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Voltage Matters

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Are Electrical Faults Putting Your Operations At Risk?

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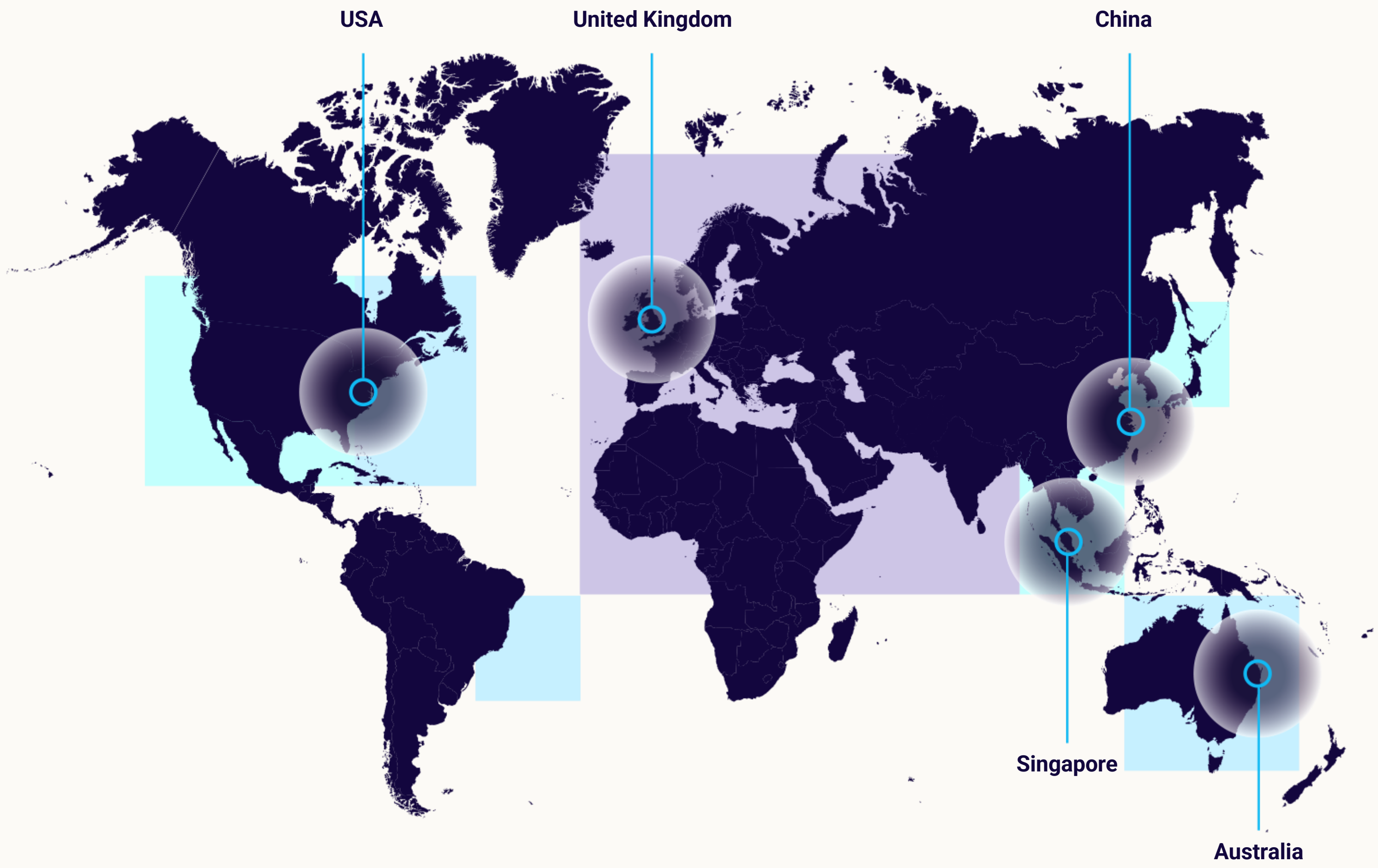

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Keynote

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Euan Kirkmorris
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Making a positive difference
for energy consumers

Voltage Management in ED3

Dr Euan Kirkmorris

Contents

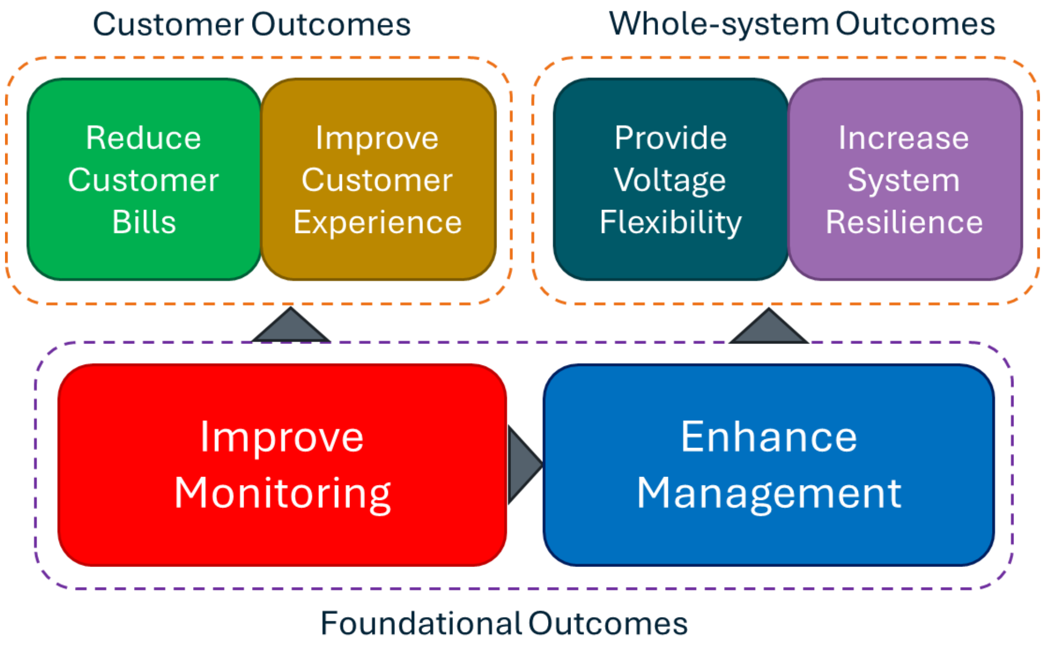
- How Ofgem's view of voltage management has evolved
- What we've set out in the Sector Specific Methodology and Business Plan Guidance
- What we are now asking industry to deliver through the business plans and voltage management strategies

Evolution of Regulatory Approach To Voltage

- Voltage has not been a big focus from a regulatory, and particularly an Ofgem, perspective in previous price controls, with considerations focused on:
  - Maintaining voltage with statutory limits
  - Delivering reliability and power quality
  - Investing in reinforcement when limits were breached
- Alongside this, Ofgem supported has supported innovation projects which drove progress, such as CLASS and Smart Street in ED1, and BEET, QUEST, and Voltmetric in ED2, and more
- In ED3 we recognise that the energy transition is significantly complicating the management of voltage on distribution and transmission networks, and so have included voltage management as new DSO responsibility

Voltage Management in ED3

- The new voltage management role involves the delivery of key outcomes.
- The foundation of the Voltage Management responsibility will be improving DSOs understanding of voltage and voltage issues on their networks and enhancing their ability to manage voltage in response.
- With these foundational outcomes in place, we expect DSOs to deliver additional outcomes with benefits to customers and to the system as a whole



Foundational Outcomes

Category	Outcome	Delivery Guidance
Foundational	Improving Monitoring	• Using existing LV monitoring supplemented with smart meter data and data from third-party assets to improve awareness of voltage issues on distribution network, and potential impacts on the transmission network • From this better understand the voltage headroom/legroom available across primary substations including flexibility capacity • Additionally, leverage analytics to predict deviations and loss events to optimise network operation
	Enhancing Management	• Improving ability to control voltage across primary network, keeping voltage within statutory limits, and optimising voltage levels across network through installation of improve voltage control and communication links to control rooms • Installing voltage control on secondary networks where this can be justified e.g. on feeders where greater control would unlock voltage headroom on primary network

Foundational Outcomes

Category	Outcome	Delivery Guidance
Customer	Reduce Customer Bills	• Optimising voltage supplied to customers to provide bills reductions through conservation voltage reduction (CVR). • Aiming to bring the voltage supplied to average customer down from the current value of around 243V to closer to the middle of voltage range (234.5V). This is a GB-wide target, DSOs should determine what is a reasonable average voltage reduction target in each of their network areas.
	Improve Customer Experience	• Managing voltage to reduce connections constraints and curtailment of DER exports • Ensuring voltage always remains within the permitted variation around the nominal voltage range at customer premises (even where deviation from this is permitted in statue or statutory guidance) to eliminate interruptions of operation of LCTs such as EV chargers and PV inverters.

Foundational Outcomes

Category	Outcome	Delivery Guidance
Whole-system	**Provide Voltage Flexibility**	• Met through the delivery of the Voltage Flexibility Service: as part of the 9am day-ahead forecast NESO will instruct which settlement periods they wish DSOs to reduce demand via voltage reduction • To achieve this, DSOs may need to improve their control room and other capabilities • We expect a Grid Code modification may be required to operationalise this service.
	Increase System Resilience	• Upgrading control room capability to call on power factor control of distribution-connected generation • Coordination with NESO to determine whole-system solutions suitable for individual GSPs. • To provide a reliable long-term solution, we believe that a Grid Code modification is required to introduce reactive power requirements at all GSPs, potentially through retroactive application of ECC.6.4.5

Delivery

- DSOs will determine how best to deliver these outcomes across different locations, network conditions, times of year, etc, including managing the complex trade-offs between them and other outcomes (e.g. losses management)
- We believe it is unlikely we can achieve full rollout in single price control period.
- In ED3 focus should be on delivering rollout of improved voltage management capability on:
  - Newly-installed or upgraded Primary Substations
  - Existing Primary Substations where new AVC scheme capability is required
  - Newly-installed or upgraded Secondary Substations unless additional cost cannot be justified
  - Existing Secondary Substations where voltage control capabilities can be economically justified
- DSOs will set out in their Voltage Management Strategies

Voltage Management Strategy

- Forming part of the DSO Strategy submitted alongside business plans, Voltage Management Strategies will set out how DSOs will:
  - Maximise benefits to customers through balancing the delivery of voltage management outcomes
  - Balance delivery of the voltage management outcomes with related outcomes such as total capacity, network headroom, and losses reduction
- The strategies must include:
  - Assessment of voltage issues, current and emerging
  - Estimation of voltage flexibility capacity
  - A baseline for reactive power performance, and identification of GSPs where action is required
  - A vision for delivering the voltage management outcomes including deliverables and how these will deliver maximum benefits to customers
  - A range of metrics, such as proportion of network where voltage can be estimated, average voltage supplied to customers, and the number and type of voltage control installations on the primary and secondary network
- DSOs will publish annual updates on their progress towards meeting the deliverables including updated metrics

Conclusions

- Voltage Management is a significant part of DSO considerations for ED3
- Alongside investing in the capabilities to tackle the increasing prevalence of voltage issues, DSOs will have to deliver outcomes which benefit customers and the wider system
- The Voltage Management Strategies will set out how each DSO will deliver these outcomes in a way which maximises benefits to customers
- Rollout of new capabilities will be targeted in ED3, with further expansion likely in ED4

Session 1 – Compliance

technology

Roger Hey

Smart GB Services on behalf of the IET

Voltage Management for a Net Zero Electricity System

IET Task and Finish Group Stage 1 Report

A Briefing for the Voltage Matters Forum 25 June 2026

Could it happen here?

The commission

- An IET Task & Finish Group is undertaking a study for Ofgem on the adequacy of grid voltage management
- An interim report has been presented to Ofgem, signalling the direction of the developing conclusions
- A final report will follow

Terms of reference

- Define the scope of voltage management concerns
- Explain the risks and the opportunities, and explore the policy context
- Explore the extent to which the GB 50Hz system might be exposed to an Iberian-style failure mode
- Provide a roadmap of what is possible and realistic, short and longer term

What happened in Iberia

- 28 April 2025: a voltage-led cascade, not a frequency event
- Initiated by over-voltage tripping of distributed generation, principally rooftop solar PV
- Rapid generation ramping outpaced relatively slow transformer tap changers
- IBR instability and interaction produced forced oscillations – fluctuations within seconds
- Operator action to manage oscillations inadvertently worsened the voltage
- The expert panel itself struggled to obtain definitive data on the initial rooftop trips

A voltage-led cascade, not a frequency event

The same blind spot exists here

Britain runs hot

- 230V nominal, but the standard distribution transformer delivers about 248V off-load
- Up to 5% of LV-connected customers experience sustained voltage above the statutory limit
- Exceedances are growing rapidly on smart meter and EV charger data
- Over 20% of EV chargers see sustained over-statutory voltage, causing charging failures
- Most transformers sit on tap +2.5%, with only about 2.5% reduction available
- At primaries, 70–80% are within four taps of the lowest for 200–300 days a year

243V
average supply vs 230V nominal

1–5%
over the legal limit

1 in 5
EV chargers over

Fast faults need a faster response

- Voltage can rise faster than mechanical tap changers can respond
- A large, growing population of inverter-based resources, poorly observed under stress
- Risk of forced oscillations and rapid voltage and frequency fluctuations
- GB rooftop solar seen disconnecting below G98 over-voltage no-trip thresholds
- Inadequate ride-through is both a customer inconvenience and a system security risk

A standard on paper is not the same as measured behaviour in the field

Two decisions, not one

- The ENA has consulted on modernising the lower statutory limit, 216V to 207V
- The Group supports the direction of legislative modernisation in principle
- But legislative change and operational voltage management are two distinct decisions
- The consultation addresses the lower limit; today's pressing problem is the upper end
- Operational action within existing limits need not wait on the legislative timetable
- Both can, and should, proceed in parallel

207V is the lower limit. Today's problem is the upper end.

Wide-area fixes at the primary, ready and affordable

- Seasonal, proactive adjustment of primary AVC set points – wide area, modest cost
- AVC compounding boosts or bucks voltage with network loading
- CLASS: tap-staggering, parallel-transformer tripping and tap lowering for fast response
- Smart meter and LV monitoring data can optimise primary tap set points
- Proven in innovation projects, but not yet standard operating procedure
- Conservation Voltage Reduction: ~1% energy saving per 1% voltage reduction

£1.5bn

a year across GB (~£56 per home)

1GW / 3GW

CLASS flex, summer / winter

You can’t manage what you can’t see

- Millions of EV chargers and smart meters already measure voltage continuously
- That data is not yet used systematically as an operational tool
- Voltage ignores the boundaries between transmission, distribution and the home
- No single party is clearly accountable for whole-system voltage
- The first actions are available, affordable, and ours to make today
- A programme of further work and a roundtable will follow

Not the technology. The coordination and the ownership.

The grid edge is a blind spot

Tahir Ayub, Network Rail

ESQCR

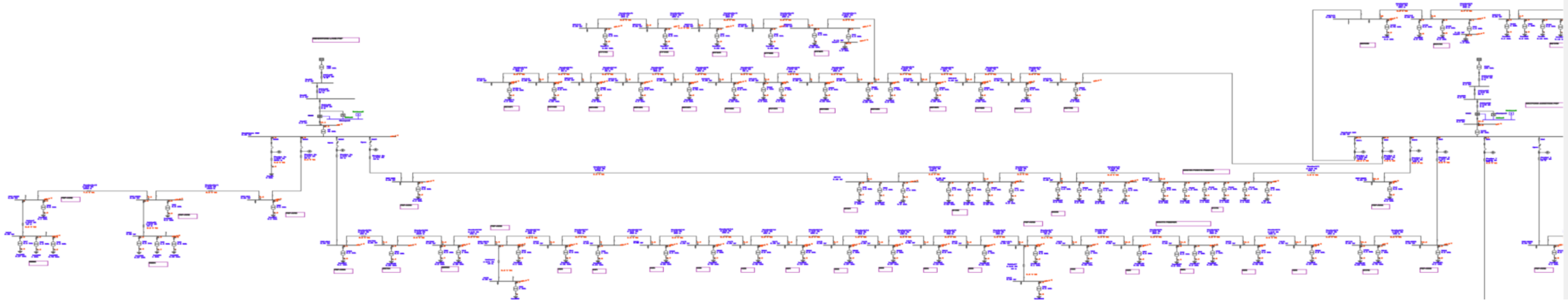
MIND THE VOLTAGE GAP

Tahir Ayub

National Technical Head Power Distribution HV/LV

Simpler.
Better.
Greener.

NetworkRail



Six-Domain Risk Assessment across Network Rail's Power Distribution Network

- **Signalling Power Distribution**
- **Telecoms Power Distribution**
- **Railway Stations**
- **Depots & Operating Centres**
- **Commercial Property Power Networks**
- **IT Servers & Network Power Supplies**

207V	6	~2028
New Statutory Floor	Asset Domains in Scope	ESQCR Amendment

ESQCR VOLTAGE LIMIT REVISION

NetworkRail

UK Voltage History & The 2026 Inflection Point

PRE-1995
THE 240V LEGACY

240V/415V
STATUTORY (±6%)

240V
ACTUAL SUPPLY

1995–2002
'HARMONISATION' PAPER EXERCISE

230V/400V
STANDARD (+10%/-6%)

240V
ACTUAL SUPPLY

2002–2026
ESQCR MAINTENANCE

230V/400V
SAME LIMITS

240V
ACTUAL SUPPLY

2026 PROPOSAL
FIRST PHYSICAL REDUCTION

207V-253V
PROPOSED LIMITS (+10%/-10%)

207V
STATUTORY MINIMUM

UNPRECEDENTED PHYSICAL IMPACT

2026 Proposal (207V) is unprecedented. The first *physical* voltage reduction after decades of 240V supply. Crucial for safety-critical infrastructure. Actual supply was ~240V for 30 years.

THREE-PHASE 400V SUPPLY — THE MATHEMATICAL LINK TO 230V AND WHY IT MATTERS

UK three-phase power is not a separate system — it is mathematically derived from the single-phase 230V supply. Any change to the 230V statutory limits propagates directly and proportionally into the three-phase 400V network and all equipment connected to it.

THE MATHEMATICAL RELATIONSHIP

$$V_{210}\ \text{(line-to-line)} = V_{230}\ \text{(phase)} \times \sqrt{3}$$

$$230\text{V} \times 1.7321 = 398.4\text{V} \approx 400\text{V nominal}$$

This √3 relationship is fixed — it is a consequence of how three-phase AC voltage waveforms are offset 120° apart. It cannot be changed by regulation, equipment design or network configuration.

What this means for ESQCR:

- ESQCR specifies the 230V phase-to-neutral (single-phase) limit only
- The 400V line-to-line voltage is derived — it has no separate statutory limit
- Any reduction in the 230V floor automatically reduces the 400V line voltage by the same percentage
- Equipment rated for 400V three-phase must therefore be assessed against the new 400V floor derived from 207V

DERIVED THREE-PHASE VOLTAGES AT EACH STATUTORY LIMIT

Scenario	Phase V (L-N)	Derived Line V (L-L) = V×√3	Change from current floor	Status
Upper limit (current & proposed)	253V	**438.1V**	—	UNCHANGED
Nominal (current & proposed)	230V	**398.4V**	—	UNCHANGED
Current lower limit (ESQCR)	216V	**374.1V**	Baseline 0V	CURRENT FLOOR
Proposed new lower limit	207V	**358.5V**	−9V phase −15.6V line	NEW FLOOR
Mid-band nominal minus 5%	218.5V	**378.4V**	Typical lower end	COMMON OPERATING

KEY INSIGHT: The proposed 207V lower floor reduces the derived three-phase line voltage from 374.1V to 358.5V — a reduction of 15.6V on three-phase circuits.

The issue is not the mean voltage — it is the extremes now simultaneously touching both limits. A 9V extension to the lower floor gives DNOs the headroom to manage peak export events without breaching the upper limit.

ASSESSMENT SCOPE — SIX ASSET DOMAINS IN NETWORK RAIL'S POWER ESTATE

Every LV and shared 11kV supply within these six domains is in scope. Dedicated 33kV+ supplies, 25kV traction and 750V DC third rail are excluded by topology — the DNO proposal does not apply to them.

01 ⚡ Signalling Power Distribution

IN-SCOPE ASSETS

- Trackside power supply Points (PSPs)
- Solid State Interlockings (SSIs) — LV supply panels
- Axle counter power units
- Level crossing barrier & detection systems
- AWS/TPWS equipment cabinets
- Lineside UPS units & standby generators

KEY RISK

HIGHEST — Safety critical. Constant-power loads increase current draw at lower V. UPS transfer thresholds set at 216V become false-trip triggers at 207V. Equipment specifications may reference 216V lower limit.

DATA: Signalling power supply records · UPS/generator schedule · Defect management (ELLIPSE)

02 📡 Telecoms Power Distribution

IN-SCOPE ASSETS

- Radio Equipment Rooms (RERs) & lineside equipment cases
- GSM-R base station power supplies
- CCTV power feeds (lineside)
- Fibre optic repeater & regeneration hut supplies
- Public address system power supplies
- Passenger Information System (PIS) cabinet feeds

KEY RISK

HIGH — Constant-power DC-DC converters standard throughout. Battery float charge voltage sensitive to supply dips. Loss of GSM-R has operational safety implications.

DATA: Fixed plant asset database · Telecoms equipment register · Monitoring (where installed)

03 🚉 Railway Stations

IN-SCOPE ASSETS

- Station building LV main distribution boards
- Escalator & lift motor drives
- Platform lighting (LED drivers — constant power)
- Retail unit LV sub-distribution
- Ticket vending machine & gate-line supplies
- Emergency lighting & fire detection systems

KEY RISK

MEDIUM-HIGH — Motor torque on escalators/lifts degrades below nominal V. Emergency systems must remain compliant with BS7671 at new lower V. Retail tenants may have sensitive equipment.

DATA: Fixed plant asset database · Electrical installation records · Periodic inspection certificates

ASSESSMENT SCOPE — SIX ASSET DOMAINS IN NETWORK RAIL'S POWER ESTATE

Every LV and shared 11kV supply within these six domains is in scope. Dedicated 33kV+ supplies, 25kV traction and 750V DC third rail are excluded by topology — the DNO proposal does not apply to them.

04 🏭 Depots & Operating Centres

IN-SCOPE ASSETS

- Train maintenance facility main intakes (LV/11kV shared)
- Traction current rectifier auxiliary supplies
- Workshop machinery & CNC equipment
- Control room and signalling centre auxiliary LV
- On-train battery charging rigs
- Welfare, office and amenity LV sub-boards

KEY RISK

MEDIUM-HIGH — Industrial motor loads susceptible to thermal trip at lower V. Battery charging efficiency reduces. Control room UPS thresholds need audit. Large sites may have multiple supply points.

05 🏢 Commercial Property Power Networks

IN-SCOPE ASSETS

- NR-owned retail and office development LV supplies
- Station retail mall sub-distribution networks
- Commercial tenant metered supplies
- Car park LV distribution (EV charging included)
- Hotel and hospitality LV supplies (managed estate)
- Network Rail Property managed building services

KEY RISK

MEDIUM — Tenant equipment diversity high. EV charger protective relays typically set to 216V lower trip: will alarm at 207V. NR has landlord obligations for supply quality under lease terms.

06 🖥 IT Servers & Network Power Supplies

IN-SCOPE ASSETS

- Data centre UPS systems (primary and secondary)
- Server room PDU supplies
- Network Operations Centre (NOC) power feeds
- Control system server room LV panels
- SCADA / operational technology power supplies
- Back-office IT infrastructure across all NR offices

KEY RISK

HIGH — Data centre UPS designed for >99.999% availability. Transfer threshold set at 216V will generate spurious mains-fail events at 207V, cycling batteries unnecessarily and reducing UPS autonomy. PDU input voltage ranges need validation against new floor.

Four data silos. One MPAN. No join.

Why ESQCR exposure today is a six-month project, not a query

DNO HH feeds

Six licensed DNOs · IDNO
Different formats, cadences

NR Energy DB

Contractual view
Supplier · tariff · agreed kVA

Sub-meter historians

Signalling FSPs · station BMS
depot incomers · per-route

Asset register

What the connection powers
Not keyed to MPAN today

TODAY · Manual reconciliation across spreadsheets, historians and contracts

ESQCR response

6-month engineering exercise per DNO notice

Settlement variance

DNO bill vs sub-meter reality is invisible

Loss attribution

HV / LV losses unmeasured, untargeted

Regen & DSR revenue

Export-capable sites not flagged

One MPAN-keyed model. Five capabilities.

What the unified data spine delivers — at a glance

ESQCR-SCOPE

Voltage triage

5,231 LV + shared-11kV connections in regulatory scope of the 216→207V proposal. Real exposure calculation is a Phase-1 deliverable.

SETTLEMENT

Billing integrity

DNO-billed kWh vs NR-measured kWh, MPAN by MPAN. 1–3% of spend recoverable.

EFFICIENCY

Loss & demand

~220 GWh/yr modelled across voltage optimisation, HV losses, BMS, point heating.

REVENUE

Regen & DSR

Export-capable connections become visible — the precondition for monetising regen-braking and DSR.

CARBON

CP7 fidelity

Carbon reporting moves from estimated to measured at 14k+ connection points.

OVERLAY

AI-ready substrate

Foundation for leveraging AI for insights

SMART METER DATA — SMETS2 MEASUREMENTS & TRIAGE INTEGRATION

SMETS2 meters provide DNO-sourced, independent voltage evidence at each supply point. Where NR sites are smart-metered, this data is the primary input to Steps 5A–5D and directly strengthens DNO hold/exclusion applications.

SMETS2 / AMR MEASUREMENTS AVAILABLE FROM DNO PER SUPPLY POINT

CATEGORY	MEASUREMENT	INTERVAL	RISK
Voltage Quality	RMS voltage (L1/L2/L3 & neutral)	1-min avg	PRIMARY
Voltage Quality	Voltage minimum/maximum (30-min window)	30-min	PRIMARY
Voltage Quality	Voltage unbalance (3-phase sites)	10-min	HIGH
Power Quality	Total Harmonic Distortion — voltage (THDv)	10-min	HIGH
Power Quality	Power factor (displacement & true)	30-min	MEDIUM
Current/Load	RMS current per phase (A)	30-min	MEDIUM
Current/Load	Active / reactive / apparent power (kVA)	30-min	MEDIUM
Energy	Import / export energy (kWh)	30-min HH	LOW
Events/Alarms	Undervoltage alarm events (threshold & count)	Event-driven	PRIMARY
Events/Alarms	Overvoltage events & duration log	Event-driven	HIGH
Events/Alarms	Power outage / interruption log	Event-driven	HIGH

EXTENDED TRIAGE — STEPS 5A–5D

5A — **Identify Smart-Metered NR Sites**
Cross-reference all six domain asset registers with DNO smart meter roll-out data via connection agreements. Flag all sites with SMETS2 or AMR metering across Signalling, Telecoms, Stations, Depots, Commercial and IT domains.

5B — **Formal SMETS2 Data Request to DNO**
Submit formal data request to each DNO for: 24-month V-min/max logs (30-min resolution), undervoltage event logs (threshold & count), THDv where available. Invoke Smart Energy Code (SEC) Schedule 4 right of access. No commercial agreement required.

5C — **Apply Smart Meter Triage Scoring Rules**
+3 if V-min < 216V ≥3× in 24 months | +2 if V-min 216–220V declining | +2 if UV alarms ≥5/year | +1 if THDv > 5% coincident with low V | AUTO TIER 1 if V-min < 210V ever recorded.

5D — **Attach to DNO Justification Pack**
SMETS2 logs are DNO-sourced, independent evidence of voltage risk. For Tier 1 sites, attach extracts directly to the DNO hold/exclusion pack — this is the strongest available basis for a derogation application.

DOMAIN RISK PROFILES — VOLTAGE SENSITIVITY BY ASSET TYPE

Each domain has distinct voltage sensitivity driven by load type, equipment specification vintage and safety-criticality. This matrix drives the triage prioritisation order.

Domain	Load Type	Primary Risk Mechanism	UPS/Gen Threshold Risk	BS7671 Zs Impact	Motor Torque Risk	Headline Tier Bias
Signalling Power Distribution	Constant-power (PSU, UPS)	UPS false-trip; PSU spec vs 207V floor; Zs	YES	YES	NO	TIER 1
Telecoms Power Distribution	Constant-power (DC-DC converters)	Battery float charge degradation; GSM-R risk	YES	PARTIAL	NO	TIER 1
IT Servers & Network Power Supplies	Constant-power (UPS / PDUs)	UPS battery cycling; PDU input range breach	YES	PARTIAL	NO	TIER 1
Railway Stations	Mixed: motors, LED, constant-P	Escalator/lift torque; BS7671 Zs on long runs	PARTIAL	YES	YES	TIER 2
Depots & Operating Centres	Industrial motors, mixed LV	Workshop motor stall; charging rig efficiency	PARTIAL	PARTIAL	YES	TIER 2
Commercial Property Power Networks	Diverse tenants, EV chargers	EV charger trip at 207V; landlord supply quality	NO	PARTIAL	NO	TIER 2/3

SCOPE — IN-SCOPE ASSETS AND IMMEDIATE EXCLUSIONS

IN SCOPE — ALL SIX DOMAINS (LV & Shared 11kV supplies only)

Signalling Power Distribution

Signalling PSUs, SSIs, axle counters, level crossings, AWS/TPWS, lineside UPS

Telecoms Power Distribution

RERs, GSM-R base stations, lineside CCTV, fibre huts, PA system panels, PIS cabinets

Railway Stations

Station LV MDBs, escalators & lifts, platform lighting, retail LV, ticket gates, emergency lighting

Depots & Operating Centres

Maintenance facility intakes, workshop machinery, charging rigs, control room LV, welfare boards

Commercial Property Power Networks

Retail/office LV, station mall distribution, tenant metered supplies, car park LV, EV chargers

IT Servers & Network Power Supplies

Data centre UPS, server room PDUs, NOC power feeds, SCADA/OT panels, office IT infrastructure

OUT OF SCOPE — IMMEDIATE EXCLUSION

Dedicated 33kV+ BSPs

NR controls its own HV/LV tap settings. The DNO proposal does not propagate beyond the customer's HV/LV transformer.

25kV AC Traction Supply

Fed from 132kV National Grid via dedicated Network Rail traction substations. Outside the DNO distribution network entirely.

750V DC Third Rail

NR-controlled rectifier output. No DNO interface at the supply output voltage. Excluded by design.

NR HV private network sites

Where NR owns the upstream transformer and controls tap position, the DNO change does not apply at the LV terminals.

RISK SCORING MATRIX & TIER ASSIGNMENT

AUG – SEP 2026

SCORING FACTORS — ALL SIX DOMAINS

Voltage Headroom	Equipment min ≤ 210V (≤1.4% above 207V)	4
Voltage Headroom	Equipment min 211–218V	2
Voltage Headroom	Equipment min > 218V (> 5.3% above 207V)	0
Zs / Protection	Measured Zs within 15% of BS7671 max at current V	+3
Monitoring / Smart	≥3 UV alarms or V-floor < 215V (24 months)	+2
Monitoring / Smart	1–2 alarms or V-min 215–220V declining	+1
Defect History	2+ voltage-related defects (36 months)	+2
Defect History	1 voltage-related defect (36 months)	+1
Asset Sensitivity	High class: Signalling / IT / Telecoms PSU/UPS	+1
Smart Meter	V-min < 210V ever recorded (SMETS2 extract)	AUTO T1

≥7

TIER 1 — CRITICAL

Immediate engineering review. DNO selective exclusion application. ESQCR/ROGS safety case. Mandatory UPS/generator threshold audit across all domain assets on site.

4–6

TIER 2 — MONITOR

Apply for DNO temporary hold (12–18 months). Enhanced voltage monitoring. Quarterly review. Escalate to Tier 1 if V-floor < 215V recorded at any subsequent monitoring cycle.

≤3

TIER 3 — LOW RISK

Accept voltage revision. Record on asset register. Trigger re-score if voltage-related defect subsequently raised. Smart meter data continues to be reviewed quarterly.

AUTO TIER 1 — BRIGHT-LINE TRIGGERS

- PSU / PDU min rated input: 207V < limit ≤ 216V
- UPS transfer threshold set at 216V (any domain)
- Generator auto-start set at 216V (any domain)
- Zs within 15% of BS7671 maximum at current V

LESSONS FROM HIGH-RELIABILITY SECTORS

Other sectors don't tolerate voltage reduction. They engineer around it. To maintain reliability, we must adopt cross-industry safety and performance standards for rail.

NUCLEAR

Redundant Coincidence Logic. Staged Disconnects (NRC BTP 8-6)

Dual-IMD logic for safe power triggers.

CALL TO ACTION Reactive — Proactive

MEDICAL

Automatic Safety Power Changeover (BS 7671 Section 710)

0.5 sec changeover <90% nominal voltage. Adopt as railway standard for Tier 1 supplies.

CALL TO ACTION Reactive — Proactive

AVIATION

Zero-Downtime Monitoring. Predictive Alerts

Enhance CableGuardian with predictive threshold alerts.

Call-to-action Reactive

INDUSTRIAL

Standardised Performance Criteria A-D. Dip Tests (IEC 61000)

Require sustained 10% depression tests from suppliers.

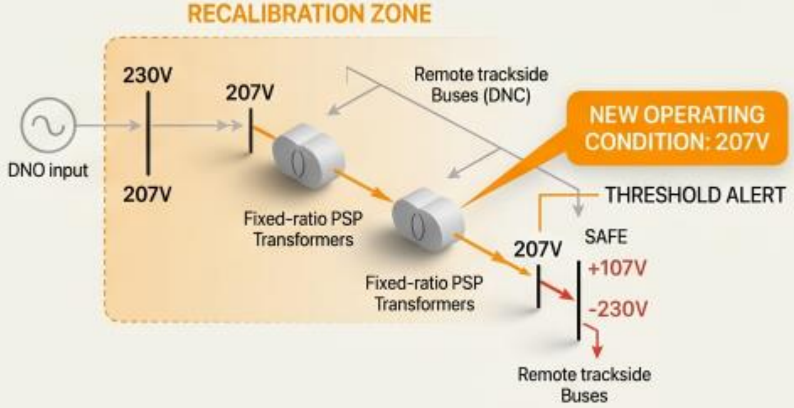
Call-to-action Proactive

DATA CENTRES

Voltage Tolerance Curves

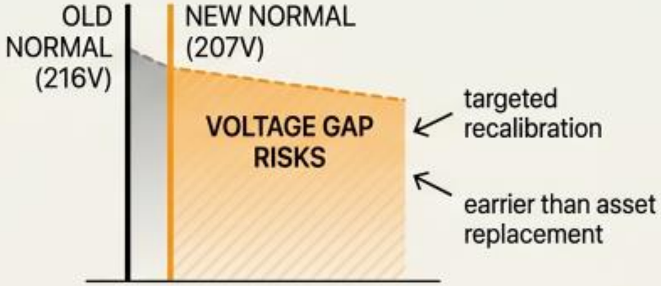
Require tolerance curves for all signalling equipment.

Call-to-action Proactive



PROACTIVE ADAPTATION TIMELINE

- 2026 — NUCLEAR COINCIDENCE LOGIC PILOT
- 2027 — MEDICAL STD ADOPTION
- 2028 — AVIATION CABLEGUARDIAN UPGRADE
- 2029 — INDUSTRIAL/ DATA CENTRE STANDARDS
- START ACHIEVED — SYSTEM REALIGNMENT ACHIEVED



10

Simpler.
Better.
Greener.

NetworkRail

END

Mark Dunk, Energy Networks Association

ENA - Statutory Voltage Limits Reform Summary Briefing

Statutory Voltage Limit Reform – *Summary*

- The requirements for the voltage to be supplied by the GB electricity networks are set nationally in the Electricity Supply Quality and Continuity Regulations. This has been partially but not fully harmonized with the EU supply voltage of 230V.

- Reforming the ESQCRs to expand the lower statutory voltage limit will create significant net positive customer benefits and improve networks' ability to connect and support customer low carbon technologies such as solar, heat pumps, and electric vehicles. It will also bring Britain more into line with the EU. Benefits include:
  - Over £8bn of capacity realized benefits enabling the connection of low carbon generation and demand technologies
  - Estimated £4.2bn in energy efficiency benefits to customers (represents est. 2% of customer energy costs) and reduced network losses over the next ten years through voltage reduction efficiency
  - And other operational and system benefits

- There are a number of impacts to low voltage equipment and devices to be acknowledged & mitigated These materialise in a rare minority of cases, where the lowest supply voltage is seen by rare and/or legacy equipment. These risks have been explored through significant research, stakeholder engagement and consultation and mitigations to the potential risks have been identified in all cases.

Activities to Date

- January 2025 - January 2026 – Engineering review & evidence development detailing benefits and challenges
- Early industry & stakeholder engagement:
  - Early engagement with AMDEA (domestic appliance manufacturer trade body), Ofgem and DESNZ
  - Workshop with stakeholders (including DESNZ) held on 8th October (50-60 attendees) with questionnaire on key points discussed
  - Follow up workshop with infrastructure operators and commercial organisations including Network Rail, Heathrow Airport, Thames Water.
- January – February 2026 - Consultation published and shared with all Distribution Code subscribers; stakeholders invited to attend workshops commenced w/c 19th January to complete 20th February.
- Ongoing engagement with key stakeholders including Network Rail, NESO, DESNZ

Summary of consultation responses

Stakeholders broadly support the principle of change, but recommend that implementation must be:

- Evidence-led
- Phased and reversible where needed
- Supported by proactive monitoring
- Accompanied by strong communication
- Backed by support mechanisms for customers
- Coordinated across DNOs, ENA, IET, manufacturers, and regulators

Some key themes:

1. Maintain a careful, phased implementation, and reverse changes at specific supply points if significant operational impacts occur
2. Proactively monitor the implementation and impacts throughout the implementation and identify risks as they occur. Specific suggestions were to use smart meter data, and to remain operationally within slightly tighter voltage bounds.
3. Clear communication to customers, including informing in advance of the change, and providing a reporting route for questions and issues.
4. Conduct assessment of protection, safety and fault level, including impact on customer protection devices. Develop an industry approach to update relevant standards (e.g. BS 7671 where necessary)
5. Consider establishing support and compensation mechanisms, including equipment/appliance upgrades, protection, and infrastructure changes needed.
6. Work with industries on sector-specific mitigation measures. This includes rail (signalling, as well as lifts, escalators and UPSs), industrial users (older installations, and equipment with sensitivity to voltage; EV chargers, electric heating, UPSs)
7. Review alignment with other, related regulation and standards, including ESQCR, industry standards (via IET and ENA)

24 responses

Estimate benefits of statutory voltage reform

There are significant and well evidenced benefits to customers, UK energy policy objectives, and DNOs ability to efficiently operate the GB low voltage networks through an expanded statutory voltage range

Benefits	Quantification (Est.)
Lower-cost and faster connections of LCTs	• **£7.6bn -** estimated capacity release benefit of the proposal due to lower-cost connection of additional DG. This is based on the total generation capacity released to customers by the effective increase in voltage headroom and would be realised over time as customers seek connection. • **£0.7bn -** Estimated capacity release benefit due to lower-cost connection of additional demand (including EVs and heat pumps). This is based on the total demand capacity released to customers by the effective increase in voltage legroom and would be realised over time as customers seek connection.
Improved energy efficiency behind the meter, lower losses and reduced customer bills	• **£4bn -** potential estimated collective UK energy efficiency savings due to reduced customer bills through conservation voltage reduction (CVR) savings. • **£0.2bn -** Estimated network losses reduction benefit. These values represent the initial estimated benefit in year one. These benefits would be expected to erode over time as customer devices (and the CVR behaviour) are changed. As such this benefit was only considered to be in effect for the first 10 years.
Enhanced DNO flexibility and control	This existing service (CLASS) has an estimated value of £25m per year. Widening the existing voltage limits could increase this benefit but currently it is unknown by how much
Avoidance of over-voltage tripping of inverters (mainly electric vehicles)	Resolve nuisance tripping issues while maintaining ESQCR compliance

Note: all of these will also provide direct and/or indirect carbon savings; not here calculated

Potential minority impacts and proposed mitigations

There are a number of impacts to low voltage equipment and devices to be acknowledged & mitigated. These risks materialise in a minority of cases, where the lowest supply voltage is seen by rare and/or legacy equipment. Mitigations to these risks have been identified in all cases.

Potential impacts	Proposed mitigation
Impacts on the performance of customer older equipment / appliances and infrastructure equipment	• *Signalling systems*: there is a known impact of low voltage on the operation of network rail legacy signalling systems installed in the 1950's. DNOs have agreed to maintain voltage levels and sequence implementation to align with already planned network rail replacement programme (approx £0.1bn estimated). These costs should be considered gross costs only as the represent rail network upgrades are already planned. • *Legacy customer appliances:* an upper estimate of c. 300 appliance would see reduced operation or failure per year. Testing has shown that none of these failures would be catastrophic.
Impacts on customer fault levels & protection	Estimate that c. 400 customer premises nationally would be impacted with slightly reduced protection effectiveness. Proposed mitigation is to monitor (including use of smart meter data) and proactively engage with customers to enable installation of RCDs and/or large cables to manage low voltage protection (approx. £0.4bn). These costs would be expected to be incurred over the initial implementation timeline - tbc subject to decision timeline, to be expected within ED3)
Impacts on customer cutouts due to increased current flow	Small proportion of customer circumstances may require cutout upgrades, but this would be where triggered by customer connection of significant new LCT devices. Thus any such edge cases would be mitigated through the replacement of older cutouts during the installation of LCTs as set out in existing DNO policy and procedures
Reactive power impact on the transmission network	The voltage reduction is expected to impact transmission system voltage management. This is proposed to be mitigated in the near term through operational actions (such as tap staggering or revised distributed generation set points), and with a key longer term requirement for DNOs, TOs and NESO to develop coordinated and collaborative reactive power and voltage control solutions to minimise the estimate is approx £0.6bn of physical mitigations over the next 10 years.

Next Steps

1. Update Evidence Case document to acknowledge and address consultation responses and summary with focus on benefits and mitigations (Early-July 2026)
   - Summary document being prepared in parallel
   - MoU between DNO – TO – NESO for improved collaboration and communication on network operability
2. Set out and share collective networks commitments on implementation approach and mitigation actions (Mid-July 2026)
3. Prepare final case for change proposal to discuss and progress with policy makers (end-July 26)

Q&A

Session 2 - ED3 Business Plans

Mark Callum, Northern Powergrid

ED3 Voltage Matters

June 2026

Mark Callum

Customer issues, what action we can take, benefits assessment

Customer issues	DNO action(s)	Customer benefit	Per customer benefit	No. customers benefitting	Overall Score
Nuisance tripping	**Reduce voltage**	Fewer nuisance trips *…Improved customer satisfaction*	M	M	M

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Nuisance tripping	**Reduce voltage**	Fewer nuisance trips *…Improved customer satisfaction*	M	M	M
High energy bills	**Reduce voltage**	Reduced energy bills *…c£20 per customer p.a.*	H	H	H
	Keep voltages high *…and apply CLASS*	Reduced energy bills *…c£2 per customer p.a.*	L	H	M

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Generation connection timescales	**Reduce voltage** *…and widen ESQCR limits*	Faster, cheaper connections	H	M	H

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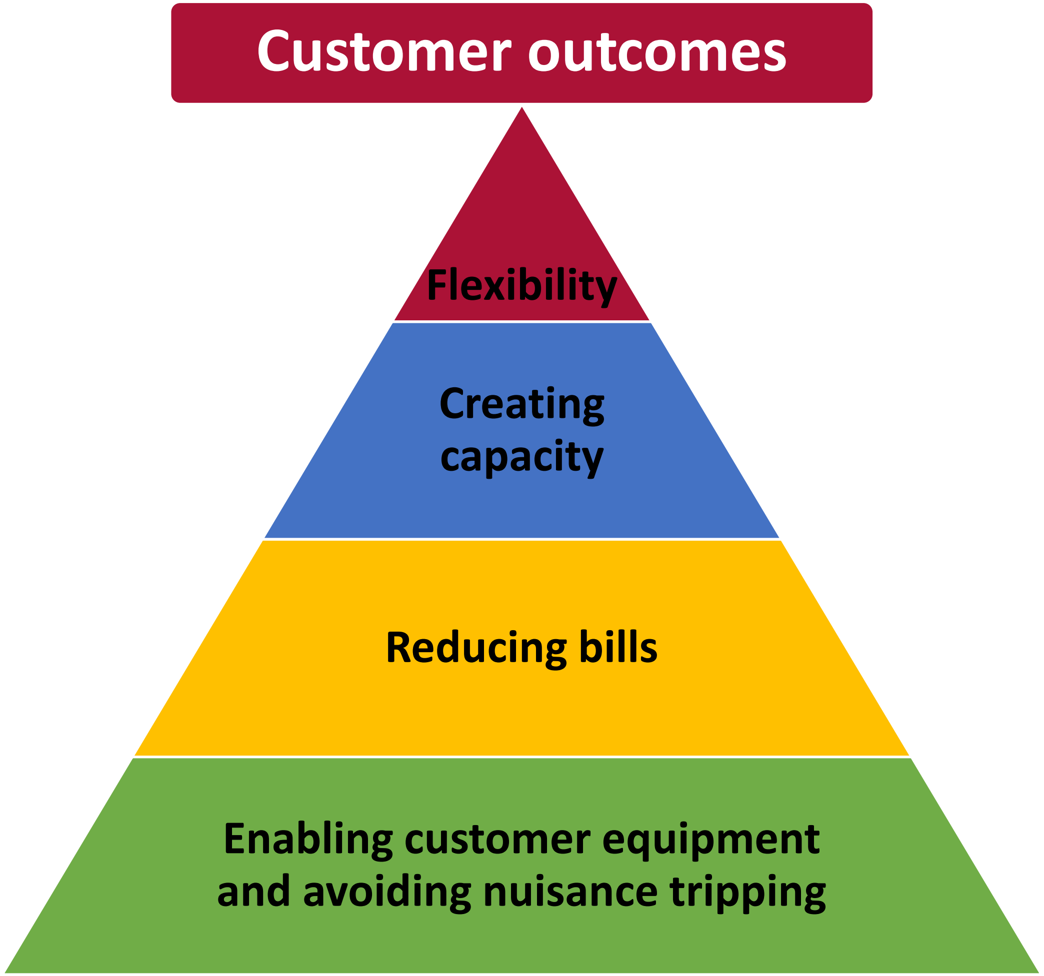
NPg's voltage management strategy aims to put customers first; removing barriers and reducing bills



NPg's voltage management strategy aims to put customers first; removing barriers and reducing bills

Customer outcomes

- Flexibility
- Creating capacity
- Reducing bills
- Enabling customer equipment and avoiding nuisance tripping

Network outcomes

- OC6

  Flexibility e.g. CLASS
- Ensuring voltage legroom and headroom is available to reduce barriers to connecting demand and generation
- CVR and reduced losses

  T/D optimisation
- Minimising ESQCR non-compliances

DNO actions

- Review effectiveness and customer benefit (OC6 & CLASS)

  Develop new market-based solutions
- Lower ESQCR limits and then lower network volts
- Implement dynamic voltage management e.g. BEET

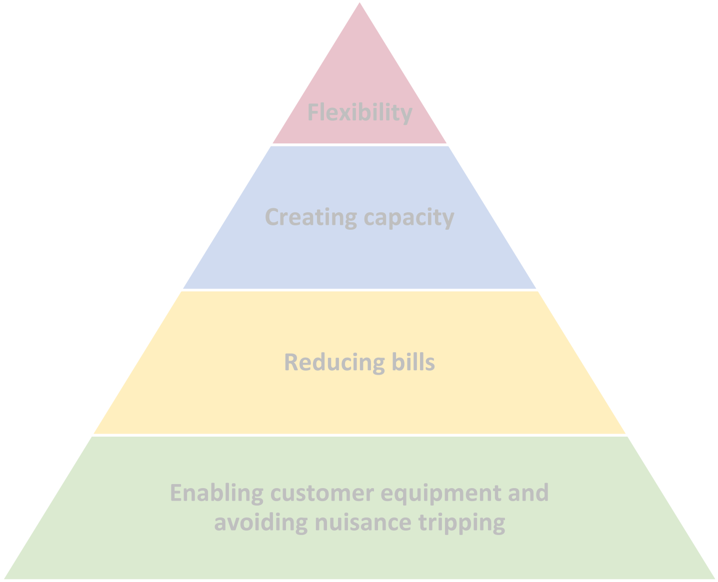
  T/D co-ordination
- Identify and resolve existing issues

NPg's voltage management strategy aims to put customers first; removing barriers and reducing bills

Customer outcomes	Network outcomes	DNO actions
Flexibility	OC6 Flexibility e.g. CLASS	Review effectiveness and customer benefit (OC6 & CLASS) Develop new market-based solutions
Creating capacity	Ensuring voltage legroom and headroom is available to reduce barriers to connecting demand and generation	Lower ESQCR limits and then lower network volts
Reducing bills	CVR and reduced losses T/D optimisation	Implement dynamic voltage management e.g. BEET T/D co-ordination group
Enabling customer equipment and avoiding nuisance tripping	Minimising ESQCR non-compliances	Identify and resolve existing issues

Overall goal: ***Dynamic management of voltages around the mid-point (230 V) to maximise customer benefit supported by new market-based (reactive power) solutions and whole system optimisation***

Key enablers



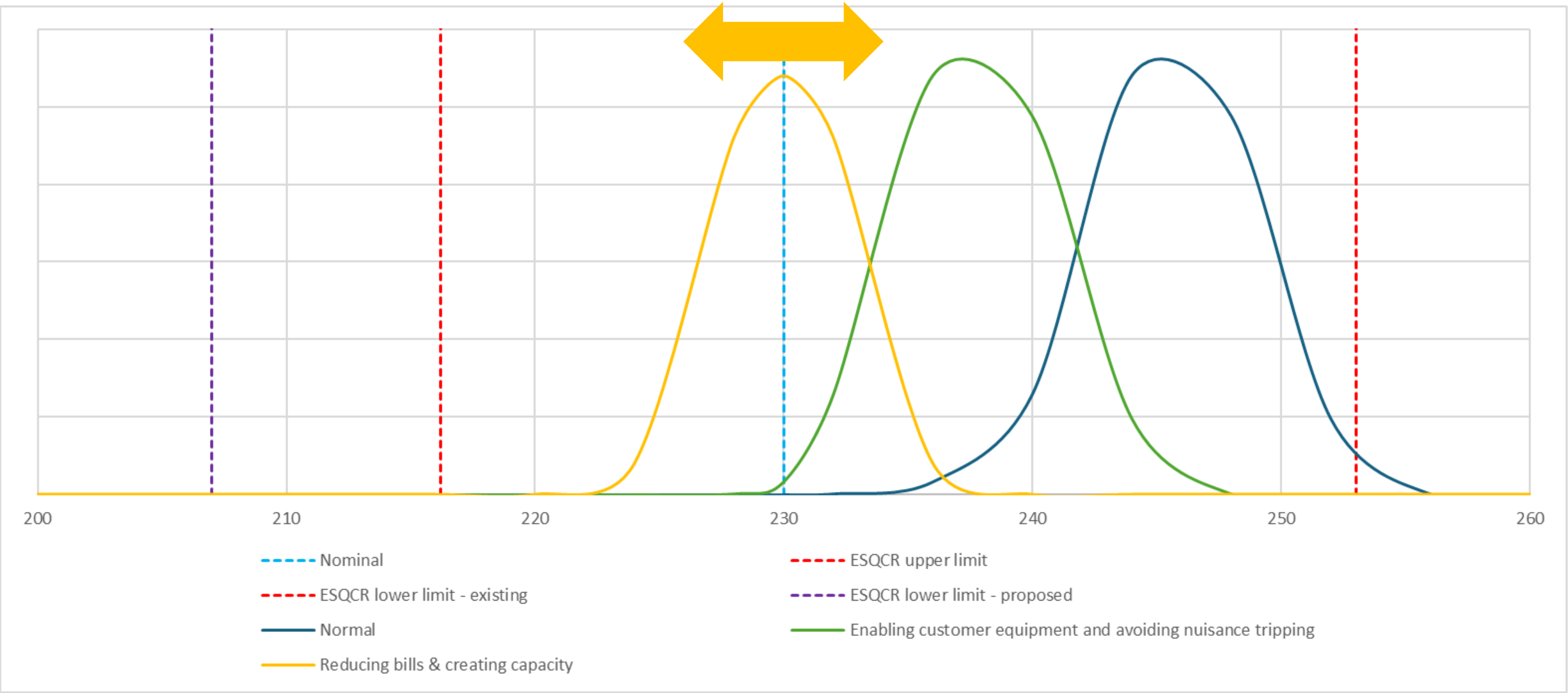
1 Improved understanding

2 New solutions

3 Coordination

4 ESQCR reform

Annex 1: Visual of NPg’s voltage management strategy and impact on customer voltages



Annex 2: Potential solutions for DNOs to manage network voltages

Solutions	Category	Maturity	Benefits
Voltage regulators – *Dynamic management of HV feeder voltages*	Network solution	10	8
LV monitors – *Continue rollout of LV monitors*	Network solution	10	6
Re-tapping secondary transformers – *Change the tap position at secondary sites to improve customer voltages*	Network solution	10	3
On-load-tap-changers – *Commission OLTCs at suitable sites*	Network solution	8	7
CLASS – *Investigate application and implementation of CLASS*	Network solution	7	5
T/D collaboration group – *Work with NESO to ensure customer focussed investment is prioritised*	**Regulatory change**	**7**	**10**
Analytics platforms – *Improve analytic platforms for proactive identification of network voltage issues*	Data analytics	7	9
Smart meter rollout – *Increase the speed of the smart meter rollout*	Regulatory change	7	7
Reduce ESQCR LV limits – *Reduce limits to support network wide voltage reduction*	**Regulatory change**	**6**	**10**
BEET – *Rollout BEET across suitable networks*	Network solution	6	9
Smarter inverters – *Mandate all new domestic inverter types are designed to support with voltage management*	**Regulatory change**	**4**	**8**
Integration with third party datasets – *Ingest EVCP data into our analytics platforms*	Data analytics	3	7
New market mechanisms – *Develop competitive mechanisms to enable DNOs to provide services*	**Regulatory change**	**2**	**10**

Underpinned by an improved understanding of voltage

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New market mechanisms – *Develop competitive mechanisms which enable DNOs to provide customer focussed services*	Regulatory change	2	10

Underpinned by an improved understanding of voltage

technology

Ben Godfrey, National Grid Electricity Distribution

Electricity
Distribution

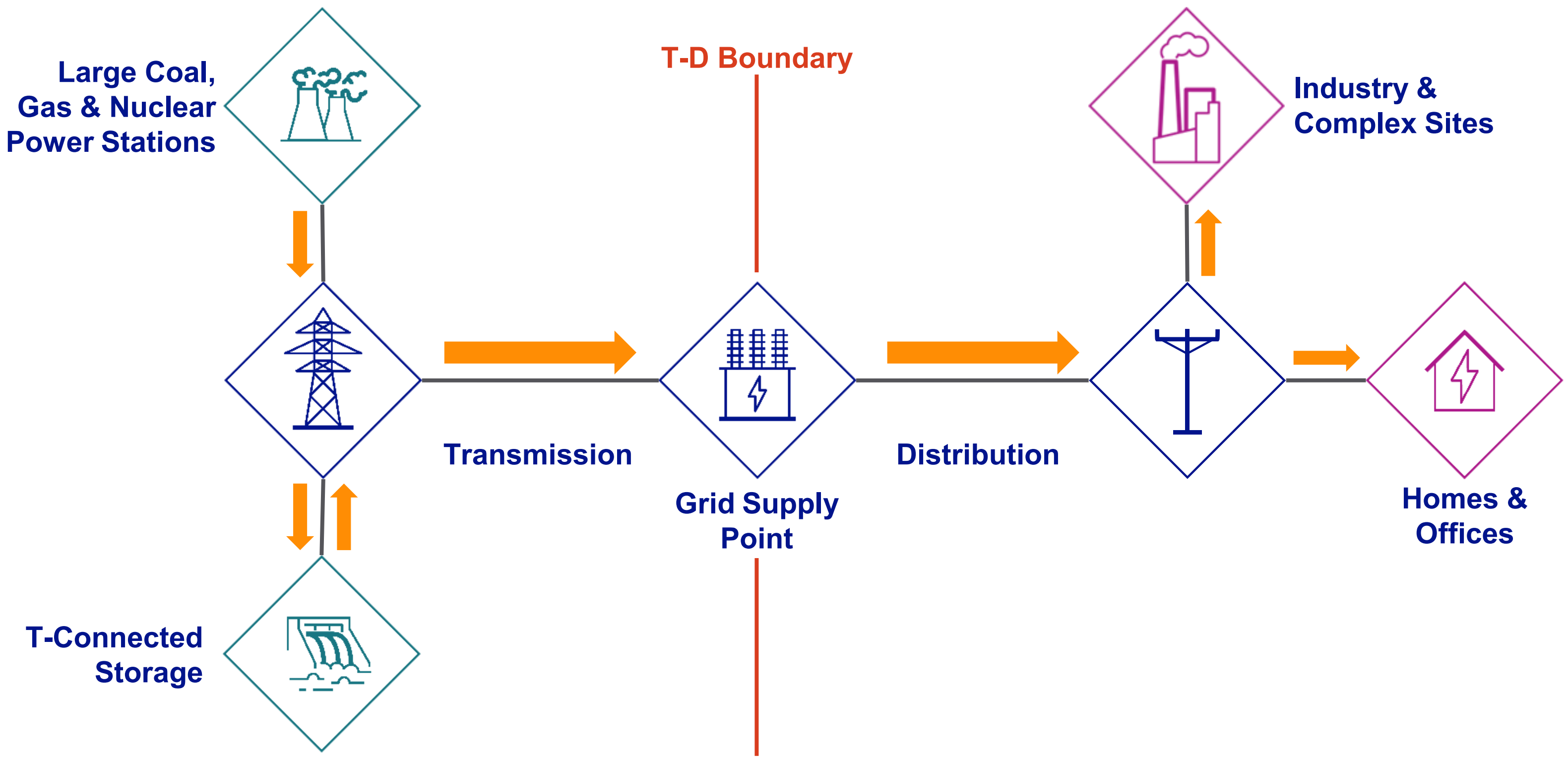
Strengthening Whole System Coordination

Ben Godfrey
Director of DSO

nationalgrid DSO

Flows through the electricity system used to be simple.

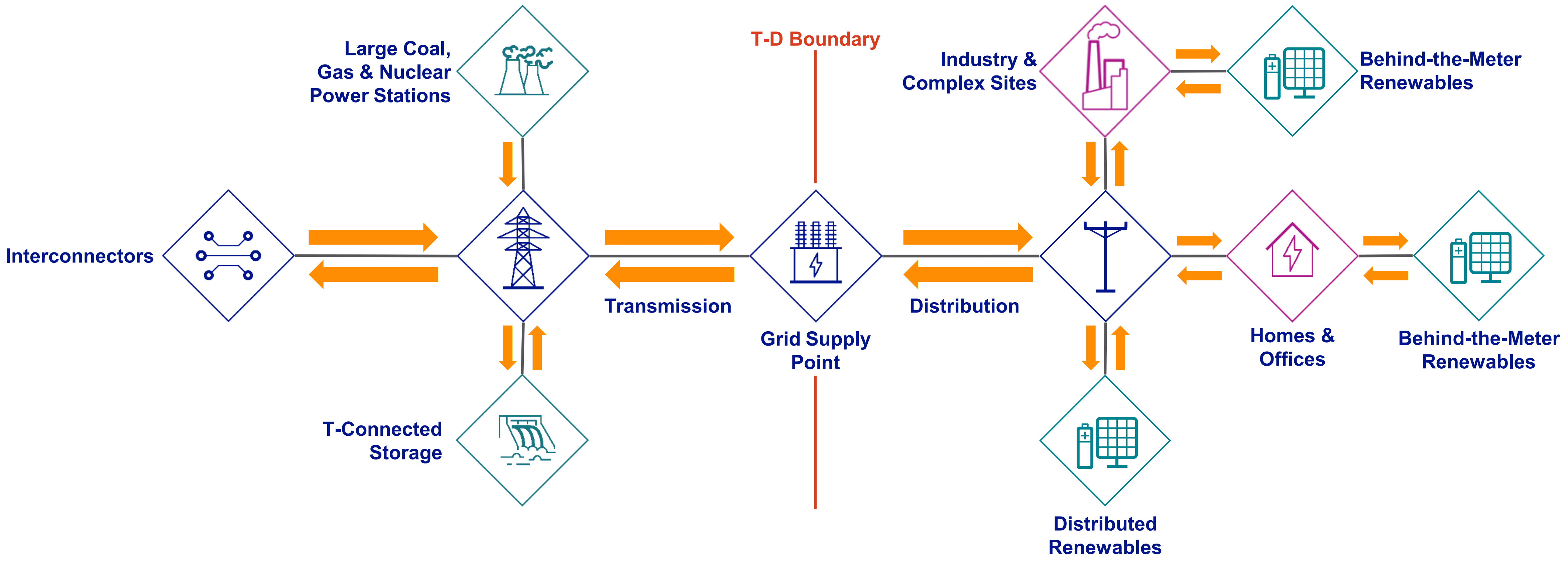
Early on, the role of the distribution network was to get power from the transmission network to users. Energy would flow through the voltage levels and the T-D boundary flows were one way.



Key: Generation & Storage, Demand, Network

But by ED2, things had changed and flows were complex

With the proliferation of generation and storage at lower voltage levels, power flows are no longer predictable, making planning and operation of distribution networks more challenging.



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Key: Generation & Storage, Demand, Network

T-D interactions in ED2: Three key areas of focus

Flexibility

Primacy rules developed and trialled

Access

MW Dispatch developed

Connections

Technical Limits rolled out at scale

Transmission system operability has changed a lot

Intermittency has increased, inertia has decreased, energy flows are more difficult to predict, the number of assets connecting to the system is increasing, all making NESO's operation of the whole system increasingly challenging. Consequently, they are actively exploring new tools to add to their toolbox (e.g. Pathfinders).

Less dispatchable generation

Reduction in traditional generation such as coal and gas.

These provide firm flexible power, inertia and voltage management.

More variable generation

Significant increase in wind and solar

Output depends upon the weather and output is highly variable

More asynchronous generation

Wind and solar are connected by inverters.

These are less flexible and do not naturally provide system services.

Many more assets, further apart

Large wind farms offshore.

Large number of smaller assets in the distribution system.

T-D Boundary in ED3: Augmenting 3 areas of delivery

What should the features of this role be in ED3 to deliver most benefits?

Planning

Operation

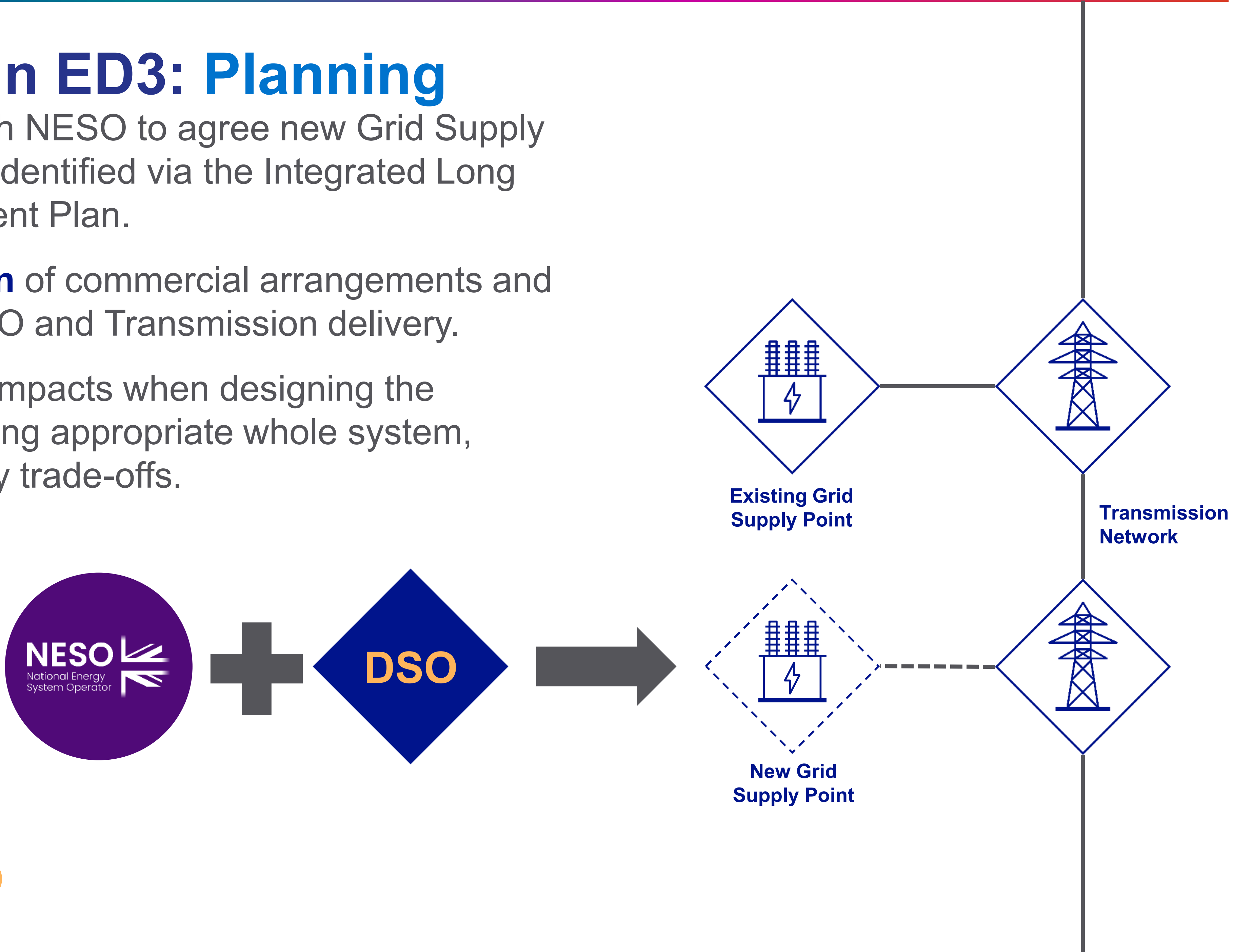
Connections

T-D Boundary in ED3: Planning

Involves collaborating with NESO to agree new Grid Supply Points, where needs are identified via the Integrated Long Term Network Development Plan.

Subsequent **coordination** of commercial arrangements and delivery assurance of DNO and Transmission delivery.

Considers Transmission impacts when designing the distribution network, making appropriate whole system, resilience and affordability trade-offs.

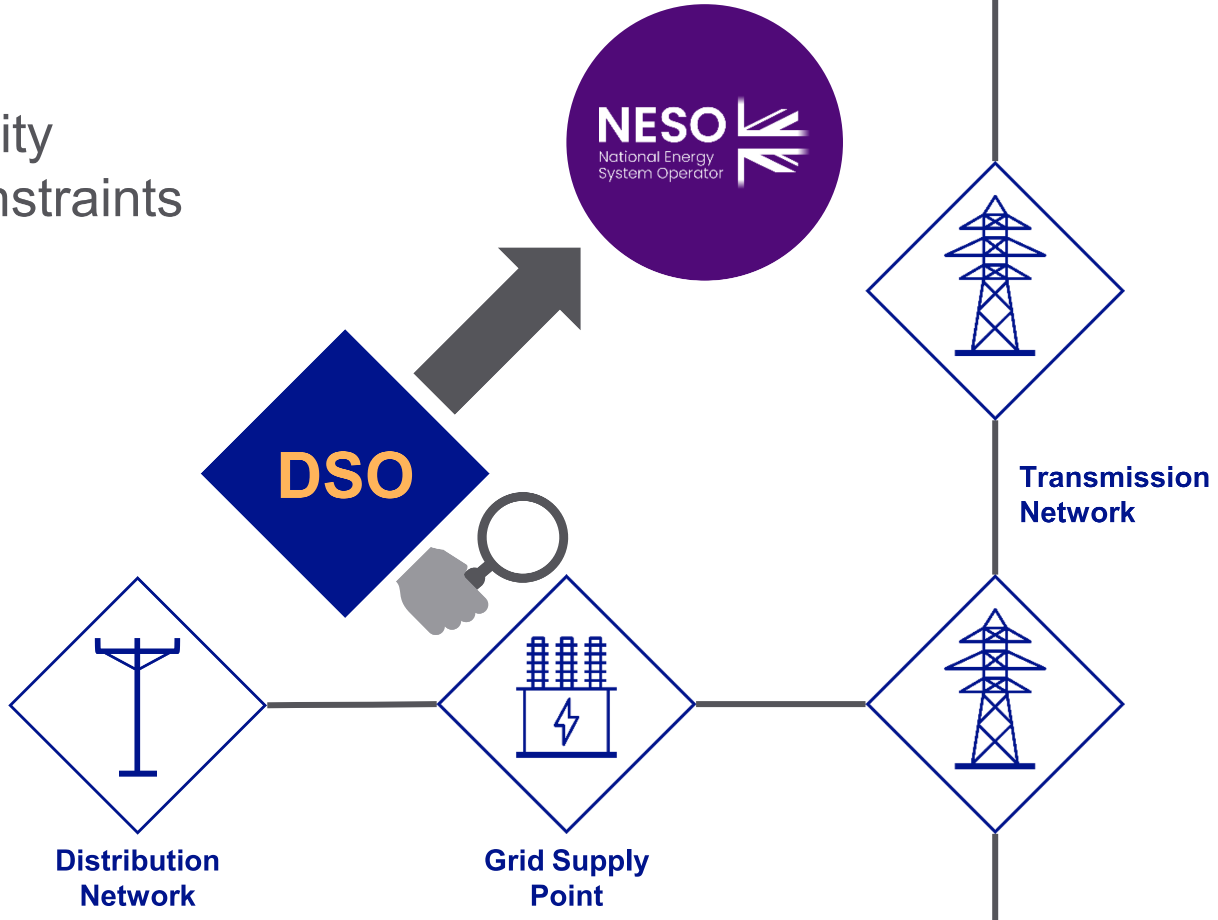


T-D Boundary in ED3: Operation

Involves providing NESO with forecast and real-time boundary flows for each Grid Supply Point, to improve the visibility and granularity of network behaviours.

Includes providing forecasts of availability of flexibility volumes behind each GSP, accounting for local constraints and faults that NESO cannot see.

Building on Ofgem's SSMD position around provision of **flexibility** and **voltage** services to NESO, DSOs could also provide options at each GSP to NESO for services that could help them manage the transmission system.



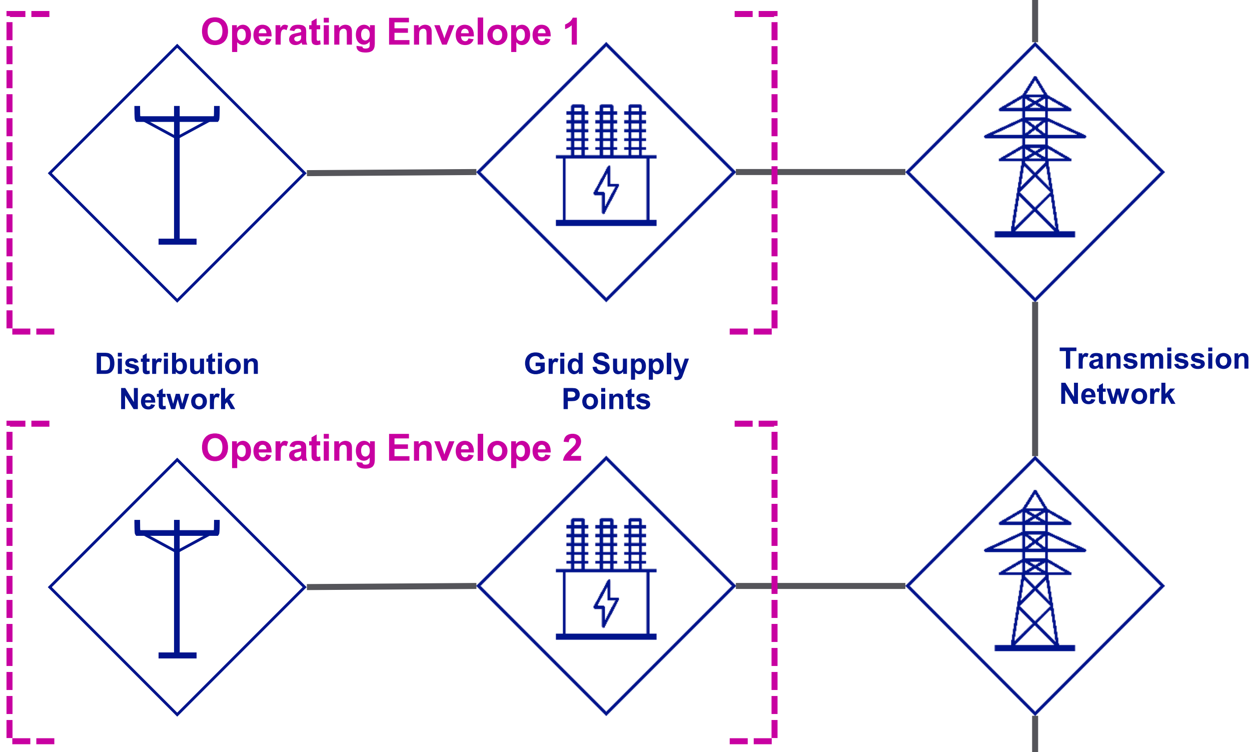
T-D Boundary in ED3: Connections

DSOs collaborate with NESO to establish operating envelopes at each GSP.

DSOs develop and manage the underlying products/services (including Technical Limits) that **accelerate** customer connections and increase the clarity/predictability of the timescales they are given.

Enables us to develop products/services to address fault level constrained connections, as well as thermally constrained connections.

Allows us to extend the current processes used for generation connections to also serve demand connections.



What does this look like in practise?

Incentive reward measured by magnitude of services offered to NESO 6

1 Establish Real Power Boundaries in BCA

- Enables growth of embedded demand and generation without impacting transmission

2 Implement real power visibility and forecasting

- Removes uncertainty for NESO and reduces system operating costs

3 Establish Reactive Power Boundaries in BCA

- Reduces voltage uncertainty and limits future reactive spill whilst still allowing embedded growth

4 Implement reactive power forecasting

- Removes uncertainty for NESO and reduces system operating costs

5 Upwards and Downwards boundary actions enabled by coordinated markets and DSO services

(thermal, voltage and reactive power markets)

Two key DSO activities currently drive most of our benefits

Accelerating Connections and Releasing Headroom will be essential for ED3, CP2030 and Net Zero. These activities already drive 94% of the value we create for our customers and consumers in ED2.

£385m
Total benefits realised in years 1,2 and 3 of ED2

Accelerating Generation (Connections)

via Technical Limits and active network management

64% of expected customer benefits in ED2

£140m Customer benefits ED2 to date

307 MW connected assets

5.8y connections time average saved

Accelerating Demand (Releasing Headroom)

via flexibility and network planning

30% of expected customer benefits in ED2

£178m Customer benefits ED2 to date

213 MVA Headroom realised by 2025

⅓ realised from flexibility

nationalgrid DSO

Electricity Distribution

Thank you

We'd really like to hear from the customers and stakeholders that we serve. If you have feedback about the contents of this pack or are interested in more information from us, please use these links:

Email: ngeddso@nationalgrid.com

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Mark Goudie, SP Energy Networks

Dynamic Voltage Control

Voltage Matters Forum June 2026

Mark Goudie
Head of Strategic Projects & System Optimisation

Needs case

Enabling customer decarbonisation and growth whilst optimising the voltage our customers experience

LCT Growth

- Voltage management increasingly difficult due to more variability in demand and generation flows
- Increasing number of LV customers experiencing over-voltages, with more under-voltage issues expected as demand grows
- Greatest impact due to changing LV demand and generation through uptake of LCT technologies such as heat pump and PV

Generation

- Voltage impact of embedded generation growing due to increasing volumes of renewable generation
- Voltage influence of embedded generation could create challenges in managing network voltage set-points if not coordinated
- Greatest impact where embedded generation is on voltage control mode to support distribution or transmission voltage

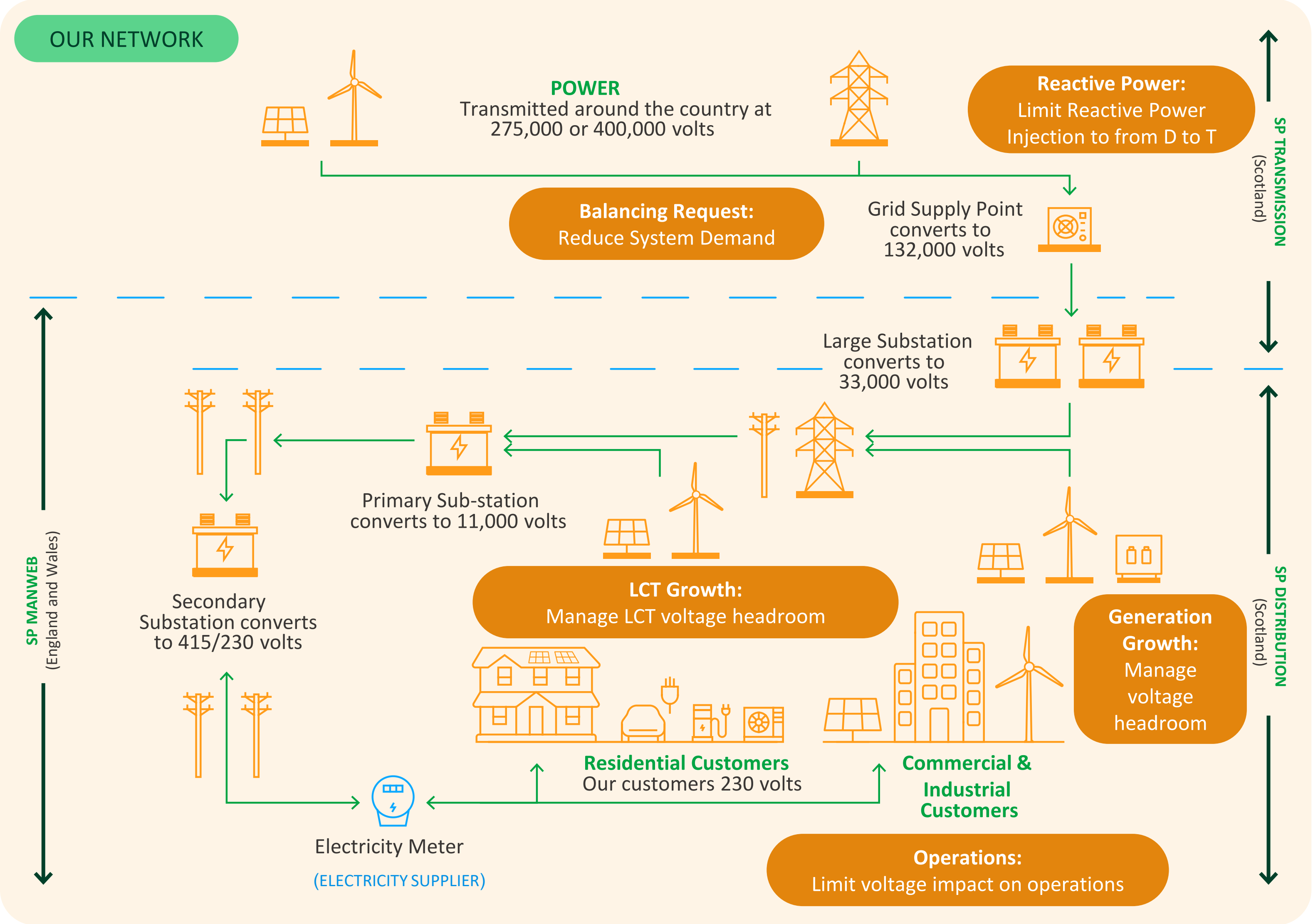
Reactive Power

- Reactive power flows at the T/D boundary becoming increasingly complex with dynamic load behaviours and increasing levels of UG assets to support electrification
- Changing demand and generation behaviours in distribution networks can introduce reactive power challenges across various network voltages

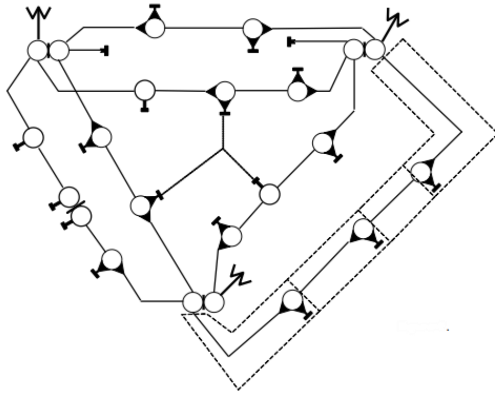
Dynamically Managing Voltage – an illustrative example

Interdependancies and Coordination

- Dynamic Voltage Control enables the DSO to manage voltage constraints on the network
- The solutions to managing these voltage constraints may conflict with one another and are dependent on the network conditions
- DSOs ability to utilise DVC and decide Primacy is key for the success of whole system and customer outcomes



Our Voltage related projects - MeshVolt



Managing voltage in a meshed network

In SPM, the highly interconnected networks require control systems to act with greater coordination and be developed with a good understanding on network impact and changing topologies and network configurations which can alter control system behaviour.

MeshVolt is focused on preparing and enabling the SPM meshed network for future deployment of DVC focusing on:

- Dynamic voltage control in meshed network
- Virtualised relay deployment
- Reactive power management under dynamic network configurations
- Proactive approach to asset management and maintenance

Benefits

- Increased hosting capacity for DER and LCTs
- Technical solution to increasing voltage volatility and managing reactive power
- Dynamic, near-real-time voltage control capability essential for future low-carbon distribution systems
- Improved operations and maintenance strategies with increasing asset utilisation

Our network provides unique challenges and opportunities for enhanced dynamic voltage control

Our Voltage related projects - GenVolt

Managing voltage in a Constraint Management Zone (CMZ)

In SPD, the high levels of distributed generation connections within rural networks require control systems to coordinate with DER and be developed with a good understanding on network and DER interactions, impacts and opportunities.

GenVolt is focused on preparing and enabling the SPD network for future deployment of DVC focusing on:

- Coordinating of DVC with DERs on voltage control mode
- Coordination of DVC and other System Optimisation actions such as Active Network Management (ANM) and Constraint Management Zone (CMZ)
- Providing T/D boundary management support through DVC and DER coordination

Benefits

- Increased hosting capacity for DER and LCTs
- Technical solution to increasing voltage volatility and managing reactive power
- Dynamic, near-real-time voltage control capability essential for future low-carbon distribution systems
- Enhanced control of DER to provide distribution and T/D boundary support

Our network provides unique challenges and opportunities for enhanced dynamic voltage control

SP Energy Networks | DSO

Ollie Cooper, Scottish and Southern Electricity Networks

ED3 VOLTAGE MANAGEMENT – USING A VOLTAGE INDEX TO GUIDE INTERVENTION

Scottish & Southern Electricity Networks

DSO Powering Change

OPTIMISATION HIERARCHY

Suggest use of a prioritisation tree:

- ✓ Simple (tractable)
- ✓ Transparent to stakeholders
- ✓ Outputs & Incentive design simplified – clearer, undistorted signals
- ✓ As network is discrete, may be limited range of practical options, making complex optimisation less relevant

- × Potentially not optimal in all situations
- × Suggested prioritisation doesn't match prominence in SSMD

Priority Tree (for investment & operational timescales) *could* be:

1) **Capacity:** Including making capacity available for whole system flexibility, to NESO services from DER & CER

2) **Resilience**

3) **Voltage Optimisation**

4) **Losses Optimisation**

5) **Providing service to NESO**

BUT…

- They're all functions of each other
- Some aspects are mandatory; some aspects have incentives which provide a means of trading-off
- Can we monetise everything to perform a 'full' optimisation (with licence obligations as constraints for example?)
- There is a broader 'DNO' set of objectives going on- and indeed a society wide optimisation… but we need to limit scope somewhere

VOLTAGE MANAGEMENT STRATEGY

Our strategy introduces a clear, phased framework of Prepare, Protect, Perform, aligned to our optimisation hierarchy of capacity > resilience > voltage > losses>ancillary services, and guided throughout by core design principles that prioritise inherently stable, low complexity and consumer focused solutions

PREPARE

- Focuses on planning and design choices that build stability into the network from the outset
- Using enhanced modelling, smart meter insights and our emerging Voltage Index, we identify where voltage margins are tightening and apply low complexity, fix at source interventions
- Such as network reconfiguration, optimised tap positions and targeted reinforcement, to prevent future issues.

PROTECT

- Provides a structured, transparent pathway for addressing voltage issues when they do arise
- Re-check Prepare phase options before escalating only where necessary
- Targeted, proportionate solutions such as OLTC, EcoVAR balancers, STATCOMs or, where efficient, local flexibility services.
- Ensures interventions are justified, consistent and deliver clear

PERFORM

- Unlocks the full value of digitalisation through near real time optimisation - by deploying a centralised Voltage Management System
- Dynamic adjustment of substation set points to improve power quality, release hosting capacity, reduce losses and enable NESO services.
- Voltage management as a whole-system capability rather than a reactive constraint.

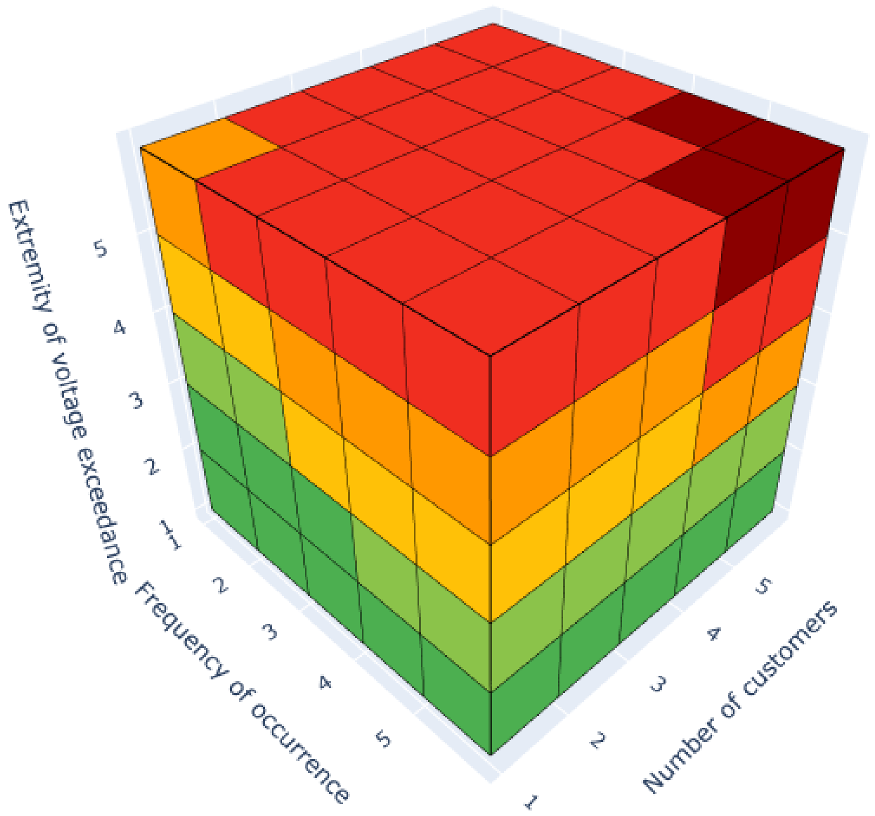
VOLTAGE INDEX

Our Voltage Index will underpin our voltage management strategy helping us determine when intervention is required whilst also providing a measure of success

If a group of customers is experiencing voltage issues, 3 dimensions are required to characterise the situation:

1. The ‘extremeness’ – i.e. how far a voltage is away from the acceptable range. It becomes a binary yes/no variable when posed as the question ‘is the voltage more extreme than the threshold of X volts?’. A separate indicator is needed for high and low voltage extremes.
2. Frequency – how frequently exceedances of a certain voltage threshold occur across a year.
3. Prevalence – how many of the customers experience exceedances over a fixed threshold with a given frequency.

Band	Low Voltage (V)	High Voltage (V)
1	222 - 235	235 - 245
2	220 - 222	245 - 248
3	216 - 220	248 - 252
4	210 - 216	252 - 258
5	< 210	> 258



Q&A

Session 3

Innovation a Customer View

technology

Ian Lee, UK Power Networks

Project EcoVAR

Trial of EcoVAR Statcom

Ian Lee – UKPN

ECOJOULE ENERGY

UK Power Networks
Delivering your electricity

Fundamentals
From EA Technology

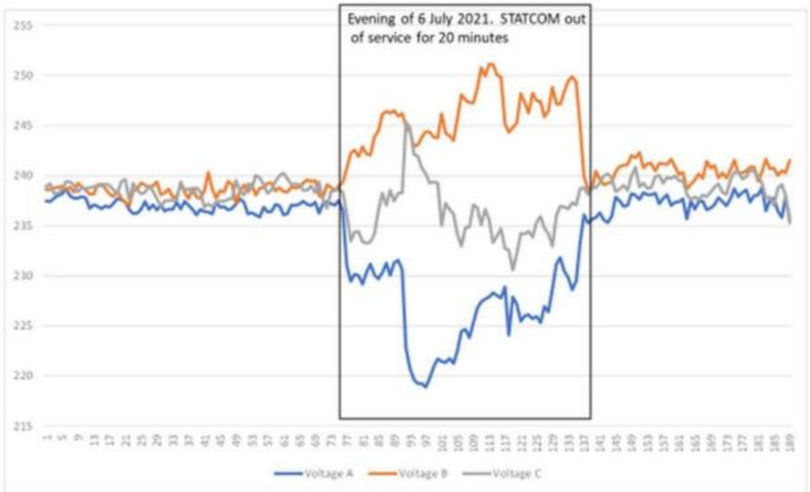
Utility Week AWARDS 2025 UTILITY OF THE YEAR

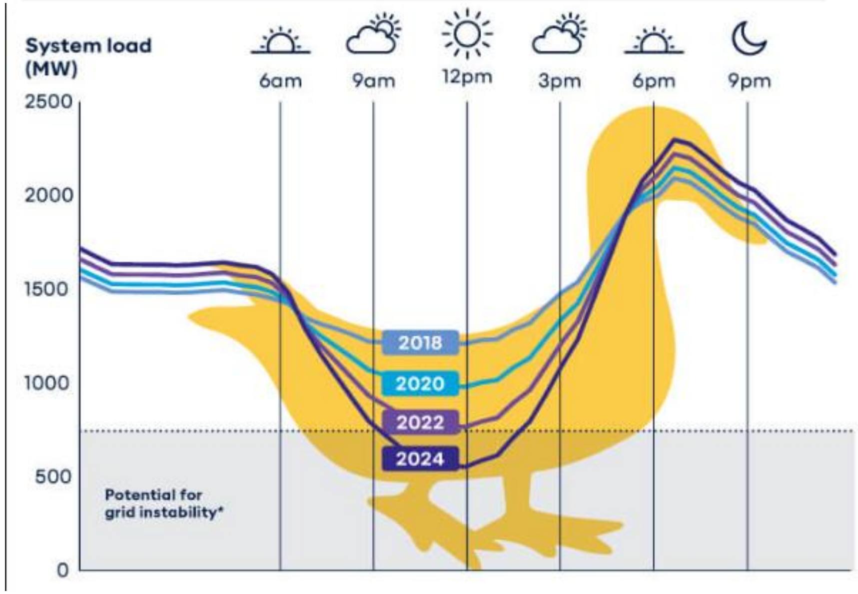
INVESTORS IN PEOPLE™
We invest in people Platinum

NES NATIONAL EQUALITY STANDARD

THE UK'S TOP 5 BEST BIG COMPANIES TO WORK FOR 2025

Mirrabooka STATCOM, very long rural residential distributor. (30 second data points)





Problem 1: **Voltage instability and phase imbalance**.

Solution: **EcoVAR and EcoSTORE** regulate voltage, balances phases on weak networks solving voltage problem.

Problem 2: Increasingly **severe "Duck Curve"** results in low / zero value energy in middle of day, price spike in evening.

Solution: **EcoSTORE** shifts solar energy thereby solving "Duck Curve" problem.

Fundamentals
From EA Technology

Project EcoVAR
Low Voltage Regulator

UK Power Networks
Delivering your electricity

Graveney and Goodstone Village Hall

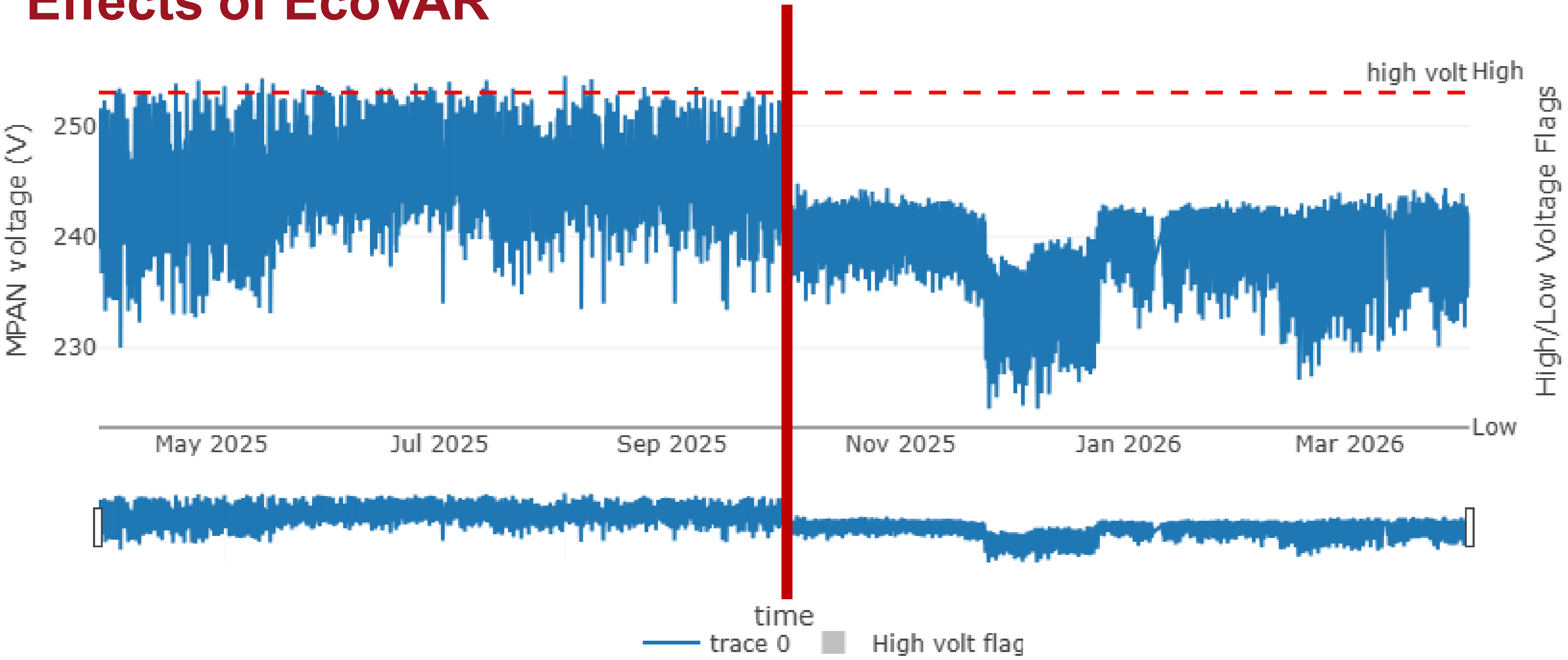
- Grant awarded for Solar Panels gy bills
- Small profit for solar generation nce

UK Power Networks
Delivering your electricity

EcoVAR Pole Mounted Statcom

UK Power Networks
Delivering your electricity

Effects of EcoVAR



Live Demo

Control Mode & Settings

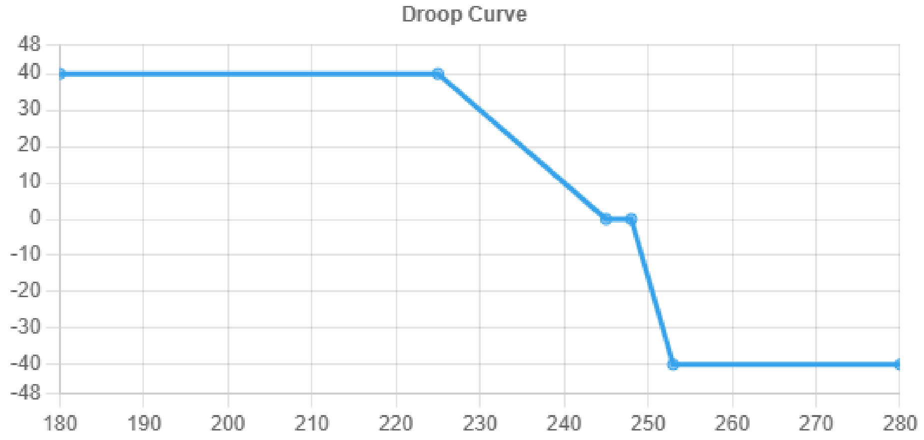
Power Limits

Maximum Reactive Power Positive (KVAR)	40.0	
Maximum Reactive Power Negative (KVAR)	40.0	
Reactive Power Ramp Rate (Sec)	0.10	

Phase Balancing

Active Power Balancing	Gain-based
Reactive/Active Priority	Q Priority

Reactive Power Mode	Automatic Droop Control / Volt-VA
V1 - Voltage Droop Low (V)	225.00
V2 - Voltage Droop Deadband Low (V)	245.00
V3 - Voltage Droop Deadband High (V)	248.00
V4 - Voltage Droop High (V)	253.00
Show Droop Curve	✓



Enable Per Phase Control ✓

Grid Settings

Nominal Voltage (V)	230.00
Grid Connection Delay (Sec)	30.00
Grid Connection Min Volt. (V)	180.00
Grid Connection Max Volt. (V)	265.00
Instant Undervoltage (V)	70.00
Delayed Undervoltage (V)	180.00
Undervoltage Delay (Sec)	2.00
Delayed Overvoltage (V)	265.00
Overvoltage Delay (Sec)	1.00
Voltage Sag/Swell Mitigation	✓
Voltage Sag Period (Sec)	2.00
Voltage Swell Period (Sec)	1.00

Lessons Learned

- Procurement
  - Shipping terms
- Networking
  - OT Network
  - IOT Sims
- Standards
  - Existing standards
  - New standards
- Training
  - Manual/Handbook/Video
- BAU Rollout
  - Deployment at scale

UK Power Networks
Delivering your electricity

Thank You

technology

Seth Treasure, National Grid

Mike Kelleher, Ohme

Electricity
Distribution

Voltage Management Trial within NGED

Seth Treasure
System Design & Power Quality
Engineering Policy

Mike Kelleher
Ohme

June 2026

nationalgrid

Electricity
Distribution

01

Overview

nationalgrid

Voltage Management

Networks

- Management of system voltage is becoming more complex and a greater focus from Regulatory bodies

Generation

- Customers increasing desire to be self sufficient or mitigate expenditure
    - Increased desire for additional export capacity
    - Regulatory desire to increase domestic capacities
        - Per connection
        - Number of connections

Voltage Management

Demand

- Low Carbon Future requiring electrification of heat and transport systems
    - Increased installation of HP and EVCPs
    - BESS becoming common place
    - Herding of customers due to promotion of tariffs (reduction of diversity factors)

Sensitive equipment

- Increased awareness of voltage within installations
    - Operation of OPDD equipment
    - Operation / identification from PGM inverters

Voltage Management

Standards

- Mis-alignment of standards / guidance or lack of
  - BS 7671 does not detail voltage rise limit beyond the meter
  - Products assessed to statutory voltage range only
  - OPDD not in alignment with BS EN 50160

History

- Networks designed with a demand & outage bias
  - Uni-directional systems
  - High output target voltage at each system level

02

Requirement

Complaint

Dursley

- Customer complaint regarding high voltages
  - Assessments undertaken to validate concern
  - 10 minute average value of up to 255V at supply terminals
  - Negatively impacting EVCP operation

System

- Secondary substation on tap 1 (no ability for further voltage reduction)
- Requirement for intervention at Primary Substation.

03

Optioneering

Data Source

Smart Metering

- NGED have updated smart meters to provide 10 min average voltage values

OHME

- Engaged OHME to assist with determine risk of intervention
- OHME provided following information;
  - Penetration of their devices – 186 devices
  - Present voltage – number of excursions & operation of OPDD
  - Pre change impact assessment for 1% reduction, inc. seasonal check
  - Pre change impact assessment for additional 1% reduction, inc. seasonal check

Electricity Distribution

04

Assessments

nationalgrid

Assessments

NGED

- Direct assessment pre & post connection confirm system betterment for customer
- Assessment of smart metering data for entire Primary substation

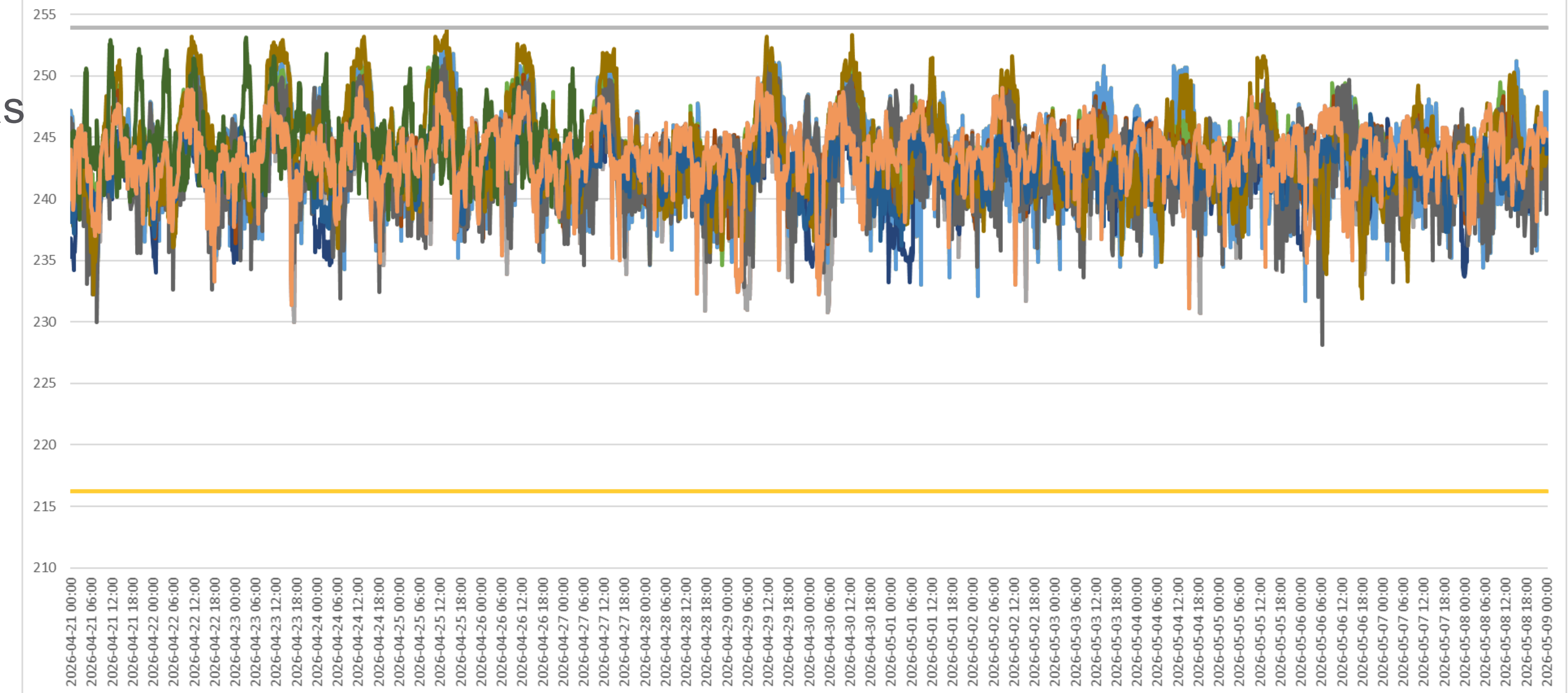
OHME

- Able to identify betterment
- Able to identify impact across whole year
- Able to identify negatively impacted customers

Assessments

NGED

- Data showing reduction but with ability for additional reduction
- 10 min ave. data as per BS EN 50160
- Secondary Sub. For enquiry

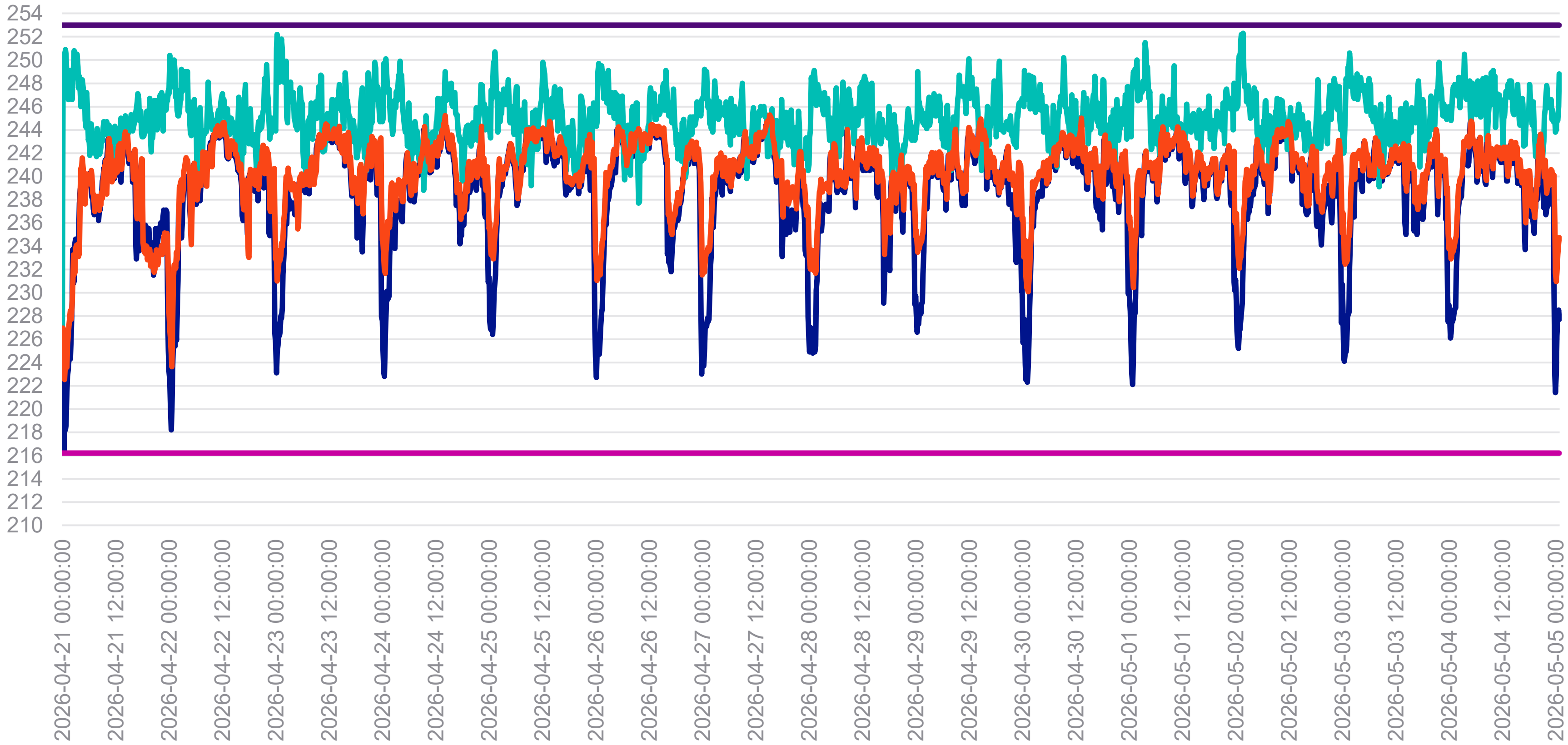


NGED

- OHME able to identify circuit of interest for intervention

- High and low voltages showing negative impact of high single phase loads (unbalance)

    - 100kVA 3ph PMT



Electricity Distribution

05

OHME Validation

nationalgrid

Ohme

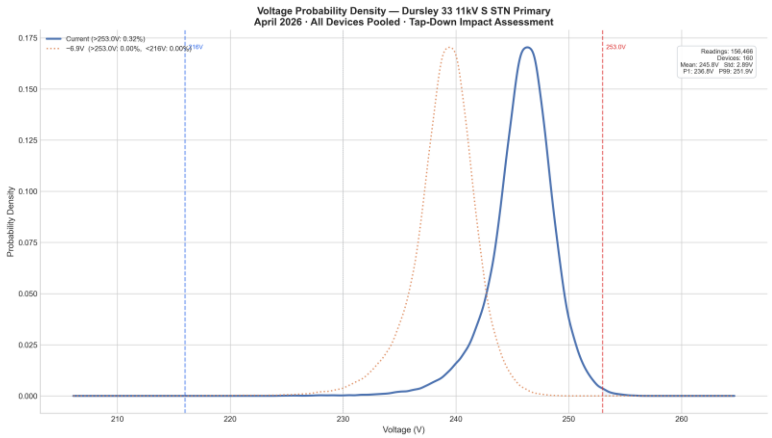
Grid Services

25/06/2026

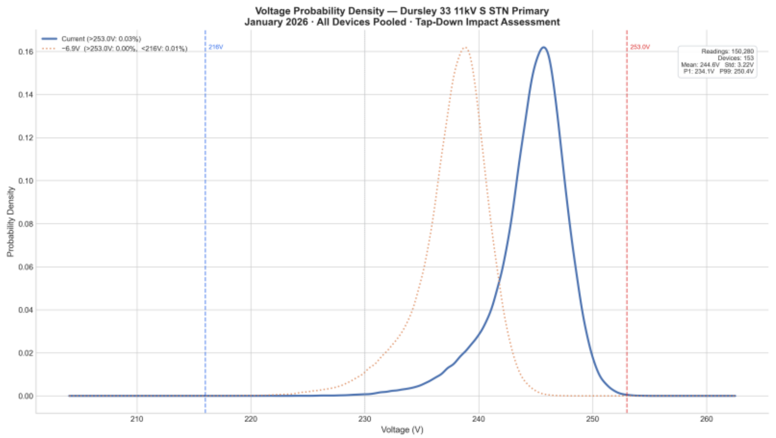
Dursley Voltage Drop Analysis

	Sunday 12th	Monday 13th	Tuesday 14th	Wednesday 15th	Thursday 16th	Friday 17th	Saturday 18th	Sunday 19th
#Devices with OV	20	13	5	5	1	0	1	1
#Devices with UV	0	0	0	0	1	0	0	0
#OV instances	439	622	71	29	5	0	5	143
#UV instances	0	0	0	0	19	0	0	0

Scenario Analysis utilising Historical Data



Primary Level	Mean	Overvoltage %	Undervoltage %
Current	245.8	0.321%	0.000%
3% Tap-Down (−6.9 V)	238.9	0.000%	0.001%



Primary Level	Mean	Overvoltage %	Undervoltage %
3% Tap-Down(-6.9 V)	237.7	0.000%	0.009%

Voltage – ED3 Sector Specific Methodology Decision

- Voltage excursions outside of statutory limits recognised as a growing problem.
- Voltage Monitoring and Voltage Management a core responsibility:
  - Reduce customer bills
  - Reduce connection constraints
  - Avoid LCT interruption
  - Prevent DER curtailment
- Improve ability to control voltage across the primary network and, where required, the secondary network

Ohme – Visibility & Analytics for Voltage Management

Required	Ohme
Voltage Data	1 minute – real time - @ grid edge (bottom-up Insights)
Coverage	National – high volumes in areas of LCT/DER concentration/clusters
Analytics	Historical dataset
	Forecasting & Scenario analysis
	Identification, ranking and prioritising areas for voltage management
	Pre voltage intervention planning
	Post voltage intervention assessment
	Intraday and seasonal voltage management

Q&A

Session 4 – Customers & Connections

technology

Mikey Clark, Relode

Relode

Data centres and voltage management

Voltage Matters Live 2026

Mikey Clark | June 2026

To deliver a clean, electric future, we need the biggest transition of energy infrastructure ever seen, in the shortest amount of time.

Focus has fallen on electricity generation, neglecting the huge coming demand increase as industries undergo an unprecedented transformation to electrify and decarbonise.

This is an uncommon moment in history.

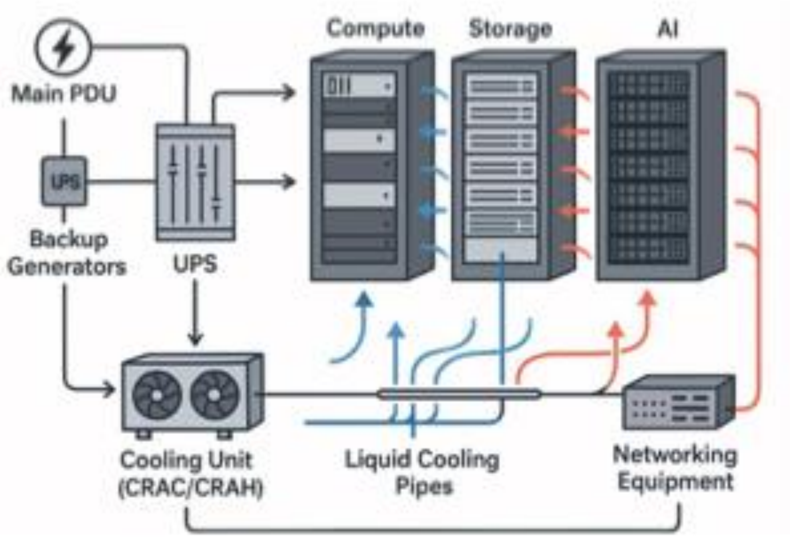
What are data centres?

Data centres are the backbone of the digital economy, providing critical services like data storage, web hosting and cloud compute.

What is a data centre?

A data centre is a secure building that hosts racks of servers, providing the power, cooling, and connectivity they need to operate. These servers deliver three core services: compute (to run applications), storage (to hold data), and AI (to power intelligent tools with GPUs).

Data centres provide the physical infrastructure to support digital services from video streaming and banking to AI and cloud applications.



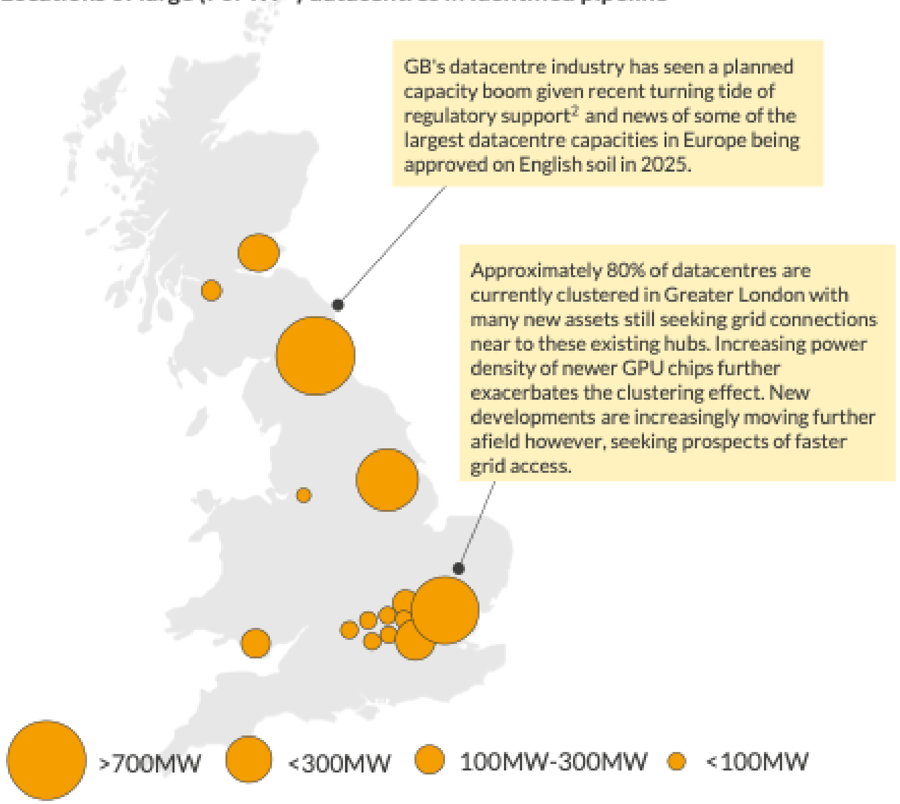
Datacentre use cases	Expected demand growth	Rack density[1] (kW/rack)
AI training and inference Building machine learning models through processing of large datasets	●	50 – 120
Cloud computing and IT services Hosting services such as AWS, Microsoft Azure, Google Cloud	◕	30 – 85
Telecommunications and media Supports 5G infrastructure and telecom networks; stores social media data and supports video streaming	◑	20 – 50
Financial services and banking Supports online banking; hosts stock exchanges and platforms for high-frequency trading	◑	20 – 50
Enterprise data requirements Stores and processes data for companies across healthcare, e-commerce, retail, energy, etc	◑	0.5 – 10

Source: Aurora Energy Research, June 2025

UK data centre pipeline

Data centres pose unique challenges to the power grid, given their increasing power density, point-source nature and tendency to cluster.

Locations of large (70MW+) datacentres in identified pipeline[1]



A hyperscale[3] 100MW datacentre connecting to one substation is equivalent to the demand of:

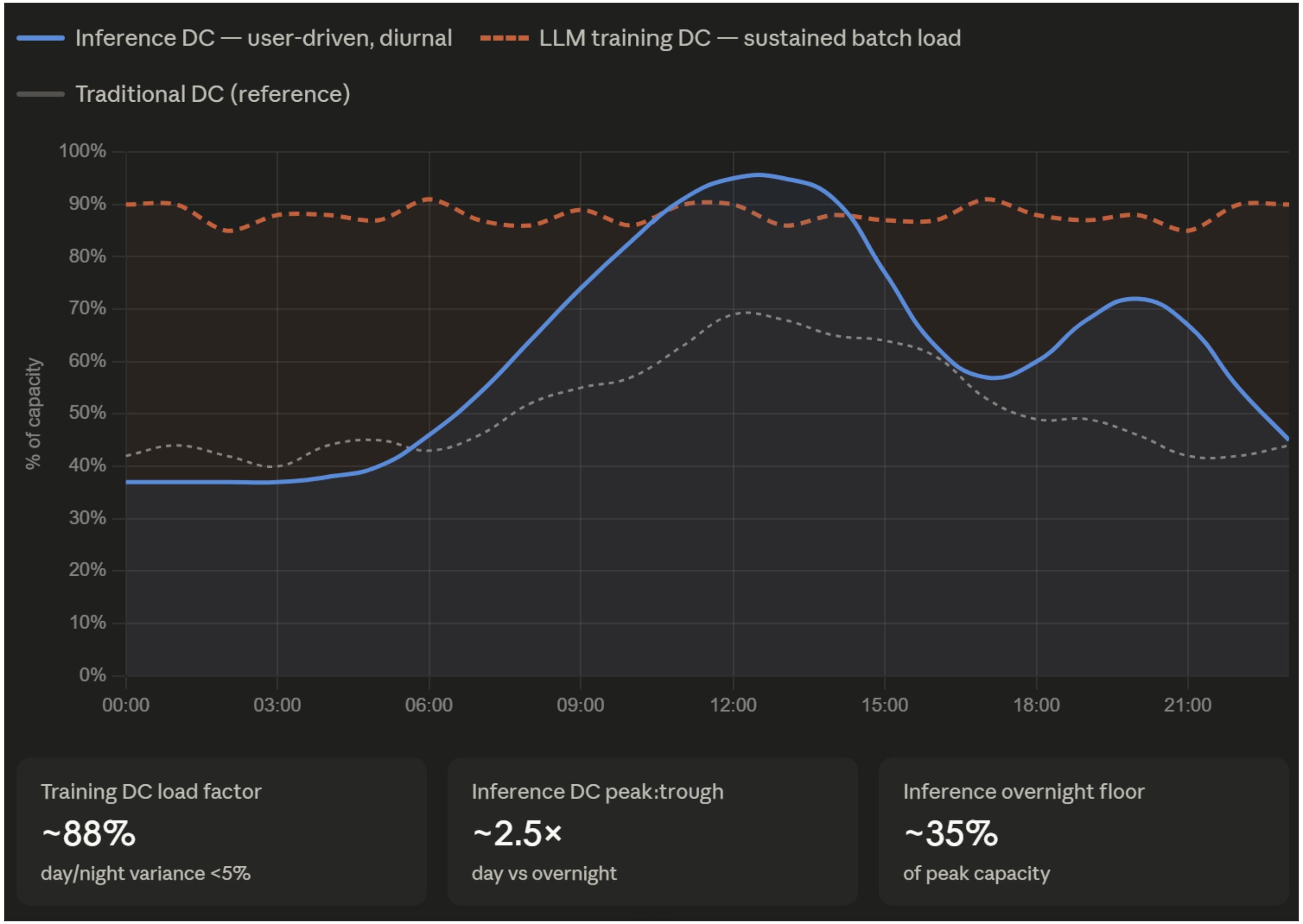
- **35 shopping malls the size of Westfield London**
- **260,000 households**
  - This is approximately 1.2% of total households today or equal to the number of houses in Sheffield
- **250,000 – 300,000 electric cars[4]**
  - This is approximately 16 - 20% of total EVs on roads today
- **40% of current electric arc furnace production capacity in the UK**
  - The UK has 4 operational electric arc furnaces which can produce 3 million tonnes of steel per year
- **~3 electrolysers, or ~11% of all electrolyser projects supported under HAR1 and HAR2 subsidy rounds**

Source: Aurora Energy Research, June 2025

Two key types of Data Centre – very different impact on Grids

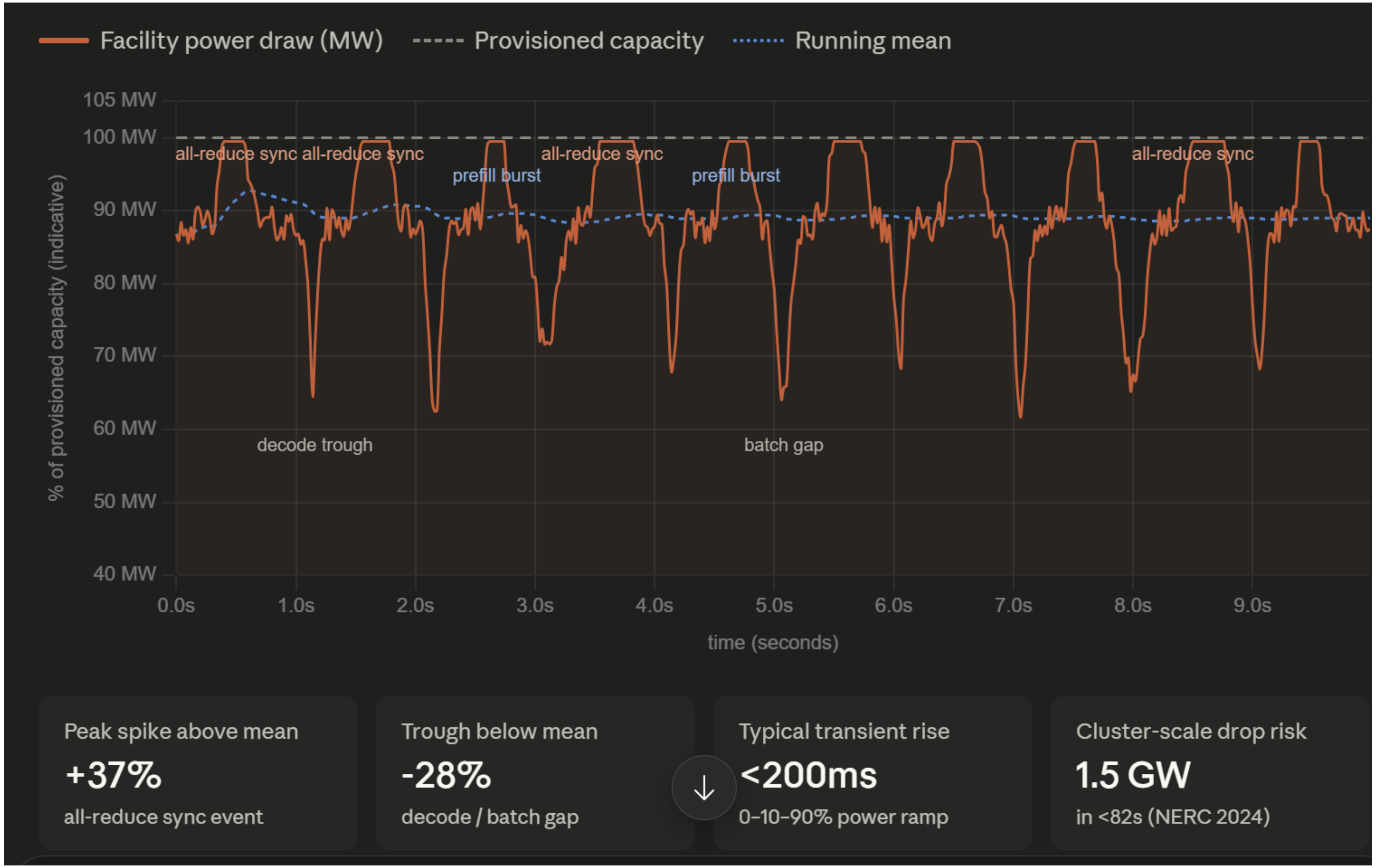
Feature	Inference DC	LLM Training DC
24hr shape	Sinusoidal diurnal — follows human usage patterns, peaks ~9am–10pm	Flat / square wave — jobs run until done regardless of time of da
Short-term volatility	Low — statistically multiplexed across many users	Very high — MW-scale transients within seconds
Load factor	Variable; can drop significantly overnight	High and consistent when jobs are running
Grid planning challenge	Day-ahead forecasting, reserve capacity	Short-term stability (transients, harmonics)

Diurnal Load shapes – Traditional vs Inference vs LLM



Indicative profiles only — based on published research characteristics (NLR/arXiv 2604.07345, Microsoft ASPLOS 2024). Not from live metered data.

LLM – time resolution matters

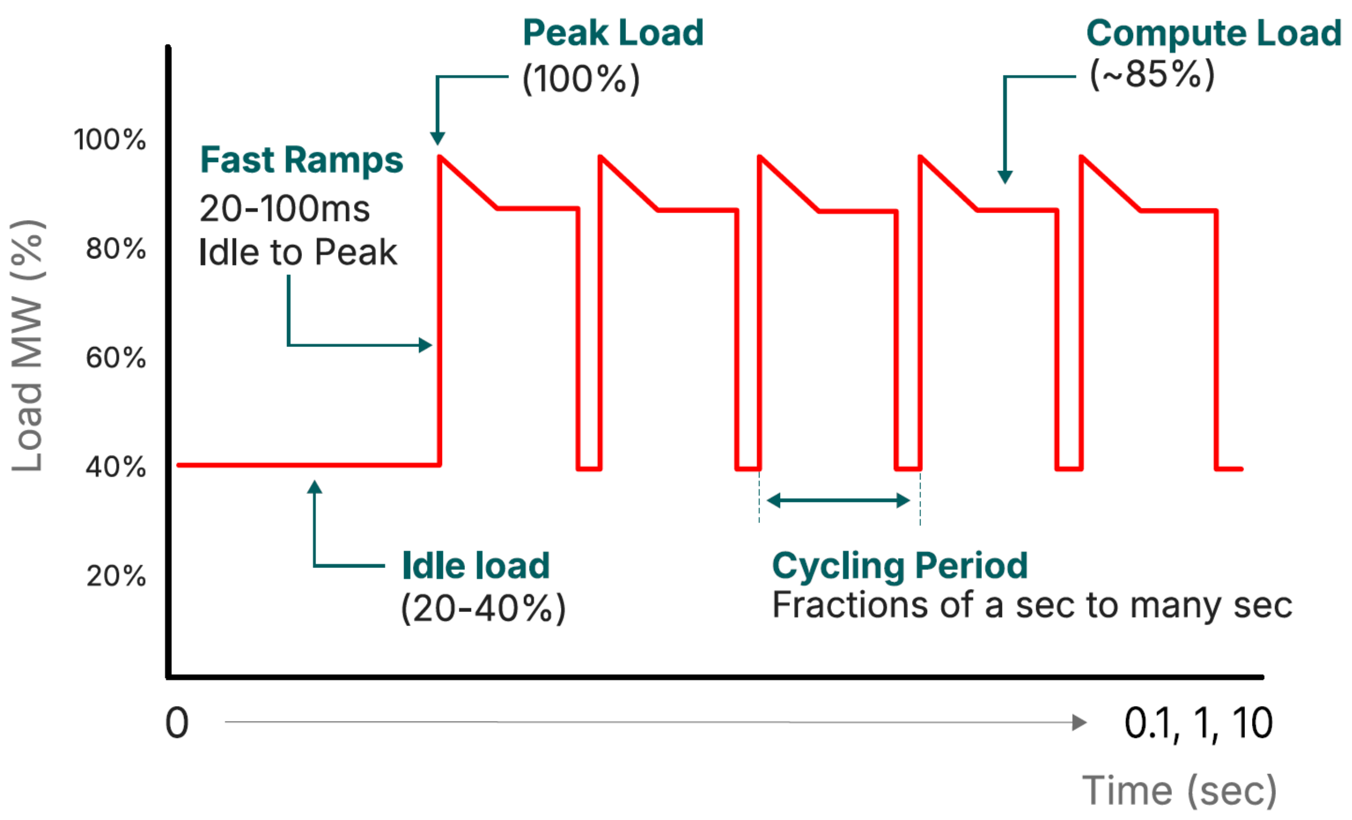


Indicative only. Spike magnitudes based on Microsoft ASPLOS 2024 and NLR/arXiv 2604.07345. Annotations show typical LLM training micro-events at 0.1s resolution.

Voltage impact (particularly LLMs)

- Large-scale AI training that uses thousands of GPUs
- This causes significant variability in power consumption, with frequent, large swings between high and low usage phases as shown in Figure 1.
- AI workload profiles show typical high-power swings of >50% of peak load at GW levels for short cycles, moving from idle at approximatively 20%-40% rack power-up to sharp peaks at 100%.
- LLMs almost certainly require additional installed equipment to manage LVRT – most likely via Grid forming inverter-based BESS or Super Capacitors

Rapid GW-scale cycling of power demand



Source: GE Vernova – Whitepaper - AI FACTORY REFERENCE DESIGNS

About Relode

Relode is building Power Parks to help energy hungry industries electrify at the speed and scale needed for the UK to compete globally.

Private and confidential

Our expert team

Our expert team have a proven track record in infrastructure development, with decades of experience across grid, planning, engineering and industry.

Mikey Clark
Chief Executive Officer

Co-founder of Pivot Power with 20+ years in electricity industry, leading high-profile renewable / R&D / infrastructure projects, including Low Carbon London and Olympic park cable tunnels.

Martin Cole
Chief Development Officer

30+ years' experience as planner / developer specialising in battery storage and renewables. Delivered 20+ project pipeline across Pivot Power and EDF Renewables.

Jonathan Gartside
Chief Operating Officer

10 years' experience as start-up COO. Founding leadership team at Bulb and Airly. 6 years in energy practice area of BCG in London.

Clare Horgan
Development Director

Experienced global engineer and project manager with a BEng in chemical & bioprocess engineering. 8 years' experience in the renewable industry.

Nicole Johnstone
Head of External Affairs

Strategic communications specialist with deep experience in engaging public bodies. 15+ years in the energy sector including Pivot Power, Open Energi, the Carbon Trust, and Eku Energy.

Dee Kelly
Head of People & Finance

A senior people and governance manager with 10+ years' experience across start-ups and global corporates. Delivered transformative projects at Pivot Power & EDF Renewables.

Adrien Lebrun
Technical Advisor

Holistic energy engineer and business leader with over 15 years' experience delivering pioneering battery storage and renewable energy projects across the GB grid. Guest Lecturer at Imperial College London.

Relode

www.relode.energy

Thank you

technology

Gemma Stanley, Octopus Energy

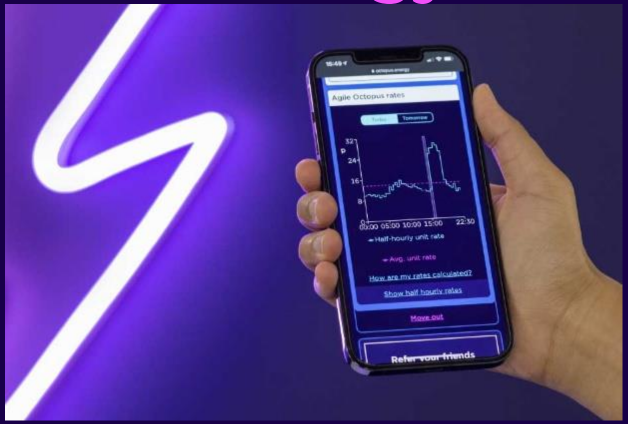
Low carbon connections

Voltage Matters 2026

Octopus Energy harnesses technology to pass the benefits of electrification to customers, creating a virtuous cycle of adoption

Octopus Energy Group spans 4 key business areas

Retail energy



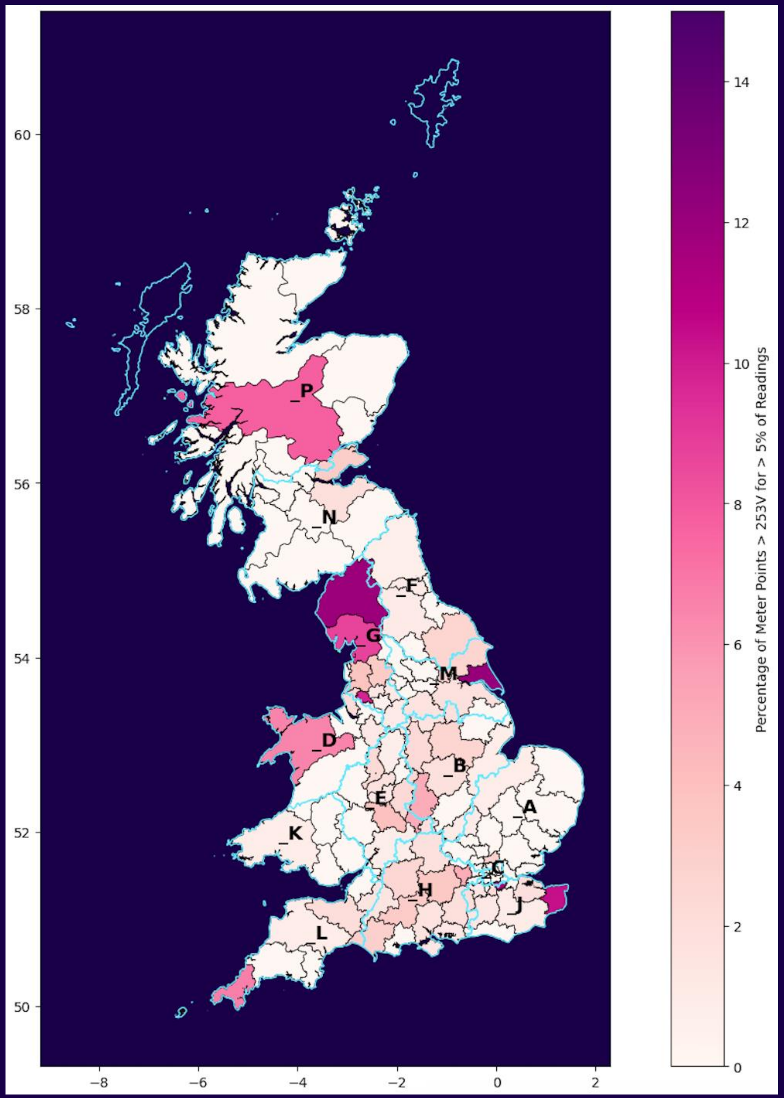
Technology

Energy services

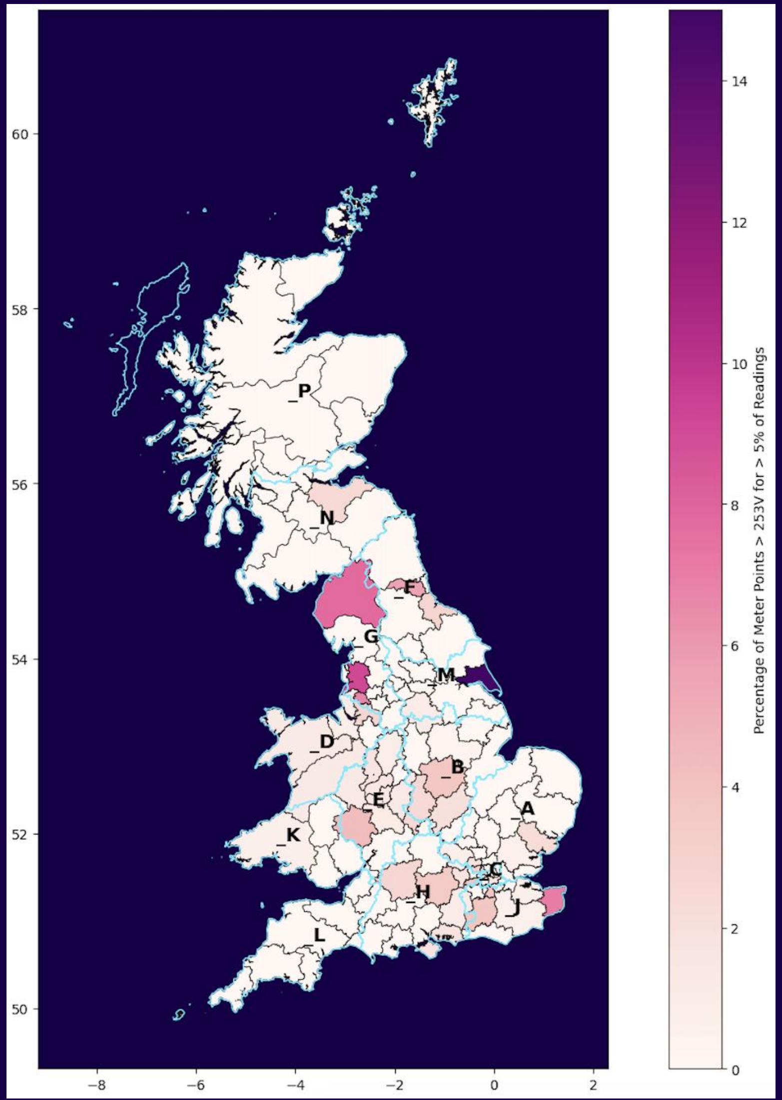
Generation

Across GB networks, some locations are already over the statutory limit for extended periods of time

- Graph shows % meter points over 253 V for more than 5% time
- Some observed seasonality
- Voltage issues likely to increase with increasing penetration of V2G and solar PV, coupled with increasing consumer awareness (e.g. EV chargers now warn consumers when the charger disconnects to avoid over-voltage problems)



June - September 2023



Nov 2023 - Jan 2024

High voltage readings across GB

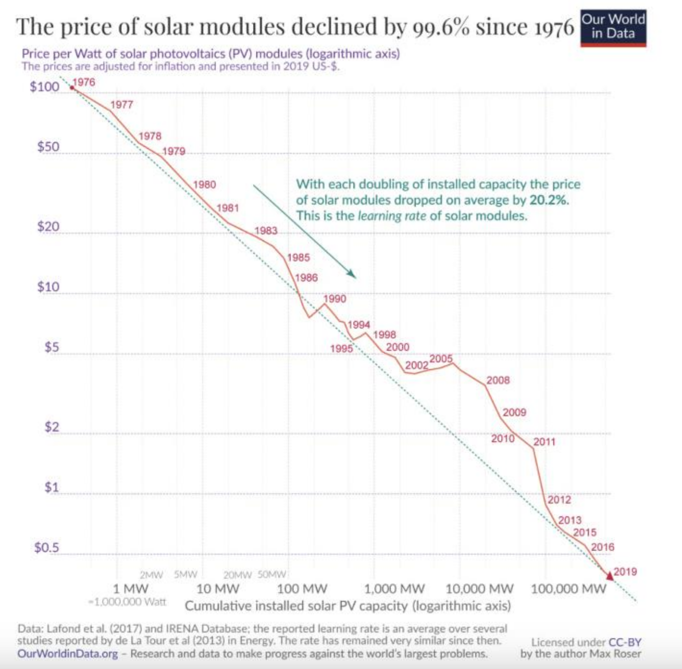
Statistics from voltage readings of ~100 randomly allocated devices over 20 days (March-April 2025)

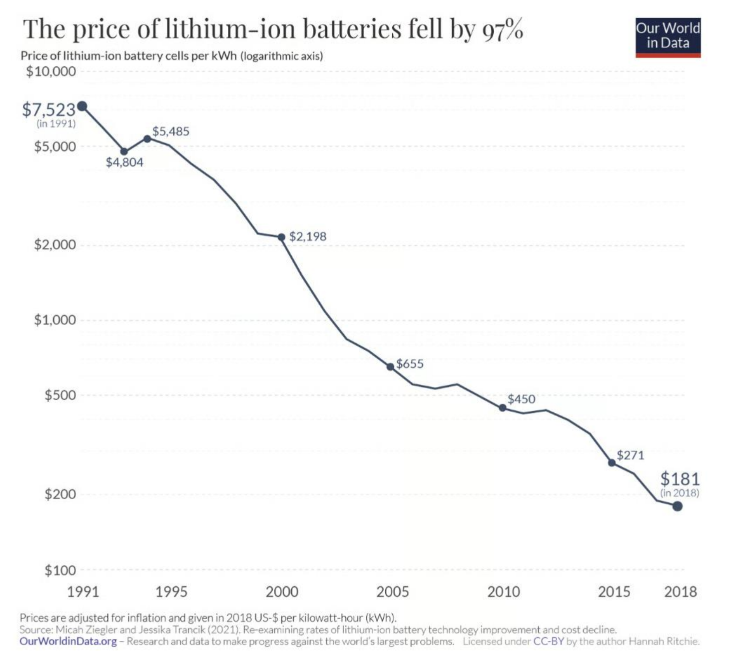
- At **243V**, daily mean voltages across GB are relatively high
- Daily max voltages across GB are higher, with **10%** of the devices experiencing over **250V** readings

Source: Octopus Energy, Intelligent Octopus fleet

Will customers be able to...

- Connect V2G?
- Connect additional solar?
- Connect batteries?






NEWS

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Business | Economy | Technology of Business | AI Business

Octopus boss: We've seen a 50% rise in solar panel sales since start of Iran war

00:46

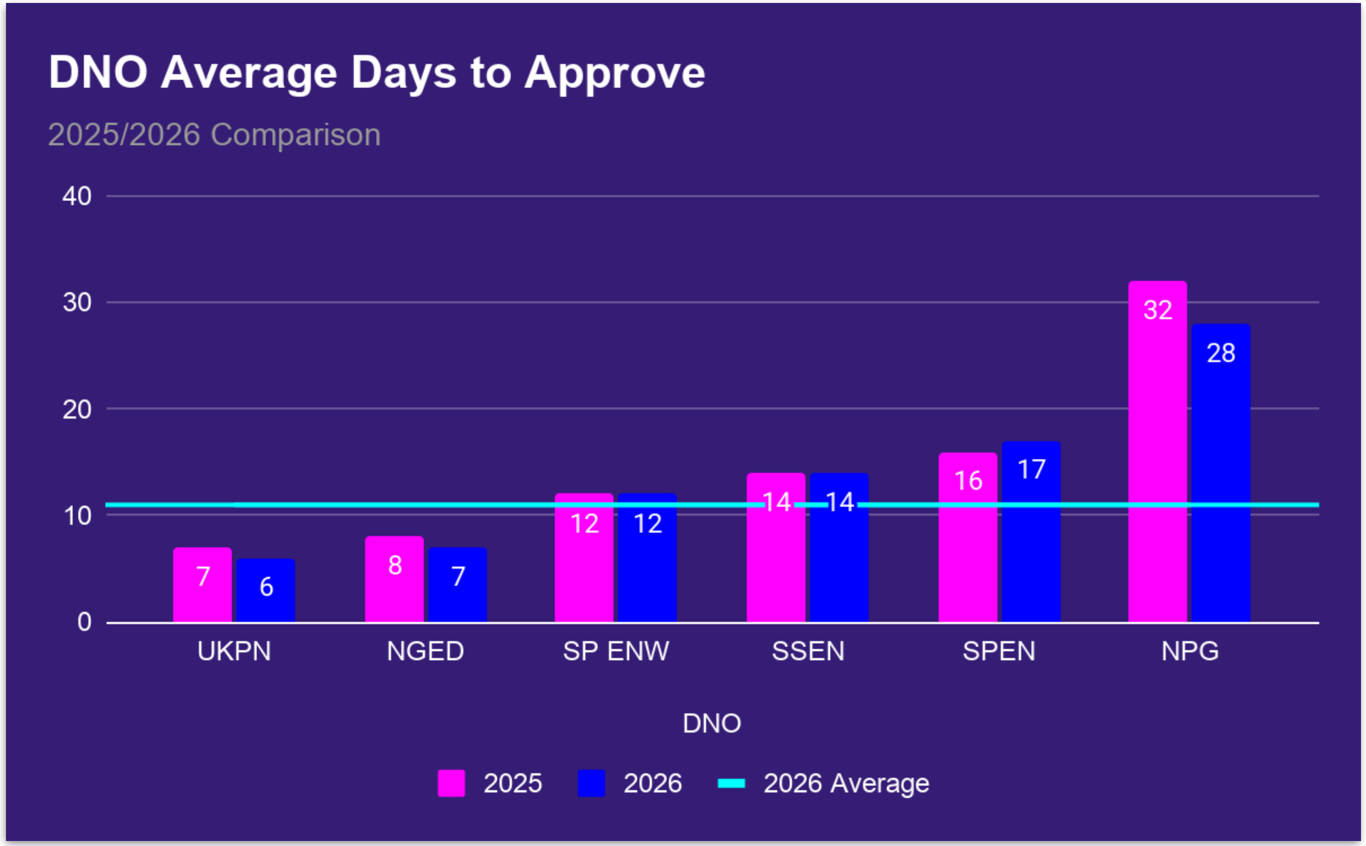
Octopus boss Greg Jackson says demand for solar panels has soared since the Iran war began

Jemma Crew

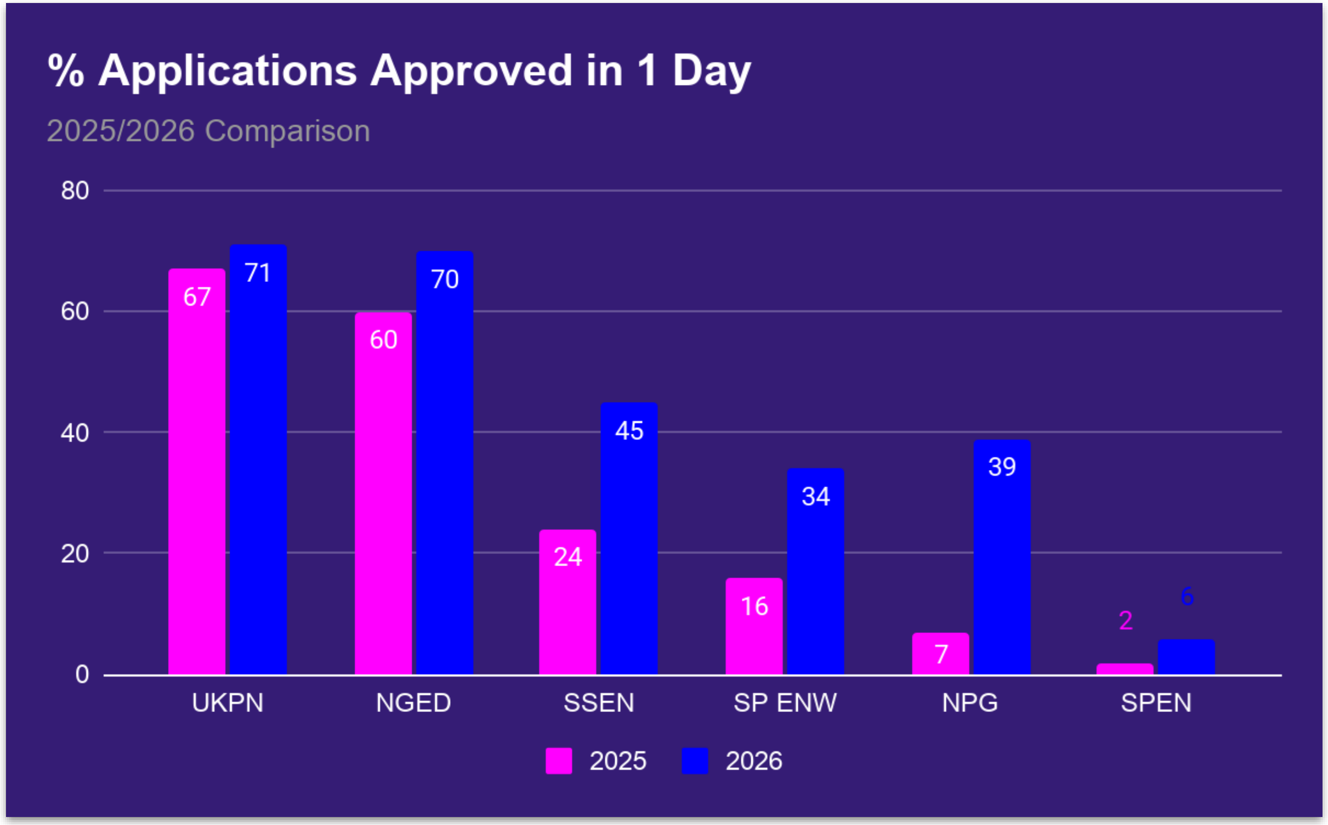
PV 99.6% declines since 1976

BESS 97% declines since 1991

Connection times varies across DNOs



Positive direction with 1 day approvals



Solar connections remain slowest

LCT	Av. number of days to approve	% Auto approval
EV	7	66
Heat Pumps	12	51
Solar	**32**	**9**

Connection restrictions impact customer choices

% of applications export limited range from 32% - 64% across DNOs

Flexibility in ED3

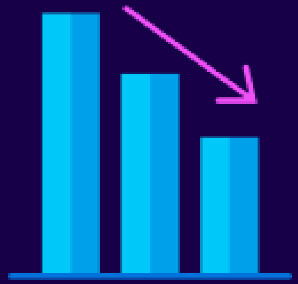
ED3 DSO
Flex Use Cases

- Reducing or deferring capex investment
- Reducing the impact of outages on generation
- Voltage management
- Accelerating connections
- Reducing curtailment of low-carbon generation
- Dynamic Overlay Tariffs
- Reducing whole-system costs through greater coordination

Flexibility can help...

Lower curtailment

Demand Turn Up service trialled or in use by multiple DSOs



Manage voltage

Market-based service in ongoing trial with UKPN

Reduce Network Spend

Reduce distribution network build by **25%.**

(Centre for Net Zero)

ED3

1. **DSO Strategy/Incentive:**
    a. **Build and Flex Strategy**: widening the set of use cases, tools and value
    b. **DSO incentive**: better standardised data and metrics required across network utilisation, voltage, losses (including av. and peak)
    c. **Voltage management**
        i. Flex services can help voltage management
        ii. Should be market based e.g. UKPN trial

2. **Connections**:
    a. DNOs must transition from permanent export limits to dynamic management e.g. DTU to reduce curtailment
    b. Offers should outline end-dates for limitations, such as by linking limits to reinforcement timelines.
    c. Use flex to accelerate connections

octopus energy

Eilert Bjerkan, MagTech AS

Voltage Matters Live 2026

Voltage Management for Capacity Reinforcement

From Compliance to Operability

Eilert Bjerkan | MAGTECH AS | 2026 June 25 | Birmingham

#VoltageMattersLive2026 #RIIO-ED3 #SmartGrids #FlexibilityFirst

Magtech™

Voltage management in the distribution grid

MVR – Medium Voltage Regulator

VRDT – Voltage Regulating Distribution Transformer

LVR – Low Voltage Regulator

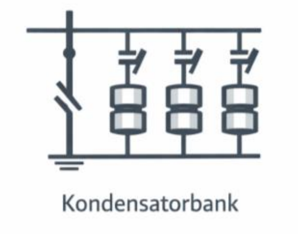
1-10 MVA, 6-36 kV, YNa0d11

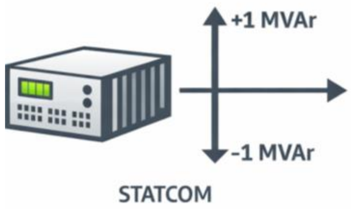
50-2500 kVA, 11/22-0,4 kV

SVB: 30-60 kVA, MVB: 10-110 kVA

Voltage regulation

Alternative to grid reinforcements





Measure	What it solves best	Reg.speed	Impact on losses	Cost (relative)	Space requirement	Delivery time	Control/ monitoring	Typical risks/pitfalls
Series regulation (line regulator / booster, voltage regulating distribution transformer)	Voltage profile along radial (especially at voltage drops with high load or infeed)	**Seconds–minutes** (tap/OLTC-step)	**Increases** somewhat (extra transformer/cable step)	**Medium**: 70-150 k€/MVA	**Medium** (kiosk/ cabinet)	**Medium**	Autonomous. Requires V/I measurement, setpoints, coordination with upstream OLTC	"Hunting" with poor dead-band, faulty coordination with customer regulation, does not affect thermal bottleneck directly
Capacitor bank (fixed/switched)	Reduce reactive current flow → better voltage and lower current	**Seconds** (switched)	**Often reduces** I^2R losses in radial (switched units may have their own small losses)	**Low–medium**: 50-120 k€/MVAr	**Medium** (switchgear/ reactor/ cabinet)	**Short/ Medium**	Simple control (cosϕ/volt), should have measurement and blocking at overvoltage	Resonance/harmonics, overcompensation at low load, switching transients, stepped regulation can cause large change in voltage
STATCOM	Fast and continuous voltage/VAR and dynamic load (charging) support	**Milliseconds–** sub-cycle	Has converter losses (typical medium) but can reduce grid losses via lower current	**High**: 120-250 k€/MVAr	**Medium** (container/cabinet/kiosk)	**Medium/ Long**	More advanced: local regulator + remote monitoring, PQ measurement, alarms	Control interaction with other regulators, requires short-circuit strength/harmonic filtering, more complex operation/regime
BESS (inverter)	**Peak shaving** (thermal capacity) **+ reactive support** (voltage) **+ ramp support + off-grid support**	**Milliseconds–** sub-cycle for Q; **seconds** for P; setpoints	Loss in inverter + battery (depends on operation), but can reduce grid losses via lower current	**High**: 120-250 k€/MVA + 200-400 k€/MWh	**Medium–High** (container + security/area)	**Medium/ Long**	Requires EMS/SCADA, SOC control, contracted operation (grid utility vs customer use)	Energy dimensioning/SOC constraints, aging/cycles, fire and space regulations, regulatory/contractual clarification on grid support. Capability curve P vs Q

The Grid Is Changing — Fast

Historical Reality	Three Key Drivers	New Reality
• One-way power flow • Voltage controlled at primary substations • Passive LV networks • Reinforcement as default response	• EV adoption at scale • Heat pump rollout • Distributed PV + batteries • Bidirectional, unpredictable flows	• Voltage becomes the first constraint • Capacity increasingly voltage-limited • Operability as important as asset ownership

Voltage is no longer just a compliance parameter — it is becoming a capacity parameter.

Magtech™

The Toolbox We Inherited

The classic toolkit:

- Primary substation AVC
- OLTC on primary transformers
- Capacitor banks
- Fixed transformer taps
- Reactive power support from generators

Why it worked:

- Predictable load growth
- Limited embedded generation
- Passive LV networks

Emerging limitations:

- Local voltage problems cannot be solved centrally
- Increasing volatility at LV level
- Voltage now interacts with connection capacity

Traditional tools were designed for a different system.

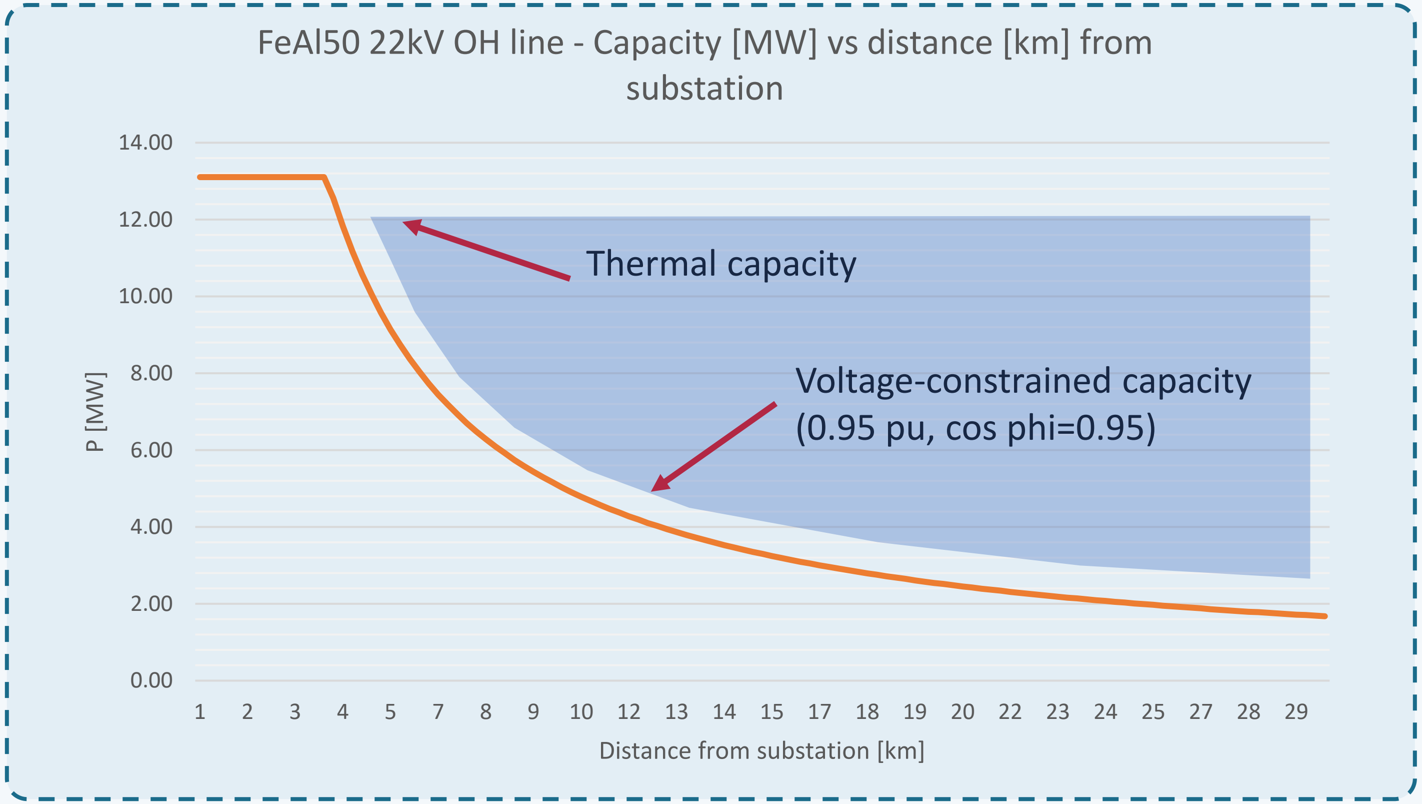
Magtech™

What's needed?

Better Monitoring	Better Management	Flexibility Provision
• Smart meter data • LV network monitoring • Third-party device data • Analytics & forecasting	• Active voltage management • Secondary transformer tap changers • Voltage optimisation • Targeted LV interventions	• Voltage-based demand reduction • Reactive power optimisation • Fast response (≤5 min) to NESO • Local flexibility markets

ED3 is not about voltage — it is about capacity, flexibility, operability and consumer value.

The Hidden Capacity Challenge



+/-5%

Voltage variation in the MV network (planning criteria)

3–5 X

Potential capacity increase at remote end

10-20%

Of the cost of traditional network reinforcement

We are not creating new capacity — we are unlocking capacity hidden inside voltage margins.

From Managing Assets to System Performance

Local Voltage Control	Digital Voltage Management	Flexibility Integration
• VRDT / On-Load Tap Changer • MV series regulators • LV series regulators • Conservation Voltage Reduction (CVR)	• Smart meter data analytics • LV network monitoring • AI/ML-driven prediction • Digital twins & ADMS • Coordinated voltage regulation	• Volt-VAR optimisation • Q(U) smart inverter control • Dynamic reactive power mgmt • Local flexibility markets

The shift: from 'managing assets' to 'managing system performance'.

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Five Barriers to Adoption

01 Engineering Conservatism

Industry defaults to 'build your way out'. Decades of reinforcement culture. Risk aversion to new control strategies.

02 The Regulatory Paradox

Historically rewarded for physical assets & CAPEX — not smarter utilisation. ED3 begins to change this.

03 The Visibility Problem

Most LV networks are poorly observed. Without data, decisions stay conservative. Ofgem's monitoring push addresses this.

04 The Business Case Problem

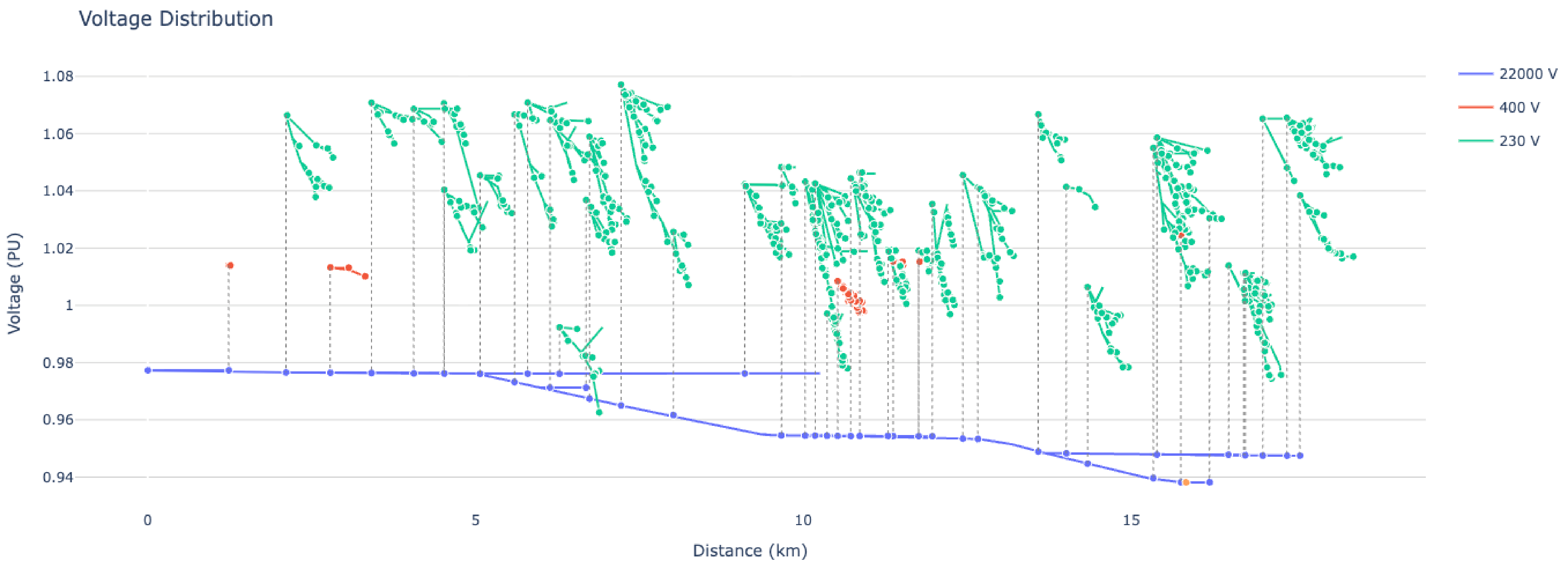
Suppliers sell equipment. DSOs buy capacity, risk reduction & TOTEX improvement. The conversation must shift to outcomes.

05 Organisational Silos

Voltage sits across planning, operations, connections & flexibility teams. Everyone benefits — nobody fully owns it.

The biggest barrier is not technology — it is moving from a reinforcement mindset to an optimisation mindset.

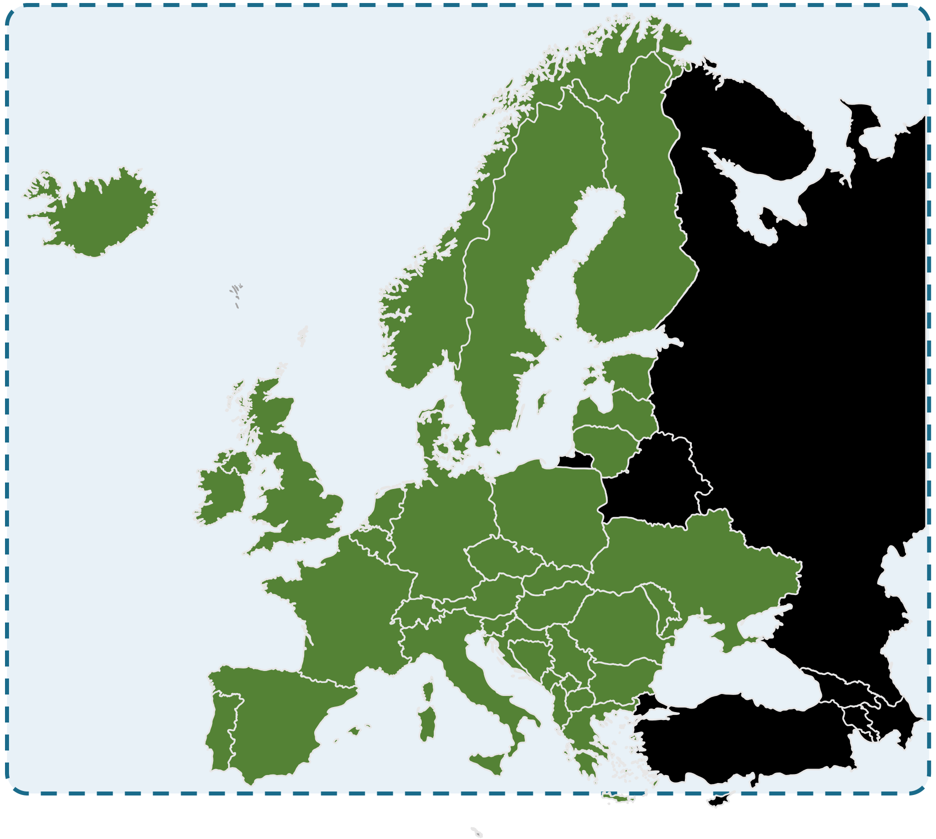
..and an important enabler: Planning tools



Scalable planning tools require visibility and digital twin capabilities.

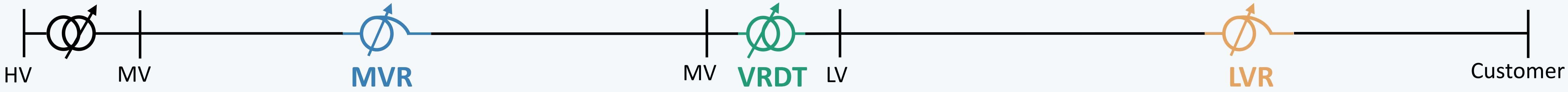
All Markets, One Fundamental Question

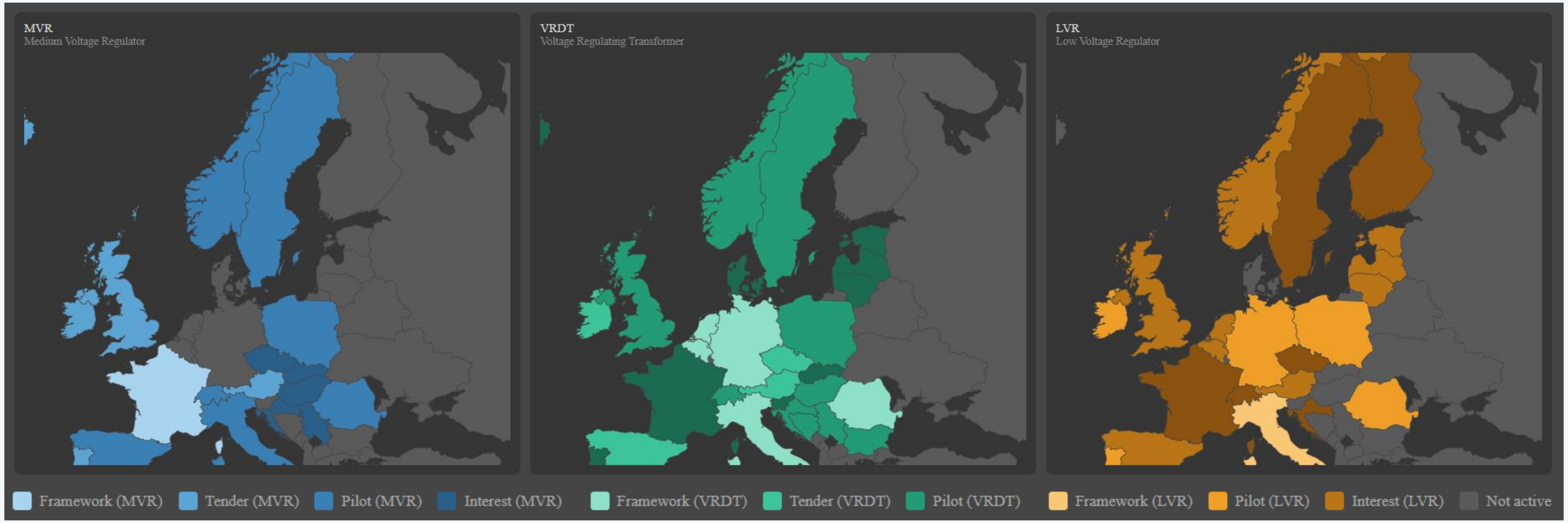
Germany Large-scale VRDT deployment (e.g. Bayernwerk). Reinforcement avoidance at scale.	**Italy** Long experience with active voltage control. High DER penetration. LV challenges
France Growing focus on flexibility and hosting capacity frameworks. MV challenges due to distributed solar generation.	**UK** Heat pumps and EV charging is straining the distribution grid.
Eastern Europe Modernisation opportunity. New infrastructure investment cycles underway.	**Nordics** Long feeders, weak networks. Electrification of transport & heavy industry.



How do we connect more customers without endlessly building more network? A shared European challenge.

Market maturity – Europe 2026





Multiyear framework agreements in France, Italy and Germany. Tenders in several countries.

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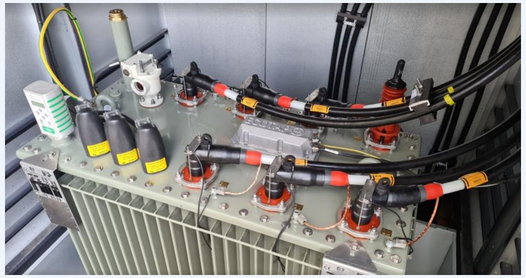
From Pilot to Business-as-Usual?

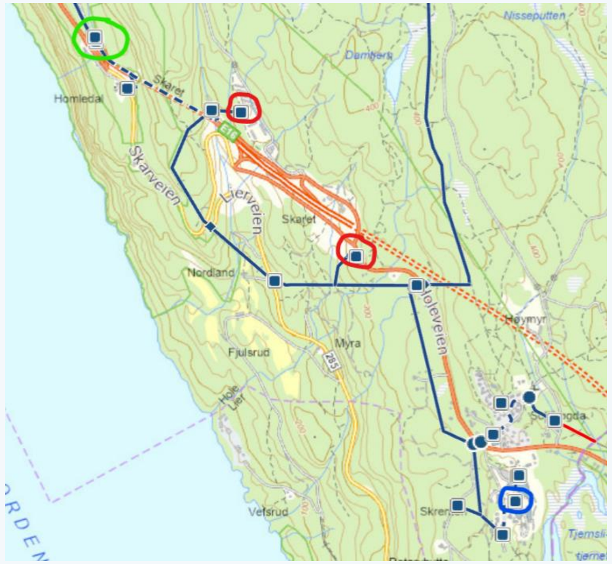
	**LVR**	Booster: First pilot installed in 2003 (Norway) Voltage Balancer: First pilot installed in 2017 (Italy)
	**VRDT**	First pilot installed in 2016 DSO: Linnea AS (Norway) Use case: Large voltage variation on 22 kV
	**MVR**	First pilot installed in 2018 DSO: Lustejok Nett (Norway) Use case: weak grid, long MV feeder, industry load

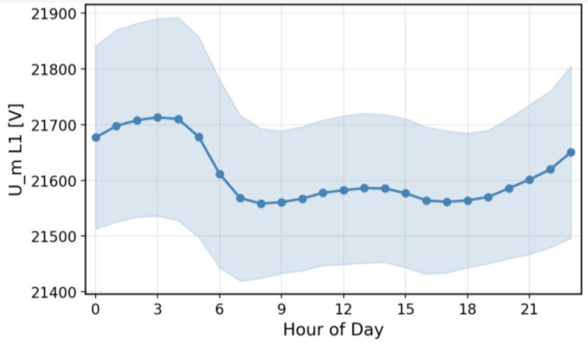
This is no longer R&D — leading DSOs are moving voltage management into operational deployment.

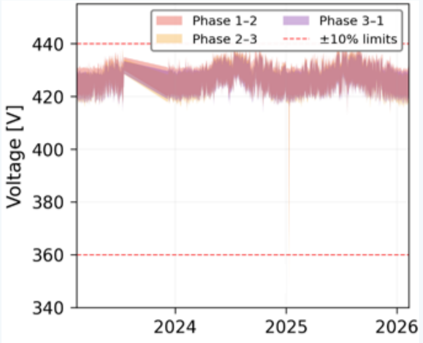
MVR-100: Data from 5 years of operation

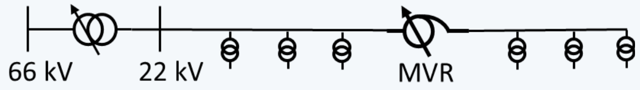
DSO: Føie AS (Norway)
Background: 2MW Tunnel project
Product: Autotransformer MVR-100 (Ecotap VPD)
Installation: 2021
No. of tappings: 3967
CIRED 2026: Paper # 1267

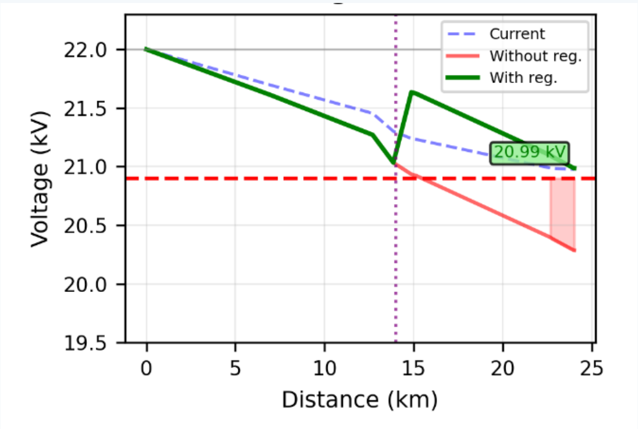
Length (m)	Type	mm²
6986	TSLF	400
5716	TSLF	240
1165	BLX	95
1008	TSLF	95
273	TSLF	240
7526	TSLF	95
125	FEAl	25
1186	BLX	95
32	TSLF	240

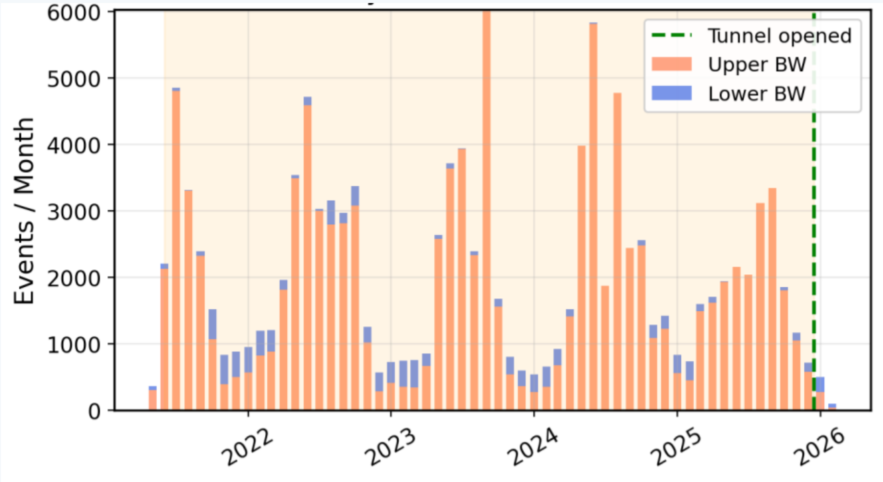












This is no longer R&D — leading DSOs are moving voltage management into operational deployment.

1	Voltage management is becoming a network planning tool. Not just an operational tool — it is now part of the capacity and connections conversation.
2	The cheapest MW is often already inside the existing network. The challenge — and the opportunity — is finding and unlocking it before digging.
3	Future networks will be controlled closer to the customer. This is the defining regulatory direction of ED3 and beyond.

"How much unused network capacity is hidden inside our voltage margins?"

Classification: Restricted

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MAGTECH AS

smartgrid The Norwegian Smartgrid Centre

ISO 9001

ISO 14001

ISO 45001

Achilles Utilities NCE QUALIFIED

CURRENT

AVA

Laura Henry, Eclipse Power

eclipse power

Customer and Connections

Laura Henry
Director of Regulation, Policy and External Affairs

Electricity Connections. Simplified.

Eclipse Assets live and in build: A track record of success

IDNO

13,000+
registered MPANs energised

1,120+
live networks

1.4GW
of transmission connections directly to NESO

45 EHV
EHV substations live and in delivery

24,700+
MPANs in the pipeline

5.5GW+
live and secured network capacity

Grid Consultancy

Delivered due diligence across grid portfolios worth over **£72 million**

Negotiated over **£220 million** in security reductions across multiple customers

Negotiated security refunds where customers had paid more than required, totalling over **£120K**

Accelerated grid connections by up to **12 months**

Microgrids & Private Networks

Delivered the UK's first Zero Bills microgrid community, connecting **113 energy-efficient homes**

Developed a private network pipeline spanning renewables, BESS, data centres, ports, and wider commercial and industrial customers across GB and European markets

50+ microgrid and private network projects in the pipeline

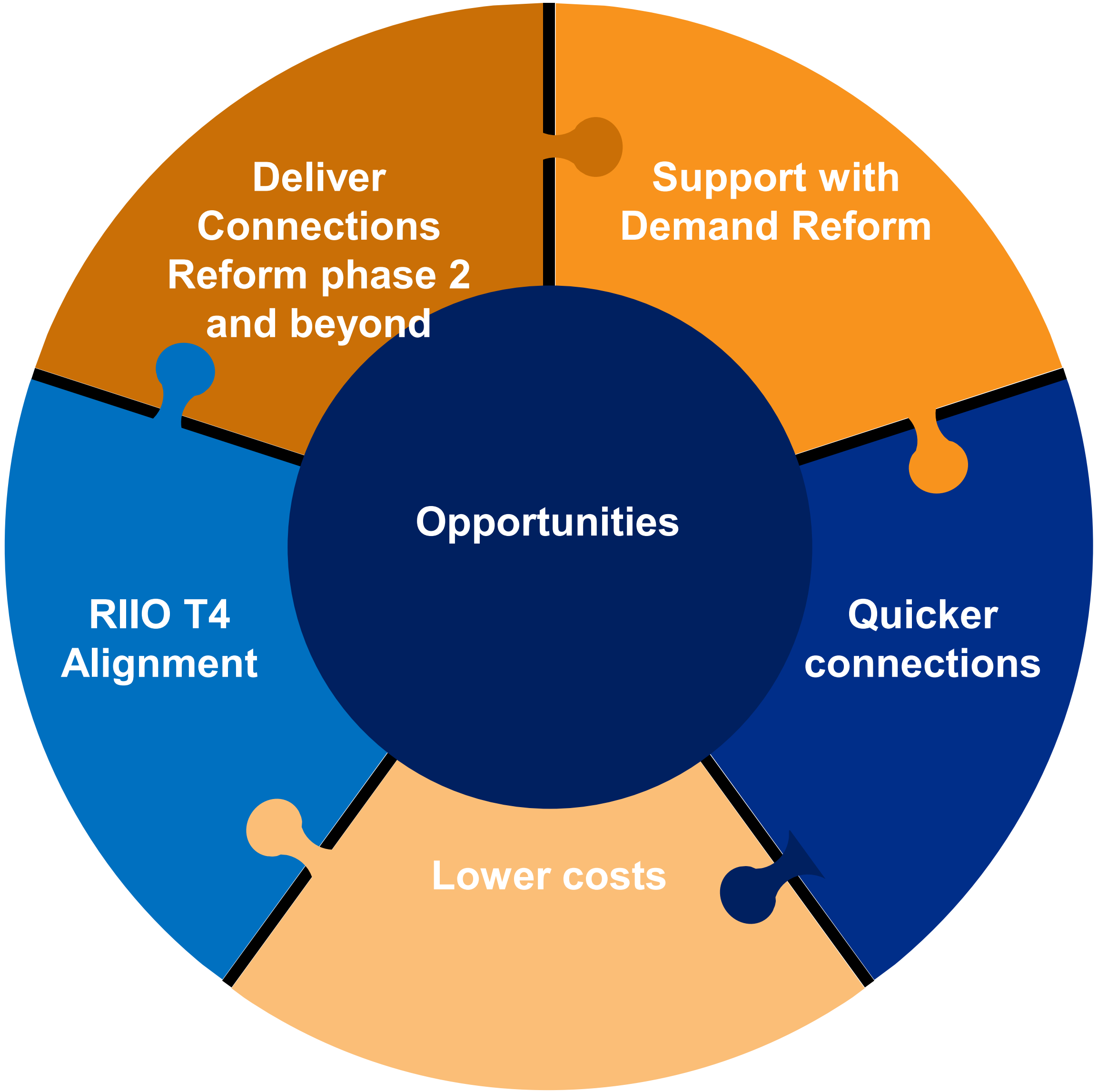
Pipeline value exceeding **£1 billion**

Solutions to a changing energy landscape

Grid congestion	→	Smarter networks
800GW+ waiting to connect in the UK	→	Co-located energy systems
Planning and infrastructure delays	→	New commercial models

Unlocking connection. Unlocking value.

ITO | Multiple opportunities to deliver key industry challenges, quicker and in a more cost-effective way



Utilise existing successful IDNO processes: There is an opportunity to utilise existing Licencing, charging and regulatory frameworks from INDOs and replicate them for ITO's.

Support with supply chain issues: Agile and streamlined procurement processes that sit outside of the frameworks that TO's have. Access to a flexible procurement / supply chain.

Allows incumbent TO's to deliver core business activites: Opening up to competition at Transmission Level allows incumbent TO's to have a more realistic workload which will enable connection dates to be more realistic resulting in quicker connections.

Enabling greater investment into the UK: Ensuring the UK is seen as a leader in both connecting projects and for investors to develop projects.

Delivers Net Zero targets: Allowing projects to connect quicker at a lower cost delivers government CP 2030 and Net Zero targets.

Faster and cheaper connections: A combination of an agile workforce and more streamlined procurement process allows for quicker connection dates at a lower cost.

Expertise at Transmission: Some IDNOs have existing experience of connecting projects into the Transmission network.

Co-Location – why now

- Increased demand for connections and capacity
  - renewable generation & net-zero, electrification of heat & transport, DC demand
- Saturation of the existing networks across voltage tiers, both for for demand & generation
- Meshed, interconnected system means symbiotic relationship between distribution & Transmission systems
- Traditional approach to reinforcement and network expansion result in longer delays to connection
- **Energy costs continue to increase despite higher saturation of renewable energy**

Thinking differently – why microgrids aren't micro anymore

- Generation & BESS developers who have planning, Gate 2 offers with <2030 dates for +400MW and have added 'final demand' to their connection
- Approach socialises the grid connection between generation and large demand - no need to wait for NGET to build out a full GSP
- The solution is equally applicable for distribution level connections and already in pre-delivery at 132kV & 33kV
- Co-location provides direct access to intermittent renewable as well as non-intermittent generation
- Meaning an equitable exchange of cheap green electrons directly into the DC's network.
- This approach *reduces* the impact on the existing networks, which should *reduce* costs to UKPLC

Lessons we’re taking forward.

1. Delivery matters

The ability to move projects in complex environments

2. Integration unlocks progress

Bespoke, tailored, innovative solutions in our offering

3. Early clarity changes outcomes

Proactive view of constraints, options and risks

4. Partnerships beat transaction

Working *with* our customers

Looking ahead: the opportunity.

This is a chance to unlock investment, enable reform and build the next layer of capability for the energy transition.

Today

Find innovative ways to enable quicker connections. In order for investor confidence to be maintained and for government climate change goals to be achieved there needs to be a different approach.

What's next?

Work with Ofgem, DESNZ, networks and wider industry to create new markets to allow quicker connections.

Why this matters

- More routes to investment and delivery
- More space for innovation and collaboration
- Greater confidence for developers, ICPs and customers
- A faster, more joined up route towards UK energy goals

Q&A

Thank you

technology

Voltage Matters

Sign up to our webinar:

Are Electrical Faults Putting Your Operations At Risk?