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Air Quality Damage Cost Guidance

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How to use damage costs: Worked example using the annual pulse approach

To illustrate how to apply damage costs to a policy appraisal that has variable pollution impacts and lasts for less than 20 years, a hypothetical policy scenario has been considered and illustrated with a step-by-step guide. This should be used in conjunction with:

- The Q&A paper[1] which sets out answers to key questions on how to use damage costs correctly and indicates what information you need to undertake a valuation; and
- The Excel template[2] which provides a user-friendly tool in valuing the air quality impacts of your policy and incorporates the calculations detailed below.

The hypothetical policy considered is as follows:

A measure aimed at improving the efficiency of domestic boilers is to be introduced. One of the expected benefits of implementing this measure is the reduction of PM emissions among other pollutants (e.g. impact on NOX emissions). This measure is being assessed for 10 years, from 2006, and is expected to reduce emissions of PM by 120 tonnes per year until 2008 and 30 tonnes per year thereafter.

Step 1 – Identify and quantify reduction in emissions

The policy brief above has identified that air quality benefits will arise from reductions in emissions of PM (particulate matter) and has outlined the level of reduction that is expected to be achieve. This is set out in the table below.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Emissions reduction (tonnes)	120	120	120	30	30	30	30	30	30	30

Step 2 – Identify which damage cost values to use

The IGCB(A) damages costs[3] for the four pollutants considered (PM, NOX, SO2 and VOCs). Depending on the nature of the policy/project and the pollutant in question a sector-specific damage cost may be available. In this instance, as the hypothetical policy scenario relates to PM emissions from domestic boilers, the damage costs for PM (domestic) should be used.

Step 3 – Convert damage costs to base year prices

Each damage cost is presented as a 'low' and 'high' estimate and both of these will need to be considered to account for the range in value the air quality impacts are likely to take. You should start with the low estimate, following the workings set out below, and then go on to repeat Steps 3 – 6 for the high estimate.

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[1] http://ww2.defra.gov.uk/environment/quality/air/air-quality/economic/
[2] http://uk-air.defra.gov.uk/library/
[3] http://ww2.defra.gov.uk/environment/quality/air/air-quality/economic/

All the damage costs value presented in Table 2 are in 2005 prices. These need to be adjusted to the baseline year for the policy/project appraisal (i.e. the year all costs and benefits are being compared against) to take into account inflation.

We recommended applying an increase of 2.5% per annum (in line with the Treasury Green Book) to adjust for prices. For example, in the scenario above the damage cost for PM (domestic) is £20,157 per tonne (in 2005 prices) and the baseline year was in 2006 the damage cost would be £20,661 per tonne (calculation: £20,157 x 1.025 = £20,661)

Step 4 – Uplift damage costs by 2%

This value now needs to be uplifted by 2% per annum to reflect the assumption that willingness to pay for health will rise in line with economic growth. A worked example of this is shown in the table below using the scenario above. The damage cost of £20,661 per tonne (already converted into 2006 prices in Step 3) are increased by 2% in 2007, then a further 2% in 2008 and so on. The compounding effect of each 2% uplift equates to the uplift factors also shown in the table below.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Uplift factor	1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20
Damage cost (£)	20,661	21,074	21,487	21,901	22,314	22,727	23,347	23,760	24,173	24,793

Step 5 – Calculate benefits for each year

These adjusted damage costs, calculated in Step 4 above, can now be used to calculate the benefits of a reduction in pollutant emitted for each year of the appraisal period. This calculation simply multiplies the expected reduction in emissions figure from Step 1 (in tonnes) by the adjusted damage cost figure and is shown, for the hypothetical scenario, in the table below.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Emissions reduction (tonnes)	120	120	120	30	30	30	30	30	30	30
Damage cost (£)	20,661	21,074	21,487	21,901	22,314	22,727	23,347	23,760	24,173	24,793
Benefit (£millions)	2.48	2.53	2.58	0.66	0.67	0.68	0.70	0.71	0.73	0.74

Step 6 – Discount benefits across the period of the policy appraisal and calculate total present value

The values calculated in Step 5 need to be discounted, to reflect the fact that current benefits have greater value in the present than future benefits, in order to determine the present value of air pollution impacts. To do this a 3.5% discount rate should be applied in line with Treasury Green Book recommendations.

To calculate the present value of air pollution impacts the undiscounted value of impacts for each year (calculated in Step 5 above) is simply multiplied by

the discount factor below, where 1.035 is the 3.5% discount rate and *t* is the number of years into the future that value is from the base year (year 0):

$$\text{Discount factor} = \frac{1}{(1.035)^t}$$

For example, the discount factor for 2009 is 0.90 as *t* is equal to 3 (see table below). The baseline year (in this case 2006) is always equal to year 0, with each following year sequentially numbered (i.e. year 1 is 2007, year 2 is 2008 and so on). This is then used to derive the present value as shown below:

Present value = Valued benefit x Discount factor

So for example in 2009, the undiscounted benefit is estimated to be £10.90 million and the discount factor is 0.90 (calculated using the first formula above). Multiplying these together generates a present value of £9.81 million. This calculation needs to be repeated for each year in the appraisal period. The table below shows the present values for the hypothetical policy scenario.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Year (t)	0	1	2	3	4	5	6	7	8	9
Discount factor	1.00	0.97	0.93	0.90	0.87	0.84	0.81	0.79	0.76	0.73
Benefit (£millions)	2.48	2.53	2.58	0.66	0.67	0.68	0.70	0.71	0.73	0.74
Present value (£millions)	2.48	2.45	2.40	0.59	0.58	0.57	0.57	0.56	0.55	0.54

The central low estimate of the total present value of air quality impacts can then be calculated by simply calculate the sum of present values across the appraisal period. For this policy measure this is £11.3 million.

Repeat Steps 3 – 6 for the high estimate of damage costs

For this hypothetical policy scenario the high estimate of the present value is £16 million. This gives a final estimate of expected present value of PM air quality benefits of £11-16 million.

Step 7 – Consider sensitivity analysis

In light of the uncertainties surrounding the damage costs derived for air pollution impact valuation, any policy/project appraisals should include a sensitivity analysis alongside the total present value calculated in Step 6 above.

Annex 1 of the Air Quality Damage Cost Methodology[4] sets out the values that should be used to carry out the sensitivity analysis. These need to be applied using the same method set out in Steps 3 – 6 above. Based on calculations using the sensitivity range for 1 year PM (domestic) damage costs, found in Annex 2, the present value range for this hypothetical policy measure is £3 to £37 million.

[4] http://ww2.defra.gov.uk/environment/quality/air/air-quality/economic/

Step 8 – Consider results alongside qualitative assessments

It is important, however, to also consider any other impacts of a change in air pollution, in a quantitative or qualitative way, alongside the total present value calculated above as these may be large in magnitude.

As highlighted previously impacts such as the effects of air pollution changes on ecosystems (e.g. through acidification) have not been included due to the significant uncertainty in valuing any quantified impacts. An attempt to qualitatively assess such impacts should be made and presented alongside the monetary assessment in order that a more robust appraisal is presented.