THE ENVIRONMENTAL IMPACTS OF TRADE LIBERALISATION AND POTENTIAL FLANKING MEASURES

Stage II of a Report to Defra

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1. EXECUTIVE SUMMARY & CONCLUSIONS

1.1. Introduction

This report constitutes Stage 2 of a two part project undertaken for Defra by the Institute for European Environmental Policy (IEEP) and GHK Consulting Ltd investigating the anticipated environmental impacts of prospective trade liberalisation and seeking to identify appropriate flanking measures. It was undertaken in a relatively short period and is intended to be a rapid summary based primarily on the literature and a limited number of interviews. No original research or fieldwork was possible. In both stages, the focus has been on a number of commodities or economic sectors. In this Stage, there are three case studies:

- Textiles
- Energy Services
- Transport of goods

In the companion volume, the report on Stage 1, the focus is on five agricultural commodities; dairy products, sugar, vegetables, cotton and poultry.

In each case study, the approach has been to outline the key characteristics of the sector, to review current production and trade patterns and to consider actual or proposed trade liberalisation measures and their likely affects. This is combined with a review of the potential environmental impacts of production and trade, whether positive or negative and the consequences of liberalisation. Possible flanking measures are proposed in response to the issues identified.

1.2. Issues Encountered

The case studies are very different in nature – one deals with manufactured products (textiles and clothing), another with services (energy services) and another with the environmental effects of liberalisation of trade in general (transport of goods).

They therefore raise some distinct issues relating to:

- Progress in liberalisation – the textiles sector has been subject to a recent step change in liberalisation, an agreement on energy services is still at an early stage of negotiation, while transport effects result from all other sectors and so reflect variations in progress across the spectrum of trade

- The variable timing of impact – this is immediate and progressing rapidly in textiles whereas energy services is largely in the future; transport impacts will continue to occur over time

- The impact of liberalisation varies in its predictability – with textiles the effect of quota removal is to some degree predictable and amenable to economic modelling; energy services is completely uncertain both in terms of the outcome of the WTO negotiations and the impact of the policy changes that they may lead to; transport impacts are so wide ranging that they introduce problems of their own, given the difficulty of modelling liberalisation across all sectors.

- Similarly the volume and type of evidence available on the impact of liberalisation varies partly because of the level of conjecture involved –there is a range of evidence available for textiles liberalisation but much less for energy services and transport. The type of literature also varies – there are quantitative modelling studies for textiles but evidence on energy services is largely speculative.

- Isolating the effects of policies designed to support liberalisation, such as tariff elimination, from the broader processes of globalisation, economic adjustment to previous liberalisation measures and more market orientated policies in many countries, is particularly difficult for freight transport but policy impacts are much clearer for textiles.

- Assessment of the environmental effects raises slightly different issues – the case studies deal with two sectors with profound and relatively well understood environmental impacts (energy and transport) but for which the effects of trade liberalisation are relatively difficult to assess, and one, textiles, where the trade effects are well studied but the environmental impacts much more difficult to assess.

- Global environmental impacts arise particularly in two sectors - for textiles, many of the impacts are very localised, while for energy and transport, global impacts of liberalisation (especially climate change) are of great concern. The main environmental impacts differ somewhat from those identified in the Stage One report, which tended to be more localised relating to land use.

- Potential policy responses need to be tailored to the different types of impacts and their timing - thus in the energy services sector the integration of environmental issues into the negotiating process is likely to be a priority, whereas for textiles, there is a need for regulations at the national level, as well as a potential role for labelling and marketing initiatives. For transport, cross-cutting policy measures such as environmental taxes are the greatest priority.

1.3. Summary of Impacts by Sector

The most important environmental issue related to changes in **textiles** production appears to be the risk of water pollution. This is an issue primarily of local concern and one that is likely to be most effectively dealt with through regulatory and other approaches at the national level, especially in countries outside Europe where production is expected to increase. There is a lack of information available on the specific impacts of textiles production in those countries where production is predicted to increase post-liberalisation.

The agenda for liberalisation in the **energy** services sector is still at an early stage of its development, and the environmental effects of liberalisation are still highly uncertain. It is likely that liberalisation will bring a number of environmental risks, while potentially also yielding some environmental benefits. Further information on the specific impacts expected from liberalisation of energy services are needed, but this may not be possible until more details of likely liberalisation proposals emerge.

In the case of international **freight transport**, the upward trend in the volume traded is anticipated to create environmental pressures arising from emissions of air pollutants, increased requirement for certain categories of infrastructure and congestion. It is difficult to get credible estimates of the volume of additional transport likely to arise as a result of liberalisation, given the underlying trends driven by economic growth and globalisation. Several of the commodities being traded on a larger scale will be transported by sea, including oil, minerals and most manufactured goods. A smaller but significant proportion will be transported by road, resulting in higher emissions per tonne kilometre and greater congestion, particularly in busy corridors. Air freight accounts for less than 1% by weight (although a much higher proportion by value) of international freight transport but it is growing significantly faster than freight transport as a whole and the environmental impact per tonne kilometre is very much greater with respect to air pollutants, particularly greenhouse gas emissions. Trade in high value and fresh goods for which tight deadlines apply is thus disproportionately costly for the environment.

Table 1-1 below provides an overall summary of the significance of environmental impacts identified in each case study.

Table 1-1 - Summary of impacts by sector

	Textiles	Energy services	Transport
Land Use and Landscape	-	**	**

Key:

- no impact identified

* minor impact possible

** potentially significant impact, at least locally

*** substantial impact expected.

Soil	*	**	**
Water Quality and Supply	***	**	**
Resource Use/Waste (including pesticides)	**	**	**
Biodiversity	*	**	**
Air Quality	**	***	***
Climate Change	*	***	***
Human Health	**	**	**

1.4. General Conclusions

On the evidence of the case studies, it is difficult to generalise about the environmental impacts of trade liberalisation, which need to be examined on a sector by sector basis. Across the sectors as a whole, the potential impacts are very wide-ranging and must be viewed over the longer term as well as in the more immediate future, which has been the main focus of this project.

Previous liberalisation measures in many economic sectors and regional groupings have contributed to the process of economic growth and the relocation of production in pursuit of comparative advantage. Higher levels of consumption tend to create greater environmental pressure, offset to varying degrees by greater efficiency, technical advance and new investment in environmental protection. The relocation of production may not in itself have any great environmental significance, other than altering transport requirements. However, in practice, it may be associated with different production technologies, input patterns etc and may alter the regulatory climate in which production occurs, with consequences for environmental standards. In this sense, liberalisation is highly significant for the environment, even if short term changes in trade patterns are not critical for the global environment.

Liberalisation has the potential to give rise to environmental benefits as well as costs. For example, liberalisation of energy services could encourage transfer of cleaner technologies and environmental expertise, to countries where they are in limited supply

and encourage reform of environmentally damaging subsidies, as well as giving rise to various environmental risks, such as reduced constraints on oil extraction in sensitive areas. For both the energy services and transport sectors, liberalisation is likely to have widespread environmental impacts across the world. For textiles, adverse impacts will occur mainly in Asia (especially China, India and Bangladesh).

The precise effects of future liberalisation are rather uncertain, not least because of the limitations of the models available and the inherent difficulty of modelling some responses – such as the effects of removing non-tariff barriers. Some changes in trade may occur faster than the models predict, as appears likely for textiles. In other cases policy-led liberalisation may be one of a number of strands in a process of greater market orientation and globalisation taking place over time, with no rapid step change in trade taking place. The current situation with clothing and textiles may be rather exceptional.

The textile case study suggests that liberalisation can trigger a relatively rapid relocation of production, with significant local environmental impacts. Other manufacturing sectors may experience similar changes, perhaps less rapidly. More typically, liberalisation may have more modest short term effects while contributing to major long term adjustments. This suggests that policy responses need to address trade in general and not just specific trade liberalisation measures. In fact, most of the "flanking measures" considered here fulfil this wider role.

Liberalisation of some sectors, such as energy services, essentially involves a process of deregulation, and raises potential conflicts with the need for environmental regulation. There has been some debate about whether environmental factors should be integral to, or separate from, trade liberalisation negotiations, but the need to ensure that governments are able to maintain (genuine) environmental protection measures suggests that environmental considerations need to be "on the table" and potential conflicts identified and resolved.

1.5. Flanking Measures

Flanking measures to address adverse environmental impacts need to consider both short term adjustments and problems arising from longer term changes in production and trade patterns. Proposals have been identified for the three sectors as summarised in Table 1-2 below.

Table 1-2: Summary of suggested flanking measures

Sector	**Impact**	***Flanking Measure***
Textiles	Localised problems relating to water use and pollution, air pollution and waste management	Regulations in producing countries
		Eco-labelling schemes

	pollution and waste management	**Technical assistance and investment support through development programmes**
Energy Services	Varied and widespread environmental impacts of energy sector may be exacerbated by liberalisation	Multilateral environmental agreements
		Domestic regulations
		Support for sustainable energy through development programmes
	Impacts of multilateral energy services companies	**International guidelines for multinational energy service companies**
		Reporting standards and voluntary codes of practice for UK based companies
	Increased energy demand as a result of lower prices	**Economic instruments (domestic and international)**
	Potential conflicts between liberalisation and environmental regulation	**Ensuring that environmental matters are integrated into trade negotiations and potential conflicts identified and addressed**
Transport	General environmental impacts of transport exacerbated by trade liberalisation	**Economic instruments to internalise external costs, particularly for aviation**
		Stricter international and European regulations, particularly for the less well regulated modes, i.e. aviation and sea
		Consumer awareness campaign linked to labelling of country of origin
	Possible impacts of liberalisation of transport services through GATS	**Addressing environmental concerns in negotiations**
Bold indicates areas where new initiatives may be required, and where the UK and EU potentially have a role to play.		

While many of the impacts of liberalisation are best addressed through domestic measures, such as pollution control regulations in the countries concerned, particularly where production is increasing, others are within the influence of the UK and EU. Two of the case studies (transport and energy services) highlight the need for international action, and the role of MEAs (especially Kyoto) in addressing trade related environmental concerns. Potential measures include:

- An integrated approach to trade negotiations. Ensuring that the GATS negotiations for energy services and transport services take account of environmental impacts.

- Internalising environmental costs, through appropriate measures e.g. in the transport and energy sector. International progress on the taxation of aircraft fuel, or an equivalent measure would address a key transport issue

- Setting standards. Negotiating international standards for the activities of multinational companies, especially in the energy services sector, and/or introducing reporting requirements or codes of conduct for UK/EU based companies

- Consumer Awareness/Ecolabelling Programmes. These allow consumer choice to become a more informed and effective mechanism, for example in relation to textiles and food products.

- Development Assistance Programmes. Providing technical support, capacity building and aid for investment in cleaner technologies through international development initiatives.

1.6. Further Research Needs

Each of the case studies highlights significant further research needs. Because of the differences between them, it is not appropriate to generalise. Research needs are identified in each section succinctly towards the end of each chapter.

2. INTRODUCTION AND CONTEXT

2.1. Purpose of this report

The Institute for European Environmental Policy (IEEP) and GHK Consulting Ltd (GHK) have been commissioned by Defra to examine the environmental impacts of trade liberalisation in certain sectors and to identify appropriate flanking measures to address these impacts. The study is intended to provide a relatively rapid survey of the potential environmental effects of trade liberalisation, based on existing published literature of the environmental impacts of different commodities and sectors, and the expected impacts of liberalisation on these commodities and sectors.

The study is organised in two stages:

- Stage 1 of the study focused on case studies of five agricultural commodities – dairy, sugar, vegetables, cotton and poultry;
- Stage 2 of the study focuses on the wider impacts of liberalisation in different sectors. The case studies for Stage 2 are textiles, energy services and transport of goods.

The study is a desk-based exercise focused primarily on the literature and selected interviews with specialists and stakeholders. It has not been possible within the timescale and budget available to undertake any original research or fieldwork.

This report presents the findings of Stage 2 of the study.

2.2. Overview of trade liberalisation agenda

The process of trade liberalisation has been underway for several decades. At a global level, negotiations are now concentrated within the World Trade Organisation (WTO), with the majority of nations now members of this forum. Agreements within the WTO take place within a series of 'rounds'. The current 'Doha' or 'development' round includes agriculture and services, as well as addressing issues relevant to many other economic sectors. These include negotiations or investigations regarding implementation issues and concerns; market access for non-agricultural products; trade related aspects of international property rights; the relationship between trade and investment; the interaction between trade and competition policy; transparency in government procurement; trade facilitation; WTO rules; dispute settlement; trade and the environment; e-commerce; small economies; trade, debt and finance; trade and technology transfer; technical cooperation and capacity building; least developed countries; and special and differential treatment. The round itself is in the process of moving towards conclusions and we are at an interim stage currently. The overall direction of liberalisation is fairly clear but the precise nature of further agreements and the timescale for their implementation is still uncertain.

Alongside the global picture is a series of bi-lateral and multi-lateral trade agreements, in which the EU is an active participant. Whilst these trade agreements vary greatly in focus and substance, the overall direction is towards greater liberalisation, even where 'sensitive' products are excluded.

The report of stage one of this study was primarily concerned with agricultural trade and liberalisation, and considered the likely impacts of the Doha round on the agricultural sector and their implications for the environment. The agenda for agriculture focuses on three main fronts: reductions in 'Domestic Support'; increased market access; and reductions in export subsidies and other equivalent measures such as export credits.

This report considers the likely environmental impacts of liberalisation on the textiles, energy services and freight transport sectors. The liberalisation agenda for these three sectors is slightly different in each case, and differs from that relating to the agricultural commodities addressed in Stage One of this study.

The **textiles** sector has recently undergone a major liberalisation with the cessation of the Agreement on Textiles and Clothing on 1 January 2005 and the elimination of the quota regime for the sector, which is now subject to the general rules and disciplines of the multilateral trading system.

The **energy services** sector is included in the WTO's General Agreement on Trade in Services (GATS). The GATS requires member governments to undertake negotiations on specific issues and to enter into successive rounds of negotiations to progressively liberalise trade in services. Negotiations are still ongoing.

The **transport sector** plays a central role in the trade in goods and services, and will therefore be affected by measures to liberalise trade in all sectors, as well as specific measures to liberalise transport services within the GATS.

The agenda for liberalisation within each sector is described in more detail in the case studies below.

2.3. Rationale for selecting case studies

The three sectoral case studies were chosen in collaboration with Defra. The reasons for choosing each were as follows:

- **Textiles:** this was selected due to the immediate and ongoing liberalisation of the sector and the opportunity to follow on from the cotton case study in Part One. Textiles have traditionally been a heavily protected sector, and liberalisation is having profound impacts. Changes in the patterns of production and trade in textiles have potential impacts that are quite different from those arising in the other two case studies.

- **Energy Services:** is currently the subject of negotiations under the General Agreement on Trade in Services, and is a broadly defined sector where impacts from trade liberalisation are potentially wide. Because the effects of energy on the environment are profound and wide-ranging, the effects of liberalisation on the environment, though subject to substantial uncertainty, are potentially large.
- **The Transport of goods:** was selected in order to enhance our understanding of the impacts of the worldwide growth in transport as a result of trade liberalisation. The case study considers the issue of food freight specifically, and examines its impacts compared with those of other sectors.

2.4. Structure of this report

This report contains a series of introductory sections, outlining the approach adopted and discussing some of the key methodological issues addressed by the study, before moving on to present the individual commodity case studies.

Section 3 discusses some of the methodological issues inherent in the assessment of the effects of trade liberalisation on non-agricultural production and trade. It builds on the overview for agricultural commodities presented in the Stage 1 report, and considers some of the different issues encountered in assessing impacts outside the agricultural sector. It goes on to consider the assessment of environmental impacts, providing a brief overview of the literature available and the issues, gaps and limitations encountered, before introducing the role of flanking measures outside the agricultural sector.

Sections 4 to 6 present the individual case studies. The case studies provide a brief introduction to the sector concerned, before reviewing data on current patterns and trends in production and trade, considering the impact of government policy, and identifying the likely effects of trade liberalisation. By combining this with a review of the different environmental impacts of production and trade in different parts of the world, each case study seeks to assess the likely environmental impacts of anticipated trade liberalisation. This is followed by a discussion of the flanking measures that may be adopted to address adverse impacts. Key conclusions, including an assessment of further research needs, are then presented.

Section 7 presents the overall conclusions drawn by IEEP and GHK on completion of the study.

3. METHODOLOGICAL ISSUES

3.1. Assessing the Impact of Liberalisation on Production and Trade

The current study is concerned with predicting the expected future environmental effects of current and expected future trade liberalisation scenarios. Though a review of literature examining the effects of previous trade liberalisation measures (e.g.the North American Free Trade Agreement (NAFTA) and the Uruguay Round) on the environment can provide some insight into the possible impact of future reforms, exploring the effects of current and future scenarios requires a forward looking, predictive approach. This involves two stages, the first predicting the likely impacts of trade liberalisation scenarios on production and trade, and the second combining these predictions with knowledge of the environmental effects of changes in patterns of production and trade, in order to assess the potential environmental impacts of liberalisation.

A review of the methodological issues involved in trade modelling is presented in the Stage One report for this study. A large number of studies have modelled the effects of liberalisation on patterns of production and trade in agricultural commodities. Agricultural commodities are particularly amenable to this type of approach, since they are subject to a relatively transparent system of subsidies, price supports, tariffs and export subsidies. The process of trade liberalisation directly affects these key economic variables and, by feeding them into agricultural trade models, predictions can be made about the effects on production and trade. The relatively standardised nature of commodities means that they have fixed prices and are amenable to economic modelling. Several trade models focus specifically on the agricultural sector, such as the OECD's AGLINK model and the APTSM model developed by UNCTAD and the FAO. Other more general models such as GTAP – a multi-sectoral general equilibrium model - have also been used widely in modelling liberalisation of agricultural trade.

Compared to those in the first stage of this study, the case studies presented in this report have found a relative scarcity of studies modelling the effects of trade liberalisation on the sectors of interest.

Most evidence is available in the **textiles** sector, which of the three is the one most amenable to modelling the effects of trade liberalisation. This is because the principal effect of liberalisation is the removal of import quotas, and the removal of such quantitative restrictions on trade is relatively easily assessed using models such as GTAP.

In contrast, no modelling studies were found which focused on the **energy** services sector. Services are much less amenable to modelling because they are less standardised than commodities, and are subject to a variety of more complex trade

restrictions, regulations and non-tariff barriers. Furthermore, negotiations in this sector are still ongoing and their outcome is subject to a large degree of uncertainty, so that the input of data into a trade model would be highly debatable. As a result, the available evidence relating to the potential environmental impacts of energy services liberalisation is somewhat speculative and based on a discussion of the potential risks and benefits, rather than analysis of expected changes in patterns of production and trade.

The impacts of liberalisation on the freight transport sector depend on the effects on patterns of trade in goods and services in general. However, surprisingly few studies have sought to predict the impact of liberalisation on overall patterns of trade in the main economic all sectors. This is primarily because of the wide-ranging and complex nature of the trade liberalisation agenda and the very large number of variables and uncertainties involved in modelling trade liberalisation impacts across all sectors. Nevertheless, some information about the expected impacts on transport is available, and can be used as a basis for assessing possible environmental impacts.

3.2. Assessing the Effects on the Environment

The review was undertaken as a desk-based research exercise. For each of the sectors examined, an analysis of environmental and trade-related literature was undertaken. Impacts in the EU and other OECD countries were examined, along with impacts in less developed countries. Where available, reviews of the effects of trade liberalisation to date were considered, and, where possible, used to estimate the potential effects of future changes in trade. Reviews were obtained from industry organisations, environmental non-governmental organisations and government agencies, as well as international organisations such as the OECD, the World Bank and FAO.

In all three of the sectors considered, changes in the international economy are taking place as a result of many different influences, amongst which liberalisation is clearly one. In examining specific agricultural commodities in the first stage of this study, it was often possible to pinpoint substantive changes in trade that are likely to occur over time because of specific and predictable trade liberalisation measures. For example, the effects of reductions in import tariffs on production and trade in different commodities has been predicted using agricultural trade models, and this can be combined with knowledge of the environmental effects of different production systems to assess likely environmental impacts. For textiles, the situation is somewhat parallel to that of agriculture and anticipated changes in trade flows and shifts in location of production can be evaluated for their environmental impact, albeit with limited data available. In the transport case, it is more difficult to isolate the precise impact of liberalisation from other factors contributing to a marked increase in freight transport. Whilst we can explore the environmental implications of rising vehicle or tonne kilometres travelled, separating out the contribution of policy liberalisation is more difficult. Little evidence is available of potential future effects because of the very wide range of different

sectors and trade measures potentially affected by liberalisation. For energy services, liberalisation is at a much earlier stage as noted above. Estimating the environmental consequences is therefore more speculative although the investigation reveals that they are potentially very large.

3.3. The Role of Flanking Measures

Where implementing a policy will have significant adverse environmental, social or economic effects, it may be necessary to establish 'flanking measures' to seek to improve the outcomes attributable to the policy. Flanking measures accompany central policy measures pursuing a core agenda and so help to achieve a more balanced outcome, correct perverse effects and reinforce positive impacts. In the context of trade liberalisation, flanking policies might aim to secure objectives which liberalisation could fail to do, prevent unwanted side effects, or encourage the delivery of desired environmental outcomes.

Possible flanking measures for agricultural trade are described in some detail in the report of Part 1 of this project which should be read alongside this section. Many of the same measures are applicable to influencing non-agricultural policy. Flanking measures can be applied through different types of policy intervention that might seek to deal with the environmental effects of trade liberalisation. These include, for example:

- Trade bans and restrictions (e.g. bans on textiles produced using azo-dyes);
- Import/export-related economic instruments such as tariffs;
- Domestic economic instruments such as fuel taxes and tradeable permits;
- Environmental regulations – e.g. limits on the concentration of pollutants in waters;
- Marketing and labelling initiatives – e.g. eco-labelling schemes, consumer information programmes; and
- Technical assistance measures – e.g. advisory, training, education and business support programmes designed to help countries to reduce the environmental impacts of production and trade or respond to positive opportunities.

Measures could be applied:

- Multilaterally – through international environmental agreements, programmes or schemes that seek to ban, restrict, regulate or encourage trade in different goods and services;
- Bilaterally – through agreements between importing and exporting countries;
- Unilaterally by the importing country – e.g. regulations or restrictions on imports, product standards etc;
- Unilaterally by the exporting country – e.g. domestic planning policies, environmental regulations, production standards, measures to regulate exports.

Criteria for the selection of flanking measures are likely to include:

- applicability to the environmental issue in question, and to the relevant national or international context;
- political acceptability;
- WTO compatibility;
- practicality;
- enforceability;
- cost-effectiveness; and
- coherence and consistency with other trade and environmental policies.

These criteria have been considered in the analysis of potential flanking measures for each sector discussed in the case studies that follow.

4. TEXTILES

4.1. Brief overview of the textiles industry

This case study focuses on the textile and clothing industry. It does not cover leather production or processing, or the agricultural production of the raw materials (cotton, flax, wool, silk, hemp) that are in turn processed into natural fibres. The environmental impacts of cotton production were discussed in the Part 1 report from this project.

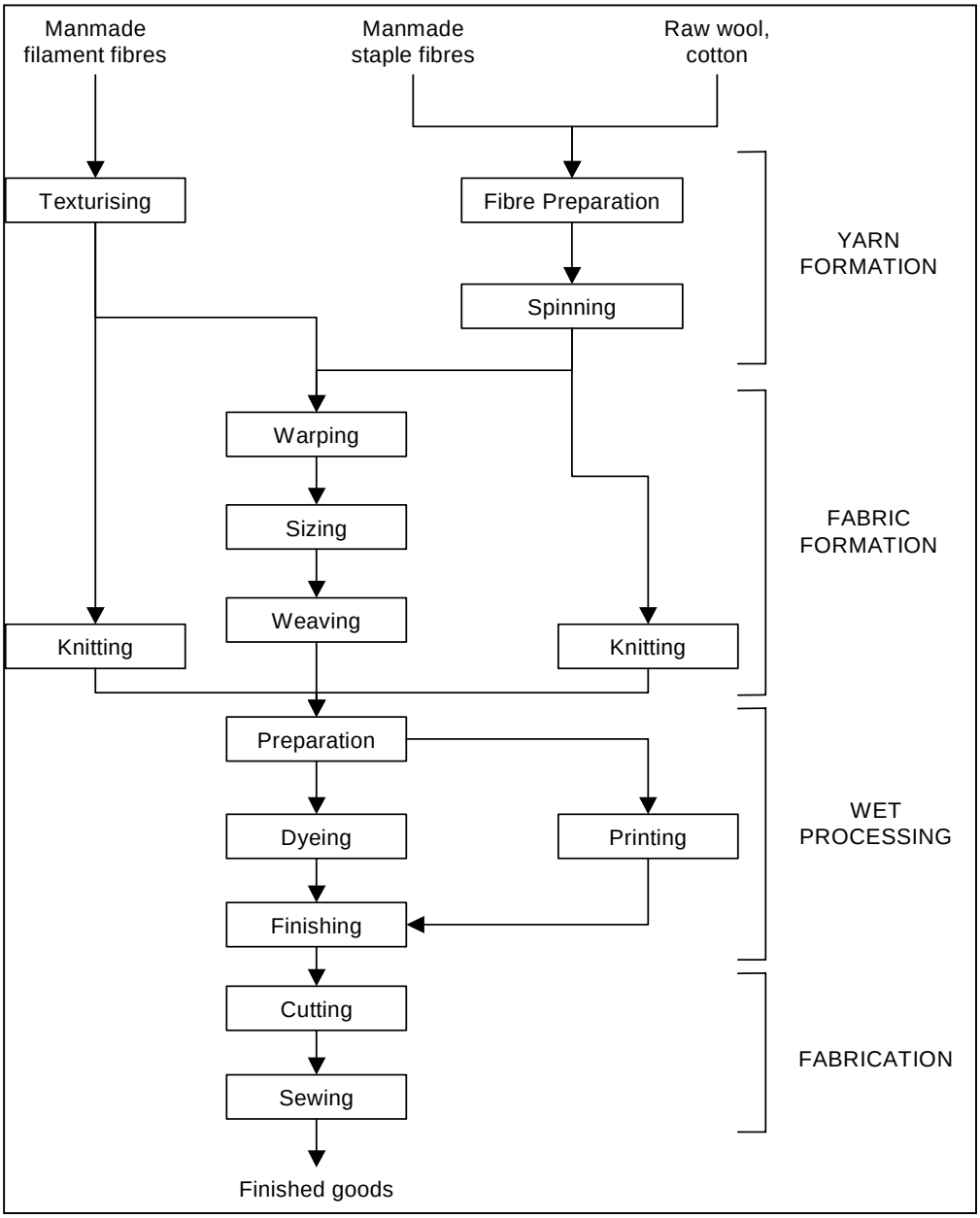


Figure 4-1: Typical textile processing flow chart (from USEPA 1997)

Textiles are either made either from natural or synthetic fibres. The former include vegetable fibres such as cotton; animal fibres such as wool and silk; and chemically and physically modified natural fibres such as cellulose from wood pulp which is processed to make rayon, acetate and triacetate. Synthetic fibres are manufactured from polymerised petrochemicals.

At a global scale the production of natural fibres is approximately equal in volume to the production of synthetic fibres, and polyester accounts for about 50% of synthetics. In 2000, the annual production of synthetic fibres was around 31.3 million tonnes, compared with a world total production of textiles of 45 million tonnes (Slater, 2003). Some key characteristics of different raw materials used for textiles are shown in Table 4-1, drawing out some sustainability issues. A flow chart showing the path for textile processing is shown in Figure 4-1.

Table 4-1: Some key differences between the five main types of fibre (from Laursen et al, 1997)

Characteristics in the production of raw materials for fibres					
Characterisation	Wool	Cotton	Viscose	Polyester	Acrylic
Renewability	x	x	(x)[#]		
Wood based			x		
Plant based		x			
Animal based	x				
Petro-chemical based				x	x
Scarce resources				x	x
Potential sustainability	x	x	(x)		
Water consumption	x	x	x	x	x
Use of hazardous substances	x	x	x	x	x
Energy consuming processes			x	x	x

[#]Viscose is only partly renewable as fossil fuels are part of the energy consumption required for further processing

The raw material for polymer production is almost exclusively oil. The oil is 'cracked' to separate it into segments of a small range of molecular weights, and the relevant segments are converted into a form suitable for polymerisation. The process uses large amounts of energy and produces water in the form of steam, along with solid and liquid by-products.

Long and complicated industrial chains are a feature of the textiles industry. Demand is largely driven by three end-uses: clothes, home-furnishing, and industrial use. The industry is composed of a large number of sub-sectors covering the entire production cycle from the production of raw material for man-made fibres to semi-processed (yarn, woven and knitted fabrics) and final products (carpets, home textiles, clothing and textiles for industrial use).

World production of textiles is now centred in Asia, but Western Europe still produces a moderate share of world exports. Within the EU, the textile and clothing industry is concentrated in Italy, the UK, France, Germany, Spain, Poland, the Czech Republic, and Hungary. Portugal, Belgium and Greece also have significant production. Romania and Bulgaria are also major textile/clothing producers.

Many textiles are made from blends of two or more different fibres. It is therefore difficult to quantify the environmental impacts of types of specific fibres in isolation.

4.2. Effects of Trade Liberalisation on the Sector

4.2.1. Current patterns of Production, Consumption and Trade

According to the latest market report of Saurer, the Swiss textiles machinery manufacturer, the world's annual production of fibre increased to 67 million tonnes in 2004. Some 37.9 million tonnes, or 56% of fibre output, was accounted for by man-made fibre production, with natural fibres (cotton, wool and silk) making up the remaining 44%. Polyester is the leading man-made fibre, with global output of 24.5 million tonnes (Table 4-2).

Table 4-2: World Textiles Output, 2004

Fibre	Output (mt)	%
Polyester	24.5	37%
Nylon	4.2	6%
Polypropylene	3.1	5%
Acrylics	2.7	4%
Cellulosics	3.2	5%
Other man-made	0.2	0%
Total man-made	*37.9*	*57%*
Natural fibres (cotton, wool, silk)	29.1	43%
Total	**67.0**	**100%**

Source: Saurer AG (2005)

Saurer estimates that Asia now accounts for 65% of world production of man-made fibres, with China providing 30% of world output. There are other significant Asian producers, notably India and Pakistan.

Table 4-3: World Production of Man-Made Fibres

Region	Share of Output
China	30%

Rest of Asia	35%
Rest of World	35%
Total	**100%**

Source: Saurer AG

Asia accounts for 50% of world textile exports by value, with the other main exporting regions being Western Europe (25%) and North America (10%). Asian countries are also the largest importers of textiles, though the region as a whole is a significant net exporter (Table 4-4).

Table 4-4: World Textiles Trade by Region (current prices)

	Exports		**Imports**	
	1995	**2003**	**1995**	**2003**
Value ($bn)	112.1	136.9		
% Share:				
Western Europe	25	25	20	18
North America	8	10	12	15
Other Developed	7	5	7	5
Developed Countries	*39*	*40*	*38*	*39*
Asia	51	50	36	30
Latin America	3	3	6	8
Africa and M East	3	3	11	12
Developing Economies	*57*	*55*	*53*	*50*
Economies in Transition	4	5	8	11
World	**100**	**100**	**100**	**100**

Source: WTO (2004)

China is the world's leading textiles exporter, accounting for 20% of global exports, followed by the EU, US, Korea and Taiwan. The EU is the world's leading importer, followed by the US, China, Mexico and Japan (table 4.5).

Table 4-5: Leading Exporters and Importers of Textiles

	Value, 2003 ($bn)	Share, 1995 (%)	Share, 2003 (%)
Exporters			
China	26.9	12.4	19.7
EU15	26.4	19.6	19.3
US	10.9	6.6	8.0
Korea	10.1	11.0	7.4
Taipei, Chinese	9.3	10.6	6.8
Importers			
EU15	20.0	14.6	13.6
US	18.2	9.0	12.5
China	14.2	9.4	9.7
Mexico	5.5	1.5	3.7
Japan	5.0	5.1	3.4

Source: WTO (2004)

4.2.2. Trends in Production, Consumption and Trade

The past 20 years have seen substantial growth in world textiles output. Growth rates since the early 1990s have averaged 4.5% per annum for man-made fibres and 2% for natural fibres. In 2004, Saurer reported that fibre consumption increased by 6.7% to 67.44 million tonnes, the fastest rate of annual growth since the mid 1980s. Man made fibre consumption increased by 7.9% to 38 million tonnes (Saurer, 2005).

Saurer's data also indicates a continuing shift in patterns of production. China has increased its production of man made fibres from 3.2 million tonnes in 1995 to 14.2 million tonnes in 2004, when it produced 37% of world output. The US, now the world's second largest producer, experienced a decline in output from 4.2 to 3.7 million tonnes over the same period.

The last 25 years have seen a dramatic shift in the balance of world textiles production. Whereas in 1980 53% of world textile output was produced in Europe, by 1995 the European share had fallen to 29%. By contrast, Asia produced 27% of world output in 1980, but was producing 44% by 1995. China's share alone rose from 7.9% to 10.7%. Indonesia, from a very low base, accounted for 2% of world textile production by 1995 (ILO, 2000).

These trends have continued in recent years, with Asia, and particularly China, accounting for an even larger share of world output. China's share of world exports increased from 12% in 1995 to 20% in 2003.

Since the beginning of 2005, there has been a further substantial increase in China's dominance of world production and trade, following the cessation of export limits under the former Multi-Fibre Agreement. A surge in exports of textiles and clothing to the EU prompted Trade Commissioner Peter Mandelson to launch an enquiry into the matter in April 2005. The US has experienced a similar surge of imports from China, prompting it to reintroduce import quotas on certain Chinese textile products in May 2005. Some forecasts suggest that China's share of world textiles output is expected to increase to more than 50% within three years (BBC, 2005).

Fastest growth is occurring in the market for technical textiles, for non-clothing applications in sectors such as automotive, furniture, health and hygiene, transportation, construction and the environment. The processes used to produce technical textiles are intensive in their use of human and physical capital, and are currently concentrated in developed countries, though growth in developing countries is expected to follow (Audet, 2004).

4.2.3. The Effects of Government Policy

Before the introduction of the WTO's Agreement on Textiles and Clothing (ATC) on 1 January 1995, a large portion of textiles and clothing exports from developing to industrialised countries was subject to quotas under the Multifibre Arrangement (MFA), a special regime outside normal GATT rules. Under the MFA, which lasted between 1974 and 1994, textile and clothing quotas were negotiated bilaterally. The MFA provided for the application of selective quantitative restrictions when surges in imports caused, or threatened to cause, serious damage to the industry of the importing country. The MFA was a significant departure from GATT rules, and particularly the principle of non-discrimination (WTO, undated).

Under the MFA, developed countries – and especially the EU, US, Canada and Norway – have used quota restrictions to protect their domestic textiles industries. As a result, production in these countries has been higher than it would have been under free trade, while the growth of the textiles sector in developing countries, and particularly those in Asia, has been restricted. Removal of these restrictions was expected to bring substantial economic welfare gains to the EU and US, and lead to significant growth in the production and exports of developing countries (UNCTAD, 2004).

On 1 January 1995, the MFA was replaced by the ATC, which set out a transitional process for the progressive enlargement and eventual removal of quotas, and the integration of textile products into the rules of the GATT. The Textiles Monitoring Body (TMB) was established to supervise the implementation of the agreement. The ATC terminated on 1 January 2005, following the expiry of the ten year transition period, and the removal of quotas.

4.2.4. Scope and Agenda for Further Liberalisation

On 1 January 2005, after more than 40 years of quota restrictions, the textile and clothing sector became subject to the general rules of the GATT. The world textiles market has entered a new period in which production and trade adjust to a new and more liberalised trading environment. However, the sector is still affected by higher than average tariffs and by tariff peaks and tariff escalation, which are being addressed through the current Doha Development Round (Harbinson, 2005). The average post–Uruguay Round tariffs on textiles and clothing for the three major industrial country markets are 14.6 per cent for the United States, 9.1 per cent for the European Union and 7.6 per cent for Japan, compared to average industrial tariffs of 3.5 percent, 3.6 percent and 1.7 percent, respectively (UNCTAD, 2004). Other concerns about trade barriers expressed by the International Textiles and Clothing Bureau (ITCB) relate to the rules of origin for textile and clothing products applied by developed countries, the application of anti-dumping measures, and the proliferation of social standards (ITCB, 2005).

Substantial concerns have been raised about the effects of the cessation of quotas, and particularly concerns that China may be exploiting the situation to promote unfair competition and monopolise world textile and apparel trade. For example, the Global Alliance for Fair Textile Trade (GAFTT), representing 96 trade groups in 54 countries, has argued that China is seeking to dominate world trade in textiles and apparel and is using unfair and illegal practices such as currency manipulation, subsidisation of state enterprises, the extension of free capital by central banks and illegal export tax rebates. GAFTT has expressed concern that Vietnam is seeking WTO membership and is likely to use similar unfair practices. GAFTT has commented that the previous quota system allowed virtually every developing country controlled access to the main developed economy markets. The alliance has called on the governments of the EU, US and Canada to implement special safeguards allowed under the WTO to prevent China from monopolising their markets (GAFTT, 2005). The EU has already begun to investigate this issue following a surge in Chinese imports and introduced quotas in June 2005. A surge in textile and clothing imports from China prompted the US to reintroduce quotas on three categories of Chinese textile imports in May 2005, claiming that thousands of US jobs were at risk, and sparking a new trade dispute.

On the other hand, UNCTAD (2004) has stressed the benefits of the cessation of the ATC for both developing countries as exporters and developed countries as importers, and has expressed concern that the removal of quotas should not be accompanied by the introduction of non-tariff barriers.

The WTO has responded to concerns expressed by LDCs by announcing the preparation of a paper that will examine options to improve the competitiveness of LDCs in the textiles and clothing market. These options include IMF and World Bank coherence programmes, more flexible rules of origin, technical assistance and capacity

building, bilateral cooperation programmes and other means to tackle constraints affecting LDC exports (Harbinson, 2005).

4.2.5. The Expected Impact of Liberalisation on Patterns of Production, Consumption and Trade

This section reviews a variety of studies modelling the impacts of trade liberalisation in the textiles sector (see below). In summary, modelling studies predict the following effects of liberalisation in the textile and clothing sectors:

- A small (<5%) overall increase in world textiles production;
- Small (up to 10%) declines in production in the EU, US and Japan;
- Increases in production in China, India and other developing countries, with various studies predicting growth of up to 33%;
- More dramatic shifts in patterns of trade, with China gaining a large (up to 50%) share of world export markets and developed country exports declining.

Overall, the impacts of liberalisation on production are expected to be small compared to baseline trends. Impacts on trade will be more significant, with liberalisation helping China, India and other developing countries to expand their market share further.

Nordas (2005) reviewed a variety of studies estimating the impact of phasing out quotas, and concluded that all of them found China to be the big winner, predicted to account for between a third and 50% of future world exports of textiles and clothing. China gains most from the cessation of quotas because it is by far the most restricted exporter to the quota restricting countries, has huge production capacity, and a low cost base. The author noted, however, that certain factors are likely to restrain China's export growth, notably the tendency for the share of the textiles and clothing sector to decline in a growing economy; the desire for retailers to diversify their sourcing, and the potential of other exporters such as India and Bangladesh, with even lower labour costs. Evidence reviewed by Nordas predicted a net overall decline in world employment in the sector of between 1% and 2.5% by 2018 as a result of quota phase-out, with the biggest decline in employment occurring in Turkey (-23-33%) and North Africa (-9-16%), but new jobs created in China (+12-30%) and India (+1-5%). In each case the larger shifts refer to clothing related employment and the smaller shifts occur in textiles employment. Continuing declines in employment are also expected in the EU and US.

A WTO discussion paper by Nordas (2004) used the GTAP general equilibrium model to assess the impacts of eliminating quotas on textiles and clothing. The study predicted that the share of textiles imports in domestic demand would increase from

20.9% to 21.5% in the USA/Canada and from 52.5% to 53% in the EU. More dramatic effects were forecast in the clothing sector, with the share of imports in domestic demand increasing from 33.8% to 45.0% in the USA/Canada and 48.5% to 51.0% in the EU. China and India were both expected to increase their share of both EU and US markets. The study predicted that countries close to the major markets are likely to be less affected by competition from China and India than was anticipated by previous studies, and that Mexico and the Caribbean, Eastern Europe and North Africa are likely to remain important exporters to the US and EU respectively. Countries most likely to lose market share are those located far from the major markets and which have had tariff or quota free access or non-binding quotas, as well as domestic producers in the EU, US and Canada.

A critique of the WTO discussion paper by ITCB (undated) noted that it contained various methodological inaccuracies, and also stressed the limitations of modelling studies such as this in dealing with some of the key drivers of world trade in textiles, such as rules of origin. The latter affect the ability of developing countries to penetrate EU and US markets and are likely to explain differences in export performance.

Macdonald et al (2001) also used the GTAP model to assess the impact of liberalisation of the textiles and clothing trade. Over a 25 year period, the following effects of phasing out quota were predicted:

- A 2.5% increase in the overall value of world textiles output for both textiles and apparel over 25 years, with slightly larger increases in volumes accompanied by a 2% decline in prices;
- An increase in world trade of 5-16%, with greatest growth in clothing exports;
- Increased apparel exports by China (+37%), India (+36%), rest of Asia (+42%);
- Declining exports by Mexico and the Caribbean (-8%) and Eastern Europe and North Africa (-6%), as competition for North American and EU markets increases;
- Increases in textile output in China (+9%), India (+8%), other Asia (+12%), Middle East (+10%), former Soviet Union (+6%) and other Latin America (+4%);
- Declining textile output in the US/Canada, EU and Japan/Korea/Taiwan (all -2%) and Australia/New Zealand (-4%);
- An increase in global welfare of $103 bn over 5 years and $204 bn over 25 years.

IFM (2004) reviewed a variety of studies modelling the effects of quota removal in the textiles and clothing sectors. They concluded that EU production of textiles and clothing would decline by between 3% (textiles) and 8% (clothing) in the EU over a 15

year period, in response to a drop in prices brought about by increased global competition. China's output of textiles was predicted to increase by 12% and its output of clothing by 33%. India experiences smaller changes in output, as its exports were less constrained by quota than those of China.

A paper by the OECD (2003) summarised 16 studies modelling the effects of liberalisation in the textiles sector, based on differing modelling approaches, base data, and structural assumptions. The modelling results consistently indicate considerable shifts in textiles and clothing production and trade through implementation of the ATC. However, they suggest that the overall impact on aggregate world textiles output will be modest. There is pressure for a large-scale reallocation of resources, with production of textiles and clothing expanding in Asian and other developing countries. In parallel, textiles and clothing production in industrialised countries is expected to contract significantly, while imports of textiles and clothing from developing countries increase. All the studies reviewed foresaw increases in global welfare as a result of a liberalisation of trade in textiles and clothing. But the estimates of welfare gains show considerable variation, with expected annual global benefits ranging from $6.5 billion to $324 billion. Some studies predicted ATC reform to account for up to two-thirds of all gains from the Uruguay Round, while others put the contribution of textiles and clothing liberalisation at merely 5 per cent. There is similar discrepancy with respect to the distribution of welfare gains. A number of analysts saw developing countries as the main beneficiaries of ATC reform, while others expected them in the aggregate to lose from the policy changes.

Audet (2004) considered issues of structural adjustment in the textiles and clothing sectors in the post ATC trading environment. The main drivers of adjustment in the textiles sector were identified as: the migration of textile production to developing countries; the adoption of up-to-date equipment by producers; the fading attractiveness of outward processing programmes; and the importance of rules of origin to qualify for preferential trade arrangements. China is expanding its market share significantly, with use of modern equipment driving improvements in productivity. China's clothing sector is also expanding, benefiting from access to high quality textile inputs from domestic sources. Globalised knowledge networks are shrinking the productivity gap between developed and developing countries, as the most competitive developing countries are able to operate modern machinery efficiently. Rules of origin are used to ensure that preferential trade arrangements benefit the countries targeted – while these rules need to be sufficiently stringent to achieve this, there is a danger that, if overly restrictive, they can be a barrier to trade.

4.3. Environmental impacts

4.3.1. Land use/landscape

The main land use impacts of textile production relate to the effects of producing the natural fibres used in the industry. As these are agricultural impacts, they are not considered further in this case study. The landscape effects of cotton production were considered in part 1 of this project. No references to landscape effects from production of synthetic polymers have been located.

4.3.2. Water quality and supply

Water use

This section does not consider water used in the agricultural production of natural fibres such as cotton, but it should be noted that this is a significant part of the overall impact of producing natural fibres – e.g. in order to produce one kilogram of cotton, between 7,000 and 29,000 litres of freshwater are required, with the figure varying according to the efficiency of the irrigation system used (see Part 1 final report).

Around 420-740 litres of water are needed per kilogram of viscose fibre produced (Laursen et al, 1997). Much of this water is solely used for cooling, however, and can be immediately discharged. There is little data available on water use in polyester production, but this is estimated to be low in comparison with other fibres. Production of acrylic fibres is estimated to require around 210 litres of water per kilogram of fibre (Laursen et al, 1997).

The water requirement for processing one kilogram of fibre into fabric can vary widely depending on the processes involved. For example, for knitted bleached cotton fabric in Bangladesh, around 72 litres of water are needed to process one kilogram. Up to 200 litres may be needed for fabric that is scored, bleached and dyed (Cherrett et al 2005). Woven fabric generally requires less processing water than knitted fabric due to differences in the dyeing process.

Problems related to water consumption are exacerbated in China, which has the largest share of world exports, and where production is predicted to increase. This is due to the outdated equipment used by Chinese textile producers. The industry has a low automation level and low utilisation efficiency of raw materials. The water consumption per unit product is about 50 per cent higher than in developed countries (IISD 2004). Similar issues are likely to exist in India and other parts of Asia although no specific data on these areas could be located.

Water quality

Impacts on water quality are significant at several stages during the textile production process. A summary of the impacts at these key stages is set out in

Table 4-6.

Table 4-6: Water quality impacts of different stages in textile production (information from Laursen et al (1997) except where otherwise indicated).

Production Stage/Process	Impacts on water quality
Sizing/desizing (prior to weaving). This is a process that increases the strength of the yarn. It is not necessary for knitted fabrics. The components of size can vary, but normally the major component is a polymer such as starch, modified starch, or a synthetic size such as polyvinyl alcohol or carboxymethyl cellulose.	• washing out of the size (desizing) is a highly polluting process, contributing around 60 per cent of the total chemical oxygen demand (COD) generated by wet processing of textiles (c90g/kg textile); • desizing also contributes to biological oxygen demand (BOD), c14-50g/kg textiles is generated; • sizes may contain the following pollutants, depending on the requirements: fatty lubricants, weighting agents, biocides, antistatic agents, tints, antifoams, emulsifiers, urea, pentochlorophenol; • starch sizes can be removed through use of enzymes, or by oxidation – they cannot be reused; • synthetic sizes are usually water soluble – it is possible to recover, concentrate and reuse some synthetic sizes where companies carry out sizing, weaving, and desizing at the same location; • In 1996 it was estimated that more than 90 percent of the size used by the US textile industry, or 90,000 tons, was disposed of in the effluent stream with the remaining 10 percent being recycled (USEPA, 1997).
Scouring/washing is carried out on all fibres, although light washing may be adequate to clean pure man-made fibres. Removing contamination from wool and cotton (natural oils and waxes) may involve alkaline treatments using sodium hydroxide and/or sodium carbonate, wetting agents, detergents, and sequestrents.	• the discharge from scouring/washing contributes significantly to COD and BOD – between 86-113g/kg textiles of COD is generated, and between 14-47g/kg of BOD; • it is possible to use solvents (perchloroethylene) instead of water for scouring, but this is rarely done in Europe because of the ecotoxicological properties of the solvents and the limited fabric purification that can be achieved.
Dyeing/printing is performed to give the textile or material a desired colour. It can be performed on the fibre, yarn, fabric, or made up products. Approximately 3,000 different dyestuffs are used by the textile industry. In dyeing mills, a large number of dyestuffs are used. Consumption per kg of fabric varies from about 2-80 g depending on the colour intensity desired. The main categories of dyestuffs are: cationic or basic; acid; metal complex; direct; disperse; sulphur; azoic; and reaction or reactive.	• the primary source of wastewater from dyeing is spent dyebath and washwater; • wastewater typically contains by-products, residual dye, and auxiliary chemicals, and can also contain additional pollutants such as oxalic acid; • in 1995 it was estimated that 10 to 15 per cent of the 700,000 tonnes of dyes produced worldwide was disposed of in effluent (USEPA 1997); • the average wastewater generation from a dyeing facility in the USA was estimated at between one and two million gallons per day in 1997 (USEPA 1997); • in China, domestically made dyes usually have lower dye uptake and because of lack of effective management in the dyeing process, dye residual in wastewater is nearly two times higher per product than the amount discharged in developed countries (IISD 2004).

Most developed countries have regulations in place to deal with water pollution. In the EU, for example, the Urban Waste Water Treatment Directive (91/271/EEC) requires Member States to ensure that industrial wastewater (including that from textile

production) is treated to a certain standard prior to its release. The potential impacts of textile production on water quality will be more severe in countries without good (or well enforced) environmental protection regulations. Developed countries where textile production is predicted to decrease will probably not experience improvements in water quality as good standards are usually already being maintained.

In China, effluent from the cotton textile industry comes mainly from the printing and dyeing processes. Effluent (including from the pre-treatment process, dyeing or printing process, and finishing process) is mainly organic in nature. Contributing six per cent of the total, the textile industry is one of the major producers of industrial wastewater in China. Within the textile industry, cotton produces 80 per cent of the effluent (IISD 2004).

Over the past few years, the Chinese government has been taking increasingly strict control of industrial pollution and urging industries to adjust structures and upgrade products. As a result, the ratio of treated water in compliance with national standards is increasing. However, a 2004 publication on trends in textile production in China indicated that there would be a need to double wastewater treatment capacity there in order to maintain current levels of COD removal (IISD 2004).

On the positive side, trade liberalisation is predicted to lower the cost of imported dyes which are more effective and more environmentally sound – China has made specific commitments related to reducing tariffs on such dyes (IISD 2004).

4.3.3. Resource use/waste

The predicted increase in textile production in countries such as China will inevitably lead to increased consumption of resources such as water, electric power, various auxiliaries, additives and dyes (IISD 2004). If the percentage of standard wastewater discharge remains unchanged, increased resource consumption will lead to increased wastewater discharge and increased Chemical Oxygen Demand (discussed in the section above on water quality).

Energy use in production varies according to textile type, but also according to the different processes used in manufacture (see Table 4-7)

Table 4-7: Energy consumption for different fibres during production (Laursen et al, 1997)

Process	Wool	Cotton	Viscose	Polyester	Acrylic
Production of raw material	8 MJ/kg	48.65 MJ/kg	2 MJ/kg	50 MJ/kg	52 MJ/kg
Production and spinning of fibre	N/a	N/a	33.3 MJ/kg	13.64 MJ/kg	46.3 MJ/kg
Spinning of staple fibre yarn	Rough estimate based on cotton/polyester data 15-45 MJ/kg				
Warp size and weaving	Rough estimate based on cotton/polyester data 10-30 MJ/kg				
Knitting	Rough estimate based on cotton/polyester data 5-20 MJ/kg				

Dyeing/washing/drying	Rough estimate based on cotton/polyester data 3.5-13 MJ/kg
Finishing	Rough estimate based on cotton/polyester data 4-8 MJ/kg

The primary solid residual wastes generated from the textile industry are non-hazardous and include fabric and yarn scrap, off-spec yarn and fabric, and packaging waste. Cutting room waste generates a high volume of fabric scrap that can be reduced by increasing fabric utilization efficiency in cutting and sewing. Typical efficiency for using fabric averages from 72 to 94 percent (USEPA 1997).

Although a large portion of cutting waste goes to landfill, some innovative programmes are being implemented to recycle this material. Some facilities collect cotton lint for resale. Cotton waste, leaves, and stems collected during the yarn formation have been sold to farmers as animal feed (USEPA 1997).

However, some residues and sludges from textile production may contain toxic organic chemicals and metals. They need to be properly managed with disposal in approved, secure landfills. Some may require treatment (e.g. by incineration) before disposal (World Bank 1998).

4.3.4. Biodiversity

The main biodiversity impacts of textile production relate to the effects of producing the natural fibres used in the industry. As these are agricultural impacts, they are not considered further in this case study. The biodiversity impacts of cotton production are discussed in the report for Part 1 of this project.

There will also be biodiversity impacts from the water pollution arising from production. If wastewater from textile production is released untreated into waterways, the increased BOD and COD can reduce river water oxygen levels. In turn, this may reduce the biodiversity of aquatic communities, and the death of aquatic organisms (EEA, 2003). In addition, the release of dye pigments into waterways may give 'shadow effects' causing reduced photosynthesis (Laursen et al 1997). No specific examples of biodiversity impacts due to textile production were located in the course of this project.

4.3.5. Air quality

The production of the fibres that are used to make textiles and clothing involves processes that produce air emissions. These are most significant in polyester production, which produces air emissions both at the stage of resin manufacture and fibre formation (see

Table 4-8). Air emissions during the agricultural phase of natural fibre production are not considered (but for cotton these are discussed in the report for Part 1).

Table 4-8: Air emissions (mg/kg fibre) during polyester production (from Laursen et al, 1997)

	Polyester resin manufacture	Polyester filament fibre manufacture	Total atmospheric emissions
Particulates	5,000	4,700	9,700
Nitrogen Oxides	12,000	4,300	16,300
Hydrocarbons	34,000	1,000	35,000
Sulphur Oxides	18,000	7,100	25,100
Carbon Monoxides	16,000	1,300	17,300
Aldehydes	610	44	654
Methane	24	5.1	29
Other organics	4,600	260	4,860
Kerosene	0.33	0.24	0.57
Ammonia	32	1.8	34
Antimony	0.012	-	0.0012
Lead	0.14	0.013	0.15
Actaldehyde	20	-	20
1,4 dioxane	1	-	1
Ethylene Glycol	20	-	20
Sulphuric acid	0.01	-	0.01

Textile production from fibres also produces emissions to air. Key emissions during the textile production process include fine carbon particles emitted by wool carbonising during yarn formation and acetic acid and formaldehyde emitted during the dyeing process (Laursen et al, 1997). Air pollution control measures can include the use of carbon adsorption systems, thermal oxidation, aqueous absorber systems and liquid waste incineration. These techniques can reduce discharges of volatile organic compounds and carbon monoxide by up to 99.9 per cent (Laursen et al, 1997).

Many developed countries have regulations and standards in place to maintain air quality. In the EU, the IPPC Directive (96/61/EC) covers 'plants for the pre-treatment (operations such as washing, bleaching, mercerization) or dyeing of fibres or textiles where the treatment capacity exceeds 10 tonnes per day'. This means that textile production plants covered by the Directive must obtain a permit to operate, and must use best available techniques in operation. Research on such techniques is continuing in Europe (see e.g. Laursen et al 2002), and has led to substantial reductions in the levels of point source pollution from textile production in Europe.

In developing countries, where textile production is predicted to increase after liberalisation of trade, environmental regulations may not be in place or be well enforced. In China and India, air quality in many cities is already low. Energy needs are met largely by burning low quality coal, resulting in environmentally damaging acid rain, and subsequent water pollution. Problems with acid rain and subsequent water

pollution are thought to be worsening in China (see, e.g. China Daily, 2005), India and Bangladesh due to increased industrialisation and economic growth.

In India, the textile industry has been estimated to contribute around 11.1 per cent of total industrial emissions of pollutants (particulates, sulphur and nitrogen) (UNEP, undated). Only the food products and iron/steel industries were more significant in their emissions. In China, Ho and Jorgensen (2003) found that the textiles industry was less significant when compared with other industries, with a contribution of only 0.7 per cent of particulate emissions, and 1.7 per cent of SO2. Industries such as non-metal mineral products, metals smelting, chemicals, and electricity were more significant polluters.

4.3.6. Climate change/greenhouse gas emissions

Greenhouse gas (GHG) emissions from textile production relate to the energy used during the production process and the emissions produced during transport of textiles both after production and between production stages. In countries such as China, India and Bangladesh where a high proportion of energy needs are met through burning coal, the GHG emissions in relation to textiles are relatively high. No specific figures on the contribution of the textile industry to overall global or national GHG emissions could be located. It is likely, however, that the textile industry is a small contributor in comparison to the metallurgy and energy industries (IISD 2004).

Textile materials have to be transported by vehicles during and after production. As textile production is often carried out far from places where the raw materials are grown or produced, the greenhouse gas emissions related to their transport are significant in some cases. Increased production in developing countries when the major consumer markets remain in the USA and Europe can be expected to increase GHG emissions in relation to transport of textiles, although most transport from Asia to the US and the EU is expected to take place by sea, and this form of transport has relatively low emissions per tonne kilometre (OECD 1997). Emissions from displaced export pathways will fall. No specific data on these emissions was located.

4.3.7. Plant and animal health

The main plant and animal health impacts of textile production relate to the effects of producing the natural fibres used in the industry. As these are agricultural impacts, they are not considered further in this case study.

There are, however, potential human health impacts arising from textile production. Some of the chemicals and dyes used in textile production have the potential to cause allergic reactions and other health problems, e.g. formaldehyde and azo dyes (European Commission 2002). As a result, many countries have established regulations setting maximum limits for, or banning, these substances in textiles and clothing. These

regulations have positive flow-on effects for the environment, as a result of reduced use of toxic substances (see Box 4-1).

Box 4-1: The ban on azo-dyes in Germany – implications for India

In 1994 the German government introduced measures to prohibit the import of textiles containing certain azo dyes. The introduction of these regulations had direct implications for India's textile industry where a large proportion of exports were destined for Germany. India's government responded by matching the German standards with the Ministry of Environment and Forests announcing in 1995 that it was prohibiting the handling of 74 azo dyes throughout the country under the Environmental (Protection) Act. Imports of the dyes were also restricted. The Ministry of Textiles focussed its attention on strengthening the capacity of the decentralised sector.

The industry itself also took steps to meet or surpass these new requirements. Some companies sought ISO and eco-label certification, and were subsequently able to get premium prices for their products.

(IIED 1997)

In the past, fashion trends have governed the level of demand for organic and 'natural' looking undyed products. It seems now that demand for organic cotton may be increasing as a by-product of the world demand for organic food (UNESCAP 2000).

4.4. Analysis of the impacts of current/forecast liberalisation proposals

Production of textiles is predicted to increase in China more than in any other country. The cotton industry is the largest sector of the Chinese textile industry and cotton satisfies the clothing needs of more than one billion people in China. China ranks first in the world in production capacity, and in cotton yarn and fabric production (IISD 2004).

China has strong competitive advantages in terms of labour and textile fibre resources. Labour costs in China are 20–40 times lower than countries such as Japan and the United States, and two to four times lower than in some developing countries such as Thailand. In 2000, China's textile fibre production was 19 per cent of the world total. According to the General Administration of the Customs of China, the growth rate of China's textile and garment exports was 2.31 per cent in 2001; 15.66 per cent in 2002; and 27.72 per cent in 2003 (IISD 2004).

As far as the environment is concerned, increased production will inevitably lead to increased consumption of various resources, such as water, electric power, various auxiliaries, additives and dyes, etc. If the percentage of standard effluent discharge remains unchanged, increased resource consumption will impose a heavier burden on

the environment through increased wastewater discharge and chemical oxygen demand (COD) discharge (IISD 2004).

Trade liberalisation is expected to lead to a modest increase in overall world textiles output, but a more pronounced shift in the balance of output towards developing countries, especially in Asia. A key impact of trade liberalisation will be to shift environmental pressures away from developed countries and towards developing ones, especially China, India and Bangladesh. Since environmental regulations on the textiles industry tend to be less demanding in these countries than in the EU, US and Japan, whose market share is declining, a net increase in the environmental impacts of the sector can be expected. However, it should be noted that most of the impacts identified are local, rather than global, in nature.

On the other hand, since joining the WTO, China has imposed stricter requirements on dyes and the demand for eco-friendly dyes has increased. Imported dyes perform better than locally-made ones, but also are more expensive. According to China's commitments to the WTO, the tariff rate on dye imports will drop from the present 10.8 per cent to 6.5 per cent in 2008. By then, the cost of imported dyes will drop accordingly and Chinese enterprises will use a larger proportion of imported dyes. As imported dyes are more eco-friendly than locally-made ones, they will help to reduce environmental pollution (IISD 2004).

In summary, therefore, the principal environmental issues expected to arise from liberalisation are as follows:

- increased demand on environmental resources (water, air, electricity) in countries where production is predicted to increase (China, India, Bangladesh);
- increased risk of water pollution in countries where production is predicted to increase; and
- a potential improvement in technology in producer countries which may alleviate some environmental problems in the long-term.

The principal environmental impacts of trade liberalisation on the textiles sector are therefore expected to be local impacts in the countries experiencing production growth.

The effect of trade liberalisation needs to be considered against existing trends in output and trade, which are reflected in a major shift in the balance of world output towards Asia, and China in particular. Trade liberalisation will serve to exacerbate the environmental pressures resulting from these trends.

4.5. Analysis of potential flanking measures

The current debate about the surge in imports in textiles provides an opportunity to raise the profile of environmental issues in the textiles sector. Textile production is predicted to increase most in China and India, with expected reductions in the EU,

USA and Japan. This discussion focuses on measures to address the impacts of increased production.

Reductions in textile production are not expected to result in adverse environmental effects in those countries where this is predicted. However, significant environmental improvement in these countries is not predicted either, as most production in developed countries is already required to comply with strict regulations with regard to emissions.

The countries where textile production is predicted to increase due to liberalised trade do (generally) already have environmental regulations in place attempting to limit the adverse environmental effects of industry. However, difficulties in enforcing such regulations have been identified (e.g. UNEP, undated). With this in mind, development of additional local regulation cannot be expected to be more effective unless there is a change in the approach to enforcement or the resources that are available for enforcement.

Best available techniques in textile production are advanced in Europe (e.g. see Laursen et al, 2002). Technical assistance programmes could assist manufacturers in countries where production is expected to increase to adopt best techniques and reduce negative environment impacts more rapidly. This is an area where the UK could have a role through its international aid programmes.

A dramatic liberalisation of trade in textiles and clothing took place in 2005 with the removal of import quotas following cessation of the Agreement on Textiles and Clothing. This has already resulted in increased textile production in the countries discussed in this report, and this increase is expected to continue. It is not realistic to recommend the general reinstatement of quotas, as this would violate WTO rules, but the USA has imposed emergency quotas for some categories of clothing imports from China in June, the EU and China agreed a deal to manage the growth of Chinese textile imports to the EU until 2008, for ten product categories of concern (European Commission, 2005). These moves were prompted by concerns about a sudden loss of competitiveness in both the EU and US, amid claims about unfair competition from China.

However, in August, it became apparent that the European limits had 'backfired' somewhat, with millions of clothing items stuck on boats and in ports, due to traders having placed orders that exceeded the new quota limits. Limits in six of the ten categories had been met or exceeded by August, and the European Commission seemed to be seeking ways in which to make the June agreement more flexible (Financial Times, 2005).

Table 4-9: Summary of impacts of liberalised trade in textiles, and potential flanking measures. Key impacts in bold.

Type of impact	**In Europe**	**European flanking measures**	**Type of impact**	**Outside Europe**	**Flanking measures for effects outside Europe**
Land use/landscape	For all types of impact: the liberalisation is likely to cause a reduction in textile and clothing production in Europe. This is expected to produce moderate environmental benefits.	None needed.	Land use/landscape	None significant at this stage of production.	None needed.
Water quality and supply			**Water quality and supply**	**Large amounts of water used, and efficiency lower in some countries due to outdated equipment.** **Downstream water pollution from wet processing and dyeing can lead to tinting of water, contamination with heavy metals and other substances, and de-oxygenisation of waterways due to release of material with high chemical or biological oxygen demand.**	**Effects are likely to be concentrated at specific sites near to textile production. National regulation should be used to maintain water quality.** **As national water quality is a domestic issue for producer countries, the most appropriate way for the UK to address it will be through 'soft' flanking measures. These could include:** • **eco-labelling;** • **aid to support upgrade of production equipment where this will improve discharges to water; and/or** • **technical assistance to achieve use of best available techniques.**
Resource use/waste			Resource use/waste	Textile production generates several types of waste including cutting waste and residues that may contain chemicals and metals.	Effects will be localised. Potential flanking measures will be similar to those suggested to deal with water quality.

Type of impact	In Europe	European flanking measures	Type of impact	Outside Europe	Flanking measures for effects outside Europe
Biodiversity	For all types of impact: liberalisation is likely to cause a reduction in textile and clothing production in Europe. Some modest local benefits can be expected.	None needed.	Biodiversity	There are likely to be some negative impacts on biodiversity as a flow-on effect from water pollution and water use.	Effects are likely to be concentrated at specific sites near to textile production, as they are directly related to water issues discussed above. National regulation should be used to maintain water quality, and the UK could aim to influence this as discussed. There could also be opportunities for the UK to assist in lessening biodiversity impacts through its influence in international fora such as the CBD Conference of Parties.

Type of impact	In Europe	European flanking measures	Type of impact	Outside Europe	Flanking measures for effects outside Europe
Air quality			Air quality	Textile production results in emissions of a wide variety of air pollutants.	Effects are likely to be concentrated at specific sites near to textile production, as with the water issues discussed above. As national air quality is a domestic issue for producer countries, the most appropriate way for the UK to address it will be through 'soft' flanking measures. These could include: • aid to support upgrade of production equipment where this will improve discharges to water; and/or • technical assistance to achieve use of best available techniques. Textile production is generally not the main contributor to air pollution in producer countries, so any flanking measures should aim to deal with other polluting industries as well.
Climate change/greenhouse gases			Climate change/greenhouse gases	No specific issues.	None needed.

Type of impact	In Europe	European flanking measures	Type of impact	Outside Europe	Flanking measures for effects outside Europe
Plant and animal health			Plant and animal health	There are possible human health impacts arising from the use of certain substances (e.g. azo dyes) in textile production.	Implementation of domestic restrictions on the import of products made using specific chemicals may have significant effects in producer countries. Such restrictions are already in place in the case of azo-dyes in the EU.

With regard to GHG emissions, China and India, where textile manufacturing is predicted to increase most, are both parties to the Kyoto protocol, but are not Annex 1 countries with specific emissions targets. Improving technology to allow clean energy production is a global issue with implications for all industries, not solely textiles. Influencing the uptake of clean technologies in China and India is recognised as vital if global objectives in relation to climate change are to be met. The UK has already taken action to influence this through its leadership on climate change during its Presidency of the G8 and should continue to give this priority, both nationally and within the EU.

An eco-labelling scheme may provide one of the best opportunities for developed countries such as the UK to influence the environmental effects of trade liberalisation measures, and indeed of textiles trade in general. The environmental impacts of liberalisation of the cotton sector and the role of eco-labelling in addressing these is discussed in the Part 1 report of this study. Since natural and synthetic textiles products are clearly close substitutes and give rise to a wide range of environmental impacts, there is merit in considering the development of a general textiles eco-labelling initiative that deals with the range of impacts of textiles production.

However, eco-labelling schemes can be difficult to implement in less developed countries where enforceability and traceability are problematic, and may place a high burden on producers. In addition, if there is a high price differential between eco-produced and conventional goods, consumers may be reluctant to pay a premium price. The potential impact of an eco-label for textiles has not been fully investigated.

Table 4-9 summarises the main impacts of liberalised trade in textiles in and outside Europe, and suggests flanking measures to deal with negative impacts where appropriate.

4.6. Conclusions

In this sector, we have had to base judgements on environmental impacts on incomplete information. Trade liberalisation has already led to substantial changes in the textile industry and its global distribution, with some accompanying changes in industrial practices. Further changes are expected in the coming years as major export markets such as the EU and USA continue to phase out import quotas and the effects of revaluing the Chinese yuan become apparent.

Taking the global picture into account, and bearing in mind the main sources of production now and in the future, the most important environmental issue related to changes in textiles production appears to be the risk of water pollution. This is an issue primarily of local concern and one that is likely to be most effectively dealt with through regulatory and other approaches at the national level, especially in countries outside Europe where production is expected to increase. Consequently, the scope for the EU or the UK to influence the problem directly through unilateral flanking measures is limited.

The most effective way for the UK and other developed nations to ameliorate the environmental impacts of the textile industry in those countries where production will increase is likely to be through 'soft' flanking measures such as:

- provision of technical support in the areas of best available/non-polluting technology and clean energy production;
- provision of advice on enforcement of environmental regulation and mechanisms to develop more effective measures to minimise environmental damage;
- continued international support of programmes to reduce the emission of CO2 and reduce the impacts of climate change; and
- development and support of eco-labelling mechanisms to allow consumer choice and provision of consumer information on the environmental costs of textile production.

4.7. Future research needs

Although we have been able to identify some of the key environmental pressures and benefits arising from textile production, we cannot specify the exact effects in the countries where production is predicted to increase following further trade liberalisation. It would be particularly helpful to have more research on certain questions e.g.:

- basic data and information on the existing actual environmental effects of the textile industry in the countries in which production is predicted to increase (especially China, India and Bangladesh);
- the significance of the textile industry in contributing to water pollution incidents and stresses related to water consumption in those countries where textile production is predicted to increase;
- the possible role of eco-labelling schemes in dealing with the environmental effects of textiles, both natural and synthetic, including design and implementation issues and their likely effectiveness in changing consumer behaviour; and
- the effectiveness of existing environmental regulations that apply to the textile industry, and the barriers to the effectiveness of such regulations.

5. ENERGY SERVICES

5.1. The Energy Services Sector

The energy sector comprises a wide range of activities involving the supply of energy goods (such as coal, gas and oil), as well as a variety of service activities which support different energy sub-sectors and different stages of the energy cycle, from exploration through to retail supply. Given its strategic importance, the energy sector has traditionally been highly regulated worldwide, and there is scope for significant further liberalisation. While the physical trade in energy goods such as coal and oil can be dealt with in a similar way to the trade in other goods, the energy services sector, which is complex and subject to substantial barriers to trade, presents a variety of distinct challenges. Liberalisation of trade in energy services is currently the subject of negotiations under the GATS (General Agreement on Trade in Services) negotiations.

Negotiating proposals relating to the energy services sector note the lack of a formal definition of energy services within the GATS, but suggest definitions which cover the whole energy cycle, including:

- Geological exploration;
- Drilling and completion of oil and gas wells;
- Oil and gas production related services;
- Design and construction of facilities to produce, transform and supply energy;
- Operation, management and maintenance of energy facilities and of energy networks, including transportation, transmission and distribution of energy;
- Environmental services for the energy industry;
- Wholesale marketing of energy;
- Retail supply of energy[1].

The principal sub-sectors of the energy sector are:

- Coal, including hard coal, lignite and peat. A large proportion of coal output is supplied to the electricity industry. Though coal itself is a good rather than a service, the sub-sector is a consumer of energy services (e.g. technical services relating to mining, transport and distribution services).
- Oil, with key activities including exploration and extraction of crude oil, drilling, completing and equipping wells, service activities in support of oil

[1] It is important to note that the term "energy services" has a somewhat different definition in a UK domestic context, implying a shift away from the supply of energy as a commodity and towards an approach focusing on the services derived from the use of energy. This definition emphasises the importance of energy efficiency and the development of a long term relationship between the energy user and supplier, to mutual advantage. This approach has been promoted in the UK by the DTI's Energy Services Working Group (ESWG, 2003).

exploration and production and the manufacture of refined petroleum products (gasoline, kerosene, distillate fuel oils, residual fuel oils, lubricants, etc.). This sector is dominated by large, vertically integrated multinationals, engaged in the extraction, refining and distribution of oil products, and is a significant user of energy services.

- Natural gas. Exploration and production are closely linked to exploration and production of oil and the establishments involved are often also involved in transmission and distribution. However, the gas transmission and distribution sectors present characteristics rather different from oil and more similar to electricity – while gas itself is a physical product, most commercial activities concerned with its supply and distribution can be regarded as services. Gas is normally transported and traded via high-pressure pipeline networks between geographically neighbouring countries. Major pipeline networks run across Europe and North America and link Europe to North Africa and the former USSR. Long-distance transportation and trade, however, often takes place in the form of liquefied natural gas (LNG) as technical barriers and costs involved in building pipeline networks are too high. For example the major consumers of natural gas in the Far East (Japan, South Korea and Taiwan) are separated by oceans from the main producers (Indonesia, Malaysia and Australia), so that trade takes pace mainly in LNG. This sector, like electricity, has been traditionally dominated by state-owned vertically integrated utilities, which produced, purchased or imported gas, and stored, transported and delivered it to the end users. The introduction of competition in some countries (e.g. US and UK) has altered this pattern, allowing for the emergence of independent producers and distributors.
- Electricity. The supply of electricity involves purchasing of fuel; constructing power stations and generating electricity; expanding, operating and maintaining transmission and distribution networks; trading bulk electricity (both nationally and internationally); supplying and metering; and operating customer billing and accounting systems. Secondary electricity is produced by the combustion of fossil fuels such as coal, oil and natural gas. Primary electricity includes nuclear power plants, hydroelectric plants, wind power plants and other sources of renewable energy. Most countries, with the exception of the United States and Japan, have had one vertically integrated, state-owned utility company, responsible for supplying electricity. This situation began to change in the 1990s with the introduction of competition in several countries including Argentina, Australia, Chile, Norway, Sweden and the United Kingdom.
- Renewable energy. Renewable energy sources are not depleted by their exploitation to produce electricity, heat or liquid fuels. They include: hydroelectric power, biomass, geothermal energy, wind power and solar energy. The renewable energy sector offers opportunities for energy related services such as engineering and consulting services, as production is not only limited to major suppliers but it can also involve end consumers. In this sub-

sector an important role is also performed by research and development services which are carried out predominantly by departments of large energy companies and universities, and funded by government as well as private institutions.

There has been some debate about the distinction between energy goods and energy services, and the precise definition of energy services is subject to ongoing negotiations in the WTO. While some products of the energy sector, such as oil and solid fuels, are clearly goods rather than services, the supply and distribution of others such as electricity and natural gas has strong service elements. At the same time, services play an important role in supporting activities in all sub-sectors of the energy sector. Energy services therefore potentially relate to all commercial activities within the energy sector except for the physical trade in fuels (oil, coal and other solid fuels, liquefied natural gas etc), plant and equipment. Submissions to the WTO have suggested that a checklist is developed covering agreed energy services. The EU's position asserts that energy services can be defined irrespective of the energy source involved, and include services related to: exploration and production; construction of energy facilities; networks; storage; supply; use; decommissioning; and installation, maintenance and repair of equipment.

The WTO has recognised that the transport and distribution of electricity and gas cannot be assimilated to that of other goods, given the specific characteristics of the goods (many impossible or difficult to store) and of the nature of the transport and distribution networks in question (quasi natural monopolies). The distribution and supply of electricity and gas can therefore be regarded as services. In contrast, transport and distribution of other energy products such as coal and oil are treated in the same way as transport and distribution of other goods.

Energy services worldwide have traditionally been dominated by state-owned, vertically integrated utilities, engaged in the production, transport and distribution of energy products, leaving little margin for trade and competition. The trend towards privatisation and liberalisation in the sector has been relatively recent (WTO, 1998). In liberalised markets, core energy services such as transport, transmission and distribution are increasingly supplied by independent operators under conditions of competition. Other services include consulting (in various fields including energy efficiency, conservation and 'renewable' energy), construction, maintenance of the network, and services related to distribution such as metering and billing.

Energy services have a key role to play in international development. Some two billion people in developing countries have no access to commercial energy sources, and energy services can help to provide access to energy in support of development (UNCTAD, 2003).

5.2. Effects of Trade Liberalisation on the Sector

5.2.1. Current patterns of Production, Consumption and Trade

Sources and Production of Energy

Energy is probably the biggest business in the world economy, with a turnover of at least US$ 1.7 trillion a year. The World Energy Council has estimated that global investment in energy between 1990 and 2020 will total some US$ 30 trillion at 1992 prices (Zarilli, 2003).

In spite of increasing environmental concerns about the impacts of the energy sector, the world's commercial energy mix continues to be dominated by fossil fuels (Table 5-1). The last 30 years have seen a reduction in the relative importance of oil and coal and an increase in the share of energy demand met by natural gas and nuclear power. Overall energy supply has increased by 70% over this period.

Table 5-1: Fuel Shares of Total Primary Energy Supply (%)

	1973	2002
Oil	45.0	34.9
Coal	24.8	23.5
Natural Gas	16.2	21.2
Combustible Renewables and Waste	11.2	10.9
Hydro	1.8	2.2
Nuclear	0.9	6.8
Other	0.1	0.5
Total (%)	100.0	100.0
Total (Mtoe)*	**6,034**	**10,230**

**Million tonnes oil equivalent*

Source: IEA (2004)

Table 5-2 gives details of the relative shares of different regions in the production of energy from different sources. The figures indicate that OECD countries produce more than 50% of the world's energy, with China, the rest of Asia and the former USSR the next largest producers. The Middle East is the largest oil producer.

Table 5-2: Regional Shares of Energy Production (2002/3, %)

	Oil	Natural Gas	Coal	Nuclear	Hydro	Total Primary Energy Supply
OECD	27.1	41.5	34.6	85.5	48.6	52.2
Middle East	29.7	9.4	-	-	0.7	4.2
Former USSR	13.8	28.2	7.9	8.9	8.6	9.1
Non OECD Europe	0.3	0.7	0.1	1.2	1.8	1.0
China	4.4	1.4	37.3	-	10.8	12.2

Asia	4.8	8.9	12.5	2.3	6.2	11.6
Latin America	9.1	4.4	1.5	-	20.1	4.4
Africa	10.8	5.5	6.1	-	3.2	5.3
Other	-	-	-	2.1	-	-
World	100	100	100	100	100	100
Total	**3,712 Mt**	**2,719 billion m^3**	**4,038 Mt**	**2,660 TWh**	**2,676 TWh**	**10,230 Mtoe**

Source: IEA (2004)

Access to energy varies dramatically between countries and regions. Around one billion people in the industrialised countries consume nearly 60 per cent of the total energy supply, whereas the five billion people living in developing countries consume the remaining 40 per cent. At least two billion people, mainly in the rural areas of poor countries, lack access to electricity, but the real number may be considerably higher. In some African countries the electrification rate is as low as 2-3 per cent. The use of inferior fuels – for example charcoal, crop residues and cow dung – usually in ways that are damaging to both human health and the environment, may account for around a quarter of the world's total energy consumption and three quarters of all energy used by households in developing countries (Zarilli, 2003).

Patterns of production and trade vary markedly between energy products and energy services. Production and exports of energy goods tend to be dominated by countries with the greatest endowments of energy resources, while the energy services market is influenced by a wider range of factors such as technology, government policy, and the extent of liberalisation and competition in domestic markets.

Proven oil reserves are concentrated in the Middle East, which is home to 64% of world reserves, followed by South America, North America, Africa, Europe, Asia, and Oceania. Coal, on the other hand, is much more concentrated, with 75% of all proven reserves falling in only six countries. However, these countries are widely spread geographically (United States, Russia, China, Australia, India and Germany). The largest proven natural gas reserves exist in Europe and the Middle East, followed by Asia, Africa, North America, South America and Oceania. The United States has the largest share of global installed nuclear capacity (29% of world total), followed by France (18%) and Japan (12%). Nuclear power provides 78% of France's electricity. Hydroelectric power is the most widely used source of renewable commercial energy worldwide, being generated in 158 countries (WEC, 1998).

IEA data indicate that total final consumption of energy increased by 56% between 1973 and 2003. The OECD's share of world consumption declined to 52% in 2003, with rapid growth in Asia, Africa and the Middle East.

Table 5-3: Total Final Consumption of Energy (%)

	1973	2003
OECD	62.5	52.1
Middle East	2.1	4.1
Former USSR	14.1	8.6

Non OECD Europe	2.8	0.9
China	5.8	11.6
Asia	4.9	12
Latin America	5	5
Africa	2.8	5.7
World	**100**	**100**
Total (Mtoe)	**4,549**	**7,095**

Source: IEA (2004)

Current trends are seeing further rapid expansion in energy demand in China and other parts of Asia.

Trade in Energy Products

The patterns of international trade in energy products vary significantly between the various sectors. Coal and oil, easily stored and transported, are traded worldwide, while gas and electricity are mostly traded on a regional basis, due to storage and transportation difficulties. Most trade in natural gas (76% of total world trade) takes place between Canada and the US and between Russia and Western Europe. Canada is the main source for US natural gas imports, accounting for 99% of total imports of natural gas in 1995. Three quarters of world gas is transported via pipeline, the remainder is transformed into liquefied natural gas (LNG) and shipped. LNG trade is most common in Asia (*supra*); Japan alone accounts for more than half of the world's LNG imports. A small amount of gas is traded in Asia via pipeline between Malaysia and Singapore, while the construction of an ASEAN wide pipeline network is under discussion (WTO, 1998). As a result of these constraints, only 24% of world gas production is traded internationally, compared to 70% of crude oil (Zarilli, 2003).

The regional nature of electricity trade is even more accentuated than for gas, due to the non-storability of electric power and to the reliance on networks as the only means of transport. Moreover, electricity trade depends on the existence of interconnections between national electricity grids. In the European Union opportunities for electricity trade with non-EU Countries have been historically limited by the lack of grid interconnection, Norway and Switzerland being the only two countries exchanging significant amounts of electricity with the EU. This has been partly remedied by the linking up of Poland, Czech Republic and Slovakia to the main European grid. In the United States until the mid 1960s very little electricity was traded even within regions. This has changed radically, as in 1995 trade among regions was five times as large as in 1965 and the US has become a net importer of electricity from Canada and Mexico. In Asia, interconnections exist between Thailand and Laos, Indonesia and Singapore, Vietnam and Laos, China and Hong Kong, and are being considered between Thailand and Malaysia. An ASEAN electricity grid has also been discussed by an ASEAN inter utility group.

Trade in Energy Services

Trade in energy services is less constrained by geographic barriers than trade in energy goods.

The GATS distinguishes between four modes of supplying services: cross-border trade, consumption abroad, commercial presence, and presence of natural persons.

1. Cross-border supply is defined to cover services flows from the territory of one Member into the territory of another Member (e.g. via telecommunications or mail);

2. Consumption abroad refers to situations where a service consumer (e.g. tourist or patient) moves into another Member's territory to obtain a service;

3. Commercial presence implies that a service supplier of one Member establishes a territorial presence, including through ownership or lease of premises, in another Member's territory to provide a service (e.g. domestic subsidiaries of foreign insurance companies or hotel chains); and

4. Presence of natural persons consists of persons of one Member entering the territory of another Member to supply a service.

Trade in energy services is usually undertaken in three of the four defined modes. First, there is cross-border supply of services (Mode 1). The energy services most likely to be traded across borders include transport, design and engineering (for example, using the Internet), and financial services associated with energy trading, marketing, brokerage and risk management. Second, the most significant trade mode in energy services is that of commercial presence (Mode 3). Typical examples would be a foreign-owned energy distributor or the presence of a foreign concessionaire or contract management company. Finally, trade in energy services would often involve the temporary movement of natural persons (Mode 4). The issues involved in the latter mode are common to most service sectors (Cassim and Jackson, 2003).

Trade in energy services under mode 3 may take a variety of different forms, including build/operate/transfer models (involving a long term contract between a contractor and government) and independent power producers (which own and operate their own plant) (Zarilli, 2003).

GATS proposals have been careful to state that the ownership of natural resources is not intended to be put in question. Much of the focus of proposals in the GATS has been on the upstream services sector, i.e. services linked to oil and gas fields including geological exploration, drilling, well testing and wireline services, completion and cementing services, and production services. Negotiations on liberalisation have huge strategic implications, because of the need for dramatic new investments to ensure adequate oil and gas production to meet expected demand over the next 20 years. Thus US policy in this area aims to promote the exploitation of energy reserves globally while promoting US exports of energy-related goods and services (Gibbs, 2003).

Trade in energy services, in particular establishment based trade (mode three), is less affected by the network transportation constraints deriving from geographical distance and lack of interconnection, as service suppliers can establish and supply energy services such transmission and distribution in countries which have liberalised and opened their markets to international competition. Cross-border supply of energy services (mode one), on the other hand might be seriously affected by distance and lack of interconnection between the country of origin of the service supplier and the destination country.

With the support of mode three commitments, competitive suppliers could take advantage of the privatisation, liberalisation and unbundling of national energy markets, especially in the electricity and gas sectors. Unbundling of vertically integrated utilities allows for the emergence and the liberalisation of important services such as transportation and distribution, by separating activities within the energy value added chain. The network-bound distribution of gas and electricity should also make possible the supply of energy distribution services cross-border, where interconnection exist between different national networks. Consultancy services in the energy sector could also benefit from GATS mode four commitments (WTO, 1998).

Energy Services – Key Players

Countries with well developed energy service sectors tend to be those with more liberalised markets which have encouraged competition in the energy supply chain and encouraged companies to export to overseas energy markets. These are mostly developed countries and include the US, EU, Canada, Venezuela and Norway. In the EU, liberalisation and increased competition in energy markets have led to a flurry of cross-border mergers and acquisitions, strengthening the international capabilities of energy service companies. There is a fear that large-scale energy mergers will lead to a situation where national monopolies and oligopolies will be replaced by a single market dominated by six or seven mega-utilities (Zarilli, 2003). Venezuela has taken active steps to encourage the development of its energy services sector, and now has a growing energy services sector, dominated by small and medium-sized enterprises (SMEs).

Increasingly, energy services are provided by specialised firms whose services are contracted by the major oil companies that have gradually out-sourced these services, dismantling their corresponding technical departments. These services suppliers must cope with a market characterised by dramatic fluctuations in demand, and be flexible enough to supply a variety of services in different parts of the world (Gibbs, 2003).

According to 1999 figures, six of the world's 25 largest trans-national corporations (TNCs) and two of the 10 largest TNCs from developing countries operate in the energy services industry (especially petroleum exploration, refining and distribution) (Borrero, 2003).

The petroleum and natural gas sectors are dominated by large, vertically integrated multinationals engaged in the extraction, refining and distribution of oil and gas products. Smaller companies provide specialised services to these multinational companies, which contract out most of the services they need to find, develop and deliver oil and gas.

The supply of gas has traditionally been dominated by state-owned vertically integrated utilities, which produced, purchased or imported gas, and stored, transported and delivered it to end-users. The introduction of competition in some countries has altered this pattern, allowing the emergence of independent operators. In liberalised markets, gas transport via pipeline – which remains a natural monopoly – has been separated from the other functions, namely production, wholesale and retail. Regulated third-party access gives any gas producer the ability to transport its product to the end market and any customer the ability to buy gas from any producer or wholesaler. Open access to transport and storage has stimulated the appearance of large numbers of traders.

Only a limited number of developing countries have experience with structural reform in the energy sector; consequently, most countries have not developed those emerging energy services that usually emanate from the breaking up of integrated energy systems and the introduction of competition, especially in the gas and electricity segments (Zarilli, 2003).

Developing country energy producers tend to be major importers of the traditional energy services, such as services related to oil and gas exploration, well and pipeline building, drilling services and derrick erection. The provision of these services, which tend to be increasingly sophisticated and technology-intensive, often goes beyond developing country capacity (Zarilli, 2003).

5.2.2. Trends in Production, Consumption and Trade

According to the projections of the IEA (2004), total primary energy supply will increase by 18% between 2002 and 2010 and by 59% between 2002 and 2030. The main sources of primary energy in the year 2030 will be oil (35%), followed by natural gas (26%) and coal (22%, Table 5-4).

Table 5-4: Future Trends in Total Primary Energy Supply (%)

	2010	**2030**
Oil	35.3	35.4
Gas	23.1	25.8
Coal	22.3	22.1
Nuclear	6.2	4.3
Hydro	2.3	2.2
Other	10.9	10.1
Total (%)	**100**	**100**
Total (Mtoe)	**12,100**	**16,300**

Source: IEA (2004)

The OECD's share of world energy supply is expected to fall further to 44% by 2030, with China (14.3%) and the rest of Asia (14.7%) further increasing their share of world supply (IEA, 2004). The IEA expects growth in the supply of natural gas at the expense of nuclear energy and coal, due to its relative environmental cleanliness as well as technological advances in combined-cycle gas turbines (CCGTs) shifting the economics of power generation in its favour. China and India, which have abundant reserves and growing electricity demand, are expected to contribute to a large proportion of the increase in world coal demand. Nuclear power is expected to peak around 2010, but then decline, as a result of retirement of reactors and safety concerns following the Chernobyl accident. Demand will increase in only a few countries, mostly in Asia. Hydropower's share of the energy mix is expected to decline because most of the best sites have already been exploited, while environmental/social concerns connected with new dams will limit its expansion. Other renewables, such as geothermal, solar, wind, tidal, wave energy, combustible renewables ("biomass"), and waste, are expected to be the fastest growing primary energy source, especially in OECD countries. The IEA projected that nearly 5000 GW of new electricity generating capacity would be installed around the world between 2000 and 2030, with total installed capacity rising from 3397 GW in 1999 to 7157 GW in 2030. The report predicted that more than half of that capacity would be installed in developing countries, particularly in Asia (IEA, 2002). More competitive markets will govern the future development of the power-generation sector. In the OECD and some developing countries, electricity markets are undergoing rapid reform. This is likely to promote economic efficiency and result in prices that reflect the market costs of supply more closely (WTO, 2001).

Most of the projected increase in world primary energy demand will come from developing countries, as a result of rapid economic growth, industrial expansion, population growth and urbanisation. The IEA projects a substantial increase in energy trade over the next 20 years. The expansion will encompass all fossil fuels and electricity, but to different degrees. A particularly sharp increase will take place in trade in oil and gas. The cost and facility with which energy is transported are important determinants of international trade. Gas and electricity, which are largely grid-bound, will require enormous infrastructure outlays before trade can take place. However, the liberalisation of energy markets, which will allow consumers to shop for the cheapest source of electricity, is likely to stimulate both demand and cross-border trade (IEA, 2000).

Despite rising energy demand, the World Energy Council (WEC, 2000) has agreed that energy resources are plentiful and not expected to be a limiting factor in global economic growth.

5.2.3. The Effects of Government Policy on Trade

Historically, governments have intervened in the energy sector through a variety of direct and indirect financial and administrative measures. Regulations, taxes, charges, budgetary transfers, tariffs and quotas have all have a place amongst the measures used. Generally, intervention has been justified on the basis of a variety of policy goals:

- achievement of energy security through maintenance of certain levels of domestic energy production and diversification of sources
- maintenance of certain levels of employment, furtherance of regional development, and guaranteeing minimum access to energy by different income groups (i.e. social concerns)
- avoidance of the inefficiencies associated with leaving the so-called "natural monopolies" of energy production and distribution to unregulated ownership by private entities,
- generation of revenue, and
- environmental protection, which is a more recent concern (WTO, 2001).

Governments have generally subordinated trade policy in this sector to energy security concerns (UNCTAD, 2000).

Market access and national treatment restrictions to trade in energy services are similar to those faced by many service providers and include obstacles to the right of establishment, an inability to provide cross-border services, and discriminatory treatment between foreign and domestic service providers. Furthermore, energy sector regulatory frameworks can often be opaque, discriminatory and arbitrary. Without a regulatory framework that provides a transparent and justifiable basis for fair competition, energy service companies are often at a disadvantage to a favoured competitor. Market access and national treatment commitments, while necessary, are often not sufficient to assure liberalisation of energy services. Regulatory reform and certainty are often also necessary for liberalisation (Cassim and Jackson, 2003).

With few exceptions, the process of internal liberalisation is still at its early stages in those countries where it has begun, while in most countries the energy sector is still dominated by state-owned utilities. The breaking up of the public monopolies and the unbundling of vertically integrated utilities is the first market access issue on the road to multilateral liberalisation in this sector. Liberalisation needs to be accompanied by regulation to ensure it is not nullified by the market power of existing suppliers, especially those who control the transmission and distribution networks. This situation is similar to that of telecommunication services where market access and national treatment commitments have been supplemented by additional commitments on regulatory principles aimed at ensuring some basic conditions of competition in the

liberalised markets (including interconnection to the network for new entrants)(WTO, 1998).

Cross-border trade in energy services encounters market access, national treatment, and other regulatory barriers and restrictive business practices by incumbent operators controlling transmission and distribution networks. Unlike trade in goods, trade in services is defined as including the cross-border movement of the factors of production (capital, mode three and labour, mode four) (WTO, 1998).

Several countries around the world have began the liberalisation process by opening their electricity generation industries to competition and have invited independent power producers (IPPs) to develop capacity in addition to that built by the utilities in place. In some developing countries the entry into the market of foreign owned IPPs was made inevitable by the inability of state owned utilities to finance all of the rapid expansion in power generating capacity needed. However, a lack of local market knowledge has caused some companies to struggle in entering overseas markets, causing financial losses – examples being US companies entering the UK and vice-versa.

IEA (2000b) noted that the energy sector is undergoing market-oriented reform in both OECD and non-OECD countries. In OECD countries, there is a clear trend towards a new organisation of the electricity industry to allow for greater competition between generators (i.e. to move away from vertically integrated utilities), and to allow consumers to choose their own suppliers. Virtually all OECD countries have opened up their electricity markets for big industrial users and, in a number of countries, for households and small companies as well. By 2007, the IEA forecasts that roughly 500 million consumers (and all large industrial users) in the OECD will be entitled to choose their electricity supplier. Several OECD countries have also taken steps towards liberalising their natural gas markets, at least for large industrial users (e.g. power generators). With respect to coal, while subsidy reform is underway, the IEA does not expect total subsidy elimination in the near future. Energy sector reform is also occurring in non-OECD countries, through de-monopolisation of state-owned energy utilities; removal of subsidies, price controls, trade and investment barriers; and privatisation.

5.2.4. Scope and Agenda for Further Liberalisation

New negotiations aimed at achieving a higher level of liberalisation of trade in services were launched in the year 2000 under Article XIX of the General Agreement on Trade in Services (GATS). Few WTO members have made commitments on access to their domestic markets for energy services. However, the process of structural reform of the energy sector in both developed and developing countries has resulted in the externalisation of previously integrated services and the demand for new energy services. Energy services are therefore attracting much attention in the current GATS

negotiations. Negotiating proposals relating to the energy services sector have been submitted by the European Union, the United States, Canada, Norway, Japan, Chile and Venezuela.

The impact of liberalisation commitments on energy services differs between countries. Some energy producing countries have adopted successful polices aimed at developing a strong domestic energy services sector, especially in the upstream segment of the industry (e.g., exploration, extraction, transport) as a stimulus to overall development. Those countries may be looking for export opportunities for their firms through the opening of foreign energy services markets. Other energy-producing countries, which have not yet developed a domestic energy services sector, may be focusing their efforts in making sure that the presence in their territories of foreign firms/suppliers providing energy services will contribute to the development or strengthening of domestic capacities in the sector. Thus negotiations reflect both commercial interests and strategic considerations (Zarilli, 2002).

Most analysts identify four broad drivers for power sector reform internationally. First, there is the desire to improve investment and operational efficiencies that blight the performance of monopoly utilities. Second, technological innovations - particularly in efficient, less capital intensive generation plants and in new information and communication technologies (ICTs) - make it possible to organise the industry so that new entrants can compete more easily. Third, the need for massive new capacity expansion results in increased demands for finance that is not readily available from public sources and forces greater reliance on private sector involvement. In the fourth place, restructuring and privatisation create opportunities to unlock economic value and reduce government debt. Other country-specific drivers - such as ideological commitments to liberalise the economy or simply the need to follow the wave of reform that is sweeping through nearly all power sectors around the world - have also been identified (Cassim and Jackson, 2004).

Much of the focus of proposals for energy services under the GATS has been on upstream services in the oil and gas sector. US policy aims to boost the exploitation of oil and gas reserves in key regions such as the Caribbean, the Middle East and Central Asia, and to promote exports of US energy-related goods and services in these regions (Gibbs, 2003).

Another key area for negotiation is the liberalisation of transmission and distribution networks. Because of the infeasibility of replicating energy networks, especially for electricity and gas, a key issue in liberalisation relates to opening access to existing networks to third party suppliers, thus providing opportunities for cross-border supply of energy. This has featured in GATS proposals by the US and Norway (Gibbs, 2003).

Liberalisation of domestic energy markets, particularly through privatisation and break-up of state-owned utilities, separation of production from transmission and distribution,

and promotion of competition and trade, is in several respects a precursor to the liberalisation of energy services and so the two agendas are linked. The EU has stressed the benefits of this approach at the domestic level, which was agreed in pronciple by all Member States at the Barcelona summit in 2002. However, promoting liberalisation of domestic markets clearly goes well beyond international commitments relating to market access and national treatment and so raises issues about the precise purpose and scope of GATS (Gibbs, 2003).

While many of the main oil producing countries are currently not members of the WTO, several are in the process of accession or in negotiation to join, including Saudi Arabia, Algeria, Iran, Libya, Russia, Kazakhstan and Azerbaijan, as well as developing producers such as Vietnam, Sudan and Yemen. Countries seeking to join the WTO account for nearly 50% of world petroleum exports, and a larger share of reserves, and liberalisation of energy services markets is therefore a key aspect of the accession negotiations (Gibbs, 2003).

The EU has endorsed the concept of a single market for electricity. Traditionally, EU member states have had separate, national energy markets dominated by monopoly suppliers. In December 1996, after eight years of negotiations, Community Directive 96/92 EC was adopted (OJ L 27, 30.1.1997) with the aim of contributing to the three energy policy objectives of the EU, namely increased competitiveness, improved environmental protection and greater security of supplies. The Directive established targets for the progressive liberalisation of energy markets. Despite the liberalisation process, barriers to trade exist and real competition remains limited. It has proved very difficult to combat the market power of former national monopolies and oligopolies, which continue to dominate most local markets. Gaining uncontrolled access, at a competitive price, to transmission and distribution networks remains a problem. However, cross-border takeovers, mergers and joint ventures are occurring in Europe at a very fast pace, more than in any other region, as companies strive to protect their share of national markets and gain share in other member States (Zarilli, 2003).

5.2.5. Expected Impact of Liberalisation on Patterns of Production, Consumption and Trade

The US negotiating position on energy services liberalisation asserts that all countries can be expected to benefit, since energy is a catalyst for economic development and the provision of essential social services. The argument is that opening up markets provides a choice of resources, suppliers, technology, equipment and know-how to a country. Liberalisation of a country's market for energy services does not require it to yield ownership of its underlying energy resources. Open access to transmission networks and competition among generators has resulted in significant price decreases and improved service to customers. The availability of varied sources of energy at reasonable prices is, it is argued, a significant determinant of a nation's ability to compete in the world market place (Ekimoff, 2003).

There are few studies quantifying the impacts of liberalisation of trade in energy services. This is especially because the effects of current trade barriers are very difficult to quantify and model. This is in contrast to energy goods, where liberalisation involves effects which are easier to model, such as tariff removal. For example, a study by Schneider et al (2000) considered the effects on the energy sector through trade liberalisation in the APEC (Asia Pacific Economic Cooperation) region. Production and trade in oil, gas and coal are expected to grow substantially as a result of economic growth and restructuring caused by trade liberalisation, and in response to liberalisation in markets for energy goods themselves.

However, it seems clear that the likely effects of liberalisation of the energy services sector will be to provide new export opportunities for the stronger, more competitive international energy services companies, most of which are based in developed countries. US and EU suppliers in particular are likely to exploit the competitive advantages they have developed in domestic markets to increase their activities in developing countries. The beneficiaries will include multinational energy service companies, as well as smaller companies providing a range of energy related services.

Liberalisation of energy markets will also affect energy prices, influencing energy supply and demand. The effect of increased competition is to reduce energy prices, potentially stimulating energy demand. On the other hand, liberalisation often results in the removal of subsidies, which may have the effect of increasing energy prices. Wälde and Gunst (2003) point to the example of the UK, where liberalisation of the energy services sector has led to increased competition and lower prices. Conversely, liberalisation of the gas market in Argentina in the early 1990s, involving removal of price controls and introduction of competition, actually resulted in an increase in gas prices, because pre-reform prices had been set at artificially low levels (Melly, 2003).

5.3. Environmental Impacts of Energy

The environmental impacts of energy production and consumption are many and varied, and occur at the local, regional and global levels. These impacts vary by energy type. Rather than a comprehensive review of the environmental impacts of energy, this case study provides a broad overview of the main impacts. Because there is a high degree of uncertainty surrounding the effects of liberalisation on the energy sector and hence on the environment, this review focuses on the environmental impacts of energy services in general rather than trade related effects. By reviewing the variety of impacts of the sector, this section helps to identify those effects that have the potential to be either exacerbated or mitigated by trade liberalisation. Section 5.4 then goes on to consider the implications of liberalisation of the energy services sector, and to discuss its potential environmental impacts.

In reviewing the impact of different fossil fuels on the environment it is important to consider the entire "fuel cycle", in other words their effects throughout the different

stages of mining/extraction, production, transportation, distribution, combustion, and disposal. In general, the impact of energy on the environment depends on: (1) the total amount of energy consumed, (2) the specific mix of fuels used (since different environmental problems are linked to different fuels and to their cycles), (3) the efficiency at which primary energy is converted into useful energy, and (4) the technologies in use (e.g. car fuel efficiency).

5.3.1. Climate change/greenhouse gas emissions

The production and use of energy is the largest contributor to greenhouse gas emissions. Burning of fossil fuels in power stations is a major source of CO_2 emissions, with coal and oil producing higher carbon emissions per unit of energy than gas. While coal is the most carbon intensive fossil fuel, oil is responsible for most CO_2 emissions worldwide due its dominant share in world consumption.

Methane is the second most important greenhouse gas after carbon dioxide. The main energy-related sources of man-made methane emissions are from gas transmission and distribution, coal mining and offshore oil and gas production. Natural gas, which is primarily composed of methane, is a much more potent greenhouse gas than carbon dioxide. Moreover, as harnessing gas and transporting it to distant markets requires substantial infrastructure, natural gas flaring and venting takes place in significant amounts in many parts of the developing world to allow for oil exploitation. This wastes a valuable natural resource and contributes to climate change. Coal mining accounted for 11% of the UK's methane emissions in 2000, down from 41% in 1970, with gas leaks accounting for 15% of emissions in 2000. Methane emissions are a major safety concern as well as a greenhouse gas and air quality issue (DTI, 2002).

According to the IEA (2000), OECD countries were responsible for 51% of global CO_2 emissions in 1997, developing countries for 38% and transition economies for 11%. By 2020, developing countries will account for 50%, OECD countries for 40% and transition economies for 10%. Per capita emissions in developed countries, however, will continue to be much higher than in the developing world. Power generation and transportation are the two main sources of CO_2 emissions worldwide, with power generation expected to contribute 4.0 billion tonnes of the 8.7 billion tonne increase in global CO2 emissions expected between 1990 and 2010 (IEA, 2000).

Increased uptake of nuclear and renewable sources of power offers opportunities to reduce carbon emissions, but gives rise to other environmental issues. Wind power is growing rapidly in Europe. Nuclear power remains highly contentious with plants closing in Europe and few countries anticipating further construction, while some experts agree that it will need to be seriously considered as part of a strategy to reduce carbon dioxide emissions (Zarilli, 2003).

5.3.2. Air quality

Energy consumption is the leading source of a variety of air pollutants. For example, in the UK, energy consumption was estimated to account for 96% of nitrogen oxides, 94% of sulphur dioxide, 93% of 1,3-butadiene, 84% of benzene, 94% of carbon monoxide, 71% of lead and 61% of PM10 emissions in 2000, although each of these had fallen significantly since 1990 levels (DTI, 2002). These figures include the use of fuels in vehicles as well as power stations and other industrial uses.

The above pollutants give rise to a variety of impacts on human health and the environment. As well as contributing to local air pollution, emissions of sulphur dioxide (SO_2) and nitrogen oxides are the cause of longer range environmental problems through acid rain, affecting a variety of terrestrial and aquatic ecosystems.

Use of cleaner fuels (especially a switch from coal to gas) and investment in flue gas scrubbing have significantly reduced SOx and NOx emissions in North America and Europe since the 1970s. Less stringent environmental regulations mean that energy systems in developing countries are often more polluting than in Europe and North America.

Leakages in natural gas pipelines can result in the dangerous releases of gas into the atmosphere. Nuclear power stations give rise to radioactive emissions to air, though these are declining in the UK and other developed countries (DTI, 2002).

5.3.3. Land Use/Landscape

Most forms of energy can have negative impacts on landscape and habitats. These may result from:

- Coal mining. Extraction of coal has major impacts on the landscape, with opencast sites having a greater visual impact than deep mines (DTI, 2002).
- Exploration and drilling for gas and oil. In Ecuador, in a recent lawsuit between Texaco and Amazonian Indians, Texaco was alleged to have caused direct damage to 400,000 hectares and indirectly to 1 million hectares of land (Zarilli, 2003). In the US, there is strong opposition to the prospect of drilling for oil in the Arctic National Wildlife Refuge (www.anwr.org).
- Construction of oil and gas pipelines and electricity transmission and distribution networks. Oil pipelines have had considerable impacts on the landscape in Russia and elsewhere. Overhead wires and pylons used in the distribution of electricity can have substantial visual impacts.
- Construction of power stations, oil refineries, and gas storage installations.
- Renewables. Windfarms can have negative impacts on landscape and are facing increasing public opposition in many areas. Hydro-electric dams also have significant landscape impacts and can adversely affect wildlife habitats.

It is, however, also important to note the potential for commercial energy services to reduce pressures on landscape and habitats, e.g. by reducing fuel related deforestation in developing countries.

5.3.4. Soil

Soil impacts include:

- Disturbance of soil through exploration, drilling and extraction of oil, gas and coal;
- Contamination of soil at gas works, coal mines, oil refineries and power stations. When coal mines close, the land can become derelict due to the presence of chemical wastes or the presence of physical hazards such as shafts, holes and tunnels. Major efforts are required to bring this land back into use, such as the UK's National Coalfields Programme (DTI, 2002). Many former gasworks sites and power stations also suffer from contamination.

5.3.5. Water quality and supply

- Water pollution results from a variety of energy related activities, including:
- Coal mining. Water pollution problems arise when water is pumped from working mines or flows from abandoned mines into water supplies.
- Oil spills – high profile oil spills such as the Exxon Valdez disaster in Alaska in 1989 and the Amoco Cadiz accident off France in 1978 have polluted the marine environment and damaged marine ecosystems. More diffuse pollution results from small scale and frequent spillages and discharges into the sea from a variety of extraction and transport activities, which collectively involve large quantities of oil and damage marine life. Pollution also results from accidents at oil and gas installations. For example, an explosion sank a rig in the Roncador field off the North Eastern coast of Rio de Janeiro, Brazil, in 2001, killing 11 people and causing a major escape of oil and gas into the marine environment (Offshore Technology, 2002).
- Leakages of natural gas have been shown to have damaged aquatic ecosystems in a variety of locations such as the Sea of Asov, Sea of Okhotsk, Black Sea, North Sea and coast of California, affecting fish and other organisms (Patin, 1999).
- Nuclear power stations give rise to radioactive discharges to water, though these are declining in the UK and other developed countries (DTI, 2002).

5.3.6. Resource use/waste, including pesticides

Key issues relate to:

- Consumption of non-renewable resources (oil, gas, coal, nuclear)
- The problem of treatment and disposal of nuclear waste, and decommissioning of nuclear power stations.
- Disposal of waste from minerals extraction, particularly in the coal sector, which can have significant landscape impacts.

- Disposal of wastes from oil and gas extraction, such as drilling liquids, interstitial waters and drill cuttings (sludge). Uncontrolled dumping of these wastes can pollute soil and water. In Russia, there have been incidents of illegal dumping in the Sea of Okhotsk from oil drilling operations. In Mexico, a wide range of pollution impacts have been reported in the state of Tabasco as a result of disposal of wastes from extraction of oil, most of which is exported to the US market (Global Exchange, 1996).
- Decomissioning of oil and gas installations. In the UK, public attention was drawn to this issue in 1995, when public controversy led to the abandonment of proposals to dispose of the Brent Spar oil storage and loading buoy to sea, and the facility was eventually recycled. The platform was shown to contain between 71 and 100 tonnes of residual hydrocarbons as well as naturally occurring radioactive material (DTI, 2002).

5.3.7. Biodiversity

Impacts relate to:

- Destruction of habitats through land use change, as identified under Land Use/Landscape above
- The direct effects of pollution, e.g. impacts of oil spills on marine and aquatic life. Birds are particularly badly affected by oil spills, as they have difficulty in distinguishing between oil and water, with the result that their wings can become covered with oil. This can lead to drowning, since they are unable to fly away, or poisoning from attempts to clean their plumage. The impact of the Sea Empress oil tanker running aground off the coast of South Wales in 1996 was estimated to have caused the death of nearly 70,000 birds, as well as damaging shore seaweeds and invertebrates in large quantities and leaving masses of cockles and shellfish stranded (DTI, 2002).
- Indirect effects resulting from pollution and climate change. For example, acid rain has depleted aquatic and terrestrial ecosystems in Europe and North America, while many species and habitats are believed to be at risk from climate change.

5.3.8. Human Health and Noise

Zarilli (2003) argued that the lack of access to commercial energy services is a major factor affecting the health of people in developing countries, who are forced to rely on inferior energy sources such as charcoal, crop residues and cow dung, often in ways that are damaging to human health and the environment. The author argued that "the lack of access to modern and sustainable energy is a major cause of environmental degradation in vast areas of the developing world, and a major impediment to sustainable development. For example, work by the World Bank, has found that the urban areas of China lose some 20 per cent of potential economic output because of the effect on human health of dirty energy use. In India, indoor air pollution from dirty

fuels causes as many as two million premature deaths a year, particularly among women and girls, who do most of the cooking.

Nevertheless, commercial production of energy goods and services also gives rise to a variety of impacts, particularly through combustion of more polluting fuels such as coal. There are also widespread concerns about the health effects of nuclear power, not least following the 1986 Chernobyl disaster, and Russia is prominent amongst the countries that still have high risk nuclear power stations in operation (Bank Information Centre, 2005). Coal mining gives rise to a variety of health problems – such as lung diseases and vibration related problems among workers. In the UK alone, by the middle of May 2002, more than 327,000 people had claimed compensation for these problems and more than £850 million had been paid out by the DTI (DTI, 2002). Mining accidents are a serious hazard in many countries, with substantial numbers of deaths reported in China.

Natural gas leaks can cause death and illness by carbon monoxide poisoning and as a result of accidents through explosions and fires. Contact with electricity can cause death and injury in the workplace and to domestic users. Power stations and wind farms can also have noise impacts.

5.3.9. Distributional impacts

The environmental effects of energy are widespread, occurring throughout the world. While energy use per head is much higher in the developed than the developing countries, environmental impacts are often most severe in countries with least developed environmental regulation and planning laws.

5.4. Analysis of impacts of current/forecast liberalisation proposals

The potential environmental effects of liberalisation in the energy services market need to be viewed against a backdrop of increasing energy supply and demand, especially in developing countries, which will put growing pressure on the environment.

Current negotiations on the liberalisation of energy services are very wide ranging, and could have significant and varied impacts on the environment. Given that the scope and content of negotiations is still under discussion, there is little firm evidence of the likely environmental impacts of liberalisation. Environmental concerns are prominent in the debate and negotiations, but very much at a general level. Proponents of liberalisation identify a range of potential benefits, while opponents emphasise the potential risks of liberalisation for the environment.

The potential environmental benefits of liberalisation include:

- The removal of environmentally damaging subsidies (e.g. for coal use);
- The positive effects of competition on environmental standards, especially where incumbent monopoly suppliers relied on polluting energy sources;

- The enhanced transfer of clean technologies, renewables and environmental services.

The potential environmental risks of liberalisation include:

- Concerns that liberalisation will favour trans-national corporations at the expense of local communities; leading to insensitive or inappropriate decisions
- Concerns that potential GATS rules could restrict the ability of countries to regulate the environmental impacts of the energy sector, including by placing limits on the exploitation of natural resources;
- Concerns that privatisation and deregulation may be followed by under-investment in environmental controls;
- Risks of environmental damage where liberalisation of services leads to longer distance transport of fuels (e.g. natural gas);
- The tendency for liberalisation to lower energy prices by stimulating competition in energy markets. This will tend to increase energy demand and its associated environmental impacts, if not offset by increasing energy taxes or other measures.

As noted above, liberalisation can either increase energy prices (through subsidy removal) or reduce them (through increased competition). Depending on the circumstances, therefore, demand for energy may decline or increase, and there may be positive or negative environmental consequences. The net effect will vary from one country to another, depending on the existing nature and extent of regulation and competition. Wälde and Gunst (2003) argue that, where liberalisation boosts competition and reduces energy prices, this provides an opportunity for higher energy taxes, so that the government can share in the gains from liberalisation.

In the UK, the real price of electricity fell by 24% between 1990 (when privatisation took place and competition was introduced) and 2001, while the price of gas fell by 33% in real terms between 1986 (the year of privatisation) and 2001. Smaller declines in the real price of coal and oil were observed between 1990 and 2001 (DTI, 2002). Liberalisation was clearly a major, but not the sole factor involved. This suggests that significant effects might be expected in other countries which liberalise energy markets in future.

Opponents of the GATS have argued that they are designed to provide trans-national corporations like Enron with the tools they need to take control of much of what remains of the world's '*commons*'. Enron, which lobbied for deregulation of energy markets prior to its demise, was involved in a variety of overseas activities subject to controversy on environmental grounds, including the construction of the Dhabol power plant in India, and pipelines between Chile and Argentina and Mozambique and South Africa. In each case it has been argued that political lobbying in support of Enron conflicted with the interests of the communities affected (CorpWatch, 2001).

Friends of the Earth International (2001) voiced opposition to the continuation of the GATS on the grounds that it has the potential to create adverse environmental and social impacts in a wide range of sectors, including energy services, and that it provides substantial rights to trans-national corporations (including oil and electricity companies) at the expense of sustainable environmental and social policies. FoEI noted that the environmental and social impacts of the sector are wide-ranging and well-known, including: the local environmental impacts of oil exploration and extraction and pipeline construction and transport, including deforestation and toxic contamination; other local environmental impacts from fuel refining operations and electrical power generation; major contributions to climate change; and frequent impacts on indigenous community and human rights.

The report concluded that the expansion of energy service operations will worsen these impacts, and GATS rules will make it increasingly difficult to adopt and enforce environmental and natural resource protection. It argued that GATS disciplines could restrict governments' ability to place new quantitative environmental restrictions on fossil fuel exploration and drilling, extraction, facility construction, and petroleum pipeline construction and operation.

FoEI expressed concern that governments' ability to introduce limits on the following would be inhibited:

- the number of oil rigs constructed in a certain area;
- the length, size or throughput of a pipeline;
- the number of oil refineries or their operations; and
- operations of power plants.

Furthermore, FoEI argued, even in a situation where an electricity deregulation or privatisation scheme was proven to be harmful for environmental or social reasons, it would be extremely difficult - if not impossible - for a government to move away from that scheme. The negotiations on domestic regulation disciplines could also lead to a requirement on governments to ensure that their regulations for energy extraction and production are "no more burdensome than necessary" according to WTO panels. This requirement would force governments to demonstrate that they have adopted a policy that is the least restrictive one available as far as transnational energy operators are concerned. Further, the application of the GATS in electricity distribution could require countries to open markets to cross-border electricity supply and distribution services, even if it involves electricity produced in a manner that causes environmental damage. Finally, it was argued that the GATS will reinforce increased privatisation of essential electricity services and make it more difficult to ensure that access will be equitable. Efforts to ensure equitable and widespread access to electricity, including sustainably produced electricity, could thus be significantly undermined by GATS restrictions.

FOEI called for the WTO to conduct a fully public, comprehensive and meaningful assessment of the past and future impacts of services liberalisation to ensure the GATS does not undermine social and environmental sustainability. The organisation called for national governments to:

- cease the GATS negotiations
- exclude all services related to natural resource extraction or nuclear energy;
- exclude all publicly provided and essential services from GATS disciplines;
- include environmental exceptions for measures relating to the conservation of exhaustible natural resources and explicitly reject any "least trade restrictive" test;
- permit distinctions between different types of energy technologies; and
- ensure that developing countries in particular have the right to protect their environment and social needs, including through special safeguards.

Some NGOs have argued that the liberalisation of energy services in Central, Eastern and South-Eastern Europe has led to the provision of "perverse subsidies" to private investors. It is claimed that, in order to promote rapid liberalisation of energy markets, governments have relaxed regulatory restrictions and offered a variety of financial incentives and preferential trading terms to investors, often perpetuating fossil fuel and nuclear systems and blocking the promotion of new and cleaner forms of energy technology. It is also argued that privatisation, especially when carried out hastily and with a lack of transparency, can exacerbate environmental problems. The independence, mandate and enforcement capabilities of the regulator are key factors in determining potential environmental consequences. NGOs have called for strategic environmental assessment of privatisation projects, especially those that receive funding from international financial institutions such as EBRD (Bank Information Center, 2005).

Some concern about the potential environmental impacts of trade in energy services have been expressed at the WTO's Committee on Trade and the Environment (CTE). At a meeting of the CTE in October 2001, Switzerland requested the WTO Secretariat to conduct a literature survey on the environmental impact of services liberalisation in four sectors, including energy. This request was supported by the EU, Japan, the United States, the Czech Republic, Canada and Norway

Much of the debate about the potential environmental benefits of trade liberalisation in the energy sector has focused on the potential benefits of removing subsidies. For example, Page (1999) argued that subsidies and other encouragement of domestic production in developed countries restrict access by developing countries, and that developed countries would see a clear environmental gain from liberalisation.

WTO (undated) has pointed out that some of its members are of the view that the energy sector presents a potential "win-win-win" situation for environment, trade and development. They argue that existing taxation and subsidy schemes in OECD countries are generally biased and discriminatory vis-à-vis petroleum products. There

are negligible taxes on coal and gas, and, in addition, coal products in many OECD countries are subsidised. It is suggested by these Members that subsidies be removed and that fuel taxation be restructured to reflect carbon content — this would ensure that polluting sources (with higher carbon content) are penalised, not favoured. Other Members consider that the WTO's Committee on Trade and Environment is not the appropriate forum to discuss the impact of measures taken to mitigate climate change, as this is being dealt with adequately in the UNFCCC and the Kyoto Protocol.

WTO (2001) noted that much of the literature argues that subsidy reform and the restructuring of energy taxes are necessary for environmental improvement. Key to sustainable development is to ensure that price and incentive structures reflect the true costs and benefits of production and consumption. By distorting prices, subsidies encourage the inefficient use of energy resources, and discourage energy conservation and the expanded use of renewable sources of energy. Moreover, some encourage obsolete and environmentally inefficient technologies to remain in operation. Subsidy reform is therefore required. While some argue that certain kinds of energy taxes offset the environmentally damaging effects of subsidies when they fall on the very same fuels, much has been written in the literature on the fact that their imposition is no alternative to subsidy reform. This is the case as taxes generally do not fall on the same part of the production/consumption chain as subsidies and do not affect, therefore, the same decisions. In addition to subsidy reform, environmental policy measures such as regulations and economic instruments are required to bring the private benefits associated with energy production and consumption in line with its social costs.

The WTO paper warned that drawing conclusions about "win-win" situations for trade and the environment must be avoided, since the environmental effects of removing trade restrictions and distortions depend on a range of factors, including the response of energy prices, the effect of prices on consumption and the mix of fuels used, and the response of R&D to these developments. There is a danger that one set of problems associated with a particular fuel mix may simply be substituted for another, following trade liberalisation. The paper also argued that while trade policy reform can contribute to environmental improvement, it is not a substitute for environmental policies, which will always be needed.

Furthermore, energy subsidies can sometimes have environmental benefits. For example, UNEP (2001) noted that encouraging the use of oil products can reduce deforestation in developing countries as poor rural and peri-urban households switch from firewood, and that this is a major reason for the maintenance of subsidies to kerosene and LPG in many countries. Public funding of fossil-fuel R&D activities may yield positive environmental effects if it results in development and deployment of more efficient, cleaner burning technologies. Subsidies to support renewables, nuclear power and energy-efficient technologies may help to reduce greenhouse gas emissions. However, Saudi Arabia (2002) in a submission to the WTO's Committee on Trade and

Environment, argued that financial supports for renewables are given at the expense of other energy forms and are discriminatory in nature.

In examining the environmental benefits of removing trade restrictions and distortions, much emphasis has been placed in the literature on CO_2 emissions reductions, because of the importance of climate change. However, it must be remembered that climate change is not the only environmental consequence of energy use, and that some of the local and regional problems that production and consumption may cause can have just as serious a health and an environmental impact as global ones. Nevertheless, WTO (2001) quoted the results of an IEA study that attempted to determine the effects of the removal of all subsidies for energy end-use on CO_2 emissions in eight of the largest energy consuming developing countries. Most of the subsidies in these countries are geared towards consumption. The study predicted that, following subsidy removal, energy consumption would drop by approximately 13% and CO_2 emissions by around 16%, in part due to the removal of heavy subsidies on coal. The study also concluded that, because subsidies distort prices and encourage economically inefficient decisions to be made, economic efficiency gains would be made in all eight countries. Moreover, removal of consumption subsidies leads to reduced overall energy consumption and import demand, improving world energy security.

In a communication to the WTO on energy and the environment, the EU pointed out various potential environmental gains from liberalisation. For example, state controlled energy markets may maintain the use of more polluting fossil fuels, fail to internalise the environmental costs of energy, and promote over-use of energy by maintaining artificially low energy markets. In these cases liberalisation has the potential to bring significant environmental gains. The communication stressed the importance of initiatives under the Kyoto protocol to address climate change impacts (European Communities, 2001).

Van Grasstek (2003) noted the high profile of environmental issues in trade policy in general, and in the energy sector in particular, which is often identified as a leading contributor to such environmental problems as oil spills, global warming and potential nuclear disasters. Debates over energy policy in the United States always entail conflict between those who see ready supplies of low-cost energy as the solution to the energy problem and those who view cheap power as a major cause of environmental woes. This conflict has lately become an important element in the politics of United States trade policy, with Democrats insisting that environmental issues should be "on the table" in trade negotiations and Republicans insisting that these are extraneous considerations that should be dealt with elsewhere.

Canada has argued that further liberalisation of energy services markets could help expand the use of environmentally friendly technologies and increase the transfer of skills (De Menezes, 2003).

The EU's negotiating position on energy services recognises the specific characteristics of the energy sector and the important public policy considerations and regulatory issues they raise. As a result, the EU has not called for deregulation of the sector but argued for the establishment of an appropriately transparent, objective and pro-competitive regulatory framework for this sector, reflecting the need to ensure a balance between trade, liberalisation and the public policy objectives of regulatory measures (European Communities, 2001).

Zarilli (2003) – discussing approaches to liberalisation of energy services in developing countries – argued that a set of "public services" obligations could be attached to ensure that developing countries could obtain benefits they might not be able to effectively negotiate with stronger trading partners, or investors in a bilateral context. The objective would be (a) to "level the playing field"; (b) to link energy and development in a clear manner – including the achievement of public services goals; and (c) to prevent developing countries from competing among themselves to attract investment in the energy sector by lowering their requirements vis-à-vis foreign providers. Such public service obligations could include environmental provisions.

Article 3.2 of the EC Electricity Directive states that "Member States may impose on undertakings operating in the electricity sector, in the general economic interest, public service obligations which may relate to security, including security of supply, regularity, quality and price of supplies and to environmental protection".

The GATS recognises the right of Members to regulate and to introduce new regulations aimed at achieving national policy objectives. Public service obligations aimed at providing reliable access to energy for the population or the protection of the environment are examples of such policies (Butkeviciene, 2003).

Japan's proposal on energy services highlighted the importance of environmental issues, stressing the belief that efforts should be made in all countries to harmonise energy policies with environmental policies in accordance with their national circumstances. Japan argues that countries investing in environmental measures should not in any way be disadvantaged in energy services trade. Member countries should be allowed to adopt regulatory measures which are transparent, competition-neutral and not more burdensome than necessary (Government of Japan, 2003).

5.5. Analysis of potential flanking measures

The discussion above is clearly inconclusive, suggesting that liberalisation could give rise to a range of potential positive and negative effects, and that these are likely to vary by region and national circumstances. However, since the environmental impacts of the energy sector are profound and wide-ranging, any changes in patterns of supply and demand caused by liberalisation of energy markets are clearly of great interest to policy makers. This highlights the important role of targeted environmental measures within liberalised energy markets. However, the concerns expressed by FoEI and

others also emphasise the importance of ensuring that liberalisation of energy services through the GATS is not allowed to reduce the ability of individual governments to address legitimate environmental concerns, by means of regulation and economic instruments. The risk that energy market deregulation could limit the role of environmental regulation argues that environmental considerations need to be kept "on the table" in trade negotiations, as well as being addressed through separate measures.

The discussion raises a series of general concerns as well as potential benefits of energy services liberalisation, rather than suggesting specific concerns relating to environmental problems in particular markets. It follows that any policy response at this stage is likely to be generic and wide-ranging in its nature, and designed to address a variety of potential impacts relating to energy services worldwide.

The following potential responses should be considered:

1. Advocating the integration of environmental considerations into the GATS. There has been some debate within the GATS as to whether environmental concerns should be integrated into the process rather than dealt with through separate instruments. However, the environmental impacts of energy are substantial and wide ranging, while regulatory and economic instruments designed to address them are closely linked to the regulation of energy markets themselves. The potential conflicts between market deregulation and environmental protection measures suggest that the two need to be dealt with in an integrated way. In particular, there is a need to:

- Emphasise the importance within the energy services negotiations of improving the environmental performance of the energy sector, and establish environmental enhancement as a legitimate goal of liberalisation;
- Ensure that rules on liberalisation of energy services do not restrict the ability of individual governments to implement environmental regulations, including restrictions on the exploitation of natural resources and the development of energy infrastructure, and restrictions on particular energy technologies where these are considered environmentally damaging;
- Enable environmental factors to be considered in reform of subsidies and state-owned energy monopolies.
- Insist on a Strategic Environmental Assessment of any energy services proposals under the GATS.

2. Pushing for full and effective implementation of relevant Multilateral Environmental Agreements. The Kyoto Protocol to the Framework Convention on Climate Change (UNFCC) is perhaps the most significant MEA relevant to the impacts of energy services, and allows a variety of responses with implications for trade, but not specifically trade limiting measures. By continuing to show shown strong leadership in advocating international action to combat climate change, the UK can help to address one of the main impacts of expansion of energy use and energy services. Other relevant MEAs to which the EU is a signatory include:

- Convention on Long-range Transboundary Air Pollution (CLRTAP) and associated protocols dealing with different air pollutants.
- The Convention for the Protection of the Marine Environment of the NE Atlantic (OSPAR).
- Agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances (Bonn Agreement).
- Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region (Oil Spills Protocol).
- Convention on the Conservation of the marine fauna and flora of the Antarctic.
- Convention for the protection of the Mediterranean Sea against pollution (Barcelona Convention) and associated protocols dealing with oil pollution and pollution from ships and land based sources.

3. Raising standards among UK energy service companies. The UK has a number of energy service companies with international activities and/or aspirations, operating especially in the oil, gas and electricity markets. These companies are well positioned to benefit from the liberalisation of energy services markets worldwide. The UK can potentially influence the environmental performance of these companies overseas, for example through:

- Voluntary initiatives to promote corporate social responsibility (e.g. CSR guidelines, FTSE 4 Good index), ensuring that these take account of environmental standards for overseas energy services activities;
- Strengthening international guidelines (such as the UN Global Compact, OECD Guidelines on Multinational Enterprises, Extractive Industries Transparency Initiative), and ensuring that these take account of environmental aspects of international energy services;
- Ensuring that guidelines for environmental reporting fully take account of the potential environmental impacts of energy services activities;
- Introducing mandatory reporting of environmental performance by multi-national companies.

4. Economic Instruments. Economic instruments such as taxes and tradable permits can be used to encourage more efficient use of energy by seeking to ensure that energy prices reflect environmental costs. They therefore have an important role to play in addressing the environmental impact of energy use and energy services. By raising energy prices, appropriate economic instruments have a strong potential role to play in offsetting the tendency for liberalisation of energy services markets to reduce energy prices and therefore to encourage increased consumption. Instruments may be introduced at the national level (e.g. national carbon or energy taxes) or internationally (e.g. tradable permits for carbon emissions).

5. National regulations. Many of the environmental impacts of energy and related services are best addressed through national regulations, such as laws governing resource extraction, location of pipelines and power plant, water and air pollution, product standards (e.g. sulphur content of fuels) and prevention of oil spills. In most cases the UK is likely to have limited influence on the development and enforcement of

regulation in other countries, though there will be potential benefits in exchanging experience and assisting in capacity building.

6. International development programmes. Given the important role of energy in economic development, energy systems are often a key component of overseas development programmes. It is important that UK sponsored development projects promote sustainable energy systems and seek to reduce the environmental impact of energy services. The UK can offer technical assistance to developing countries in this respect.

5.6. Conclusions

The supply and consumption of energy has widespread and substantial impacts on the environment. Given that the agenda for liberalisation in the energy services sector is still at an early stage of its development, the environmental effects of liberalisation are still highly uncertain. It is likely that liberalisation will bring a number of environmental risks, while potentially also yielding some environmental benefits.

Given these risks and uncertainties, a priority must be to ensure that the GATS negotiations on energy services take full account of the need to ensure protection of the environment. At the same time, there is a need to continue to advance measures to improve the environmental performance of the energy sector, through appropriate regulation, economic instruments and multilateral environmental agreements. Given the potential benefits that UK companies can gain from energy services liberalisation, the UK should also take steps to enhance the environmental performance of energy service companies in their overseas operations.

5.7. Further Research Needs

This case study has highlighted a range of potential environmental issues arising from liberalisation of energy services, but very little information is available about the specific impacts that might be expected, and potential policy responses. Key priorities for further research are as follows:

- A more detailed analysis of the specific environmental impacts that can be expected from liberalisation of energy services, perhaps with case studies relating to individual countries and sub-sectors. This may not be possible until more details of likely liberalisation proposals emerge.
- Ongoing briefings on the state of play of energy services negotiations, and analysis of the potential to incorporate environmental issues into the GATS.
- Research into the environmental performance of multi-national energy service companies, and potential measures to enhance this.

6. INTERNATIONAL TRANSPORT OF GOODS

6.1. Transport and International Trade

Transport plays an essential role in international trade. Since the transport sector also has major impacts on the environment, transport related environmental impacts of liberalisation are potentially substantial and wide-ranging. However, the broad topic of transport arising from trade liberalisation is unlike the other case studies undertaken in the course of this project. Whereas the case studies on commodities, and those on textiles and energy services, focus on a particular product or service to be traded, transport is a by-product of that trade, rather than something that trade liberalisation is trying to stimulate.

The movement towards trade liberalisation can also affect the transport sector through the direct impact of the liberalisation of transport services, i.e. the removal of trade barriers in different types of transport services, which could affect transport patterns and therefore impact on the environment. These impacts should not be underestimated, as the liberalisation of the transport sector has the potential to affect costs, volumes, modes and distances. In the new Member States of the EU, for example, the trade liberalisation of the road haulage industry has had a significant impact on goods movements and modal shares. Nevertheless, the wider transport impacts of liberalisation are likely to be greater, as they relate to all movements of goods and are closely related to the trade in services. Hence, the latter are the subject of this case study.

In examining the international transport of goods in a European context, it is important to be clear about what the term 'international transport' means. In the discussion that follows, references to international transport generally mean transport between nations, as you would expect. However, when references are made to EU external trade, the figures given relate to transport from one of the EU's 25 Member States to a non-EU country. Hence, transport between Member States has been excluded from the statistics used below.

6.1.1. Trends in international trade

The international freight transport sector directly reflects world flows of imports and exports, in quantity as well as in type of goods transported. According to the WTO's International Trade Statistics 2002, world merchandise exports grew by 83% in value in the 1990s, whereas world production grew only by 27%. In 2001 the main products traded (in value) were machinery and transport equipment (42% of total trade flows), followed by mining (14%) and agriculture (9.4%). Trade flows were concentrated in Western Europe (43% of total trade flows), Asia (26%), and the USA (17%). Latin America accounted for 6% of total trade (Borregard *et al*, 2003).

Economic development in Pacific Asia, and in China in particular, has been the dominant factor behind the growth of international transport in recent years. Since the trading distances involved are often considerable, this has resulted in increasing demands on the maritime shipping industry and on port activities. As its industrial and manufacturing activities develop, China is importing growing quantities of raw materials and energy and exporting growing quantities of manufactured goods. The outcome has been a surge in the demand for international transport. For example, the ports in the Pearl River delta in Guangdong province now handle almost as many containers as all the ports in the United States combined (Rodrigue, 2005).

Road and rail tend to occupy a relatively small role in international freight transport, being primarily modes for national or regional transport services. Surface transport is generally less good for very long distances, and therefore inter-continental trade, although road transport, in particular, is important for NAFTA and the EU, which are the world's two largest trading blocs. For example, a substantial share of the NAFTA trade between Canada, United States and Mexico is supported by trucking, as well as a large share of the Western European trade (Rodrigue, 2005). The sea remains the most important mode for international freight transport, with global seaborne trade totalling 5.9 billion tonnes in 2002 (UNCTAD, 2003).

Table 6-1: Modal Shares of U.S. International Merchandise Trade by Value and Weight: 2001

Mode	Value (%)	Weight (%)
Water	38.4	77.7
Air	27.7	0.4
Truck	21.1	11.0
Rail	4.9	5.9
Pipeline	1.4	4.8
Other and unknown	6.5	0.2
Total, all modes	**100.0**	**100.0**

Source: Bureau of Transportation Statistics (2003)

The importance of seabourne trade can be seen in comparable figures for the world's two largest economies – the US and the EU (see Table 6-1 and Table 6-2, respectively). For both, transport by sea is the most popular modal choice by weight for international freight (77.7% and 38.3%, respectively). The figure for the US is much higher, whereas more international trade travels by road in the EU (29.9% as opposed to 11%

in the US)[2]. These figures are not surprising given the different political natures of North America and Europe. The amount of international trade by weight transported by the other modes is small in both cases, with air transporting less than 1% by weight in both cases. By value, however, trade by air makes up 27.7% of total trade for the US and 15% for the EU, as it moves relatively high value goods compared to other modes. Thus by value, air transport is the second most important mode in international trade for the US and the third most important for the EU. The statistics suggest that for both the US and the EU, relatively low value goods tend to be transported by rail, pipelines[3] and (for the EU) inland waterways, as the proportion of trade by these modes is less by value than it is by weight.

Table 6-2: Modal Shares of EU-25 Exports to non EU-25 countries by Value and Weight: 2003

Mode	Value (%)	Weight (%)
Sea	25.4	38.3
Inland waterways	0.6	5.9
Air	15.0	0.8
Road	38.3	29.9
Rail	3.1	5.4
Pipeline	0.8	5.3
Other and unknown	16.8	14.4
Total, all modes	**100.0**	**100.0**

Source: European Commission DG TREN/Eurostat (2004)

Statistics published by the UK's Department of Transport (2003) show that sea is the dominant freight mode for UK international trade[4], with the weight lifted having increased from 325 million tonnes in 1991 to 419 million tonnes in 2001. The dominance of sea is not surprising given that the UK is an island, and, for the same reason, road transport is not significant. Rail freight – carried via the Channel Tunnel (both through rail traffic and lorries on the Shuttle) – has increased rapidly since the Tunnel opened in 1994 and in 2001 stood at 18 million tonnes. Air transport is still a relatively small proportion of UK international freight lifted by weight, as in 2001 it

[2] The figure for the EU seems high, intuitively, as the first impression would be that external trade by road has to go eastwards, and that it is unlikely that such trade amounts to nearly 40% of all EU trade by value. However, one has to remember that much north-south and south-north trade between EU countries has to pass through non-EU member Switzerland.

[3] It is worth noting that pipelines are a special case, as they are only good for liquids and gases, but are the most efficient means of moving these in high volumes.

[4] The figures include trade to other EU Member States.

amounted to only two million tonnes, although this figure had doubled in the previous ten years. However, this trade has a high value, as about a quarter of UK visible trade in value terms goes by air.

In order to put the growth of freight transport into context, it is useful to identify the extent to which air freight contributes to the overall growth in air traffic. Tables 6.3 and 6.4 compare air transport movements dedicated to passenger and freight for the UK, the EU and the world's busiest 30 airports, respectively. It is striking that cargo aircraft only account for a very small proportion of total aircraft movements – 3% in the UK and 4% in the EU, as well as for the world's busiest airports. Of the extra-EU flights (ie excluding those originating and terminating in the EU), the figure rises to 6%, which is still relatively small. Obtaining historical information for the global and EU levels is difficult, eg comparable data has only been collated at the EU level since 2003 and is still not available for all Member States. However, figures for the UK suggest that the proportion of air movements that are undertaken by cargo flights has declined in the last decade (from 6% in 1996). However, it must be underlined that this does not give a clear picture of trends in freight transport. As can also be seen from Table 6.3, for the UK, only 37% of air freight by weight is carried in cargo aircraft – the remaining 63% being carried in the holds of passenger aircraft. Hence, the increasing number of passenger aircraft movements enables the transport of more freight.

Table 6.3: Air transport movements*, and air freight tonnes lifted, UK, 1996 and 2004

	Air transport movements				Tonnes lifted by type of aircraft			
	Cargo aircraft	Passenger aircraft	Total aircraft	Proportion cargo aircraft movements	In cargo aircraft	In passenger aircraft	Total	Proportion moved in cargo aircraft
1996	102,721	1,582,868	1,685,589	6%	537,211	1,246,151	1,783,362	30%
2004	73,782	2,134,577	2,208,359	3%	878,250	1,492,699	2,370,949	37%
% change	-28%	35%	31%		63%	20%	33%	

Source: CAA, http://www.caa.co.uk/default.aspx?categoryid=80&pagetype=88&sglid=3&fld=2004Annual

* Note: Air transport movements are defined as 'landings or takeoffs of aircraft engaged on the transport of passengers, cargo or mail on commercial terms'.

Table 6.4: Commercial Aircraft Movements: Top 30 world airports, EU

	Passenger aircraft	Cargo aircraft	Total aircraft	Proportion cargo aircraft movements
World's busiest 30 airports, 2004[i]	**12,457,273**	**516,055**	**12,973,328**	**4%**
EU25[ii]	**11,816,323**	**488,935**	**12,305,258**	**4%**
- Intra EU-25	*10,033,353*	*381,739*	*10,415,092*	*4%*
- Extra EU	*1,782,970*	*107,196*	*1,890,166*	*6%*
Proportion of total that is extra-EU	*15%*	*22%*	*15%*	

Source: Personal communications with:

i) Airports Council International (ACI World Headquarters, Geneva, Switzerland) www.aci.aero

ii) Eurostat, excludes Lithuania

6.1.2. Trends in food travel

There is an increasing body of evidence that our food is travelling further, which results in adverse environmental impacts. In 1999, the NGO, Sustain underlined that the UK was becoming less self-sufficient when it comes to food production (Sustain, 1999). Using the Government's own figures, it showed that the proportion of food consumed (by value) in the UK that was grown domestically declined between 1993 and 1998 by 5% to just over 68%. For indigenous types of food the proportion dropped by 3% to 82.3%. Hence more food was being imported.

The most recent government statistics indicates that this trend is increasing (DEFRA, 2005). In 2004, provisional figures suggest that, by value UK self-sufficiency in all food was 63.4%, while the figure was 74.2% for non-indigenous foods. Equivalent figures for the mid-1990s (averaged over 1993 to 1995) were 73.7% and 86.1%, which shows a decrease of 10% and 12%, respectively, over a decade. Smith *et al* (2005) quoted FAO figures to show that UK imports of food by weight have increased by 10% since 1961, although imports of certain products have increased, while those of others have declined. For example, half of all vegetables and 95% of all fruit consumed in the UK came from overseas in 2002, whereas there has been a large decrease in the import of cereals. The report further noted that over half the food imported in 2002 could, in principle, in agronomic terms, have been sourced in the UK at the time it was imported. They thus concluded that an important driver is also supermarkets' preference for dealing with suppliers which can provide large quantities of produce all year around.

Hoskins (1998) highlighted some of these issues with respect to milk, noting that, for example, in 1997, the UK:

- Imported 126 million litres of milk, but exported 270 million tonnes;

- Imported 23,000 tonnes of milk powder, but exported 153,000 tonnes, most of which left the EU;
- Imported 115,000 tonnes of butter, 44% of which came from outside of the EU, but exported 67,000 tonnes, 40% of which left the EU.

It is worth noting that the figures used by DEFRA and FAO (as quoted by Smith et al) measure trade in different units (value and weight) and are therefore likely to be hiding different, more complex trends. The increasing trend in the weight of food imported implies that the quantity of food being imported is rising, although whether this is due simply to increased consumption or more complex trends is difficult to clarify without further investigation. For example, the increase in weight could be partially attributable to increases in the amount of packaging in which food is transported. Similarly, the fact that the DEFRA figures show that the UK is becoming less self-sufficient in terms of value of food consumed is not necessarily that revealing. For example, an increase in consumption of high value processed food could have occurred, while the value of food produced domestically has not changed. Hoskins' figures suggest that food is being exported that could be consumed domestically, but this does not mean that the products concerned are direct substitutes. There are likely to be more complex underlying trends taking place, such as trade in different types of the same commodity.

Smith *et al* estimated that only 3.1% of food miles are due to imports from developing countries, and that 70% of this is food that is non-indigenous to the UK. Further, they suggest that most of these imports will arrive by sea, although a proportion will come by air, which has disproportionately high environmental costs (see below). They also calculated the distances travelled by food in the UK, both within the country and overseas, together with an estimate as to how these have changed over the previous 10 years (see Table 6.5). They concluded that UK-related food transport accounted for 30 billion vehicle kilometres and 234 billion tonne-kilometres in 2002, which takes into account all aspects of the food's journey. The majority of the vehicle-kilometre figure – 83% - was in the UK, while only 21% of the tonne-kilometre figure occurred in the UK, reflecting the larger loads and comparatively longer distances involved in international trade. It is worth noting that around 40% of the vehicle kilometres in the UK takes place in urban areas and is undertaken by light commercial vehicles (12%) and cars (28%), the latter being post-retail kilometrage from the shop to the home.

Table 6.5: Distance travelled by food in the UK (1992 and 2002)

	In UK		Overseas		Total	
	1992	2002	1992	2002	1992	2002
Total tonne km (billion)	**39**	**50**	**164**	**183**	**203**	**234**
Total vehicle km (billion)	**21**	**25**	**6**	**5**	**27**	**30**
Tonne km by HGV (million)	36,278	47,400	26,467	29,471	62,745	76,871
Vehicle km by HGV (million)	5,391	5,812	3,933	3,613	9,325	9,425
Vehicle km by air (million)	0	0	11	27	11	27

Source: Smith et al *(2005)*

They concluded that the distance travelled by food is growing – vehicle-kilometres have increased by 11% since 1992, although interestingly this includes a slight decline in the amount of travel undertaken overseas. They attributed the latter to a trend for the UK to trade more with its northern EU neighbours at the expense of its southern partners. Additionally, tonne kilometres travelled have increased by 15%. However, it should be noted that increases in the distances travelled within the UK are not linked to increasing trade, rather they are associated with, for example, the location decisions taken by supermarkets in relation to the siting of depots and superstores.

While the amount of food tonne-kilometres in HGVs has increased by nearly 23% since 1992, the amount of vehicle-kilometres had not increased as much due to efficiency gains. One further trend worth noting is that while the amount of food vehicle-kilometres travelled by air is still less than 0.1% of the total figure, this has increased by 140% in 10 years and contributes disproportionately to CO_2 emissions (see below). Pretty *et al* (2005) estimated that UK air freight export and imports amount to less than 1 billion tonne-kilometres, and noted that this is relatively small when compared to road freight. Globally, the OECD estimated that the proportion of air freight is still relatively small – at less than 1% in the early 1990s – but even then that it was growing rapidly (OECD, 1997). Although the amount of air freight is still relatively small, the relative environmental impact and costs associated with air travel make the increasing trend a particular concern.

In spite of the fact that food is travelling further, it is worth noting that, by value, trade in food is not growing as fast as trade in other sectors. In 2004, the value of EU international trade, i.e. trade to countries not in the EU, was around €2 billion (see Table 6.6), of which between 5% and 6% was in food, drink and tobacco products. This proportion has declined since 1999 due to much slower growth compared to that for total trade.

Table 6.6: Extra EU-25 trade (1 000 million EUR)

		1999	2000	2001	2002	2003	2004	% growth 1999 - 2004
All trade	**Imports**	**746.62**	**995.98**	**983.75**	**942.21**	**940.81**	**1029.46**	38%
	Exports	**689.43**	**857.78**	**895.84**	**903.55**	**883.05**	**968.21**	40%
Food, drink, tobacco	Imports	50.24	54.64	57.89	58.06	57.08	58.36	16%
	Exports	41.94	48.03	49.86	50.52	49.2	49.05	17%
% FDT* of total	Imports	6.7%	5.5%	5.9%	6.2%	6.1%	5.7%	
	Exports	6.1%	5.6%	5.6%	5.6%	5.6%	5.1%	

* FDT = Food, drink and tobacco

Source: Derived from Eurosat (2005)

6.2. The Impact of Trade Liberalisation on Transport

While a number of different studies have assessed the impacts of trade liberalisation for different commodities and sectors, very little evidence is available of the likely overall effects of liberalisation on world trade. Modelling the overall impact of liberalisation is highly complex because it affects a wide range of different goods and services and takes a variety of different forms, involving the dismantling of a variety of tariff and non-tariff barriers in different countries.

OECD (1997) used an international trade model to simulate the effects of Uruguay Round commitments to reduce trade barriers and trade-distorting measures. The results predicted that, overall, intercontinental sea transport would increase slightly, with the magnitude and direction of changes varying widely by export or import flow, commodity sector and region. A few post-Uruguay Round trade flows even showed relative decreases in international transport. The study predicted:

- A 3-4% overall increase in the global volume of goods traded, and a 4-5% increase in international transport associated with these changes;
- Largest increases in trade volumes occur among previously highly protected sectors (e.g. 9-14% for agriculture and 44-49% for textiles/apparel), but not necessarily matched by proportionate increases in transport, which also varies by sector. Agricultural goods are transported less far, whereas the large increases in trade of textiles/apparel are associated with even greater increases in international transport;

- Manufactured goods in general (with the exception of transport equipment) show above-average increases in trade expansion and are transported relatively even further;
- The continued dominance of heavy, bulk commodities, such as ores, coal and petroleum, in global seaborne trade and their stagnant levels of trade and stagnant or even decreasing distances transported, dampens the total increase in world transport for all commodities;
- Regional differences are evident, with US exports showing the largest growth in transport, and Asia taking imports transported from above world average distances. International transport of agricultural goods from Europe was predicted to fall by 18%, while Japanese agricultural imports were associated with a 37% increase in transport. All OECD countries/regions show significant increases in transport of imports of textiles/apparel (+9% to +120%) and all areas (except Japan and Australia/New Zealand) also show increases in the transport of textiles/apparel exports (+9% to +22%).

However, the study predicted that changes in international transport associated with the implementation of the Uruguay Round commitments would be small compared to those resulting from economic growth for other reasons. This does not imply that environmental concerns stemming from increased freight movements are unfounded, since international trade and freight movements are expected to grow rapidly due to a number of factors other than solely the implementation of Uruguay Round commitments. Macro-economic model projections of growth in transport of internationally traded goods predicted growth of 71% between 1997 and 2004, the year of the full implementation of the Uruguay Round commitments. This is more than 15 times greater than the 4.5% attributable to Uruguay Round liberalisation. Sectoral projections showed much greater rates of growth in international transport for all manufactured goods, including intermediate goods used as inputs into manufacturing, than for agricultural and mineral primary commodities (OECD, 1997).

The results of modelling studies assessing the effects of liberalisation on trade in individual agricultural commodities and in textiles are summarised in other case studies in this and the Stage 1 report. These reach similar general conclusions to the OECD study, indicating that significant increases in trade are expected for textiles and the most protected agricultural commodities, but that in most cases the effects of trade liberalisation itself are outweighed by broader economic trends.

6.3.

6.4. Environmental Impacts of Transport

The environmental impacts of transport can be broadly classified into those associated with the vehicle (including its movement) and those linked to the infrastructure. A

qualitative overview of the principal environmental impacts of transport associated with freight is given in Table 6.7.

The scale of environmental impacts can differ significantly by mode, as is shown in Table 6.8 for a range of air pollutants. The wide ranges for emission levels reflect the fact that the emissions from vehicles in the more strictly regulated OECD countries will be significantly less than some vehicles used in the rest of the world (see Table 6.8). However, they do illustrate that road transport is significantly more polluting per tonne-kilometre than either rail or sea, though for regulated pollutants the gap is narrowing. Unfortunately, comparable emissions from aviation are not given.

Table 6.7: Overview of the principal environmental impacts of transport associated with trade

Environmental impact	Mode of transport					
	Sea	Road	Air	Inland waterways	Rail	Pipeline
	Impacts associated with the vehicle					
Local pollution	Combustion of fossil fuels leads to emission of pollutants* that adversely effect air quality, particularly near ports	Combustion of fossil fuels leads to emission of pollutants* that adversely effect air quality, particularly in urban areas	Combustion of fossil fuels leads to emission of pollutants* that adversely effect air quality, particularly near airports	Combustion of fossil fuels leads to emission of pollutants* that adversely effect air quality, particularly near ports	Where fossil fuels are used, pollutants* are emitted that adversely effect air quality; where electricity is used, emission of pollutants at power stations impact in the same way	N/a
Climate change	The combustion of fossil fuels leads to the emission of carbon dioxide that contributes to climate change	The combustion of fossil fuels leads to the emission of carbon dioxide that contributes to climate change	The combustion of fossil fuels leads to the emission of carbon dioxide that contributes to climate change; high altitude emissions of other pollutants also have an impact	The combustion of fossil fuels leads to the emission of carbon dioxide that contributes to climate change	The combustion of fossil fuels leads to the emission of carbon dioxide, either from the vehicle or from the power station, that contribute to climate change	N/a
Noise	Relatively low level of noise impact	Resulting from the use of lorries; principally a problem where there are residences/work places near roads used by lorries	Resulting from aircraft taking off; principally a problem near airports	Relatively low level of noise impact	Resulting from the use of trains; principally a problem where there are residences/work places near railways used and fright depots	N/a
Waste	All vehicles have to be constructed, maintained during their useful operation and disposed of at the end of their useful life – all of which produces different types and amounts of waste that needs to be disposed of					N/a

Water pollution	Caused by release and accidental spillage of (waste) substances into the sea	Caused by run-off from roads and leakages	Caused by run-off from runways and leakages	Caused by release and accidental spillage of (waste) substances into inland waterways	Caused by accidental spillages.	N/a
	Impacts associated with infrastructure					
Habitat loss	Caused by the take and use of land near the sea for ports, which can impact on marine wildlife	Caused by the take and use of land for roads, which can impact on wildlife	Caused by the take and use of land for airports	Caused by the take and use of land for inland ports, which can impact on wildlife	Caused by the take and use of land for railways, which can impact on wildlife	Caused by the take and use of land

* Including carbon monoxide, oxides of nitrogen, volatile organic compounds, particulates and, when dirtier fuel is used, sulphur dioxide

Table 6.8: Ranges of air emission rates for trucks, trains and ships (grams per tonne-kilometre)

Pollutant	Truck	Train	Ship
CO	0.25 – 2.40	0.02 – 0.15	0.018 – 0.02
CO_2	127.00 – 451.00	41.00 – 102.00	30.00 – 40.00
HC	0.30 – 1.57	0.01 – 0.07	0.04 – 0.08
NO_x	1.85 – 5.65	0.20 – 1.01	0.26 – 0.58
SO_2	0.10 – 0.43	0.07 – 0.18	0.02 – 0.05
Particulates	0.04 – 0.90	0.01 – 0.08	0.02 – 0.04
VOCs	1.10	0.08	0.04 – 0.10

Source: OECD (1997)

In relation to the food sector, Smith *et al* estimated the pollution caused by the transport of food to and within the UK (see Table 6.9). The relative reduction in emissions in the UK compared to emissions overseas since 1992 is notable, particularly when one considers that the number of vehicle kilometres in the UK has increased whereas overseas it has decreased (see Table 6.5, above). This reflects the impact of the relatively stricter emission standards in the UK that have led to, on average, a relatively larger emissions reduction than overseas, even though emissions of most pollutants have declined overseas, as well. The one exception is CO_2, the emissions of which have increased domestically and overseas. The report estimated that food transport, including the transport undertaken after it has been purchased, is responsible for 19 million tonnes of CO_2 emissions, which is equivalent to 1.8% of the UK's annual CO_2 emissions and 8.7% of its transport CO_2 emissions. Even though air and sea travel make up a negligible proportion of food vehicle-kilometres, Smith et al concluded that these modes contribute 11% and 12%, respectively, of the CO_2 emissions that are associated with UK food transport.

Table 6.9: Pollutants emitted in the UK and overseas as a result of UK food transport (1992 and 2002)

Pollutant	In UK		Overseas		Total	
	1992	2002	1992	2002	1992	2002
Total CO_2 emissions (million tonnes)	8.9	9.7	7.9	9.2	16.9	19.1
Total PM_{10} emissions (thousand tonnes)	5.6	2.5	3.8	2.8	9.5	5.3
Total NO_x emissions (thousand tonnes)	105	72	101	85	206	158
Total SO_2 emissions (thousand tonnes)	9	0	43	41	51	41

Source: Smith et al *(2005)*

A qualitative overview of the way in which vehicle emission and fuel quality standards vary in different regions of the world is given in Table 6.10. While clearly the table is a generalisation, it gives an idea of how and why vehicle and fuel quality standards differ in different parts of the world. Generally speaking, stricter emission and fuel quality standards are applied in developed countries than in developing countries, and to modes that are used more in urban areas than elsewhere. Hence, ships, even though they are relatively fuel-efficient and can carry vast quantities of produce, tend to be subject to less stringent standards with regard to the technology and fuel that they employ. Lorries, on the other hand, are relatively more strictly regulated, but much smaller and therefore not as efficient. Emission and fuel quality standards for rail transport are somewhere between the two.

Table 6.10: Characterising emissions and fuel quality standards by region

	EU/US, Canada, Japan	Industrialising world, eg China	Least developed world, eg sub-Saharan Africa
Road	Relatively strict emission and fuel quality standards	Introducing stricter emission standards, although lagging behind those of the EU and US	Less strict standards – often imported second hand vehicles from the developed world; exacerbated by poor fuel quality and low levels of maintenance
Rail	Standards generally not as strict as those for road, although minimal standards exist	Standards generally not as high as those in the US/EU; vehicles likely to be older	
Air transport	Emission standards for 'landing and take off' cycle; oldest planes excluded from the EU	As global market place and regulated by ICAO, emission standards are similar to those for EU/US; more use of older, more polluting aircraft, however	
Inland waterways	Some limitations on emissions and attention to fuel quality	Emission standards likely to be less strict than those of EU/US; likely to be more use of older vehicles; exacerbated by poor fuel quality and low levels of maintenance	
Sea	Some limitations on emissions; regulations on fuel quality used in certain areas	Emission standards likely to be less strict than those of EU/US; likely to be more use of older vehicles; exacerbated by poor fuel quality and low levels of maintenance	

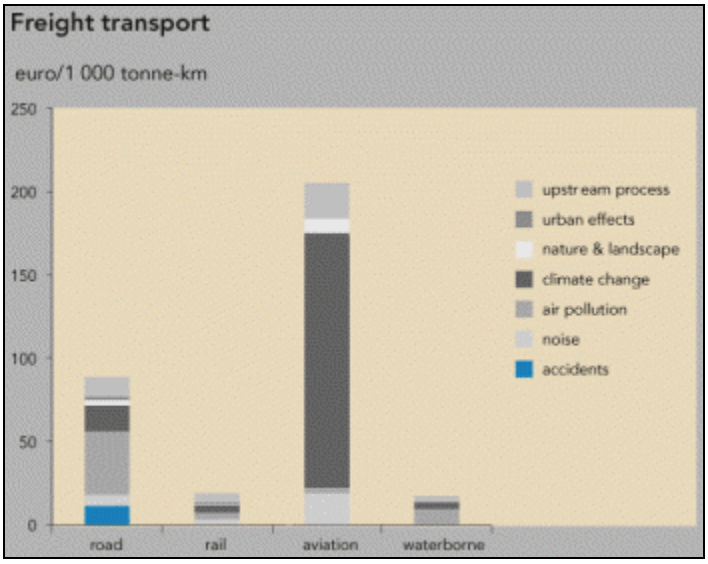
Calculating the external costs of transport has been undertaken at a number of different levels by various authors (eg Peirson *et al*, 1995; Maddison *et al*, 1996). A 2000 study by INFRAS/IWW estimated the average external costs for transport in Western Europe for 1995, the figures from which are still utilised by the European Environment Agency suggesting that no more comprehensive study for the EU may subsequently have been released. The study calculated the external costs (excluding congestion) for passenger transport and for freight separately and concluded for the latter that the external costs of aviation, measured in Euros per tonne-kilometre, were significantly more than those for road. In turn, the average external costs for road transport are significantly greater than those for rail and waterborne freight (see Figure 6-1).

Smith *et al* (2005) calculated that the social costs associated with the transport of food in the UK amounted to £9 billion of which only around £1 billion relates to

environmental impacts – climate change, air quality and noise – with the rest resulting from congestion, accidents and infrastructure damage.

It is important to note that the debate about food miles brings in factors other than transport impacts, and embraces a variety of environmental, social and economic concerns. A variety of factors are stimulating interest in local food, including the desire to re-connect food producers and consumers (and hence raise awareness about food production systems), and issues of traceability, food quality (arising from concerns about the impact of transport times and distances on freshness and flavour), and cultural factors (including the role of food producers in society and the customs relating to seasonality of produce). In this sense, the impacts of food trade are to some extent distinct from issues relating to trade in other products.

Figure 6-1: Average external costs for freight transport for western Europe (1995)



Source: INFRAS/IWW (2000), figure sourced from EEA (2005)

6.5. The Environmental Impact of Transport resulting from Trade Liberalisation

Even though the transport impacts of liberalisation are wide ranging, and cut across all sectors, there is surprisingly little literature on the issue. While the environmental and other sustainability implications of trade are increasingly being recognised as a problem, the impacts on transport are dealt with in a far from comprehensive manner. For example, UNEP has published a handbook on environment and trade but it only makes a passing reference to the impacts of trade on increasing transport, principally in the context of the transport of hazardous goods (UNEP/IISD, 2000). While it does note that transport has adverse environmental impacts, it falls back on the traditional economic explanation for this that this is the result of a lack of internalisation of external (social) costs, so that those who use transport do not pay the full cost of its use.

UNEP has also undertaken a series of case studies on trade liberalisation and its impact on the environment, one of which looked at the impact on the transport sector in India as a result of trade liberalisation (UNEP, 1999). The starting point of the relevant case study was that increased air pollution was occurring as a result of liberalisation, however, the policy recommendations to remedy the problems were all end-of-pipe measures, as they proposed that pollution reduction measures needed to be taken to address emissions from new and existing vehicles. This was probably an appropriate conclusion for a country like India, where dramatic gains could probably be made through the application of end-of-pipe measures, but the conclusion would not apply in Europe. Similarly, the Strategic Impact Assessment (SIA), of the current WTO negotiations, undertaken on behalf of the European Commission, which included agriculture as a case study, does not address transport in great detail. Rather it notes that increased trade will lead to increased transport and that this is likely to increase the adverse environmental impact of transport, particularly when this additional transport is undertaken by road or air (Kirkpatrick and George, 2005). However, no more detailed analysis was given.

Evidence suggests that trade liberalisation can be expected to lead to increased movement of goods, but that the marginal impact of liberalisation itself is likely to be relatively small compared to the effects of wider economic forces. Increased trade movements are likely to increase pressure on the environment, relative to a non-liberalisation scenario. However, trends in the overall environmental impact of international freight transport will depend on other factors, such as the efficiency of fuel use, the development and application of technology to reduce atmospheric emissions, and the liberalisation of the transport services sector itself.

OECD (1997) concluded that trade liberalisation could be expected to lead to an increase in overall transport volumes, with the Uruguay round expected to bring a 4-5% increase in intercontinental transport flows. This would be expected to increase the environmental impacts of freight transport, especially since much of the increase would be accounted for by road movements by heavy goods vehicles. However, the paper estimated that intercontinental freight flows (measured in tonne-kilometres) would increase by 70% even in the absence of liberalisation, such that the increased impact of liberalisation would be only one fifteenth of that caused by wider economic factors. The OECD also considered the effect of liberalisation in the transport services sector, with reference to North America and the EU. While liberalisation was found to bring economic benefits in both cases, the environmental effects were found to be rather different. In North America, liberalisation of road and rail transport has been accompanied by increased transport efficiency, new technological development and new investments in rail freight infrastructure. The result has been an increase in the share of freight carried by rail and a reduction in energy consumption. In the EU, however, where liberalisation of road freight preceded that of other sectors, there has been a

substantial increase in road freight and associated environmental impacts, particularly in certain ecologically sensitive road corridors, such as those in the Alps.

Ang-Olson and Cowart (undated) examined the current and future impact of trade liberalisation on air quality in key North American transport corridors as a result of trade liberalisation under NAFTA. The analysis focused on five specific bi-national corridor segments: Vancouver-Seattle, Winnipeg-Fargo, Toronto-Detroit, San Antonio-Monterrey and Tucson-Hermosillo. For each segment, commodity-flow and ground freight traffic volumes (truck and rail) were used to develop a sketch-level estimate of current air pollution emissions associated with cross-border trade. Cross-border freight was found to be responsible for 3% to 11% of all mobile source NOx emissions and 5% to 16% of all mobile source PM-10 emissions in the corridor regions. Trade forecasts to 2020 were used to develop a sketch-level estimate of future trade-related emissions. CO_2 emissions from cross-border trade were predicted to increase by 2.4 to 4 times over their current levels in the five corridors. However, due to expected improvement in criteria pollutant emission controls for trucks and locomotives, total trade-related emissions of NO_x and PM_{10} in 2020 were expected to decline or remain constant compared to current levels, despite trade volumes that grow by two to four times. The paper also discussed the impact of six emission mitigation strategies: alternative fuels for heavy trucks, reducing border delay, low sulphur diesel and use of advanced emission controls for trucks in Mexico, reducing empty freight mileage, expanded use of longer combination vehicles, and use of advanced emission controls for locomotives. All of these strategies were expected to reduce certain pollutants in certain areas, with the greatest improvements expected from measures to introduce low sulphur diesel and advanced control technologies for Mexican trucks and locomotives.

The case studies of agricultural commodities in the report of stage 1 of this study suggested that liberalisation would impact significantly on patterns of trade in the more heavily protected agricultural commodities such as sugar, dairy products and cotton. However, studies suggest that there is likely to be little overall change in trade volumes, but a substantial shift in the market share of different exporting and importing countries, with, in general, Brazil, Argentina, Australia and New Zealand increasing exports and the US and EU reducing them. The environmental effects of these changes are difficult to predict and depend on the overall distances traveled as well as the transport modes and technologies employed.

Table 6.11 attempts to provide an overview of the potential impacts on transport if trade in goods with different characteristics were liberalised. For this purpose, we have characterised goods by whether they are high value and time critical. Additionally, the transport/environment impact will depend on whether increased inter- or intra-continental trade flows result from such liberalisation, but which of these occurs for a particular sector will depend on the conditions and circumstances of that sector.

Broadly speaking, if trade results in the liberalisation of sectors of high value and/or time critical goods accompanied by more intra-continental travel, e.g. fresh flowers and vegetables, then more air travel can be expected, along with the associated, relatively high environmental impact. On the other hand, if liberalisation leads to an increase in intra-continental trade, then more road-based freight is likely to occur, particularly over shorter distances. Of course, in such an event and for some products, rail could be a competitor to road transport for the majority of the length of the journey, if not the local collection and distribution. If trade liberalisation were to result in increased trade in low value goods, such as ores, the delivery of which was not time critical, then more shipping by sea or inland waterways, where possible, is likely to occur.

Table 6.11: Potential impact of trade liberalisation

Type of goods liberalised	**Impact on trade**			
	More intra-continental flows		More inter-continental flows	
High value, time critical, eg fresh flowers and vegetables	Possible increases in road freight for shorter distances and air travel over longer distances	Environmental impact: Medium/high	Increase in air travel	Environmental impact: High
Low value, time critical, eg Just in time in industrial components	Possible increases in road freight for shorter distances and air travel over longer distances	Environmental impact: Medium/high	Increase in air travel	Environmental impact: High
High value, not time critical, eg diamonds	Possible increases in road freight for shorter distances and air travel over longer distances	Environmental impact: Medium/high	Increase in air travel	Environmental impact: High
Low value, not time critical, eg coal	Increases in use of railways, inland waterways and short sea shipping, plus pipelines, where relevant	Environmental impact: Low/medium	Increase in sea transport	Environmental impact: Low

Evidence of the effect of liberalisation on different types of products and different modes of transport is limited. However, available evidence suggests that the greatest impacts will occur on the most protected market sectors, especially textiles and the more heavily protected agricultural commodities (e.g. sugar, cotton and dairy products). Most of these commodities tend to be transported in bulk by sea and/or road, which have relatively lower environmental impacts than air transport.

However, the OECD study also predicted above average expansion of trade in manufactured goods, over longer average distances, as a result of liberalisation. Particularly where high value manufactured goods are involved, this can be expected to increase further the demand for air freight and its environmental impacts.

In contrast, liberalisation is expected to have less impact on some heavy, bulk commodities such as ores and petroleum, typically transported by sea. However, irrespective of the effects of liberalisation itself, trade in natural resources is increasing as a result of increased demand from China and the rest of Asia.

Both Smith *et al* (2005) and Garnett (2003) noted that the best environmental option might not necessarily be the one that reduces the amount of transport. At one level, this is because of the differing environmental impacts of the potential modes used, as noted in Table 6.7 and Table 6.8, above. However, the consideration is in fact broader than this. For example, a case study in Smith et al suggested that it was better in terms of the energy balance and CO_2 and other emissions to import tomatoes from Spain, rather than grow them in the UK under artificial conditions. Assuming this is correct, they still noted that a broader analysis of other sustainability criteria, e.g. water use, might lead to another conclusion.

6.6. Analysis of Potential Flanking Measures

Before identifying possible policy measures to address the potentially adverse impacts of trade liberalisation on the transport sector, it is interesting to review the factors that other authors have identified as underlying the increase in international trade.

In relation to the transport of UK food, Smith *et al* (2005) identified three factors that are contributing to food travelling further: an increase in trade; trends in transport logistics and retail operations; and the increased use of cars for food shopping. They suggested that factors that have led to the increase in the amount of trade include cheaper and easier long-distance transport, a higher demand for overseas produce and the globalisation and concentration of supply and retail structures. Garnett (2003) suggested four factors similar to those identified by Smith *et al* that underlie an increase in the distance travelled by food: shops; shoppers; the global supply chain and international and national institutions. In the final category, she noted the influence of freer trade resulting from the actions of the WTO and its predecessors. In addition to freer trade, the desire of countries to attract inward investment also enables value to be added cheaply to products in third countries, e.g. chicken processing in Thailand and Brazil and vegetable preparation in Kenya.

Simms (2000) noted that the long-distance international travel by both sea and air is effectively subsidised, as it is exempt from taxes, such as those to which road transport is usually subject. Hence, international freight travel does not cover its external social

costs, and therefore, according to economic theory, there is likely to be too much of such travel being undertaken in relation to what would be economically efficient.

Policy options for reducing the environmental impacts of transport resulting from trade, let alone trade liberalisation, need to be appropriately targeted. Smith *et al* (2005) note a number of possible policy options, focussing mainly on the food sector. These include:

- Sourcing more food locally, where appropriate, through, for example, consumer awareness, procurement policies and support for locally-produced food;
- Reducing car food shopping, through better access to shops for non-car modes, more home delivery, and land use policies;
- Reducing the environmental impact of transport, eg improved logistics, cleaner vehicles, more use of rail;
- Internalising the social costs of transport; and
- Improving the sustainability of the food chain, eg more ethical trading and improved energy efficiency.

Simms and Garnett also suggest increased local sourcing, and actions to promote it, should be part of the solution. How such policies might sit with international trade law is not explored. The food sector has a particularly high public profile and the chances of individual carry more weight than in many other sectors, but some of the potential flanking measures will be similar.

Reducing the environmental impact of transport vehicles is an ongoing priority for policy with or without liberalisation, as can be witnessed in the EU with the imposition of continually more stringent vehicle standards for road and now rail. Strict vehicle standards already exist in other OECD nations, and are being introduced in developing countries, e.g. China. However, as noted in Table 6.11, in the poorest developing countries, emission standards for vehicles are rarely strict, and even if they are, they are unlikely to be enforced. Another gap is the relative lack of regulatory attention paid to date to emission standards for vehicles travelling internationally. The quality of the fuel used, notably by international shipping, is also a problem.

As noted in the previous section, for some freight journeys rail transport is a potential competitor to road transport. As the former is, or at least has the potential to be, more environmentally-friendly, then policy promoting the transfer of long-distance freight from road to rail, where possible, would also improve the environmental performance of trade.

Arguably, the most glaring policy gap for international travel is the absence of taxes on fuel. The UNEP trade and the environment manual notes that the lack of external cost pricing for transport leads to adverse environmental impacts. The absence of

comparative taxes on fuel used internationally, particularly when compared to fuel used locally on the roads, arguably leads to economically inefficient and environmentally damaging international transport and trade.

In summary, therefore, the principal flanking measures to deal with the environmental impacts of trade liberalisation (and indeed, of trade in general) are:

1. Economic instruments. Fuel taxes have the ability to "internalise" the environmental costs of freight transport, and hence lead to patterns of trade that are more economically efficient and environmentally benign. The most urgent action is required in the air transport sector, since aviation fuel is currently untaxed. Given the difficulty and questionable effectiveness of unilateral action, there is a need for the UK Government to continue to argue for international agreement on the taxation of aviation fuel. Failing that, the Government should push for an agreement at the European level to ensure that the price of air transport reflects its external costs, this needs to include flights originating from outside of the EU. There are various ways to do this, with both taxation and emissions trading systems offering possible routes.

2. Regulation. Regulation will continue to have an important role at the European and national levels, to limit emissions from vehicles and to control the impacts of transport infrastructure. It is also important in relation to particular environmental problems (e.g. pollution from shipping, prevention of tanker accidents etc). The UK should, therefore, continue to press for stricter vehicle emission standards to be introduced at the European and international levels. Of particular importance would be stricter international standards for aircraft and ships, given the fact that road and rail transport are relatively well regulated at the European (and therefore national) level. The UK also has a role in promoting awareness of environmental impacts and in provision of advice and technical assistance to other countries (e.g. as part of development programmes).

3. Consumer Awareness and Product Labelling. Even though only a small proportion of EU external trade is food, drink and tobacco, in terms of volume this still amounts to a significant amount of trade and therefore should not be neglected for the purposes of policy. "Country of origin" labelling, therefore, has the potential to play an important role in raising awareness of the potential environmental impacts of trade, especially if supported by consumer awareness programmes, e.g. to raise awareness of the environmental impacts of food miles. This could be tackled through joint initiatives with food retailers and processors.

4. Transport Services Negotiations. As well as the wider impacts of trade liberalisation on the transport sector, the liberalisation of the transport services

sector (currently under negotiation through the GATS) also has the potential to have significant environmental effects. As with energy services, environmental factors need to be closely integrated into the negotiating process.

6.7. Conclusions

Transport plays a vital role in international trade, and this in turn has a substantial impact on the environment. Although some of the environmental impacts of transport are being lessened by cleaner technologies, continuing growth in trade volumes is placing an increasing burden on the environment, with greenhouse gas emissions giving particular cause for concern. Evidence of the likely effects of trade liberalisation on transport movements is sparse, but suggests that liberalisation will tend to exacerbate these impacts, although the impact is expected to be relatively small compared to existing trends.

The increasing impacts of trade-related transport on the environment call for further action by policy-makers, which is likely to include the development of economic instruments, regulatory measures and consumer awareness programmes. The evidence of the case study suggests that these measures should relate to the impacts of trade in general, rather than trade liberalisation in particular. However, negotiations relating to the liberalisation of transport services themselves also have the potential to impact on the environment, suggesting a need to incorporate environmental considerations into the GATS negotiations.

6.8. Further Research Needs

This case study has highlighted surprisingly large gaps in the evidence available about the effects of trade, let alone trade liberalisation, on transport and the environment. In particular there is a need for further studies to predict the effects of trade liberalisation on transport movements. These might include multi-sectoral modelling studies, such as that undertaken by the OECD, or wider reviews of the trade liberalisation literature, identifying the implications of different sectoral studies for likely transport movements. Additionally, there is clearly a need to give greater consideration to the impacts on transport of broader sustainability impact assessments of trade, such as that recently undertaken for the European Commission.

Further evidence about the environmental effects of trade would also be valuable, including studies examining the environmental impacts of different products, countries and transport modes. Much has been written on the food miles issue, but there would be benefits in further work to assess its significance in the wider trade policy context, while recognising that food miles give rise to distinct issues of their own, as well as being of concern from a transport perspective.

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