WS1B P6 Operational DER Visibility and Monitoring

GC0117 Workgroup Meeting

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Agenda

1. WS1B P6 Background, Scope and Timelines
2. DER (Capacity, voltage level) and DER data points in scope of WS1B P6
3. Use Cases, Volumes and Data Points
4. Operational metering Functional Specifications
5. Operational metering DNO’s GAP analysis
6. Operational metering CBA

1. WS1B P6 Background, Scope and Timelines

Ofgem Call for evidence: Visibility of distributed generation connected to the GB distribution networks

- On Friday 9 August 2019, a power outage caused interruptions to over 1 million consumers. A large volume of distributed generation (DG) tripped or deloaded during the event, but evidence of which specific generators were affected, the total reduction in output, and the actual cause of this was very limited.

- Following this event, Ofgem opened an investigation into the power outage and concluded that DNOs lack consistent and complete information on the operational characteristics and performance of distributed generators connected to their networks.

- In August 2020, Ofgem published a call for evidence on DG visibility, highlighting the shortfall in the collection and recording of real-time data associated with distributed generation

Ofgem Questions on DER Visibility

1. Are there **additional DG data points**, such as real-time MW/MVAr output, load factors and protection settings, which would aid in the prevention of, live management, and recovery from loss of supply events?
2. What **value** will these additional characteristics provide to
   a) improving the **planning, security and real time operation** of the GB transmission and distribution systems?
   b) to **improving DSO function delivery** by the DNOs or other stakeholders? DSO functions may include network management, flexibility procurement, and service conflict avoidance.
3. At what **temporal resolution** (instantaneous, seconds, minutes etc.) would real time data on DG be valuable to improve the resilience of the GB electricity system in the prevention of, live management, and recovery from loss of supply events?
4. What **investment** would be required for monitoring, collecting, storing and disseminating real time operational data associated with DG? Which party should be responsible for these investments? How does this vary, based on the size of visible DG at 1MW or 50kW?

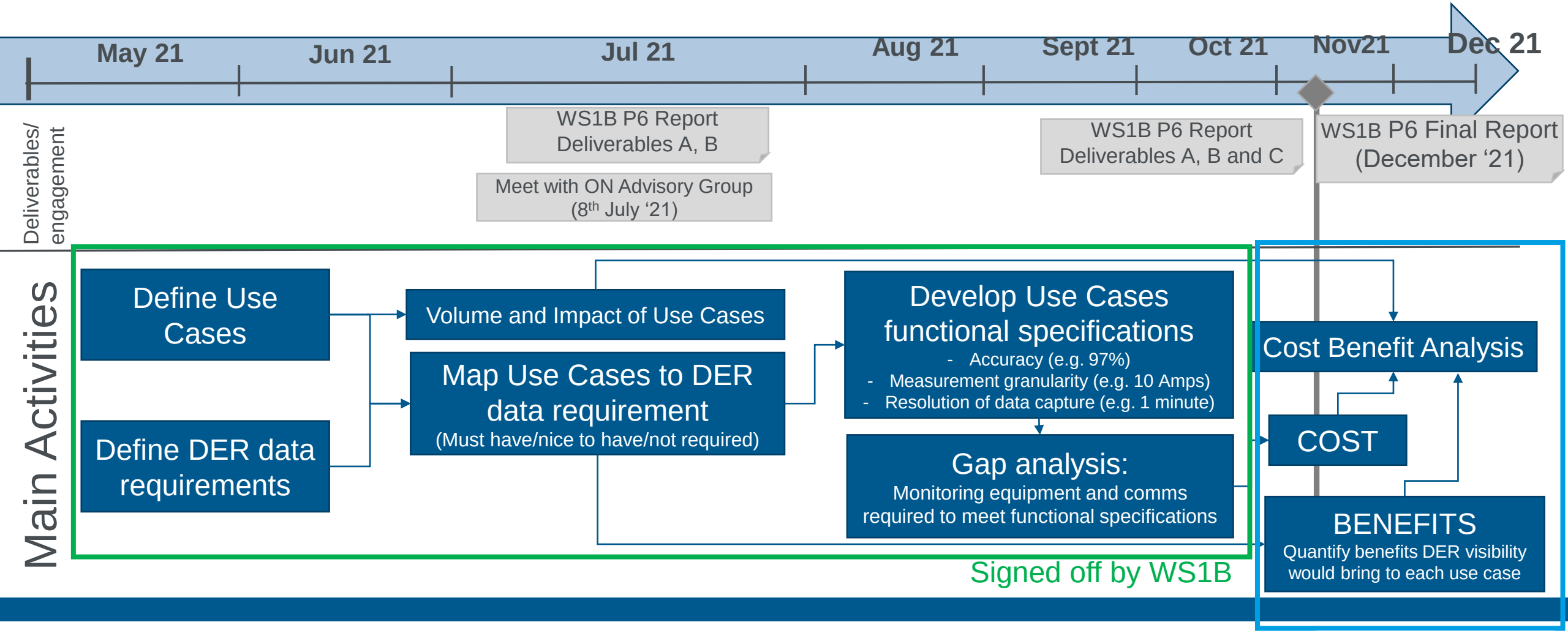
P6 Project Initiation Document (PID)

Ref	Product Element	Activities	Timeline
A	Definition of use case variables	Define and list all possible parameters and variables for DG and DER monitoring.	Feb 21
B	Agreement on use cases and volumes	Define the specific articulations of uses cases. DNOs and the ESO to infill the volumes of examples against each use case.	Mar – May 21
C	Development of functional specifications	Define the functional specifications that would enable sufficient data capture and transfer against each of the agreed use cases.	Jun – Jul 21
D	Cost benefit analyses	(A) All network licensees to collaborate to define the quantitative and qualitative parameters for a CBA. (B) Undertake CBA against the articulated use cases.	Aug – Dec 21

Outcome

Inputs to inform the development of the policy on DER monitoring requirements.

WS1B P6 - Timelines



2. WS1B P6 - DER and Data Points in scope

Operational DER visibility – scope boundary

POC Voltage level

From HV busbar at secondary substation to 132kV bar at Grid Supply Points (GSP)

DER capacity

In line with G99 (Type A, B, C, D).

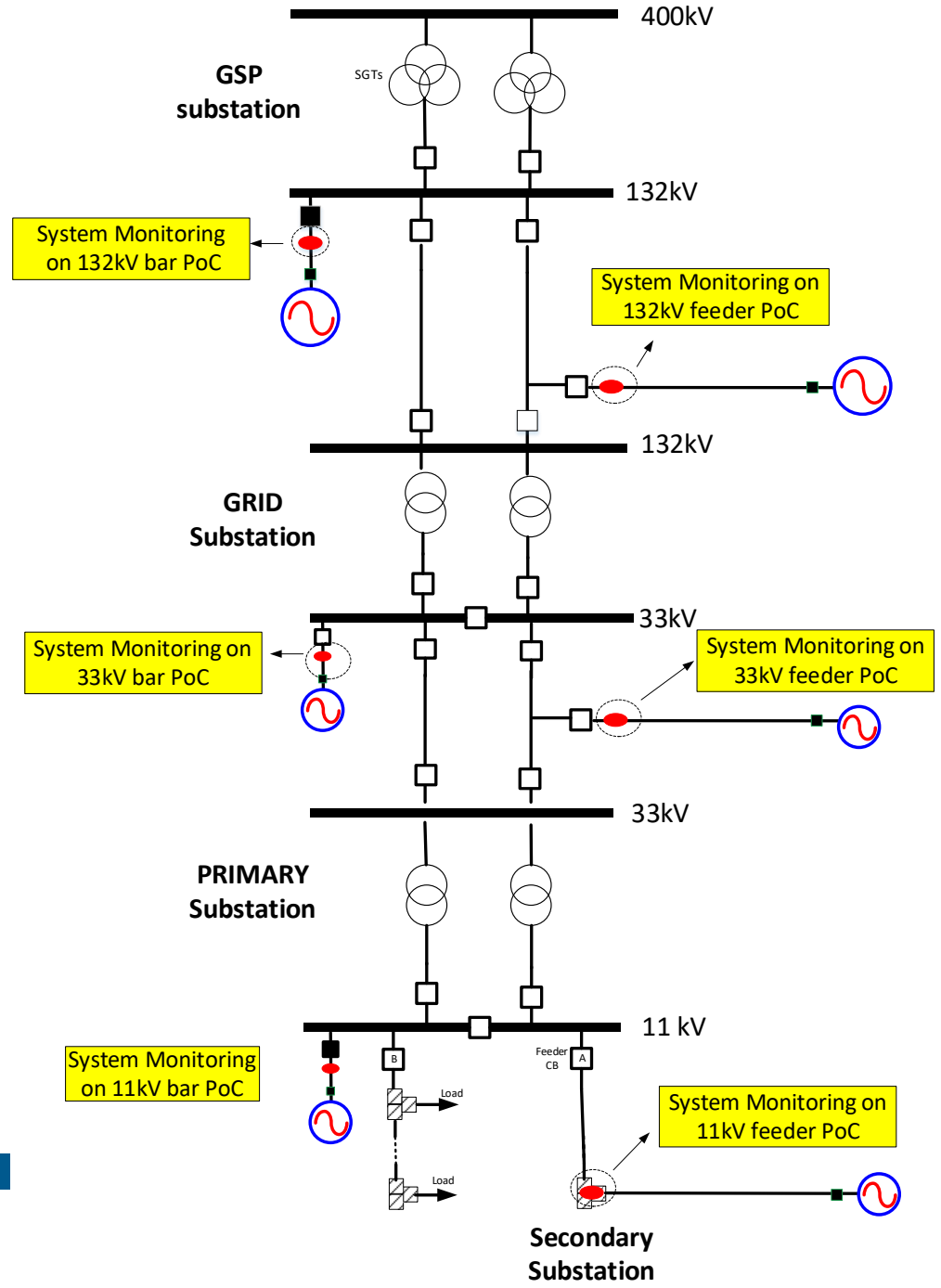
Minimum capacity to be determined as part of CBA

Connection Date

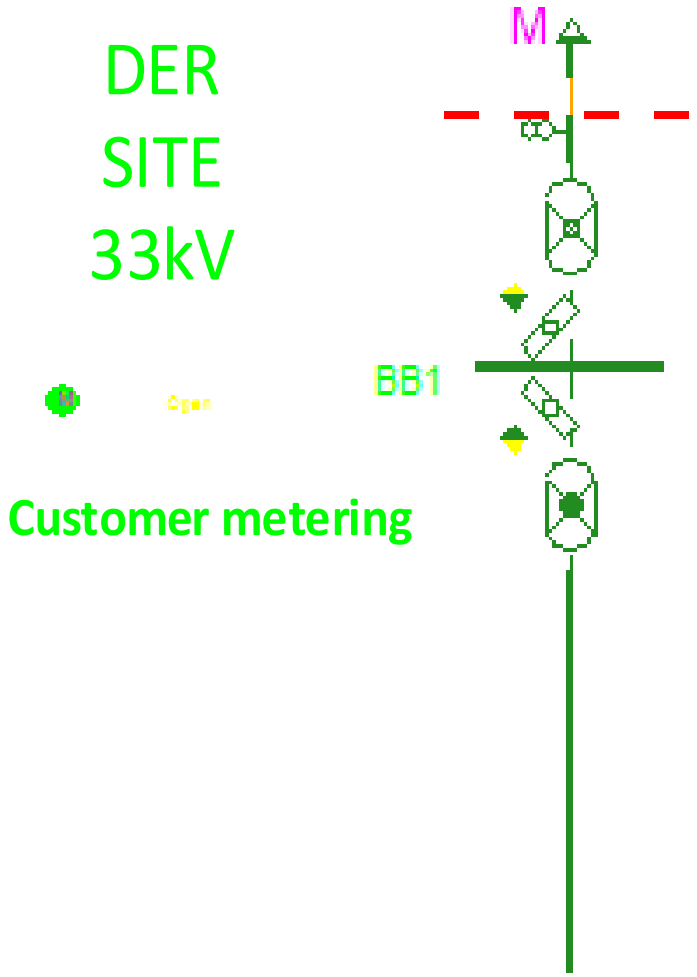
New and existing DER

DER type

Distributed Generators (DG). Demand has been excluded from this year's scope



Data Points in scope (restricted from initial list)



Telemetry Data (SCADA)

- **Raw data**
  - Amps, kW, kVAr, kV
  - Frequency
  - CB status
  - Weather Data @ POC
  - Power Quality monitoing
- **Availability Data**
  - DERavailability (0/1)
  - Capacity in Service
- **Processed data**
  - Load Factor
  - State of Energy (Storage)
  - Power Available

3. WS1B P6 – Use Cases, Volumes and Data Points

WS1B P6 – Use Cases

DER providing service to DNO only	• 1. Flexible Connections dispatch (ANM) • 2. Flexibility Service dispatch
DER proving service to ESO only	• 3. Ancillary and Balancing services • 4. System Restoration (black start) • 5. Capacity Mechanism Planning
DER providing services to a DNO and ESO	• 6.Whole-system coordination (resolving conflict of Services)
All DER -Improvement of existing processes	• 7. System resilience (Major network event recovery) • 8. Improved real-time Network Operation • 9. Improved Outage Planning processes (DNO)/ Network Access Planning (ESO) • 10. Improved Network Planning processes (DNO)/ Network Access Planning (ESO) • 11. Improved Demand forecasting processes • 12. Real-time DSO Data transparency • 13. DER compliance with relevant standards
Market facilitation (non-DSO services)	• 14. Facilitation of new Markets (e.g. peer-to-peer)

WS1B P6 – Volume of Use Cases

THEME	#	USE CASE	VOLUMES (Frequency of occurrence)	IMPACT		
				Network	Commercial	Stability GB system
DER providing service to DNO only	1	Flexible Connections dispatch	High (3)	Low (1)	High (3)	Low (1)
	2	Flexibility Service dispatch	Medium (2)	Medium (2	Medium (2)	Low (1)
DER providing service to ESO only	3	DER providing ancillary and balancing services	High (3)	Medium (2)	High (3)	Medium (2)
	4	DER providing System Restoration (Black start)	Low (1)	High (3)	Medium (2)	High (3)
	5	Capacity Planning Mechanism	Medium (2)	Medium (2)	Medium (2)	High (3)
DER providing services to a DNO and the ESO	6	Whole system coordination (resolving Conflicts of Services)	Medium (2)	High (3)	Medium (2)	Medium (2)
All DER - Improvement of existing processes	7	System resilience (Major network event recovery)	Low (1)	High (3)	Medium (2)	High (3)
	8	Improved real-time Network Operation	High (3)	High (3)	Medium (2)	Medium (2)
	9	Improved outage planning processes (DNO) /Network Access planning (ESO)	High (3)	High (3)	Medium (2)	Low (1)
	10	Improved Network Planning processes (DNO) /Network Access planning (ESO)	Medium (2)	Medium (2)	Medium (2)	Low (1)
	11	Improved demand forecasting processes	High (3)	Medium (2)	High (3)	High (3)
	12	Real-time DSO data transparency	High (3)	Low (1)	Low (1)	Low (1)
	13	DER compliance with relevant standards (EREC, connection agreement , Distribution code)	Low (1)	Low (1)	Low (1)	Low (1)
Market facilitation	14	Facilitation of new markets (e.g. peer-to-peer)	High (3)	Low (1)	Medium (2)	Low (1)

DER visibility and monitoring: Identified DER Data Points

Raw POC Data	• Operational metering: Amps, Volts, W, VARs, • Power Factor, Frequency • Breaker and Isolator status • Power Quality Monitoring • Weather Data • Protection operation (?)
Processed Data	• Load Factor • Power Available • State of Energy
Forecasted Data	• MW Forecasted /Declared MW output
Availability Data	• DER under maintenance (Availability (0/1)) • MW Capacity in Service • Planned DER outage
Market Data	• Service contracted, Volume of Service contracted, Volume of service forecasted, Volume of service dispatched, activation period
Static Data	• Capacity, Technology Type and PQ envelope • Ramp-up and ramp-down rates • Minimum partial output • Fault infeed parameters • Protection settings • Address, MPAN and Site Number

Colour Code: Real Time Data / Non-real time data

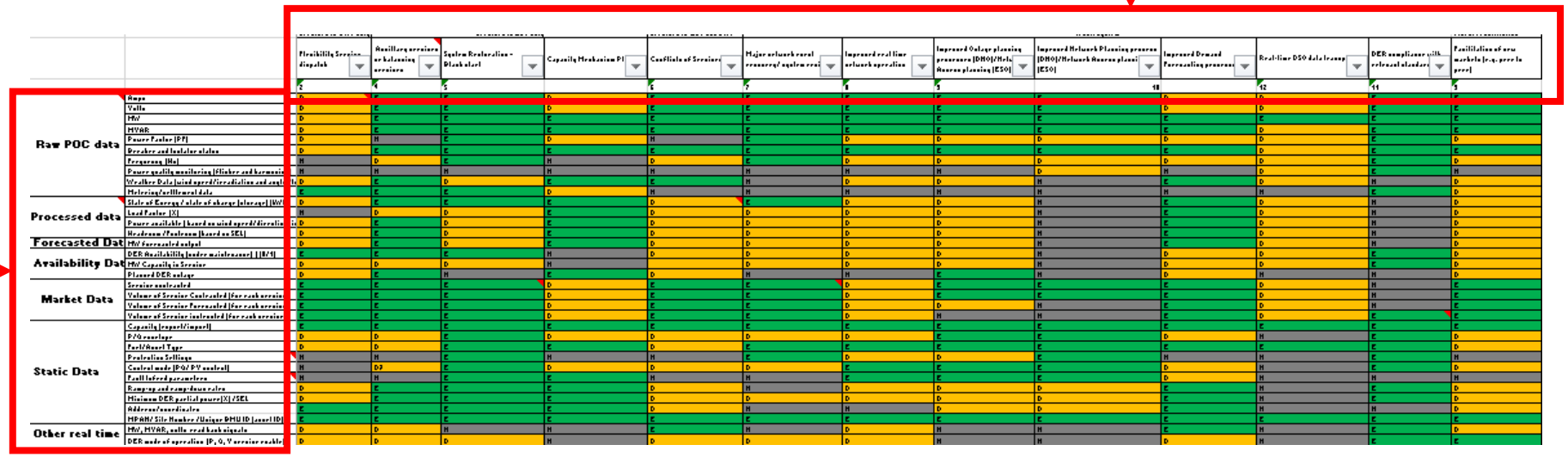
WS1P P6 Data Points Mapping

The use Cases have been mapped to the identified DER data points, as follow:

- **Essential Data**
- **Desirable Data**
- **Data not required**

Use Cases

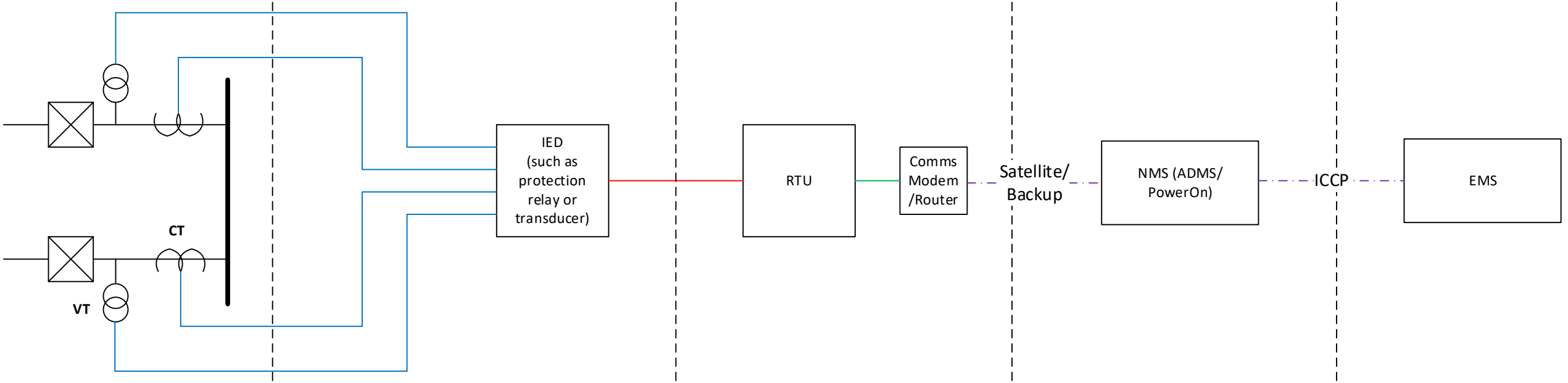
DER Data Points



A closer look to the Outage Planning Process and Flexibility Service Dispatch is available in the next slides.

4. Operational Metering Functional Specifications

Operational Metering equipment



CTs and VTs. These are connected to the network with a proportional analogue output connected to the input of the IED device (Protection Relay, transducer etc)

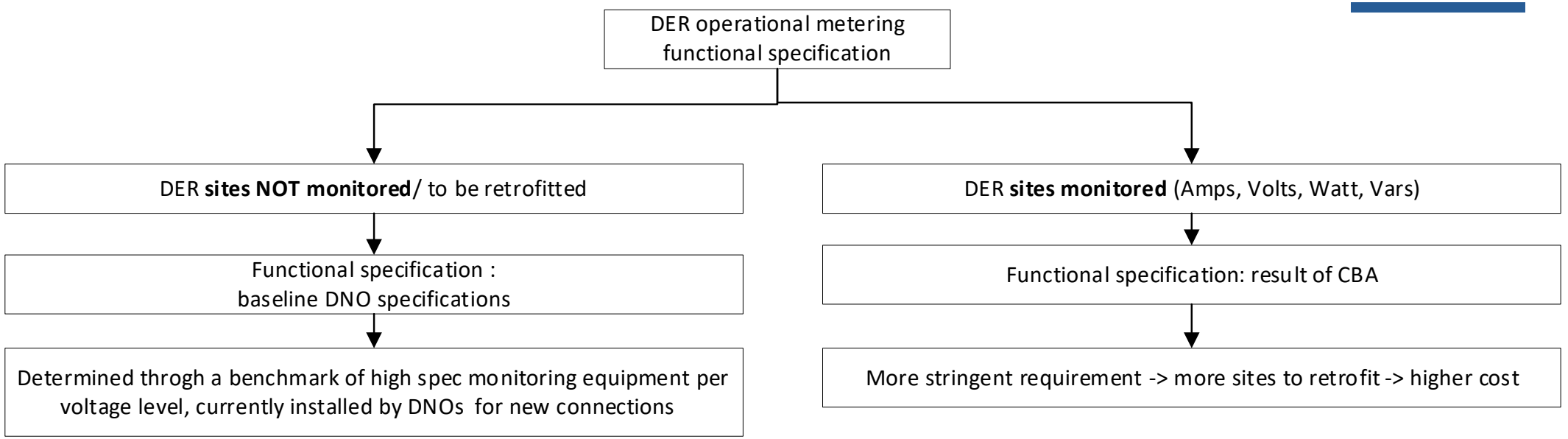
IED device. This is usually installed on or within the switchgear panel. This will have an Analogue to Digital convertor to sample the analogue input value and digitise it.

The **RTU** receives the sampled analogue values from the IED device using a comms bus (serial bus for older devices, and Ethernet for modern), and makes them available for the NMS to collect when the NMS polls the RTU for analogue data.

NMS . The NMS (DNO's network management system) will receive and utilise any analogue data sent by the RTU

EMS. The EMS (ESO's energy management system) will receiv analogue data from the NMS

Operational Metering Functional Specifications



	Accuracy	Resolution of data capture/ refresh rate
	Amps, Volts, W, Vars	
132kV EHV connections	95% of better	1% change or lower
33kV EHV connections		
11kV switchgear connections		
11kV feeder RMU connections (NVD Panel)		

Benchmarking of DNO high spec monitoring equipment

			CT		IED (Protection relay/ PQM/ transducer)			CT + IED	VT + IED	CT + VT + IED	RTU deadbanding
		VT Class	CT Class	CT accuracy error	ATD bits	Measuring range of the IED [A]	Amps/Volts Accuracy error of the IED	Amps accuracy percentage	Volts accuracy percentage	MW/MVAR accuracy percentage	Refresh Rate
NIE	132kV EHV connections	0.2	0.2s	0.20%	TBA	TBA	TBA	99.3%	99.3%	98.57%	TBA
	33kV EHV connections	0.2	0.2s	0.20%	TBA	TBA	TBA	99.3%	99.3%	98.59%	TBA
	11kV switchgear connections	0.2	0.2s	0.20%	TBA	TBA	TBA	99.3%	99.3%	98.58%	TBA
	11kV feeder RMU connections (NVD Panel)	0.2	0.2s	0.20%	TBA	TBA	TBA	99.3%	99.3%	98.59%	TBA
ENW	132kV EHV connections	1.0	PX	0.50%	16	TBA	TBA	99.2%	98.7%	97.97%	1%
	33kV EHV connections	1.0	PX	0.50%	16	TBA	TBA	99.2%	98.7%	97.99%	1%
	11kV switchgear connections	1.0	10P20/0.5	0.50%	16	TBA	TBA	99.2%	98.7%	97.98%	1%
	11kV feeder RMU connections (NVD Panel	1.0	10P20	3%	16	TBA	TBA	96.7%	98.7%	95.49%	1%
UKPN	132kV EHV connections	0.2	5P20 (protection CT)	1%	16	40,000	0.50%	97.89%	99.3%	97.19%	0.20%
	33kV EHV connections	0.5	5P10 (protection CT)	1%	16	31,500	0.50%	98.02%	99.3%	97.32%	0.20%
	11kV HV Panel switchgear connections	0.5	5P10 (protection CT)	1%	16	2,100	0.50%	98.47%	99.3%	97.77%	0.20%
	11kV feeder RMU connections (NVD Panel	0.5	0.5s (Measurement CT)	0.5%	16	400	0.50%	98.99%	99.0%	97.99%	0.20%
SPEN	132kV	1.0/3P	5P10/5P20 (protection CT)	0.5%	16	2000	0.20%	99.3%	98.8%	98.07%	1%
	33 kV (feeders and Grid sites)	0.2	5P10 (protection CT)	1.0%	16	800	0.20%	98.8%	99.6%	98.39%	1%
	33/11 Primaries	0.2	5P10 (protection CT)	1.0%	16	1200	0.20%	98.8%	99.6%	98.38%	1%
	11kV feeder RMU connections (NVD Panel	0.2	5P10 (protection CT)	1.0%	16	800	0.20%	98.8%	99.6%	98.39%	1%

Accuracy requirement

Resolution of data capture requirement

Benchmarking of DNO high spec monitoring equipment

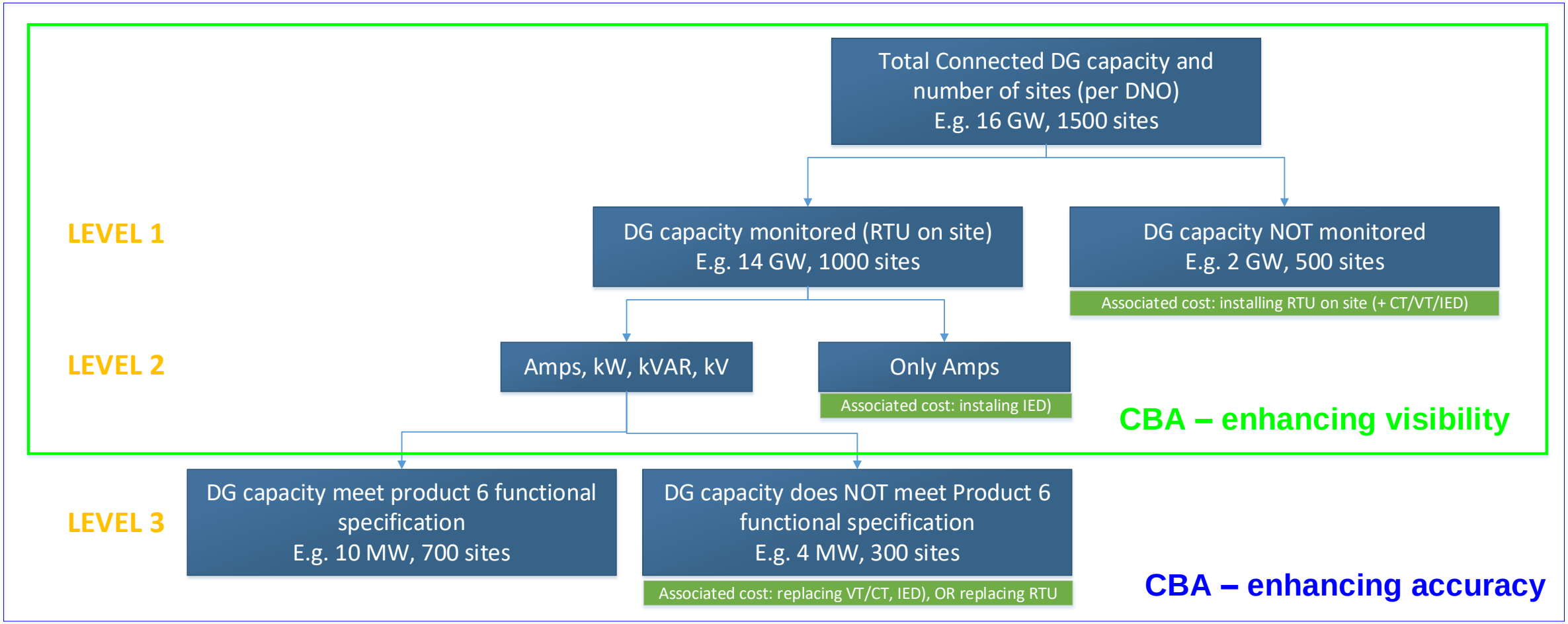
			CT		IED (Protection relay/ PQM/ transducer)			CT + IED	VT + IED	CT + VT + IED	RTU deadbanding
		VT Class	CT Class	CT accuracy error	ATD bits	Measuring range of the IED [A]	Amps/Volts Accuracy error of the IED	Amps accuracy percentage	Volts accuracy percentage	MW/MVAR accuracy percentage	
SSE	132kV EHV connections	0.2	5P10	1%	16	800	1%	98.0%	98.8%	96.79%	0.5%
	33kV EHV connections	0.2/0.5	5P20	1%	16	800	1%	98.0%	98.5%	96.49%	0.5%
	11kV switchgear connections	0.5	PX	1%	16	800	1%	98.0%	98.5%	96.49%	0.5%
	11kV feeder RMU connections (NVD Panel	0.5	0.5S	0.5%	16	400	1%	98.5%	98.5%	96.99%	0.5%
WPD	132kV EHV connections	0.5	TBA	TBA	16	1A or 5A (ct sec)	0.50%	98.5%	99.0%	97.47%	TBA
	33kV EHV connections	0.5	TBA	TBA	16	1A or 5A (ct sec)	0.50%	98.5%	99.0%	97.49%	TBA
	11kV switchgear connections	0.5	5P20 (protection CT)	1.0%	16	1A or 5A (ct sec)	0.50%	98.5%	99.0%	97.48%	TBA
	11kV feeder RMU connections (NVD Panel	0.5	0.2s	0.2%	16	1A or 5A (ct sec)	0.50%	99.3%	99.0%	98.29%	TBA
NPG	132kV EHV connections	< 1%	5P10 (protection CT)	1.0%	16	1A or 5A (ct sec)	0.20%	98.8%	98.8%	97.57%	TBA
	33kV EHV connections	<1%	5P10 (protection CT)	1.0%	16	1A or 5A (ct sec)	0.20%	98.8%	98.8%	97.59%	TBA
	11kV switchgear connections	<1%	5P10 (protection CT)	1.0%	16	1A or 5A (ct sec)	0.20%	98.8%	98.8%	97.58%	TBA
	11kV feeder RMU connections (NVD Panel	<1%	5P10 (protection CT)	1.0%	16	1A or 5A (ct sec)	0.20%	98.8%	98.8%	97.59%	TBA

Accuracy requirement

Resolution of data capture requirement

Operational Metering DNO's Gap analysis

Gap Analysis and operational metering CBA



Initial Gap Analys Results (level 1)

DNO	VOLTAGE LEVEL	NUMBER OF SITES	CAPACITY [MW]	Sites monitored (RTU on site)		Sites non monitored	
				# Sites	Capacity [MW]	#Sites	Capacity
ENW	132 33 11 / 6.6	11 61 190		10 (95%) 55 (> 90%) 9 (<5%)		1 (5%) 6 (<10%) 181 (>95%)	
SPEN	132						
	33	81	1705	73 (90%)	1646	8 (10%)	59
	11	276	504	29 (10%)	187.6	247 (90%)	316
UKPN	132	28	3230.2	28 (100%)	3230.2	0 (0%)	0
	33	200	2800.9	199 (99.995%)	2787.5	1 (0.5%)	13.4
	11	245	781.9	41 (16%)	237	204 (83%)	544.9
WPD	132						
	33						
	11						
SSE	132 33 11						
NPG	132	13	2600	2		0	
	66/33	101	3000	13		66	
	20/11/6	469	1500	5		440	
NIE							

Initial Gap Analys Results (level 2)

Level 2 (DIRECTIONAL POWER FLOW AVAILABLE?) x				
	Voltage Level	Number of sites Monitored	FULL METERING (P, Q, V, I)	CURRENT ONLY
ENW				
SPEN				
UKPN	132	28	28 (100%)	0 (0%)
	33	199	195 (98%)	4 (2%)
	11	41	25 (60%)	16 (40%)
WPD				
SSE				

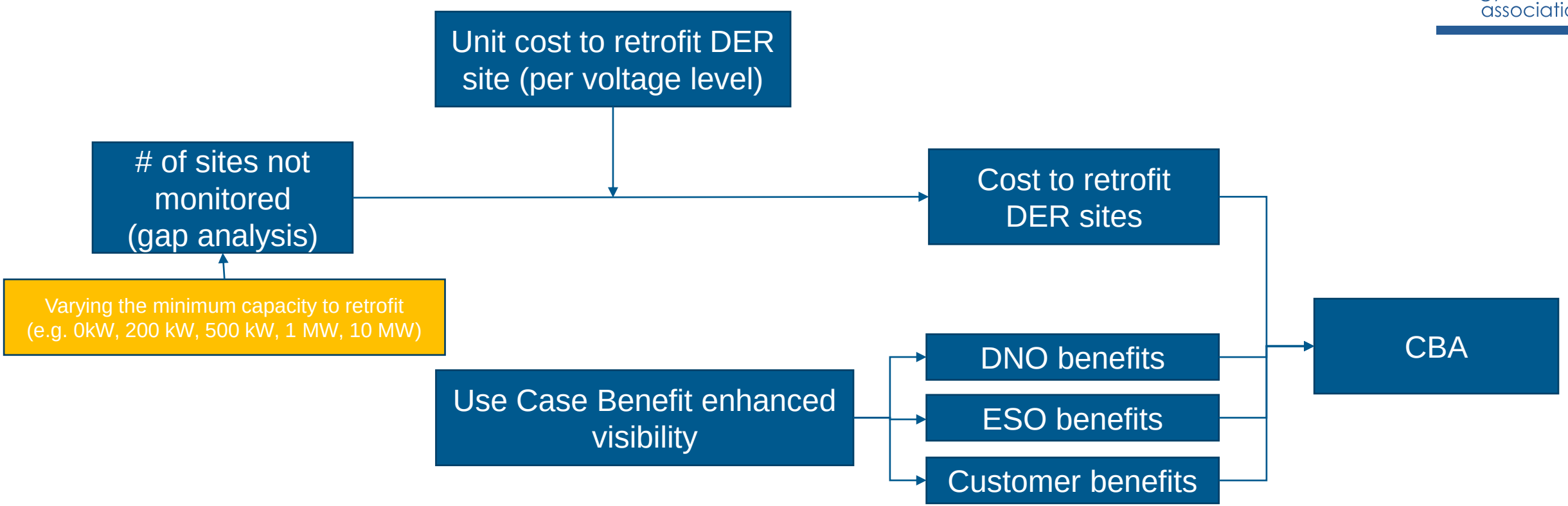
Operational Metering CBA

Operational metering CBA - Enhancing Visibility

- Cost of retrofitting DER not currently monitored vs benefits that additional visibility will bring to all the identified use cases
- The previously defined use cases' **Volumes and Impact** will play a role in the CBA: DER monitoring associated to a use case with a high volume and high impact could be given a higher weight with respect to a use cases with a low volume and low impact.
- In the first place consider retrofitting all sites not/partially monitored regardless of capacity and assess benefits of FULL visibility. If the CBA turns out to be negative or not strongly positive, the approach would be to vary the minimum capacity to retrofit (e.g. 200 kW, 500 kW, 1 MW) and assess related benefits.

Ofgem is looking for unique CBA based on aggregated costs vs aggregated use case benefits (i.e. costs of making DER sites visible (mostly HV) vs benefits of full EHV and HV visibility to ESO and DNOs). We will be providing breakdown of use case benefits for information.

CBA – operational metering (level 1 and 2) - ENHANCING VISIBILITY



CBA will determine the minimum DER capacity worth retrofitting

CBA Operational metering - ENHANCING VISIBILITY (level 1 and 2)

Costs Item	Number of Sites	Unit Cost	£
COST TO RETROFIT existing sites NOT Monitored	204 sites @ 11kV 1 site @ 33kV	XX £/site at 11kV YY £/site at 33 kV	XX
COST TO RETROFIT Existing Sites PARTIALLY Monitored	4 sites @ 33kV 16 sites @ 11kV	XX £/site at 11kV YY £/site at 33 kV	YY
Comms cost (SCADA/ ICCP) to make data available to DNO/ESO?			
…….			

Benefits (continues)	DNO benefits	ESO benefits	Customer benefits	£
Flexible Connections dispatch (ANM)	no additional benefits			
Flexibility Service dispatch	MW over procured * [£/MW] payment + MWh over dispatched *[£/MWh] payment			
DER providing ancillary and balancing services				
DER providing System Restoration (Black start)				
Capacity Mechanism Planning		availability payment [£/MWh]* over-procurement figures		

CBA Operational metering ENHANCING VISIBILITY (level 1 and 2) – in progress

Benefits (continues)	DNO benefits	ESO benefits	Customer benefits	£
Whole System coordination (resolving conflict of services)				
Improved system resilience (Major network event recovery)/ Emergency planning				
Improved real-time network Operation				
Improved outage planning processes (DNO)/Network Access planning (ESO)				
Improved Network Planning process (DNO)/Network Access planning (ESO)				
Demand Forecasting processes	Quantify DNO benefit transitioning from worst case assumption (max gen/min load) to a more realistic view	Quantify ESO benefit improving forecasting accuracy		
Real-time DSO data transparency				
DER compliance with relevant standards				
Facilitation of new markets (e.g. peer-to-peer)				

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