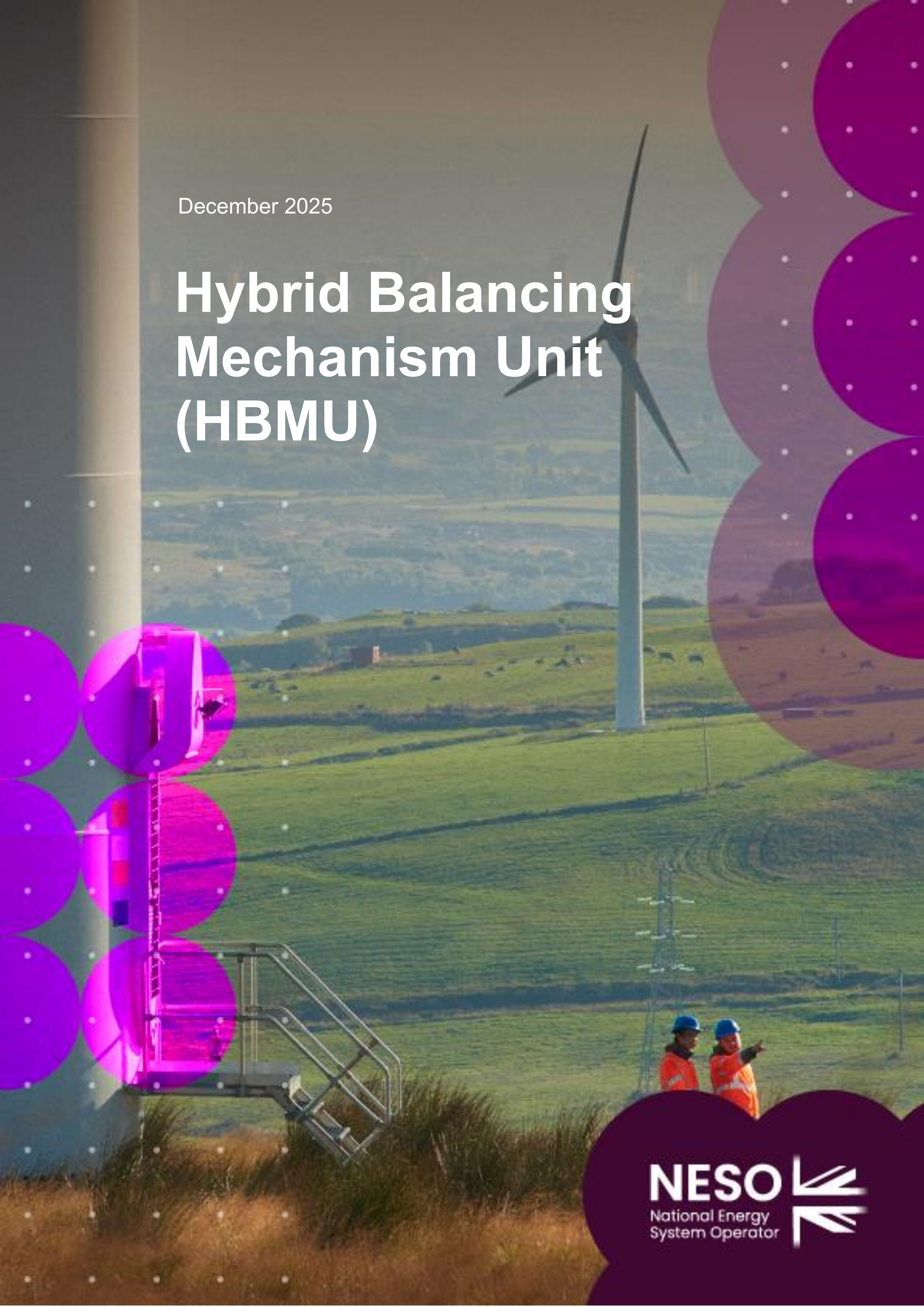

December 2025

Hybrid Balancing Mechanism Unit (HBMU)

NESO
National Energy System Operator

Public

Contents

1. Executive Summary

The Clean Flexibility Roadmap 2025 recognises the potential value of co-location in making efficient use of existing infrastructure and identifies the lack of hybrid metering provisions in markets as hindering development of co-located projects. Noting NESOs commitment in the Roadmap, we have produced this report as an assessment of the challenges and opportunities of Hybrid Balancing Mechanism Units (HBMU) and intend to use this as a basis for ongoing discussion.

Current arrangements allow for single technology HBMUs under very limited circumstances (through Code Modification P484 (P484) – full detail here) and NESOs published co-location guidance currently requires those co-located sites comprising multiple technologies to be classified into separate Balancing Mechanism Units (BMUs), such that they can be separately instructible and controllable.

This report summarises the potential benefits and challenges associated with HBMUs, and the accompanying Impact Assessment assesses the scope and scale of change that would be required if HBMUs were to be introduced. This information was gathered through engagement with industry and in collaboration with various NESO departments.

Engagement with industry has provided NESO with valuable insights into the key drivers underpinning HBMU discussions. With rapid growth of co-located technologies expected, perception within industry is that regulatory frameworks are not keeping pace with the technological innovation needed to fully unlock and optimise commercial opportunities. The potential for HMBUs could reduce both capital and operational expenditure by enabling a single grid connection and streamlining metering requirements. Furthermore, HBMUs may offer the opportunity to maximise commercial avenues, support grid balancing and constraint management, and facilitate the deployment of innovative solutions across the sector.

For the purposes of this assessment, NESO have defined three HBMU types to consider the different commercial and operation arrangements HBMUs could support, and these are summarised below:

Type 1 HBMU – single technologies, multiple commercial arrangements, contained within a single BMU

Type 2 HBMU – multiple generation and/or storage technologies, contained within a single BMU

Type 3 HBMU – mix of generation and demand technologies, contained within a single BMU

The assessment first considers the impact of adopting Type 1 HBMUs under the current limited arrangements facilitated through P484, and then further discusses the adoption of Type 1, 2 and 3 HBMUs across the industry more broadly.

The assessment found that the adoption of Type 1 HBMUs under current limited arrangements ie BMUs including Contracts for Difference (CfD) and non CfD assets (see P484 for full details), presents low residual risk, after mitigation. The behaviour of a single technology is predictable, and settlement impacts, while requiring additional sub-metering data, are manageable within the CfD framework.

The analysis confirmed that enabling Type 1 HBMUs more broadly, ie outside of the CfD framework, does however introduce additional risk.

Notwithstanding the potential benefits Type 2 and Type 3 HBMUs could deliver, this assessment highlights that they present significantly higher risk. Combining technologies with different generation characteristics would significantly complicate accurate forecasting and may undermine delivery, as the Electricity National Control Centre (ENCC) cannot reliably predict BMU behaviour. Both Type 2 and Type 3 create substantial settlement, visibility, operational, and system security challenges. Several risks were assessed as high, with the residual risk after mitigation remaining significant.

While there may be potential efficiencies and benefits, including commercial optimisation of assets under HBMU arrangements, NESO notes that many configurations sought by developers are already achievable under existing co-location guidance, which continue to require separate BMUs to maintain operational visibility. For completeness, this is also explored below.

NESO's findings are presented to support further conversation in these areas, and we welcome further engagement via box.hybridmetering@neso.energy

2. Introduction and Context

2.1. Background

The Clean Flexibility Roadmap 2025 (‘the Roadmap’) recognises the potential value of co-location in making more efficient use of existing grid infrastructure and potentially reducing both the need for additional network buildout, and in some cases the capital costs for individual projects. The Roadmap therefore commits to addressing hurdles related to the deployment of co-located projects ahead of 2030, including consideration of HBMUs.

The Roadmap specifically identifies that “a lack of hybrid metering provisions in markets is hindering co-location”. Some in industry echo this view, and the current state definition of a BMU is being questioned by market participants seeking commercial optimisation.

As per the Roadmap and to begin to address some of these questions, NESO has conducted an impact assessment, to explore the potential implication of HBMUs in a holistic way. NESO welcome further engagement; if you have queries or comments, please get in touch with us at:

box.hybridmetering@neso.energy

2.2. Industry View

NESO undertook targeted industry engagement from 31 January to 21 February 2025 to gather views on hybrid metering and to understand industry motivations surrounding HBMUs.

The feedback that followed reinforced that motivations vary significantly, with a focus on commercial optimisation, simplification of operation and reduction of administrative complexity, see further details below:

Key benefits

- HBMUs may reduce CAPEX costs for developers with more projects able to connect in HBMU arrangements with one grid connection
- HBMUs have the potential to enable participants to maximize their current connection capacity
- HBMUs could increase potential returns on asset investment with easier ability to stack commercial arrangements
- HBMUs may provide new opportunities for participants to support balancing the network, reducing constraints and necessity to curtail renewable generation
- HMBUs may reduce OPEX costs due to a lower number of meters to operate and maintain
- HBMUs could enable a wider array of innovative solutions to be designed and implemented across UK networks

It should be noted that many of the motivations cited by industry align more closely with co-location rather than HBMUs. NESOs co-location guidance documents make clear that developers can pursue a wide range of asset configurations provided each asset remains a separate BMU. This document points to current co-location guidelines that NESO believes provide developers with the flexibility they need, so that HBMU is not seen as required when existing solutions are sufficient.

2.3. Purpose of this Report & Impact Assessment

Recognising the potential benefits around HBMUs (which have been identified by NESO though industry engagement as above), the purpose of this report is to provide an assessment of HBMU configurations, with a more detailed impact assessment alongside to set out the system-level impacts associated with different types of hybrid metering arrangements, and to describe the implications for registration, operation, settlement, and system security. The conclusions are intended to support further conversations, signpost related work undertaken within the co-location space and identify areas where further analysis may still be required.

3. Definitions and Typology

The development of a clear and consistent definition of HBMUs is essential for understanding the implications of enabling such arrangements. As above, distinction is also required between HBMUs and existing concepts such as co-location.

3.1. Balancing Mechanism Unit (BMU)

BMUs are the fundamental operational building blocks of the GB electricity system. A BMU is a registered unit that exports or imports electricity and is treated as a single entity for balancing and settlement purposes. The industry Codes including the Balancing and Settlement Code (BSC) define the requirements for BMU operation, including the obligation that each BMU contains plant and apparatus that can be controlled and measured as a single unit.

BMUs can be classed as either a Primary BMU or a Secondary BMU. A Primary BMU is the smallest grouping of generation and/or demand equipment that can be independently metered for Settlement, and all generation and demand equipment must be captured in a Primary BM Unit.

Secondary BM Units can be registered by Virtual Lead Party (VLP) and Asset Metering VLPs. For further information please see the relevant industry Codes.

3.2. Co-location

Co-location arrangements are defined as the installation of Power Generating Modules (PGMs), Electricity Storage Facilities (ESFs) or demand facilities of different technologies and/or fuel types at the same site or Power Station while connected to the GB electricity system as different BMUs. Co-located technologies share a connection point but must be registered and metered separately, such that they are separately instructible and controllable.

3.3. Hybrid Balancing Mechanism Unit (HBMU)

For the purposes of this assessment, HBMUs have been defined as a registration/metering configuration allowing for assets with different commercial arrangements (or different technology types), which share a grid connection point, to be registered together as a single BMU. This configuration employs sub-metering or flexible metering arrangements to allow for the distinct settlement, operational control, and regulatory treatment of each asset component within the BMU.

3.4. Types of HBMU

Three types of HBMU have been classified for the purposes of this assessment. The distinctions in HBMU set ups are illustrated in the examples shown below.

3.4.1. Type 1 HBMUs — Single Technology, Multiple Commercial Arrangements.

BMUs containing assets of the **same technology type** but with **different commercial arrangements**.

These configurations involve a single generating technology with subsets of the same asset that fall under different commercial regimes (e.g. one portion under a CfD and another portion under merchant arrangements).

Sub-metering is present to distinguish separate commercial arrangements within the same BMU.

3.4.2. Type 2 HBMUs — Multiple Generation or Storage Technologies.

BMUs containing assets of **different technology types**, but only include technologies classed as **generation or storage**.

These configurations involve more than one generating technology or fuel type (e.g. wind and solar), or generation and storage technologies (e.g. solar and battery) registered under a single BMU. Type 2 HBMUs may contain assets with similar commercial arrangements (e.g. CfD assets only), or assets with different commercial arrangements (e.g. CfD and merchant).

Sub-metering is present to distinguish different technologies or separate commercial arrangements within the same BMU.

3.4.3. Type 3 HBMUs — Combined Generation and Demand.

BMUs containing assets of **different technology types**, which include technologies classed as **generation and demand**.

These configurations include both generation and demand technologies (e.g. wind and hydrogen electrolysis). These represent the most complex configurations because of the incorporation of generation and demand assets (with differing operational behaviours and requirements) within one BMU. Type 3 HBMUs also have the potential to represent intersections between multiple energy vectors (e.g. where green hydrogen production is present).

Sub-metering is present to distinguish different technologies or separate commercial arrangements within the same BMU.

3.4.4. HBMU Examples

The diagrams below show examples of set ups under the three different HBMU types defined for the purposes of this assessment.

Type 1 Single tech, multiple commercial set ups	**Type 2** Multiple generation and/or storage technologies	**Type 3** Mix of generation and demand

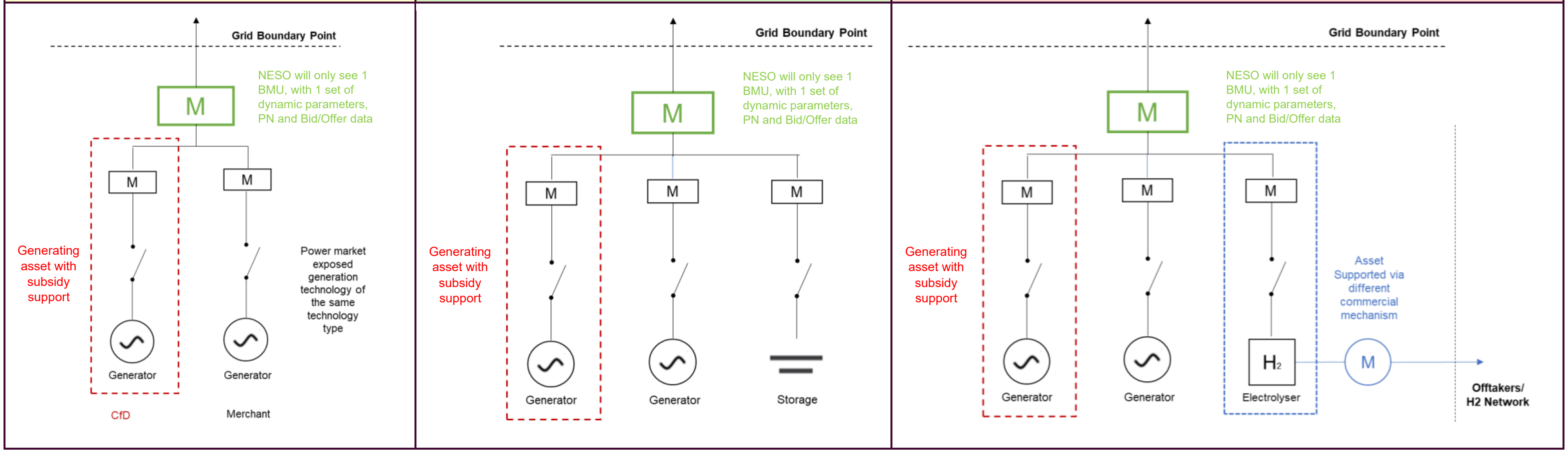

Figure 1: Examples of asset metering arrangements under the three different HBMU types

4. Current Operating Baseline

The current operating baseline is built upon four key principles:

1. Each BMU must consist of plant and apparatus that can be treated as a single operational unit, with consistent behaviour for dispatch and forecasting.
2. Co-located assets must remain in separate BMUs, even where they share a connection point, except in narrowly defined circumstances under Code Modification P484.
3. Sub-metering may be used to distinguish commercial arrangements within a single technology type, but not to support multi-technology configurations within a single BMU.
4. NESOs forecasting, settlement, and control frameworks are designed around technology-specific behaviours, which limits the extent to which varied assets can be combined without structural change.

These principles have been built, and are enforced through guidance and policy, with the key governing documents summarised below:

4.1. Guidance Notes for Co-location of Different Technologies

NESO's current guidance for co-located assets aims to provide more clarity around the technical requirements and compliance approach for co-located technology projects in development, covering different types of connection to the transmission system and the compliance processes for different connection types.

The guidance also provides clarity on the definition of co-location, stating that a co-located site is one where generating assets belonging to different technologies and/or fuel types, including storage and demand, are installed at the same site or Power Station and connected to the GB electricity system.

Crucially the guidance maintains that assets of different technology type must register as separate BMUs, even when sharing a common point of connection – the specific wording in section '3.2.1.2 – BM Units Registration' of this guidance is reiterated below:

In case of a co-located site, the Power Generating Module comprising different technology and/or fuel type shall be classified into separate BM Units such that they can be separately instructible and controllable. They may, however, share a common Point of Connection. In this instance, if there is one Power Park Module the Generator will need to apply for a Non-Standard BMU through the Balancing and Settlement Code (BSC) Panel.

Read the full guidance note here.

4.2. Guidance on Enabling Asset Metering for Co-located Assets

NESO is also continuing to develop guidance covering specific configurations to implement co-location, such as DC-coupled co-located sites. Guidance published in October 2025 provides direction on enabling DC-coupled co-located Photovoltaic (PV) and Battery Energy Storage System (BESS) BMUs to participate in the Balancing Mechanism and Dynamic Response Markets, by addressing issues on Submission of PNs (Physical Notifications) & BOAs (Bid-Offer Acceptances), Operational Metering, Settlements, Performance Monitoring for Dynamic Response, and Alignment with Codes.

In the new setup the PV and BESS sites are co-located behind a single Grid Entry Point via a DC-AC inverter, however it is explicitly stated that the assets are required to be registered as separate secondary BMUs (i.e., one BMU per technology).

It should be noted that NESO is progressing further work on solutions that would enable participation by other expected co-located configurations.

Read the full guidance note here.

4.3. P484 Code Modification

In May 2025, the Low Carbon Contracts Company (LCCC) raised a modification request to enable CfD and non-CfD assets to be registered within one BMU in exceptional cases. Code Modification P484 ('P484') was approved to allow such arrangements where appropriate. NESO conducted an internal assessment which concluded that impacts on processes and systems were minimal.

P484 therefore creates a narrowly defined pathway for single-technology hybrid arrangements which include assets holding a contract through the CfD framework. P484 enables, in exceptional cases, a single BMU to include assets of the same technology type that operate under different commercial regimes, provided that sub-metering is installed to enable CfD payments to be reconciled accurately. LCCC monitors these arrangements.

5. Impact Assessment

5.1 Approach/Methodology

NESO's Impact Assessment has been developed through a mix of engagement with industry and internal NESO experts. Some of the activities undertaken to build this knowledge base and formulate the Impact Assessment are listed below:

- Consideration of evidence from previous public consultations and responses (e.g. CfD Allocation Round 7 consultation response by DESNZ where HBMU implementation was considered but not implemented)
- NESO led industry call for evidence from 31 January to 21 February 2025 and continued engagement with external industry stakeholders
- NESO formation of an internal working group to identify areas of opportunity and risk

NESO have explored both the challenges and opportunities that the introduction of HBMUs may present, and our impact assessment highlights the scale and severity of the potential impacts, with consideration to the stages in the customer journey that would likely be affected. The impact assessment also sets out potential mitigations and explores the costs of changes required to implement these, to derive a 'post mitigation impact score'.

The assessment first considers the impact of adopting Type 1 HBMUs in line with what's permissible under Code Modification P484. The assessment subsequently explores the adoption of Type 1, 2 and 3 HBMUs in a broader industry context.

NESO welcomes ongoing engagement to continue to develop knowledge around HBMUs.

5.2 Overview of HBMU Opportunities and Challenges

The below shows a high-level summary of the opportunities and challenges associated with HBMU implementation in relation to the stage of the customer journey at which the opportunity/challenge would be expected to have an impact.

For full details of the identified challenges, please refer to the accompanying Impact Assessment document.

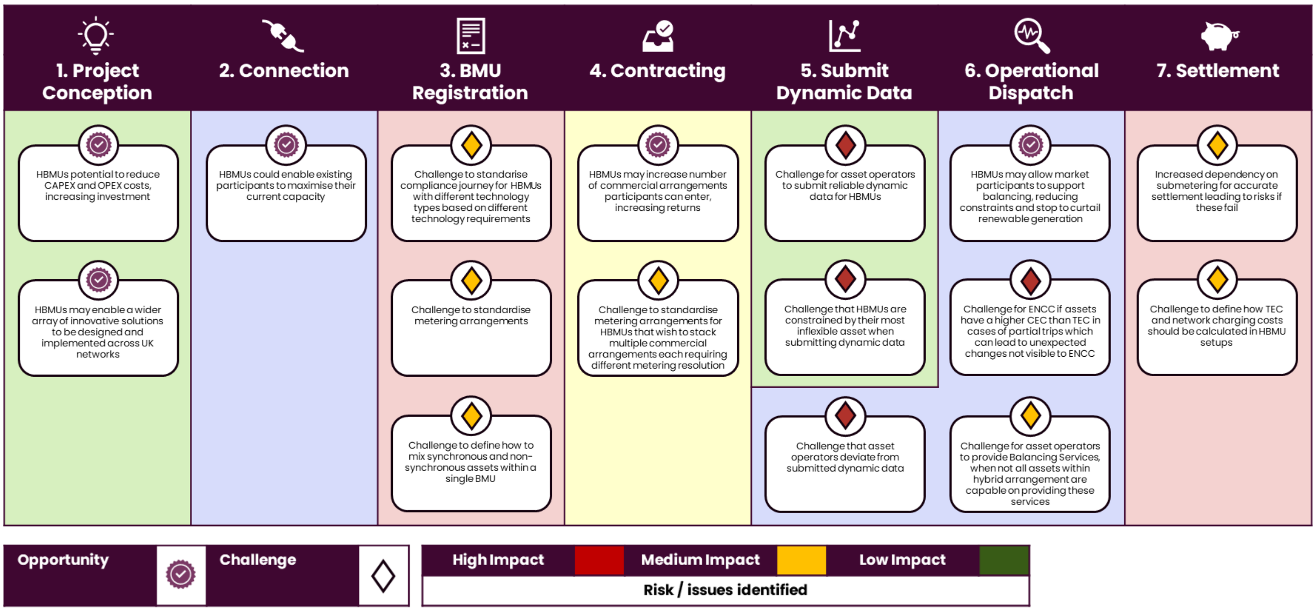

Figure 2: Key impacts across the customer journey.

5.3 Findings for Code Modification P484 (Type 1, Single Technology)

The primary risks noted relate to the availability, accuracy and reliance of sub-metering data for the purposes of settlement. These risks are characterised as manageable, falling into the category of low-impact operational adjustments.

Operationally, forecasting is largely preserved because generation remains homogeneous. Generating units of the same technology behave predictably and follow consistent patterns. Bid Offer Acceptance (BOA) behaviour for Type 1 HBMUs does not materially differ from standard single-technology BMUs, and the ENCC can continue to rely on established forecasting, dispatch, and monitoring processes.

Accordingly, the assessment categorises all residual impacts, after mitigation, as low. NESO anticipates minimal operational impact from these requests, as we only expect only a small number of submissions, primarily from large, experienced operators who are adept at accurate forecasting and capable of providing full flexibility through BOAs.

5.4 Findings for Holistic Type 1 HBMUs

Assessing the adoption of Type 1 HBMUs more broadly requires consideration of a range of commercial arrangements and potential combinations outside of those allowable under P484. This was found to present additional risk.

Additional risks include the potential impacts of wider code changes and increased complexity for BMUs under fault investigation. These are mostly able to be managed in the context of a Type 1 single technology HBMU, but do leave higher residual risk when application of Type 1 is broadened to include a wide range of commercial arrangements (vs the more limited implementation of Type 1 under P484).

Expanding P484 into a holistic Type 1 approach would necessitate all BMUs involved to provide accurate Physical Notifications (PNs), reflecting both weather and commercial activity. This shift would also require the routine submission of offer and bid prices, enabling NESO to manage assets flexibly and maintain system security and efficiency. Such an expansion would have greater implementation impacts than P484 alone, necessitating further collaboration with the market to address complexities, such as negative pricing scenarios and assets with more varied commercial arrangements.

5.5 Findings for Type 2 HBMUs

Type 2 HBMUs introduce far greater complexity because it is much more difficult to forecast amalgamated different technologies in order to provide delivery assurance. Each technology responds differently to weather conditions and market incentives, such that a single Physical Notification (PN) would attempt to represent multiple generation sources with potentially conflicting behaviours.

BOA delivery becomes ambiguous under this configuration. The ENCC must issue a single instruction to a BMU that contains distinct technologies with different physical capabilities and constraints. The ENCC must have continuous clear predictions of what will outturn from each BMU on an hourly basis, which Type 2 HBMUs undermine.

Settlement poses additional complexity because asset-level performance would no longer be visible without suitable mitigation.

The risk assessment classifies many Type 2 impacts as high, with these remaining high even with listed mitigations.

5.6 Findings for Type 3 HBMUs

Type 3 HBMUs represent the highest level of complexity and risk. The inclusion of demand assets—such as hydrogen electrolysers or data centres, means that the BMU contains components with fundamentally incompatible behaviour profiles, emphasising that demand responds primarily to commercial drivers rather than system operation. This removes NESO’s ability to forecast BMU behaviour with accuracy.

Our full impact assessment consistently shows that BOA compliance becomes extremely difficult and undermines NESO's real-time control capability. Settlement and dispatch visibility are described as severely impacted. Type 3HBMUs would conceal the interaction between generation and internal demand behind a single BMU, preventing NESO from determining what portion of BMU behaviour is attributable to system need versus internal optimisation.

For the full assessment please refer to the Impact Assessment published alongside this document.

6. Conclusion

Working alongside industry, NESO recognises that HBMU arrangements may offer opportunities to boost commercial opportunities and lower costs. However, the existing arrangements allowable within the co-location space, may already offer suitable flexible arrangements without the need for a complete re-design of industry processes – which may result in increased risk to the consumer - required to facilitate HBMUs.

NESO has utilised expertise both internally and across the wider industry to conclude that Type 1 HBMU does not present any material operational issues within the current understanding of P484 but may do if applied more broadly across industry.

NESOs Impact Assessment finds that under Type 2 and 3 HBMUs when multiple technologies, storage and/or demand are placed behind a single BMU, the risks are material and not readily mitigable without fundamental redesign of operational, forecasting and settlement processes.

Future changes to data visibility, metering standards, revenue design, or industry code reform programmes may be relevant to future reassessment of specific HBMU use cases, but they do not alter the findings of this assessment under present arrangements.

Finally, industry participants may benefit from the increase in more flexible commercial arrangements being explored within the co-location space. While there may be potential efficiencies and commercial optimisation of assets under HBMU arrangements, NESO notes that many configurations sought by developers are already achievable under existing co-location guidance, which continues to require separate BMUs to maintain operational visibility.

We would welcome further industry engagement via box.hybridmetering@neso.energy

Appendix 1: Glossary

Acronym	Description
AC	Alternating Current
BESS	Battery Energy Storage System
BM	Balancing Mechanism
BMU	Balancing Mechanism Unit
BOA	Bid-Offer Acceptance
BSC	Balancing and Settlement Code
CEC	Connection Entry Capacity
CfD	Contracts for Difference
DC	Direct Current
DESNZ	Department for Energy Security and Net Zero
ENCC	Electricity National Control Centre
ESF	Electricity Storage Facility
HBMU	Hybrid Balancing Mechanism Unit
LCCC	Low Carbon Contracts Company
NESO	National Energy System Operator
P484	Balancing and Settlement Code Modification P484
PGM	Power Generating Module
PN	Physical Notification
PV	Photovoltaic
TEC	Transmission Entry Capacity
VLP	Virtual Lead Party