

Valuation of energy use and greenhouse gas emissions for appraisal and evaluation

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1

Introduction

This document is a supplement to HM Treasury's Green Book¹ and provides guidance on how to value Energy use and emissions of Greenhouse Gases (GHGs) in Options Appraisal when working on policies, programmes and projects for Business Cases and Impact Assessment reporting. Valuing both energy use and greenhouse gases is vital in order to ensure that full account of changes in energy use and GHG emissions is built into decision making. The guidance on Options Appraisal should be understood against the background of Green Book guidance on Appraisal and Business Cases. Guidance on Risk management is available in HMT's Orange book² and on post implementation Evaluation of policies, programmes and projects in the Magenta³ book. Guidance on Impact assessment reporting is available from the Better Regulation Executive. This guidance also outlines the reporting requirements for compliance with **carbon budgets** and **cost effectiveness** of climate change policies.

This guidance should be used to help assess proposals leading to an increase or a reduction in energy use or GHG emissions in the UK, it covers proposals that have a **direct** impact on energy use and supply and those with an **indirect** impact through planning, construction, land use change or the introduction of new products that use energy. Government departments and their subsidiary bodies must also carry out **carbon impact assessments**, as required by the revised BRE Impact Assessment guidelines.⁴ This requires analysts to quantify the carbon impacts of their policies and to value significant impacts using the revised carbon valuation methodology (July 2009).⁵

There is a complementary **spreadsheet calculation toolkit**⁶ designed to convert increases or decreases in energy consumption into changes in greenhouse gas emissions.⁷ This spreadsheet also contains the latest assumptions for carbon values,

¹ The Treasury Green Book available at the <http://www.hm-treasury.gov.uk/data_greenbook_index.htm>

² The Orange Book is available at <http://www.hm-treasury.gov.uk/d/orange_book.pdf>

³ The Magenta Book on Evaluation is available at <http://www.nationalschool.gov.uk/policyhub/evaluating_policy/magenta_book/>

⁴ <http://www.berr.gov.uk/whatwedo/bre/index.html>

⁵ See http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/valuation/valuation.aspx

⁶ The toolkit can be downloaded from the carbon valuation web page of the DECC website available at http://www.decc.gov.uk/en/content/cms/statistics/analysts_group/analysts_group.aspx

⁷ Where the change in energy is expressed in terms of a change in energy production the toolkit should not be used. However, the fossil fuel price and carbon values tables in this guidance can be used to help value changes in the level and type of energy production.

energy prices, long run variable energy supply costs, emission factors and air quality damage costs over the 2008–2050 period. For many proposals with a relatively modest impact on energy use and/or emissions, the accompanying spreadsheet toolkit will complete all of the calculations required.

In addition to this guidance and the spreadsheet toolkit, further background analysis (including guidance on policy evaluation) and explanations of the methodology used for this guidance can be found at the IAG webpage on the DECC web site⁸

This guidance was last updated in **October 2011**. It will continue to be reviewed and will be updated in the light of continuing improvements in the understanding of energy markets, climate change and the policy environment. Any questions on this guidance, the spreadsheet toolkit or the background information should be addressed to: GHGappraisal@decc.gsi.gov.uk.

⁸ See http://www.decc.gov.uk/en/content/cms/statistics/analysts_group/analysts_group.aspx

2

Valuation of Energy Use and Greenhouse Gas Emissions

This chapter is about valuing the energy use and GHG emissions effects occurring as a result of a proposed policy, programme or project as required for the purposes of appraisal and evaluation by the Green Book.

A spreadsheet tool has been developed which automatically performs the calculations required to derive values for changes in energy use and GHG up to the year 2100. A step-by-step user guide for this tool can be found in Annex A. The data tables underlying the methodology can be found at the end of this document and can be downloaded in excel format from DECC's Interdepartmental Analysts Group (IAG) web page at http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/valuation/valuation.aspx.

Where a proposal is likely to require the use of large quantities of imported materials such as steel, concrete or bio fuels some of this material may be from countries without carbon pricing arrangements and so the material costs will not include the cost of the GHG used in their production. Such large scale projects need to identify and include this material at a value which is adjusted to take account of the carbon emission, in such cases guidance should be sought from DECC at GHGappraisal@decc.gsi.gov.uk.

The following sub sections of this chapter from 2.1 to 2.7 explain the calculations which are performed by the spreadsheet. A few very large scale (so called non marginal) proposals may be on scale which would be big enough to affect the long run assumptions for factors such as the marginal cost of energy which underlie the data used in this guidance. In such cases the spreadsheet tool and tables should not be used and alternative analysis will be required, guidance on which should be sought from DECC at GHGappraisal@decc.gsi.gov.uk. Whether the proposal is likely to be 'significant' in this sense is a decision that must ultimately be taken by those responsible for appraising the policy in question, advice may however be sought from DECC at GHGappraisal@decc.gsi.gov.uk.

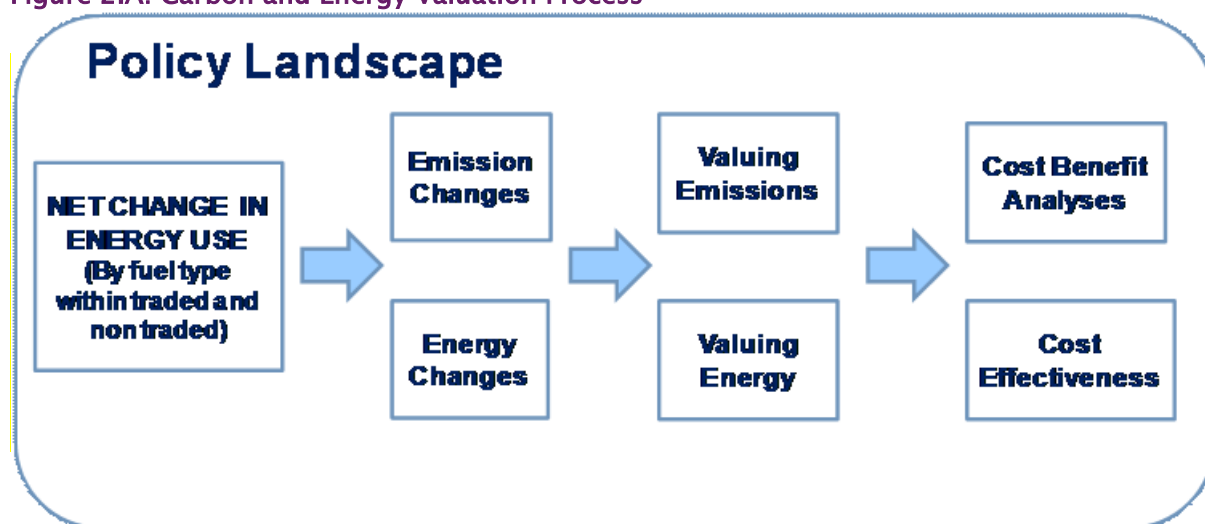
A policy that changes energy use will translate into changes in emissions and changes in energy supply. A value for the former is arrived at by converting all emissions into tonnes of carbon dioxide equivalent (section 2.2) and then valuing them using the carbon valuation methodology (section 2.3), whereas changes in energy supply are valued using estimates of the long-run variable costs of energy (section 2.5). Figure 2.A provides an illustration of this.

2.1 Option Appraisal

For all proposals, the short list of options which are appraised in detail must include the “do nothing” option to provide the counterfactual. A “do minimum” option should also always be included as a check against more interventionist action, and this also represents the counterfactual in cases where it is not possible to ‘do nothing’.

The counterfactual includes all policies to which the government is already committed and which have funding. DECC’s latest energy model projections will therefore need to be referred to.¹ The most up-to-date set of emissions projections can be obtained by contacting <GHGappraisal@decc.gsi.gov.uk>. Forecasts produced by the Department for Transport will need to be referred to for transport measures.

Figure 2.A: Carbon and Energy Valuation Process



It is important to include all changes in energy use and UK GHG emissions occurring as a result of a proposal, not just those occurring within the immediate sector or scope. For instance, planning decisions may impact on transport emissions as well as emissions from buildings.

2.2 Policy Overlaps and Synergies

It is also important that the combined effects of policies are assessed and that policies are not just assessed individually. Overlaps may sometimes reduce the combined effectiveness of policies. For example, the savings from the installation of a more efficient boiler will be lower in a house that already has cavity wall

¹ <http://www.decc.gov.uk/en/content/cms/statistics/projections/projections.aspx>

insulation. On the other hand, other policies may have synergies that make the combined effects greater.

Policies that are correlated (because of overlaps or synergies) should be treated together in subgroups. The values should be given for the total of the policies making up the sub-group. For example, the climate change levy and the negotiated agreements would be a correlated group and therefore only one expected value, highest value and lowest value would be needed for the combination.

2.3 Quantifying Greenhouse Gas Emissions

Energy used can be input to the spreadsheet tool to derive a valuation of the resulting GHG effects. These values are appropriate for proposals which are unlikely to affect the long run costs of energy supply. Very large proposals which are likely to impact on long run energy supply costs will need to be analysed differently and advice should be sought from <GHGappraisal@decc.gsi.gov.uk>. For proposals which involve a sizeable quantity of goods produced abroad, also see section 2.6.

Energy use is converted into a corresponding amount of CO₂² by multiplying fuel use (in kWh, therm, tonne or litre) by a fuel-specific (and unit specific) marginal emission factor:

$$\Delta \text{ Emissions} = [\Delta \text{ fuel}_F \times \text{ Marginal Emission factor}_{\text{Fuel}}]$$

Marginal emission³ factors for different fuel types are reported in **Tables 1, 2a and 2b** available from the DECC's IAG web page.⁴ The emissions factors will be kept under review and updated as necessary as they are subject to considerable uncertainty in the long-term, particularly in the electricity sector where it is unclear what type/mix of generation will constitute the marginal source of electricity supply.

All changes in GHG emissions should be presented in tonnes of carbon dioxide equivalent (tCO₂e). The table below shows the equivalence factors.⁵

² Prior to 2007, figures for changes in GHG emissions were presented in terms of carbon (C). Any such figures should be converted into units of CO₂e using the conventional conversion factor of 44/12 (e.g. 1 tonne of C emissions is equivalent to 1 x (44/12) = 3.67 tonnes of CO₂e).

³ For policies that directly change the level or type of energy production the toolkit should not be used and analysts should draw on the relevant tables in this guidance to calculate the value of the change in emissions and energy production.

⁴ http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

For more information on the methodology used to derive the emissions factors and the variable costs of energy see background documentation (Chapter 2) available on the IAG web page on the DECC's web site. See http://www.decc.gov.uk/en/content/cms/statistics/analysts_group/analysts_group.aspx

⁵ The conversion factors in the table 2.A incorporate (GWP) values relevant to reporting under UNFCCC, as published by the IPCC in its *Second Assessment Report, Climate Change 1995. The Science of Climate Change. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change*. (Eds. J. T Houghton et al, 1996). Revised GWP values have since been published by the IPCC in the Fourth Assessment Report (2007) but current UNFCCC Guidelines on Reporting and Review, adopted before the publication of the Fourth Assessment Report, require emission estimates to be based on the GWPs in the IPCC

Table 2.A: Emission Factors for converting Greenhouse Gas Emissions into Carbon Dioxide Equivalents

Greenhouse Gas	Global Warming Potential per unit weight
Carbon Dioxide (CO ₂)	1
Methane (CH ₄)	21
Nitrous Oxide (N ₂ O)	310
HFC - 134a	1,300
HFC - 143a	3,800
Sulphur hexafluoride	23,900
Carbon Dioxide as Carbon	3.67

Second Assessment Report. A second table (Table 5b) includes other greenhouse gases not listed in the Kyoto protocol or covered by reporting under UNFCCC. These GWP conversion factors have been taken from the IPCC's Fourth Assessment Report (2007). See Annex 5 of Guidelines of Defra's GHG conversion factors for company reporting available at <http://www.defra.gov.uk/environment/business/reporting/pdf/20090928-guidelines-ghg-conversion-factors.pdf>

Box 2.A How to use an emissions factor to convert changes in energy use into changes in emissions for appraisal of policy A

An energy efficiency programme is being considered which reduces the use of gas by householders. Gas consumption is cut by 10GWh (10 million Kwh) relative to the “do nothing” option in each year between 2011 and 2020. Table 1 below demonstrates how this change in energy use is multiplied by the appropriate marginal emissions factor (see table 2a in the supplementary excel tables⁶) to calculate the change in emissions.

Table 1: Calculating changes in emissions

	2011	2012	2013	...	2018	2019	2020
Change in energy use, GWh	-10	-10	-10	...	-10	-10	-10
Emissions factor (gas, table 2), tCO ₂ /GWh (kgCO ₂ /Kwh)	183.2 (0.183)	183.2 (0.183)	183.2 (0.183)	...	183.2 (0.183)	183.2 (0.183)	183.2 (0.183)
Emissions saving, tCO ₂ (MtCO ₂)	1832 (0.0018)	1832 (0.0018)	1832 (0.0018)	...	1832 (0.0018)	1832 (0.0018)	1832 (0.0018)

2.4 Valuing Greenhouse Gas Emissions

The changes in GHG emissions derived above, expressed in tonnes of carbon dioxide equivalent, now need to be valued in monetary terms.

The EU Climate and Energy Package (December 2008), introduced separate emissions reduction targets for the traded sector (that is those emissions covered by the EU Emission Trading System), and for the non-traded sector (that is those emission not covered by the EU Emission Trading System). The presence of separate targets in the Traded and Non-Traded sectors implies that emissions in the two sectors are essentially different commodities. Changes in emissions which occur in the traded sector are valued at the Traded Price of Carbon (TPC), whereas changes in emissions in the non-traded sector are valued at the Non-Traded Price of Carbon (NTPC). These traded and non-traded prices are currently different, but will converge, becoming equal in 2030 and subsequently following the same trajectory. This is based on the assumption that there will be a functioning global carbon market by 2030. Table 3 available from the DECC's IAG webpage⁷ details the traded and non-traded carbon values to be used in economic appraisal over the 2008 to

⁶ http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

⁷ http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

2100 period.⁸ **Box 2.B** provides a brief example of how the traded and non-traded carbon values are applied in policy appraisal.

2.5 Mapping fuel emissions into traded and non traded sectors

Table 2.B shows how to map emissions from different fuel types into the traded and non-traded sectors (see also Table 2B). For example, emissions from gas (not used by large electricity producers) should be included in the non-traded sector whereas emissions from electricity production should be included in the traded sector.

Table 2.B: Example of attribution of emissions to the traded and non traded sector

Traded (organisation in the EU ETS)	Non Traded
Electricity (all grid electricity is generated by organization in the EU ETS)	Gas and coal for domestic heating
Coal and gas (used in organisations in the EU ETS)	Petrol and diesel used for road transport
Aviation from 2012 onwards	Fuel/oil used for domestic heating

⁸ Please note that the Traded Price of Carbon will be updated annually and the next update is scheduled for 2011.

Box 2.B: How to use the traded and non traded carbon values for option appraisal

An energy efficiency programme is being considered which reduces the use of gas and electricity by householders. UK electricity consumption (traded) is cut by 15GWh while household gas consumption (non-traded) is cut by 10GWh. These are annual differences from the counterfactual “do nothing” option for each year between 2011 and 2050. Tables 1 and 2 show how to value the emission reductions using the new carbon values. These monetary savings can then be discounted in the usual way following Green Book guidance.

Table 1: Valuing the reduction in traded sector emissions

	2011	2012	2013	...	2048	2049	2050
Change in energy use, GWh	-15	-15	-15	...	-15	-15	-15
Marginal emissions factor (electricity, Table 1), tCO ₂ /GWh (KgCO ₂ /Kwh)	373 (0.37)	373 (0.37)	373 (0.37)	...	25 (0.025)	24 (0.024)	23 (0.023)
Emissions saving, tCO ₂ (MtCO ₂)	5602 (0.0056)	5602 (0.0056)	5602 (0.0056)	...	380 (.00038)	360 (.00036)	339 (.00034)
Traded carbon price, 2009£/tCO ₂ (see table 3)	13	14	16	...	198	205	212
Value of savings, thousand 2009£	75	81	89	75	73	72

Table 2: Valuing the reduction in non-traded sector emissions

	2011	2012	2013	...	2048	2049	2050
Change in energy use, GWh	-10	-10	-10	...	-10	-10	-10
Marginal emissions factor (gas, table 2), tCO ₂ /GWh (kgCO ₂ /kwh)	183.2 (0.183)	183.2 (0.183)	183.2 (0.183)	...	183.2 (0.183)	183.2 (0.183)	183.2 (0.183)
Emissions saving, tCO ₂	1832	1832	1832	...	1832	1832	1832
Non-traded carbon price, 2009£/tCO ₂ (see table 3)	56	56	57	...	198	205	212
Value of savings, thousand 2009£	101	103	105	...	363	375	388

2.6 Treatment of Emissions Embedded in Imported Materials

For appraisal purposes the “GHG emissions content” of all materials used to implement a proposal are included. Where a very large scale proposal is likely to include significant quantities of imported material such as cement, steel or bio fuels

it is reasonable to make adjustments to account for the value of the externality if they originate from countries which do not have a system of carbon pricing.⁹ This is because the price will not include the cost of the GHG emissions resulting from their production. For many proposals this would be unnecessary or disproportionate but where the volume of such materials is large then additional analysis must be undertaken, advice on this should be sought from <GHGappraisal@decc.gsi.gov.uk>.

Where it is proportionate and possible to identify the impact of the proposal on emissions overseas or on emissions that occur outside the target framework (e.g. radiative forcing from aviation), the change in emissions overseas should be valued at the **Traded Carbon Value** over the 2010 –2030 period (Table 3). The use of the traded price of carbon is a pragmatic choice based on the fact that most of the products that are likely to have an impact on emissions overseas (e.g. cement, steel, iron etc) are traded sector products. Beyond 2030, the working assumption of a fully functioning global carbon market implies that the carbon costs will be already internalised in the import price of each product. Therefore, no adjustment will be required after this date provided that the projected import costs include the cost of carbon.

There are inevitably important practical complications in assessing the carbon impact of imported products, work is underway that will provide additional guidance on the treatment of such so called embedded emissions in appraisal.

DECC will however not include the GHG emissions of imported materials as part of the UK's national inventory because the Government has agreed to report national territorial emissions at the point of release, as recommended by the International Panel on Climate Change.¹⁰ This means that the national inventory in principle includes all greenhouse gas emissions generated as part of the production of goods and services within a country (e.g. the UK) regardless of where these are consumed (either in the UK or exported).

⁹ Although there is no requirement to include a proposals embedded emissions in the UK inventory, the decision making and appraisal process should take into account the impact of UK policy on emissions from abroad if it is proportionate and practical. For example, some bio-fuels for consumption in the UK are imported from outside the UK, so domestic bio-fuel consumption will have implications for emissions in other parts of the world as a result of bio-fuel production processes. If these emissions occurred outside of a capped traded sector, then appraisal should account for the additional costs of the policy due to emissions overseas. Where emissions occur in economies that have an emissions cap for the relevant sector, then the price of the relevant product will already include a cost of carbon.

¹⁰ For more information on this see <http://www.defra.gov.uk/evidence/statistics/environment/globalatmos/index.htm>.

Box 2.C: Valuing emissions changes in waste policy

A nationwide scheme that encourages households to recycle paper reduces the quantity of paper that is sent to landfill. It is estimated that during the course of the scheme (2011 – 2018) the reductions in paper sent to landfill result in methane savings of 200,000tCO₂e/year from landfill sites within the UK. In addition, the production of recycled paper within the UK significantly reduces the quantity of paper imported into the UK from non-capped countries. Using trade data and levels of carbon intensity attributed to the non-capped countries, it is estimated the reduction in imported paper saves 120,000tCO₂e/year of emissions from the non-capped country through reduced production of paper. These emissions should be valued using the Traded Price of Carbon (TPC) estimates reported in Table 3.

UK non-traded savings: (40tCO₂e * non-traded price of carbon) for each year 2011 – 2018:

	2011	2012	2013	2014	2015	2016	2017	2018
Emission savings, tCO ₂ e, '000s	200	200	200	200	200	200	200	200
Non-traded price, £2011	56	56	57	58	59	60	61	62
Value of savings, £m 2011	11.1	11.3	11.5	11.6	11.8	11.9	12.2	12.3

Embedded carbon savings: (35tCO₂e * traded price of carbon) for each year 2011 – 2018:

	2011	2012	2013	2014	2015	2016	2017	2018
Emission savings, tCO ₂ e, '000s	120	120	120	120	120	120	120	120
Traded carbon value, £2011	3	14	16	17	19	21	22	24
Value of savings, (£m 2011)	1615	1615	1908	2050	2266	2462	2628	2821

2.7 Valuing Changes in Energy Use

Changes in energy use, for the purpose of economic appraisal, should be valued at the **long-run variable cost of energy supply**.¹¹ More precisely:

¹¹ Further background on valuing energy use is available in the background documentation (Chapter 2) in support of this guidance. This is available on the IAG webpage of the DECC's web site. See http://www.decc.gov.uk/en/content/cms/statistics/analysts_group/analysts_group.aspx

Value of energy use = changes in energy/fuel use by type of energy/fuel * long-run variable supply cost of relevant energy/fuel

The supply cost reflects the long-term variable cost components of energy supply and therefore excludes costs (such as head office overheads) that will continue to be incurred at the same level in the long run despite marginal changes in energy use. The variable costs **exclude carbon costs**, since these are valued separately, and also excludes taxes and other charges.

A reduction in the use of energy saves resources from production through to supply and includes both the economic value of the energy commodity itself and the change in capital costs associated with transmission and distribution. As these delivery costs are likely to vary by end user, variable supply cost values should therefore be specific to the sector in which the savings occur.

The variable supply costs for different energy types and end-users can be found in **Tables 4 to 9 available from the DECC's IAG web page**¹². These tables provide projected costs for a central fossil fuel price scenario. **Tables 10–21** provide costs for low, high and high-high fossil fuel price scenarios and should be used to test the sensitivity of the policy appraisal to changes in fossil fuel prices.

These estimates of the long-run variable supply costs for different fossil fuel prices should not be considered forecasts, but as estimates to assist in policy appraisal.

2.8 Accounting for the UK's Renewable Energy Strategy

The EU Climate and Energy Package creates a target proportion of energy consumption which is to be delivered from renewable sources. The target follows a rising trajectory to reach 15% of capped gross final energy consumption by 2020.¹³

Changes in final energy consumption in 2020 (with the exception in most cases of changes in aviation consumption¹⁴) will change the absolute level of renewable energy supply that the UK is required to achieve. Reductions in energy consumption in 2020 will therefore be associated with an avoided cost of renewables. Similarly, policy measures that lead to renewable deployment in 2020 that is not counted under the Renewable Energy Strategy analysis (to be verified with DECC) would also be associated with an avoided cost. Although there are interim targets for renewable energy to 2020, for the purposes of analysis, it is suggested that only changes in

¹² http://www.decc.gov.uk/en/content/cms/statistics/analysts_group/analysts_group.aspx

¹³ As defined in the Renewable Energy Directive, the definition of gross final energy consumption (gfec) in the target is capped by setting a maximum value on the level of aviation within gfec at 6.18% of the uncapped level of gross final energy consumption.

¹⁴ A change in UK aviation consumption in 2020 that leaves the level of aviation consumption above 6.18% of gfec will not have any effect on the level of the renewables target. Changes that bring the level below 6.18% would reduce the target.

final energy consumption in 2020 are counted as having an avoided cost of renewables to be included in Impact Assessments.

Note that the following figures are based on the 2008 Renewable Energy Strategy consultation and an updated figure will probably be provided in the next methodological update scheduled for 2012. There are complications in valuing the avoided costs of renewables through reducing UK final energy consumption in 2020. For example, delivering a MWh of renewable energy in any particular year requires support to investors in the renewable energy plant that continues over a significant period. The Renewables Obligation has been extended to 2037 for this reason. Reduced final energy consumption in 2020 would therefore deliver cost savings for more than a decade.

Any reduction in the amount of renewable energy required avoids costs and these should be valued in addition to the savings in emissions and variable energy supply costs from the reduction in energy use.

The marginal cost of delivering renewable energy to meet the UK renewable energy target has been estimated to be £120/MWh (in 2009 prices) in 2020 over and above the displaced energy and carbon costs. The target level of renewable energy delivery in 2020 is 15% of final energy consumption. Reducing final energy consumption by 1 MWh in 2020 will reduce the quantity of renewable energy required by 0.15 MWh. This suggests the avoided costs of renewables would be approximately £18/MWh (in 2009 prices) in 2020.

For illustrative purposes all changes in final energy consumption should be valued at £18/MWh. Owing to the uncertainty inherent in this figure, the costs and benefits of a policy should be presented both **with and without** the impact of the policy on the costs to the UK of the renewable energy target.

Changes in the level of renewable energy delivered should be valued using the marginal cost of delivering it from other sources: £120/MWh.

2.9 Valuing Direct Rebound Effects

Policies that save energy (such as insulation) reduce energy bills and increase consumers disposable income, which may in turn lead to greater consumption of energy. This is known as the “**rebound effect**”.¹⁵

¹⁵ On the rebound effect see also UK ERC (2007) available at <http://www.ukerc.ac.uk/Downloads/PDF/07/0710ReboundEffect/0710SuppNote.pdf>

The welfare derived from this increased energy use should be counted as a social benefit within the appraisal. Only the resource and emission savings of the net reduction in energy which results from the energy saving policy should be valued, however.

When valuing the welfare benefit of direct rebound effects the **full retail price** (including tax) should be used. This is based on the assumption that consumers are willing to pay at least the full retail price for the welfare they gain from the increased energy use. For example, if an energy efficiency measure has the technical potential to reduce energy consumption by 100 units and still leave the level of “comfort” unchanged, but the consumer chooses to only reduce consumption by 40 units, then the rebound effect amounts to 60 units of energy and the net change in energy use is 40 units of energy. These 40 units are valued in accordance with the rest of this guidance, accounting for resource cost and emissions savings. The 60 units are valued at the full retail price, as a welfare benefit (i.e. an increase in “comfort”).

The spreadsheet tool published alongside this guidance can help with valuing rebound effects.¹⁶ For further information on the rebound effect please contact GHGappraisal@decc.gsi.gov.uk.

2.10 Security of Energy Supply

A policy that has a major impact on energy consumption or production could **affect security of energy supply – i.e. the ability of the UK to meet its energy needs**. Quantitative evidence where possible (see below), and a qualitative assessment where not, should be provided to assess the security of supply impact of a policy.

To understand fully the implications of policies on energy security, two key aspects need to be considered: the likelihood of physical interruption to energy supplies, and the effects on price volatility.

In theory, a monetary value could be calculated to estimate the **expected energy unserved** (i.e. the probabilities of different sizes of interruptions to the supply of energy relative to the demand at any point in time) multiplied by the value of lost load (i.e. the value that customers attach to the energy unserved). Conducting this analysis for each of the years of the lifetime of a project, and comparing this to the ‘do nothing’ counterfactual case, would provide a Net Present Value of security benefits that could be compared to the costs of delivering reductions in the

¹⁶ Spreadsheet toolkit can be downloaded from the IAG web page on the DECC website available on http://www.decc.gov.uk/en/content/cms/statistics/analysts_group/analysts_group.asp

probability of interruptions. Such an approach is possible **for electricity generation** and where possible it is recommended.

However, **for other fuels**, this methodology is more problematic because of the difficulty in calculating both the change in the expected energy unserved, and the value of lost load. In those cases we look at the drivers (or inputs) of security of supply, namely spare capacity, diversity (of fuel and infrastructure), reliability (of fuel and infrastructure) and effective price signals.

See Chapter 7 of the background documentation for guidance on the questions that you should consider to assess the implications of policies on security of supply.¹⁷ For further assistance please contact GHGappraisal@decc.gsi.gov.uk.

2.11 Air Quality Impact

Air pollution can generally be defined as airborne chemicals, particulates and biological materials that cause harm to humans or damage the environment. Under this definition, there are three key groups of impacts: adverse health impacts (including mortality and morbidity), immediate environmental impacts (such as acidification and soil eutrophication), and long-term environmental impacts (which include climate change). Air quality policies typically focus on the human health and immediate environmental impacts, while climate change policy focuses primarily on the long-term climate change potential. Given this definition, there are clear links between climate change mitigation policies and air quality policies. Though the majority of overlaps are mutually beneficial i.e. a policy option designed to reduce CO₂ will also reduce other air pollutants (and vice versa for air quality policies), this is not always the case; in some cases, trade-offs will exist.¹⁸

To help realise the synergies and minimise any trade-offs, policymakers should build the air quality impacts of their policy into their appraisal process, where possible, using monetary values. The Interdepartmental Group on Costs and Benefits (IGCB), a Defra-led panel of experts, has developed a number of monetisation methodologies to aid such policymakers, which include:

- Where any policy is expected to reduce air quality below national obligations, then the **abatement cost** of restoring compliance should be factored into the appraisal. This should be undertaken through an estimation of the cost of offsetting measures (the “abatement cost” approach).

¹⁷ Background documentation for the guidance is available from the DECC’s IAG web page available at the http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/valuation/valuation.aspx

¹⁸ Information on the potential synergies and trade-offs between climate change mitigation and air quality can be found in the 2007 Air Quality Environment Group (AQEG) report “[Air quality and climate change: a UK perspective](#)”.

- For any policy where improving air quality is the primary aim, or estimated air quality impacts are above £20m or last longer than 20 years, a **bespoke air quality impact valuation** (the “impact pathway” approach) should be undertaken.
- For any policy where there are minor, air quality impacts of below £20m or lasting less than 20 years, an online calculator can be used to monetise impacts (the “damage costs” approach)¹⁹:
 - Where the change in emissions arising from the policy is known, please use **Damage Costs Calculator**, which relates emissions to monetary values.
 - Where the change in emissions arising from the policy is **not** known, please use the **Activities Costs Calculator**, which links a wide range of actions and technologies with the associated level of emissions generated that are then valued monetarily.

Air quality, as with most environmental assets, is subject to a number of major threshold and equity factors, which are protected through the establishment of minimum standards on ambient concentrations, emissions and exposure. These standards are delivered through national and international obligations covering these areas. To reflect the importance of these standards, any policy, programme or project which is expected to result in non-compliance should estimate and cost the necessary measures to restore compliance. This approach is known as the “abatement cost” approach.

The impact pathway approach follows the source of the emission to its dispersion in the atmosphere, and the resultant exposure to estimate a range of end points (such as health impacts) that are valued. Impacts therefore vary based on a range of considerations (such as dispersion and toxicity) that arise from differences in geographical location and population exposed. At present, this approach has been used to estimate the impact of four different air pollutants: nitrous oxide (NO_x), sulphur dioxide (SO₂), ammonia (NH₃) and particulate matter (PM₁₀).

“Damage costs” are based on the impact pathway approach, but have been calculated using a range of representative emissions in order to estimate an average **marginal** effect for each additional tonne of gas introduced into the atmosphere. These primarily value health impacts²⁰, though non-health impacts are also included. Damage costs are not linked to exceedences of limit values.²¹

¹⁹ For further information on air quality impacts, please contact igcb@defra.gsi.gov.uk or visit <http://www.defra.gov.uk/environment/quality/air/airquality/panels/igcb/pathway.htm>. <http://www.defra.gov.uk/environment/quality/air/airquality/panels/igcb/tools.htm>.

²⁰ Health impacts: Morbidity and mortality impacts used in the model are based on recommendations by the Committee on the Medical Effects of Air Pollution (COMEAP). Health impacts evaluated in the model are linked to incidences of respiratory or cardiac disease, but do not include others where the evidence is less robust, for example, long-term exposure effects or increased likelihood of asthma in children.

²¹ The IGCB is developing a tool which compares the cost effectiveness of different abatement measures – for further information, please visit <http://www.defra.gov.uk/evidence/economics/igcb/index.htm>.

It must be noted that these monetary values do not include all the likely impacts of air pollution, such as non-health impacts on acidification and soil eutrophication, and do not include the impacts on ecosystems, visibility or ozone depletion.

Changes in energy use can be used to estimate the changes in the level of pollutants emitted. **Tables 22–23 available from the DECC’s IAG web page**²² provide air quality valuations for changes in the use of road transport and energy production. Damage costs estimates are differentiated by location of fuel use to account for the fact that a policy that targets the reduction in fuel use in inner cities will reduce the damage costs of air pollution more than a policy that addresses rural fuel use (due to differences in the population exposed).²³

2.12 Wider Environmental Impacts

Many policies can have incidental but significant impacts – both positive and negative – on the wider environment beyond GHG emissions and the air quality impacts discussed above. Landscape, biodiversity, noise, water quality and quantity, and flood risk all need to be considered in appraising policy options.

In many cases there are ancillary benefits to reducing our dependence on fossil fuels such as improved air quality covered earlier. Other climate change mitigation policies may risk damaging the natural environment. It is important to include these impacts in analysis to ensure the most cost effective approach is being taken.

The Treasury Green Book guidance states that policy appraisal should seek to identify all the costs and benefits including environmental.²⁴ While impacts on the environment often do not have any market prices, it is important to try and use evidence on non market values attached to environmental impacts where feasible. There are different methodologies for obtaining monetary values resulting from change in the environment.²⁵ This enables environmental impacts to be valued on a consistent basis with other financial costs and benefits.

Where the expected policy impact on the environment is significant, an ecosystem services framework²⁶ can aid comprehensive analysis of the impacts. This

²² http://www.decc.gov.uk/en/content/cms/statistics/analysts_group/analysts_group.aspx

²³ Further guidance on the evaluation of air quality is available from the IGCB website at

www.defra.gov.uk/evidence/economics/igcb/index.htm.

²⁴ http://www.hm-treasury.gov.uk/d/green_book_complete.pdf

²⁵ For more details on environmental valuation methods, see DEFRA web page on tools for environmental valuation (currently under construction).

²⁶ Ecosystem services are defined as services provided by the natural environment that benefit people. For more details, see “An introductory guide to valuing ecosystem services”, Defra (2007): <http://www.defra.gov.uk/environment/policy/natural-environ/using/value.htm>

methodology provides a broader framework for considering all the environmental impacts of a policy and identifying the economic end points that can be valued.

Defra has produced detailed guidance on assessing wider environmental impacts at <http://www.defra.gov.uk/environment/index.htm>. This includes a checklist of questions on wider environmental impacts and a step by step guide to how to go about assessing, quantifying and valuing any environmental changes.

2.13 Sensitivity Analysis

For option appraisal, it is necessary to conduct sensitivity analysis around all options including the 'do nothing' option (counterfactual baseline) against which GHG savings are estimated.

Sensitivity analysis should be conducted for a **range of key variables**. For example, changes in **fossil fuel price** assumptions could make a considerable difference to the scale of the costs and benefits. The spreadsheet toolkit allows for some sensitivity analysis regarding carbon values, long-run variable energy supply costs and retail energy prices.

Switching values should also be calculated where appropriate to show by how much a key variable would have to change to make it not worth undertaking an option.

A further sensitivity test could replace the expected value of the change in GHG emissions with the highest and lowest values likely to occur to see how this affects the ranking of the various policy options. Judgement will be needed to define these high and low values. Where the probability distribution of the change in GHG emissions is known, the highest and lowest values could be defined as the upper and lower ends of the 95% confidence interval.

Implicit in appraisal and evaluation may be a plethora of assumptions about human behaviour, for instance assumptions relating to the effectiveness with which people put new technologies to use. Analysis should consider hidden or implicit assumptions about human behaviours and ensure that, at the minimum, all such assumptions are given consideration and clearly stated

When conducting an appraisal involving a significant number of variables with multiple sources of uncertainty a **Monte Carlo analysis** may be appropriate provided that the cost is proportionate to the costs, benefits and risks under consideration.

3

Reporting for Carbon Budgets

Under the Climate Change Act (2008) the Government is committed to legally binding carbon budgets. These are five year period targets for the UK's GHG emissions set fifteen years ahead, and currently legislated for 2008–12, 2013–17 and 2018–22.

Monitoring progress towards these targets is of great importance and consequently it is vital that appraisals produce emission figures in line with carbon budget accounting and reporting requirements, as well as provide DECC with sufficient information for their GHG projections. This involves the following reporting:

- a) **The annual change (relative to the “do nothing” counterfactual option and with consideration of policy overlaps) in UK territorial GHG emissions** (in MtCO₂e), broken-down by sector (Power Generation, Transport, Workplaces and Industry, Homes, Waste, Agriculture and Public) and by incidence in the EU Emissions Trading System (ETS) or non-ETS sector.
- b) **A headline figure of the total emission impact** of the policy (in MtCO₂e) broken-down by the ETS and the non-ETS sectors
- c) **The forecast** – if applicable – of the **purchase of offset credits by UK plc** that a policy may incentivise or require for compliance.
- d) **Annual figures for the net change in energy use converted into MtCO₂e** broken down by fuel, user and sector.
- e) **Cost effectiveness** – should also be reported as discussed in Chapter 4.

Figure 3A below shows a suggested template for presenting these figures in Impact Assessments. Additional information is provided in 3.1 on how to complete this table.

Table 3A: Suggested template for presenting emission savings in Impact Assessment¹

Version of GHG guidance used: e.g. March 2010		Emission Changes* (MtCO ₂ e) - By Budget Period			Emission Savings (MtCO ₂ e) - Annual Projections																
Sector		CB I: 2008-2012	CB II: 2013-2017	CB III: 2018-2022	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022		
Power sector	Traded	0	0	0																	
	Non-traded	0	0	0																	
Transport	Traded	0	0	0																	
	Non-traded	0	0	0																	
Workplaces & Industry	Traded	0	0	0																	
	Non-traded	0	0	0																	
Homes	Traded	0	0	0																	
	Non-traded	0	0	0																	
Waste	Traded	0	0	0																	
	Non-traded	0	0	0																	
Agriculture	Traded	0	0	0																	
	Non-traded	0	0	0																	
Public	Traded	0	0	0																	
	Non-traded	0	0	0																	
Total	Traded	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Non-traded	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Cost effectiveness	% of lifetime emissions below traded cost comparator																				
	% of lifetime emissions below non-traded cost comparator																				

* Important note: Please enter net emission savings as positive numbers and net emission increases as negative numbers.

f) In order to include policies, once firm and funded, into the UK emissions projections baseline, policy analysts should contact GHGappraisal@decc.gsi.gov.uk for instructions and information required.

3.1 Completing the table to report carbon impacts for carbon budgets

The table should report the total *change* in GHG emissions owing to the policy, whether the policy leads to greater GHG emissions or GHG emissions savings.

To report total GHG emission impacts both the CO₂ and non-CO₂ (converted to CO₂e) must be included (see table 2A). This means that as well as identifying the change in CO₂ emissions from a change in energy fuel use, the impact on the other major greenhouse gases must be reported and converted into the carbon dioxide equivalent. This includes methane from landfill and agricultural livestock, nitrous oxide from fertilizer use and production and F gas emissions (HFC, PFCs and SF₆).

The table below presents the steps to follow to help allocate the emissions changes to the correct sectors to fill in the Carbon budgets reporting table under point a. above.

¹ This table can be downloaded from the IAG web page on the DECC's web site available at http://www.decc.gov.uk/en/content/cms/statistics/analysts_group/analysts_group.aspx

Table 3B: Attribution of emissions to the traded and non traded sector

Step 1 Identify the source of emissions change	Step 2 Allocate the source as traded or non traded sector emissions	Step 3 Attribute traded and non traded emissions to the appropriate sector
CO2 from energy use		
Electricity	Traded - supplied by grid from Major Power Producers Non Traded - on site electricity generation from small non ETS operators	Power Sector - policies affecting carbon intensity of supply Transport/Workplaces/Homes/Agriculture/Waste/Public - policies affecting demand for grid electricity Attribute to sector generating electricity Transport/Workplaces/Homes/Agriculture/Waste/Public
Gas	Non Traded Traded if used by ETS operators	Transport/Workplaces/Homes/Agriculture/Waste/Public If Major Power Producers = Power Sector If heavy industry EU ETS = Workplaces Traded
Fuel/Heating Oil	Non Traded	Transport/Workplaces/Homes/Agriculture/Waste/Public
Coal	Non Traded Traded if used by ETS operators	Transport/Workplaces/Homes/Agriculture/Waste/Public If Major Power Producers = Power Sector If heavy industry EU ETS = Workplaces Traded
Biomass	Non Traded	Transport/Workplaces/Homes/Agriculture/Waste/Public
Aviation fuel	Non Traded before 2012, Traded from 2012	Transport Non Traded before 2012 Transport Traded from 2012
Non CO2 emissions		
Methane from landfill	Non Traded	Waste
Methane from agricultural livestock	Non Traded	Agriculture
Methane from industry	Non Traded	Workplaces
Nitrous Oxide fertilizer use on farms	Non Traded	Agriculture
Nitrous Oxide fertilizer production	Non Traded	Workplaces
F gas related emissions	Non Traded	Workplaces

^Note that N2O and PFCs emitted by EU ETS installation will be covered under the ETS in phase 3 commencing 2013 and will therefore become traded sector emissions.

4

Cost Effectiveness

Government Departments are required to report a measure of the proportion of carbon savings the costs of which falls below the carbon price.

Cost effectiveness should be reported if the carbon savings from the policy meet either of the two following criteria:

- if the policy lifetime is less than 20 years and the stream of CO₂e savings exceeds 0.1 MtCO₂e average per year, or
- if the policy lifetime is more than 20 years and the stream of CO₂e savings exceeds 2.0 Mt CO₂e over the policy's lifetime and exceeds an average per year of 0.05 MtCO₂e.

In most cases, checking whether the policy results in a positive NPV is sufficient to determine the cost-effectiveness of your policy. If the NPV is positive, 100% of your emissions are cost-effective. Conversely, if the NPV is negative, 0% of the emissions are abated cost-effectively. However, this binary indicator fails to account for the fact that a policy could contain a mix of abatement technologies, some of which are cost effective and some of which are not. Analysts are therefore encouraged to disaggregate their policy package if possible and assess the cost-effectiveness of the resultant components.

For policies that can be disaggregated into the traded and non-traded sectors, testing for cost-effectiveness can be done using the following methodology. The cost effectiveness indicator for a policy is derived by dividing the NPV excluding the carbon benefits of the traded or non-traded sector (depending on the sector of interest) by the tonnes of carbon saved in the traded or non-traded sector (expressed as a change and therefore a negative number).

$$\text{Cost Effectiveness (£/tCO}_2\text{e)} = \frac{\text{NPV} - \text{PVB carbon (either traded or non traded sector)}}{\text{Total carbon saved either in the traded or non traded sector (tonne of CO}_2\text{e)}}$$

Analysts should use the equation above when calculating the cost effectiveness of policies which impact on the traded and the non-traded sector.¹

Where a policy impacts on both (traded and non traded) sectors, the NPV will contain benefits from reducing both traded or non-traded emissions. It is therefore important to remove traded or non traded carbon benefits depending on whether the traded or non-traded sector is being investigated.

In order to identify whether a policy is cost effective, the cost effectiveness indicator should be compared against the traded or non-traded sector comparator defined as the weighted average discounted traded or non-traded sector cost of carbon (see Table 6A below for an example).

If the cost effectiveness indicator (a proxy for the net social cost of the policy) is lower than the relevant comparator (a proxy for the relevant carbon price) then 100% of the emissions are being abated in a cost-effective way or the policy is cost effective. If the cost effectiveness indicator is higher than the relevant comparator then 0% of the emissions are being abated cost effectively.

The Traded and Non-Traded Cost Comparators can be calculated using the following steps. Using the **Traded Cost Comparator** as an example (see table 5A):

- Step 1) Annualise the change in traded sector emissions;
- Step 2) Weight each year's change in traded sector emissions against the lifetime change in traded sector emissions;
- Step 3) Set out the TPC price schedule for the lifetime of the policy;
- Step 4) Discount the TPC price schedule to calculate present values (based on the Green Book discount rates)
- Step 5) Multiply the annualised values from steps 2 and 4 (weight x discounted TPC price)
- Step 6) Sum all the years in step 5 to give the Traded Cost Comparator.

The **Non Traded Cost Comparator** is calculated in the same way except the change in non-traded emissions and the NTPC price schedule should be used.

¹ It is important to note the **sign convention**. A positive number of the indicator represents a net cost per tonne of CO₂, whilst a negative number is a net benefit per tonne of CO₂e. This is different from standard convention where if a policy has a NPV of £50,000 then it has a net benefit.

Table 4.A: Calculating the Traded Cost Comparator

Year		2011	2012	2013	2014	2015	2016	Total
Step	Measure Year	0	1	2	3	4	5	
1	Mt CO ₂ (net)	0.5	0.48	0.68	0.44	0.45	0.39	2.94
2	Weight (=Year emissions/total lifetime emissions)	=0.5/ 2.9 =0.17	0.16	0.23	0.15	0.15	0.13	1.0
3	Traded price schedule (£/tCO ₂ e) (from table 3 ²)	13	14	16	17	19	20	
4	Discounted Traded Price (NPV) (i.e. applying Green Book discount rates)	13	14	15	15	16	17	
5	Weight x discounted Traded price	2.3	2.3	£3.4	£2.3	£2.5	£2.3	
6	Traded cost comparator (TCC) = sum of step 5							£15.1

If the Cost Effectiveness Indicator for the traded sector is below the Traded Cost Comparator (TPC) then the policy is cost effective. Likewise, if the Cost Effectiveness Indicator for the non traded sector is below the Non Traded Cost Comparator (NTSC) then the policy is cost effective.

The approach discussed above identifies whether a policy as a whole is cost effective or not. To more accurately assess the proportion of emissions reductions which are cost effective a more detailed methodology is currently being developed.

² http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

Box 4.A. Examples of cost effectiveness calculations

Example 1: An energy education programme reduces the use of gas by householders. The net present value of the programme is £10,000. The programme reduces GHG emissions in the **traded sector** (lower electricity use) by 300 tonnes of CO₂e. All reductions occur in the first year of the policy. It is assumed there are no wider impacts. The traded price of carbon is 13£/tCO₂ in 2011.

The **traded** sector cost-effectiveness:

$$= \frac{(\text{NPV} - \text{PVB (traded carbon savings)})}{\text{carbon saved in traded sector}}$$

$$\begin{aligned} \text{Cost-effectiveness} &= (£10,000 - (300 * £13)) / -300 \\ &= -£20.3/\text{tCO}_2\text{e saved in the traded sector} \end{aligned}$$

The policy is cost effective.

Example 2: Consider a policy that drives the uptake of ground source heat pumps. It results in lower emissions in the **non-traded sector** of 1,000 tonnes of CO₂e, and a decrease in emissions in the **traded sector** of 800 tonnes of CO₂e. The NPV of the policy is £22,000. All reductions occur in the first year of the policy. It is assumed there are no wider impacts. The traded and non-traded price of carbon in 2011 are 13£/tCO₂e and 56£/tCO₂e respectively.

Looking at the cost effectiveness in the non traded sector,

$$\begin{aligned} \text{Cost-effectiveness} &= \frac{(\text{NPV} - \text{PVB (non traded carbon savings)})}{\text{carbon saved in non-traded sector}} \end{aligned}$$

$$\begin{aligned} &= ((22,000 - (1,000 * £56)) / -1,000) \\ &= £34/\text{tCO}_2\text{e in the non-traded sector} \end{aligned}$$

The policy delivers each tonne of non-traded carbon savings at £34/CO₂e that is lower than the relevant (non traded) carbon price of 56£/tCO₂e. Therefore, the policy is cost effective.

A The Toolkit

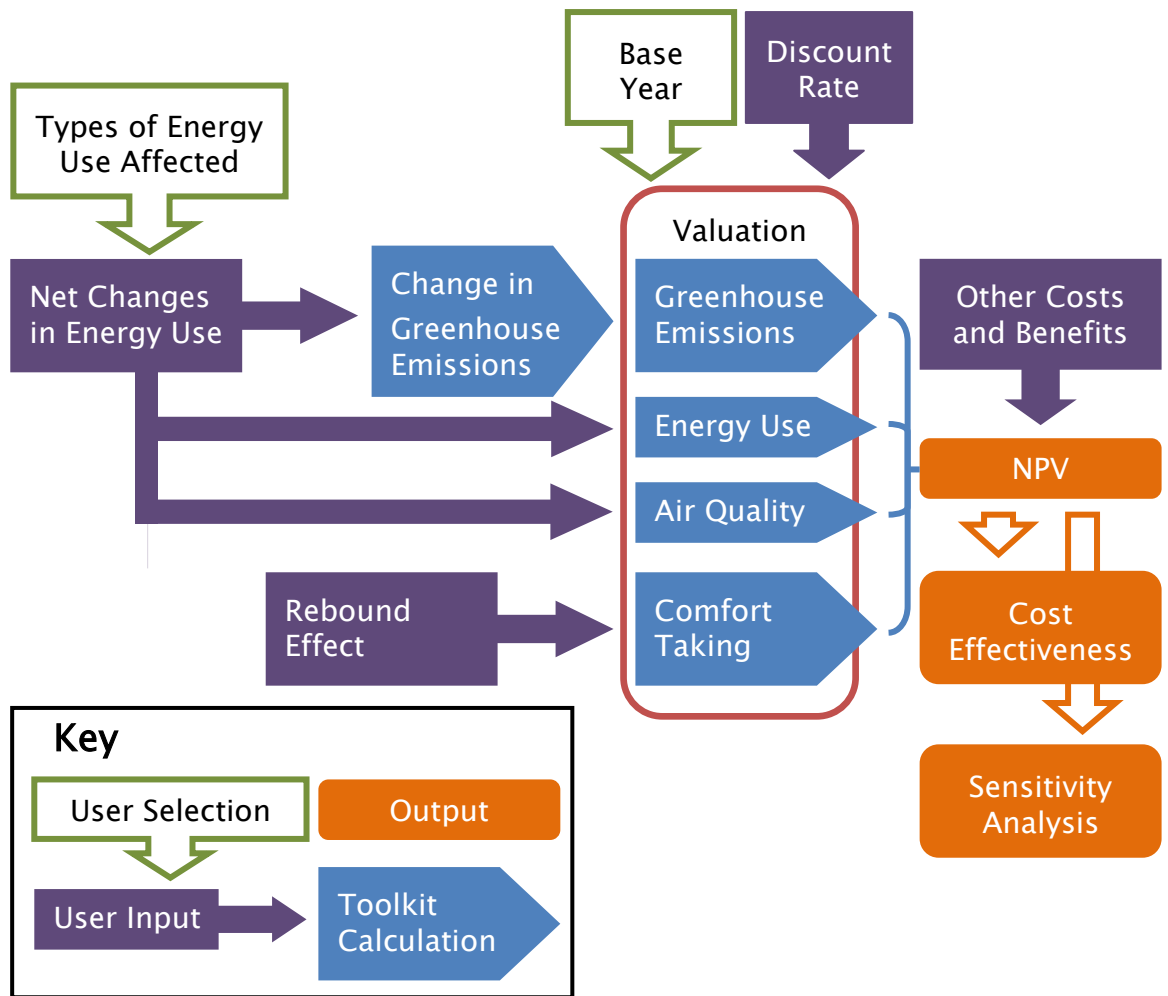
A.1 The Toolkit is an Excel workbook that has been designed to streamline the policy appraisal process, quickly taking care of the calculations involved. It helps to implement the guidance detailed in the rest of this document and provides additional tools to help analysts quickly conduct sensitivity analysis and assess cost-effectiveness.³

A.2 The diagram below provides a stylised overview of the Toolkit's function. After the analyst has determined the net changes in energy use attributable to his or her policy, these are entered into the Toolkit. Using this information, the Toolkit will then quantify the associated impact on emissions. It will also value the changes in energy use, the changes in emissions and the changes in air quality automatically. For energy efficiency policies, there is also the option of entering information on the size of any rebound effects, thereby allowing the Toolkit to value the comfort taking involved.

A.3 The remainder of this annex consists of a step-by-step guide to using the Toolkit. However, it is worth noting that if you wish to customise the Toolkit or add extensions specific to your analysis, the Toolkit is relatively easy to modify. Although its mechanics are largely hidden to avoid confusion, they can be revealed, and protected sections can be unlocked and then overwritten without using a password. For the majority of users however, the standard Toolkit should provide an easy way to ensure that your analysis is fully consistent with the guidance in this document.

³ It can be downloaded from the DECC's IAG webpage. See http://www.decc.gov.uk/en/content/cms/statistics/analysts_group/analysts_group.aspx

Figure A.1: Toolkit Processes



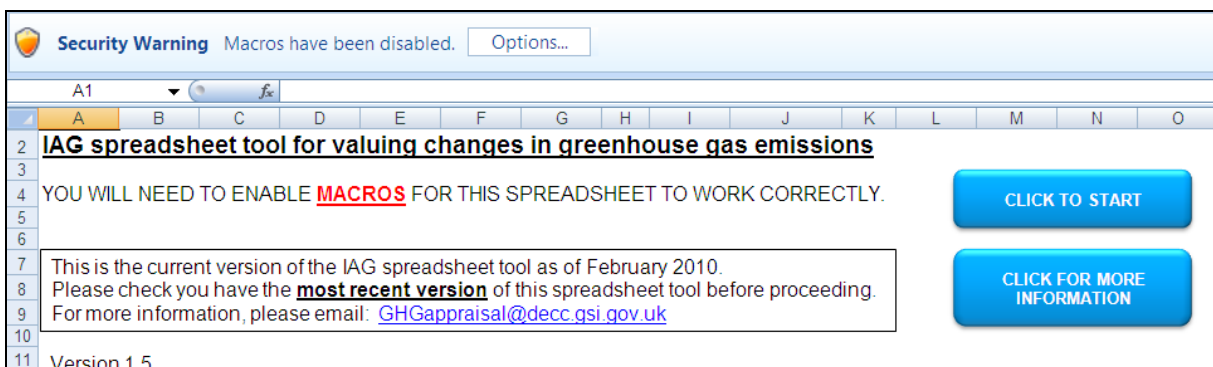
Step-by-Step Guide

The following section provides a step-by-step guide to using the Toolkit.

Introductory Page

Step 1 – Check version

The Toolkit is updated to reflect methodological changes and DECC’s latest projections. Before starting you should always check that the version number on the introductory page matches the version of the Toolkit available on DECC’s website.



Step 2 – Enable macros

The Toolkit requires macros to be enabled. After enabling macros, click on the ‘Click to Start’ button.

Initial Inputs

Initial Inputs

Changes in Energy Use

Additional Assumptions

Results

Cost-Effectiveness

Sensitivity Analysis

1. Select the sectors in which this policy results in changes in energy use or production

Traded sector (EU ETS)	Electricity	<input checked="" type="checkbox"/>	All grid electricity is generated by EU ETS installations in the EU
	Gas (used by EU ETS installations)	<input checked="" type="checkbox"/>	For example, reducing gas use by EU ETS installations
	Coal (used by EU ETS installations)	<input checked="" type="checkbox"/>	For example, reducing coal use by EU ETS installations
	Aviation from 2012 onwards	<input checked="" type="checkbox"/>	Aviation will be included in EU ETS (traded sector) from 2012 onwards
Non-traded sector	Gas	<input checked="" type="checkbox"/>	For example, gas used to heat homes
	Coal	<input checked="" type="checkbox"/>	For example, domestic use of coal to heat the home
	Fuel oil/heating oil	<input checked="" type="checkbox"/>	For example, burning heating oil in the home
	Road transport (petrol and DERV)	<input checked="" type="checkbox"/>	All petrol and DERV road transport is in the non-traded sector
	Aviation up to 2011	<input checked="" type="checkbox"/>	Up to 2011, aviation is in the non-traded sector
	Biomass	<input checked="" type="checkbox"/>	This tool will only calculate the air quality impacts of biomass

2. What is the appraisal period start date?

3. What is the appraisal period end date?

4. What is the name of your policy?

5. What year should costs and benefits be discounted to?

6. What is the current year?

NOTE: this spreadsheet does not currently complete data for years before 2010!

CLICK TO GO BACK

CLICK TO RESET

CLICK TO CONTINUE

Step 3 – Select the types of energy use influenced by your policy

Click on the checkboxes to select the types of energy use that you’re interested in. Selecting a box displays some brief guidance on when it is likely to be affected. Forms of energy use that are not selected will be hidden in subsequent sections.

Step 4 – Select the start and end year of your appraisal period

Enter the first and last year in which your policy has a cost or benefit, even if these are not related to energy use or climate change. Years outside of this range will be hidden in subsequent sections. Note that there is incomplete data before 2010. As a result, the toolkit may return erroneous results for years before 2010.

Step 5 – Enter the name of your policy

Optionally, you can enter the name of your policy to help differentiate this version of the Toolkit.

Step 6 – Enter the year to discount to

Enter the base year that you want the Toolkit to discount all costs and benefits to.

Step 7 – Enter the current year

If your computer clock is incorrect, enter the current year. The toolkit uses this information to set the declining discount rate periods recommended in the Green Book. When you are ready to proceed, press ‘Click to Continue’.

Changes in Energy Use

The Changes in Energy Use page is where most of the detailed data on a policy is entered. The types of energy use and the years shown reflect the initial inputs that were entered.

The screenshot shows a software interface for entering energy use data. At the top, a process flow diagram consists of five chevron-shaped boxes: 'Initial Inputs' (blue), 'Changes in Energy Use' (orange), 'Additional Assumptions' (pink), 'Results' (green), and 'Cost-Effectiveness' (purple) with 'Sensitivity Analysis' (purple) below it. Below the diagram are four blue buttons: 'CLICK TO GO BACK', 'CLICK TO CLEAR ALL ENERGY INPUTS', 'CLICK FOR HELP ON UNITS OF ENERGY', and 'CLICK FOR HELP ON REBOUND EFFECT'. Below the buttons is instructional text: 'Please enter the 'change in energy use' for each sector and year from your policy scenario in the units shown. These changes should be entered relative to the DfT baseline and account for policy overlaps. A reduction in energy use compared to the baseline (an energy saving) should be noted as a negative figure. An increase in energy use should be noted as a positive figure. All energy figures should relate to the gross calorific value of the relevant fuel. Electricity use should be entered in terms of gross electricity (including distribution losses). For help on energy units or on the rebound effect, please click the relevant button above.'

TRADED		2010	2011	2012	2013	2014	2015	2016	2017
Electricity									
Net Change - Domestic	(GWh)								
Net Change - Commercial	(GWh)								
Net Change - Industrial	(GWh)								
Direct Rebound - Domestic	(%)	0%	0%	0%	0%	0%	0%	0%	0%
Direct Rebound - Commercial	(%)	0%	0%	0%	0%	0%	0%	0%	0%
Direct Rebound - Industrial	(%)	0%	0%	0%	0%	0%	0%	0%	0%
Direct Rebound - Domestic	(GWh)	0	0	0	0	0	0	0	0
Direct Rebound - Commercial	(GWh)	0	0	0	0	0	0	0	0
Direct Rebound - Industrial	(GWh)	0	0	0	0	0	0	0	0
Gas									
Net Change - Domestic	(GWh)								
Net Change - Commercial	(GWh)								

Step 8 – Enter the net change in energy use

All of the types of energy use that were selected on the previous page will have its own section on this page. These sections are arranged vertically and extend horizontally with a separate column for each year of the policy appraisal period. The first few rows in each section are labelled ‘Net Change’ and are followed by a unit (e.g. GWh). You should enter the net change in energy use for each type of energy in each year in the units given. Reductions in energy use should be inputted as negative numbers and should be net of any rebound effect. Cells can be left blank. Often, there will be three separate ‘Net Change’ rows: Domestic, Commercial and Industrial. Where there are several ‘Net Change’ rows, make sure that you enter the energy changes in the relevant row.

Step 9 – Enter your estimated rebound effect

Optionally, if your policy is expected to result in a rebound effect, you can enter the expected rebound using the rows labelled ‘Direct Rebound’. Where the ‘Net Change’ has been subdivided (e.g. between domestic, commercial and industrial) the same division is used for the rebound effect. The rebound effect can be entered either as a percentage of the *gross* change in energy or as an absolute quantity. The rows for entering a percentage (labelled with ‘%’) are shown above the rows for entering a quantity (labelled with the relevant unit, e.g. GWh). Note that each % cell is linked to the equivalent unit cell with a formula and vice versa. You will need to overwrite one or the other cell to enter your estimate of the rebound effect. When you do so, the other cell in the pair will automatically update itself to be consistent with your entry. If you want additional help on rebound effects, press ‘Click for Help on Rebound Effect’. When you are ready to proceed, press ‘Click to Continue’.

Additional Assumptions

The screenshot shows a spreadsheet interface with the following content:

Process Flow: Initial Inputs → Changes in Energy Use → Additional Assumptions → Results → Cost-Effectiveness / Sensitivity Analysis

Buttons: CLICK TO GO BACK, CLICK TO CONTINUE, CLICK TO EDIT ASSUMPTIONS BY INDIVIDUAL YEAR, CLICK TO REVERT TO CONSTANT SPLIT ACROSS YEARS

1. What is the discount rate?

3.50%	for the first 30 years (from the current year)
3.00%	for the period 31 to 75 years (from the current year)
2.50%	for the period more than 75 years (from the current year)

This spreadsheet recommends

2. What are the proportions of fuel used by different road transport vehicle types?

Vehicle type - petrol		% split
LGV	%	2.4
Car	%	97.6

SPLIT ADDS UP TO 100%

Vehicle type - DERV		% split
LGV	%	31.5
Car	%	24.6
Rigid HGV	%	19.8
Articulated HGV	%	24.1

SPLIT ADDS UP TO 100%

44 NB: defaults are calculated from two publications - Transport Statistics Great Britain (2008, Tables 3.1 & 3.4) and Road Freight Statistics (2007, Table 1.12)

Step 10 – Enter the discount rate

The Toolkit defaults to the discount rates recommended by the Green Book. However, if you wish to use different discount rate assumptions, you can enter them here for the time periods specified.

Step 11 – Enter road transport assumptions

Optionally, if you selected road transport earlier, you can specify how the net

change in road fuel use is distributed among different vehicle types.⁴ This information is used to value the resultant air quality impact. If you want to have the proportions attributable to different vehicle types differ between years, you can press ‘Click to Edit Assumptions by Individual Year’. When you are ready to proceed, press ‘Click to Continue’.

Results

Results Summary
(£ 2009)

Net change in energy use	£0
Net change in emissions	£0
Net air quality impact	£0

NPV (Net Present Value)

Total other costs (including policy costs)	£0
Total other benefits	£0
NPV inc. other costs/benefits	£0

Energy price scenario: Central
Carbon price scenario: Central
Base year: 2009

Appraisal period (years): 91
Annualised NPV: £0

Other Major Outputs

CHANGES IN CO2 EMISSIONS
(minus indicates an emissions saving)

Net emissions CO ₂ in the traded sector	0.000
Net emissions CO ₂ in the non-traded sector	0.000

TRADED SECTOR (EU ETS)
(£ 2009, PV 2009)
minus indicates a cost

Net change in energy use	£0
Net change in emissions	£0
Net air quality impact	£0
TOTAL	£0

NON-TRADED SECTOR
(£ 2009, PV 2009)
minus indicates a cost

Net change in energy use	£0
Net change in emissions	£0
Net air quality impact	£0

Carbon Budgets

UK GHG EMISSIONS
(minus is a reduction in emissions)

	2008-2012	2013-2017	2018-2022
Net change in CO ₂ (traded)	0.000	0.000	0.000
Net change in CO ₂ (non-traded)	0.000	0.000	0.000

The Results page shows a number of summary outputs. It is divided into three sections: Results Summary, Other Major Outputs and Carbon Budgets. The Results Summary at the top of the page contains a box showing the energy and carbon price scenarios being used to generate the results on the rest of the page. Below that it shows the base year, to which all the values are discounted. The value of the changes in energy use, emissions and air quality are shown on the left. If other policy benefits and costs are entered (as described in more detail later), these will also be shown here, above the policy’s NPV. The number of years in the policy appraisal period and the annualised NPV are shown to the right.

The ‘Other Major Outputs’ section appears in the bottom left. At the top it shows the change in greenhouse gas emissions disaggregated by traded and non-traded

⁴ The default values come from Transport Statistics Great Britain (DfT).

sector. Below this the value of changes in energy use, emissions and air quality are also shown disaggregated by sector.

The ‘Carbon Budgets’ section to the right shows the change in greenhouse gas emissions disaggregated by traded and non-traded sector and carbon budget period, as required for carbon budget reporting.

To the right of this page are three buttons, which are described in detail in the following sections.

Cost Effectiveness

Press on ‘Click to Add Other Policy Costs and Benefits’ to allow the Toolkit to calculate the Cost Effectiveness Indicator for you. Doing so will take you to the Cost Effectiveness page.

	A	B	C	D	O	P	Q	R	S	T	U	V	W	X	Y
2															
3	<p>Other Policy Costs and Benefits</p> <p>Cost effectiveness analysis provides an estimate of the net social cost per tonne of GHG reduction in the traded and/or non-traded sectors.</p> <p>To calculate the cost-effectiveness indicator, you will need to enter any other quantified costs and benefits of your policy (for example policy costs, comfort taking, health benefits, etc).</p> <p>CLICK TO GO BACK CLICK TO CLEAR ALL OTHER COSTS & BENEFITS</p>														
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16	Other costs (undiscounted)	(£ 2009)													
17	Other costs (discounted)	(£ 2009)	0	0	0	0	0	0	0	0	0	0	0	0	0
18			<i>A positive figure here represents a real cost (i.e. a negative figure would be a real benefit)</i>												
19															
20	Primary rebound effects (e.g. comfort taking, undiscounted)	(£ 2009)	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Other benefits (undiscounted)	(£ 2009)													
22	Total other benefits (discounted)	(£ 2009)	0	0	0	0	0	0	0	0	0	0	0	0	0
23			<i>A positive figure here represents a real benefit (i.e. a negative figure would be a real cost)</i>												
24															
25	Traded sector energy use	(£ 2009)	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Non-traded sector energy use	(£ 2009)	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Traded sector CO ₂ emissions	(£ 2009)	0	0	0	0	0	0	0	0	0	0	0	0	0
28	Non-traded sector CO ₂ emissions	(£ 2009)	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Traded sector air quality	(£ 2009)	0	0	0	0	0	0	0	0	0	0	0	0	0
30	Non-traded sector air quality	(£ 2009)	0	0	0	0	0	0	0	0	0	0	0	0	0
31															
32															
33															
34	TRADED SECTOR: Cost-Effectiveness Indicator														
35															
36	Net change in traded sector CO ₂ (tonnes)		0												
37	Overall NPV minus PV of traded sector CO ₂		£0												
38	Cost-Effectiveness Indicator (CEI)		-												
39															
40	Weighted Average Discounted (WAD) traded carbon price		-												
41															
42															
43															
44															
45															
46	NON-TRADED SECTOR: Cost-Effectiveness Indicator														
47															
48	Net change in non-traded sector CO ₂ (tonnes)		0												
49	Overall NPV minus PV of non-traded sector CO ₂		£0												
50	Cost-Effectiveness Indicator (CEI)		-												
51															
52	Weighted Average Discounted (WAD) non-traded carbon price		-												
53															
54															
55															
56															
57	The cost-effectiveness figures for the traded and non-traded sectors should be compared to the WAD traded carbon price and the WAD non-traded carbon price respectively.														
58															

Step 12 – Enter other costs

In the topmost row, enter any undiscounted costs that are not accounted for directly by the Toolkit. Costs should be entered as a positive number. The discounted equivalent will be shown in the row immediately below.

Step 13 – Enter other benefits

In the row labelled ‘Other benefits (undiscounted)’, enter any undiscounted benefits

not accounted for directly by the Toolkit. If you previously entered the size of the rebound effect, the Toolkit will value the comfort taking separately; this should not be included in your entry here. Benefits should be entered as a positive number. The total discounted value and the value of any comfort taking will be summed in the row immediately below.

After completing these two steps, the Toolkit will correctly display the cost effectiveness indicator for traded and non-traded emissions in the two coloured boxes at the bottom of the page. It will also show the carbon savings and the NPV net of carbon benefits used to calculate the cost effectiveness indicator, as well as the weighted price of carbon against which the cost effectiveness indicator should be compared.

Any other costs and benefits entered on this page will now be reflected on the Results page.

When you are ready, press ‘Click to Go Back’ to return to the Results page.

Sensitivity Analysis

From the Results page, press on ‘Click to Conduct Sensitivity Analysis’ to quickly check how sensitive your results are to different energy and carbon price scenarios. Doing so will take you to the Sensitivity Analysis page.

1. Select which energy price scenario you want to use:

2. Select which carbon price scenario you want to use:

3. Use the results below as an indication of the sensitivity of your analysis to energy and carbon prices assumption

Sensitivity Results Summary
(£ 2009)

Net change in energy use	<input type="text" value="£0"/>		Energy price scenario:	Central
Net change in emissions	<input type="text" value="£0"/>		Carbon price scenario:	Central
Net air quality impact	<input type="text" value="£0"/>		Base year:	2009
NPV (Net Present Value)	<input type="text" value="£0"/>	→	Appraisal period (years):	<input type="text" value="91"/>
			Annualised NPV	<input type="text" value="£0"/>
Total other costs (including policy costs)	<input type="text" value="£0"/>			
Total other benefits	<input type="text" value="£0"/>			
NPV inc. other costs/benefits	<input type="text" value="£0"/>	→	Annualised NPV	<input type="text" value="£0"/>

Step 14 – Select energy and carbon price scenario

Clicking on the scenario names in the boxes at the top of this page will open up dropdown lists, allowing you to select one of several scenarios for each. The summary results below will update automatically to reflect your selections.

Descriptions of the energy price scenarios are available on the DECC website.⁵ When you are ready, press 'Click to Reset Scenarios and Go Back' to return to the Results page.

Detailed Outputs

Press on 'Click to Create Customised Detailed Outputs' to have the Toolkit display more detailed output tables. Doing so will prompt you to choose the set of outputs that you want to see. After you select an option, you will be taken to a new page containing a set of tables detailing the outputs covered by your selection. From this page you can press 'Click to View Complete Outputs' to have the Toolkit return a comprehensive set of detailed outputs covering all of the options listed previously. This can be useful if you want to conduct further analysis using these outputs.

	A	B	M	N	O	P	Q	R	
1	Policy Name	<input type="button" value="CLICK TO GO BACK"/>			<input type="button" value="BUILD ANOTHER TABLE"/>			<input type="button" value="CLICK TO VIEW COMPLETE OUTPUTS"/>	
2									
3									
4									
			2010	2011	2012	2013	2014	2015	
6	Change in energy use - electricity (traded)	(GWh)	0	0	0	0	0	0	
7	Value of change in energy use (undiscounted)	(£ 2009)	0	0	0	0	0	0	
8	Value of change in energy use (discounted)	(£ 2009)	0	0	0	0	0	0	
9									
10	Change in energy use - gas (traded)	(GWh)	0	0	0	0	0	0	
11	Value of change in energy use (undiscounted)	(£ 2009)	0	0	0	0	0	0	
12	Value of change in energy use (discounted)	(£ 2009)	0	0	0	0	0	0	
13									
14	Change in energy use - coal (traded)	(GWh)	0	0	0	0	0	0	
15	Value of change in energy use (undiscounted)	(£ 2009)	0	0	0	0	0	0	

⁵ See 'DECC fossil fuel price assumptions' at <http://www.decc.gov.uk/en/content/cms/statistics/projections/projections.aspx>

B

A Checklist for Analysts

1. Have you considered possible overlaps or synergies with other policies?
2. Have you valued changes in GHG in the non-ETS sectors using the Non-Traded Price of Carbon? Have you valued changes in GHG in the ETS sectors using the Traded Price of Carbon?
3. Have you used the resource costs of energy when valuing the costs and benefits to the UK of changes in energy use?
4. Have you used the full retail price, including tax, of energy when working out sub-sectoral distributional impacts and the value of any direct rebound effects (e.g. comfort taking)?
5. Have you valued the air quality impacts of changes in energy use?
6. Have you specified the change in energy consumption?
7. Have scenarios been conducted for a good range of the main input variables?
8. Have you considered optimism bias?
9. Have you made explicit any assumptions about behaviours in the analysis?
 - Are the assumptions based on evidence and is this clearly set out?
 - Where evidence is lacking has this been made clear?
 - Is the outcome of the policy dependant on assumptions of how people use technology?
10. Have you involved your Better Regulation Unit as early as possible and ensured that they are copied the final Impact Assessment so that it is uploaded onto the IA library?
11. Have you set out the compliance costs (red tape) of the policy?
12. Have you reported administrative costs using the standard cost model? (contact your Better Regulation Unit for further advice if required)
13. Have you used the official template for the evidence base section, thereby presenting the reader with a familiar format? (contact your Better Regulation Unit for a copy if required)
14. Have you considered the need to evaluate your policy post-implementation and made preparations for such evaluation?
15. Have you ensured that all the numbers in the summary page are clearly referenced in the supporting evidence and that their derivation is explained in detail?

C List of Tables

Tables 1,2a and 2b provide the recommended emissions factors for electricity and other fuel types.¹

Table 3 summarises the carbon values to be used in the traded and non traded sector.

Tables 4–9 provide the recommended energy prices for a central fossil fuel price scenario.

Tables 10–21 provide energy price sensitivities for low, high and high–high fossil fuel price scenarios.

Tables 22–23 report air quality damage costs estimates.

Table 24 reports DECC’s fossil fuel price assumptions

All the tables can be downloaded, in excel format, at the following address:

http://www.decc.gov.uk/en/content/cms/statistics/analysts_group/analysts_group.aspx

¹ For company reporting please use the DEFRA guidance available at the following address
<http://www.defra.gov.uk/environment/business/reporting/conversion-factors.htm>