

Overview

1. Polychlorinated biphenyls (PCBs) are a highly toxic product whose production was banned by the Stockholm Convention on Persistent Organic Pollutants in 2001. They are organic chlorinated compounds. Polychlorinated biphenyls were once widely deployed as dielectric and coolant fluids in electrical apparatus, carbonless copy paper and in heat transfer fluids. Because of their durability, PCBs are still widely in use, even though their manufacture has declined drastically since the 1960s, when a host of problems were identified. PCBs are both toxic and carcinogenic and their durability biochemistry means they persist in ecosystems notably bio-accumulate in apex predators like Orcas and Polar Bears as well as in humans.
2. The EU Persistent Organic Pollutants Regulation (POP Regulation) was recast in June 2019 to require that “Member States shall identify and remove from use equipment (e.g. transformers, capacitors or other receptacles containing liquid stocks) containing more than 0,005 % (50 ppm) PCBs and volumes greater than 0,05 dm³ (50 ml), as soon as possible but no later than 31 December 2025”¹.
3. DNOs were not provided with any specific allowances to fund PCB related activities in RIIO-ED1 and the EU POP Regulations were not implemented in the UK until May 2020. For similar reasons, there were no opportunities for DNOs to request additional funding through the RIIO-ED1 Mid-Period Review of Outputs. There are no other mechanisms available in the RIIO-ED1 framework to enable additional funding to be provided.
4. While deadline for compliance is the end of 2025 which falls into the RIIO-ED2 period, in order to meet obligations in 2025, there are clear benefits for some DNOs/DNO customers from starting activities in RIIO-ED1 to meet significant deliverability challenges. Note that the scale of increased asset changes required, and in particular pole mounted transformers (PMTs) changes, is not uniform across all DNOs with some DNOs facing much greater deliverability challenges than others if delivery of this mandatory activity is only fully mobilised in ED2.
5. There is therefore a need for a new mechanism to enable some DNO activities to be brought forward from RIIO-ED2 into RIIO-ED1 to accelerate delivery in line with the 2025 deadline, and to reduce the economic impact of the peak activities Summer 2023 to December 2025 in terms of unit costs of equipment and contracting resources.
6. In order to help meet the UK’s December 2025 obligations, Scottish Hydro Electric Power Distribution Plc (SHEPD) requests an additional allowance of £5.9m in 12/13 prices under Ofgem’s ED1 Green Recovery Scheme to begin to deliver the required outputs in the remaining RIIO-ED1 period. A detailed breakdown of costs and associated narrative is provided below the summary cost category table:

Cost category	Cost £m in 12/13 prices
Asset replacement (inc. PMTs/GMTs, pole replacement where required)	£4,257,224
Data gathering activities (for both PMTs/GMTs)	£1,465,760
Additional costs (if applicable)	£132,474
Total	£5,855,458

¹ REGULATION (EU) 2019/1021 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2019 on persistent organic pollutants (recast). UK Regulation -The Persistent Organic Pollutants (Various Amendments) Regulations 2019, SI 2019/1099

We have completed the full breakdown of costs in the proposed cost reporting worksheet which we have provided as part of this submission.

Impact on RIIO-ED2

Summary of our RIIO-ED2 proposals on PCBs

Ofgem has been highlighting the possibility of additional funding for PCB removal in RIIO-ED1. In our RIIO-ED2 business plan, we made the following assumptions around the volumes which we would deliver in RIIO-ED1 and this informed our RIIO-ED2 volumes and funding request:

Pole Mounted Transformers (PMT) volumes for replacement in SHEPD

Vol (#)	RIIO-ED1 Accelerated 2021-2023	RIIO-ED2 Baseline 2023-25	RIIO- ED2 UM Volumes
PMT (mainly 11kV)	1,234	2,900	3,475
PMT (mainly 33kV)	55	129	196

Ground Mounted Transformers (GMT) volumes for replacement in SHEPD

	RIIO-ED1 Accelerated 2021-2023	RIIO-ED2 Baseline 2023-25	RIIO-ED2 UM Volumes
GMT (Oil Change) (minimum)	45	59	0
GMT (Replacement for 11kv only) (minimum)	10	5	112

We have proposed an uncertainty mechanism for PCBs in our ED2 business plan. This is because the number of transformers we will need to replace due to PCBs is unknown until we have sampled a statistically significant number of assets. That sampling is ongoing (and in part subject to this funding request). The uncertainty mechanism is designed to enable us to deliver the required volumes identified by sampling (based on an aggressive assumption that 50% of sites will require replacement). We also highlighted that given the uncertainty mechanism could be used if funding was not provided in RIIO-ED1, or funding was delayed.

Updated view on PCB volumes in ED1

The assumptions for our RIIO-ED2 business plan were finalized in October (given sign off and assurance). They have had to be updated for this submission due to two factors:

- **Delay in funding:** The working assumption was that additional ED1 funding would be confirmed in Autumn last year. As this is now slipping a few months, we have less time to deliver the work. Consequently, as set out below, we are revising down our ask in RIIO-ED1; and

The table below highlights the updated volumes which we are now asking for in RIIO-ED1.

Asset/Activity	RIIO-ED1 volumes assumed in RIIO-ED2 business plan	Revised RIIO-ED1 volumes	Difference
PMT (mainly 11kV)	1234	1177	-57
PMT (mainly 33kV)	55	0	-55
GMT (oil change)	45	45	0
GMT (replacement)	10	2	-8

As a result of reprofiling of volumes stated in our RIIO-ED2 business plan, we will be delivering more in RIIO-ED2. However, this will not change the baseline numbers which we have requested Ex-Ante funding for. However, depending on the results of our sampling and testing, we need to trigger our proposed uncertainty mechanism, around PCBs. The uncertainty mechanism was proposed precisely for this purpose, given the uncertainties around volumes we needed to replace and whether funding would be provided in RIIO-ED1.²

Asset Replacement

PMT replacement – Cohort Model

- There are a significant number of PMTs on the DNOs' networks to test³/replace, therefore using an industry statistical model (The Model) developed by the ENA, approved by the Environment Agency (via RPS 246) and supported by the Welsh and Scottish Environmental Agencies, all DNOs are sampling transformers based on manufacturer and year. This information is then used to place assets into cohort categories. A number of each cohort will be tested. If a certain percentage of the cohort comes back negative, i.e. it does not contain PCB it will be moved to 'green' and the transformers within that cohort do not need to be tested/replaced by the end of 2025 (i.e. they are statically clean and can remain in service). Where the sampling indicates that a certain proportion of assets contain PCBs, they are classed in the red category (to be replaced). Where we are still waiting on sampling, the asset is classed as amber.
- The most recent iteration of the Model (September 2021) has identified the following classification of assets, for SHEPD, out to 2025:

Category for PMTs	Volume
Red (to be replaced)	2896 ⁴
Amber (a sample need replaced to establish if cohort replacement is required or not)	8,772 (1431 of these to be sampled – sampling will run across RIIO-ED1 and RIO-ED2)
Green (does not need replacing – with output of current cohort modelling)	7049

² https://ssenfuture.co.uk/wp-content/uploads/2021/12/A_17.1_UncertaintyMechanisms_CLEANFINAL_REDACTED.pdf

³ PMTs are sealed units and in service testing is therefore not possible. Testing is conducted on disposal by an Environment Agency licensed waste disposal contractor

⁴ Via the ENA Cohort Model Sep 2021 Update, SHEPD identified 1942 PMTs in Red Category. In addition, 954 PMTs have been identified to be replaced due to lack of cohort information, e.g., missing either Maker or YoM after inspection.

9. In the RIIO-ED1 period, from 2020/21, SHEPD, will expect to deliver/have delivered the following volumes / cost (12/13 prices):

	2020/21	2021/22	2022/23
PMT replacement - Volumes	78	277	900
PMT replacement - Costs	£260,520.00	£925,180.00	£3,006,000.00
Replacement Poles / Additional poles - Volumes	2	0	20
Replacement / Additional Poles – Costs	£3,880.00	£0	£38,800.00

To demonstrate efficiency the cost for the PMTs and Poles is to be referenced to the Ofgem view of efficient unit costs determined in the Disaggregated Cost Benchmarking Model in the Final Determinations for ED1 (ED1 FD).

10. In addition, there may be requirements to install or upgrade associated equipment at the time of the works which are not included in the efficient unit cost above, e.g. installation or upgrade of earthing, upgrade of spur line protection to meet the spec of the uprated transformers (these do not have discrete unit costs in ED1 FD):

12/13 prices	2020/21	2021/22	2022/23
Earthing - Volumes	0	0	0
Earthing - Costs	0	0	0
Protection upgrades - Volumes	0	0	0
Protection upgrades - Costs	0	0	0
Others - Volumes	0	0	0
Others - Costs	0	0	0

Please add additional rows if required.

We do not see these works as a direct consequence of PCB works

GMT replacement

11. GMT testing and replacements are outside of the scope of the ENA statistical model. We are proposing the following GMT replacement costs in RIIO-ED1, due to PCBs.

12/13 prices	2020/21	2021/22	2022/23
GMT replacement Volumes	0	0	2
GMT replacement Costs	0	0	£22,844.35

The focus of our PCB replacement activities in RIIO-ED1 will be on replacing PMTs and data gathering across PMTs and GMTs. For GMTs we plan to try and flush oil out and change in order to get PCBs removed, or below the required levels. However, our initial work indicates that PCB levels will be high in some assets, requiring multiple flushes and oil changes. In these cases, it will be more efficient to replace the asset. We consider these will be minimal, particularly in RIIO-ED1 but we have included a couple of GMTs where we already see replacement to be a more efficient option.

Data Gathering activities to inform replacements

12. Additional data gathering activities have been conducted to inform both the PMT statistical model and other PCB work as set out below. Without these activities there would have been inefficiencies in the work conducted.

Activity (12/13 prices)	2020/21	2021/22	2022/23
Data gathering – PMT (e.g. drones) – Volumes	0	8,004	0
Data gathering – PMT (e.g. drones) – Costs	£0	£293,123.91	£0
Data gathering – GMT – Volumes	0	25	0
Data gathering – GMT – Costs	£0	£2,048.66	£0
Persistent Organic Pollutant Oil Testing (PMTs) – Volumes	78	277	900
Persistent Organic Pollutant Oil Testing (PMTs) – Costs	£1,946.31	£6,809.74	£22,125.51
Persistent Organic Pollutant Oil Testing (GMTs) – Volumes	0	21	3,946
Persistent Organic Pollutant Oil Testing (GMTs) – Costs	£0	£3,081.18	£517,376.46
Persistent Organic Pollutant Oil Changes (GMTs) – Volumes	0	0	45
Persistent Organic Pollutant Oil Changes (GMTs) – Costs	£0	£0	£619,249.70

PMT Data Gathering for ENA Cohort Model

We are proposing to spend £0.3m on PMT Data gathering and oil testing for the ENA Cohort model. Sampling is essential if we are to properly inform our PCB removal plan. Without it we will have to assume that all in-scope transformers contain PCBs and must be replaced. This would be a substantial cost to consumers and not deliverable by the end of 2025.

The Statistical Cohort approach, developed with the ENA and Environment Agency (EA), which has been adopted by us for PMTs, is based on an ISO approved methodology model which is populated by test results from all UK DNO's. The Maker and Year combination for each PMT manufactured before 1987⁵ is recorded and allocated to a Cohort group as containing insulating oil that is either statistically contaminated, clean or more data required. The statistically contaminated assets are then placed in a register for assets for replacement by 31 December 2025. It is important to note that to test a PMT requires its removal from the network and intrusive intervention to gain access to the oil to gain a test sample. Consequently, the PMTs required to be tested for the Cohort model approach will need to be replaced. The Cohort model approach provides an approved and reliable basis for scheduling our programme of contaminated transformer replacements. This approach is supported by the EA through the associated RPS 246 ("Transformers containing PCBs: new rules - RPS 246").

To support the ENA Cohort Model, we need to provide necessary information for each PMT to enable the modelling exercise. An initial inspection programme was completed in September 2021 to feed initial data into the Model on Manufactures and Year of Manufacture. This helped inform our RIIO-ED2 business plan. However, as highlighted in our RIIO-ED2 business plan, further sampling is required to identify the exact number of PCBs which require replacement (hence our proposed uncertainty mechanism on PCBs). We plan to continue with this testing and sampling in RIIO-ED1 to get visibility of the precise replacement numbers as early as possible, so we can mobilise to replace all the PMTs needed to meet the legal requirement.

GMTs Data Gathering & Sampling

We are proposing to spend £1.14m on GMT Data Gathering and Sampling activities, including GMT oil changes.

Our approach for GMTs is to test our population installed pre 1987 to determine the PCB concentration (if any) of the transformer oil in parts per million (ppm).

In 2021, we carried out the GMT Inspection to collect the necessary information to ensure the completeness of our GMT asset attributes in RIIO-ED1. In addition, a statistically significant sample of our GMT population was tested in spring 2021 in order to give an indication of the required level of intervention required to achieve legislative compliance across the fleet by the 2025 deadline. This has been used to inform our ED2 plan. This also helped to prioritise the testing for GMTs made by a specific maker which are more likely contaminated with PCB so that asset interventions can be planned as early as possible. Using the results of this of this sample, we have identified potential volumes for oil change and replacement in RIIO-ED1 and RIIO-ED2.

However, our GMT testing programme is not as advanced as that for PMTs and we have a substantial volume of GMTs to test (3946) in 2022/23. This testing will help identify where we need to change oil on GMTs (or potentially replace) and where they can remain on the network. It will also inform the extent to which we need to trigger our proposed uncertainty mechanism around PCBs in RIIO-ED2.

Our intervention strategy for GMTs with PCB contamination over 50 ppm is to perform a "Drain and Refill" (oil change) in the first instance. (Draining off the original oil and replacing it with clean oil has been shown to reduce the residual PCB level to below 5 % of the initial value).

For GMTs with a PCB level less than or equal to 50ppm, in line with the legislative requirement, we can continue to operate those GMTs and dispose them as soon as possible after the end of their useful lives. Where a PCB test shows a sample of a GMT's oil to contain over 50 ppm of PCB then remedial work must be carried out.

Consequently, the GMT testing represents an efficient use of money and resources as it will mean we can target GMT only where necessary.

Additional costs

13. To be justified by each DNO.

14. For example, the nature of individual projects to replace PMTs is such that there is likely to be significant project indirect costs, e.g. costs incurred due to land access, outage planning / live line job planning and integrated project planning. Note that unless generators are deployed each of these replacements will need pre-planned customer outages with associated QoS incentive impacts.

Activity (12/13 prices)	2020/21	2021/22	2022/23
Indirects	£9,594.30	£28,357.53	£94,521.83

Additional Costs

We are forecasting £0.13m for additional resources to drive the PCB replacement programme. This reflects part time resources used to date and full time dedicated resource from next year as we move more into delivery of PMT replacements in particular.

Additional back-office resources are required to support delivery of this very significant program of works that was not provided as part of our RIIO-ED1 allowance, following the EU POP Regulations implementation in May 2020. This project has a high volume of asset replacements and a very tight deadline (end of 2025). It requires a focused and dedicated team to track and record delivery and reporting in conjunction with our other committed delivery programs during ED1 & into ED2.

The resources for the PCB replacement programme comprise of:

- A Project Manager (managing workflow, task instructions, outage or generation provision, customer liaison and finance):
- Admin Support (supporting the project manager):
- A Data Analyst (assisting with asset referencing and sampling work)

Going forward, without these additional roles, going forward we will be unable to run the programme without diverting resource from other front line delivery roles. Doing so would impact our ability to meet our RIIO-ED2 outputs and commitments.

Deliverability in ED1

15. The proposed additional programme that this submission seeks to funding for may represent deliverability challenges within the remaining period of ED1 (with reference to historic and current planned ED1 run rates). Any specific challenges and solutions identified by individual DNOs should be set out below, however the agreed approach is that these outputs will be subject to the same treatment as Green Recovery Projects in that any delivery that is delayed into ED2 will still be required to be delivered by DNOs at the ED1 unit cost set out above rather than the agreed ED2 unit cost. This inherently incentivises DNOs to seek funding for a programme that can be delivered within ED1.

We have assessed deliverability within the context on our existing work programmed around load and non-load. We are conscious that as we see load growth and connections requests increase in recent years. Consequently, there are a number of schemes in particular to deliver in the last 14 months of ED1. Similarly, we have a number of non-load schemes to deliver, particularly in relation to network automation, secondary plant replacement and network IIS improvement projects. Consequently, we are operating in an environment where our capacity to deliver new programmes is tight.

The main challenges identified to deliverability of the stated volumes will be regarding the GMT sampling and oil replacement which will need to fit around planned maintenance activities. The high volume of pole mounted transformers to be replaced will put pressure on our ability to carry out other core overhead line works, in addition there will be an increase in disruption on the network (more outages) and an increase in hot-glove live line activity. One further potential issue would be the recurrence of PMT supply issues suffered in the second half of 2021.

However, we have been aware of the requirements to remove PCB affected PMTs and GMTs for the last two years and it has been factored this into our delivery model. Consequently, we are confident of delivery for the following reasons:

- We have already laid much of the groundwork in terms of data gathering for PMTs which means that the focus is now on delivery
- We have the skills and capability to undertake this work. While high volume, the work is relatively straightforward, and the majority of our overhead lines resource are qualified to undertake it. In SHEPD we have some existing projects suffering delays due to wayleaves which means we have existing front-line resources which can be diverted to deliver PCB replacement.
- We have already factored in PMT replacement into our planned outage programme.
- There are limited factors outside our control which could impact deliverability. We do not require land access or consents for most of the work. There may be some design work associated with upgrades but that is for a fairly limited number.
- We have already engaged and are discussing with our suppliers how to source the volumes of Transformers required in RIIO-ED1. Our request has been sized to meet where we are confident of obtaining transformers. Many of those required we already have in stock.
- Subject to the approval of this submission, we will have a dedicated back-office team to drive forward this programme, process data and ensure delivery.

Future Proofing

16. When pole mounted transformers are replaced under this programme there is an opportunity to future proof the transformers by upgrading the transformer to a larger size to accommodate future load growth expected to accommodate Low Carbon Technologies, which will have an added benefit in the immediate term of reducing network technical losses.
17. The agreed approach is that DNOs will consider each transformer being replaced in the context of it's Distribution Future Energy Scenarios referenced in ED2 plans and will consider upsizing the transformer accordingly.

Over the past few years, we have been moving away from the industry's conventional, historic-driven forecasts to a scenario-based forecasting methodology called Distribution Future Energy Scenarios (DFES).

Our DFES forecasts the expected load growth for our assets for the period of 2024 to 2050, under a range of scenarios. These scenarios are based on the Electricity System Operators Future Energy Scenarios tailored through specific local engagement with our stakeholders. These scenarios all indicate an increase in load over time, in order to meet net zero by 2050. The variations are mostly around the timing of increases.

We want to avoid a situation where we replace transformers on a like for like basis, under our PCB replacement programme now, only to have to reinforce those same assets in the future. Upgrading transformers is relatively low marginal cost. Consequently, to ensure best value to our customers, we are ensuring that we map the DFES across to all the assets which may need replacing under our PCB replacement programme. We will upgrade those assets that we know we will replace due to the PCB regulatory compliance, where the 2050 DFES provides strong evidence on expected capacity by 2050.

To demonstrate the principle, we have performed the analysis on the "Red" cohort to map PMT load capacity from its existing capacity to expected capacity. The table indicates where we would upgrade and to what capacity.

PMT Load Analysis for Red Cohort		Expected Capacity - 2050 DFES					Total
		25kVA	50kVA	100kVA	200kVA	To be Confirmed	
Existing PMT Capacity	25kVA	1,445	363	40	5		1,853
	50kVA		374	83	13		470
	100kVA			163	35		198
	200kVA				38		38
	To be Confirmed					337	337
	Total	1,445	737	286	91	337	2,896

The initial analysis shows that out of 2896 PMTs in the Red Cohort, 2020 PMTs will be replaced on the "like for like" basis, 539 PMTs will be replaced on the "upgrade" basis, e.g., upgrade from 25kVA to 50kVA for 363 PMTs, and 337 PMTs will need further inspection to confirm their existing capacity.

We plan to undertake this type of analysis across all PMTs and GMTs which need replacing due to PCBs. This will help us identify where upgrades are likely to be needed. We will use this analysis as a guide over where it makes sense to upgrade the transformer (at low incremental cost) in order to provide additional capacity on the network and avoid having to reinforce that asset over the next 20 years. The number of upgrades will be reported through the cost reporting worksheet.

We will continuously update our 2050 DFES and review the outcomes together with the local knowledge to optimise our decision on the level of upgrades required.

ED2 Deliverability and Efficiency Challenges

18. The potential scale of PMT replacement programmes faced by some DNOs could present significant delivery challenges in ED2 which are also likely to present as upwards pressures on costs, whether this be from competition for overhead line contracting resources or increased demand on equipment manufacturers.
19. Accelerating a proportion of the industry PMT replacement programme into ED1 will reduce pressure on input costs for all DNOs by smoothing the industries delivery profile and reducing the peak demand on manufacturing and contractors during a more concentrated period (April 2023-December 2025).

There are some clear benefits of starting to deliver our PCB replacement and testing activity in RIIO-ED1, rather than moving all activity and costs in to RIIO-ED2.

We are asking for funding to replace 27% of the PCB impacted transformers which we need to remove by December 2025.⁶ We are also proposing to conclude 100% of our GMT testing programme and 43% of our GMT oil changes. The tables below show the average annual volumes of activity around PCB replacement during RIIO-ED2 both with and without starting the programme in RIIO-ED1, in order to highlight the deliverability pressures which would ensue from lack of funding in RIIO-ED1.

SHEPD PMT Asset Replacement volumes excluding RIIO-ED2 UM – with and without RIIO-ED1 funding

Year	Proposed plan (starting in ED1)	Without starting the PCB replacement in RIIO ED1	% increase for ED2
2021/22	277	-	
2022/23	900	-	
2023/24	1,134	1,558	37%
2024/25	1,134	1,558	37%
2025/26	882	1,212	37%
Total	4,327	4,327	0%
% proposed in RIIO-ED1	27%		

This shows a 37% increase in annual workload in RIIO-ED2, should funding not be approved in RIIO-ED1.

⁶ This does not include the potential additional volumes included in our RIIO-ED2 uncertainty mechanism.

SHEPD GMT oil testing volumes excluding RIIO-ED2 UM – with and without RIIO-ED1 funding

Year	Proposed plan (starting in ED1)	Without starting the PCB replacement in RIIO ED1	% increase for ED2
2021/22	21	-	
2022/23	3,946	-	
2023/24		2,380	
2024/25		1,587	
2025/26	-	-	
Total	3,967	3,967	0%
% proposed in RIIO-ED1	100%		

This shows that all our remaining GMT testing volumes would be required in RIIO-ED2, if we do not secure funding in RIIO-ED1. Given that the testing is essential to assess the number of GMTs which need replacing or draining, not starting this programme until 2023/24 would have significant implications for meeting the legal requirements around removing PCB affected assets.

SHEPD GMT oil change volumes, excluding ED2 UM – with and without RIIO-ED1 funding

Year	Proposed plan (starting in ED1)	Without starting the PCB replacement in RIIO ED1	% increase for ED2
2021/22	-	-	
2022/23	45	-	
2023/24	59	62	6%
2024/25	0	42	n/a
2025/26	-		
Total	104	104	0%
% proposed in RIIO-ED1	43%		

Again, this illustrates a significant increase needed in RIIO-ED2.

We are conscious that our RIIO-ED2 business plan includes ambitious plans to increase network capacity to meet the demands from low carbon technologies and renewable generation which connect to our network. We want to ensure that we can deliver this. Starting PCB replacement in RIIO-ED1 will enable us to phase work more efficiently across ED1 and ED2.

In addition, we are very aware that PCBs are pollutants. There is benefit to the environment and consequently to our customers of removing them from the network as soon as possible.