

# OPEN (One Planet Economic Network)

*Building the evidence base,  
applications and capacity to  
support sustainable consumption  
and production*

## TECHNICAL REPORT - Part F

*Energy & waste*

*A report to WWF-UK*

June 2006



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# Status of this report

This report is a consultation draft version 0.9 as of August 2006.

Consultation responses will be compiled, together with the results of a consultation workshop, and incorporated in the final version. There are 3 key documents available for consultation:

1. OPEN – Consultation questions
2. OPEN – Prospectus (main report)
3. OPEN – Technical Report:
  - Part A – policy & research framework
  - Part B – macro-economic modelling
  - Part C – food & international trade
  - Part D – built environment
  - Part E – products & services
  - Part F – energy & waste

This last is available as a set of pdf files from [www.ecologicalbudget.org.uk](http://www.ecologicalbudget.org.uk) Hard copies are available by request.

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# Contents

1. Introduction .....	7
1.1 The One Planet Economy Network.....	7
1.1.1 The Ecological Budget UK.....	7
1.1.2 Role of this paper .....	8
1.2 Consultation questions .....	8
1.3 Activity sector framework.....	10
1.3.1 Resource flow template.....	10
1.3.2 Abbreviations in tables .....	12
2. Energy & climate .....	13
2.1 Energy and climate.....	13
2.1.1 Profile of the sector.....	13
2.1.2 Towards Factor 4 .....	14
2.1.3 Summary & questions.....	14
2.2 Towards a policy framework.....	15
2.2.1 Main themes in the policy framework .....	15
2.2.2 Current UK policy .....	16
2.2.3 Fossil fuels program.....	18
2.2.4 Renewable energy program .....	18
2.2.5 Micro-generation & distribution program.....	19
2.3 Energy: model framework.....	19
2.3.1 Key trends and drivers .....	19
2.3.2 Energy: resource flow effects .....	20
2.3.3 Energy: activity model settings.....	21
2.3.4 Energy: economic model .....	21
3. Waste & resources.....	22
3.1 Waste & resources.....	22
3.1.1 Profile of the sector.....	22
3.1.2 Towards Factor 4 .....	23
3.1.3 Summary & questions.....	23
3.2 Waste & resources: policy framework .....	24
3.2.1 Overall policy objectives .....	24
3.2.2 Economic profiles .....	24
3.2.3 Technical profile .....	25
3.2.4 Current policy review .....	25
3.2.5 Sustainable resource management program.....	26
3.2.6 Sustainable waste management program .....	27
3.2.7 Sustainable packaging program: .....	27
3.3 Waste & resources: model framework .....	28

3.3.1 Waste & resources: resource flow model.....	28
3.3.2 Waste & resources: activity model settings .....	29
3.3.3 Waste & resources: economic model.....	29
4. Appendix .....	30
4.1 Glossary .....	30

# 1. Introduction

*This section is an introduction to the Ecological Budget UK project, the OPEN program, and the OPEN consultation.*

## 1.1 THE ONE PLANET ECONOMY NETWORK

In a world of accelerating climate change, deforestation, urbanization, water scarcity and a host of other problems, it is clear that new models of sustainable development are needed.

The “*One Planet Economy Network*” (OPEN) is working towards a more sustainable future for the UK and its place in the world. This is based on the ‘*One Planet*’ agenda for transformation of the economy, to one which works within global resources and limits.<sup>1</sup>

The OPEN Prospectus and main report highlights the challenges and targets to 2050, and the scale of the changes needed in the UK economy. It shows the beginning of an evidence base in the UK accounts, and the applications to setting targets and actions. It sets out a process for building of intelligence, and invites contributions to help achieve this.

The One Planet Economy is a huge concept, with many dimensions and many uncertainties. This is why it is set out as a ‘framework’ method and ‘network’ process – not aiming at fixed solutions, so much as a coordinated investigation and discussion, taking these questions forward step by step.

### 1.1.1 The Ecological Budget UK

The Ecological Budget UK is a unique evidence base for sustainable consumption and production. The project was funded by the Biffaward trust and others, and run by WWF-UK, in collaboration with the Stockholm Environment Institute and the Centre for Urban & Regional Ecology.

At the core of the Ecological Budget UK is a method of calculating the flows of carbon, materials and eco-footprint, from every type of consumption and production in the UK economy, allocated by regions and devolved countries (Wales, Scotland, Northern Ireland).<sup>2</sup>

The Ecological Budget UK is unique in that it shows:

- the total global impact of UK production in 123 sectors, and consumption in 68 categories, including imports and exports:
- the upstream and downstream impacts of each sector or activity:
- the distribution of consumption impacts between regions, local authorities, and social classes.

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1 There general foundation for this is in the One Planet Living program of WWF – [www.wwf.org](http://www.wwf.org) and its application in the Global Footprint Network – [www.gfn.org](http://www.gfn.org)

2 See the report ‘Counting Consumption’ and further details on [www.ecologicalbudget.org.uk](http://www.ecologicalbudget.org.uk)

Each of these is shown by three key measures: material flow, climate emissions (CO<sub>2</sub>) and eco-footprint.

The UK Baseline Report “*Counting Consumption*” presents a comprehensive set of physical accounts, covering carbon, resource flows and ecological footprint from consumption and production in the UK regions and devolved countries. Several regional applications were drawn from this in the North West, North East and West Midlands. Interactive access to this data is provided through the “*REAP toolkit*”, a software package for analysis and assessment of future scenarios and policy options.

#### 1.1.2 Role of this paper

This paper forms part of a series comprising a lengthy Technical Report, to be continued as work in progress. It is designed to fit within the methodology of the OPEN program and the Ecological Budget UK: further details can be found in the OPEN main report and Technical Report Part A. All materials are available on [www.ecologicalbudget.org.uk](http://www.ecologicalbudget.org.uk) and [www.eco-region.org](http://www.eco-region.org)

This paper is a demonstration of the *framework approach* and the *network process*. Clearly, global supply chains have huge impacts, from developed to developing nations, and the challenge of increasing overall resource efficiency by a Factor Four seems an almost impossible dream. Yet the need is clear, if humanity is to survive and prosper equitably on the resources of one planet. There are also many technological and institutional solutions around, as well as barriers, conflicts, policy traps and so on. To put these together needs a *framework approach* – an open minded coordination of many kinds of evidence from different sectors and bodies at various levels. It also needs a *network process* – building the capacity of stakeholders for foresight and learning.

Overall, this paper is work in progress for the framework approach to evidence building, pointing the way to lines of research and action for the coming years.

- We do not claim to present final solutions, as the significance is more in the debate and research process.
- We do not show very detailed quantitative outputs, at this point, as the focus of discussion is more on institutional questions.

#### 1.2 CONSULTATION QUESTIONS

The questions below are raised for each of the sectors in the Technical Report: i.e. food & farming: built environment: transport: goods & products: commercial services: public services: energy & emissions: resources & waste.

Please supply your responses on the sectors wherever you have expertise, using the forms overleaf as a guide. Each response might be anything from a short note marked up on the form, to an extended discussion. The main form is reproduced in each of the technical reports.

Where possible the research team will follow up selected responses by phone. Otherwise, respondents are invited to submit a marked up form and/or extended responses by email. Responses will be treated in strict confidence, unless permission is given for attributed quotes. When complete, please return email responses and/or marked up forms to:

Stuart Bond, WWF-UK, Panda House, Godalming, Surrey GU7 1XR  
[sbond@wwf.org.uk](mailto:sbond@wwf.org.uk)

Question	Example	Response
1. What is your estimate of the most probable trend in resource use in your sector, by 2020 and/or 2050?	(e.g. rapid rise: some increase: no change: reduction: rapid fall)	
2. What is the likelihood of achieving a Factor 4 resource efficiency in your sector, by 2020 or 2050?	(e.g. very strong, probable, possible, unlikely, impossible)	
3. What are the main priorities for action in achieving a Factor 4 efficiency in your sector?	(e.g. new technology: tax & spend policy: infrastructure: behaviour change: regulation & planning, etc).	
4. What are the most significant barriers and challenges to achieving a Factor 4 efficiency in your sector?	(e.g. too expensive, too risky, consumer resistance etc).	
5. If there is a realistic chance of achieving a Factor 4 efficiency, who has the main responsibility for making this happen?	(e.g. government, local authorities, businesses, retailers, consumers, media, new technology).	
6. If government needs to take a lead, what are the most important actions they should take?	(e.g. taxes, subsidies, investment, procurement, regulations, infrastructure: local, regional or national?)	
7. If business needs to take a lead, what are the most important actions they should take?	(e.g. new technology, pollution control, longer product life, higher efficiency, changes to retail etc?)	
8. If consumers and retailers are involved, how can current trends of growing material consumption be altered?	(e.g. ethical trading, health scares, education & marketing, media features, community action, spiritual change?),	
9. If international trade is significant in your sector, what are the most important changes which are needed?	(e.g. trade liberalization, ethical trading, economic partnerships, overseas investment, tariffs & quotas?)	
10. Are there any other issues which are important to the question of achieving / not achieving a Factor 4 efficiency in your sector, by 2020 and/or 2050?		

## 1.3 ACTIVITY SECTOR FRAMEWORK

### 1.3.1 Resource flow template

To structure the research process we use a *'framework' approach* to coordinate a wide range of physical, economic and political issues. This is based on summary tables of resource flow effects and fiscal policy to move towards the Factor Four (F-4) goals, in each of the activity sectors, as arranged by the resource flow chain. Note that the F-4 scenarios contain 2 main variations, for high / low fossil fuel prices.

The modelling challenge is then to consider which of these measures is directly represented, proxied or assumed by other means, in each of the potential modelling methods.

Below is the 'general' template which shows the expected pattern of change in resource flows and their implications, right across the economy and policy landscape. This is then interpreted in detail for each of the 8 activity sectors, as shown in other sections of the Technical Report series.

Each of the activity sectors then divides into 2-3 *'policy programs'*, i.e. clusters of supply chains and demand types, as follows. Each of these programs is identified with a *fiscal balance*:

This shows either *'net income to public'* or *'net expenditure from public'*. This is a summary of the anticipated pattern of fiscal flows in the F-4 scenario, which looks at the potential for a strategic redistribution and re-investment, from one sector to another.

	Material sources	Manufacturing	Logistics	Services	Demand side 1	Demand side 2	Products in use	Externalities
PHYSICAL	Import %, source, extraction mode	Energy in production	Transport distance & mode	Tertiary activity & value added	Intensity & utilization factors	Consumption / mode choice	Product life: energy efficiency	Waste, recycling, emissions
F1 – projection	Import % growth:	Decoupling rate = growth rate	Air freight growth					Continuing disposal
F4 - scenario	Import reduction	Rapid energy efficiency	Low impact modes	Increased material recirculation	Increased utilization	Switch to low impact products	Increased product life & re-use: higher efficiency	Integrated resource management
Policy options	Resource protection	New processes: new products	Integrated supply chain mgmt	ICT based markets / exchanges	Utilization incentives	Integrated planning & resource mgmt	Regulation / quotas / labelling	Regulation / legal liability
ECONOMIC	Commodity prices: market effects	Fuel costs: factor & finance cost	Int. transport fuel / transaction cost	labour costs: investment costs	Consumer exp / saving: discount rate	Market behaviour: stock turnover	Product life: energy prices in operation	External costs / impact charges
F1 – projection	Prices stay low	Fuel / material costs level	Fuel costs level	Service sector growth	High time preference & short term investment	Efficiency gains overtaken by increased spend	Fixed capital increases	UK costs internalized, others externalized
F4 - scenario	Prices rise	Fuel / material costs rise	Fuel costs rise	Investment & share value linked to CSR	Low time preference & long term investment	Lower quantity, higher quality purchases	Increased product life & re-use: higher efficiency	Total costs internalized & marketized
Policy options	Commodity levies / tariffs	Carbon tax: public procurement for clean technology	transport fuel tax: Multi-lateral aviation tax	Incentives for CSR & environ.mgmt	Public procurement for market transform	Incentives for demand side management	Eco-labels & incentives for product life & efficiency	Emission & eco-services trading schemes
INSTITUTIONAL				Service economy / social economy	Utilization choices	Behavioural choices	Operational choices	Waste practices
Policy options	International developmt: ethical trading	Producer responsibility & env management	CSR & Env.managem ent	CSR	Social economy & civic society	Social economy & civic society		

- Horizontally, the template is arranged from material sources to production, distribution, consumption and externalities, in the order of the input-output tables.
- Vertically, the template is arranged by the two main scenarios, F1 baseline and F4 target: and then the ‘policy options’ i.e. the range of likely measures which may achieve the transition from F1 to F4 scenario.
- *Physical effects* are to be tested and calibrated in the REAP modelling system, as far as possible.
- *Economic effects* are to be tested and calibrated in the MDM modelling system, as far as possible (see section below).
- *Social / institutional* issues are there for reference and for the scenario narratives. It is not expected that these can be modelled directly.

Also, there are relationships between the physical options and economic policy options, as on the template. In some cases the economic policy is a means to achieve the physical policy (e.g. new technology in production). In other cases the physical policy is a means to achieve the economic policy (e.g. spatial planning in order to reduce transaction costs, in turn to promote

recycling). Arguably, most options available to government fall into the first category, and most available to business are in the second, but there are many exceptions to this.

### 1.3.2 Abbreviations in tables

In addition to the general ‘resource flow scenario’ table above, there are two further tables shown for most sectors:

- ***Activity model setting*** table: this shows sample figures for the main scenario variables and policy levers. These are intended to be built into the REAP ‘***activity model***’ in the next phase.
- ***Economic policy table***: this shows the broad shape of fiscal policy and identifies the items with significant macro-economic implications.

Within the tables, the abbreviations include –

*Italics shows exogenous / endogenous effects - % refers to annual change from baseline in the F-4 scenarios.*

**Normal type shows other related policy measures: z% refers to approx proportion of total revenue in that sector which is to be re-invested.**

**x%:y% refers to x% of total sector GVA in tax: then y% annual growth in tax rate.**

Normal type shows other related policy measures: z% refers to approx proportion of total revenue in that sector which is to be re-invested.

‘MT’ = market transformation

‘CCL’ = Climate Change Levy

## 2. Energy & climate

### 2.1 ENERGY AND CLIMATE

#### 2.1.1 Profile of the sector

Energy is very topical at the time of writing – the DTI Energy Review, the Stern Review on the economics of climate change, and the DEFRA Climate Change Programme Review, are all current – even while more urgent estimates arrive daily, of more extreme events and risks from climate change.

This sector focuses on the supply side to meet energy demand, as generated from each of the other sectors, i.e. food, shelter, transport, products, services and public. In many ways the energy question is at the heart of the OPEN agenda. If current energy supply systems can be *de-carbonized*, and then the options *de-materialized*: and if other land-use and environmental impacts can be greatly reduced, then effectively the level in energy demand is not an issue – the OPEN goals could be achieved even with rising energy demand. However in practice it is more plausible that changes will be spread across the board, at each stage in the chain from supply to demand.

Following the logic of the supply chain template, there are several agendas to consider:

- Fuel sources, resource depletion, and the impacts of each fuel option.
- Energy conversion and distribution technology, i.e. for electricity or other medium
- Direct emissions and waste, and energy system life cycle impacts

In terms of technological options for supply, several kinds of policy packages can be considered (pending the various policy reviews above):

- Conventional fossil fuels – phasing out due to likely resource depletion & price rises
- Alternative fossil / new coal technology – possible rapid development, with a changing impact profile, i.e. cleaner burn, but strip mining overseas.
- Diverse combinations for various UK and local renewable sources.
- Potential for bio-fuels for transport – possible greater environmental impact.
- Potential for shift to new technological platform – i.e. hydrogen
- Replacement nuclear plants to maintain the current fraction of UK electricity: albeit life-cycle costs and risks.

There is also a national / regional policy and economic agenda, with added social dimensions. Energy is increasingly a globalized industry, with larger UK / EU inter-connectors planned for gas and electric. The majority of UK distribution is now foreign-owned, and UK fuel self sufficiency is declining. However there are new opportunities for renewable and embedded

generation at the local / regional level. Energy security is a key concern, in the light of international tension.

#### 2.1.2 Towards Factor 4

One over-riding question can be framed as – *peak oil vs emissions controls?* – i.e. will the oil (and later on the gas) start to run dry, or if not, then how climate emissions should be contained otherwise by policy. If the latter case, then there are further questions at national and international level, i.e. targets vs trading: taxes vs quotas: and offsets vs emissions.

A further over-riding question is whether nuclear energy development is a valid response to the decarbonising of the electricity supply industry, as suggested by the DTI Energy Review.

Demonstrating an alternative to direct regulation, the European Trading Scheme (ETS) is so far more or less successful, the only drawback being that a tonne of carbon is trading at €20-30, a small fraction of its estimated social cost of damage.<sup>3</sup>

Is there a valid response for the OPEN in the face of such complexity and controversy? The OPEN approach suggests a ‘no-regrets’ approach to UK energy policy – in other words, working with the uncertainties of emissions trading, market prices, technological innovation and so on, to provide the optimum steps forward, which are technologically robust, low risk and low impact. This ‘*zen and the art of climate maintenance*’ is likely to put the focus back on demand side management in the sectors above: to encourage UK renewable sources with embedded generation: avoid technologies with long term risks and uncertain hazards: encourage sources with spin-off benefits such as rural economies, and so on.<sup>4</sup>

#### 2.1.3 Summary & questions

Main resource effects on the energy supply side:

- Shift to renewable sources with low impact storage technology
- Energy diversity and flexibility maintained
- Embedded sources and generation with spin-off benefits.

Main economic effects of this program:

- Expansion of EU emissions trading scheme.
- International levies on carbon in transport fuel.
- Tradeable quotas on commercial and domestic energy use.
- Fiscal effect on the average household: no net change, where generally rising energy efficiency balances rises in unit costs, across all sectors.

Key public messages and questions for survey:

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<sup>3</sup> The social cost of carbon is considered in the Technical Report Part A

<sup>4</sup> Rayner & Malone 1998

- “Green energy on your doorstep
- “Wind power - protecting your children’s climate.
- “Would you pay a penny per litre to support your local planet?”

Key issues & questions – many strategic options:

- The big energy supply questions: low impact fossil fuel, nuclear or renewables?
- Large scale globalized / small scale decentralized grids?
- Political economy of utility privatization – reliable energy security, flexibility, diversity vs lowest cost?

## 2.2 TOWARDS A POLICY FRAMEWORK

The energy policy framework here focuses on the technology and logistics on the supply side: (the demand side is covered in detail in the other sectors, although there is overlap in the case of building micro-generation, etc).

- Fossil fuels
- Renewables
- Micro-generation / co-generation and distribution
- Nuclear – this is a challenging issue which is not covered specifically in this project.

### 2.2.1 Main themes in the policy framework

General objectives: supply side and demand side management to meet –

- climate emissions targets, focused on decarbonisation of supply
- footprint targets where different, for other non-carbon impacts
- energy security, reliability, diversity, economic vitality etc

Achieving these goals would rest on three main platforms: each takes something of the aspirations of the DTI Energy Review and turns it into a solid framework.

### ***Public ‘stewardship’ of energy & climate emissions.***

- This implies an expansion of the EU Emissions Trading Scheme, as soon as this is more stable.
- The ETS would contain a long term cap reduction strategy at the target rate: between -2% per year for the IPCC targets, and -3.3% per year for the Factor Four targets.
- The government would take a larger share than the current allowable 5%, and auction these permits.
- The revenues would be re-invested in further R&D and low impact infrastructure.

### ***Progressive allocation***

The current debate on DTQs may continue for some time, as the mechanics of such a scheme could be very challenging, even while the concept is very attractive and timely. However the notion of progressive allocation between households and businesses may be achieved in various ways, with the objectives of least cost allocation, encouraging behaviour change and encouraging efficiency investment:

- Progressive tariff structures: either at point of use, as in housing: and/or at point of investment, as in vehicle purchase.
- Credit transfers,
- ‘Energy services’ requirements on utilities, as hinted at in the DTI Energy Review.

### ***Diversity & localization***

The localization of energy supply and demand is not only a technical matter, as generally presented in the DTI Energy Review. It also has the potential to re-direct investment and change behaviour at the community and neighbourhood level, where a localized public stewardship may be very effective.

- Net fiscal effect on the average household: no net change, where generally rising energy efficiency balances rises in unit costs, across all sectors.

In one sense this policy framework should add up to more than a set of fiscal and regulatory measures. It amounts to a new kind of institutional platform, or compact between society, energy providers and users. The concept of stakeholding or ***public stewardship*** emerges as the political and ethical underpinning of the wide range of market and technical options.

#### 2.2.2 Current UK policy

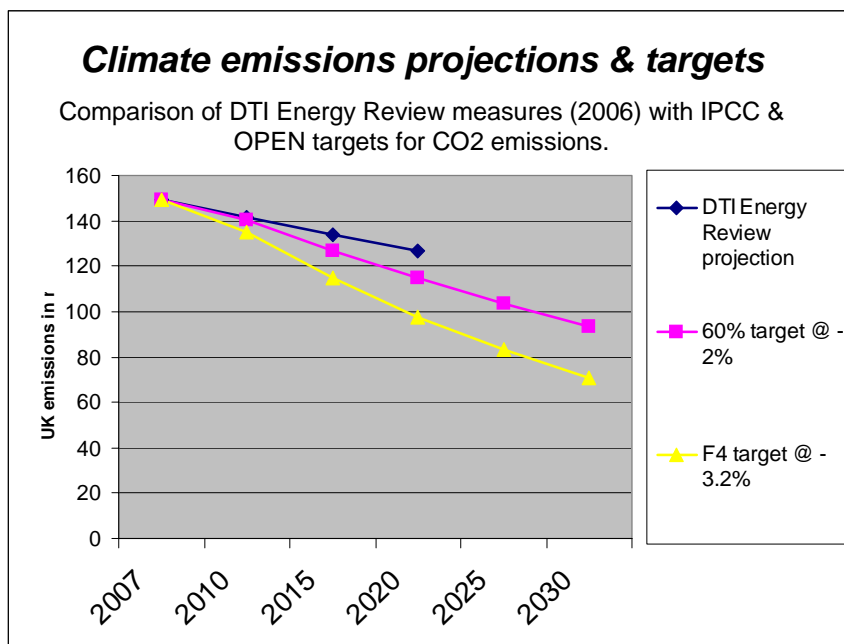
The DTI Energy Review (2006) sets out a large package of measures designed to ensure energy security and environmental sustainability. There are criticisms on all sides, to the effect that actions are shorter than words, but it is generally recognized that the government at least takes the agenda seriously.

The net effect of the measures has been estimated at 22.5 MtC reduction from current projections (the actual figures are not made clear in the report).

<b>Carbon impact of government measures announced since the 2006 Climate Change Programme Review (except where denoted†)</b>	
	<b>MtC abated in 2020</b>
Better Billing	0 – 0.1
Changes to the Renewables Obligation <sup>1</sup>	0.7 – 1.5
EU Emissions Trading Scheme <sup>2</sup>	8
More energy efficient products <sup>3</sup>	2
Nuclear new build <sup>4</sup>	0 – 1.1
Renewable Transport Fuel Obligation	0.3 – 1.1
New measure for achieving carbon savings from large non-energy intensive organisations	1.2
Successor to EU voluntary agreements on new car fuel efficiency <sup>5</sup>	1.8 – 2.1
Continued commitment on energy suppliers to 2020 <sup>6</sup>	3.0 – 4.0
†Continuation of building regulations 2005 <sup>7</sup>	2.5 – 3.0
Carbon neutral government <sup>8</sup>	0 – 0.8
Carbon neutral developments <sup>9</sup>	0 – 0.4
<b>Total</b>	<b>19.5 – 25.3</b>

This amounts to a reduction path of approximately -1.2% per year (calculated from 2007-2020). This is additional to those proposed by the Climate Change Review (2006), but this was focused on short term actions by 2010 for the Kyoto targets.

This is just over half of the reduction path required by the government's own 60% target. It is just over one third of the reductions proposed of the OPEN Factor Four target, at -3.2% year on year.



	2007	2010	2015	2020	2025	2030	growth rate
DTI Energy Review projection	149	141.5	134	126.5			-1.20%
60% target @ -2%	149	140.24	126.76	114.58	103.58	93.62	-2.00%
F4 target @ -3.2%	149	135.15	114.87	97.63	82.97	70.52	-3.20%
DTI Energy Review possible extension	149	139	129	119			-1.80%

However if we add in the further possible measures suggested by the DTI Energy Review, the situation at least to 2020 looks more positive, if quite uncertain. The targeted reduction is then a reduction of -1.8% per year, not far from the IPCC target rate of -2% per year.

<b>Further possible measures suggested by DTI Energy Review</b>	
surface transport to be included in EU ETS: quite uncertain	4.0 - 7.0
pilot carbon capture & storage scheme	0.3
additional nuclear power stations: doubling existing scale of proposals:	1.1
<b>TOTAL possible savings MtC: mean 6.9</b>	<b>5.4 – 8.4</b>

### 2.2.3 Fossil fuels program

#### ***Net fiscal balance – revenue to public***

- ETS scheme: we propose that the scheme introduce over a period of time, a ‘public stakeholding’, which will provide both a public collateral and stabilization force in the market. The alteration of the cap (target) can then proceed more smoothly by policy objective, and can be set in advance for greater transparency. As with treasury bonds, the government can then adjust its level of equity or liquidity by trading its stakeholding, releasing funds for investment where needed.
- The transport fuel duty needs to continue on the escalator, where it has stalled due to public sensitivity and high oil prices. There is a presentational problem, in that the public see much pain for no gain. Possible sources of incentive include – credits for purchasing alternative fuel vehicles: ‘travel impact miles’ as in the inter-modal section above:
- Extension of the transport fuel duty to non-carbon fuels, based on assessment of the eco-footprint. This aims to capture the land and community impacts of palm olive or rapeseed production, which can be severe, and in some cases more than the fossil fuel impacts.
- At the same time there may be public support needed for the alternative fuel distribution network. This may be modest seed funding, public procurement conditions, or simply preferential treatment in siting and planning permissions.
- Ethical trading & CSR accreditation for oil supply chains: to be instituted through the public procurement & contract specification supply chain. This would aim towards a ‘fair trade’ oil / gas accreditation as an industry standard.

### 2.2.4 Renewable energy program

#### ***Net fiscal balance: expenditure by public***

- The renewables obligation needs to be extended and strengthened. We propose that the direct subsidy level for each technology be adjusted in inverse proportion to the life cycle

carbon / footprint impacts of the technology, i.e. so that the lowest impact technologies attract the highest rates of subsidy.

- Further development is to be achieved mainly through the public procurement and associated supply chains. All buildings directly or indirectly funded by public investment should include for ZED standards and local renewable sources: the resulting market will then be of a size where only small seed corn funding will be needed to achieve a viable market by the private sector.
- There is an extra-over cost for the public procurement, generally estimated at 1-2% of total building costs: this may be funded through the ESCO route, i.e. advance finance based on future savings.

#### 2.2.5 Micro-generation & distribution program

##### ***Net fiscal balance: expenditure by public***

- Micro-generation (local CHP, fuel cells, heat pumps etc) should be a standard specification for all buildings directly or indirectly funded through public procurement. The extra over costs can be managed as above.
- For local distribution of direct heat / cooling, this is a clear case of market failure, or at least missed opportunities. There is a strong case for the public sector to take the lead in laying down essential infrastructure for the longer term, which can then serve the changing needs of firms or householders. However there are problems with commercial uncertainty and payback periods. There are also uncertainties where heating demand is undermined by higher efficiency standards.
- With the onset of climate change in the urban environment it may be that the future demand is more in cooling services than in heating, however this so far has not been designed in to anything but the largest buildings. In reality the distribution networks are a very small fraction of development land values or overall development costs. We propose that a requirement to provide or contribute to an infrastructure fund is built into planning conditions on any urban masterplan scheme, just as with transport or other connections.

## 2.3 ENERGY: MODEL FRAMEWORK

### 2.3.1 Key trends and drivers

- ***Renewable supply*** (from the region): the regional renewables strategy if implemented, would provide a total of 9% of the regional power supply. There would be a small contribution to space heating by various means.
- ***Heat direct supply***: this includes estimates of localized renewables and the effects of building design on heating requirements – i.e. passive solar energy. This does not often figure in engineering assessments, as it is technically outside the system of production and distribution. Potential design improvements for passive solar energy can amount to 50% of household energy demand, if the increasing requirement for summer cooling is taken into account.
- ***Combined heat and power %***: this is generally framed in terms of co-generation with district heating (CHP-DH).

- **Energy recovery:** this is the counterpart to the same item on the waste account, showing the energy contribution of the WTE programme.

### 2.3.2 Energy: resource flow effects

ENERGY								
	Material sources	Logistics	Manufacturing	Services	Demand side 1	Demand side 2	Products in use	Externalities
<b>PHYSICAL</b>	Import %, source, extraction mode	Transport distance & mode	Energy in production	Tertiary activity & value added	Intensity & utilization factors	Consumption / mode choice	Product life: energy efficiency	Waste, recycling %: waste mgmt: emissions
<b>F1 – projection</b>	Coal & tar: nuclear: some renewable	Import % rising from Africa, Asia			UK final energy demand 1% growth			UK CO2 emissions – level
<b>F4 - scenario</b>	Shift to renewables	Embedded & local renewables where possible	New power generation technology	Energy services	UK final energy demand --1% reduction	Direct heat & cooling	Design for ultra-low energy	UK CO2 emissions – 3% reduction
<b>Policy options</b>	Resource protection	Integrated supply chain mgmt	New processes: new products	ESCOs & similar	Diversified energy grid	Infrastructure for heat distribution	Stock replacement programme	
<b>ECONOMIC</b>	Commodity prices: market effects	Int. transport fuel / transaction cost	Fuel costs: factor & finance cost	labour costs: investment costs	Consumer exp / saving: social discount	Market behaviour: stock turnover	Product life: energy prices in operation	External costs / impact charges
<b>F1 – projection</b>	Energy prices stay low		Energy prices stay low		UK final energy demand 1% growth			UK costs internalized / other externalized
<b>F4 - scenario</b>	Renewables costs reduce	International transport costs rise	Energy prices rise	Investment & share value linked to energy eff	UK final energy demand --1% reduction	Investment based on triple accounting	Incentives for ultra-efficient products	Total costs internalized
<b>Policy options</b>	Renewable development incentives	International fuel tax	Carbon levy: public procurement for clean technology	Tax incentives for partnership investment	Public procurement for energy transform	Cross-subsidy for demand side management	Eco-labels linked to tax incentives	Emission trading scheme enlarged
<b>INSTITUTIONAL</b>				Service economy / social economy	Utilization choices	Behavioural choices	Operational choices	Waste practices
<b>Policy options</b>	International development & ethical trading	CSR	Producer responsibility: env management	CSR	Regional Partnership energy agencies	Social economy & civic society	Education for ZED design & operation	

### 2.3.3 Energy: activity model settings

PUBLIC									
	Import %, source, extraction mode	Manufact & material productn	Logistics & distribution	Tertiary activity & value added	Demand intensity & utilization	Demand type / mode choice	Product operation	Waste / emissions	Overall trend projection
Ratios		X	X	X	X	X	X	X	=
Core factors	Energy int. of av. extraction	Energy int of manuf.	Trans distance in supply chain	Energy int. of service value add.	Social utilization in demand	Total demand	Energy int. in use	% total MF to waste	Av energy per unit material demand
Linked factors	Material options		Energy int.of transport mode	Energy int distribution chain	Stock / consumption level	Product type choice	Utilization factor in use	% waste not recycled	
Other linked factors	Other impact of extraction	Other impact of manuf.	Other impacts by mode	Packaging etc		Product life turnover			
F1 – core factors	+0.5%	-0.5%	+1%	+1%	+0.5%	+0.5%	-1%	-0.5%	1.5%
F1 – linked			+1%	+1%	0	0	-0.5%	-0.5%	
F1 – other				+1%		1%			
F4 – core factors	-0.5%	-1%	0	+0.5%	0	0	-1%	-1%	-3% (target)
F4 – linked									
F4 – other									

### 2.3.4 Energy: economic model

ENERGY											
	Primary sources	Manufact & material productn	Logistics & distributn	Tertiary activity & value added	Demand intensity & utilization	Demand type / mode choice	Product operation	Waste / emissions	Overall projection	Revenue policy	Revenue policy
Fossil fuel program	Extraction duties extended		Transport fuel levy extended to non-fossil fuels					Emissions trading scheme - extended			Support for alternative fuel infrastructure
Renewable program		Renewables obligation extended								Renewable subsidy / procurement specs	
Micro & distribution program					Planning conditions for infrastructure contribution					Public procurement specs for micro	

## 3. Waste & resources

### 3.1 WASTE & RESOURCES

#### 3.1.1 Profile of the sector

Waste management policy is in a state of flux at the time of writing, with the UK waste strategy review in progress, along with the waves of incoming EU directives.

The sector as defined here, covers the economic activities of waste recovery and disposal, material re-manufacturing and recycling, sewage and other sanitary services, other material flows in agriculture, power generation and so on. The agenda for 'sustainable' waste management also raises more general questions on the flow of resources around the material economy, as explored in section 4:

- Waste management & recycling is a small sector in economic terms, but clearly very significant in terms of resource flow;
- One key issue in resource flow terms is not only the quantity of re-use / recycling, as the quality of end-uses
- A Factor 4 economy would see the main flows of materials as secondary – recycled, re-manufactured, re-used materials and products would become the default choice for most forms of production and value added.

In UK policy terms the main current reference point is the landfill levy 'escalator', which increases to £21 per tonne in 2006. At the point when it reaches £35 per tonne, then other waste recovery technologies may become comparable in terms of pure cost. However as with other infrastructure issues, there are strong lock-in effects to capital investments and supply contracts. Experience shows that economic incentives need to be combined with institutional & behavioural incentives, which are otherwise hard to shift.

#### **SCENARIO BOX - WASTE vs RESOURCES in 2050**

It seems remarkable now that the UK used to put so much stuff in holes in the ground, as recently as 2006 – one calculation showed that £1 in every £15 profit in industry was binned.

Actually, we had to go through several decades of confusion and controversy. There were protest riots on incinerator projects, chemical sabotage of sewage plants, and huge lawsuits against landfill operators for loss of property values.

Who could bring together manufacturers and packagers together with distributors and housing managers? Surprisingly, local schools turned out to be the catalyst. When it came to creative re-use of packaging, re-manufacturing of products, recycling of oddments and so on, no-one could beat the kids. In fact, working out how to deal with all that stuff seemed to have very high educational value, in an otherwise overheated service sector world. So when the energy crunch came in the 2030's, and raw material prices shot through the roof, schools and the neighbourhood social enterprises which grew around them did very well indeed.

The result – rather than use the bin bags which are now about £15 a time to empty, people walk down to the re-manufacturing shed with all their old bits and bats, and come back with furniture, audio stuff or whatever. Of course the big retailers didn't like it, and some went under rapidly. Then finally they realized they could actually shift their operations to higher value added lines.... But that's another story.

### 3.1.2 Towards Factor 4

By implication, the different objectives of waste recycling, waste recovery and waste minimization are not necessarily converging to one win-win solution. Rather, they may be in competition for technological options and available resources. The framing of the agenda itself as a ‘waste’ issue is in a way foreclosing other more constructive approaches which lie upstream.

A OPEN approach to a Factor 4 resource / waste system would aim towards an integrated market transformation approach. Here, product design, material sources, logistics systems, consumer services, and fiscal incentives are all to be integrated with the available resources coming through the waste stream. The example of the Irish tax on plastic bags shows how a modest economic measure can coordinate with changing awareness, to result in major improvements in the waste stream.

### 3.1.3 Summary & questions

#### Main resource effects

- All manufactured products designed for re-use & recycling
- All packaging designed for re-use & recycling
- Industrial clusters & networks designed around material cascades
- Increased secondary owners’ markets for waste minimization

#### Main economic effects:

- Material / waste levies on international trade to raise prices of raw materials,
- All packaging on deposit-return / trading schemes
- Climate levies on manufacturing & distribution: re-invested to industrial innovation.
- Public procurement incentives for market transformation
- Economic structural shift from resource added to value added activity.
- Budget effect on the average family: overall saving on household expenditure, due to lower council tax & lower material prices: balanced by higher waste disposal unit costs.

#### Key public messages and questions for survey:

- “Minerals don’t grow on trees
- “How much of your household income is going in the bin?”

#### Key issues & questions:

- Given the acceleration in many technological innovations, is increased recycling and re-manufacturing of products realistic?
- How much more expensive should materials become in order to encourage more material recovery and recycling?
- Could the UK waste disposal shortfall be solved by sending waste to China in return load containers?

### 3.2 WASTE & RESOURCES: POLICY FRAMEWORK

This module concerns the ‘supply’ of waste and resource management services, to meet demand for material transfers, which is generated from other sectors. There are 3 main policy programs:

- Sustainable resource management: recycling, re-use & re-manufacturing
- Sustainable waste management: recovery & disposal methods
- Sustainable packaging program: includes containers, packaging, product ancillaries, logistics ancillaries etc

#### 3.2.1 Overall policy objectives

As waste is often a complex and contradictory sector, any economic policies should be as clear as possible about the kind of objectives they are designed to achieve. We could summarize these:

- Behaviour change on the consumer & community level so that waste is avoided, sorted, re-used, sorted for recycling, etc.
- Behaviour change on the producer & distribution side, so that waste is avoided, sorted, re-used, sorted for recycling, etc.
- System change in packaging, so that all forms of packaging are designed for deposit- return, re-use and recovery, and the financial incentives are there to encourage that.
- A national network of resource management hubs, from local to inter-regional scale, connected by low impact transport modes wherever possible. Each of these acts as material stockpile, sorting depot, recovery plant, re-use exchange point and so on, at the appropriate scale.

#### 3.2.2 Economic profiles

The current economic profile of the sector as of 2005:

- Materials in the waste management system: 120m tonnes per year
- Waste management GVA: £4-5bn:
- Combined GVA of waste, sanitary & sewage industries: £11bn
- Landfill levy income: £900 m per year

Policy target economic profile, as at 2030: this suggests broad changes based on the resource flow frameworks below:

- Materials in the waste management system: 80 m tonnes per year
- Waste & resource management GVA: £6-8bn
- Gross income to government: £1800m per year
- Re-investment in R&D, infrastructure & community programs: £900m per year

### 3.2.3 Technical profile

The position of waste in the resource flow framework needs to be identified, so that its role in the OPEN or Factor Four targets can be assessed.

Based on recent data from the REAP system and recent Environment Agency survey of commercial and industrial waste, calculation is in progress for the total embodied climate emissions and eco-footprint. Generally there are a number of ways to assess this:

- Waste as representing a proportion of material inputs, with calculation of the embodied energy / footprint as a proportion of inputs: more significant for industrial waste.
- Waste as representing a residual element of material outputs at the consumption side: more significant for post-consumer waste
- Waste as disposable packaging (a major portion of MSW), which represents the organization of the logistics more than consumption or production.
- Commercial waste arising from non-material intensive industries, can be difficult to categorize.
- Wastes from primary industries, mostly non-controlled, such as agriculture and mining, represent technical operations and not necessarily materials lost, until the displacement and disturbance is significant in itself.
- In each of the above cases, the potential for energy recovery or other bio-mass recovery can be offset against the opportunity costs of the waste material.
- In each of the above cases, the logistics, handling and waste management method itself has energy, climate and emissions impacts.

### 3.2.4 Current policy review

The DEFRA Waste Strategy Review is out to consultation at the time of writing. The broad theme is that much progress has been made since 2000, but much remains to be done.

“In revising our strategy we need to build on this progress to make sure that we meet our Landfill Directive targets and other European commitments. But we also need to shift the emphasis for the future:

- putting greater focus on waste prevention and embedding this in the wider Sustainable Consumption and Production (SCP) agenda alongside other environmental impacts;
- seeing waste as a resource and extending a recycling and re-use culture beyond the home to workplaces, shopping and leisure activities;
- highlighting sustainable waste management in the non municipal sectors (over ten times the size of household waste including commercial, industrial, construction, demolition, mining and quarry wastes which have varying characteristics) with greater integration of planning and procurement between municipal and some non-municipal waste; and
- securing technologically efficient investment in the treatment of waste in each part of the chain. Previous relatively cheap landfill ‘solutions’ are not an option and the step-change in investment that has already begun will need to gather pace.

Looking forward we expect that:

- there will be continuing growth in household waste but at a reduced rate;

- national household waste recycling and composting rates of more than 40% in 2010 and 45% in 2015 could be reached (comfortably exceeding the current targets of 30% and 33%);
- meeting the landfill directive diversion targets for municipal waste in 2010, 2013 and 2020 remains challenging but achievable; but depends on necessary investment soon in new facilities, including those to increase materials recovery and recover energy from waste where there is no reasonable prospect that it can be recycled or composted;
- without further action there will be some growth in commercial waste overall, with significant growth in some sectors;
- the *WS2000* target for use of landfill for industrial and commercial waste in 2005 is likely to be met and recycling is set to increase, but a continuing decline in the use of landfill will be difficult to achieve across all sectors;
- target levels of recycling of packaging waste, waste electrical and electronic equipment (WEEE) and end-of-life vehicles (ELV) are expected to be met by the stated deadlines but will need to be maintained at least at these levels thereafter."

Most of the measures proposed for consultation are strengthening of existing, rather than radically new. The general implication is that the OPEN targets will require more radical thinking which works right across the board – technology, logistics, economics and particularly behaviour change in businesses and households.

### 3.2.5 Sustainable resource management program

This program concerns the part of the waste management industry which is little understood and under-resourced, the re-entry of materials and products back into the industrial system.

- This concerns the handling of the ‘recycleates’ and ‘re-usables’ which have already entered the waste stream.
- It also concerns product design, process design, materials handling, materials logistics and consumer behaviour. For instance a ‘car boot sale’ is a demonstration of re-use through exchange of goods which might otherwise go into the waste stream.

#### ***Overall fiscal balance: net expenditure from government.***

This implies an overall transfer of resources from waste management to resource management. In other words, levies on disposal would increase to a point where not only external costs were recouped, but re-investment was funded on a major scale.

This sector is possibly the most indirect in terms of the econometric modelling approach, i.e. we need broad proxies for material costs offset, income / expenditure balance from waste programs.

Generally it may fall to the public sector to lead the investment in a new generation of infrastructure, mainly through a targeted public procurement coupled with incentive-based credits.

The policy framework would look at the following:

- Investment in a national network of resource management hubs, from local to inter-regional scale, connected by low impact transport modes wherever possible. Each of these acts as

material stockpile, sorting depot, recovery plant, re-use exchange point and so on, at the appropriate scale. Such investment would be done as pump-priming of PPP arrangements, through the public procurement route.

- Re-manufacturing R&D & recycle market development: increase the investment in WRAP, Envirolink and others, in order to target substances, industrial sectors, and exchange facilities.
- information systems: national real time database & tracking system for waste / resource movements, exchanges and economic incentives (the e-bay of the waste world).

### 3.2.6 Sustainable waste management program

Includes household MSW, commercial & industrial, special waste streams

#### ***fiscal balance: net income to public sector***

- Landfill levy escalator: the current level of £21 per tonne for MSW is some way off the current target of £35 per tonne, which is thought to be the average industry cost of recycling. However if the institutional barriers, transaction costs and market failures are taken into account, then possibly a much higher rate of £70 per tonne would be more effective in achieving the objectives. (C Mitchell paper).
- ‘end fate levy’ – applies to all materials / products at the point of sale (industry-industry or business-consumer), which do not demonstrate a known recovery / recycling / re-use pathway.
- Special wastes: e.g. electronics: producer-responsibility take back scheme, i.e. for every battery or appliance sold, the manufacturer is obliged to take a proportion back, or pay an enhanced ‘end-fate levy’ geared to the toxicity of the materials. The proportion would increase over time towards 100%. This would push up the market price of returned goods towards the levy or shadow cost equivalent. Question over imported goods??

### 3.2.7 Sustainable packaging program:

Including containers, packaging, ancillaries, logistics devices e.g. pallets

#### ***fiscal balance: net neutrality of income / expenditure***

##### ***Summary of policies:***

- Packaging recovery note scheme: strengthen and widen the scheme to all forms of packaging, containers, product ancillaries etc
- The main instrument for the above is proposed as the ‘End fate packaging levy’ - – applies to all materials / products at the point of sale, which do not demonstrate a known recovery / recycling / re-use pathway. This is a form of producer responsibility scheme designed to encourage re-use, deposit-returnable containers etc. E.g. a producer will put drinks in bottles with a levy: the consumer will claim the deposit on return to the retailer: the retailer will handle and return the empties for a proportion of the income.
- Community packaging credit program: this recognizes that behavioural change and community attitudes is the other side to the whole agenda. With a system of neighbourhood

level promotions and kerbside infrastructure, coupled with a community fund for local environmental improvements, providing direct rewards for community behaviour change.

### 3.3 WASTE & RESOURCES: MODEL FRAMEWORK

#### 3.3.1 Waste & resources: resource flow model

WASTE								
	Material sources	Logistics	Manufacturing	Services	Demand side 1	Demand side 2	Products in use	Externalities
PHYSICAL	Import %, source, extraction mode	Transport distance & mode	Energy in production	Tertiary activity & value added	Intensity & utilization factors	Consumption / mode choice	Product life: energy efficiency	Waste, recycling %: waste mgmt: emissions
F1 – projection	Import % growth:	Air freight growth	Decoupling rate = growth rate					Continuing disposal
F4 - scenario	Import reduction	Low impact modes	Rapid energy efficiency		Increased utilization		Increased product life & re-use: higher efficiency	Integrated resource management
Policy options	Resource protection	Integrated supply chain mgmt	New processes: new products	ICT based markets / exchanges	Utilization incentives	Integrated planning & resource mgmt	Regulation / quotas / labelling	Regulation / legal liability
ECONOMIC	Commodity prices: market effects	Int. transport fuel / transaction cost	Fuel costs: factor & finance cost	labour costs: investment costs	Consumer exp / saving: social discount rate	Market behaviour: stock turnover	Product life: energy prices in operation	External costs / impact charges
F1 – projection	Prices stay low	Fuel costs level	Fuel / material costs level	Service sector growth	High time preference & short term investment	Efficiency gains overtaken by increased spend	Fixed capital increases	UK costs internalized, others externalized
F4 - scenario	Prices rise	Fuel costs rise	Fuel / material costs rise	Investment & share value linked to CSR	Low time preference & long term investment	Lower quantity, higher quality purchases	Increased product life & re-use: higher efficiency	Total costs internalized & marketized
Policy options	Commodity levies / tariffs	Multi-lateral aviation tax	Carbon tax: public procurement for clean technology	Incentives for CSR & environ.mgmt	Public procurement for market transform	Incentives for demand side management	Eco-labels & incentives for product life & efficiency	Emission & eco-services trading schemes
INSTITUTIONAL				Service economy / social economy	Utilization choices	Behavioural choices	Operational choices	Waste practices
Policy options	International development: ethical trading	CSR	Producer responsibility: env management	CSR	Social economy & civic society	Social economy & civic society		

### 3.3.2 Waste & resources: activity model settings

PUBLIC									
	Import %, source, extraction mode	Manufact & material productn	Logistics & distribution	Tertiary activity & value added	Demand intensity & utilization	Demand type / mode choice	Product operation	Waste / emissions	Overall trend projection
<b>Ratios</b>		X	X	X	X	X	X	X	=
<b>Core factors</b>	Energy int. of av. extraction	Energy int of manuf.	Trans distance in supply chain	Energy int. of service value add.	Social utilization in demand	Total demand	Energy int. in use	% total MF to waste	Av energy per unit material demand
<b>Linked factors</b>	Material options		Energy int.of transport mode	Energy int distribution chain	Stock / consumption level	Product type choice	Utilization factor in use	% waste not recycled	
<b>Other linked factors</b>	Other impact of extraction	Other impact of manuf.	Other impacts by mode	Packaging etc		Product life turnover			
<b>F1 – core factors</b>	<b>+0.5%</b>	<b>-0.5%</b>	<b>+1%</b>	<b>+1%</b>	<b>+0.5%</b>	<b>+0.5%</b>	<b>-1%</b>	<b>-0.5%</b>	<b>1.5%</b>
<b>F1 – linked</b>			+1%	+1%	0	0	-0.5%	-0.5%	
<b>F1 – other</b>				+1%		1%			
<b>F4 – core factors</b>	<b>-0.5%</b>	<b>-1%</b>	<b>0</b>	<b>+0.5%</b>	<b>0</b>	<b>0</b>	<b>-1%</b>	<b>-1%</b>	<b>-3% (target)</b>
<b>F4 – linked</b>									
<b>F4 – other</b>									

### 3.3.3 Waste & resources: economic model

WASTE											
POLICY PROG RAMS	Primary sources	Manufact & material productn	Logistics & distributn	Tertiary activity & value added	Demand intensity & utilization	Demand type / mode choice	Product operation	Waste / emissions	Overall projection	Revenue policy	Revenue policy
<b>Waste program</b>		End fate levy: 10%:5%			Community credit scheme			Landfill levy escalator to £70	All EU directive targets	ZEW Procurement policies	
<b>Resource management program</b>		End fate levy: 10%:5%			Market development via procurement				F-4 targets	Resource management hubs	Investment industrial symbiosis R&D
<b>Packaging program</b>		End fate packaging levy: 10%:5%	100% Producer respons scheme		HH deposit return				ZEW packaging / logistics		Integrated logistics infrastructure

## 4. Appendix

### 4.1 GLOSSARY

BATNEEC	‘best available technology not entailing excessive cost’
BAU	‘business as usual’ scenarios
BPEO	‘best practicable environmental option’
CAP	Common Agricultural Policy
CE	Cambridge Econometrics
COICOP	national database of household expenditure
CSR	corporate social responsibility
CURE	Centre for Urban & Regional Ecology
DA	devolved administration, i.e. Wales, Scotland, Northern Ireland
DBFO	design, build, finance & operate scheme
DCLG	Department of Communities & Local Government
DEFRA	Department of Environment, Food and Rural Affairs
DPSIR	‘driving forces, pressures, state, impact, response’ framework for indicators
DOT	Department of Transport
DTI	Department of Trade and Industry
EA	Environment Agency
EEA	European Environment Agency
EFTA	European Free Trade Area
ETS	Emissions Trading Scheme
EU	European Union
F-4	factor four reduction scenario
GDP	Gross Domestic Product
IA	integrated assessment
IO	input-output methodology
ICT	information & communications technology
IPCC	Inter-Governmental Panel on the Scientific Assessment of Climate Change
IPPC	‘integrated pollution prevention and control’
ISEW	‘Index of Sustainable Economic Welfare’
LCA	‘life-cycle analysis’ of environmental impacts
NHS	National Health Service
ODPM	Office of the Deputy Prime Minister
ONS	Office of National Statistics
OPEN	One Planet Economy Network
OST	Office of Science & Technology
PFI	Private Finance Initiative
RDA	Regional Development Agency
REEIO	Regional Economy-Environment Input-Output (software model)
REAP	Resource Analysis Programme (software model)
RSS	Regional Spatial Strategy

RSDf	Regional Sustainable Development Framework
SA	sustainability appraisal
SCPnet	'Sustainable Consumption & Production network'
SEA	strategic environmental assessment
SEI	Stockholm Environment Institute
WFD	EU Water Framework Directive
WTO	World Trade Organization
WDA	waste disposal authority