Welcome to

The Project Closedown Event

An interactive webinar event
30 November 2022

Distributed ReStart

Energy restoration for tomorrow

In partnership with:

tnei

SP ENERGY NETWORKS

nationalgridESO


Welcome
Peter Chandler
The Project Closedown Event | 30 November 2022
Distributed ReStart
Energy restoration for tomorrow

Agenda

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- **Welcome** – Peter Chandler
- **Project review** – Michael Kenny
- **Power Engineering & Trials** – Jack Haynes
- **Organisational, Systems & Telecommunications** – Michael Kenny and Chris Salter
- **Cost benefit analysis** – Gordon McFadzean
- **Procurement & Compliance (inc. transition to BAU)** – Hannah Rochford
- **Final thoughts** – Peter Chandler
- **Q&A** – Colin Foote and project team

Project review

Michael Kenny

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Project Review – Overview of the project and it's achievements

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Power Engineering & (live) Trials (PET):

- Demonstration of Black Start from DER using Renewable generation
- Defined the functional Specification for a DRZ Controller (GE prototype, designed, built & tested)
- Defined all required DER and DNO Network protection settings & equipment

Organisation, Systems & Telecoms (OST):

- Demonstration of Black Start from DER via live Desk-Top Exercises – new 'bottom-up' restoration process validated by industry
- Defined the functional Specification for a resilient System & Comms infrastructure
- Defined all required DER, DNO, TO & ESO Network change impacts

Procurement & Compliance (P&C):

- Demonstration of Black Start from DER procurement via the Mock Tender
- Defined the Grid Code changes & modifications required to support the ESRS & Distributed Restoration
- Defined & agreed with Ofgem, the new funding mechanisms to allow DERs and DNOs to tender for the new services (SE & Northern Tenders in progress towards BAU)

Knowledge & Dissemination (K&D)

27 Reports & Briefs, 10 Engagements events, 4 DRZC Functional Design Specs, 6 live trials stage podcasts during Covid 19, 6 Stakeholder Advisory Panel quarterly sessions, start & end of project animation videos, and counting!

Power Engineering & Trials

Jack Haynes

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Project Motivation

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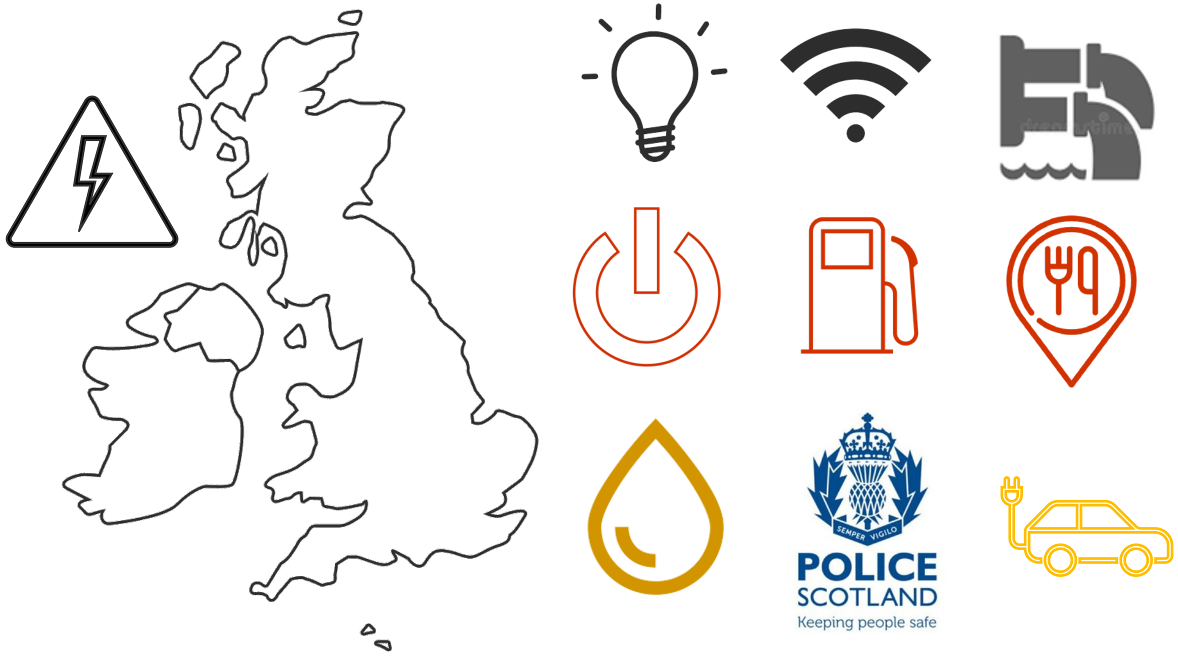
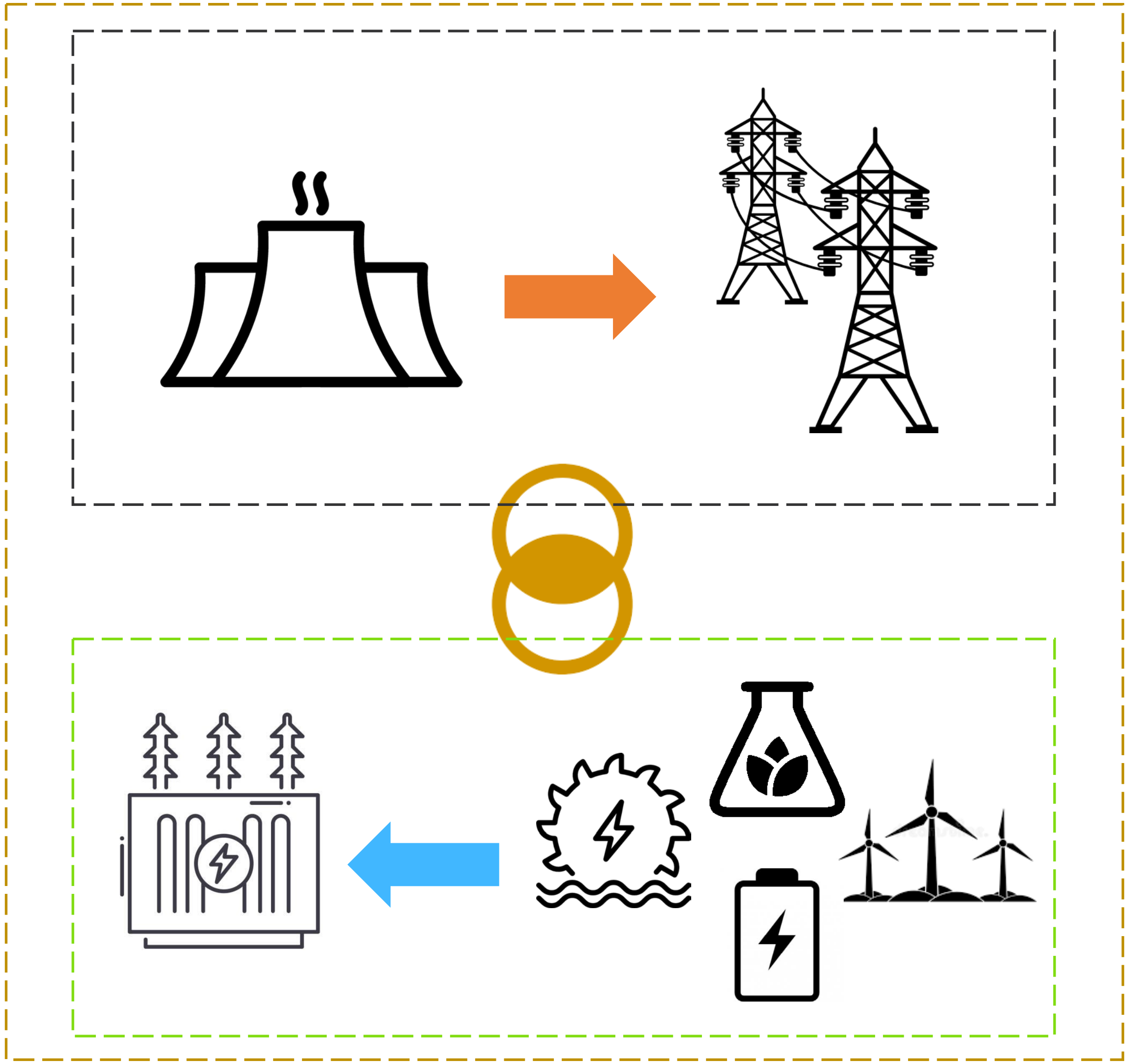
Critical to ensuring stability in UK power networks sector and providing benchmark for worldwide utilisation





7 days for full restoration

nationalgrid

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Work Completed to Date – Galloway and Chapelcross

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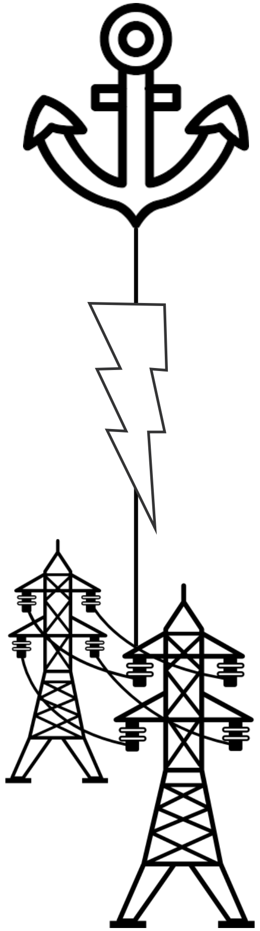
Power Engineering Trials Workstream (PET)

Kendoon Hydro – Apr 22

Energised up to 275kV from 13MVA Generator & measure BLPU of Hydro



Stevenscroft Biomass – June 22

Energised up to 400kV from 53MVA Generator & measure BLPU of Biomass

DRZ Requirements – Network Requirements

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1) Protection

- Alternative settings applied as required for Black Start
  - Can be programmed into 'Group 2' settings on modern relays and enabled via SCADA

2) Earthing

- 'Switchable' Earthing transformer required at 33 kV beside Anchor generator
  - With 132/33 kV or 275/33 kV transformers not in the initial DRZ network the 33 kV network will be unearthed
  - ESQCR requires an earth 'as close as practical' to the source of voltage

3) Resilience

- The 33 kV and primary (33/11 kV) substation will require resilient protection/telecoms for up to 72 hours
  - Sufficient capacity batteries or standby generation

4) Switchgear capability

- The switchgear needs to be capable of switching and fault breaking duty associated with an islanded network
  - Switching – the circuit breakers may need to break the purely reactive current associated with an energised network with no load
  - Fault breaking – studies have shown Transient Recovery Voltage (TRV) may exceed switchgear ratings when fault levels are low
    - Results in a high rate of rise of voltage across the CB opening contacts
    - Vacuum interrupters are further vulnerable to re-ignitions which may cause generator/transformer winding damage

DRZ Requirements – Distributed Energy Resources (DER)

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The total requirements for each DRZ will be site specific (depending on the scope of the DRZ and capability of DER within), but will consist of the following:

Service	Requirement	Description	Potential providers
Anchor generator (or power park)	Essential	Only one anchor generator is required per power island. Self-start and provide a controlled voltage source, able to energise the network to reach the next resource.	Synchronous generator, or other technology with required capability. A single point of connection is required with the DNO network.
Fast MW Control	Potential	May be required to supplement technical capability of anchor generator for example enhance block loading.	Battery, loadbank, flywheel, generator, others.
Inertia	Potential	Increase frequency stability of the DRZ and/or/ allow greater demand blocks to be picked up.	Synchronous generator, synchronous compensator (an inherent response is required without any measurement delays), others.
Frequency control	Potential	May be required to support the anchor generator to maintain frequency parameters during normal operation.	Synchronous generator, converter based sources with appropriate control, others.
Voltage control	Potential	May be required to enhance the MVAr capability of the DRZ to expand the island/energise to a higher voltage.	Wind farm, solar, battery, synchronous gen, Statcom, SVC, others.
Short circuit level	Potential	Increase the DRZ fault level. Facilitate protection operation at higher voltage levels or converter DER to connect	Synchronous generator, synchronous compensator, others.
Energy (MWh)	Potential	Enhance capability of the DRZ to restore demand above the capacity of the anchor generator. This could come from other any other gens on the island. (May be schedulable or intermittent.)	Schedulable MW - Synchronous generator (additional to the anchor), Intermittent resources (constrained and controlled by a set point),demand side management, others.

Nature of Innovation

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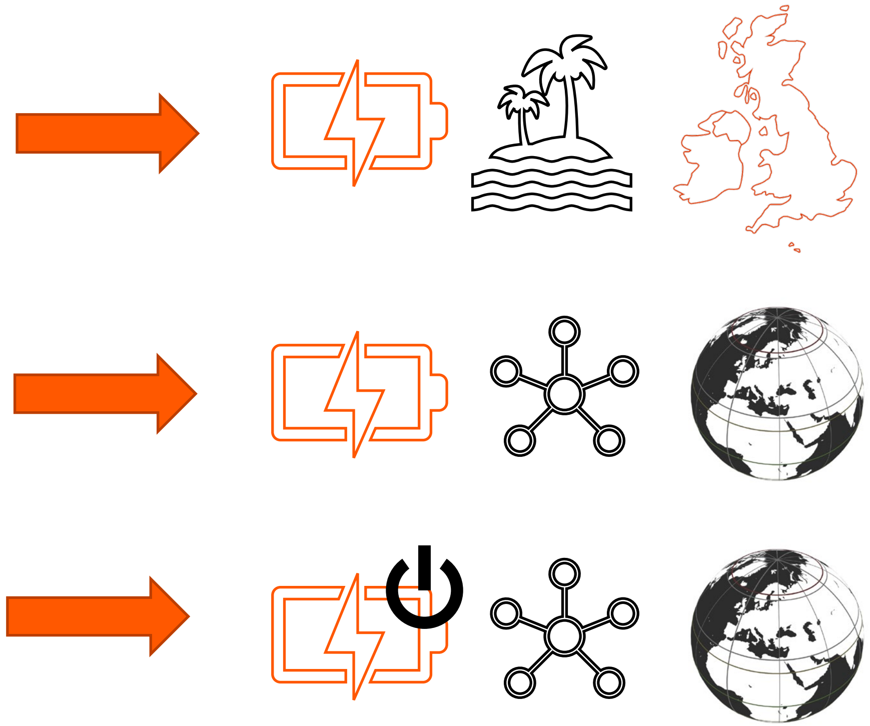
Ground breaking trials led by SP Energy Networks

Phase	Deliverables
1	**Grid forming** battery tests, without diesel generator **Grid following** battery tests, with diesel generator - droop control **Grid following** battery tests, with diesel generator - set point control
2	**Primary transformer energisation through grid forming** BESS, with/ without diesel genset **Redhouse GT1 and Glenniston 132 kV energisation through grid forming** BESS, with/without diesel genset
3	**Self starting grid forming** battery tests under DRZC control **Optimised power island control** through DRZC with **multiple DERs contributing to island** **Resynchronisation** of power island to intact SPEN network



BAU Solution

Phase 1 – Energising Greenspan 33 kV network

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Phase 1 Key Deliverables:

Grid Forming Mode:

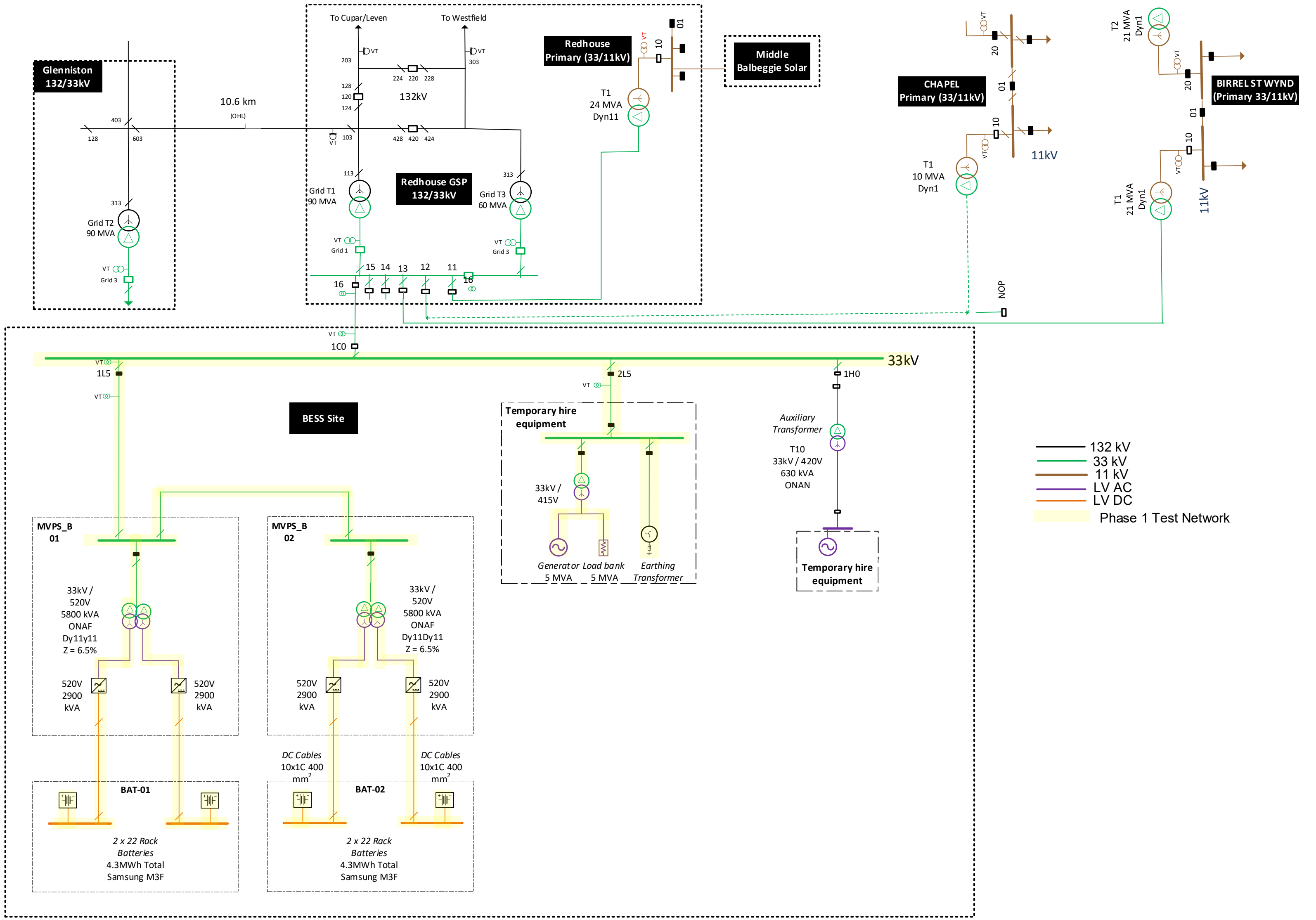
- **Energise Greenspan 33kV network from BESS in grid forming mode**
- Tests with and without diesel generator
- Implement load steps, charge/ discharge transition, transformer energisation
- Droop and set point control testing

Grid Following Mode – Droop Control:

- Energise Greenspan 33kV network via diesel generator with BESS in grid following mode **using droop control**
- Implement load steps and evaluate response

Grid Following Mode – Set Point Control:

- Energise Greenspan 33 kV network via diesel generator with BESS in grid following mode **using set point control**
- Test 4 quadrant operation



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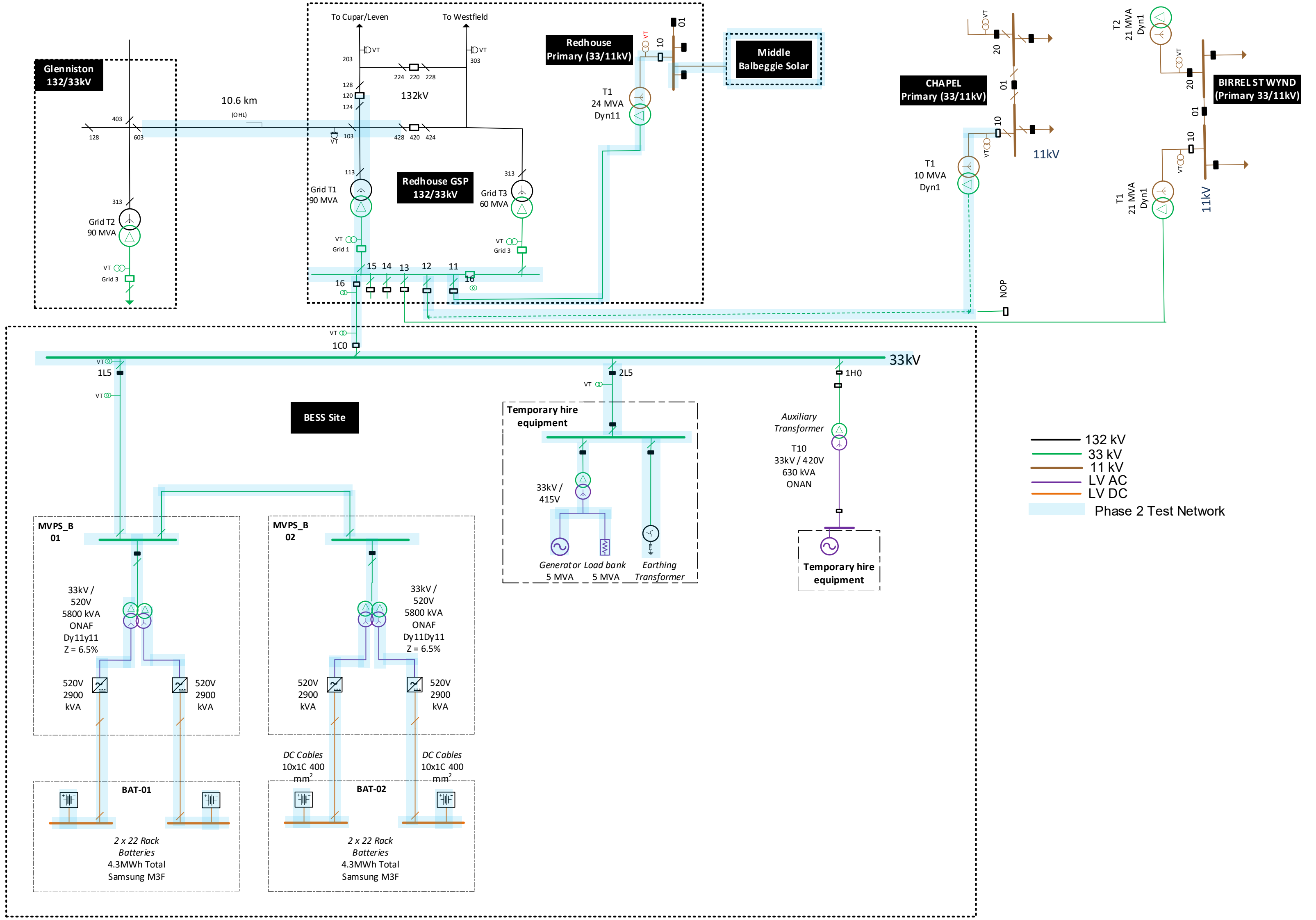
Phase 2 Key Deliverables:

Energise SPD Primary Transformers:

- Energise Redhouse Primary T1 and Chapel Primary T1 from Greenspan site. **Include Balbeggie Solar**
- Primaries to be energised separately and simultaneously.
- Energisation from Diesel only, BESS & Diesel and BESS only.

Energise SPT 132 kV Network:

- Energise Redhouse GT1 and 132kV OHL to Glenniston from Greenspan site.
- Redhouse GT1 to be energised separately and then with OHL.
- Energisation from Diesel only, BESS & Diesel and BESS only.



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DRZC Phase – Phase 2 Expanded/ repeated under DRZC with loadbank control

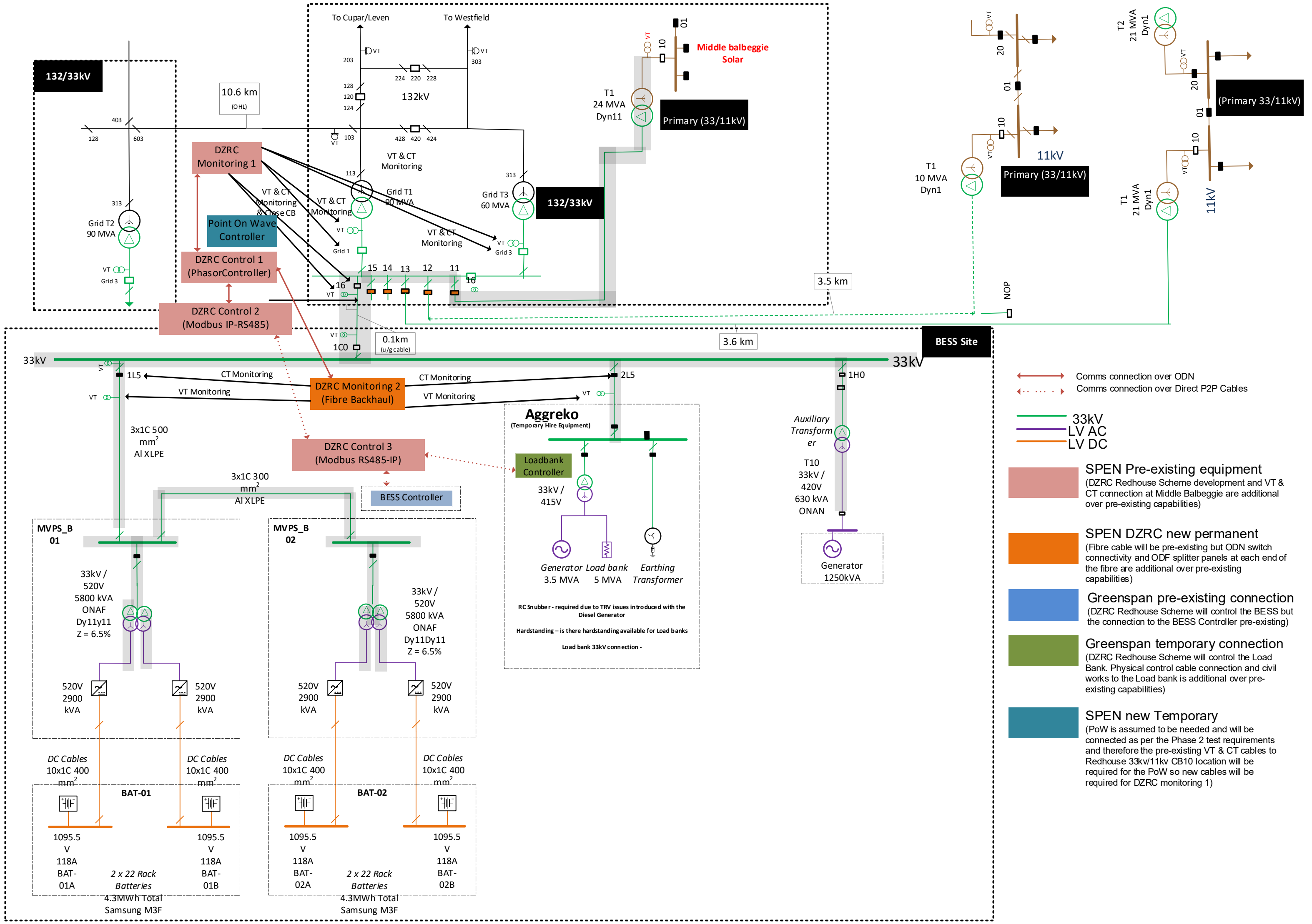
Additional Infrastructure needed

Test regime

1. BESS grid forming on & network energised
2. DRZC takes control
3. BESS, Solar, Diesel Gens and Load bank outputs all contribute to DRZ
4. DRZC only controls load bank and BESS

Outputs

Demonstrate DRZC ability to operate, monitor and control a BESS DRZ with local network energised and multiple DERs



Organisational, Systems & Telecommunications

Michael Kenny and Chris Salter

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Organisational Outputs:

- New strategic command and control model required with significantly enhanced role for DNOs and new capability for DER
- Full end to end process documentation including testing via desktop exercises and creation of an example distribution restoration zone plan
- Change assessment for all parties involved in the restoration process in final report

ESO continue to coordinate national restoration including instructing the start of plans whilst DNOs lead locally. The DNO makes use of a control system for management of real time frequency, voltage and generator dispatch

TO

- Transmission network switching actions
- Data provision to DNO
- Co-develop transmission level strategy
- Increased number of new DRZ

NGESO

- Declare Black Start
- National strategy
- Regional strategy
- Instruct DRZ start
- Instruct transmission restoration route
- Instruct power island growth outside of DRZ

DNO

- Declare and instruct restoration to service providers
- Develop local restoration strategy
- Distribution network switching actions
- Local voltage and frequency management

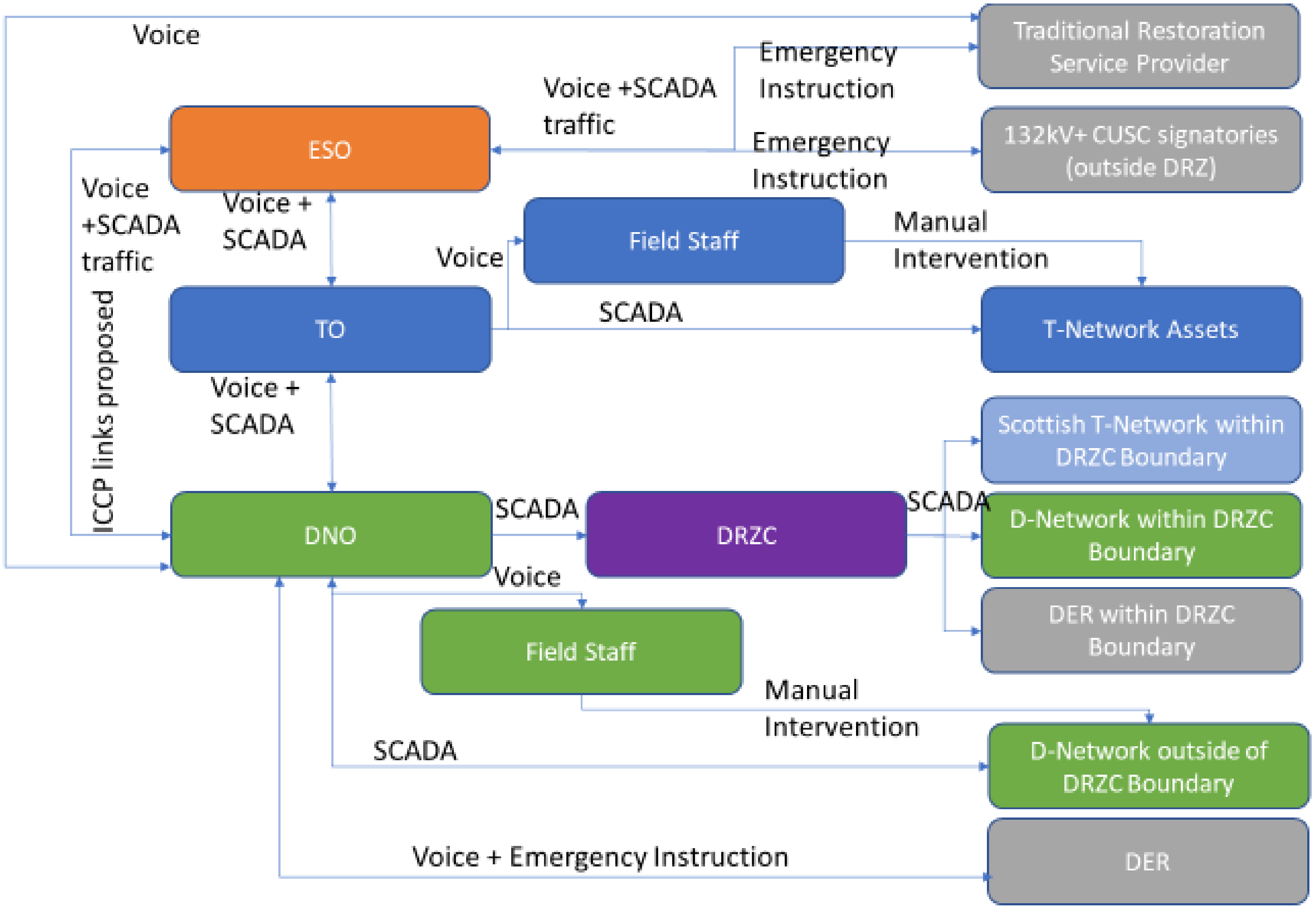
DER

- Multiple individual providers deliver different services to the restoration zone
- Anchor DER provides the initial voltage and frequency source
- Top-up service providers support power island growth

Desktop Exercise Attendees
Thanks to all involved!

Systems & Telecommunications outputs:

- Full specification of the interfaces and communications methods between organisations
- Functional specification created detailing all technical and non-technical aspects for a power resilient communications network which is able to facilitate the control system requirements
- Detailed cyber security assessment of the control system and communications network including recommendations for roll-out GB wide
- Technology agnostic approach to enable lowest cost GB wide roll-out based upon existing infrastructure wherever possible



Cost benefit analysis

Gordon McFadzean

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CBA Methodology

System Restoration Requirements
(MW per restoration zone)

Restoration costs by power station type
(£ / MW / year)

Restoration capability by power station type
(MW)

Restoration Procurement Model

- Rank capacity by £ / MW / year cost
- Select cheapest MW capability
- Stop when zonal MW requirement is met

Restoration Costs
(£ / year)

Distributed ReStart makes additional capacity available from the distribution network

Cost Benefit Analysis (CBA)

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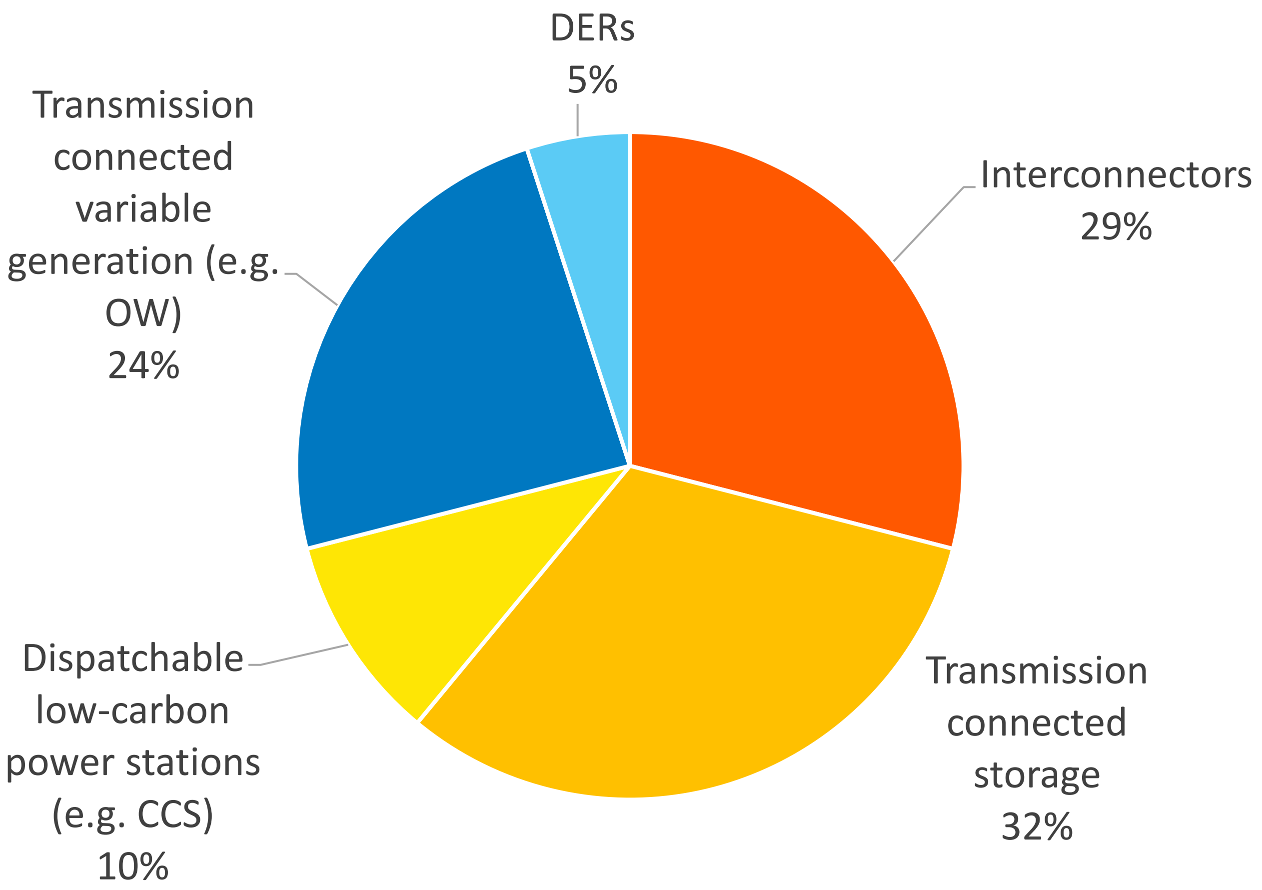
- DERs only make up a small proportion of the overall restoration capability in 2050
- However, the overall restoration capability looks very different, and is very reliant on:
    - Storage
    - Variable generation like offshore wind
    - Interconnectors
    - Dispatchable low-carbon power like CCS and hydrogen

Restoration provided by 2050 *(Leading the Way Scenario)*



Cost Benefit Analysis (CBA)

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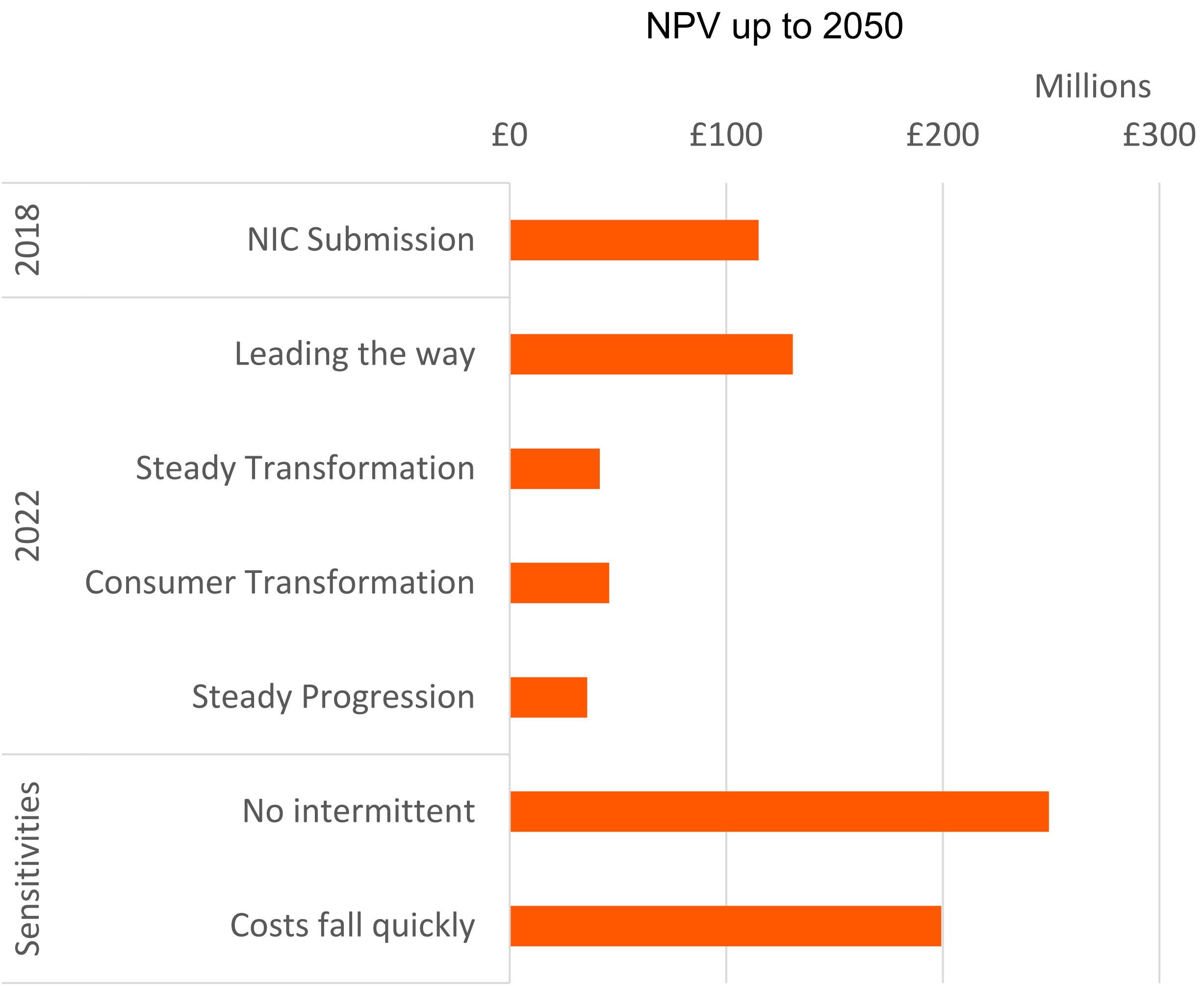
- The “headline” benefit under the Leading the Way scenario is similar to the original 2018 submission.
- In this scenario, without distributed restoration, there may not be enough restoration capability in the system.
- The method is less beneficial in scenarios which can use other technologies for restoration
- If costs fall quickly, or if other technologies can’t be used as easily, then benefits are higher.



Procurement & Compliance (inc. transition to BAU)

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Key messages from the P&C final report

1. Proposals meet the commercial objectives for Distribution Restoration service – to promote accelerated restoration times and add financial value
to end consumer

2. Our service designs will look to procure the right functional capabilities from the right DER providers in a DRZ in order to be compliant with the ESRS

3. A fit for purpose, end-to-end procurement process has been designed – which includes an enhanced role for the DNOs

4. Codes work will future-proof Distribution Restoration service – a detailed review of the industry codes, legal text drafting and progressing through ongoing code modifications

Download from:
https://www.nationalgrideso.com/uk/electricity-transmission/future-energy/projects/distributed-restart/key-documents

one meetings with DER providers, DNOs and wider industry

Key Deliverable from Procurement and Compliance Workstream

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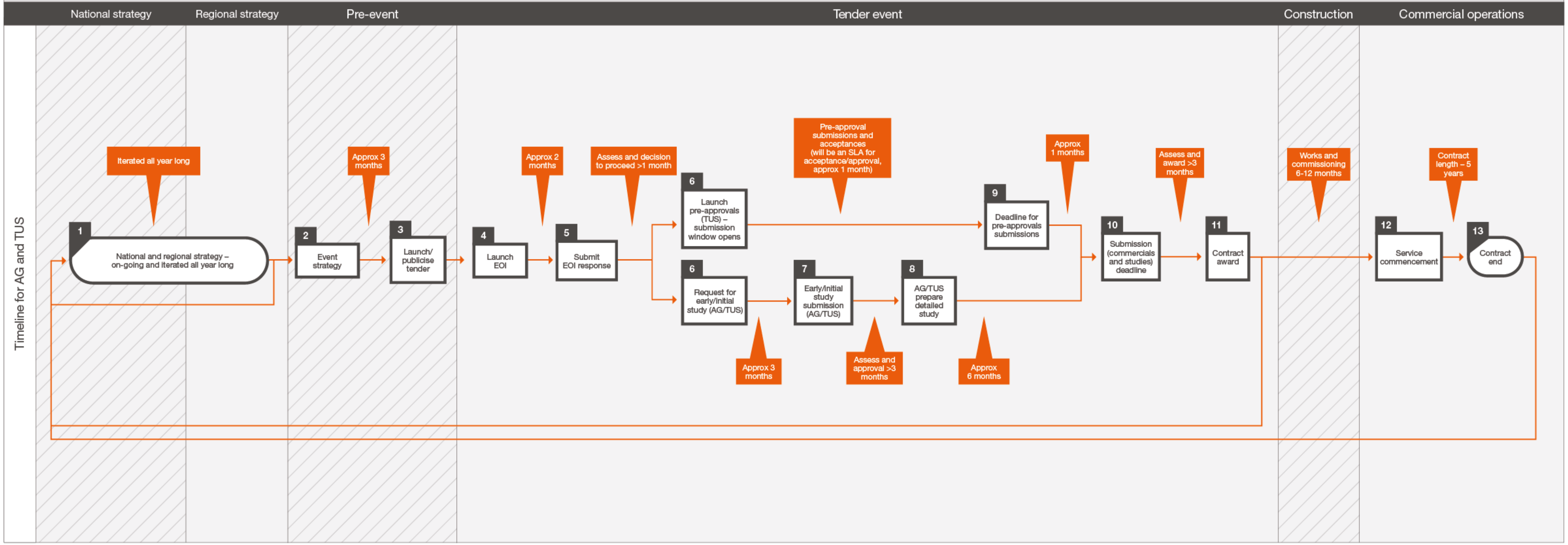
Distribution Restoration procurement process map



Roles of the DNOs in this procurement process:

- Input/run regional strategy
- Be involved in assessing tender submissions at each stage
- Feed into the combined assessment
- Engage with all relevant parties to agree DRZ Plan
- Complete any enabling works/ commissioning assessments
- Be involved with in-contract assurance /testing

Our final recommendations following stakeholder and DNO engagements

Procurement Lead:

ESO to lead until an industry decision is made, then handover accordingly

Section 3.3 in the P&C final report

Settlement & Funding:

ESO to pay DER contracted costs but DNO to recover their network upgrade costs through price control

Section 9 in the P&C final report

Contracting:

Open and transparent Tripartite contract between ESO, DNO/DSO and DERs – both AG and TUS

Section 10 in the P&C final report and Appendix 2

Codes:

Recommendations will be reviewed as part of the GC0156 code modification process

Section 12 in the P&C final report and Appendix 3

The options, criteria, stakeholder engagement and decisions are elaborated in the P&C final report

Next Steps: Transition of Process to ESR BAU Tenders in 2022

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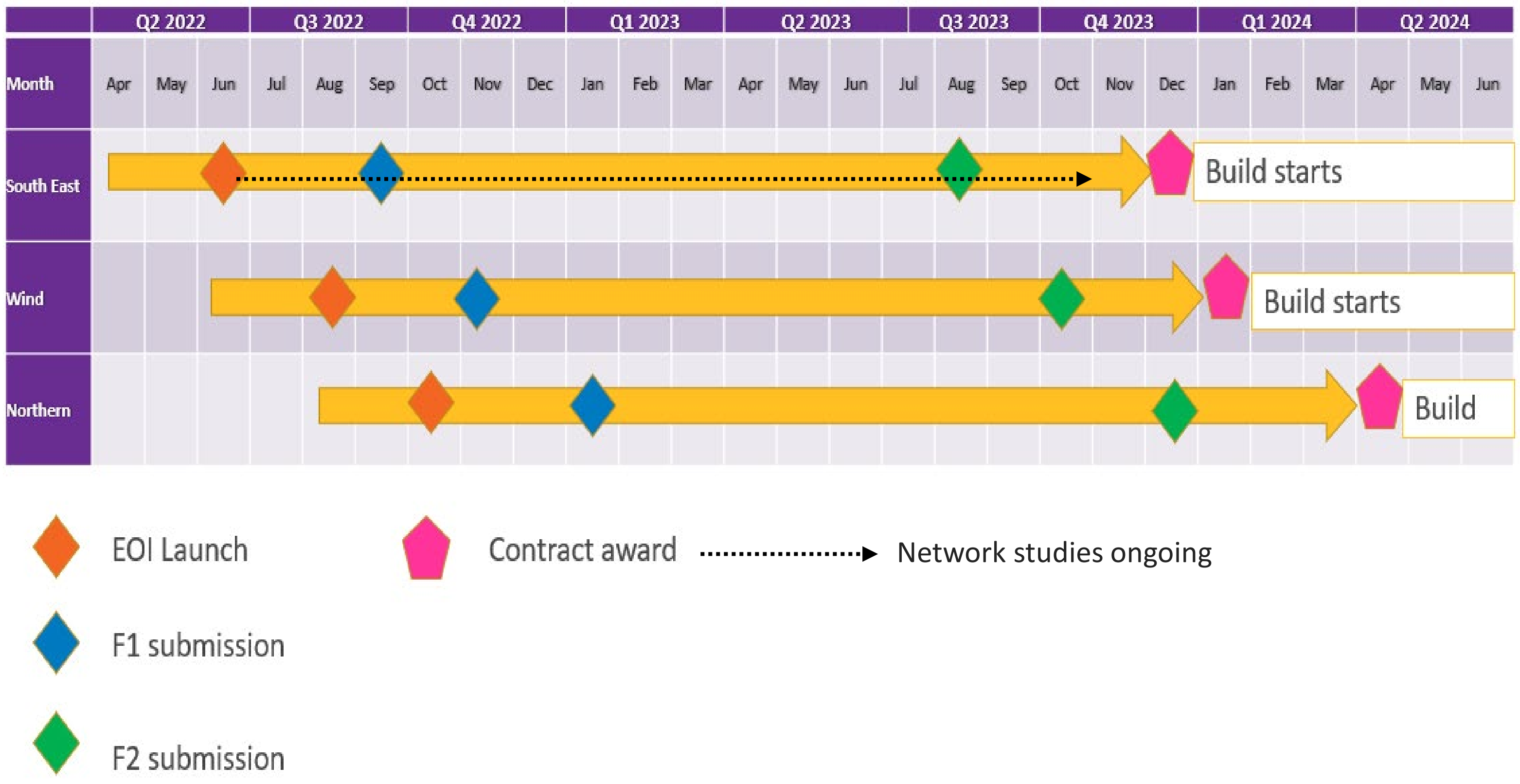
ESR tender rollout plan for 2022 – Including DER for Distribution Restoration

- South East Region – EOI in June 2022, Service go-live in Jul 2025
- Wind Nation-wide – EOI in Aug 2022, Service go-live December 2026 or 2028
- Northern Region – EOI in Oct 2022, Service go-live in Nov 2025
- DNO Collaboration ongoing
- EOI results have surpassed our forecasts
- Ofgem and BEIS are kept well-informed throughout the processes



Final thoughts

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Q&A

Colin Foote and project team

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