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PWR Stakeholder Priorities & Benefits Report

Powering Wales Renewably Project

Version 1.0 27 June 2024

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1. Foreword

Pweru Cymru yn adnewyddol, (Powering Wales Renewably, PWR), under the ESO's leadership, brings together the full Welsh energy system value-chain from the Welsh Government, renewables developers and operators, network operators, through to end users.

PWR collaboration is informing and demonstrating the value of digitalisation and data accessibility to accelerate the energy transition and deliver a decarbonised energy system. Innovation has been targeted to specifically overcome core barriers to the Welsh Government's decarbonisation plans, and deliver the associated societal benefits for Wales's citizens, businesses, and communities.

PWR is structured to deliver three Use Cases, the associated benefits of which have been identified through extensive stakeholder feedback from across the energy system value chain. Each Use Case is focused on a specific challenge area that can be solved through the delivery of a foundational, connected digital twin of the Welsh energy system. This will ignite new markets and innovations that will evidence the value of access to energy system data and digitalisation of the energy system. These use cases are:

- **Foundation** – that will provide the core data model and supporting engineering foundations for an interoperable digital twin of the status of the Welsh Energy system.
- **Whole System Integrated Planning** – that will bring together and inform strategic plans of the Energy System and enable informed decision making based on a common data set.
- **Flexibility Co-ordination** – that will enable, for the first time, a co-ordinated view of flexibility across Wales and its interaction with ANM, building on the Foundation Use Case to provide insight on efficient planning and enactment of flexibility resources.

Powering Wales Renewably is an accelerator and pathfinder for the future Digitalised Energy system. The project will fast track the digitalisation of the energy system in a meaningful and wide-ranging way, whilst supporting the people of Wales in leading delivery of GB's net zero commitments. PWR builds on the work of the Energy Digitalisation Taskforce (EDiT), Energy Data Taskforce (EDTF) and is aligned with the objectives of the UK's first Energy Digitalisation Strategy.

"The digitalisation of the energy sector is critical to reaching net zero by 2050 and supporting a smart, flexible energy system … To be successful, we must ensure digital cohesion with other sectors from the start…"

BEIS, Ofgem and Innovate UK Statement on the Energy Digitalisation Taskforce Report – 19th July 2021

This document is a consolidation of the learning gained from the first two phases of the project and describes at a high level the design that will support the Powering Wales Renewably model. The model has been informed by and is aligned with the Virtual Energy System. The learning from Powering Wales Renewably will help inform the design of the data sharing infrastructure across the industry in the future.

The learning has been made possible by the commitment and collaboration of all the partners during Discovery and Alpha Phases which we thank them for, and we look forward to continuing the collaboration in the Beta phase. We welcome any comments or questions on this document as we further prepare for Beta.

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2. Purpose

The purpose of this document is to provide a high-level design summary supporting the ESO SIF Beta submission for Powering Wales Renewably.

The Powering Wales Renewably (Alpha) project developed Use Cases mapped to captured requirements to enable and assist the Welsh Government decarbonisation strategy by addressing the following areas:

- The lack of locational visibility of the challenges, and common understanding by all stakeholders, of the whole energy system network status, including accepted connections.
- Flexibility not being treated as a whole system resource, and fully coordinated between transmission and distribution networks.
- Local area energy plans, network development plans, and the connections queue, lack alignment, leading to net-zero delivery having substantive uncertainties.

This document has been generated during the SIF Alpha phase with the intention of identifying the high-level design requirements via a stakeholder-driven requirements capture and high-level Use Case design process.

This summary has the following purposes:

- Describing the requirements captured and how they inform the design of the three Use Cases that were identified by the stakeholders during the Alpha phase and are to be further developed and implemented in the PWR Beta phase.
- Informing the Beta phase High-Level Design (HLD) should the Project proceed.
- It describes the Use Cases designs which address the requirements and core problems.

This is a living document which will describe the high-level design of the PWR Beta implementation going forward as the Beta project progresses and informed the costing and technical submission for the Beta phase itself by partners.

3. Project Context

This section describes how the project engaged with partners and stakeholders. Specific problems were identified, and requirements to mitigate them collated. These requirements were then consolidated into high-level use case designs utilising a proven benefits dependency framework to ensure benefits delivery.

3.1. Stakeholder Engagement

During the Alpha phase, stakeholder engagement was maintained through a three-stage approach. Initial bi-lateral meetings with the partners and stakeholders (listed below), were followed by reviews by activity groupings for the Welsh Government and developers/operators, the network operators, and customers, followed by a joint design review. The outcomes identified as important by the partners and stakeholders have been used to prioritise project deliverables.

Organisation	Relevant Activity	Project Role
Welsh Government	Welsh Energy Policy & Plans	Partner
Electricity System Operator (NESO)	Transmission System Operation	Partner
National Grid Electricity Transmission (NGET)	Transmission System Owner	Partner
National Grid Electricity Distribution (NGED)	South Wales Electricity Distribution	Partner
Scottish Power Energy Networks (SPEN)	North Wales Electricity Distribution	Partner
Cenin Renewables Limited	Renewables Developer/Operator	Partner
Tupa Energy	BESS Developer	Stakeholder
Statkraft	Renewables & Grid Services Developer/Operator	Stakeholder
RWE Pembroke Net Zero Centre PNZC	Renewables & Grid Services/Developer	Stakeholder
Ynni Cymru	Smart Local Energy System Development	Stakeholder
Community Energy Wales	Community Energy Development	Stakeholder
Energy Local	Local renewable supply electricity clubs	Stakeholder
Farmers Union of Wales	Representing Welsh Farmers	Stakeholder

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Organisation	Relevant Activity	Project Role
Baileys and Partners	Rural renewable energy consultancy	Stakeholder
Sero	Housing stock Net Zero strategies development.	Stakeholder

Table 1 - Project Stakeholders

3.2. Core Problem Definition

PWR is designed to address three substantive problems identified in the discovery phase and further understood and refined in Alpha, namely:

Problem	Addressed by
The lack of visibility, and a common understanding by stakeholders, of the whole energy system network challenges. Data is published, but industry and external datasets are not transparently catalogued and correlated to fully satisfy the needs of system users created by the energy system transition.	PWR Use Case 1 A and Use Case 1 B
Flexibility is not yet treated as a whole system resource nor fully coordinated between transmission and distribution.	PWR Use Case 2 A and Use Case 2 B
Local area energy plans, network development plans, and the connections queue, lack alignment, leading to potential synergies being hard to identify.	PWR Use Case 3 A and Use Case 3 B

Table 2 – Addressing the core PWR problems

3.3. Multi-Stakeholder Use Case Design Overview

From the outset the design of the use cases was targeted to be modular, serve multiple stakeholders, and be underpinned by a Welsh network digital twin. Initially scoped to serve the electricity network, the digital twin is now extended to include multiple energy vectors in Use Case 3. The digital twin maximises utilisation of the available accelerators in the form of the existing integrated network models of the two adjacent North and South electricity distribution models to which transmission can be added.

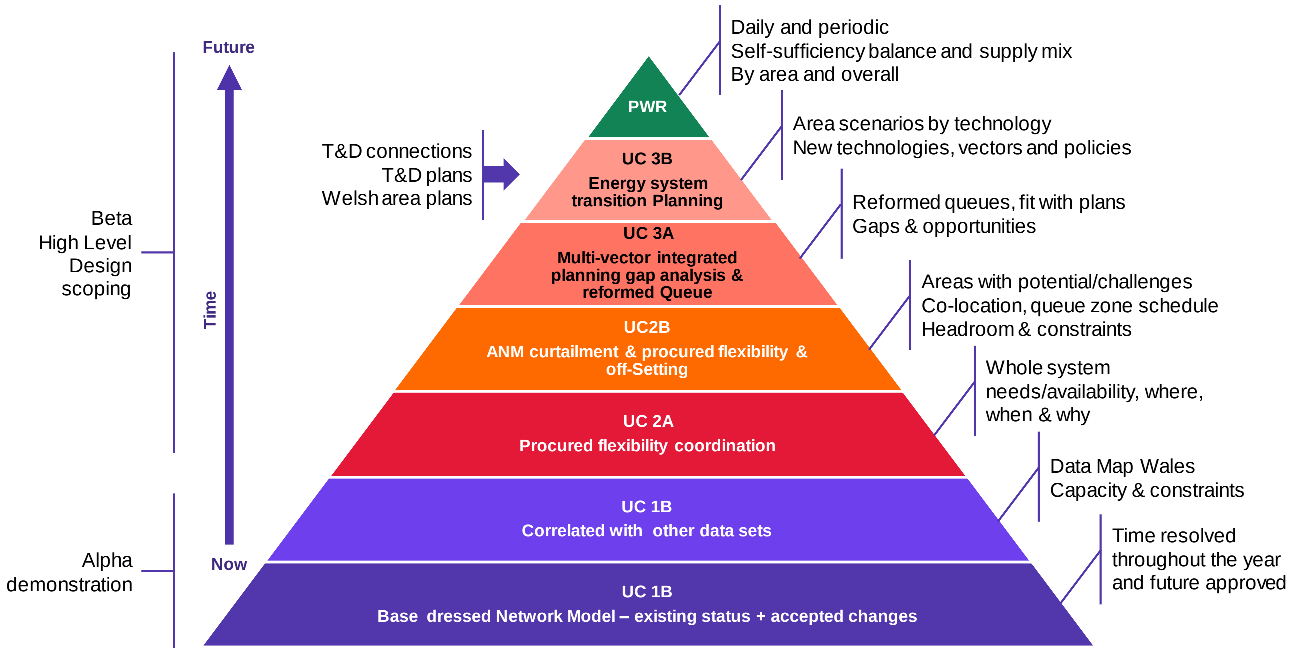

Figure 1 - Use Case Overview

The use cases have been aligned in pairs to tackle the core problem definitions in sequence, starting with the foundation common view of the combined T&D network status including accepted connections, flexibility coordination and its interaction with ANM curtailment and off-setting, and then multi-vector integrated planning to deliver the required energy system transition. The use cases start in the present network status, but then extend the analysis timescale forwards incrementally to 2035.

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3.4. Stakeholder Requirements

Three main techniques were used to gather stakeholder requirements.

i. Root cause analysis of the core problems identified, across all stakeholders, indexed against the key factors relating to regulation, technical, procedural, commercial, delivering a stakeholder common view, and the Welsh energy plans.

ii. Stakeholder specific feedback on a strawman list of specific requirements developed through discovery and alpha phase stakeholder dialogue, with the addition of individual stakeholder priorities.

iii. PWR Pilot feedback over several iterations of interactive demonstrations.

3.4.1. Contextual Feedback

Using technique (i) above the aggregated root cause analysis across all stakeholders is summarised diagramatically against the core problems identified. Negative and positive aspects have been included without exclusion, or attribution to individual stakeholders, to generate a common line of sight of the challenges involved from a distributed perspective.

3.4.1.1. Use Case 1 A & Use Case 1 B - The lack of visibility, and a common understanding by stakeholders, of the whole electricity system network challenges.

The whole electricity system visibility challenge of the existing network status is characterised by a substantive accepted to connect queue, uncertainty as to which connections will progress, high connection application attrition, and delays in connection. The Winser [1]report has driven reform with the Network companies responding to Ofgem and DESNZ by taking measures to accelerate connections. The widespread dependence of DER distribution connections on transmission constraints is being responded to with Active Network Management options. Some stakeholder feedback mentioned the need to avoid possible unintended consequences of moving to first ready connections that may disadvantage local initiatives. Wales is proactively pursuing local area energy plans and other initiatives including Community Energy Wales, Ynni Cymru, and a State Developer, with the objective of meeting local, regional, and National Welsh needs.

[1] https://www.gov.uk/government/publications/accelerating-electricity-transmission-network-deployment-electricity-network-commissioners-recommendations

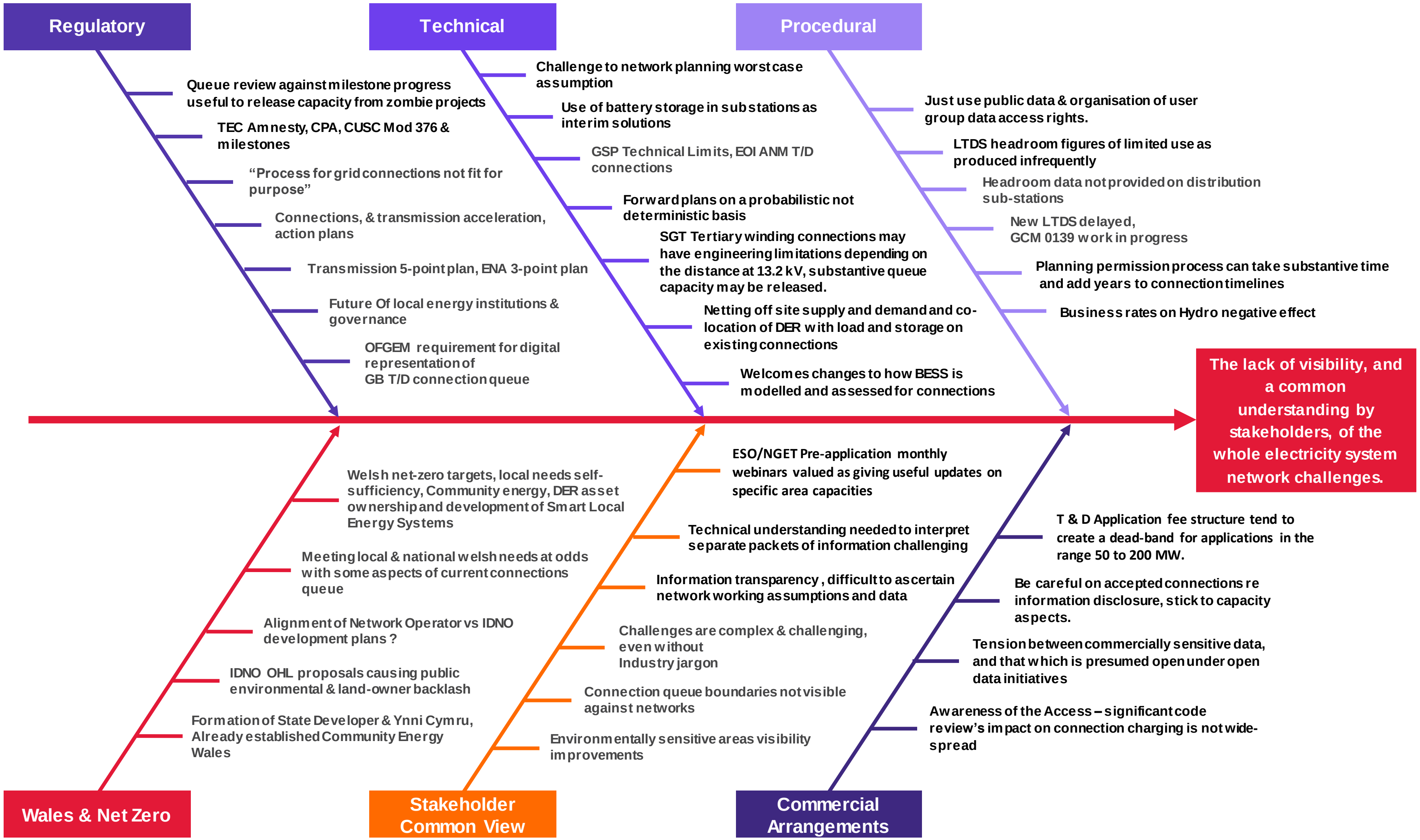

Figure 2 - Use Case 1 (A & B) Contextual Feedback

IDNO 132 kV over head-line proposals to connect their own energy parks have caused planning consternation with local communities and raised strategic network planning coordination questions. Accepted GSP SGT tertiary connections are not easily related to GSP Appendix G [2]connection queues, as they are listed separately in the TEC register. Appendix G is aggregated at GSP and not shown locationally against the downstream network. Shared 132 kV assets span the western border between NGED South Wales and SPEN SPM areas as a legacy of previously forming part of the transmission system before being transferred to the distribution network operators. Arrangements for competition in onshore transmission are also being progressed. In short, the existing Welsh whole electricity system has the strong potential for additional transparency with a combined transmission and distribution network locational connection queue, correlated with additional data against an intelligent model of the electricity network.

3.4.1.2. Use Case 2 A & B - Flexibility is not yet treated as a whole system resource and fully coordinated between transmission and distribution.

The whole system flexibility coordination challenge can be characterised by the current lack of a single view of all network operator flexibility requirements, all DER availability, and the resultant selection and delivery. Network operators can benefit from accessing additional details on location, capabilities, and the track record of DER sites. Coordination between transmission and distribution requirements at a portfolio level offers additional advantages in avoiding over-buying and stacking value. DER sites themselves can benefit from knowing the full range of opportunities with the network operators, and assistance in addressing different market platforms and the complexity of participation. Primacy rules address network operator interactions at individual sites, but not at a whole system flexibility portfolio level.

[2] https://www.nationalgrid.co.uk/our-network/statement-of-works/appendix-g-overview

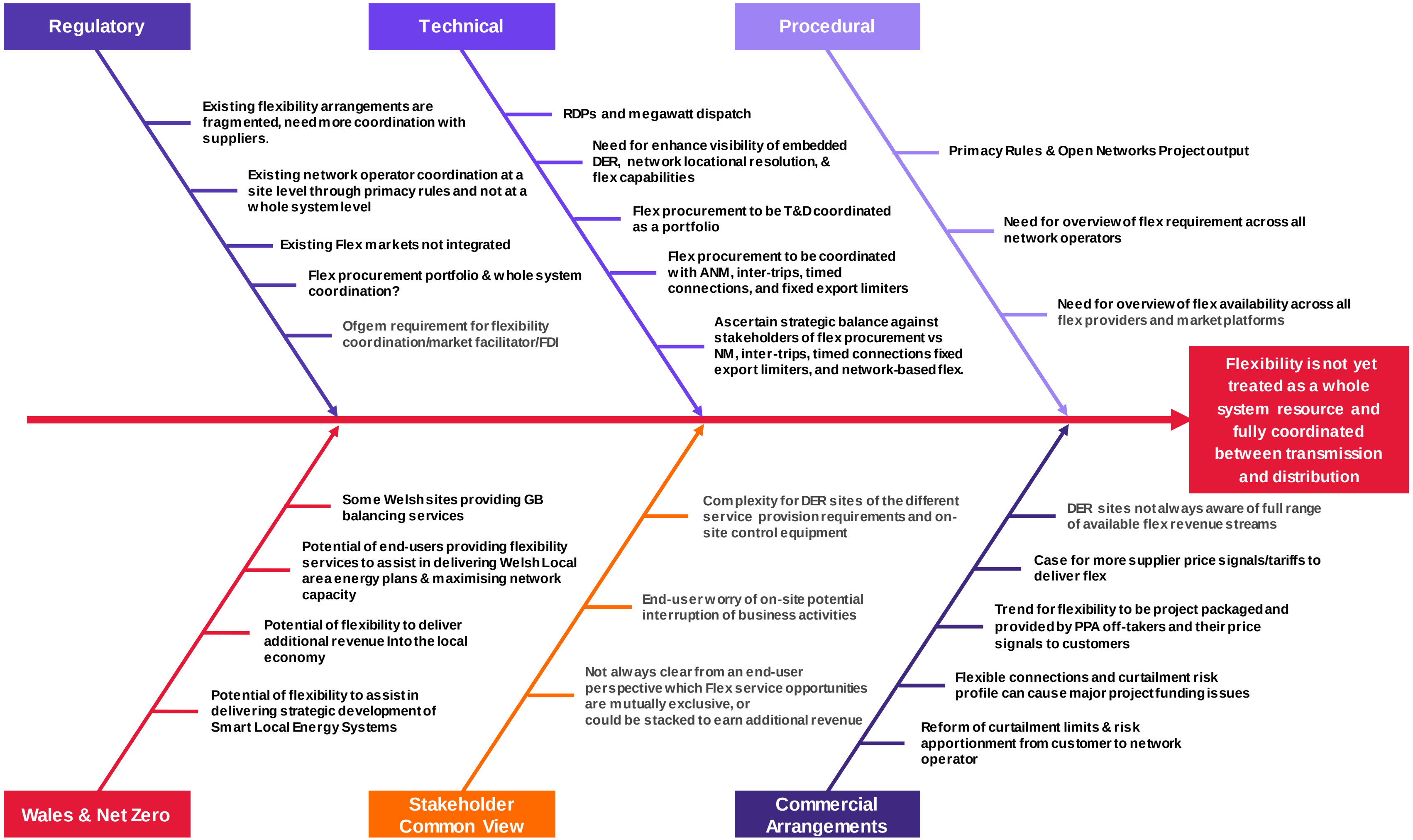

Figure 3 - Use Case 2 (A & B) Contextual Feedback

The interaction of procured flexibility and the deployment of active network management in the same networks is not transparent, for example, in it's the effect on curtailment limits. The use of off-setting generation with load is used by customers behind the meter but is not actively encouraged at a network scale to offer an opportunity for additional decarbonisation demand instead of curtailing generation. The potential for future active network management scheme extension to control flexible decarbonisation demand as well as curtail generation was noted and could be coupled with initiatives such as local supply and the further establishment of Smart Local Energy Systems. Reduced fragmentation of flexibility services was mentioned by several stakeholders, as was the potential to enhance integration with supplier tariff arrangements. The flexibility requirements extend beyond constraint mitigation to balancing and grid services encompassing the wider coordination challenge across stakeholders.

3.4.1.3. Use Case 3 A & B - Local area energy plans, network development plans, and the connections queue, lack alignment, leading to potential synergies being hard to identify.

The energy system transition planning and delivery challenge can be characterised by the trichotomy represented by the emerging energy plans, the network development plans, and the connections queue. The extensive accepted to connect connection queue is driving network plans, but carries significant uncertainty as to connection completion, and lacks alignment to current energy plans. The need was expressed for a whole-system energy model, base-lined with the existing networks status, from which to model forward and inform future option choices and track actual delivery. Such a ground-up model needs to include a current plan gap analysis and potential actions to better coordinate energy system transition delivery in Wales.

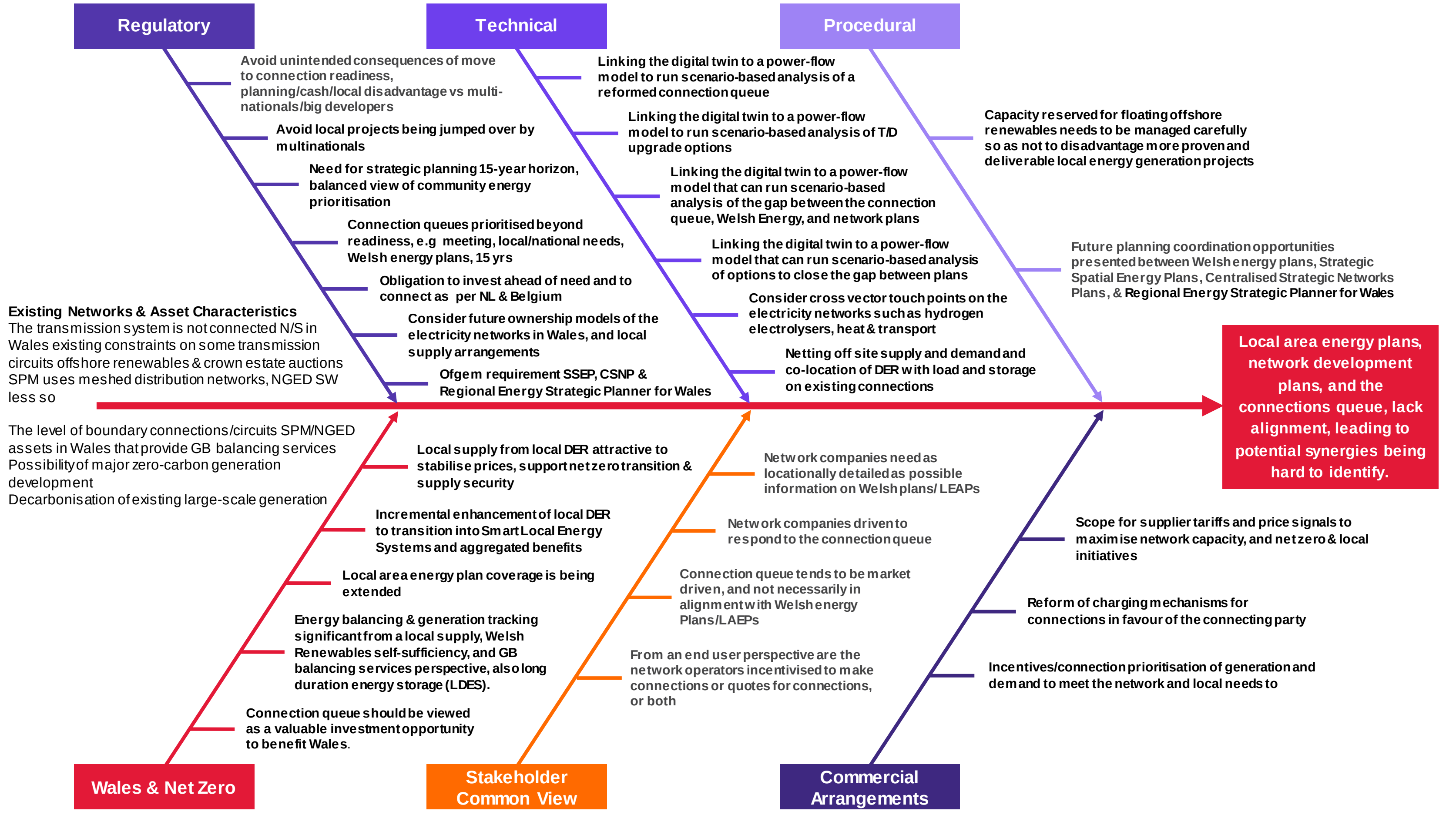

Figure 4 - Use Case 3 (A & B) Contextual Feedback

Decarbonisation of heating and transport, as well as long duration electricity storage, and hydrogen initiatives need to be taken account of in the model as additional locational energy vector touch points. Wales has specific additional challenges such as significant non-mains gas areas, and a rural topography for EV deployment. Stakeholders expressed the potential paradigm shift between the free market for connections and the future potential of queue shaping incentives that could be designed to encourage demand or generation type locationally to benefit customers and enhance network capacity utilisation. Additionally, it was thought that the model could inform on the effects of initiatives such as local power plans and the formation of Great British Energy should these or similar be taken up, and potential investment interventions from the already initiated Welsh State Developer and Great British Nuclear. It was also felt that planning with widely positioned scenarios may need to converge on a plan to deliver the Welsh energy system transition that can be adaptive to actual progession, change, emerging technologies, and specific opportunities.

Although some of the factors identified and recorded are beyound the direct scope of the project, the technique yielded an excellent consolidation of the core problem contexts and framed the need for the more specific requirements and avoiding unintended consequences.

3.4.2. Requirements based Feedback

Using technique (ii) above in section 3.4 the specific requirements tested with stakeholders are shown below, and were rated by stakeholders as of high, medium or low priority with accompanying reasoning as to the rating. Stakeholders were also invited to add what they considered to be missing, and all of the feedback was consolidated and high level design priorites abstracted and taken forward into the use case high level design and benefits dependency analysis.

Requirements Summary

	Use Case 1A Foundation Status
1a	T&D Existing DER Connected
1b	T&D Existing Demand Time Series GSP BSP PSS DSS
2	T&D Accepted DER Connections
3	T/D Accepted Demand Connections
4	T/D Display Load & Generation Headroom
5	T/D Display Constraints & Zones affected & reinforcement
6	Display Appendix G GSP information & downstream DER Connections by category and network connection point.
7	Distribution DER Connection Offers Accepted subject to Transmission Confirmation
8	Show networks eligible for accelerated non-firm offers, based on GSP technical limits, in advance of required transmission works.
9	Network asset rating & basic engineering details

	Use Case 1B Existing Potential
1	Identify areas likely to attract Renewables DER investment & increase reverse power-flows
2	Which areas have network capacity and high renewables potential average Windspeed/Solar, now and after planned accepted connection & LRE reinforcement. Consider storage
3	Identifying areas that might benefit from queue changes that release capacity that coincides with areas of high renewables potential. (Queue blocking release)
4	Consider decarbonisation loads in areas reaching generation hosting capacity
5	Consider renewable generation/storage in areas reaching load capacity
6	Which communities have network capacity and high renewables potential av. Windspeed/Solar, now and after planned accepted connection & LRE reinforcement.

	Use Case 2A Flex Coordination
1	Visibility of T&D DER flex capabilities
2	Consolidated view of multiple T&D network operator flex requests.
3	Consolidated view of flex availability.
4	Consolidated view of multiple T&D network coordinated selection, and enaction.
5	Visibility of DSO to ESO flex Services
6	T& D Flexibility requirements for planned outage management
7	Visibility of T& D System flexibility measures, reconfiguration, voltage control and reactive

	Use Case 2B DER Curtailment
1	Transmission connected curtailment
2	Visibility of T&D ANM and contracted flex interaction
3	Model dependencies between T&D ANM on non-firm connections, and on coordinated contracted response. Considering impact of interim non-firm EOI for transmission dependent embedded DER connections on the procured contract flex..
4	Embedded distribution DER, transmission curtailment
5	Embedded DER distribution curtailment
6	Understanding reasons for curtailment and alleviation paths through network development

Internal

	Use Case 3A T/D Planning
1	Visualise coordinated connection reform against both transmission and distribution networks. Connect direct to transmission, embedded DER under appendix G, accelerated non-firm under point 2 of the ENAs three -point plan
2	Gap Analysis of combined Transmission and Distribution network plans to optimise development options. Consider reinforcements in NOA and HND
3	Identify dependencies between T&D constraints, reinforcements and connections.
4	Also show queue at distribution level that do not have transmission dependencies.
5	Enhanced identification of constraints for use in planned outage management utilising flexibility.
6	Show queued connections at an earlier stage than fully T&D accepted against the network, utilise ENA milestone guides.

	Use Case 3B EST Planning
1	Enhanced linkage between T/D network development plans, modelling the T/D connections queue, and LAEP plans including specific sites, LCT adoption & development areas
2	Through modelling scenarios show the level of alignment between these plans and key decisions presenting
3	Identify capacity release and network location from queue reform.
4	Identify capacity and locations eligible for accelerated non-firm connections
5	Identify sites for major DER/LCT developments and initiatives within the Welsh energy & carbon reduction plans.
6	Consider interaction between reinforcement and meeting local needs with alternative less impactful options

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3.5. Alpha Phase Foundation Pilot System

To rapidly progress the vision for the foundation use cases a Foundation Pilot System was developed. Through a series of workshops, utilising cause and effect analysis, benefits dependency mapping, and demonstrations of the Foundation Pilot System, stakeholders were engaged, and their requirements collated and aligned.

Thie pilot system is a locally held static data prototype to demonstrate the approach, principles, and the potential benefits of the fuller PWR solution to be delivered in Beta.

The key functional advancement, demonstrated by the system, is the ability to locationally correlate multiple separate datasets indexed against a fully connected intelligent network model that delivers the proposed use case benefits. This represents a key innovation over previously available simple map overlays and generalised heat maps. This advance will, in a later stage of the Beta project, also enable the production of a combined Transmission and Distribution Common Information Model (CIM) output for integrated power-flow analysis.

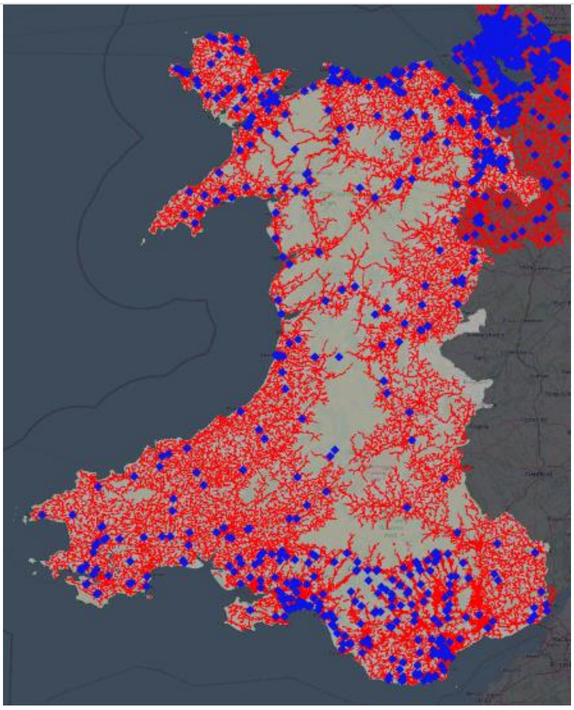


Figure 5 - Combined Network View with Primary Substations

The figure opposite shows the combined High Voltage distribution systems of Scottish Power's Merseyside and North Wales (SP MANWEB) and National Grid Electricity Distribution (NGED) South Wales, with their respective primary substation locations. This combined network view provides an improved indication of the availability of electricity networks in specific locations. This cannot be achieved using the, currently published, "zone of supply footprints", alone.

Behind this visual representation, the detailed electrical connectivity and characteristics of the network are also present. This not only supports further analysis of the network but also allows for additional information to be directly correlated to assets on that network. For example, timeseries data (e.g. load graphs) and constraint information might be made available in this way.

In this manner, multiple datasets can be locationally correlated to the core network model, as required, rather than just being shown as unrelated overlays.

Additional non-network information can also be included and used for analysis or identification purposes.
The figure opposite shows land area classification for National Parks, Areas of Outstanding Natural Beauty (AONB) and Sites of Special Scientific Interest (SSSI), in various shades of green. The Local Authority boundaries are shown as grey lines, and the electricity distribution network boundaries are shown as magenta lines.
These geographic areas can be used to identify or select containing items for localised analysis, such as for Local Area Energy Planning (LAEP) purposes.

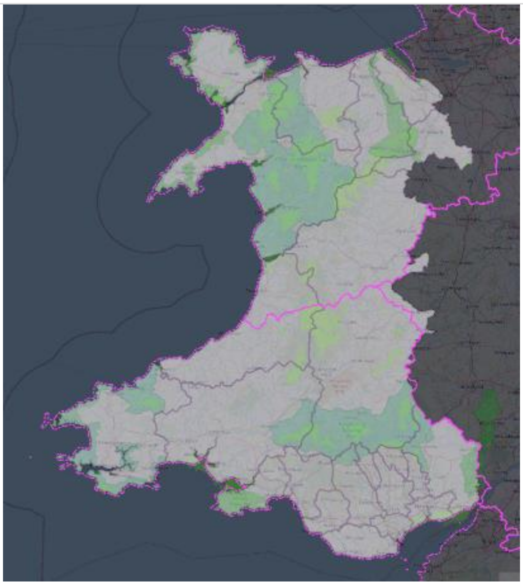


Figure 6 - Combined Network view with AONB/SSI with DNO Boundaries

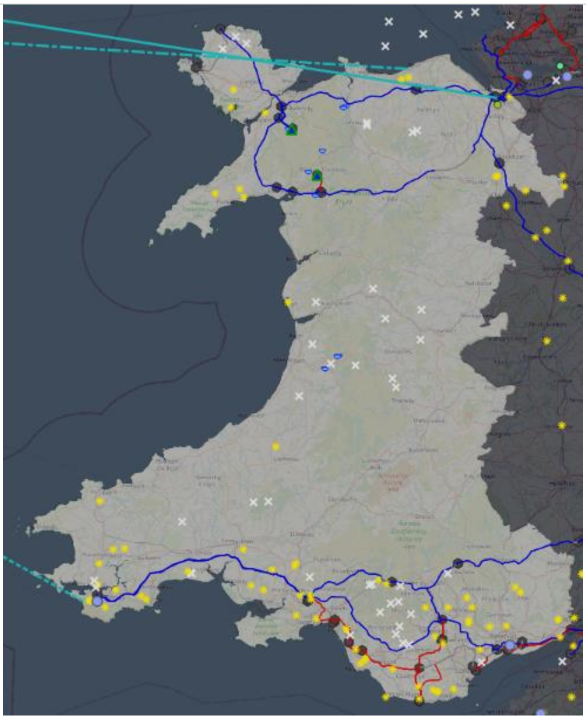
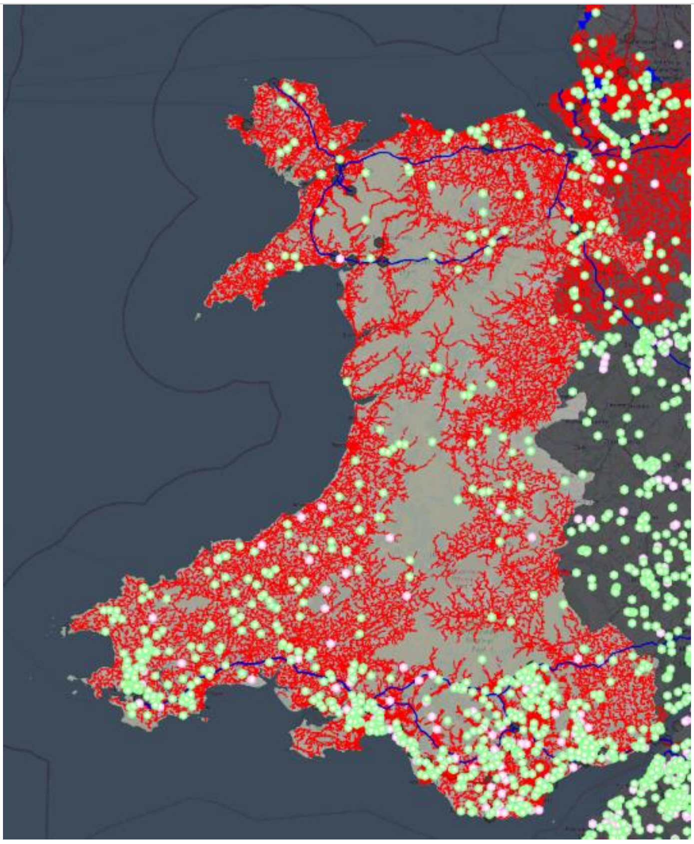


Figure 7 - Combined Network View with Power Stations and Interconnectors

Information was gathered from a diverse range of sources, to build up a holistic model of the Welsh electricity system.
The figure opposite shows the locations of existing power stations, obtained from the Digest of UK Energy Statistics (DUKES[3]), with the operational and proposed end points of electricity interconnectors, obtained from the ESO interconnector register. These energy sources can, in time, be properly connected to the underlying energy network models.
Gas system data was also obtained, at a later stage in the pilot, demonstrating that building the model to support all energy vectors was not only possible but will be essential to the future operation of a whole energy system model. Further development of this area will be a key part of the next phase of the project.

[3] https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

This figure shows the locations of Distributed Energy Resource (DER) installations recorded and published by the electricity distribution network companies, in their “Embedded Capacity Register” reports. The DERs are coloured green, where the installation is already connected, and pink, where the installation has received acceptance to connect but is not yet operating. Using the proposed commissioning dates for the installations, it is also possible to track the progressive development of the connected fleet of DER installations into the future and compare this with local energy plans.	 Figure 8 - Combined Network View with ECR status

Incorporation of additional datasets into the Foundation Pilot System demonstrated the possibilities that could be unlocked by the combined analysis of such data. Workshop stakeholders also identified that incorporation of additional information would be necessary. For example, it was requested that information be collected to support consideration of offshore work as well as onshore connections. This further highlighted the need for adaptability in the design of the system to be implemented.

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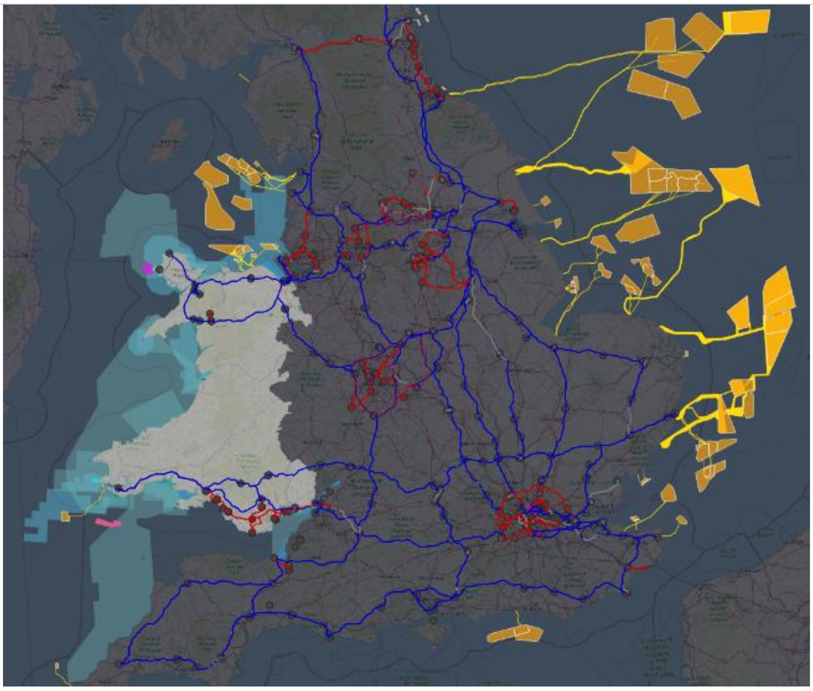

Figure 9 - Combined Network with Nature Protection Zones

This final representation shows the marine area nature protection classifications in place around the Welsh coastline, alongside the Crown Estates controlled areas in Wales and England that have been released for energy generation purposes.
This also demonstrates that the East Coast of England has, to date, seen more significant windfarm development opportunities, by comparison to those considered around the Welsh coastline.

Further possibilities are largely only limited by the processing resource and the availability of spatial data for that purpose.

For the above figures, the following should be acknowledged:

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Additional data from:

Scottish Power Energy Networks

National Grid Electricity Distribution

Wales & West Utilities

Welsh Government

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3.6. Individual Use Case Design

The high-level designs for the individual use cases have been produced below using the benefits management approach developed by Professor John Ward of Cranfield University. The diagrams show a benefits dependency for each use case identifying the business change, enablers and ICT required to deliver specific benefits. The approach was selected as it can be applied across the diverse stakeholder group and aligns well to the strategic intent of the SIF funding which requires industry take-up of the solutions proposed and inherent benefit realisation.

3.6.1. Use Case 1 A Foundation

Use Case 1 A is the foundation digital twin of the electricity distribution and transmission networks relevant to Wales. The resultant network model is dressed by correlating published data which depicts a combined T&D visualisation of the existing network status, including connected and accepted to connect DER.

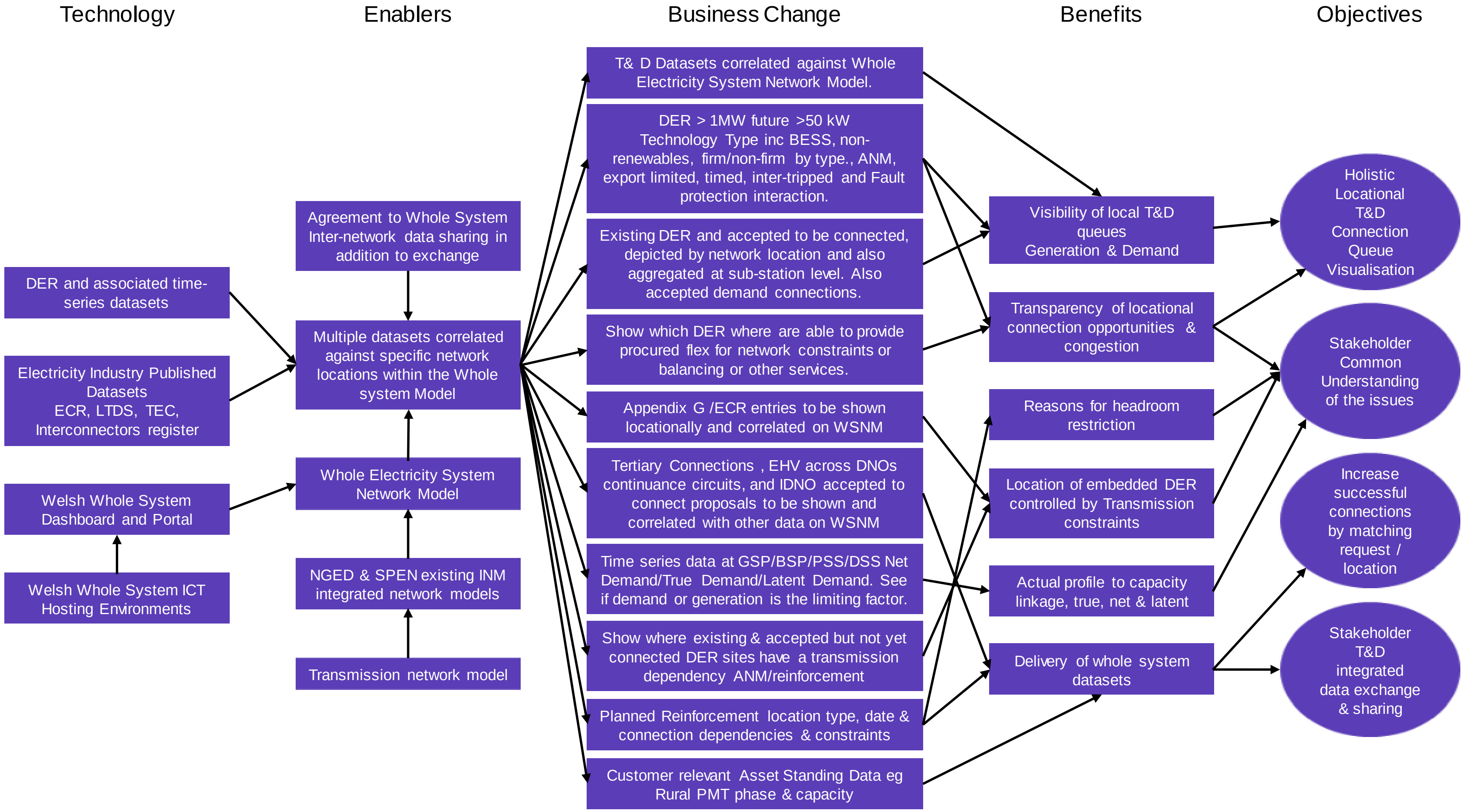

Figure 10 - Use Case 1 A Benefits Dependencies

The foundation use case delivers transparency to GSP/SGT tertiary connections, IDNO EHV overhead line proposals, and assets that cross DNO areas such as the 132kV lines feeding mid-Wales from the south. In addition, the location of Appendix G connections, time series true, net and latent demand at different sub-station voltage levels, and planned reinforcement is considered. Due regard will be given to only using open data and not commercially confidential or data redacted for other reasons. Benefits include transparency of locational queues, a common basis for stakeholder understanding of network challenges, helping to align request to network capacity, and enabling whole-system data exchange/sharing.

3.6.2. Use Case 1 B Data Correlation

Use Case 1 B data correlation adds the capability to utilise additional data sets, such as an areas potential for renewables, the absence of mains gas, or other demographic data. The solution parts reused from the previous use case are shown in white.

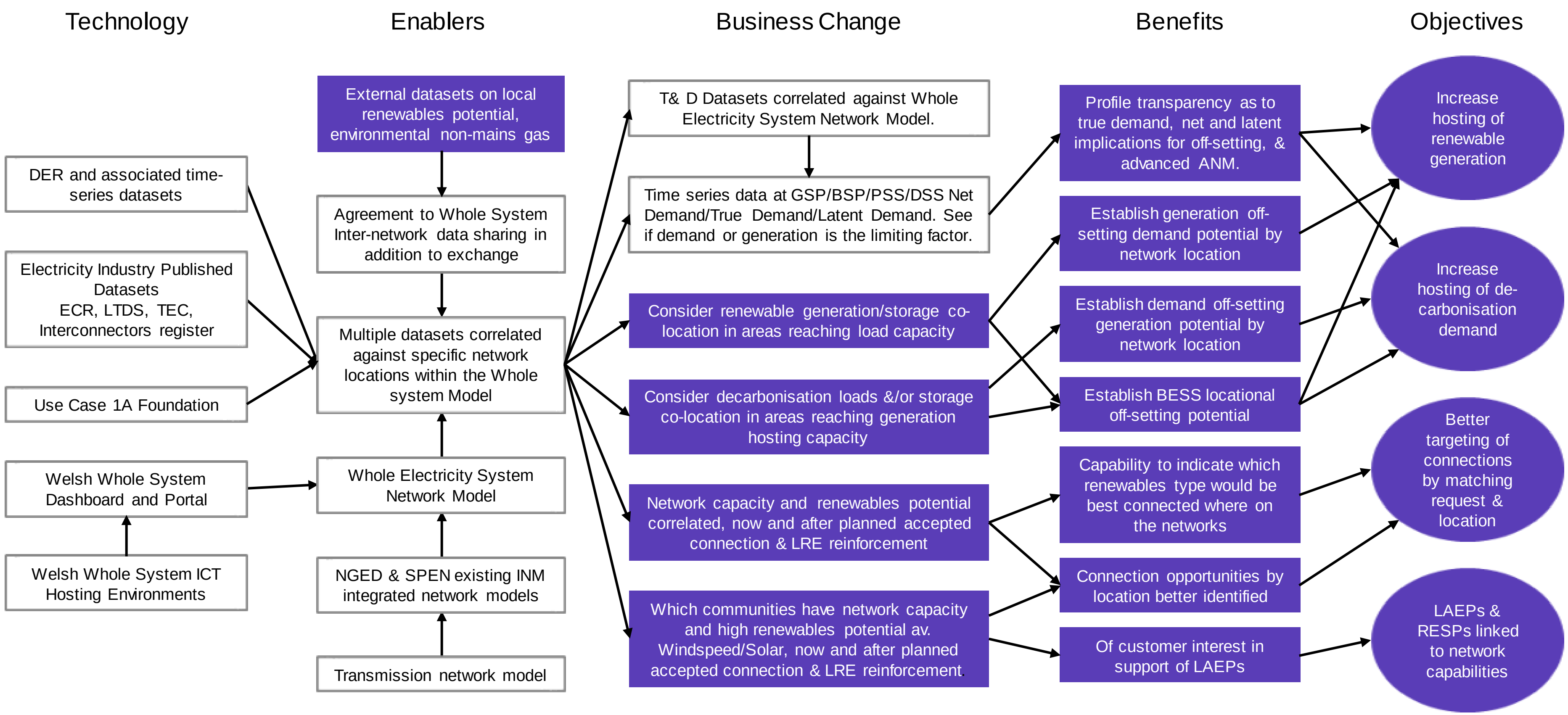

Figure 11- Use Case 1 B Benefits Dependencies

Profile analysis of time series data is deployed to determine the locational potential of off-setting constraints with decarbonisation demand or generation as appropriate. The benefits sought include additional demand or renewable generation hosting as a counterfactual to curtailment or procured flexibility. Off-setting was proposed as a key component to developing smart local energy systems and local supply initiatives. In addition, areas with strong renewables potential correlated with available network headroom are identified.

3.6.3. Use Case 2 A Flexibility Coordination

Use Case 2 A flexibility coordination is designed to deliver a whole system portfolio level aggregation of the flexibility required from all the network operators in Wales, and the full availability of responding DER across all market platforms. The actual delivery of flexibility is also recorded.

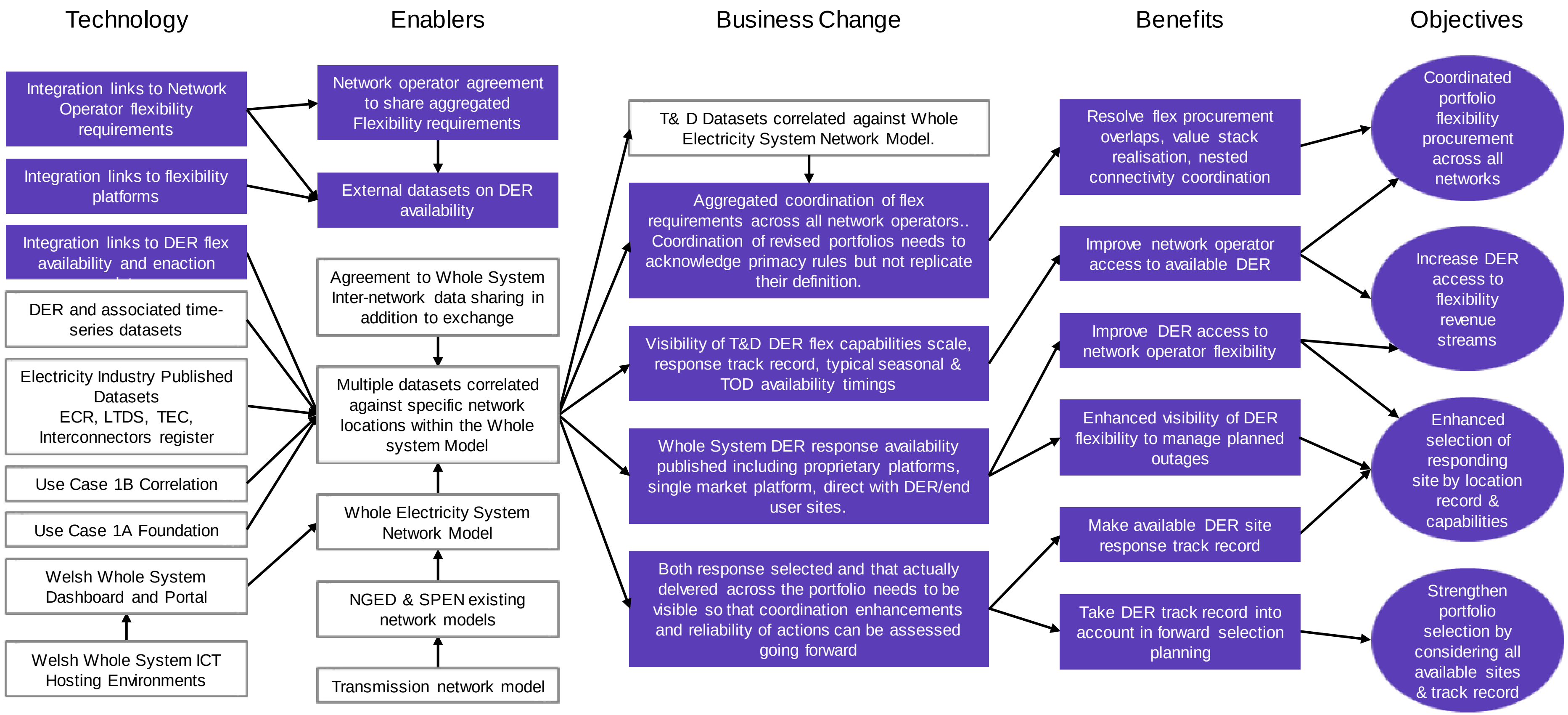

Figure 12- Use Case 2 A Benefits Dependencies

The solution does not seek to change primacy rules as it focusses on coordination benefits available from different flexibility activity in the same network connectivity including constraint mitigation, balancing, and grid services. Benefits include resolving at a portfolio-level T&D procurement overlaps, and value stack realisation. Additionally, respondent selection enhancement taking location and track record into account and making service provision opportunities more accessible to DER operators.

3.6.4. Use Case 2 B ANM Curtailment & Procured Flexibility and Off-Setting

Use Case 2 B ANM Curtailment & Procured Flexibility and Off-Setting builds on the previous flexibility coordination use case and models the interaction of procured flexibility, ANM curtailment, and off-setting within the same network. It is recognised that ANM curtailment and procured flex are not now usually combined at the same site but can be deployed at different sites in the same network. Additionally, off-setting generation constraints with decarbonisation demand is not currently widely adopted, it could be combined with ANM schemes or deployed separately on individual sites.

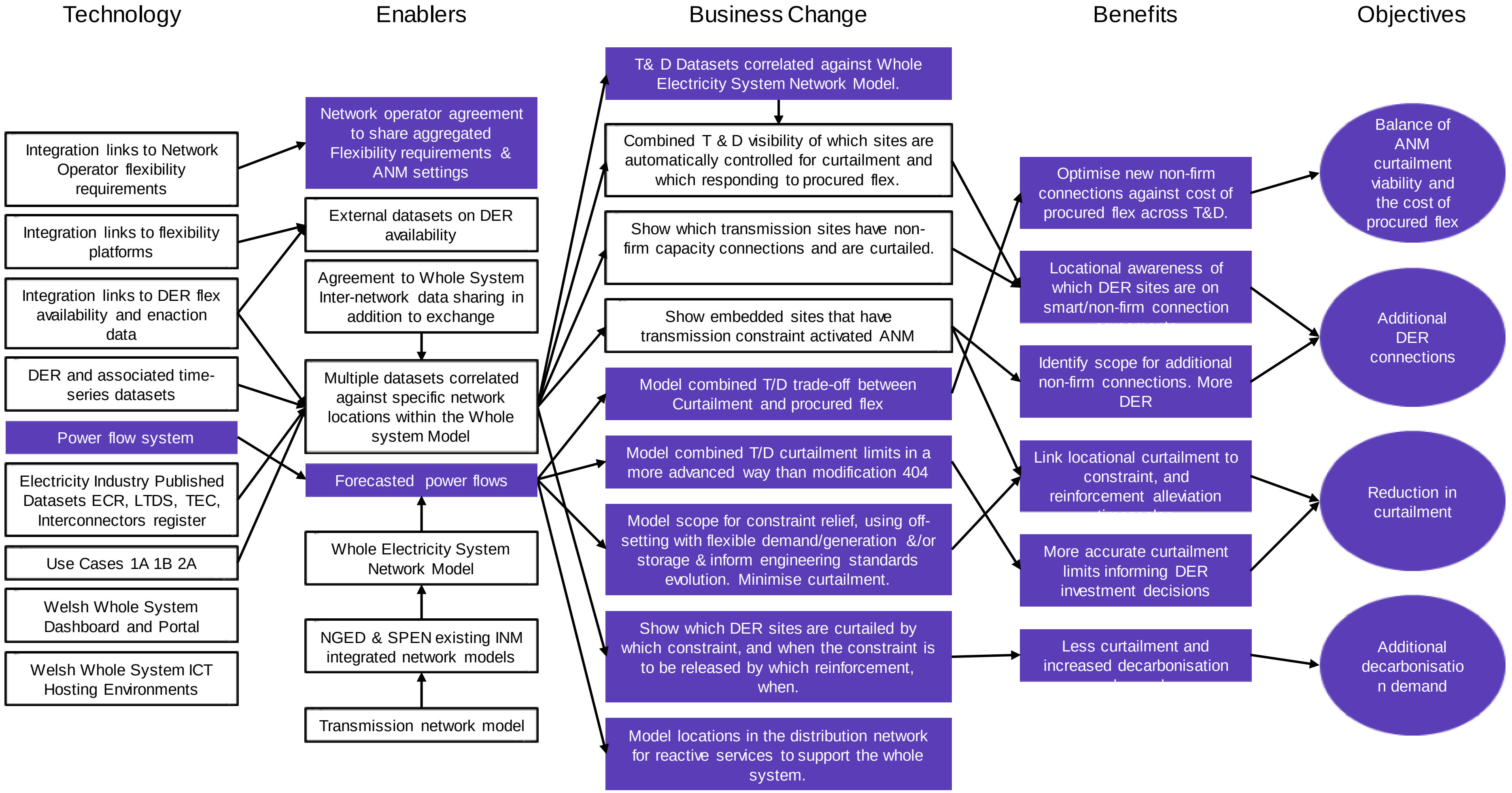

Figure 13 - Use Case 2 B Benefits Dependencies

Benefits sought include minimising curtailment and the cost of procured flexibility, maximising decarbonisation demand hosting, whilst enabling connections with viable curtailment limits. The use case will inform the further development of engineering standards taking the range of techniques into account, the balance between techniques, and advancing the establishment of equitable curtailment limits.

3.6.5. Use Case 3 A Integrated Planning

Use Case 3 A integrated planning establishes the multi-vector digital twin by adding the gas and emerging hydrogen networks. Disruptive low carbon technologies such as long duration electricity storage, and artificial intelligence and small area planning techniques will be deployed. The connection queue is considered in its shovel ready order, and the initial outputs of the new strategic top-down, bottom up, and regional energy integration plans are incorporated.

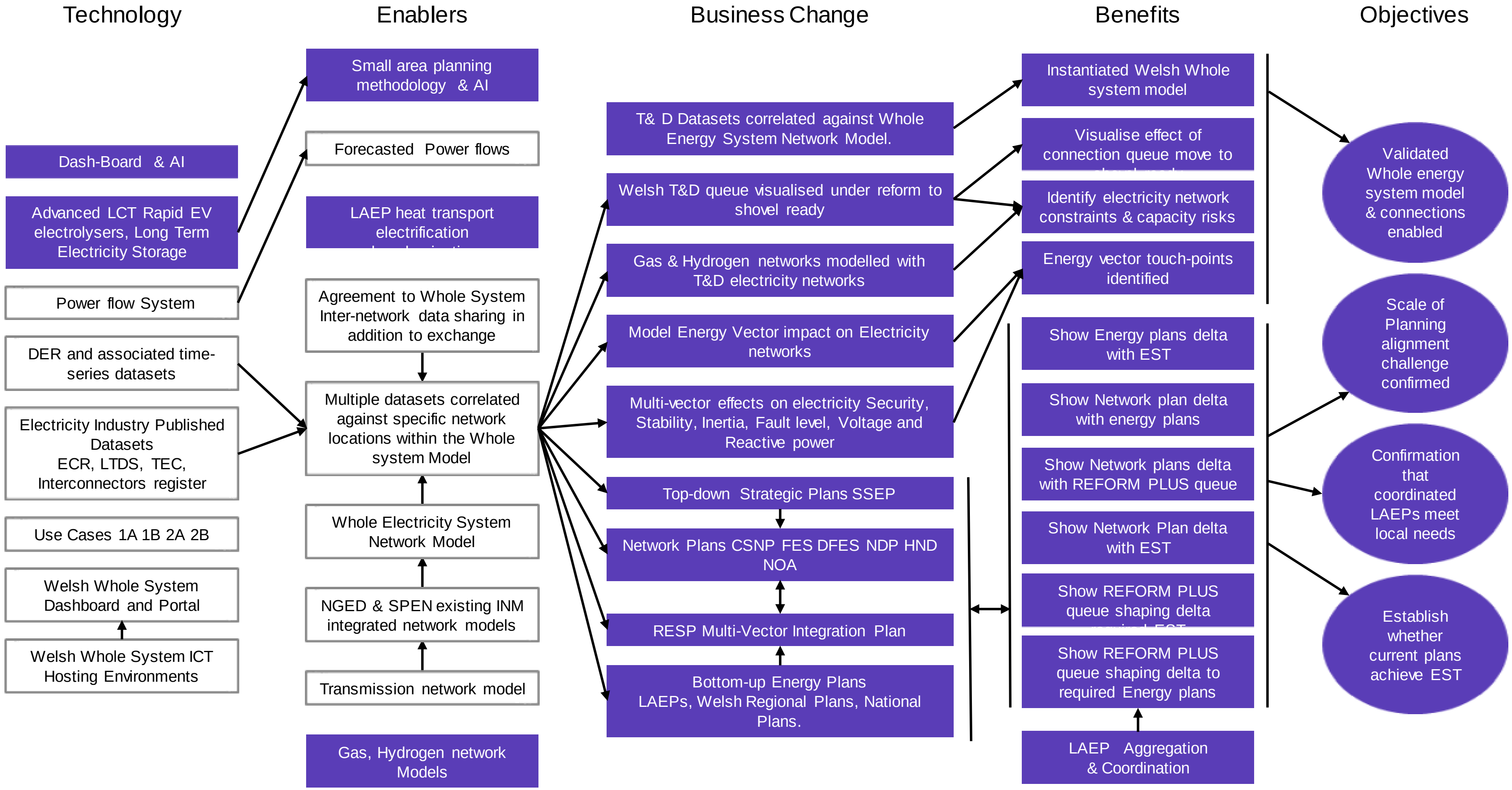

Figure 14 - Use Case 3 A Benefits Dependencies

Key outputs are to baseline the current energy system delivery projection for Wales against a plan gap analysis. Benefits include the delivery of an instantiated and validated whole energy system for Wales, ascertaining the scale of the planning alignment challenge, and confirmation of the existing trajectory towards net zero.

3.6.6. Use Case 3 B Energy System Transition Planning

Use case 3 B Energy transition planning builds on Use Case 3 A and updates the connection queue to consider additional criteria that could be applied to new applications to shape the connection queue. Top-down strategic plans are the compared with bottom up and the integrating regional strategic energy plans to perform a gap analysis and critically consider macro-options to achieve plan alignment.

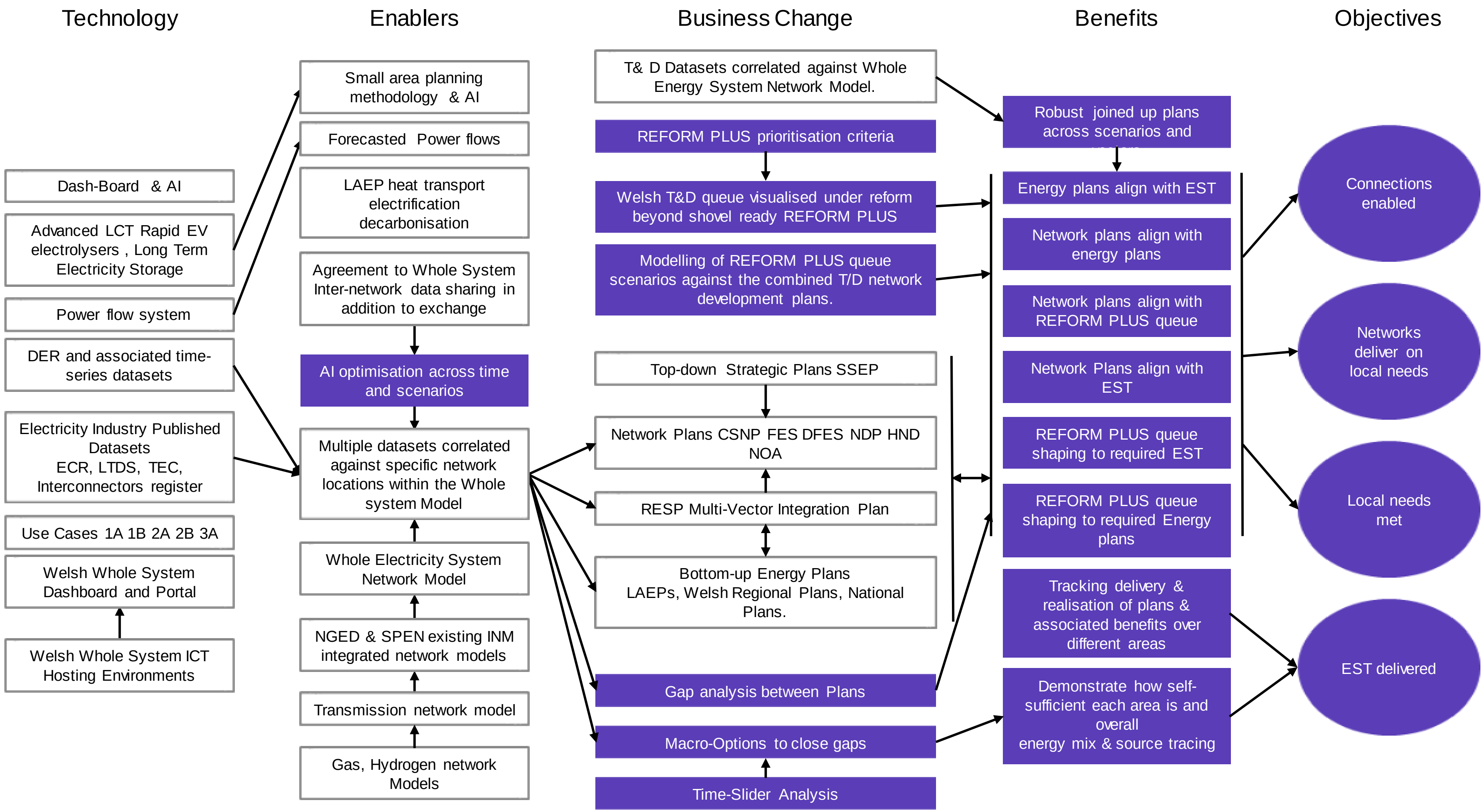

Figure 15 - Use Case 3 B Benefits Dependencies

Output is also sought as to the temporal tracking of actual transition achievement against aligned plans. Benefits include effective energy system transition delivery, through delivering on local needs with network enablement.

3.7. Multi-Stakeholder Use Case Benefits Realisation

An example user journey for Use Case 1 A is shown below showing how a user request to see the locational connection queue and network data can be supported by the digital twin intelligent network model correlating separate datasets and presenting the resulting visualisation.

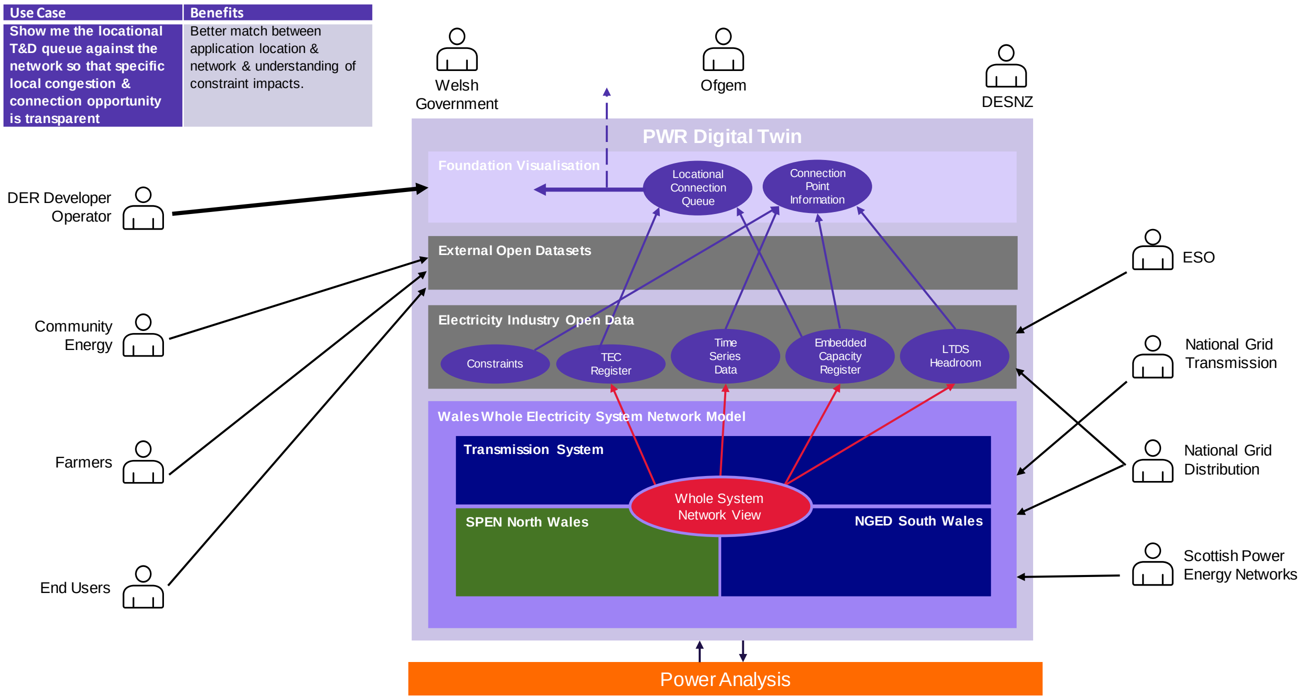

Figure 16 - Use Case 1 A Use Case Journey Diagram

At a use case level, benefits are described and summarised below:

Within each use case are several examples below of which stakeholders benefit from specific needs being delivered, with the darker colour shade on each tick indicating the primary beneficiaries.

The specific examples are clustered into the three core problem areas being addressed by the use cases as previously defined.

Use Case	Benefit	Customers	Network Operators	Developers /Operators	Welsh Government	OFGEM DESNZ
The lack of visibility, and a common understanding by stakeholders of the whole electricity system network challenges.						
Use Case 1 A Foundation						
Show me the locational T&D queue against the network so that specific local congestion & connection opportunity is transparent	Better match between application location & network & understanding of constraint impacts.	√	√	√	√	√
Is the connection queue aligned to net zero/EST pathway/LEAP?	Least cost EST delivery	√	√		√	√
How can I correlate different published datasets to my point of connection interest to reveal time-series data defined actual capacity and existing & accepted connections?	Delivering a better match between network & applications	√		√		
Which network investments will relieve which constraints to enable which connections when.	Better timing of applications	√	√	√	√	√
Whole systems foundation visualisation of network issues	Common stakeholder understanding	√	√	√	√	√
How do IDNO OHL proposals relate to network development plans?	Whole-system visibility to enable strategic decisions	√	√	√	√	√
Where are accepted tertiary connections proposed & what is the potential knock-on effect of capacity release if subject to attrition	Accelerated connections if capacity released	√	√	√	√	√
For distribution assets that have area continuance e.g. 132 kV OHL can T&D data sharing be better enabled?	Enhanced data sharing & transparency for planning		√			
Use Case 1 B Data Correlation						
What are the flexibility capabilities/track record of DER sites, and which are ANM/smart connection controlled	Maximising DER flex revenues through visibility. Enhance network operator selection through location & response.	√	√	√	√	√
Where on the network is best to connect which type of generation?	Network needs & headroom corelated with locational renewables potential.	√	√	√	√	√
Which network location/profiles offer potential for storage	Greater use of existing capacity	√	√	√	√	√
Which network location/profiles offer potential for off-setting generation constraints with decarbonisation demand?	Avoiding curtailment and hosting decarbonisation demand	√	√	√	√	√
Which network location/profiles offer potential for off-setting demand constraints with renewable generation?	Avoiding additional network capacity & hosting more renewable generation	√	√	√	√	√

Which communities have network capacity and high renewable potential	Assisting community energy scheme establishment	√		√	√	√

Table 3 – Use Case 1 Benefits Mapping

Use Case	Benefit	Customers	Networks	Developers/ Operators	Welsh Government	OFGEM DESNZ
Flexibility is not yet treated as a whole system resource and fully coordinated between transmission and distribution.						
Use Case 2 A Flexibility Coordination						
Which T&D DER have flex capabilities where, to what scale & availability timing, & which are ANM controlled, inter-trip, export limited or timed?	Improve T&D network operator access to available DER, enhanced selection on location/track record.	√	√	√	√	
What is the aggregated portfolio of flex requirements across all network operators?	Resolve flex procurement overlaps, value stack realisation, nested connectivity coordination.		√	√	√	√
What is the Whole System DER response availability including proprietary platforms, single market platform, direct with DER/end user sites.	Increase DER access to flexibility revenue streams. Enhanced selection for network operators.		√	√	√	√
At a whole-system portfolio which DER sites were selected, and which delivered response.	Take DER T&D flexibility response track record into account in forward selection planning.		√	√	√	√
Use Case 2 B ANM Curtailment/Flexibility/Off-Setting						
What is the network capacity and flex cost trade-off between curtailment and procured flex in the same network.	Optimise new smart connections against cost of T&D procured flex.		√	√	√	
Can curtailment limits as defined in SCR 404 be calculated in a more equitable way.	More accurate curtailment limits informing DER investment decisions.	√	√	√	√	√
What is the locational opportunity for generation constraint relief and curtailment avoidance through off setting with flexible demand/storage & inform engineering standards evolution.	Less renewable generation curtailment and more hosted decarbonisation demand.	√	√	√	√	√
What is the locational opportunity for demand constraint relief through offsetting with additional generation/storage.	Additional renewable generation.	√	√	√	√	√
Show which DER sites are curtailed by which constraint and when the constraint is to be released by which reinforcement.	Constraint persistence informs connection timings, and storage viability for constraint relief.		√	√	√	√
Model locations in the distribution network for new reactive, stability, security services to support the whole system.	Opportunities for network service investment and revenue streams		√	√	√	√

Table 4 – Use Case 2 Benefits Mapping

Use Case	Benefit	Customers	Networks	Developers/ Operators	Welsh Government	OFGEM DESNZ
Local area energy plans, network development plans, and the connections queue, lack alignment, leading to potential synergies being hard to identify.						
Use Case 3 A Integrated Planning						
What does a Whole Energy System Network Model for Wales look like?	Instantiated & validated Whole energy system model & connections enabled.	√	√	√	√	√
What is the effect of Welsh T&D queue reform to shovel ready.	Visualise connection queue moved to shovel ready order		√	√	√	√
What is the effect of other Energy Vector impacts on the Electricity networks?	Energy vector to electricity network touchpoints identified, and capacity & constraint effects.	√	√	√	√	√
What are the multi-vector effects on electricity Security, Stability, Inertia, Fault level, Voltage and Reactive power.	Delivery need identified for additional distribution network operational services & mitigations.		√	√	√	√
What is the alignment between the top-down energy plans, network plans, RESP integration plans, bottom-up energy plans and the cmp376 reformed queue.	Scale of Planning alignment challenge confirmed, & if current plans achieve the EST pathway.		√	√	√	√
Use Case 3 B Energy System Transition Planning						
What are the connection queue potential REFORM PLUS prioritisation criteria beyond shovel ready?	Establish front-runner criteria & test for unintended consequences.		√	√	√	√
What is the effect of connection queue REFORM Plus?	Visualisation of the locational REFORM PLUS connection queue.		√	√	√	√
What is the alignment between the top-down energy plans, network plans, RESP integration plans, bottom-up energy plans and the REFORM PLUS connection queue.	Plan gap analysis delivered & connection queue shaping potential.	√	√	√	√	√
What are the Macro network options required to close the plan gaps?	Delivery of time constrained EST whilst meeting local needs cost effectively. Strategic multi-vector integration plan alignment.	√	√	√	√	√
We need to track delivery & realisation of plans & associated benefits over different areas	Time slider capability to check transition progress and take adaptive controlling actions.	√	√	√	√	√

Table 5 – Use Case 3 Benefits Mapping