

Public

Quantitative Assessment of Self and Central Scheduling in GB

Executive summary

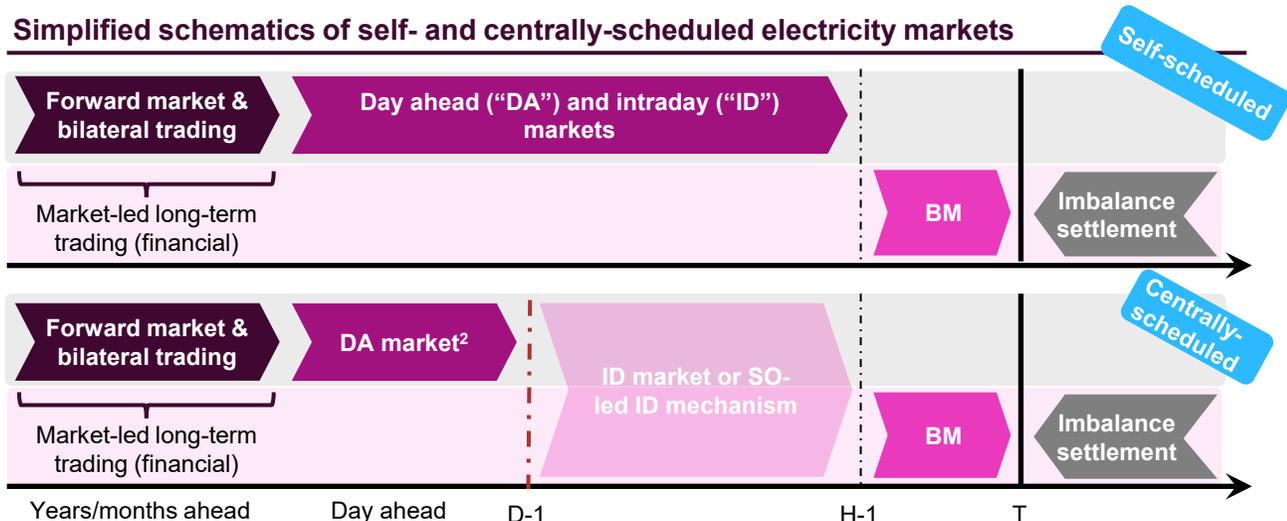
Report by FTI Consulting for NESO

March 2025

NESO commissioned FTI Consulting to quantitatively assess the potential benefits case for central scheduling

- In the context of the Review of Electricity Market Arrangements (“REMA”), NESO commissioned a qualitative report to evaluate whether there might be a case for change to the current scheduling mechanism in Great Britain (“GB”).
- The report, published in May 2024, concluded that there is a case for change, and outlined two high-level approaches as potential routes for improvement:¹
 - Augmenting the existing balancing mechanism (“BM”) process; and**
 - Formalising NESO’s role as “de facto central scheduler”.**
- By introducing central scheduling (illustrated in the stylised diagram below), NESO would be able to coordinate demand and supply in a manner consistent with transmission (“Tx”) system limitations earlier (e.g. at day ahead (“DA”) stage), but it might reduce market participants’ ability to adjust their schedule close to delivery.
- The trade-off between an earlier consideration of Tx network limitations under central scheduling *versus* market participants’ ability to trade out their forecast errors in the GB-wide wholesale (“WS”) market until close to delivery under self-scheduling requires a quantitative evaluation.

- In this context, NESO commissioned FTI Consulting (“FTI”) to quantitatively assess the impact of introducing central scheduling in GB under the current national WS market design. NESO also asked FTI to examine whether similar benefits could be delivered by improvements to the BM, and how the case for central scheduling might change if GB would move to a zonal WS market design.
- Our work builds on two reports previously prepared by FTI for NESO, which qualitatively and quantitatively assessed the case for and impact of co-optimised procurement of energy, reserve and response services relative to the current sequential procurement. A key assumption underpinning FTI’s previous work was that the co-optimisation of energy and selected ancillary services (“AS”) would be performed under central scheduling. However, the wider implications of this assumption were not part of the scope of our earlier work.
- This report therefore complements previous FTI work by directly evaluating the impacts of a potential transition from a self-scheduling design to a central scheduling design. The key questions that this report covers are summarised in the table below.



Key questions that this report covers

- ⚡ *How does the consideration of Tx constraints in the DA schedule affect consumer, producer and system outcomes?*
- 📈 *What is more valuable: solving transmission constraints at DA or allowing a market-led solving of net GB imbalances closer to delivery?*
- ⚖️ *To what extent could amendments to the BM reduce constraint costs?*
- 🔗 *How does the case for central scheduling change under a zonal wholesale market design compared to a national design?*

¹ AFRY (2024) GB scheduling and dispatch – A case for change (link).
² Schedule determined at DA via Security Constrained Economic Dispatch (“SCED”) algorithm which accounts for Tx system constraints.

FTI focused on the trade-off between earlier resolving of thermal Tx constraints *versus* earlier solving of net GB imbalances

- By design, the current GB self-scheduling arrangements include **market-led GB-wide balancing** up to gate closure time (“GCT”) in the ID WS market, incentivised on the basis of a **national WS price**.
- **Intra-GB Tx constraints** are not considered by market participants in the WS market; instead, they are managed by NESO alongside **residual energy imbalances post-GCT** in the BM.¹
- In this report, we examine two key impacts that a move to central scheduling could have in the GB context:



Earlier resolving of thermal Tx constraints on the GB network

- A key benefit of central scheduling is that a central operator can significantly reduce system costs by optimising the schedule around system needs, on a unit-by-unit basis, at an earlier stage than the BM.
- By explicitly considering system constraints and reliability needs as part of the WS market schedule, a central operator could access a broader range of generators (e.g. those with longer lead times) and lower the cost to reposition interconnectors (“ICs”) (and possibly other flexible assets), which would reduce the reliance on more expensive NESO actions nearer real time (“RT”).
- To test this effect, the assessment **considers the impact of NESO resolving Tx constraints at different stages of the scheduling process** under self- and central scheduling.

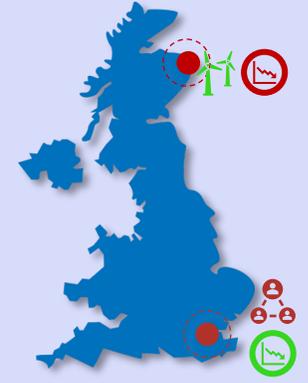


Hypothesis 1: Central scheduling resolves thermal Tx constraints more cost effectively and this is more beneficial than allowing market participants to resolve net GB-wide imbalances until GCT (currently at 1 hour before RT).



Imperfect anticipation of generation and demand patterns at the DA stage

- However, a central operator’s ability to reduce system costs would be limited by the extent to which demand and available supply were accurately forecasted at the time of determining the DA WS schedule.
- By determining a firm, physically feasible schedule at DA (rather than post-GCT), a centrally scheduled market may be less able to adjust the schedule in response to evolving demand and supply conditions in the hours leading up to delivery than market participants could themselves achieve under a self-scheduled market (by adjusting the positions of the units in their portfolio and/or via ID WS trading).
- To test this effect, **‘forecast errors’ are introduced in the modelled DA schedule for wind, solar and demand**, calibrated using historical data from NESO.



Hypothesis 2: Self-scheduling market participants resolve net GB-wide imbalances before GCT via the ID WS market, and associated savings outweigh the benefits of resolving thermal Tx constraints earlier.

The assessment seeks to quantify which of these two effects dominates, and the extent to which this varies across national and zonal WS market designs.

³ ¹ In some cases, NESO can take actions to resolve anticipated Tx constraints ahead of GCT, for example redispatching of interconnectors via countertrading.

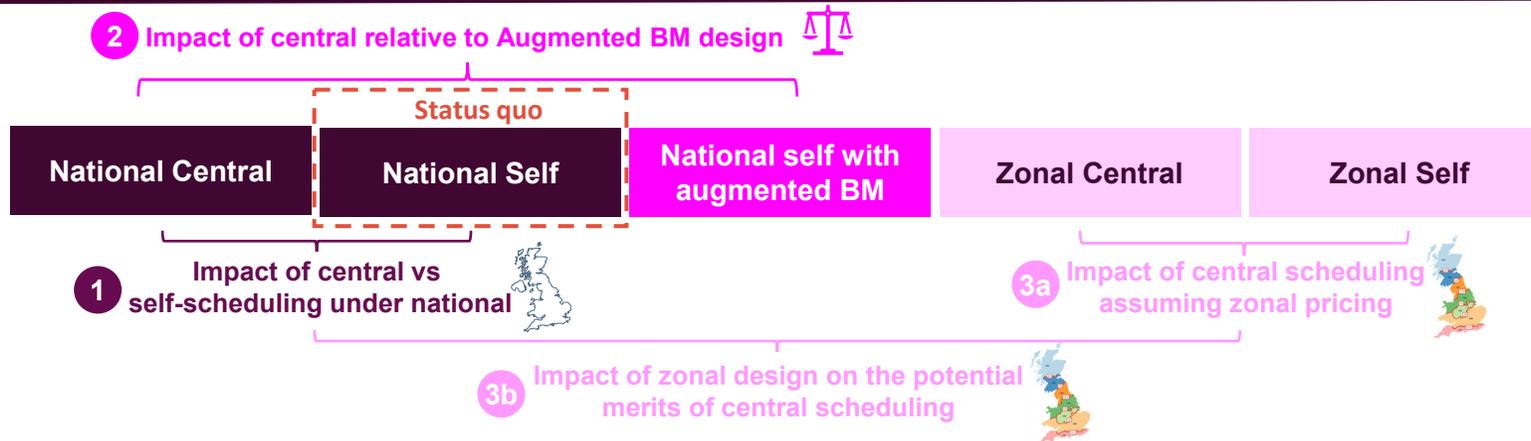
FTI assessed the case for central scheduling under three scenarios using five model set-ups

FTI performed the assessment under three scenarios for the period 2030 - 2040:

- 1 **'Status-quo' with national WS pricing** in place for both the self- and central scheduling arrangements;
- 2 **National WS pricing** in place for both scheduling arrangements, but with an amended BM intended to reduce constraint costs under self-scheduling (an **'Augmented BM'**); and
- 3 **Zonal WS pricing** in place for both scheduling arrangements, with a Baseline BM.¹

FTI quantified the potential benefits of central scheduling under the three scenarios by comparing outcomes between five different model set-ups, as set out in the figure below.

Model setup overview



- FTI performed this analysis by modelling a nodal representation of GB on the Plexos® Integrated Energy Model platform.
- This is integrated with FTI's pan-European model, facilitating simultaneous clearing across GB and Europe.
- Key modelling assumptions were developed through extensive engagement with NESO and DESNZ, with the intention, where possible to align with the assumptions used in other quantitative assessments performed by DESNZ within the wider REMA process.²
- Modelling assumptions for GB generation and transmission align with FES 2022 Leading the Way and HND/NOA7 Refresh respectively, while EU assumptions align with FES 22 EU Consumer Transformation (collectively "2022 input assumptions").

¹ Although augmentations to the BM may be made in tandem with a transition to zonal pricing, we assume a 'Baseline BM' under our zonal assessment to isolate the impacts between the two potential policy directions.

² Key modelling assumptions, such as generation capacity, electricity demand, and commodity prices, are consistent across the five model set-ups. The pink box on the right outlines the differing modelling assumptions.

Modelling assumptions

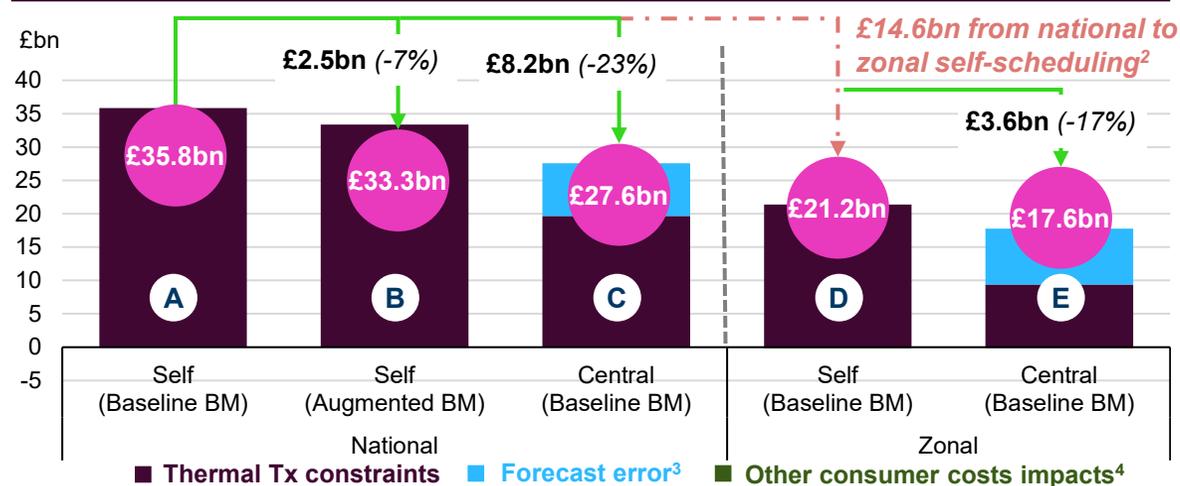
The five model set-ups combine different scheduling arrangements (central/self), with different WS market designs (national/zonal), and therefore vary in terms of:

- **The price used to schedule assets:** under self-scheduling, assets are scheduled relative to either a national or zonal WS price. In the case of central scheduling, resources are scheduled based on a 'shadow nodal price' (i.e. considering thermal Tx limitations).
- **The price used to compensate assets,** which may differ from the prices used to schedule assets (and hence require additional make-whole "transfer" payments).
- **The mechanisms for resolving forecast errors** in place: the net GB-wide imbalance due to DA forecast errors is resolved in the ID WS market under self-scheduling, while imbalances are resolved in the BM under central scheduling.

In addition, under the self-scheduling arrangement we compare a **'Baseline BM'** and an **'Augmented BM'**.

In the modelled scenarios, central scheduling reduces GB consumer costs by £3.6bn-£8.2bn over the 11-year modelling period)

GB consumer costs incurred under self- vs central scheduling, £bn, Present Value 2030-2040 (2022 input assumptions)¹



- Under **national** WS pricing, a move **from self- to central scheduling** lowers aggregate GB consumer costs by **£8.2bn**.
- Retaining self-scheduling with an improved use of thermal and storage assets in an **Augmented BM** would instead (i.e. as an alternative to central scheduling) reduce consumer costs by **£2.5bn**.
- Alternatively, keeping self-scheduling but **transitioning to zonal** WS pricing would reduce GB consumer costs by **£14.6bn**.
- Introducing **central scheduling under a zonal design** would provide a further incremental GB consumer cost reduction of **£3.6bn**.



Key findings

- 1. Central scheduling leads to a reduction in aggregate GB consumer costs under national design of £8.2bn** (moving from A to C, in the modelled period of 2030-2040). This indicates that solving Tx constraints at DA stage is, based on the modelled scenario, more valuable than solving GB-wide imbalances by market participants pre-GCT (i.e. the cost of resolving Tx constraints is higher than the cost of addressing forecast errors post-GCT).
- 2. The benefits of central scheduling are highest in years when the congestion on intra-GB Tx network is highest.** In one modelled year, where the congestion is relatively modest, central scheduling has higher GB consumer costs than self-scheduling (see the next slide).
- 3. If considered as a potential alternative to central scheduling, introducing a zonal WS design would reduce GB consumer costs by £14.6bn** (in the modelled period of 2030-2040). **Overall, zonal pricing with self-scheduling would lead to £6.4bn (D minus C) lower GB consumer costs than national design with central scheduling** (i.e. the move from A to D saves more consumer costs than the move from A to C).
- 4. Introducing central scheduling remains beneficial under zonal WS pricing**, though its incremental benefit is less pronounced. Under a zonal market design central scheduling reduces costs by **£3.6bn** (from D to E), compared to **£8.2bn** under national design (from A to C), but is nevertheless still positive for GB consumers.
- 5. Augmentations to the BM process could reduce GB consumer costs (£2.5bn in moving from A to B).** However, this reform does not reduce GB consumer costs by a significant margin and hence **cannot be seen as a credible alternative to either central scheduling or a zonal WS market design.**

¹ This excludes day ahead WS costs, as these are equivalent between self- and central scheduling.

² We do not assume any change in cost of capital or implementation costs under zonal pricing, nor other benefits of zonal pricing such as potential re-siting of new assets.

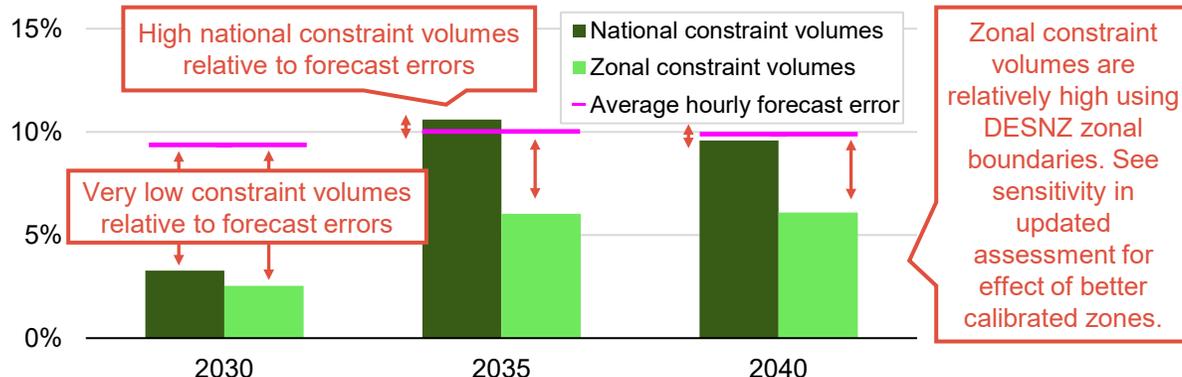
³ Forecast errors represent the cost of adjusting to evolving forecasts of RES (solar and wind) and demand between DA and GCT under each market design.

⁴ Other consumer cost impacts include the changes in DA and ID WS costs, CfD payments, and intra-GB congestion rents under zonal pricing relative to under national pricing. The other consumer cost impacts of zonal pricing can be positive or negative on aggregate and in the modelled scenario largely net off, combined providing a small residual net benefit to consumers across the modelled period.

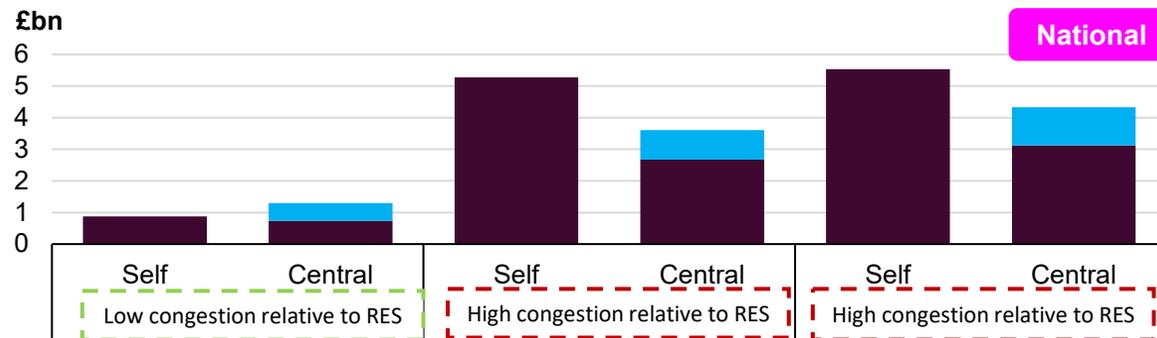
Benefits of central scheduling are driven by the: (i) WS market design; (ii) level of Tx congestion; and (iii) size of forecast errors

- Under self-scheduling Tx constraints are resolved post-GCT. Under central scheduling, Tx constraints are resolved at the DA stage and transfer payments are made to make up for cost recovery and firm access.¹
- In the modelled scenario, 2030 Tx constraint volumes are relatively low compared to the average hourly forecast errors (figure below). By contrast, **Tx constraint volumes increase in 2035 and 2040** while average forecast error remains relatively stable.²
- Consequently, **in 2030, the fall in Tx constraint costs under central scheduling is outweighed by the increased cost of resolving forecast errors, and hence GB consumers costs are higher under central scheduling compared to self.**³ This holds under both national and zonal pricing as shown figures on the right).
- In 2035 and 2040 the **Tx constraint volumes are higher and much closer to the forecast error** (figure below) and as a result **consumer costs are lower under central scheduling** compared to self (figures on the right), as Tx constraint costs become more material compared to forecast errors.⁴

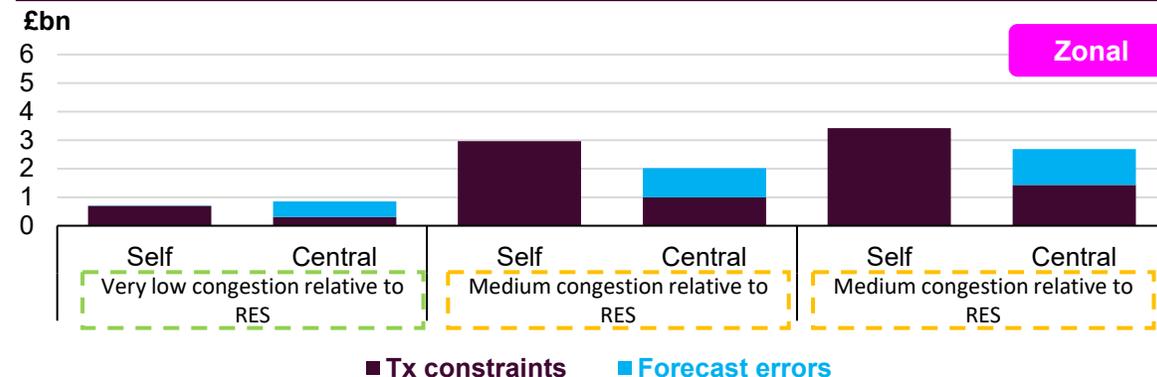
Constraint volumes under self-scheduling (% of demand) and average hourly forecast error (% of demand), 2030 – 2040



Consumer costs of resolving thermal Tx constraints and forecast errors under self- and central scheduling with national WS pricing, £bn, 2030-2040



Consumer costs of resolving thermal Tx constraints and forecast error under self- and central scheduling with zonal WS pricing, £bn, 2030-2040



¹ Minor Tx constraints can arise in the BM under central scheduling due to forecast errors.

² Intermittent RES capacity and hence the absolute forecast error increases across the modelling horizon, but total demand also increases such that the average forecast error remains stable.

³ Under self-scheduling, DA forecast errors are resolved in the intraday market just before GCT, while under central scheduling forecast errors are resolved

⁶ post-GCT.

⁴ The ratio of forecast errors and constraint volumes should be read as a qualitative relationship; there is no direct linear relationship between these two indicators.

Our central scheduling benefits assessment relies on several key assumptions which may benefit from further analysis



Conservative assumptions: Factors which could lead to benefits being underestimated

- **No ID trading (central):** We assume no ID trading under central scheduling. However, ID trading may be possible under central scheduling, which would make the design more attractive.
- **Perfect ID trading (self):** All forecast errors are assumed to be resolved via ID trading under self-scheduling, likely underestimating balancing costs under self-scheduling.
- **No bid uplifts:** We do not consider bid uplifts ('downlifts') in the BM, reducing modelled balancing costs. As BM costs are much higher under self-scheduling, this assumption is conservative for the case for central scheduling.
- **No Inc-Dec gaming:** We do not model gaming between the WS market and BM under either design, but self-scheduling is arguably more prone to such gaming.¹
- **Non-quantified benefits:** Broader potential benefits of central scheduling, such as increased SO asset visibility, market transparency and the co-optimisation of WS scheduling and AS, are not quantified.²



Uncertain impact: Could have positive or negative impact on estimate of benefits

- **Input assumptions:** Different input assumptions, such as capacity outlook and commodity prices, could affect the benefits case for central scheduling.³
- **Forecast accuracy:** DA RES/load forecast accuracy is assumed constant across the modelling horizon. Should forecasting improve/worsen over time, the benefits of central scheduling are underestimated/ overestimated.
- **Non-quantified impacts:** It is unclear how central scheduling would impact the required cost of capital for generators. We note that the modelled market design includes 'make-whole' transfer payments to limit revenue impacts on generators at DA.
- **NIV chasing:** Not modelled here, but subsequent FTI modelling for NESO found minimal impact of NIV chasing on balancing costs under self-scheduling with no consistent directional impact.
- **Number of zones and delineation:** The assessment uses a zonal design provided by DESNZ. Different zones (number or delineation) will impact the benefits of central scheduling under a zonal market design.⁴



Overestimation: Factors which could lead to benefits being overestimated

- **Nodal scheduling of ICs (central):** ICs are assumed to be scheduled perfectly relative to GB shadow nodal prices and WS prices in the connected country.⁵ With explicit cross-border trading, WS price forecast errors by IC capacity holders could cause ICs to be misaligned with the 'optimal' GB schedule.
- **No transfer payment offer uplift (central):** We assume no offer uplifts in the DA market for units that are scheduled under central but not scheduled under self.⁶ We make this assumption as the central schedule is set at DA while BM actions under self-scheduling are undertaken one hour or less before delivery. However, including offer uplifts for transfer payments would reduce the benefits case for central scheduling.
- **Portfolio scheduling (self):** Under both scheduling arrangements we model unit-based scheduling. Potential benefits from portfolio scheduling under self (mostly relevant for thermal units) are not modelled.
- **Non-quantified costs:** Implementation costs associated with a transition to central scheduling are not measured.

¹ Under self-scheduling portfolio owners can strategically position their assets at GCT in anticipation of how that positioning could lead to an increased need to resolve Tx constraints in the BM. The same portfolio owners could benefit from resolving those self-induced constraints. Under central scheduling, Tx constraints are resolved at the DA stage and the SO has visibility at asset-level. Rules must be put in place to avoid assets unwinding their positions relative to the central schedule. Policing the former is arguably harder than the latter.

² The co-optimisation of WS scheduling and AS was examined in a separate report prepared by FTI for NESO. PV consumer benefits for 2025-2035 were estimated £4.9bn.

³ The impact of updating input assumptions to align with FES 24, TYNDP 24, CP2030, and Beyond 2030 (collectively "2024 input assumptions") has subsequently been examined by FTI for NESO.

⁴ Deployed GB zones are not calibrated to modelled congestion boundaries, implying a conservative benefit estimate of a zonal market design (under the same scheduling approach). In subsequent modelling, adjusting zonal boundaries to align more closely with modelled congestion boundaries increased socio-economic benefits of zonal self-scheduling relative to national self-scheduling by £5.1bn (PV 2030-2040, 2024 input assumptions).

⁷ ⁵ The interactions between cross-border trade arrangements and scheduling options are analysed in depth in a separate report prepared by FTI for NESO.

⁶ By contrast, constrained-on units in the BM under both scheduling arrangements are assumed to include an offer uplift, which is more relevant for self-scheduling due to higher BM volumes.

