SP Energy Networks 2015–2023 Business Plan

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Annex

Risk Modelling for RIIO-ED1

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SP ENERGY NETWORKS

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Risk Modelling for RIIO-ED1

Prepared for SP Energy Networks

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1. Overview

SP Energy Networks has commissioned NERA Economic Consulting to develop a financial risk modelling platform for use by its DNO businesses during the RIIO-ED1 price control review. The main aim of this model is to assess the financeability of the regulated business over the period from 2015-2023, given the company's business plan cost forecasts, and assumptions regarding key regulatory parameters.

1.1. Accounting for Risk and Uncertainty

Ofgem requires DNOs to submit well-justified business plans that set out their strategy to manage risks and uncertainties in an efficient way. For instance, Ofgem's Strategy Consultation paper states that *"DNOs will… be required to demonstrate that their proposals take account of the various risks and uncertainties and provide a strategy to deal with these efficiently and maintain delivery"* and that *"The overarching principle for uncertainty mechanisms under the RIIO model is that we expect network companies to manage the uncertainty they face".1*

Our work aims to assist SP Energy Networks in meeting this standard in compiling its business plan. To achieve this, the first step is to identify and quantify the various risk factors that its two DNO businesses face over the upcoming control period. We list the risk factors we identified and analysed in Section 2 of this report, which also describes the data we used in this study.

The next stage of our work was to develop a modelling framework within which to assess how these various risk factors affect the two licensed distribution businesses. To do this, as described in Section 3, we built on Ofgem's draft financial model[2] by adding the functionality to perform Monte Carlo simulations. Monte Carlo simulations allow SP Energy Networks to track how uncertainty around key input assumptions (e.g. opex or cost of debt risk) feed through into the "bottom line" for the business, i.e. its financial statements. Principally, the model we developed allows the derivation of probability distributions for a range of key financial ratios, including both credit and equity metrics, from assumed probability distributions on the risk factors identified in Section 2 of this report.

1.2. Identifying Appropriate Regulatory Parameters

Ofgem's Strategy Consultation document requires that that DNOs' business plans include "*proposals for notional gearing and where we should land within this cost of equity range (6.0-7.2 per cent), based on detailed evidence of their cash flow risk*".[3]

The model allows SP Energy Networks to track how the probability distributions around financial ratios change following changes to regulatory parameters such as the allowed cost

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1 Strategy Consultation for the RIIO-ED1 price control – Overview", Ofgem, September 2012, pages 31 and 39.

2 RIIO Price Control Financial Model (PCFM) - LiMo ED C1 84_SP DNO 03-05-13, as received from Scottish Power on 10th May 2013.

3 "Strategy Consultation for the RIIO-ED1 price control – Overview", Ofgem, September 2012, page 6.

of equity and notional gearing. This functionality can help to identify levels for the notional gearing and cost of equity that are consistent with SP Energy Network's cash flow risk. In addition, the model can inform an assessment of appropriate levels for other regulatory parameters such as depreciation asset lives, IQI additional income, notional gearing, cost of debt indexation mechanisms and the capitalisation rate.

Because Ofgem is required to ensure that an efficient network company is financeable when setting price controls, the model allows SP Energy Networks to assess whether a given package of regulatory parameters is "appropriate" based on whether it passes a financeability test. As Ofgem states in its Strategy Consultation, "*We expect all business plans to contain… a holistic view of the package the DNO believes to be appropriate, i.e. the company's view on financeability metrics (with evidence), against their view on expenditure and outputs*".[4]

When setting price controls, Ofgem typically defines a financeable price control package as one that allows an efficient company to attain a "comfortable investment grade" credit rating (i.e. in the BBB to A range)[5] while securing finance to facilitate the delivery of its regulatory obligations.[6] We therefore built into the model the capability to perform a financeability test by comparing the modelled probability distributions around key credit metrics against the thresholds for each metric published by ratings agencies, as described in Section 3.2.

Although ratings agencies use a degree of judgment when setting credit ratings, comparing modelled ratios to published thresholds allows an approximate assessment of the likelihood that the companies will retain credit metrics consistent with issuing investment grade debt over the upcoming control period. Hence, a high probability of ratios below the level required for investment grade would suggest the DNOs are not financeable under the assumed package of regulatory parameters. In contrast, a low probability of ratios below this level suggests the company would be financeable.

The model also derives probability distributions around equity metrics. For example, Ofgem has said previously that "*in RIIO price controls our intention is that companies should be able to achieve an upside return on (notional) equity in the low double-digits, and be exposed to a downside return at or below the cost of debt*".[7] Therefore, for example, by examining the probability distribution around outturn Return on Regulated Equity (RORE), it is possible to assess whether the proposed price control package is consistent with this aim. The model also examines the equity ratios that form part of Ofgem's financeability test, i.e. Regulated Equity / EBITDA, and Regulated Equity / Regulated Earnings.[8]

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4 Strategy Consultation for the RIIO-ED1 price control – Overview", Ofgem, September 2012, page 32.

5 Moody's equivalent for a triple B rating is denominated as "Baa".

6 Strategy decision for the RIIO-ED1 electricity distribution price control: Financial issues Supplementary annex to RIIO-ED1 overview paper, Ofgem (26d/13), 4 March 2013, para 3.1.

7 RIIO-GD1: Final Proposals - Finance and uncertainty supporting document, Ofgem, 17 December 2012, para 3.37.

8 Strategy decision for the RIIO-ED1 electricity distribution price control: Financial issues Supplementary annex to RIIO-ED1 overview paper, Ofgem (26d/13), 4 March 2013, para 3.4.

2. Identifying and Quantifying Risk Factors

2.1. Process

We began this model development task by identifying and quantifying key drivers of costs and revenue. As a starting point, we reviewed Ofgem's Strategy Consultation document and the subsequent decision document, in particular the supplementary annexes on "Outputs, incentives and innovation", "Uncertainty mechanisms" and "Financial Issues".

We compiled a list of key sources of risk which included all main components of the price control, such as capex, opex, cost of debt, real price effects, as well as the incentive schemes that Ofgem has proposed as part of the RIIO-ED1 package. At the same time, we reviewed the different uncertainty mechanisms Ofgem has proposed that mitigate some exposure to these risks. Through discussion with SP, we established which cost and revenue risk factors were most material, and so merit detailed treatment within the Financial Risk Model.

For each of the key risk factors, we formed assumptions regarding the statistical distributions of the cost and/or revenue impact, where appropriate, taking into account the likely limits on revenue exposure set under the price control. For example, Ofgem defines upper and lower bounds on the revenue impact for certain incentive schemes, and in these cases we defined the distribution on the revenue to be within the range set by Ofgem.

In discussion with Scottish Power, we defined assumptions on the appropriate "shape" of the statistical distributions we assumed and parameterized the distributions according to input data from Scottish Power or from our own independent analysis. Generally, we model the distributions in such way that Scottish Power's central view of its costs of performance is considered as the most likely outcome, i.e. the mode of the distribution.

2.2. Data and Assumptions

2.2.1. Cost uncertainties and uncertainty mechanisms

The starting point for modelling of cost uncertainties is the cost forecasts contained in the SPD and SPMW Business Plans. The model determines the DNOs' revenue entitlement for the upcoming review based on an Ofgem:DNO totex or IQI ratio, which serves as an input into the Financial Risk Model. The business plan cost forecasts provide the mode of the statistical distributions for actual costs we assume in the Financial Risk Model. The model also includes functionality to set the mode of the statistical distributions for actual costs equal to Ofgem's Final Proposals assessment of costs.

We also explicitly model the effects of Ofgem's proposed uncertainty mechanisms, taking into account the mechanics of the regulatory framework that aim to mitigate some of the business risks DNOs face; hence we avoid the potential for overstating the DNOs risk exposure. The following paragraphs describe the distributional assumptions we assume and set out the major incentive and uncertainty schemes we model.

2.2.1.1. Totex / IQI incentive mechanism

In the RIIO-ED1 framework, most major cost categories are subject to the totex incentive mechanisms, also known as the IQI efficiency incentive. The IQI incentive mechanism determines the share of totex overspend that the DNO will bear, or conversely, the share the DNO retains if it underspends.

The strength of the IQI efficiency incentive is determined by Ofgem's assessment of the DNOs' efficient costs (Ofgem:DNO totex ratio) and its calibration of the IQI matrix. To determine the efficiency incentive strength, we have used an IQI matrix calibrated by SP, as Ofgem has not yet published its proposed IQI matrix for the RIIO ED1 control.

For the simulation of outturn costs, we specify statistical distributions for the following categories of totex:

- Load related capex;
- Non-load related capex – asset replacement;
- Non-load related capex – other;
- Faults;
- Tree cutting; and
- Controllable opex.

The model assumes triangular distributions for each of these categories of totex over the RIIO-ED1 period. The most likely case can be defined as the Business Plan cost forecast, the Ofgem Final Proposals totex assessment, or an alternative most likely case defined by the user. The user can then specify upper and lower bounds on cost risk for each of the above categories. Having specified distributional assumptions regarding the costs, in each simulation run, the model picks a random value from the assumed distribution. The DNO then bears the share of any totex over- or underspend, as defined by the IQI efficiency incentive.

2.2.1.2. Load related expenditure

Ofgem has decided that DNOs can trigger a reopener for load-related capex if they can demonstrate a net efficient expenditure 20% greater or smaller than Ofgem's base allowance over the whole ED1 period (i.e. actuals plus forecasts for the remainder of the period), and the level of overspend is equal to or exceeds the materiality threshold of 1% of average annual base revenue.

As noted above, the risk model generates stochastic expenditures for the years up to the reopener window. At the reopener, companies have to forecast their overspend for the remainder of the price control period. We made the simplifying assumption that the forecast overspend for the period as a whole is extrapolated from the overspend seen to date. Simulated actual expenditure is assessed against the reopener conditions, and the reopener is triggered only if both conditions are satisfied. If triggered, the reopener adjusts for any variation in efficient expenditure beyond the 20% deadband. We modelled the uncertainty mechanism in line with Ofgem's decision to have two reopener windows in 2017 and in 2020.

2.2.1.3. Non-load related capex - asset replacement

As noted above, asset replacement expenditure is simulated based on a triangular distribution around the SP cost forecasts or Ofgem's Final Proposals totex assessment. However, this category of expenditure is subject to a separate assessment that we developed the functionality to model.

At RIIO-ED1, Ofgem decided to modify the existing health index (HI) by stripping out the criticality element and creating a separate criticality index, measured on a scale of C1 to C4. Furthermore, the health and criticality scores for relevant assets will be combined and consolidated into a newly developed composite risk index. Using DNOs' forecasts for their network's position according to the new H&CI index, Ofgem proposes to calculate an expected improvement in each DNO's asset risk score based on their business plans, which will represent the DNOs' agreed deliverable for RIIO-ED1. At the end of RIIO-ED1, if the DNO fails to demonstrate that its actual level of asset replacement meets the level agreed at the beginning of the price review, the DNO will be penalised through a penalty of 2.5% of the value of this underspend through a downward adjustment to its RIIO-ED2 allowed revenue. If the DNO meets the requirement, an upward adjustment to its RIIO-ED2 allowed revenue will be applied, such that it receives a reward of 2.5% of the value of this overspend.

In developing the model, we built in a place holder that allows the user to enter the year in which this review of DNOs' performance against the H&CI index occurs, and to model the effect of this review on cash flows. Ofgem proposes to specify the agreed deliverable for this mechanism based on a target risk score. As it remains unclear at the current stage, how Ofgem would calculate such a score, we based the modelling on financial expenditures for H&CI relevant assets. However, if as currently envisaged, the review will only take place at the end of ED1, there will be no financial impact for the ongoing RIIO-ED1 years so the scheme has no effect on the modelling.

2.2.1.4. Smart metering volume driver

Ofgem has proposed a smart metering volume driver for the upcoming price control, which will link allowed revenues to the number of call-outs associated with the smart meter roll out. We have incorporated a placeholder for the proposed smart metering volume driver, although at the current stage, we have not been able to form reliable assumptions on the volume targets or the incentive rate, so the driver is currently deactivated.

2.2.1.5. Non-controllable opex (non-totex)

Non-controllable opex does not form part of totex (i.e. for the IQI) and is treated as a pass-through item in the financial model. The Financial Model simulates uncertainty in non-controllable opex using a triangular distribution, but because it is a pass-through item, allowed revenue adjusts (with a lag – see Section 3.3 below) to reflect simulated costs.

2.2.2. Incentive schemes

Ofgem considers a number of incentive schemes for RIIO-ED1 to encourage the DNOs to deliver the primary outputs and secondary deliverables efficiently. Most incentives include financial rewards or penalties, while some are reputational or informational or have a potential financial impact only on the subsequent price control in ED2 through a later true-up.

For our risk modelling and financeability assessment, we focused on those incentives that create revenue risks in the RIIO-ED1 period.

In general, for the revenue outcome from incentive schemes, we defined triangular distributions around Scottish Power's view on the most likely outcome (i.e. mode). Where Ofgem has defined a maximum reward or a maximum penalty a DNO can receive through an incentive scheme, these incentive revenue caps and floors determine the upper and lower bound of the triangular distribution.

Incentive scheme performance in one year is most likely correlated with performance in another year during the price control. Outputs and deliverables such as customer satisfaction evolve gradually over time. A year of poor performance with maximum penalty in one area is unlikely to be followed by a year with strong over-performance and high revenue rewards. The model therefore simulates the incentive scheme outcomes by taking random draws from the described distributions for the first and the last RIIO-ED1 price control years (i.e. 2015/16 and 2022/23) and interpolates the outcomes for the period in between.

2.2.2.1. Broad Measure of Customer Satisfaction (BMCS)

The revenue exposure related to the Broad Measure of Customer Satisfaction is stated as a percentage of the annual allowed base revenue, which we assume is represented by the baseline Final Proposals allowance, excluding the effects of all incentive and uncertainty mechanisms.

The BMCS incentive scheme incorporates five different elements, each with a respective maximum reward or penalty the DNO can receive (see Table 2.1). The total revenue exposure sums up to $^{+}$/- 1.5% of annual base revenue. We defined the outcome for each category as a triangular distribution around SP's view on the likeliest outcome. The upper and lower bound of the triangular distribution are determined by Ofgem's proposed caps and floors.

Table 2.1
Broad Measure of Customer Satisfaction: Revenue Exposure

[as % of base revenue]	**Maximum Penalty / Lower bound**	**Maximum Reward / Upper bound**
Customer Satisfaction Survey		
Minor connections	-0.5%	+0.5%
Interruptions	-0.3%	+0.3%
General inquiry	-0.2%	+0.2%
Complaints metrics	-0.5%	+0.0%
Stakeholder engagement	-0.0%	+0.5%
Total	-1.5%	+1.5%

Source: Ofgem Strategy Decision "Outputs, Incentives and Innovation", Scottish Power data.

2.2.2.2. Interruption Incentive Scheme (IIS)

Ofgem sets the overall revenue exposure for the Interruption Incentive Scheme at +/-250 basis points RORE basis points per annum with a symmetric revenue and penalty cap. To model this scheme, we calculate the value 250 basis point on RORE in £ million, and assume a triangular distribution around this revenue effect around SP's best view on the most likely revenue outcome from the IIS.

2.2.2.3. Connections Guaranteed Standards of Performance

The Connections Guaranteed Standards of Performance scheme is a penalty-only mechanism. Operators have to pay prescribed levels of compensation to the customer where GSOP standards are not being met. Our model uses a triangular distribution with a mode and upside limit of £0, with the lower bound determined by SP's view on its maximum exposure.

We considered the expected cost per annum for GS2. The mode of the triangular distribution we assume is at the most likely level forecast by SP, with an upper bound at zero and a lower bound in line with SP's view on its maximum downside exposure. Additionally, we modelled GS6 payments in case of non-completed connection works as a low probability high impact risk factor. We modelled the exposure to these exceptional one-off payments through a , such that the user enters an appropriate probability of the event resulting in penalty payments, as well as the average payment per event.[9]

2.2.2.4. Time to connect (minor connection customers)

The time to connect incentive scheme applied to minor connection customers is a reward-only incentive. As such, the triangular distribution for the revenue outcome resulting from the scheme has a downside cap at £0. Ofgem sets the maximum revenue reward to +0.4% of annual base revenue which we take to be the upside cap of a triangular distribution.

2.2.2.5. Incentive on Connection Engagement (major connection customers)

By contrast, the Incentive on Connection Engagement (ICE), which relates to major connection customers solely, is a penalty-only incentive. The maximum revenue exposure for a licensee is -0.9% of annual base revenue.

The Strategy Decision documents state that the maximum penalty that can be applied to a DNO will be proportionate to the market segments that have passed the Competition Test, but Ofgem has yet to decide on the approach used to scale the size of penalty. Our risk model adopts a working assumption of maximum risk exposure, and defines a triangular distribution with lower bound at 0.9% of base revenue and upper bound at zero.

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9 Please note that GS6 in fact distinguishes between four different types of connections work for which four different daily penalty rates apply in the event of uncompleted work. We consider a high level aggregate approach here and consider an overall GS6 outcome. If detailed data is available, the model may accomplish for the different types of connections and payments.

2.2.3. Cost of debt

The cost of debt is determined by the interest rate of embedded and new debt and the amounts of debt outstanding. The Financial Risk Model accounts for uncertainty around both the interest rate and the amount of debt issued over ED1.

2.2.3.1. Amount of debt outstanding

The amount of new debt in any year depends on SP's refinancing requirements, the cash flow from investments, the cash flow from operations and (net) cash flow to equity. All else equal, higher refinancing requirements, more capex, less operating income, and higher dividends will lead to more new debt issuance.

The model treats SP's capex program for ED1 as exogenous; simulation results will have an impact on cash flows from operations, which will have a knock-on effect on the amount of new debt. This means the amount of new debt is endogenously determined by our model.

The amount of embedded debt is consistent with SP's gearing assumption.

2.2.3.2. Interest rate

We assume the cost of SP's *embedded debt* is based on SP's actual embedded debt costs.

New debt requirement over the RIIO ED1 period is modelled as:

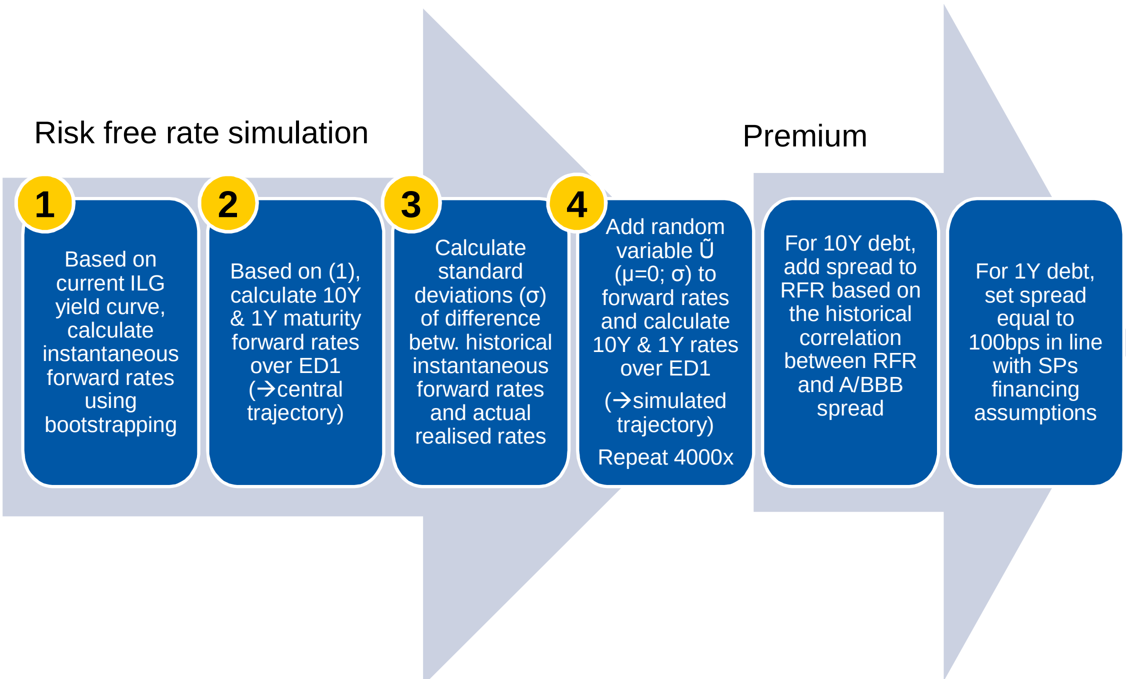
- *Floating rate debt:* up to a £200m threshold, the model issues short-term floating rate debt. The cost of floating rate debt is equal to the simulated 1 year risk-free rate plus 100bps, in line with SP's financing arrangements.

- *Fixed rate debt*: once the £200m threshold is breached, the model issues long-term fixed rate debt. Fixed rate debt is issued at the simulated iBoxx A/BBB rate prevailing at the time of issuance.

2.2.3.3. Interest rates projections for ED1

We project interest rates as the sum of projected real risk free rates and projected debt premiums. Figure 2.1summarises our approach of calculating interest rate trajectories over ED1.

Figure 2.1
Approach of calculating interest rate trajectories over ED1



Source: NERA illustration

Simulating risk-free rates

We project real risk free interest rates with a maturity of 1 and 10 years for each year of ED1 (trajectory of interest rates) based on instantaneous forward rates. We derive forward rates from the current ILG yield curve using the bootstrapping method. We refer to this trajectory as our central forecast. Our method of projecting interest rates rests on the concept of "expectations theory", which states that forward interest rates can be used as forecasts for future interest rates.

Algebraically, the 10 year maturity forward rate in year 1 ($f_{10,1}$) is calculated from instantaneous forward rates as follows:

$$f_{10,1} = [f_{2,0} \text{ x } f_{3,0} \text{ x } f_{4,0} \text{ x } f_{5,0} \text{ x } f_{6,0} \text{ x } f_{7,0} \text{ x } f_{8,0} \text{ x } f_{9,0} \text{ x } f_{10,0} \text{ x } f_{11,0}\ ]\wedge^{(1/10)}$$

where $f_{x,0}$ is the instantaneous forward rate in year x at time 0, defined as "1+ rate". Similarly, we calculate $f_{10,2}$ $f_{10,3}$ …, $f_{10,8}$ for years 2, 3, …, 8 of ED1.

In order to capture the uncertainty around our central forecast, we calculate a large number (4000) of trajectories. For example, we calculate an alternative 10 year maturity forward rate in year 1 ($f°_{10,1}$) as follows:

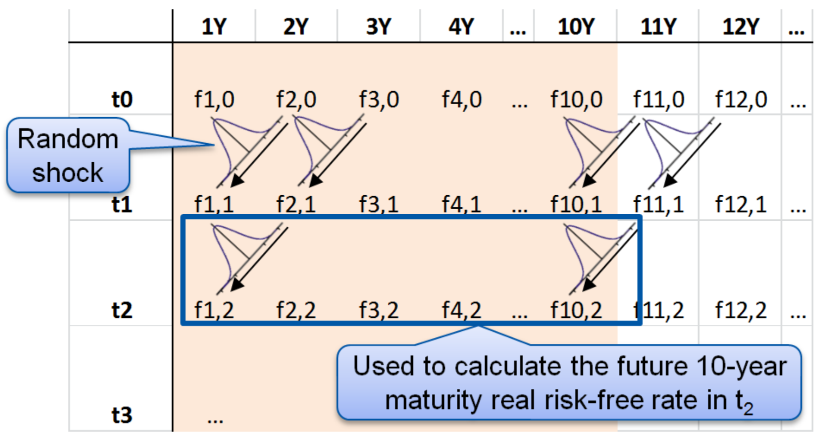
$$f°_{10,1} = [(f_{2,0} + \tilde{U}_1) \text{ x } (f_{3,0} + \tilde{U}_1) \text{ x } \ldots \text{ x } (f_{11,0}\ + \tilde{U}_1)]\wedge^{(1/10)}$$

where $\tilde{U}_1$ is an independent and identically distributed (iid) random "shock", with zero mean and positive standard deviation (σ_1). Similarly, we calculate $f^{\circ}_{10,2}$ $f^{\circ}_{10,3}$ …, $f^{\circ}_{10,8}$ by adding random shocks $\tilde{U}_2$, $\tilde{U}_3$, $\tilde{U}_4$, …, $\tilde{U}_8$.

We calculate the standard deviation of $\tilde{U}$ based on time series evidence. For example, we calculate σ_1 as the standard deviation of the historical difference between the forward rate $f_{2,0}$ in t-1 and the realised rate $f_{1,1}$ in t. Similarly, for the standard deviation of $\tilde{U}_2$, σ_1, we calculate the difference between $f_{3,0}$ in t-1 and the realised rate $f_{2,1}$, etc. We perform these calculations over a period of 27 years (since ILG data is available) and calculate the standard deviations of the differences.

The process of calculating real risk free interest rates is illustrated in the figure below.

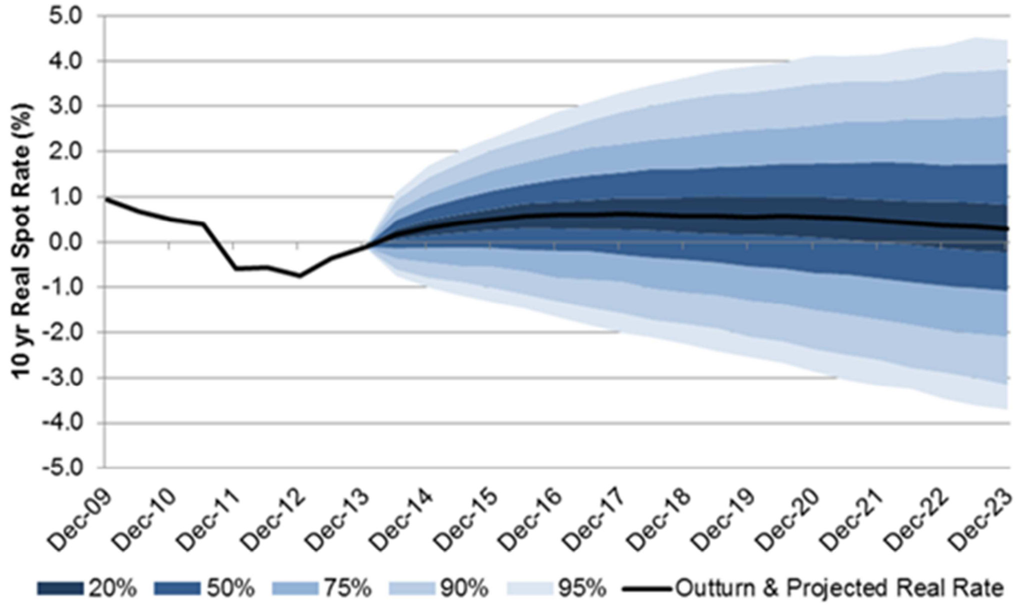
Figure 2.2
Calculation of 10 Year Maturity Interest Rates



Source: NERA analysis

Figure 2.3 shows the distribution of trajectories following the described method above. Our risk model randomly chooses a trajectory at a time; each trajectory is chosen with equal probability.

Figure 2.3
Distribution of 10 Y Maturity Interest Rates over RIIO-ED1



Source: NERA analysis

To model the risk-free component associated with SP's long-term debt, we draw on the simulations of 10 year government debt yields (as illustrated in Figure 2.3). For the risk-free component of SP's short-term debt, we draw on our simulations of 1 year government debt yields. The future real cost of debt issued by SP is then calculated by adding to the simulated real risk-free rate a debt premium spread, as we explain below.

Debt premium

For SP's new long-term debt, the *spread* corresponds to the expected debt premium paid by an A/BBB-rated non-financial company on top of the risk-free rate for a bond with a maturity of 10+ years. We modelled the spread based on the historical relationship between the debt premium/spread and the level of the real risk free rate, where the spread is calculated as the relevant iBoxx index used by Ofgem to set allowed debt costs minus the yield on government debt of a similar maturity (both in real terms). Our analysis showed a negative correlation between the spread and risk free rate, as illustrated in Figure 2.4.[10] Drawing on the historical relationship, we model the level of the future spread in each year as inversely correlated to the level of the simulated real risk free rate, so that the actual (real) cost of new debt is less volatile than the simulated risk free rate.

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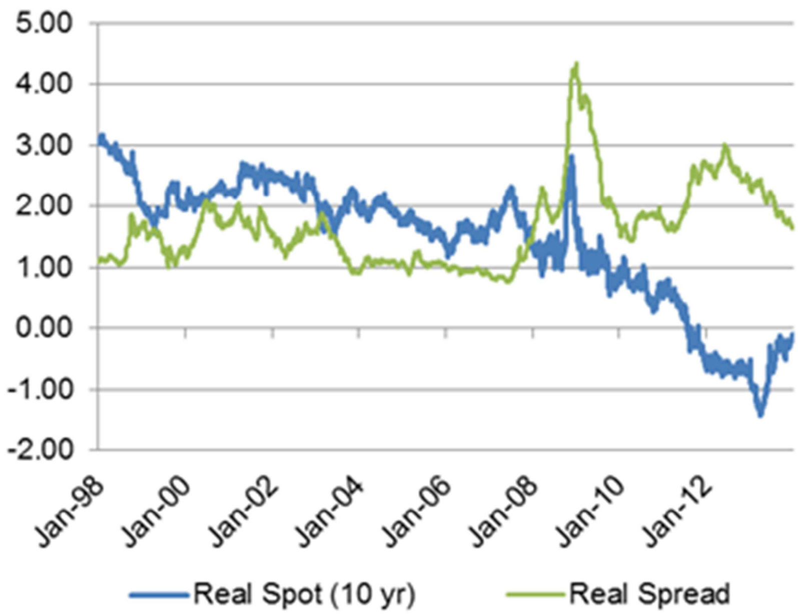
[10] Specifically, we estimated the relationship between the spread and risk-free rate as follows: real spread on A/BBB debt = 212 bps *minus* 0.31 * RfR.

Figure 2.4
There is an Inverse Relationship Between Debt Premium and Real Risk-Free Rate



Source: NERA analysis of Bloomberg data

The real cost of new short-term debt is calculated by adding a spread of 100 bps to the simulated one year maturity risk free rate, in line with financing arrangements specified by SP.

In addition, some of SP's embedded long term debt is priced at LIBOR + debt premium. We calculate future values of LIBOR by adding a spread to the simulated real one year risk-free rate. The estimated spread is calibrated using historical LIBOR data, using a similar methodology as for A/BBB rated bonds.

The actual *nominal* cost of debt is then obtained by applying the Fisher formula to the future real cost of debt using expected inflation.

Ofgem's future allowed cost of debt in each year of the RIIO-ED1 period is updated with the simulated costs of new debt for an A/BBB-rated non-financials corporate bond with 10+ year maturity.[11]

2.2.4. RPI

Allowed revenues in the model are indexed each year based on a forecast of RPI. The current version of the risk model uses the central RPI forecast of 3.1% p.a. reported in the latest Ofgem RIIO-ED1 model that was made available to us (LiMo ED C1 199b_NonFT_DNO 19-01-14).

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[11] Note that the cost of debt allowance in the model is an allowance in real terms and inflation is remunerated through indexation of the revenues, in line with Ofgem's methodology.

However, we also developed an alternative approach for the assessment of simulated RPI risk, where in each simulation run the model selects an inflation forecast from a range of different independent forecasts for RPI during the RIIO-period.[12] These inflation forecasts are all reported in the HM Treasury Publication "Forecasts for the UK economy: a comparison of independent forecasts" from November 2013 and drawn from reputable sources; hence they are assumed to occur with equal probability.

2.2.5. RPE

At present, we do not model uncertainty about future RPEs separately from the other risk factors affecting the various categories of expenditure (see above). However, we have incorporated an alternative approach for simulating RPE uncertainty into the model, which is described in a separate report prepared by SP.

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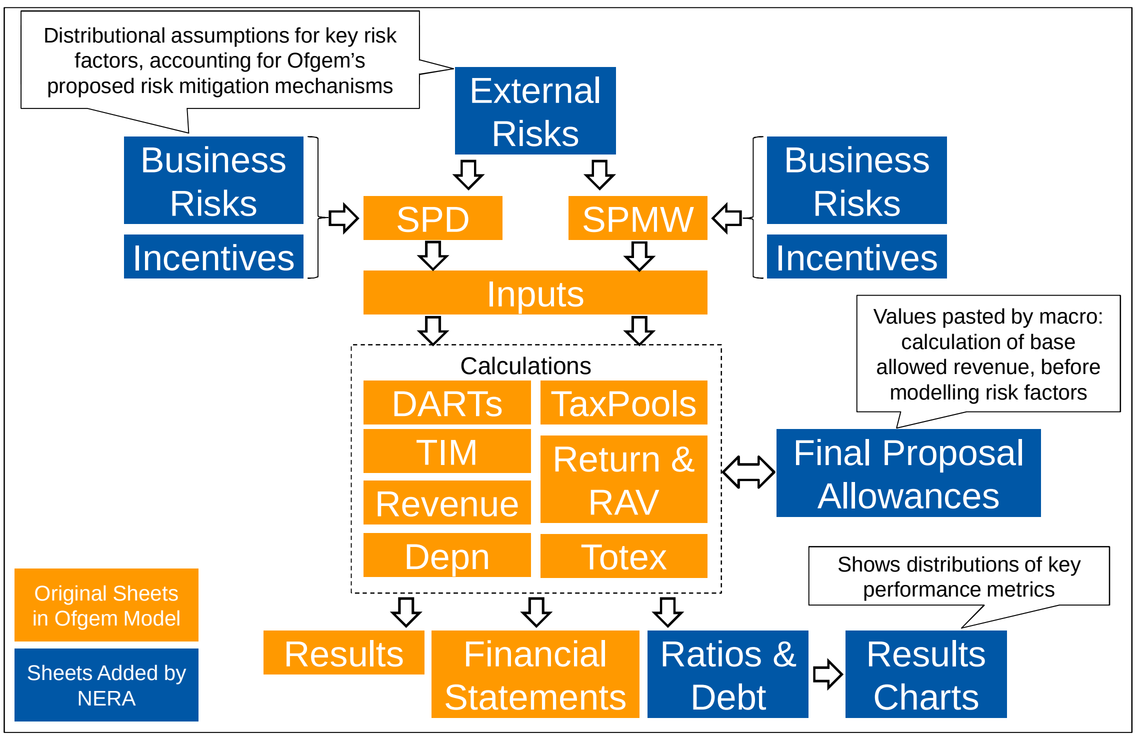
12 We assemble the medium term forecasts available. If the forecast is not complete for the entire ED1 period we substitute the average value of forecasted RPI growth for years where it is not available.

3. Modelling Approach

3.1. Overview of Model Structure

The Monte Carlo simulation tool we developed for Scottish Power builds on Ofgem's draft regulatory Price Control Financial Model for RIIO-ED1.[13] We have restructured and added to Ofgem's model in order to transform the deterministic regulatory model into a risk model that explicitly distinguishes between actual and allowed costs and can simulate random variation of the key risk factors using Oracle's software "Crystal Ball".

Figure 3.1
Illustration of the Main Changes to Ofgem Model to Incorporate Monte Carlo Model Framework



Source: NERA illustration

Figure 3.1 illustrates the structural changes we have undertaken to get from the Ofgem model to a Monte Carlo model framework. Key changes include:

- Differentiating between actual costs and allowed costs, and turning input factors into stochastic variables. Final proposals totex allowances are determined in "Allowed totex" sheets, using the business plan cost forecasts and the assumed Ofgem:DNO totex or IQI ratio. The FP allowances then feed into the SPD and SPMW Input sheets and through the existing financial model to calculate FP allowed revenues. Actual costs are modelled as

13 Model version LiMO C1 84, received from Scottish Power on 10th May 2013.

stochastic variables, mainly on the "Business Risk" sheets. From the "Business Risk" sheets, simulated costs feed through into the financial statements worksheets. By accounting for risk mitigation mechanisms and the modelling of re-openers, IQI cost sharing or indexation mechanisms, we avoid the potential for overstating the risk exposure of the business;

- Including model flexibility to set mean of the simulated totex distributions equal to business plan totex, the Final Proposals totex allowances or an alternative user defined value. To do this, we included a switch on the User Interface worksheet;
- Modelling of the annual iteration process that updates allowed revenue (see Section 3.3) in line with outturn simulated totex, including the use of a macro to calculate, and then fix across all iterations of the Monte Carlo simulation, the FP allowances;
- Modelling of Ofgem's risk mitigation mechanisms. As noted above, the "Business Risk" sheets calculate how allowed revenue changes following shocks to costs;
- Modelling of incentive schemes and resulting revenue impact. These calculations are mainly performed on the "Incentives" worksheets;
- Modelling of external risk factors, such as the cost of debt or inflation. The prevailing cost of debt is a random variable, as described in Section 2.2.3 above, which is simulated on the "External Risks" sheet. We also model explicitly how this feeds into the 10-year trailing average cost of debt index, and hence the allowed cost of debt;
- Including model flexibility to switch between notional and actual financing structure. To do this, we included a series of switches on the User Interface worksheet;
- Modelling automated issuance of debt. Debt is issued within the price control period to ensure the business has sufficient cash to cover (stochastic) expenditure, as described further in Section 3.2 below;
- Generating distributional charts for key financial ratios and financeability metrics. As we discuss below in Section 3.4, the model recalculates all relevant ratios and records how these ratios vary from one iteration to the next. The analysis of the realised values resulting from hundreds or thousands of iterations allows the derivation of probability distributions for each financial metric.

3.2. Modelling of Finance & Tax

Consistent with Ofgem's modelling approach, we assume that at the start of the price control period the amount of embedded debt in the business is set equal to the assumed notional gearing level, multiplied by the RAV.[14] Likewise, we assume that in the first year of the control period that the company has equity in the business equal to RAV multiplied by (1-assumed notional gearing). We assume interest costs related to embedded debt are equal to Ofgem's 10-year trailing average cost of debt.

As we roll forward the Monte Carlo simulation over time, the model assumes that cash flow short falls during a year are financed (in the first instance) through short-term floating rate

[14] From a financing perspective, we modelled each of SP's DNOs as a separate ring-fenced entity.

loans. However, we assume a limit on the size of the short-term floating rate facility such that whenever the closing value of short-term floating rate debt exceeds this threshold, the model automatically issues a new long-term bond. Both the threshold for bond issuance and nominal value of new bonds are model inputs. The costs of variable debt and long-term bonds are stochastically simulated within the model.

In line with Ofgem's modelling approach, we assume that:

- The model injects new equity to ensure that modelled gearing does not exceed assumed notional gearing by more than a user specified threshold amount;
- Each DNO's annual cash outgoings include dividends equal to 5% of the notional equity portion of RAV; and
- Of each DNO's long-term debt, 25% is index-linked.

Finally, the model also allows the user to consider a scenario in which the costs of embedded debt are based on the company's actual rather than its notional financing structure. The actual financing structure calculates the outturn cost of debt based on the DNOs' actual embedded debt.

3.3. The Annual Iteration Process

One of the major differences between Ofgem's model and our Financial Risk Model is the distinction between allowed and actual costs and revenue in the stochastic framework. The RIIO-ED1 regulatory framework will include an Annual Iteration Process that updates the allowed revenue for DNOs, as actual data becomes available on their actual performance, costs and output levels.

As a starting point to modelling the Annual Iteration Process, we developed a macro that calculates baseline Final Proposals Allowances, assuming no uncertainty and that actual costs and outturn costs are equal at the level forecast in the Business Plan. It then saves the values in the "FP Allowances" sheet, which it can then compare against recalculated allowed revenue at each subsequent simulation.

The model then sets actual revenue equal to the Final Proposals Allowances for the first years of the price control period, and adjusts actual revenue with a lag once actual outturn allowed revenue is generated from the simulation, i.e. after accounting for simulated costs and the various uncertainty and risk mitigation mechanisms. Specifically, the model calculates an incremental change to Final Proposal base revenue, known as the "MOD" term for each period, which is determined as the delta between actual and allowed revenue, inflated (or deflated) at the WACC. The adjustment lag (in years) is an input assumption that the user can specify.[15]

[15] While Ofgem's deterministic model calculated the MOD term only for one year at each time and saved historical values, our Financial Risk Model incorporates the functionality to recalculate base revenue each year for the whole RIIO-ED1 period.

3.4. Model Outputs to Assess Financeability

By running many iterations of the model, the model derives probability distributions around key metrics of the DNOs' financial performance. In particular, the model allows the derivation of distributions around the key financial ratios that Ofgem uses to assess financeability, and the ratings agencies use to set credit ratings. As a starting point, the model therefore derives distributions of the ratios shown in Table 3.1.

Table 3.1 sets out the definitions of the ratios and the reference value for a Baa rating for each sub-factor according to Moody's rating methodology for regulated electric and gas networks. However, in interpreting these ratios, we recognise that a projection that one or more financial ratios will fall below the thresholds normally required to achieve an investment grade rating does not necessarily mean it would be downgraded and/or is not financeable. Specifically, ratings agencies examine trends and exercise judgment when evaluating a company's creditworthiness. They also consider a broader range of factors than just credit scores, including, for example, the regulatory environment.

Table 3.1
Financial Ratios and Reference Value for Baa (Moody's)

Ratio	Definition	Reference for Baa
Credit Ratios		
FFO interest cover ratio (cash interest only)	(FFO + Net cash interest paid) / Net cash interest paid	≥ 2.5
Post-Maintenance Interest Cover Ratio	(FFO - RAV Depreciation + Net cash interest paid) / Net cash interest paid	≥ 1.4
Gearing	Closing Net Debt / Closing RAV	≤ 75%
FFO / Net debt	(FFO + Net inflation interest paid) / Closing Net Debt	≥ 8%
RCF / Capex	(Retained Cash Flow + Net inflation interest paid) / Capex (slow pot expenditure)	≥ 1.0
RCF / Net Debt	(Retained Cash Flow + Net inflation interest paid) / Closing Net Debt	≥ 10%
Equity Ratios		
RORE (Notional gearing, Allowed CoD)	Regulated equity return (Actual return net of regulated debt return at allowed CoD) / Regulated equity (notional equity share of RAV)	n/a
RORE (Notional gearing, Actual CoD)	Regulated equity return (Actual return net of regulated debt return at actual CoD) / Regulated equity (notional equity share of RAV)	n/a
Regulated Equity / EBITDA	(Closing Net Debt + Closing RAV) / EBITDA	n/a
Regulated Equity / PAT	(Closing Net Debt + Closing RAV) / Profits after tax	n/a
Dividend Cover Ratio	Profits after tax / Dividends paid	n/a

Scale and Complexity of Capital Programme		
Capex / RAV	Capex (slow pot expenditure) / Closing RAV	≤ 12%

Source: Ofgem RIIO PCFM version LiMO CM 84, Moody's Rating Methodology: Regulated Electric and Gas Networks, NERA.

In addition to the above ratios, we therefore aggregate a series of credit metrics into a single index that reflects the company's overall credit score using the weightings published by Moody's.[16] The single index we derive from our Financial Risk Model combines the company's performance against financial ratio thresholds with scores relating to other determinants of its overall creditworthiness. The resulting index can then be compared to published thresholds consistent with a range of credit ratings. Moody's assessment of credit risk in the regulated electric and gas networks sector focuses on four broad factors which encompass 13 specific sub-factors. Our Financial Risk Model simulates key credit metrics and the Capex-to-RAV ratio which reflects the scale and complexity of Scottish Power's capital programme.

In calculating the Moody's index, we keep the scores achieved by the companies for sub-factors besides financial ratio performance and capex programme constant across scenarios, and set them based on data from SP. This means, for example, that we assume no change in the ratings agencies' perception of the regulatory regime in the UK, or the business models operated by the DNOs. Table 3.2 shows the weighting for each factor and the assumed rating score for SP.

Although we have tried to implement Moody's ratings methodology as closely as possible to the approach described in its Rating Methodology for Regulated Electric and Gas Networks, there is some ambiguity in Moody's descriptions, in particular about the application of the second stage weighting (Moody's step 6).[17]

Furthermore, the methodology states that the rating utilises historical and projected financial results, depending on whether Moody's believes that a company's credit metrics will improve or deteriorate.[18] For our simulations, we use a historical 3-year average of the key credit metrics.

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16 Moody's Rating Methodology: Regulated Electric and Gas Networks, Moody's Global Infrastructure Finance, August 2009.

17 We apply a simple multiplication of the sub-factor weighting with both the Step 3 penalty factor (1,1,1,1.15,2.3) and the Step 6 numerical factor (1,3,6,9,12,15), consistent with Moody's example set out in footnote 3 on page 7of the Rating Methodology.

18 Moody's Rating Methodology, page 6 and page 19.

Table 3.2
Rating Factor Weighting and Rating Value Assumptions

	Rating Factors	Factor Weighting	Rating for SP
1	**Regulatory Environment and Asset Ownership Model**		
	Stability & predictability of regulatory regime	15%	Aaa
	Asset ownership model	10%	Aa
	Cost and investment recovery	10%	A
	Revenue risk	5%	Aa
2	**Efficiency and Execution Risk**		
	Cost efficiency	6%	Baa
	Scale and complexity of capital programme (Capex/RAV)	4%	simulated
3	**Stability Of Business Model and Financial Structure**		
	Ability and willingness to pursue opportunistic corporate activity	3.33%	A
	Ability and willingness to increase leverage	3.33%	Baa
	Targeted proportion of operating profit outside core regulated activities	3.33%	Aaa
4	**Key Credit metrics**		
	3yr PMICR	15%	simulated
	3-yr Net Debt/RAV	15%	simulated
	3-yr FFO/Net Debt	5%	simulated
	3-yr RCF/Capex	5%	simulated
	Total	**100%**	

Source: Moody's Rating Methodology: Regulated Electric and Gas Networks, NERA.

In addition to these ratios used by ratings agencies, at recent price controls Ofgem has also used the Return on Regulated Equity (RORE) as another means of assessing DNOs' financeability. The model allows us to estimate probability distributions around RORE, for comparison against Ofgem's aspiration that DNOs can achieve an upside return on (notional) equity in the low double-digits, and be exposed to a downside return at or below the cost of debt (see Section 1.2 above).

We calculate the equity return as the DNO's total actual revenue after annual iteration process, less allowed regulated debt return[19], less allowances for fast-pot expenditure, non-controllable opex, RAV depreciation, ,pass-through items and tax allowance and less totex over/underspend not funded via the IQI mechanism. Deviations of the resulting equity return from the Ofgem notional cost of equity indicate operational over- or underperformance at notional gearing and notional cost of debt.

While this RORE definition, consistent with Ofgem, does not account for any over- or underperformance resulting from the mismatch between actual and allowed cost of debt, we also calculate an alternative RORE at notional gearing but at actual cost of debt. The calculation of the regulated equity return for this equity metric differs from the above in that

[19] Regulated debt refers to the debt level at notional gearing.

it deducts the regulated debt return at actual instead of allowed cost of debt, with everything else being the same.

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