CCM INCENTIVE CALIBRATION

A report to Ofgem

NOVEMBER 2020

AFRY
ÅF PÖYRY

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AFRY Management Consulting provides leading-edge consulting and advisory services covering the whole value chain in energy, forest and bio-based industries. Our energy practice is the leading provider of strategic, commercial, regulatory and policy advice to European energy markets. Our energy team of over 250 specialists offers unparalleled expertise in the rapidly changing energy markets across Europe, the Middle East, Asia, Africa and the Americas.

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1 Introduction

Ofgem commissioned a partnership of CEPA, AFRY Management Consulting (AFRY) and Economic Consulting Associates to provide economic advice for RIIO2. This report has been prepared by AFRY under this Economic Strategic Partner contract for RIIO2.

1.1 Scope

AFRY has been commissioned by Ofgem to:

- scrutinise NGG's consultation response to Ofgem's RIIO-GT2 draft determination (DD) and comment on/address those areas where NGG has challenged the report produced by AFRY, to inform Ofgem's views on the constraint management incentive; and
- assess the information contained in NGG's response to DD and review the information provided, so as to consider what justification there is for recalibrating the incentive, especially whether to increase the annual target and the caps and collars and what any recalibration should be.

1.2 Background

1.2.1 AFRY's original scopes of work

Network Capability

AFRY was commissioned by Ofgem in late 2019 to scrutinise NGGT's Network Capability work, and separately, in January 2020, to scrutinise NGGT's proposal for the Constraint Cost Management Incentive.

In respect of Network Capability, AFRY was asked by Ofgem to:

- review the methodology and audit the models used by NGG to assess the physical capability of the network; and
- to assess the design thereof and the levels proposed by NGG for RIIO2 network capability targets.

In particular we were asked to review the documents requested by Ofgem's Sector Specific Methodology to establish whether NGGT had provided what had been requested.

Constraint Cost Management incentive

In respect of CCM, we were asked to assess three areas associated with the CCM incentive:

- Scrutinise NGGT's final BP proposal, and opine on whether it is robust enough, well-justified and sensible, including reviewing:
  - the actual performance data shown and assumptions made for RIIO-GT1 and whether these have been incorporated in NGGT's key considerations for the RIIO2 period;
  - the target-setting methodology for the RIIO2 as presented in the BP including the forecasted number of constraints, and justification behind their proposals. Verify that the proposed target-setting methodology robust enough and that its magnitude is well justified and reasonable; and
  - NGGT's proposal to remove the revenue stream from the short-term products when they scale back and the likely impact this will have on the CCM incentive itself.
- Advise on the RIIO2 CCM incentive scheme design that would incentivise NGGT to improve their performance in the CCM-related activities and provide most value to consumers.
- Review the report on consumer value of the CCM incentive in RIIO1 and RIIO2 (the "FTI CCM Report"), the assumptions, calculations made, as well as the robustness of the conclusions the independent consultancy (FTI) company came to. Advise whether there is sufficient evidence that the CCM incentive delivered value to consumers and how much that value was.

1.2.2 Procedure, sources and output

Whilst there was a degree of overlap between the two assignments because there is dependency in the underlying business processes, the projects were contracted and managed independently of each other.

The Network Capability involved the provision of a suite of documents by NGGT, physical meetings on site at NGGT's Warwick office, formal Q&A, various informal email correspondence and telephone conversations. The meetings allowed AFRY to gain a detailed understanding of the Network Capability process, including providing a limited audit of some of the underlying models and calculations. During the Network Capability project it was established between AFRY and NGGT that undertaking new hydraulic network analysis runs would be too time consuming given the timescales for the project. This limited AFRY's ability to ask for additional evidence.

The CCM incentive report focussed on scrutinising the material submitted by NGGT in its RIIO2 Business Plan. Interaction with NGGT occurred via the formal Q&A process.

Our output from the Network Capability work was included in a report, "Audit of Network Capability Assessment", dated 3rd April 2020 ("Network Capability Report"). A redacted version was published alongside Ofgem's RIIO2 Draft Determination (DD).

Our output from the CCM Incentive review work was included in a report, "NGGTs Constraint Cost Management Incentive scheme", dated 9th June 2020 ("CCM Report"). A redacted version was published alongside Ofgem's RIIO2 DD.

1.2.3 NGGT responses

Within their response to the DD, NGGT provided three documents that provide commentary and criticism on the Network Capability and CCM reports, alongside additional and/or clarifying evidence.

These three documents are:

- the CCM incentive response which is included in their DD response annex on Output Delivery Incentives ("CCM response")[1];
- the Network Capability response which is included in their DD response annex on Network Capability ("Network Capability response")[2] (together, the "NGGT response documents"); and
- a report from FTI Consulting, "NGGT's Constraint Cost Management Incentive and Network Capability: a review of Ofgem's proposals for RIIO-T2", 3 September 2020[3].

The majority of the points raised by FTI Consulting are repeated in the NGGT response documents.

This report focusses on the NGGT response documents.

1.3 Structure of this report

This report is structured as follows:

- Chapter 2 sets out, for each criticism, our response and any amended view we take;
- Chapter 3 considers additional understanding that has been gained following NGG's DD response; and
- Chapter 4 sets out a final summary with our overall position taking account of their views.

In reviewing our reports in light of NGGTs comments, we have independently spotted a separate minor factual inaccuracy. We also highlight this in Chapter 2.

[1] https://www.nationalgrid.com/uk/gas-transmission/document/132941/download
[2] https://www.nationalgrid.com/uk/gas-transmission/document/132936/download
[3] https://www.nationalgrid.com/uk/gas-transmission/document/132931/download

2 Response to NGGT criticisms

This chapter sets out, for each criticism, our response and any amended view we take.

This chapter considers the criticisms made by NGG in their DD response annexes. Firstly we consider the criticisms contained in the CCM response, and secondly we consider the criticisms contained in the Network Capability response. This chapter is arranged to respond to the points in the order in which they appear within the NGGT response documents.

Our reports were produced in the reverse order, however, which is reflected in the summary of our findings presented in Chapter 4.

2.1 CCM incentive scheme

NGGT's CCM response provides commentary and additional evidence under the headings:

- CCM consumer value;
- the proposed target;
- the proposed CCM reopener; and
- removal of entry overruns.

In addition to this, NGGT provide a series of additional clarifications which we briefly address.

Our CCM report's primary conclusion was that NGGTs proposed RIIO2 incentive was not robust and was not well-justified. We did not provide any recommendations to Ofgem. We concluded that:

- RIIO1 performance had not been adequately explained by NGGT and that it is not clear that it has delivered value for consumers;
- the forecasted CCM constraint costs were based on underlying assumptions within the Network Capability process which do not reflect typical operating conditions and therefore overestimate the number and magnitude of constraints as well as the associated costs; and

— that NGGT has failed to demonstrate that the proposed scheme delivers consumer value.

Our report also considered that the approaches to accommodating some risk as "business as usual" were not robust.

In respect of NGGT's responses:

— no additional information has been provided to explain RIIO1 performance;

— whist NGGT provides clarifications and additional information that alleviates some of our concerns regarding the assumptions underpinning the analysis, these are not fully alleviated (these are primarily discussed on Section 2.2);

— we continue to believe that the assumptions that NGGT have relied on to demonstrate consumer value carry a degree of uncertainty which impacts the reliability of that demonstration; and

— we continue to believe that the approaches to accommodating some risk as "business as usual" are not robust.

In the light of clarifications from NGGT we have modified our analysis regarding the proposed reopener mechanism, however this does not impact on our broader conclusions.

2.1.1 CCM Consumer value

Our CCM report contained a section discussing FTI's analysis of the consumer benefits of the RIIO1 and proposed RIIO2 schemes.

We highlighted that FTI had assumed [redacted] we demonstrated that the mid-point of the range of consumer values for RIIO1 was negative, and that if the same number of avoided actions per year were assumed for RII02, the mid-point of that would also be negative.

We highlighted that FTI had assumed [redacted] which was 3.4 times larger than the historical example available at the time their report was written [redacted].

We noted that FTI had made assumptions regarding the costs of [redacted]. We considered that there might be mitigations available to NGG to alleviate these [redacted].

NGGT states:

"AFRY's conclusions on the consumer value case articulated in our business plan centre on the fact that assumptions have been made on the costs and frequency of constraint management actions in the absence of an incentive. Whilst we agree assumptions have had to be made, we fail to see how we, or

indeed any party, can articulate the consumer value of the scheme without making such assumptions. Whilst we don't believe it would be prudent to restate the consumer value analysis conducted here, we do continue to believe the assumptions we have used are based on robust logic, that they are entirely reasonable and could still be viewed as conservative."

Our conclusions on consumer value[4] were that, amongst other things, because of the paucity of historical data the underlying analysis carries a degree of uncertainty which impacts its reliability. As such, there had been a failure to robustly demonstrate that the schemes deliver value for consumers. We maintain that conclusion.

2.1.2 Proposed CCM target

2.1.2.1 General criticism

NGGT states:

"We are deeply concerned that the AFRY critique of our proposed CCM target is demonstrably flawed and, in places, factually incorrect. We therefore strongly disagree that such a flawed critique has been used by Ofgem to dismiss our proposed target and the rationale underpinning it."

We acknowledge that there are minor factual inaccuracies in our work. These are addressed below, located where they are made apparent in NGGTs response.

Our original conclusions were drawn on the basis of the information provided to us during our initial engagement and through clarification meetings and SQs. In NGGTs DD response documents, NGGT has provided new information that modifies earlier information. To the extent that this new information is a correct explanation, then our original assessment would be changed. The changed assessment is presented in Chapter 4.

2.1.2.2 Typical operating conditions

In relation to our statement within the CCM report, *"the forecasted CCM incentive cost target is based on assumptions which do not reflect typical operating conditions and therefore overestimate the number and magnitude of constraints as well as the associated costs"*, NGGT states:

"We are very concerned that AFRY have provided no clear evidence to substantiate such a statement, given its importance and implication. It is not clear to us what AFRY are basing this assessment on, what AFRY consider typical operating conditions to be or why they consider that our proposed target was based on assumptions that do not reflect typical operating conditions. No explanation is offered to substantiate this position…"

NGGT has quoted from the Executive Summary of our CCM report. The conclusions in the CCM report contain a fuller statement that clearly points

[4] Section 5.4 of the AFRY CCM Incentive Report.

the reader to the assumptions made in the Network Capability process. Within the CCM report, we make reference to our Network Capability report.

We came to this conclusion because of the evidence presented to us at the time. This evidence is discussed in Section 2.2.1.

2.1.2.3 Accounting for 'business as usual'

Within NGGTs proposal for the target cost level for the CCM scheme, they considered that some of the forecasted costs could be managed by them as 'business as usual' (BAU) activity. They used two approaches: for some South Wales entry constraints they assumed up to 4mcm/d of capability shortfall could be managed as BAU; for all other constraints, they assumed 67% of the forecast could be managed as BAU. We criticised their approaches to accommodating BAU.

There are a number of points we wish to address under this heading of accounting for business as usual. These are:

- the logic behind the 67% reduction;
- a (minor) error in respect of the number of historical;
- conceding a point in relation to double counting;
- explaining the relationship between number and magnitude of events;
- clarifying our suggestions for using of 4mcm/d for all South Wales entry constraint risks; and
- an assessment of some additional information in respect of South Wales entry capacity.

Logic behind the 67% reduction

NGGT states:

*"We disagree with AFRY that BAU should be based upon historic (sic) costs incurred through the scheme as this fails to recognise the purpose of the incentive itself to minimise these costs… AFRY state that "*the ~12 events forecasts at the start of RIIO1 lead to direct costs, whereas the ~4 historical events have not triggered constraint costs. In fact, to date, there have been precisely two historical events consistent with the type of events in the forecast number which, assuming the rest of the methodology is sound, suggests the 67% reduction should actually be a 84% reduction.*" We again consider that this logic fails to recognise that a purpose of the incentive is to minimise costs. As stressed in our business plan proposal we used scale back events as they are the first commercial tool we utilise to manage constraints and are quantifiable and tangible as commercial actions taken during the RIIO1 period. We disagree with AFRY's assertion that the ~12 events forecasts for RIIO1 would lead to direct costs, rather they illustrated the cost risk we expected to face under the RIIO1 period."*

We agree with the concept that observable historical costs may be influenced by the positive actions that NGGT has taken to minimise them. Our report has not suggested that BAU should be accounted for using historical costs: we have observed that NGGT has chosen not to examine costs and has not

explained why. We have been clear to suggest that 'business as usual practice' – i.e. the actions of NGGT – should be incorporated into the Network Capability analysis. We concluded that "*different underlying assumptions, which reflect typical operational practice and 'business as usual' and which are reasonable and justifiable, would be expected to significantly reduce the forecast…number of constraint events [and] their costs.*"

The average of ~4 constraint days per annum is derived solely from scale-back events[5] (this is detailed in NGGT_SQ_POL55. The actual average is actually less than 4 days per annum.) The RIIO1 forecast assumed ~12 constraint events per annum, with an associated total cost, constructed from underlying assumptions on price per event[6]. The RIIO1 forecast did not assume that any of the constraints could be mitigated through the use of scale backs. The RIIO2 forecast similarly assumes that none of the forecast constraints can be resolved using scale backs[7].

NGGT characterise both a cost-free scale back and a forecasted costly constraint action as a 'commercial action'[8]. If scale backs are a commercial action that alleviates a real constraint, then they should be included as a tool to alleviate a forecasted constraint[9], at zero cost. On the other hand, if they are not a commercial action that alleviates a real constraint then they should be disregarded.

We continue to believe that comparing the number of cost-free scale-back events with the forecasted number of costly constraint actions is not an appropriate way to consider positive 'business as usual' actions.

Error in respect of the number of historical events

In our statement that, "*there have been precisely two historical events consistent with the type of events in the forecast number which, assuming the rest of the methodology is sound, suggests the 67% reduction should actually be a 84% reduction*", we are not clear that this is actually two constraint management events over the entirety of RIIO1 to the date of our report (locational sell actions at [redacted][10]). We have erroneously interpreted this as events per annum and with this incorrect interpretation go on to suggest that the reduction should by 84%, not 67%. Correcting the erroneous interpretation would suggest that the reduction should be 97.6%.

[5] Scale-back events allow NGGT to reclaim some capacity entitlements without cost.
[6] See pp83-84 of RIIO-T1 NGGT Business Plan "Annex A Buybacks/Constraint Management", May 2012. Available publicly here: https://www.nationalgrid.com/uk/gas-transmission/uk/gas-transmission/document/68501/download
[7] See pp26-27 of NGGT Annex A3.03 Output Delivery Incentives, December 2019.
[8] See p39 of NGGT Annex A3.03 Output Delivery Incentives, December 2019.
[9] The only tools considered were locational sell actions (some of which have associated counter-locational buy actions) and buy-backs.
[10] Detail provided by NGGT in response to SQ56.

Concession on double counting

NGGT states:

"AFRY conclude that 'alongside the FES-based scenarios, the underlying supply/demand scenarios that feed the calculation of raw constraint costs already include historical information. Therefore, applying an additional adjustment based on holistic observation may possibly lead to a double-counting of historical information, increasing the inaccuracy of the proposed target'*. This conclusion is wrong. We'd like it noted that there is no double counting of historic information. Our business plan was clear and explicit that our Monte Carlo analysis would select single scenarios for each run and hence double counting simply is not possible. When generating constraint forecasts, the model performs its Monte Carlo analysis and picks the independent scenarios with an 8/10 chance of selecting from the FES data, a 1/10 chance of selecting from the Historic flows and a 1/10 chance of selecting from the Uniform Distribution."*

We concede that whilst the FES forecasts already take account of historical flow information, the subsequent Monte Carlo analysis and the proposed modification of the raw constraint cost forecast by reference to historical commercial action are not double counting this information.

However, conceding this point this does not alter our conclusion that the logic underpinning the 67% reduction in cost in not sound.

The relationship between number and magnitude of events

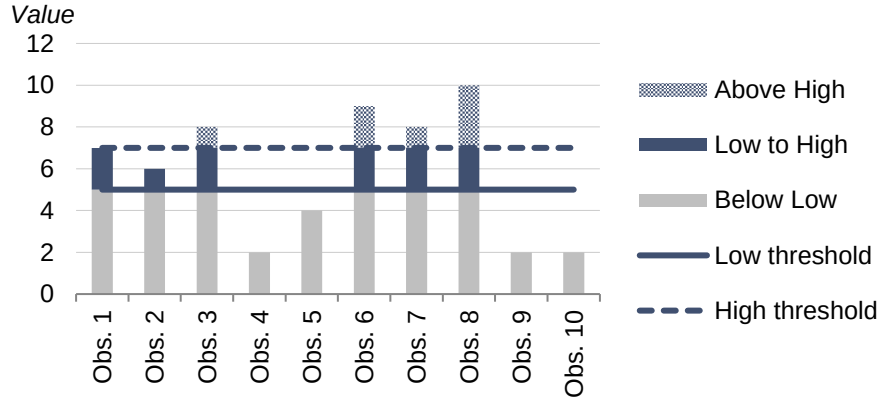
NGGT states:

"For South Wales risk specifically, AFRY make several observations that we'd like to clarify and expand on. We note that AFRY conclude that 'a 4 mcm/d increase in capability applied before the forecast of the number of constraint events (i.e. within the Network Capability process) would not only have a very significant impact on the number of events forecast, but we would also expect this to reduce the average magnitude of each event.' *Critically and disappointingly AFRY do not substantiate how or why this conclusion has been reached."*

The network capability is represented as a threshold. The Monte Carlo analysis returns the number and magnitude of points above the threshold. Raising the threshold is expected to lower both the number of points above the threshold and their average magnitude. This is shown in Exhibit 2.1 below.

Exhibit 2.1 – Impact of changes to thresholds

This stylistic chart demonstrates the impact of raising a threshold. The observation that a higher threshold yields a lower average magnitude holds true in all cases where there is at least one observation above the low threshold.



Threshold	Low	High
Vol. above threshold	18	7
Frequency	6	4
Avg. vol. above	3	1.75

Source: AFRY Management Consulting

Clarifying our suggestions for using of 4mcm/d for all South Wales entry constraint risks

NGGT states:

"AFRY go on to state 'We also do not understand why the 4 mcm/d-based reduction should only be applied to the uniform distribution case'*. We were clear in our business plan that the Uniform distribution was unique to South Wales but only contributed 1/10th of the scenarios applied to establish the South Wales risk. The FES and historic scenarios were not unique to South Wales and encompassed all points on the network, therefore we took a whole system approach to reduce the cost target and reduced the cost associated to that proportion of our risk output by 67%. To apply a 4 mcm/d reduction in addition to the 67% reduction would not be appropriate or practical and potentially would double count risk reduction."*

We accept that the 4mcm/d reduction should not apply in addition to the 'whole system' reduction that NGGT has applied. However, we remain of the opinion that the 4mcm/d margin should be applied to all instances of forecasted South Wales entry constraints, regardless of the underlying scenario being examined. We expect that the 4mcm/d margin would, at least in part, be indicated by the cumulative effect of changes to the other assumptions we discuss within this document.

In addition, we consider that similar margins should be assessed and applied at other entry points for the same reasons that it is appropriate to apply the 4mcm/d reduction in the South Wales case. As stated, we remain unconvinced of the approach used by NGGT to accommodating business as usual activity in the FES/historic forecasts.

Assessment of NGGT's additional information in respect of South Wales entry constraints

NGGT go on to include additional evidence on the impact of the raw constraint costs of an additional 5% of network capability in South Wales. It is not clear if or how this is equivalent to the 4mcm/d figure that was originally considered as business as usual. It would have been more informative if NGGT had considered the flat 4mcm/d figure in this analysis.

Figure 12.05 on page 44 of the December Business Plan core document[11] indicates a capability of between approximately 40mcm/d at a national demand level of 100mcm/d and approximately 85mcm/d at national demand levels over 360mcm/d. This suggests that 5% is equivalent to between 2mcm/d and 4mcm/d additional capacity.

The additional evidence presents additional statistics for South Wales entry constraints' frequency and the magnitude of the associated buy-back – for ease of reference this is included in Exhibit 2.2 below.

Exhibit 2.2 – NGGT South Wales statistics

These tables, copied from NGGT's Draft Determination Response Annex on Output Delivery Incentives, show statistics regarding the frequency of constraint ("Number of Constraint Days") and the associated aggregate buy-back cost ("Constraint Cost") for those constraints, for the original assessment included in the December 2019 Business Plan's calculations ("Before Adjustment") and for a revised which increases network capability by 5%.

Before Adjustment (Original RIIO Numbers)

SW Entry

Number of Constraint Days

	Min	Avg	Max	P10	P50	P90
21/22	4	8	22	6	7	9
22/23	5	9	22	7	7	10
23/24	4	9	26	7	8	13
24/25	5	11	31	7	8	15
25/26	5	11	34	7	10	15
	Total	48				

Constraint Cost (£m)

Min	Avg	Max	P10	P50	P90
7.4	30.7	117.2	20.8	29.6	40.7
10.4	32.6	103.9	21.7	30.9	43.4
10.4	35.8	151.6	22.0	32.2	54.7
9.8	41.0	143.0	23.5	35.5	65.2
12.5	44.0	149.4	25.3	38.2	70.0
Total	184.0				

REDACTED

Revised figures have been redacted in NGGTs publication of their Draft Determination response.
"Before Adjustment" figures are presented in Fig. 22 of "Annex A3.03 Output Delivery Incentives", December 2019, part of the NGGT Business Plan Submission, available here:
https://www.nationalgrid.com/uk/gas-transmission/document/129441/download

Notes: We assume "Avg" is the arithmetic mean
Source: NGGT Draft Determination Response Annex, September 2020 (confidential version supplied to Ofgem).

An immediate observation from this data is that despite the increase in capability, the average forecast constraint cost has increased (by

[11] Available publicly here: https://www.nationalgrid.com/uk/gas-transmission/document/129016/download

approximately [redacted]%) in 2023/24, despite the average forecast number of events having fallen. We assume this is because the forecast constraint magnitude has been resampled.

A simple analysis of these revised statistics is presented in Exhibit 2.3 below. We compute "constraint cost per event" metrics, which represents the expected average cost of a constraint. Because the ratio of the types of action – buy-back or locational action – is a fixed assumption (50:50), and that the price paid for the action is also a fixed assumption (based on 60p/th, as discussed in Section 2.2.2.5), the only cost driver that is changing is the magnitude of the constraint action.

We note that the average of the "constraint cost per event" has increased which given fixed assumptions on price and type of action is counterintuitive. Furthermore:

- the change in the forecasted average constraint cost risk across the RIIO period (£[redacted]) is much lower than the change in the total of the forecasted P(50) constraint cost risk across the RIIO period (£[redacted]); and
- the change in the inferred, per event constraint cost is near zero across all summary statistics except for the average.

We do not understand why this would be the case, and this feature makes it difficult to understand how forecast costs have changed.

NGGT use this analysis to conclude that integrating a 4mcm/d increase in capability into the inputs reduces the magnitude of the risk that they face by less than applying it to the outputs. We are not convinced that the analysis demonstrates this because:

- NGGT have investigated a 5% increase in network capability which, at lower demand levels which are expected to drive the majority of the constraint costs, is somewhat less than 4mcm/d; and
- the features of the statistical output make it difficult to understand how the costs have changed.

After considering the new information, we remain unconvinced of the approach used by NGGT to accommodating business as usual activity in the FES/historic forecasts.

Nevertheless, and assuming the statistical output is correct for the "average figures", we welcome the additional analysis that NGGT has provided, as it provides a better reflection of the true network capability and, allied to assumptions of the proportion of constraint actions that need to be managed with buy-backs (discussed in Chapter 3), a surer footing on which to size the incentive.

Exhibit 2.3 – Analysis of NGGTs revised statistics

This table presents some simple analysis of the statistics presented in Exhibit 2.2.

	Number of Constraint Days						Constraint Cost						Constraint cost per event (mean)					
	Min	Avg	Max	P10	P50	P90	Min	Avg	Max	P10	P50	P90	Min	Avg	Max	P10	P50	P90
Before adjustment																		
21/22	4	8	22	6	7	9	7.4	30.7	117.2	20.8	29.6	40.7	1.85	3.84	5.33	3.47	4.23	4.52
22/23	5	9	22	7	7	10	10.4	32.6	103.9	21.7	30.9	43.4	2.08	3.62	4.72	3.10	4.41	4.34
23/24	4	9	26	7	8	13	10.4	35.8	151.6	22	32.2	54.7	2.60	3.98	5.83	3.14	4.03	4.21
24/25	5	11	31	7	8	15	9.8	41	143	23.5	35.5	65.2	1.96	3.73	4.61	3.36	4.44	4.35
25/26	5	11	34	7	10	15	12.5	44	149.4	25.3	38.2	70	2.50	4.00	4.39	3.61	3.82	4.67
Total across RIIO period							50.5	**184**	665.1	113.3	166.4	274						
After adjustment																		
21/22	[redacted]																	
22/23																		
23/24																		
24/25																		
25/26																		
Total across RIIO period																		
Changes due to adjustment																		
21/22	[redacted]																	
22/23																		
23/24																		
24/25																		
25/26																		
Total change across RIIO period																		

REDACTED

REDACTED

Notes: Grey shaded areas are a copy of the NGGT tables. Blue shaded areas are AFRY analysis. Highlighted cells are referred to in the commentary.
Source: AFRY after NGGT

2.1.3 CCM reopener

NGGT proposed a re-opener for the incentive scheme, based on breaching the proposed cap and collar. Our views were that the cap and collar were unlikely to be breached, but that the asymmetrical nature of the proposal (reopened after two successive breaches of cap, but only one breach of collar) reduced NGGTs risk and so this element of the proposal (they asymmetry) should be rejected.

NGGT states:

"We do note that AFRY state that a re-opener would lead to an additional reduction in risk to us. However, we fail to see how this conclusion has been made; a re-opener would give rise to a review which could result in the scheme parameters being increased, decreased or remaining as-is."

Whilst we accept that the outcome of any review is not predetermined. Our view was formed by the fact that the proposed triggers for re-opening are asymmetrical: two successive breaches of the cap are required whereas only one breach of the collar is required. However, we have subsequently considered this matter carefully, and can see that it would better protect the interest of consumers if the scheme were re-opened in the event of breaching the collar, regardless of how it is re-opened following a breach of the cap.

"AFRY also state that there is no identification of the elements and/or events that may trigger a reopening of the scheme. We were clear in our business plan proposal that there could be many reasons, including potential unforeseen events, which could lead to the scheme cap or collar being breached. As such, we didn't believe it was appropriate to explicitly detail each possible reason, we instead proposed that the trigger for a scheme review would be a cap or collar breach and the reasons for the cap and collar breach would form part of the dialogue with Ofgem to establish the scope of the review, or not as the case may be."

We accept NGGT's justification for not including identification of the elements and/or events that may trigger a reopening, however we note that our criticism formed part of a set of observations exemplifying the lack of detail in the proposal and the lack of justification for the asymmetry. On reflection we agree that, should a reopener be appropriate, identifying the requirement for it should be simple.

2.1.4 Removal of entry overruns

Ofgem's DD proposed removing entry capacity overruns from the incentive scheme. For our report, Ofgem had asked us to specifically consider the role of System Overrun Charges in the RIIO1 incentive performance.

NGGT states:

"We believe it to be misleading for AFRY to critique our RIIO1 business plan rationale for inclusion of entry overruns; the current document under review is the Business Plan for RIIO2 and makes no reference to this rationale."

We do not agree that our report was critical of the RIIO1 business plan rationale – we merely repeated the justifications provided by NGGT[12].

NGGT states:

"Finally, both the AFRY Constraint Management annex and Ofgem's draft determination suggest that we could seek to maximise the revenue from overruns to offset the cost of constraints."

Our examination was retrospective, not forward looking: "*there is no clear evidence to show that the incentive has been successful in encouraging the release of additional capacity, or that NGGT has taken specific action to maximise these revenues.*" Notwithstanding, we would like to clarify that we found no evidence to suggest that NGGT had taken specific action to maximise overrun revenues.

2.1.5 Further points of clarification

These are discussed in Exhibit 2.4 below.

Exhibit 2.4 – Further points of clarification

This table discusses each point clarified by NGGT.

Quote from AFRY Report	Clarification from NGGT	Response from AFRY
"NGGT consistently and overwhelmingly outperforms: in each year, the performance measure exceeds the target by over £28m."	*"We'd like to point out that our incentive performance under RIIO1 to date has only been around 54% of the maximum reward attainable though the CCM scheme. When subject to the sharing factor, this has resulted in £99m being returned to customers to date."*	NGGT discuss a different metric which does not imping on our observation.
"The proposal includes a revised target based on the forecasted costs of network constraints."	*"We'd like to clarify that the target we proposed is based upon the forecast cost risk we expect to manage, not the forecast costs we expect to incur. We also removed forecast revenues from the target, based upon the average annual revenues we saw through the scheme in RIIO1, excluding some outliers."*	We don't see the difference – the forecast cost risk is based on NGGT's forecast of the number of incidents and the cost of managing those constraints.

[12] SQ 79, 20/03/2020.

Quote from AFRY Report	Clarification from NGGT	Response from AFRY
"Constraint avoidance costs … The treatment of these costs – i.e. whether they have been otherwise recovered from consumers through Totex allowances – is also not clear."	*"We can confirm the costs quoted in the AFRY report are logged against the Totex allowances and therefore subject to the Totex sharing factor".*	The clarification is helpful.
"Significantly lowering the sharing factor proposed by NGGT would reduce the risks of NGGT receiving windfall gains whilst maintaining an incentive on CCM".	*"We disagree with this statement, we believe the level of the scheme cap is more appropriate to guard against windfall gains. The sharing factor is more appropriate to ensure the right balance of risk and reward between ourselves and our customers."*	We agree with the clarification.
"While the proposed RIIO2 scheme retains the cap and collar structure as a means of risk management, the proposed collar limit has been significantly reduced, so we would expect a material reduction in the associated risk. The reduction is not presented in the proposed scheme's description."	*"We proposed a symmetrical scheme to help ensure balanced focus on risk and reward. We set both the reduced cap and collar at levels we believe are possible, but unlikely to be reached. We don't consider it appropriate to proportionally alter scheme collars dependant on the level of risk and doing such could have significant implications. Further, reducing the collar as proposed by [AFRY] does not reduce the risk, instead it simply reduces our exposure to that risk, with the balance moving to the consumer."*	NGGT provide additional justification. To clarify our original text, "While the proposed RIIO2 scheme retains the cap and collar structure as a means of risk management, the proposed collar limit has been significantly reduced, so we would expect a material reduction in the associated risk to NGGT. The reduction is not presented in the proposed scheme's description."
"NGGT appear also to have significant concerns with the raw forecasts produced because of the two reductions to the raw forecast costs".	*"We'd like to make it clear that we do not have concerns with the raw forecasts which we believe is a robust representation of the risk we expect to manage in RIIO2. We applied reductions as we believe it is appropriate to stretch performance and apply learnings from the*	We accept that NGGT believe that their forecasts are robust, and that the subsequent modifications are a genuine attempt to integrate "business as usual" activity. However, for the reasons set out above in Section 2.1.2.3, we continue to be of the opinion that "business

Quote from AFRY Report	Clarification from NGGT	Response from AFRY
	previous price control period of the level of risk we managed without the need for commercial action. This is entirely consistent with the principles we have adopted in the design of all proposed RIIO2 ODIs, whereby the targets proposed ensure we must go beyond business as usual to generate reward."	as usual" activity should be integrated into the Network Capability process rather than applied ex-post. In particular, we that note Figure 3 in the NGGT Draft Determination Response Annex[13] includes a capability figure that appears to be calculated on a weekly basis, which indicates that at least for historical perspective more dynamic capability metrics are available.

Source: AFRY, after NGGT.

2.2 Network Capability

NGGT provides commentary on our Network Capability Report in their Draft Determination Response Annex on Network Capability[14]. NGGT's response is provided as follows:

- commentary on two of three particular findings (identified as 'weaknesses' by Ofgem[15]), namely:
  - within-day flow assumptions; and
  - pressure assumptions; and
- commentary on some of the impacts we have assessed.

In addition to this, NGGT commissioned an independent report by FTI in respect of the third 'weakness' regarding assumed prices. This section addresses the Network Capability response.

Broadly, our Network Capability report concluded that the Network Capability process and supporting documentation appeared to be helpful to add transparency to what is a very complex set of analyses, and a good basis for investigating the relationships between forecasted user requirements and network capability, but that there are some elements that may require deeper analysis by NGG in order to provide confidence in the presented outcomes. We highlighted concerns with:

[13] Available in the public version at https://www2.nationalgrid.com/uk/gas-transmission/uk/gas-transmission/document/132941/download
[14] Public version available here: https://www.nationalgrid.com/uk/gas-transmission/document/132936/download
[15] See paragraph 2.138 of Ofgem's DD in respect of NGGT. Available at: https://www.ofgem.gov.uk/system/files/docs/2020/07/draft_determinations_-_nggt_annex.pdf

- network analysis assumptions regarding within-day flow patterns;
- network analysis assumptions regarding pressures;
- assumptions regarding the price paid for effecting constraint management actions;
- the choice of model for interpolating between or extrapolating from network analysis results.

We recommended that Ofgem should require NGG to undertake additional analysis to provide an understanding of the sensitivity of network capability to these underlying assumptions.

In respect of NGGT's response:

- NGGT has provided some additional evidence that alleviates some, but not all, of our concerns regarding within-day flow pattern assumptions.
- NGGT has provided clarification regarding the choice of model for interpolating between and extrapolating from network analysis results and additional evidence which alleviates our concerns.
- Whilst the response regarding pressure assumptions mitigates some aspects of our concern, we are still concerned that the pressure assumptions used do not reflect operational reality and may not be appropriate.
- Our analysis of the assumptions regarding the price paid for effecting constraint management actions was incorrect, however following clarification from NGGT, additional analysis (provided in Chapter 3) reinforces our original concerns.

So, whilst some of our concerns have been addressed by NGGT, there are still some elements that may require deeper analysis by NGG in order to provide confidence in the presented outcomes.

2.2.1 Assumptions in the network analysis models regarding within-day flow patterns

In respect of the within-day assumptions made by NGGT, we observed that: "*for entry, as the approach only considers backloading and disregards any coincident frontloading, it is likely to be overstating an average requirement for within-day flow; for the power-sector, the approach does not filter out those situations which are otherwise considered as un-forecasted within-day change (e.g. for a sudden loss of wind generation), which may mean that some historical observations are double-counted; and for GDNs, the approach assumes that all GDNs simultaneously demand all of their capacity rights.*" We concluded that these assumptions impacted on the reliability of the analysis and that NGGT may therefore understate network capability.

NGGT includes some additional evidence and discussion considering the impact of their within-day assumptions. Firstly NGGT considers how the within-day assumptions across all entry points might impact capability, then NGGT considers how within-day assumptions at local entry points might impact capability, then NGGT considers exit assumptions for power stations and GDN offtakes. We address each of these points in turn.

2.2.1.1 Entry backloading, national

Transmission Planning Code

NGGT quote page 68 of the Transmission Planning Code (TPC):

"Increasing within day flexible behaviour however, and in this case a growing tendency to backload supplies within the gas day, has led to the need to revise this approximation and explicitly model within day supply profiling, in addition to flat supplies. The aim of this section then is to describe National Grid's methodology for calculating such profiles for use within network analysis."

We are unable to locate that precise quote. The version of the TPC[16] which we have relied on in our analysis is dated December 2019, and includes similar text at page 63:

"Increasing within-day flexible behaviours and a growing tendency to backload supplies within the gas day, have led the need to revise this approximation. We now explicitly model within-day supply profiling as well as flat supplies. This section describes our methodology for calculating such profiles for use within network analysis."

We assume that NGGT has made a referential error in the quotation and that we are and have been referencing the correct version of the TPC.

Additional evidence

In their response annex NGGT states:

"Subsequent analysis looking at South Wales suggests, through our adopted method, that this national backloading behaviour has a negligible impact on daily Entry Capability. Sensitivity analysis conducted after the audit has tested nationally flat supplies and this has shown no impact to the capability of these sites."

Later, NGGT state:

"We have carried out further research, with reference to the Milford Haven Entry Point using flat supplies at all terminals, and analysis shows the same capabilities as when we used profiled supplies [redacted]*. This work supports our assertion that this change to linepack depletion does not impact the Network Entry Capability at Entry Points."*

This analysis was not available at the time of our examination of the Network Capability process. During the project we had established with NGGT that re-running network analyses would be time consuming and would not be available in the timescales available to us – we reported that "*a number of aspects of the process are resource intensive making iterative recalibration*

[16] Available here: https://www.nationalgrid.com/uk/gas-transmission/document/128221/download

difficult". Our Network Capability report recommended that, "*Ofgem require NGG to undertake additional analysis to provide an understanding of the sensitivity of network capability to these underlying assumptions*".

We note that the additional evidence only relates to South Wales entry capacity, although we accept that this represents the majority of the forecast constraint risk. We now accept that, on its own, general entry profiling will have a negligible impact and it may be negligible in the subsequent statistical analysis. However, we consider that this should be considered as part of a broader, cumulative effect of changed assumptions.

2.2.1.2 Entry backloading, local

NGGT states:

"For the Entry zones, where Network Capability is being calculated, maximum flow rates are applied based on historic observations and known site capabilities. This has the effect of 'flattening' the local profiles as we approach maximum capability and significantly reducing the local 'backloading' potential and therefore its effect on the capability value. This assumption was discussed with AFRY, however it does not appear to be reflected in their report."

We acknowledge that this was discussed with us, and accept that, at daily flows which tend towards the maximum daily flow capability of upstream equipment[17], there are fewer opportunities for backloading supplies. However, at the lower network capability levels associated with lower local demand, there continues to be an opportunity for backloading. As NGGT themselves state:

"It is at these lower demands that the majority of Entry Constraints are currently predicted"

We therefore continue to believe that not including coincident frontloading in the generation of within-day profiles could have an impact on the subsequent analysis. We do not know if it is significant because NGGT has not provided any quantification of the impact. As mentioned above, we did not request this analysis at the time, but recommended that Ofgem require NGGT to undertake additional analysis.

2.2.1.3 Exit, power stations

NGGT states:

"From the report alone it was unclear what AFRY's concern was regarding un-forecasted change and 'double counting'."

We stated that NGGT had *"[selected] profiles for selected gas-fired power stations are created from historical observations on the days with highest linepack movements"* and that *"un-forecasted within-day flow possibilities*

[17] Howsoever defined. We note that this could be a real physical constraint either inferred by NGGT from historical observations or directly known, or a contractual restriction.

that are subsequently included in the pressure [cover] assumptions". We noted that the approach (to producing a within-day profile for power generation) did not "*filter out situations which are considered as un-forecasted within day change*".

To clarify, our understanding is that the within-day profiles are generated on the basis of a set of historical observations. Notwithstanding that this is a reduced set of observations relating to days of high linepack movement, we understand this set includes situations where there is a degree of un-forecasted within-day change. These situations are also used in the calculation of "pressure covers", which are also applied in the network modelling. Hence the impact of un-forecasted within-day change is covered twice in the network analysis that is being used to feed a forecast of average operating conditions.

Again, correcting this in isolation may have small, perhaps negligible, impact on network capability, but, i) we do not know if it is significant because NGGT has not provided any quantification of the impact, and ii) the aggregate impact may be more significant.

"However, from discussions at the time we believe this again is primarily related to Exit Capability and has little impact on Entry Capability."

Evidence provided to us during the course of the Network Capability Audit[18] showed that assumptions on exit – specifically, the 06:00 Assured Offtake Pressure (AOP[19]) at [redacted] – provided binding constraints on entry capability assessment. The correspondence contained two charts, shown below in Exhibit 2.5, used by NGGT to demonstrate the constraints that applied within entry capability analysis for Milford Haven. Within the correspondence, AFRY stated it "*can see from the chart that the* [redacted] *AOP forms a constraint*". The response from NGGT did not comment on this statement. As such, throughout our work we have assumed that such exit constraints – profiles and pressure requirements – apply within entry capability analysis.

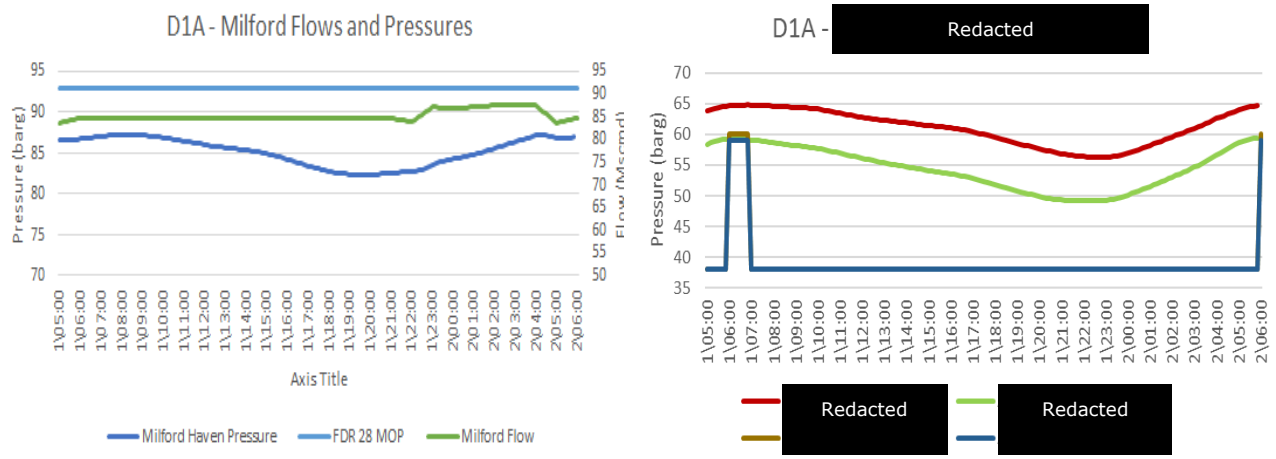
The NGGT statement does not provide new evidence to change our current view that exit constraints may have an impact on entry capability analysis.

[18] This was via a series of email correspondence between Angus Paxton (AFRY) and [redacted] (NGGT), dated 3 Feb 2020 through to 13 Mar 2020.

[19] Assured Offtake Pressure will be abbreviated to AOP. AOP should not be confused with 'agreed offtake pressure' which, in respect of a GDN, is a different concept.

Exhibit 2.5 – Milford Haven pressure constraints

These two charts, copied from NGGT correspondence, show pressures and flow at Milford Haven, and corresponding downstream pressures at [redacted] and [redacted], from a network analysis model. These are placed alongside pressure constraints – maximum pressure (MOP) at Milford Haven, and minimum pressures (Assured Offtake Pressures, AOP) at [redacted] and [redacted] (~59barg). The chart shows that [redacted] AOP forms the binding constraint – additional flows at Milford Haven cannot be accommodated due to the assumption that the 06:00 AOP at [redacted] needs to be maintained.



Notes: D1A refers to Day 1 on an Average Load Curve, and represents the highest demand level that would be expected in an 'average' year.
Source: NGGT email correspondence – [redacted] to Angus Paxton, 17 Feb 2020.

NGGT states:

"Observed power station behaviour impacts within day linepack depletion and our ability to ensure we are able to meet End of Day (EOD) Exit pressures linked to our 1 in 20 supply obligations. This is reflected in a more challenging way at a small number of extremity sites, consistent with ensuring security of supply on Exit. The pressure cover approach is covered later in this document, but the variation with local demand should reduce any double counting effect suggested here."

In light of the above clarification of our report (that there is a link between exit constraints and entry capability), this observation (that there is no double counting) may not be relevant.

In respect of the statement however we note that observed power station behaviour occurs independent of underlying demand levels. We agree that it is appropriate to consider this, and pressure covers, for 1 in 20 peak day planning and security of supply analysis, however it does not follow that the same approach should be used for determining the network capability under non-peak conditions. We understand that *"the variation with local demand"* refers to an assumption that the pressure cover is relaxed at lower local demand levels.

2.2.1.4 Exit, GDNs

NGGT states:

"Exit Capability is predicated on the 1 in 20 peak demand levels, consistent with the Pipeline Security Standard. Being 1 day in 20 years, it is, by definition, an extreme event. Again, the impact of this assumption affects Exit Capability and not Entry Capability directly. Using the level of sold capacity at each Gas Distribution Network (GDN) for our Peak 1 in 20 analysis, which is in line with our methodologies, seems prudent to ensure security of supply under our obligated conditions."

We do not disagree with the approach for peak 1 in 20 analysis.

NGGT then states:

"Away from peak demand, our analysis uses planning data provided by the GDNs in line with the UNC to reflect their Capacity (both Flat and Flex) requirements at lower demand levels."

Our report repeated the understanding that we took from discussions with NGGT that the within-day profiles created for GDN offtakes reflected their NTS Exit (Flexibility) Capacity entitlements.

The above statement is not clear. GDNs hold "Capacity" rights, comprising "NTS Exit (Flexibility) Capacity" and "NTS Exit (Flat) Capacity" pursuant to the Uniform Network Code (UNC) Transportation Principal Document (TPD) section J. These are typically considered as peak-day requirements (although we understand that GDNs' requirements for NTS Exit (Flexibility) Capacity are often determined at levels lower than peak day).

In addition, the GDNs provide additional information, known as "Forecast Offtake Information" and including "Offtake Flexibility Quantity", etc., pursuant to the Offtake Arrangements Document (OAD) section H. This does not constitute capacity.

If the NGGT statement is referencing Forecast Offtake Information, then we may have taken the wrong understanding from the discussions with NGGT. Indeed we note from the TPC that it refers to OAD section H data being used for off-peak analysis.

If it is indeed the case that Forecast Offtake Information is being used to generate within-day profile information then we may need to revise our findings on this point, however we have a residual concern that these profiles are assumed to be required simultaneously. As such, it is not clear to us whether this issue is material or not.

NGGT states:

"[Away from peak demand]… We also use historic agreed pressure information to replicate, where appropriate, agreed lower pressures at DN offtakes."

This statement is inconsistent with the observations regarding [redacted] AOP in relation to Milford Haven entry capability at Day 1 Average (which is not a

1-in-20 peak demand) conditions shown above in Exhibit 2.5. In addition the TPC is clear that AOPs are maintained in network analysis models[20] – *"the following pressure limits will be observed within the analysis … AOP at exit points".*

However, the TPC is not clear that AOPs are supplanted by agreed pressures – *"where [agreed] pressures different to the AOPs are regularly agreed under typical operation, these are considered, alongside AOPs, when assessing efficient operation of the NTS."*

Furthermore, the document describing the network capability network analysis[21] provided to us on 15 Jan 2020 states:

[redacted]

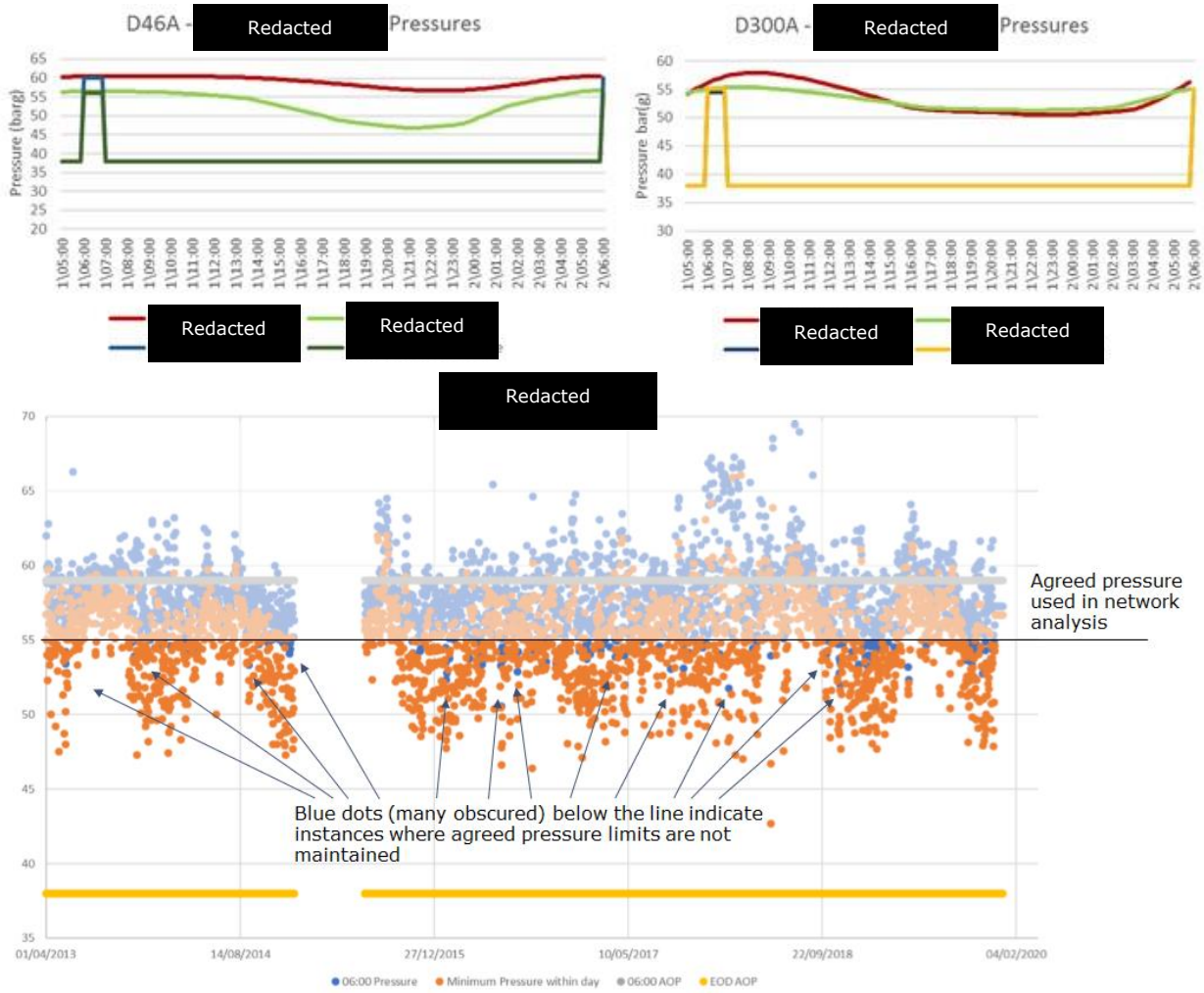
The document fails to mention agreed pressures. We did not seek specific clarification on this ambiguity at the time. However, other evidence provided by NGGT at the time demonstrates that the constraint for [redacted] at other, lower demand levels, was set at an agreed pressure for 06:00 of ~55barg.

Our conclusion in our review was that the minimum pressure levels applied by NGGT in their analysis were not completely representative of normal operating pressures and therefore lead to incorrect results. We based this on evidence reviewed at the time, including that shown in Exhibit 2.6 below. NGGT disputes this conclusion but has not provided additional information to cause us to change our view.

[20] Ibid, footnote 16. Section 6.16, pp29-30.
[21] NGGT "Network Capability Analysis Methodology", v3 Approved, 7 Jan 2020. We have been unable to locate a publicly available version of this document.

Exhibit 2.6 – [redacted] agreed pressure assumption and historical pressures

The top two charts shows the level of the agreed pressure constraint applied in the Milford Haven entry analysis, from which we estimate the 06:00 agreed pressure constraint is 55barg. The second chart shows the historical pressures experienced at [redacted] GDN offtake alongside the agreed pressure. This demonstrates that there are several occasions in history where the 06:00 agreed pressure is not maintained at 06:00 (as indicated).



Notes: Data gap due to NGGT systems change
Source: NGGT

We also note that the process of setting an "agreed pressure" results in their agreement from time to time: NGGT are free to request downward revisions and GDNs are required to agree where the GDN considers it does not materially prejudice the safe and efficient operation of their network. This could mean that there are AOPs or agreed pressures which form binding constraints within the network analysis which, under the conditions being tested via the rest of the Network Capability process (i.e. the points in the "Toby Space"[22]), GDNs could agree to reduce.

[22] "Toby Space" refers to the large set (~350,000 per FES scenario per year) of potential supply and demand conditions used within the Network Capability analysis.

We acknowledge that it would be impractical to seek to agree different pressures for each point examined in the Network Capability process, however it would be straightforward to examine the sensitivity of network capability to reductions in the assumed pressures at locations where history suggests this is possible.

Again, considering this issue in isolation may have small, perhaps negligible, impact on network capability. We identified this as a potential issue in our analysis and noted that it would require additional analysis.

2.2.1.5 Requirements for pressure

Our report states, *"we would expect relaxed assumptions on pressure to yield greater levels of network capability. Despite information on the magnitude of relaxing this assumption being requested from NGG we have received no information and therefore cannot say whether it has a material impact on the Network Capability assessment."*

NGGT states:

"There are different pressure assumptions for Entry Points and Exit Points. The Entry Point pressures are linked to Maximum Operating Pressures (MOP) at the specific facility and are typically 1 barg below this level, to allow for any pressure fluctuation in upset conditions. These are predicated on the physical assets at the site. As a reasonable and prudent operator, we do not believe that we should alter these values and operate closer or at the MOP."

We note that we have not commented on the use of entry pressure constraints in our report.

To test the robustness of this response, evidence could be requested from NGGT to state, for each entry point, what the specific pressures that are used in the analysis are (we understand these are operational "alarm pressures"), and the history of pressures at the location.

We requested historical pressures from NGGT[23]. NGGT declined to provide the information. In their response they stated, [redacted] This evidence suggests that the alarm pressures can be breached without requiring subsequent commercial action.

However, we understand that TFAs are a physical tool that is used as one of the last resorts in physical control and that it would ordinarily be the case that commercial action would have been taken beforehand. As such, we accept and acknowledge the point, although it has no bearing on our report.

[23] Email from Angus Paxton to [redacted], 18 Feb 2020.

NGGT goes on to state:

*"For Exit Points, there are, as AFRY point out: '*Assured Offtake Pressures (AOP) are the rights to pressure that have been secured by GDNs. Anticipated Normal Operating Pressures (ANOP) are the pressure levels, indicated to network users, that are anticipated to be normally available. Both AOP and ANOP are defined in the Uniform Network Code*.'*

When conducting Entry Capability analysis, an Agreed Offtake Pressure is used for Exit Points at demand levels where these have historically been agreed. These points are where, historically, the Gas Control Room has consistently been able to agree, with the customer, lower pressures than the Assured Offtake Pressure when required (as described in the Transmission Planning Code). This process is also defined in the UNC and the analysis pressures used reflect the pressures historically agreed at equivalent demand levels. These agreed pressures are generally activated on low demand days and so would have no impact on the 1 in 20 requirements of the system's Exit Capability where the Network Capability modelling is performed."

As we note above, operational history demonstrates that such pressures are not always maintained, and the approach disregards the possibility that new agreed pressures could be requested from time to time by NGGT. NGGT's statement therefore does not lead us to change our conclusions.

2.2.2 NGGT's commentary on impacts

2.2.2.1 Definition of Network Zones

Our report stated, "*the partitioning of the network into zones is a requirement of the process and their definition is based on the network topology, geography and whether entry or exit capacity is being modelled. It is unclear how different partitions effect the results.*"

NGGT states:

"The creation of the regional Exit and Entry Zones is arranged around key infrastructure assets (location of supply terminals, pipe lines, compressor stations and key demand centres). The zones best reflect how gas flows within the network based on experiential judgement. AFRY's summary of it being 'unclear how different partitions effect the results' is unhelpful without some supporting evidence on how they would propose altering the partitions and in what way it would affect the results."

It was not our remit to provide evidence – we have referred only to evidence provided by NGGT. As the evidence did not include any analysis to explore whether different partitions affect the results, we were unable to confirm whether alternative partition definitions would affect the results.

2.2.2.2 Network capability requirements assumptions

Selection of Toby Space distributions

Our report stated, *"Ultimately, these [Toby Space] statistical distributions rely on expert judgement. Though, in general, the choice appear well-founded, the decision is not always supported by numerical tests. If alternative assumptions had been made, this could lead to results which may change the outcomes (i.e. changed constraint cost forecasts, changed CBA outcomes."*

NGGT states:

"Where we use statistical distributions to generate the range of supply and demand forecasts in 'TobySpace' (a data set reflecting probable ranges of supply and demand), a combination of expert judgement and numerical tests are used. Each year we validate whether the distributions used the previous year are still the best fit by back testing against historic data. This is done by numerical testing in our statistics packages. We also create several iterations of a set of specific forecasts and see which of these produce the most sensible forecasts, using our experience. If the numbers in the test are close, inconclusive or any change could be said to be down to unusual recent historic behaviour, and unlikely to be part of sustained long term change, then we use our expert judgement along with information from Energy Insights to make informed decisions on whether to change the distributions used."

This additional explanation provides reassurance and supports our conclusion that the choice appears well-founded.

Weighting and amalgamation of FES scenarios

Our report stated, *"Examples of the inputs include the overall supply/demand patterns and the rate of depletion of supplies from the UKCS. Different scenarios will lead to different utilisation levels of assets and a number may become redundant in different scenarios. In particular, in Consumer Evolution in 2030, the Intact Entry Capability will be ~25mscm/d above the Toby Space points, while in Steady Progression, the Intact Entry Capability line remains close to the Toby Space points. It is anticipated therefore, that there will be markedly different constraint costs in each scenario. However, in the constraint risk forecasting methodology, a probability is associated to each, leading to a single set of constraint cost forecasts for each of the RIIO2 years. This assumption is likely to overstate requirements in the long-run and could impact the network capability requirements as well as the CBA results."*

NGGT states:

"We assume an equal likelihood of each FES scenario occurring. Axiomatic to FES is to capture the full range of plausible future energy pathways out to 2050. We have applied equal weighting precisely because we do not know what is more likely to happen – and we are just as likely to understate rather than overstate. If we had picked a scenario then AFRY's point would have more bearing. We create a full TobySpace dataset for each scenario and then

we sample from those equally. For RIIO2's 5-year period, there is minimal difference in the 2018 FES and TobySpace scenarios. Consequently, there is little over or under statement in any case and the post 2030 constraints, for the compressor cost benefit analyses (CBA) were not significantly impacted by this assumption."

We acknowledge the intent of FES is to define a series of four plausible future scenarios that describe an envelope of possibilities, and that these are given equal weighting in the constraint risk forecasting process.

Our original text was not clear. We were trying to communicate that providing network capability for all four FES scenarios, simultaneously, is likely to overstate physical requirements because not all four FES scenarios will coincidentally materialise. On reflection, we consider this point to be minor because it unlikely to significantly impact constraint risks within RIIO2 timescales.

Additional weighting for high South Wales flows

Our report stated, *"This assumption has been based on expert judgement. Any additional weighting will lead to increases in constraints and constraint costs. The impact of the assumption depends on the confidence of the judgement applied."*

NGGT states:

"The application of expert judgement is part of the added value that we bring to the energy industry and whilst we accept fully that 'The impact of the assumption depends on the confidence of the judgement applied.' is true but no alternatives to expert judgement are suggested."

We accept and acknowledge the high degree of expertise within NGGT. In line with our scope we were flagging where some subjective adjustments are made that we were unable to definitively assess.

"We feel that the comment 'will lead to increases in constraints and constraint costs' is not strictly speaking correct. The uniform distribution, [chosen…to reflect absolute uncertainty], is just as likely to predict low Milford Haven flows as it is to predict high Milford Haven flows. We believe the longer term historic element also more closely reflects the historic flows that have been observed but are not commonly seen in the FES predictions."

The likelihood of the FES scenarios predicting high South Wales flows is less than the likelihood of the Uniform distribution predicting high South Wales flows. Introducing the Uniform distribution to the combined analysis therefore adds additional weighting to the likelihood of high South Wales flows. This leads to higher number of constraints and constraint costs.

These additional costs are isolated in the table "Delta between average South Wales Combination forecast with and without uniform (£m)" (Figure 30) in the December Business Plan Annex A3.03 (public domain and confidential versions).

2.2.2.3 Network capability analysis assumptions

Network configuration continues in an analogous manner to current practise

Our report states, *"The Network Capability Analysis used in the assessment of the Boundary Curves follows the TPC, and the results are quite tightly linked to the pressure bounds of the network defined by the TPC. Should there be changes to pressure covers then it is expected to have direct implications to the network capability."*

NGGT states:

"Entry pressure cover is used to reflect operational compressor usage and is not applied in a way that restricts an Entry Point Capability. On Entry we apply a limit of 1 barg below the Maximum Operating Pressure of the pipe, as per the Safety Case. It is Entry capabilities based on this approach that feed into the overwhelming majority of constraint Management costs (~97%). It is not typically the case that maintaining Exit pressure cover has the effect of restricting Entry Capability and no forecast Entry Capability shortfalls are the result of maintaining Exit pressure covers."

We address this statement in Sections 2.2.1.4 and 2.2.1.5 above.

Consideration of compressor trips in the Compressor Availability assessment and the pressure cover

Our report states, *"The impact of considering compressor trips both in the pressure cover as well as in the Compressor Availability assessment used in the CBA (see Section 3.5) would lead to an underestimation of the network capability. However, the number of days of outage in a year due to Minor trips is small in comparison to Medium, Severe and Critical outages. Therefore it is expected that the implication would be small."*

NGGT states:

"AFRY state that the impact of the assumption 'would be small' but its anticipated magnitude is given as 'Moderate'. The above assumption is correct, but the pressure cover referred to is only applied to Exit Capability, where we are considering the 1 in 20 capability, in the event of an unplanned outage of a compressor unit. We do build in a level of security, because we are dealing with extreme events which allows for unplanned compressor trips and therefore the pressure cover level gives the Gas Control Room time to react and put in place remedial actions, such as starting an alternative compressor unit. This does not apply to the Network Entry Capability where a pressure cover is not applied, we believe this is a misunderstanding on AFRY's part."

We acknowledge the ambiguity in our definition of magnitude. We did not misunderstand the situation, although we acknowledge that because this is material only in respect of exit capability, the magnitude is small. This does not impact our conclusions.

Correspondence between gas turbine output changes and pressure cover

Our report states, *"Analysis on historical data has been performed into the changes in gas turbine output. It is noted that this is more likely to happen in the morning and in the early evening. However, the pressure cover is applied throughout the day. This may over-allocate pressure cover and lead to a reduction in the assessed Network Capability."*

NGGT states:

"We believe that this is once again referring to Exit Capability under normal operation and does not impact Network Entry Capability. In our 1 in 20 analysis, we would expect power stations (gas turbines) to be close to or at maximum output and in this case we would apply a lower (or zero) pressure cover to account for gas turbines being unable to increase their flow rate. There are occasions where local GDN Assured Pressures impact capability but, as above, there are no forecast Entry Capability shortfalls as a result of maintaining exit pressure covers."

We can confirm that we were considering exit capability under normal operation, and acknowledge that the pressure cover applied to cover for changes in power station output are lowered. On reflection, and notwithstanding the ambiguity in our definition of magnitude, this clarification allows us to reclassify the impact as minor.

Within-day profiles chosen in the Network Capability Analysis are indicative of constraint day behaviour

Our report states, *"The TPC describes the within-day flows which are used for the Network Capability Analysis. To assess the implication of within-day variations, supply flows accounting for linepack depletion (i.e., those backloading) are considered; while a proportion of those frontloading is ignored. This will reduce the network capability and impact the number of times a constraint occurs and the magnitude of the constraint."*

NGGT state:

"As supplies get closer to their daily maxima so their within day profile potential becomes flattened. We have carried out further research, with reference to the Milford Haven Entry Point using flat supplies at all terminals, and analysis shows the same capabilities as when we used profiled supplies [redacted]*. This work supports our assertion that this change to linepack depletion does not impact the Network Entry Capability at Entry Points."*

We discuss this point in Section 2.2.1.1 above.

2.2.2.4 Constraint cost evaluation assumptions

Fitting of statistical distributions to the number and magnitude of the constraints

Our report stated, *"This can mean that the statistics defining the shape parameters may be inaccurate … they may lead to a constant error factor."*

NGGT provides some additional explanation of the statistical sampling undertaken and states:

"We do not understand how this would lead to a "constant error factor" as we do not apply a statistical correction which would lead to such an error factor."

The use of the term 'constant' is perhaps misleading. We would like to clarify our observation: the selection of a probability distribution and its relevant parameters (i.e. Poisson and mean for frequency, various others for magnitude) is sensitive where they are being fitted using a small number of samples. So, where there is a small number of constraints returned from the intersection of the boundary curve and the Toby Space, there is a lower confidence that the statistics returned from either of the two chosen probability distributions are accurate. This may produce an error term in the output statistics.

However, to further expand the observation, we note i) that we would not expect bias in these errors – outputs are just as likely to be understated than overstated, and ii) we would expect the largest errors to occur at the lower levels of risk – i.e. where there are a low number of observations of constraint. We therefore revise our conclusion on this matter.

(Under this heading NGGT go on to highlight some additional evidence in respect of a sensitivity on South Wales entry network capabilities. These are discussed in Section 2.1.2 above).

Fitting of functions to form a boundary curve

Our report stated, *"There are a small number of data points associated with the Boundary Curve which makes successful curve fitting difficult. There are further assumptions such as a smooth curve is the best fit to the data points. A large discontinuity could impact the constraint costs, which may affect CBA outcomes."*

NGGT provide additional evidence to support the use of a quadratic curve in respect of South Wales entry capacity. This is helpful and supports our assessment that this presents a minor impact.

Coincidence between compressor availability and demand days

Our report stated, "*The compressor unavailability assessment includes repair times and maintenance times. Each is unified in the development of the compressor units availability statistics. The Boundary Curves are defined by the number of units available and Monte Carlo simulations based on availability statistics. It is unknown how results will differ if modelling*

accounted for the scheduling of maintenance at times of reduced constraint risk."

NGGT clarify that within the network capability assessment, it is assumed that 75% of compressor maintenance is scheduled at times when the compressor is not required. This is a helpful clarification and supports our assessment that this would present a minor impact on network capability.

2.2.2.5 Investment decisions, CBA and Capability Targets assumptions

Assessment of prices in the constraint methodology

Our report states, *"The cost of the constraints depends the price associated with a locational buy or capacity buy back. It is assumed that these are at 60p/therm in the Business Plan. This can affect the CBA results. However, in the CBA, sensitivities around the costs are performed to inform on what investment decisions are made. Therefore changes in the assumptions on price are unlikely to effect the network capability."*

NGGT states:

"this point is factually incorrect and is probably due to a misunderstanding on AFRY's part that was not picked up during discussions. 60 p/them is used as a base price and a [redacted] discount is applied to locational sell actions because we assume that if we need to do a buy action, we will do it at [redacted] of the base price. This process is laid out in our methodology statement."

We recognise that we interpreted the price for locational actions incorrectly.

In reviewing NGGTs response we revisited the documentation provided during the project, which has i) highlighted the ambiguity that led to our misunderstanding, and ii) demonstrated an additional feature of NGGT's analysis with which we have concerns. These additional concerns are discussed Chapter 3.

Comparison of compression investment options

NGGT provide further clarification regarding the assessment of the options for Wormington compressor. We acknowledge that the assumption is that neighbouring stations are 100% available.

NGGT states:

"The decision not to include the constraint risk for loss of compression at any other site was made because … both sites have on-site backup and high levels of availability … [and] the high resource requirement to assess the Network Capability for all the different combinations of compression across multiple sites would give little benefit given the availability expectation for those sites."

This supports our assessment that this would present a minor impact on network capability, however we remain keen to highlight the assumption as

future applications of the methodology may require investment decisions between compressor stations.

Balance between expert opinion and CBA results

NGGT agree with our assessment.

2.2.2.6 Network capability assessment cycle implications

NGGT agree with our assessment.

2.3 FTI report

We have reviewed the additional FTI report that accompanied NGGT's response documents. The majority of the points contained therein have been addressed above.

2.4 Minor factual inaccuracy

In revisiting our report, we have spotted an additional minor factual inaccuracy. On page 21 of our CCM Incentive report, we describe locational sell actions at Pembroke Power Station and Milford Haven[24] as costs whereas they represent revenues to NGGT. This does not impinge on our conclusions, which are further supported by additional analysis presented in Chapter 3.

[24] Detailed in SQ56.

3 Additional understanding

This chapter considers additional understanding that has been gained following NGG's DD response.

3.1 Assumptions on the prices for resolving constraints

3.1.1 Effect of assumptions

The December BP states that the BEIS fossil fuel price of 60p/th is used for costing constraints. As established in Section 2.2.2.5, locational sell actions are priced at [redacted] of this (i.e. they generate revenues of [redacted]p/th[25]), and counter-locational buy actions are priced at [redacted] (i.e. cost [redacted]p/th).

The December BP states, "*For Entry capacity constraints, we currently assume that 50% of constraints will be resolved through capacity buy backs, 50% will be resolved through locational sell actions and 50% of those locational sell actions will require a counter locational buy action.*"

This means that half of location sell actions generate a revenue of [redacted]p/th, and the other half of locational sell actions generate both a revenue of [redacted]p/th and a cost of [redacted]p/th. This means that the average cost of a locational action is [redacted]p/th (i.e. [redacted]).

As NGGT assume that 50% of all constraints are managed through the use of buy-back – which is a relatively large volume multiplied by a relatively large price – we expect that the vast majority (over [redacted][26]) of constraint costs forecast relate to buy-back, and the costs of locational actions are negligible.

Consider the ratio of these three numbers - buy-backs (50%), locational sell actions alone (25%), and locational sell actions that are accompanied by

[25] These are revenues to NGG, although represent a cost to consumers, as the volumes of gas are ultimately offset by volumes of gas bought at market prices by NGG at other times and carried by changes in linepack.

[26] Assuming equal volumes, locational action costs would be [redacted]% [redacted] of total, however buy-back volumes are higher than locational action volumes which further concentrates the influence of buy-backs on total forecasted costs.

locational buy actions (25%). As locational sell actions generate a revenue to NGGT, it is theoretically possible to select a different ratio at which the forecasted cost of constraints is zero.

This observation leads us to consider whether the assumptions regarding the balance between locational actions and buy-backs are appropriate for producing constraint cost targets.

3.1.2 History of constraint actions

In this section we consider the financial impact of constraint actions and their type.

We note that buy-backs have not been used as a constraint management tool since July 2006. All constraints since then have been managed through the use of cost-free scale-backs (discussed in 2.1.2.3 above), and locational sell actions.

Recent history

We note that recent constraint management actions at Milford Haven have all used locational sell actions, and that these have generated revenues for NGGT at prices of 21p/th, 11.2p/th, 8.1p/th and 5.3p/th for 20 January, 18 April, 20 April and 21 April respectively. This is an average price of 10.9p/th.

These figures compare against System Average prices of 28.7p/th, 15p/th, 9.3p/th and 10.8p/th respectively.

RIIO1 period

Prior the recent history, two locational sell actions were used at Pembroke Power Station to manage Milford Haven entry capacity constraints. Both of these actions occurred on the same gas day, generating revenues for NGG. They were effected at an average price of [redacted]p/th against a SAP of [redacted]p/th.

Prior to RIIO1

We understand that the last buy-back action taken by NGGT was in July 2006 in relation to the shutdown of a pipeline to enable the tie-in of a new pipeline[27]. The constraint lasted for several days, and involved buy-back and locational sell actions at St. Fergus and Teesside as well as locational buy actions at Bacton. The average buy-back price was 32.2p/th, and the constraints resulted in a significant cost (£28m) which was recovered from consumers.

3.1.3 Analysis

Given the history, we have reservations with the assumption that 50% of future constraints will need to be managed with buy-backs. All constraint management actions over the RIIO1 period relate to South Wales entry capacity constraints, and they have all been resolved through the use of

[27] NGGT presentation available here: https://slideplayer.com/slide/4467403/

locational sell actions. An assumption of 0% would be indicated by the RIIO1 history. Nevertheless, the July 2006 constraints demonstrate that buy-backs can have considerable impact when they are required.

Neither of the assumptions for the proportion of constraints that require a buy-back, 0% or 50%, seem tenable. It seems sensible that some allowance for possible buy-back situations should be catered for in the incentive mechanism. In the event that substantial, expensive buy-backs are required to manage realised constraints, the scheme could potentially be re-opened to adjust the target to reflect the emerging reality.

We recommend that Ofgem and/or NGGT explore a different assumption regarding the proportion of constraints that is met by buy-backs.

3.2 Recalibration

3.2.1 Target costs

Considering the discussion in Section 3.1 and Chapter 2, we identify a possible way of recalibrating the incentive cost target parameter to reflect the new information.

The issues discussed distil to two observations:

1. The robustness of the assumption that 50% of entry capacity constraint constraints requiring buy-backs.
2. Concerns regarding detailed network analysis assumptions.

We consider these below.

3.2.1.1 Impact of changing the proportion of buy-backs

A lower assumption on the proportion of buy-back impacts on the constraint cost forecast by reducing the total volume of buy-back, but increasing the total volume of locational actions.

Consider a constraint cost that comprises 100 units of buy-back volume (at 60p/th) and 40 units of locational action volume (at [redacted]p/th). The total cost of constraints is £[redacted]. If we modified the assumption on the proportion of buy-backs to 5%, we would expect the total volume of buy-backs to fall to 10 units (5%/50% * 100 units), and the total volume of locational actions to increase to 76 units (95%/50% * 40 units), and the total cost of constraints to fall to £[redacted] which represents [redacted]% of the original cost.

3.2.1.2 Mitigating network analysis concerns

We note that our concerns regarding network analysis assumptions are partly mitigated by the additional analysis in respect of South Wales entry constraints.

The residual unmitigated components relate to:

- the use of a 5% increase in capability rather than a 4mcm/d increase; and

— the impact that changed assumptions would have on constraint cost forecasts for South East Entry and South East Exit.

In respect of the former component, as noted above in Section 2.2.1.3, at lower demand levels 5% additional capability at Milford Haven is expected to represent 2mcm/d, at higher demand levels it is more representative of the target 4mcm/d. We anticipate that the decrease in constraint actions is 75% of the decrease expected[28].

For the latter component, we expect that similar levels of reduction in forecasted risk could be achieved by integrating business as usual management.

3.2.1.3 Target calculation

Using the logic describe above, we calculate the following.

Exhibit 3.1 – Possible incentive target calibration

This shows our calculations for a revised CCM incentive target cost, based on i) absorbing similar levels of risk management to SE entry and SO exit as implied by a +4mcm/d network capability at Milford Haven, and ii) then applying a different assumption on the proportion of constraints managed through buy-back actions (5%).

			Formula year commencing					**RIIO-2**
	Source	**Item**	**2021**	**2022**	**2023**	**2024**	**2025**	**Average**
a	BP Annex A3.03 Fig 22	SO Exit, original capability (£m)	6.3	5.8	3.8	3.1	2.2	4.24
b	BP Annex A3.03 Fig 22	SE Entry, original capability (£m)	2.8	5.1	6.8	7.7	10.5	6.58
c	BP Annex A3.03 Fig 22	SW Entry, original capability (£m)	30.7	32.6	35.8	41	44	36.82
d	ODI response annex p11	SW Entry, revised capability at +5% (£m)	[redacted]					
e	*(c-d)/c, minimum 0*	SW Entry reduction at +5% (%)						
f	*e / 0.75*	SW Entry reduction at +4mcmd (%)						
g	*c-((c-d)/0.75)*	SW Entry, revised capability at +4mcmd (£m)						
h	*a * (1-f)*	SO Exit, revised capability (£m)						
i	*b * (1-f)*	SE Entry, revised capability (£m)						
j	*Reduction calculations*	Reduction for a 5% BB proportion (%)						
k	*g * j*	SW Entry, revised capab, revised BB (£m)						
l	*i * j*	SE Entry, revised capab, revised BB (£m)						
	h+k+l	Total target						

Note: Reduction calculations have assumed 100 parts buy-back volume (i.e. buy back from baseline to capability) to 40 parts locational action volume (demand for capacity to capability).
Source: AFRY calculations based on NGGT data and AFRY assumptions.

3.2.2 Caps and collars

We do not have sufficient information to suggest the levels of caps and collars that would be appropriate for mitigating NGG's risks, however they should be reset to reflect any recalibrated target.

3.2.3 Sharing factors

Again, we do not have sufficient information to suggest sharing factors that might apply. However, we do note that there could be interactions between

[28] This figure is derived from algebra. Assuming network capability is linear and that costs are dominated by buy-back volumes, the change in buy-back volumes is determined by the difference in the areas of two triangles.

the CCM incentive scheme and the Totex incentive mechanism, which could result in distortions were the sharing factors to be different.

4 Final summary

This chapter sets out a final summary with our overall position taking account of their views.

Our original conclusions were drawn on the basis of the information provided to us during our initial engagement and through clarification meetings and SQs. In NGGTs DD response documents, NGGT has provided new information that changes our conclusions in part.

4.1 Network Capability

In respect of Network Capability, our original conclusions were that the Network Capability process and supporting documentation appeared to be both helpful to add transparency to what is a very complex set of analyses and a good basis for investigating the relationships between forecasted user requirements and network capability, but that there are some elements that may require deeper analysis by NGG in order to provide confidence in the presented outcomes. We highlighted concerns with:

- network analysis assumptions regarding within-day flow patterns;
- network analysis assumptions regarding pressures;
- assumptions regarding the price paid for effecting constraint management actions; and
- the choice of model for interpolating between or extrapolating from network analysis results.

NGGTs DD response:

- provides some additional evidence that alleviates most of our concerns regarding within-day flow pattern assumptions;
- mitigates some aspects of our concern regarding assumptions on pressure;
- highlights that our analysis of the assumptions regarding the price paid for effecting constraint management actions was incorrect; and

— provides clarification and additional evidence regarding the choice of model for interpolating between and extrapolating from network analysis results which fully alleviates our concerns.

However we remain concerned that the pressure assumptions used do not reflect operational reality and may not be appropriate for forecasting constraint risk, and we also now consider that the constraint costs forecasted by the network capability process rely on potentially arbitrary assumptions that are not supported by historical observation.

So, whilst some of our concerns have been addressed by NGGT, there are still some elements that may require deeper analysis by NGG in order to provide confidence in the presented outcomes. We originally recommended that Ofgem should require NGG to undertake additional analysis to provide an understanding of the sensitivity of network capability to these underlying assumptions. We continue to support that conclusion.

4.2 CCM incentive

Our CCM report's primary conclusion was that NGGTs proposed RIIO2 incentive was not robust and was not well-justified. We concluded that:

— RIIO1 performance had not been adequately explained by NGGT and that it is not clear that it has delivered value for consumers;

— the forecasted CCM constraint costs were based on underlying assumptions within the Network Capability process which do not reflect typical operating conditions and therefore overestimate the number and magnitude of constraints as well as the associated costs; and

— that NGGT has failed to demonstrate that the proposed scheme delivers consumer value.

Our report also considered that the approaches to accommodating some risk as "business as usual" were not robust.

In respect of NGGT's responses:

— no additional information has been provided to explain RIIO1 performance;

— our conclusions on Network Capability have not significantly shifted;

— we continue to believe that the assumptions that NGGT have relied on to demonstrate consumer value carry a degree of uncertainty which impacts the reliability of that demonstration; and

— we continue to believe that the approaches to accommodating some risk as "business as usual" are not robust.

In the light of clarifications from NGGT we have modified our analysis regarding the proposed reopener mechanism, however this does not impact on our broader conclusions.

4.3 Overall conclusions

We continue to believe that Network Capability process and supporting documentation appeared to be both helpful to add transparency to what is a

very complex set of analyses and a good basis for investigating the relationships between forecasted user requirements and network capability. We remain concerned however that the pressure assumptions used do not reflect operational reality and may not be appropriate for forecasting constraint risk. We also consider that the constraint costs forecasted by the network capability process rely on assumptions on the proportion of constraints that required buy-back which are arbitrary and are not supported by historical observation or other justification.

In respect of ways in which recalibration of the incentive might be contemplated, we note:

1. The robustness of the assumption that 50% of entry capacity constraint constraints requiring buy-backs.
2. Concerns regarding detailed network analysis assumptions.

Using the available data, we suggest a mechanism for accommodating these concerns to generate a revised target. A key assumption will be the proportion of entry capacity constraints that require buy-back actions to resolve them.

TABLE OF EXHIBITS

Quality control

Roles	Name	Date
Authors	Angus Paxton	10/11/2020
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ÅF and Pöyry have come together as AFRY. We don’t care much about making history.

We care about making future.

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