

Safety, Resilience, and Reliability Working Group

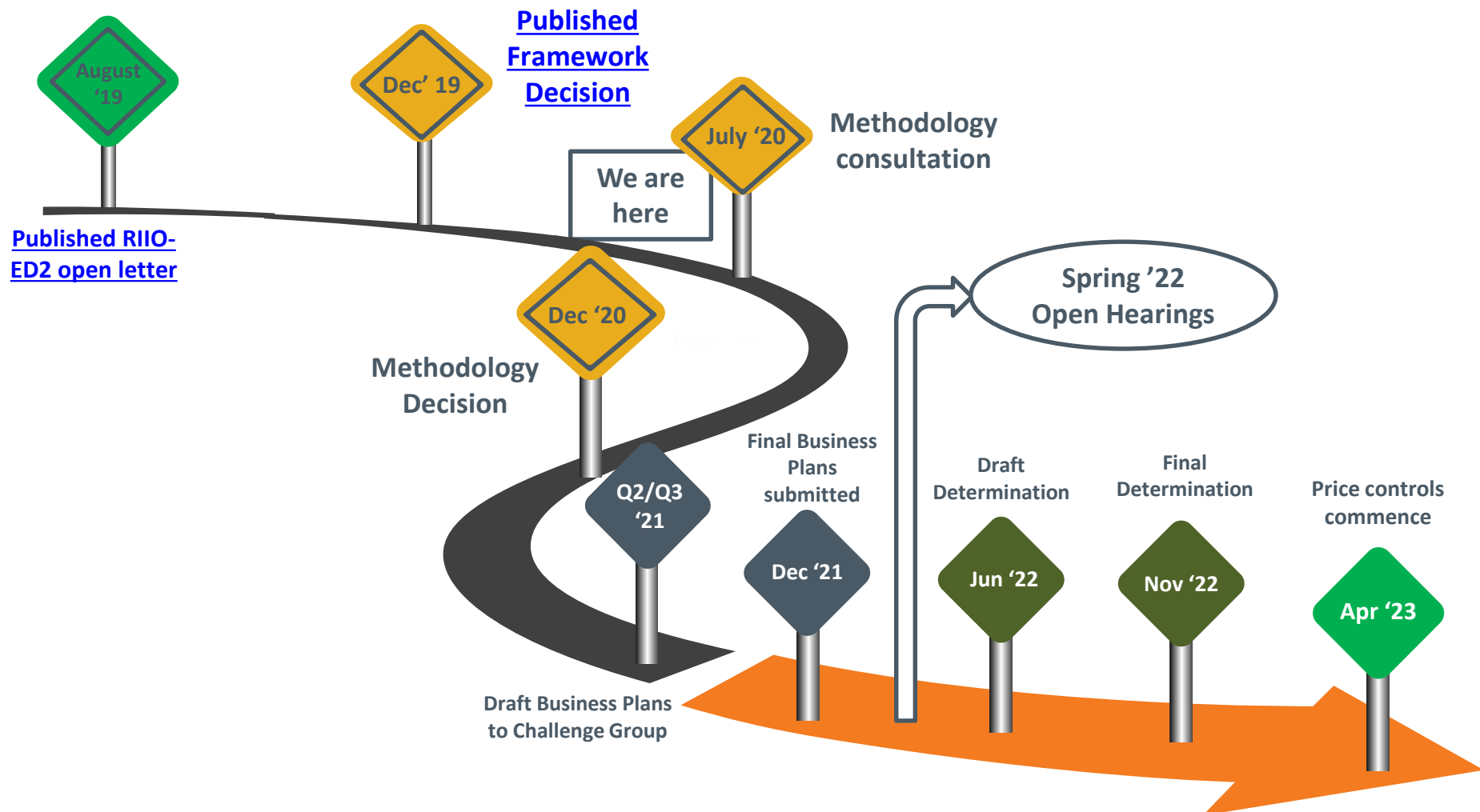
Meeting 15 – Load Indices



RIIO Electricity Distribution
07/07/2020

Safety, Resilience, and Reliability Working Group

- Welcome and introductions from Ofgem
- Discussion on LIs
- Presentation from SPEN – Load Index Developments
- Presentation from UKPN – Network Utilisation
- Review of actions, next steps

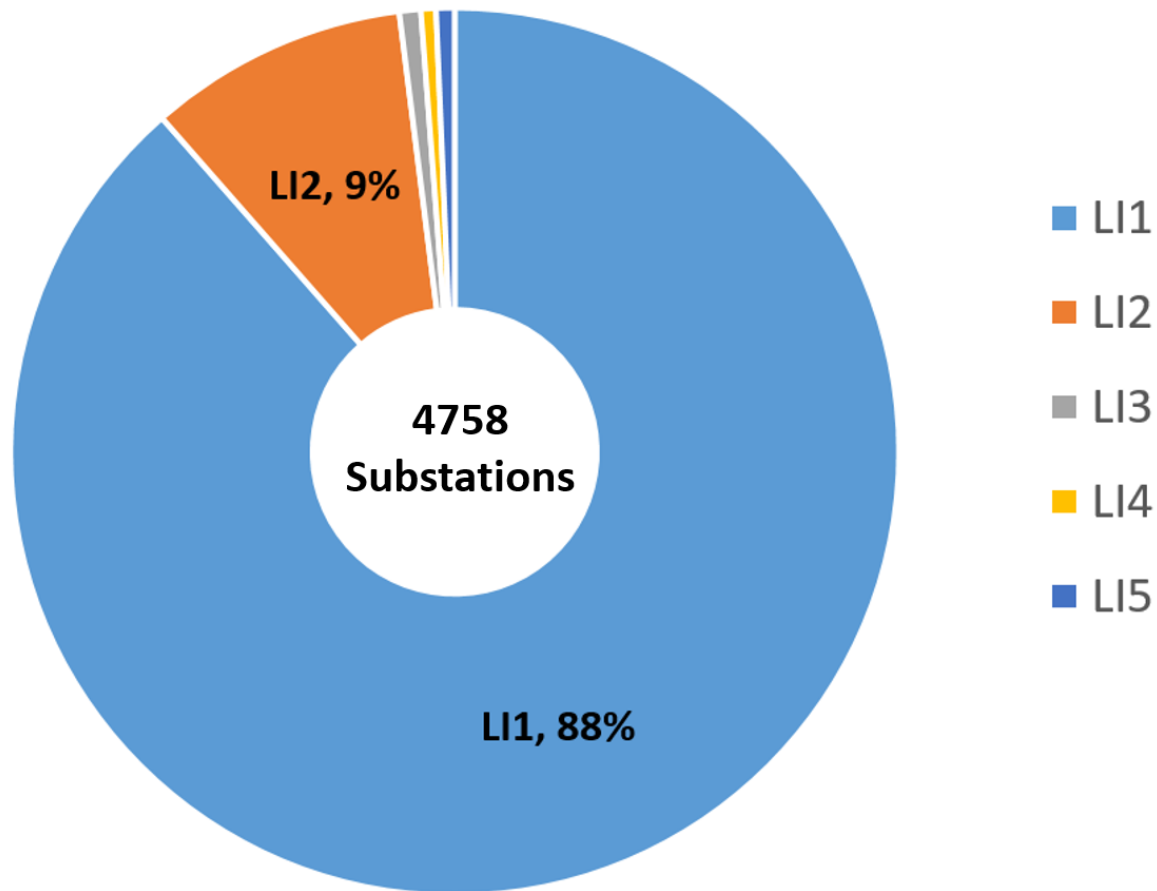


LI discussion

- LIs measure the utilisation of primary network substations, tracking trends in utilisation; they help determine when DNOs may need to intervene to ensure the long-term reliability of the network.
- The LIs tie a DNO's investment to the delivery of a particular level of utilisation at the end of the price control.
- Each substation (or group of interconnected substations) is allocated a 'loading level' according to the amount of its total capacity utilised by existing demand.
- Load index data can be converted to a risk score by multiplying the number of customers supplied from a substation by a weighting that is dependent upon the load index.
- Applying these weightings to the LIs and multiplying by the number of customers at each substation gives the total load risk on the network.
- There are five levels:

$$\sum_{1}^n \text{Weighting}_n * \text{Customer numbers}_n$$

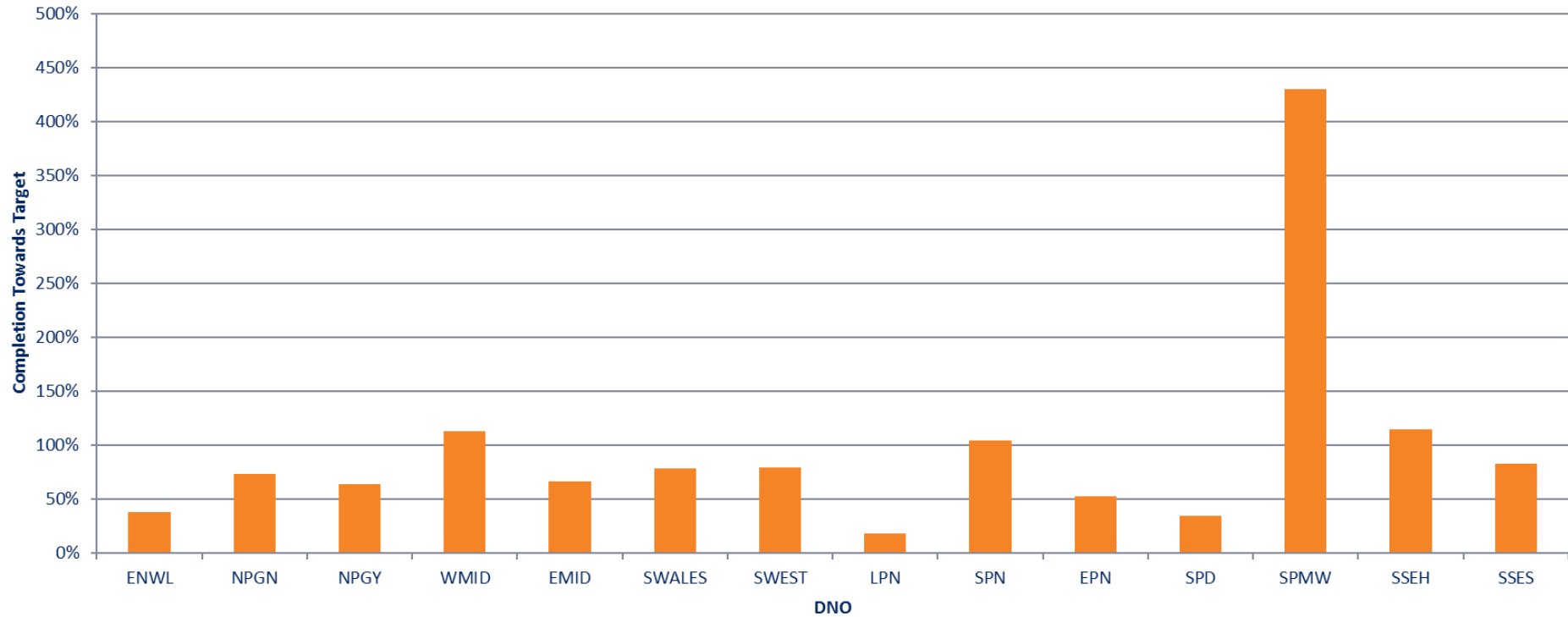
Ranking	Loading (percentage)		Duration Factor (hours)		Risk weighting	
	Lower bound	Upper bound	Lower bound	Upper bound	Ranking	Weighting
LI1	0%	<80%	n/a	n/a	LI1	1
LI2	80%	<95%	n/a	n/a	LI2	1
LI3	95%	<99%	n/a	n/a	LI3	1
LI4	99%	n/a	0	<9	LI4	20
LI5	99%	n/a	9	n/a	LI5	100

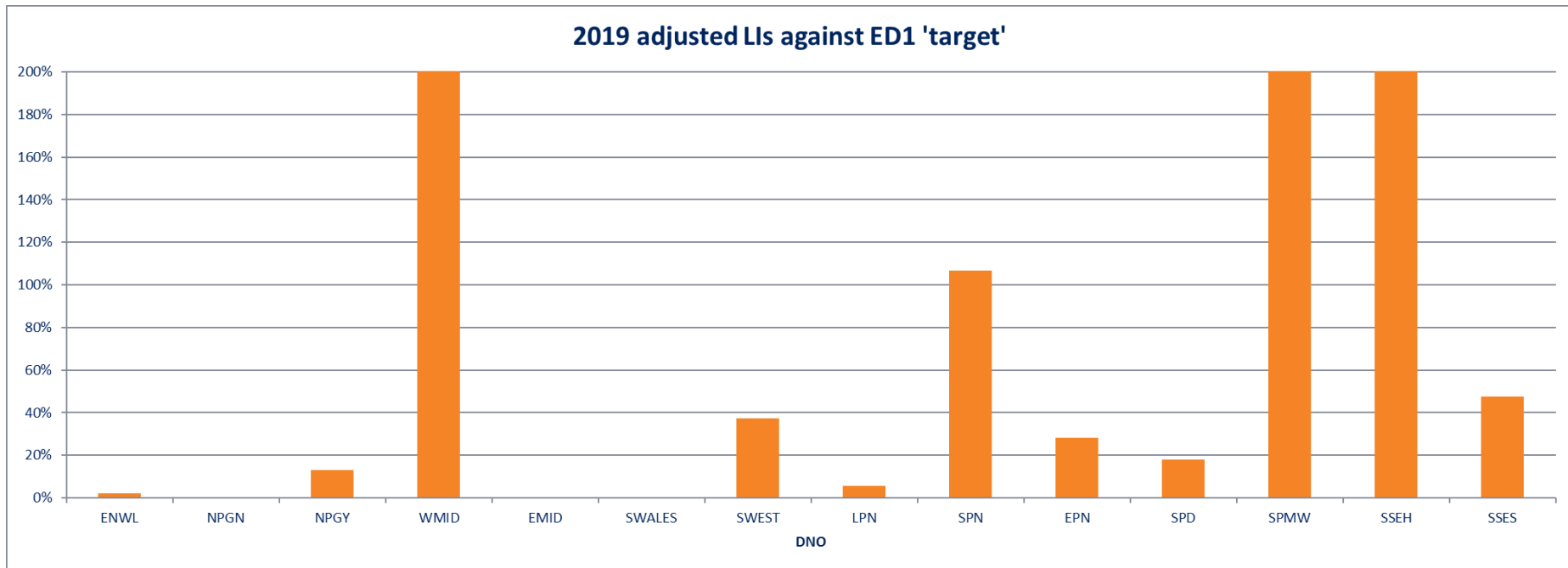


	BPDT 2012	2016	2019
ENWL	90%	98%	98%
NPGN	96%	99%	100%
NPGY	96%	99%	99%
WMID	84%	96%	98%
EMID	89%	96%	99%
SWALES	97%	100%	100%
SWEST	97%	98%	100%
LPN	79%	94%	95%
SPN	87%	93%	94%
EPN	89%	96%	97%
SPD	90%	98%	98%
SPMW	90%	94%	97%
SSEH	92%	91%	97%
SSES	96%	98%	99%

DNO	Customers (18/19)	LI firm capacity (MVA)			MVA/cust	Weighted Risk Score (in BPDT)			LI risk points (reported)	
		2016	2019	CAGR		Without Investment (1 April 2015)	Without Investment (31 March 2023)	With Investment (31 March 2023)	2018	2019
ENWL	2,393,226	14,069	14,027	-0.24%	5.85	21,605,986	32,452,507	12,720,028	4,924,049	4,924,049
NPGN	1,606,300	6,960	7,021	0.65%	4.39	2,976,867	3,576,040	3,355,013	2,431,402	2,431,402
NPGY	2,306,293	13,230	13,379	0.78%	5.83	6,673,161	9,619,304	6,722,652	4,697,143	4,697,143
WMID	2,491,212	9,392	9,498	0.50%	3.81	8,338,896	25,115,535	3,452,548	3,485,099	3,485,099
EMID	2,658,397	14,024	14,361	1.02%	5.38	6,998,048	22,672,296	7,674,857	5,229,128	5,229,128
SWALES	1,137,812	3,918	3,955	0.63%	3.49	1,589,608	1,676,286	1,676,286	1,306,766	1,306,766
SWEST	1,624,131	8,016	8,360	0.28%	4.96	3,061,322	22,514,386	4,302,630	3,290,554	3,290,554
LPN	2,357,951	10,004	10,186	-0.86%	4.17	25,321,912	72,621,208	26,903,798	10,883,819	10,883,819
SPN	2,304,887	11,046	11,212	1.85%	4.97	29,467,068	39,642,638	13,946,151	11,677,819	11,677,819
EPN	3,638,189	18,264	18,193	0.59%	5.08	24,327,425	56,755,092	21,205,439	15,008,853	15,008,853
SPD	2,002,889	7,410	7,436	-0.08%	3.69	10,079,777	18,451,112	9,627,389	4,168,646	4,168,646
SPMW	1,512,275	8,323	8,497	1.04%	5.62	2,642,760	5,344,166	1,123,017	17,817,522	17,817,522
SSEH	778,304	3,352	3,266	-1.35%	4.19	2,387,071	6,063,270	847,412	1,625,901	1,625,901
SSES	3,067,988	19,619	20,186	0.21%	6.42	6,434,452	22,855,210	8,660,027	6,661,154	6,661,154
	29,879,854	147,627	149,576	0.45%	4.98	151,904,353	339,359,051	122,217,248	93,207,855	93,207,855

2019 Risk Score Against 'Target' Loading Risk Points With Investment (31st March 2023)





	LI firm capacity	LI maximum demand	%
ENWL	14,027	8,500	61%
NPGN	7,021	4,059	58%
NPGY	13,379	7,179	54%
WMID	9,498	5,362	56%
EMID	14,361	8,615	60%
SWALES	3,955	2,072	52%
SWEST	8,360	4,582	55%
LPN	10,186	6,343	62%
SPN	11,212	7,014	63%
EPN	18,193	11,202	62%
SPD	7,436	3,591	48%
SPMW	8,497	5,515	65%
SSEH	3,266	1,626	50%
SSES	20,186	11,285	56%
Total	20,187	11,285	56%

DNOs agree that the LIs for EHV and 132kV networks should continue within ED2 for both the assessment of business plan forecasts and the operation of uncertainty mechanisms

- They quantify a significant driver of EHV and 132kV general reinforcement expenditure
- They are an established measure within companies
- Simple amendments can be made to incorporate forecasts and data relating to the use of flexibility

To improve the LIs at primary and to make the LI more applicable it was discussed that:

- the bandings could be improved
- they should include additional information relating to non-conventional reinforcement solutions

DNOs raised that the total loading risk score for a licence area is dependent on the total number of customers within that area and by the overall design of the primary networks in terms of multiple transformation levels.

- A small rural DNO will have fewer customers than a large urban DNO which means that the cumulative customer risk score will be correspondingly higher in large urban DNO.
- Also, in networks that utilise both 132/EHV and EHV/11kV transformation levels each customer will tend to be counted twice in this cumulative risk score.

WPD raised to us this measure of network risk may not represent which is the riskiest network. The small rural DNO may have more LI5 substations than the large urban DNO, but the large urban DNO could have more risk points (simply due to having more customers).

These loading risk scores can be normalised by using the total number of 'load customers' (the sum of all the customers supplied by primary substations, including double counting where multiple voltage levels are used). By dividing the load risk by load customers a range of scores from 1-100 will be obtained

Circumstances	Risk per load customer
All LI1-LI3 (no LI4 or LI5)	1.0
2.5% of customers at LI4	1.5
2.5% of customers at LI5	3.5
10% of customers at LI4	2.9
10% of customers at LI5	10.9
100% of customers at LI4	20.0
100% of customers at LI5	100.0

Does this normalisation remove the customer volume bias in a similar way to the calculation of CMLs?

Presentation from SPEN: Load Index Development

SRRWG Load Index Development

7th July 2020



Agenda

- ED2 Load Index Requirements
- Proposed Changes
- Revised Risk Reporting Structure (Straw-man)
 - Demand Index
 - Generation Index
 - Fault Level Index
 - Flexibility Index



ED2 Load Index Requirements

Load Index needs to be developed to adequately assess risk as networks facilitate decarbonisation

Existing Load Index

Demand	
Thermal	✓
Voltage	✓
Fault Level	✗
Generation	
Thermal	✗
Voltage	✗
Fault Level	✗
Interventions	
Conventional	✓
Flexibility	✗

Load Index assesses network risk by comparing network demand with capacity.

Load Index enables network risk to be tracked over time as well as demand driven intervention requirements.


Decentralised generation and flexibility are increasing network risk and need to be included within Load Index.

Managing loading risk as we transition to Net Zero



Proposed Changes

Load Index should reflect the **changing use of networks** by incorporating **Demand, Generation, Fault Level, and Flexibility.**

Component	Description	Comments
Load Index (LI)	Categorise the risk of max demand (latent) versus firm capacity at the LI substation/group level.	Consistent with the RIIO-ED1 measures.
Distributed Generation Index (DGI)	Categorise the risk of generation hosting capacity versus maximum observed level of generation at a substation level.	 New components in RIIO-ED2 BPDTs & annual RRP
Fault Level Index (FLI)	Categorise the risk of the fault level duty versus equipment capability at the LI substation/group level.	
Flexibility Index (FI)	Categorise the risk associated with un-secured demand managed by flexibility	
Total	Combine to provide an aggregate view of Load Related	
Load Related Risk	Risk at Substation & Group level.	



Total Loading Risk - Straw-man

Total Load Related Risk



Demand Index

LI Logic				
Ranking	Loading (percentage)		Duration Factor (hours)	
	Lower bound	Upper bound	Lower bound	Upper bound
L11	0%	<80%	n/a	n/a
L12	80%	<95%	n/a	n/a
L13	95%	<99%	n/a	n/a
L14	99%	n/a	0	<9
L15	99%	n/a	9	n/a

Risk weighting	
Ranking	Weighting
L11	1
L12	1
L13	1
L14	20
L15	100

Generation Index

DGI Logic		
Rank	Generation (percentage)	
	Lower bound	Upper bound
DGI 1	0%	<50%
DGI 2	50%	<80%
DGI 3	80%	<90%
DGI 4	90%	<95%
DGI 5	95%	n/a

Risk weighting	
Rank	Weighting
DGI 1	1
DGI 2	1
DGI 3	1
DGI 4	20
DGI 5	100

Fault Level Index

FLI Logic		
Ranking	Fault level (percentage)	
	Lower bound	Upper bound
FLI 1	0%	<50%
FLI 2	50%	<80%
FLI 3	80%	<90%
FLI 4	90%	<95%
FLI 5	95%	n/a

Flexibility Index

Flexibility Index Logic		
Rank	Available Flex / Unsecure demand	
	Lower bound	Upper bound
FI 1	tbc	tbc
FI 2	tbc	tbc
FI 3	tbc	tbc
FI 4	tbc	tbc
FI 5	tbc	tbc

Risk weighting	
Rank	Weighting
FI 1	1
FI 2	1
FI 3	1
FI 4	tbc
FI 5	tbc

Demand Index Development

Existing Load Index becomes Demand Index with some minor improvements

LI Logic

Ranking	Loading (percentage)		Duration Factor (hours)	
	Lower bound	Upper bound	Lower bound	Upper bound
LI1	0%	<80%	n/a	n/a
LI2	80%	<95%	n/a	n/a
LI3	95%	<99%	n/a	n/a
LI4	99%	n/a	0	<9
LI5	99%	n/a	9	n/a

Risk weighting

Ranking	Weighting
LI1	1
LI2	1
LI3	1
LI4	20
LI5	100

- Review levels and width of the LI bandings as they are sensitive to small increases in demand and are set close to capacity limits.
- Further guidance for the calculation of firm capacity to ensure a consistent approach.
- Consideration of extension to secondary networks for ED3 (not currently feasible due to limitations of secondary substation monitoring).

Retain and Improve the Existing Load Index Metric

Draft Distributed Generation Index Tables - Straw-man

Consider generation hosting capacity versus maximum observed level of generation at substation/group level.

GENERATION GROUP DESCRIPTION					GENERATION INDEX - CURRENT										
	Substation	Substation primary voltage	Substation secondary voltage	No. of customers	Substation generation unconstrained capacity under intact conditions	Available DSR (demand turn up) adjustment	Total generation unconstrained capacity under intact conditions	Available additional ANM capacity	Total unfirm generation capacity	Limiting factor	Substation observed maximum generation	Curtailment	Maximum generation as % of generation unfirm capacity	DGI ranking	DGI risk points
No.	Substation name	(kV)	(kV)	#	MVA	MVA (+)	MVA	MVA	MVA	(A-K)	MVA	MWh	%	DGI1 - DGI5	Generation risk points

INTERVENTION DETAIL						
Intervention action during year	DNO reference for intervention (eg project id)	Expenditure in-year	DG Firm capacity change resulting from intervention	Demand change resulting from intervention	Type of intervention	Intervention description
in progress / completed		£m	MVA	MVA	Conventional / Innovative / Mixed	comment

- Evaluate Generation **Capacity** and **Max** Generation at substation/group level i.e. Peak Generation as % of capacity (intact conditions).
- Generation driven **interventions** can be **tracked**, including DG Index movements and associated investment.
- **Demand Side Response** (DSR) and Capacity made available by **ANM** should be listed along with actual levels of **curtailment**.



Draft Fault Level Index Tables - Straw-man

Categorise the risk of the fault level duty versus equipment capability at the LI substation/group level

FAULT LEVEL GROUP DESCRIPTION				FAULT LEVEL - CURRENT								
	Substation	Substation primary voltage	Substation secondary voltage	Busbars at FLI 1	Busbars at FLI 2	Busbars at FLI 3	Busbars at FLI 4	Busbars at FLI 5	Total number of busbars	Busbars operationally managed	Overall Fault Level Index ranking	Upstream constraint
No.	Substation name	(kV)	(kV)	#	#	#	#	#	#	#	FLI 1 - FLI 5	(Y/N)

- Apply a Fault Level Index ranking according to the **Fault Level Duty** as % of **Equipment Rating**.
- Report most demanding condition (3-phase/Line-ground, make/ break/ withstand) at each site/group.
- List where Fault Levels are **operationally managed**, or **constrained** by upstream ratings, against the substation/group.
- Fault Level **interventions** detailed, including the FL Index movements and associated **Investment**.

INTERVENTION DETAIL									
Intervention action during year	DNO reference for intervention (eg project id)	Expenditure in-year	Fault level ranking resulting from intervention					Type of intervention	Intervention description
in progress / completed		£m	Busbars at FLI 1	Busbars at FLI 2	Busbars at FLI 3	Busbars at FLI 4	Busbars at FLI 5	Conventional / Innovative / Mixed	comment



Draft Flexibility Index Table – Straw-man

Categorise the risk of the level of un-secured demand managed by Flexibility contracts

FLEXIBILITY GROUP DESCRIPTION				
	Substation	Substation primary voltage	Substation secondary voltage	No. of customers
No.	Substation name	(kV)	(kV)	#

FLEXIBILITY CONTRACTS											
Capacity of Pre-fault contracts	Volume of Pre-fault contracts	Capacity of Post-fault contracts	Volume of Post-fault contracts	Capacity of Restore contracts	Volume of Restore contracts	Demand exceeding Firm Capacity (excl. Flex)	Demand exceeding Firm Capacity (excl. Flex)	FI ranking	FI risk points		
MVA	#	MVA	#	MVA	#	MW	MWh	F11 - FI15	Flexibility risk points		

- Consider the level of demand exceeding firm capacity (MW and MWh).
- Report the capacity and volume of Pre-fault, Post-fault and Restore Flexibility contracts being used to manage the un-secure demand.



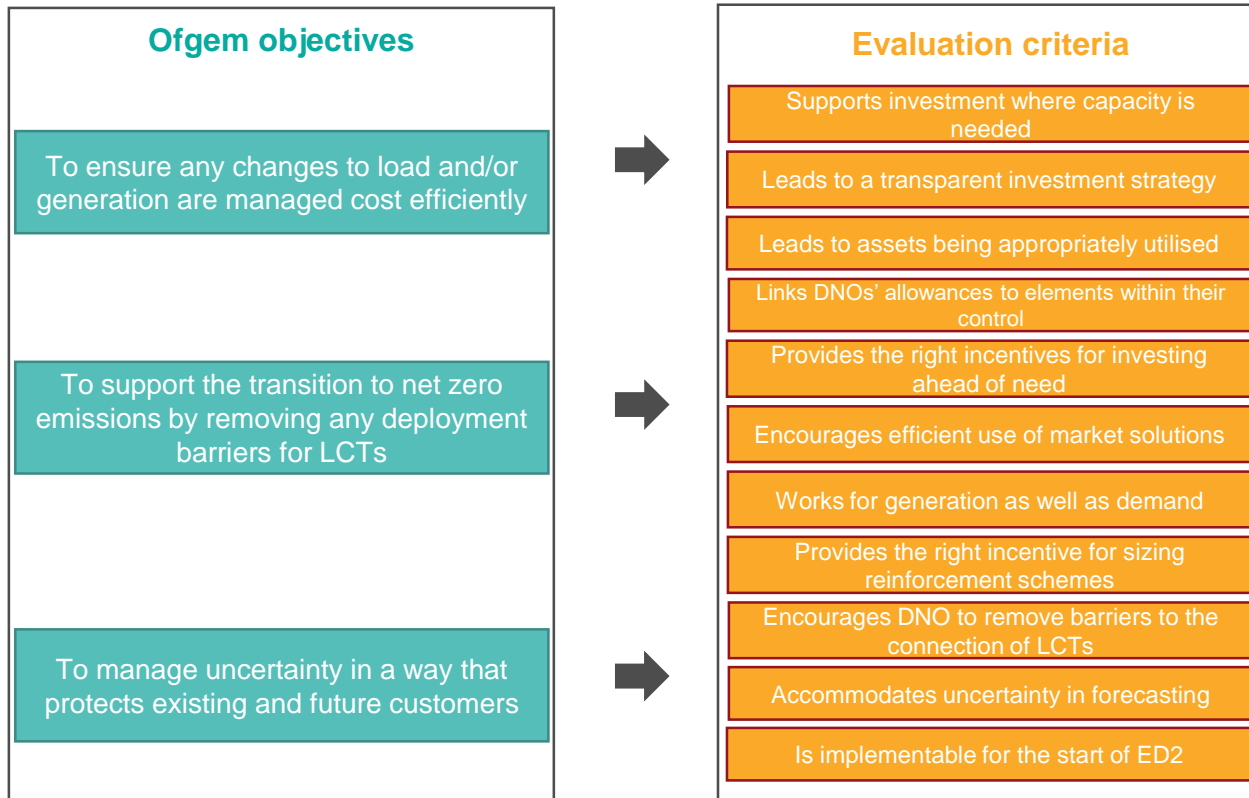
Presentation from UKPN: Network Utilisation

UKPN – Network Utilisation

7 July 2020

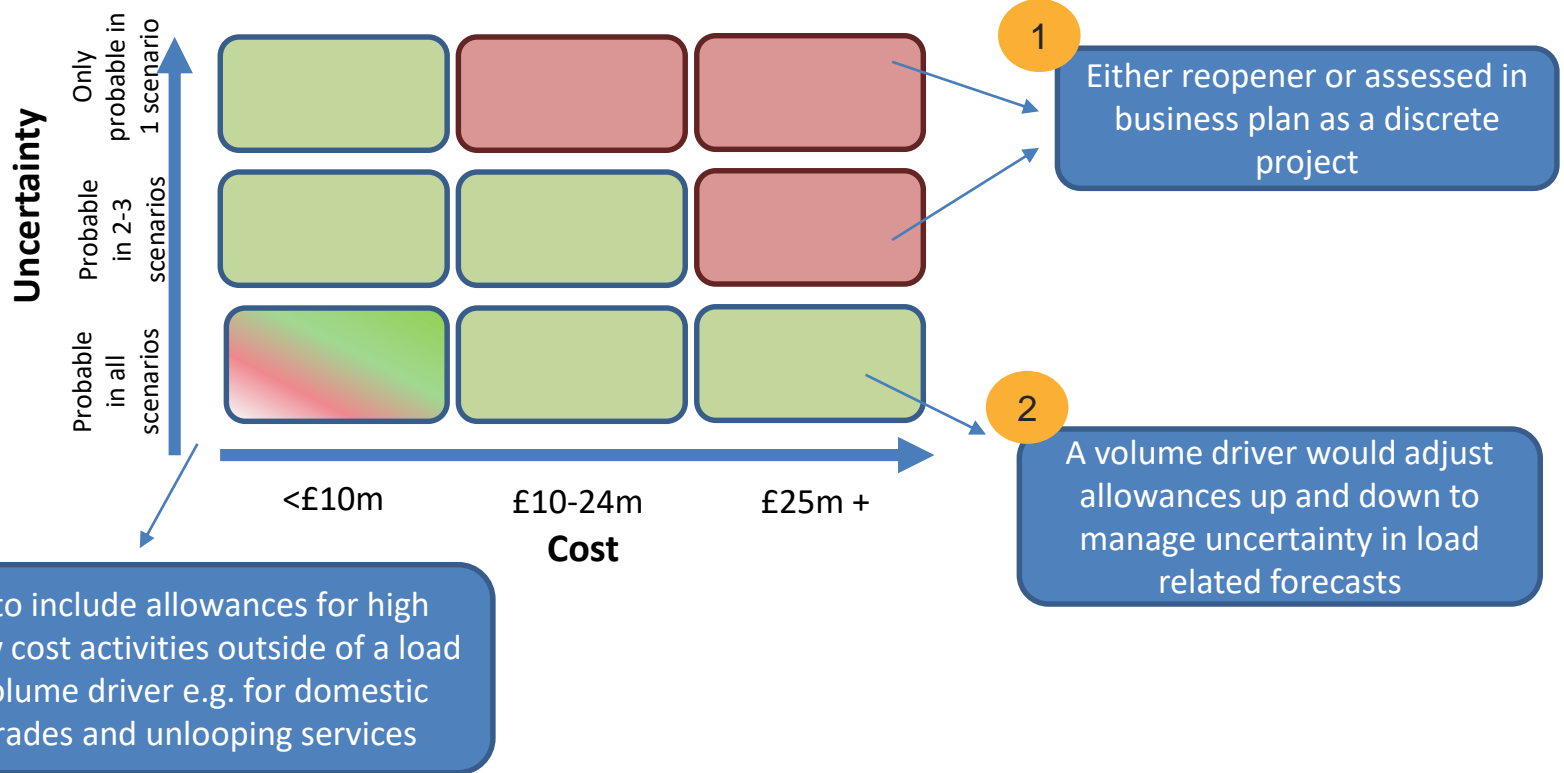


Objectives and evaluation criteria for a load related mechanism



We use these criteria to assess different options for an LRE mechanism later in this pack

Where a new volume driver could apply



Background on utilisation

What do we mean by utilisation

- A measure of how loaded network assets are – typically interested in the maximum
- The concept of tracking assets by utilisation is already well established at Primary level via the Load Index

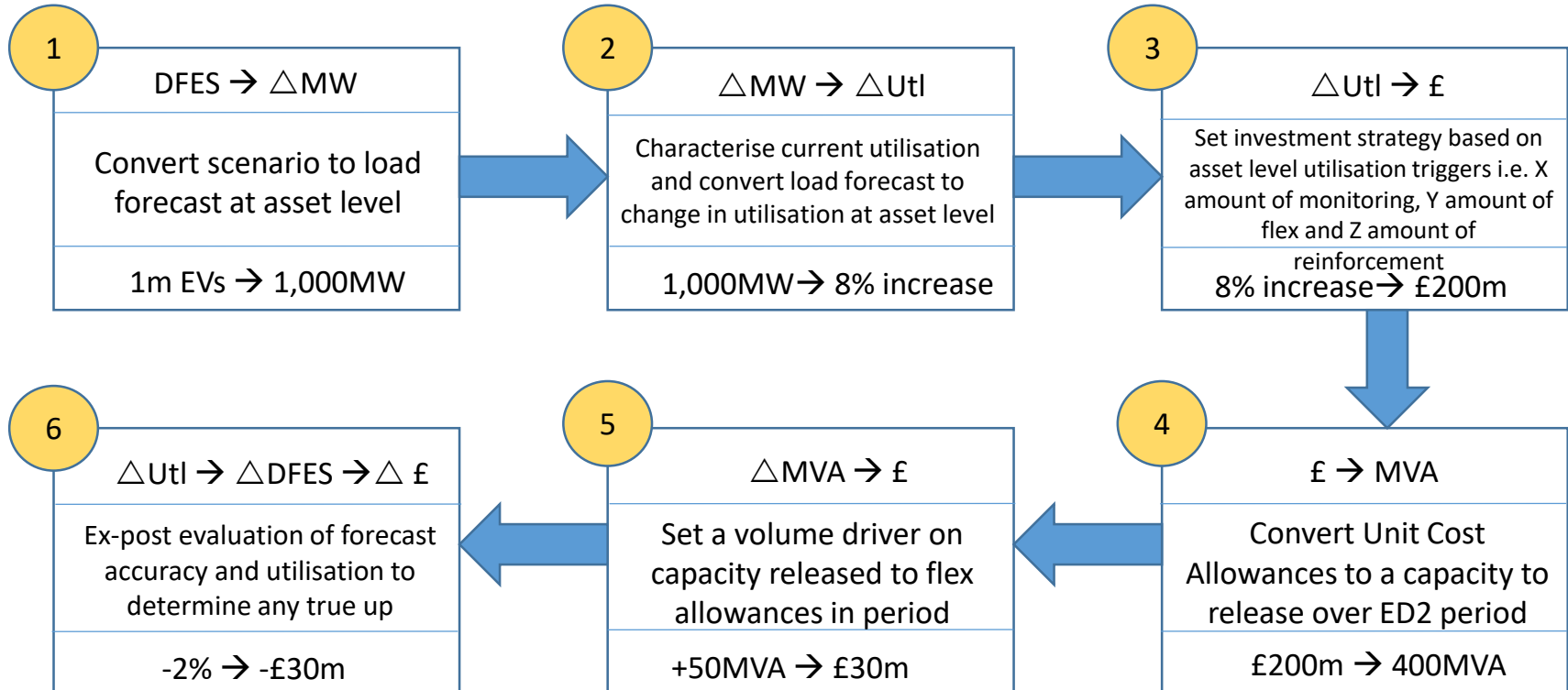
Why an utilisation metric at the secondary level is in both our and our customers' interests

- Ultimate aim of the DNO is to facilitate any increase in demand and new connections at lowest cost
- An utilisation metric encourages DNOs to intervene where most needed and in a consistent manner

How could a new utilisation metric work

- Secondary network more complex and uncertain, it makes sense to use utilisation to justify and evidence interventions and subsequent funding
- Improved asset data can help drive decision making and evidence
- Can appropriately reflect different unit costs of interventions at different utilisation levels

Overview of utilisation mechanism



Using utilisation to evidence the investment strategy

- 1 Start with the DFES to understand the impact of load growth on individual sites and the impact on overall utilisation of the network
- 2 Identify the types of interventions required and how these may vary by the utilisation of asset – e.g. mix of interventions per utilisation band
- 3 Develop a £/MVA released per utilisation band or single composite unit cost based on blend of interventions
- 4 Forecast capacity to be released per utilisation band to manage load growth
- 5 Propose allowances based on forecast capacity released in each utilisation band x unit cost for each utilisation band and set out forecast utilisation following that capacity released

Utilisation bands	Step 1 →		Step 2 →	Step 3 →	Step 4 →	Step 5	
	Sites per banding Start ED2 (2023-24)	DNO best view of sites per banding at End ED2 (2027-28) <u>without</u> intervention (%)	Intervention types – applied per banding	Average Unit Cost per intervention mix (£/MVA)	DNO best view ED2 capacity released (MVA)	ED2 Ex Ante allowance (£m)	DNO best view of sites per banding at End ED2 (2027-28) <u>with</u> intervention (%)
0-60%	75%	60%	No intervention	£0	n/a	0	70%
60-80%	10%	20%	Intervention mix 1	£15,000	42	0.6	15%
80-100%	10%	10%	Intervention mix 2	£90,000	46	4.1	15%
>100%	5%	10%	Intervention mix 3	£600,000	338	203	0%
Average	40%	50%					45%
Total	100%	100%			425	207	100%

Using utilisation as a basis of a volume driver

- 1 Track utilisation of assets in each year of ED2 and assess the difference between actual and forecast number of assets in each utilisation band in each year of ED2
- 2 Report actual capacity released per utilisation band in each year of ED2
- 3 Apply unit costs per utilisation band (or composite unit cost) to the difference between actual and forecast capacity released to identify where the volume driver kicks in (this could be subject to a deadband)

Utilisation bands	Step 1 →		Step 2 →		Step 3	
	Difference between forecast and actual percentage of sites in each utilisation banding		Actual capacity released (MVA) per utilisation banding per year		Apply unit cost to each utilisation banding to calculate volume driver allowances (£m)	
	2024	2027	2024	2027	2024	2027
0-60%	-2%	-2%	0	0	0	0
60-80%	4%	4%	7	10	0.1	0.2
80-100%	17%	17%	7	11	1	1
>100%	5%	25%	50	109	30	65
Total Actual	42.8%	46.9%	65	130	31	67
Total Forecast	41.8%	46.1%	62	107	30	53
Difference	1.0%	0.8%	3	23	1	13

The volume driver encourages DNOs to release more capacity where they can evidence more assets have moved into higher utilisation bands

Using utilisation to check capacity released is efficient

- 1 Assess expected capacity release per utilisation band and compare to actual capacity released
- 2 This allows Ofgem to identify where actual capacity released is higher or lower than expected
- 3 This can be taken into account in a close-out mechanism and it can also be linked to the starting point for ED3, identifying where there is existing capacity on the network

Utilisation bands	Step 1 and Step 2					
	Difference between DNO ED2 best view and actual					
	Forecast sites per utilisation banding (end of ED2)	Expected Capacity released (MVA)	Forecast spend (£m)	Actual Capacity released (MVA)	Actual spend (£m)	Actual sites per utilisation banding (end of ED2)
0-60%	75%	n/a	0	0	0	80%
60-80%	10%	42	0.6	50	0.8	15%
80-100%	10%	46	4.1	50	4.5	5%
>100%	5%	338	203	500	300	0%
Average	40%					35%
Total	100%	425	208		305.	100%

- In example the load growth does not vary from forecast
- But the DNO released more capacity than forecast
- Meaning overall utilisation is lower than forecast
- This could be used as a trigger to assess whether additional capacity release was efficient and could have a bearing on ED3 allowances
- The measure of utilisation could also be based around MW connected per MVA released

Assessment of options against evaluation criteria

Below is an initial assessment of the options against the principles developed for the mechanism

Criteria	Option 1: ED1 arrangements	Option 2: £/MW volume driver	Option 3: £/MVa volume driver	Option 4: £/MVa volume driver based around utilisation
Supports investment where capacity is needed	2	2	1	3
Leads to a transparent investment strategy	1	2	1	3
Leads to assets being appropriately utilised	2	3	1	3
Links DNOs' allowances to elements within their control	2	1	3	3
Provides the right incentive for investing ahead of need	1	2	1	2
Encourages efficient use of market solutions	2	2	1	3
Works for generation as well as demand	3	3	3	2
Provides the right incentive for sizing reinforcement schemes	2	1	1	2
Encourages DNOs to remove barriers to the connection of LCTs	1	3	1	3
Accommodates uncertainty in load forecasting	2	3	3	3
Is implementable for ED2	3	2	3	3
Total score	21	24	19	30

A metric around utilisation appears to perform more consistency against the criteria. Its key strengths are:

- It provides real transparency around the investment strategy
- It links revenues to an aspect which DNOs can control (capacity released)
- It links capacity released (and spend) to a tangible output – utilisation. This protects against over-investment
- It promotes improvement in asset data quality to track and report utilisation – ensuring that investment is justified
- It provides a strong basis to assess investment in longer term (ED3 and beyond)

Actions, next steps and AOB

- We do not have a date yet for our next session on LIs. Further work is needed if we want to develop the Lis.
- We will circulate notes and an actions log from this meeting.

Our core purpose is to ensure that all consumers can get good value and service from the energy market. In support of this we favour market solutions where practical, incentive regulation for monopolies and an approach that seeks to enable innovation and beneficial change whilst protecting consumers.

We will ensure that Ofgem will operate as an efficient organisation, driven by skilled and empowered staff, that will act quickly, predictably and effectively in the consumer interest, based on independent and transparent insight into consumers' experiences and the operation of energy systems and markets.