Workshop on "The Policy Application of Consumer Accounting"

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1   Introduction

The workshop was designed to consider the application of a growing body of work that has measured the Greenhouse Gas Emissions from consumption. The majority of European experts working in this field gathered to consider the relevance of consumption based accounting to measuring progress towards equitable carbon budgets, the development of national level consumption strategies and trade policy. Finally, the workshop considered the barriers and opportunities that exist in the use of consumption based accounts.

This report provides a summary of the event, documenting the key findings of the workshop.

2   Session 1: the use of Consumption based Accounting for Measuring Progress

2.1   Presentations

Dr. Julia Steinberger (Sustainability Research Institute, University of Leeds)

Dr. Alice Bows (Sustainable Consumption Institute, University of Manchester)

Prof. John Barrett (Sustainability Research Institute, University of Leeds)

Moderator:

Adrian Gault (Chief Economist, Committee on Climate Change)

2.2   Summary of the presentations

Recent studies have demonstrated that emission reductions have been insufficient to avoid a high probability of experiencing "dangerous" climate change in the long-run. In fact, global CO_2 emissions have continued to grow. National climate policies in Annex B countries, including the UK, which have a focus on territorial emissions, are not in line with a 2°C target. Everything indicates that under the

current pathway, the world is undertaking lower-than-necessary mitigation actions and, consequently, this will require higher adaptation efforts in the future.

In the case of the UK and other developed countries, carbon intensity has improved in many sectors due to technology-induced changes. However, consumption expenditure in these same nations has simultaneously increased over the years. Specifically, there has been an increasing demand in domestic sectors, such as manufacturing, transport and services, as well as in imports (which are more carbon intensive). In this sense, consumption has offset the efficiency gains derived from technological improvements. In other words, consumption has been the primary driver of the significant rise in cumulative emissions.

Existing studies have demonstrated that it is possible to quantify with a certain level of precision the amount of CO_2 emissions that are caused by global consumption. If the emissions reduction targets were to be achieved in the UK just by reducing consumption rates, economic growth would have to decline annually by 3%. This clearly illustrates the scale of the problem. Nonetheless, if alternative solutions are to be developed, these will depend not only on our understanding of the causes, but also on how emissions are measured and in the way responsibility is allocated among countries.

Emissions will tend to be driven more by non-Annex I countries. From a production-based perspective, emissions from non-Annex I nations have already surpassed the levels registered in industrialised nations. From a CB approach, global emissions have been dominated by Annex I countries so far, but it is expected that non-Annex I emissions will overtake them very soon (although it is uncertain when this will happen). Thus, different implications are conveyed by each of these standpoints.

In both cases, it is urgent for Annex I countries to drop their emissions immediately, in order to make room for emissions increases in non-Annex I nations. Emissions in the latter group of countries, on the other hand, should experience an early peak (optimistically by 2020), so as to achieve a moderate chance of avoiding "dangerous" climate change effects in the long-run. This does not allow much room for non-Annex I nations to manoeuvre. Apart from efficiency gains derived from technological improvements, supply and demand-side measures are vital. Reductions would need to target Annex I consumption trends and supply chains. This, in turn, could help to reduce consumption-emissions growth in non-Annex I countries.

High-income nations that enjoy high-development levels produce a high level of CO_2 emissions. On the contrary, low-income countries with low-development levels generate lower flows of emissions. Under the current economic system, it is not possible to attain the best of both worlds; that is, attaining high-income and high-development levels while achieving low carbon emissions at the same time. The message is then clear: economic growth and rising consumption rates represent impediments for effective reductions.

However, this does not mean that developing nations will not accomplish higher levels of development while reducing their emissions at the same time. In 2005, the amount of CO_2 emissions per capita was approximately 1.2 tonnes on average, but it is expected that emissions across countries will tend to converge.

There is a correlation between the human development index (HDI) and CO_2 emissions per capita. A recent study has shown that the fitted curves tend to shift upwards over time, indicating that the system has become more efficient over time. This means that more development has been achieved

with less carbon per capita. The threshold of a good quality of life (HDI = 0.8) is being achieved at lower and lower carbon emissions. It is expected that the trend will continue in the future, and the threshold of 0.6 tons per capita will be achieved by 2030. However, it is not clear if this amount of CO_2 will be sufficient to achieve the 2°C target. There are some very interesting trends when you look at the curves from a consumption perspective – countries tend to cluster more closely to global trends.

2.3 Discussion

The fact the a 2°C future may be now unachievable and that the current economic model does not lead to better development levels without generating more carbon conveys a sense of despair. In fact, many scenarios present gloomy prospects. However, mainstream studies that bestow an important role on technology improvements often transmit more optimistic visions. For example, analyses sponsored by oil companies usually describe a brighter future. These contradictory views demonstrate an existing lack of consensus in the matter. It is then important to resolve these differences in order to develop viable solutions.

Drastic measures are required to tackle climate change and have a moderate chance of avoiding "dangerous" and uncertain effects. Simultaneously, adaptation alternatives should start to be planned and implemented. All this indicated the importance of moving politics in the right direction, since these are currently advancing very slowly.

2.4 Key Research Questions

- Which are the linkages between technology improvements and consumption? Does higher demand increase efficiency improvements?
- How will the rebound effects (direct and indirect) influence the level of consumption-induced reductions?
- How to create consciousness in rich countries about where and what to spend? How to introduce incentives to change consumer behaviour in rich countries (invest more in reducing emissions)?
- How to promote the low-carbon values among consumers?

3 Session 2: Development of Consumer Strategies

3.1 Presentations

Sara Eppel (Head of Sustainable Products, Department for Environment, Food and Rural Affairs)

Dr. Harry Wilting (Head of PBL Netherlands Environmental Assessment Agency)

Prof. Arnold Tukker (TNO, Delft, Netherlands and NTNU, Trondheim, Norway)

Keith James (Waste Resources Action Programme, UK)

Moderator:

Prof. Jouni Paavola (Sustainability Research Institute, University of Leeds)

3.2   Summary of the presentations

The rise in consumption based GHG emissions in the UK has been significant. Between 2000 and 2008 emissions have increased by 15%, despite a decline in territorial emissions. This represents an annual increase in emissions of nearly 2%. In 2004, the majority of the UK's GHG emissions related to the consumption of UK residents occurred overseas (54%). Over the total consumer GHG emissions, 75% relate to products for government and households and 25% from direct household fuel burning for heating and transport. The UK is not too different from other European countries all displaying a similar pattern even though they might be on different stages along this path towards growing consumer emissions and stabilising or reducing territorial emissions.

Defra's policy approach to addressing the rising consumption emissions of the UK has been:

- Influence EU for sustainable, low carbon economy with resource efficiency
- Work with industry to take account of life cycle environmental impacts through supply chain
- Understand behaviours

In terms of the direction of the newly formed coalition government the policy approach has been for less regulation and more soft (nudge) behavioural approaches. Additionally, more action from businesses and exploring the business opportunity are on the agenda. Finally, Defra will continue to update their growing evidence base on sustainable consumption and production.

As mentioned, one of the key policy outcomes is for business and consumers to raise standards and change the supply chain (eg less materials, recover materials, new tech, better performing products made and demanded). The current tools being used by the UK Government include:

- Carbon Footprinting (revised PAS 2050)
- Product Category Rules or Supplementary Guidance for food groups and home improvement
- Also consider energy/water/biodiversity
- Standards, labelling and ecodesign – 11 products regulated, Government Buying Standards, Ecolabel, 2012 review of EcoDesign Directive – big opportunity to include full impacts, Product Lifetimes report published 12 July
- Voluntary action with business – showed slide on stages of influence
- Behavioural change – showed factors that influence and the key principles that inform behavioural approaches
- To influence behaviour Defra are publishing Framework for Sustainable Living, doing action research etc.

Other presenters highlighted the wide variation in efficiencies across sectors and countries. The example of the Dutch carbon footprint was provided. Comparisons were made between the proportion of total consumption impacts by product group and production impact by industrial sector. Services have a high impact from a consumption perspective and the energy sector has a high impact form a production perspective. Clearly, there is a need to identify reduction options from both the supply and demand side. The example of meat and dairy demonstrates opportunities exist throughout the supply chain to reduce emissions. There are number of demand side options to reduce emissions. Key strategies being:

- Extending product lifetime
- Product and material substitution
- Sharing products
- Purchasing products with individualised design
- Providing services in the place of products

Again, the rebound effect was raised, mentioning it is important to address this as part of any policy. Finally, an interesting graph showing how various green products in Netherlands increased market share through first voluntary initiatives, then govt stimulation then becomes regular / standard through regulation or culture shift.

The next presenter starting by highlighting the how consumption and production based accounts can show value added by industry for final use categories, demonstrating that the system is complete and consistent. The EU EIPRO (single country) data has helped to set priorities (eg food and housing consumption categories – healthy diets, reduces emissions) (see Tukker et al 2011, Ecological Economics (in press)). The Input-Output approaches can an excellent alternative to process life cycle assessment, which, although it is more detailed, is less consistent and includes truncation errors.

Considerable attention was drawn to the UNEP Resource Panel Report that demonstrated that a doubling of consumption expenditure under current technology would result in an 80% increase in global CO_2 emission by 2050. This would mean that a factor 16 reduction would be needed.

The issue of decoupling was raised suggesting that eco-efficiency could not deliver this, raising issues of quality of life and investment in green infrastructure.

The final presenter provided evidence from a study that quantified the GHG emission reduction of different resource efficiency strategies. Resource efficiency was defined as,

"reducing the environmental impact of the consumption and production of goods and services over their full life cycle" (UNEP 2009).

The report provides an in-depth analysis of the links between dematerialisation and climate change mitigation. Methods used for Material Flow Analyses (MFA) within the wider context of industrial ecology (which includes a focus on all resource flows in an economy, not purely material tonnage) tend to focus either on detoxification and pollution reduction or dematerialisation and resource productivity. An environmentally extended input-output (EEIO) model incorporates both aspects, which need to be dealt with when looking at how to meet challenging greenhouse gas (GHG) emission targets. The approach understands both production systems and consumption patterns and has the ability through scenarios to analyse the (GHG) effectiveness of a wide range of material efficiency options.

The analysis presented adopts an environmentally extended input-output approach to assess the role of material efficiency measures in reducing UK GHG emissions by 2050. A method for projecting the variables and parameters in the model, including the supply of and demand for materials and products, is presented and applied to investigate thirteen resource efficiency strategies. It is important that the market failures associated with consumption strategies are understood in a more

detailed way. It is particularly important to understand the barriers to efficiency consumption created by the emotional life of goods versus their technical life.

3.3 Discussion

There was a great deal of discussion related to the challenges associated with intervening in production, when this production happened overseas. It was considered that the supply chain of international companies was an effective way to tackle this along with foreign policy and bilateral trade relationships. Increasing the role of business in governance of supply chains would be important and could include voluntary instruments (such as the Courtauld Commitment). It was noted that the EC had a major programme (SWITCH Asia) that aimed to influence SCP in Asia, which would be beneficial for these types of problems.

The rebound effect was discussed, in terms of time and weight – new technology has given us more time to consume and lighter technology allows us to be more mobile.

3.4 Key Research Questions

- How effective are softer behavioural change approaches to reducing consumption emissions?
- What stronger alternatives do we have to encourage demand side reductions and how politically acceptable are these alternatives?
- What do interventions derived from the consumption approach offer that is different to a territorial approach?
- How should the rebound effect be incorporate into consumption policy?

4 Session 3: Trade

4.1 Presenters

Dr. Glen Peters (CICERO)

Dr. Graham Sinden (Carbon Trust)

Dr. Karen Turner (Stirling University)

Moderator:

Prof. Michael Grubb (University of Cambridge)

4.2 Summary of Presentations

Over the last two decades, emissions from developed countries (Annex B) have stabilised, while emissions from developing nations have grown considerably. However, there has been a growing transfer of emissions from the former group of countries to the latter ones via international trade. This suggests that consumption in developed nations constitutes the primary driver of emissions. In this sense, the first group of countries have become net importers and their developing counterparts are net exporters of emissions.

The growth in consumption-based (CB) emissions has offset Kyoto reductions. Within the EU ETS, growth in embodied carbon imports is five times larger than estimates of unmitigated carbon leakage.

Trade represents the link between production and consumption on a global scale and plays an important role in transferring emissions between regions. While global GDP and emissions have grown at similar rates, international trade has expanded three times faster. Nonetheless, trade does not represent a problem in itself. The problem lies in the current production methods and consumption patterns.

There are 10 major regional flows of CO_2 emissions embedded in semi-finished/finished goods and commodities (50%-50% split) on a global scale. The top four flows originate in China, and represent significant net emission transfers to other regions in the world.

In the case of the UK, almost half of the country's emissions arising from domestic consumption are generated in foreign regions. It is estimated that by 2025 imported emissions in the UK could be as large as domestic emissions.

It is expected that the explosive growth of international trade will level out at some point. The undervaluation of the Chinese currency —a measure that has maintained the competitiveness of China's exports—, and the deficit-driven consumption in the US cannot continue forever. Otherwise, the outcome will prove to be unsustainable. However, projections have not been made in this respect.

From a consumption perspective, emissions from developed countries still exceed those from developing nations. Nevertheless, current trends indicate that emissions from developing nations might soon surpass those of industrialised countries. For example, 50% of China's growth in emissions was initially due to the production of exports, but now a larger part of its emissions account for capital investment oriented towards domestic consumption. This same pattern is found in other big emerging economies.

Modelling and data

Most consumption-based (CB) emissions analyses have relied on Multi-Regional Input-Output (MRIO) models. The drawback is that these models just show a static picture. It is important to know what has happened in the past and what will happen in the future. Consequently, dynamic models are required.

IO analysis is a special case of a wider set of models known as Computable General Equilibrium (CGE). In fact, CGE incorporates IO databases at its core. Hence, both techniques can be used together to actively model demand and supply behaviour, determine prices and quantities, as well as to examine different theoretical perspectives of how key markets function and adjust in response to a policy or external changes. These models could be particularly useful to analyse impacts on key variables from a production and/or a consumption perspective in a dynamic way.

In terms of data, there is a great deal of work required to generate reliable, global data. There are only a limited number of global databases available, and GTAP is currently used most extensively. However, it is difficult to assess the level of confidence that is involved in GTAP-based studies, due to

the uncertainties derived from the initial calculation of the data and the age of the data (currently 2004). Thus, researchers usually tend to sacrifice accuracy in preference of obtaining useful insights (such as long-term trends of global emissions). In addition, the GTAP database might be limited to address specific policy applications, such as border taxing.

There are currently several efforts to develop alternatives and improve data quality and extend it to more countries/regions, sectors/industries/products and years. For example, the OECD has started to prepare CB data and develop MRIO models to undertake this kind of studies.

Carbon leakage

Studies have not found real evidence that supports the existence of strong CL (i.e. increased emissions in Non-Annex B countries due to mitigation efforts undertaken in Annex B nations) at today's prices. However, a better assessment is required in this respect. Problems related to modelling, data and the assumptions that are used should be resolved so as to provide a definite conclusion. On the other hand, existing analyses have pointed out that weak CL (i.e. increased production in Non-Annex B countries to meet increasing demand in Annex B nations) is significantly larger than strong CL. This kind of leakage is mainly due to pre-existing policies and economic and institutional conditions. And it also shows an increasing global separation between production and consumption.

Potential solutions

There are a range of "top-down" and "bottom-up" measures to address CB emissions, which may involve only the major economies and a number of sectors/industries. Or they may well involve the whole world. Some of the measures that could be developed are:

- A CB approach to Emission Trading Systems (ETS), which might be sought in parallel to a global deal on climate change. This option might appear to be gold plated, but it is very interventionist and is difficult to implement.
- Stimulate demand for low carbon products using product carbon footprinting.
- Base carbon pricing on current value added tax (VAT) systems, which are applied directly to consumption, and is neutral in terms of competitiveness. Exports would be excluded and imports included.
- Need for increased global RD&D to reduce emissions from key carbon intensive sectors to ensure that global consumption can continue.

Border adjustments

Other measures that have been regularly proposed are border adjustment mechanisms (BATs). Some countries are currently discussing their viability. For example, Australia is analysing the implementation of border carbon rebates. However, a number of issues must be taken into account, such as discrimination (i.e. which imports/industries/countries should be included) and mutual recognition (i.e. recognise the cost of carbon already paid by producers in the region of export). On the other hand, there are a range of BATs (e.g. CB ETS, direct border pricing, certificate retirements, etc.) and measurement options (e.g. global average, best available technology, worst available technology, etc.).

It is difficult to predict when border adjustments will start to be implemented or if they will be applied at all. This will ultimately depend on the development of other alternative schemes.

4.3 Discussion

Some researchers think that mixing IPCC and WTO regulations will lead to slower negotiations. However, if measures such as border adjustments —and other related measures that deal with consumption-induced emissions— are not included in the negotiations, then it will be difficult to start discussing these issues more widely in global forums. There is particular concern over Border Trade Adjustments which may be constrained by data.

Deeper, broader and more harmonised climate policies that avoid fragmentation should be developed. Additionally, countries should build national inventories of emissions from both production and consumption-based perspectives. These inventories represent more than just numbers, since they allow identifying drivers, are useful to analyse global supply chains and contribute to design efficient policies. Moreover, these inventories should be reported, monitored and verified in order to track progress towards policy goals.

When developing policy ne need to take into account issues such as carbon leakage and competitiveness. Care should be taken with regard to cross boundary intervention. There are legal issues associated with regulating trade and this poses a significant challenge.

4.4 Future Research Questions

There are a number of issues that need to be examined.

- What should be done differently if CB accounting was adopted?
- When will the explosive growth of international trade start to level out?
- What role will international trade play in emission reductions in the future?
- When will CB emissions from developing nations surpass those of industrialised countries?
- When will border adjustments start to be implemented and what kind of impact will they produce?

5 Session 4: Barriers and Opportunities

5.1 Presenters

John Van Ardenne (European Environment Agency)

Eva (Swedish Environmental Protection Agency)

Moderator:

Professor Andy Gouldson (Centre for Climate Change Economics and Policy, Centre for Low Carbon Futures, University of Leeds)

5.2 Summary of presentations

The concept of CBA is very new to some countries and may present a significant challenge to policy makers. There may be limited capacity to develop policy on the basis of what is a relatively new evidence base. Countries report on territorial emission because they are legally obliged to. It is important that we do not use the consumption approach to disqualify the territorial approach.

Territorial accounting is embedded in national and international policy and suggesting a replacement could actually delay action. CBA should instead be promoted in parallel to territorial accounting.

The European Environment Agency (EEA) is legally obliged to deliver UNFCCC inventories. However, as part of its programme it is already looking at consumption accounting (including as part of its State of the Environment Reports). The EEA won't produce a report any time soon on consumption based emissions partly because of its obligation to report to UNFCCC. However, it's important to make data available to consumers.

For a lot of businesses and consumers action on SCP is a new message, meaning they may not be receptive to this new policy area. However, it is essential that business and consumers take action to reduce the global impact of European consumption. This will need a sophisticated policy package. Independent of any policy package designed for action on SCP we need indicators. These might include:

- Progress towards sustainable production: energy efficiency in industry
- Progress towards reducing greenhouse gas emissions
- Role of consumption: direct and indirect domestic emissions
- Role of consumption: emissions by end-user

We need to understand the methodology for quantifying these indicators and make sure the correct messages are composed. The European Environment Agency is doing a range of projects to understand data and indicators and look at existing data from a different perspective. It is important to explain to people the difference between data sources (for example, NAMEA and IPCC) especially whether data includes LULUFC.

Some countries have taken a strong position of consumption emissions (see Defra presentation for UK position). In 1999, Sweden set itself the challenging goal of solving all environmental problems within a generation. In 2008, it was recognised that Sweden had a significant environmental impact outside its territorial borders and initial work has been undertaken to calculate this impact. A report has been prepared that reviews methods for measuring the global impacts of Sweden. It identifies the strengths, weaknesses and gaps in methodologies for measurement. A new research programme will be developed to address gaps in measurement methodologies. The report summarised that Sweden can currently measure:

- GHG

A methodology is developed for:

- Chemical use

More time is needed to get data on:

- Land use (2-5 years away)
- Water (2-5 years away)
- Biodiversity (10 years away – significant work required)

A new goal has been added to the National Environmental Strategy that limits an increase in environmental and health problems outside Sweden's borders. An interim consumption strategy has been discussed but no proposals have been finalised yet.

An experiment is being run in Sweden called the One Tonne Life. It is currently 6 months in with six months remaining. A family of four is living a 'normal' but 'climate smart' life [less than one tonne carbon per capita(?)]. They have achieved a 1.5 tonne life but this was only with lots of support from specialists on retrofitting and low carbon transport [they have been given all the low carbon gadgets]. Reporting has been done by Chalmers University. The biggest challenge is the fact that the carbon 'rucksack [presumably indirect emissions] is 900kg.

5.3   Key research questions

- How can we build capacity in policy makers to more effectively use CBA evidence base?
- What is the role of business and consumers in addressing consumption emissions?
- What are the most effective and relevant indicators for sustainable consumption and production and what methods should be used to quantify these indicators?
- How can we effectively communicate the assumptions, limitations and differences of the data sources supporting CBA?

6   Summary

This section is principally based on the concluding comments of Professor Jim Skea of UKERC and CCC and the subsequent discussion.

There are two major challenges for the consumption approach to emissions accounting:

- The evidence base is at very different stages of maturity:
    - Identifying the problem and the size of the problem is mature
    - Identifying the size of the opportunity for dealing with the problem is immature (but note that there is a strong policy agenda around resource efficiency and consumer behaviour, which is very relevant).
- There is a lack of traction on political processes:
    - The climate change act has been sold as the most comprehensive climate legislation in the world and is the primary focus of policy makers in this area. However, the consumption approach could be seen to counter this legislation, which makes embedding it in policy very difficult.

The response to these issues is very dependent on whether there is a global deal of emissions reduction. However, the responsibility should be allocated to the people who have the power to change things. There is a wide scope of measures that could be used in response to these challenges, some more traditional climate and energy (which rest with DECC) and some more widely applicable to consumption and trade (which should be targeted towards Defra, FCO and cross-whitehall initiatives).

We need to infiltrate these policy systems with messages appropriate to the people who are implementing change but we need to be aware that the consumption approach will never replace territorial emissions accounting.

Accepting the consumption approach requires a huge leap in concept, accounting methodology and politics so will not happen immediately. We need to be willing to push policy makers gradually, perhaps using an incremental approach from production, to production plus. For example, import charges on cement are potentially acceptable – we could build on this.

There has been a lot of academic debate on the likelihood of a global deal and there is still a great deal of uncertainty surrounding this. However, it is interesting to note that this has been addressed more explicitly in the private sector. In scenarios developed by Shell, even in the more positive and sustainable scenario commentary (their blueprints scenario) identified that there would not be complete multi-lateral agreements. Early evidence suggests that we are more closely following their 'scramble' scenario where action would be unilateral and that indigenous sources of energy would dominate. This would indicate that a multilateral agreement was a long way off; but probably years, rather than the decades.

We know that there is a great deal of work required to improve the reliability of data that supports CBA both in how it is gathered and how it is used. We need to be aware that certain types of policy and monitoring and reporting require robust data, and there is not sufficiency confidence in CBA data for it to be used for this purpose at present. Revisions to territorial reporting to improve the sectoral disaggregation of emissions accounts, supporting data collection in non-annex B countries and improving the reporting of trade data would go a long way towards improving the quality of CBA data. However we should not let data challenges prelude action. We can already derive a great deal of evidence from historical trends and high level analysis.

There may be benefit in improving our understanding of the distribution of emissions across different geodemographic groups. It can be restricting to assume that there is an 'average' consumer, whereas in reality there is a great deal of variation in expenditure patterns and drivers of consumption across groups in society. This could help to focus behaviour change policy more effectively towards the consumption patterns of these groups. However, it is clear that there will be political resistance to this approach and that sophisticated fiscal policy in this area is difficult. Means testing of benefits is difficult enough – means testing of taxes would be impossible.

But in parallel to improvements to data, we need to think about what the CBA approach tells us about different or extra action that is required over and above the territorial action that would be happening anyway. This may be supported by producing a comprehensive document outlining the current application of the CBA approach to demonstrate how much it is supporting policy development already.

So what would we do if there was a global deal? One of the first things we could do is to adjust territorial caps to reflect consumption emissions but CBA should not replace territorial accounting for two reasons;

- there is a territorial based legal structure already in place and replacing this with consumption could lead to a situation of mitigation inertia, which we cannot afford to introduce.
- Territorial accounts are required to produce consumption accounts

When considering policy in this situation we may find that national action may have limited or no effect globally. It would be beneficial to identify things you can do at a national level that more cost

effectively reduce global emissions. In addition to that we need to identify ineffective policy and perverse subsidies[1] and find the things we are doing at a national level that make no sense globally. For example shale gas – it has a very high carbon impact relative to natural gas. If we are replacing current infrastructure with gas to reduce carbon intensity it may actually backfire if intensity of gas [as a result of switch to shale gas] increases.

We need to identify proactive measures that would address lifecycle emissions. For example by adding I/O into the Markal model. There has been some excellent work on the embedded impacts of renewable technologies: we may emit more emissions through technology production than we would save from decarbonising the UK energy system.

The focus today has been on resource efficiency and behaviour change – this is good but we need a long term vision for resource efficiency. Taking the example of energy – a lot of kit is being developed and delivered but what is the consequence of this on industrial structure [which would affect i/o data] and on carbon emissions [of producing kit]. Consumer behaviour change is good but it's difficult for organisations like CCC to quantify the effects and as a result targets are all very technocratic at the moment.

Trade is starting to feature in discussions of emissions and this is right and good. However, politicians, in particular, are nervous of border adjustment and mixing climate and trade policy. This could make international negotiations very difficult – the WTO could really slow down action and we may need to explore some of the softer ways in which emissions in trade could be addressed.

Sectoral agreements are interesting and were strongly promoted by Japan in recent negotiations. However, the UK sees them as an obstacle to a universal cap and trade system. As a result, 'softer' agreements – using benchmarking and information flows – may have a lot more potential.

We need to find the thin end of the wedge and apply it.

We need to find what is unique about this area and how to take it forward.

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[1] For example, the recent IEA review of national energy policies and the OECD programme to investigate Fossil Fuel subsidies, which found that globally the subsidy was $20-25/tonne carbon, completely overwhelming the EU ETS price of 15 Euros/tonne. UKERC came across similar challenges while working with UAR on Clean Energy Policy – subsidised FF (eg petrol costs significantly reduced for locals) posed an enormous challenge.