DSOF Roundtable Sessions & NIA Project Call Event

25th January 2018

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Network Strategy & Innovation within WPD

Benjamin Godfrey, Network Strategy Team Manager

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Today's Agenda & Format

Tea & Coffee throughout

13.00pm Lunch

- **Welcome & Housekeeping**
- **Network Strategy within WPD**
  Ben Godfrey, Network Strategy Team Manager
- **Distribution System Operability Framework**
  Oliver Spink, Network Strategy Engineer
- **Network Monitoring Roundtable**
  David Tuffery, Network Strategy Engineer
- **Fault Level Management Roundtable**
  Clive Goodman, Network Strategy Engineer
- **Flexibility Roundtable**
  Ben Godfrey, Network Strategy Team Manager
- **Innovation Strategy & NIA Project Call**
  Jonathan Berry, Innovation & Low Carbon Networks Engineer

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Network Strategy

WPD's Network Strategy team is responsible for a number of key outputs, contributing to the efficient and economic development of the network from five years out and beyond.

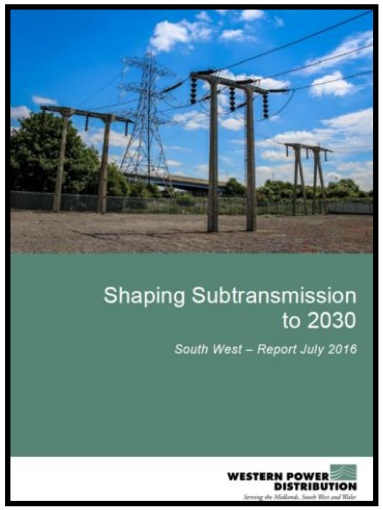
Our main focus topics are:

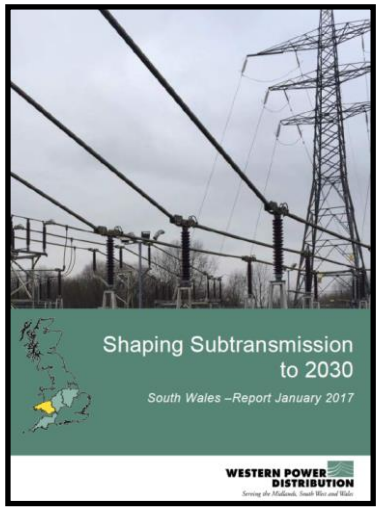
- Developing advanced modelling techniques to inform strategic studies.
- Alignment of our strategic studies with National Grid's FES work.
- Progression of a joint WPD/NGET Regional Development Plan for the network in the South West.
- National work on developing the technical interface between NGET and DNOs through ENA's Open Networks programme.
- Delivery of WPD's Distribution System Operability Framework documents.
- Development of WPD's strategy to enable transition to a DSO.
- Co-ordination of the responses to Government, regulator and external stakeholder consultations on DSO vision and strategy.

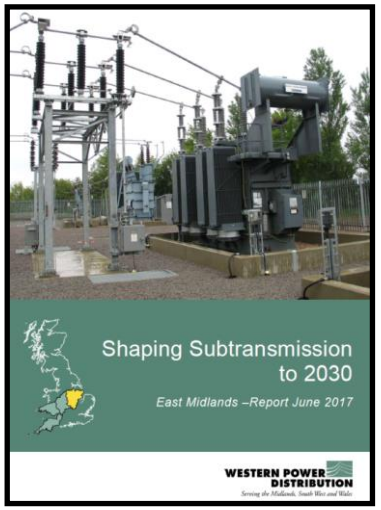
WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

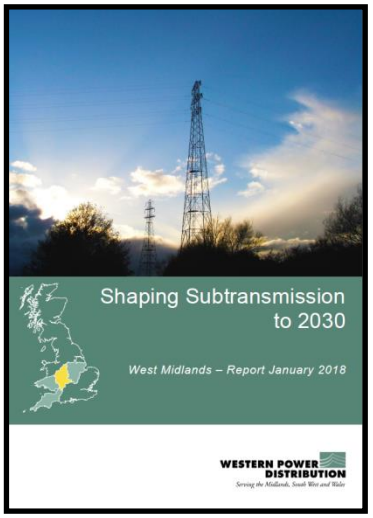
Strategic Investment Options

Western Power Distribution has been undertaking analysis on long term strategic studies, to better understand the potential growth in the connection of distributed generation (DG) and energy demand in all its licence areas, and how that future growth may impact on the network.







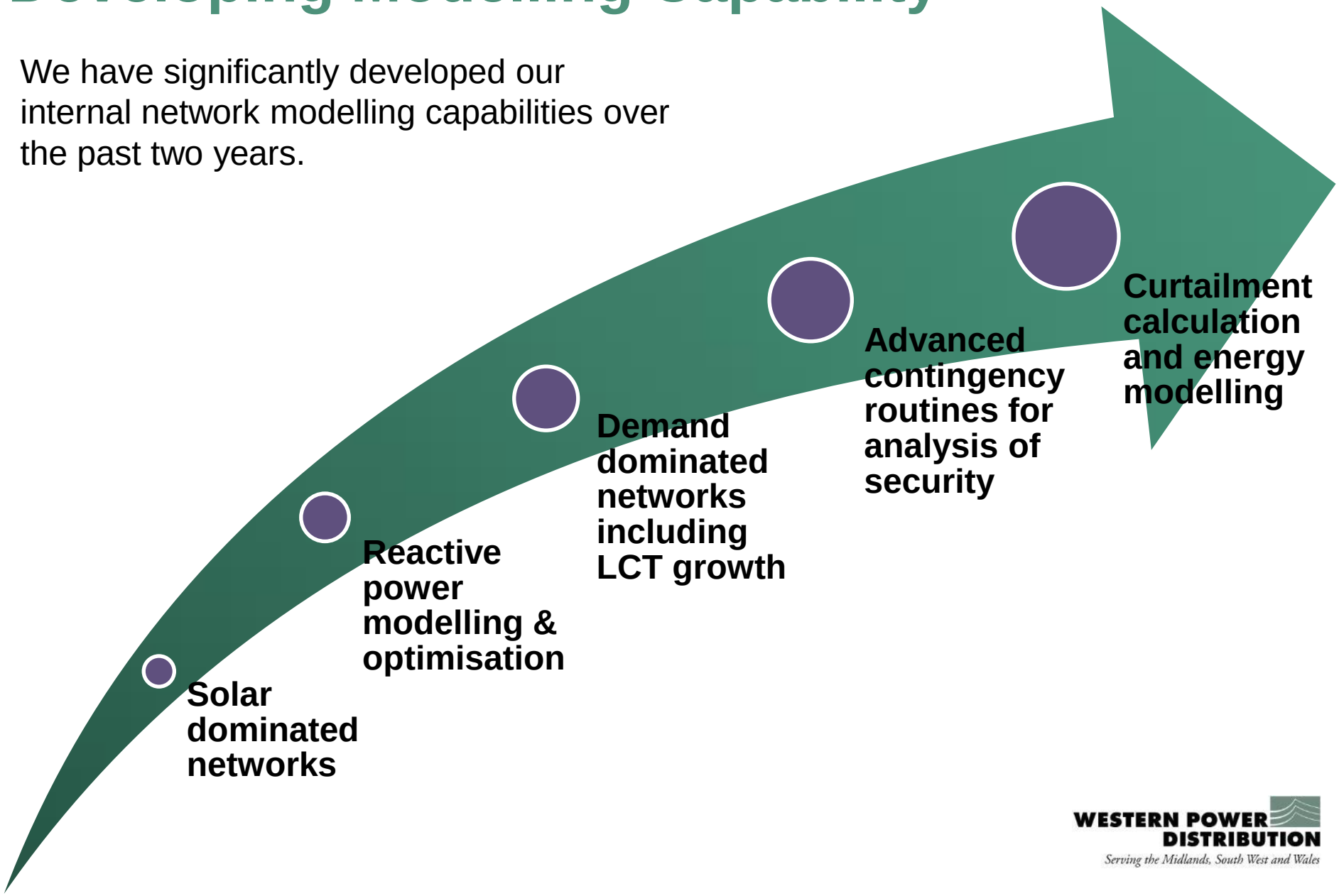


Every 6 months we publish a strategic investment study report on one of our four licence areas.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Developing Modelling Capability

We have significantly developed our internal network modelling capabilities over the past two years.



WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

NG/WPD Regional Development Programme

National Grid and WPD are collaborating on a joint Regional Development Programme, focussing on transmission and distribution networks in the South West.

- Sharing of existing data and network models on a more granular basis.
- Collaborative design of whole system modelling studies, covering steady state thermal, voltage and fault level.
- National Grid to share dynamic modelling techniques.
- Covers three scenarios:
  - 2020 3GW
  - 2025 4GW
  - 2030 5GW

- **Future network requirements** will be modelled and solved using both conventional reinforcement and compensatory curtailment.
- Collaborative **Whole System Network Options Assessment** will be trialled.
- Processes, methodologies and results to be documented for external publishing.
- **Programme to report in March.**

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

NG/WPD Regional Development Programme

- ✓ Quicker connections
- ✓ Cheaper connections
- ✓ Access to existing markets
- ✓ Development of new markets
- ✓ Enabling more DG & LCT through flexibility

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Recent Network Strategy Publications

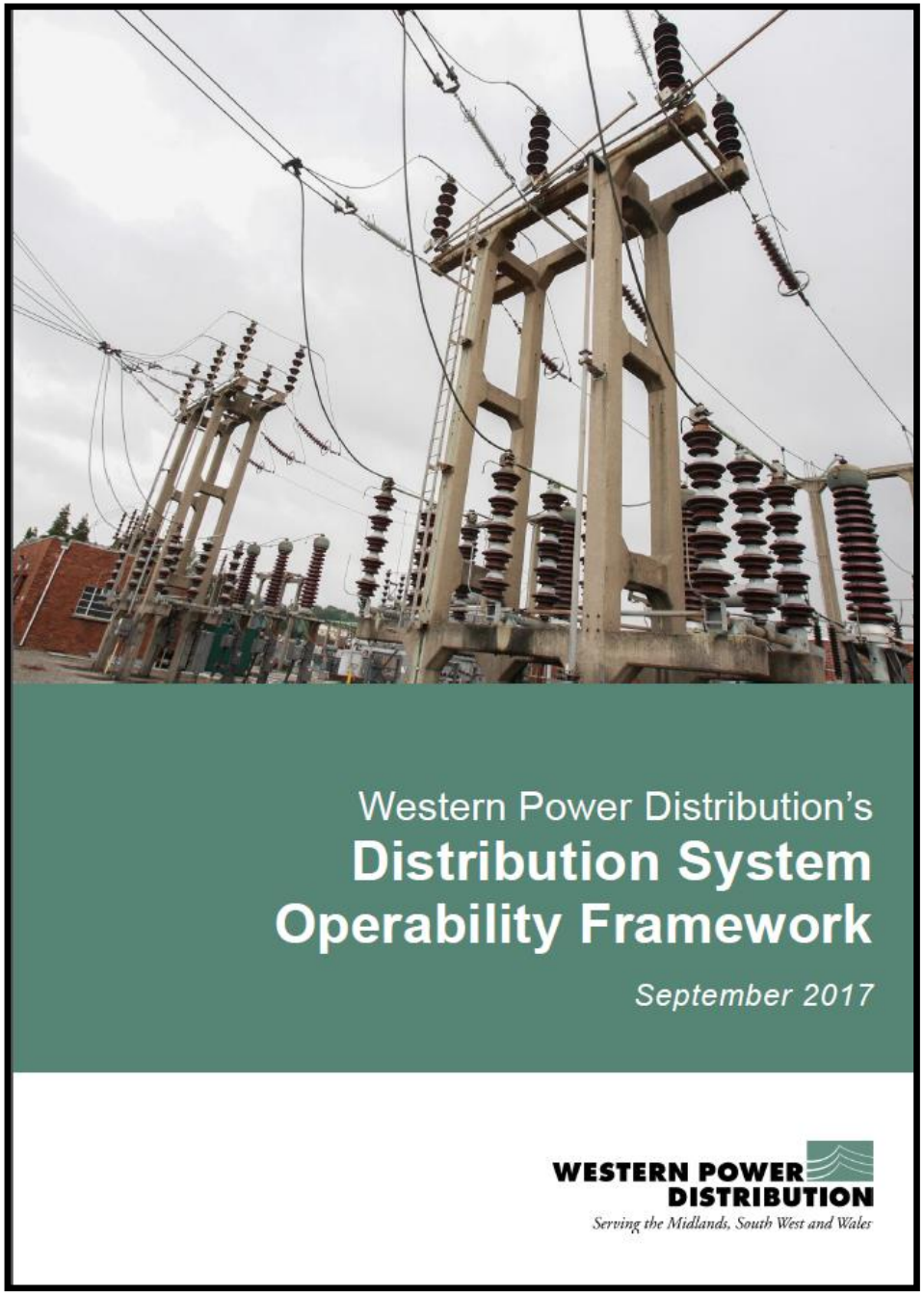
- **Distribution System Operability Framework (DSOF)**
  WPD's DSOF document aims to stimulate wider collaboration with industry, adjacent sectors and other key stakeholders by expanding on some key issues and challenges facing distribution network operators.

- **Energy Storage Growth Scenarios & Operating Modes Consultation**
  This consultation sought to understand the potential scale of growth of energy storage, the type of energy storage assets/projects that are likely to be deployed within its network and the typical operating behaviour of storage assets. The results report was published in August.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Distribution System Operability Framework (DSOF)

Oliver Spink, Network Strategy Engineer



Aims and Objectives

The DSOF aims to highlight some of the technical and commercial challenges facing Distribution Network Operators as they become Distribution System Operators.

The challenges are presented as subject articles in the three core areas which are identified in WPD's business plan:

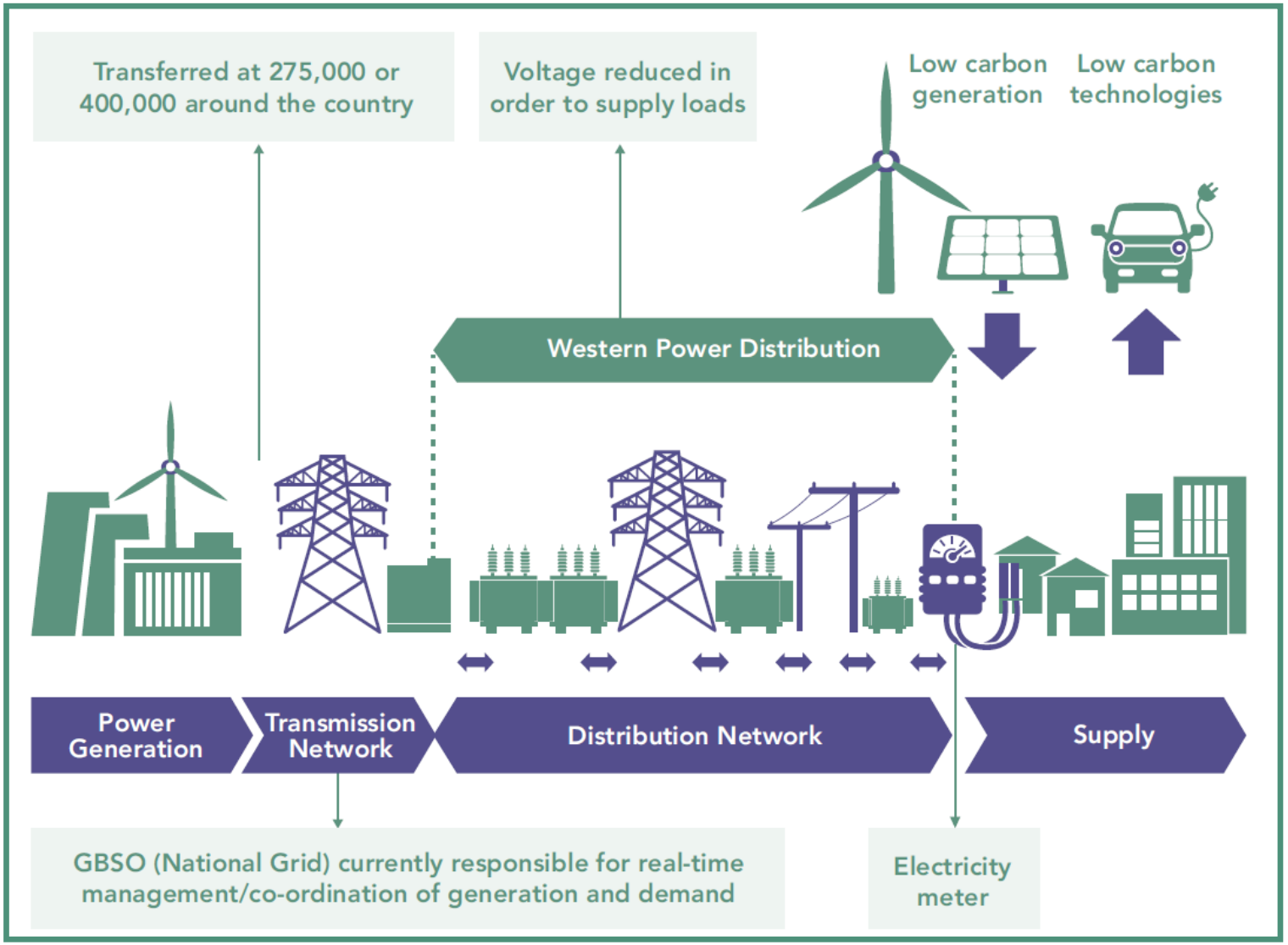
Assets	Network Operations	Customers
Analysing data, enhancing modelling techniques and testing alternative connection strategies.	Demonstrating the direct benefits from smart grids for network performance and service delivery.	Developing new technologies and solutions to meet customer's needs, such as enabling the connection of Low Carbon Technologies (LCT).
Articles: 1. Network Modelling and Analysis 2. Network Monitoring and Visibility 3. Data and Forecasting	**Articles:** 1. Fault Level Management 2. Arc Suppression Coils 3. Low Frequency Demand Disconnection	**Articles:** 1. Flexibility Services 2. Changing Demand Profiles 3. Power Quality

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

DSOF Themes

Changing Electricity Network

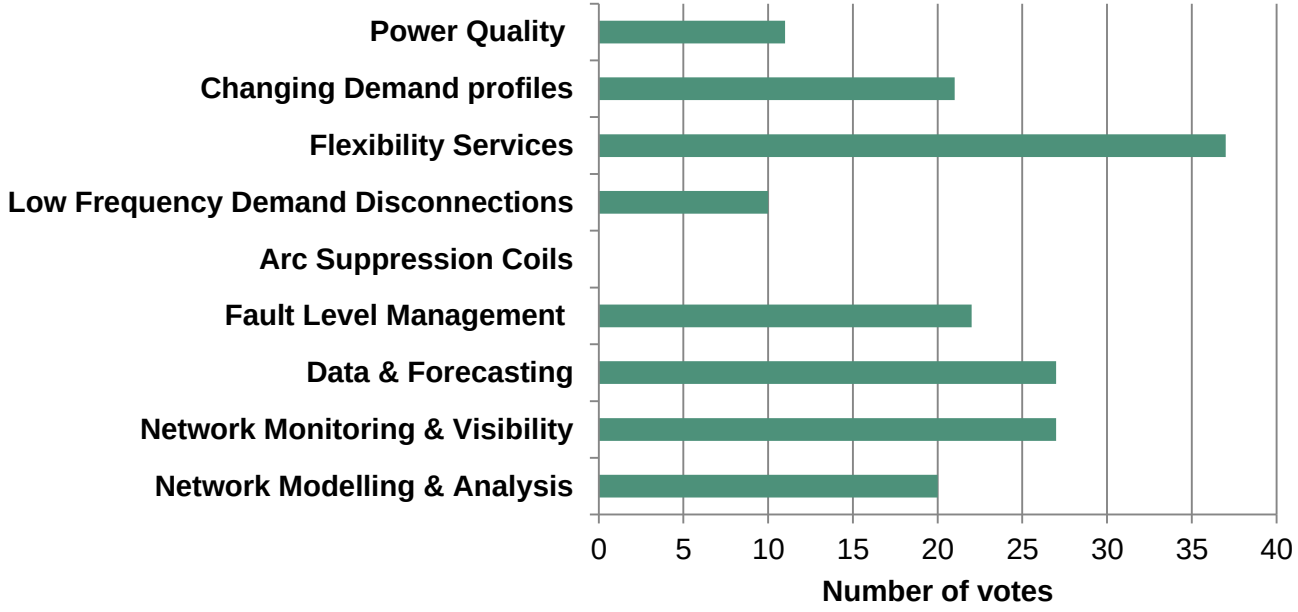
DSO Transition



Focus For Today

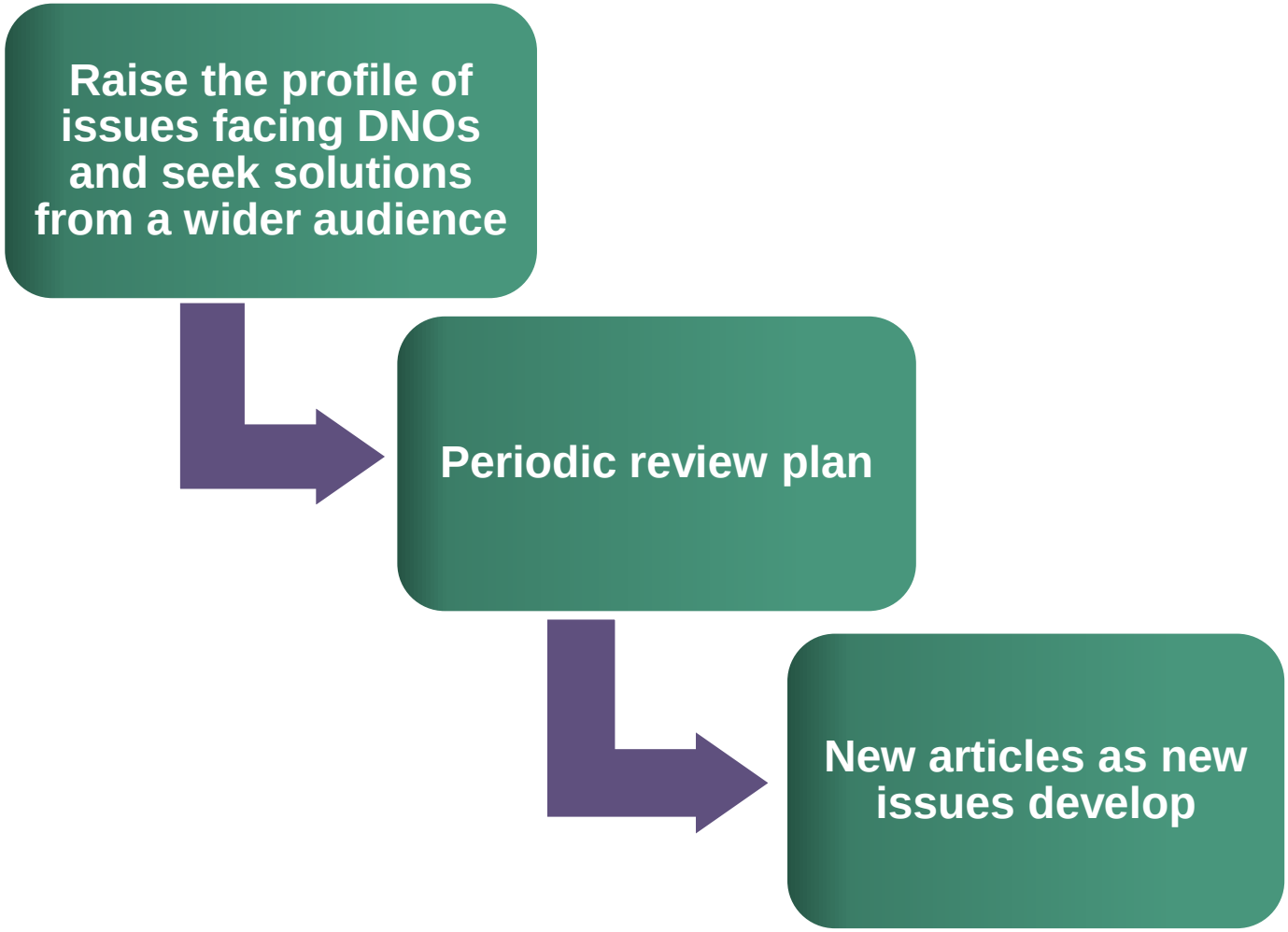
- Three topics presented on:
  - Network Monitoring & Visibility
  - Fault Level Management
  - Flexibility Services

- Roundtable discussion and questions
- WPD's Innovation Strategy & NIA Project Call



WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

DSOF - Next Steps



WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Network Monitoring and Visibility

David Tuffery, Network Strategy Engineer

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Existing Monitoring and Visibility

The type of monitoring that is typically installed on the network:

- Voltage and current measurements
- Real and reactive power flow measurements
- Switchgear status, operations and failures
- Transformer tap positions
- Protection operations

Factors that influence the level of monitoring and visibility:

- Voltage level
- Geographic location
- Network topology

For remote monitoring and control a reliable and secure communication medium is needed. Typical communication mediums are Microwave, Radio and Fibre.

Drivers For Improved Monitoring

Operational

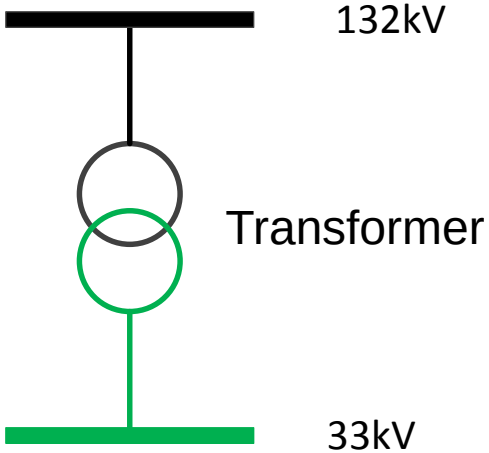
- Rolling out smart grid network solutions and smart grid alternative connection solutions
- Higher confidence in pre-fault and post-fault network conditions
- Improve network security and reliability

Design

- Enables accurate modelling of the network
- Ability to assess traditional reinforcement options against non build solutions
- Looking to determine generation and demand coincident and persistence factors
- New systems and innovation projects requiring additional data

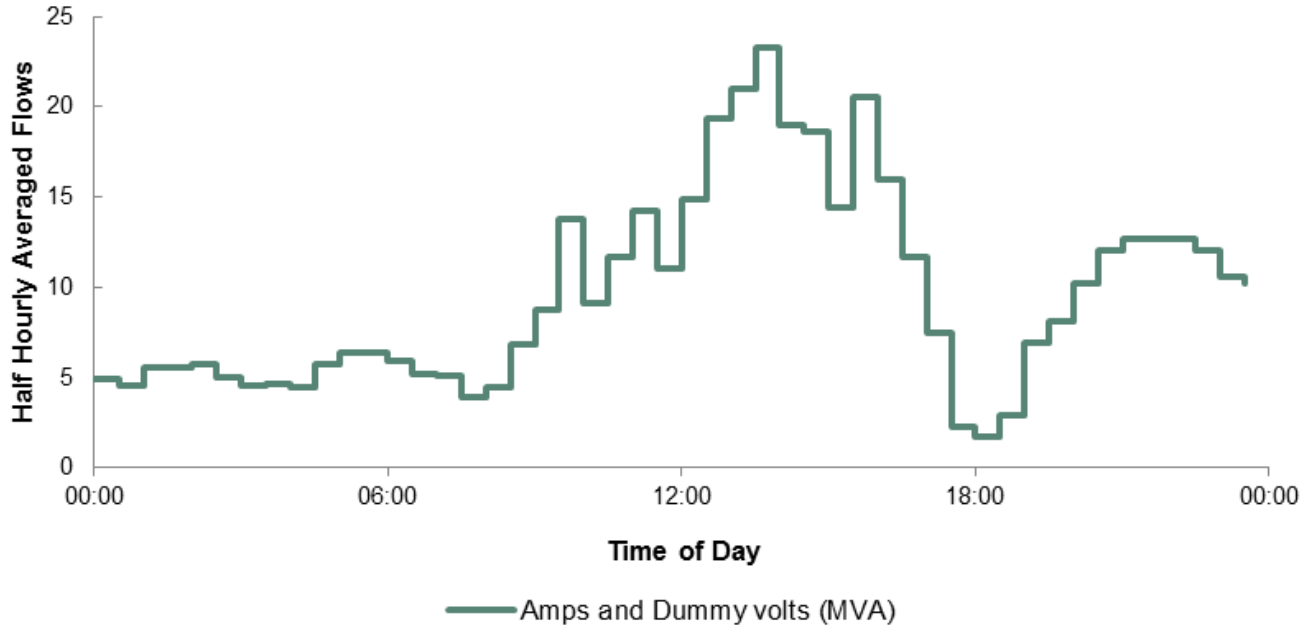
Directional Powerflow Example

This example highlight why the type of monitoring installed is becoming increasingly important to design and operate a network

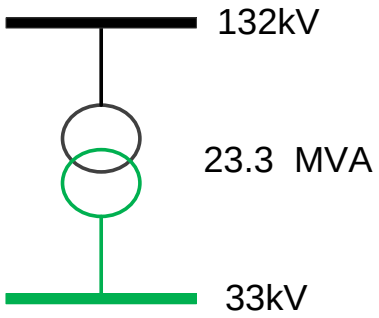


Method	Precise MVA value	Direction available	Real (MW) Component	Reactive (MVAr) Component
Amps and assumed Volts	No	No	No	No
Volts and Amps	Yes	No	No	No
Derived MW and MVAr	Yes	Yes	Yes	Yes

Amps and Assumed Volts



At 13:30 to 14:00 half hourly averaged power flows as seen with Amps monitoring (dummy volts)



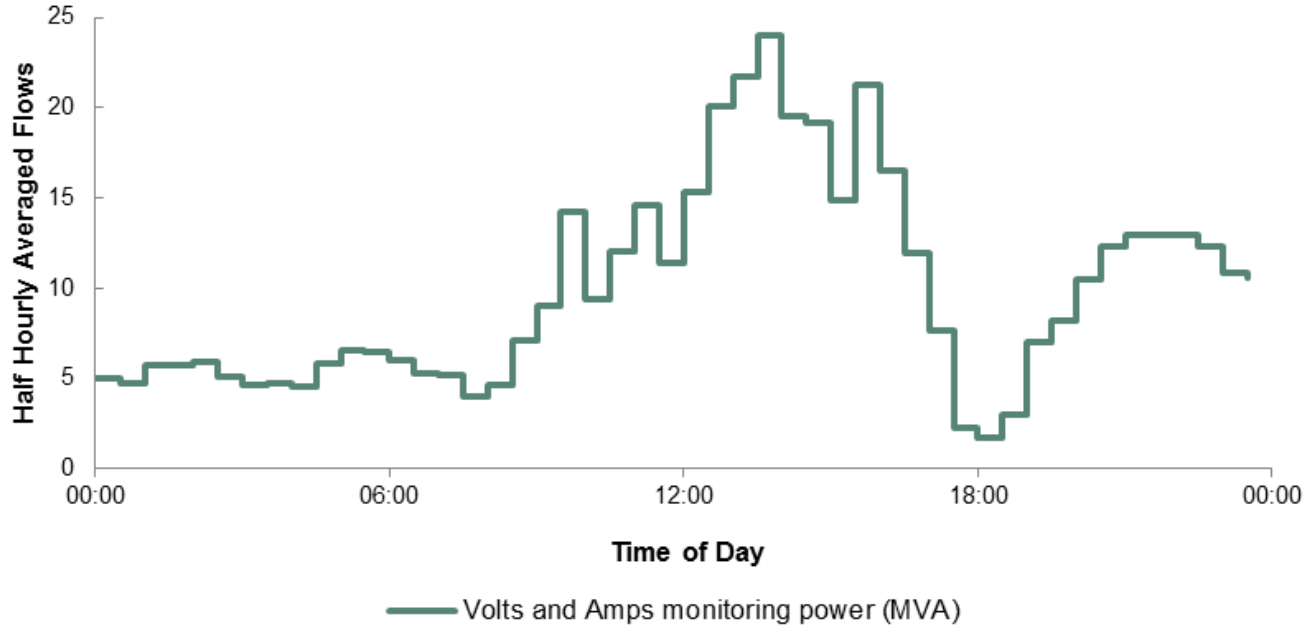
No Direction information

No MW and MVAr component

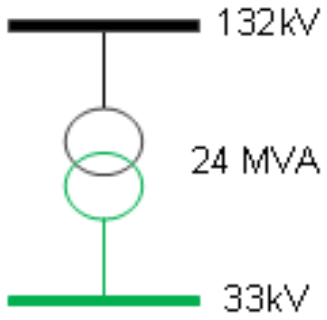
No Power Factor information

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Amps and Volts



At 13:30 to 14:00 half hourly averaged power flows as seen with Amps and Volts monitoring



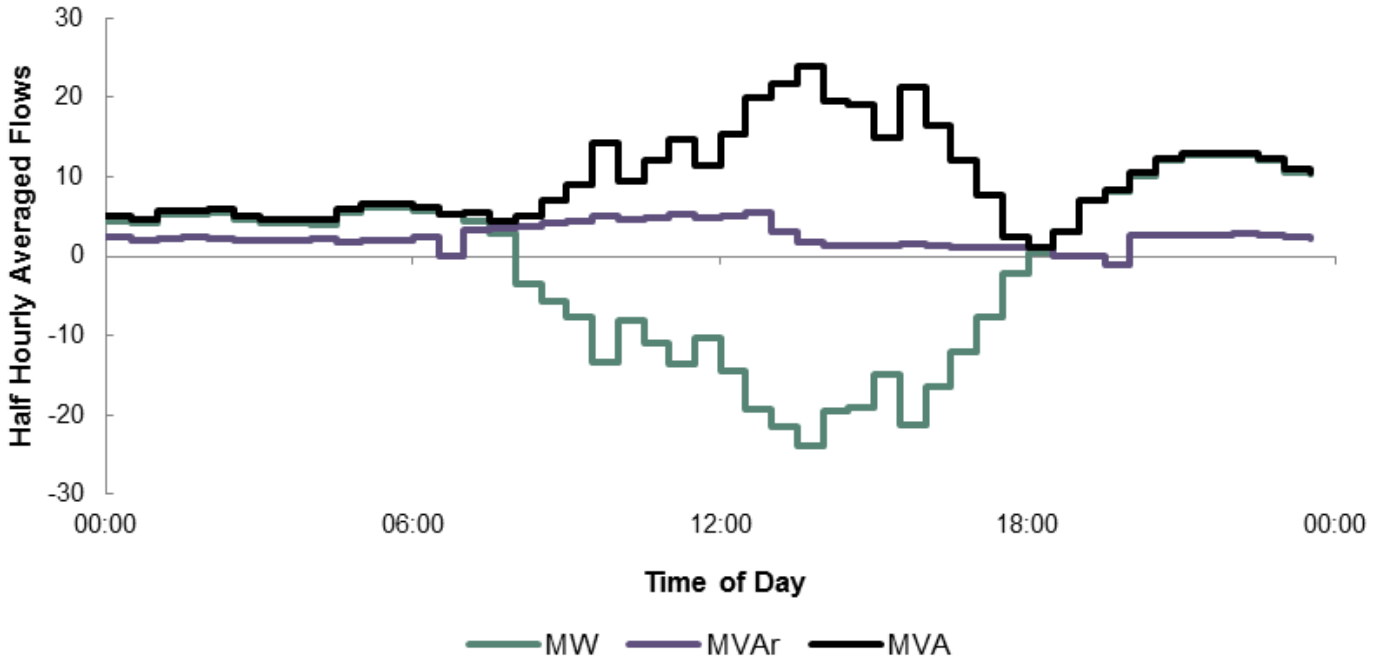
No Direction information

No MW and MVAr component

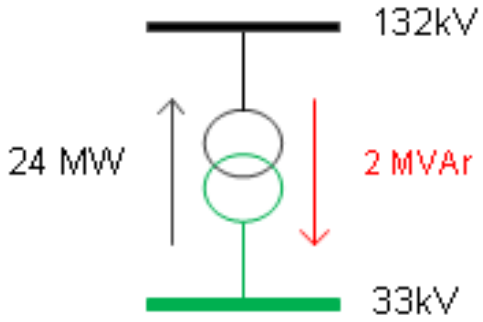
No Power Factor information

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

MW and MVAr



At 13:30 to 14:00 half hourly averaged power flows as seen directional MW and MVAr monitoring



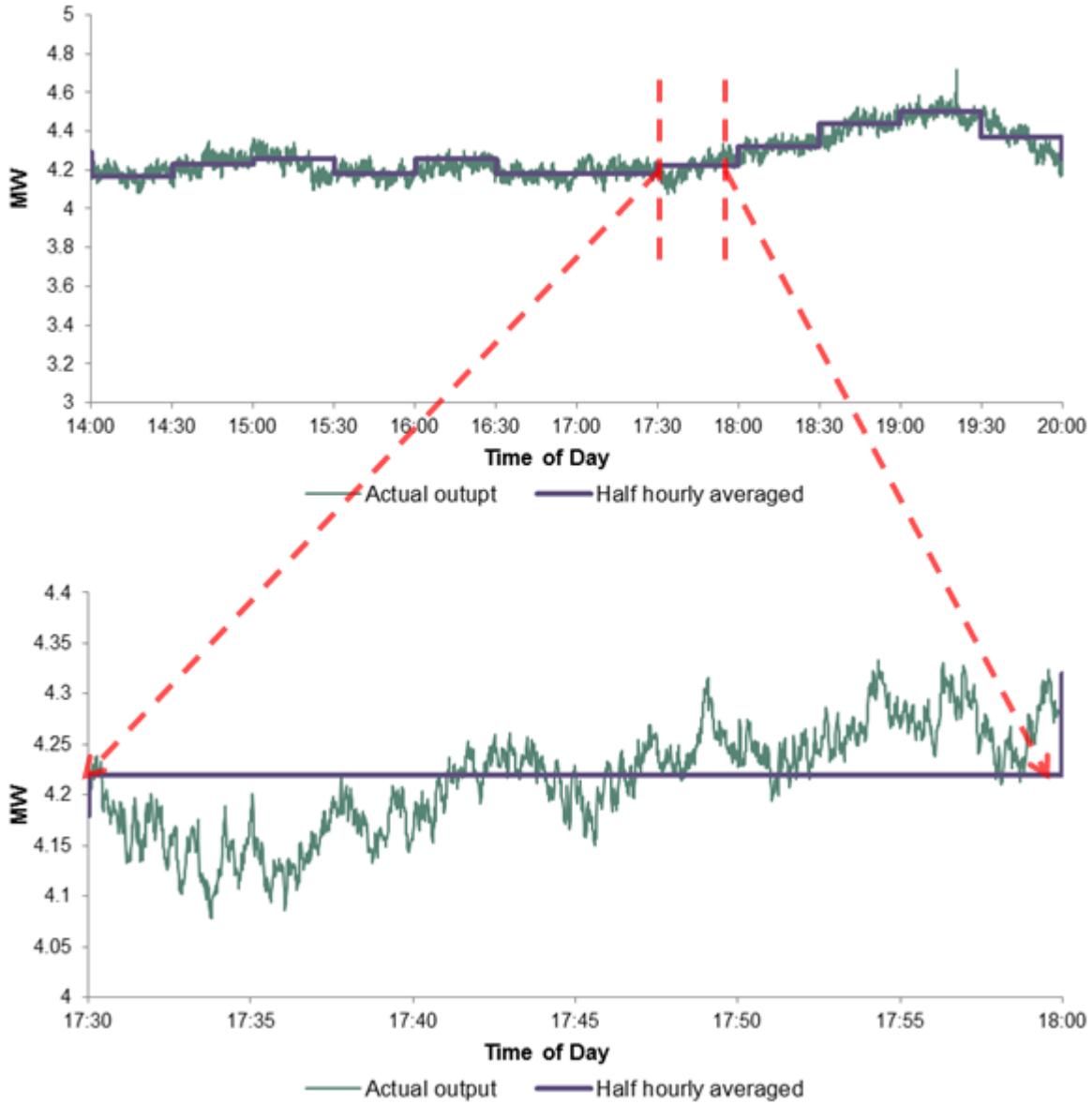
Direction information

MW and MVAr component

Power Factor information

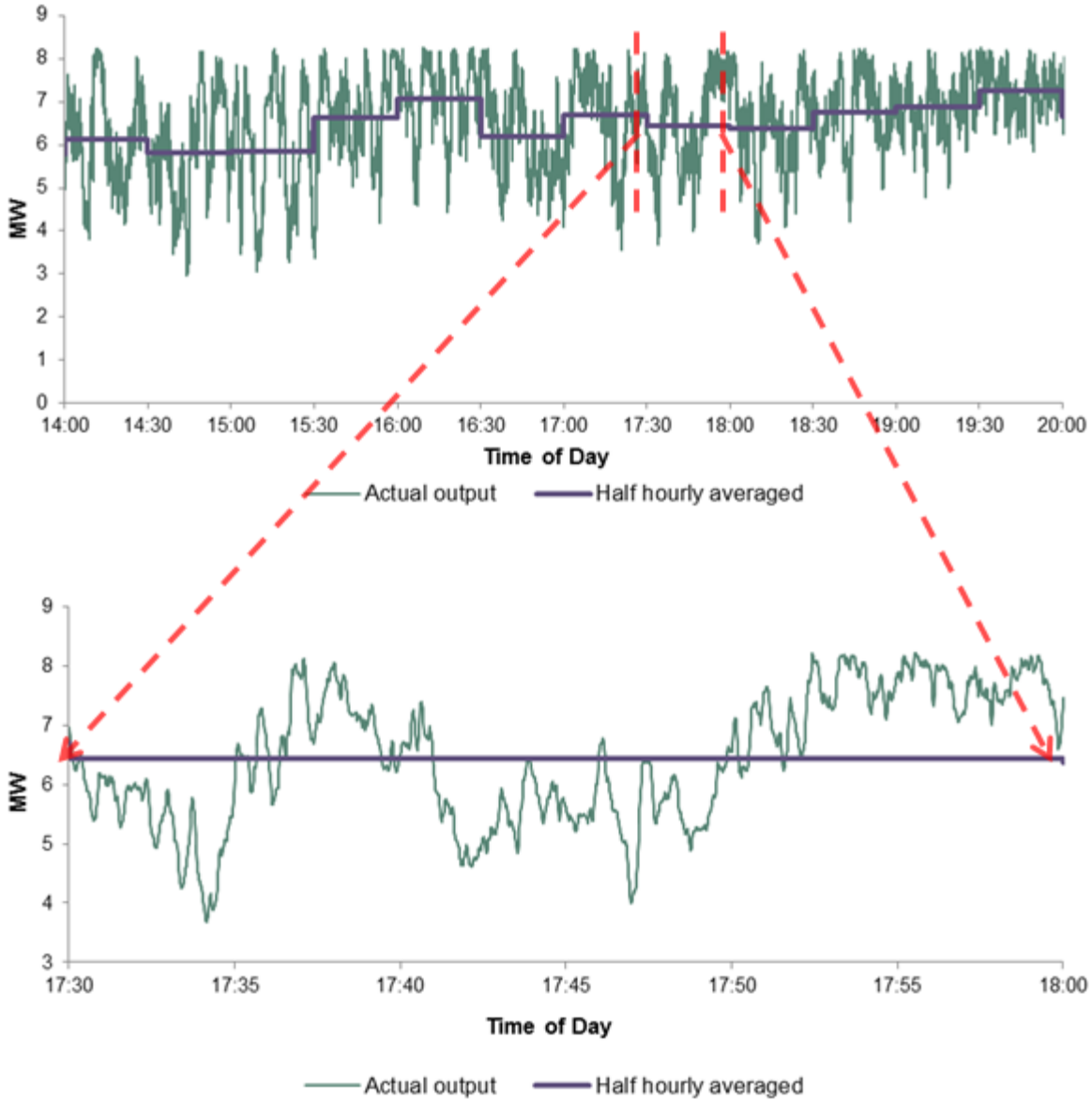
WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Granularity of Data – Demand Dominated



WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Granularity of Data – Generation Dominated



WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

What We Are Doing?

- Proactively investing in network monitoring
- A combination of retrofitting existing monitoring and installing new monitoring and control
- A recent investigation has identified sites across all four WPD licence areas that are in need of full MW and MVAr monitoring, due to likely reverse power-flow or faulty equipment
- WPD expect this trend to continue, with the rollout of monitoring and control equipment proliferating down the voltage levels, with the LV being the last to get detailed monitoring and control
- Looking at implementing new systems that have the ability to record all instantaneous data
- Ensure the communication system does not impede network development, a collaborative approach will be taken when engaging Office of Communications (Ofcom)

Round Table Discussion

Questions:

1. **Is half hourly averaged data still sufficient to design a network?**

2. **What level of monitoring will be required on the LV network and at how quickly will it be needed?**

3. **Where is the balance between conservative design assumptions and investment in additional monitoring equipment?**

4. **What information would need to be made publically available for WPD to signpost areas with network constraints with the aim of contracting services?**

5. **Do you see the communication infrastructure being a constraint on smart grid development?**

6. **What additional monitoring may be required in the future?**

Fault Level Management

Clive Goodman, Network Strategy Engineer

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Fault Level Management

Fault Level can be defined as a measure of the current (or power) which flows in a circuit due to a fault and is measured in kA (or MVA). When a fault occurs on the transmission or distribution system, the current which flows into the fault will be derived from a combination of three sources**:**

- Major generating stations via the transmission and distribution networks (i.e. system derived fault current);
- Embedded generators connected to the local network; and
- Conversion of the mechanical inertia of rotating plant equipment connected to the system into electrical energy.

Importance of Fault Level Management

Fault levels must be managed carefully to ensure that:

- Switchgear and other equipment are not overstressed and at risk of failure during faults
- Dangerous voltages do not occur during earth faults.
- Protection schemes operate correctly in the event of faults
- A high level of power quality is supplied to customers

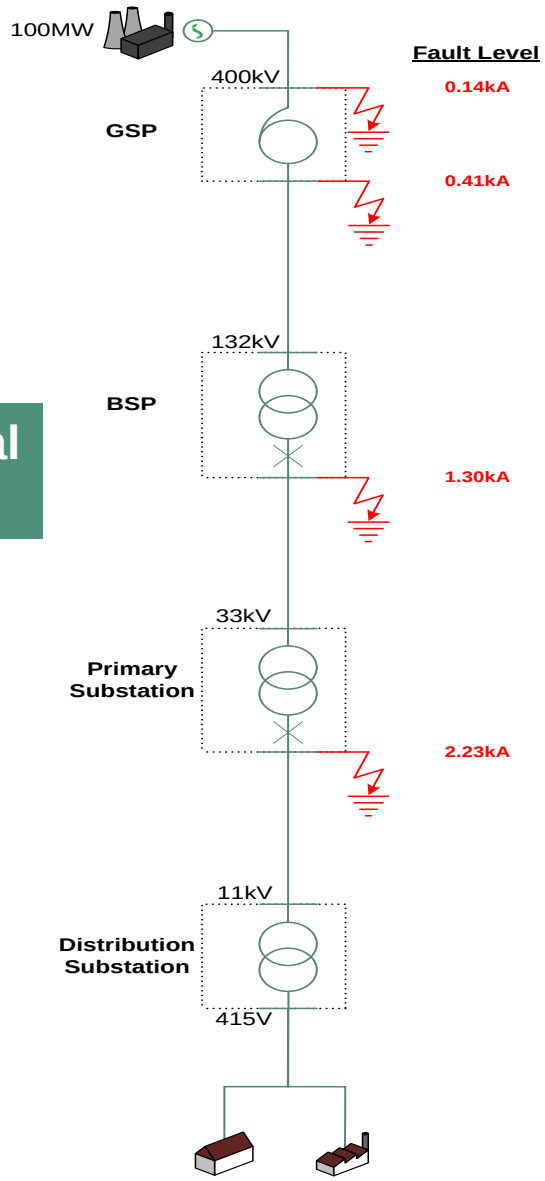
Impact of Change in Generation Mix

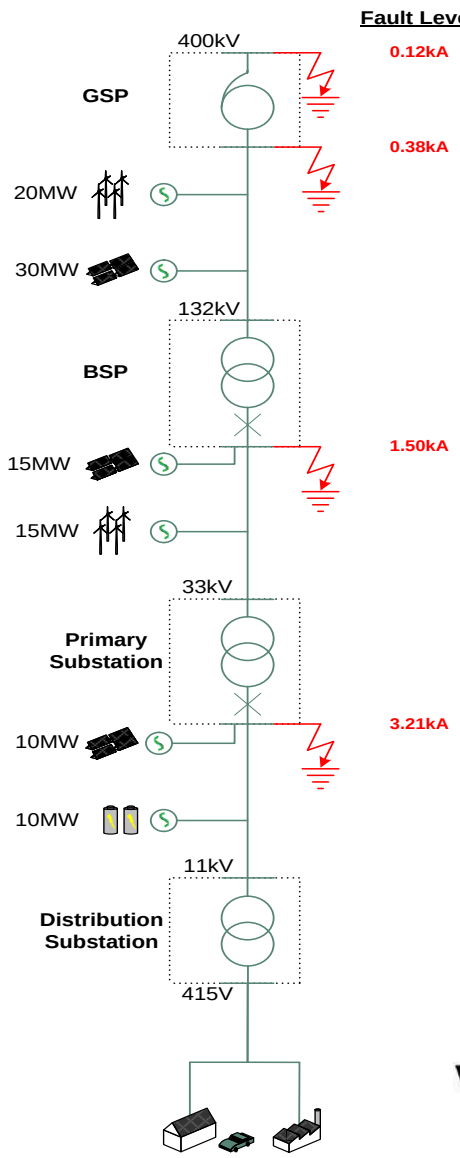
Shift in the generation mix in recent years:

- Decommissioning of synchronous generation on the transmission network resulting in the reduction of fault level infeed from the transmission system.
- Distributed generators utilising power electronic converters providing a lower fault current contribution compared to synchronous and asynchronous machines.
- Increased numbers of distributed generators has increased the number of points of fault infeed.
- Increased numbers of distributed generators has increased the average steady state fault levels on the distribution system (eg.11kV, 33kV, 66kV,132kV).

Impact of Change in Generation Mix

Traditional Network





Current Network

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Network Impacts

Switchgear Overstressing due to increased fault levels – safety & equipment damage

Protection grading margins more difficult to achieve with non-uniform increase in fault currents

Need to differentiate between Load and Fault current

Increased fault clearance times results in sustained fault currents being carried for a longer time – potential equipment damage

Protection Systems require a balance of selectivity, stability, speed, sensitivity & cost – Changes in the generation mix change this balance

Increased X/R ratios results in de-rating of switchgear- replacement of otherwise healthy equipment

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Network Solutions - Short Term

- **Switchgear Replacement – Costs, timescales**
- **Use of higher impedance Transformers (decrease fault level)– Cost implications of replacement & increase in network losses**
- **Use of current limiting reactors – whilst relatively cost effective additional effort to maintain the voltage profile and increase in network losses**
- **Network reconfiguration to increase impedance (decrease fault level) – increase in system losses, reduced power quality & security of supply**

Network Solutions - Long term

- **Enhanced assessment – improvement in network modelling to improve accuracy and understanding**
- **Real-time Management – monitoring (Steady State) & measuring (Faulted State)**
- **Mitigation technology – Reduction of system fault level using new technology that can limit the flow of short-circuit currents**

Round Table Discussions

Questions:

1. **What obstacles are there towards implementing Active Network Management for Fault Levels on the distribution network?**
2. **Our FlexDGrid project looks to monitor, model and mitigate the impact of Fault Level on our system – is this the right approach?**
3. **Is Fault Level monitoring and modelling sufficiently accurate at the moment?**
4. **Are the Fault Level mitigation techniques mature enough to deploy in UK networks?**
5. **To what extent will protection devices be affected and can they be adapted?**

Flexibility Roundtable

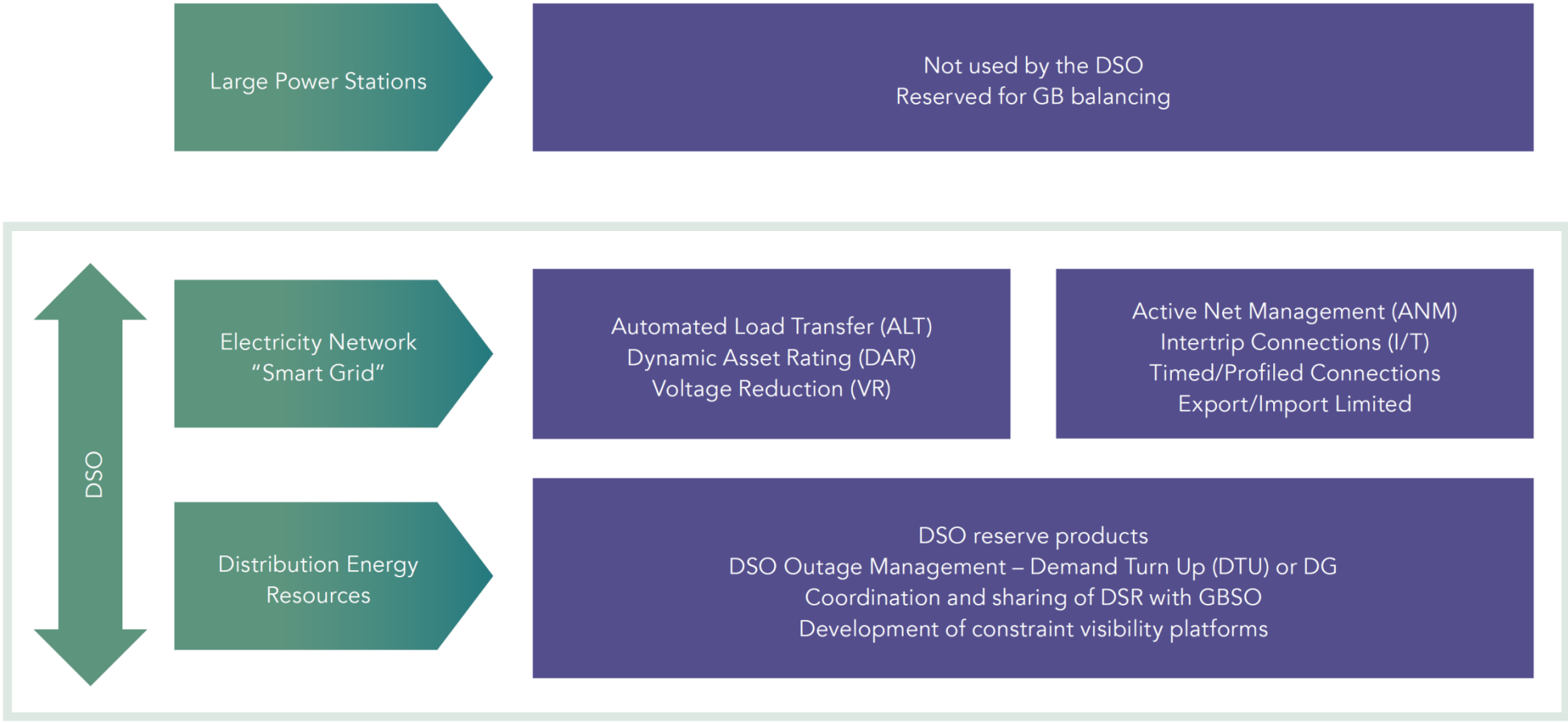
Benjamin Godfrey, Network Strategy Team Manager

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Electricity System Flexibility

Electricity System Flexibility can come from three sources:

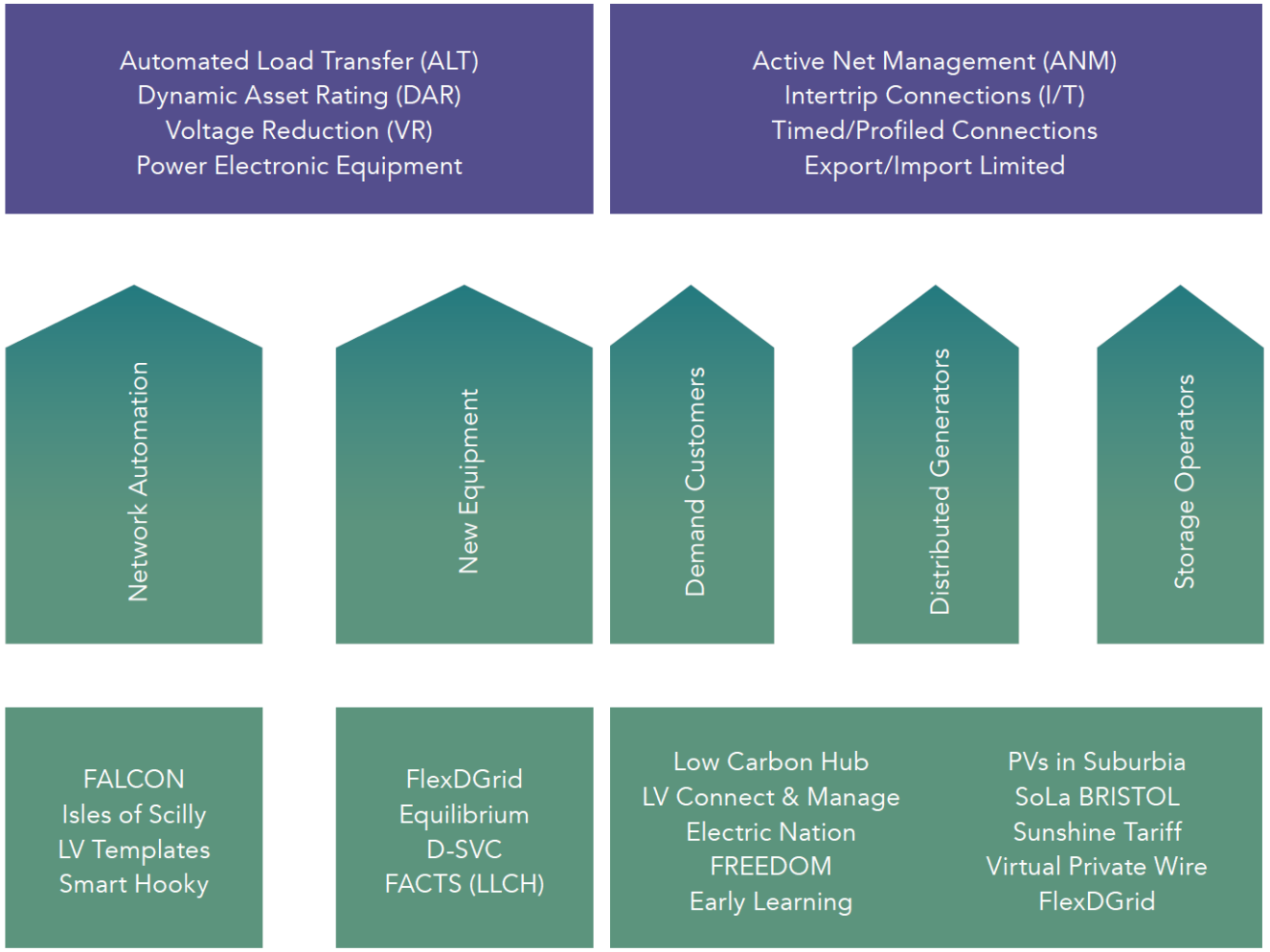


WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Distribution System Flexibility

Distribution networks can inherently provide flexibility and DSOs will play a central role in ensuring this source of flexibility is utilised, helping reducing whole system costs and keeping bills low for customers.

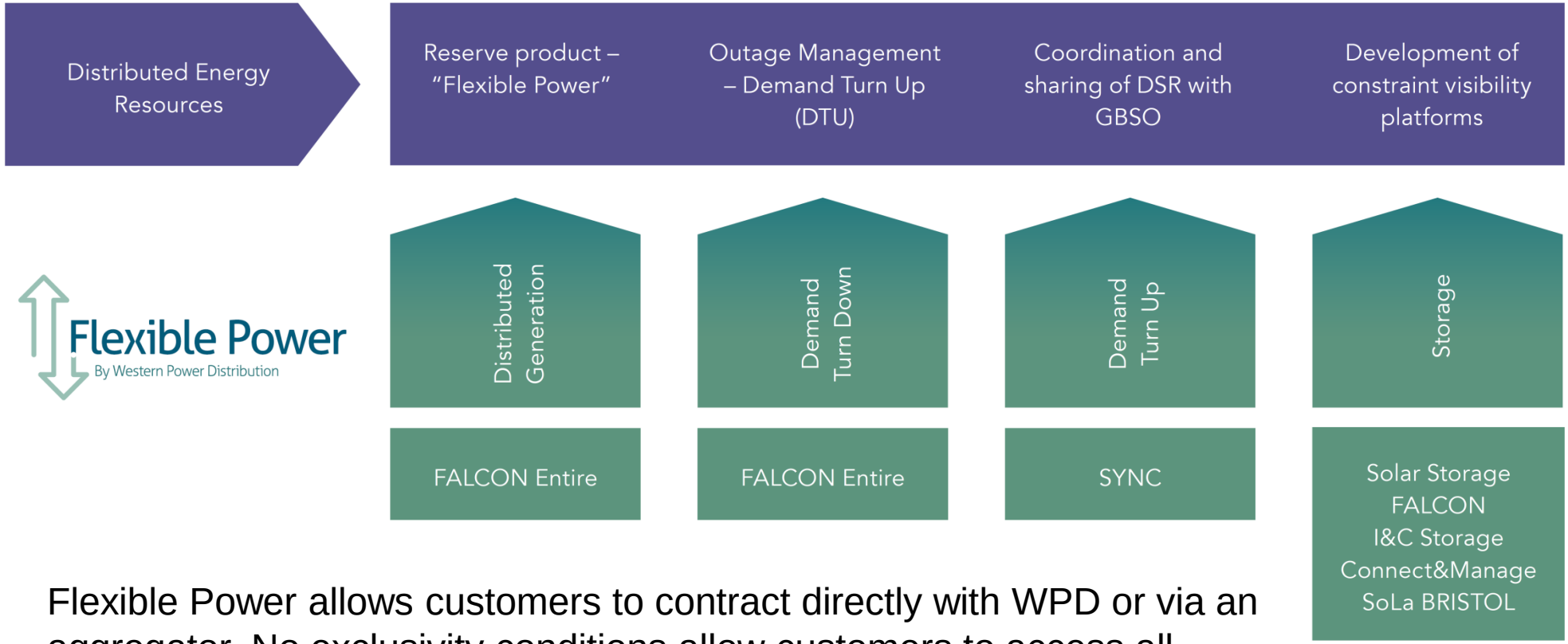
Many of these forms of flexibility have been explored by WPD within our Innovation Programme.



WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Customer Provided Flexibility

Consumers and businesses that invest in demand flexibility, storage or generation (that can offset local peak demand) could help reduce constraints and manage network costs.



Flexible Power allows customers to contract directly with WPD or via an aggregator. No exclusivity conditions allow customers to access all markets.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Facilitation of Flexibility Markets

WPD strongly believes that customer connected flexibility and distribution network smart grid flexibility can help alleviate both transmission and distribution constraints and contribute to releasing additional capacity on both the transmission and distribution networks.

There is significant value for both active and passive customers connected to the electricity network in maximising the usage of these flexibility sources where it is effective and economic to do so.

In order to economically achieve this, the greatest number of participants must be able to provide services across a number of market procurers.

- Facilitating accessibility to markets,
- Increased transmission and distribution co-ordination,
- Product/Service convergence,
- Signposting for services.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Facilitation of Flexibility Markets

During 2018 and 2019 WPD will begin to facilitate these new markets and empower our customers to provide benefits across the whole electricity system.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Efficient Whole System Flexibility

Whole system flexibility will delivered through markets with multiple routes, enabling customers to choose which procurers to provide to and allowing multiple revenue streams to be stacked.

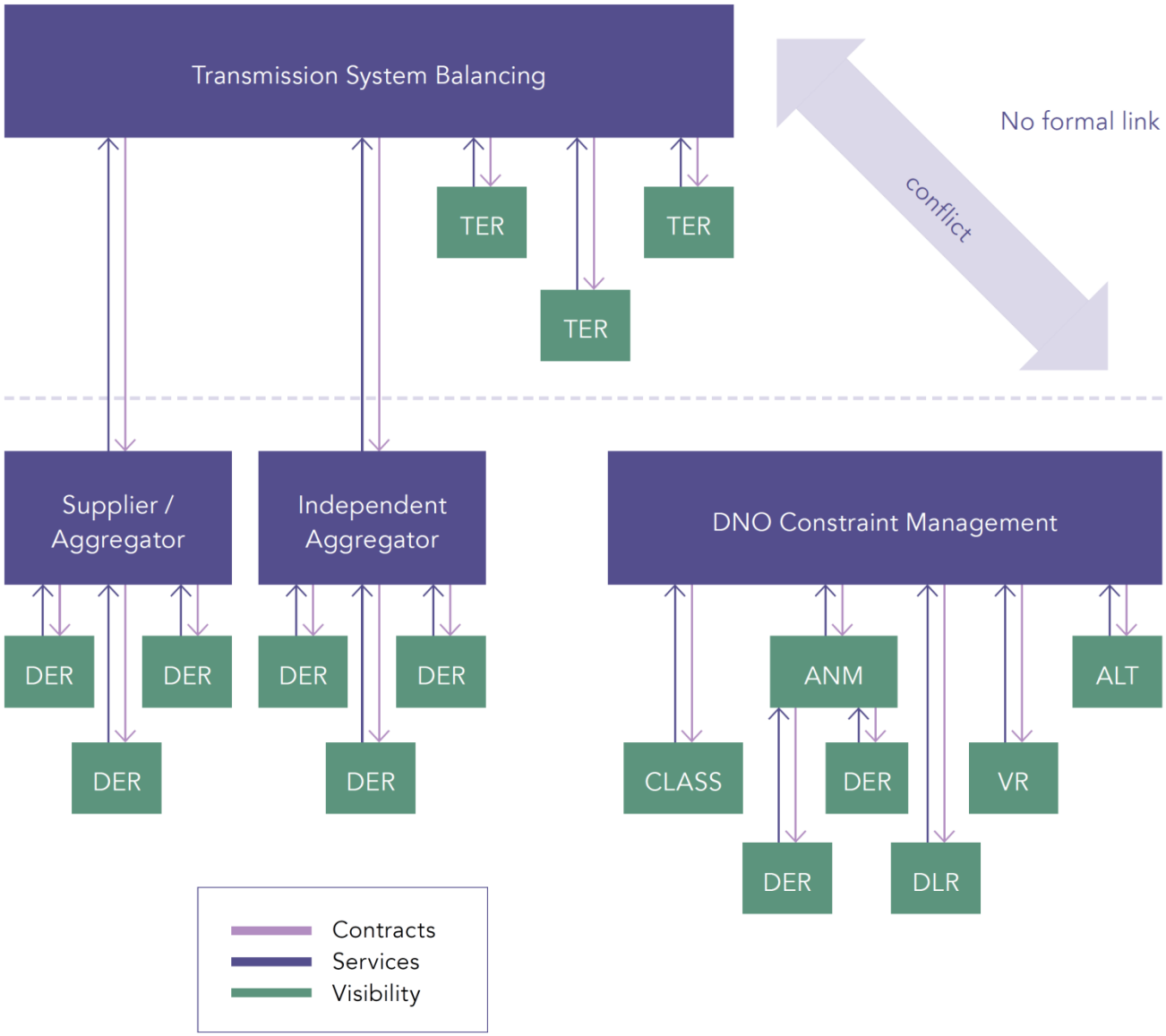
Co-ordination of these services and products will be key to ensuring conflicts are minimised and the electricity system remains efficient.

- DSO services will be regional specific, lower power and high energy.
- GBSO services will be nationwide, higher power and low energy.

It is likely that DSO services will be able to be combined and stacked to deliver required services for the GBSO. GBSO services are unlikely to be able to wholly resolve distribution constraints.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

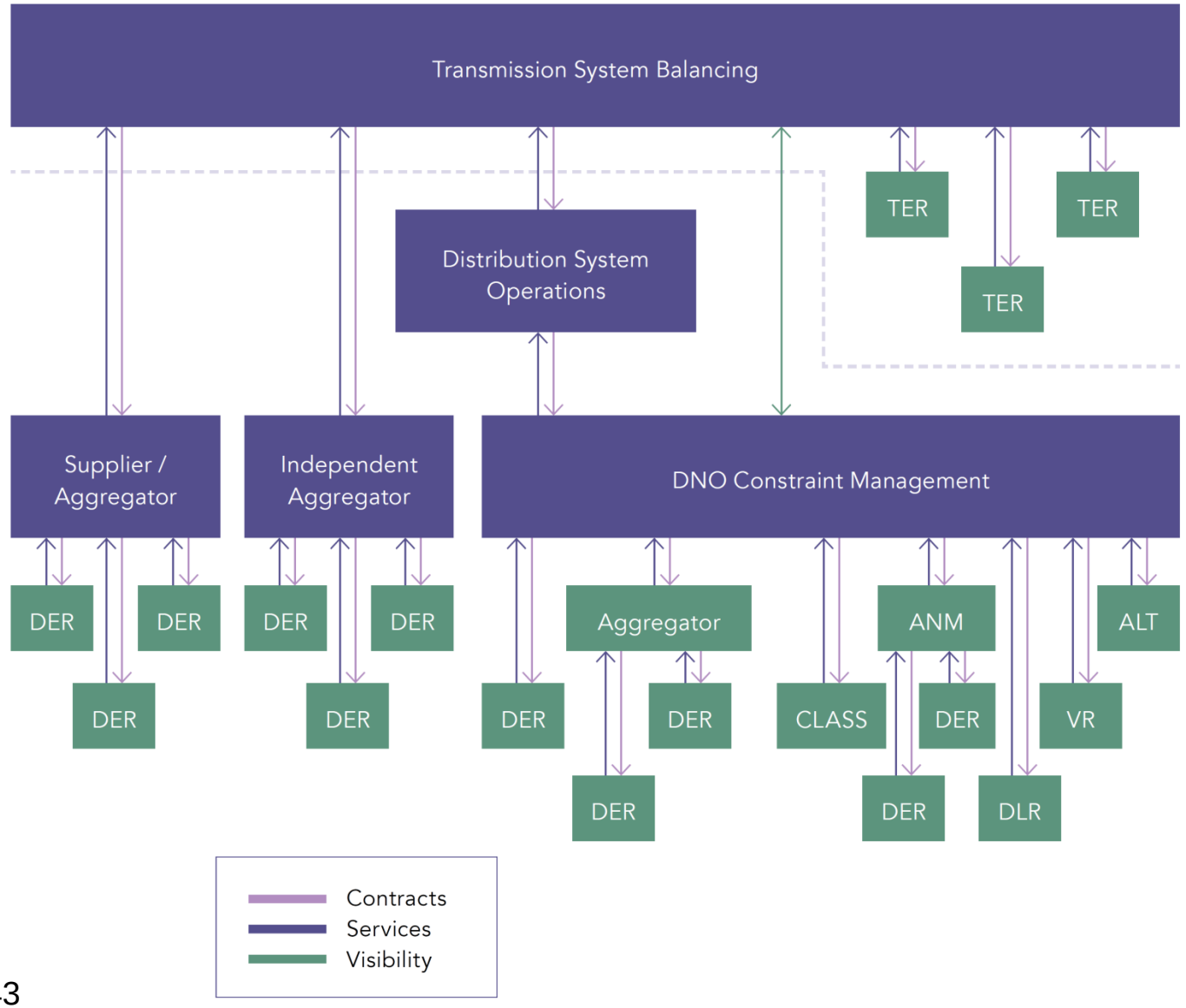
Current Market Model



In passive networks this model has proven most efficient, however as distribution networks become more active, the current market model for procuring and controlling flexibility begins to become more inefficient due to increasing conflicts between System Operator actions and distribution constraint management.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

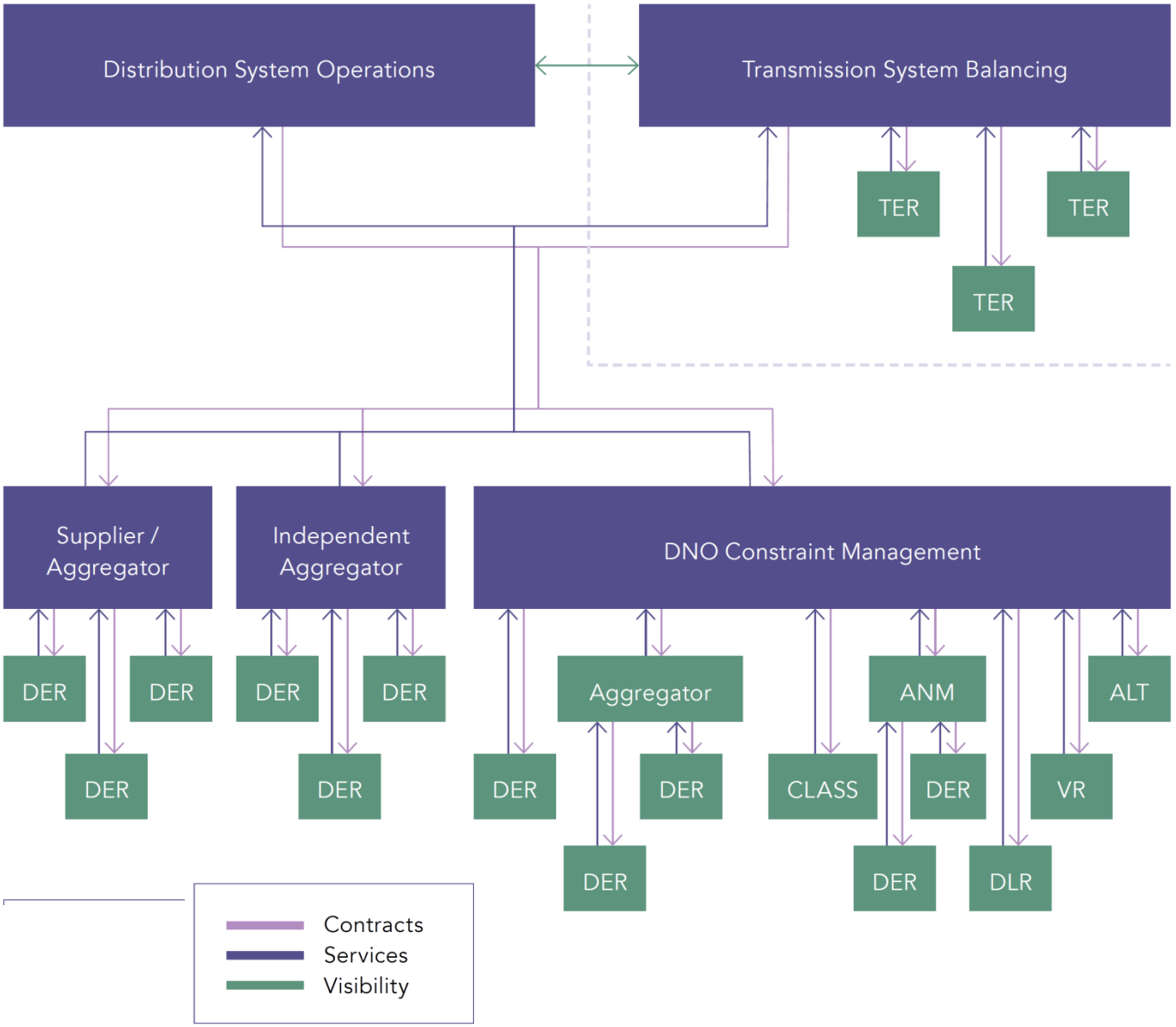
GBSO Led Market Model



The extension of the GB System Operator as market orchestrator relies on the SO understanding all distribution network constraints. It will require complex information exchange and duplication of investment planning and network management efforts. It also enhances the reliance on a single regulated monopoly.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Co-ordinated Market Model

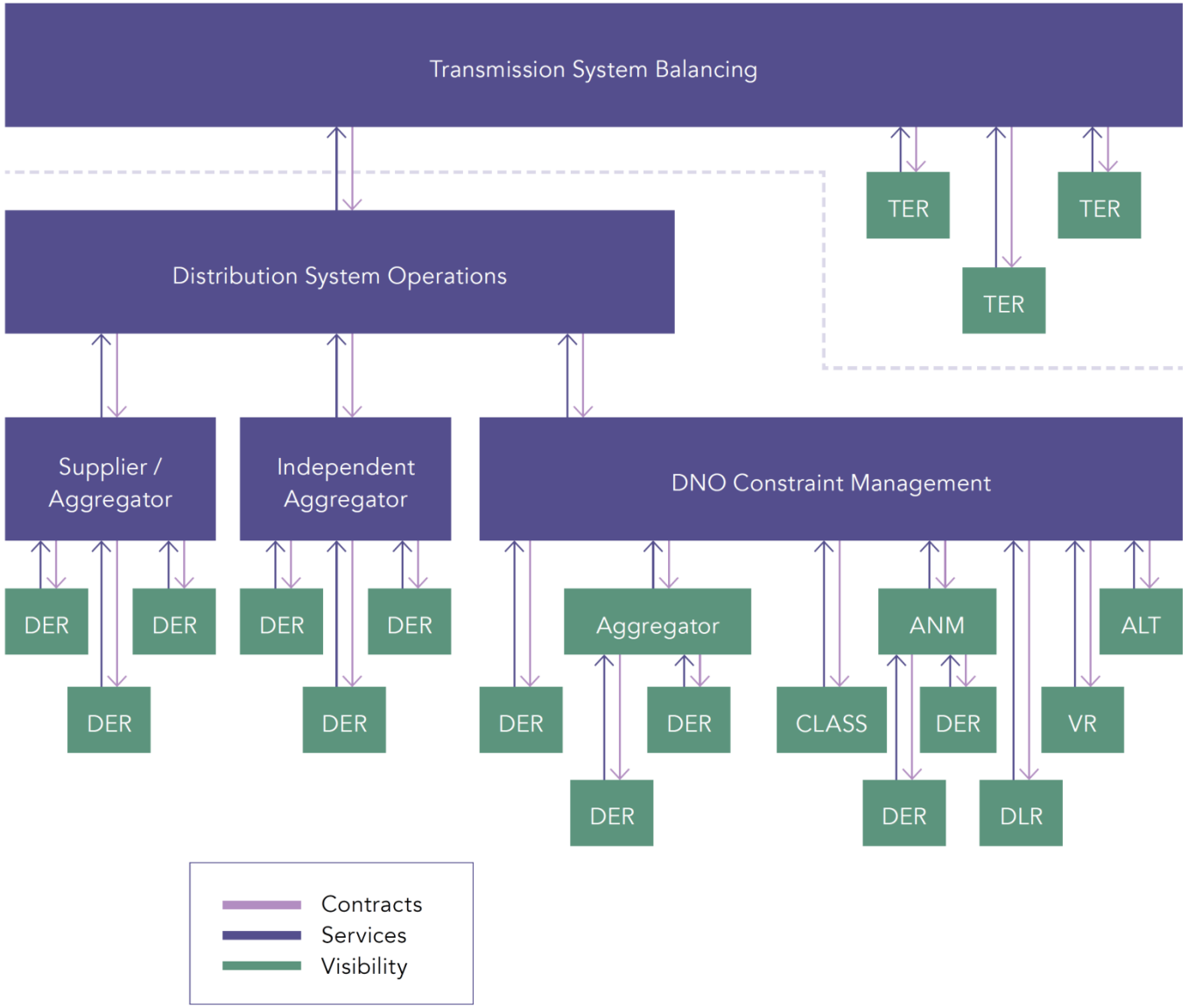


A co-ordinated market model for procurement and control of flexibility allows all parties to have visibility of actions and allows enables customers to choose all markets.

It requires complex data exchanges and requires flexibility products and services to be designed to avoid conflict.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

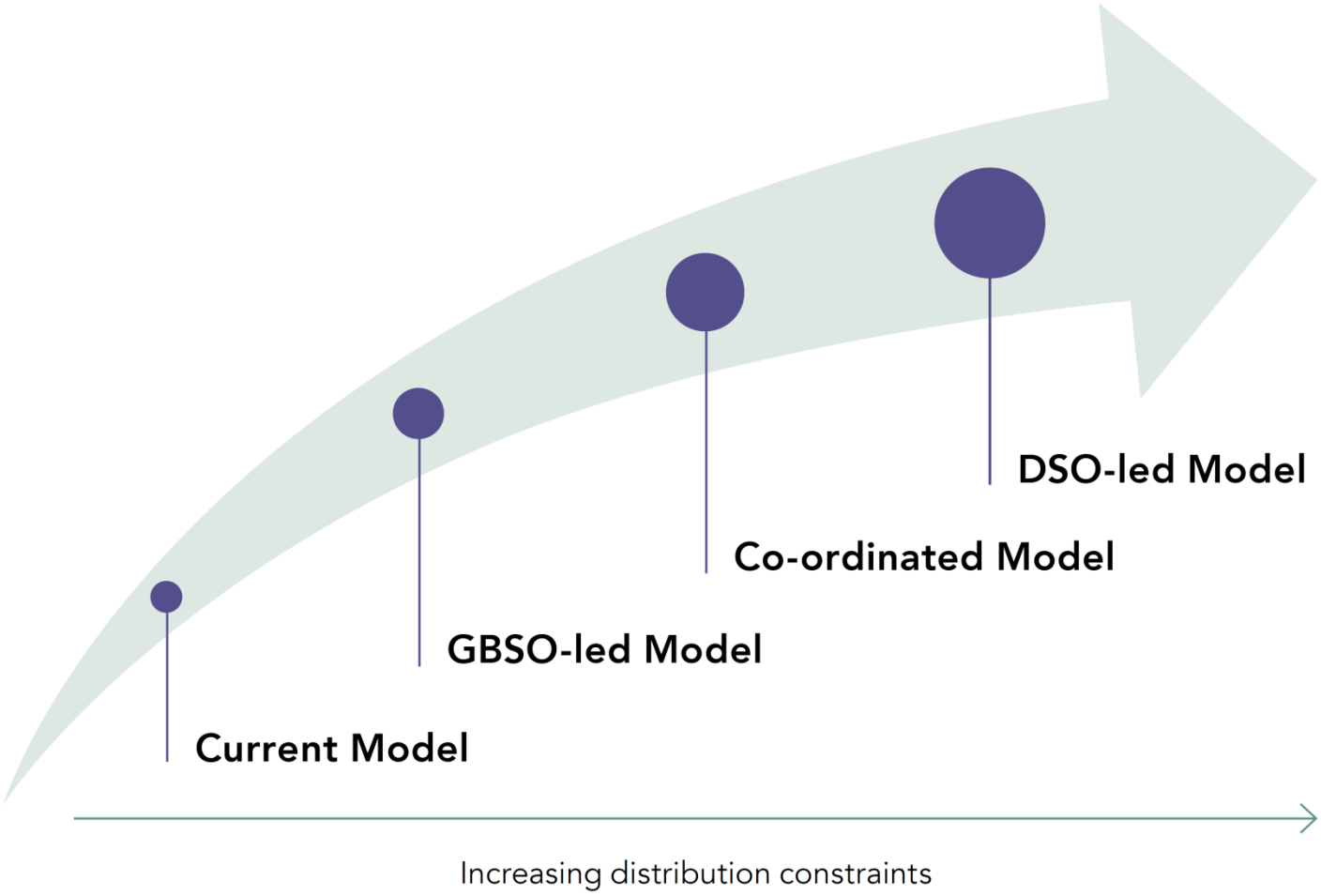
DSO Led Market Model



With the Distribution System Operator as market orchestrator, the efficient co-ordination of the market is inherent, as the GBSO is only offered services which are not conflicted. The DSO will manage the system to ensure there is network capacity for the most economic services.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Market Model Transition



As distribution constraints increase and the level of embedded DER grows, the amount and complexity of data required to manage the system efficiently greatly increases. To maintain system efficiency, the balance of decision making must become more regionally devolved.

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Roundtable Discussions

Questions:

1. Is there sufficient flexibility currently installed, but not utilised?

2. What types of flexibility will be prevalent and upon what timescales will these appear?

3. Who should provide flexibility to the networks? Should there be any rules or limits on this?

4. What information would help customers invest in flexibility on the networks?

5. What would a balance between market fluidity and certainty of contracts look like?

6. Should all market models be considered? Are there any other market models that need to be considered?

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

Innovation Strategy & NIA Call

Jonathan Berry
Innovation & Low Carbon Networks Engineer

Agenda

- **Innovation Strategy**
  - Electricity Network (Joint) Strategy
  - WPD Strategy – What, Why and When…

- **Network Innovation Allowance Projects**
  - Outline of NIA projects
  - WPD's portfolio
  - Third Party experience
  - NIA Call

Electricity Network Innovation Strategy

- 30th June 2017 Ofgem updated the licence conditions to include the production of a Joint Innovation Strategy (Electricity and Gas)
- Publication date – 31st March 2018
- Stakeholders to be consulted

The delivery of an Electricity Network Innovation Strategy is a critical part of the ENA's innovation work programme, as it makes the ongoing collaborative work within the ENA and its Members more visible. The Electricity Network Innovation Strategy will ensure that all the relevant network licensees work together in relation to innovation, which will result in coordinated action on priority areas such as reducing cost to the customer, making our service more reliable and supporting the low carbon economy. It will also have implications for the Distribution System Operator (DSO) Transition which is the subject of the Open Networks project, also being led by the ENA on behalf of the GB network operators.

Strategy Production Process

- UK electricity sector context
- Insights from other global learning

- Networks licensees' innovation strategies
- Sector trends
- 1st Stakeholder consultation

- Innovation projects 2015-2017
- Areas of priority

- Industry tipping points
- Planned innovation projects
- 2nd stakeholder consultation

- Co-ordinated and optimised innovation activities

Strategy Themes

Industry trends

1. Shifting power-generating sources and resulting revolution in the utilities industry
2. The power of customer choice and changing energy demands
3. Policy drivers
4. The smart, flexible energy system and the DSO transition
5. Uncertainty and choices for the electricity network companies

Existing innovation strategies

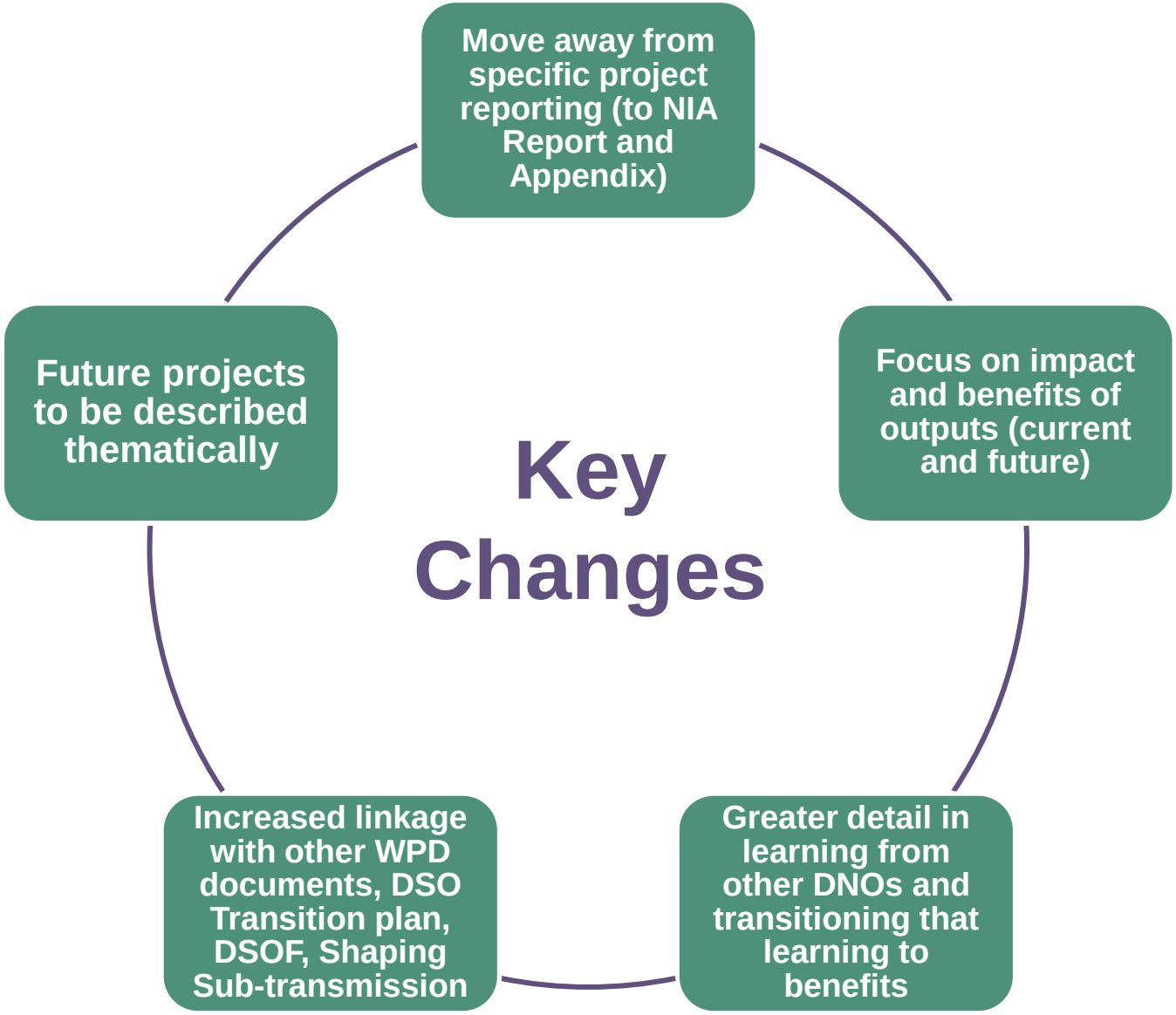
Innovation themes

- #1 Networks improvements and system operability
- #2 Transition to a low-carbon future
- #3 New technologies and commercial evolution
- #4 Customer and stakeholder focus
- #5 Safety, health and environment

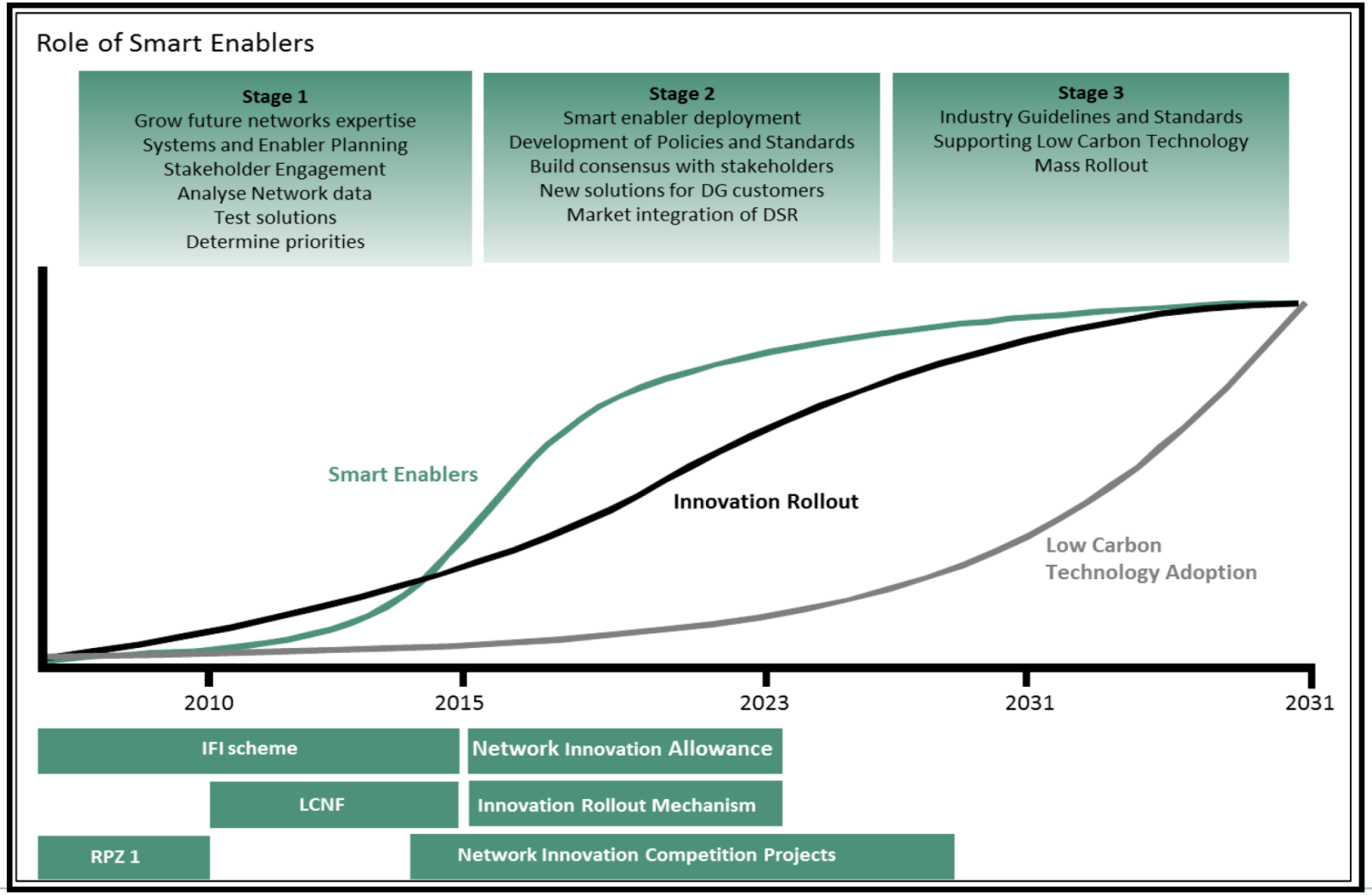
WPD Innovation Strategy

- Originally produced to support RIIO ED-1
- Updated annually – previously February
- To be updated in July 2018
  - Enabling synergies to the joint strategy to be included where appropriate
  - Aligning with the publication date of the NIA Annual Report

Key Changes


Move away from specific project reporting (to NIA Report and Appendix)
Focus on impact and benefits of outputs (current and future)
Greater detail in learning from other DNOs and transitioning that learning to benefits
Increased linkage with other WPD documents, DSO Transition plan, DSOF, Shaping Sub-transmission
Future projects to be described thematically

Smart Enablers



Themes

- Forecasting and DSO
- Smart Technologies
- EVs and Communities
- Whole System

WESTERN POWER DISTRIBUTION
INNOVATION

Network Innovation Allowance

Future Networks Programme

Assets

- Telemetry
- Decision support
- Improved assets
- New assets
- Flexibility

Customers

- New connections
- Upgrades
- Information
- Self Serve
- Products/Service

Operations

- Reliability
- Forecasting
- DSO
- DSR
- GBSO Interface

Network and Customer Data

- Airborne Inspections
- AIRSTART[1]
- Telecoms Analysis
- Superconducting Cable
- SF6 Alternatives
- MVDC Test Lab
- Smart Energy Laboratory
- Statistical Ratings
- Primary Network Power Quality Analysis

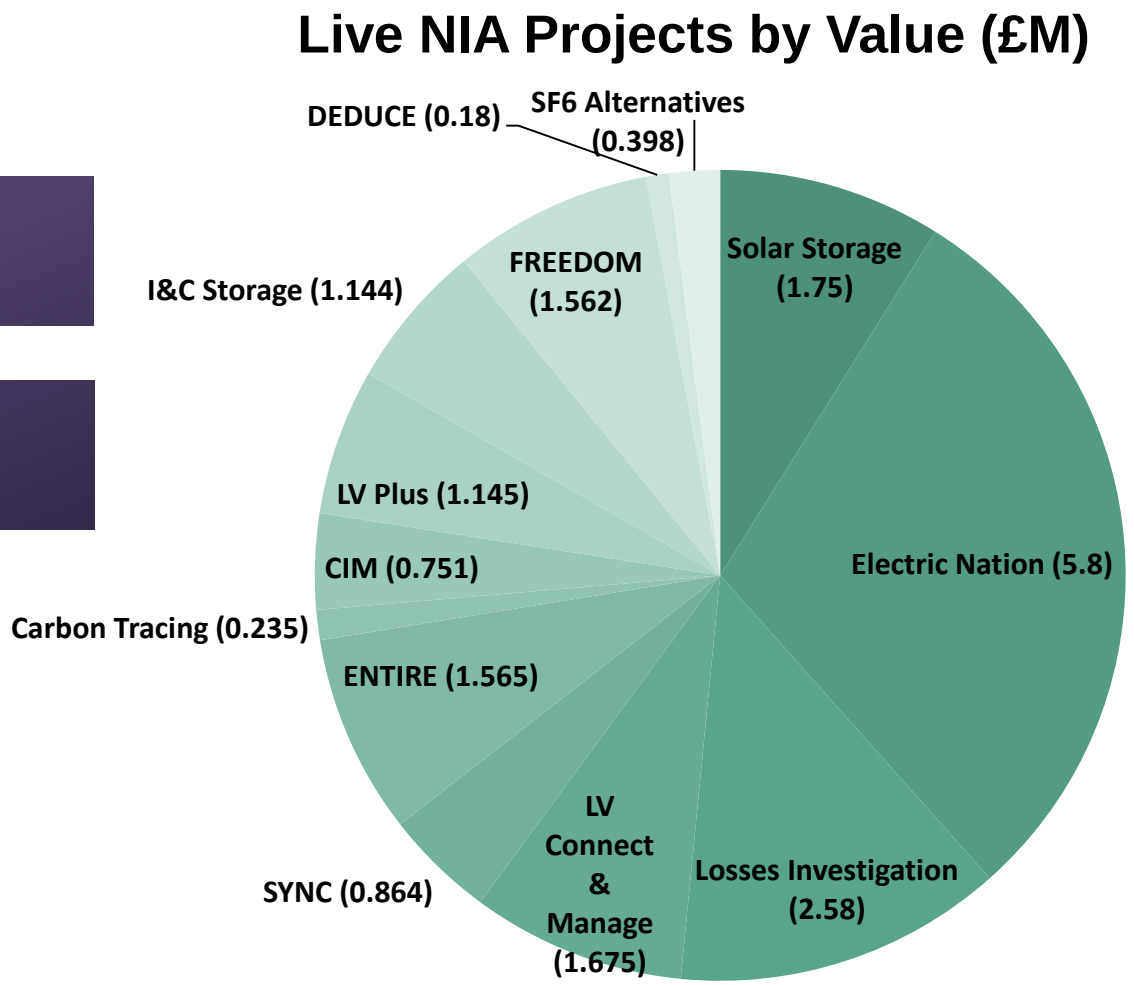
- FREEDOM
- Hydrogen Heat & Fleet
- Carbon Tracing
- Solar Storage
- LV Connect and Manage
- Sunshine Tariff
- Electric Nation
- Industrial & Commercial Storage
- Smart Systems and Heat[2]

- DSO/SO Shared Services
- Project SYNC
- Project ENTIRE
- Smart Meter data for Network Operations
- Distribution Operability Framework
- Times Series Data Quality
- Voltage Reduction Analysis
- LV Connectivity
- Losses Investigation

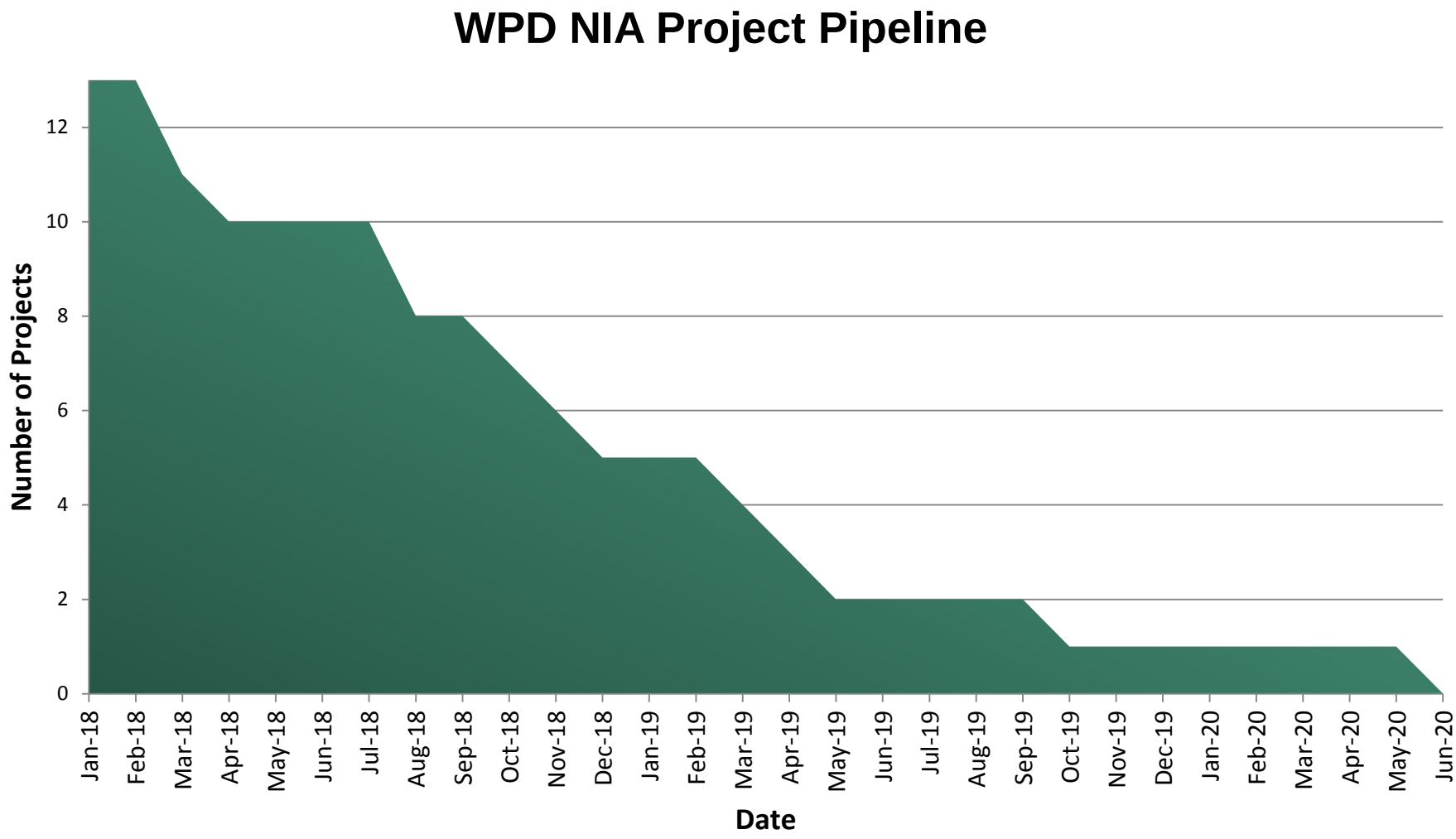
NIA Portfolio

Completed NIA Projects: 14
Projects' Spend: £2.52M

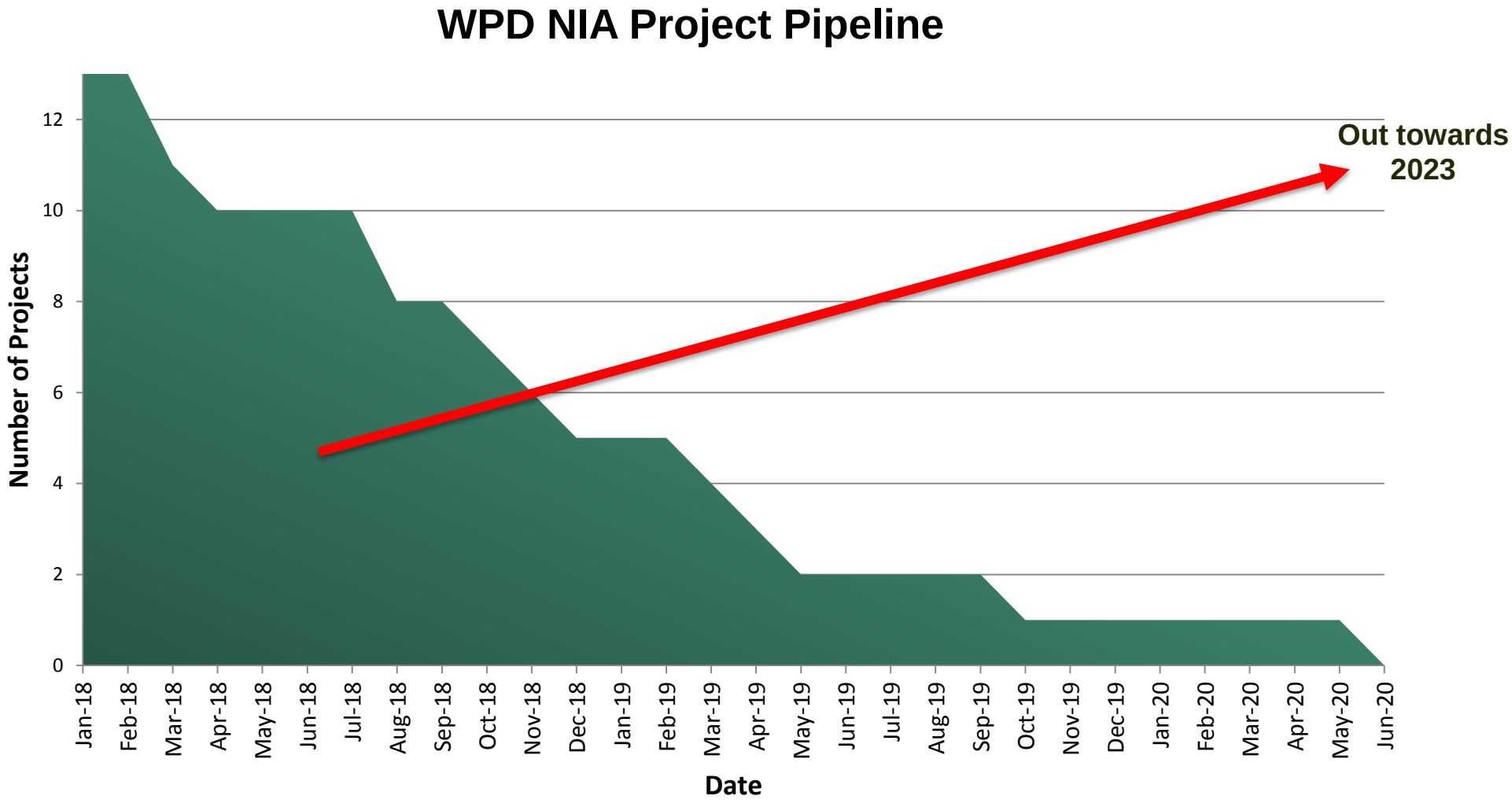
Live NIA Projects: 13
Projects' Value: £19.65M



NIA Project Timelines

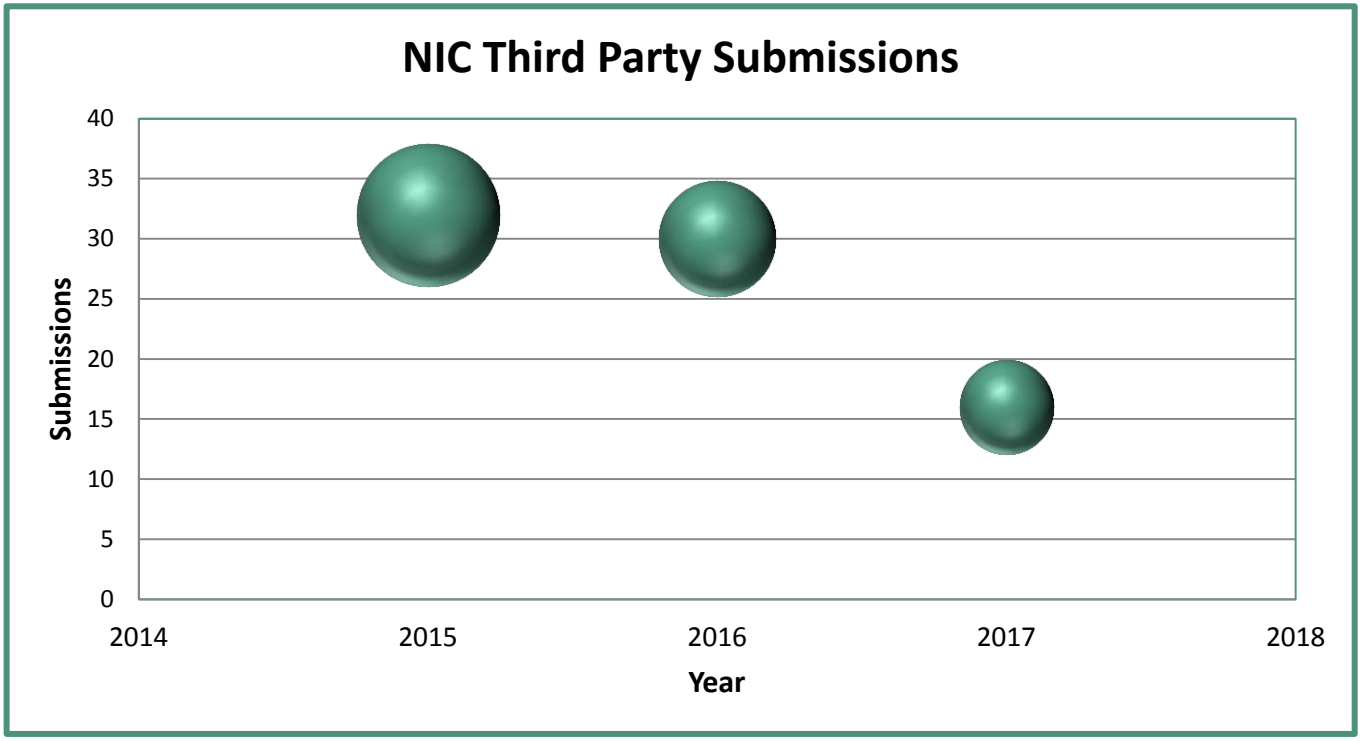


NIA Project Timelines

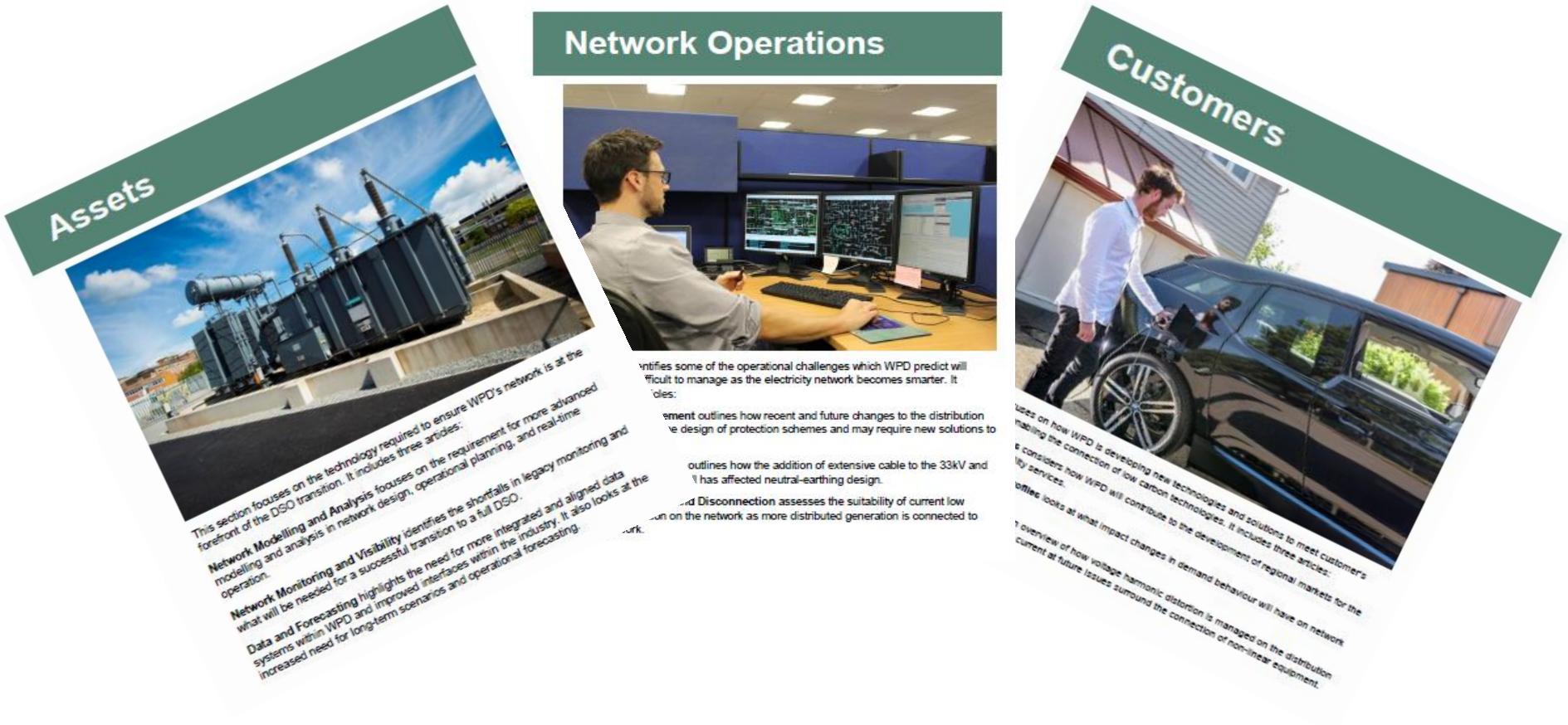


Third Party Involvement to date

- Third party involvement at NIC level is now mandatory (included within the governance)
- 3rd year third party NIC call recently completed

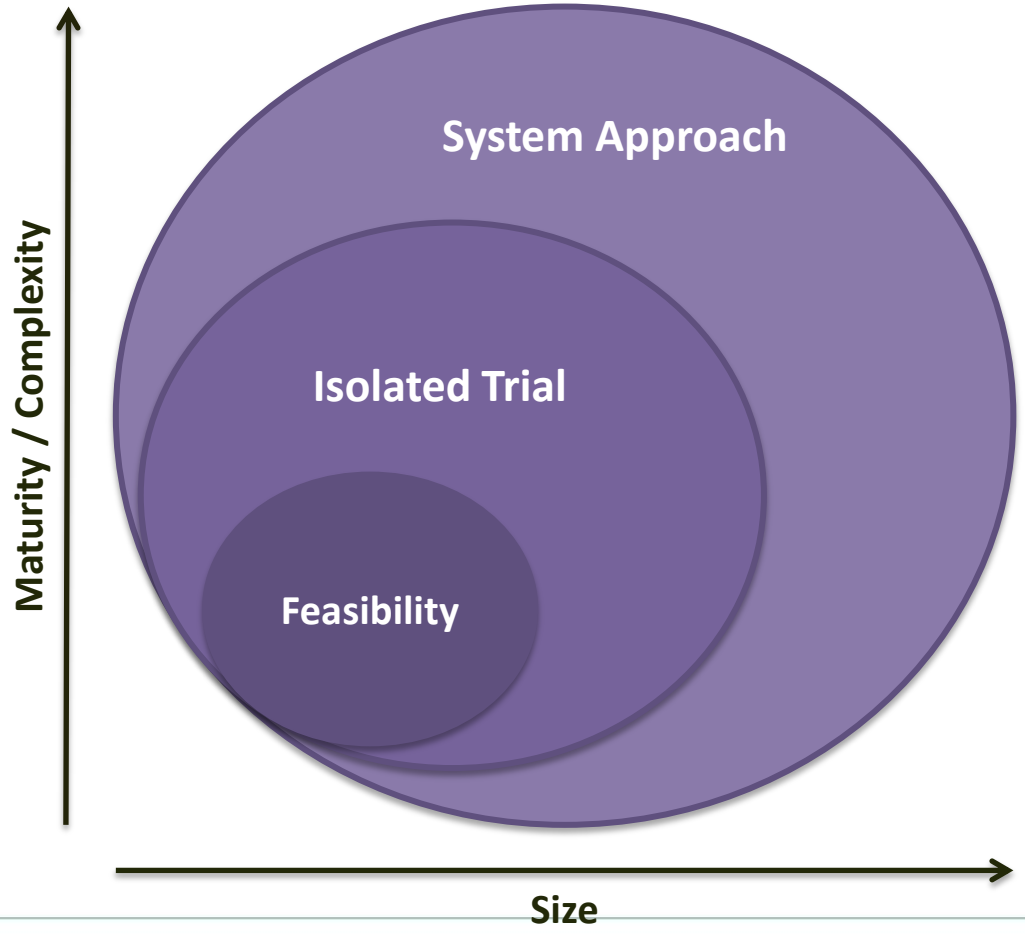


NIA Third Party Call



NIA Third Party Call

- Looking for a range of projects covering the areas and themes



NIA Third Party Call

- Clear and defined projects (not concepts or boxes)
- Identified deliverables, outputs and outcomes
- Capability and capacity to manage and deliver

To be released on the **26th January** via:

- Achilles;
- ENA's Collaboration Portal; and
- WPD's Innovation Strategy.

Further Collaboration

All our reports, webinars and presentations are published online at:
http://www.westernpower.co.uk/netstrat

If you have any questions in relation to WPD's Network Strategy work, please contact WPD on the details below:

Email: wpdnetworkstrategy@westernpower.co.uk

By post:
Network Strategy Team
Western Power Distribution
Feeder Road
Bristol
BS2 0TB

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales