www.gov.uk/defra

Department
for Environment
Food & Rural Affairs

Forecasting 2020 Waste Arisings and Treatment Capacity

Analysis to Inform the Review of Defra Financial Support for the Norfolk County Council Residual Waste Treatment Project

October 2013

© Crown copyright 2013

You may re-use this information (not including logos) free of charge in any format or medium, under the terms of the Open Government Licence. To view this licence, visit www.nationalarchives.gov.uk/doc/open-government-licence/ or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or e-mail: psi@nationalarchives.gsi.gov.uk

This document/publication is also available on our website at:

https://www.gov.uk/government/policies/reducing-and-managing-waste

Any enquiries regarding this document/publication should be sent to us at:

WIDP.ProgrammeOffice@defra.gsi.gov.uk

Waste Infrastructure Programme Office
2nd Floor, Nobel House
17 Smith Square
London

PB 14031

Contents

Executive Summary

Introduction

This paper sets out analysis used to forecast levels of waste arisings and treatment capacity in England in 2020. Forecasts are used to assess the amount of biodegradable municipal waste that goes to landfill and hence whether England is expected to meet the diversion levels in 2020 that are necessary for the UK to achieve the target under the EU Landfill Directive.

The analysis provides estimates of the likelihood of meeting the Landfill Directive target. The potential impact of delivery of the Norfolk County Council (NCC) residual waste treatment project on the likelihood of meeting the target is also assessed. The NCC project is considered to inform a review by the Secretary of State for Environment, Food and Rural Affairs of Defra's financial support for the project.

The results of this analysis reflect updated data that has become available since the previous forecasting report of February 2013[1].

Methodology

Forecasts are made of waste arisings and treatment capacity to establish whether sufficient capacity is expected to be in place to meet the requirements of the Landfill Directive target in 2020. This requires predicting future behaviour of a number of uncertain factors, such as waste arisings, recycling rates, when infrastructure projects are likely to come online and how much waste they will divert from landfill.

There are considerable uncertainties over forecasting these factors to 2020. For example, changes in the economy, attitudes to waste, access to finance and many other issues can all potentially impact future trends. There are also limitations in some of the data available. For example, commercial and industrial waste data is not regularly available making future trends especially difficult to predict. Therefore ranges are applied to key assumptions and forecasts. A 'Monte-Carlo' modelling technique[2] is then used to bring together the uncertain factors and give an overall range of results. This is used to predict the likelihood of having sufficient capacity to meet the 2020 target.

Whilst this methodology provides a robust approach to uncertainty, the results are dependent upon the ranges applied to the various factors within the analysis. These have been based on evidence and expert judgement, but cannot be known with certainty.

[1] See Defra (2013), "Forecasting 2020 Waste Arisings and Treatment Capacity", revised February 2013 report. Note that a revised version of the original February 2013 report was published in October 2013.
[2] The Monte-Carlo method is a statistical approach to modelling uncertainty.

Furthermore, there is an unavoidable degree of model uncertainty; that is, the results depend on the type of model that is used, as well as the values of the parameters chosen within that model.

This overall approach to the modelling was developed following the commissioning of external consultants to review and refine previous models. The refined modelling approach was subjected to internal review and sign-off from Defra's chief economist.

Results

The likelihood of meeting the Landfill Directive target in 2020 is determined by the proportion of simulations (out of a total of 10,000) that produce capacity surplus to that required to meet the target. The analysis concludes that:

- There is a very wide range of possible net capacity positions in 2020. This includes outcomes in which capacity is more than sufficient to divert enough waste to meet the target and outcomes where capacity is insufficient to divert enough waste to meet the target.
- There is a high likelihood of meeting or exceeding the target using the ranges of inputs that we believe to be realistic. The most likely outcome is that there will be more capacity than required to meet the target.
- If the NCC project is assumed not to contribute any operational capacity by 2020, the likelihood of meeting or exceeding the 2020 diversion target is estimated to be approximately 95% using the ranges of inputs that we believe to be realistic. In this scenario the mean outcome is approximately 2.5 million tonnes of capacity above that required to meet the target.
- If the NCC project is assumed to contribute operational capacity by 2020, this increases the estimated likelihood of meeting or exceeding the 2020 diversion target, by approximately one percentage point, using the ranges of inputs that we believe to be realistic. In this scenario the mean outcome is approximately 2.7 million tonnes of capacity above that required to meet the target.

Model Testing

To the extent that the Monte-Carlo method incorporates ranges around key parameters, the modelling already takes account of variations in these parameters. However, the appropriate values to attach to model parameters cannot be known with certainty. As such there are a range of further tests that can be undertaken to test the sensitivity of the results to key inputs and assumptions.

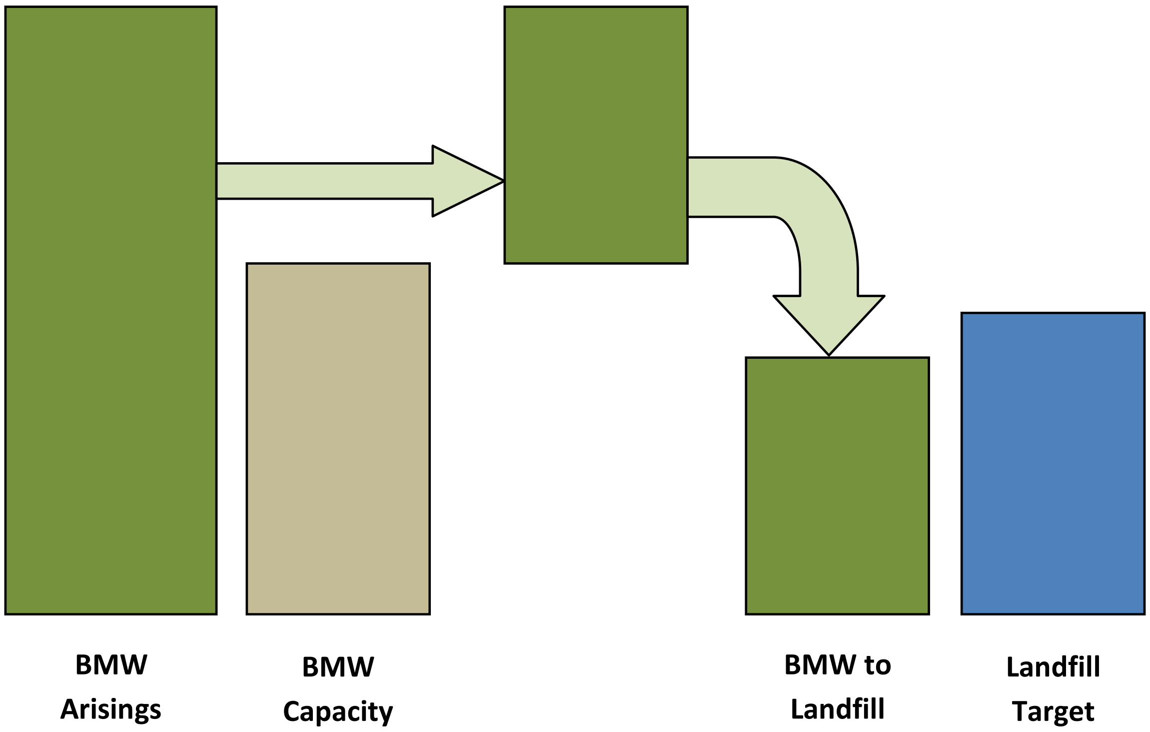
Tipping point analysis is used to test what level key factors, such as waste arisings, would need to reach for the estimated likelihood of meeting the 2020 target to fall to approximately 50%. Further testing is applied to assess the sensitivity to changing other key inputs and assumptions, including those that are not given ranges in the main analysis. These tests include assumptions that we believe to be unlikely in order to demonstrate the potential impact of such scenarios occurring. This testing finds that the model conclusions are robust to fairly large changes in key variables. The sensitivity tests produce estimated likelihoods of meeting the target ranging from approximately 77% in the lowest case assessed, to approximately 99% in the highest case.

1 Introduction

The infrastructure capacity model forecasts waste arisings and treatment capacity in England to establish whether sufficient capacity is expected to be in place to meet the requirements of the EU Landfill Directive targets for biodegradable municipal waste (BMW)[3]. The target requires that the amount of BMW sent to landfill in 2020 is reduced to 35% of 1995 levels (England's implied share of this target is to reduce BMW to landfill to 10.2 million tonnes).

Figure 1 below illustrates this process: the forecast level of residual BMW in 2020 is compared to the forecast level of residual BMW capacity in 2020; the difference between these two quantities is then compared to the Landfill Directive target.

Figure 1: Illustration of Model Process



The analysis requires forecasting future outcomes which are subject to considerable uncertainties. Future waste levels, recycling rates and compositions cannot be known for certain. There are limitations in some of the data available, such as a lack of regular data for commercial and industrial waste (C&I). Forecasting future trends is especially uncertain at the present time because it is difficult to distinguish between recessionary effects, long-run trends and policy impacts in past data. There is also inherent uncertainty in the timing and delivery of large scale infrastructure projects such as those for waste, especially following a recession.

[3] See European Council (1999), Council Directive 1999/31/EC.

An approach is therefore used which provides a range of possible outcomes and a probability of meeting the 2020 target based on these results. This approach uses ranges for the various uncertain factors and applies a 'Monte-Carlo' technique[4], which runs thousands of simulations of possible outcomes to establish the possible range of outcomes from varying the uncertain factors or inputs. The ranges to apply to the inputs have been based on evidence and expert judgement, with relatively broad ranges used for more uncertain inputs.

The result is a fuller understanding of the possible impacts of uncertainty and the likelihood of meeting the 2020 target based on the parameters used in the analysis.

[4] The Monte-Carlo method is a statistical approach to modelling uncertainty.

2 Updates Since Previous Analysis

The methodology used in this analysis is the same as that outlined in the revised February 2013 report. This section outlines changes to reflect new data that has become available since the previous analysis was undertaken[5].

2.1 Waste Arisings and Recycling[6]

Household waste arisings are forecast based on trends in past data using a SARIMA econometric forecasting approach[7]. The latest complete year of data is 2011-12, in which there were 22.9 million tonnes of household waste arisings. This data was used in the forecasts published in the revised February 2013 report.

An additional three quarters of data have since become available, for the first three quarters of 2012-13 in a statistical release of 8th August. This data shows arisings of 17.6 million tonnes from April to December 2012. The forecast used has been updated to take account of this new data. This approach provides a range of outcomes based on two alternative specifications of the SARIMA model, as in the previous analysis. The upper forecast shows gradually increasing waste arisings going forward and the lower forecast shows gradually decreasing waste arisings. The central estimates show a slight increase in waste arisings, reaching 23.2 million tonnes per year by 2020. This updated central forecast is slightly higher than the previous forecast of 22.6 million tonnes and the range is slightly wider. This reflects the new data that has since become available.

The assumption for household recycling rates in 2020 has also been updated. The latest statistics showed that 43.6 per cent of household waste was recycled, composted and reused in the 12 months to December 2012, increasing from 43.0 per cent in the 2011/12 financial year. The household recycling rate is assumed to reach 50% in 2020, with a range of five percentage points either side of this central assumption. This is slightly lower than previous forecasts due to a slightly lower than expected household recycling rate in the latest data.

Commercial and industrial (C&I) waste arisings are forecast in line with economic growth. Office of Budget Responsibility (OBR) forecasts from March 2013 show lower growth in the near term than the previous OBR forecast in December 2012. Updating for this slightly reduces the C&I waste arisings forecasts, with the central outcome falling slightly from 23.1 million tonnes to 22.9 million tonnes of municipal C&I waste per year by 2020[8].

---

[5] See the revised February 2013 report for further details of the forecasting methodology. See Appendix A of this report for a summary of the inputs used in the current analysis.
[6] Department for Environment, Food and Rural Affairs - Waste Statistics.
[7] Seasonal Auto-Regressive Integrated Moving Average. This type of economic model uses patterns in seasonal past data to forecast forward. See the revised February 2013 report for further details.
[8] C&I waste arisings are forecast with growth in the C&I sectors measured by Gross Value Added (GVA). The GVA forecasts used are produced by Oxford Economics, with an adjustment made to ensure

2.2 Infrastructure Capacity

Future landfill diversion capacity is forecast by applying risk adjustments to waste infrastructure projects that could be delivered by 2020. These adjustments control for uncertainty over when projects are likely to come on line and how much waste they will divert.

Project data has been updated to take into account information that has become available since the previous analysis was undertaken[9]. For example, where projects have progressed to select a single preferred bidder, more information on future capacity has become available for those projects. The updated data affects 35 projects, with the overall impact being an increase in expected capacity by 2020.

The analysis now includes a contribution from one of the projects from which Defra's provisional allocation of funding was withdrawn in February 2013. This is because, since the decision was announced, the Merseyside Waste Management Project has progressed to select a preferred bidder, indicating that the project is proceeding[10]. Previously a conservative assumption was made to assume no capacity from any of the three projects for which provisional funding was withdrawn. A conservative assumption is still made in this analysis to assume no capacity from the other two projects.

Taken together the updated project information implies average estimated biodegradable municipal waste diversion capacity of approximately 6.4 million tonnes by 2020 with no contribution from the NCC project, or approximately 6.6 million tonnes if the NCC project is assumed to be delivered by 2020. This is higher than the 5.9[11] million tonnes forecast in the revised February 2013 report.

consistency with Office of Budget Responsibility Gross Domestic Product (GDP) forecasts from the March 2013 "Economic and Fiscal Outlook" report.

[9] Project data in this analysis is taken from the assumed position of projects in the Defra Waste Infrastructure Delivery Programme (WIDP) database up to 21st August 2013.

[10] We note that the decision on the preferred bidder has been challenged by an unsuccessful bidder and this has been taken into account in determining the risk adjustment for this project.

[11] See the revised February 2013 report for further details. This estimate assumes no capacity from the three projects from which the provisional allocation of funding was withdrawn and a risk adjusted contribution from the NCC project.

3 Results

Using the method and parameters outlined, the likelihood of meeting the Landfill Directive target in 2020 is determined by the proportion of simulations (out of a total of 10,000) that produce treatment capacity above that required to meet the target. There is a very wide range of possible net capacity positions in 2020. This includes positions where capacity is more than sufficient to divert enough waste to meet the target; and positions where capacity is insufficient to divert enough waste to meet the target.

The analysis is run either assuming the NCC project definitely does not contribute any operational capacity by 2020, or assuming that the NCC project definitely does contribute capacity by 2020. This allows comparison of the maximum potential impact of the NCC project on the likelihood of meeting the target (with other input assumptions unchanged). However, in practice there is a degree of risk of non-delivery of the NCC project by the target date as infrastructure projects of this nature can sometimes be subject to delays.

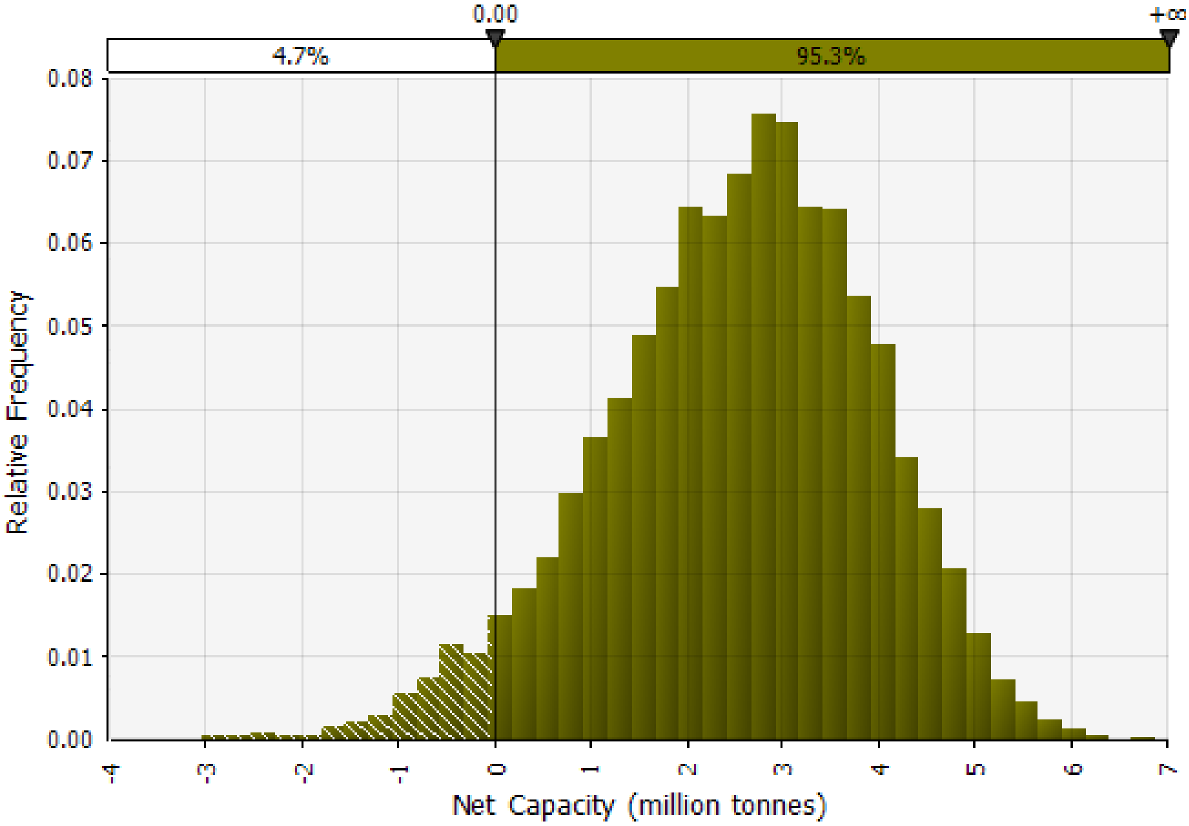
If the NCC project is assumed not to contribute any operational capacity by 2020, the likelihood of meeting or exceeding the 2020 diversion target is estimated to be approximately 95%. In this scenario the mean outcome is approximately 2.5 million tonnes of capacity above that required to meet the target.

This result is demonstrated in Figure 2 below. The net capacities towards the centre of the distribution are most likely to occur, while those outcomes at either end are relatively unlikely but possible. Of all predicted outcomes, approximately 95% are above zero, representing more than enough capacity to meet the target. The vertical-axis can be interpreted as the percentage likelihood (0.01 = 1%) of a specific net capacity value (horizontal-axis) occurring.

This result is a similar estimated likelihood of meeting the target to that forecast in the revised February 2013 report, which also estimates a likelihood of approximately 95%[12].

[12] See the revised February 2013 report for further details. This estimate assumes no capacity from the three projects from which the provisional allocation of funding was withdrawn and a risk adjusted contribution from the NCC project.

Figure 2: Range of Net Capacity Results Assuming No Contribution from NCC Project



If it assumed that the NCC project does deliver operational capacity by 2020, this will increase the likelihood of meeting the target. This increase is estimated to be approximately one percentage point, as shown in Table 1. The average forecast level of capacity above that required to meet the target also increases, to approximately 2.7 million tonnes.

Table 1: Summary of Results

Scenario	Likelihood of Meeting Target	Average Surplus Above Target (Mt)
No contribution from NCC project	95.3%	2.5
Full contribution from NCC project	96.1%	2.7

4 Tipping Points

This section identifies values of key inputs such that there is just sufficient capacity to meet the Landfill Directive target.

The tipping point analysis is applied to the inputs to which the results are most sensitive. These are identified as: household arisings, C&I arisings, household recycling rate, C&I recycling rate, biodegradable component of municipal solid waste, and EfW utilisation. Each of these inputs is tested individually to establish the value for which the forecast capacity is just sufficient to achieve the necessary diversion to meet the Landfill Directive target in 2020. That is, the input value at which there is approximately a 50-50 chance of meeting the target or not. Levels beyond the critical values would imply that capacity is forecast to be below the level necessary to meet the target on average. Table 2 summarises these critical values for all of the inputs mentioned above.

Table 2: Summary of Tipping Point Analysis

Input	Central value (in 2020)	Forecast range	Critical value	% Distance from limit of range
Household arisings	23.2 Mt	20.1-26.3 Mt	32.0 Mt	22%
C&I arisings (municipal component)	22.9 Mt	20.6-26.2 Mt	34.6 Mt	32%
Household recycling rate	50%	45-55%	34%	23%
C&I recycling rate	62%	54-70%	42%	22%
Biodegradable content of municipal solid waste	68%	55-75%	90%	20%
EfW utilisation	100%	90-105%	52%	42%

To test the tipping points, inputs are entered as fixed values rather than the ranges and assumptions used in the main analysis. The critical value for household waste arisings (32.0 million tonnes) is 22% outside the forecast range, and a level higher than has been observed in the data. The critical value for the municipal component of C&I arisings (34.6 million tonnes) is 32% outside the forecast range. This level of arisings is significantly above that reported in the 2009 survey[13].The analysis suggests a return to these levels by 2020 is unlikely. Not only are these levels beyond the upper ranges of forecast arisings, they are also beyond the range of outcomes when a 20% upward 'shock' is applied in the analysis[14]. For example, it requires arisings to reach the maximum point in the forecast range and to also experience a higher upward shock beyond that already high level.

[13] Department for Environment, Food and Rural Affairs - Waste Statistics.

[14] The possibility of upward shocks to waste arisings are included in the main analysis to control for the possibility that there could be a change is waste arisings trends from the patterns observed in the past data. See Appendix A. The tipping point tests for waste arisings enter fixed values rather than the ranges and shocks used in the main analysis.

The critical values for household and C&I recycling rates are also significantly outside the ranges used. Both require a fall in rates to levels that last occurred several years ago, when in practice we anticipate increasing recycling rates going forward.

The critical values for the biodegradable content of municipal waste and EfW utilisation are also significantly outside the probable range.

However, it is important to note that these results are based on testing inputs individually. There are potential combinations of values for these inputs (within the assumed ranges) that can result in forecast capacity that is just sufficient to meet the target. For example, the combination of inputs in Table 3 results in such an outcome (with other assumptions unchanged).

Table 3: Example Inputs to Reach Tipping Point When Varied Simultaneously

Input	Value
Household arisings	24.5
C&I arisings (municipal component)	26.0
Household recycling rate	46.5%
C&I recycling rate	54.0%

Whilst possible (based on the ranges used in the analysis), such an outcome relies on several inputs collectively reaching levels that are relatively unlikely individually, and hence even more unlikely together.

5 Sensitivity Analysis

Whilst the Monte-Carlo analysis already incorporates uncertainty by applying ranges to key parameters, further testing is undertaken to outline the sensitivity of the results to alternative assumptions or approaches.

In various ways, these sensitivity tests assess the extent to which the output of the model changes when the inputs, or modelling methods, vary from the assumptions used in the main analysis. The sensitivity testing also includes inputs that are given a single value rather than ranges in the analysis. The following inputs and sensitivities are tested:

1. Sensitivity to an alternative forecasting approach.
2. Sensitivity to correlations.
3. Sensitivity to waste arisings.
4. Sensitivity to recycling rates.
5. Sensitivity to project level risk adjustments.
6. Sensitivity to the programme level risk adjustment.

5.1 Alternative modelling approach

An alternative method to forecasting net capacity in 2020 was considered. The standard approach to modelling has been to forecast the level of waste arisings in 2020 and the level of available capacity in 2020; the two are then compared to derive an expected net capacity. By contrast, the alternative methodology takes as a starting point the latest available data for the level of waste sent to landfill. It then adds on the expected change in arisings based on the household and C&I projections and subtracts the expected change in diversion capacity. This is carried forward to 2020 to estimate an alternative expected surplus or deficit in capacity.

Assuming no capacity contribution from the NCC project, the standard and alternative methodologies return likelihoods of meeting the 2020 diversion target of approximately 95% and 90% respectively, as detailed in Table 4. Hence the alternative approach suggests a similar, but lower, likelihood of meeting the target. The impact of assuming that the NCC project becomes operational is slightly higher under the alternative approach, at approximately two percentage points.

Table 4: Sensitivity to Alternative Modelling Approach

Likelihood of meeting target	Scenario	
	NCC project contributes in full	NCC project does not contribute
Standard	96.1%	95.3%
Alternative	92.2%	90.3%

Whilst the alternative approach has the advantage of making use of the latest landfill returns data, the use of one year of data will not capture annual fluctuations. Hence the alternative approach places reliance on information from one year of data which may not be representative of future years. In addition, landfill returns data will typically reflect the average capacity over the course of a year, rather than the total capacity available at the end of that year. Hence additional infrastructure that becomes operational over the course of a year may not be fully reflected. In this respect the alternative method is likely to slightly underestimate operational capacity. For these reasons, the standard approach is preferred. The alternative approach nonetheless provides a useful comparison[15].

5.2 Input correlations

The correlations between inputs are difficult to know with certainty; hence, the sensitivity of the results to these assumptions is tested. There are two correlations that are used in the main analysis:

- Household and C&I arisings are assumed to be positively correlated (correlation coefficient of 0.25).
- Household recycling rate and the C&I recycling rate are also are assumed to be positively correlated (correlation coefficient of 0.25).

Alternative correlation assumptions were tested. This included both alternative values for the two correlations already described and the addition of other possible correlations.

It is possible that household arisings could be correlated with the household recycling rate, as they may have common drivers. Similarly, it is possible that C&I arisings could be correlated with the C&I recycling rate. For example, policy initiatives may simultaneously cause waste arisings to fall while causing recycling to increase. On the other hand, it does not seem clear that an increase in waste arisings should necessarily be associated with a fall in the recycling rate, since recycling capacity is flexible (at least within reasonable variations). No correlation has been assumed, but this assumption is tested for sensitivity.

There may also be a correlation between arisings and project delivery if, for example, increases in waste arisings are associated with an increased likelihood of infrastructure coming on line. This suggests a possible positive correlation. However, it would likely take a significant and sustained change in arisings for a correlation to occur, with large time lags for capacity to respond (due to long lead-in times). Therefore, whilst a correlation could be possible in the long-term, this is unlikely over the time period under consideration (i.e., to 2020). No correlation has been assumed, but this assumption is tested for sensitivity.

Finally, there may be a correlation between the delivery of individual projects; for example, if some common factor (e.g. economic growth) simultaneously increases the probability of delivery for multiple projects. This suggests a possible positive correlation. The assumption is that there is unlikely to be a significant correlation between individual projects since the key factors determining delivery (securing financial assistance, obtaining

[15] Further discussion of the relative merits of the standard and alternative approaches is outlined in the methodology review undertaken by NERA Economic Consulting. See NERA Economic Consulting (2012), "Review of Methodology for Forecasting Waste Infrastructure Requirements".

a contract, etc.) are determined largely by factors specific to each project. Furthermore, competition between projects might offset any positive correlation impacts. No correlation has been assumed, but this assumption is tested for sensitivity.

Therefore, there are six possible correlations that are tested: (1) household and C&I arisings; (2) household and C&I recycling rates; (3) household arisings and household recycling rates; (4) C&I arisings and C&I recycling rates; (5) arisings and project delivery; and (6) between individual projects.

An increase in correlations (1) and (2) causes a decrease in the probability of meeting the target. A positive correlation for (3) and (4) causes an increase in the probability of meeting the target and a negative correlation reduces the probability. A positive correlation for (5) and (6) causes an increase in the probability of meeting the target. Table 5 outlines possible high and low cases for the likelihood of meeting the target, based on varying the correlation inputs. Table 6 shows the probability of meeting the target under these scenarios, compared to the main analysis.

Table 5: Correlations Input Cases

Correlations	Main Analysis	Low Case	High Case
Household Arisings and C&I Arisings	0.25	0.50	0.00
Household Recycling and C&I Recycling	0.25	0.50	0.00
Household Arising and Recycling	0.00	-0.25	0.25
C&I Arising and C&I Recycling	0.00	-0.25	0.25
Arisings and Project Delivery	0.00	0.00	0.25
Between Different Projects	0.00	0.00	0.25

Table 6: Sensitivity to Correlation Inputs

Likelihood of meeting target	**Scenario**	
	NCC project contributes in full	NCC project does not contribute
Main Analysis	96.1%	95.3%
Low Case	95.9%	95.0%
High Case	96.8%	95.8%

Correlations in the low case slightly decrease the probability of meeting the 2020 target compared to the main analysis and correlations in the high case slightly increase the probability of meeting the 2020 target. However, overall the results show little sensitivity to the changes to the correlation inputs. This suggests the analysis is not especially sensitive to even large deviations in these correlations.

5.3 Waste Arisings

Two sensitivity tests are applied for waste arisings:

1. Sensitivity to higher waste arisings.
2. Sensitivity to upwards shocks to waste arisings.

In order to test the sensitivity of the percentage likelihood of meeting the 2020 target, assumptions are tested at the extreme of the ranges used in the main analysis. The results are estimated when it is assumed that household arisings reach the maximum value of the assumed range (26.3Mt) with certainty. The possibility of 'upward shocks' to this level is also included. Therefore household arisings reach a high level (at least 26.3 Mt) with 100% probability rather than the range of possible outcomes that is assumed in the main analysis. The same test is conducted for C&I arisings (using the maximum value of the range from the main analysis of 26.2Mt).

Table 7 shows the results of these tests in comparison to the range used in the main analysis. The results show some sensitivity; however, the possibility of such an outcome is already included within the ranges used in the main analysis, albeit at a much lower probability. These scenarios are considered unlikely because they assume levels of arisings that have not been observed in past data and which are considerably higher than estimates of current arisings.

Table 7: Sensitivity to Higher Arisings

Likelihood of meeting target	Scenario	
	NCC project contributes in full	NCC project does not contribute
Main Analysis	96.1%	95.3%
HH arisings at maximum	87.4%	85.3%
C&I arisings at maximum	91.1%	89.2%

In addition to the waste arisings forecast ranges, the possibility of upward 'shocks' to waste arisings are included in the analysis. The main analysis includes a 20% chance of a 20% increase to both household and C&I arisings in 2020. This size of shock is based on a reversal of the observed fall in arisings after 2002-03[16]. The sensitivity of the results to this shock assumption is tested by varying the probability of the shock from 10% to 30%. Table 8 shows the model results under three cases: 20% (as in the main analysis), 10% and 30%.

Table 8: Sensitivity to Shocks to Waste Arisings

Likelihood of meeting target	Scenario	
	NCC project contributes in full	NCC project does not contribute
Main Analysis (20%)	96.1%	95.3%
10% probability of shock	98.0%	97.6%
30% probability of shock	93.8%	92.5%

The results show some sensitivity to this input parameter. However, the analysis already takes a conservative approach by assuming an asymmetric (i.e., only upward) shock.

[16] Department for Environment, Food and Rural Affairs, Local authority collected waste management – annual results, November 2012 release.

5.4 Recycling Rates

Recycling rates have increased historically and further increases are assumed in the main analysis. The central assumptions are a household recycling rate of 50% and a C&I recycling rate of 62% in 2020. Relatively broad ranges are applied around these rates to incorporate uncertainty (see Appendix A). However, the sensitivity of the results to lower than expected recycling rates is tested.

As with arisings, in order to test the sensitivity of the percentage likelihood of meeting the 2020 target, extreme assumptions are tested. The results are estimated when it is assumed that there is no progress in recycling rates. Hence the household recycling rate remains unchanged from the last observed annual data (43.6% in 2012). The same test is conducted for the C&I recycling rate (for which the latest observed data is 52% in 2009).

Table 9 shows the results of these tests in comparison to the range used in the main analysis. The results are sensitive to these changes in assumption, particularly to the C&I recycling rate. However, these scenarios are considered highly unlikely since the long term trend for recycling has been upwards. The test for the C&I recycling rate is especially extreme given the rate used is from 2009 and significant progress has been observed in other recycling rates since then. Furthermore, the UK is committed to meeting a target of 50% household recycling by 2020.

Table 9: Sensitivity to No Progress in Recycling Rates

Likelihood of meeting target	Scenario	
	NCC project contributes in full	NCC project does not contribute
HH recycling rate unchanged from last observation (43.6%)	88.0%	85.6%
C&I recycling rate unchanged from last observation (52%)	80.4%	76.6%

5.5 Project Level Risk

The probability of an individual project delivering capacity is determined by its 'Red-Amber-Green' (RAG) status to which a delivery adjustment rate (DAR) is assigned (see Appendix A). The rating assigned to a project is determined by an objective assessment of its progress towards delivery. To test the sensitivity of the output to these probabilities, two scenarios were considered: a Low Case (Table 10) in which each RAG status probability was reduced by 10 percentage points (but going no lower than 0% and excluding those plants that are already operational or cancelled); and a High Case (Table 11) in which each RAG status probability was increased by 10 percentage points (but going no higher than 100% and excluding those plants that are already operational or cancelled). Table 12 shows the probability of meeting the target under the main analysis, and the Low and High cases.

Table 10: Delivery Adjustment Rates - Low Case

Delivery Adjustment Rates low case	PFI	PPP	Merchant	Project Status
B	100%	100%	100%	Fully operational
G	80%	80%	80%	Commissioning
AG	70%	70%	70%	Financial close, with planning
A	60%	60%	30%	Financial close, no planning
AR	50%	50%	10%	In procurement, no planning
R	10%	10%	0%	Unlikely to go live by 2020
n/a	0%	0%	0%	Cancelled Project

Table 11: Delivery Adjustment Rates - High Case

Delivery Adjustment Rates high case	PFI	PPP	Merchant	Project Status
B	100%	100%	100%	Fully operational
G	100%	100%	100%	Commissioning
AG	90%	90%	90%	Financial close, with planning
A	80%	80%	50%	Financial close, no planning
AR	70%	70%	30%	In procurement, no planning
R	30%	30%	13%	Unlikely to go live by 2020
n/a	0%	0%	0%	Cancelled Project

Table 12: Sensitivity to Delivery Adjustment Rates

Likelihood of meeting target	Scenario	
	NCC project contributes in full	NCC project does not contribute
Main Analysis	96.1%	95.3%
Low Case	92.5%	91.0%
High Case	99.2%	98.9%

The results demonstrate some sensitivity to the assumed rate of delivery, but remain relatively high in all cases. The rating system used is based on professional expertise in the sector and was supported in the independent review of the model[17].

5.6 Programme level risk

The sensitivity of the results to the programme level risk parameter is tested by performing analysis with this parameter set to fixed values (rather than the range of 90% to 100% used in the main analysis). The parameter is set to a fixed value of 100% (meaning no programme level risk adjustment) and set to a fixed value of 80% (meaning a higher risk adjustment). Table 13 below summarises the results from this test.

[17] NERA Economic Consulting (2012), "Review of Methodology for Forecasting Waste Infrastructure Requirements".

Table 13: Sensitivity to Programme Level Risk

Likelihood of meeting target	Scenario	
	NCC project contributes in full	NCC project does not contribute
Main Analysis	96.1%	95.3%
Low Case (80%)	88.1%	86.1%
High Case (100%)	97.9%	97.2%

Reducing the programme level risk parameter has a relatively large effect on the probability of meeting the 2020 target compared to other sensitivity tests. However, the inclusion of a programme level risk adjustment in the main analysis already reflects a cautious approach.

5.7 Summary of sensitivity analysis

Results from the sensitivity analysis are summarised in Table 14 below. This testing finds that the results are robust to fairly large changes in key variables. The sensitivity tests produce estimated likelihoods of meeting the target ranging from approximately 77% in the lowest case assessed, to approximately 99% in the highest case. These tests include assumptions that we believe to be unlikely in order to demonstrate the potential impact of such scenarios occurring.

Table 14: Summary of Sensitivity Analysis

Sensitivity Test	NCC project contributes in full	NCC project does not contribute
Main Analysis	96.1%	95.3%
Alternative forecasting approach		
Alternative Method	92.2%	90.3%
Correlations		
Low Case	95.9%	95.0%
High Case	96.8%	95.8%
Higher waste arisings		
HH arisings at maximum	87.4%	85.3%
C&I arisings at maximum	91.1%	89.2%
Shocks to waste arisings		
10% probability of shock	98.0%	97.6%
30% probability of shock	93.8%	92.5%
Recycling Rates		
No progress in HH recycling	88.0%	85.6%
No progress in C&I recycling rate	80.4%	76.6%
Project level risk adjustments		
Low Case	92.5%	91.0%
High Case	99.2%	98.9%
Programme level risk adjustment		
Low Case	88.1%	86.1%
High Case	97.9%	97.2%

References

Department for Environment, Food and Rural Affairs (2013), "Forecasting 2020 Waste Arisings and Treatment Capacity – Revised February 2013 Report", https://www.gov.uk/government/publications/forecasting-2020-waste-arisings-and-treatment-capacity

Department for Environment, Food and Rural Affairs (2010), "Spending Review 2010 – Changes to Waste PFI Programme", http://archive.defra.gov.uk/environment/waste/localauth/funding/pfi/documents/pfi-supporting-analysis-waste101206.pdf

Department for Environment, Food and Rural Affairs, Commercial and Industrial Waste statistics, June 2011 Release, https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs/series/waste-and-recycling-statistics

Department for Environment, Food and Rural Affairs, Local Authority Collected Waste statistics, https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs/series/waste-and-recycling-statistics

European Council (1999), Council Directive 1999/31/EC of 26th April 1999 on the landfill of waste

Greene, W.H. (2008), "Econometric Analysis", Sixth Edition, Harlow: Pearson Education

HM Revenue and Customs, Landfill Tax Bulletins, https://www.uktradeinfo.com/statistics/pages/taxanddutybulletins.aspx

International Energy Agency (2008), "Worldwide Trends in Energy Use and Efficiency"

Krausmann, F., Gingrich, S., Eisenmenger, N., Erb, K., Haberl, H., Fischer-Kowalski, M. (2009), "Growth in global materials use, GDP and population during the 20th century", Ecological Economics, No. 68, pp2696-2705

NERA Economic Consulting (2012), "Review of Methodology for Forecasting Waste Infrastructure Requirements", http://randd.defra.gov.uk/

OECD, "Resource Productivity in the G8 and the OECD", http://www.oecd.org/env/waste/47944428.pdf

Office for Budget Responsibility (March 2013), "Economic and Fiscal Outlook", http://budgetresponsibility.independent.gov.uk/economic-and-fiscal-outlook-march-2013/

Appendix A – Summary of Input Parameters

This appendix summarises the ranges of values applied to the model parameters for 2020. These ranges are unchanged compared to the revised February 2013 report apart from the updates described above in Section 2 of this report. Further explanation of all of the ranges used is provided in the revised February 2013 report.

Table A1 summarises the waste inputs. ‘Upward shocks to waste arisings’ incorporate the possibility that waste arisings patterns could potentially change from those observed in the past data. Whilst the main ranges for waste arisings allow for the possibility of increases in waste arisings, the upward shocks incorporate the possibility of a sharper rise; for example, occurring as the result of a more pronounced economic recovery. ‘BMW content’ refers to the biodegradable content of municipal solid waste. This assumption is necessary to determine the proportion of waste arisings that are relevant to the 2020 target. ‘MSW content’ refers to the proportion of C&I waste that is municipal solid waste. This is also used to help determine the proportion of waste arisings that are relevant to the target, as only part of the C&I waste is relevant.

Table A2 summarises capacity inputs. There are three types of technology specific input adjustments that are used in the analysis:

- Utilisation rates – this accounts for the possibility that projects deliver less than their headline capacity. For example, where permitted throughput of waste feedstock is reported rather than actual throughput (since the latter can be significantly less than the former).
- Diversion efficiency – this describes the proportion of biodegradable waste going to a facility that is diverted from going to landfill. This is generally less than 100% (except in the case of Energy from Waste (EfW) facilities) because some residue waste still goes to landfill and/or the biodegradable reduction is not completely efficient.
- Tonnes to EfW – this describes the proportion of waste derived from mechanical biological treatment processing (fuel fraction) that is passed on to an EfW facility.

In addition, adjustments are made to control for risks around project delivery. Project level ‘Delivery adjustment rates’ are applied. These adjustments reflect project level risks around delivery by 2020 and are based on a ‘Red-Amber-Green’ (RAG) status applied to each project. A programme level risk adjustment is also applied. This adjustment is made to account for the possibility of unforeseen events that could reduce the amount of capacity delivered across all projects going forward.

Table A1: Summary of Waste Inputs[18]

Waste arisings pre-shock	Distribution	Central	Minimum	Maximum	Forecast Rationale
Household waste	Triangular	23.2	20.1	26.3	SARIMA econometric model
C&I waste (municipal component)	Triangular	22.9	20.6	26.2	Sector growth forecasts and efficiency assumptions
Upward 'shocks' to arisings	**Probability**	**Magnitude**			
Household waste	20%	20%			Past occurrences of shocks to arisings
C&I waste	20%	20%			Past occurrences of shocks to arisings
Recycling rates	**Distribution**	**Central**	**Minimum**	**Maximum**	
Household waste	Triangular	50%	45%	55%	Continuation of upward trend in line with household recycling target
C&I waste	Triangular	62%	54%	70%	Continuation of upward trend
BMW content					
BMW content of MSW	Triangular	68%	55%	75%	Wide range due to data limitations
MSW content					
MSW % of industrial waste	Uniform	19%	15%	23%	Municipal component estimate from C&I survey 2009
MSW % of commercial waste	Uniform	84%	79%	89%	Municipal component estimate from C&I survey 2009

[18] A triangular distribution places the greatest probability of occurrence on the central value and least probability on the limits of the range. A uniform distribution places equal probability of occurrence on all values within the range.

Table A2: Summary of Capacity Inputs[19]

Utilisation Rates	Distribution	Central	Minimum	Maximum
BMBT Utilisation	Triangular	80%	75%	100%
EfW Utilisation	Triangular	100%	90%	105%
LFMBT Utilisation	Triangular	80%	75%	100%
MT Utilisation	Triangular	80%	75%	100%
Diversion Efficiency				
BMBT Efficiency	Triangular	85%	70%	90%
EfW Efficiency	n/a	100%	100%	100%
LFMBT Efficiency	Triangular	77%	50%	90%
MT Efficiency	n/a	0%	0%	0%
Tonnes to EfW				
BMBT to EfW	Triangular	50%	40%	60%
EfW to EfW	n/a	100%	100%	100%
LFMBT to EfW	n/a	0%	0%	0%
MT to EfW	Triangular	85%	70%	90%
Programme level risk				
% of capacity online	Uniform	95%	90%	100%

Delivery Adjustment Rates				
	PFI	PPP	Merchant	Project Status
B	100%	100%	100%	Fully operational
G	90%	90%	90%	Commissioning
AG	80%	80%	80%	Financial close, with planning
A	70%	70%	40%	Financial close, no planning
AR	60%	60%	20%	In procurement, no planning
R	20%	20%	3%	Unlikely to go live by 2020
n/a	0%	0%	0%	Cancelled Project

[19] PFI = Private Finance Initiative; PPP = Public Private Partnership; Merchant refers to facilities that are financed without a long-term government anchor contract for municipal waste in place.

Appendix B – Detailed Forecast Results

Table B1 provides detailed 2020 forecast outputs. The updated project information discussed in Section 2 is reflected in the forecast diversion capacity for biodegradable municipal waste (BMW).

Table B1 gives the mean values for the outputs, as well as the 90th percentile value (for which only 10% of model iterations will be higher) and the 10th percentile value (for which only 10% of model iterations will be lower). Results are shown either assuming no operational capacity from the NCC project by 2020, or assuming that the project is delivered by 2020 with certainty.

Table B1: Forecast Outputs

Assuming no contribution from NCC project			
Mt	Mean	90th Percentile	10th Percentile
Waste Arising	48.3	53.0	44.3
Waste Recycled	27.1	30.0	24.4
Residual Waste	21.3	23.7	19.0
Residual BMW	14.0	16.0	12.2
Diversion Capacity (for BMW)	6.4	7.2	5.6
BMW to Landfill (Target = 10.2)	7.6	9.5	5.9
Surplus capacity	2.5	4.2	0.7

Assuming full contribution from NCC project			
Mt	Mean	90th Percentile	10th Percentile
Waste Arising	48.3	53.0	44.3
Waste Recycled	27.1	30.0	24.4
Residual Waste	21.3	23.7	19.0
Residual BMW	14.0	16.0	12.2
Diversion Capacity (for BMW)	6.6	7.4	5.8
BMW to Landfill (Target = 10.2)	7.5	9.3	5.7
Surplus capacity	2.7	4.4	0.9

Table B2 provides the forecast outputs from the revised February 2013 report[20]. The updated analysis in this report produces slightly higher levels of forecast residual waste but also higher capacity forecasts compared to the revised February 2013 report. The net

[20]See the revised February 2013 report for further details. Estimates quoted assume no capacity from the three projects from which the provisional allocation of funding was withdrawn and a risk adjusted contribution from the NCC project.

effect is that the results are very similar in terms of the total capacity that is 'surplus' compared to that required to meet the target.

Table B2: Revised February 2013 Forecast Outputs

Mt	Mean	90th Percentile	10th Percentile
Waste Arising	47.9	52.4	44.1
Waste Recycled	27.2	30.1	24.6
Residual Waste	20.7	23.1	18.6
Residual BMW	13.7	15.6	11.9
Diversion Capacity (for BMW)	5.9	6.6	5.1
BMW to Landfill (Target = 10.2)	7.8	9.5	6.1
Surplus capacity	2.4	4.0	0.6

As noted in the revised February 2013 report, the analysis originally published in February did not fully account for all of the known potential capacity expected to be delivered by 2020. This meant that the likelihood of meeting the target was underestimated. The report originally published in February 2013 estimated the likelihood of meeting the target to be approximately 93%. This estimate increased slightly in the revised February 2013 analysis, to approximately 95%[21]. As noted above, the results of the revised February 2013 analysis are also similar to the current results outlined in this report.

[21] Estimates quoted assume no capacity from the three projects from which the provisional allocation of funding was withdrawn and a risk adjusted contribution from the NCC project.