

Model user guide

Opportunity cost calculations for
spectrum proposed for award to a band
manager with obligations to PMSE

6 May 2009

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1 Introduction to the model

This model user guide has been written to complement Analysys Mason's report for Ofcom titled "Opportunity cost and AIP calculations for spectrum proposed to a band manager with obligations to PMSE" (reference number 13997-184).

The report was part of a study for Ofcom to calculate the opportunity costs and recommend administered incentive pricing (AIP) levels for spectrum to be awarded to a band manager with obligations toward programme-making and special events (PMSE) in the UK. During the study Analysys Mason generated an opportunity cost model; this guide provides an overview of its structure and how to use it. `

The report and model are available to download from: <http://www.ofcom.org.uk/consult/condocs/>.

2 Structure of the model

The model contains eight worksheets:

- *Contents* contains information on the model version and authors
- *Style guidelines* contains the list of cell styles used in subsequent worksheets
- *Parameters* contains inputs that can be changed by the user, which drive the calculations throughout the whole model
- *Inputs* contains information on historical usage and population coverage of each frequency range (FR), which are used in calculations throughout the model
- *PMSE users* contains the calculations which determine the marginal benefit of each FR to the PMSE community
- *Alternative users* contains the calculations which determine the marginal benefit of each FR to each viable alternative use
- *Summary* calculates the opportunity cost of each FR using the PMSE marginal benefits and the alternative use marginal benefits
- *Tables for report* gives the resulting rounded opportunity cost for each FR and aggregated results for each band group.

Figure 2.1 below shows the overall calculation structure of the model and the relationship between the six calculations worksheets.

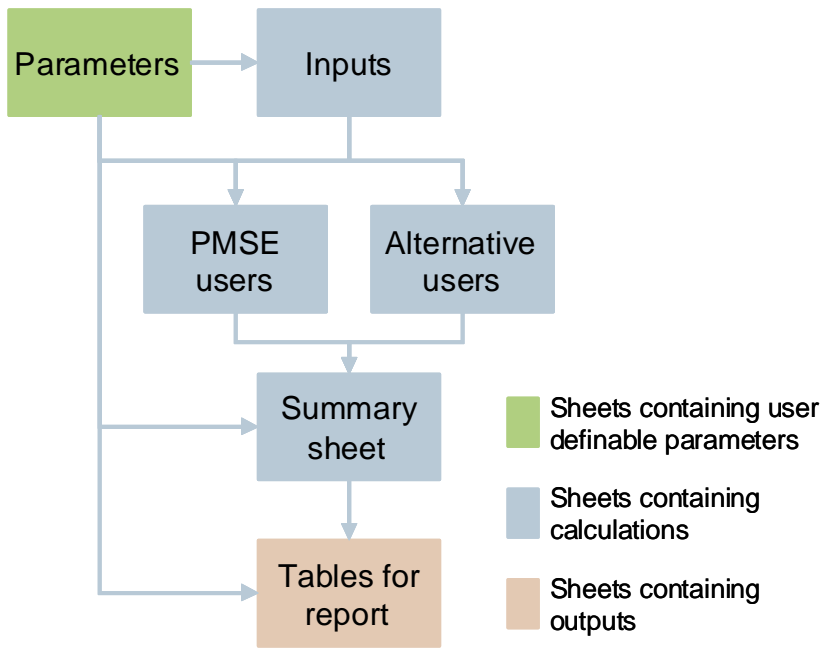


Figure 2.1: Overall structure of the model
 [Source: Analysys Mason]

In the remainder of this section we describe the calculation flow through each of these six worksheets.

2.1 Parameters

The *Parameters* worksheet contains all of the parameters used to drive calculations throughout the model. There are no calculations in this worksheet. It is split into four parts.

- General parameters – these include basic parameters, such as the number of months in a year, as well those which affect to how many significant figures the end results (in the *Tables for report*) are rounded.
- Population coverage parameters – these define the population living in different regions of the UK and assign weightings to each region. We defined three population density regions: A, B and C, with A (London) being the highest density area. We assigned weighting factors to each in order to reflect the fact that more densely populated areas will be valued more highly by current and alternative users. These parameters are used to scale the opportunity cost results to the parts of the UK where each FR is available. More information on our chosen weightings is given in Sections 4.2.2 and D.1 of the report.
- PMSE parameters – these drive the PMSE marginal benefit calculations. The user can adjust equipment numbers, growth rates, equipment costs, equipment lifetimes and cost of capital factors for each type of PMSE application.

- Alternative use parameters – these define the assumed viability of each alternative use in each band group. Parameters that drive the marginal benefit calculations for each alternative use are also included here.

2.2 Inputs

The *Inputs* worksheet contains the results of two pieces of analysis conducted separately. Firstly, it contains the results of Analysys Mason's analysis of JFMG's assignment database (See Section 3.1 in the report). This analysis determined the number of assignments and assignment days by FR for each PMSE application for the years ending September 2006 and September 2008. Secondly, it contains the results of Analysys Mason's geographical analysis to determine the population which can be covered by each FR in three regions of the UK (A, B and C). This geographical analysis was based on information provided by JFMG regarding the geographic constraints of each FR.

In this worksheet the geographical and assignment data is manipulated so it can be used to drive the marginal benefit calculations later on in the model. Specifically, weighted population coverage by FR (used to scale the opportunity cost results to the parts of the UK in which each FR is available) and the relative number of assignments in each FR (used to allocate total equipment numbers between FRs) are used to drive marginal benefit calculations.

2.3 PMSE users

The *PMSE users* worksheet determines the marginal benefit of each FR to PMSE users. As outlined in Sections 6.3 and 7.2.1 of the report, marginal benefits are only calculated for FRs in which:

- there is excess demand from either PMSE or alternative uses
- PMSE equipment would be stranded if an increment of spectrum was made unavailable to PMSE users.

The marginal benefit of each FR for the seven PMSE applications (as identified in Section 3.1 of the report) are calculated separately and then added together to find the overall marginal benefit of each FR to PMSE users. The seven types of PMSE application are:

- radio microphones
- in-ear monitors (IEMs)
- talkback systems
- telemetry links
- audio links
- video links
- wireless cameras (included in video links by JFMG).

The marginal benefits are calculated by multiplying the total equipment estimated to be in the UK market in mid-2010, by the unit cost of equipment annualised over the lifetime of the equipment. This figure is then multiplied by a weighting factor to scale the opportunity cost results to the parts of the UK where each FR is available and by a second factor which allows for any uncertainty in the calculation. The second factor is introduced in order to produce a conservative estimate of marginal benefits and is outlined in more detail in Section 7.2.6 of the report. Figure 2.2 below shows the marginal benefit calculation flow.

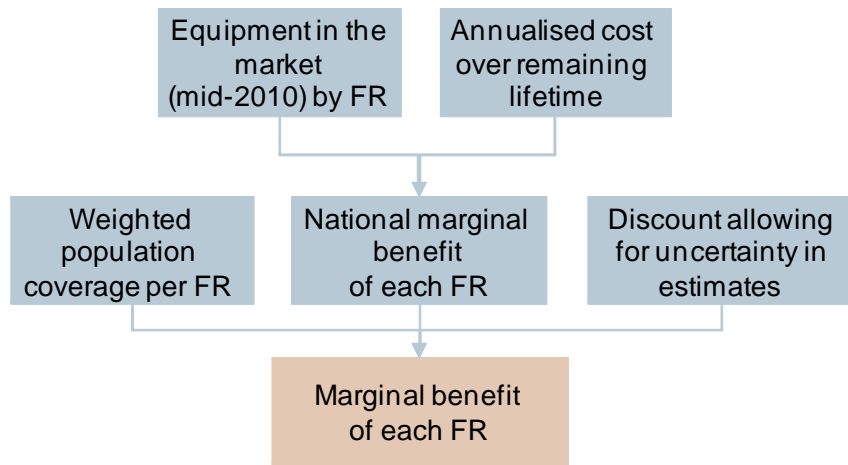


Figure 2.2: Calculation flow determining the marginal benefit of spectrum for PMSE [Source: Analysys Mason]

Determining the annualised unit cost of equipment

For each PMSE application, the annualised unit cost of a piece of equipment is calculated. This calculation requires an estimate of the average cost of a piece of equipment, the average lifetime of that equipment and the weighted average cost of capital (WACC) which is typically applied to the capital investment needed to purchase the equipment. Figure 2.3 below outlines the corresponding calculation flow.

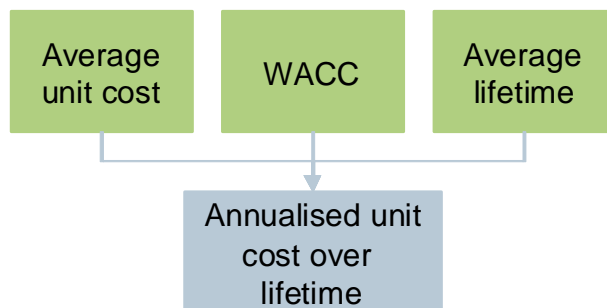


Figure 2.3: Calculation flow determining the annualised unit cost over the remaining lifetime of a piece of equipment [Source: Analysys Mason]

Determining the amount of equipment in the market

The quantity and quality of information available regarding the amount of PMSE equipment in the UK varies significantly by PMSE application. Therefore, we have selected an approach based on the application (a more detailed discussion is given in Section 7.2 of the report).

For radio microphones and IEMs, we have used estimates made by Sagentia in their report “Use of UHF Spectrum for Programme Making and Special Events in the UK” (2006) to approximate the quantity of equipment in the UK.

The total number of talkback systems and wireless cameras in the UK has been estimated using information provided during interviews with stakeholders. The annual growth in the amount of equipment in the market has been estimated using the growth in assignments based on JFMG’s database. This quantity is then allocated to each FR based on the relative number of assignments made in the year ending September 2008.

For telemetry links, audio links and video links, the total equipment in the market has been estimated by calculating the number of assignments in a year, then dividing by an estimated number of assignments per piece of equipment. As the definition of video links in JFMG’s database includes wireless cameras, we have subtracted our estimation of wireless cameras from the total video links estimate. The remaining calculation to determine the equipment in mid-2010 by FR is the same as for wireless cameras and talkback systems.

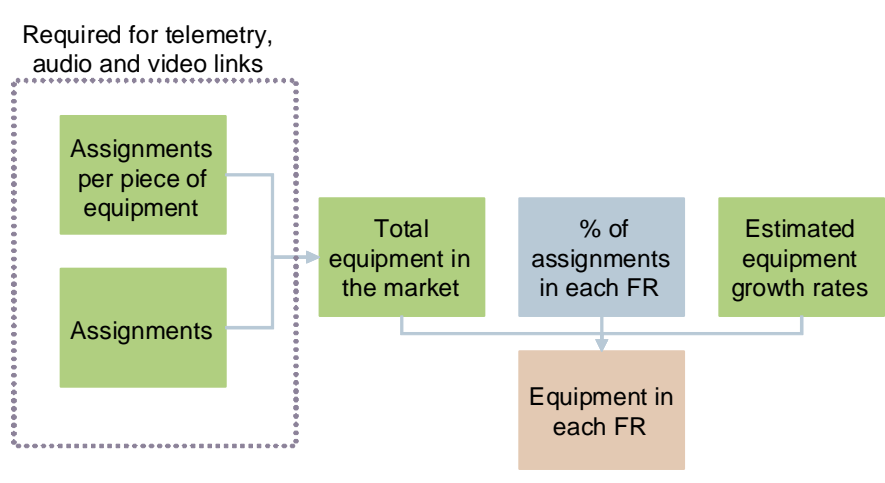


Figure 2.4: Calculation flow for determining the amount of equipment in the market [Source: Analysys Mason]

2.4 Alternative users

The *Alternative users* worksheet determines the marginal benefit (in mid-2010) of each FR to each alternative use. As outlined in the Section 6.3 of the report, marginal benefits are only calculated for the FRs which we have deemed to have excess demand.

We have employed a variety of methods to calculate the marginal benefit of alternative uses. Due to variations in the amount of information available it was not possible to use the same approach to value spectrum for all uses. Section 7.3 of the report outlines the marginal benefit calculations for each alternative use in detail.

2.5 Summary

The *Summary* calculates the opportunity cost of each FR from the PMSE marginal benefit, marginal benefits of each alternative use and the viability probability percentages of each alternative use. The opportunity cost of each FR is essentially a probability weighted calculation using the marginal benefit of the spectrum to PMSE and all viable alternative users.

As outlined in Section 7.4 of the report, in situations when there are several potential alternative uses in a band group, we assume that the likelihood of alternative uses being viable is correlated. As shown in Figure 2.5, this effectively maximises the overlap in a probability Venn diagram representing alternative uses. When the overlap between the circles is maximised, the “no alternative use” percentage is also maximised, meaning that the overall weighted average marginal benefit will be minimised. This is consistent with our overall approach of producing conservative opportunity cost estimates.

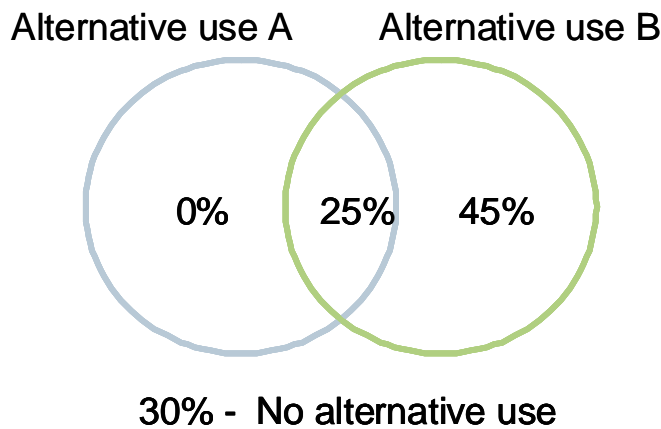


Figure 2.5: Diagram showing probabilities assuming that viability percentages are correlated [Source: Analysys Mason]

Figure 2.6 below shows the calculation flow for determining the opportunity cost for a FR with two alternative uses.

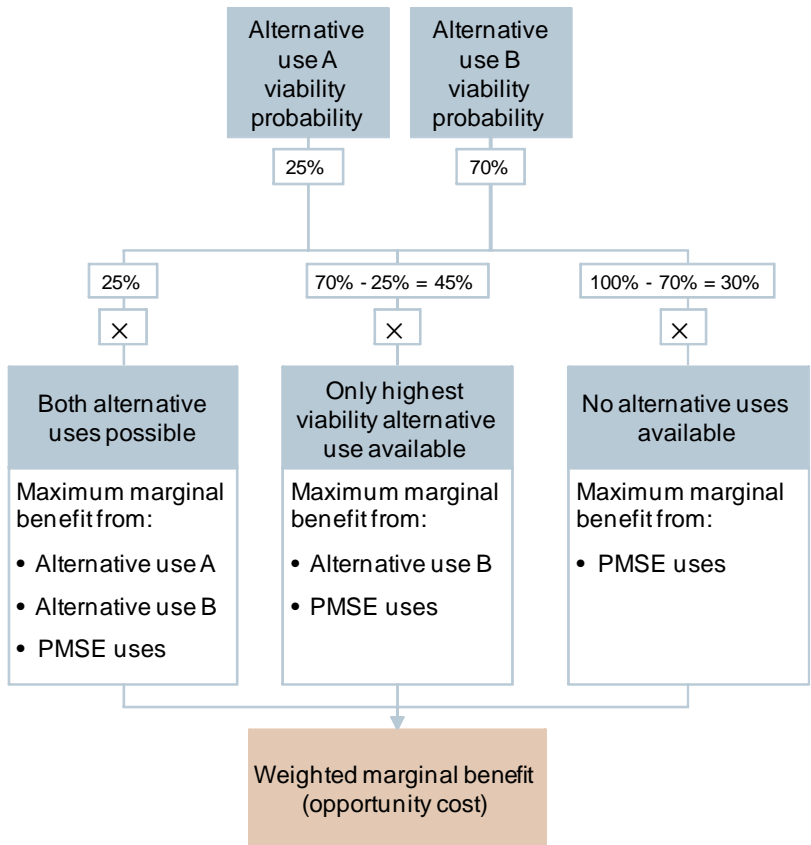


Figure 2.6: Example of how the opportunity cost is determined for a FR with two alternative uses (with viability probabilities of 25% and 70%) [Source: Analysys Mason]

2.6 Tables for report

The *Tables for report* worksheet displays the resulting rounded opportunity cost for each FR, as well as aggregated results for each band group. Figures are rounded to the number of significant figures defined in the *Parameters* worksheet (the default setting is 3).

For each FR and each band group, a number of outputs of the model are displayed:

- highest value alternative use
- marginal benefit to the highest value alternative use
- marginal benefit to PMSE users
- opportunity cost
- marginal benefit to the highest value alternative use per MHz
- marginal benefit to PMSE users per MHz
- opportunity cost per MHz.

3 How to use the model

The model has been designed to be simple to use: it calculates automatically and does not contain any macros.

In this section we describe how to use the model to:

- quickly navigate through the model and view the outputs
- alter the high-level inputs to the model and view the revised results.

3.1 Navigating the model and viewing the outputs

To view the results of the model please look at the *Tables for report* worksheet. This worksheet displays the opportunity cost calculated for each FR as well as aggregated results for each band group. These results are rounded to three significant figures. To view the results to a different number of significant figures they should alter the number in cell F11 in the *Parameters* worksheet.

3.2 Adjusting the high-level inputs into the model

To adjust the high-level inputs of the model use the *Parameters* worksheet (to change the high-level inputs) and *Tables for report* worksheet (to view the results). There are two exceptions to this, which we discuss below:

- adjusting whether there is excess demand for alternative uses in each FR
- adjusting the number of UHF radio microphones in the market by mid-2010.

Guide to adjusting the inputs in the Parameters worksheet

We have used Analysys Mason's cell styles in this model – an overview of these styles is provided in the *Style guidelines* worksheet. Adjusting the inputs relies on this style information, which refers to the functionality of each cell.

Although all the parameters can be adjusted, we suggest that the following inputs may be of most interest to a user:

- the percentage reduction of PMSE marginal benefit due to uncertainty (cell F26)
- whether excess demand is present in a band group AND whether PMSE equipment will be stranded should an increment of spectrum be removed (cells F29–F51)

- average unit cost of PMSE equipment:
 - a radio microphone (cell F79)
 - a radio microphone in Channel 69 (cell F80)
 - an IEM (cell F97)
 - a talkback system (cell F115)
 - a series of factors used to determine the cost of a data link (cells F132–F135)
 - an audio link (cell F156)
 - a video link (cell F176)
 - a wireless camera (cell F193)

- alternative use viability probabilities in each band group (cells D204–H226).

Adjusting whether there is excess demand for alternative uses in each FR

The user can adjust the viability probabilities of each alternative use in the *Parameters* worksheet. However, if this is adjusted, the *Alternative users* worksheet must also be adjusted to show whether excess demand is present in each FR. In order for the marginal benefit of an alternative use to be included in the calculation of opportunity cost for an FR, the appropriate cell in columns I and L must be set to “TRUE”. It is important to adjust these cells when changes are made to the viability probabilities.

If in doubt the user should change all values in columns I and L to “TRUE”. In this situation, the correct opportunity cost will always be calculated in the *Summary* and *Tables for report* worksheets. However the “highest value alternative use” and “marginal benefit to the highest alternative use” figures reported could potentially be incorrect.

Adjusting the number of UHF radio microphones in the market by mid-2010

An important input is the estimate of the number of UHF microphones (Channel 69 and the TV interleaved spectrum) in the market in mid-2010. We have estimated the amount of equipment in the market if the average radio microphone lifetime is set at 3, 5, 7 or 10 years.

If the lifetime is set using one of these timeframes (cell F81 in the *Parameters* worksheet), our estimates of the amount of equipment will be used automatically. If a different lifetime or a number of radio microphones is entered, an estimate of the number of UHF radio microphones in mid-2010 should also be entered into cell D33 in the *PMSE users* worksheet.