Network Output Measures Rebasing Methodology

Issue A3.5: Draft for review

VERSION CONTROL

VERSION HISTORY

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1 Introduction

Ofgem have instructed the Transmission Owners (TO's) to develop a rebasing methodology that will enable the existing RIIO-T1 replacement priority targets (as set out in Special Licence Condition 2M) to be expressed in a format that is consistent with the latest version of the NOMs methodology, Issue 18. This will then allow the TOs to report, and the Authority to assess, performance at the end of the price control and facilitate the objective implementation of the incentive methodology.

The requirements for rebasing were established in the 2016 Ofgem Direction[1] and in their Further Instructions issued on 8th June 2017[2]. The high-level requirements for the methodology are as set out in Sections 13 and 14 of the Further Instructions.

The Rebasing Direction set out by Ofgem requires the TOs to rebase their RIIO-T1 volume based targets into Monetised Risk targets in which each category of lead asset, split by voltage is assigned a monetised value. The fundamental principle of rebasing is that the TOs should demonstrate how their Monetised Risk targets are as equally challenging as the original volume based target. The details of the methodology, rebased targets and the principle to demonstrate that they are equally challenging are explained in detail below.

2 Rebasing methodology

This section will outline the general principles and approach that NGET will adopt in carrying out the rebasing exercise.

2.1 Background

The original targets (or Network Replacement Outputs within Special Condition 2M) were specified as an asset distribution at 31st March 2021. These were split by lead asset category, by voltage level and arranged by Replacement Priority (RP). The RP was determined by the former NOMs methodology Issue 4[3] and was based on the mapping of an asset's Asset Health index (AH) and its criticality (C). These values were then mapped onto a matrix which determines that particular asset RP. The matrix used to determine RPs is shown below.

Table2.1: RIIO-T1 RP table

	AHI 1	AHI 2	AHI 3	AHI 4	AHI 5
C1	RP4	RP4	RP4	RP1	RP1
C2	RP4	RP4	RP4	RP2	RP1
C3	RP4	RP4	RP4	RP3	RP2
C4	RP4	RP4	RP4	RP3	RP2

[1] https://www.ofgem.gov.uk/system/files/docs/2016/04/160429_et_noms_direction_subsid_3.pdf

[2] https://www.ofgem.gov.uk/system/files/docs/2017/06/et_noms_instructions_for_further_development_final_2.pdf

[3] ..\Proposed Network Output Measure Methodology - Issue 4_Ofgem.pdf

The target was set as the number of assets at each voltage level in each Replacement Priority category as at the 31st March 2021.

2.2 General Approach

The current NOMs methodology (Issue 18) proposed to calculate a Probability of Failure (PoF) and Consequence of failure (CoF) for each asset, and these will then be multiplied together to establish a monetised risk value.

The former and current versions of the methodologies are not directly comparable due to the different inputs and calculations of probability used and the variances in the assessment of consequence.

For the purposes of rebasing the consequence of failure values have been fixed at the 2017 values for the RIIO-T1 Price Control. This was agreed by the TOs to prevent any benefit or detriment as a result of material change to system, safety or environmental factors.

To derive a value of network monetised risk which represents the forecast condition of the assets at the end of the RIIO-T1 period after intervention a number of steps have to be followed. The steps are outlined as follows:

1. **TOs will calculate the Network Monetised Risk at the start of the RIIO-T1 period.**
   NGET will derive the value of Monetised Risk on their network at the start of the RIIO-T1 period by applying the current NOMs methodology. It will populate their respective data models based upon the information available to them as at the start of the period (2013). The target was set based on the asset information (e.g. inventory, condition) known at November 2010. This information was 'frozen' to set the target.
   Data gap and neutral factors in 2010 data: Most of the assets have all necessary data to calculate monetised risk as at 2010, but for few assets, some of these parameters had not been recorded or were not used in 2010 which created a data gap. Neutral factors (NF) are introduced into 2010 assets wherever the data gap exists. Data gap is schematically represented below:

Table 2.2: Schematic representation of data gap

EoL (2010) Data	EoL (2017) Data
a1	a2
b1	b2
c1	c2
??	d2

For calculating 2010 End of Life (EoL), missing data d1 is needed. The missing data is replaced with a neutral factor, which may vary from 0 (min) to 2017 (max) value. Note that 2017 data value could be considered maximum provided that the asset is not replaced from 2010.

Determination of End of Life (EoL) and Equivalent age (EA): During RIIO-T1 period, asset health is scored from 1 to 5 (OFGEM) & 1 to 4 (NGET) based on available asset health information as well as best engineering judgement. In the new NOMs model, asset health score is calculated based on end of life modifier (EoL) which uses parameters from asset health condition information.

For 2010 data, the end of life modifier score is calculated for each asset for all six lead assets such as underground cables, overhead lines (Conductors & Fittings), transformers, reactors and switchgear. The equation used to calculate EOL is explained in NARA[4]. For assets with a data gap, EoL is calculated with min (0) and max (2017) NFs. Equivalent age is calculated for all assets using the health score and asset Weibull deterioration curves.

PoF, CoF and monetised risk calculation: All inputs are used by FMEA to calculate PoF and CoF. Consequences of failure (CoF) fall into four categories: system, safety, environment and financial. These categories reflect the impact of the various events specific to the asset and the consequences are consistent for each class of failure mode. Safety and environment criticality is based on 2010 values. Consequences are calculated based on 2017 values.

Monetized risk is calculated for all assets. Assets with data gap, monetised risk is calculated using NF (min=0) and NF (max = 2017 value) and the change in risk is used as a measure to decide the NF. If the risk difference is less than 5%, then the NF is accepted as a data and then the risk with NF is used to represent the risk of the asset.

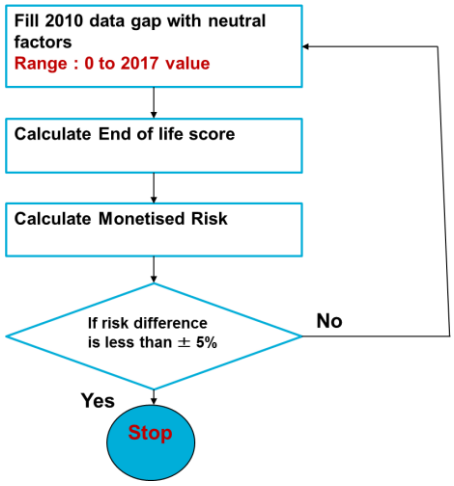

Figure 2.1: Decision tree to select neutral factor

2. **Each TO will then produce a forecast of Monetised Risk at the end of the RIIO-T1 period after all interventions specified in their respective business plans have been applied.**

NGET will allow the Monetised Risk position to deteriorate, as set out in the methodology, to a forecast value representative of the end of the RIIO-T1 period. This represents the no intervention risk position at the end of the T1 period.

[4] https://www.ofgem.gov.uk/system/files/docs/2018/08/nget_network_asset_risk_annex.pdf

Then, the RIIO-T1 business plan will be applied against the 2010 inventory to get end of RIIO-T1 forecast value. The monetised risk associated with the resulting distribution of assets become our rebased monetised risk target/outputs.

A high-level diagram outlining the general process is shown below. This will apply to all lead asset categories.

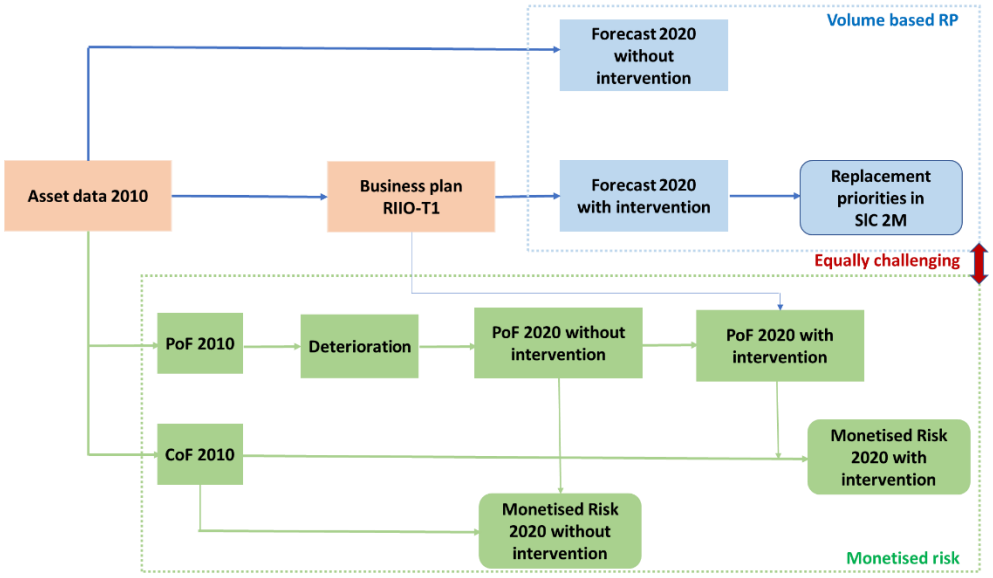

Figure 2.2: Schematic representation for rebasing methodology

2.3 Equally challenging rebased targets

The basic principle behind rebasing is that the newly derived monetised risk targets will be as 'equally challenging' as the Network Output Replacement targets which they are being translated from.

As the interventions in this approach are the same as the RIIO-T1 Business Plan that set the original targets, the effect of translating these interventions into monetised risk will result in targets which are considered equally challenging.

To confirm that the Rebasing Methodology is equally challenging, a volume test will be applied. This will confirm that the same volumes that are in the RIIO-T1 Business Plan equal the same volumes to achieve the rebased target.

3 Results and Discussion

3.1 RIIO-T1 data preparation

2010 data is compiled for all six lead assets as given below in Table 3.1.

Table 3.1 Summary of asset data used for RIIO-T1 submission

	Cables	Conductors	Fittings	Transformer	Reactor	Switchgear
Assets	635.32 km	14,105 km	14,117 km	774	144	2789
LR	17	164	167	35	24	360
Interventions till T1	23	69	183	162	1	331
All data needed to calculate monetised risk is available?	Yes	Yes	Yes	No	No	No

3.1.1 Data gap for 2010 assets

The gaps in the data were determined for all six lead assets with reference to the current condition (2017) and are shown in Table 3.2. Cables have all data needed to calculate monetised risk with respect to 2017 position. Overhead lines have no data gap as we are considering only preliminary score for health score calculations. The RIIO-T1 submission is only based on preliminary score as secondary score is yet to develop completely for overheadlines. Transformer, reactors and switchgear have data gaps which need to be replaced with neutral factors.

Table 3.2: Summary of asset gaps in 2010 data

Asset	**Data gap**
Cable	0%
Conductor*	0%
Fitting*	0%
Transformer	25%
Reactor	25%
SWG	19%

*Only preliminary score is considered

3.1.2 Neutral factors (NF) in Transformer, Reactor and Switchgear

Transformer and Reactor: Neutral factor is introduced to the missing Other Component Score (OCS) data in 2010. Compared to the 2017 data, 75 transformers and 5 reactors did not have an OCS value which are filled with their corresponding 2017 data as neutral factors.

Since all these assets are not replaced after 2010, we can use 2017 value as the maximum value reached for OCS at 2010. Note that 88 transformers have tap changer score (a component in OCS) which is observed only in 2015 and is not counted for 2010 OCS.

Switchgear: Data gap of 19% with respect to 2017 is calculated for switchgear based on fault duty current. 1236 assets need 2017 values. For maintenance dominated CB (1553), duty factor is not included in EoL calculation, so the effect of fault duty current on EoL calculation is very minimal. The number of assets replaced from 2010 are 16. Out of these 16, the number of poor condition CB (having EoL>70) are 7, 2 assets are coming under refurbishment candidates (EoL = 0) and the remaining 7 are using the 2017 values. We can use the 2017 fault current values for the missing values in 2010 asset data.

3.2 Determination of EoL and PoF

EoL is calculated using the equations given in NARA. Given EoL score, age and asset deterioration type, equivalent age is calculated for each asset. Equivalent age is then used to calculate probability of failure for all assets. In order to be consistent with RIIO -T1 submission, we considered the following for all six lead assets:

- LR assets are treated by removing their replacement year and allowing them to continuously increase in network risk.
- Deterioration curve is the same as used in RIIO T1 submission.
- Only End of life failure mode is considered in FMEA calculations.
- For switchgear, 932 refurbishment candidates assets are treated with EoL = 0. These assets are identified as potential candidates for doing interventions (refurb) in T1 period. In the RIIO T1 submission, these assets were modelled using a deterioration curve representing their asset lives following refurbishment, asset health was assigned as 2 and RP 10+. In monetized risk model, these assets are having EoL= 0 to be consistent with RIIO-T1 submission and they are allowed to deteriorate.

  In RIIO -T1 submission, 146 high duty circuit breakers are assigned with constant deterioration profile. The operational duty is assumed at 300 operations however there may be variation in this duty. To represent this in the model, the high duty assets were modelled on the Non_Deterioration curve to reduce complexity. Within the risk model, the mechanical operational duty is accessed as part of the asset score therefore removing the need for a proxy of operational duty with assets deteriorated on the curve which reflects the current intervention state. It is treated by using deterioration curves that reflect the high duty imposed on the asset.

End of life modifier (EoL) score is calculated for transformers, reactors and switchgear with and without neutral factors.

-For transformer and reactor, the difference in EoL between with NF =0 and NF= 2017 value are 10 and 3.4 % respectively. The change in PoF is less than 1% for both the assets

-For Switchgear, the difference in EoL between with NF =0 and NF= 2017 value is 1 % and corresponding PoF change is less than 1%.

3.3 Determination of CoF & monetised risk

In rebasing work, safety and environment criticality are calculated based on 2010 values. Safety, environment and system consequences are calculated based on 2017/18 values, whereas financial consequence is based on 2016/17 values.

Risk is calculated by the product of PoF and CoF and the network risk for NGET is calculated by summing the asset risk associated with each lead asset. Monetised risk is calculated for assets with neutral factor and the change in risk with NF =0 and NF=2017 and is summarized in the table below.

Table 3.3: Effect of neutral factors on monetized risk

Asset	Neutral factor (NF)	EoL change with NF=0 & NF = 2017	PoF change with NF=0 & NF = 2017	Risk change with NF=0 & NF = 2017	Remarks
Transformer	2017 values for OCS (75 Tx)	10%	1%	1%	2017 values are used as NF
Reactor	2017 values for OCS (5 Rx)	3.4%	0.1%	1%	2017 values are used as NF
Switchgear	2017 values for fault current (1236 SWG)	0.6%	1%	<1%	2017 values are used as NF

3.4 Rebased monetised targets

Monetised risk is calculated for all six lead assets with and without RIIO-T1 business plan. 2010 assets are allowed to deteriorate to calculate the 2020 forecast without any business plan. 2010 asset data and RIIO-T1 business plan is used to calculate the 2020 forecast with plan and this represents the monetised rebased risk targets. The summary is given in Figures 3.1 & 3.2.

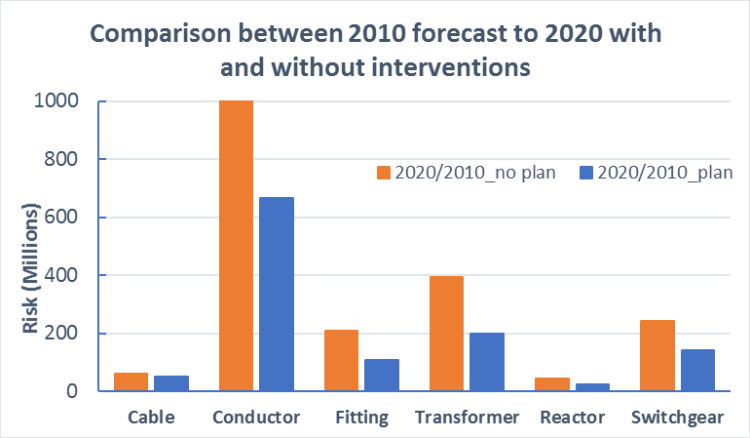

Figure 3.1 Monetised risk comparison between with and without interventions for 2020 forecast

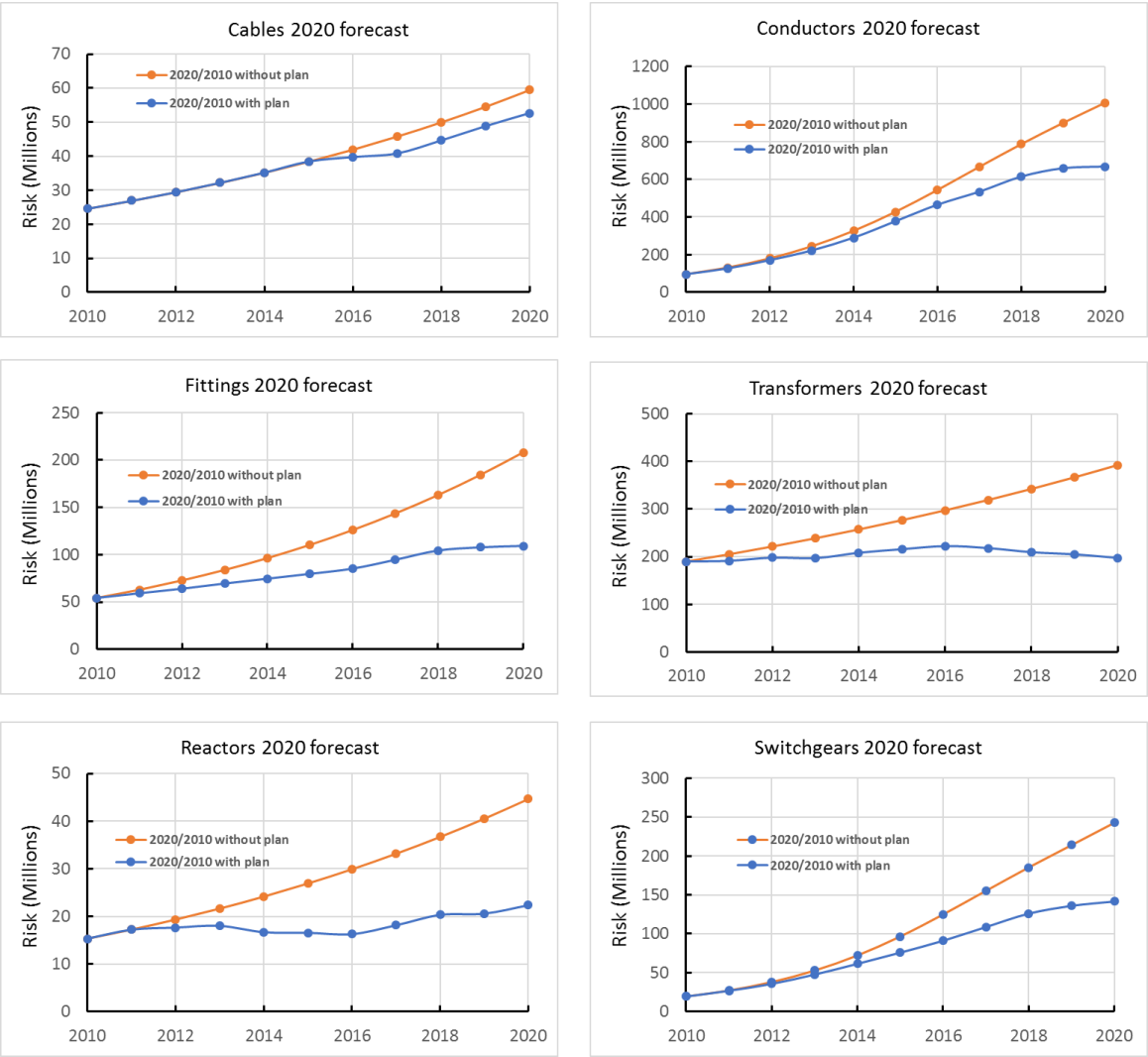

Figure 3.2: Summary of six lead assets rebased targets

Monetised risk 2020 with intervention risk position is the rebased target. This target is the translation of targets given in Licence 2M. The rebased monetised target at 2020 is **1.2 Billion**.

Table 3.4: Monetised risk target at 2020

	2020/2010_no plan	2020/2010_plan
Cable	59,510,589	52,581,436
Conductor	1,007,515,533	667,000,000
Fitting	207,883,456	109,000,000
Transformer	392,044,082	197,000,000
Reactor	44,665,957	22,411,582
Switchgear	242,722,939	141,000,000
Total	1,954,342,555	**1,190,000,000**

4 Conclusion

As given by OFGEM directions, 2M Licence target is translated into monetised risk target. NGET used RIIO T1 starting data (2010/11) for rebasing. Cables and overheadlines had all necessary data to calculate monetised risk, whereas transformers, reactors and switchgear used 2010 data as well as neutral factors (2017 data) to calculate the risk. PoF is calculated from 2010 EoL, CoF is taken from 2017 values and hence monetised risk is calculated by multiplying PoF and CoF values.

2010 assets are allowed to deteriorate to calculate the 2020 monetised risk forecast without any business plan. 2010 asset data and RIIO-T1 business plan is used to calculate the 2020 monetised risk forecast with plan and this value represents rebased monetised risk target. The rebased monetised risk target is calculated as 1.2 Billion.

GLOSSARY

Consequence	Outcome of an event affecting objectives
Consequence of Failure (CoF)	A consequence can be caused by more than one Failure Mode. This is monetised values for the Safety, Environmental, System and Financial consequences
Monetised Risk	A financial measure of risk calculated as a utility function
Network Output Measures or NOMs	The measures defined in paragraph 2L.4 of Special Condition 2L (Methodology for Network Output Measures).
Failure Mode	A distinct way in which a component can fail
Network Replacement Outputs	The Replacement Priority profile that the licensee is required to deliver on its Transmission System by 31 March 2021 that has been approved as part of the Price Control Review and funded in its Opening Base Revenue Allowance, as measured by the Network Output Measures. Specified in Special License Condition 2M
Neutral Factor	A factor required to complete the risk calculation where the data required does not exist.
Probability of Failure (PoF)	The likelihood that a Failure Mode will occur in a given time period
Replacement Priority	The category assigned to an asset to prioritise the requirement for intervention (replacement & refurbishment) based on a measure of its PoF and CoF.
TO	(Onshore) Transmission Owner