

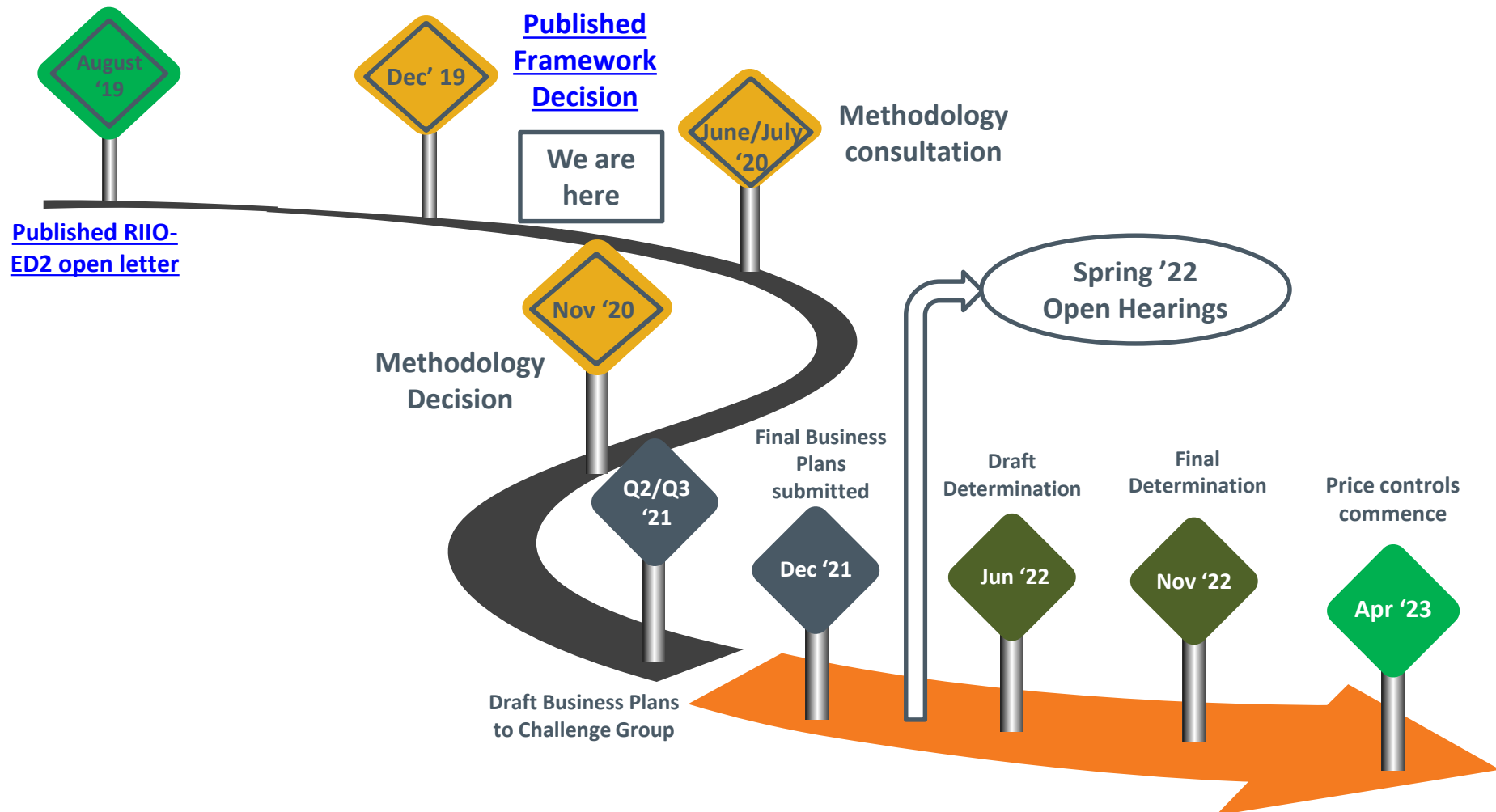
RIIO-ED2

Cost Assessment Working Group – Meeting 4



Electricity Distribution Team
13th March 2020

- Welcome and Introductions: 10:00-10:15
- Review of DNO RAG assessment of ED1 disaggregated models: 10:15-11:00
- Ofgem presentation on GD2 disaggregated models: 11:00-11:30
- ENWL presentation on middle models: 11:30-12:00
- Lunch: 12:00-12:30
- ENWL/WPD presentation on Ofwat's PR19: 12:30-13:15
- NPg presentation on disaggregated models: 13:15-14:00
- Actions, Next Steps, and AOB: 14:00-14:15



- We propose to hold a WG session approximately every three weeks with feedback sessions to make sure all ground is covered and prioritised appropriately.
- We plan to run sessions in the Glasgow and London Ofgem offices.
- Depending on room availability, we may need to restrict the number of representatives that each member organisation sends to meetings of the Group

Date	Location	Summary	Items to cover
14 January 20	London	Introductory session	ToR, Priorities
11-Feb-20	Glasgow	Key principles	
25-Feb-20	London	Totex, BPI & interpolation, Regional and special factors, How it all fits together	Drivers, duration periods, role of history vs forecasts Review totex models
13-Mar-20	London	Role of disagg modelling Uncertainty mechanisms	Review of ED1 and GD2 disagg models PR19 and middle model reviews
27-Mar-20	London	Productivity, frontier shift, indexation, RPEs	
8-Apr-20	London	How it all fits together (again)	
28-Apr-20	Glasgow	CBA development EJP development	

Review of DNO RAG assessment of ED1 disaggregated models

ED2 Disaggregated Benchmarking Review – Feedback from SPEN, UKPN, WPD, SSEN, and ENWL



Methodology for Disag Model Critique

Assessed each individual disag model by the Cost Assessment building blocks

Technique	Score 1 to 3
Sample	Score 1 to 3
Costs (or unit cost)	Score 1 to 3
Cost Drivers (or volume)	Score 1 to 3
Overall Suitability in ED2	Total (max 12, min 4)

Score 1 – Not suitable for ED2 based on ED1 methodology

Score 2 – Suitable for ED2 but with changes

Score 3 – Suitable for ED2 as per ED1 methodology



Responses from 5 DNOS (**SPEN, UKPN, WPD, SSEN, ENWL**) = Score between 20 and 60 for each ED1 disag model

Purpose of these slides;

- View the priority areas for ED1 Disag Modelling and understand whether any DNOs want to take lead in model development
- Understand if there are any new areas which warrant their own BPDT / Disag assessment

Disaggregated Benchmarking Models – DNO Feedback

Suitable for ED2 but with a few adjustments/considerations		Not suitable for ED2 based on ED1 methodology Score 0 - 40	
Table	Table Description	Table	Table Description
C12	BSCs:	CV1	Primary network reinforcement
CV7	Asset replacement	CV2	Secondary reinforcement
CV14	Legal & safety	CV21 and CV22	Losses and environment
CV16	Flood resilience	CV11	Operational IT&T
C2	Connections	CV5	Diversions
CV35	CAIs: operational training and workforce renewal	C4	Non-operational capex: IT&T
C9	Core CAIs	CV8	Refurbishment
CV4	Transmission connection points	CV13	BT21C
CV18	ESQCR	CV15	QoS
CV17	Rising and lateral mains (RLM)	C5	Non-operational capex: property
CV27	Severe weather – 1-in-20	C13	BSC: IT&T
C10	CAIs: wayleaves	C11	CAIs: vehicles and transport
CV29	Tree cutting	C6	Non-operational capex: vehicles and transport
C7	NOC - ST&E	CV3	Fault level reinforcement
CV12	Black start	CV10	Civil works
CV28	Occurrences not incentivised (ONIs)		
CV26	Troublecall		
CV34	Ex-ante smart meter call out costs		
CV30 &			
CV31	Inspections and maintenance (I&M)		
CV6	Diversions: rail electrification		
CV33 &			
CV34	NOCs other		

Suitable for ED2 with no adjustments

Score 60

Table	Table Description
C3	CNI

Priority Areas – Disaggregated Benchmarking

Not suitable for ED2 based on ED1 methodology

Programme area	DNO Comments
Primary network reinforcement (n-2)	How is Flexibility assessed. Modelling to take account of site specific project traits (through EJP?). Very low volumes means low confidence in costs being representative. Consider future network strategy. UCIs to be reviewed. Interactions with NARM
Primary network reinforcement (n-1)	Model retain ability to split out costs associated with civils & other Consider efficiency of delivery as well as efficiency of design Adjustment factor for capacity added Consider if ratio between capacity added and demand growth is correct measure for vol adj Review of how flexibility is treated in determining capacity added
LCT reinforcement	Growth in EVs and Heat Pumps driving additional reinforcement requirements "Touch Once" principles is making network 2050 ready Anticipatory Investment/Strategic Investment Uncertainty Mechanisms/Volume drivers Charging boundaries
Secondary reinforcement	(blank)
Operational IT&T	Alternative drivers to MEAV DSO/Cyber Security impacts Project based method of assessment
Losses and environment	Reflect legislative changes Detail from environmental and innovation pack to be considered

Programme area	DNO Comments
Diversions	Reactive nature of volumes Wider sample of data Forecast data more reliable than historic Volume driver flex arrangements given this is not DNO initiated work
Non-operational capex: IT&T	Not appropriate to use MEAV Difficulty in applying quantitative techniques to non op capex as schemes differ in timing and nature No consistent volume count that can be recorded for IT non-op capex DSO cyber resilience costs
BT21C	Programme completed in ED1
Refurbishment	Lack of consistent 'unit' across each category making it difficult to assess - comparisons invalid Nonsensical to use age based models as these are based on retirement of asset Update based on SDI/Non SDI split Tie in with NARMS/output of Asset Replacement
QoS	Cost assessment to reflect policy position
BSC: IT&T	Not appropriate to use MEAV Expert view to be defined Cyber security and DSO support Ongoing IT&T costs could again be assessed on quantitative basis
Non-operational capex: property	Alternative drivers to MEAV Are historic less appropriate than in ED1 Level of cost depends of property policy of company DSO considerations Economies of scale for larger groups (one head office)
CAIs: vehicles and transport	Lease vs buy approach by DNOs Speed of EV adoption Impact of LA policy Combining CAIs and Non Op Capex will somewhat eliminate bias
Non-operational capex: vehicles and transport	Combining CAIs and Non Op Capex will eliminate bias
Fault level reinforcement	Differing solutions adopted by DNOs Bespoke assessment approach needed Difficulty in establishing a standard unit
Civil works	Unit cost approach flawed No definable 'unit' same works may be undertaken on one through to multiple visits Cost / number of substations to be considered

Disaggregated Benchmarking

Suitable for ED2 but with a few adjustments/considerations

Programme area	DNO Comments
BSC	Not appropriate to use MEAV Need to consider if BSC is same as IT&t to warrant same CA approach
Asset replacement	132kV Unit Costs generalisation Asset Health/Risk (NARMs) should be considered Non like for like solutions Illogical removal of run rates Be wary of unit costs being skewed Take median of population of assets being installed across all DNOs Small sample for DNOs with 20kV/66kV assets Output from CBAs may be different to age based modelling/run rate analysis
Legal & safety	Need to consider if there are any inconsistencies between DNO work content May not be able to compare data Qualitative justification important
Connections	Is use of histoics appropriate? Impact of charging review Available volume data Charging boundaries
Flood resilience	Engineering justification to be considered for any special bespoke arrangements
CAIs: operational training and workforce renewal	Comission a similar study to that in ED1? Impact of emerging workforce diversity policies
Core CAIs	Assessment at more disag level as not all activities driven by MEAV or asset installations Additional costs assoociated with DSO DNO indirect FTEs Better cost driver to MEAV OH Clearances
ESQCR	Levels of activity vary across country, review applicability of using all 13 DNOs

Programme area	DNO Comments
Transmission connection points	Assuming no change in policy Limited number in ED1
Rising and lateral mains (RLM)	N/A
Severe weather – 1-in-20	Is ED1 approach still valid?
CAIs: wayleaves	Alternative cost drivers to network length History may be decent indicator of ongoing costs per DNO Changes in local circumstances may necessitate qualitative element of assessment Differing land values should be reflected in how any UCI is built up
Non Op Capex: ST&E	Consider comparability of costs in ED1 reporting Normalisation adjustment spread across directs No concerns over data consistency therefore role for quantitative benchmarking
Tree cutting	Technique changes to consider ratio approach Tree cutting cycles used to normalise LIDAR to be considered Bundling up c&v overlooks differences in activity-cost relationships More disag approach to be taken Spens infeested more appropriate driver seperate qual/quantitative info on lidar may be appropriate Number of customers protected by tree cutting (risk based approach should be explored)
Black start	Must comply with latest undertermined spec Volume driver linked to a risk level
Occurrences not incentivised (ONIs)	Use of unit cost derived from median and DNO own value allows for variability of work scope Considerations made for cut out reporting across tables ensuring no cherry picking Significant divergence in performance vs allowance in ED1
Troublecall	Unbundling of voltage levels Review ratio benchmarking Tie in with modelling work undertaken by IIS target setting Ex ante / UM which have major bearing on fault performance factored into overall assessment
Ex-ante smart meter call out costs	Should be extended to match govt policy
Inspections and maintenance (I&M)	Asset register volumes over MEAV (as to not give bias to LV) MEAV reasonable driver Cost per asset over cost per activity Subdivide MEAV across voltages and broad asset types Better cost driver than MEAV can be found
Diversions: rail electrification	If reopener consider then method of assessment established upfront Outside totex, or assessed case by case
NOCs other	N/A

Ofgem presentation on GD2 disaggregated models

Mixture of work/activity drivers and scale variables used to model activity level costs

Bottom-up model	Cost driver
Work management	MEAV
Emergency	CSV (80% # customers, 20% # external condition reports)
Repairs	# external condition reports
Maintenance	Maintenance MEAV
Reinforcement	Mains synthetic costs
Connections	Connections synthetic costs
Repex	Repex synthetic costs

Top-down

- Totex
- Includes bottom-up regression activities and other activities

50%
weighting

Middle-up

- Opex
- Capex
- Repex

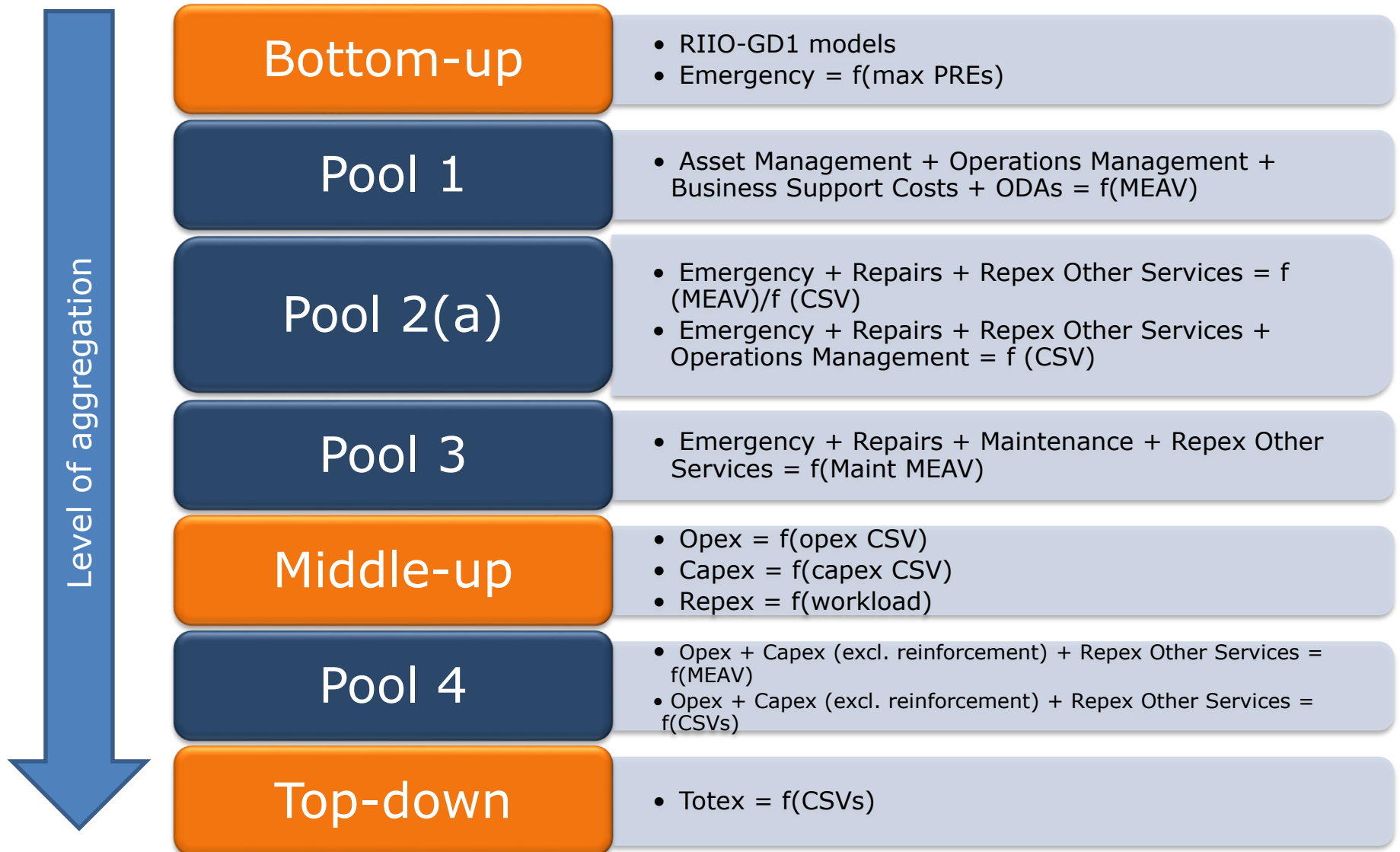
Not used
in FP

Bottom-up

- Work management
- Emergency
- Repairs
- Maintenance
- Reinforcement
- Connections
- Repex

50%
weighting

- **Complementary**
 - Consider activities that staff jointly undertake such as emergency and repairs
- **Cost trade-offs**
 - Consider capex/repex v opex trade-offs
- **Cost boundary complexity**
 - Consider reporting treatment of repex/capex v opex activities (e.g. maintenance)
- **Risk of inaccurate/biased models**
 - Note that adding a 'weak' regression to a stronger regression could reduce the overall strength of the regression



- Estimated coefficients of cost drivers are always statistically significant
- Some bottom-up models exhibit particularly low R^2 values
- Many models fail the non-linearity test (5% significance level)
- Among the estimated models, those using MEAV as a driver generally exhibit poor performance
- Further data adjustments may resolve these issues

ENWL presentation on 'middle models'



Middle model approaches

Cost Assessment WG

13 March 2020

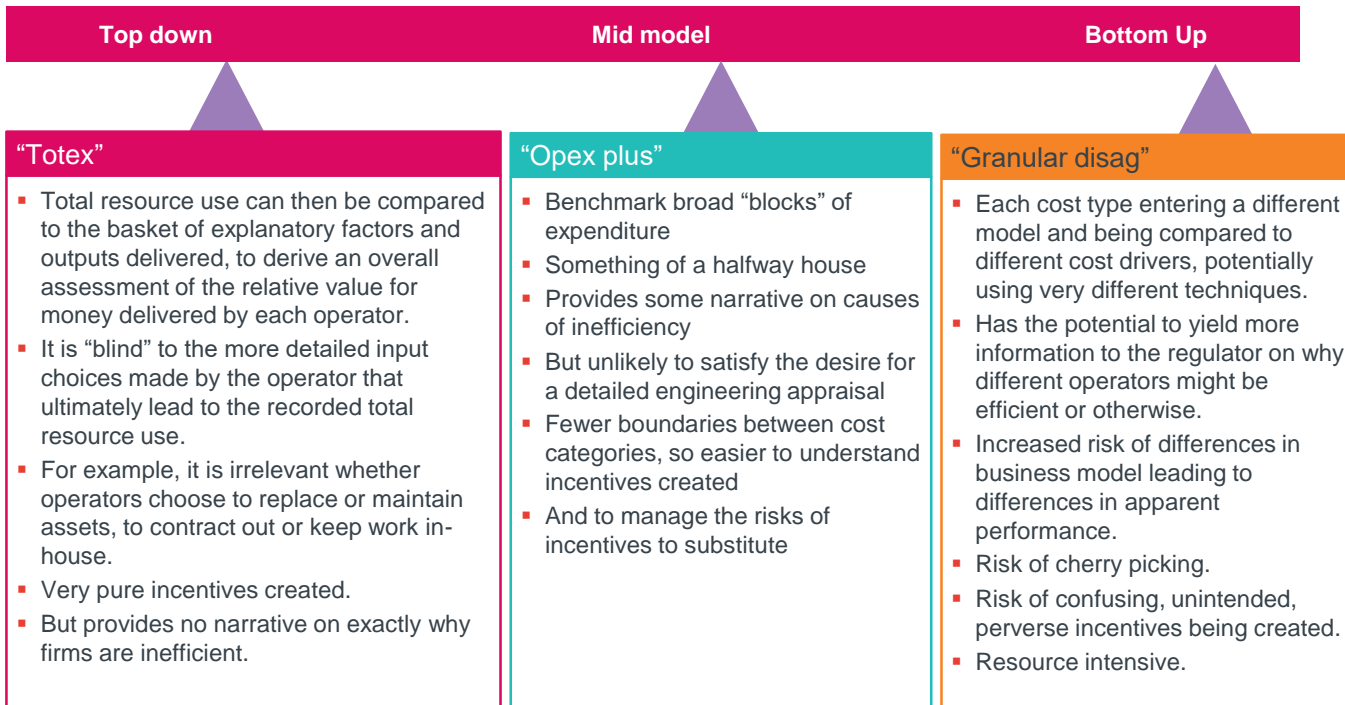
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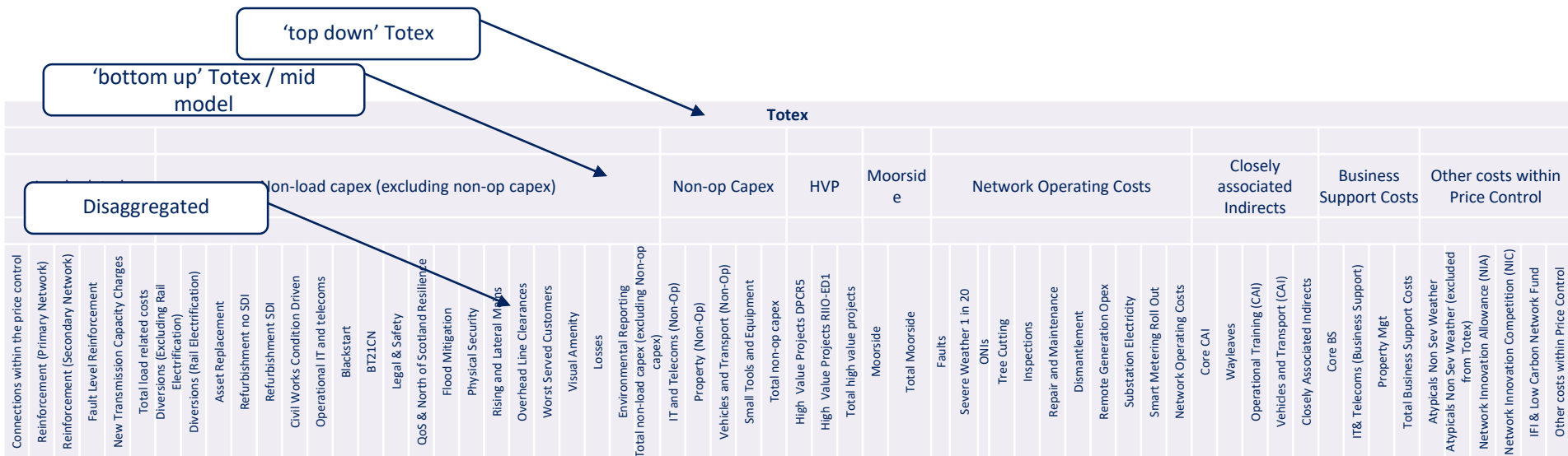


- Mid model is one of the options included in the RIIO Handbook





- Econometric modelling forms a central part of the RIIO cost assessment toolkit
- Cost assessment undertaken at three different levels within the DNO cost base
- Table C1 provides basic building block structure of cost base



Why have a middle model?



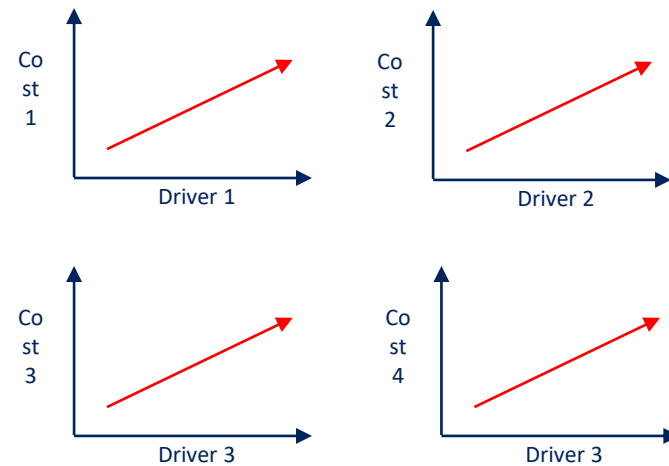
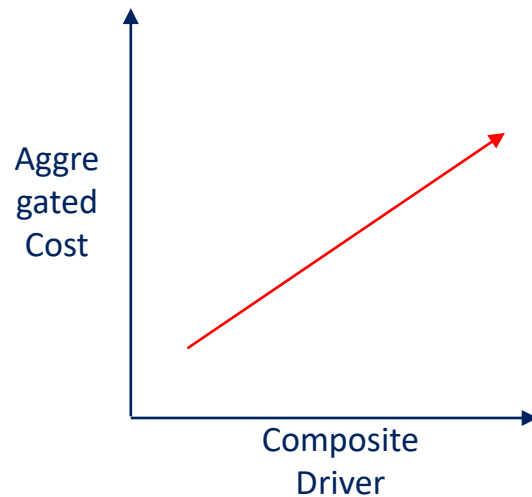
Model	Advantages	Disadvantages
Totex (Top-down)	<ul style="list-style-type: none">• Simple comparative analysis across DNOs.• Largely immune to trade-offs between activities and reporting differences.• Avoids cherry-picking between model.• Focuses on the lowest cost solution to a problem over time in order to deliver the outputs set.	<ul style="list-style-type: none">• Cost drivers limited.• Leads to less intuitive relationship between cost drivers and costs.
Disaggregated (Bottom up)	<ul style="list-style-type: none">• Allows for richer model specification.• More intuitive relationships between cost drivers and costs.• Can better reflect company specific issues.• Allows for flexibility in underlying modelling techniques according to cost grouping under consideration.	<ul style="list-style-type: none">• May lead to sub-optimal overall positions.• Can introduce cherry-picking.• Can lose sight of the wider cost picture.

- Where should the cost assessment land between the two “extremes”?
- A middle model helps to overcome disadvantages of choosing either approach by disaggregating the totex approach or aggregating the disagg equivalent
- ‘Middle model’ terminology was used to describe a ‘bottom up totex model’ and also a family of regression models with individual cost drivers

'Middle Model' approach



- Breaks cost base down into blocks & considers options for respective blocks
- In model form, can either aggregate costs & driver functions into single model, or generate discrete models per cost block and aggregate



Ofgem Slow-Track Model Composition



Totex (Top Down)	Totex (Middle)	Disaggregated (Bottom up)
Regression analysis used to determine efficient costs relative to a composite scale variable (CSV)	Uses regression analysis.	Incorporates a mixture of cost assessment techniques including regression analysis, ratio analysis, trend analysis and technical assessment. The approach is tailored to the activity being assessed.
The CSV was a combination of MEAV and customer numbers, with a weighting of 88% and 12%, respectively	Aggregates drivers used in the disaggregated analysis into a single CSV.	
13 years of data (five years of DPCR5 and eight years of RIIO-ED1).	13 years of data (five years of DPCR5 and eight years of RIIO-ED1).	
Some cost activities excluded.	Some cost activities excluded.	

Weights used for the Middle Model CSV

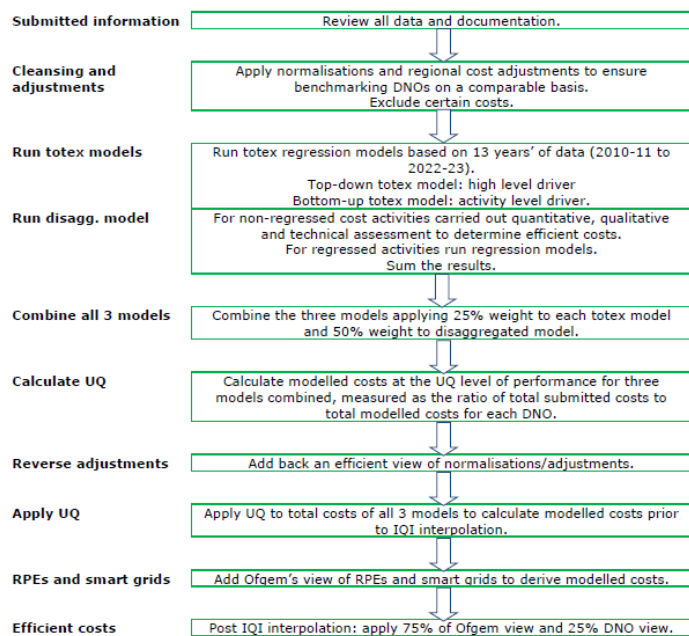
	Activity Area	Identified Driver	Weight
1	Connections	Units distributed	2.9%
2	Diversion	Total length	2.5%
3	Reinforcement	Units distributed	7.5%
4	ESQCR	Overhead LV and HV line length	0.5%
5	Asset replacement	MEAV_SPMWSF	18.2%
6	Refurbishment	MEAV_SPMWSF	2.5%
7	Civil works	MEAV_SPMWSF	2.8%
8	Operational IT&T	Total length	1.4%
9	Non Op Capex	MEAV_SPMWSF	2.4%
10	Legal & Safety	MEAV_SPMWSF	1.5%
11	HVP Asset replacement	Units distributed	0.5%
12	HVP General Reinforcement	Units distributed	0.6%
13	HVP Fault Level Reinforcement	Units distributed	0.6%
14	HVP Legal & Safety	Units distributed	0.5%
15	HVP BT 21st Century	Units distributed	0.4%
16	HVP Other	Units distributed	0.0%
17	Flooding	MEAV_SPMWSF	0.3%
18	Business Support	MEAV_SPMWSF	12.1%
19	BT 21st Century	MEAV_SPMWSF	0.3%
20	CAI	MEAV_SPMWSF	22.5%
21	Losses and other environmental	MEAV_SPMWSF	0.4%
22	NOCs Other	MEAV_SPMWSF	1.0%
23	Tree Cutting	Spans cut	3.1%
24	Black Start	MEAV_SPMWSF	0.2%
25	Inspection & Maintenance	MEAV_SPMWSF	3.9%
26	Troublecall	Total faults	9.5%
27	ONIs	Total ONIs	1.9%
28	Severe Weather 1 in 20	Overhead LV and HV line length	0.3%

- How should a middle model be specified? There can be various approaches to cost aggregation and driver specification.
- Early ENWL ED1 middle model development attempted to accommodate some modelling flexibility within an Excel environment.

Summary ED1 Cost Assessment Approach

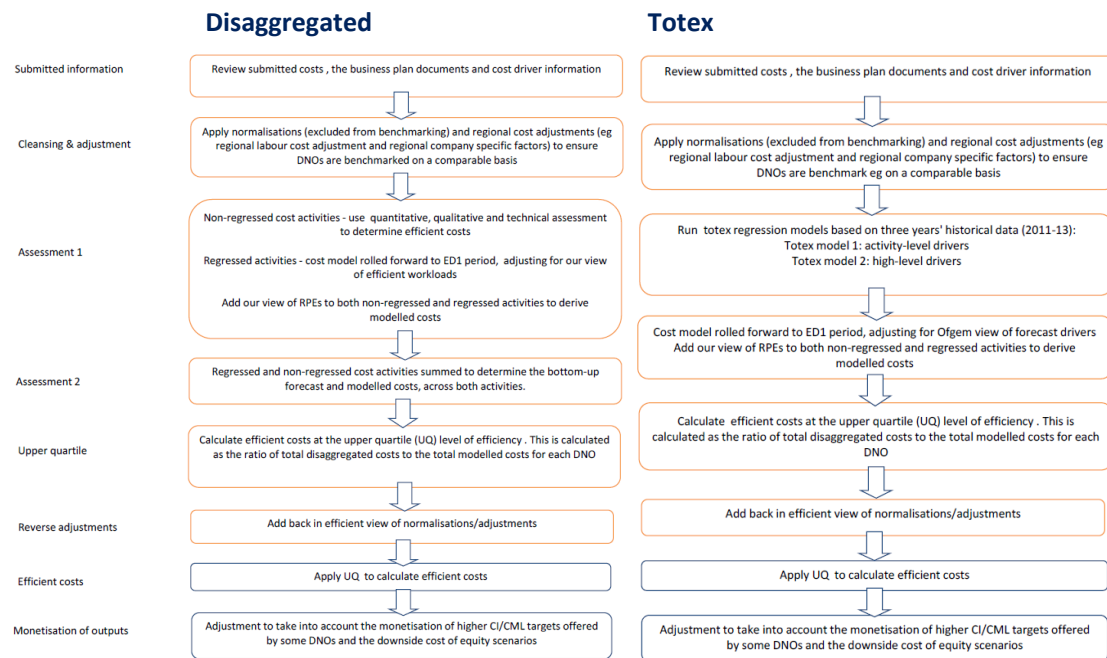


Slow-Track



Model Weighting	
Totex (Top-down)	25%
Totex (Middle)	25%
Disaggregated	50%

Fast-Track



Model Weighting	
Totex (Top-down)	12.5%
Totex (Middle)	12.5%
Disaggregated	75.0%



- Traditional RIIO cost analysis
 - Prime modelling approach
 - Contributor to composite analysis
 - Sense check only
 - Not used
- Non-traditional approach
 - Mid model potentially allows for a different perspective on cost analysis
 - ED1 RIGs brought integrated approach to Costs & Volumes reporting
 - Could use mid model to take a 'rows' perspective rather than previous 'columns' approach
 - Could look at overall network maintenance costs (eg NLR capex + NOCs)
 - Would need to consider interaction with NARMs

Lunch

ENWL/WPD presentation on Ofwat's PR19

Cost Assessment Insights from PR19

Cost Assessment Working Group – 13th March 2020

Agenda

- Objectives/ summary of what looked at
- Background
- General approach
- Cost assessment framework
 - Treatment of costs
 - Base costs assessment
 - Enhancement costs assessment
 - Adjustments including unmodeled costs
 - Framework schematic
- Summary
- Supplementary material

Objectives/ summary of what looked at

- To provide an overview of cost assessment for PR19 and context about the framework for water sector as a whole
- To highlight the decisions that Ofwat made with regards to:
 - Treatment and assessment of costs including aggregation
 - The role of triangulation of cost modelling
 - Treatment of costs outside of core modelling
- Therefore other areas such as regional factors and RPEs are referenced but for brevity can be looked at in more detail in future sessions

...Essentially the facts

Background to PR19 and Water sector

Wholesale controls				Retail controls	
Water resources	Water network plus	Wastewater network plus	Bioresources	Residential	Business (Wales*)
Initial assessment of business plans					
Customer engagement					
Affordability and vulnerability					
Performance commitments and outcome delivery incentives					
Resilience					
Wholesale form of control				Retail form of control	
Total revenue control	Total revenue control	Total revenue control	Average revenue control	Average revenue control	Average revenue control
Direct procurement for customers					
Efficient totex allowance	Efficient totex allowance	Efficient totex allowance	Efficient totex allowance	Efficient totex allowance	Efficient CTS** per customer group
Return on capital	Return on capital	Return on capital	Return on capital	Retail margins	Retail margins
Financeability					
Accounting for past delivery					
Confidence and assurance					

* We will set an average revenue control for all business retail customers in Wales and business retail customers of non-exited retailers in England.

** Cost-to-serve

- 17 companies in Wholesale Water, 11 in Wholesale Wastewater
- Separate control for Thames Wastewater Services – Thames Tideway Tunnel Project
- *business retail customers whose areas are wholly / mainly in Wales and for companies whose areas are wholly or mainly in England that have not exited the business retail market

Background to PR19 cost assessment

The CMA reviewed Ofwat's PR14 models and made the below observations. The CMA developed alternative models to assess Bristol Water's efficient expenditure.

- Use of Totex Models
 - The timing of investment needs
 - The inclusion of enhancement expenditure
 - Lack of more granular benchmarking analysis
- Model Specification
 - The use of the translog functional form
 - The assumed relationship between expenditure and the cost drivers
 - Inclusion of inputs in the explanatory variables
 - Potential missing cost drivers
- Statistical and model estimation issues
 - Number of explanatory variables relative to sample size and variation
 - Relatively short data period
 - Pre-modelling adjustments as alternative to statistical estimation

Background to development of PR19 Cost Assessment Framework

- Because of CMA findings there was a need to run a collaborative process of framework development for cost assessment
- CAWG which ran from Q1 2016 to Q2 2018
- In-house (Ofwat) and third party consultant (CEPA/Vivid economics) and academic advisors (Professor Andrew Smith and Dr Thijs Dekker of the University of Leeds)
- Trial run and 'offline' data collection exercise which was then rolled into standard reporting process (APR) and rationalised for BPDTs
- Consultation on Econometric Cost Models where companies were able to propose models and model forms (382 models received from companies and Ofwat)
- Early submission of special cost adjustment claims – May 2018

General Approach to Cost Assessment at PR19

1. Splitting of TOTEX into base (BOTEX) and enhancement expenditure
2. Emphasis on benchmarking analysis – at various levels of TOTEX
3. Triangulation
4. Upper quartile efficiency benchmark – or better
5. Costs excluded from benchmarking analysis (policy items).
6. Adjustments for special cost factors.
7. Further adjustments outside the main special cost factor process.

8. ... That all feed into the company assessment and categorisation

Cost assessment framework - approach to treatment of costs

- TOTEX framework to remove any bias towards opex / capex similar to ED but different...

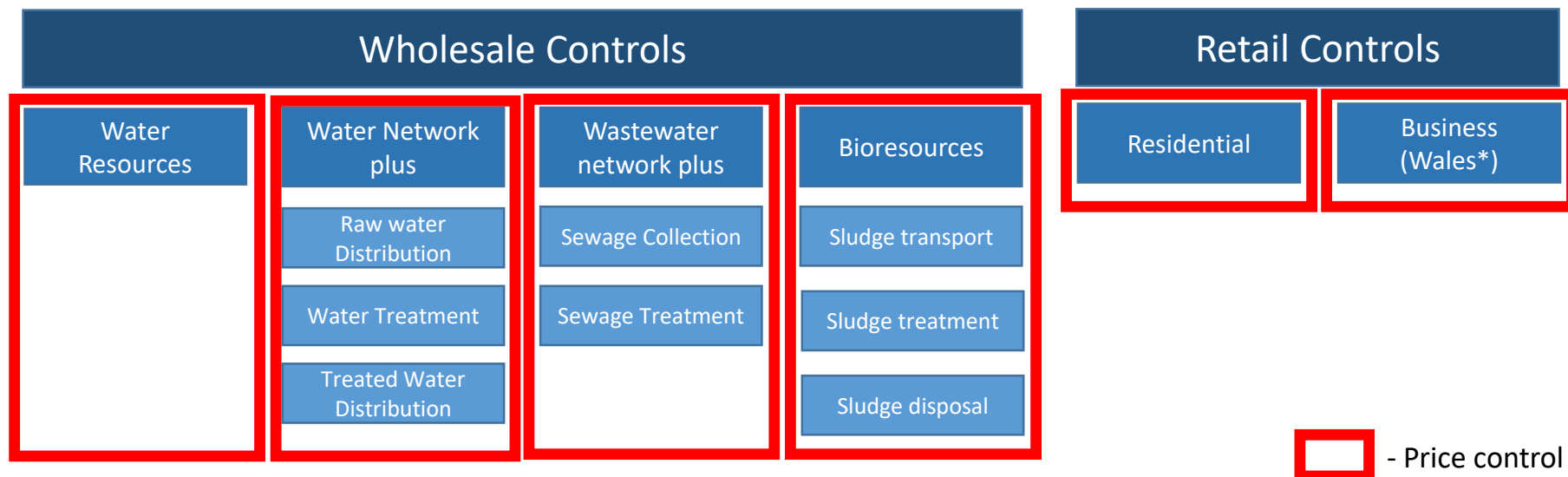
...with TOTEX split into:

Base Costs (BOTEX)	Enhancement Costs
<ul style="list-style-type: none">• Maintain operations, assets and performance (operational expenditure, OPEX and capital maintenance expenditure)	<ul style="list-style-type: none">• Typically capital to enhance the network, split by category / purpose of spend (e.g. resilience, new developments, lead reduction, etc.)

- With Base and Enhancement costs assessed separately and with different techniques and approaches

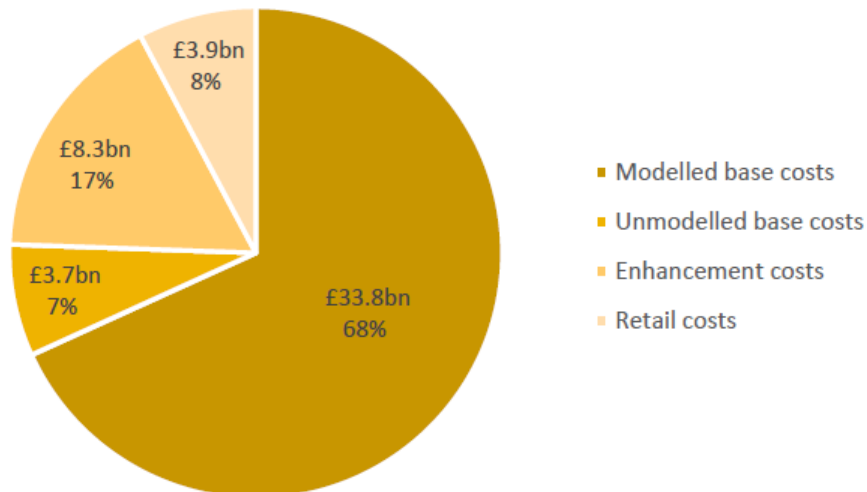
Cost Assessment Framework at PR19

... and a further split into the following cost structure



- Cost assessment framework (TOTEX = Base Expenditure (BOTEX) + Enhancement expenditure) structured around these expenditure categories across the below 'supply chain'

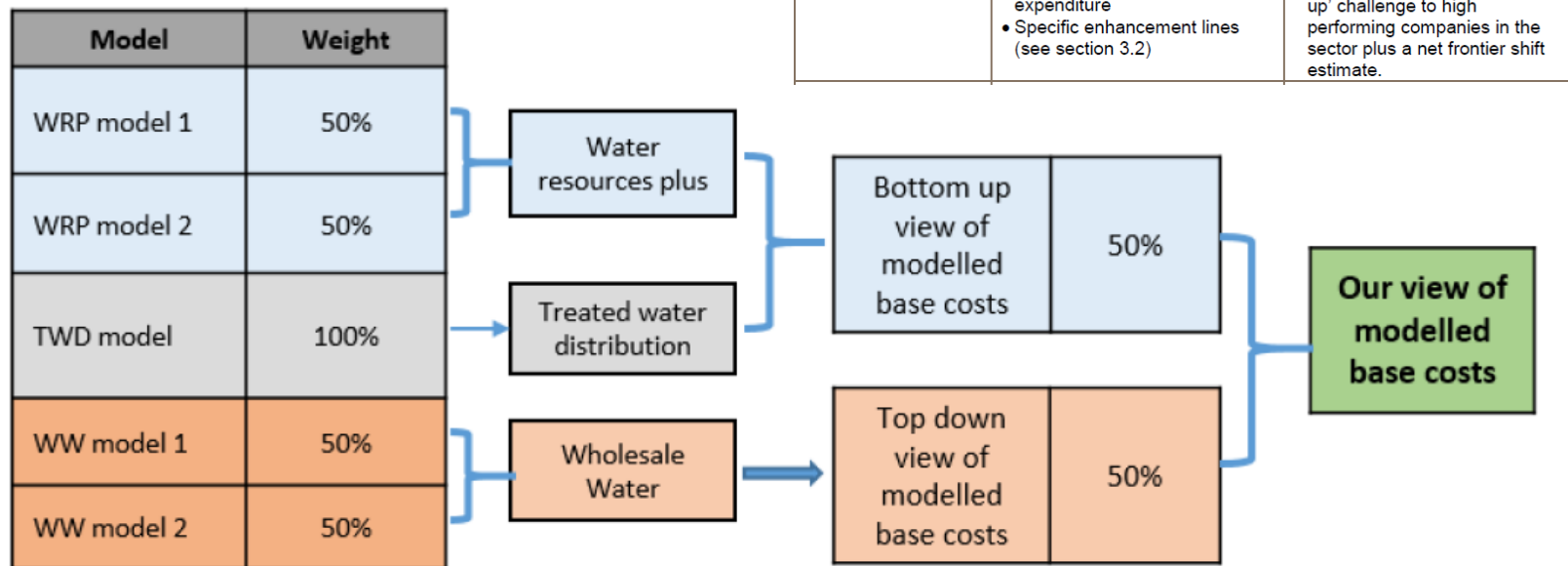
Cost Assessment Framework at PR19



	Building block	Costs included	Assessment approach
Wholesale services	Modelled 'base' costs	<ul style="list-style-type: none"> Operating expenditure (excluding specific cost items included in 'unmodelled base costs') Maintenance capital expenditure Specific enhancement lines (see section 3.2) 	<ul style="list-style-type: none"> Econometric models using outturn data (see Annex 2) Assessment of cost adjustment claims Efficiency challenge: a 'catch-up' challenge to high performing companies in the sector plus a net frontier shift estimate.
	Unmodelled base costs	<ul style="list-style-type: none"> Business rates Water abstraction charges (water only) Traffic Management Act costs Wastewater Industrial Emissions Directive costs (wastewater only) 	<ul style="list-style-type: none"> Various methods as appropriate. Assessment based on business plan (forecast) data. Assessment of cost adjustment claims A net frontier shift estimate
	Enhancement expenditure	<ul style="list-style-type: none"> Enhancement expenditure as reported in business plans (tables WS2 and WWS2), except lines that we now include in modelled base costs (see section 4) 	<ul style="list-style-type: none"> Various methods as appropriate: <ul style="list-style-type: none"> benchmarking models deep/shallow dive assessment Assessment of cost adjustment claims A net frontier shift estimate for certain categories

Cost Assessment Framework at PR19 – base costs

Wholesale Modelled Base Costs - Water



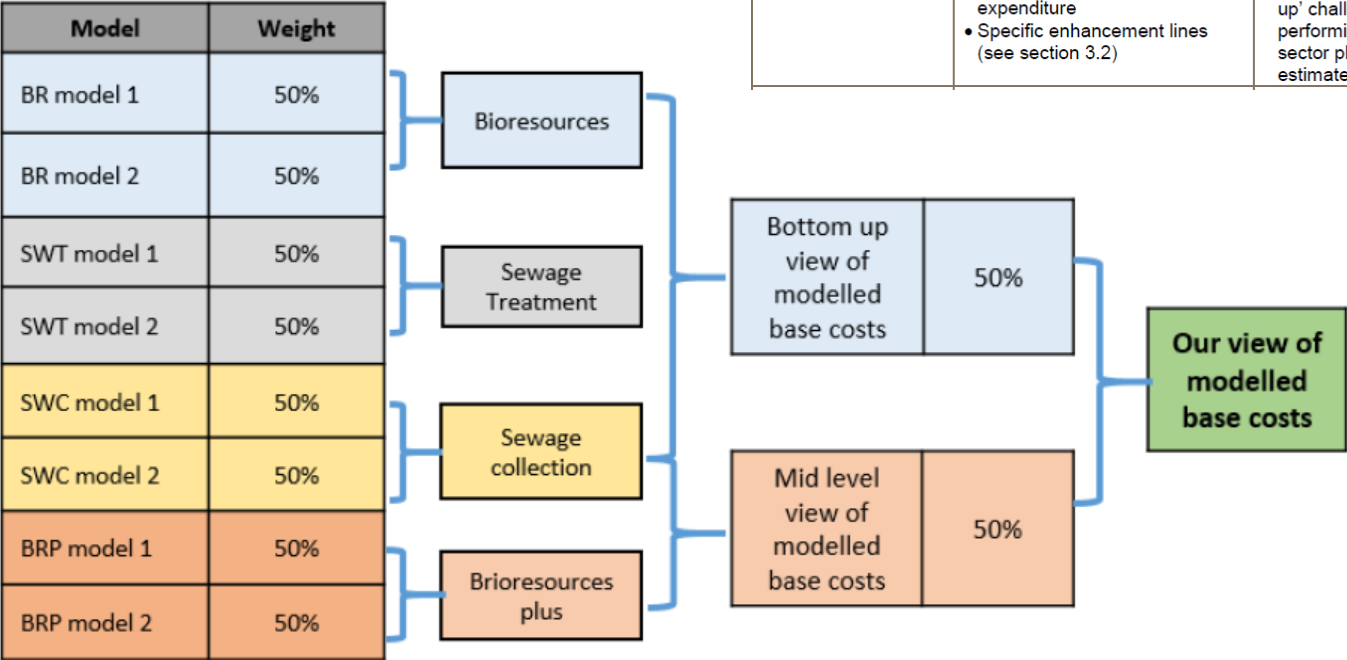
Cost Assessment Framework at PR19 – base costs

Wholesale Modelled Base Costs - Water

Model name	WRP1	WRP2	TWD1	WW1	WW2
Dependent variable (log)	Water resources + Raw water distribution + Water treatment		Treated water distribution	Wholesale water total	
Connected properties (log)	1.007***	1.007***		1.034***	1.020***
Lengths of main (log)			1.049***		
Water treated at works of complexity levels 3 to 6 (%)	0.008***			0.005***	
Weighted average treatment complexity (log)		0.486***			0.568***
Number of booster pumping stations per lengths of main (log)			0.455***	0.231**	0.256***
Weighted average density (log)	-1.647***	-0.981**	-3.120***	-2.220***	-1.789***
Squared term of log of weighted average density	0.103***	0.056 (0.120)	0.248***	0.156***	0.125***
Constant term	-4.274**	-6.607***	5.686***	-1.106 (0.483)	-2.725**
Overall R-Squared	0.93	0.92	0.97	0.98	0.98
Number of observations	141	141	141	141	141

Cost Assessment Framework at PR19 – base costs

Wholesale Modelled Base Costs - Wastewater



Building block	Costs included	Assessment approach
Modelled 'base' costs	<ul style="list-style-type: none">• Operating expenditure (excluding specific cost items included in 'unmodelled base costs')• Maintenance capital expenditure• Specific enhancement lines (see section 3.2)	<ul style="list-style-type: none">• Econometric models using outturn data (see Annex 2)• Assessment of cost adjustment claims• Efficiency challenge: a 'catch-up' challenge to high performing companies in the sector plus a net frontier shift estimate.

Cost Assessment Framework at PR19 – base costs

Wholesale Modelled Base Costs - Wastewater

Model name	SWC1	SWC2	SWT1	SWT2	BR1	BR2	BRP1	BRP2
Dependent variable (log)	Sewage collection		Sewage treatment		Bioresources		Bioresources + Sewage treatment	
Sewer length (log)	0.839***	0.896***						
Load (log)			0.779***	0.773***			0.765***	0.762***
Sludge produced (log)					1.274***	1.265**		
Load treated in size bands 1-3 (%)			0.045***		0.057**		0.038*	
Load treated in size band 6 (%)				-0.013**				-0.011**
Pumping capacity per sewer length (log)	0.317*	0.606***						
Load with ammonia consent below 3mg/l (%)			0.004***	0.004***			0.005***	0.005***
Number of properties per sewer length (log)	0.998**							
Weighted average density (log)		0.178 (0.146)			-0.295**			
Sewage treatment works per number of properties (log)						0.397*		
Constant term	-8.124***	-6.416***	-5.228***	-3.988***	-0.389 (0.648)	0.994*	-4.753***	-3.709***
Overall R-Squared	0.93	0.88	0.88	0.87	0.82	0.79	0.92	0.92
Number of observations	80	80	80	80	80	80	80	80

Cost Assessment Framework at PR19 – Enhancement Costs

Enhancement Costs – Water and Wastewater

Enhancement expenditure	<ul style="list-style-type: none"> Enhancement expenditure as reported in business plans (tables WS2 and WWS2), except lines that we now include in modelled base costs (see section 4) 	<ul style="list-style-type: none"> Various methods as appropriate: <ul style="list-style-type: none"> benchmarking models deep/shallow dive assessment Assessment of cost adjustment claims A net frontier shift estimate for certain categories
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- Assessment within and across price control structures
- Assessment by enhancement category (many aligned to a performance commitments) or group of enhancement categories where synergies between programmes / projects likely or differences in cost allocations by companies
- Assessment methods
 - Primary method: Benchmarking analysis of forecast costs. Typically for common activities and costs across companies where appropriate cost drivers could be identified. Used econometric or unit cost models
 - Where modelling not appropriate, BP evidence base was relied upon:
 - Shallow Dive – light touch assessment for low materiality costs (<0.5% of wholesale totex in respective control)
 - Deep Dive – more thorough assessment for high materiality costs (>0.5% of wholesale totex in respective control). Approach similar to that used for Ofwat's assessment of cost adjustment claims
- Application of the 'company efficiency factor' as a link between modelled base cost assessment and enhancement cost assessment

Cost Assessment Framework at PR19 – Enhancement Costs

Enhancement Costs – Water

Wholesale Water Enhancement feeder model: Drinkingwater protection

Wholesale Water Enhancement feeder model: Ecological improvements

Wholesale Water Enhancement feeder model: Eels regulations

Wholesale Water Enhancement feeder model: Freeform

Wholesale Water Enhancement feeder model: Improvement to river flows

Wholesale Water Enhancement feeder model: Invasive species

Wholesale Water Enhancement feeder model: Investigations

Wholesale Water Enhancement feeder model: Lead standards

Wholesale Water Enhancement feeder model: Metering

Wholesale Water Enhancement feeder model: Raw water deterioration

Wholesale Water Enhancement feeder model: Resilience

Wholesale Water Enhancement feeder model: Supply demand balance

Wholesale Water Enhancement feeder model: Security

Wholesale Water Enhancement feeder model: Strategic regional

Wholesale Water Enhancement feeder model: Taste, odour, colour

Wholesale Water Enhancement feeder model: Water framework directive

No models all assessed on expert review (shallow/deep dive based on materiality)

Enhancement expenditure	<ul style="list-style-type: none"> Enhancement expenditure as reported in business plans (tables WS2 and WWS2), except lines that we now include in modelled base costs (see section 4) 	<ul style="list-style-type: none"> Various methods as appropriate: <ul style="list-style-type: none"> benchmarking models deep/shallow dive assessment Assessment of cost adjustment claims A net frontier shift estimate for certain categories
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Cost Assessment Framework at PR19 – Enhancement Costs

Enhancement Costs – Waste

Wholesale Wastewater Enhancement feeder model: Chemicals investigations
Wholesale Wastewater Enhancement feeder model: Chemicals removal
Wholesale Wastewater Enhancement feeder model: Conservation drivers
Wholesale Wastewater Enhancement feeder model: Discharge relocation
Wholesale Wastewater Enhancement feeder model: Eels regulations
Wholesale Wastewater Enhancement feeder model: Event duration monitoring
Wholesale Wastewater Enhancement feeder model: First time sewerage
Wholesale Wastewater Enhancement feeder model: Flow monitoring
Wholesale Wastewater Enhancement feeder model: Flow to full schemes
Wholesale Wastewater Enhancement feeder model: Freeform
Wholesale Wastewater Enhancement feeder model: Groundwater schemes
Wholesale Wastewater Enhancement feeder model: Investigations
Wholesale Wastewater Enhancement feeder model: Monitoring flows at combined sewer over flow events
Wholesale Wastewater Enhancement feeder model: N-removal

3 models developed
with only 2 used with
50/50 weighting

Enhancement expenditure	<ul style="list-style-type: none"> Enhancement expenditure as reported in business plans (tables WS2 and WWS2), except lines that we now include in modelled base costs (see section 4) 	<ul style="list-style-type: none"> Various methods as appropriate: <ul style="list-style-type: none"> benchmarking models deep/shallow dive assessment Assessment of cost adjustment claims A net frontier shift estimate for certain categories
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Wholesale Wastewater Enhancement feeder model: Odour
Wholesale Wastewater Enhancement feeder model: P-removal technology investigations
Wholesale Wastewater Enhancement feeder model: P-removal
Wholesale Wastewater Enhancement feeder model: Resilience
Wholesale Wastewater Enhancement feeder model: Sanitary parameters
Wholesale Wastewater Enhancement feeder model: Security
Wholesale Wastewater Enhancement feeder model: Sludge
Wholesale Wastewater Enhancement feeder model: Spill frequency
Wholesale Wastewater Enhancement feeder model: Storm tank capacity
Wholesale Wastewater Enhancement feeder model: Ultraviolet disinfection

Adjustments

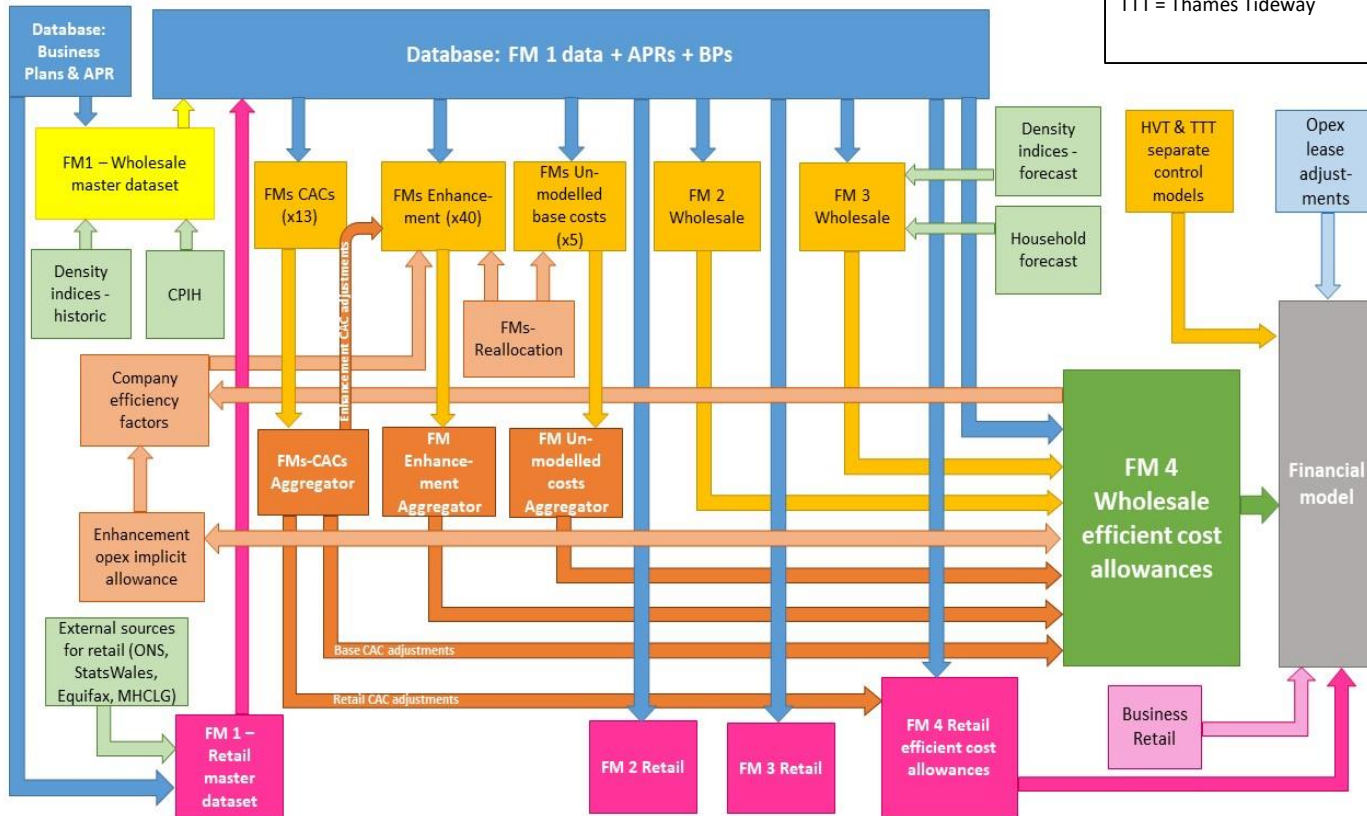
Unmodelled base costs	<ul style="list-style-type: none"> • Business rates • Water abstraction charges (water only) • Traffic Management Act costs • Wastewater Industrial Emissions Directive costs (wastewater only) 	<ul style="list-style-type: none"> • Various methods as appropriate. Assessment based on business plan (forecast) data. • Assessment of cost adjustment claims • A net frontier shift estimate
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- Cost adjustment claims (formerly special cost factors)
 - Early submission – Prior to business plan submission
 - Symmetry adjustment floated but not fulfilled
 - Incentive framework to discourage high numbers of submissions
 - Materiality thresholds tougher than PR14 and varied by control
 - High evidence requirement
- Regional Factors
 - Conclusion on labour and density adjustments
- Frontier Shift
 - Based on evidence of TOTEX framework delivering efficiencies in current control and productivity indices
- Real Price Effects (RPEs), above CPIH
 - Applied to labour

Process schematic

Key:

FM = Feeder model
 CAC = Cost adjustment claim
 CPIH = Consumer Prices Index including owner occupiers' housing costs
 ONS = Office for National Statistics
 MHCLG = Ministry of Housing, Communities and Local Government
 HVT = Havant Thicket
 TTT = Thames Tideway



The diagram is a simplified process model to indicate the relationship between the various feeder models and data sources used to assess wholesale and retail expenditure cost efficiency models.

Summary

- Ofwat used a suite of models at various levels of aggregation to support its determination of cost allowances.
- Splitting of cost into categories gave an additional disaggregation of cost
- Offline adjustments such as cost adjustment claim process were used to reflect differences in companies requirements although these had a high evidential bar for acceptance
- Triangulation was arbitrarily weighted
- Significant movements in assessment methodology from Draft to Final determination

PR19 Referrals to the CMA...

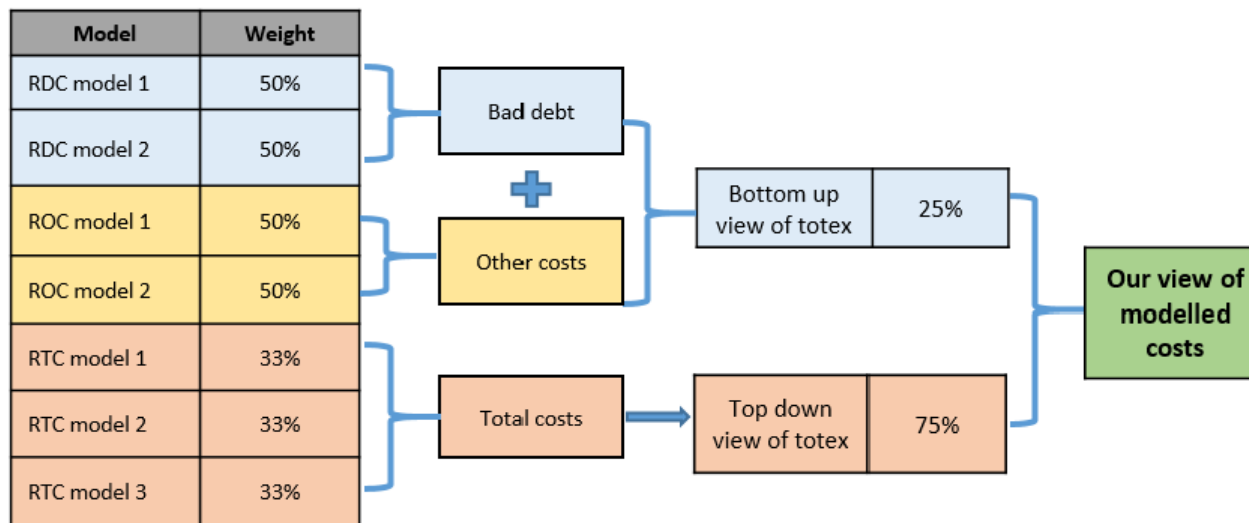
- Bristol Water
 - Yorkshire Water
 - Anglian Water
 - Northumbrian Water
-
- With cost assessment and service requirements likely to be central to cases as cost models don't take into account quality or service drivers, and so hypothetical UQ cost baseline and hypothetical UQ service baseline creates unachievable baseline for companies as a whole.

Supplementary slides

Key Changes from Draft to Final Determination

- Additional year of data included (18/19)
- Further cost item excluded from modelled base costs – diversions
- Additional +/- adjustment to base allowances for growth
- Used companies cost driver forecasts for single variable – water treatment complexity, instead of independent view
- Change in weights applied to retail models
- Efficiency benchmark made harder from UQ to 4th placed company in wholesale water (out of 17) and 3rd in wholesale wastewater (out of 11)
- Frontier efficiency challenge reduced from 1.5% p/a to 1.1% p/a, but extended (along with the application of RPEs) to all wholesale base costs (at DD only applied to modelled base costs)
- Change in the weighting applied to leakage measures used to inform enhancement funding for leakage reduction (75% top-down : 25% bottom-up, compared to at DD of a 50% : 50% ratio) and a number of changes made to retail cost driver data.

Efficient Retail Costs



Efficient Retail Costs

Model name	RDC1	RDC2	ROC1	ROC2	RTC1	RTC2	RTC3
Dependent variable (log)	Bad debt and bad debt management costs per household		Other retail costs per household		Total retail costs per household		
Average bill size (log)	1.190***	1.158***			0.458***	0.526***	0.603***
Proportion of households with default (Equifax variable) (%)	0.067***				0.024 {0.106}	0.030**	
Proportion of households income deprived (income score of IMD) (%)		0.076***					0.059***
Total migration (% of population)		0.035**					0.037**
Proportion of dual service households (%)			0.002*	0.002**			
Proportion of metered households (%)			0.007***	0.007***	0.004 {0.321}	0.004 {0.206}	0.002 {0.436}
Number of households connections (log)				-0.039 {0.394}		-0.059*	-0.116**
Constant term	-6.032***	-5.680***	2.400***	2.909***	-0.014 (0.980)	0.226 (0.653)	0.200 (0.564)
Overall R-Squared	0.77	0.78	0.13	0.15	0.67	0.70	0.71
Number of observations	105	105	105	105	105	105	105

* Other retail costs include customer service, other operating costs, meter reading, recharges and depreciation.

PR19 Timetable

5yr Price Control – 1st April 2020 to 31st March 2025

	PR19 Framework	PR19 Cost Assessment
Q1 2016 to Q1 2017	Ofwat CAWG, broadly monthly	
Q3 2017	Draft Methodology Consultation	Consultation included Ofgem's high level framework for 'Securing Cost Efficiency'
Q4 2017	Final Methodology	Methodology included Ofgem's high level framework for 'Securing Cost Efficiency'
Q1 2018	<ul style="list-style-type: none"> • Draft BPDTs and financial model published • Company submissions of draft Water Resource Management Plans 	<ul style="list-style-type: none"> • BPDT data capture designed to support possibility of middle and totex models (primarily) • A consultation on Econometric Cost Modelling for Pr19
Q2 2018	<ul style="list-style-type: none"> • Updated BPDTs published • Early submission of Performance Commitment definitions and expected Special Factors 	
Q3 2018	<ul style="list-style-type: none"> • Annual Report submission • PR14 Reconciliation models and Bioresources market information published 	
Q3 2018	Business Plan Submission, company representations	
Q1 2019	<ul style="list-style-type: none"> • Initial Assessment of Plans • Company Monitoring Framework Assessment 	
Q2 2019	<ul style="list-style-type: none"> • Draft Determinations for exceptional / fast-tracked plans • Revised BPs submitted by slow-track / significant scrutiny companies 	
Q3 2019	Draft Determinations for slow-track / significant scrutiny companies	
Q4 2019	Final Determinations	
Q1 2020	Decision to accept / appeal FD...	

NPg presentation on disaggregated models



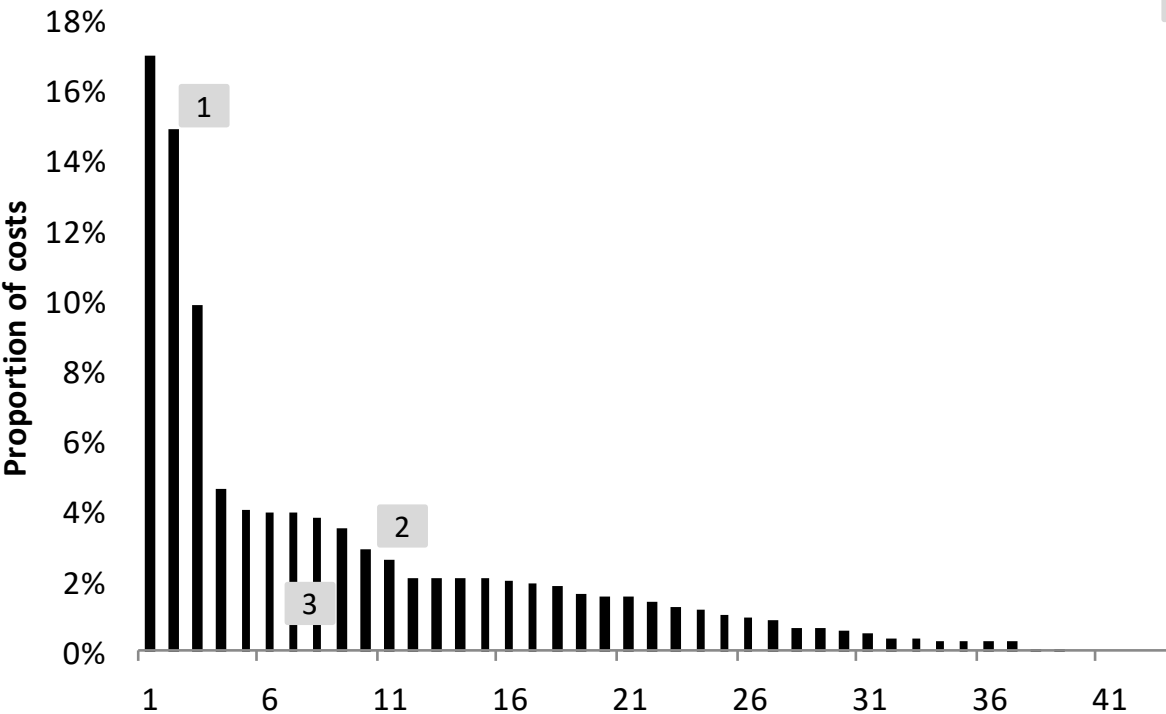
Assessing the ED1 disaggregated models

*Presentation to the
ED2 cost assessment working group
13 March 2020*

Assessing whether the ED1 disaggregated modelling suite was fit for purpose is critical to the direction of the ED2 price control review

- The cost assessment working group needs to consider the approach to ED2 cost modelling, including:
 - The role and purpose of different types of modelling
 - How that modelling can be conducted
- The meetings to date have highlighted some important issues around disaggregated modelling:
 - Some parties think the ED1 disaggregated models offer a template for ED2 modelling (meeting 1)
 - There is top-down evidence that those models delivered poor outcomes and “fit” worse than the totex models (meeting 2)
- Key questions therefore include:
 - Whether any disaggregated modelling should be used at ED2;
 - If so, how it should be used; and
 - What any disaggregated models should look like
- This pack assesses whether the ED1 disaggregated modelling suite offers a fit for purpose template (if disaggregated modelling is to be used at all)

The ED1 disaggregated modelling suite was highly granular, covering 42 cost areas and thousands of individual benchmarks



- 1 Only three of the individual models covered more than ca. 5% of the cost base
- 2 There was a long tail of models covering relatively small pots of costs
- 3 Many of the individual models were further sub-divided into dozens or hundreds of benchmarks

There were five main types of ED1 disaggregated model, with very different properties

	No. of models	Share of costs	
Regression models	3	19%	<ul style="list-style-type: none"> ▪ Assessment of the total cost of an activity ▪ Whole-sector benchmarks ▪ Cost driver(s) control for “scale” ▪ Different techniques / sophistication
Ratio models	10	19%	
Expert or qualitative review	7	6%	<ul style="list-style-type: none"> ▪ Topic specific / driven by available approaches ▪ Likely to start from company plan
Unit cost models with separate volume scrutiny	10	40%	<ul style="list-style-type: none"> ▪ Granularity driven by split of reported unit costs ▪ Units cost benchmarks not always the whole sector ▪ Start from company plan volumes ▪ Don’t capture volume / unit cost trade offs
Unit cost models with no volume scrutiny	12	15%	

Ratchets and qualitative adjustments were also layered onto the raw modelling results

Ratchets

- Costs set at “lower of”:
 - Modelled result; or
 - Company plan

Qualitative adjustments

- Line by line adjustments to modelling results
- Relatively low bar applied (compared to e.g. totex adjustment)

Frontier and CEPA have developed a comprehensive framework for assessing cost benchmarking models

Robustness

- Does the model pass statistical tests? (Frontier and CEPA)
 - Can it be statistically tested?
- Are the results overly sensitive to small changes in input data?
- Is the general ranking stable under alternative specifications
- Are the cost drivers accurately and consistently measurable?
- Is there too much noise in the data?

Transparency

- Do the models have an economic or technical rationale?
- Is it clear what conduct is being rewarded?
- How long would an informed person take to understand the key drivers of the overall results?

Promote efficiency

- Are potentially substitutable costs subject to similar “strength”?
- Are incentives distorted over one cost or another?
- Would the approach overly incentivise deferral of costs necessary to meet net zero?
- Are complimentary costs grouped together?
- Are substitutable costs grouped together?
- Are the cost drivers beyond company control?
- Is the conduct that is being rewarded efficient?

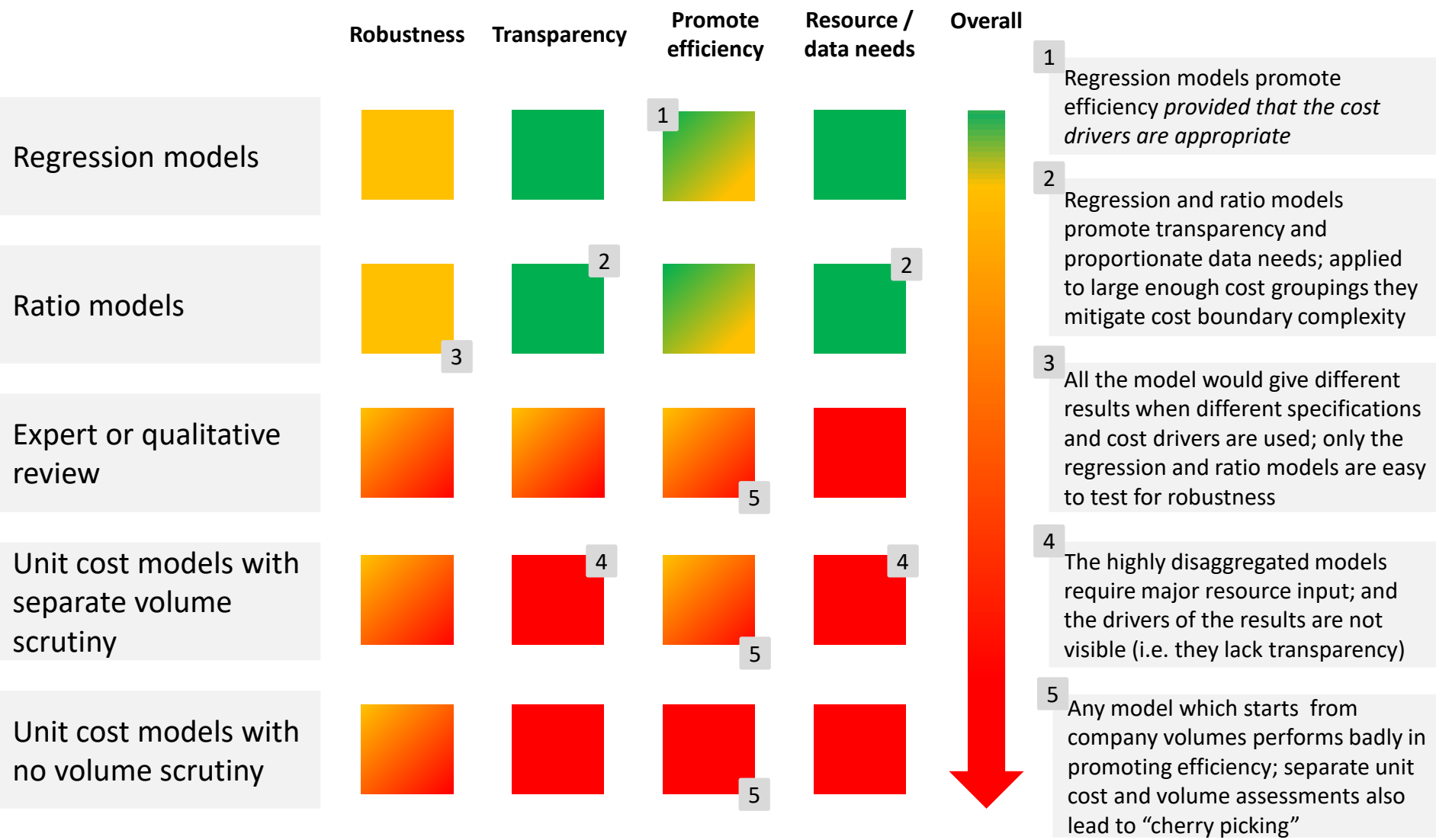
Resource / data needs.











- How much data does the modelling need?
- How complex are the cost boundaries?
- Is it possible to collect the necessary data accurately enough?
- What are the total resource costs (Ofgem, companies ,advisors)?

Key: Red = Frontier
Blue = CEPA
Black = addition

Assessment

The more disaggregated the model, the worse it performs: most critically in terms of how it promotes efficiency



	Robustness	Transparency	Promote efficiency	Resource / data needs	Overall	
Ratchets			¹ 			¹ When applied in economic regulation, ratchets have exceptionally poor incentive properties. ^[1] This is well understood in the economic literature. ^[2]
Within model “qualitative” adjustments					² 	² Qualitative adjustments made line by line within models lack transparency, have high resource needs and are likely to undermine efficiency incentives

[1] Ofgem’s RIIO-2 principle that it will set cost allowances at the lower of plan or benchmark is counterbalanced by its principle that it will provide a reward equivalent to the foregone allowances

[2] See Freixas, X., Guesnerie, R., and J. Tirole. (1985). “Planning under Incomplete Information and the Ratchet Effect,” Review of Economic Studies, 173–191 (cited in Jean Tirole’s noble prize acceptance speech)

The ED1 disaggregated models are not fit for purpose as the starting point for ED2; Ofgem should take a different approach

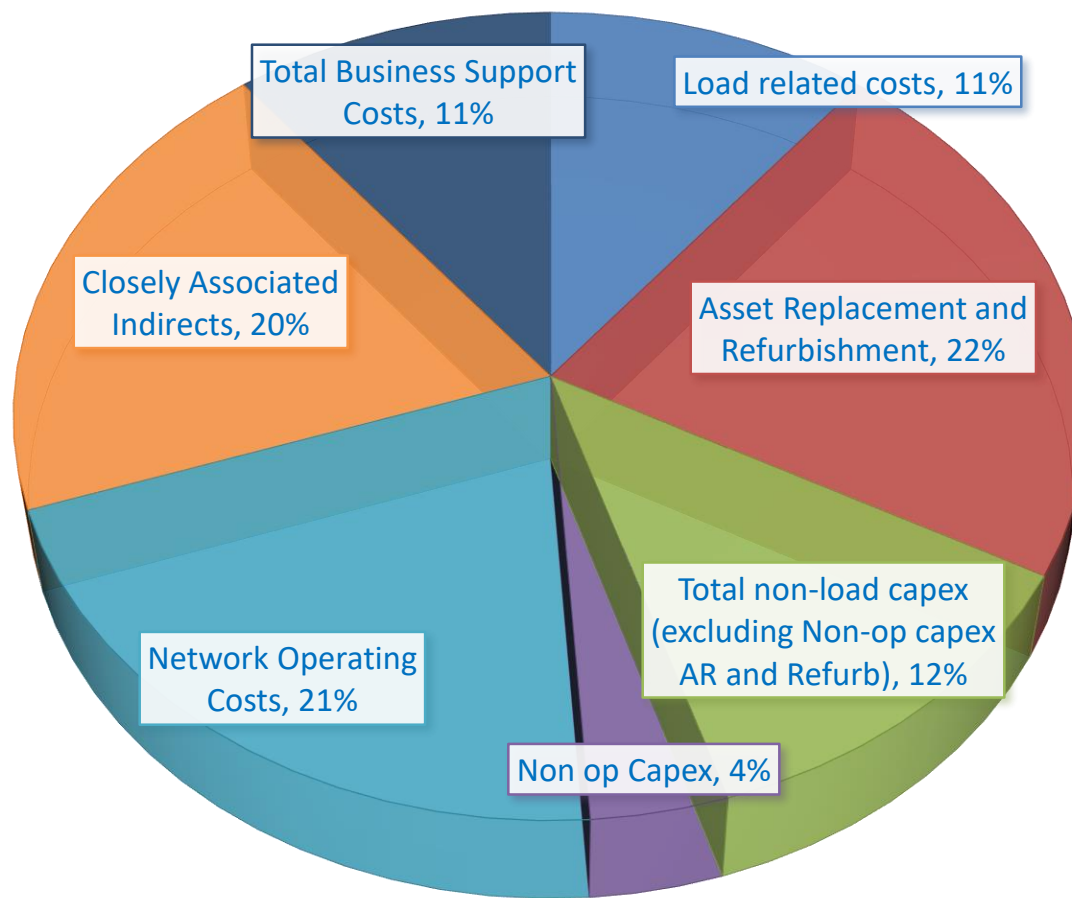
- The highly-disaggregated unit cost models perform very poorly on transparency, resource requirements and promoting efficiency; while expert review has similar properties
- The implementation of ratchets and qualitative adjustments with these models made these issues even worse
- The disaggregated regression models (or ratio models) perform far better in general, provided that the cost drivers are chosen and evaluated carefully
- For ED2 Ofgem should therefore:
 - Consider using a totex-only approach
 - If it uses disaggregated modelling, use a very different set of disaggregated models, including:
 - Much higher level cost groupings, that capture :
 - complementary and substitutable costs,
 - accounting allocation trade-offs;
 - Total costs, not separate volume and unit cost assessments, to reduce business model distortions;
 - More use of regression analysis
 - No use of ratchets
 - Application of a high bar for all adjustments to expenditure
- A high-level approach to modelling costs is not new in regulatory terms:
 - Ofgem's modelling in earlier price controls had many similar elements
 - Ofwat has implemented a largely-totex approach to water distribution at PR19

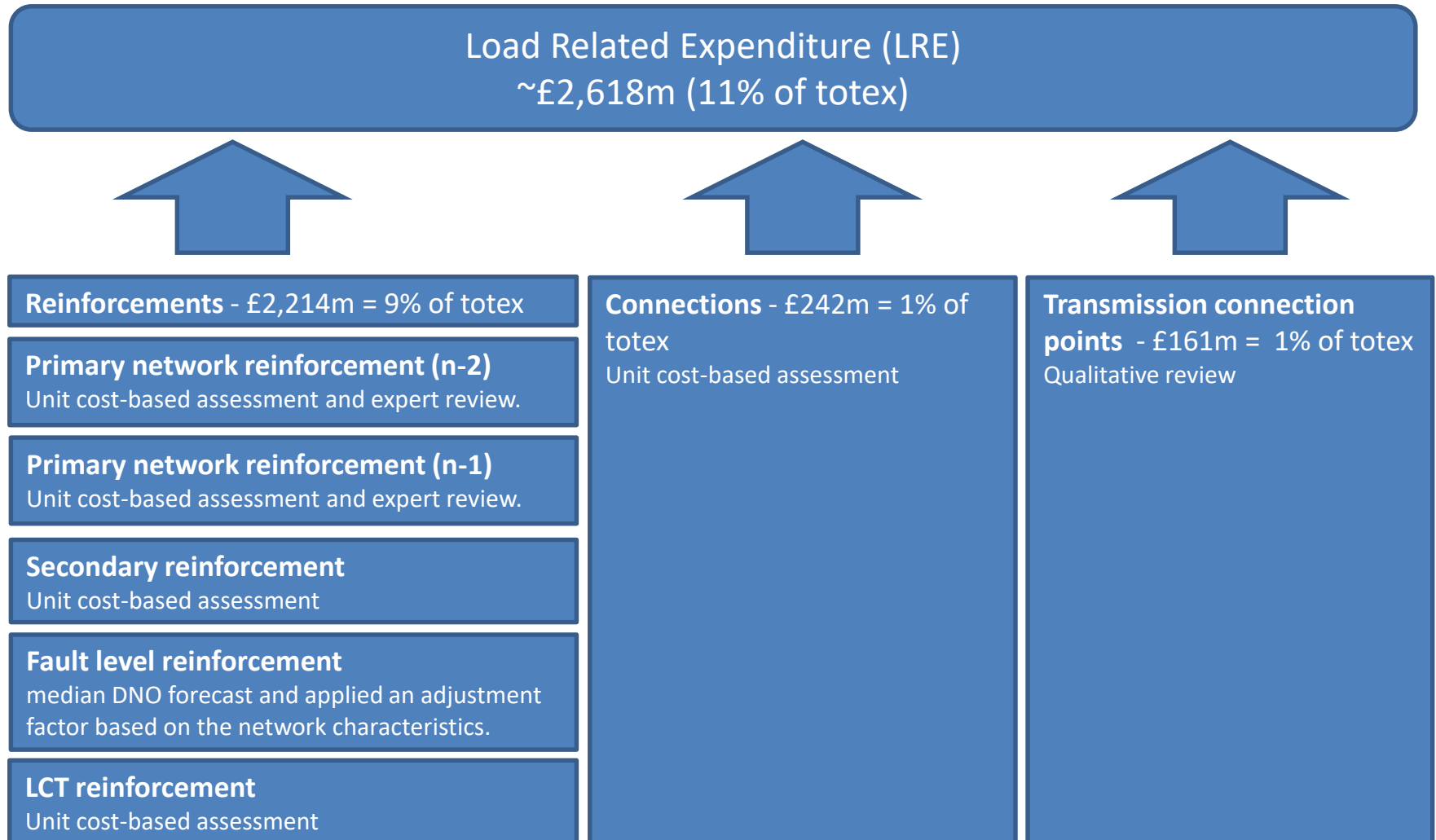
- The next meeting will take place on 27th March. It will be in London.
- We will circulate notes and an actions log from this meeting.

Annexes



RIIO-ED1: PERCENTAGE BREAKDOWN OF TOTEX ALLOWANCES





Non-Load Related Expenditure (NLRE) excluding Non-op Capex, AR and Refurb
~£3,007m (12% of totex)

Diversions - £714m = 3% of totex
Unit cost-based assessment using
eight years of RIIO-ED1 data.

Losses and environment -
£116m = 0.5% of totex
Unit cost-based assessment bespoke
to each category, but generally median
unit costs using 13 years of data.

Operational IT&T - £442m = 2%
of totex
Quantitative and Qualitative
assessment. Unit cost-based
assessment using MEAV as cost driver
and 13 years of data.

Civil works - £725m = 3% of totex
Run rate analysis.
Unit cost-based assessment

ESQCR - £199 = 1% of totex
Lower of modelled or submitted costs.
Unit cost-based assessment at each
voltage using 13 years of data.

Black Start - £55m = 0.2% of totex
Unit cost-based assessment using eight
years of RIIO-ED1 data.

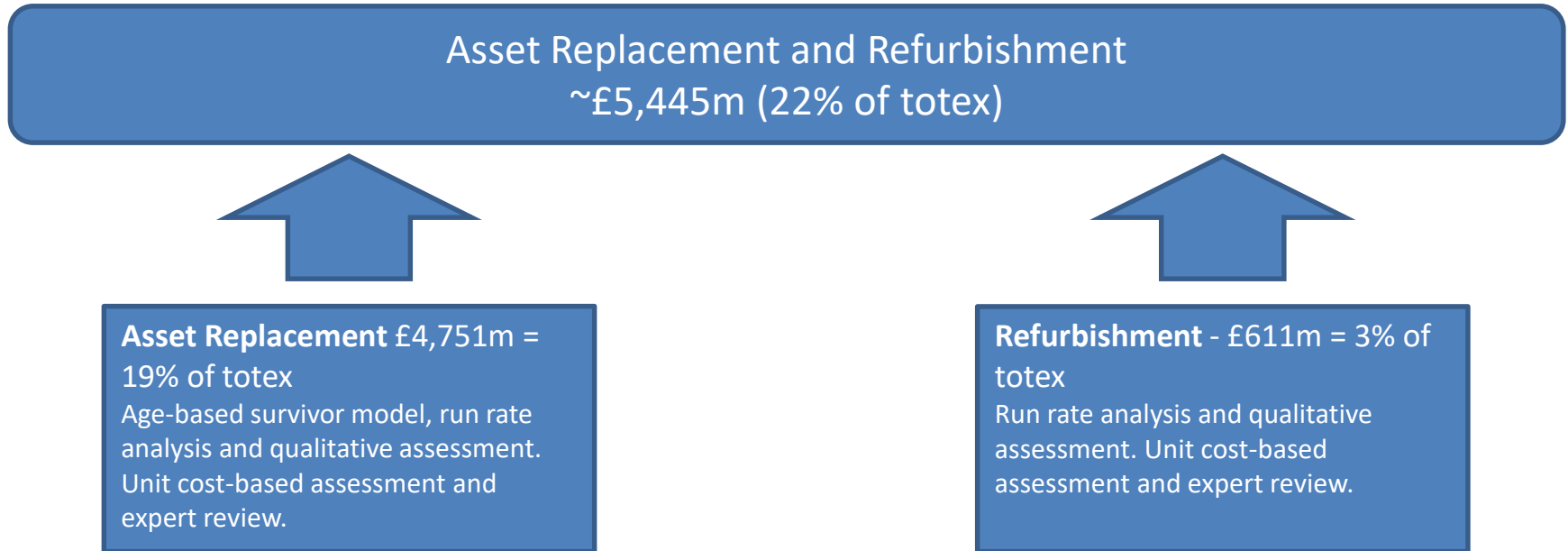
BT21C - £74m = 0.3% of totex
Unit cost-based assessment using 13
years of data.

Improved Resilience
Technical review.

Legal & Safety -£446 = 2% of totex
Lower of modelled or submitted costs.
Unit cost-based assessment at each
voltage using 13 years of data.

Flood Resilience - £101m = 0.5% of
totex
Risk-based approach. Unit cost of each
risk point reduced/maintained the lower
of the DNO's own and the industry LQ.
Unit cost applied that to the delta.

Rising and Lateral Mains (RLM) -
£177m = 0.7% of totex
Unit cost-based assessment based on
customer numbers as cost driver using
all 13 years of data.



Network Operating Costs (NOCs)
~£5,110m (21% of totex)

Faults/ Trouble Call - £2,752m = 11%
of totex

**HV & LV Overhead
lines, and Plant and
Equipment**

Three regressions
(fault volumes as
driver)

**132kV to LV
Network Faults (excl
above)** – x15
bespoke assessment
(fault volumes)– unit
cost-based
assessment

**Occurrences not
incentivised (ONIs)** –
x1 Regression (ONIs
volume) (£557m)

**1 in 20 Severe
Weather Exceptional
Events**– x1 bespoke
assessment (£107m)

Tree-cutting -
£887m = 3% of
totex

**“ENATS 43-8” Tree
cutting**– x1 Regression
using spans cut as
driver (alternative
drivers considered but
not used)

**“Resilience” Tree
cutting**– ETR 132 unit
cost assessment (excl.
NPg)

I&M - £1,060m =
4% of totex

**Inspection and
Maintenance**– x1
Assessment based on
Total I&M £m/MEAV
OHL+Plant

NOCs Other -
£256m = 1% of totex

**Substation
Electricity**– x1 unit
cost assessment

Dismantlement– x1
bespoke assessment –
annual DR5 spend

**Remote location
generation (fuel)**–
annual DR5 spend

**Remote location
generation (fuel)**–
Annual DR5 spend

Closely Associated Indirects (CAIs)
~£4,818m (20% totex)



CAIs network design and engineering, project management, system mapping, EMCS, stores, network policy, control centre, call centre—Regression analysis

CAIs wayleaves – Unit cost-based assessment using 13 years of data and total network length as cost driver.

CAIs vehicles and transport –
Assessed with non-op capex vehicles. Unit cost-based assessment using 13 years of data and total network length as cost driver.

CAIs op training and workforce – Unit cost-based assessment on DNO employee numbers.

