise to over £400 year (almost £8 a week).[44] A four-fold increase in the cost of aviation fuel, bunker fuel for ships, petrol and diesel for cars and trucks, will hit UK households to the tune of over £800 a year, more than £15 a week.

STIR FRY

To get a better understanding of the impact of increasing transport costs, we examine a case study of a stir-fry, in which all of the ingredients are imported to the UK by plane. The results are shown in Table Eight below. Until recently, aviation fuel costs have been low and amounted to between

5p and 9p when transporting each ingredient. On average this is 14p per kg of produce. However, recent price rises have resulted in airfreight energy prices doubling to current levels of between 12p and 22p per ingredient. Average fuel costs for the ingredients in the stir fry are currently 35p per kg – an increase of 59p for the seven ingredients in the meal.

If the price of aviation fuel doubles again, the aviation fuel costs associated with these 7 products (2.8 kilograms in total) will reach £2.47. If aviation fuel prices quadruple, then importing these items by plane will cost 395p, about £3 more than it costs at present. Importing half a kilogram of prawns from Thailand or half a kilogram of carrots from South Africa alone will amount to 89p in fuel costs.

Currently aviation fuel costs represent between 2% and 12% of the retail price of these products. If there is a 4-fold increase in the price of aviation fuel, it will represent up to 75% of the (current) retail price.

It should be noted that these price increases relate only to aviation fuel. Increasing oil and gas costs will impact upon the cost of cultivating, packaging and refrigerating these products as well as all other transport stages in the supply chain.

						Price of aviation fuel (pence)				
Ingredient	Origin	Distance	Price per ingredient (pence)	Ingredient weight kg	MJ per quantity purchased	1	2	3	4	5
Runner Beans (sliced)	Kenya	6804	278	0.400	23.1	5.1	12.7	21.6	31.8	50.8
Baby Corn	Thailand	9534	198	0.300	24.3	5.4	13.3	22.7	33.4	53.4
Sugarsnap Peas	Kenya	6804	198	0.374	21.6	4.8	11.9	20.2	29.7	47.5
King Prawns	Thailand	9534	250	0.500	40.5	9.0	22.2	37.8	55.6	89.0
Baby Spinach	California	8774	100	0.300	22.4	5.0	12.3	20.9	30.7	49.1
Flat Beans	Morocco	2088	198	0.400	7.1	1.6	3.9	6.6	9.7	15.6
Baby Carrot	South Africa	9622	120	0.500	40.9	9.1	22.5	38.2	56.1	89.8
Total		**53160**	**1342**	**2.8**	**180.0**	**40.0**	**98.8**	**168.1**	**247.1**	**395.2**

Table Eight - Summary of the analysis of the impacts of increasing energy and transport costs on the price of typical stir fry

BEEF BURGER

The ingredients and the energy requirements for each ingredient of a beef burger purchased from a fast-food outlet are shown below.[45]

	Ingredients		Energy consumption (MJ)			
	kg	grammes	Low	%	High	%
Bread bun	0.0740	74.0	1.030	14.1	3.320	17.8

Beef burger meat	0.0900	90.0	5.530	75.9	10.450	56.1
Lettuce	0.0280	28.0	0.100	1.4	4.360	23.4
Onions (freeze dried)	0.0017	1.7	0.065	0.9	0.108	0.6
Cucumber (pickled)	0.0074	7.4	0.042	0.6	0.056	0.3
Cheese	0.0145	14.5	0.540	7.4	0.910	4.9
	0.2156	**215.6**	**7.307**		**19.204**	

Table Nine - Ingredients and energy consumption of a beef burger

As the table demonstrates, the total energy consumption for beef burger (containing 90 grammes of beef) is between 7.3 and 19.2MJ. The inclusion of a low and a high energy value for each ingredient reflects the way in which each ingredient can be produced, processed, stored and transported. For example, the energy use in lettuce production shows high variation due to the methods used during cultivation. The two options considered are open ground (3.4 MJ per kilogram lettuce) or in a heated glasshouse (160 MJ per kilogram lettuce).

If energy and transport fuel prices increase, there will be a knock on effect throughout the supply chain, as seen in Table Ten below.

			Energy Cost (pence)				
		Energy Use (MJ)	1	2	3	4	5
BUN	Crop production incl. drying	*0.24*	0.429	0.659	0.989	1.319	2.637
	Milling	*0.39*	0.271	0.650	0.975	1.625	2.167
	Baking	*1.00*	0.278	0.556	0.833	1.111	2.222
	Storage	*1.60*	1.110	2.667	4.000	6.667	8.890
	Transportation	*0.09*	0.161	0.247	0.371	0.495	0.989
	Subtotal	*3.32*	2.248	4.779	7.168	11.217	16.905
BEEF	Crop production, drying, fodder	*5.00*	8.930	13.736	20.604	27.475	54.945
	Stable, slaughtering, cutting	*1.40*	0.972	2.333	3.500	5.834	7.778
	Grinding, freezing	*0.16*	0.111	0.267	0.400	0.667	0.889
	Storage	*2.30*	1.596	3.833	5.750	9.584	12.779
	Frying	*0.59*	0.164	0.328	0.491	0.655	1.311
	Transportation	*1.00*	1.786	2.747	4.121	5.495	10.989
	Subtotal	*10.45*	13.559	23.245	34.867	49.710	88.691
LETTUCE	Crop production	*4.27*	7.626	11.731	17.596	23.464	46.923
	Storage	*0.05*	0.035	0.083	0.125	0.208	0.278
	Transportation	*0.04*	0.071	0.110	0.165	0.220	0.440
	Subtotal	*4.36*	7.732	11.924	17.886	23.892	47.640
ONIONS	crop production	*0.02*	0.027	0.041	0.062	0.082	0.165
	freeze-drying	*0.07*	0.051	0.122	0.183	0.304	0.406
	storage	*0.01*	0.006	0.015	0.023	0.039	0.052
	transportation	*0.01*	0.019	0.030	0.045	0.060	0.120

	Subtotal	*0.11*	0.103	0.208	0.312	0.485	0.742
CUCUMBER	crop production	*0.01*	0.017	0.027	0.040	0.053	0.107
	storage	*0.01*	0.005	0.012	0.019	0.031	0.041
	pickling	*0.03*	0.009	0.018	0.027	0.036	0.071
	transportation	*0.01*	0.013	0.020	0.030	0.040	0.079
	Subtotal	*0.06*	0.044	0.077	0.115	0.159	0.298
CHEESE	Crop production, drying, fodder	*0.37*	0.661	1.016	1.525	2.033	4.066
	Milking, making cheese	*0.32*	0.222	0.533	0.800	1.333	1.778
	Storage	*0.07*	0.049	0.117	0.175	0.292	0.389
	Transportation	*0.15*	0.268	0.412	0.618	0.824	1.648
	Subtotal	*0.91*	1.199	2.079	3.118	4.483	7.881
	TOTAL	***19.20***	**24.89**	**42.31**	**63.47**	**89.95**	**162.16**
	Increase over scenario 1			1.7	2.6	3.6	6.5

Table Ten - Beef burger results: modeling increasing energy and transport costs and ingredient price

Current energy costs are around 42 pence per burger, a 1.7-fold increase on energy costs compared to recent lows for energy supplies and transport fuels. In theory, this increase of 17 pence should already have been passed on to the fast food outlet and then the consumer.

The final three energy price scenarios (3-5) would add 39p, 65p, and 137p, respectively, to the total energy and transport fuel costs compared to the low price scenario (1).

If energy prices double in the future, this increase could result in the energy costs of a beefburger rising to 90p; if the energy prices quadruple, the energy costs associated with the burger could be 162p. In the case of the latter, a burger that currently costs around 80p in a fast food outlet could cost £2 or more.

CHICKEN

The UK chicken supply chain consumes the energy equivalent of 12 million barrels of oil (1.9 billion litres) each year. That's 1,114 litres of crude for every tonne of chicken supplied to the consumer.

Appendix Four shows a summary of the likely impact of increased energy prices on the retail cost of chicken. It compares energy usage and the potential costs of a chicken up to the point of sale, and up to the point of consumption. Energy usage allowed for at the consumer stage includes driving by car to the shops, refrigerating or freezing the chicken and finally cooking it.

The increased energy costs are a significant proportion of retail price. For example, most retailers offer an 'economy' option priced between £2.50 and £3.50 for a 1.5kg uncooked bird. Based on an average of £3.00, the present energy costs in scenario 2 amounts to around 25% of the retail price.

If energy costs double, the additional costs over current prices for an uncooked chicken would be 91p (166.1p minus 75.3p). If they quadruple, the additional energy costs of an uncooked chicken would be 205p (280.6p minus 75.3p), and its price in the supermarket would rise to over £5.[46] If the additional cost of the energy required for transportation, freezing and cooking at home is taken into account, then it would cost around £9 to put a cooked chicken on the table, whereas it currently only costs around £4 to do so.[47]

STRAWBERRIES

This final case study looks at another example of a product imported by plane - strawberries from California. In 2004 the UK imported 1200 tonnes of strawberries from the USA. They can be purchased for as little as £1 for a 250g punnet (£4 per kilogram). Currently, aviation fuel amounts to about 41p per kilogram of produce imported from California. If aviation fuel prices double, the cost of imports of strawberries from California will increase to 82p per kg strawberries, and if there is a 4-fold rise in fuel price the cost of the airfreight of strawberries could rise to 163p.

						Cost of aviation fuel (pence)				
Ingredient	**Origin**	**Distance**	**Price per kilogram (pence)**	**kg**	**MJ/kg**	**1**	**2**	**3**	**4**	**5**
Strawberries	California	8774	400	1.0	74.6	16.6	40.9	81.8	122.7	163.6

Table Twelve - Summary of the analysis of the impacts of increasing transport costs on the price of strawberries

Strawberry production is also energy intensive (even if not in a heated glasshouse) if it is mechanised and pesticide is applied, as Table Thirteen below shows. The main energy inputs are petrol and pesticide with the total energy consumption being 8.2 MJ per kilogram of strawberries.

	per hectare	**per kg strawberries**		**MJ per kg Strawberries**
Yield, kg/ha	23538			
Plants, nu. per ha	59304			
Petrol, l/ha	786	0.0334	litre	1.42
Electricity, MJ/ha	11117	0.4723	MJ	0.47
N-applied, kg/ha	224	0.0095	kg	0.64
P-applied, kg/ha	56	0.0024	kg	0.04
K-applied, kg/ha	185	0.0079	kg	0.11
Pesticides, active substance kg/ha	297	0.0126	kg	5.28
Limestone applied, kg/ha	2621	0.1114	kg	0.13
Machinery, kg/ha	38	0.0016	kg	0.13
				8.22

Table Thirteen - Energy consumption of strawberry production in the USA

When strawberries are produced in a heated glasshouse, the energy consumption soars. One study in Sweden found that 50 litres of fuel oil are used per metre square to heat glasshouses: 293 MJ per kilogram of strawberries. Even if, as claimed, there has been a shift to the use of natural gas to heat glasshouses, the energy consumption is in the range of 50-150 MJ per kilogram of strawberries.

It seems, then, that importing strawberries by plane will very soon become much more expensive, as will the production of strawberries (as well as other products such as lettuce and tomatoes) in glasshouses heated with fuel oil or natural gas. Rising fossil fuel costs will therefore result in a more seasonal diet.

The results of these case studies give an indication of the magnitude of food price increases if oil and gas prices continue to rise. The additional cost of a beefburger could be between 90p and 162p if there is a further 1.5 and 4-fold increase in the price of food system inputs. A £3 whole chicken would nearly double in price, or more than double if the costs of shopping by car, storage and cooking in the home are included. For the ingredients of a stir-fry, the transport costs alone would increase by between 170p and 395p.

However, further increases in oil, gas and electricity prices, which many are now predicting, will affect food security as well as food affordability. The complete reliance on fossil fuels in supermarket supply chains means that a further sharp and sudden increase in energy costs could lead to food shortages.

WHO IS REALLY PAYING THE COST?

"$100/barrel oil has gone from sensationalist claim to credible reality. While the rise in crude prices, as well as other commodities, has broken all previous assumptions, what has been equally surprising has been the lack of impact of high energy prices on world growth. An oil shock of this proportion should have caused widespread inflation, resulting in higher interest rates, which in turn would have put a break on world trade and thus the continued rise in demand for crude. Instead inflation in both the developed and developing worlds has pretty much been kept under control. Manufacturers have been unable to pass on increased energy prices to consumers and have instead had to accept reduced margins….However, there are signs that any slack there has now been exhausted." [48]

Energy Economist, *$100/barrel oil -- coming soon to an exchange near you*, 2006

Over the last few years, the price of oil has increased by over 250% [49], and food input costs by 50-150%, yet these costs have not yet been passed on into higher supermarket food prices to any significant extent.

We should not assume, however, that this can continue indefinitely. Indeed, increasing costs are now beginning to filter through to the retail price of food, as farmers, processors, packagers and manufacturers of inputs to all stages of the food chain can no longer absorb increasing production costs. They are increasing the price of their products because "efficiency" and "productivity" measures are reaching their limit.

Yet it is true that, since 1998, food prices have risen by only 8.5%, compared to an increase of 22% across items generally – see Diagram Four. This is easier to understand once the various measures that have been used to keep food prices low are examined. These include:

- The replacement of human labour by machinery and equipment resulting in industrialised farming and the production of one crop on a vast scale. This has been possible because labour costs in industrialised nations have been higher than energy and transport fuel costs.
- A move towards long distance transportation of food and food system inputs, and sourcing from countries where labour costs remain low e.g. Asia, South America and Africa.
- The stranglehold which the large multiple retailers have over the whole food chain. This has meant that the increasing production costs associated with rising energy and resource prices are not being passed up the chain.

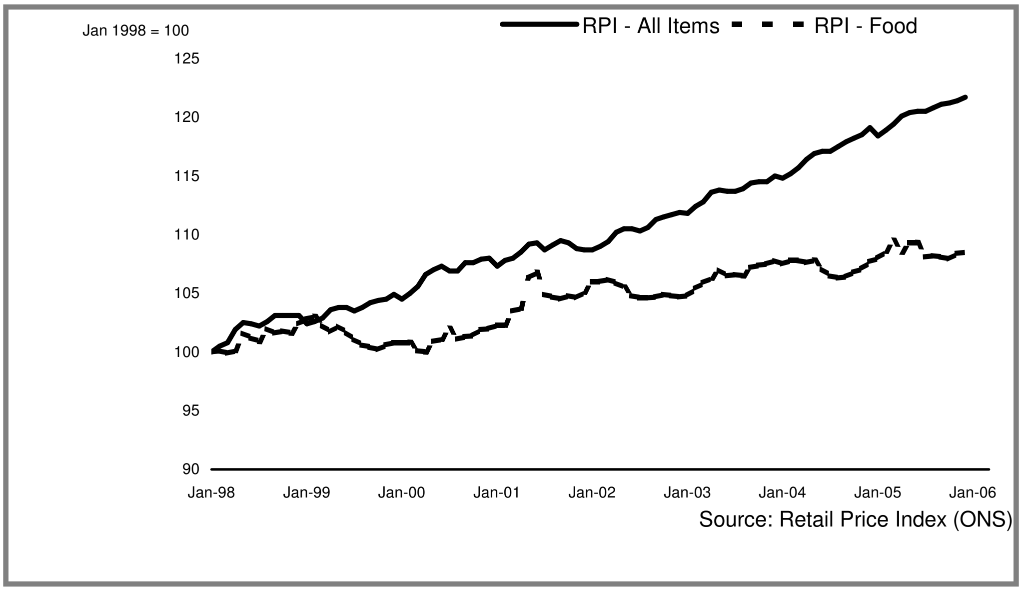

Diagram Four - Changes in retail price indices NB the food price increase of 8.5% since 1998 is for all UK food sales based on the governments Retail Price Index

Consequently, although every stage in the food chain has begun to be affected by increasing oil and gas prices - from farmers through to those that transport food, fertiliser manufacturers, food processors and the packaging companies - the costs have so far not been passed on to retailers and the consumer. So who is paying the price?

FARMERS

"The figures show improvements made by farmers have been unrewarded due to rising costs and a food chain which fails to respond. It is high time the retailers, processors and competition authorities recognised that farmers, like anyone else in business, must be allowed to pass on increases in the cost of production."[50]

Tim Bennett, NFU president

Diagram Five shows that in 1990 the price that UK farmers received for their produce was considerably higher than the price they paid for inputs (such as seeds, electricity, diesel, fertilisers, pesticides and machinery). However, since 2000, the cost of most farm inputs has continued to rise and the price farmers receive for their produce has fallen. Production costs have been approaching the price farmers receive for their products and, in 2004, were higher than farmers' income. In the following year, farm energy costs rose by 21% and fertiliser prices by 11%. To put it simply – for an increasing number, UK farming doesn't pay. While food prices are artificially kept low, more and more farmers are forced off the land, thereby jeopardising the very expertise and resources that will need to be drawn upon if we are to face up to the challenge of peak oil and its impact on the availability of food.

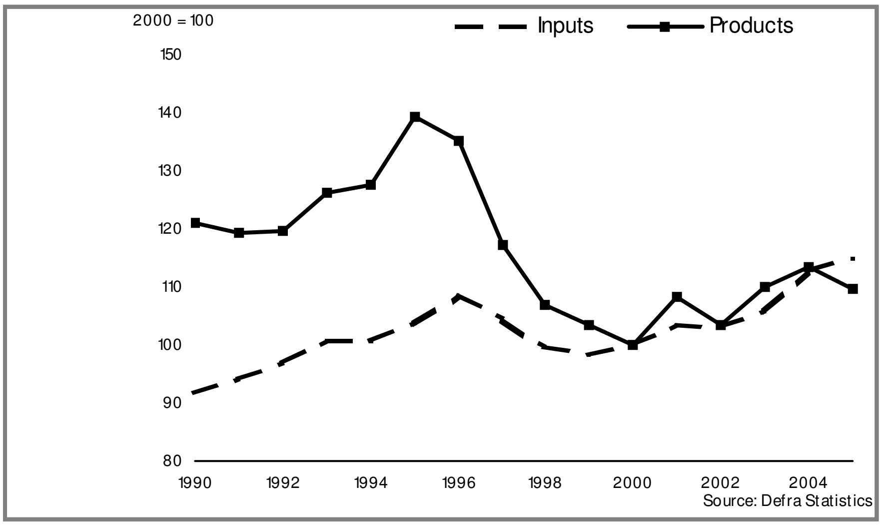

Diagram Five - UK price indices for agricultural products and agricultural inputs

RETAILERS

Sitting at the top of the food chain are the supermarkets. It's not surprising that most people are unaware of peak oil and the impacts it will have on the food system, since the supermarket shelves are still full, and prices still fail to reflect the true energy costs of food production.

Food system input costs have increased over the last few years, for example nitrogen fertiliser by 90% since 2000, diesel by 50% since 1998 and aviation fuel by 150% between 2000 and 2006, yet these increases are nowhere near the rate of increase in crude oil. The Grocer magazine has been tracking food prices at the 6 largest supermarket retailers for 9 years. The magazine found that during these 9 years, the 33 items in a standard shopping basket had increased in price by only 25 pence - from £37.50 to £37.75.

But things are beginning to change.

Sales and profits of the world's largest supermarket, Walmart, have continued to fall since oil price rises began in 2004. Wal-Mart relies on customers driving to their large stores, but increases in the price of petrol and diesel have discouraged some customers from making the trip quite as often. Wal-Mart, like other US retailers, faces higher shipping costs to get goods from the farm to the factory, then to the distribution centre and finally to stores. As a result, stock in Wal-Mart dropped in value by 25% from $60 per share to under $45 per share between November 2004 and September 2005.[51] In August 2005, Wal-Mart announced that higher-than- expected oil prices had cut into the corporation's profits for the 2nd quarter of 2005.

In 2006 the inflationary pressures associated with higher energy, fuel and resource costs finally began to filter through to UK food retail prices, creating some fluctuations. In the 12 months to June 2006, food prices increased by less than 1% and actually fell between June 2005 and January 2006. Yet in a single week, the first week of June 2006, the food price rise was 2%.

THE ENVIRONMENT

It is also important to consider other costs associated with the food system that neither the food retailer nor consumers currently pay for. These are referred to as external environmental and social costs and include greenhouse gas emissions, air pollution, noise, congestion, low pay, accidents and infrastructure. Table Fourteen, below, provides a summary of some of the externalities associated with UK farming and food distribution. This amounts to £10.6 billion each year and is equivalent to £425 per household per year, before external costs associated with the manufacture and distribution of fertiliser, pesticide, packaging, vehicle, refrigeration equipment etc. Such environmental free riding will not last forever, and political debate is increasingly looking at ways to internalise these costs via various forms of green taxation, so that that they are paid for by the producer, retailer and consumer rather than experienced by society at large in terms of environmental problems such as transport pollution and climate change.

	External Cost (£ Billion)	**per household per year (£)**	**per household per week (£)**
Agriculture	1.51	60.40	1.16
Food distribution	9.12	364.92	7.02
Total	**10.63**	**425.32**	**8.18**
Subsidy	2.88	115.20	2.22
Total (including subsidy)	**13.51**	**540.52**	**10.39**

Table Fourteen - External costs of UK farming and food distribution [52]

ENDING OUR ADDICTION

"National political leaders seem reluctant to face the coming downturn in oil and to plan for it even though it will almost certainly become one of the great fault lines in the history of civilization. Trends now taken for granted, such as urbanization and globalization, could be reversed almost overnight as oil becomes scarce and costly. The inability of national governments to manage the energy transition could lead to a failure of confidence in leaders and to failed states." [53]

Lester Brown, *Plan B 2.0: Rescuing a Planet under stress and a civilisation in trouble*, 2006

SUSTAINABLE FOOD SYSTEMS

Achieving food security in an era of peak oil is an urgent political priority. This will involve a move towards more low-energy and low-input farming, and the development of more localised markets.

The sharp increase in the price of all inputs to the food chain in recent years, together with practical ways of addressing them via alternative, more sustainable technologies, are summarised below.

Food System Input	Examples	Alternatives
OIL	Increase in price of barrel of crude from \$10 in 1998/99 to \$75 in 2006 (above \$50 for the whole of the year to May 2006 reaching a high of \$75)	Numerous safe options such as judicious use of biofuels, biomass, wind power, tidal, small-scale hydro and solar as well as plant materials to produce natural dyes, plastics and oils etc.
NATURAL GAS	Since 2003, gas prices for the manufacturing sector have tripled. In 2006 the UK's first-ever 'gas balancing alert' was issued, telling traders that gas demand might have to be reduced, initially for businesses. Wholesale gas prices increase fourfold in one day in March 2006.	Biogas and renewable energy (above)
ELECTRICITY	Electricity prices have doubled over the last few years.	Reduced consumption combined with efficiency and decentralised renewable energy systems
FERTILISER	Nitrogen fertiliser prices have doubled since 2003.	Alternative methods of increasing soil fertility are available such as green manures, biogas filtrate, rotation and composting. Additionally, the nutrient cycle can be closed so that animal and human manures are used.

DIESEL and PETROL	Transport fuel prices increased by 50% between 1998 and 2005. In 2006 reached landmark of £1 per litre.	Biofuels are an option, but only if agricultural production of the inputs is not energy intensive (see energy security versus food security, above). Oil depletion will require significant cuts in the distance food is transported (including shopping by car) and a food system in which the majority of our food is sourced locally.
AVIATION FUEL	The price of aviation fuel increased by 29% in the year to June 2006 and by 150% between 2000 and 2006 from 83 cents per gallon to 215 cents per gallon.	Transporting food thousands of miles by plane will soon be seen as enormously wasteful, resulting in a shift to far greater local and national food production

Table Fifteen - Examples of price changes for food system inputs and the sustainable alternatives

A SUSTAINABLE GLOBAL FRAMEWORK

For the last few decades, a crisis has engulfed the majority of farmers worldwide - from Britain to Brazil, from Germany to the Gambia. Since the 1980s, neo-liberal economics have flourished, with new impetus given in the 1990s by the policies of the World Trade Organisation's Agreement on Agriculture (AOA) and the European Union's Single Market. The net result of these policies has been the collapse of the price that farmers receive for their produce. The post war emphasis on maintaining national food security, with domestic policies in place to help achieve this, is long gone. In its place are mandatory rules of trade that promote the interests of agribusiness, industrial production, and long distance transport, and that force countries to compete to produce each other's food at the expense of domestic production. These free-trade rules are a disaster for food security, particularly in poorer countries, as subsistence farms are increasingly put out of business or forced into export production instead.

Relocalising our food systems will ultimately require a complete change in direction, away from the policies of the EU's Common Agricultural Policy and the rules of the World Trade Organisation, both of which are based on ever greater international trade and globalisation of the food system. Instead, the central aim of trade and food policy should be a just and environmentally sound food security programme, for all nations, through the prioritisation of self-reliance and reduced energy use. Fortunately, there are an increasing number of practical examples of the success of local food initiatives – the challenge will be to replicate these on a much wider scale.[54]

The following package of measures would be instrumental in helping to meet this challenge:

1. The creation of a funding and policy framework to ensure a food and agricultural system based on food security for all countries. Such a system would provide farmers with an adequate income, ensuring as much national and regional self-reliance as possible. Production methods would have to meet key environmental and animal welfare standards, as well as provide healthy food. Purchasing and marketing systems would contribute to the diversification and renewal of rural communities. Given the threats posed by peak oil, the reduction of fossil fuel use would need to prioritised across the framework.

2. The introduction of national import controls on food that can otherwise be produced efficiently domestically. The ability to introduce such controls must be the prerogative of all countries worldwide and is essential to the success of step one.

3. Reduction in profit margins for the hugely powerful food processors and supermarkets. This would be a key part of any such transition particularly in developed countries and would ensure that the impact of rising farm gate prices does not fall disproportionately on the poor. Instruments such as a new, legally enforceable Code of Conduct for major supermarkets and processors could be introduced, to give farmers greater powers in their relationship to buyers, while - more fundamentally - there should be widespread consultation to set an upper limit for what each supermarket's fair share of the market should be. At present the level of monopoly control is unacceptably high, with Tesco alone accounting for over 30% of all grocery sales in the UK.[55]

4. The issue of food poverty must be tackled. This could be done through a combination of improved social welfare, a higher minimum wage, and improved access to reasonably priced, healthy food.

5. The promotion of self-reliance. Excess EU production currently results in the subsidised dumping of surpluses in developing countries, with disastrous results for the livelihoods of some of the world's poorest farmers. Greater self-reliance would end this practice and therefore have benefits for the world's poorer areas as well.

6. Rewriting the EU Treaty and the rules of the World Trade Organisation. This is necessary to ensure that food security and maximum self sufficiency, with its inherent reduction in fossil fuel use, replaces the present emphasis on more open markets and international competitiveness. At the same time, poorer countries which currently depend on their exports to EU markets, must be supported in order to enable them to develop stronger national and regional markets closer to home.

We are also calling for the urgent establishment of a Royal Commission on Food Security, as a vital step in raising much greater political awareness of the pressing need to decouple our food system from dependence on fossil fuels.

These are ambitious demands. Yet the scale of the crisis we face demands no less.

APPENDICES

APPENDIX ONE

EXPLANATION OF CALCULATIONS FOR CASE STUDIES

The case studies assess the impact of rising energy costs on a number of food items, assuming the following five price scenarios:

Price Band	*Represents*
1	Lowest price over the last few years
2	Current or recent prices
3	An increase of up to 2-fold on current prices
4	An increase of up to 3-fold on current prices
5	An increase of up to 4-fold on current prices

Table Sixteen – energy price scenarios

However, the food system uses oil and gas and their derivatives in many ways e.g. diesel, fuel oil and aviation fuel during food distribution; natural gas as an input in synthetic nitrogen fertiliser manufacture; petrochemicals derived from oil as feedstock for pesticides and plastics; electricity to power irrigation systems, food processing and cooking; and gas to produce steam and heat during food processing and to cook food. The price of each of these energy sources has therefore been calculated for each of the above 5 scenarios.

Data Sources for Price band 1 and 2

The data sources for price bands 1 and 2 in Table 1(ie the lowest price over the last few years and the current or recent price of each energy input) are found in Table 2.

	Lowest price over the last few years	**Current or recent price**
Diesel	The average price during 1998 was 65 pence per litre.[56]	The price during August 2006 reached 100 pence per litre with the average UK price being 99.4 pence per litre during that month.[57]
Gas (industry and manufacturing)	During the 4th quarter of 2004, the average price was 1 pence per kWh.[58]	The cost of gas for medium users in the first quarter of 2006 was 2 pence per kWh.[59]
Gas (households and caterers)	In 2003 the average gas price	Provisional figures for 2006 are

	for small users was 1.5 pence /kWh.[60]	2.8 pence/kWh.
Electricity (industry and manufacturing)	During the 2nd quarter of 2002 large electricity users paid 2.5 pence/kWh.[61]	During the 1st quarter of 2006 the price had risen to 6 pence/kWh.[62]
Electricity (households and caterers)	In 2002 the average price for electricity was 7 pence per kWh.[63]	In the 1st quarter of 2006, prices rose to 10 pence per kWh.
Aviation fuel	In 2000 the average price of aviation fuel was 87 cents/gallon or 12.8 pence/litre.[64]	On June 9th the price of aviation fuel was 215.5 cents/gallon or 31.6 pence/litre.[65]

Table Seventeen

To be able to compare the different energy sources used in the food system, data for the energy content of each fuel in Table Seventeen is converted to a standard unit of pence per megajoule in Table Eighteen. (The International Energy Agency's Energy Statistics Manual is used to convert data on transport fuels in the table below from pence per litre to pence per Megajoule (MJ) and for gas and electricity to convert pence per kilowatt hour (kWh) to pence per MJ.)

	pence per MJ								
	1	2	3	4	5	increase 1-5	increase 2-3	increase 2-4	increase 2-5
Diesel	1.786	2.747	4.121	5.495	10.989	*6.2*	*1.5*	*2*	*4.0*
Gas (industry and manufacturing)	0.278	0.556	0.833	1.111	2.222	*8.0*	*1.5*	*2*	*4.0*
Gas (households and caterers)	0.417	0.833	1.389	1.944	2.778	*6.7*	*1.7*	*2.3*	*3.3*
Electricity (industry and manufacturing)	0.694	1.667	2.500	4.167	5.556	*8.0*	*1.5*	*2.5*	*3.3*
Electricity (households and caterers)	1.944	2.778	5.556	6.944	11.111	*5.7*	*2*	*2.5*	*4.0*
Aviation fuel	0.222	0.549	0.934	1.373	2.196	*9.9*	*2*	*2.5*	*4.0*
							1.7	2.3	3.8
	pence per litre								
Diesel	65	100	150	200	400				

Table Eighteen - energy prices (pence per MJ) for 5 scenarios

These energy bands are also based on the following prices, in pence, for a litre of diesel: 65, 100, 150, 200, 400. A similar price range is used for natural gas, electricity and aviation.

Rationale behind the projections of price band 3-5

The bands 3-5 are based on possible price rises given the likely potential effect of peak oil on the price of future supplies of oil and gas and their derivatives as diesel, electricity and aviation fuel. Although the price of oil and gas are linked, there isn't always a very direct relationship between oil prices and the energy prices for the range of sources used in the food system.

Diesel price, for example, increased by only 50% between 1998 and 2006, while crude price increased by 600% from $10 to $70 dollars a barrel.

There is also the potential for a sudden, sharp price rise caused by external events. Wholesale gas prices increased fourfold in one day in March 2006 (see Table Fifteen) when Russia began to flex her muscle and use oil and gas as a political weapon.

An increase of up to 3-4 fold in the price of natural gas, electricity, diesel and aviation fuel is highly likely, even probable, during the next decade.

This 'what-If' scenario modelling is an analysis of impact on food prices if there is up to a 4 fold increase in natural gas, electricity, diesel and aviation fuel over the next 10 years or so.

Some of the recent price events and projections about future prices which have led to this range are:

1. There has been a 7-fold (600%) increase in the price of a barrel of oil over the last few years from $10 in 1999 to reach the $70-$75 level experienced during April and May 2006. Between 2002 and 2006 the increase in oil price from $20 a barrel to over £70 constituted a rise in price of over 250%.
2. Even though food system input costs have increased over the last few years, for example nitrogen fertiliser by 90% since 2000, diesel by 50% since 1998 and aviation fuel by 150% between 2000 and 2006, these increases are nowhere near the rate of increase in crude described in (1). So there could be further increases in input costs even if the cost of crude does not rise in the near future and prices remain in the $65-75 a barrel range.
3. "I think we might see $100 oil in the next five years." Sir Bill Gammell, Cairn Energy, February 2006.[66]
   "Goldman Sachs have said that the oil market may be in the early stages of a 'super spike', which could push prices as high as $105 a barrel." [67]
   "Oil is far too cheap at the moment….The figure I'd use is around $182 a barrel. We need to price oil realistically to control its demand. That is because global production is peaking." Matthew Simmons, an energy investment banker, adviser to the Bush-Cheney energy plan, June 2004.[68]
4. Official predictions of oil price forecasts over the short (next 10 years) and medium period (10-30 years), such as those of the International Energy Agency (IEA) and the US Energy Information Administration (EIA), have turned out to be serious underestimates. The US EIA thought oil price in 2006 would be somewhere between $25 and $40 a barrel. The IEA was even more mistaken expecting prices to fall back from the highs in 2004 to $22 in 2006. Both organisations predicted that crude would remain below $50 a barrel in the medium term. In 2005 the IEA the agency had predicted a nominal oil price in 2030 of $65 a barrel. The IEA '2006 World Energy Outlook' warned that US and European oil fields that have been used to reduce reliance on Opec, the cartel that supplies 40 per cent of the world's oil, would peak within the next ten years. Given that, they predicted that if world demand continued on its current path, nominal oil prices would hit $97.30 a barrel in 2030.
5. By contrast a report prepared by energy economists at the French investment bank Ixis-CIB has warned crude oil prices could touch $380 a barrel by 2015. Analysts Patrick Artus and Moncef Kaabi said in the next 10 years demand for oil will outstrip supply by around 8 million barrels per day.[69]

APPENDIX TWO
CALCULATING THE ENERGY COSTS FOR CHICKEN PRODUCTION AND SUPPLY

The value of 0.52 pence for consumer storage (band 1 in green below) is derived by multiplying the energy use of this stage (0.27MJ – highlighted in yellow below) by the cost of 1.94 pence per MJ for domestic electricity to power the refrigerator (band 1 in green in Table Nineteen Below).

Fresh/chilled whole chicken (1.5kg)				Energy Costs (pence)				
	Energy Use (MJ)	*% excluding consumer*	*% including consumer*	**1**	**2**	**3**	**4**	**5**
CONSUMER STORAGE	**0.27**		*0.4*	0.52	0.75	1.50	1.87	3.00
CONSUMER COOKING	**32.40**		*44.4*	62.99	90.00	180.01	224.99	360.00
SHOPPING	**2.81**		*3.8*	5.02	7.72	11.58	15.44	30.88
RETAIL STORAGE	**10.80**	*28.8*	*14.8*	7.50	18.00	27.00	45.00	60.00
PRE-CONSUMER TRANSPORT	**8.64**	*23.0*	*11.8*	15.43	23.73	35.61	47.48	94.94
WHOLESALE/ RDC	**0.46**	*1.2*	*0.6*	0.32	0.77	1.15	1.91	2.55
PROCESSING & PACKAGING	**3.51**	*9.4*	*4.8*	0.98	1.95	14.46	3.90	7.80
TRANSPORT PRE SLAUGHTER	**2.16**	*5.8*	*3.0*	3.86	5.93	8.90	11.87	23.74
AGRICULTURE	**7.34**	*19.6*	*10.1*	5.10	12.24	18.36	30.60	40.80
AGRICULTURAL SUPPLIES	**4.62**	*12.3*	*6.3*	8.25	12.68	19.03	25.37	50.74
TOTAL (excluding consumer stage)	***37.53***	*100.0*		***41.42***	***75.31***	***124.51***	***166.14***	***280.58***
TOTAL (including consumer stage)	**73.01**		**100.0**	**109.95**	**173.78**	**317.60**	**408.44**	**674.45**

Table Nineteen - Results of the analysis of the impact of increasing energy and transport costs on the price of chicken

APPENDIX THREE
UK FOOD TRANSPORT FUEL USE AND COSTS

	Fuel Use		Food Transport Costs (£)				
	tonnes	litres	1	2	3	4	5
Diesel	3,937,000	4,665,345,000	3,032,474,250	4,665,345,000	6,998,017,500	9,330,690,000	18,661,380,000
Fuel Oil	765,000	803,250,000	80,325,000	160,650,000	240,975,000	321,300,000	642,600,000
Aviation Fuel	654,000	814,884,000	104,058,283	257,753,562	438,181,056	644,383,906	1,031,014,249
Total	5,356,000	6,283,479,000	3,216,857,533	5,083,748,562	7,677,173,556	10,296,373,906	20,334,994,249
Per Household (per year)	0.214	251.34	128.67	203.35	307.09	411.85	813.39977
Per Household (per week)	0.0041	4.8334	2.47	3.91	5.91	7.92	15.64

APPENDIX FOUR

SUMMARY OF THE LIKELY IMPACT OF INCREASED ENERGY PRICES ON THE RETAIL COST OF CHICKEN

	Energy Use (MJ)			Energy Costs (pence)				
				1	2	3	4	5
Fresh/Chilled whole chicken (1.5kg) - cooked at home	37.5	excluding consumer stage	Energy costs (pence)	41.4	75.3	124.5	166.1	280.6
			Energy costs as a percentage of retail price	12	22	37	49	83
			Increase in energy costs over current prices (pence)			49.2	90.8	205.3
	73	including consumer stage	Energy costs (pence)	110	173.8	317.6	408.4	674.5
			Energy costs as a percentage of retail price	33	51	94	121	200
			Increase in energy costs over current prices (pence)			143.8	234.6	500.7
						53	82	127
						60.2	158.3	310.3
						261	408.5	614.8
						77	121	182
						132.2	279.7	486

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43 DOW Jones newswires, 7 November, 2004
44 Platts (2006) *$100/barrel oil -- coming soon to an exchange near you.* May 16, 2006. Extract from a feature article on the formation and impact of high oil prices in the June 1 edition of Energy Economist at http://www.platts.com/Oil/Resources/News%20Features/onehundreddollaroil/index.xml
45 Based on a 1999 data survey by Carlsson-Kanyama and Faist (2000) *Energy Use in the Food Sector: A data survey*, Environmental Strategies Research Group, Department of Systems Ecology, Stockholm University/Department of Civil and Environmental Engineering, Swiss Federal Institute of Technology, Zurich
46 Today's non-energy costs of a chicken is £3 minus 75p – ie £2.25, and if the price of energy quadruples (scenario 5) then the cost of the chicken is over £5 (ie £2.25 plus £2.80)
47 The additional energy costs of putting a £3 chicken on the table is 173.8 minus 75.3 – ie around £1. See Appendix 4
48 Platts, op cit
49 There has been a 7-fold (600%) increase in the price of a barrel of oil over the last few years from $10 in 1999 to reach the $70-$75 level experienced during April and May 2006. Even if we consider the price before and after this dip, which was around $20 between 1994 and 1998 and averaged about $25 between 1999 and 2002, the price rise since 2002 is very large. Between 2002 and 2006 the increase in oil price from $20 a barrel to over £70 constitutes a rise in price of over 250%
50 Joanne Pugh, 2006, *Increasing costs are driving down agricultural earnings*, Farmers Guardian 3 February, 2006
51 http://finance.yahoo.com/q/bc?s=WMT&t=2y
52 Data from J.N. Pretty, A.S. Ball, T. Lang and J.I.L. Morison (2005) *Farm costs and food miles: An assessment of the full cost of the UK weekly food basket.* Department of Biological Sciences and Centre for Environment and Society, University of Essex and Department of Health Management and Food Policy, City University, London, United Kingdom. Food Policy 22 February 2005 and AEAT (2005) *The Validity of Food Miles as an Indicator of Sustainable Development.* Final Report produced for DEFRA JULY 2005 ED50254 Issue 7 AEA Technology, Report number ED50254 Issue 7
53 Lester Brown, op cit
54 see *Local Food: Benefits and Opportunities*, Caroline Lucas MEP and Andy Jones, European Parliament 2003
55 foxnews.com, 5 December 2006
56 Based on Table 4.1.2 'Average annual retail prices of petroleum products and a crude oil price index' in DTI's Quarterly Energy Prices at http://www.dtistats.net/energystats/qep411.xls
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