GtripleC

Implications for climate change policy of trends in exports and imports of energy commodities and manufactured goods

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EXECUTIVE SUMMARY

The policy context

A number of formal and informal policy processes are underway to explore the issue of 'where to next' for the international climate change regime post-2012. Currently these are informed by data based mainly on production statistics only. A key purpose of this study and report is to raise issues associated with trade in energy commodities and manufactured goods, in order to ensure that important perspectives which can be discerned from considering this 'consumption side' are not overlooked.

A number of previous studies and papers have explored issues regarding embodied greenhouse gas emissions in traded energy commodities and manufactured goods. This study draws out key messages from these. It also expands on the existing literature by covering some non-CO_2 greenhouse gas emissions, and also by considering traded renewables-based commodities. This work is *not* intended to be a comprehensive resource of quantitative data. Rather, examples of data are selected to help articulate and elaborate key issues.

The policy issue

In a world where the cost of carbon was fully reflected in the market price of all energy commodities and manufactured goods, *transferred benefits and avoided costs* occurring as a result of international trade should not go uncompensated. The cost of upstream emissions embodied in traded energy commodities or manufactured goods would be internalised in the cost of such items, i.e. the cost would be passed through to the importer, rather than being potentially an uncompensated cost to the producer. The price of electricity in a given importer-side market would include the cost of carbon of the most greenhouse gas (GHG) intensive generation in the mix. Renewables-based (zero emissions) generation would see this carbon value as a realisable economic 'rent', as would any less-GHG intensive generation to a degree. This would provide incentives for existing renewables and for increases in the supply of renewables.

But the real world is still far from reflecting this idealised market model. While the Kyoto Protocol, in particular its market-based mechanisms, will lead to the internalising of a 'cost of carbon' to some degree, the coverage across countries and sectors is only very partial. This reflects not only the coverage of the international agreement itself (including the difference in treatment of industrialised and developing countries and the fact that some countries have not ratified the Protocol), but also the differences in countries' domestic policies and measures addressing energy as well as climate change.

A key objective of this study, then, is to identify, qualify, and where possible quantify, the nature and scale of significant instances where *transferred benefits and avoided costs* occur – and the extent to which the exporter is likely to be compensated in the absence of policies intended for this purpose. A transparent articulation of this issue and information is expected to usefully inform the development of ideas about responsibility sharing within a future, more-encompassing international climate change regime.

What matters most are **trends** in emissions data. A negotiation process that incorporates the possibility of differentiation provides ample room to adjust responsibilities so as to account for different circumstances. But it will be extremely important to understand the circumstances that are likely to prevail.

Key data and insights

Overall, OECD countries are major net importers of energy commodities, but some OECD countries are major exporters. These trade differentials are generally increasing with time. Moreover, embodied emissions associated with fossil-based energy trade are considerable. Embodied emissions in traded goods are also significant and increasing. This is not surprising, given global trade liberalisation.

Both of these trends are of particular relevance to any exporters who will bear responsibility for these emissions. They are also important to importing countries, which need to understand how these trade trends might contribute to reduced domestic emissions. A key message, then, is that it is feasible to address the underlying policy issue in the responsibility sharing phase of a multilateral climate change negotiation. But this will require good data (including projections) for the key countries concerned, which generally is not readily available at this time.

A key OECD study for embodied emissions in manufactured goods looked at detailed trade figures for a subset of key importing OECD countries for which input-output trade data was available. This group of countries is responsible for over 80% of global GDP and CO_2 emissions. One could expect that a more detailed and up-to-date analysis would reveal additional significant trends of embodied emissions in traded goods, including cases where the importers are developing countries, e.g. rapidly developing countries in Asia. Moreover, it is already clear that some of the key exporters of embodied emissions are developed countries (exporting to other developed countries).

The issue is not simply one of benefits to developed countries and possible disbenefits to developing countries. There is a much more complex mosaic.

Importantly, both sides of the ‘ledger’ need to be looked at. A country can be a significant importer from one or some exporters, while at the same time being a significant exporter to other countries, and a net exporter overall. Making value judgements about the embodied emissions import-export balance for a given country requires an understanding of what national circumstances may be at play.

This work has also shown that there is currently no international carbon market mechanism that provides an incentive for the production in developing countries of renewables-based energy commodities (e.g. electricity or biofuels) for consumption by industrialised countries. A possible mechanism is outlined in an appendix.

SECTION 1. INTRODUCTION AND CONTEXT

A number of previous studies and papers have explored issues regarding embodied[1] greenhouse gas emissions in traded energy commodities and manufactured goods. Appendix A lists the main studies researched in the preparation of this report.

The most substantive quantitative work on these topics is found in:

(i) Ahmad and Wyckoff, *Carbon Dioxide emissions embodied in international trade of goods,* OECD, November 2003.[2] Data provided in this report has been the basis for a number of subsequent studies, as it is for this report.

    However, this foundation OECD work was prepared for, and mostly circulated to, a statistics/analytical audience and so policy implications were not drawn out in the paper. Instead, the paper was seen as providing a statistical resource that could assist policy making.

(ii) Bosi and Riey, *Greenhouse Gas Implications of International Energy Trade*, IEA. October 2002.

Whereas Ahmad and Wyckoff (2003) focuses on embodied emissions in traded goods, Bosi and Riey (2002) focuses on upstream emissions in traded energy commodities. In some cases there are overlaps in these data sets, as goods exported may contain an element of upstream emissions of energy commodity inputs that were originally imported.

This study and report draws out key messages from this body of existing work that are relevant to the international policy community working on the post-2012 or so-called 'beyond-Kyoto' international climate change regime. It also expands on the existing literature in two key ways.

First, it is not restricted to CO_2 emissions, although quantitative information on non-CO_2 greenhouse gas (GHG) emissions embodied in traded products is far less available.

Second, it goes beyond embodied emissions to consider traded renewables-based commodities, in particular electricity and bioenergy, as well. In this instance there may not be embodied emissions, but a similar set of issues can apply. In the case of bioenergy from harvested wood products, some additional issues can arise.

This study and report is not intended to be a comprehensive resource of quantitative data. Rather, examples of data are selected to help articulate and elaborate key issues. It is these messages that are important, not the underlying data per se. Appropriate care and judgement about what is significant has of course been exercised in selecting and analysing the underlying data, to ensure that the messages are robust.

The general expectation is that this study will lead to more comprehensive statistical and analytical work by others, where the themes articulated here are considered to be worthy of further investigation.

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[1] Embodied emissions are all the emissions that have occurred 'upstream' in the production of a good (e.g. a car), as distinct from emissions associated with the use of the good itself. For commodities such as oil or natural gas, embodied emissions include production and transformation emissions as distinct from eventual combustion emissions.

[2] The OECD document number for this report is DSTI/DOC(2003)15.

Key concepts

The policy implications which this work focuses on are the ***transferred benefits and avoided costs***[3] associated with traded energy commodities and manufactured goods. The central economic issue can be described as follows:

> In a world where the cost of carbon is fully reflected in the market price of all energy commodities and manufactured goods, *transferred benefits and avoided costs* occurring as a result of international trade should not go uncompensated. For example, the cost of upstream emissions embodied in traded energy commodities or manufactured goods would be internalised in the cost of such items, i.e. the cost would be passed through to the importer, rather than being a potentially uncompensated cost to the producer. The price of electricity in a given importer-side market would include the cost of carbon of the most GHG intensive generation in the mix. Renewables-based (zero emissions) generation would see this carbon value as a realisable economic 'rent', as would any less-GHG intensive generation to a smaller degree. This would provide incentives for existing renewables and for increases in the supply of renewables.
>
> But the real world is still far from reflecting this idealised market model. While the Kyoto Protocol, in particular its market-based mechanisms, will lead to the internalising of a 'cost of carbon' to some degree, the coverage across countries and sectors is only very partial. This reflects not only the coverage of the international agreement itself (including the difference in treatment of industrialised and developing countries and the fact that some countries have not ratified the Protocol), but also the differences in countries' domestic policies and measures addressing energy as well as climate change. For example, to what extent will either liberalised competitive or regulated energy markets be effective in transmitting an additional carbon price signal through to the end consumer?

A key objective of this study, then, is to identify, qualify, and where possible quantify, the nature and scale of significant instances where *transferred benefits and avoided costs* occur – and the extent to which the exporter is likely to be compensated in the absence of policies intended for this purpose. A transparent articulation of this issue and information is expected to usefully inform the development of ideas about responsibility sharing within a future, more-encompassing international climate change regime.

This issue is particularly one of equity, and would add to a range of other equity-based issues that are being canvassed in a range of future-directed analyses and consideration. As an OECD Roundtable on Sustainable Development discussion[4] noted:

- *When a country's figure for production is higher than that for consumption, the country is in effect generating carbon dioxide to meet the consumption needs of other countries.*
- *Should developing countries be responsible for consumption by rich industrialised countries? In the end this is a question about equity. It is subjective and controversial.*

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[3] The distinction in meaning intended here between transferred *benefits* and *avoided costs* is that in the latter case a country importing a commodity or product with high embodied emissions avoids the possible cost of having these emissions in its domestic inventory. The former case is for renewables-based commodities or products. In this instance the benefit of emissions-free production is passed on to the importer (a situation which may in fact represent an opportunity cost to the exporter if the renewables-based commodities or products could have been used domestically and displaced the use of fossil-based commodities or products).

[4] Sustaining Whose Development? Analysing the International Effect of National Policies; Anne Harrison, Vangelis Vitalis and the RH Simon Upton; OECD Roundtable on Sustainable Development

A paper by the Pew Center on Global Climate Change[5] framed it this way:

- *We live in a world with a high and growing volume of international trade. Thus some countries, such as producers of metals or large volumes of manufactured goods, generate emissions to make products that are used elsewhere in the world. There are equity grounds for the proposition that those who receive the benefits of the emission (or embedded carbon) associated with the production of such goods should carry the cost. Emissions might then be assessed and penalised at the point of consumption. Otherwise a steel exporter would be carrying a carbon burden for those who use the steel.*

On strict economic grounds, it is possible to question where the economic costs and benefits of international trade actually fall, and hence the attendant equity implications. However, to the extent that the economies of exporting countries have benefited from the production, a cost of carbon emissions has definitely not been internalised in this equation for production from developing countries – and probably not for production from industrialised countries either.

This issue concerns more than equity alone. To the extent that these situations occur, they undermine incentives for renewables and less-GHG intensive fuels and processes by distorting the market in 'unclimate-friendly' ways. The issues explored in the renewables section of this work should therefore inform both the climate change and renewable energy policy communities. This should be of relevance to a number of countries where electricity grids cross borders. The same is true for trade in renewables-based biofuel, which could be increasingly significant.

Policy relevance

A number of formal and informal policy activities are underway to explore the issue of 'where to next' for the international climate change regime. Currently these are informed by data based mainly on production statistics only. A key purpose of this study and report is to raise issues associated with trade in energy commodities and manufactured products, so as to ensure that important perspectives which can be discerned from considering this 'consumption side' are not overlooked.

One key issue being explored by a number of policy groups is the so-called 'sectoral approach'. This has two different aspects. One is trans-national in its focus, i.e. that corporations involved in globally traded emissions intensive commodities (e.g. cement, steel, aluminium) might take on responsibilities at a global sector level, rather than have these fall under national obligations. The second is sub-national in its focus, in particular for developing countries. The notion here is that, rather than considering economy-wide responsibilities, countries may agree on crediting baselines for specific sectors (e.g. electricity generation). If the baselines are bettered, these sectors will then generate credits, so as to mobilise inward investment in clean technologies.

An understanding of current trade-influenced emissions trends is of value to both these considerations. A key effort of this study has therefore been to 'unpack' national and regional-level statistics to the underlying sector data, where this has been possible and is relevant. But it has not been within the scope of this study to develop new data sets. It relies on existing data (which is referenced), and is constrained by the limitations of this data. These are flagged to caution readers against assuming degrees of quantitative certainty that are not appropriate.

This work is primarily intended to provide information in ways which stimulate discussion and further analysis. It is not intended to draw conclusions that in any way prescribe suggested ways forward. Rather, it is an input to processes that in time may have such outcomes. One objective is therefore to

[5] Equity and Climate: In Principle and Practice; John Ashton and Xueman Wang (In *Beyond Kyoto – Advancing the international effort against climate change*, Pew Center on Global Climate Change, December 2003)

make the work available to policy makers at sessions of the UNFCCC Subsidiary Bodies and in informal post-2012 dialogues and thinktanks. It is framed so as to make it easily accessible to these key policy audiences and settings.

Organisation of the report

Section 2 describes the nature of the data sets that have been researched and utilised in developing any quantitative results. It outlines some relevant limitations of the methodologies underlying these data sets, and the nature of uncertainties. It also describes the methodology used in this work to unpack and/or re-present data.

Section 3 provides data and analysis addressing the key objective noted above, i.e. to identify 'significant instances where *transferred benefits and avoided costs* occur – and the extent to which the exporter is likely to be compensated in the absence of policies intended for this purpose'.

Section 4 draws out some of the key policy-relevant 'messages' and issues from this data. It uses a number of example cases to help do this, in a manner that is intended to be thought provoking, but not judgemental or prejudicial.

Appendix A lists the existing literature that has informed this report.

Appendix B reproduces a paper written on a subject that emerged in the development of this work, *A carbon market mechanism to incentivise renewables and innovation*.

SECTION 2. DATA SETS AND METHODOLOGIES

An underlying premise of this work is that quantitative results of this type will primarily inform the 'responsibility sharing' stage of negotiations, which may lead to the next stage of the international accord to address climate change, whether this turns out to be a second commitment period of the Kyoto Protocol, or something different.

It is specifically *not* the premise that trade-related data should be incorporated into the inventory and accounting systems established under the UNFCCC and Kyoto Protocol, so as to put these onto a consumption versus production basis. The current 'in-country' emissions inventory-based accounting system is the result of over a decade of intensive design and multilateral negotiation. Few would entertain the notion that this should be changed, in particular by introducing the complexities and uncertainties of embodied emissions in individual traded commodities and products. Indeed, there would be a huge 'push-back' internationally to any such idea.

The work also assumes that differentiation[6] becomes the norm of such negotiations, i.e. that the 'national' circumstances of countries, or groups of countries, are taken into account in the negotiation process and its outcome.

Given this underlying premise and assumption, what form of data will usefully contribute to a negotiation process? The view taken here is that what matters most are **trends** in emissions data. This is because a negotiation process that incorporates the possibility of differentiation provides ample room to adjust responsibilities to account for different circumstances. But it is extremely important to understand the circumstances that are likely to prevail. Understanding the trends of key drivers is crucial to this.

A simple example helps to make this point. Imagine that a developing country is considering an appropriate crediting baseline for its power sector. It would need to have a good sense of the likely emissions associated with electricity consumption of manufacturing plants producing products for export, so as to ensure that these were included in its baseline. Correspondingly, an industrialised country considering possibly much deeper reduction targets would need to understand the contribution to domestic reductions that might be achieved because of changing import patterns through globalisation. It would also need to understand the implications of its exports. Each of these countries would want to have an understanding of the other's circumstance. This would particularly be the case where the sum of the negotiated outcomes for all countries involved is intended to be some form of quantitative emissions limit, i.e. accepting higher emissions in one country or group of countries means allowing lower emissions in other countries.

The focus on data in this study has therefore been on trends rather than absolutes, and on trends connected to changing trade flows, not simply those due to increased domestic consumption from economic growth (although clearly there are linkages between these).

Data sets

The following sets of data have therefore been the focus of the research underlying this report. In some cases it has been possible to use this data directly, with relatively minor unpacking or re-presenting. In other cases data from different sources has been brought together and, along with some assumptions, configured to the form required.

[6] The term differentiation was used in the Kyoto negotiations to describe an outcome for targets for industrialised countries that was different to a uniform binding percentage reduction for all. But in its wider sense, differentiation simply can mean the prospect for differently formulated responsibilities for different countries or groups of countries.

1. Indicators of embodied emissions in trade in energy commodities, 1990 and 2000

   (a) Major exports and imports of oil, natural gas and coal

   (b) Major exports and imports of electricity

   Associated with this, for exports, there is a breakdown into fossil- and renewables-based domestic production. From this data, judgements can be made as to the amount of renewables-based exports.

   Data for these two elements is primarily derived from Bosi and Riey (2002) as updated by subsequent publications of the underlying IEA statistics, namely *Energy Statistics of OECD Countries (2003)* and *Energy Statistics of non-OECD Countries (2003)*.

   (c) Major exports and imports of renewables-based biofuels[7]

   Data on trade in biofuels is derived from *Renewables Information, IEA (2004)*.

2. Embodied emissions in trade in manufactured goods, 1990 to 2000

   (a) Direct and indirect[8] emissions of carbon dioxide in exported manufactured goods, including the embodied emissions in imports of input commodities and goods.

   This data is primarily derived from the OECD work by Ahmad and Wyckoff (2003).

   (b) Proxy for methane in some agricultural products (meat products from ruminant animals)

   This data is from FAO Tradebooks for 1990 and 2000.

Issues associated with key data sources and data presentation

Bosi and Riey (2002)

This study provides summary statistics of major energy trade flows in 1999 for both OECD and non-OECD countries. For IEA countries it also analyses the upstream (production and transformation) greenhouse gas emissions associated with energy trade flows in 1990 and 1999. This was done for each of oil, gas, coal and electricity. This enabled a calculation of emissions from the domestic consumption of energy that is adjusted for the embodied emissions in energy imports, less those in energy exports[9]. The emissions calculated include both combustion and fugitive emissions, and both CO_2 and non-CO_2.

While this provides a useful and deeper understanding of emissions associated with energy use, a fuller understanding of 'consumption footprints' needs to take traded goods into account too. For example, an importer of coal may produce steel (and then cars) for export, or an importer of

[7] Any consideration of biofuels can be complicated by the ongoing debate about who should have the responsibility for emissions from the use of harvested wood products, the exporter or the importer. See Sidebox 1 for a discussion on this point.

[8] Indirect emissions are, for example in auto manufacturing, the embodied emissions in inputs like electricity, steel and aluminium, whereas direct emissions would be from combustion of fossil fuels in the manufacturing process

[9] i.e. emissions from "consumption" of energy = emissions from domestic production/transformation plus emissions from domestic use plus embodied production/transformation emissions from imported energy minus production/transformation emissions from exported energy.

electricity may produce aluminium for export, etc. The Ahmad and Wyckoff (2003) work on trade in manufactured goods helps to complete this picture. However, these sets of statistics have not yet been assembled in a comprehensive manner. While this report includes results from both these earlier efforts, its purpose is not to do a substantive quantitative statistical analysis.

One important methodological issue in both Bosi and Riey (2002) and Ahmad and Wyckoff (2003) is that the data for emissions related to trade in electricity is based on a simplifying assumption (because of data availability issues) that the balance between fossil-based and renewables-based electricity in exports is the same as the balance in domestic production.

This assumption may have a significant effect on the data. In practice, the source of surplus electricity production made available for export will vary according to a range of electricity system architecture and weather factors. For example, export power grids and internal transmission linkages and constraints may exist at a regional rather than national level, so the renewables-fossil balance might reflect regional production resources rather than national resources. For systems relying substantially on hydro storage, but with some fossil component, the question is which represents base load and which the surplus, as weather varies between ‘dry’ and ‘wet’ years. This in turn may depend on the nature of the electricity market or regulatory regime by which generation resources are dispatched. For example, both regionality and hydro storage factors are likely to occur in relation to electricity exports from British Columbia, Canada to the US Pacific Northwest.

Because of the possible effects of adopting this simplifying assumption, the results provided in Section 3 keep electricity trade in units of GWh, but provide additional data from which judgements about embodied emissions, including those of an ‘opportunity cost’ nature, can be made separately. The point of this study is to outline examples of where there may be significant changes in trends of trade that have emissions consequences. This can be served with data provided in units of something other than GHG emissions.

There are also methodological issues with estimates of upstream production and transformation emissions. For OECD countries, GHG emissions factors can be derived from their UNFCCC reporting of emissions for these activities. These are country specific. For example, flaring practices may differ at oil and gas production facilities. Such data is not generally available from non-OECD countries. For these estimates, Bosi and Riey (2002) used data provided by RIVM, based on the EDGAR 3.0 database. However, because emissions estimates were reported only for IEA countries, the statistics tables in Bosi and Riey (2002) do not provide a basis for estimates of upstream emissions for non-IEA exporting countries.

Applying the same logic as for electricity that identifying changes in trade patterns can be served by data in units other than GHG emissions, this report provides data in the units of the commodities.

<u>Ahmad and Wyckoff (2003)</u>

This study is the most extensive to date on embodied emissions in traded products. It looks at embodied emissions in manufactured goods in a range of industry categories involved in international trade between a range of countries.

The data most relevant for this work was included in Annex A to the main study. This provided a time series of data, structured to show the embodied emissions in *imports* by ten OECD countries of the categories of products included in the analysis. A data matrix was provided for each of the 10 countries, showing embodied emissions in imports from each of a broader set of countries, or groups of countries. In Table 1 below, Column A lists the 10 importing countries. Column B lists the countries, or groups of countries, exporting to those in Column A.

Table 1. List of importing and exporting countries in OECD study data set

A: Importing Countries	B: Countries exporting to countries in Column A
Australia	Canada
Canada	China
Denmark	Eastern/Central Europe
France	EU15
Germany	EFTA & Turkey
Italy	Japan
Japan	Korea, Australia & NZ
Norway	Mexico
UK	OPEC
US	Rest of World
	US

For this study the focus is more on exporter-side data, so the data matrix in Annex A of Ahmad and Wyckoff (2003) was reconfigured to show exported embodied emissions from the Column B countries or groups of countries. This data is, however, still derived from the importers-side figures.[10]

One issue with the data provided in Annex A was differences in the time series of the data. For a given importing country, this was provided for a five year period around the year of the core input-output data set; which differed among the countries. A five year period was chosen because it was important to illustrate how embodied emissions evolved over time; but the evolution over a longer time period was not presented, because the further the move from the base input-output year, the greater the uncertainty of the data. Nonetheless, it is possible to create estimates outside these five years by extrapolating from the underlying OECD data set (albeit with increasing uncertainty). This is done here so as to be able to review the same 1990 to 2000 period as for the analysis of energy commodities.

Results of this analysis are provided in Section 3. These include totals in units of Mt CO_2. For some cases the totals data is 'unpacked' to show, for a given exporter, results for specific importing countries and for specific subcategories or sectors of goods. This was able to be done because the underlying methodology of Ahmad and Wyckoff (2003) started with import bilateral trade data at the ISIC[11] manufactured goods code level. Per country emission factors were then applied to the bilateral trade data and the ISIC-level data built up to country totals. The analysis presented here was made possible by accessing database information at the core ISIC level.

[10] An issue raised in Ahmad and Wyckoff (2003) about data of this type is that there may be discrepancies between importers' and exporters' trade statistics
[11] International Standard Industrial Classification of All Economic Activities, Third Revision, (ISIC, Rev.3)

Issues regarding non-CO_2 data sources

The key issue here was determining what might be considered significant enough to elaborate in this study and report, given that its purpose is to draw out key themes and messages, and not to provide a comprehensive resource of quantitative data.

A number of reports helped in determining significance:

- *Climate Data: A Sectoral Perspective*, Baumert, Herzog and Pershing, WRI (2005)

  This shows that of the non-CO_2 gases, only methane and nitrous oxide (at 14% and 8% respectively of total global greenhouse gas emissions in 2000) seem significant. High GWP non-CO_2 gases account for only 1%. In addition, the primary emitting sector of methane and nitrous oxide is the agricultural sector.

- *Global emissions of gaseous emissions of NH_3, NO and N_20 from agricultural land*, FAO and IFA (2001)

  This indicates that, for nitrous oxide, the most significant source is related to animals, not crops.

- *Methane embodied in the international trade of commodities*, Sabak (1995)

  This concludes that:

  - Trade in fresh, prepared and processed meats is the most important source of embodied methane traded amongst countries
  - While dairy cows tend to be a greater source of methane on an individual basis than non-dairy cattle, far less milk and milk products than meat products are traded on international markets
  - Methane embodiment in rice is insubstantial.

Guided by this information, the analysis of non-CO_2 in this study concentrated on the trade in meat products, as these were seen as the main proxies covering both embodied methane and nitrous oxide in the agriculture sector. This data was taken from statistics contained in FAO Tradebooks.

SECTION 3. RESULTS

This section provides data and analysis addressing this report's key objective, to identify "significant instances where *transferred benefits and avoided costs* occur – and the extent to which the exporter is likely to be compensated in the absence of policies intended for this purpose". It includes a series of tables and charts that describe major trade flows in energy commodities and goods. The matter of "likelihood of compensation in the absence of policies" is taken up in Section 4.

Indicators of embodied emissions in energy commodities:

The following charts provide 1990 and 2000 data on the major exports and imports of energy commodities. OECD countries are shown first, followed by non-OECD countries.

Chart 1a. Major Exports of Crude Oil, NGL, Refinery Feedstocks and Additives; Kilotonnes

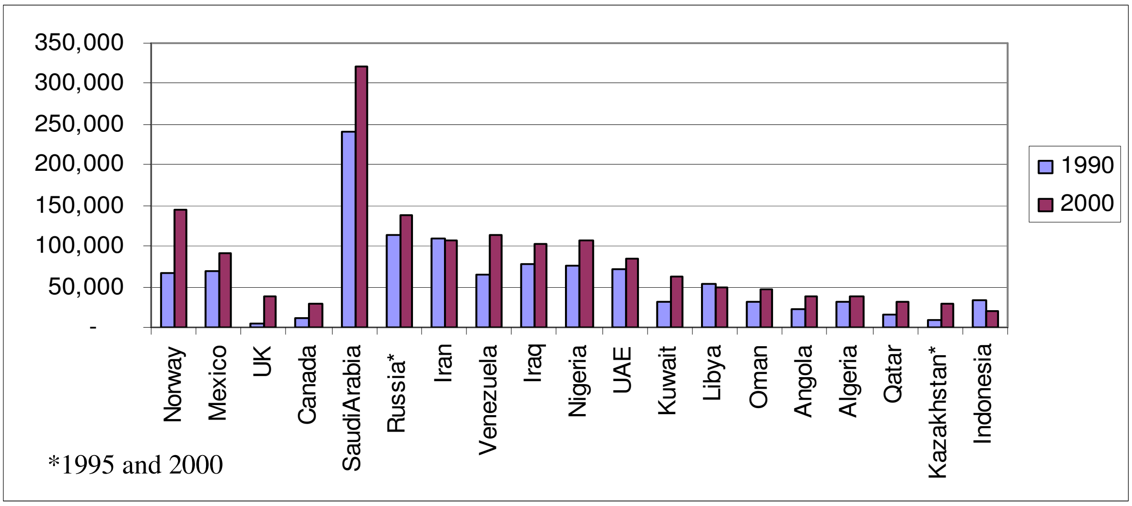


Chart 1b. Major Imports of Crude Oil, NGL, Refinery Feedstocks and Additives; Kilotonnes

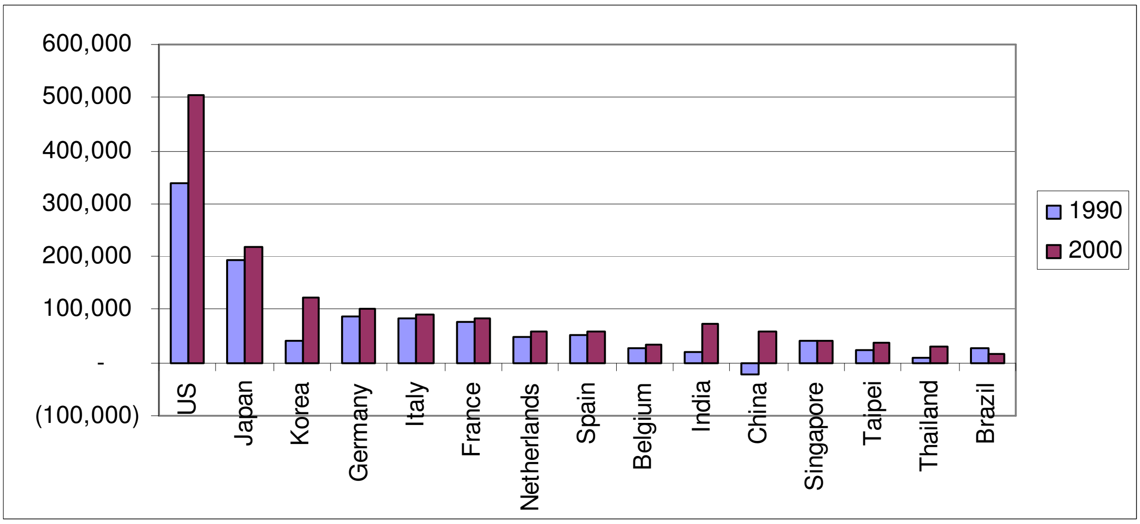


Chart 2a. Major Exports of Natural Gas; Terajoules

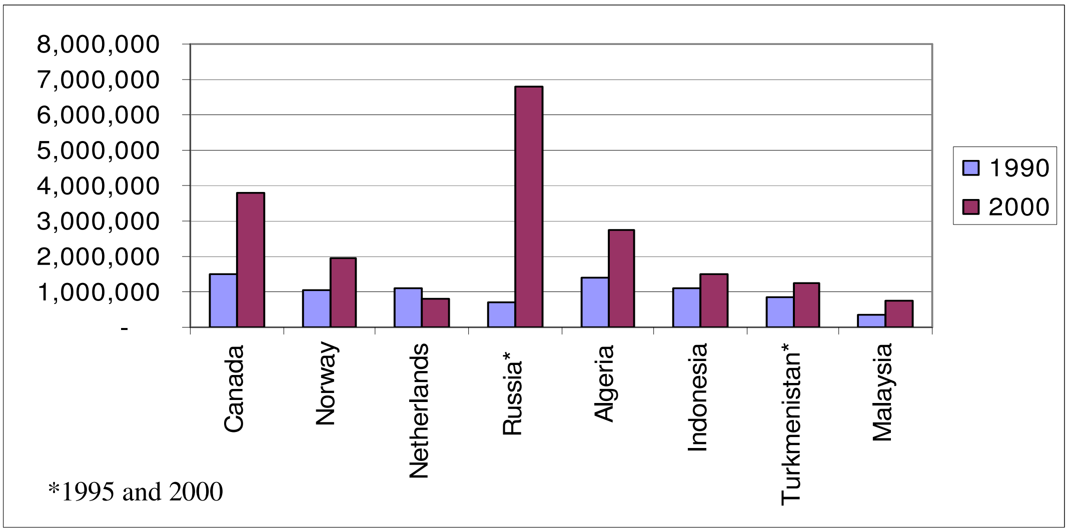


Chart 2b. Major Imports of Natural Gas; Terajoules

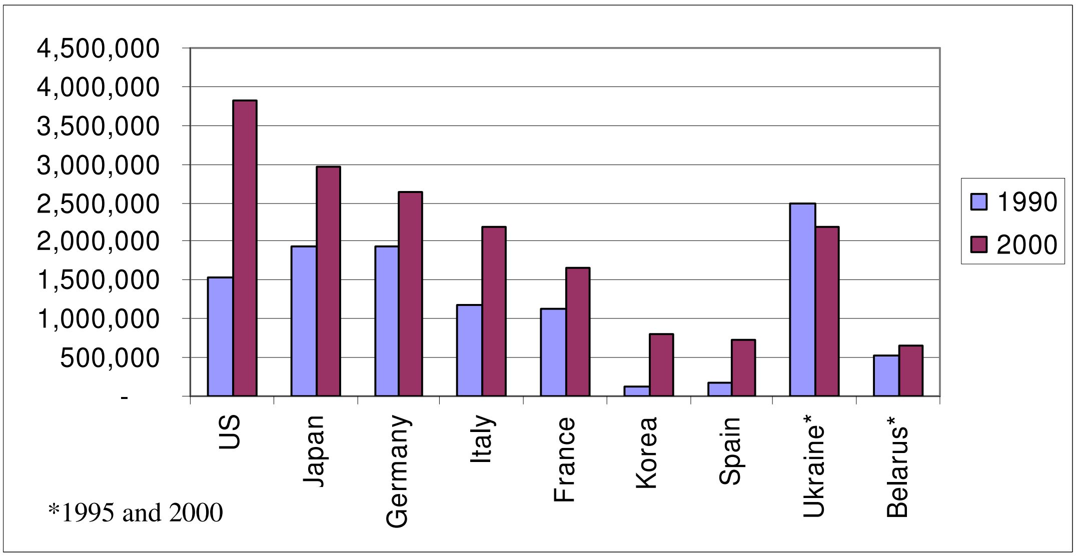


Chart 3a. Major Exports of Coking Coal and Other Bituminous Coal; Kilotonnes

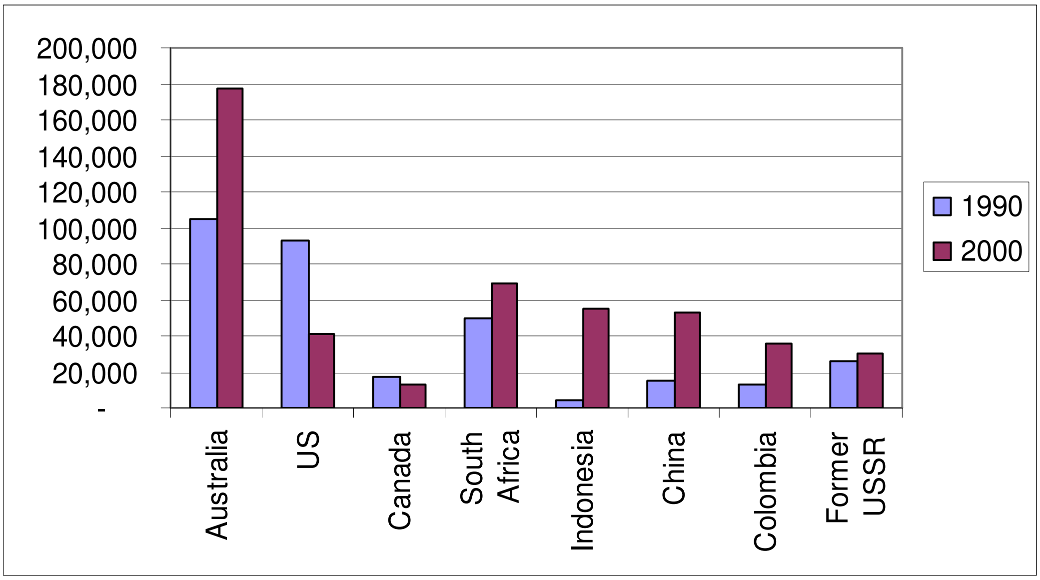


Chart 3b. Major Imports of Coking Coal and Other Bituminous Coal; Kilotonnes

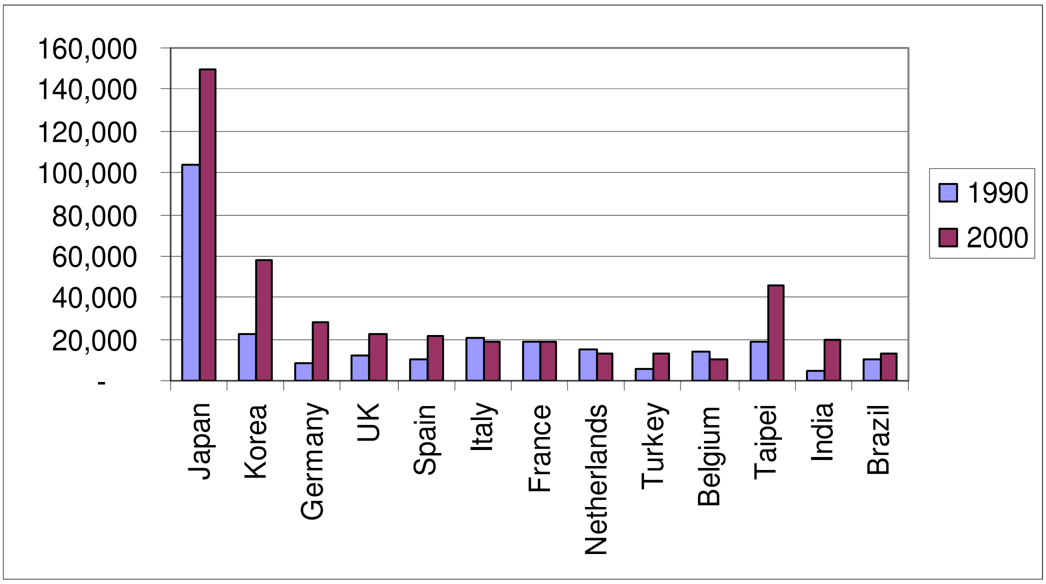


Chart 4a. Major Exports of Electricity; Gigawatthours

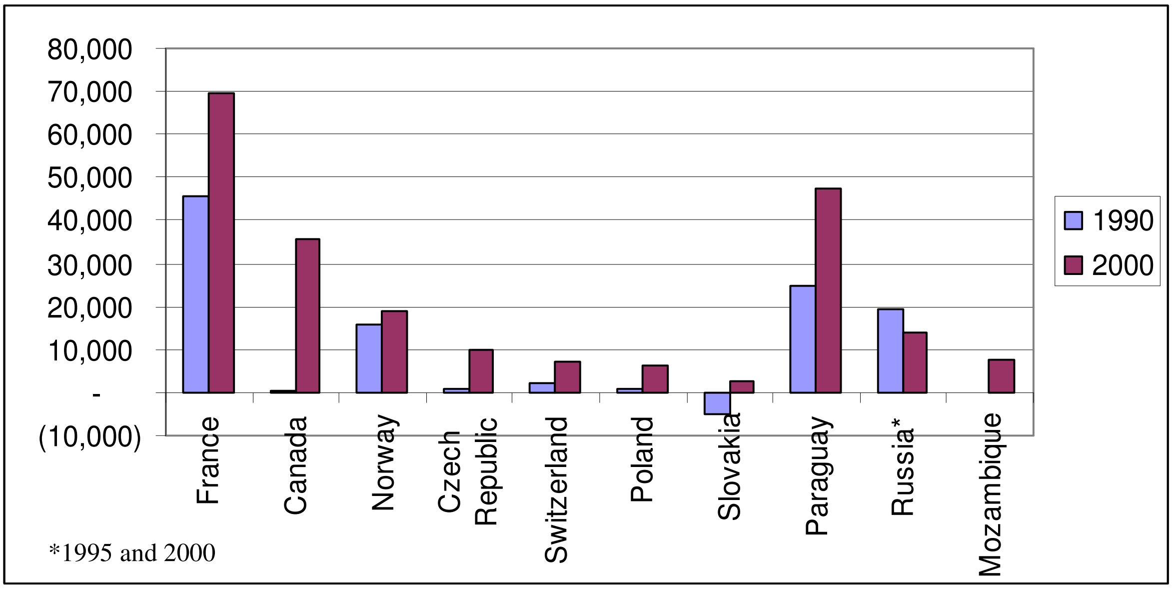
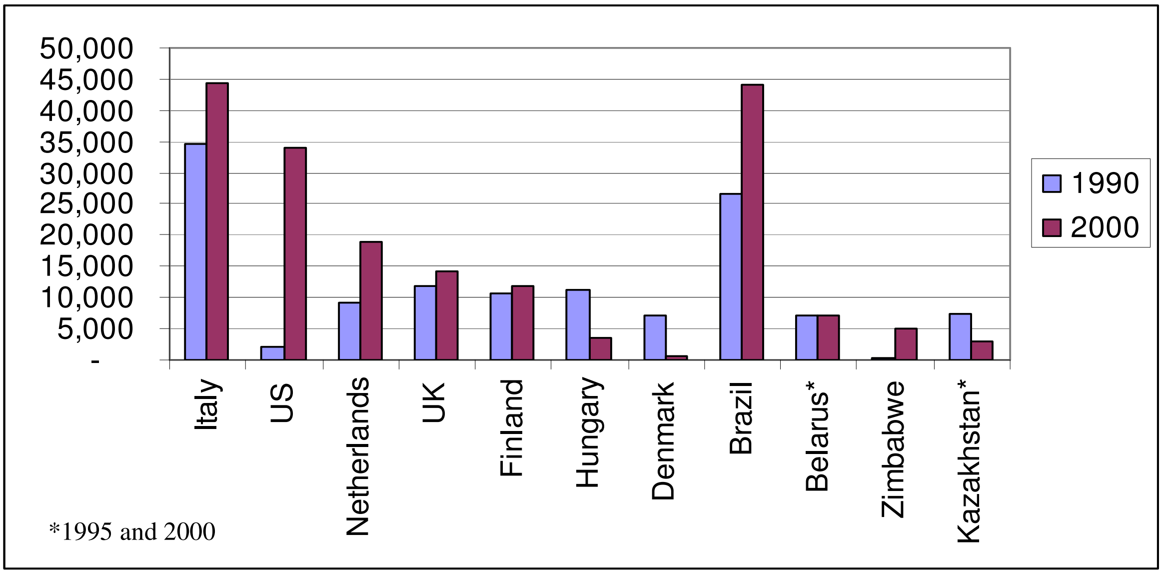


Chart 4b. Major Imports of Electricity; Gigawatthours



Data for electricity needs to be viewed with some caution when it is presented for specific years, as it is here. There can be wide year-by-year variations when there is a significant component of hydropower in the generation mix of a key exporter. In Canada, for example, 1990 was a very low export year (and correspondingly, for the US, a very low import year). Similar wide variation can occur in the Nordic countries. For example, Denmark was an exporter in 1999 and 2001. Norway was an importer in 2001.

As noted in the methodology discussion in Section 2, a key issue when analysing trade in electricity with a view to making estimates of embodied emissions is **what resource in the exporter's domestic generation mix is being exported**. The following table helps to illustrate this.

Table 2. Exported electricity and domestic production resources for main export countries

	Exports		Domestic Production									
			Fossil Fuels		Nuclear		Hydropower		Combstbl renewbls and Waste		Wind, Tide Wave & Other	
Exporters	GWh		GWh		GWh		GWh		GWh		GWh	
	1990	2000	1990	2000	1990	2000	1990	2000	1990	2000	1990	2000
France	45,438	69,479	47,118	49,736	314,081	415,162	57,350	71,816	1,643	3,290	571	650
Canada	349	35,641	108,384	166,477	72,967	72,799	296,848	358,358	3,829	7,365	26	295
Norway	15,907	19,055	224	376	-	-	121,382	142,265	242	286	-	31
Czech Republic	692	10,017	48,529	56,840	12,585	13,590	1,445	2,313	-	723	26	295
Switzerland	2,108	7,070	627	1,058	23,636	26,446	30,982	38,230	559	1,603	-	3
Poland	1,041	6,373	132,741	140,511	-	-	3,313	4,116	257	552	-	5
Slovakia	(5,196)	2,696	9,516	9,216	12,036	16,494	2,515	4,975	-	-	-	-
Paraguay	24,970	47,385	7	13	-	-	27,158	53,473	20	35	-	-
Russia*	19,605	14,055	582,474	579,078	99,532	130,715	176,412	165,375	1,579	2,538	-	6
Mozambique	(166)	7,536	170	13	-	-	284	8,836	-	-	-	-

In some cases, e.g. Norway, Paraguay and Mozambique, it is clear that the resource is hydropower. But in other cases, the amount of exports is relatively small by comparison with some of the individual resources. Canada's exports in 2000, for example, could be met by fossil fuels, nuclear power or hydropower.

This indicates that, in such cases, a deeper understanding of individual countries' circumstances is necessary to be able to make an assessment of embodied emissions in electricity trade. (A discussion related to this point is provided in Section 4.)

Bioenergy

See data in the discussion on bioenergy in Section 4.

Embodied emissions in manufactured goods

Carbon Dioxide

As noted in Section 2, these results look at **significant** examples of changes over time of embodied CO_2 exports from a number of countries or groups of countries to a number of OECD countries. The criteria for significance are:

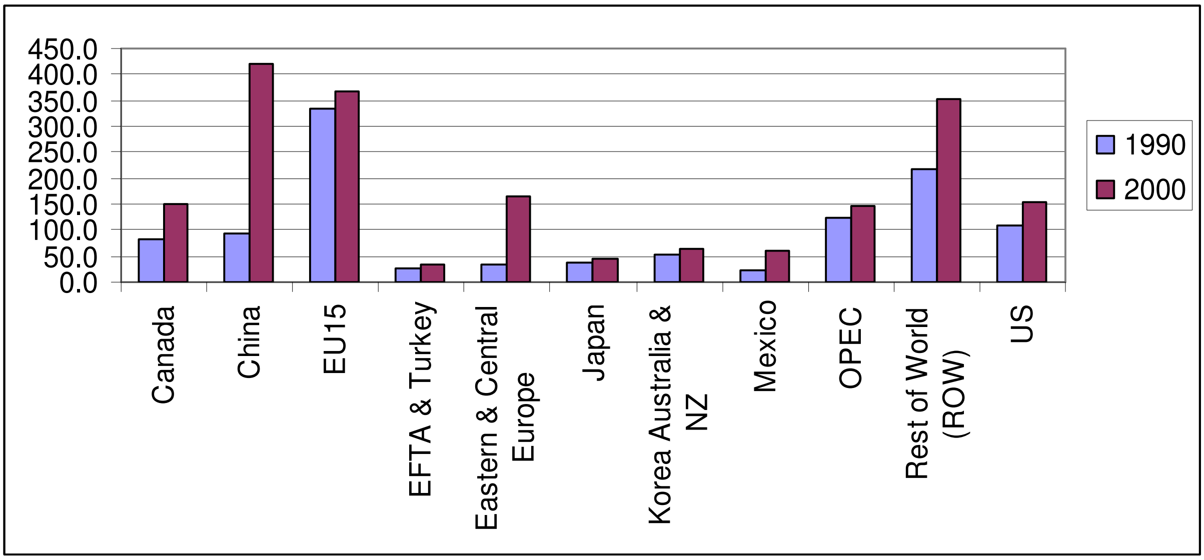
(i) that for a given exporting country (or group of countries) to a given importing country, the change over 1990 to 2000 is greater than 5%

and

(ii) this change, as a percentage of the total change for the exporter to all included importing countries, is also greater than 5%.[12]

The results of this analysis appear in the following table and charts.

Chart 5. Major exporters[13], embodied emissions in exported goods, $MtCO_2$



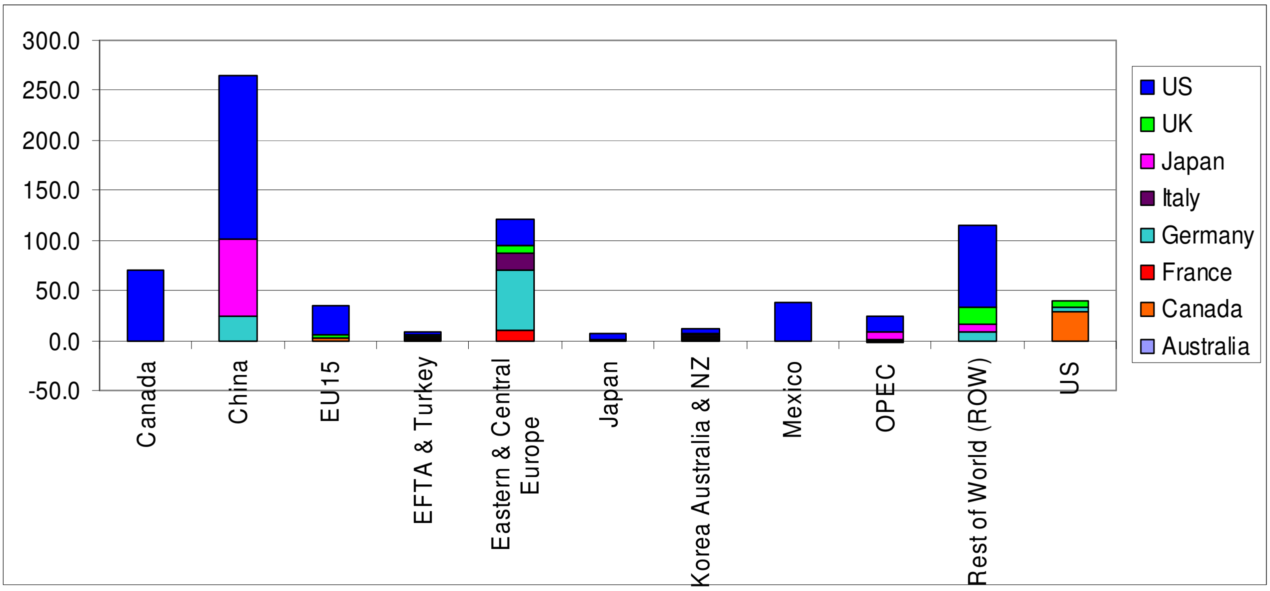
The significant trade 'pairings' accounting for the changes between 1990 and 2000 are shown in the following table and chart.

Table 3. Change (2000 minus 1990) in embodied emissions in exports of goods, $MtCO_2$

From: To:	Australia	Canada	France	Germany	Italy	Japan	UK	US
Canada								71.0
China				24.2		77.4		163.4
EU15		2.3					3.0	29.2
EFTA[14] & Turkey		0.5	1.2	0.7	1.0	-0.7	1.9	2.7
Eastern & Central Europe			10.9	59.6	16.5		8.3	25.9
Japan		0.4					0.5	6.4
Korea Australia & NZ	1.6	1.4			0.8	2.0	0.9	5.5
Mexico								37.3
OPEC	1.1			-1.9		8.2		14.3
Rest of World (ROW)				9.2		7.2	17.6	80.7
US		29.2		4.5			5.4	

[12] This is needed to avoid something seeming significant when in fact a high percentage change for a given importing country only occurs because it is working off a very small 1990 base. In practice this criterion is mostly the key determinant of 'significant'.
[13] Note that 'exporters' here does not mean net exporters. Some countries are in fact major net importers.
[14] European Free Trade Assn; includes Iceland, Norway, Switzerland and Liechtenstein

Chart 6. Graphical representation of data in Table 3



There is the potential for data based just on two years, 1990 and 2000, to be misleading as a trend, if one (or even both) of those years was affected by some anomalous circumstance. The following graphs show the 10-year trend data for the four main examples above, i.e. exports from Canada, China, Eastern & Central Europe and ROW, to the importing partners that were significant under the criteria noted above. The upwards trend is clear.

Chart 7. Embodied CO_2 in goods exported from Canada, $MtCO_2$

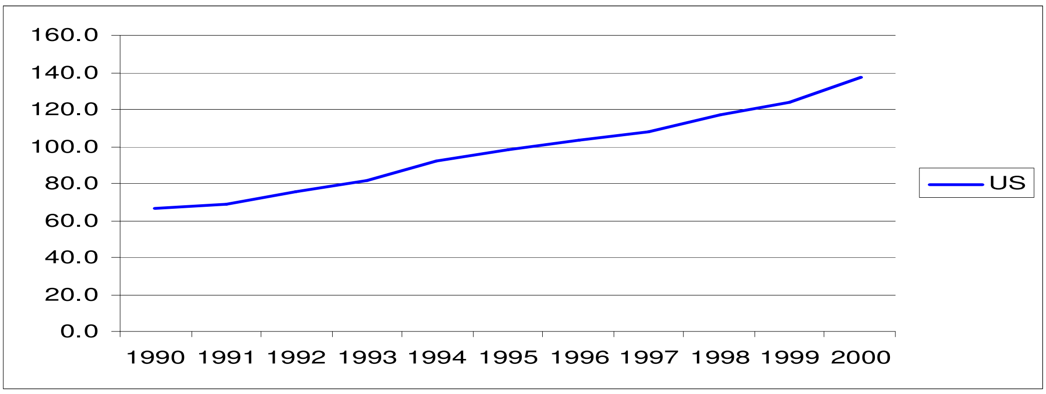


Chart 8. Embodied CO_2 in goods exported from China, $MtCO_2$

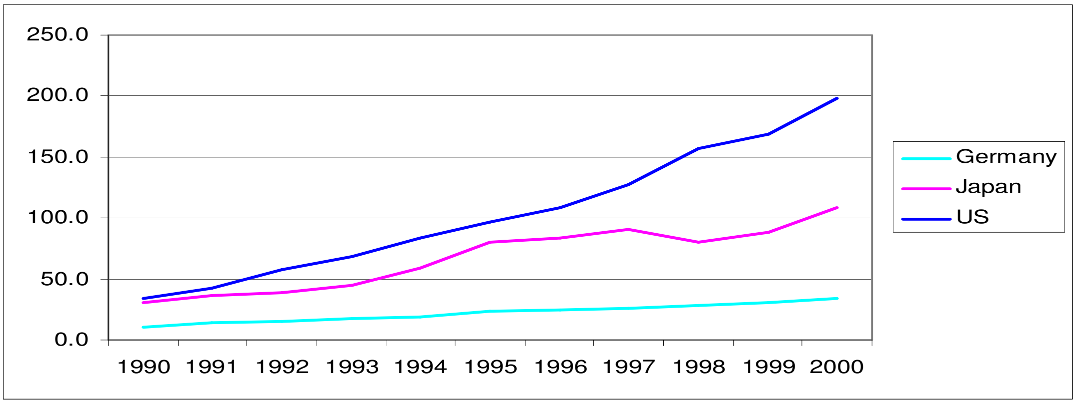


Chart 9. Embodied CO_2 in goods exported from Eastern & Central Europe, $MtCO_2$

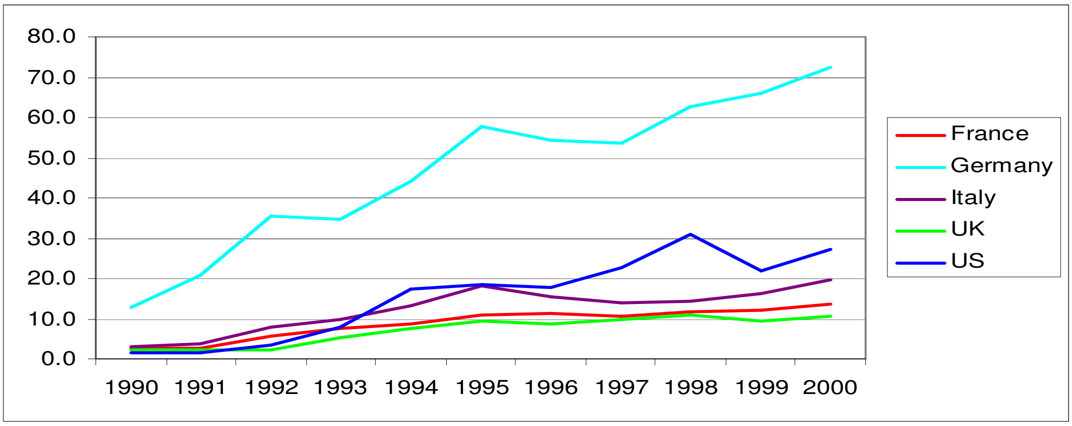
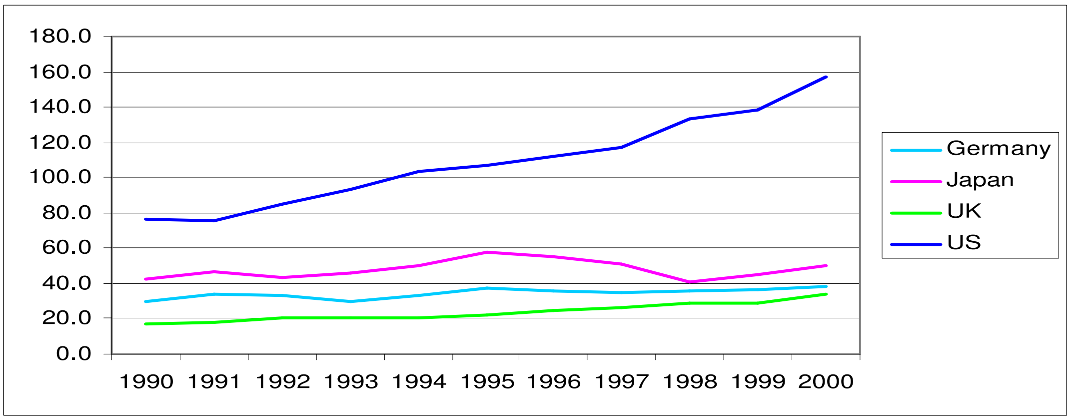
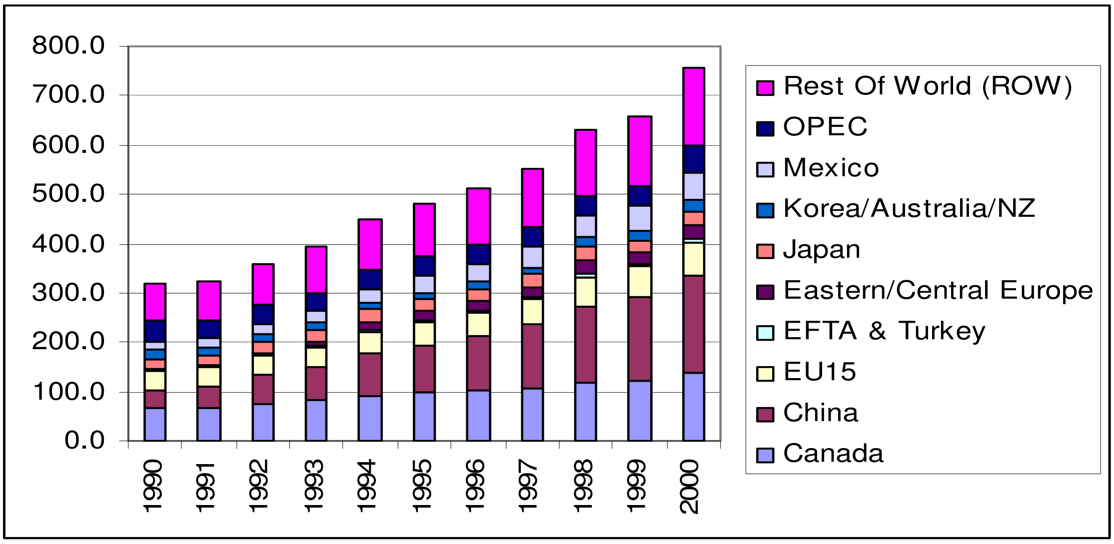


Chart 10. Embodied CO_2 in goods exported from Rest of World, $MtCO_2$



The predominance of the US as the key importer is clear from the above results. The following chart graphs the US trend over 1990-2000. This data is from Table A.2 in Ahmad and Wyckoff (2003), extrapolated to cover 1990-2000.

Chart 11. Embodied emissions in US import of goods, 1990 to 2000, MtCO2



In interpreting the data in Charts 7 to 11 and in Table 4 below, it is important to understand that changes in imported embodied emissions do not come solely from changes in the levels of trade. The other key factor is the emissions intensity for these goods in the countries of export. So, for example, if part of the changing trade patterns for a given country is more imports from country 'A' and commensurately fewer from country 'B', the differences in those countries' emissions intensities can have a significant influence on results. Moreover, changing emissions intensities over time for a given exporting country can also be significant.

Sectors analysis

An initial 'example' analysis provides a key sector analysis of the country-to-country totals in some of the main country import-export pairings identified in Table 3 above. This has been done for the following country pairs (exporter to importer):

- Canada to US
- Mexico to US
- China to US
- China to Japan
- China to Germany

The sector analysis has been done at an ISIC code level. It identifies which ISIC codes were responsible for a significant[15] portion of the growth in embodied emissions in manufactured goods between the years 1990 and 2000.

[15] In this instance, sectors responsible for greater than about 5% of the total growth in the respective country pairing.

These country pairing examples have been chosen because they were some of the more significant in Table 3. They are also country to country pairings. Analysis of regional groupings of countries is very complex (albeit potentially possible), because each country in a regional group has unique emissions coefficients for each ISIC code.

This analysis has been derived from the data and analysis underpinning Table A.2 in Ahmad and Wyckoff (2003), extrapolated to cover 1990-2000.

Table 4. Examples of sector-level portion (in %) of growth in embodied emissions in manufactured goods, 1990 to 2000

Canada to US:	**ISIC code**	
Growth in embodied emissions, 1990 to 2000		71 MT CO_2
- Mining and Quarrying	10-14	18.5%
- Motor Vehicles, Trailers and Semi-trailers	34	12.5%
- Electricity, Gas and Water supply	40-41	11.4%
- Manufacturing n.e.c.; Recycling	36-37	10.5%
- Chemicals excluding Pharmaceuticals	24 ex2423	9.1%
- Rubber and Plastics products	25	4.8%
Mexico to US:		
Growth in embodied emissions, 1990 to 2000		37 MT CO_2
- Motor Vehicles, Trailers and Semi-trailers	34	24.4%
- Mining and Quarrying	10-14	12.8%
- Textiles, Textile Products, Leather and Footwear	17-19	11.1%
- Electrical Machinery and Apparatus, n.e.c.	31	9.5%
- Radio, Television and Communication Equipment	32	9.3%
- Office, Accounting and Computing Machinery	30	5.1%
- Machinery and Equipment, n.e.c.	29	4.7%
China to US:		
Growth in embodied emissions, 1990 to 2000		163 MT CO_2
- Manufacturing n.e.c.; Recycling	36-37	19.8%
- Textiles, Textile Products, Leather and Footwear	17-19	12.8%
- Electrical Machinery and Apparatus, n.e.c.	31	11.1%
- Office, Accounting and Computing Machinery	30	8.8%
- Machinery and Equipment, n.e.c.	29	7.2%
- Radio, Television and Communication Equipment	32	7.1%
- Fabricated Metal Products	28	7.1%
- Other non-metallic Mineral Products	26	5.8%
China to Japan:		
Growth in embodied emissions, 1990 to 2000		77 MT CO_2
- Textiles, Textile Products, Leather and Footwear	17-19	31.1%
- Electrical Machinery and Apparatus, n.e.c.	31	11.7%

- Manufacturing n.e.c.; Recycling	36-37	6.8%
- Food Products, Beverages and Tobacco	15-16	6.0%
- Radio, Television and Communication Equipment	32	5.8%
- Other non-metallic Mineral Products	26	5.6%
- Office, Accounting and Computing Machinery	30	5.4%
- Machinery and Equipment, n.e.c.	29	5.3%
- Chemicals excluding Pharmaceuticals	24 ex2423	5.0%
China to Germany:		
Growth in embodied emissions, 1990 to 2000		24 MT CO_2
- Electrical Machinery and Apparatus, n.e.c.	31	15.9%
- Office, Accounting and Computing Machinery	30	10.1%
- Manufacturing n.e.c.; Recycling	36-37	10.0%
- Fabricated Metal Products	28	9.2%
- Machinery and Equipment, n.e.c.	29	9.1%
- Radio, Television and Communication Equipment	32	8.5%
- Textiles, Textile Products, Leather and Footwear	17-19	7.7%
- Medical, Precision and Optical Instruments	33	5.2%
- Other non-metallic Mineral Products	26	4.6%

Non-CO_2 emissions

As outlined in Section 2, trade flows in meat products are seen as the most significant proxy for both embodied methane and nitrous oxide. These are shown below. The significance threshold was net exports or imports over 150,000 tonnes in either 1990 or 2000.

Chart 12a. Major net exporters of meat products, kilotonnes

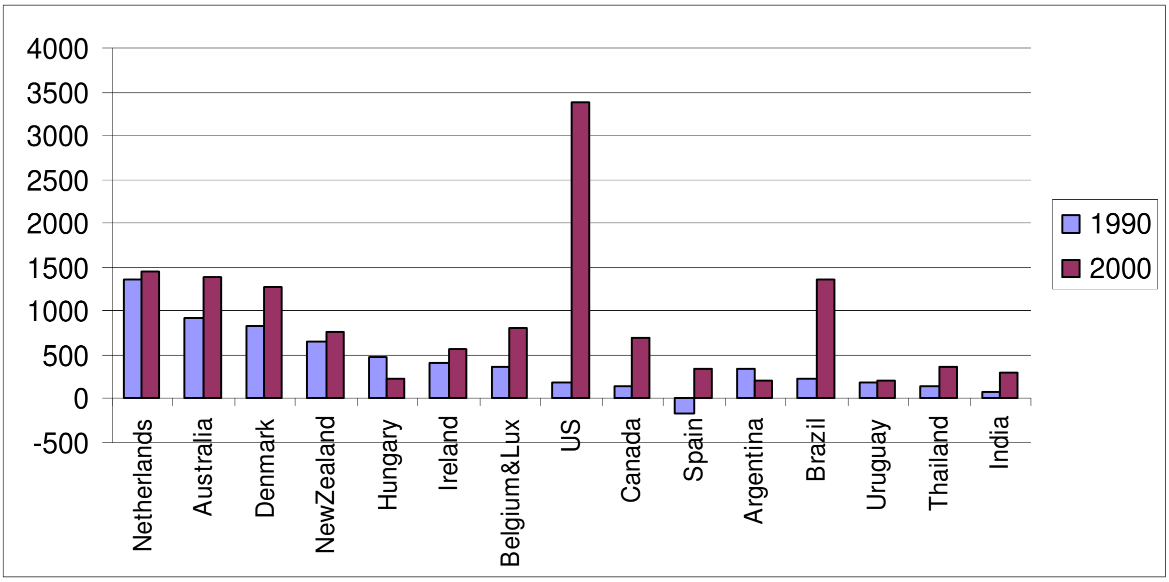
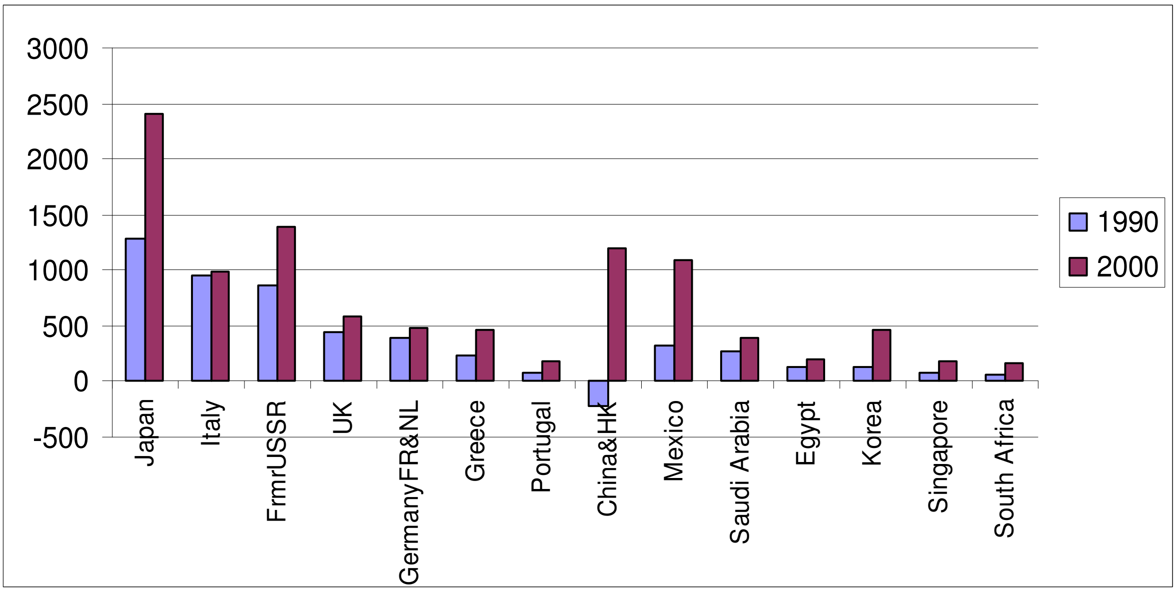


Chart 12b Major net importers of meat products, kilotonnes



SECTION 4. POLICY-RELEVANT 'MESSAGES' AND ISSUES

A general issue about the information in this report, and the insights that can be derived from it, is that it provides a useful complement to the rich information sets provided, for example, by the World Resources Institute (WRI) from their Climate Analysis Indicators Tool (CAIT). These indicators are primarily based on in-country (i.e. production) data. An understanding of the underlying export-import influences on national production data frequently helps explain what otherwise may appear to be anomalous relative rankings between countries, or trends in data.

Embodied emissions in energy commodities

Fossil fuels

The tables and charts in Section 3 graphically elaborate the messages contained in Bosi and Riey (2002): overall, OECD countries are major net importers of energy commodities, but some OECD countries are major exporters, and these trade balances are increasing with time. Moreover, Bosi and Riey (2002) show that the embodied emissions associated with fossil-based energy trade are considerable.

Bosi and Riey (2002) do not provide explicit exporter-importer 'pairings'. But from the data, it is possible in most cases to derive a good general understanding of what these are likely to be. In some cases they are obvious, e.g. electricity and gas from Canada to the US, or electricity from Paraguay to Brazil.

To derive embodied emissions data in exports of fossil-based commodities, it is necessary to know emissions factors for the associated upstream activities in specific countries. This information is available for Annex I countries from their UNFCCC inventory reporting, but is less available for non-Annex I countries. However, estimates for these factors have been made in some key databases.

With respect to embodied emissions in electricity trade, in Section 3 it was noted that a deeper understanding of individual countries' circumstances is necessary to derive more accurate assessments than those which rely on assuming a national average factor. On the other hand, with respect to the key objective of this report, this may be less important. If exports are fossil-based, this means that an importer potentially enjoys an 'avoided cost' of carbon. If exports are renewables-based, this means a 'transferred benefit' to the importer, namely that the benefit of carbon free generation is not enjoyed by the exporter. To this extent it can be seen that the potential economic gain to the importer (and opportunity cost to the exporter) is the same in either case.

Biofuels

The most notable aspect of this data is that there is very little of it. (Perhaps this is the key point.)

A table of import-export data derived from *Renewables Information, IEA (2004)* covers OECD countries only (there is no companion data for non-OECD countries) and is mostly full of zeros.[16] This is true of solid biomass, gas from biomass and liquid biofuels.

For solid biomass, only Italy stands out, importing 3,843 TJ in 1990 and 21,549 TJ in 2000. There did not seem to be a corresponding OECD country exporter. Other importers in 2000 were Belgium (4,373 TJ), Denmark (2,466 TJ), and Norway (207 TJ). Austria was an exporter in 2000 (2,067 TJ).

[16] In fact they are dashes, which is normally taken to mean zero

The only other data of any note is the beginning signs of some exporting of biofuels after 2000 (e.g. in 2003, Czech Republic 40 kT, Denmark 45 kT and Finland 52 kT). Again, there is no sign of corresponding OECD importers.

Further investigation on this matter in another IEA publication, *Renewable Energy – Market and Policy Trends in IEA Countries (2004),* provides the following insights:

- In 2001, total bioenergy supply accounted for 3% of total primary energy supply in IEA countries.
- Estimates of the economic potential of bioenergy resources in IEA countries vary from 70 EJ to more than 200 EJ per year. In 2001, the use of combustible renewables and waste was only about 7 EJ.
- Production of solid biomass in IEA countries was 5.2 EJ in 2001, representing about 80% of total combustible renewables and waste production. The renewable portion of municipal solid waste accounted for 11%, industrial waste for 5% and gas from biomass for about 4%.
- Production of liquid biofuels in IEA countries increased from 4.3 million tonnes in 1995 to 5.8 million tonnes in 2001. The US accounts for 80% of this, mostly ethanol. Other major ethanol producers are Sweden and Spain. The largest biodiesel producers are France and Germany.
- In IEA countries, the production cost of ethanol and biodiesel declined substantially over the past ten years, but is still up to three times that of gasoline and diesel. However, in some developing countries it is equal to, or lower than, the cost for fossil fuels.
- Large-scale importing of biofuels from developing countries could expand IEA markets.

Taken together, this data and information suggests that currently, international trade in bioenergy is relatively small. Countries usually use what they produce domestically. However, this could potentially change as:

(1) prices for fossil fuels in OECD countries begin to internalise a price for fossil fuel 'carbon' imposed through climate change policies in these countries;

(2) biofuels become more price competitive as oil prices increase;

(3) bioenergy targets are mandated through domestic policies, for either climate change or security of supply reasons; and

(4) industrialised countries progressively open up their domestic markets for bioenergy, in particular biofuels from developing countries.

So trade related issues of the type this paper is exploring may be something to watch as a future issue.

In this context, it is worth noting that any consideration of bioenergy derived from forest biomass can be complicated by the ongoing debate about whether the exporter or the importer should have the responsibility for emissions from the use of harvested wood products. This issue is briefly discussed in Sidebox 1 below.

Sidebox 1. Bioenergy and harvested wood products

When biomass is burned for energy, it releases CO_2, just as fossil fuels do, although emission factors are different. (Looking at the full carbon cycle, including the removal of CO_2 from the atmosphere as the biomass was grown, makes differences with fossil fuel more apparent.)

However, the inventory practice under UNFCCC reporting of CO_2 emissions has a default assumption that there are no such emissions 'for inventory reporting purposes' when biomass is burned. This is not a denial of the physical reality that there are emissions. Rather, it is to avoid the double counting of emissions. The default inventory method has in fact already counted these emissions. This is because of a conservative simplifying assumption that when standing carbon stocks in forests are reduced at the time of harvest, all this loss of carbon stock has 'there and then' been emitted to the atmosphere as CO_2. So to count the CO_2 emissions from burning biofuel would be to double count these emissions.

This issue is currently being reviewed by the UNFCCC SBSTA. These default assumptions 'for reporting purposes' have become contentious when considered 'for accounting purposes', e.g. for the Kyoto Protocol, as they now have real economic implications for countries. This is especially true when wood products, including biofuel, are internationally traded.

This paper is not the place to elaborate on the many perspectives and ideas that experts and country representatives bring to this active harvested wood products debate. But the fact that a debate is occurring and is yet to be resolved needs to be borne in mind. Any consideration of general importer-exporter issues on bioenergy that may arise from the 'bigger picture' work of this study and report are likely to be conditional on any future decision on this harvested wood products 'emissions responsibility' question.

Embodied emissions in manufactured goods

Carbon Dioxide

As could be expected, the data and analysis provided in Section 3 give the same general message as in Ahmad and Wyckoff (2003): that the embodied emissions in traded goods are significant and increasing. This is not surprising, given global trade liberalisation. The most significant importer is the US. This is not surprising either, given the size of and growth in the US economy over 1990-2000, and the substantial increases in imports of energy intensive goods from rapidly industrialising developing countries and its NAFTA[17] trade partners.

However, the results provided in Table 3 show that the US is part of a 'G7 plus Australia' suite of industrialised countries on the list of importers which were 'significant' for one or more exporters. Even this detail needs to be treated with caution, as the results of the underlying OECD study are

[17] Canada and Mexico, under the North American Free Trade Agreement

derived from analysing detailed trade figures for a subset of key importing countries. These were for countries for which input-output trade data was available to the researchers; albeit a group of countries responsible for over 80% of global GDP and CO_2 emissions.

It is likely that a more detailed and up-to-date analysis would reveal additional significant trends of embodied emissions in traded goods, including cases where the importers are developing countries, e.g. rapidly developing countries in Asia. Moreover, it is already clear that some of the key exporters of embodied emissions are developed countries (exporting to other developed countries). The issues do not simply boil down to a case of benefits to developed countries and possible disbenefits to developing countries. There is a much more complex mosaic.

Importantly, both sides of the ‘ledger’ need to be looked at. A country can be a significant importer from one or some exporters, while at the same time being a significant exporter to other countries, and being a net exporter overall.

Making value judgements about the embodied emissions import-export balance for any given country requires an understanding of what national circumstances may be at work. For example, a country that is a significant net importer of embodied emissions may be in this situation because its key energy intensive exports are hydropower based (hence not carbon-intensive), while its imports are carbon intensive. A similar country with similar imports and exports of goods could be a significant net exporter if its production of goods for export is not (or not as) hydropower based.

It gets even more complex at the industry sector level. This may be significant if sectoral-based emission responsibility proposals are to be formulated and negotiated. The data in Table 4 provides insights into the nature of the manufactured goods where the growth of embodied emissions between 1990 and 2000 is most significant. The ‘footprint’ of personal consumption by the populations of importing countries is particularly evident. But this is not unexpected, given the trade liberalisation that has occurred, and the forces of competition – both of which have seen a shift of consumer goods manufacturing to developing countries.

One standout message for all this work on embodied emissions in manufactured goods is the importance of better, more complete and more up-to-date data sets being made available to the policy analysis community. The snapshot of data looked at here, partial as it is, provides a valuable insight that confirms the significance of looking at trends in embodied emissions in traded goods. But it needs to be much improved for it to be fully usable in multilateral negotiations.

Non-CO_2

One key insight from this data is that trade in meat products is truly global, and ‘significant’ exporters and importers come from both industrialised and developing countries. The scale of changes between 1990 and 2000 is quite marked for some countries.

In terms of ascertaining whether these two snapshot years represent consistent trends into the future, it is necessary to take into account possible international food safety issues that may be occurring at given points in time (e.g. mad cow disease and foot and mouth outbreaks).[18]

Assessment of the significance of this proxy data of meat product trade flows, in terms of emissions, needs to be done at a country level and by comparison with CO_2 emissions data. For example, this data is likely to be much more significant for New Zealand than for the US, because of (1) the relative overall size of their national GHG emissions, and (2) the portion of their national GHG emissions coming from ruminant methane.

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[18] No attempt has been made here to do this.

Likelihood of compensation in the absence of policies intended for this purpose

To assess this question, the first issue to explore is what types of policies may exist that mitigate or minimise these potential costs to exporters.

One important contextual point is the current nature of the international policy regime that addresses greenhouse gas emissions, in particular the Kyoto Protocol. Most OECD countries have ratified the Protocol, but the US and Australia have not. Two OECD countries, Mexico and Korea, are not Annex B countries under the Protocol. So they do not have emission targets under its first commitment period. But the other OECD countries that have ratified do have emission targets, and hence face a direct 'cost of carbon' for emissions associated with domestic production. Also, most developing countries have ratified the Protocol, or are expected to do so. They do not have emission targets, but the Clean Development Mechanism (CDM) provides an opportunity for tradable credits for emission reductions. Hence this places an opportunity cost of sorts on their emissions.

With this context in mind, some broad points can be made:

(i) Annex B countries that are major exporters may have factored projections for this emissions load into their targets for the first commitment period. For example, while Australia has subsequently chosen not to ratify the Protocol, its self-proposed 108% target is likely to have included factoring in of projections of emissions associated with coal and gas exports, and exports of goods that have a high carbon intensity, due to Australia's predominance of coal-fired electricity generation. Similarly, Norway's 101% target may reflect their major oil and gas exporter status. Differentiation of targets is therefore one potential means to address this issue in future negotiation rounds.

(ii) In some countries and regions it can be expected that the cost of carbon will find its way to some degree into the cost of energy commodities and goods. The most notable example is in the European Union, where the EU Emissions Trading System covers major sources of CO_2 emissions, including electricity generation and carbon intensive manufacturing. To the extent that this 'internalising of the cost of carbon', does occur,[19] both EU and non-EU exporters to EU25 countries should realise a commensurately higher price for energy commodities and goods.

This raises the question, 'What about exporters to other major importers?' Other major OECD Annex B countries which have ratified the Protocol, and are major importers, have yet to fully identify and/or implement economic instrument policies that may have the effect of internalising a cost of carbon. Then there is the matter of the US, which is the predominant importer and will not ratify. The key issue in the immediate term will be whether possible state-level emissions trading programmes in the US will (1) be implemented and (2) internalise the cost of carbon into commodities and goods of the type imported. In the longer term, the question is how the US will be part of a more comprehensive international policy regime, and the extent to which such a regime internalises the cost of carbon.

In the even longer term, the issue arises of when it might be expected that a cost of carbon will be internalised into the economies of major developing country importers. While the CDM or CDM-like mechanisms can have the economic effect of placing an opportunity cost on emissions in developing countries, and thereby providing incentives for emissions reductions in

[19] This is debated given the predominance of grandparenting-based allocation of allowances in the EU ETS. Of course this may not be (as) needed in the future in the event there is a more comprehensive international regime and the competitiveness concerns that lead to grandparenting are lessened.

these countries (including investments in renewables), this is not the same as seeing an increase in the cost of energy commodities and goods in these countries.

A case for a new international crediting mechanism?

An interesting issue arises when considering the potential for increased production in developing countries of renewables-based electricity or bioenergy for use in industrialised countries. The only current carbon market mechanism directly addressing actions by developing countries is the Clean Development Mechanism. But this addresses only reductions in emissions in developing countries. What is being considered in this case is actions in developing countries (which to some extent will have associated 'upstream' emissions) that may result in significant reductions of emissions in industrialised countries.

The discussion on bioenergy in Section 4 showed that there is significant potential for increased use of bioenergy by industrialised countries, which may be imported from developing countries. There is also consideration being given, for example, to the potential for large scale imports of wind and solar-based electricity from north Africa into the Europe power grid. Looking further out, it is also possible that production of hydrogen could be done in the 'south' and exported to the 'north'. The challenges faced by industrialised countries to effect significant emission reductions in their transport sectors provide extra saliency to anything associated with renewables-based transport fuels.

Appendix B reproduces a paper written with this issue in mind in May 2005. At the time, it was possible that outcomes at the G8 meeting in Gleneagles in July could be influenced. In the event, the G8 outcomes did not get down to this level of policy specificity, but some of the general elements of the proposed action plan may facilitate further discussions of the idea put forward in this paper.

APPENDIX A. KEY REFERENCES

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APPENDIX B. A NEW CREDITING MECHANISM

A carbon market mechanism to incentivise renewables and innovation

by Murray Ward, *Global Climate Change Consultancy*

May 2005

INTRODUCTION AND CONTEXT

This short 'thinkpiece' paper proposes an idea for a new market mechanism. This could be considered as an element of a post-2012 climate change regime. It could also be trialled at a pilot scale in the Kyoto Protocol's first commitment period without any amendment to the Kyoto framework.

The idea addresses a situation (problem) that can be summarised as follows:

- The Kyoto market mechanisms provide an international framework to enable an equalised carbon price signal to be reflected in the price of energy and energy intensive goods in industrialised countries.
- But in practice this is only happening to a very limited extent. The EU ETS system will cause some level of carbon price to be internalised. But even in covered sectors (e.g. electricity generation) because of grandparented allocations it is unclear how much of the carbon price signal of EU allowances will be passed through into prices. Moreover, sectors such as transport are not covered by the EU ETS. Other major industrialised countries that have ratified the Kyoto Protocol such as Japan and Canada either have policies that will not internalise the international market price of carbon or have yet to decide if they will.
- As a consequence, any country that may seek to export a renewables-based commodity or good can only derive a carbon price value in the sale price of the commodity to the same very limited extent that the carbon price is internalised. In turn then, there is limited opportunity for a carbon price incentive being available to such countries to produce renewables-based commodities or goods, or increase the level of production sustained by the current market price.
- The same is true for innovations (e.g. technologies and systems) for which exporting countries, or entities in these countries, may need additional incentives to develop/produce for importing markets.
- In the situation of developing countries that may have national circumstance advantages for the production of land-use based commodities, e.g. biofuels, the only Kyoto market mechanism that applies to them (the CDM) does not apply in this case. This is because the CDM addresses projects in developing countries that reduce emissions in their countries not in industrialised countries.
- At the same time as some countries are calling for much deeper emission reductions by industrialised countries in the 'next' period after 2012 (in line with the stated goal of limiting climate change to 2^{o}C), emissions in the transport sector in all industrialised countries and emissions in the electricity generation sector in most industrialised countries are still on the rise.

THE IDEA: A "*RENEWABLES and INNOVATION CREDITING MECHANISM*"

It is proposed that industrialised countries create a market-based incentive through the international carbon market by creating a pool of set-aside assigned amount units (AAUs) and introducing an internationally open bid-in competitive process for projects/programmes that have as their result reductions in emissions in targeted 'problem' sectors in these industrialised countries[20].

Successful bidders would receive a guarantee of receiving Kyoto units during the commitment period upon performance of their project/programme. In turn they can 'forward sell' these units to enable them to help finance the project/programme. In this way the opportunity cost of the international price of carbon is directly provided as an incentive for these projects/programmes.

An existing conceptually similar model

As part of its domestic policy set to manage its Kyoto commitments New Zealand has implemented a mechanism called Projects to Reduce Emissions (PRE). This was implemented in 2003 and has now had two bid rounds. In 2004 it won the grand prize in NZ's Innovative Public Policy awards. When 'Point Carbon' has reported NZ as offering the highest rated JI projects, it is projects from this mechanism. So PRE is being recognised as credible, innovative and workable.

PRE has not, per se, had the international dimension discussed this paper – although even this could potentially fit with the objectives of PRE, for transportable renewables at least. But it is conceptually similar in that the NZ Government sets aside Kyoto units from its assigned amount (now 10 million over the first two bid rounds) and the promise of these upon project performance in the first Kyoto period is the economic incentive provided to successful project proponents. Moreover, there is an example of one project where a biofuels producer will be awarded units not for emission reductions in its facility but for reductions that will occur in the consumption of its product, in this case wood pellets which will offset use of coal and natural gas.

Because the NZ Government has no interest in giving away its assigned amount asset to projects that would have occurred anyway, PRE includes an additionality test including a financial assessment component. And the way the competitive tender process works, bidders are encouraged to ask for less than I unit for I tonne reduced (i.e. reveal what they really need to help make their projects financially viable). Bidders cannot ask for more than 1 unit per I tonne reduced. Through these elements the NZ Government minimises the risk of being worse off and stands to gain a little as well. Importantly, a projects mechanism such as this over time helps to shift the 'baseline' of the market settings for renewables, less GHG-intensive fuels, energy efficiency and innovation, so that in the future these gains can be achieved without needing credits, hence creating absolute emission reductions to the country's benefit[21].

In its first round, PRE also had the feature of being targeted to a specific sector and need, in this case electricity generation, because of concerns of security of supply in "very dry" years. Hydropower is the major component of NZ's supply and in a number of recent "very dry" years NZ was brought to

[20] It is not appropriate to create additional 'credits' for these reduction (i.e. like the CDM) because this would lead to 'double crediting' at the expense of the atmosphere. Because the emission reductions occur in industrialised countries, assigned amount that would otherwise need to be retired if the reductions did not occur is 'freed up' – and so is available to provide the incentive of this mechanism.

[21] For example, while PRE has supported some large early wind farms in NZ, as the wind and electricity generator industries and all the associated supporting financial and technical businesses and local regulatory players involved gain experience and reduce costs, it will be expected that wind farms will become fully economic without the need of Kyoto units – and would then not pass the PRE's additionality test.

the brink of brownouts. NZ doesn't have the option of importing electricity from a neighbour across a border.

LAUNCHING THIS IDEA

The upcoming meeting of the G8 at Gleneagles in the UK would seem to be an excellent opportunity to have as one of its 'deliverables' a commitment to implement, or at least further explore, this idea – even if just, initially, at a pilot scale.

Some reasons for this view are:

- The key themes of the G8 under the presidency of the UK include addressing poverty and development, especially in Africa, and climate change.
- The EU G8 countries are the ones calling for further (and deep) emission reductions even by 2020, consistent with the EU Council's "2^{o}C goal", also supported by key major businesses and stakeholder groups worldwide.
- Against this context, none of the G8 countries has its transport sector emissions under control, both in terms of where emissions are headed (up!) and at a policy level connecting to the international carbon market. This is also mostly true of electricity generation.
- Included in the expanded meeting at Gleneagles will be major developing country economies, some of which may represent significant potential players in renewables exports[22]. Moreover, this may be a key means for the sustainable development of these countries' economies, which in turn addresses the "eradicating poverty" theme of Gleneagles.
- The meeting includes countries that have the greatest potential for supplying climate-friendly innovations to each other and the world.
- All but one of the G8 countries have ratified the Kyoto Protocol, and all have expressed support of renewables and innovation. The one country that has not ratified could provide financial support of a form other than assigned amount units, noting that the benefits of further development in these areas will have positive spin-offs worldwide, including to this country.

Why act now?

A 2^{o}C goal implicitly means that every opportunity to reduce emissions and shift downwards the current upward emission trends needs to be seriously considered. Where technically and economically feasible (given associated projected carbon price paths) it should be acted on.

This is not a difficult mechanism to get up and running. Current 'big P' political settings, i.e. those surrounding the G8 at Gleneagles and more broadly, should be conducive not act as barriers. The New Zealand PRE model may provide a useful contribution of design and implementation ideas.

[22] Most developing countries have national circumstances very much connected to the land, i.e. rural and agricultural sectors. This is especially true of Africa, Latin America and many parts of Asia. In many cases this may mean a potential to produce biofuels or biofuel-based hydrogen for export. Some countries also have hydro potential that might be viable for hydrogen production. Moreover, some developing countries can be directly connected to power grids of neighboring industrialised country so can export renewables-based electricity. This is true even of countries in North Africa (where, for example, recent studies have pointed to a huge wind and solar thermal potential that could be utilised by Europe). These renewable electricity sources could also produce hydrogen for export where there are adequate supplies of water.

So why not act now? The world and the nascent carbon market needs some positive new initiatives!

Moreover, it would be important to consider such an idea in advance of national allocation plans in the EU ETS for the first Kyoto period (i.e. 2008-2012). This is because any set-aside of units for sectors targeted under this idea would need to be taken from any allocations (if grandparented) to these sectors if they're covered under the EU ETS. Alternatively, in the EU, the scheme could become a helpful public-private initiative between EU Governments and firms in these sectors, if these sectors are to provide units to the mechanism's pool. But, either way, this needs to be worked up in advance of NAP decisions.

Finally, ideas such as this that may have application in a broader post-2012 international climate change regime will benefit from some learning-by-doing real application. This idea can be trialled now at a contained and manageable scale.