Cost-benefit analysis for air quality policies

An update and an IPPC Directive case study

An article published in CONCAWE *Review* Vol. 15, No. 2, described the methodology for assigning a monetary value to the effects of air pollution on human health. In the present article we briefly reintroduce some important concepts, discuss updates of actual monetary values based on recent scientific work and consider other aspects of cost-benefit analysis (CBA) methodology in general. We also discuss, as a case study, the CBA prepared for the EU Commission as the basis for the IPPC Directive revision.

The metric: VPF or VOLY?

The two metrics used to monetise impacts on human health are the Value of a Prevented Fatality (VPF, also called Value of a Statistical Life VSL) and the Value of One Life Year (VOLY). While the VPF concept is very useful in a context where we consider *observable* deaths (e.g. traffic accidents), the VOLY metric is much more appropriate when looking at chronic effects of air pollution, where we consider changes in *life expectancy*. In our opinion it is the only relevant metric for chronic mortality caused by air pollution (especially particulate matter, PM).

Mean or median?

In the context of European policy development the actual monetary value used for VOLY is obtained by using survey techniques. A representative value is derived from a range or distribution of survey responses. There are two possible options: using the mean (arithmetic average) or the median (the mid-point in the range of answers). As these response ranges (distributions) are not at all Gaussian, but highly skewed, the value of the mean is extremely sensitive to a few large outliers. We therefore agree with those experts who advocate the use of the median as a much more robust representative value for the VOLY.

There is another consideration when determining an appropriate VOLY for environmental policy decisions. The median is in effect a voting system where the answer of each individual participating in the survey is counted as a 'yes' or 'no' vote because it is either above or below a reference value (i.e. the median). Using the median, one could say that every 'vote' is given the same weight. By contrast, using the mean takes the strength of the vote into account: an individual A whose answer is higher than that of individual B carries more weight in the determination of the results. Choosing the median is thus closer in spirit to a typical yes/no vote in democratic elections and this approach would thus best reflect the average public's 'willingness to pay' for improvements in health standards. It is sometimes argued that the strength of a vote should be taken into account for issues which clearly involve a matter of degree, and that the mean should therefore be used. However, in our view this argumentation is not convincing in this context, where the influence of a few high outliers on the VOLY valuation is disproportionate.

An update of VOLY values

As discussed in the Autumn 2006 article, the CAFE[1] CBA uses results obtained from the NewExt study. NewExt uses survey results obtained in Italy, France and the UK. For VOLY the NewExt recommendations are k€ 188 for the mean value and k€ 52 for the median value. The latter is sometimes rounded down to k€ 50.

Following up on the work done under NewExt, a recent Integrated Project sponsored by DG Research called NEEDS[2] extended the survey work to eight European countries (France, Spain, United Kingdom, Denmark, Switzerland, Czech Republic, Hungary and Poland). These surveys are fundamentally based on VOLY and not on VPF and are *mean* rather than median values. A final paper (deliverable D6.7 RS 1b) published in September 2006 and available from the NEEDS project website

[1] *Clean Air For Europe*

[2] *New Energy Externalities Developments for Sustainability*

(www.needs-project.org) gave a first set of recommended VOLY estimates. Another version of the final paper, dated February 2007 (not yet available from the NEEDS project website), is based on the same country surveys, but with the addition of Germany, so now covering a total of nine countries. This latest version also involves a recalculation of some of the results. The recommended figures are summarised in Table 1.

In their February 2007 version of the NEEDS report the authors opt for the mean, because in their opinion determining a VOLY for environmental policy is a matter of degree. However, we have a strong preference for using the median, because it does make the VOLY determination for environmental policy decision much more robust and also fairer. There is no clear rationale for giving more weight to some survey answers than others. This applies especially to the situation of individuals making a conscious decision to give a reply with value 'zero' (0), the so-named *non-protest zeros* which often form a significant group in this type of survey. Compared to individuals whose answer would be high, the non-protest zero individuals would receive the same weight in the 'median approach', but in the 'mean approach' they would be accorded much less weight.

At the very least, values from different sources should only be compared when they have been calculated on the same basis. Both NEEDS papers compare their mean-based VOLYs with the NewExt k€ 50 value which is based on medians. The correct comparison should be to the NewExt mean value which is estimated at k€ 118. The NEEDS VOLY estimates are therefore a factor 3.0 to 3.4 lower than the NewExt VOLY estimates. The equivalent NEEDS median-based VOLY would be about k€ 18, i.e. also a factor of 3 lower than the corresponding NewExt value.

Within each study the ratio between mean and median values seems to be the same. In both the NewExt and NEEDS studies, the mean value is a factor of about 2.2 higher than the median.

We therefore maintain our view that VOLY estimates should be based on *medians*. These can be calculated by dividing the mean values from Table 1 by a factor of 2.2.

Table 1 VOLY estimates (based on means) from the NEEDS project (k€)

Source	September 2006	February 2007 update
EU-16*	40	41
New Member Countries	25	33
Recommended for all EU-25 countries	35	40

* EU-15 + Switzerland

The latest results of the NEEDS project then lead to the following recommended VOLY estimates:

For EU16:	k€ 19
For New Member Countries	k€ 15
For EU25:	k€ 18

Some comments on cost-benefit analysis

Before discussing the IPPC Directive case study, two relevant points have to be made concerning the CBA methodology in general.

Marginal analysis

When performing a CBA, there has to be a reference situation against which one or more policy options can be considered. When these policy options are mutually exclusive it is correct to compare the outcome of each option to the reference case. When, however, the policy options are additive (or build on each other) one should look at the incremental costs and benefits of going from one option to the *next best* option. In this case, calculating all costs and benefits for the different options *relative to the reference case* produces only average values and masks the different cost levels that may occur when going from one option to the next.

Breakeven value

Normally in a CBA, all the relevant marginal costs and benefits are calculated for a range of options using the correct VOLY figure to evaluate the changes in life expectancy for each option. The optimal policy choice will then be around the point where marginal costs are approximately equal to marginal benefits.

Another way to analyse the cost-benefit of a particular policy option is to compare the recommended VOLY to

the ratio of the additional costs over the years of life lost (YOLL) associated with that option (Cost/YOLL ratio).

If the Cost/YOLL ratio is lower than the recommended values given above, then the option would be justifiable, but if the Cost/YOLL ratio is clearly higher than the recommended values it must be concluded that the proposed option cannot be justified by its effects on human health in terms of a life expectancy increase.

A case study: the proposal for a new IPPC Directive

On 21 December 2007 the EU Commission adopted a proposal for a new Integrated Pollution Prevention and Control Directive (IPPCD), covering the legislation that is concerned with the environmental permitting of most industrial and agricultural activities in Europe. The accompanying Impact Assessment (IA) contains a CBA of the newly proposed Directive. Although there are many aspects to the new IPPCD, in this article we will restrict the discussion to the CBA.

The IA presents two policy options for dealing with emissions of SO_2, NO_x and total PM, both based on applying the new IPPCD to Large Combustion Plants (LCPs). The first uses the ***upper*** value of the range in BAT Associated Emission Levels (BAT AELs) as mentioned in the BREF for Large Combustion Plants (LCP BREF) and the second (stricter) option is based on the ***lower*** value of that range.

A first issue is the choice of the two policy options. The first policy option should reflect the analysis that led to the development of the Thematic Strategy on Air Pollution (TSAP) as the outcome of the CAFE programme. The TSAP was adopted in September 2005 and it is the basis for the current revision of the National Emissions Ceiling Directive (NECD). It is a policy option which is *optimised* for cost-effectiveness over the whole of Europe. The TSAP delivers quantitative reductions for all relevant emissions while still ensuring *full compliance* with the current IPPCD everywhere in Europe. This scenario should therefore be the policy situation that we want to improve upon using a revised IPPCD and the TSAP should therefore serve as our first policy option in the IA. The second policy option can be considered as the strictest possible implementation of IPPC and is therefore akin to applying maximum emission reductions everywhere in Europe.

A second issue is that, in the IA, the costs and benefits for both options are calculated relative to the same reference case, an NECD Baseline based on the national energy projections. Because the two options are additive rather than mutually exclusive, the correct way of making this marginal analysis is to compare each option to the previous one in terms of stringency.

If we then repeat the CBA of the two IPPCD policy options, firstly using the TSAP, secondly the maximum emission reductions and applying a proper marginal analysis, we find two 'Cost/YOLL' ratios. For the step from the reference case to the first option (TSAP) we find a Cost/YOLL ratio of about k€ 50. Using the NewExt recommended median VOLY value (k€ 52) as was used for the CAFE programme, it can be concluded that the TSAP was indeed justifiable at the time (2005). However, using the updated NEEDS recommended VOLY value (k€ 18), we must conclude that the TSAP option is *no longer justified* by the benefits in life expectancy increase for the European population.

For the step from the first option (TSAP) to the second option (maximum reductions) we find a Cost/YOLL ratio of about k€ 100, clearly *much higher* than any of the recommended values mentioned above. We conclude that this step *cannot be justified* by the benefits in increased life expectancy for the European population.

Conclusions

Based on the latest scientific research, the VOLY estimate used in CBA of impacts of air pollution needs to be adjusted downwards from k€ 52 as used in the CAFE programme to k€ 18.

Using this information to check the CBA given in the Impact Assessment supporting the Commission proposal of a new IPPC Directive, it is very clear that the increased life expectancy benefits for the European population are insufficient to justify the high costs of a strict IPPC implementation (maximum reductions in emissions).