ESO Technology Advisory Council

TAC-2

5 March 2021

Meeting pack

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TAC-2 agenda

Item	Duration	Time	Topic	Presenter / lead	Notes
1	10 mins	09:00 – 09:10	Welcome and introductions	Vernon Everitt – Chair	• Opportunity for apologies from TAC-1 to introduce themselves
2	10 mins	09:10 – 09:20	Minutes of last meeting and matters arising	Vernon Everitt – Chair	• Approve terms of reference
3	10 mins	09:20 – 09:30	Business Plan summary	Craig Dyke – Head of Strategy & Regulation	
4	10 mins	09:30 – 09:40	Introduction to Role 1 (Control Centre Operations)	Gavin Brown – Power System Manager and Head of ENCC Future Design	
5	10 mins	09:40 – 09:50	Introduction to the Balancing and Network Control programmes	Graham Dolamore Ian Dytham	• Introduction to Axis collaboration tool
6	40 mins	09:50 – 10:30	Control Centre: Balancing Programme overview and technology	Graham Dolamore Sree Menon Gary White	• 20 minutes presentation, 20 minutes Q&A and discussion • Ask of TAC – input, experience, validation, advice
	10 mins	10:30 – 10:40			BREAK
7	40 mins	10:40 – 11:20	Control Centre: Network Control overview and technology	Ian Dytham Keith Eller Gary White	• 20 minutes presentation, 20 minutes Q&A and discussion • Ask of TAC – input, experience, validation, advice
8	20 mins	11:20 – 11:40	Balancing and Network Control wash-up		• Review, discussion and voting on feedback using Axis collaboration tool • Decide topics for further discussion
9	20 mins	11:40 – 12:00	Open data and digital market enablement	Colm Murphy	
10	10 mins	12:00 – 12:10	Ways of working	Vernon Everitt – Chair	• Thoughts and reflections on the first two meetings • Ideas for how they could be improved
11	5 mins	12:10 – 12:15	Next meeting and calendar	Vernon Everitt – Chair	• Confirm date and agenda for next meeting • Agree calendar
12	5 mins	12:15 – 12:20	AOB	Vernon Everitt - Chair	
		12:20	Close		

Annex

Balancing and Network Control programme two-year delivery schedules

Welcome and introductions

Item 1

TAC member introductions

Name: Teodora Kavena

Current role: Programme Manager – Smarter UK, TechUK

Name: Ulrika Wising

Current role: Global VP Customer Solutions, Shell New Energies

TAC member introductions

Name: Judith Ward

Current role: Associate, Sustainability First

Name: Emma Pinchbeck

Current role: CEO, Energy UK

Minutes of last meeting and matters arising

Item 2

Minutes of last meeting and matters arising

We will use this section of the agenda to:

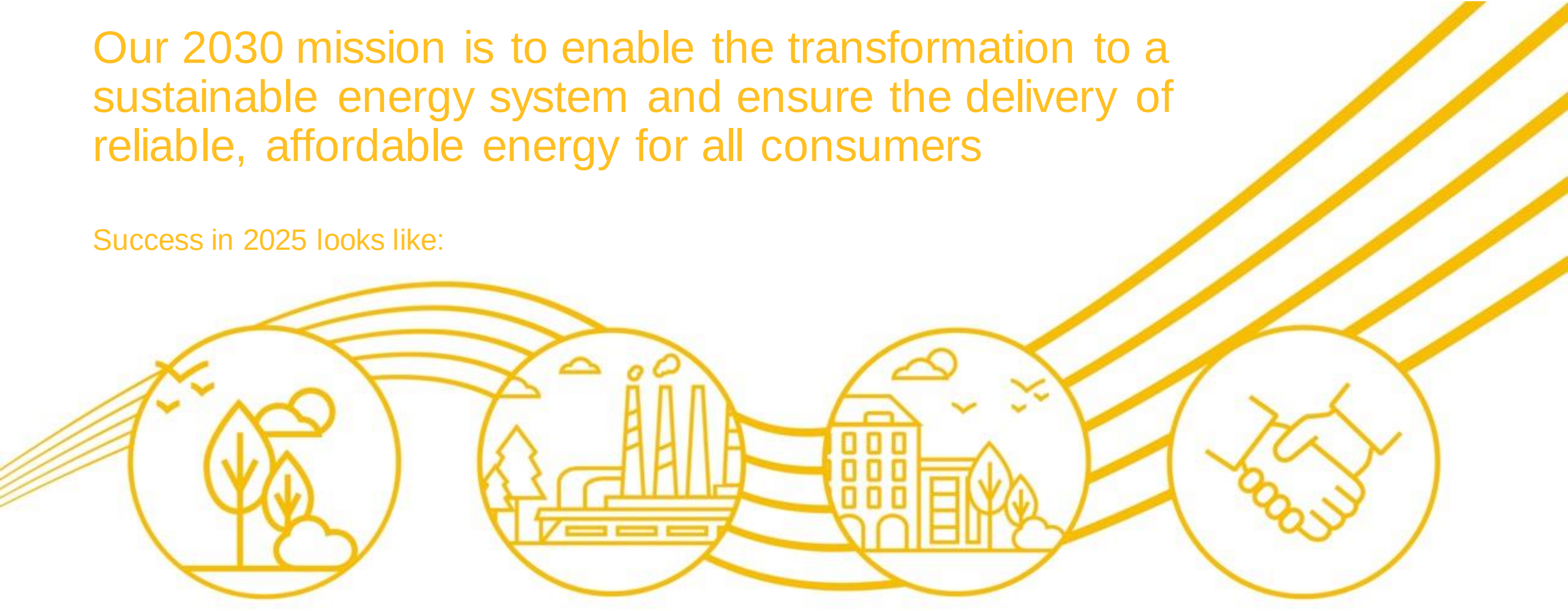
- Agree the minutes from TAC-1
- Discuss any comments on the terms of reference and approve them

Business Plan summary

Item 3

Our 2030 mission is to enable the transformation to a sustainable energy system and ensure the delivery of reliable, affordable energy for all consumers

Success in 2025 looks like:



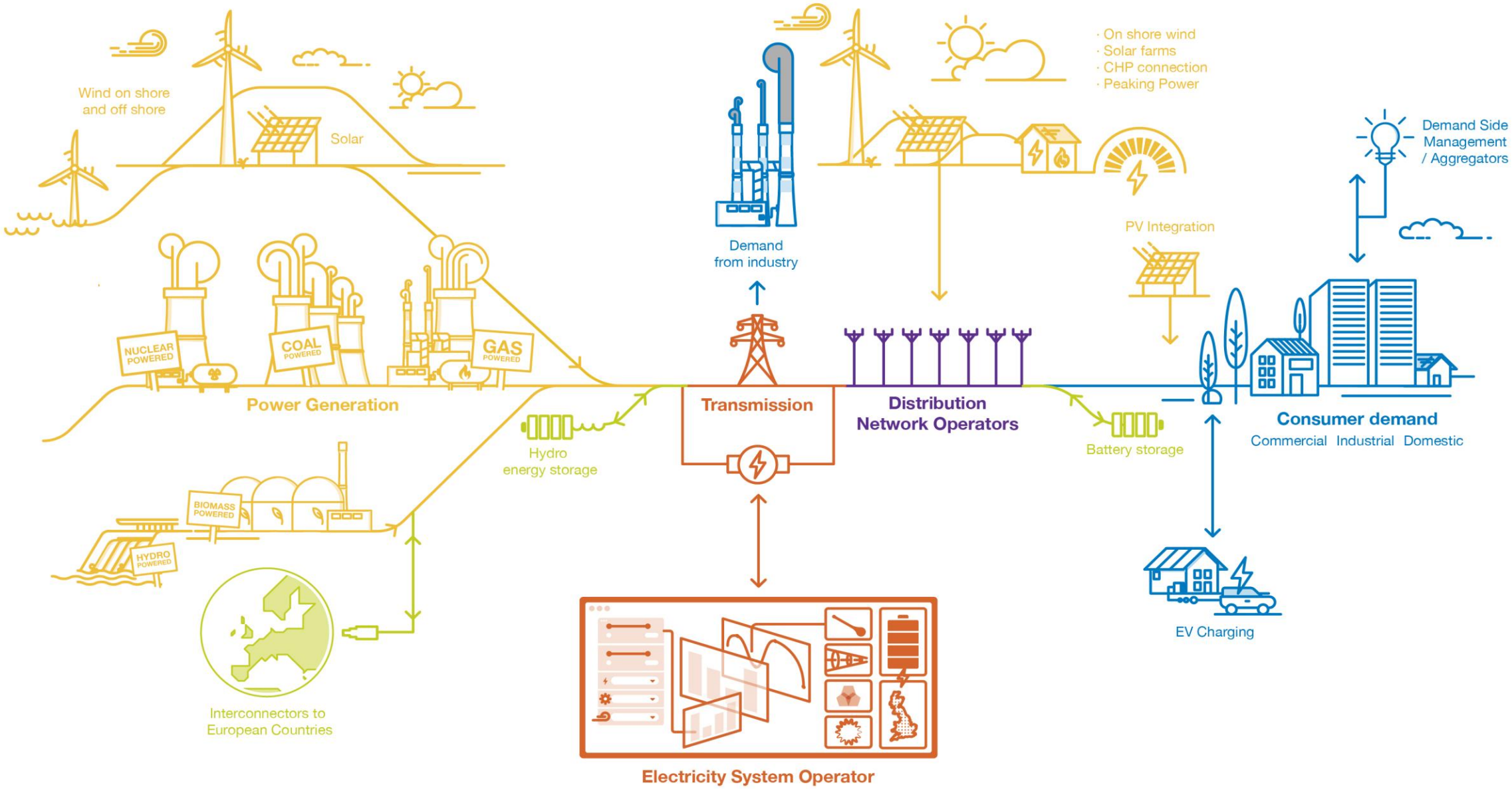
An electricity system that can operate carbon free by 2025

A whole system strategy that support net zero by 2050

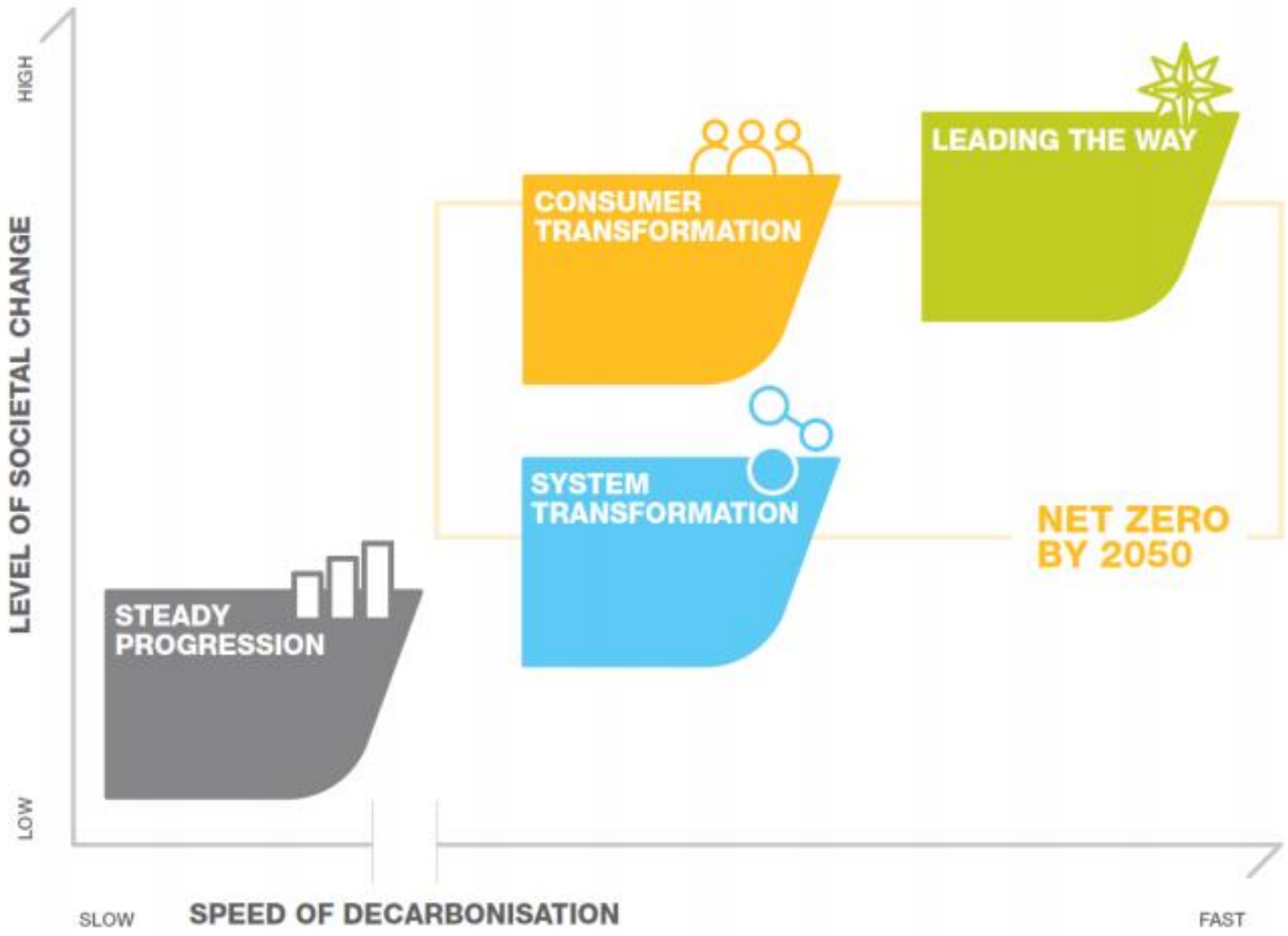
Competition everywhere

The ESO is a trusted partner

Our business plan will enable us to manage the energy system of the future…



…and provide flexibility to respond to new technology and policy



Consumer Transformation

- Electrified heating
- High energy efficiency
- Demand side flexibility

System Transformation

- Hydrogen for heating
- Lower energy efficiency
- Supply side flexibility

Leading the Way

- Significant lifestyle change
- Mix of hydrogen and electrification for heat

Steady Progression

- Minimal behaviour change
- Decarbonisation in power and transport but not heat

Our RIIO-2 Business Plan is ambitious

Role and overall grading	Delivery schedule area	Ofgem delivery schedule ambition grading
Role 1 – Control centre operations (Ambition 5/5)	1a System operation	Exceeds
	1b System restoration	Exceeds
	1c Transparency, data and forecasting	Exceeds
Role 2 – Market development and transactions (Ambition 4/5)	2a Market design	Exceeds
	2b Electricity Market Reform	Exceeds
	2c Industry codes and charging	Meets
Role 3 – System insight, planning and network development (Ambition 4/5)	3a Connections and access	Exceeds
	3b Strategy and insights	Exceeds
	3c Long term network planning	Meets

£250 million annual cost of the ESO.

Consumer bills £3 lower.

£2 billion net consumer benefits in RIIO-2

£400 million IT investment

Role 1 – Control centre operations

1a System operation

- **Transforming our control centre architecture and systems**, to be able to operate a zero carbon electricity system by 2025
- **Upgrading our control centre training and simulation capabilities**, to be able to operate the system under range of scenarios, in partnership with the wider energy industry

1b System restoration

- **Evolving our restoration procedures** to ensure the reliance and reliability of the future and ensuring they meet the expectations of consumers in a highly-electrified world.

1c Transparency, data and forecasting

- **We will adopt the Energy Data Task Force recommendations** including "presumed open"

Role 2 – Market development and transactions

2a Market design

- **Build the future balancing service and wholesale markets** – to attract the volume of flexibility we will need in the future, to achieve the UK's commitment to net zero emissions by 2050

2b Electricity market reform

- **Transform access to the Capacity Market** – to deliver security of supply with a plant mix that supports the UK's 2050 carbon target at an appropriate cost to consumers.

2c Industry codes and charging

- **Develop codes and charging arrangements that are fit for the future** – that will facilitate the rapid change needed to deliver the low carbon energy system of the future. Code governance will be seen as an enabler of change, not a barrier

Role 3 – System insight, planning and network development

3a Connections and access

- Working more closely with Distribution Network Operators (DNOs) and Transmission Owners (TOs) to **streamline the connection process**, so that parties can take a more efficient, whole electricity system view
- **Developing a whole electricity system approach** to accessing networks, therefore tackling an area of significant consumer cost.

3b Strategy and insights

- **Leading the debate** on decarbonisation of the GB energy industry, harnessing our significant expertise to identify ways to achieve the 2050 net zero target, and policy decisions that must be made

3c Long term network planning

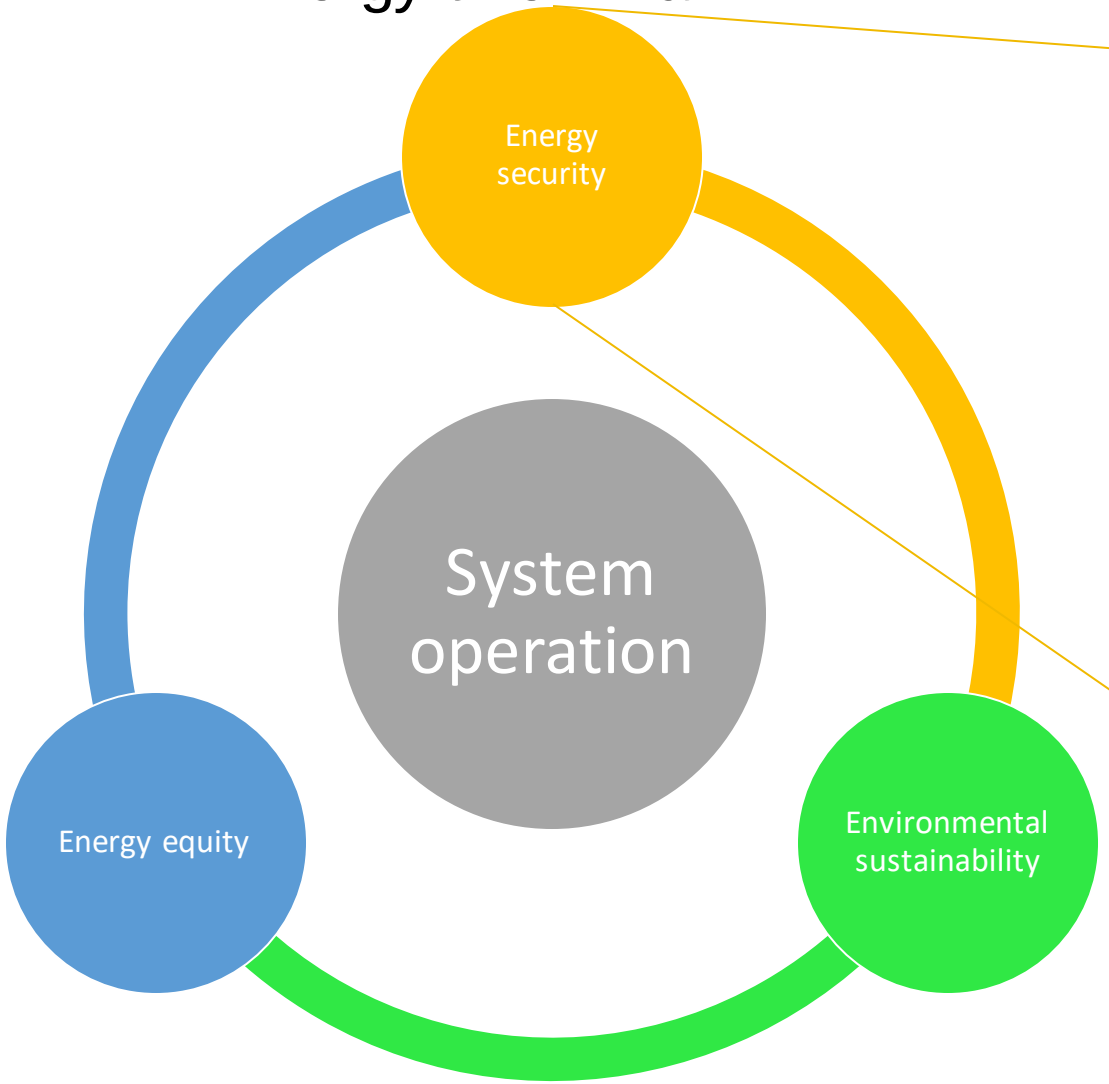
- **Deliver new competitive processes** - so asset and non-asset based solutions can compete to meet future system needs.
- **Extend and enhance the Network Options Assessment (NOA) approach** - bringing the significant cost savings the NOA has already achieved for consumers to other areas, such as end of life asset replacement decisions

Introduction to Role 1 – Control Centre operations

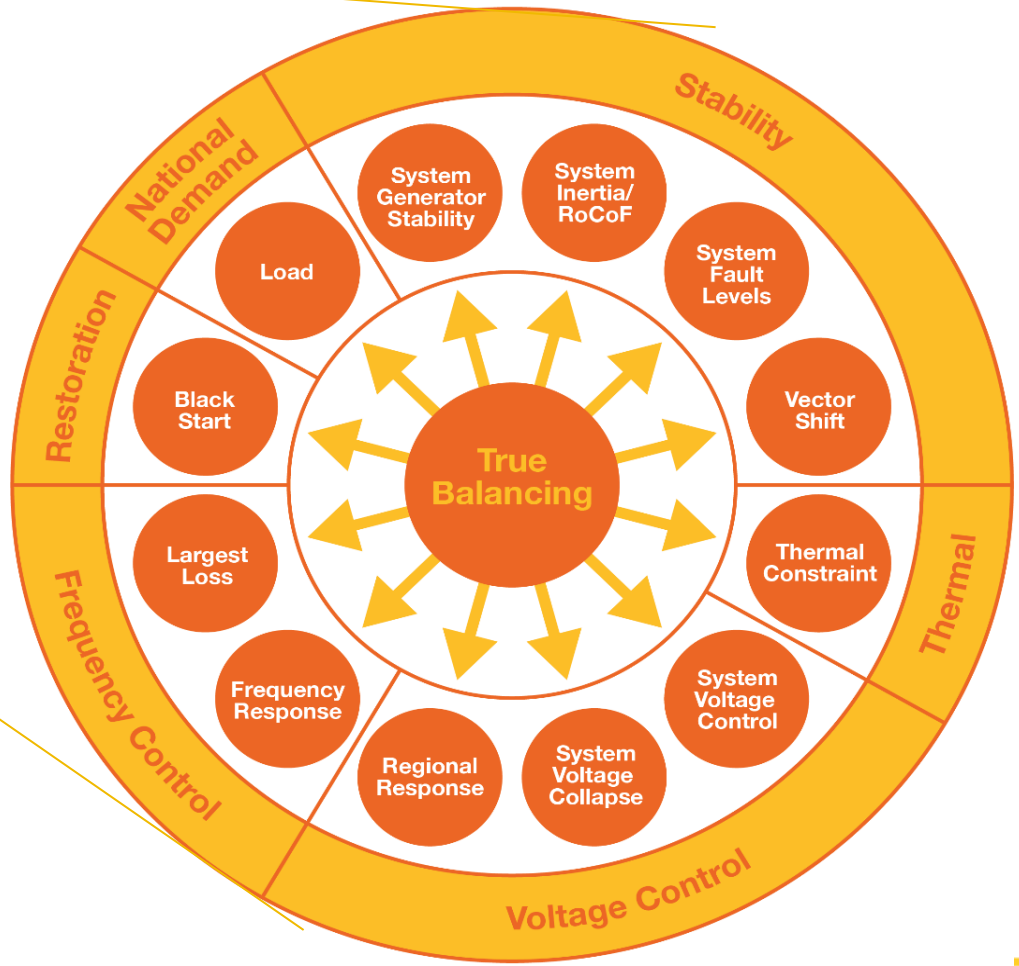
Item 4

In real-time, we need to manage the energy trilemma and a range of operability challenges

Energy trilemma

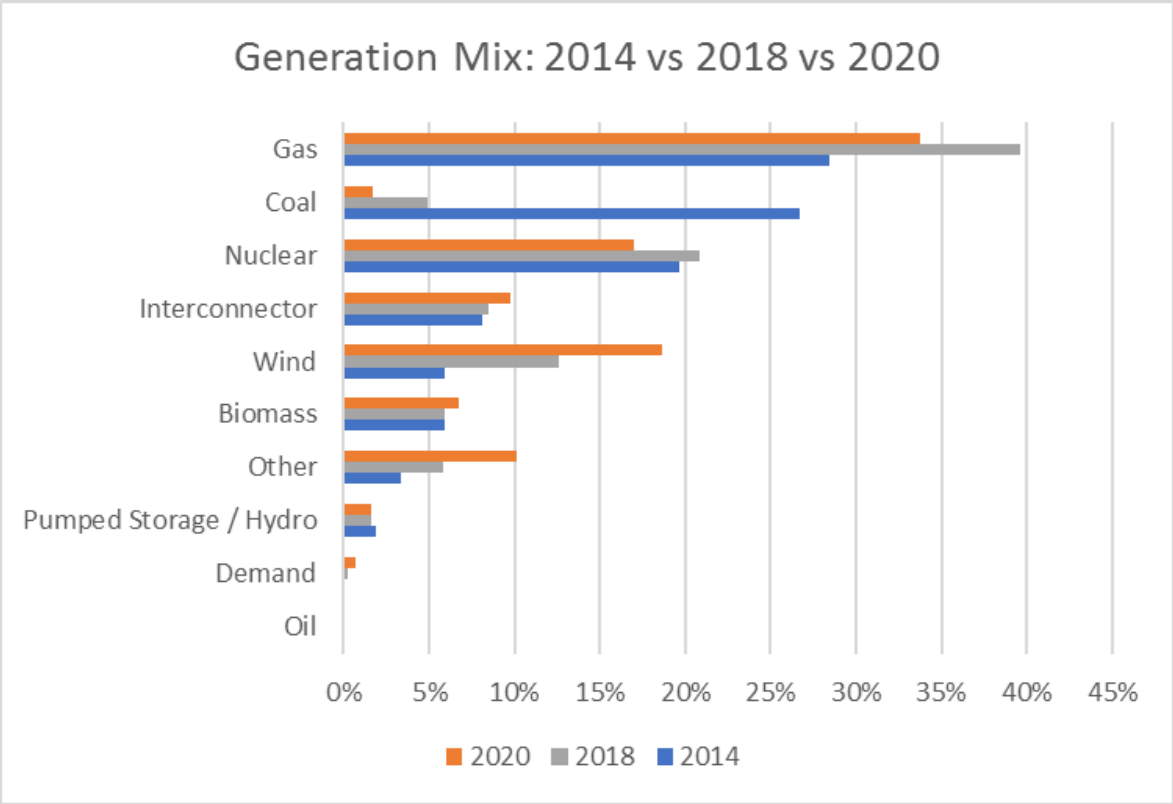


Operability challenges

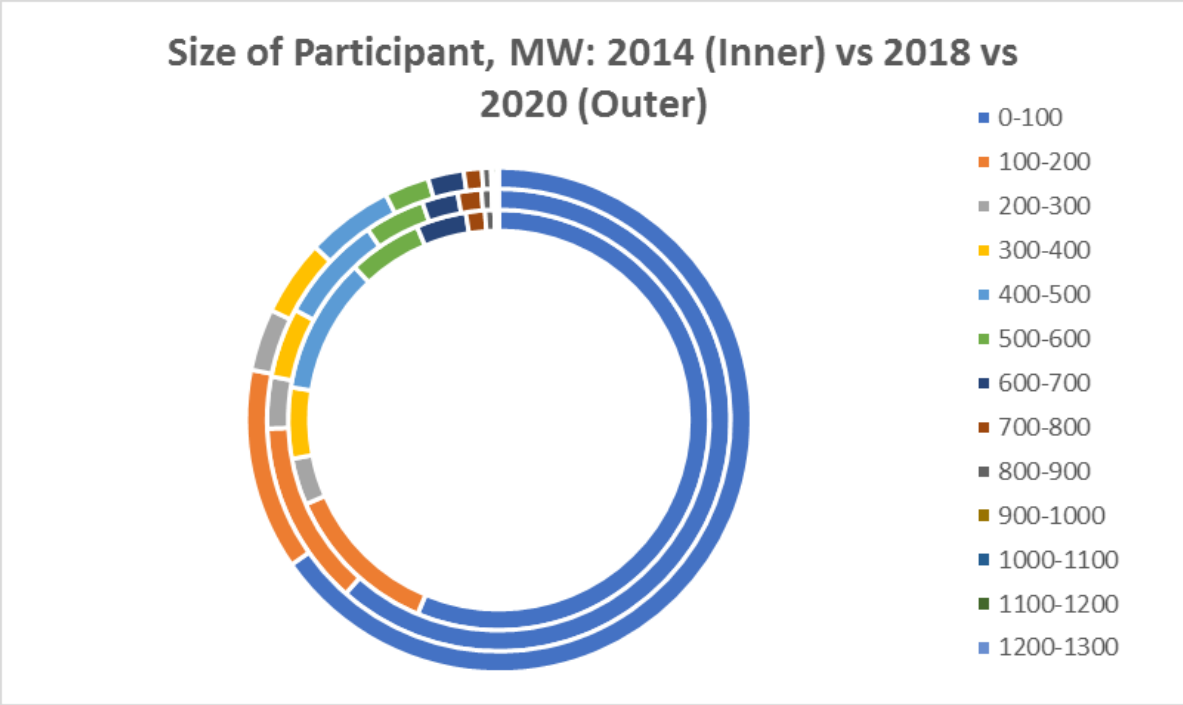


This is becoming more challenging with increased variable generation and decentralisation

- Large increase in wind and solar
- Dramatic decrease in coal, partly offset by gas



- 28% of installed capacity is at distribution level



Current control room process for one settlement period: Day-ahead to real-time

Procurement
- Procure balancing services via auctions and contracts

Forecasting
- Forecasts - demand, wind, solar
- Historic generation and demand data
- TV pick-ups
- Constraints
- Largest loss

Calculate reserve level

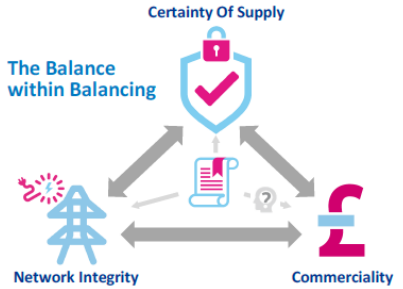
Create resource stack
- Comparing supply and demand
- Run margin analysis

Day-ahead → T-24 hours → T-18 hours → T-12 hours

Procurement | Forecasting | Scheduling

Validate SOP
- Generation changes
- Demand changes
- Forecast errors
- "What if" analysis
- Constraint analysis

Publish System Operating Plan
- Generation and demand forecasts
- Margin/shortfall
- Reserve
- Largest loss



Iterative scheduling
- Trading
- Commercial contracts
- Updated forecasts
- Updated constraint and margin analysis

Dispatch ← T-4 hours ← Scheduling ← T-8 hours

Generate advice instructions
- Confirm commitment decisions
- Re-optimise if possible

Sync data prior to instruction
- Balancing Mechanism sync/desync instructions
- Ancillary service instructions

Final instruction and monitoring
- Assess final supply and demand from physical notifications
- Allocation generation targets to zones
- Issue bid-offer acceptances (BOAs) to meet targets
- Review, monitor and re-instruct as needed

T-2 hours → T-89 minutes to T-2 minutes →

Dispatch | Dispatch

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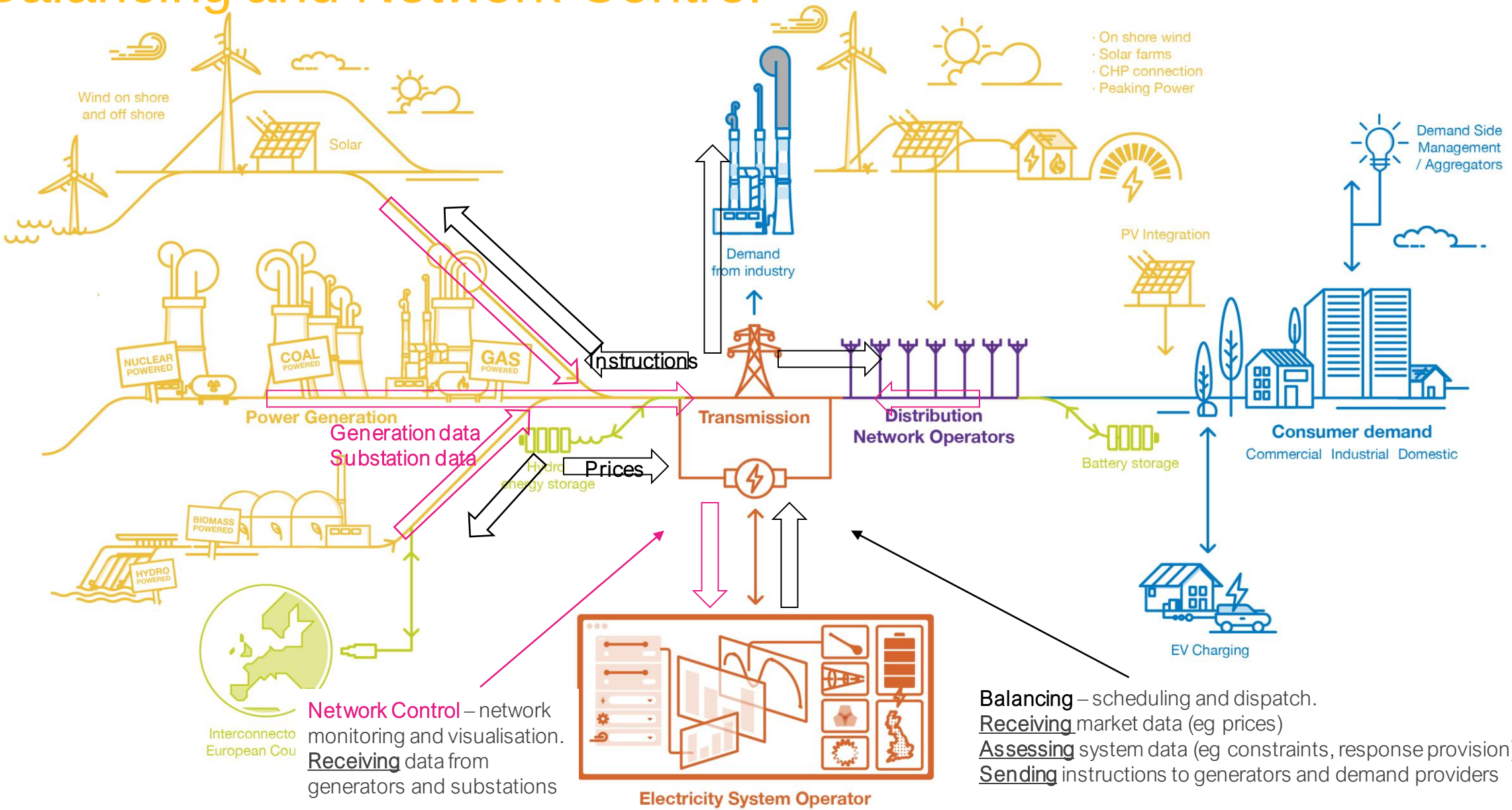
Introduction to the Balancing and Network Control Programmes

Item 5

Balancing and Network Control

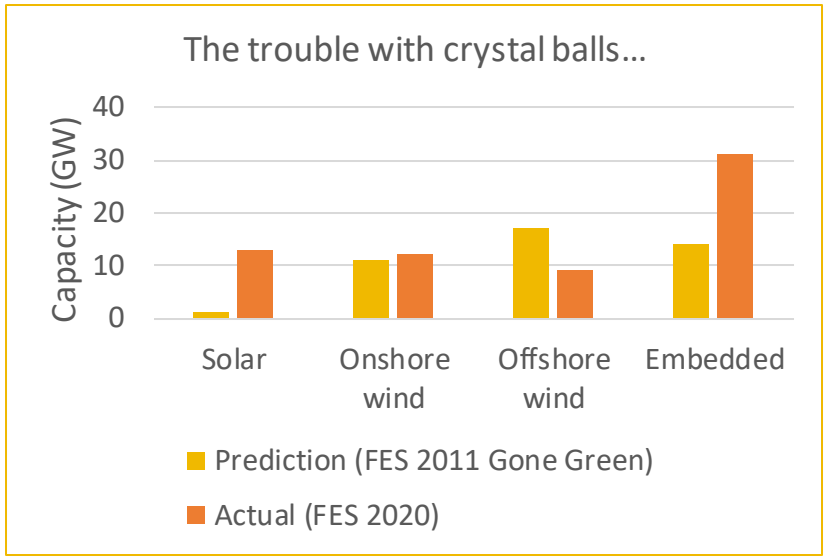


Network Control – network monitoring and visualisation.
Receiving data from generators and substations

Balancing – scheduling and dispatch.
Receiving market data (eg prices)
Assessing system data (eg constraints, response provision)
Sending instructions to generators and demand providers

We value your expertise and input

- We need to transform to be a digital and data-orientated company
- To do so, we must change internally – **people, process and technology**, and will adopt the **Agile** approach →→
- The Balancing and Network Control programmes are two of our major transformation programmes to do this
- We will seek TAC input on these programmes through the project lifecycles, focusing on:



A waterfall approach could lead to sub-optimal outcomes if we finalise requirements right now

People

- How do we move quickly but keep the pace of change manageable for the control room?
- How do we manage risk aversion with CNI systems?

Process

- How does a regulated, connected utility adopt a start-up mentality?
- What are the pitfalls of applying Agile with legacy systems and technology?

Technology

- Insight of major technology projects
- Help us understand the future of real-time data within the industry
- Offer advice on how to make best use of cloud computing, including secure cloud
- Partnerships with suppliers and academia

Accenture have kindly agreed we can use the Axis collaboration tool to capture feedback as we go – **challenges, considerations and solutions**

Control Centre: Balancing Programme overview and technology

Item 6

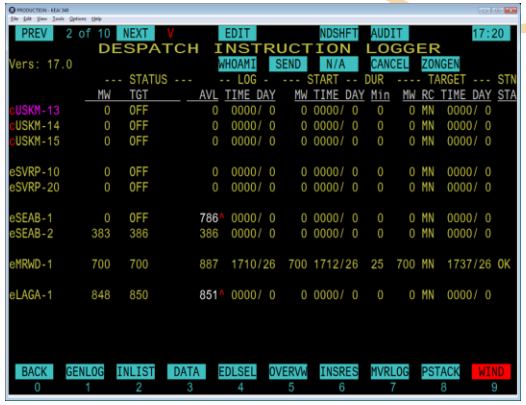
What is Balancing?

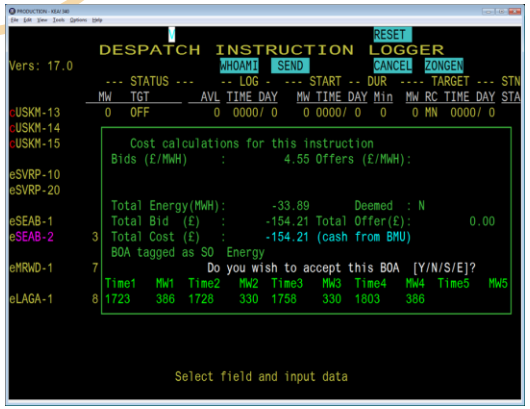
Key technology
- Oracle database
- CPLEX scheduler
- Fortran dispatch optimiser

Inputs
- Generation data
- Demand forecasts
- Response and reserve provision
- Transmission status (eg constraints)
- Market data (eg prices)

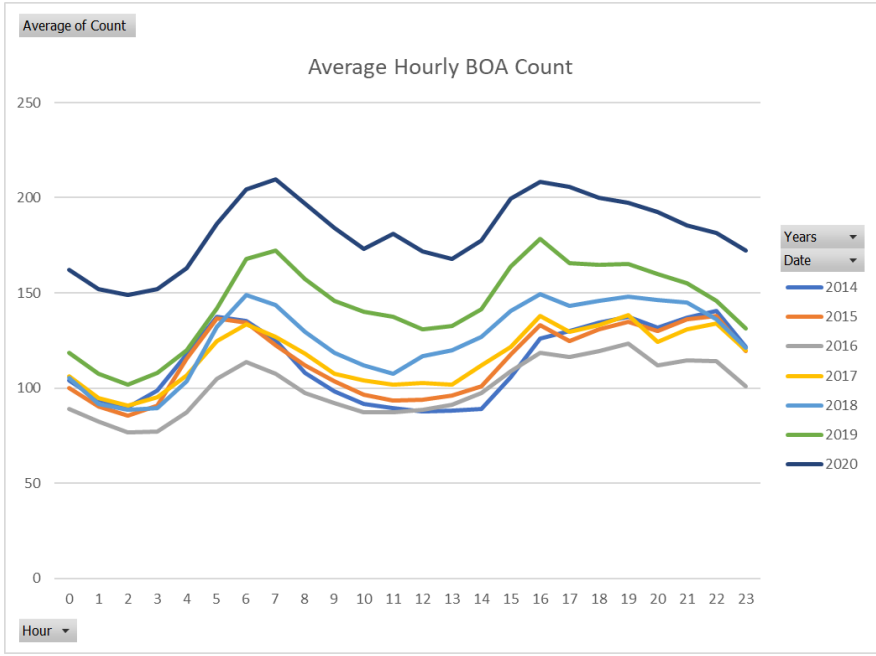
Process
- Scheduling
- Manual dispatch
- Need for redundancy

Outputs
- Instructions (Bid-Offer Acceptances)
- Current spend of £1.6bn + per year

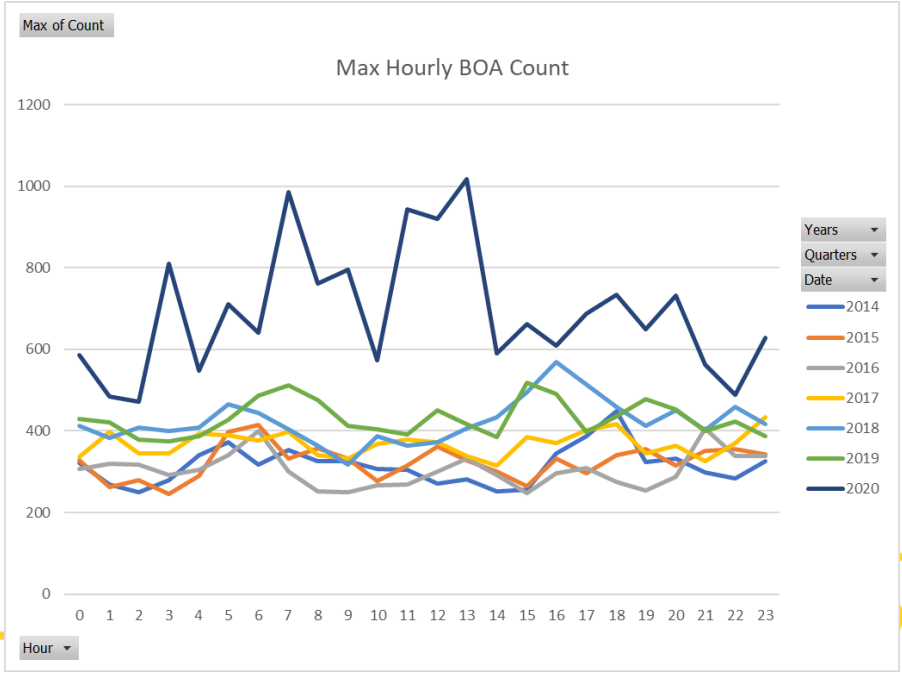




Control room user interfaces, including BOA input screens (left and centre) and BOA graph (right)



We typically send 150-200 instructions per hour…but some days we send an instruction every 3 seconds – <u>manually!</u>



Future Control Tools | Balancing Transformation

Energy System

- ZERO CARBON SYSTEM OPERATION
- 1 MW DISPATCH CAPABILITY
- LEVEL PLAYING FIELD FOR ALL TECHNOLOGY
- GREATER LEVELS OF AUTOMATION
- COMPETITION IN ALL MARKETS
- TRANSPARENCY IN DECISION MAKING

Technology

- MODERN CONTROL ROOM SYSTEMS
- ACCESSIBLE PLATFORMS
- MODULAR, MICROSERVICE ARCHITECTURE

Delivery

- CO-CREATION WITH THE INDUSTRY
- INCREMENTAL AND ITERATIVE
- AGILE APPROACH
- USING EXTERNAL EXPERTISE
- RESPECTING CONTROL ROOM DEMANDS

UNLOCKS £2BN CONSUMER BENEFIT

ENABLES ZERO-CARBON OPERATION

FACILIATES NEW MARKET PARTICIPANTS AND TECHNOLOGY

FLEXIBLE FOR FUTURE UPGRADES

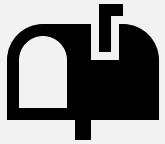
OPERATE THE FUTURE ENERGY SYSTEM

UNDERPINS THE RIIO-2 TRANSFORMATION

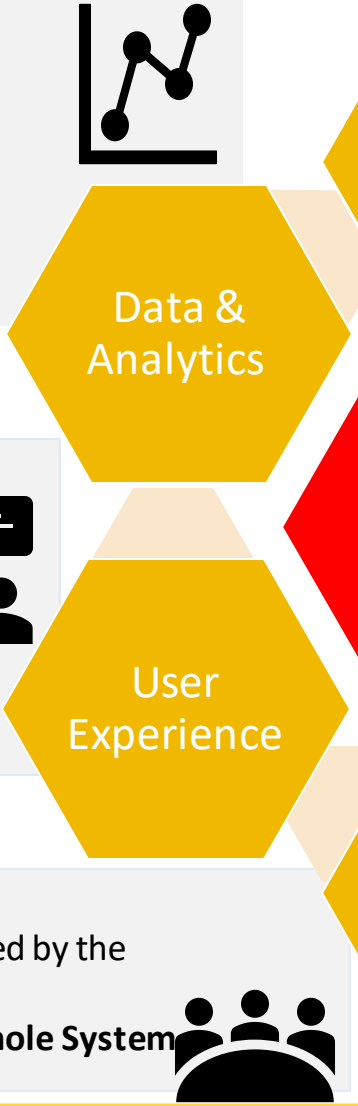
Building the open balancing platform

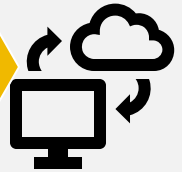
What are the problems today?

- **Data quality** leading to additional steps across all business processes
- **Information volumes** and manual data cleansing in the time required –manual process
- **Transparency of actions** – not a prerequisite feature of the systems. Manual or secondary systems required



- **Slow to respond to change** - Current speed of change fails to deliver/ keep up with the market changes
- **Silo'ed Projects** – Project coordination impared because of multiple systems of varying vintage.





- **Legacy systems with limited scalability**
- Decreasing knowledge of existing Balancing systems
- **Multiple disparate systems doing similar tasks**
- **Aged systems => Technical Debt**

- **GUI are not intuitive and dated**
- **ENCC access multiple data sources & applications**
- Video wall displaying limited operational data
- **MP experience** – additional costs to backward engineer and connect

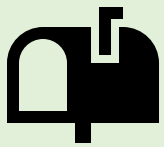
- 300+ User defined applications
- **Workarounds and manual process make balancing complex across**:
- Situational awareness improvements required

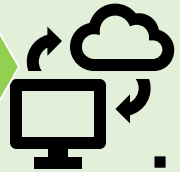
- **Services are not co-optimised**
- Current process improvements impaired by the technology
- Existing optimisers **not suitable for Whole System decisions (DER's etc)**

Where do we want to be in 2025?

- Market provides accurate data
- Systems that can handle increased volumes
- **Data-driven mindset**
- **Transparency of Actions readily available**

- Able to flex with new technology and changing policy
- Products co-ordinated across markets e2e solution (registration=>balancing=>settlements)





- **GUI are intuitive and user friendly**
- Flexible Operator UX allowing all data to be displayed
- **Standard Connection experience**

- Modern systems that can adapt with increased number of market participants and changing market products
- Volume based dispatch
- Automation and decision support reducing the Human decision variable

- Integrated balancing capability
- Workarounds or bespoke user tools quickly incorporated into main capability
- High levels of situational awareness informing decisions

- **Services co-optimised**
- Zonal approach for optimisation is efficient
- New optimisers that are **suitable for all MPs**

Balancing Transformation – Building Foundations

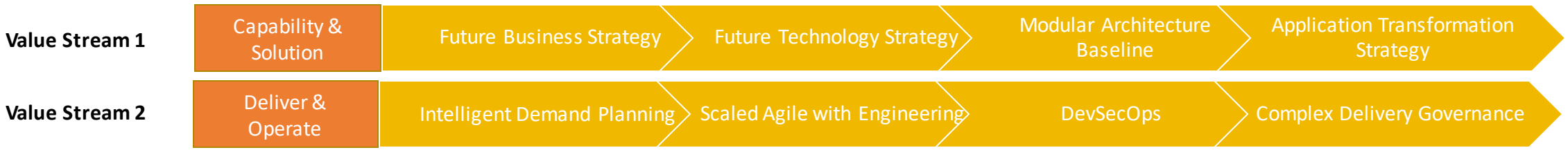
Transformation Enablers

- Define capabilities that business need and by when
- Determine technologies required to build the new Balancing platform
- Develop transform & transition journey from current to new balancing platform
- Define ways of working to deliver large scale and complex transformations incrementally
- Define governance required to deliver complex and large-scale transformations
- Define process to manage demand on current and the new balancing platform
- Define operating model to support the business capabilities enabled by the new platform

Development Enablers

- Develop a robust solution architecture for the new Balancing platform
- Build the base platform(s) for solution development
- Define capabilities/features for new Balancing platform and build the product backlog
- Complete delivery lifecycle methodologies, associated procedures and practices that support incremental delivery
- Derive a programme and solution development team structure that supports incremental delivery
- Obtain feedback from customers and continuously improve the features as the capabilities and architecture evolves
- Populate the backlog with features and user stories for the first iteration

Value Streams represent the series of steps that an organization uses to implement Solutions that provide a continuous flow of value to a customer



Balancing Roadmap

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Q3-4 – Balancing foundation specification work starts

Q4 – Balancing Roadmaps produced and published

- Overall Balancing Roadmap published, following TAC input
- Internal baseline technology roadmap
- Internal baseline functional capability roadmap

Q3-4 – Test with Technology Advisory Council

Q1-2 – build development environment and foundation infrastructure

TBC – develop sandbox testing environment

Q4 – future system architecture defined
Updated Roadmap developed with TAC and published

Q1 – migration roadmap development started

Ongoing – development of application components using production environment and sandbox

2020/21 → 2021/22 → 2022/23 → 2023/24 → 2024/25 → 2025/26 → 2026/27

Solution investigation work

Agile build of modular design

Agile build of modular design

0%

5%

60%

25%

80%

Zero-carbon operation ability

100%

Outcome:

- Clear 5 year visibility of our plans supported by TAC.
- Opportunities for rationalisation in end-to-end balancing process identified to inform system architecture and future operating model
- Understanding of the priority system issues to solve
- Understanding of current and future technology available for future system development

Outcome:

- Key future architecture designs made
- Sandbox environment developed
- Foundational infrastructure built and development environment established

Q4 – updated roadmap developed with TAC and published

Q4 – Balancing transformation complete

TBC – deliver first application components

Q4 – updated roadmap developed with TAC and published

Outcome:

- Scaled agile approach to development underway
- First application components delivered and aggregated with new control centre architecture

Outcome:

- Ability to schedule and dispatch all parties 1 MW and above
- Integrated dispatch across all platforms (including BM and PAS/ASDP)
- Increased automated dispatch capability
- Minute-by-minute balancing
- Rapid on/off balancing
- Training and simulation integrated with enhanced balancing tools
- Digital twin capability established across balancing tools

Outcome:

- Transform situational awareness tool developed
- Digital twin capability established across control centre
- Real-time study tools
- Greater resilience to poor data

Q4 Network control transformation complete

Q4 – updated roadmap developed with TAC and published

Outcome:

- Benefits: £152m*
- Enable fast response in zero-carbon system
- Enhanced cyber security systems

*calculated as net cumulative benefit (i.e. minus total investment cost) across 5 years for all 6 benefit categories for A1 Control Centre Architecture and Systems. Note this includes benefits for both Balancing and Network and Control.

Map key:

- % Progress/ benefit tracker
- Outcomes
- RIIO-2 BP commitments
- New/ supplementary info

Balancing Programme discussion

- Questions
- Review of challenges, considerations and solutions (from Axis tool)
- Discussion

Control Centre: Network Control overview and technology

Item 7

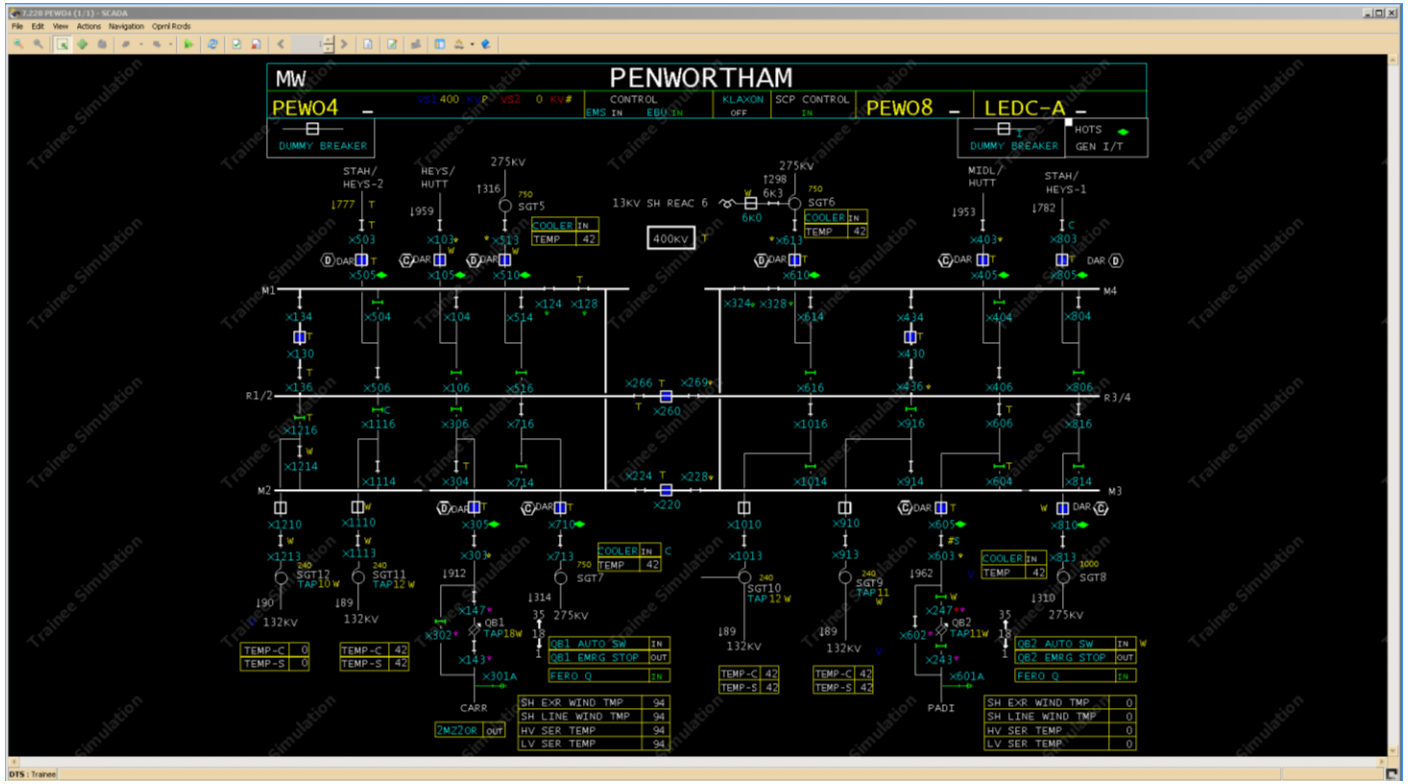
The current system – Integrated Energy Management System (iEMS)

- PowerOn Reliance system supplied by GE

- Gathers and displays real time data (voltage levels, power flows and plant states) from substations all over the country

- Allows control of plant in remote substations

- Processes data and transmits it to other systems e.g. Balancing and Energy Forecasting tools.



How does it work?

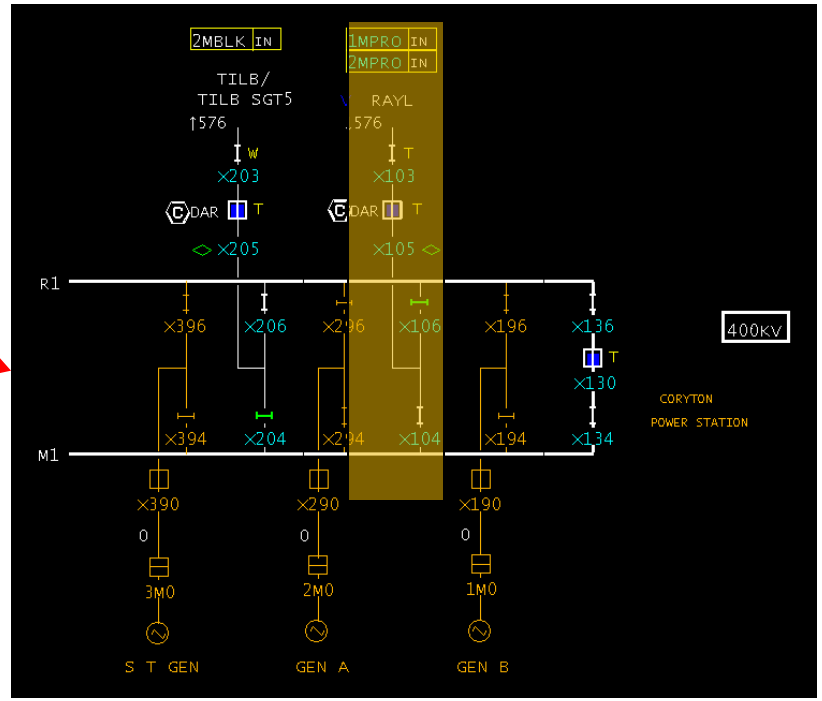
Key considerations

- **Data packets received**: billions per day
- **Redundancy**: needs to work in a restoration situation

Bay controller reads values from transducers of one bay of substation

Substation Control System collates data from all bays at the site

IEMS scans SCSs at all GB substations



Who uses the current system?

- **Electricity National Control Centre (ENCC)**
  - System operation
- **Transmission Network Control Centre (TNCC)**
  - Operational Switching
  - Safety Switching
  - Response (alarm management)
- **Planning and Analysis teams**
  - Real time studies and queries
  - System topology
  - Post-event analysis
- **Database teams**
  - SCADA data amendments
  - PNA data amendments
- **CNI teams**
  - Support the hardware and software
  - Responsible for software enhancements

What are the problems today?

- Real-time data has to flow through iEMS system to reach other tools (e.g. Balancing)
- Real-time data protected within iEMS tools – **not available for wider use**
- Analysis suite not aligned with latest industry developments

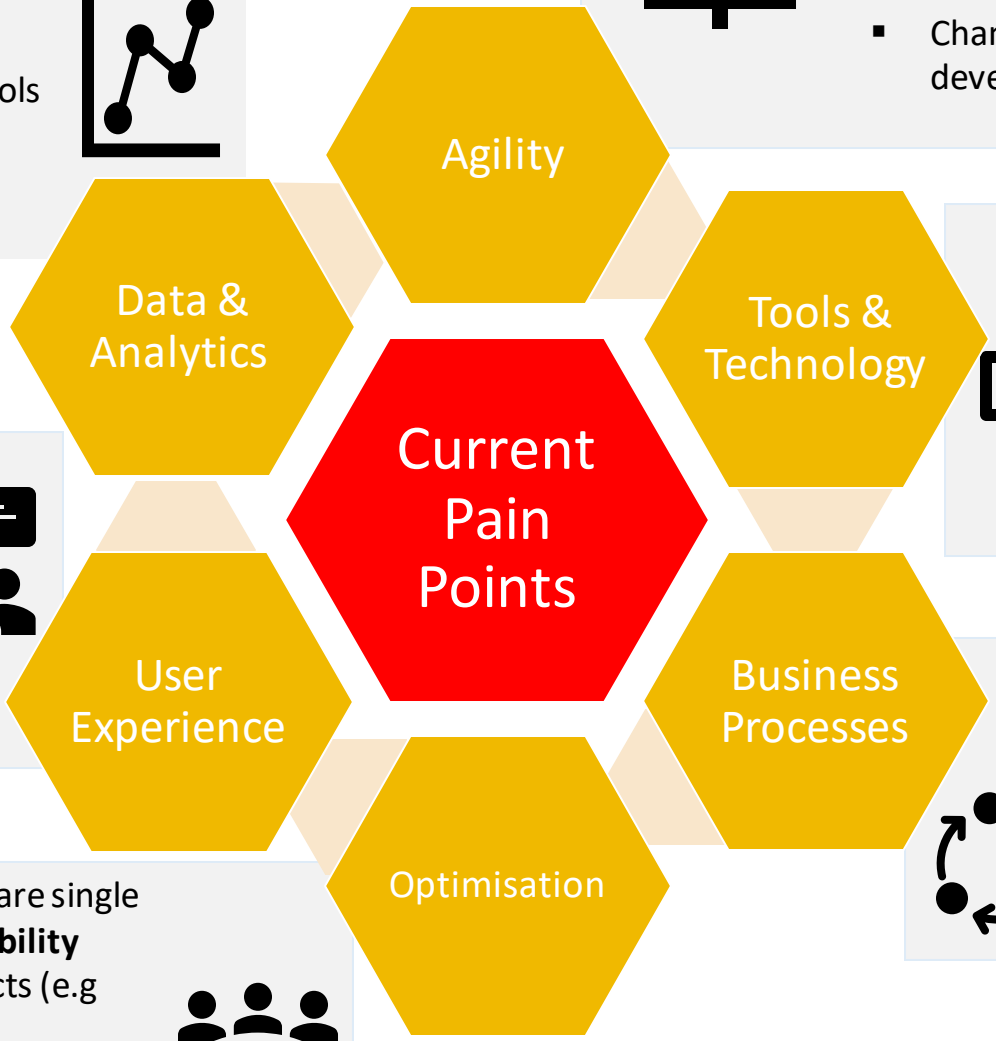
- **Refresh / replace cycles take 5 years**, with kit often close to end of support life within a similar timeframe
- Changes require significant periods of development with GE

- **Ageing system** with end of support issues
- **Decreasing resource availability** with legacy experience

- **GUI are not intuitive** and dated
- User experience compromised by having to perform multiple functions of a shared product
- Interface relies on user to interpret alarms to understand what situation the system is in

- Many custom software additions that are expensive and difficult to maintain
- **Resource intensive** processes to update models and user interface

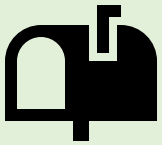
- Training and simulation environments are single snapshot and **lack real-time data capability**
- **Very little integration** between products (e.g thermal ratings, protection schedules)

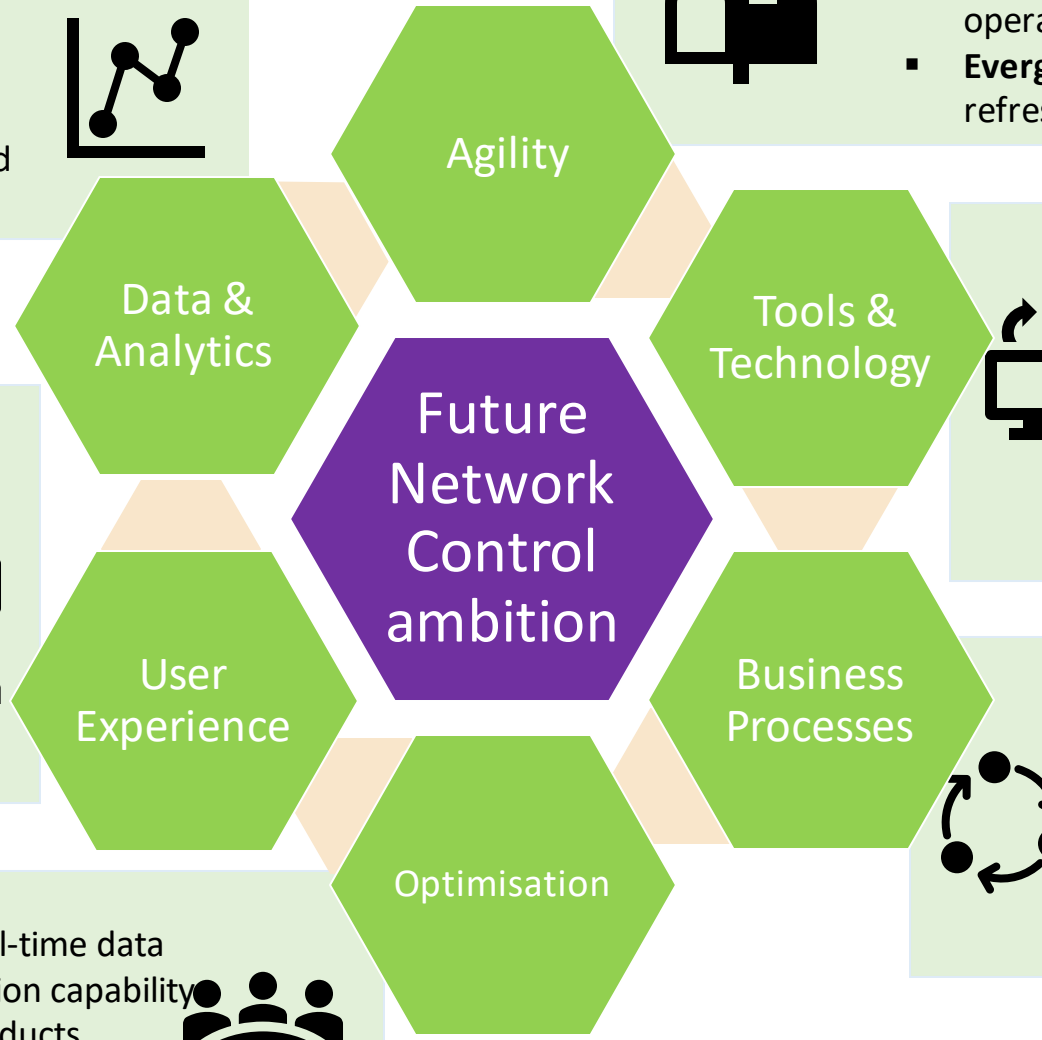


Where do we want to be in 2025?

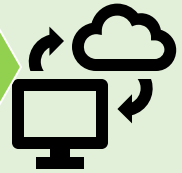
- Real-Time data can be made a**ccessible to all through** common data platform
- Streaming real-time analytics within products
- Powerful network analysis tools focused on providing **situational awareness**

- **Modular design** can be modified and maintained with no impact to real-time operations
- **Evergreen environment** that is under constant refresh cycle





- **Standardised connectivity** (e.g. APIs) to allow greater volume of third party apps to be utilised
- **Use of cloud based computing** to improve processing power when needed
- **Modern technology** increases resource pool availability

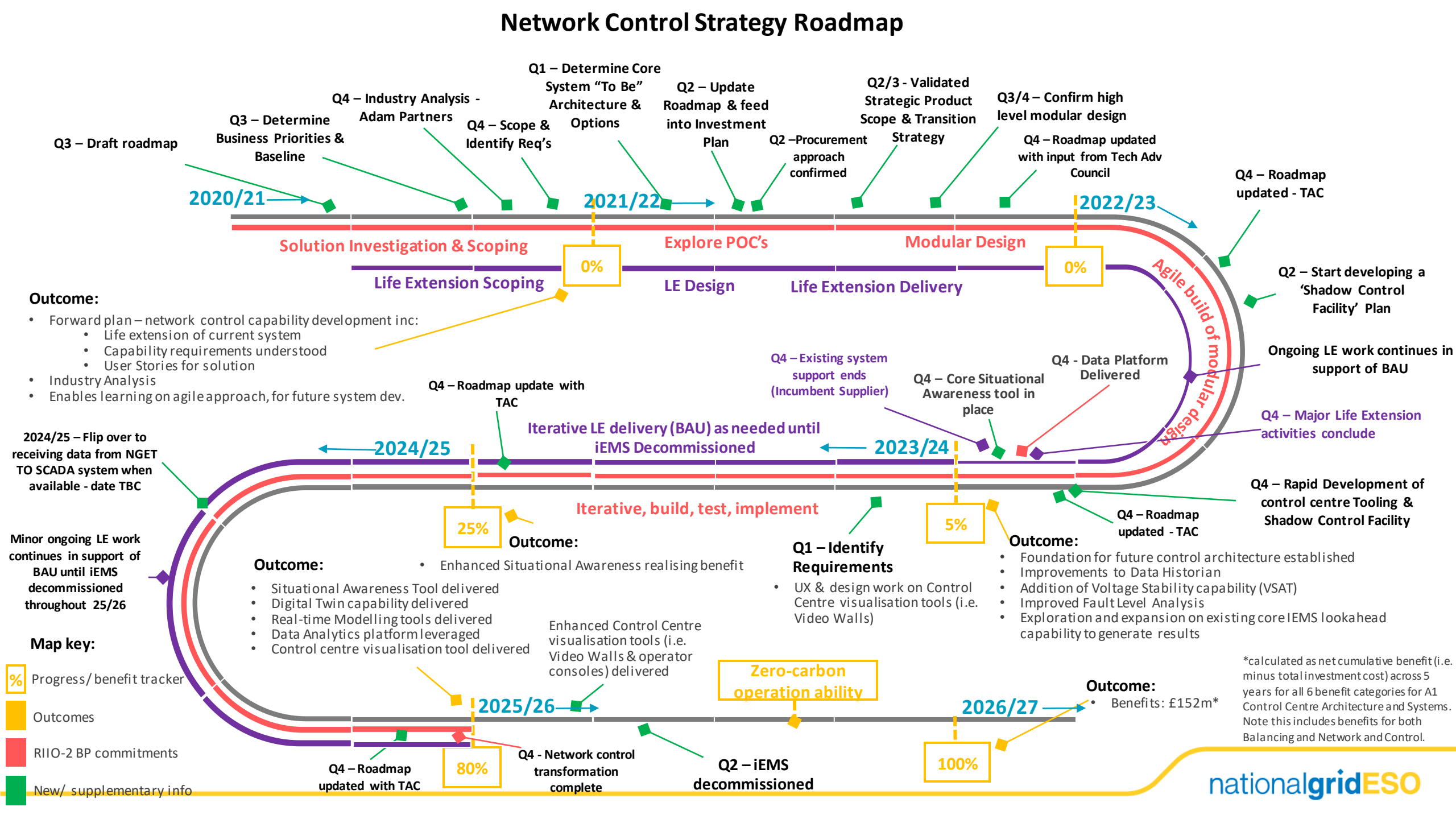


- GUI are **intuitive** and user friendly
- Product separated from NGET and focused on Situational Awareness
- Single integration layer links Balancing and Network Control products

- **Partnership** with suppliers that ensures custom user requests are integrated into standard product
- Manual work intensive processes replaced by **automation**

- **Sandbox environments** that use real-time data to enhance our training and simulation capability
- Integration with other company products

Network Control Strategy Roadmap



*calculated as net cumulative benefit (i.e. minus total investment cost) across 5 years for all 6 benefit categories for A1 Control Centre Architecture and Systems. Note this includes benefits for both Balancing and Network and Control.

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Network Control discussion

- Questions
- Review of challenges, considerations and solutions (from Axis tool)
- Discussion

Balancing and Network Control wash-up

Item 8

Balancing and Network Control wash-up

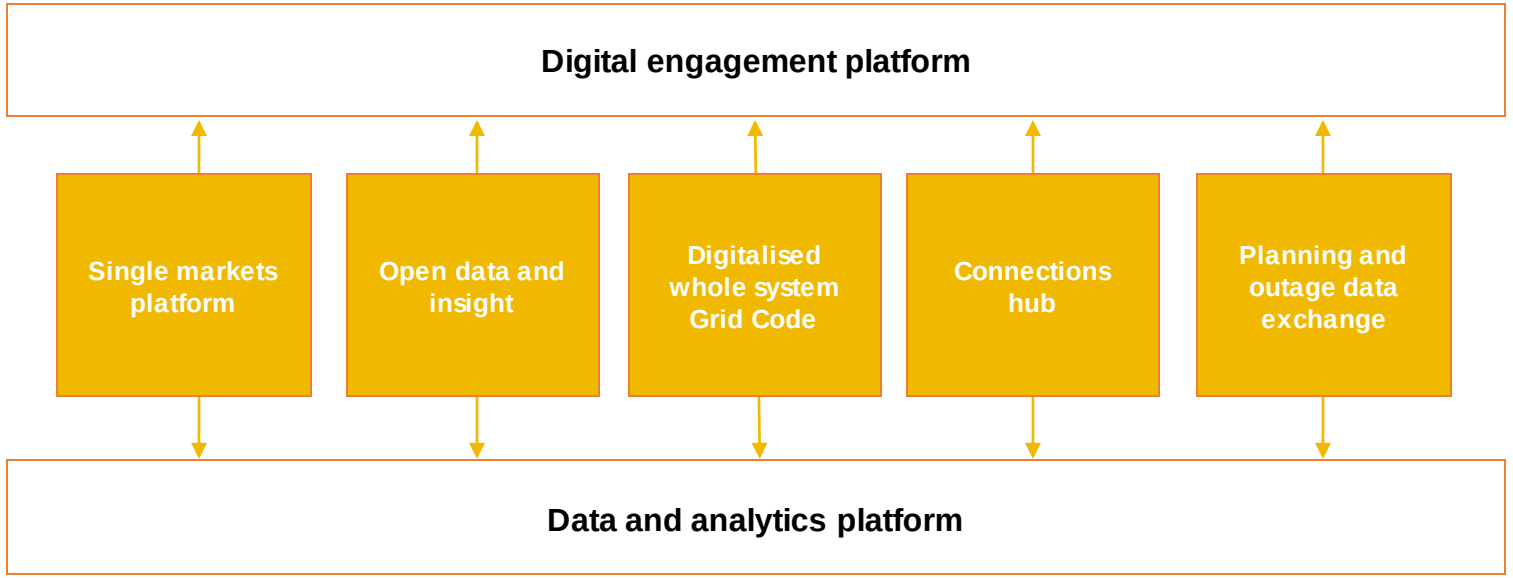
- Voting using the Axis collaboration tool
- Further discussion on priority topics identified
- Agree topics for further discussion at next meeting

Open data and digital market enablement

Item 9

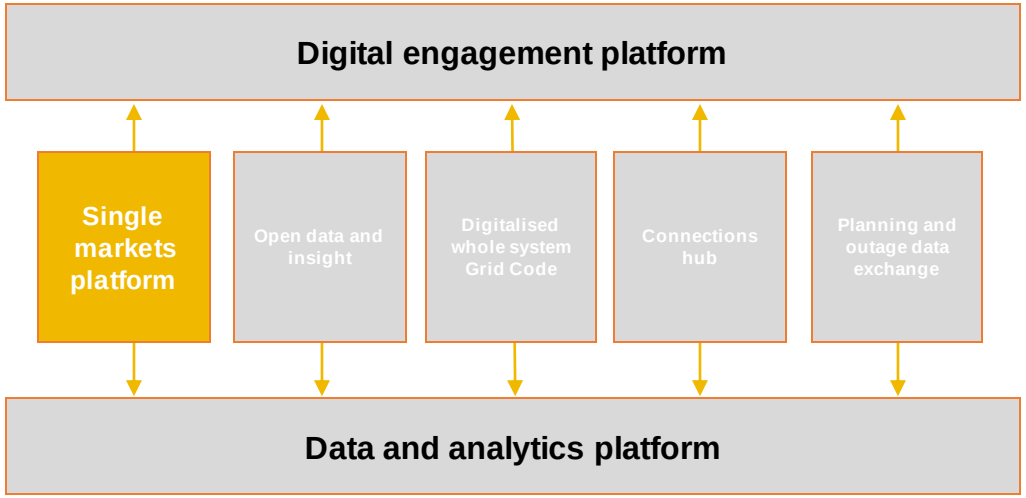
Delivering open data and digital market enablement

- Stakeholders have told us we need to make it easier for them to do business with us
- Pillar 1 of our ESO Digitalisation Strategy *Deliver open data and digital market enablement* and our *RIIO-2 Business Plan* outline our approach for using digital technology to improve the user experience
- We have proposed a suite of foundational investments that will transform how the market interacts with the ESO



All ESO markets will be accessed through a Single Markets Platform

- Accessed via the Digital Engagement Platform, this one-stop-shop will provide a portal for parties of 1 MW and above to participate in all our balancing services markets.
- It will also provide access to the Capacity Market and the Contracts for Difference (CfD) auctions.
- The platform will be based on an asset registry which identifies all characteristics of each unique asset on the system.
- The Single Markets Platform (SMP) will interface with a new auction capability scalable to new services and products, with multiple algorithms for auctions at different frequencies, spanning from yearly to day ahead.
- The SMP and other systems will be delivered in an agile and modular in collaboration with our stakeholders



The Single Markets Platform will transform the end to end process of offering services to the ESO

Information in one place

Communications on processes including contracting, testing, procurement events, performance monitoring and reporting, payment and portfolio management will all move from email to communication via the platform.

Data input

Data input and management for processes including procurement events and performance monitoring will move from offline spreadsheets to data management and communication via the single markets platform.

Online Decision Support

Messaging capabilities and validation rules will enable online decision support, for example by telling market participants which markets their assets are eligible for. The system will also notify them if they are submitting non-compliant information.

There are significant challenges to delivering the Single Markets Platform

Key challenges will include:

- Getting high quality input from users of the system who have many demands on their time
- Ensuring the project is joined up with wider industry market and platform developments (whilst delivering at pace)
- Coordinating delivery with the wider transformation of ESO systems and transitioning to new tools and processes whilst maintaining resilience of supply
- Future-proofing the systems to facilitate future, currently unseen, market transformation

Ways of working

Item 10

Ways of working

Group discussion on:

- Reflections on the first two meetings
- Suggestions for improvements

Next meeting

Item 11

Next meeting and calendar

- **Propose meeting every quarter for a half-day on the first Friday morning of the month, 9am-12.30pm**
  - 5 March 2021
  - 4 June 2021
  - 3 September 2021
  - 3 December 2021
  - 4 March 2022
  - 3 June 2022
  - 2 September 2022
  - 2 December 2022
  - 3 March 2023

- **Topics for next meeting**

Topic	Discussion items
Data and analytics platform	Introduction (similar to Balancing and Network Control today)
Digital engagement platform	
Balancing	Deeper dives into specific sections (based on TAC feedback
Network Control	

AOB

Item 12

Annex

Balancing Programme two-year delivery schedule

RIIO-1 end point	2021/22 milestones	2022/23 milestones	First year success	Second year success	Expected final delivery date and what success looks like
Balancing Roadmap developed with Technology Advisory Council (TAC) and published. It will contain a high-level view of: • Key drivers and priority user requirements. • User stories and user journeys, including how participants will interact with our systems. • Backlog and when the first items will be delivered, focusing on 2021/22 and 2022/23, based on the user requirements and asset health. • Outputs and outcomes. • Dependencies. • Progress updates (for later revisions). Early technology proof of concept working completed to: • Inform technology is appropriate • Inform programme structure, resourcing and ways of working • Inform future system architecture work Included in the above is reviewing the approach taken to develop the Modern Dispatch Optimiser, which is a trial for our RIIO-2 ways of working. Internal baseline roadmap for technology delivery (for iterative ongoing development), taking outputs of proof-of concept work and combining with known technologies. This provides an overview of what technology is available to us for future system development. Internal baseline roadmap for functional capability being delivered for key processes including scheduling and dispatch, based on current known requirements. This provides an overview of what the key system issues to solve are. Identify opportunities for end-to-end balancing process rationalisation, to inform future operating model and system architecture. Programme structure defined and resourcing strategy confirmed reflecting previously described FTE numbers). Clear governance structure defined, including TAC and internal sign-off processes.	Q1 – start developing foundational infrastructure and tooling to support applications: • Testing and automation tools • Capacity management tools • Alarm and event management • Monitoring tools • Incident management • Coding tools • Change management tools • Containerisation tools • Cyber security tools Q1 – build a platform environment to create applications in (collaboration space with servers, storage and code development infrastructure). Q2 – complete foundational infrastructure tooling work. Q2 – updated Roadmap agreed with TAC and published. Q4 – future system architecture defined, including in-scope modules for future development. Q4 - updated Roadmap agreed with TAC and published Sandbox testing environment developed (timescale TBC): • Define data inputs and data sets to test components • Define expected outputs to compare test against • Start testing priority components (to be determined).	Q1 - Migration roadmap development started, providing a view of when new systems will come online, and legacy ones switched off. Q2 – updated Roadmap agreed with TAC and published. Q4 - updated Roadmap agreed with TAC and published. Deliver first application components (timescales TBC): • Build the production environment to safely and securely develop code for 24/7 systems • Testing in sandbox environment. Ongoing agile delivery of application components, using production environment and sandbox (will be determined by Roadmap at end of RIIO-1).	Sandbox environment developed for testing components to prove components work, giving industry confidence. Key decisions on architectural design made incorporating feedback from the TAC. Priority technology identified and sourcing decisions made. Potential code changes required to support operation of the tool identified and timeline agreed with codes team. Expected development timeline agreed and roadmap published. Incremental targets for Metric 2 – CNI system reliability met. Updated programme costs to feed efficient cost benchmark review. Incremental benefits identified in cost-benefit analysis realised.	Production environment developed. Technology sourcing decisions for further application development completed. Scaled agile approach to development underway and on track against roadmap. Initial modules integrated with new control centre architecture (Activity **A1.4**). Updated roadmap published. Incremental targets for Metric 2 – CNI system reliability met. Updated programme costs to feed efficient cost benchmark review. Incremental benefits identified in cost-benefit analysis realised.	By March 2024 Control Centre engineers can schedule and dispatch a far greater number of market participants at once than they can in 2020, which is a key enabler of our ability to operate the network carbon free. Using increased automation provides market participants with greater confidence in our decision-making. ASDP has become one module of the 180 Enhanced balancing capability, integrated with other operational tools. Benefits identified in cost-benefit analysis realised. The practical improvements to system operation are: • Ability to operate the electricity system carbon-free • Ability to efficiently and transparently schedule and dispatch significantly more market participants than today • Stakeholder confidence in our control room decision making. This helps our zero-carbon operation because: • We will have the control centre tools to be able to operate the system carbon-free.

Network Control Programme two-year delivery schedule

RIIO-1 end point	2021/22 milestones	2022/23 milestones	First year success	Second year success	Expected final delivery date and what success looks like
IEMS Life Extension Detailed asset health assessment undertaken. Technical approach with stakeholders and vendors agreed. In-depth technical options analysis developed. Asset risk mitigation options determined. **Network Control Strategy** Forward Plan - Control capability development, including life extension of current system, capability requirements work ongoing between SO-TO in prep for separation of systems, user stories for new product. Network Control Roadmap developed with TAC and published. Will contain high-level view of: • Key drivers and priority deliverables • What will be delivered and when (within the detail possible) • Outputs and outcomes • Dependencies • Progress updates (for later revisions).	**IEMS Life Extension** Q1 & Q2 – Vendor negotiations to support life extension. Q3 & Q4 – Deliver high priority software and hardware life extension projects. **Network Control Strategy** Q1 – validate scope and transition strategy, based on Roadmap. Q1 – start procurement activity for core system. Q1 – commence proof of concept work. Q1 – determine core system "to be" architecture and options Q1 – commence core system requirements. Q2 – procurement approach confirmed. Q2 – finish core system requirements work. Q2 – roadmap updated with input from TAC. Q2 – finish work with NGET on capability mapping. Q2 – validate scope and transition strategy, based on Roadmap Q3 – validate scope and transition strategy, based on Roadmap Q3 – confirm high level modular design Q3 – commence core system design work. Q4 – finish core system design work. Q4 – finish procurement activity. Procurement approach confirmed. Q4 – roadmap updated with input from TAC.	**IEMS Life Extension** Q1 & Q2 - Deliver medium priority software and hardware life extension projects. Q3 & Q4 – Deliver low priority software and hardware life extension projects. **Network Control Strategy** Q1-4 - build of core situational awareness system. Q2 – roadmap updated with input from TAC. Q4 – finish proof of concept work. Q4 – roadmap updated with input from TAC. Q4 – start project to integrate core system with data and analytics platform.	**IEMS Life Extension** Design work completed. Agile delivery starting. Life extension of current systems continued including development work where necessary to manage changing network. Incremental targets for CNI system reliability metric met. **Network Control Strategy** Supplier engagement and sourcing strategy in action. Project scope for new tools developed through stakeholder engagement (e.g. TAC) and finalised. Core system requirements work completed. Core system design work complete. Proof of concepts work ongoing. Potential code changes required to support operation of the tool identified and agreed with codes team Incremental benefits identified in cost-benefit analysis realised	**IEMS Life Extension** Life extension of current systems continued including development work where necessary to manage changing network. Voltage stability analysis capability implemented Improved fault level analysis implemented Delivery continuing in an agile manner. Incremental targets for Metric 2 – CNI system reliability met. **Network Control Strategy** Core situational awareness tool delivered (but not yet in operation). This will be the core system, that links to the control centre architecture (Activity A1.4), including the data and analytics platform, and other modules. Core system delivered at this time is likely to comprise (subject to change): • Foundation architecture established • Data acquisition from Transmission Owners (TOs) • Integration with Data & Analytics platform for data storage • State estimator • Basic alarm management Other potential in-scope items delivered at this stage (subject to change): • Display capability • Contingency analysis. Core system initially running in a non-operational sandbox alongside IEMS, allowing for testing and tuning of modules. Updated roadmap agreed with TAC and published. Incremental benefits identified in cost-benefit analysis realised.	**IEMS Life Extension** Final delivery in March 2026 with the decommissioning of IEMS **Network Control Strategy** By March 2025: Business process implemented ensuring Control Centre engineers can manage and visualise far greater volumes of data than in 2020 which is a key enabler of our ability to operate the network carbon free. This information is used to better understand the operating envelope, allowing Control Centre engineers to run a more efficient system safely and at lower cost to consumers. Specific deliverables include: • Integration with new NGET SCADA system complete • Enhanced situational awareness capability delivered • Enhanced real-time modelling tools and look-ahead capability delivered • Enhanced control room visualisation delivered • Full training simulator integration (D2.3.1 / IT investment ref 200) • Shadow control room live. Benefits identified in cost-benefit analysis realised IEMS decommissioned (for ESO use)

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