Annex 15

Differences between bands – costs

Technical Study of the Effect of Frequency on 3G Infrastructure Costs

Introduction

A15.1 In this annex we set out how we have estimated the costs of network build, upgrade, operation and decommissioning of different network roll-out profiles, and hence how we have estimated the cost differences that could arise as a result of differences in the spectrum holdings of different operators.

Structure

A15.2 This annex is structured as follows:

a) We provide an **overview** of our updated methodology

b) We present a **list of the issues** we identified after consultation and present a **summary of consultation responses** and outcomes of subsequent discussions with mobile operators which have led to the refinement of our analysis.

c) We provide an **issue-by-issue analysis**. For each major issue, we explain the issue raised in more depth, describe what we have done to investigate the issue and explain our findings. We then summarise how the updated methodology accounts for the issue.

d) Finally, we present the **results** of the refined analysis.

Overview

Structure of the cost modelling

A15.3 The cost modelling take as input the roll out profiles defined in Annex 12, and calculates a total cost for each of these roll out profiles. This cost is the present value of relevant expenditures for the period 2008 to 2028, expressed in 2008 pounds.

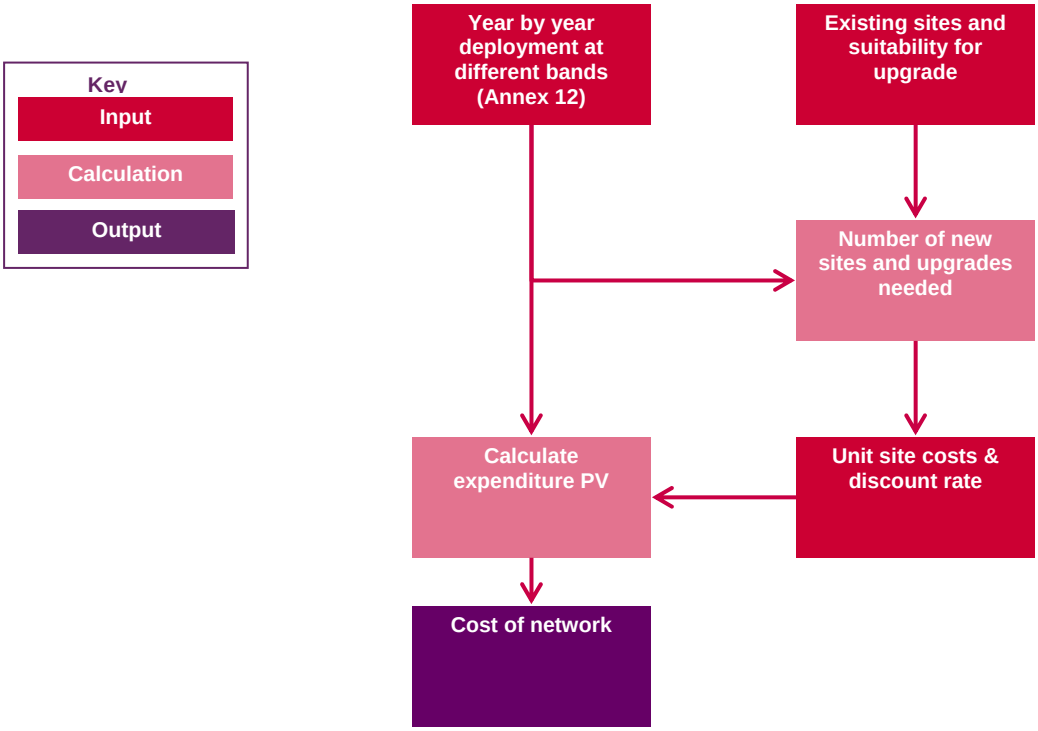
A15.4 The calculation flow is shown in Figure 1 below. The cost modelling involves the following steps:

i) We start from the roll-out profiles developed in Annex 12. These define yearly deployment of equipment for different technologies and bands (such as UMTS 900 and UMTS 2100).

ii) The equipment needed will be housed in different types of new sites and upgrades. So we sort the equipment into different categories of sites.

iii) Each different category of site may have different costs associated with them, so we compute the present value of expenditures for each of them.

Figure 1 - Cost modelling methodology



A15.5 We are interested in those costs that are impacted by the liberalisation of GSM spectrum. For this reason, we exclude the following:

- The costs of site acquisition, equipment installation, and operating costs up to 2010 (unless they are in respect of UMTS 900 sites). However we do include not only all costs of extending and upgrading the UMTS network beyond this point, but also the ongoing costs of maintaining and operating all of the UMTS network.

- The costs of GSM sites are also excluded, although we do account for the costs of upgrading them to provide different flavours of UMTS, if within the period modelled. The reason for this is that the operators' interest in providing voice services would exist whether or not liberalisation occurs, and whether or not mobile broadband becomes an important market. The fact that a number of GSM sites exist is unrelated to liberalisation. For the same reason, the overall set up of this calculation serves as a proxy for the operator that has no GSM sites – as they would have to keep some sites to carry on with voice services. Note that this is a separate issue from the costs of clearing liberalised spectrum, which is treated in Annex 16.

- We only account for equipment in the radio access network (RAN), which is driven by the number of sites.

The present value calculation

A15.6 The cost calculation is a sum of several Present Values (PV), each associated with a different set of sites. For a given site, the PV varies depending on:

- When the site is acquired

- Whether the site is eventually decommissioned or not
- What type of site it is (such as a new site or an upgrade)

A15.7 New sites incur both equipment-driven costs and site costs. Upgrades incur only equipment-driven costs.

A15.8 Capex costs are incurred once at site acquisition, and again at the end of the asset lifetime, as shown below:

Table 1 - Asset lifetime

	Equipment	Sites
Asset lifetime	10 years	20 years

A15.9 We use a range of values for site capex, shown in Table 2 below. These are the same as used in the 2007 consultation document. Prior to the 2007 consultation we asked all operators for views on site costs and received a very wide range of opinions. We proceeded to select a range that reflected the diversity of opinions. We used external experts to help select and cross-check our range of site costs.

Table 2 – Unit capex at 2008 prices

	Low	Medium	High
Site acquisition and preparation	50,000	60,000	75,000
Equipment driven costs	25,000	45,000	65,000

A15.10 We project these costs forward in time by applying inflation or deflation rates as shown in Table 3 below. The inflation trend for site acquisition and preparation is intended to reflect trends in real economic growth and the trends for equipment driven costs are a broad indication of the fall in equipment prices overtime.

Table 3 - Price trends, in real terms

	Baseline	Sensitivity one	Sensitivity two
Site acquisition and preparation	2.5%	2.0%	2.0%
Equipment driven costs	-7.5%	-5.0%	-2.5%

A15.11 The operators were only willing to provide limited information on opex levels. Based on that limited information and on advice from external experts prior to the 2007 consultation, we found that modelling annual opex as a proportion of capex was a reasonable method. By the same process, we found that 10% is a reasonable value for this proportion. We also provide a sensitivity result where the annual opex is 20% of capex.

Table 4 - Opex as a percentage of capex

	Baseline	Sensitivity
Site acquisition and preparation	10%	20%

A15.12 Note that the opex proportion is applied after the inflation / deflation trend. So the expected decrease in price of equipment through time is taken into account, when computing opex for a given year.

A15.13 We use the discount rates shown below as appropriate:

Table 5 - Discount rates

Social discount rate	3.5%
Commercial discount rate	11.5%

A15.14 We acknowledge the terminal value of the network in 2028 by deducting the residual value of sites and equipments. This residual value is calculated by linear depreciation over the lifetime of sites and equipment, plus the relevant deflation rate.

How sites are sorted into different types of upgrades and new sites

A15.15 In Annex 12, we have derived different roll out profiles that specify, for a given year, how many sites would be equipped using a given technology and band (such as UMTS 900).

A15.16 Our modelling reflects the fact that operators have a number of existing sites and that therefore these may be re-used when equipment for a new technology and band is to be installed.

A15.17 As mentioned in Annex 12, we derive roll out profiles that show 9,000 UMTS 2100 sites by end of 2010. We also assume the following breakdown of these sites:

Table 6 - Number of sites at end of 2010

UMTS 2100 only sites	3,000
UMTS 2100 and GSM combined sites	6,000
GSM only sites	250

A15.18 It is likely that only some of these sites will be suitable for upgrade. As in the previous consultation, we use as a baseline an assumption that 85% of sites are suitable. We also provide sensitivities on this proportion.

Table 7 – Proportion of existing sites suitable for upgrade

	Baseline	Sensitivity one	Sensitivity two
UMTS 2100 only sites built after 2008	95%	95%	95%
All other sites	85%	70%	95%

A15.19 The sorting of different types of sites works as follows:

- We start from the requirement for sites equipped with a given technology in a given year, as specified by the relevant roll out profile.

- If there are existing upgradable sites still available the additional equipment is counted as an upgrade, otherwise as a new site. If there are several types of upgradable sites available, sites are allocated in the following order:

Table 8 – Order of upgrade

	Order for operator with 900 MHz, upgrading to UMTS 900 MHz	Order for operator without 900 MHz, upgrading to 800 MHz
GSM and UMTS 2100 combined sites	1	1
GSM only sites	2	3
UMTS 2100 only sites	3	2

A15.20 The 900 MHz operator prioritises sites with GSM 900 MHz as the existence of 900 MHz antennas may make the upgrade easier and cheaper.

List of types of sites

A15.21 We consider that different types of site build and upgrade may incur different costs. The different types of site build and upgrade that we consider are as follows:

- **New site – single band.** Sites built for installation of a single technology and band (such as UMTS 900).

- **New sites – two bands.** Sites built for simultaneous installation of two technologies and bands (such as UMTS 900 and UMTS 2100). We expect lower implementation costs in this case.

- **Upgrade – standard.** Sites upgraded to include a single technology and band (such as UMTS 900).

- **Upgrade – simultaneous.** Sites upgraded simultaneously to two different bands and technologies (for instance, a GSM site being upgraded to UMTS 900 and UMTS 2100). We assume lower implementation costs in this case.

- **Upgrade to UMTS 900 from existing site with GSM 900 and UMTS 2100.** We assume lower implementation costs in this case, as UMTS equipment and a 900 MHz antenna would already be on site.

A15.22 The inputs on each case are shown below:

Table 9 – Types of sites and capex cost inputs as of 2008 (medium costs)

	Site acquisition and preparation	Equipment driven costs	Opex
(a) New site – single band	50,000	25,000	10%
(b) New site – simultaneous installation of two bands (a + d)	50,000	37,500	10% (of a+c)[1]
(c) Upgrade – standard	-	25,000	10%
(d) Upgrade – simultaneous	-	12,500	10% (of c)
(e) Upgrade to UMTS 900 for site with existing GSM 900 and UMTS 2100 (50% of d)	-	12,500	10%

A15.23 We arrived at the numbers above by applying a 50% discount on the initial costs of a simultaneous upgrade, and a 50% discount on upgrades to UMTS 900 for sites with existing GSM 900 and UMTS 2100. We also provide sensitivities on these inputs.

A15.24 The inputs above result in the following PVs for sites acquired in 2011 (figures for other years reflect the price trends described above).

Table 10 –Unit site costs for a site acquired in 2011 in 2008 GBP – (PV 2008-2028)

	Low costs, d.r. 3.5%	Baseline (Medium) costs, d.r. 3.5%	High costs, d.r. 3.5%	Baseline (Medium) costs, d.r. 11.5%	Medium costs, Opex sensitivity (20%), 3.5% d.r.
(a) New site - single band	175,000	236,000	310,000	154,000	368,000
(b) New site - simultaneous installation of two bands (a + d)	207,000	293,000	393,000	190,000	454,000
(c) Upgrade - standard	43,000	77,000	111,000	53,000	107,000
(d) Upgrade - simultaneous	32,000	57,000	83,000	36,000	85,000
(e) Upgrade to UMTS 900 for site with existing GSM 900 and UMTS 2100 (50% of d)	21,000	38,000	56,000	27,000	53,000

A15.25 In order to calculate costs for a network sharing operator, we assume that the total cost of ownership of a site, for an operator benefiting from a network sharing agreement, is a proportion of the cost incurred by an individual operator. We introduce an additional input, a discount on the total PV cost of a site, applied in the case of network sharing operators.

[1] There is one exception in the first year, when opex is computed as 10% of (b). This was used for mechanical simplification of the model and we understand that it has no significant impact on results. The same exception applies for the calculation of (d).

A15.26 We have found different opinions in the industry about the impact of network sharing on the total cost of ownership of sites. A review of these sources suggests that a reasonable range for the available savings would be from 20% to 35%[2]. As a baseline, we use the mid point within this range.

Table 11 - Reduction in costs for network sharing operators

Baseline	Low	High
27.5%	20%	35%

A15.27 The table below show site costs for a network sharing operator, for the baseline case.

Table 12 – Network sharing operator - Unit site costs for a site acquired in 2011 in 2008 GBP – (PV 2008-2028)

	Low costs, d.r. 3.5%	Baseline (Medium) costs, d.r. 3.5%	High costs, d.r. 3.5%	Baseline (Medium) costs, d.r. 11.5%	Medium costs, Opex sensitivity (20%), 3.5% d.r.
New site - single frequency	127,000	171,000	225,000	111,000	267,000
New site - two frequencies	150,000	213,000	285,000	138,000	329,000
Upgrade - standard	31,000	56,000	81,000	39,000	77,000
Upgrade - simultaneous	23,000	41,000	60,000	26,000	62,000

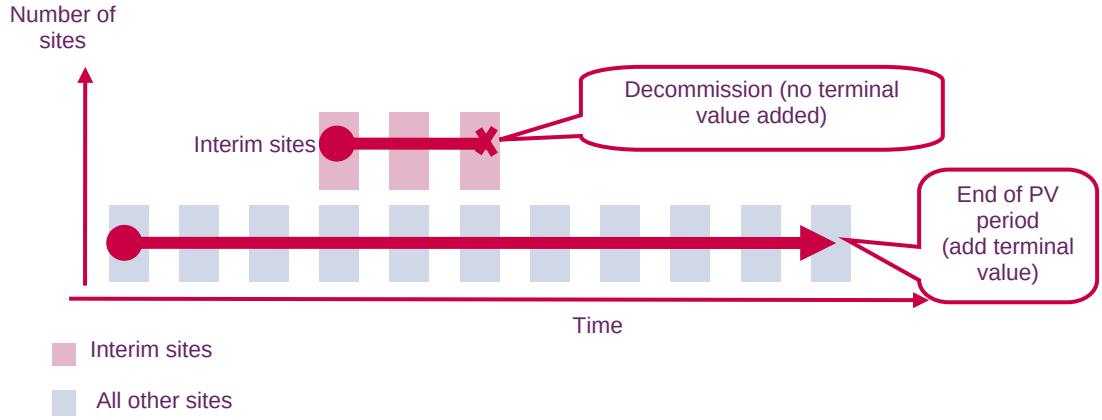
Site costs PVs for interim sites and equipment

A15.28 Many of the roll out profiles described in Annex 12 include some situations where sites and/or equipment are deployed on an interim basis, and decommissioned later.

A15.29 We model such sites or equipment by stopping the stream of costs in the given year. We do not count any residual value of the decommissioned equipments or sites, nor any decommissioning costs.

[2] The range is broadly consistent with the following sources: *On Wireless Edition 12 – Network sharing*, PA Consulting Group; *Vodafone Technology Update, 5 March 2008 – Networks*, Andy MacLeod, Director Global Networks, Vodafone

Figure 2 – How we calculate PV cost of interim sites and equipment



List of issues and summary of responses

A15.30 We examine next a list of issues raised by responses to our consultation.

A15.31 We discuss how our revised approach accounts for each of these issues, where appropriate. Confidential responses are not included but have been considered in the refined analysis.

A15.32 The issues considered are:

i) **Discount rates**. Vodafone argued that calculations should be performed using a discount rate of 11.5%. The social benefits that Ofcom is evaluating will not be realised, if the private operators do not invest.

ii) **Site costs.** We received confidential comments on unit site costs.

iii) **Variations in existing number of sites.** Orange argued that Ofcom's current work is theoretical and should be developed to take account practical situations.

iv) **Timelines and roll out profiles.** Vodafone stated that roll-out profiles shown in the 2007 consultation was too early and at odds with cost of clearance work; that the roll out ignores operator build in 2006-2010; and that the roll out needs to be linked to 3G handset adoption.

v) **Network sharing.** We received confidential queries about network sharing.

Issue-by-issue analysis

A15.33 For each of the issues identified, we present

- what the issue is
- our analysis of the issue
- our findings and how our revised approach addresses the issue

Issue 1: discount rates

Issue

A15.34 Some respondents advocated the use of a commercial discount rate of around 11.5% instead of the social discount rate of 3.5% used in the consultation.

A15.35 The reasoning is that, although Ofcom is interested in benefits for society, these will not materialise unless there is a private decision to invest in UMTS network. Private decisions are made using the commercial discount rate.

Analysis

A15.36 We agree with the basic reasoning that private decisions are made with commercial discount rates.

A15.37 However, the social rate is used to measure the impact of our decisions on society (both operators and consumers).

Findings

A15.38 Our analysis calculates cost differences using a discount rate of both 3.5% (social discount rate) and 11.5% (commercial discount rate).

Issue 2: site costs

A15.39 We have received a number of queries with respect to the site costs we used, which have been considered too high or too low by different respondents.

A15.40 This section is divided in two parts:

- We first discuss the queries about the site costs
- Then, we discuss how we calculate NPVs based on these site costs

Site costs queries – Analysis and conclusions

A15.41 There seems to be little consensus in the industry about the correct values for unit site costs to be used in our analysis. During the 2007 consultation process, we asked all operators for views on site costs and received a very wide range of opinions.

A15.42 We proceeded to select a range that reflected the diversity of opinions. We used external experts to help select and cross-check those ranges of site costs.

A15.43 Since the 2007 consultation, we have received more opinions on the values for unit site costs, but we believe this diversity of opinions is still well represented by the range we use. This wide range was shown earlier in Table 10.

How we calculate site costs NPVs – Analysis and conclusions

A15.44 Consultation respondents also argued that NPVs should not run for 20 years because this would go beyond the end date for their current 2100 MHz licences of 2021.

A15.45 We continue to believe that the use of a 20 year NPV is not inappropriate for two reasons:

- Firstly, no such end date applies in respect of licences for the use of the 900MHz and 1800MHz spectrum (and none is being proposed); the holders of these licences will continue to enjoy their benefits indefinitely, until the licences are revoked. Any advantage that the holders of these licences enjoy over the holders of licences for higher frequencies will therefore potentially continue beyond the end date of those higher frequency licences. As such our analysis is more likely to under-estimate the advantages that the holders of licences for lower frequency spectrum enjoy over those of higher frequencies.

- Secondly, our refined analysis generally assumes that operators without access to 900MHz spectrum will be able to acquire 800MHz spectrum, albeit at a later date, and use this to compete with the holders of 900MHz spectrum. As such the role of 2100 MHz spectrum in the long-term is firstly significantly diminished for all operators, and secondly is much the same for all operators. The fact that the licences for this spectrum currently expire in 2021 is therefore of little significance or relevance to our decision.

Issue 3: variations in existing number of sites

A15.46 The 2007 consultation assumed that all operators had 6,500 existing sites. This affects the cost calculation because site upgrades (to UMTS 900 for instance) are cheaper than acquiring new sites.

A15.47 Some respondents have argued that actual starting points for each operator should be used instead of a common assumption.

A15.48 Some respondents have argued that high frequency operators have a larger number of existing sites, and that therefore the cost difference metric was biased, as the cost of existing operators would be underestimated.

Analysis and conclusions

A15.49 In the revised methodology, the relevant comparison for existing number of sites is that of 2010 – because that is when liberalisation starts having an impact on costs. We only count costs from this date, as explained in the methodology section.

A15.50 Assuming that operators value mobile broadband, then the existing number of sites may largely have converged by then. Even if not, it is hard to predict which operators will be behind, if any. For example, we have not found strong evidence that operators without 900 MHz tend to have significantly more sites today.

A15.51 Therefore, our results are for the case where, by end of 2010, all operators have 9,000 UMTS 2100 sites in the densely populated areas (where 80% of the population lives).

Issue 4: Roll out profiles

A15.52 Some respondents were concerned that the roll-out periods for the various scenarios (especially low adoption) were too aggressive and not aligned to the timescales considered for cost of release.

A15.53 They argued that take-up of UMTS 900 handsets may take time, and therefore there may be no reason to roll-out a UMTS 900 network as early as implied in the consultation.

Analysis and conclusions

A15.54 We have revised our methodology comprehensively to account for these arguments, as shown in Annex 12, which examines our timing inputs.

Issue 5: network sharing

A15.55 Some respondents argued that the market is increasingly moving towards more network sharing deals, and this should be reflected in the cost difference calculations.

Conclusions

A15.56 We have accounted for network sharing by reducing the cost of ownership of sites, for a network sharing operator, as described in the overview.

Results

A15.57 We present next the results of the cost modelling in the following order:

- We first focus on the more densely populated areas. We present results for non-matching comparisons and for matching comparisons
- We then present results for the less densely populated areas
- We then present the extensive list of sensitivities performed

More densely populated areas - Non matching comparisons

A15.58 We show below the cost differences resulting from selected non matching comparisons. As described in Annexes 10 and 12, these are comparisons where we do not attempt to match the level of service provided by the two operators.

Table 13 - Cost difference in addition to quality differences

UMTS 900 operator number of sites	UMTS 2100 operator number of sites	Cost difference, single operator	Cost difference, network sharing operator
7,300	9,000	£50m	N/A
7,300	15,000	£700m	£300m
6,000	15,000	£850m	£445m

More densely populated areas - Matching comparisons

A15.59 The comparisons show the cost of an operator with 900 MHz spectrum versus an operator with 2100 MHz spectrum, for the extremes of our range of demand scenarios (discussed in Annex 11).

A15.60 We show here results for two different levels of demand:

- "Lower demand" means the data rate (throughput) that users consistently get is 384 kbps, indoor coverage is lower, and usage is low (1 MB / user / day; where "user" means the average user over all mobile subscribers).

- "Higher demand" means that the data rate that users consistently get is 2.4Mbps , better indoor penetration, and high usage (30 MB / user / day)

There are other data points in between these, which are shown in the sensitivity analysis at the end of this Annex. The results below show the extremes of the range for the whole set of demand scenarios.

A15.61 The results below are for the case where the UMTS 900 operator has 1 carrier at 900 MHz, and both operators have 2 carriers at 2100 MHz. In fact, although the UMTS 900 operator has additional carriers at 2100 MHz, because the cases below are coverage constrained, the impact of taking this into account will be very small, as shown in Annex 11 (impact in number of sites is uncertain but likely to be significantly less than 4% for the scenarios below[3]).

A15.62 The extremes of the range are shown in detail in Table 14, Table 15 and Table 16 below.

Table 14 - Number of sites operators need to match a given market scenario

Operator	Lower demand Service provided: - Minimum of 384 kbps - shallower indoor coverage - 1 MB / subscriber / day	Higher demand Service provided: - Minimum of 2.4 Mbps - deeper indoor coverage - 30 MB / subscriber / day
UMTS 900 operator	2,900	7,300 sites
UMTS 2100 operator	8,600	21,100

[3] Based on the estimate of the impact of using mixed bands as described in annex 8.

Table 15 - Additional cost per operator using a UMTS 2100 network to match the quality of a UMTS 900 network – NPV at 3.5%

	Level of quality that is important for consumers	
Cost difference	Lower demand (384 kbps / shallower indoor penetration) 1 MB / subscriber / day	Higher demand (2.4 Mbps / deeper indoor penetration) 30 MB / subscriber / day
Single UMTS2100 operator (who acquires 800 MHz)	£50m	£1.6 bn
Network sharing UMTS2100 operator (who acquires 800 MHz)	No cost advantage for 900MHz operator arising from liberalisation	£1.0bn
Single UMTS2100 operator (who does not acquire 800 MHz)	£250m	£2.2bn
Network sharing UMTS2100 operator (who does not acquire 800 MHz)	£50m	£1.4bn

Table 16 - Additional cost per operator using a UMTS 2100 network to match the quality of a UMTS 900 network – NPV at 11.5%

Cost difference	Lower demand Service provided: - Minimum of 384 kbps - shallower indoor coverage - 1 MB / subscriber / day	Higher demand Service provided: - Minimum of 2.4 Mbps - deeper indoor coverage - 30 MB / subscriber / day
Single UMTS2100 operator	£30m	£1.0bn
Network sharing UMTS2100 operator	No cost advantage for 900MHz operator arising from liberalisation	£650m

A15.63 These results use our baseline assumptions for the many parameters of the cost and technical modelling. We also present several sensitivities that show the impact of flexing these parameters in the sensitivity analysis at the end of this Annex.

Cost savings for an operator acquiring a block of 900 MHz

A15.64 An incumbent 900 MHz operator already has 900 MHz antennas and other frequency-specific equipment, and may be able to re-use them when upgrading to UMTS 900, which could lead to cost savings. These savings are unlikely to be fully available to an operator currently without 900MHz spectrum who acquires some.

A15.65 We have calculated a wide range for this effect, varying the savings resulting from re-use of 900 MHz equipment from 0% to 50% of the cost of an upgrade. As a result, the cost saving achievable by an acquirer of 900MHz spectrum varies between 90% and 100% of the cost advantage that an existing holder of 900MHz spectrum would be likely to enjoy.

Table 17 – Cost difference for an operator without 900 MHz, if they acquire a 900 MHz block

	Without 900 MHz	Acquiring a 900 MHz block
Higher demand scenario	£1.6bn	£150m

Cost differences for less densely populated areas

A15.66 Annex 14 explains the technical calculations for less densely populated areas. It is a simplified calculation for the costs of deploying a minimum level of 3G data coverage.

A15.67 We note that Hutchison 3G and T-Mobile have already announced extension of 3G service to all areas where there is currently 2G coverage. T-Mobile's current 2G network includes coverage of less densely populated areas.

A15.68 For this reason, we only calculate the cost difference for a single operator network.

A15.69 We model an operator with 3,000 existing sites in less densely populated areas. We use a slower pace of deployment than that in the densely populated areas, because we believe operators will prioritise densely populated areas. We assume that the number of sites deployed per year is between 125 and 250 new sites, or twice as many upgrades. The number of sites required is shown below.

Table 18 – Number of sites required in less densely populated areas

UMTS 900	UMTS 2100
950	2,600

Table 19 - Cost difference in less densely populated areas

	Slower roll out	Faster roll out
Cost difference in less densely populated areas	£20m	£60m

Sensitivities performed

A15.70 This section describes the sensitivity analysis we have conducted. All the sensitivities are on matching comparisons, as described in Annex 12: a pair of roll out profiles intended to achieve the same level of service, for both operators, year by year.

A15.71 This appendix is structured in a number of sections, in which we show the inputs used and sensitivities performed relating to each of the following areas of the modelling:

- Number of sites required to meet demand
- Number of sites available for upgrade
- Timing of spectrum and equipment availability, and operator's roll-out strategy
- Unit site costs

Number of sites required to meet demand

A15.72 The baseline inputs are as follows:

Table 20 – Baseline inputs, number of sites

Scenario	Number of sites needed for the 900 MHz operator	Number of sites needed for the UMTS 2100 operator	Number of sites needed for a 800 MHz operator
Lower demand	2,900	8,600	2,900
Higher demand	7,300	21,100	7,300

Variations in number of sites due to demand

A15.73 We have also investigated the results when demand is in between the above values, or outside the range we set.

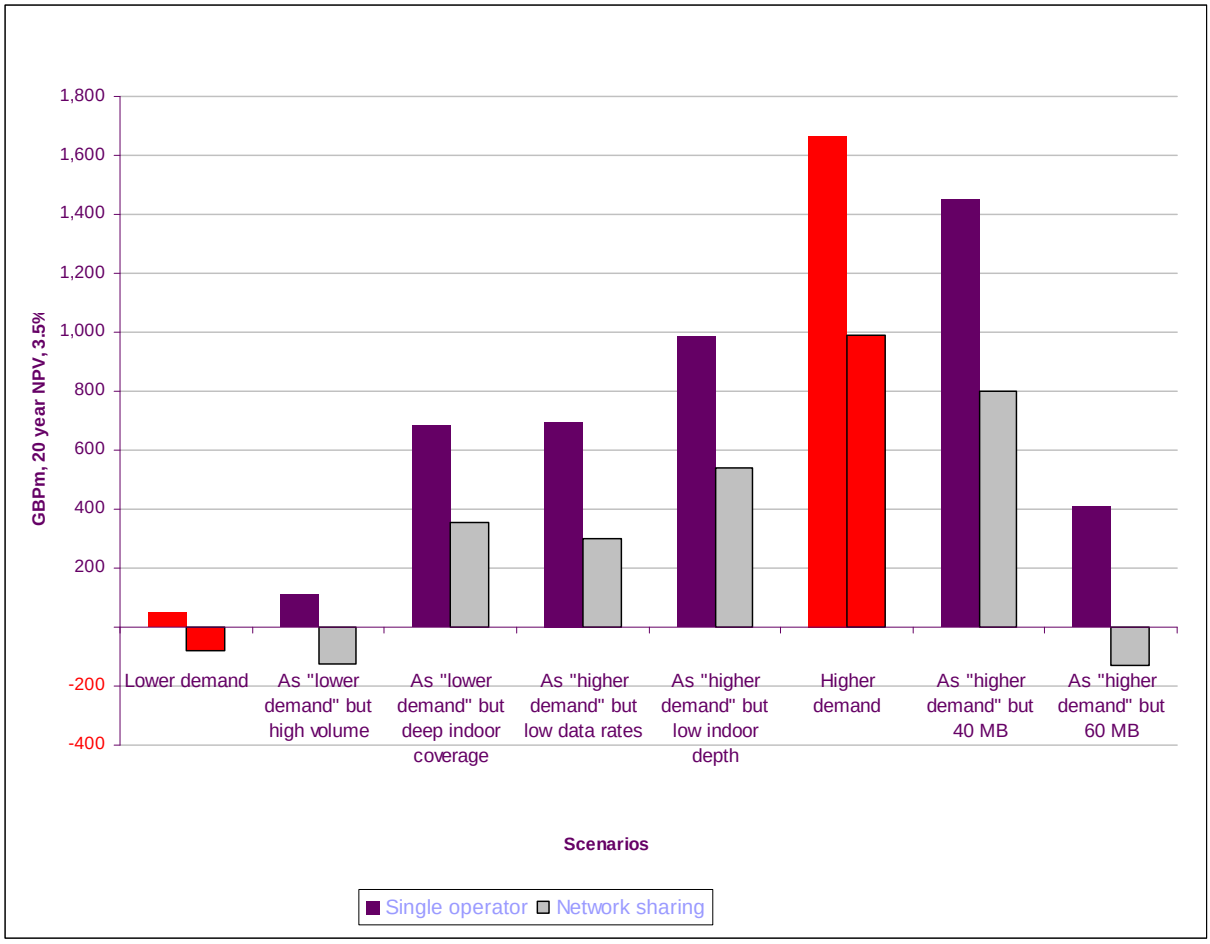
Table 21- Variations on demand

Scenario	Data rates	Indoor depth	Volume (MB / user /day)	Number of sites, 900 MHz	Number of sites, 2100 MHz
Lower demand	384kbps	Depth 1	1 MB / user / day	2,900	8,600
As "lower demand" but high volume	384kbps	Depth 1	30 MB / user / day	6,800	9,000
As "lower demand" but deep indoor coverage	384kbps	Depth 2	1 MB / user / day	4,000	12,700
Higher demand	2.4Mbps	Depth 2	30 MB	7,300	21,100
As "higher demand" but low data rates	384kbps	Depth 2	30 MB	6,800	13,100
As "higher demand" but low indoor depth	2.4Mbps	Depth 1	30 MB	5,900	14,400
As "higher demand" but 40 MB	2.4Mbps	Depth 2	40 MB	7,900	21,200
As "higher demand" but 60 MB	2.4Mbps	Depth 2	60 MB	11,800	21,400

A15.74 The chart below shows the results of this sensitivity analysis.

Figure 3 – Impact of variation in demand

(baseline highlighted in red for comparison)



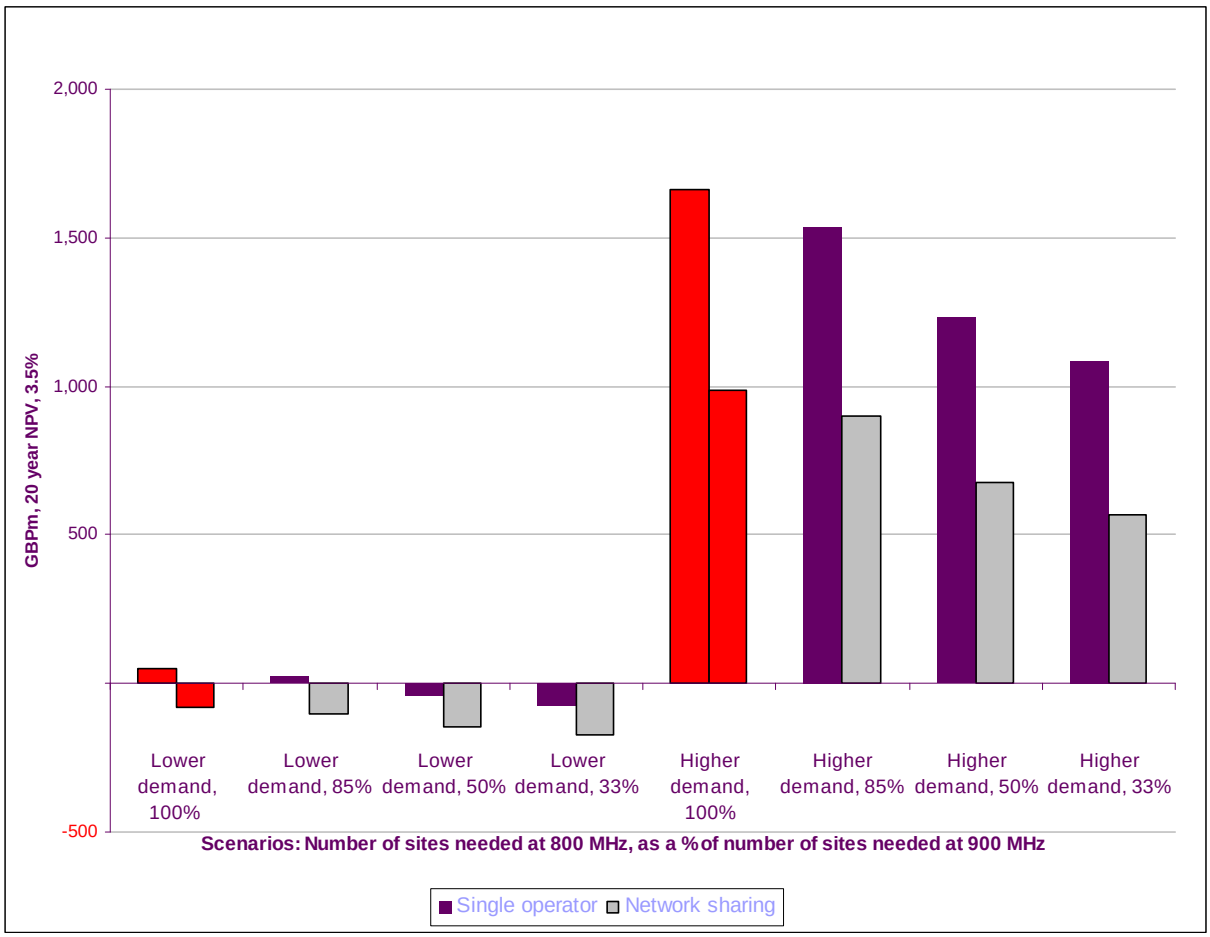
A15.75 The “lower demand” and “higher demand” scenarios sit broadly at the extremes of the range of cost differences provided by these scenarios.

Variations in number of sites needed for deploying the service at 800 MHz

A15.76 In our baseline inputs, we make the simplifying assumption that the number of sites needed to serve a given level of demand using 800 MHz is the same as that needed at 900 MHz.

A15.77 We assumed the parity of sites as a baseline, and investigated also the cases where the number of sites required at 800 MHz is smaller than those required at 900 MHz. We did this by expressing the number of sites required at 800 MHz as a fraction of those required at 900 MHz. The chart below shows the impact of varying this fraction from 100% (baseline) to as low as 33%.

Figure 4- Impact of reduced number of sites needed at 800 MHz



A15.78 The cost difference is relatively insensitive to the number of sites needed at 800 MHz: even if the number of sites needed at 800 MHz falls by two thirds, the cost difference only falls by around one third (in the higher demand case). This may seem surprising at first. The reason for this is that the cost difference is driven by the interim years, when 800 MHz is not in use yet, and a great number of 2100 MHz sites would be needed to keep pace with a UMTS 900 operator.

Variations in number of sites due to technical sensitivities

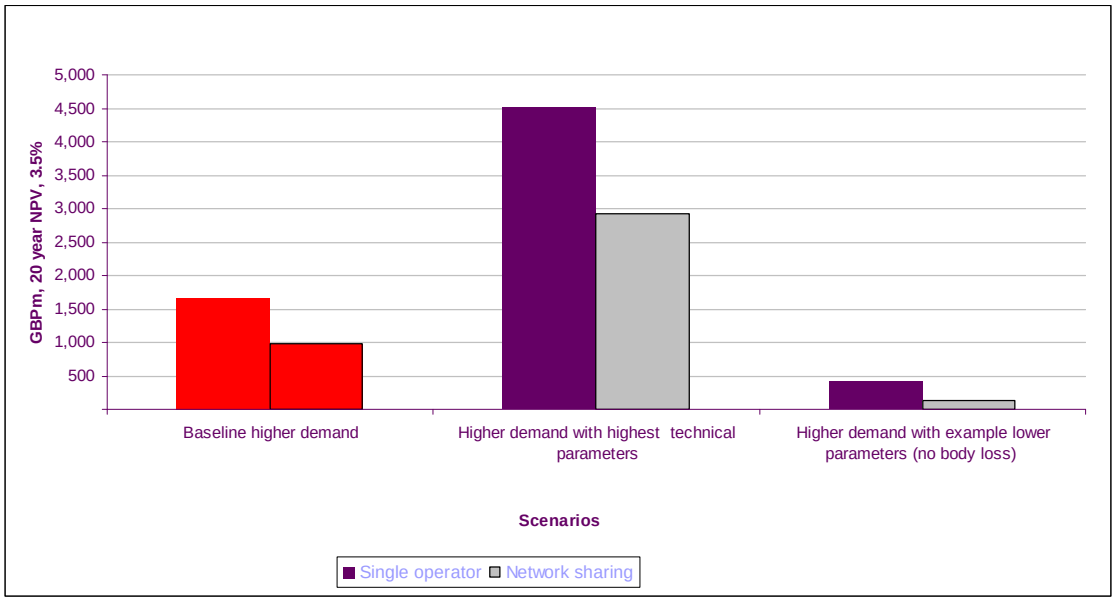
A15.79 The results presented here use our baseline set of technical parameters, described in detail in Annex 13. The choice of parameters was informed by a literature review and discussions with stakeholders. However, if we were to account for the full range of opinions on these values, the range would be wider.

A15.80 Using one extreme of these technical values would cause the cost difference to reduce to zero. Using another extreme could increase the cost different to as much as £4.6bn. This is shown in the figure below.

Table 22- Technical sensitivities inputs

	Number of sites, 900 MHz	Number of sites, 2100 MHz
Higher demand with highest technical parameters	10,000	74,100
Higher demand with example lower technical parameters (no body loss)	5,900	11,100

Figure 5 – Impact of variation in technical parameters

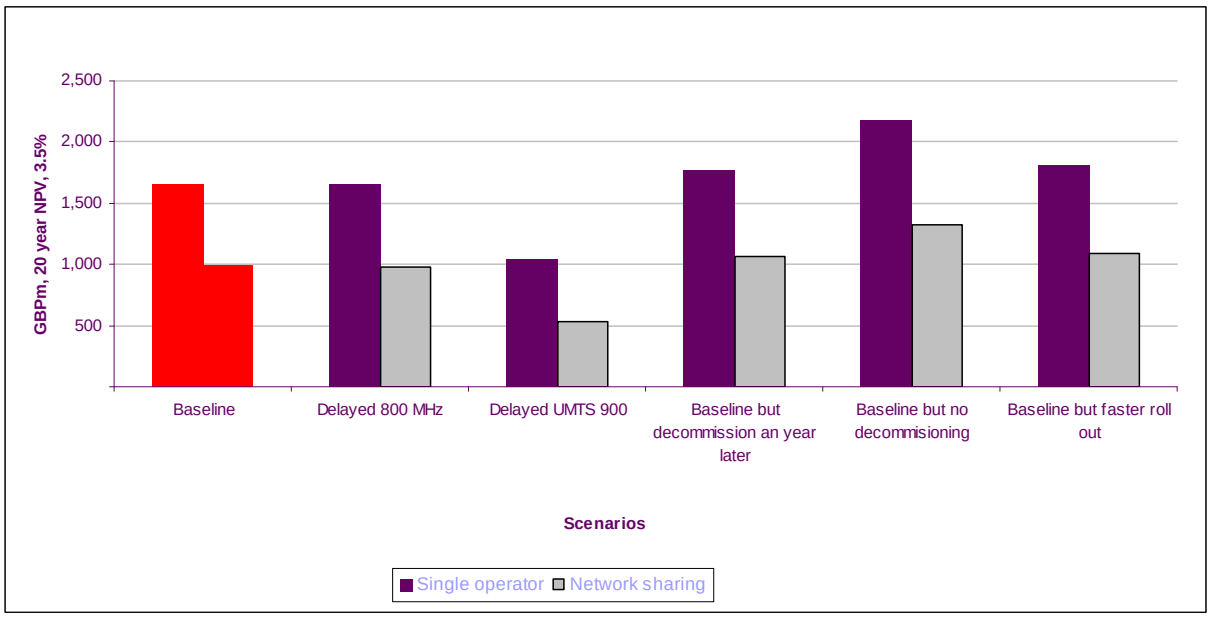


Timing of spectrum and equipment availability, and operators' strategy

A15.81 As explained earlier in Annex 12, our modelling has several timing inputs that describe the timing at which UMTS 900 and 800 MHz may be in use by consumers.

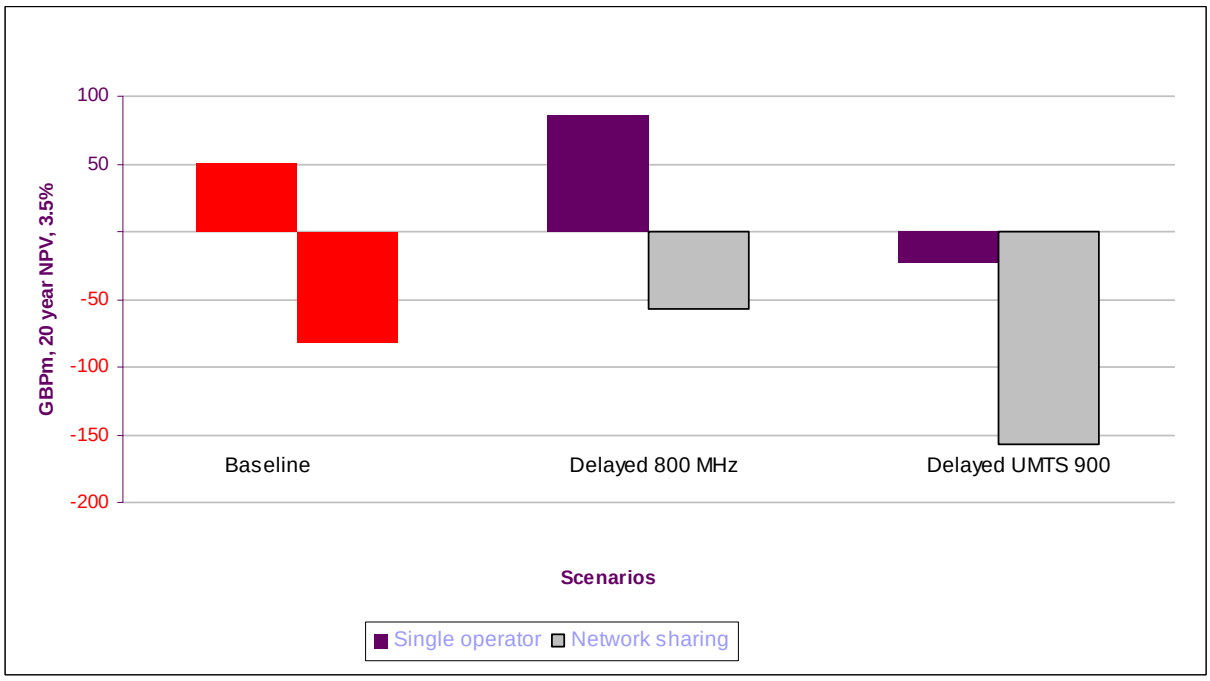
A15.82 The following results show the impact of varying these timing inputs. For the full description of the inputs being varied and the roll out profiles, refer to Annex 12. The relevant roll out pairs are numbered 17 to 25 (plus 1 and 6 for the baseline results)

Figure 6 – Impact of variation in timing inputs (higher demand)



A15.83 We have also run a subset of these for the lower demand case:

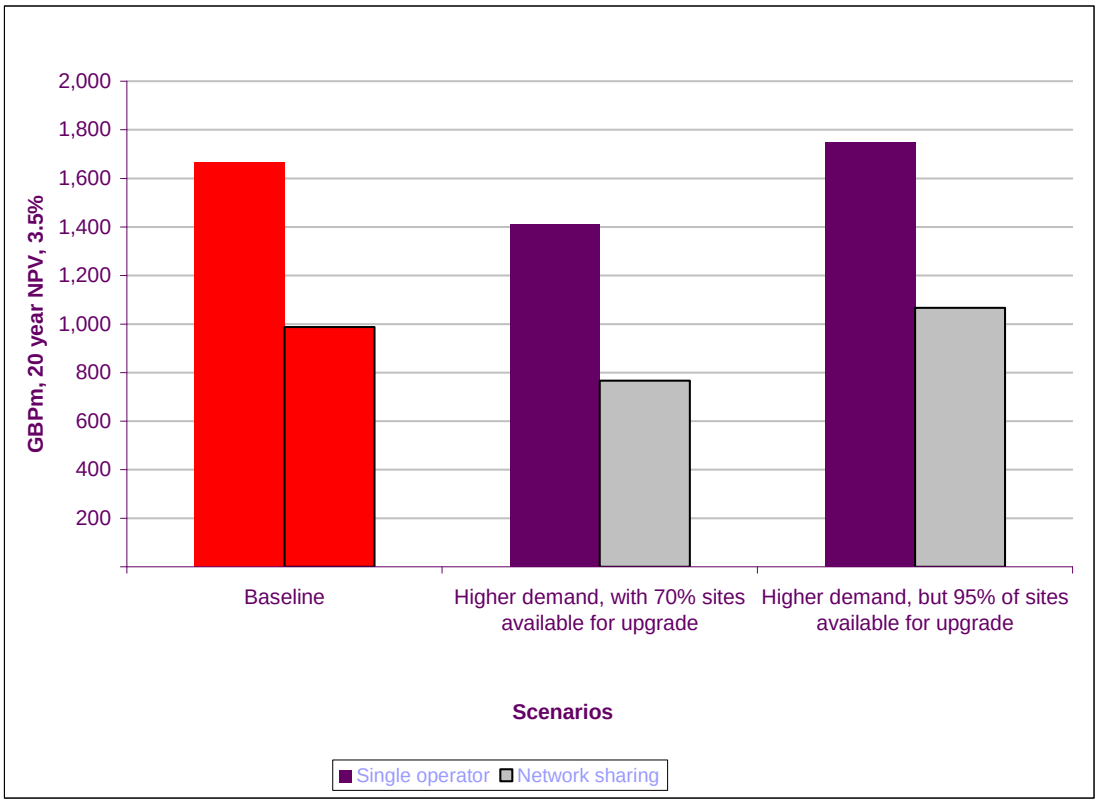
Figure 7 – Impact of variation in timing inputs (lower demand)



Number of sites available for upgrade

A15.84 As described earlier in this Annex, we use a baseline assumption that 85% of existing sites could be upgraded. Figure 8 shows the impact of varying this input.

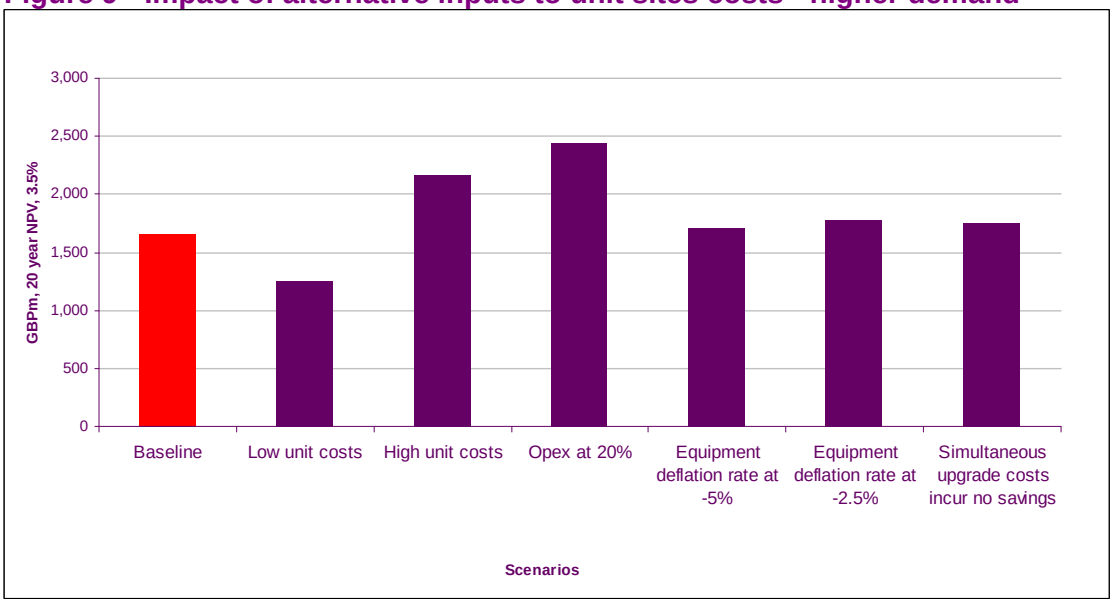
Figure 8 – Impact of variation in number of sites available for re-use



Unit site costs and data rates

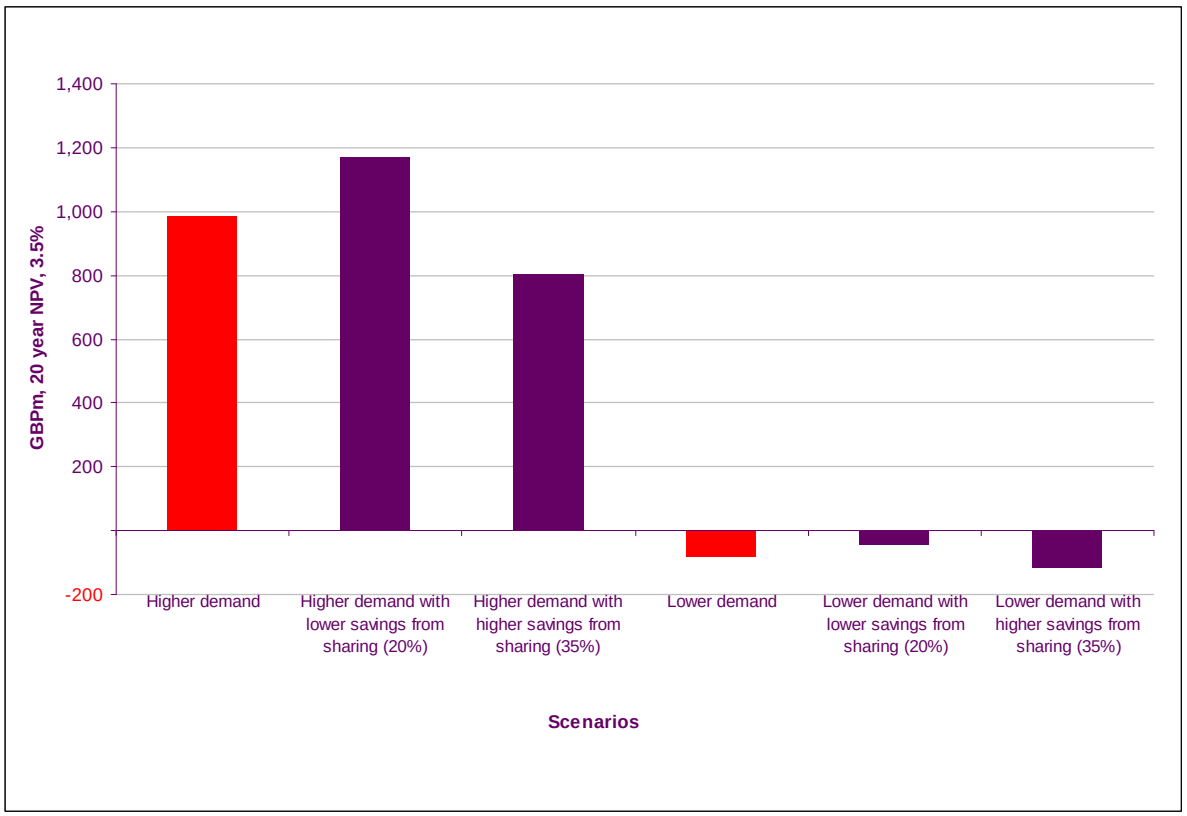
A15.85 Figure 9 shows the impact of most variations around unit site costs, as detailed in Table 9 and Table 2.

Figure 9 - Impact of alternative inputs to unit sites costs - higher demand



A15.86 Figure 10 shows sensitivities around the savings available for network sharing operators, as described in Table 11.

Figure 10 – Impact in variation in savings from network sharing



A15.87 Finally, Figure 11 shows the impact of varying the savings available when upgrading GSM 900 MHz sites that already have a 900 MHz antenna and other equipment, as shown in Table 9, row (e). These savings are only available for 900 MHz incumbents, so the sensitivity shows results when there are no such savings, as an example of the cost difference from the point of view of an acquirer.

Figure 11 – Impact of savings when reusing 900 MHz antenna and other equipment in upgrades to UMTS 900