Public

Grid Code Development Forum

2 July 2025

NESO
National Energy System Operator

Agenda

1	Introduction, meeting objectives and review of previous actions - **Claire Newton, NESO**
2	Code Administrator Update – **Lizzie Timmins, NESO (Code Administrator)**
3	Power Park Module (PPM) Reactive Power Provision Below Rated MW Output– **John Fradley, NESO**
4	GC0166 Implementation preparation: Trial/proof of concept to collect real data and test the NESO optimiser - **Philippa Banks/Steve Baker, NESO**
5	Standardisation of Power Flow Metering Polarity when Sending Data to NESO - **Pritesh Patel/Hao Guo, NESO**
6	Guidance Notes for Co-location of Different Technologies, Issue 3 (Verbal Update) - **Tanmay Kadam, NESO**
7	AOB and Meeting Close - **Claire Newton, NESO**

GCDF – Objectives and Expectations

Objective
Develop ideas, understand impacts to industry and modification content discussion, in relation to Grid Code related issues.
Anyone can bring an agenda item (not just NESO!)

Expectations
Explain acronyms and context of the update or change
Be respectful of each other's opinions and polite when providing feedback and asking questions
Contribute to the discussion
Language and Conduct to be consistent with the values of equality and diversity
Keep to agreed scope

The Forum will be recorded and made available on the GCDF webpage along with summary notes.

Code Administrator Update

Public

PPM Q Provision

Proposed GC Modification

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Future Network & Challenges

Network:

- IBR dominated – interface generation/transmission
- Non-radial offshore networks

Challenges:

- Reduction in SG – reduced network management
- Increase in Embedded generation with falling transmission demand
- Voltage management – high voltage scenarios
- Restrictions on PPM/HVDC Q provision

Potential Opportunity:

- Remove PPM/HVDC Q restrictions

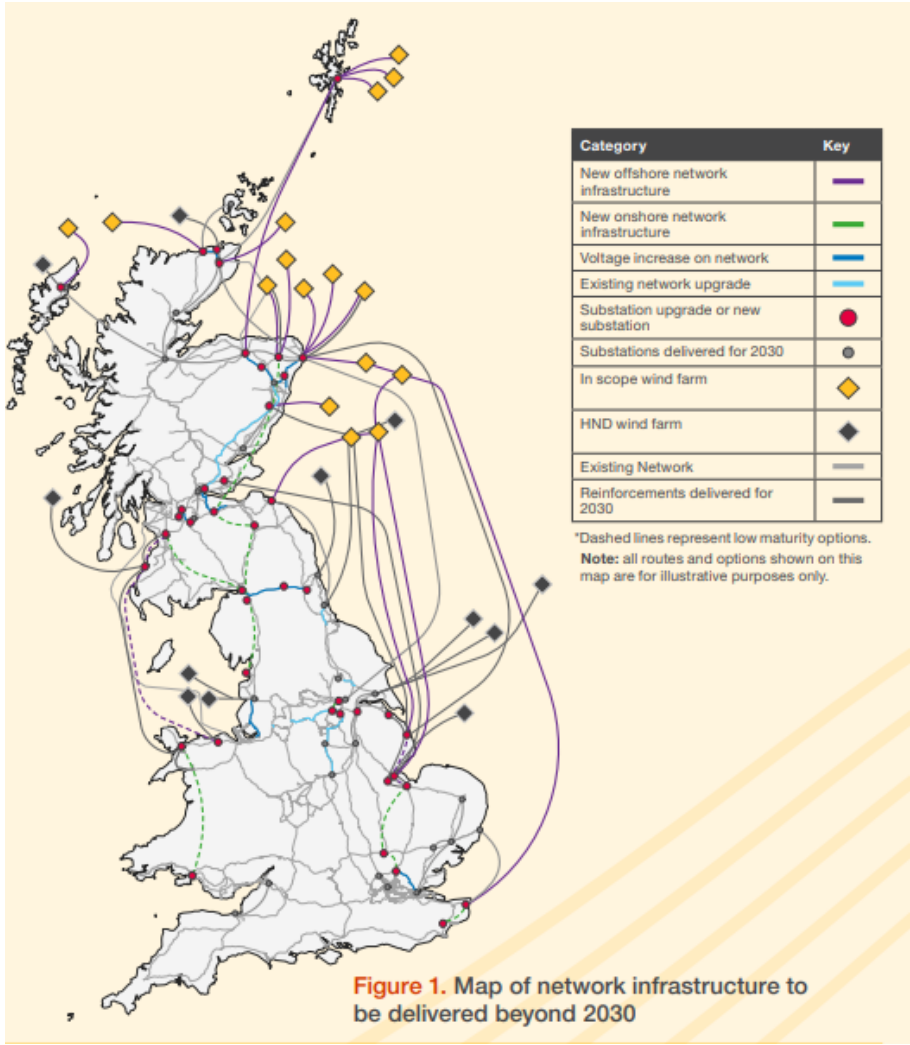

Figure 1. Map of network infrastructure to be delivered beyond 2030

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Existing PPM GC – ECC 6.3.2

History:
Developed from the very early Q capability obligations back in 2005 and then adapted when RfG was developed.

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Applicable to:
- Type C/D PPM, HVDC
- OTSDUW (offshore transmission networks)

GC Requirements:
1) Linear reduction below 0.5pu
2) Restriction below 0.2pu

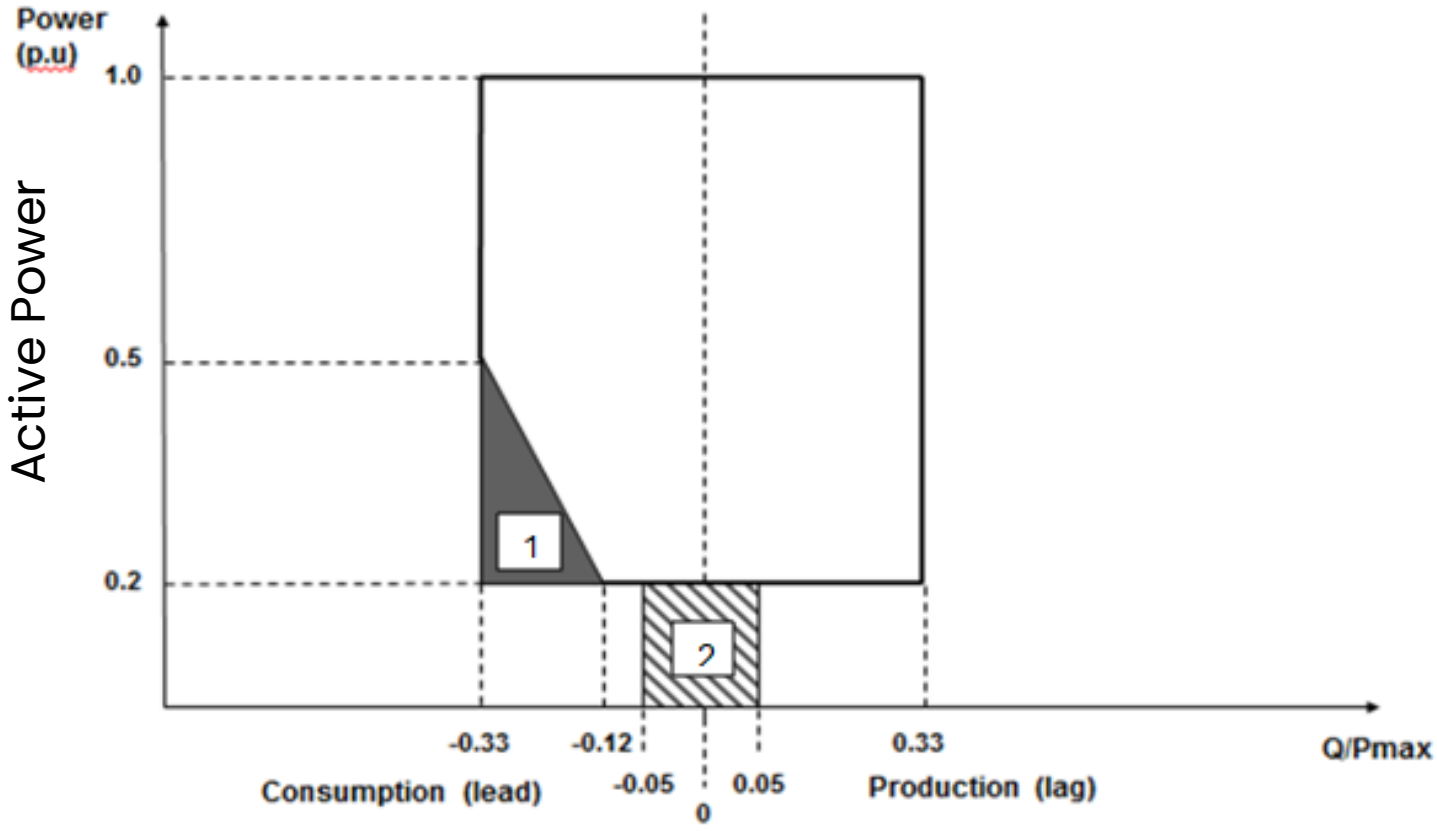

Figure 1

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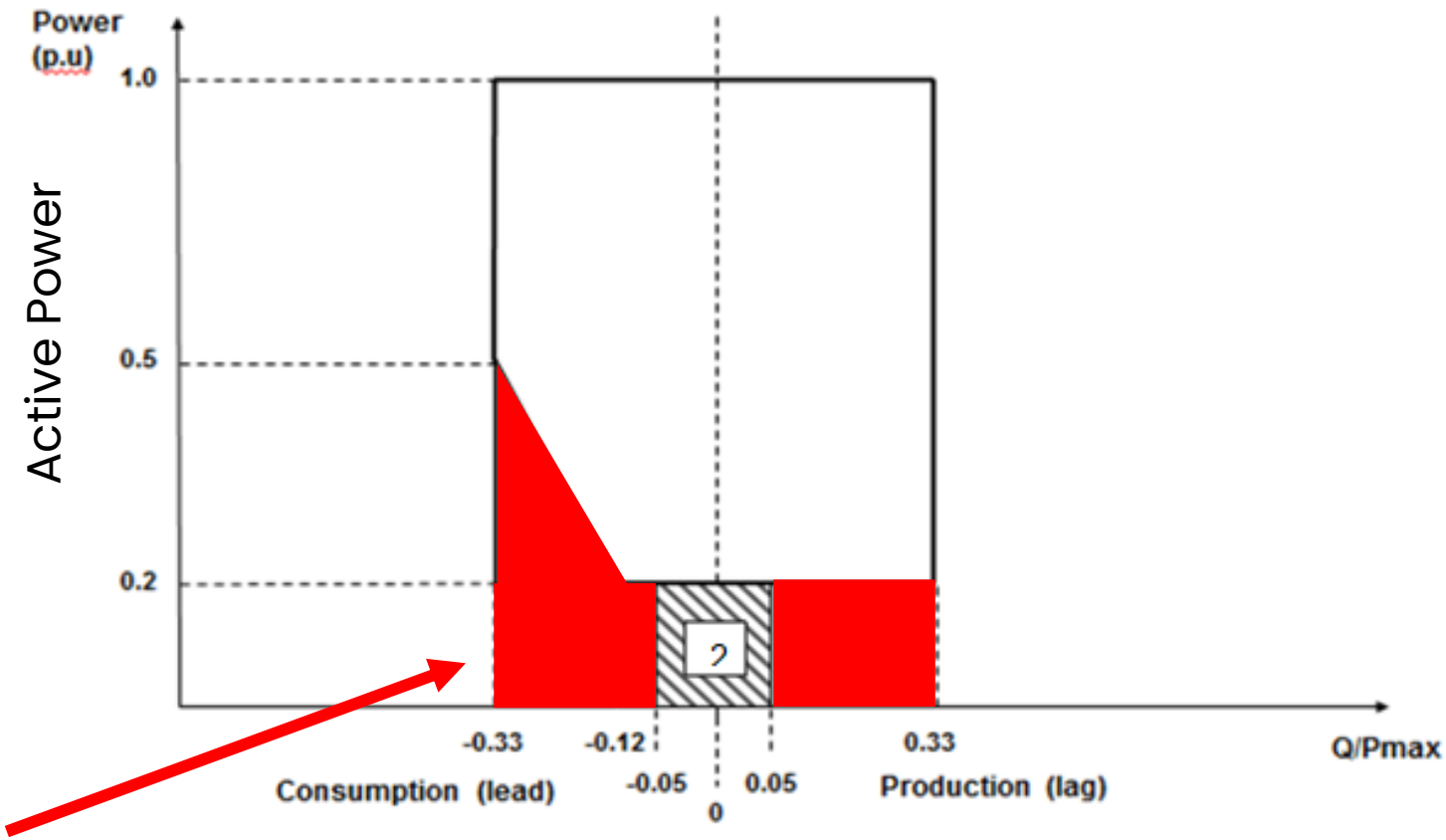

Underutilised capability

Figure 1

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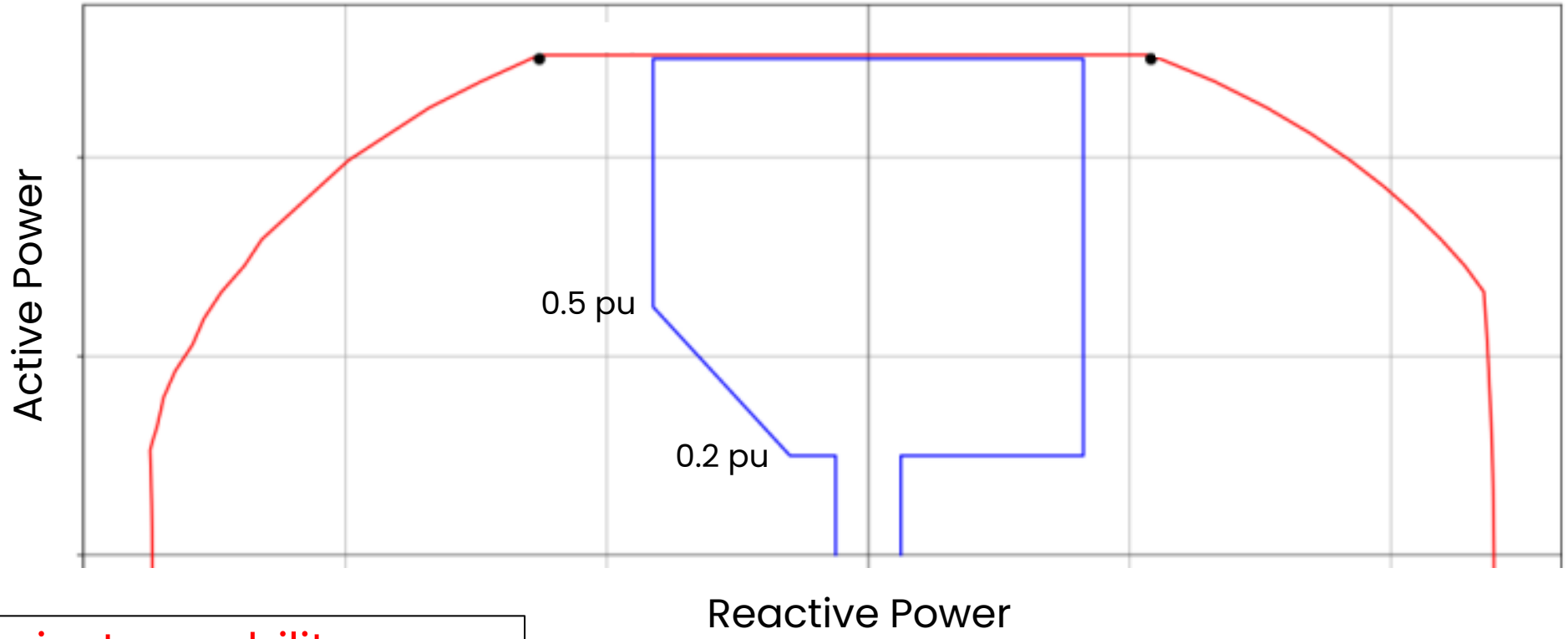
Capability from BESS Project

PQ curve capability



Project capability
Imposed requirements

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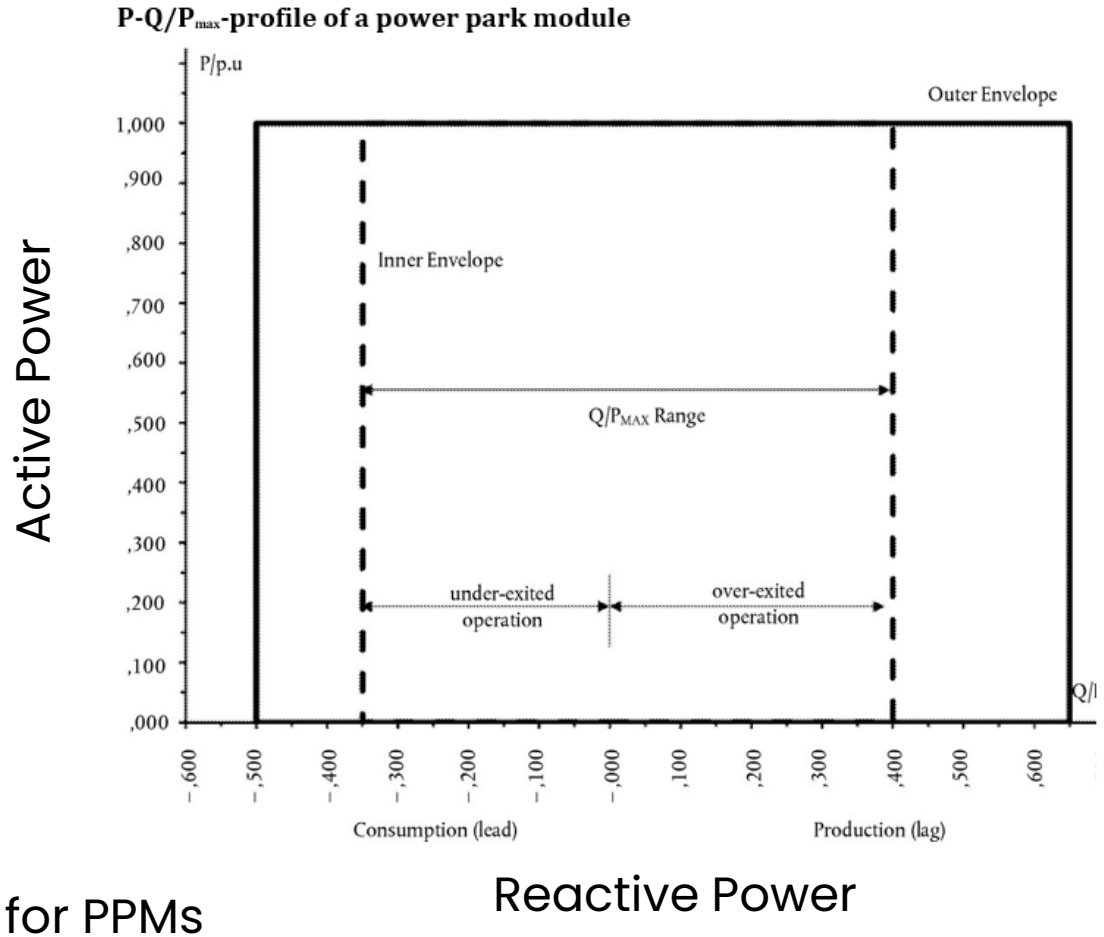
Requirement in Europe (RfG)



Article 21/22 for PPMs

(iii) when operating at an active power output below maximum capacity ($P<P_{max}$), the power park module shall be capable of providing reactive power at any operating point inside its P-Q/P_{max}-profile, if all units of that power park module which

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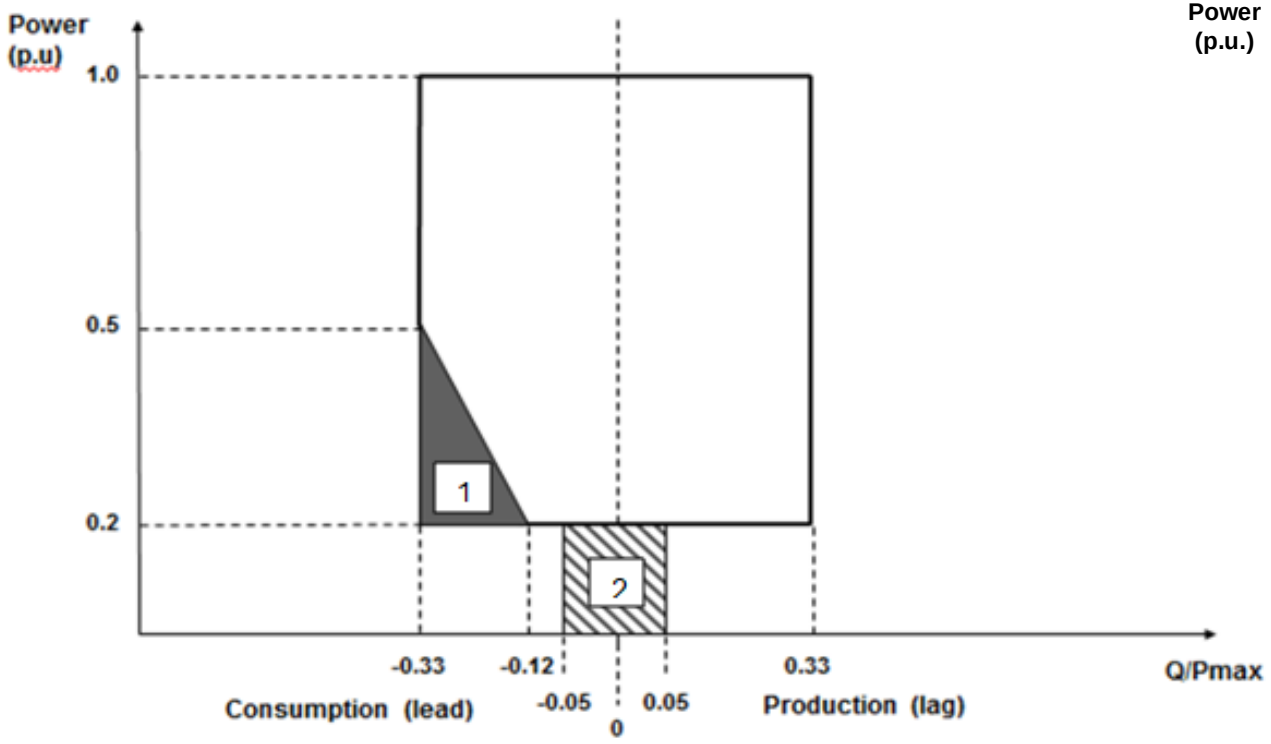
GC Proposal



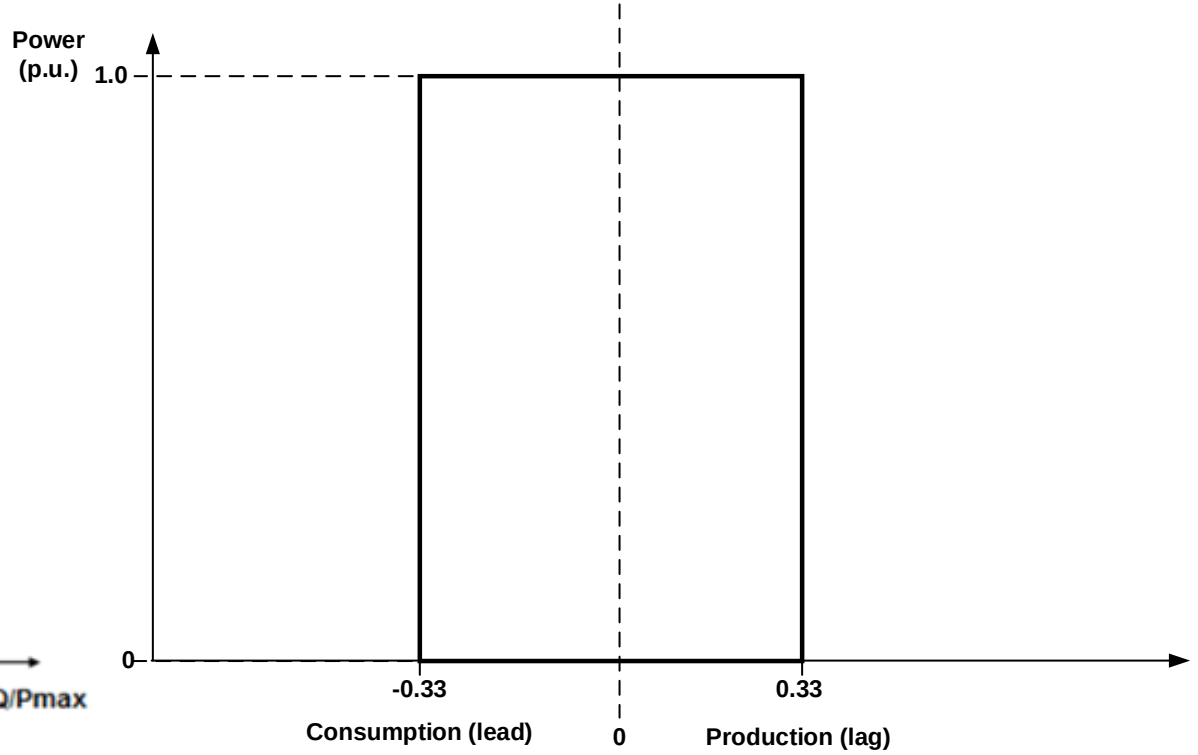


Figure 1

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Benefits –NESO/User/Customer

NESO

- The ability to access the full range of reactive power capability on a mandatory basis, providing greater certainty of the provision of the service.
- A reduction in the need to secure new investments into assets such as Statcoms.

USER

- Additional revenue for Users.
- Reduce control complexity used to meet the restrictions.

Customer

- The knock-on impact of this is a smaller tender size, lowering end consumer costs and reducing the change for unused assets.

Proposed Implementation

ECC Section

- Forward looking - proposed for all future PPMs

CC/ECC Section

Difficult to apply retrospective due to:

- Technology – LCC, DFIG
- Scheme setup/design
- Control implementation/update costs

Feedback Welcomed

Please let me know if you have any feedback relating to technical difficulties implementing the proposed changes.

GC0166
Proof of Concept Testing-

Expression of Interest

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GC0166 Proof of Concept Testing

- GC0166 addresses the problem that Electricity Storage Modules (of limited duration) can only export or import until empty or full.
- The current parameters of Maximum Delivery Period and Volume do not cater for bi-directional units, so NESO uses a '30-minute rule'.
- GC0166 working group proposes additional parameters to support an Optimiser algorithm:
  - Maximum Delivery Offer (MDO)
  - Maximum Delivery Bid (MDB)
  - Future State of Energy (FSoE)
- These will provide Control Room means to increase economic dispatch of Electricity Storage Modules and improved operational planning.

GC0166 Proof of Concept Testing Expression of Interest

- NESO seeks to undertake proof of concept testing with external partners later in 2025 ahead of operational implementation.
- We are looking for representative samples of BM Units of different types and categories and for those selected will be requesting additional data parameters for the test period.
- This testing will ask providers to submit ‘real time’ data, but for a recent historic period, recognising that neither providers nor NESO are currently set up for live streaming this data.
- To participate in this testing, (in Autumn 2025) please contact us by **31/07/25**
- For those selected we will issue a more detailed specification in coming weeks.

GC0166 Proof of Concept Testing Expression of Interest

For parties wishing to participate:

- Please contact: box.balancingprogramme@neso.energy , indicating clearly in the subject title: "**GC0166 Proof of Concept Testing Expression of Interest**"

Thank you

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Power Flow Metering Polarity Issues and proposed solution – Follow Up

Grid Code Development Forum

July 2025

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Power Flow Metering Polarity – Issue

- **Issue**
  - “Incorrect/inconsistent” polarity for power flow metering data fed into the NESO SCADA system, for example negative instead of positive flow

- **Impact for NESO**
  - Deteriorating accuracy in NESO management system
  - Reduced State Estimation reliability impacting situational awareness
  - Reduced system security and potential SQSS breach due to less effective contingency analysis
  - Additional balancing cost incurred by less efficient output from downstream NESO balancing and forecast system

- **Impact for other stakeholders**
  - Delay in setting up metering for new connections
  - Increased workload due to updating and correcting metering polarity
  - Delay in NESO’s decision making for outages and commissioning
  - Potential billing errors for settlements between NESO and energy providers

Power Flow Metering Polarity – Current Status and Effort

- **Current Status**
  - No clear and unified power flow polarity standard in Grid Code for power flow data sent to NESO
  - No clauses in Grid Code or licence obligation requesting parties to follow a power flow polarity standard and parties may choose their own convention which is inconsistent with other parts of the network
  - No clauses in Grid Code requesting parties sending power flow metering with “incorrect” polarity to fix the issue
- **Current Effort**
  - NESO regularly audits, investigates and fix meters with incorrect polarity internally, but workaround fix is temporary and not sustainable
  - NESO tries to establish communication channel with relevant parties to investigate and resolve the issues
  - NESO has set up a working group aiming to seek solutions in terms of code, standard, policy and process

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Key Update since Previous GCDF

- **Further evidence: criticality of Issues**

- **Further Clarification: the proposed unified standard for power flow metering polarity will only be applicable to new connections in this stage**

- **Further Alignment: NESO work with TOs and generator to make sure the unified standard are clear and aligned for stakeholders**

Power Flow Metering Polarity – Criticality of Issue

- **Currently 818 meters** have been identified as having incorrect polarity, this could increase if new connections do not follow the polarity standard.
  - OFTO – 416
  - TO/Generator – 402

- **2.8% of all meters** received by NESO (29,000) with incorrect polarity

- **Impact of incorrect polarity** could be incurred during NESO Operation
  3 potential scenarios:

  - **Underestimate in requirement of system response and reserve level**
    Insufficient level of response and reserve to deal with contingency for real-time operation -> system security issue and potential SQSS breach

  - **Overestimate in requirement of system response and reserve level:**
    *Extra Cost = Price of MWh * Amount of Overestimate MW * duration*

    e.g. Assume a total 10GW error causes NESO to believe additional response and reserve is required for approximately 200 hours across a year. With the average price for system response and reserve being £50/MWh, the repeating annual cost would be £50 * 10,000 * 200 = **£100m**

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Power Flow Metering Polarity – Criticality of Issue

- **Impact of incorrect polarity** could be incurred during NESO Operation
  3 potential scenarios (continued):

  - ***Extra cost when managing a constraint:***
    *Extra Cost = Price of MWh to increase Generation in Area A * Amount of Incorrect MW * duration - Price of MWh to reduce Generation in Area B * Amount of Incorrect MW * duration*

    e.g. Assume a constraint is broken by 500MW for 4 hours so generation in Area A is reduced by 500MW, however, due to group demand error resulting from incorrect polarity this was an oversell of 200MW. Generation in Area B had to be increased by 200MW to cover this unnecessary sell. Average cost of the sell MW was £40/MWh whilst buy MW was £120/MWh,
    Extra Cost = £120 * 200 * 4 - £40 * 200 * 4 = **£64k.**

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Power Flow Metering Polarity – Example Cost to Fix

- Cost to fix the meter polarity issue (based on TO data)
  (1) BAU activity: **no cost**

  (2) Software re-config and wiring changes are required on site: **£4,000 / meter**

  (3) New equipment needs to be ordered and replaced on site: **£21,000 / meter**

  (4) Meter points with 4G requirements needs to be ordered and replaced: **£98,524 / meter**

- Additional Cost for OFTO is **£100,000 / site**
  - 45 sites in total

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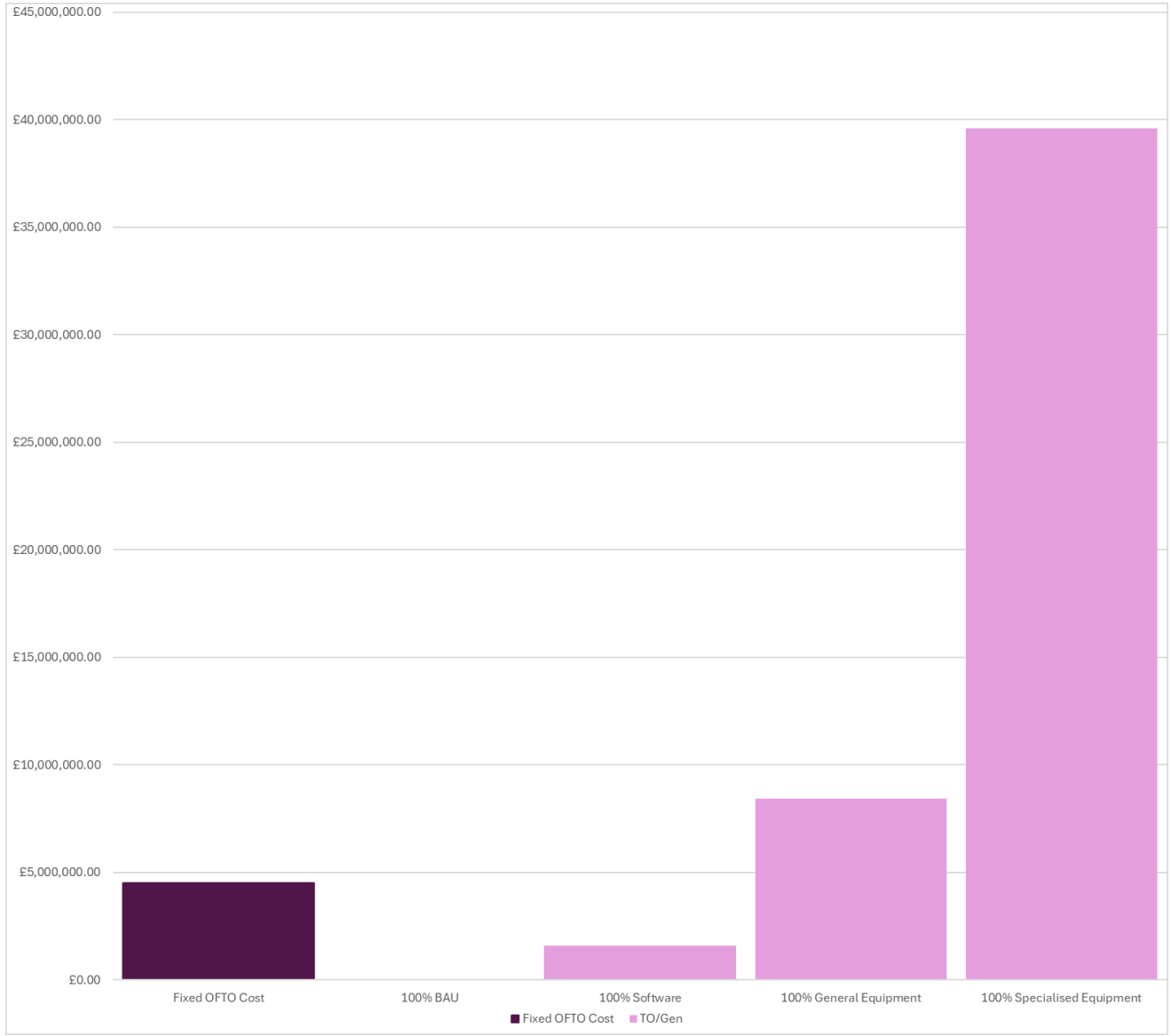
Power Flow Metering Polarity – Example Cost to Fix

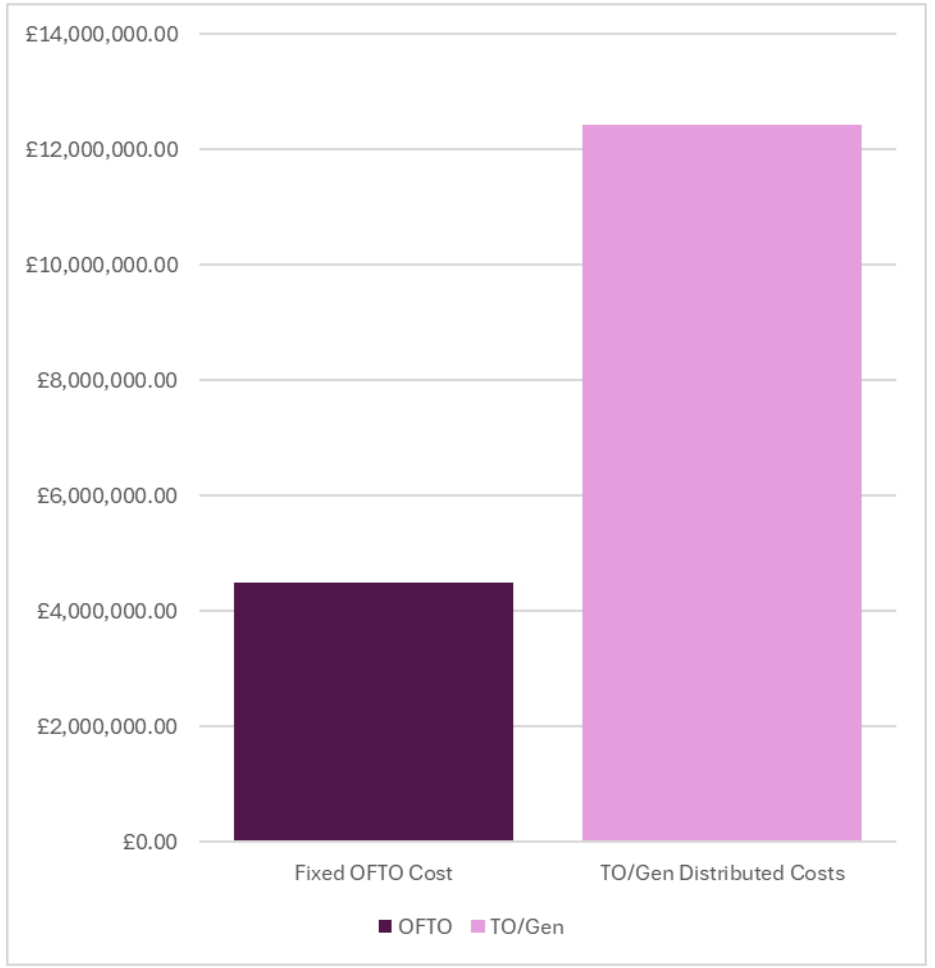
- For the 416 OFTO meters across 45 sites, total expected cost will be: **£4.5m**
- For 402 TO/Generator meters we have assumed only 1 of the 4 options has been implemented. The lowest cost would be **£0**, the highest cost would be **£39.6m**
- Therefore, the total industry cost ranges between **£4.5m to £44.1m**



Power Flow Metering Polarity – Example Cost to Fix

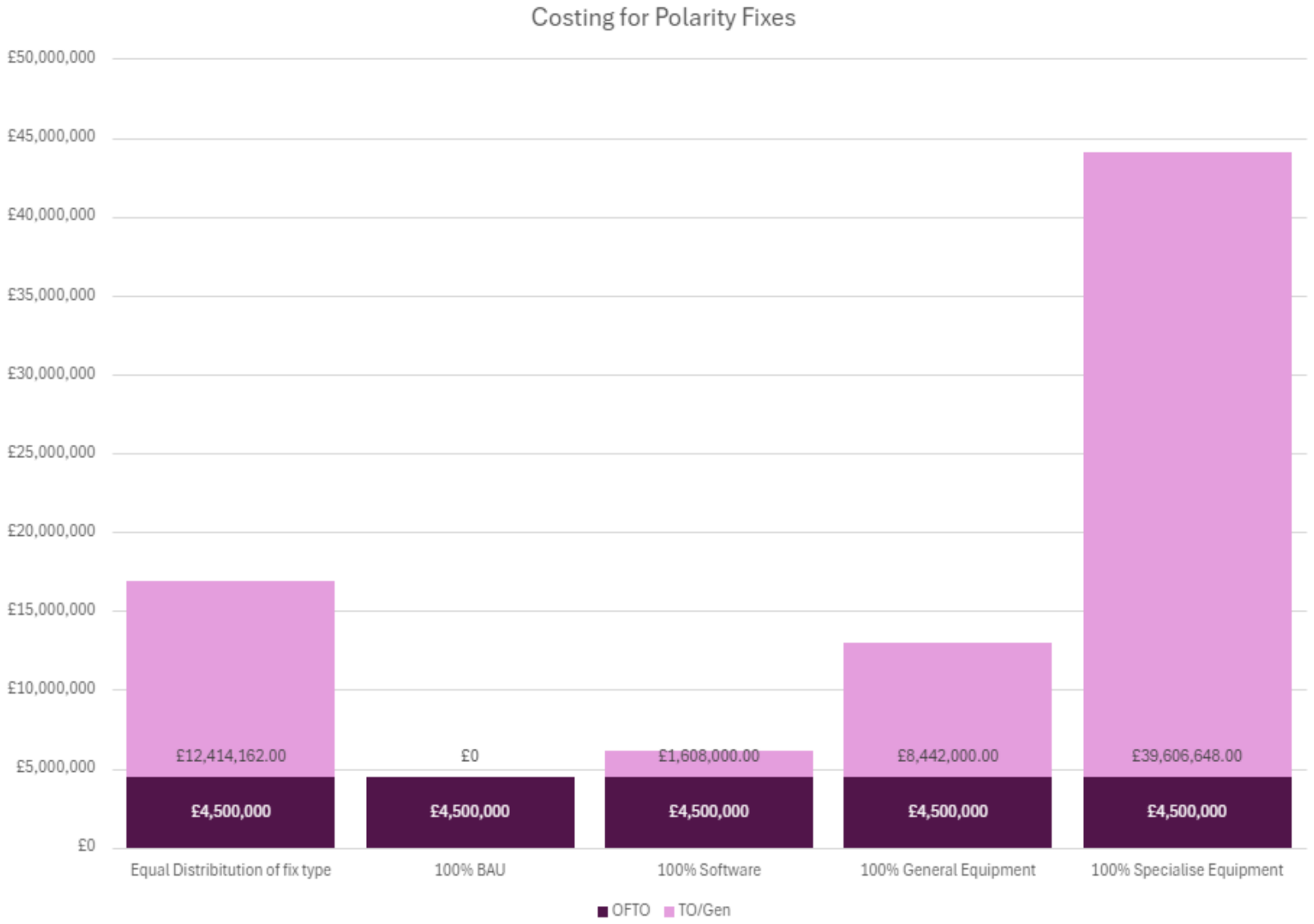
OR

- For the 402 TO/Generator meters, we have assumed equal distribution between the 4 options, with the total expected cost estimated as: **£12.4m**
- Therefore, the total industry cost would be: **£16.9m**



Considering the costs

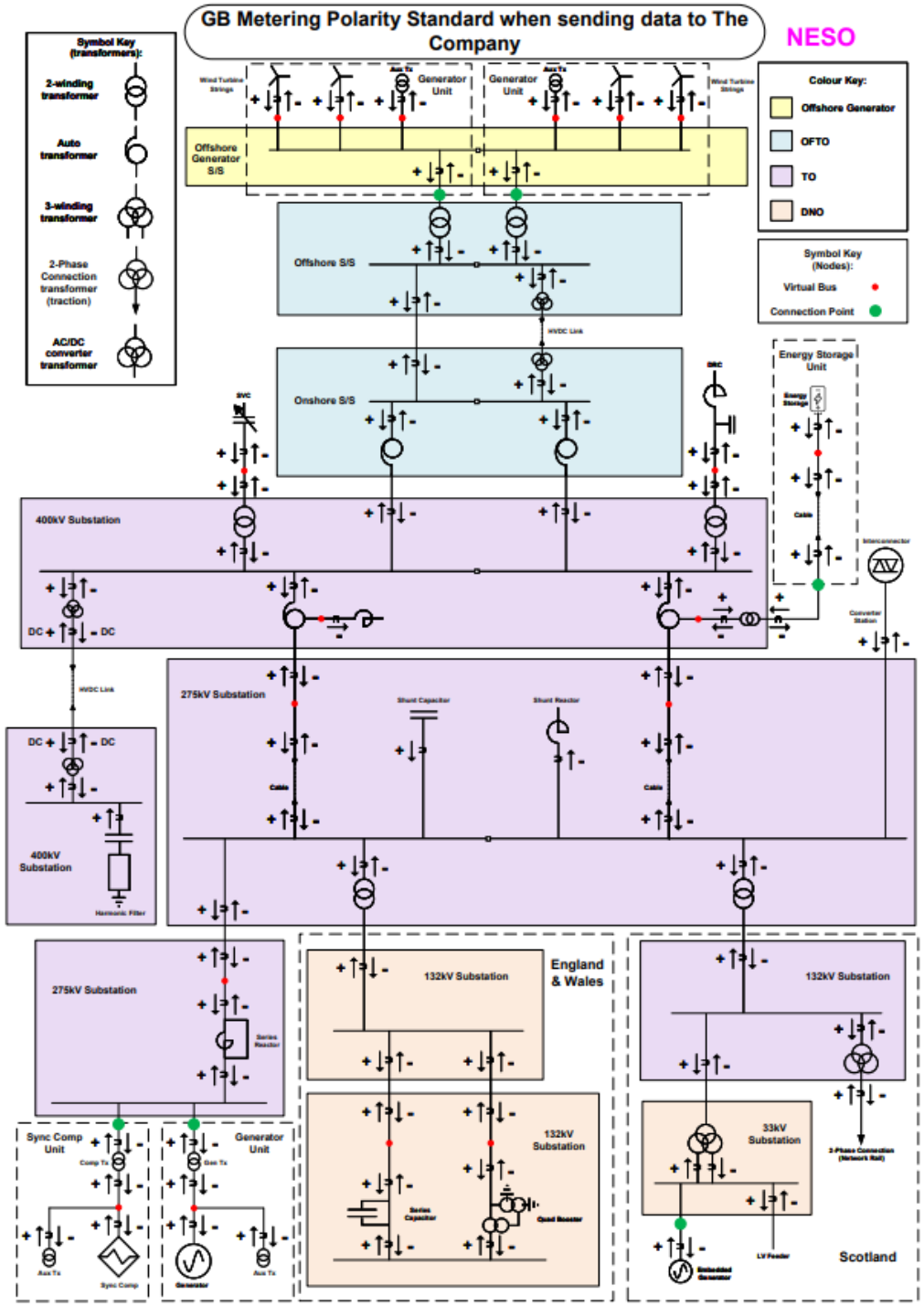
- Based on theoretical calculation:
  - Extra balancing cost incurred due to incorrect polarity estimated at **£100m** / year
  - Cost to fix all meters with incorrect polarity estimated maximum of **£44m** one off
  - More cost efficient to fix the meters compared to spending extra money to offset the impact of incorrect polarity on a continuous basis



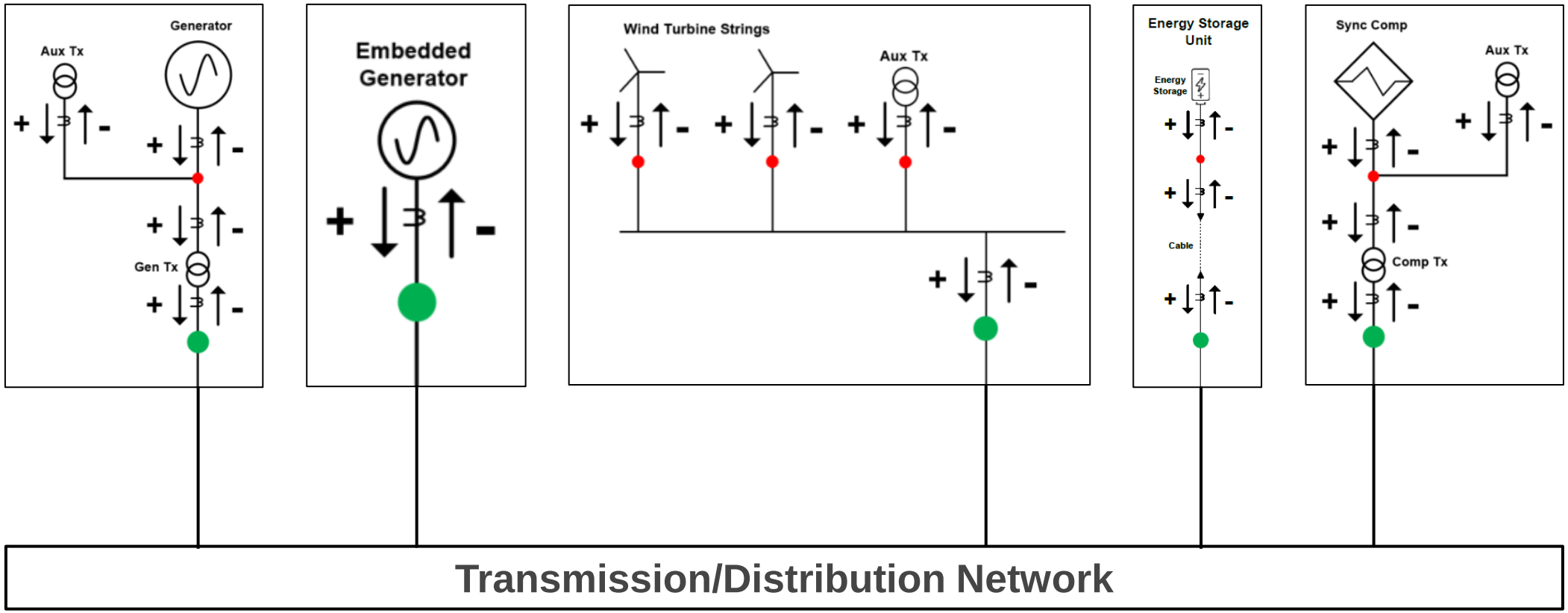
Power Flow Metering Polarity - Proposed Solution

- **Proposed Solution**
  - To develop a unified power flow polarity standard in the form of a diagram with explanatory description
  - To publish the diagram and description as an Electrical Standard which will be referred in Grid Code clause (other codes will refer to Grid Code)
  - To improve/modify processes between NESO and other parties so that the standard will be followed and referenced when setting up new metering connections to NESO SCADA
  - To ensure the polarity standard is followed during ongoing operation
  - To implement for new connections only in this stage

[Metering Polarity Standard]



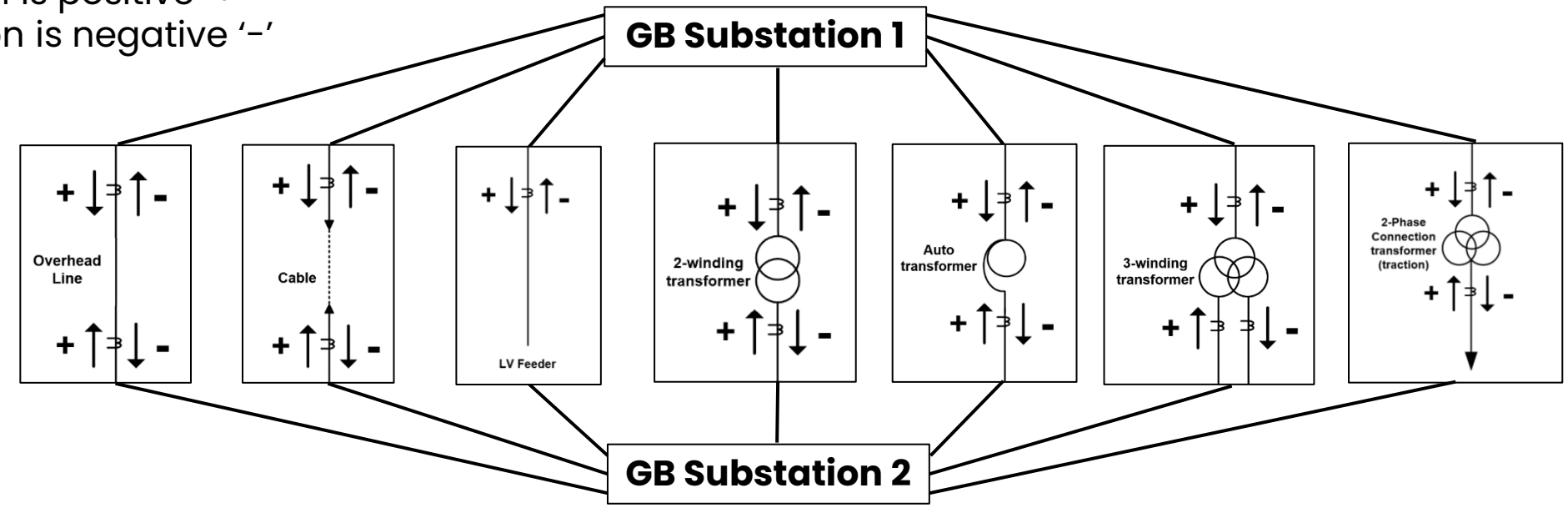
Power Flow Metering Polarity – Key Principle



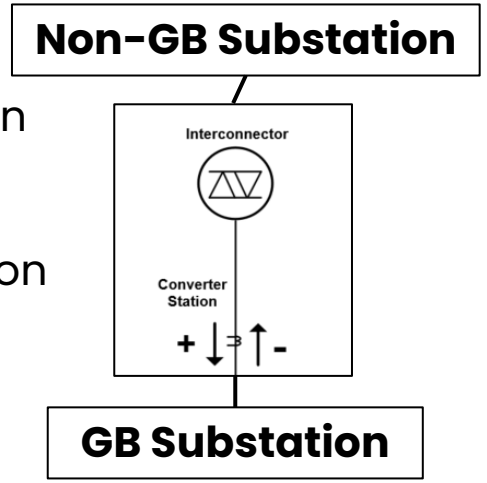
- **Generator Connections** include all assets from the Generator up to the connection point (shown by green circle).
  - All metering associated with Generator Connections is positive towards the Transmission/Distribution network and negative away from the Transmission/Distribution network.

Power Flow Metering Polarity – Key Principle

- **AC Connections between GB Substations: Overhead Line, Cable, LV feeder, Transformers**
  - leaving GB substation is positive '+'
  - Entering GB substation is negative '–'



- **International Interconnectors:**
  - Positive '+' at the converter station when power is being supplied into a GB substation
  - Negative '–' at the converter station when power is being supplied from a GB substation
  - treated like generators on the GB system



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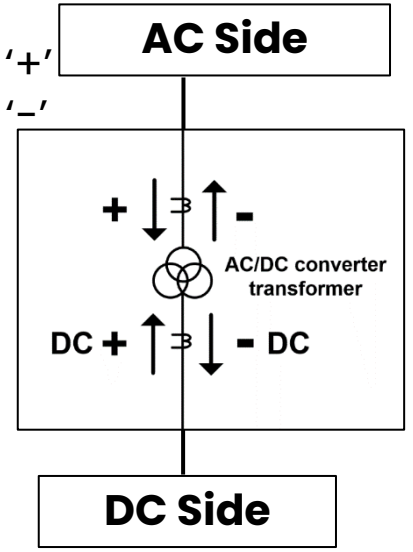
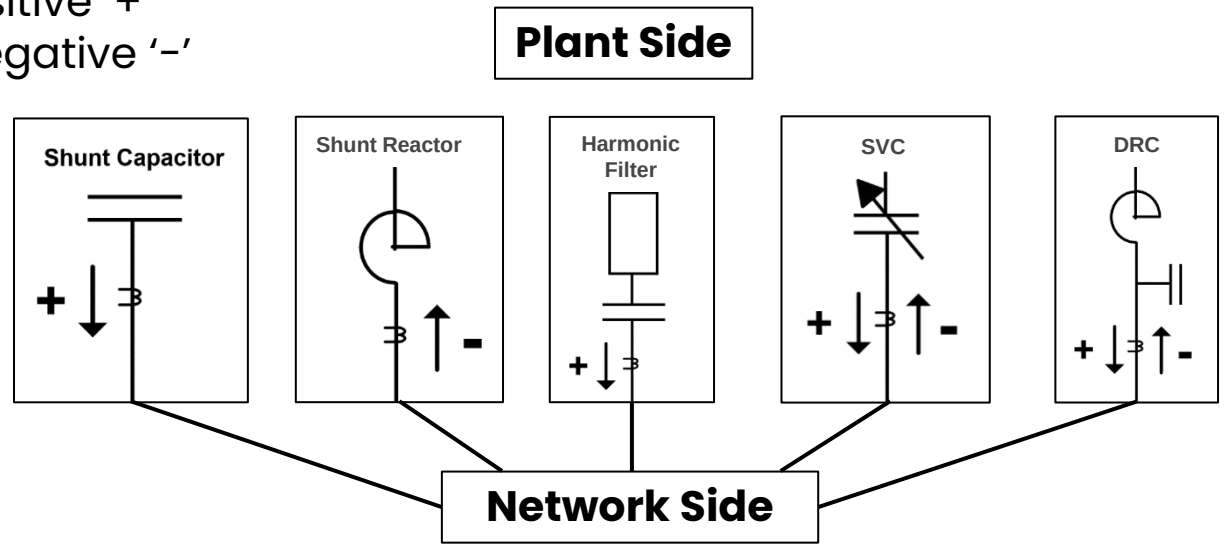
Power Flow Metering Polarity – Key Principle

- **Internal HVDC Links:**
  - entering AC/DC converter transformer is positive '+'
  - leaving AC/DC converter transformer is negative '–'

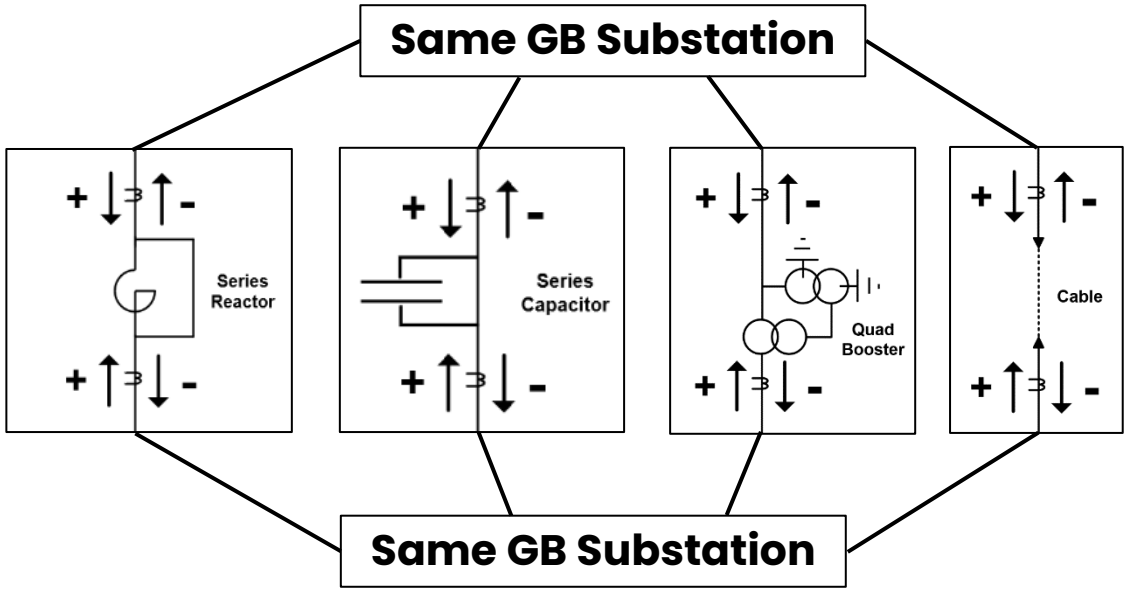


- **Shunt Connected Reactive Compensation:**
  - leaving the plant is positive '+'
  - entering the plant is negative '–'



Power Flow Metering Polarity – Key Principle

- **Series Connected Reactive Compensation and connections within a substation (e.g. a cable section)**:
  - entering the device is positive '+'
  - leaving the device is negative '–'



Power Flow Metering Polarity - Benefits

- **Benefits**
  - Improved situational awareness, system security, better forecast and reduced balancing cost
  - Reduce and/or mitigate iterations and delay for setting up new connections and approval for outage and commissioning
  - Improved coordination, efficiency and transparency between NESO and other parties following unified polarity standard and standardised process

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Questions?

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How to download GCDF Meeting Invites

Step 1: Go to the GCDF website here - Grid Code Development Forum (GCDF)

Step 2: Click the link 'Join us for GCDF meetings' here -

Step 3: Download the meetings into your calendar

AOB