RIIO-ED2 Business Plan
December 2021

SP ENERGY NETWORKS

Annex 2.1:

Innovation Strategy

PRINCIPAL PARTNER
UN CLIMATE CHANGE CONFERENCE UK 2021
IN PARTNERSHIP WITH ITALY

Contents

1 An introduction to this annex

Scope

At SP Energy Networks, we see innovation as ever more critical to the necessary advancement of our industry, and to facilitate Net Zero. This annex presents our industry leading innovation portfolio for RIIO-ED2 that will enable us to deliver a **better future, quicker** for our customers.

The scope of this annex relates to innovation activity as per paragraphs 4.33 to 4.39 of Ofgem's RIIO-ED2 Business Plan Guidance document. This includes our request for Network Innovation Allowance (NIA), captured within the "CV36a" Business Plan Data Table.

For RIIO-ED2, following engagement with our stakeholders we made the following commitment and this annex sets out our plans to achieve it (please see Annex 1.1 for our full list of commitments):

- Commitment #5:
    - We will deliver £87m of savings for our customers in RIIO-ED2 by embedding learnings from innovation projects into business as usual (BAU) and adopting best practice from successful industry trials.
    - We will keep innovation at the core of everything we do, to continue to deliver benefits for our customers and the wider energy system.

In addition to Totex funded innovation**, there is a significant and growing requirement for innovation stimulus funding** for projects which are not incentivised via Totex but are essential to facilitate the energy system transition and ensure a just transition to Net Zero.

In this annex we present well justified plans for a programme of NIA projects representing a **total investment of £35m that are expected to result in future benefits to the customer of at least £140m based on past performance.**

We see this as a justified request with evidence submitted to reflect:

- A clear, robust track record for project delivery and realised benefits
- A clear internal process for project approval and benefit tracking
- An established culture of innovation throughout our business
- Stakeholder engagement which has resonated that we must increase levels of ambition in order for the Energy Industry to meet Net Zero targets.

We are committed to continue delivering sector leading innovation, which benefits all GB customers by supporting the energy transition. This document sets out our plans for achieving this aim.

Key highlights

We have presented well justified plans for a programme of NIA projects representing a total investment of £35m, targeted to enable a **just transition to Net Zero**.

To demonstrate how our innovation programme is strategically positioned to solve Whole System Challenges, we have spotlighted five key topics, to detail both our plans and the role we envisage for these areas throughout the energy transition, as follows:

- Consumer Vulnerability
- Electrification of Heat
- Electrification of Transport
- Green Hydrogen
- Power Electronics

Finally, we have presented the robust processes we have in place to support our innovation activity across each stage, from idea development through to the whole project lifecycle, including how we identify the most promising innovations and ensure that they complete the transition to business as usual.

Benefits

Innovation is embedded throughout our RIIO-ED2 business plan. We have undertaken detailed technical studies throughout the development of our Engineering Justification Papers (EJPs) to clearly identify where previously proven innovative solutions are to be deployed.

We have identified an **£87.2m reduction in our proposed RIIO-ED2 Totex expenditure** from the deployment of previously proven innovations, summarised in Section 2. The references to the individual EJPs detailing these savings are presented in Appendix I.

Factoring in wider industry benefits, such as making the cost of new connections to our network cheaper, enabling flexibility and improvements in network performance, we estimate that our innovation portfolio will enable more than **£200m in benefits in the RIIO-ED2 period –** a clear demonstration of the benefits that innovation can bring, and the crucial role it needs to continue to play as we work towards a just transition to Net Zero.

We are acutely aware that the funding we access through various innovation mechanisms is sourced from our customers. That is why we have a strong focus on ensuring our strategy is relevant and delivers value to our customers – **we target a £4 return for every £1 invested from innovation stimulus funding**.

Customer and stakeholder input

We have engaged with our Stakeholders on our RIIO-ED2 plan and they have told us:

- not to adopt a siloed approach to the Energy System Transition (EST) and Consumer Vulnerability (CV) themes – both areas of focus should be considered when considering the impact of most innovation activities
- develop a clear thread between innovation projects to ensure long term benefits
- be more ambitious with our innovation programme in RIIO-ED2 compared with RIIO-ED1.

We agree with our stakeholders' ambition – **innovation is more important than ever if we are going to facilitate Net Zero, and maintain safety and reliability, for our customers in the most efficient ways**. That is why we commit to keeping innovation at the core of everything we do in RIIO-ED2.

These messages were consistent throughout both our targeted Stakeholder Engagement activity and also within the collaborative engagement activity undertaken with the Energy Innovation Centre (EIC)[1]. Some of the key messages from the EIC activity were as follows:

- 72% of respondents believe that environmental/social benefits should always be a targeted outcome of innovation
- 87% of respondents believe that network companies should develop their culture to increase their innovation capabilities in RIIO-2
- 60% of respondents said that DNOs should ask for an increase in NIA funding compared to RIIO-1 levels, as significant innovation is needed to support the Energy System Transition and Consumer Vulnerability themes stated by Ofgem
- 87% of respondents believe network companies should continue to collaborate with organisations like the EIC to accelerate innovation

The feedback we have received from our stakeholders has strategically informed our innovation strategy and investment ambitions which are detailed within this annex. For more detail, please see Section 7.4.1.

Delivering our Plan

During RIIO-ED1, we challenged ourselves to deliver a highly ambitious innovation programme and **have built a strong track record which reflects our capability**:

- So far in RIIO-ED1, we have led more innovation projects by licence than any other DNO.

[1] This was a collaborative activity facilitated by the EIC involving all of the EIC network member companies, both electricity (SP Energy Networks, National Grid, Scottish and Southern Energy, UK Power Networks, Northern PowerGrid) and gas (Cadent, Northern Gas Networks, National Grid, Wales and West Utilities)

- We have established a robust and complete process for identifying the strongest proposals to rolling out proven innovation in to BAU.
- **The wider community benefits directly from at least 75% of our NIA funding**. So far in RIIO-ED1, over £12m has been **shared** with SMEs, local communities, and academia partners via our open, transparent, and inclusive approach.
- We regularly **collaborate** with UK and International partners via our leading role in the Energy Innovation Centre and the Power Networks Demonstration Centre. **We benefit from their know-how and resources as for every £1 invested, we leveraged almost an additional £2 funding – creating more value for our customers.**

We fully support the Ofgem requirement that networks undertake more innovation through BAU. **We have a strong innovation culture** within SP Energy Networks. We believe that innovation is not just about technology, processes, or business models – **a key enabler for innovation is people, including our staff, our partners, and our customers**.

- We launched our Culture of Innovation internal campaign at the mid-point of RIIO-ED1 to encourage all members of staff to innovate within their role
- Through this campaign, we have also launched a series of specific challenges to our business to tap into the expertise of our staff, with the strongest ideas being delivered as part of our business via Totex allowances
- **So far, this has generated over 300 ideas, involved over 1,200 colleagues, with over 90 ideas selected for further development into Totex funded innovation projects.**
- Our network of **100 Innovation Champions throughout the business** are a key enabler to make this a success.

To develop our strategy for RIIO-ED2, we have identified key innovation areas that fall within the two high-level Ofgem themes of Energy System Transition and Consumer Vulnerability. These have then been assessed against the specific business strategies for the relevant areas, and key activities identified for which progress can be accelerated or enabled using innovation stimulus. This is a **holistic innovation strategy that is independent of funding route** (i.e. Totex or stimulus) – once the need for a project has been identified, it will be allocated the appropriate funding once approved.

We are committed to funding more innovation in RIIO-ED2 using our Totex allowance and also ensuring that we monitor and roll out proven innovation within the RIIO-ED2 period – **we already have in place the culture, personnel, and business frameworks to do this.**

To efficiently present our strategy, this document has been split into three key sections:

Looking Back - Our Track Record:

- This section explains what we do as a leader in innovation from how we deliver innovation, how we ensure that we work according to best practice and how we collaborate across the industry.
- We present our track record for rolling out innovation as BAU and the benefits this has brought to our customers. We describe how innovation runs through the culture of the organisation and demonstrate the innovation we undertake every day as part of our BAU activities.
- We also detail our past success in transitioning innovation projects into the BAU environment.

Looking Ahead - Our Ambition:

- We outline the methodology we used to derive our innovation strategy and the conclusions we have drawn from this process.
- We present our strategic breakdown of Consumer Vulnerability - under three focus areas, and the Energy System Transition - under five focus areas.
- We spotlight five topics: Consumer Vulnerability, Electrification of Heat, Electrification of Transport, Green Hydrogen, and Power Electronics – giving examples to demonstrate the extent of innovation required in RIIO-ED2.
- Finally, we articulate the breakdown of our NIA request under the derived innovation strategy.

Our Processes:

- We present the robust processes we have in place to support our innovation activity across each stage, from idea development through to the whole project lifecycle, with supporting evidence to show how this process has been refined during RIIO-ED1.
- This process includes portfolio management and benefits tracking, and our "Fast Follower" process for adopting innovation proven by other DNOs.

Signpost for Ofgem's business plan requirements

Ofgem BP Guidance No	Annex Page Number
4.32	Our focus on Whole Systems is described in Section 7.
4.33	Our business culture of innovation and BAU innovation initiatives is described in Section 2. Examples of Totex funded innovation throughout Sections 2, 5, 6 and 7.
4.34	Innovation is described throughout our business plan. References within this annex are: • Our business culture of innovation and Totex innovation initiatives is described in Section 2. • Examples of Totex funded innovation in Sections 2, 5, 6 and 7. • Section 7.4.2 on page 72 details some BAU funded innovation initiatives that we have planned for RIIO-ED2.

4.35	This is being evidenced in multiple areas:
	• Demonstrating that we have established a culture of innovation with the DRIVE campaign, with regular innovation challenges and Totex funded projects
	  ○ Section 2
	• Highlighted Totex funded innovation projects we have already undertaken and the benefits they have / are delivering
	  ○ Sections 2, 5 and 6
	• Building on ED1 progress, we have redesigned our innovation process for ED2 as a holistic process that is independent of funding route. Governed by Innovation Board.
	  ○ Section 7.1 and Section 8

4.36	• a strategic approach to innovation activities, which builds upon industry-wide challenges and industry-wide strategic direction.
	  ○ Innovation is one of the golden threads throughout our business plan and highlighted as a key part of our strategy
	  ○ Our RIIO-ED2 Innovation Strategy and Delivery Plans are detailed in Section 7
	• how they will consider, and mitigate if necessary, the potential impacts of their innovation activities on consumers in vulnerable situations.
	  ○ Innovation strategy highlights consumer vulnerability as a key Ofgem theme and central to our plans: Sections 7.1 and 7.2.
	  ○ Consumer Vulnerability is a spotlighted innovation area: Section 7.3.1
	  ○ Section 7.4 states that we will assess the impact on consumers in vulnerable situations for all innovation projects, including Totex funded DRIVE campaigns
	• consideration of innovative whole system approaches as potential solutions to problems.

	○ Discussed in Section 7, and five whole system innovation areas (including Consumer Vulnerability) have been spotlighted in Section 7.3 • how plans for RIIO-ED2 build on past projects completed by themselves and others, considering lessons learned from these past projects. ○ We have embedded innovation from previous projects by ourselves and others throughout our business plan. This is referenced with the associated benefits mapped within Section 2.2. ○ Section 5 describes our past successful innovation projects and how they have been transitioned into BAU ○ Appendix I presents a cross-reference to all RIIO-ED2 Engineering Justification Papers which propose the use of innovative solutions in preference to traditional network reinforcement or modernisation options. ○ Chapter "Innovation – at the core of everything we do" in section 4 of the main business plan narrative describes the process we followed to review over 200 innovation projects that we or other network companies completed, and how we have then built our business plan using the outputs from these projects. A summary of the outputs from this process is presented within this annex, Appendix V. • plans for third-party involvement in their innovation activities, demonstrating how they will increase third-party involvement in their innovation activities and ensure full consideration of third-party innovation ideas. They may, for example, include plans for independent consideration of which third-party innovation ideas to take forward. ○ Our collaboration partners are presented in Section 4 ○ Examples of our extensive collaboration with third parties throughout the document, particularly Sections 3, 4, 5 and 6 • plans to collaborate with other network companies and other interested bodies and to disseminate learning from innovation. ○ Our collaboration partners are presented in Section 4 ○ Examples of our extensive collaboration with third parties throughout the document, particularly Sections 3, 4, 5 and 6 • a framework for rolling out proven RIIO-ED2 innovation into business during the course of the RIIO-ED2 price control. ○ Our RIIO-ED2 innovation delivery plan is presented in Section 7. ○ Our processes are described in detail in Section 8 ○ Our track record for having followed these processes is presented in Sections 2 and 5, with worked examples in Appendix IV. • how they propose to monitor the benefits of planned RIIO-ED2 innovation and reduce costs in other areas during the course of RIIO-ED2 using this innovation. ○ Our innovation delivery plan is presented in Section 7. ○ Our processes are described in detail in Section 8. This includes the process for rolling out proven innovation as BAU which is a continuous process.
4.37	• We have embedded innovation from previous projects by ourselves and others throughout our business plan. This is cross-referenced and the associated benefits mapped within Section 2.2. • Section 5 describes our past successful innovation projects and how they have been transitioned into BAU • Appendix I presents a cross-reference to all RIIO-ED2 Engineering Justification Papers which propose the use of innovative solutions in preference to traditional network reinforcement or modernisation options. • Chapter "Innovation – at the core of everything we do" in section 4 in the main business plan narrative describes the process we followed to review over 200 innovation projects that we or other network companies completed, and how we have then built our business plan using the outputs from these projects. A summary of the outputs from this process is presented within this annex, Appendix V. • The innovation project mapping includes projects led by other DNOs (Fast Followers). Our Fast Follower process is presented in Section 8.3.
4.38	• Our detailed NIA request is set out in Section 7.4 of this Annex, with supporting evidence in the Appendices.
4.39	• Our detailed NIA request is set out in Section 7.4 of this Annex, with supporting evidence in the Appendices.

5.22	• Full Annex
5.26	• Full Annex
5.47	• Full Annex

2 Looking Back - Our Track Record

2.1 We are a proven leader in innovation

During RIIO-ED1, SP Energy Networks has delivered a highly ambitious innovation programme - so far in RIIO-ED1, we have led more innovation projects by licence than any other DNO. Looking to the future, innovation underpins our entire Business Plan for RIIO-ED2.

Innovation will help us facilitate the Net Zero transition, as society becomes increasingly reliant on electricity. Our Distribution Future Energy Scenarios (DFES)[2] forecast that up to 1.8m electric vehicles and 1.1m heat pumps will connect to our networks by 2030, potentially requiring investment in our low voltage (LV) network at 12 times the level we have seen in the last 10 years of investment. Therefore, innovation has to be at the heart of the transition to a Net Zero economy, as we seek to facilitate the electrification of transport and heat, and whole system challenges, which we want to achieve in a fair and just way for every customer.

We can demonstrate that we have all the expertise and experience necessary to deliver the planned innovation strategy in RIIO-ED2 and that we have a clear pathway to integrate this into our business and share the learning across our industry.

2.2 Proven innovation rolled out as Business as Usual

Our RIIO-ED2 Business Plan is built on proven RIIO-ED1 and DPCR5 innovation. This includes projects funded from previous and existing innovation stimulus, including:

- DPCR5 stimulus mechanisms:
    - Innovation Funding Incentive (IFI)
    - Low Carbon Networks Fund Tier 1 and Tier 2 (LCNF)
- RIIO-ED1 stimulus mechanisms:
    - Network Innovation Allowance (NIA)
    - Network Innovation Competition (NIC)
    - Innovation Rollout Mechanism (IRM)

In RIIO-ED2, we will keep innovation at the heart of our business, so that we deliver tangible benefits within RIIO-ED2 and beyond.

The key innovations that are embedded throughout our RIIO-ED2 business plan are summarised within this section in through to Table 5. **These innovations have resulted in a £87.2m reduction in our RIIO-ED2 Totex expenditure (£46.33m for SP Manweb, £40.84m for SP Distribution).**

Factoring in wider industry benefits, such as making the cost of new connections to our network cheaper, and improvements in network performance, we estimate that our innovation portfolio will enable more than **£200m in benefits within the RIIO-ED2 period –** a clear demonstration of the benefits that innovation can bring, and the critical role it needs to continue to play as we work towards **a just transition to Net Zero.**

[2] https://www.spenergynetworks.co.uk/pages/distribution_future_energy_scenarios.aspx

Table 1: Embedded innovation driving decreased RIIO-ED2 Totex expenditure[3]

Project Title	Funding Source	Reference	Technique or Solution	Forecast ED2 Benefit £m	Areas of BP benefitting					Reference document[4]
					ED2 Load Investment	ED Customer Service	ED2 Non-Load Investment	ED2 Sustainability	ED2 Connections	
Real Time Fault Level Monitoring	NIA	NIA_SPEN_0015	Fault Level Management	**42.8**	●				●	EJP
Active Fault Level Management	NIA	NIA_SPEN_0014								
Enhanced Real-Time Cable Temperature Monitoring	NIA	NIA_SPEN_0003	Real time thermal ratings	**23.5**	●				●	EJP
EVOLVE	BAU	BAU	LV Monitoring							
Flexible Networks	LCNF Tier 2	LCNF Tier 2								
LV Engine	NIC	NIC	Power Electronics (Solid State Transformers)							
On load tap changer	BAU	BAU	Voltage Control							
Technical Review of Non-conventional StatCom Applications	NIA	NIA_SPEN_0018	StatCom Solutions	**17.4**	●					EJP
Novel Transformer Bunding	BAU	BAU	More efficient technique	**3.5**			●	●		EJP
Total benefit £m				**£87.2m**						

Please see Appendix I for details of all the Engineering Justification Papers that can be cross-referenced to the above savings.

[3] Further details for all of the projects referenced are presented later in this document.
[4] Detailed referencing for all Engineering Justification Papers is presented in Appendix I

Table 2 Projects with ongoing value - estimated benefits within RIIO-ED2*

Project Title	Funding Source	Reference	Technique or Solution	Forecast ED2 Benefit £m	Areas of BP benefitting					Reference document[5]
					ED2 Load Investment	ED Customer Service	ED2 Non-Load Investment	ED2 Sustainability	ED2 Connections	
WANDA	NIA	NIA_SPEN_0022	Load Forecasting	3	•				•	NIA CBA
NCEWS (NAVI)	NIA	NIA_SPEN_0016	Load Forecasting	1.2	•				•	NIA CBA
Virtual World Asset Management	NIA	NIA_SPEN_0002	LiDAR for vegetation management	4.9			•			NIA CBA
Asset Risk Optimisation	NIA & BAU	NIA_ENWL005 & BAU	Asset Intervention Optimisation	1.5			•			**

Total	**£10.6M**

**These benefits are encapsulated in the DSO[6] CBA (WANDA and NCEWS) and Data and Digitalisation CBA[7] (Virtual World Asset Management and Asset Risk Optimisation)*
***Please refer to "Annex 4A.4 Network Asset Risk Strategy".*

Table 3 DSO and New Connections: RIIO-ED2 Benefits from Innovation

Project Title	Funding Source	Reference	Technique or Solution
Accelerating Renewable Connections	LCNF Tier 2	LCNF_SPEN_02	Enabling flexibility with non-firm connections
Dumfries and Galloway	IRM	IRM	
Real Time Fault Level Monitoring	NIA	NIA_SPEN_0015	Fault Level Management
Active Fault Level Management	NIA	NIA_SPEN_0014	
EVOLVE	BAU	BAU	LV Monitoring, load forecasting, automation of quotations, standardisation of quotations, etc
WANDA	NIA	NIA_SPEN_0022	
NCEWS (NAVI)	NIA	NIA_SPEN_0016	

Total	**Between £133m and £334m NPV payback over 45-year period[8]**

[5] Detailed referencing for all Engineering Justification Papers is presented in Appendix I
[6] ED2-NLR(O)-SPEN-001- DSO – EJP – Issue 1
[7] Please see Annex 4C.1: IT and Digitalisation Strategy
[8] From DSO Engineering Justification Paper (ED2-NLR(O)-SPEN-001- DSO – EJP – Issue 1)

Table 4 Network Performance: RIIO-ED2 Benefits from Innovation

Project Title	Funding Source	Reference	Technique or Solution	Forecast ED2 Benefit:				
				CI / CML	SP Distribution		SP Manweb	
					Min	Max	Min	Max
APRS & PORT	BAU	BAU	Network Automation	CI	0.44	3.62	0.61	2.56
				CML	0.07	0.50	0.10	0.43
EVOLVE (LV Monitoring)	BAU	BAU	Network monitoring, pre-fault identification	CI	0.58	0.72	0.55	0.69
				CML	0.25	0.46	0.22	0.40
SINE Post	NIA	NIA_ SPEN0012	Network monitoring and fault identification	CI	0	0	0	0
				CML	0.52	1.53	0	0.72

CML: Customer Minutes Lost, reduction per customer
CI: Customer Interruptions, reduction per 100 customers

Table 5 Sustainability: RIIO-ED2 Benefits from Innovation

Project Title	Funding Source	Reference	Technique or Solution	Environmental Benefits
Introduction of environmentally friendly alternatives to SF6	NIA	NIA_SPT_1604	Remove dependency on SF6 switchgear, also more environmentally friendly oil	Long term carbon benefits from reducing the use of SF6
A Substation Of the Future	NIA	NIA_SPEN_0052		
Reuse of existing concrete assets	NIA	NIA_SPT_1606	Reduction in material waste	Long term carbon benefits by reducing waste
Operational Assessment of Composite Poles	NIA	NIA_SPEN_0019	Removing dependency on Creosote treated poles.	Approx. 12,000 LV poles will be renewed on network in ED2, all Creosote free.
Ultrapole	NIA	NIA_SSEPD_0006		
APPEAL	NIA	NIA_SPEN_0008		
Transformer Bunding	BAU	BAU	Reduction in materials, waste	Long term carbon benefits by reducing resources used
Transformer Oil Regeneration	NIA	NIA_NGET_0088	Reusing transformer oil instead of renewing and disposing of old oil	Two grid transformers proposed in ED2, avoiding disposal of 29,700 litres of oil each transformer

For more information, please refer to Annex 1.3: Sustainability Strategy and Annex 4C.3: Environmental Action Plan.

2.3 We are a company with innovation built into our DNA

Fundamentally, innovation is about doing things differently to make things better. For us, it is about making sure that we are continually evolving as a business. This includes:

- delivering value for our customers
- delivering a smarter and more flexible network, and
- delivering a more sustainable network.

Innovation is about everything we do. It is about people and not just technology – people's skills and behaviours, and the processes and systems that support them.

It is about delivering for our customers and stakeholders, enabling and accelerating energy policy delivery, and being inclusive for everyone. We can demonstrate that our people and culture make up part of our capability to innovate and is one of our strengths in this regard.

2.3.1 We challenge ourselves to do things differently

Our people across the business seek to realise innovation and improvements in their day to day roles. As well as large Totex funded innovation projects, such as our EVOLVE project (see Section 5.1), lots of innovation we undertake is incremental improvement embedded in our Business As Usual (BAU) culture.

Our Engineering Standards team continually **work with suppliers** to improve the efficiency and sustainability of our procurement. A recent example is an initiative to improve the sustainability of jointing resin supplies.

Our Business Change team, including trained Six-Sigma Black-Belts[9] actively pursues business improvement opportunities. For example, considering whether artificial intelligence and machine learning could improve the efficiency of overhead line inspections.

We hold **Dragon's Den events** where we facilitate our people to develop ideas and concepts in response to business challenges. These create real solutions to problems which we then either implement directly or use to feed our innovation project portfolio.

2.3.2 A focus on our Innovation Culture - DRIVE

In 2019, we saw an opportunity to strengthen our culture and go further. As a result, we launched our DRIVE[10] initiative to create further opportunities for collaboration, enable our staff to develop and contribute to innovative ideas and to share successes. As part of this campaign we introduced a new digital innovation platform, which we have named "iHub", and recruited over 100 innovation champions within our business.

Our innovation platform has seen a huge success in engaging our staff and realising their potential from resulting projects.

We have done this by:

- Launching a series of challenges to the business through the platform, all of which are sponsored by one or more of our executive team.
- Each challenge is presented as a focused question with context, examples of what good ideas look like and criteria (such as timescale or budget where appropriate) to generate high quality ideas
- Every idea can be viewed and commented on by all staff members to help improve the idea and develop it further. A team of moderators is appointed to help give each idea the best possible promotion
- Every idea is then evaluated by experts within the business to determine feasibility and present the best ideas back to the sponsor, who then approves and owns these ideas as they become projects and are delivered.

So far, we have seen active participation from over **1,200 colleagues who have contributed over 300 ideas, with over 90 ideas selected for further development into Totex funded innovation projects** to be taken forward for delivery.

[9] A recognised business qualification
[10] Delivering Real Innovation and Engagement (DRIVE)

Some examples of the successful projects from this process are:

- Using drones for pre-condition site assessments to achieve higher quality evidence of conditions on site before work - supporting our stakeholder engagement activities;
- 'Help' videos for customers about faults, made available to customers through our call centre to support Customer Engagement;
- Thermal Imaging Endoscopes for supporting asset and site inspections;
- Monetising Scrap Metal to realise value from our waste; and
- Landslide mitigation through surveying sites and applying anchoring systems where appropriate and also avoiding known vulnerable areas.

In addition to delivering internally sourced ideas, the Innovation Champions have also enabled the rollout of proven innovation from other network companies. An example of this was the deployment of thermal imaging cameras to quickly locate cable faults – this was a SSEN NIA funded project called 'TOUCAN'[11] and was identified as having high potential using our 'Fast Follower' process (see section 8.3). Our innovation champions organised workshops for our operational staff, led by SSEN, allowing us to deploy the solution as BAU. For more information on this, please see section 4.7.

These successful projects are a direct result of how we have engaged our people and brought them together in a collaborative format. We have now recruited **over 100 Innovation Champions** throughout our business – these staff have all received training in how to facilitate innovation discussion sessions and develop ideas into solutions.

The above examples are only a handful of the cases where we are proud to see how our staff have demonstrated our innovative and collaborative culture and we will continue to develop this.

In RIIO-ED2, we will continue to hold these campaign challenges and build in processes as part of our business as usual innovation, to allow regular engagement with our partners beyond our business that can provide additional ideas and comments on key challenges.

[11] https://smarter.energynetworks.org/projects/nia_ssepd_0021/

3 We seek to always share and learn – Global Best Practice

As a subsidiary of a Global Energy Company, Iberdrola, we have various mechanisms in place to ensure we share and build upon learning from across the group.

- **Global Practice Groups (GPGs)** across the networks run by Iberdrola promote exchange of ideas and innovation among representatives from companies from across the globe. The GPGs promote best practice adoption and sharing among countries and enhance global innovation across a range of technical topics across the business. The GPGs focus on driving efficiency and sustainability within the business through innovation.
- **Continuous engagement with suppliers and manufacturers:** As part of our standards and specifications activities we continuously engage with vendors through trade events and dedicated meetings to assess the innovation in their product roadmaps. Where appropriate we adopt innovative solutions applicable to our business. Some of the examples of efficiencies created through such engagement can be seen through our distribution switchgear and transformer replacement programmes. We have also driven product portfolio development with vendors through constant engagement with them on topics such as SF6 free switchgear and monitoring & control applications.
- **Membership and Participation in international research bodies**: Many of our engineers and the business itself is a member of international committees such as CIRED, Cigre, ENTSOE, IEEE and others. There is constant engagement with these committees and sharing of best practices that help bring globally innovative ideas and solutions into our day to day business areas. This includes active participation at technical working groups.
- **Engagement and dissemination at international events**: with a particular focus on innovation, we actively engage at international conference events hosted by bodies such as CIRED, Cigre and the ENA. Our presence at these events will often include submission of research papers for publication, exhibition stands and presentation opportunities. This activity provides an outlet for the international dissemination of progress with key innovation projects, with recent examples being CIRED papers / presentations featuring our LV Engine, THOR Hammer and Real Time Fault Level Monitoring projects, in addition to BAU research activity such as our failure analysis of trifurcating cable joints[12]. Our presence at these events also allows us to engage with the international community and identify new and emerging technology and opportunities for future projects with both UK and international partners.
- **Engagement with government trade commission:** we actively engage with international trade representatives to build our network of international suppliers of new technology and solutions. For example, regular meetings with the Canadian Trade Commissioner and attendance at events hosted at the Canadian Embassy, London, to network with Canadian based innovators interested in engaging with the UK market.

[12] References for all papers available upon request.

4 We innovate in collaboration with our peers

Collaboration is essential for enabling innovation. This includes projects within our NIA portfolio that are collaborative with other networks – this allows us to share knowledge, and jointly steer new developments for the benefit of the industry as a whole. We are actively engaged with a number of forums that facilitate these collaborations, in addition to academic and European collaborations, which are all summarised in this section.

4.1 Power Networks Demonstration Centre (PNDC)

SP Energy Networks are Tier 1 members of the PNDC and help to set its direction through seats on the Executive Board and Technical Board.

The Power Networks Demonstration Centre (PNDC) was founded through support from the University of Strathclyde, The Scottish Funding Council, Scottish Enterprise, SP Energy Networks and Scottish and Southern Electricity Networks. It has the aim of **accelerating the adoption of innovative research and technologies from early stage research into business as usual adoption** by the electricity industry.

Building the next generation of energy networks requires collaboration and the PNDC connects stakeholders through every stage of the innovation process. The unique facility enables highly realistic and accelerated technology testing alongside a rich portfolio of research programmes across the full Smart Grid domain.

The PNDC Core Research Programme falls into the six themes of research as listed below. Each theme is stimulated by academic, industry and research input, providing for effective innovation:

- Asset Management
- Communication and Systems Integration
- Network and Demand-Side Management
- Power Electronics and Distributed Energy
- Protection and Control
- Sensors and Measurement

The PNDC has undertaken 200 projects to date. Active participation by SP Energy Networks in the PNDC research programme helps us to accelerate and de-risk deployment of new solutions onto our networks. For example, PNDC have been the primary support to SP Energy Networks in our projects on converting existing

cables to LVDC[13] operation. They have played a leading role in digital substations[14], supporting both SP Energy Networks and UK Power Networks[15] on different projects.

PNDC has been extremely successful in leveraging additional funding in addition to innovation stimulus. Funding from commercial organisations and grant funding over the last 3 years amounts to over £2m.

In preparation for RIIO-ED2, the PNDC has recently introduced three "Focus Areas" (Digital Substation, Control Room of the Future, and Integrated Energy Systems) to help address major industry system-level challenges.

The centre is currently broadening its capabilities and partner network to focus on the validation and acceleration of whole energy system solutions, which aligns with priorities in the SP Energy Networks RIIO-ED2 Innovation Strategy.

4.2 The Energy Innovation Centre (EIC)

In 2008, a number of UK energy networks, including SP Energy Networks, decided to work together to improve collaboration with Small and Medium sized Enterprises (SMEs) to accelerate innovation performance to enable the transition to a low carbon economy. The outcome of this was the Energy Innovation Centre (EIC) - a not-for-profit organisation, owned by seven utility partners. The EIC works with 8000+ innovators across the world. Over 150 calls for innovation have been launched and 85% of these calls have been successful in sourcing a solution. The EIC provides a shared platform to bring networks partners and the innovator community together, in order to facilitate processes that take innovation projects from an idea to business as usual.

One of the key objectives of EIC is to support innovators, to make it easier for innovators to get their ideas or products in front of the networks' partners. They have created a dedicated innovator support page to provide access to free information, tools, and services to help innovators progress their ideas. As a member of the Innovation Community, an innovator is able to:

- Propose solutions to specific Industry Challenges or Calls for Innovation, which have been identified by network partners.

[13] Our "Transition to low voltage distribution networks phase 1" (https://www.smarternetworks.org/project/nia_spen_0028) and "phase 2" projects (https://www.smarternetworks.org/project/nia_spen_0047)
[14] Our "System Integrity and Restorative Actions (SIARA)" project (https://www.smarternetworks.org/project/nia_spen_1802)
[15] UK Power Network's "Constellation" project

- Submit innovative ideas or products that they feel could benefit network partners, whether they're development proposals or market ready solutions

Some existing examples of how SP Energy Networks is engaging and supporting third party innovators through the EIC in collaboration with other networks include our industry leading projects **APPEAL** and the **Real Time Fault Level Monitor** – both of which are discussed in more detail later.

4.3 ScottishPower and HALO Scotland Partnership

The HALO Kilmarnock is an imaginative, innovative, and inspirational regeneration initiative located on the site of the former Johnnie Walker bottling plant in Kilmarnock, East Ayrshire.

SP Energy Networks and the wider ScottishPower group is working with HALO Scotland on a £5 million, five-year programme, building upon the "utility of the future" vision. ScottishPower will be a leader in The HALO's Innovation and Enterprise Centre and its Digital and Cyber Zone where The HALO and ScottishPower will create a cyber and digital training and learning facility at the forefront of the "Fourth Industrial Revolution".

This unique partnership between SPEN and The HALO will:

- Explore energy innovations for a lower carbon society whilst inspiring a digitally skilled generation
- Drive a new digital and cyber skilled workforce, upskilling our existing workforce and others
- See ScottishPower partner with The HALO to establish a Children's Innovation Centre and Nursery of the Future in collaboration with Ayrshire College

Scotland's First Minister, Nicola Sturgeon MSP, said: "This partnership is great news for the Ayrshire and Scottish economy. It is hugely inspiring to see the HALO development contributing to the regeneration of Kilmarnock and doing so in a way which supports innovation, digital skills and, through this partnership with ScottishPower, contributing to Scotland's low carbon future."

4.4 ENA Innovation Managers Group (IMG)

Innovation at ENA is governed by two key working groups; Electricity Innovation Managers (EIM) and Gas Innovation and Governance Group (GIGG). The Electricity Innovation Managers (EIM) represents all Electricity Networks across Transmission and Distribution, as well as the Electricity System Operator (ESO).

As part of the ENA IMG, we undertake a range of collaborative innovation activities, and host a range of innovation events and conferences, including our annual Energy Networks Innovation Conference.

The ENA's innovation working groups ensure successful collaboration to support the delivery of innovation projects, minimise duplication of projects and disseminate and share learning from innovation projects.

This collaboration is not just amongst ENA members but with wider industry innovation across relevant sectors and bodies such as the Energy Systems Catapult (ESC), Energy Innovation Centre (EIC), Innovate UK and relevant BEIS Innovation Teams (Smart Systems, Modernising Energy Data, etc).

4.5 Applying Open Innovation in the Utility Sector

Open innovation is a term used to promote an information age mindset toward innovation.

Open innovation offers a platform for organisations to harness ideas, insights, and experience from outside their usual sphere of influence to help do things better.

We're working with Scottish Enterprise and 13 businesses and public sector organisations to create a series of innovation challenges which are open for a wide range of businesses and other organisations, including many outside our sector, to respond to.

Scottish Enterprise is sponsoring the initiative. It has assembled the cohort of organisations to participate and are supporting through funding, training and development in the skills required and ongoing support and monitoring in association with University of Strathclyde Business School.

The cohort consists of 13 companies and public sector bodies, including SP Energy Networks, who form the cohort of organisations sharing experience and learning.

It is a principle of open innovation that challenges are opened up to solver communities. We are working with the Scottish Enterprise community of Scottish SMEs, together with two international solver communities; Ennomotive and Nine Sigma, which together comprise many thousands of solvers.

Through this initiative, SP Energy Networks has initiated work and established contracts with various SMEs that we would not normally have found within our sphere of influence. As well as the contracts arising from this project, this has opened new opportunities for future innovation projects with these companies.

4.6 Examples of collaborative projects

This section highlights some examples from our innovation project portfolio where we are actively collaborating with partners from across the energy industry. Further detail on some of these projects can be found in later sections as referenced below.

Project name: LV Engine

- Funding mechanism: Network Innovation Competition, £8.3m
- Network partner(s): SP Energy Networks (lead), UK Power Networks
- Further details on this project are in section 6.2.3

Project name: Distributed Restart

- Funding mechanism: Network Innovation Competition, £10.3m
- Network partner(s): SP Energy Networks, National Grid Electricity System Operator (lead)
- Further details on this project:
    - This project is exploring how distributed energy resources can be used to restore power in the unlikely event of a total or partial shutdown of the National Electricity Transmission System.
    - The enormous growth in DER presents an opportunity to develop a radically different approach to system restoration, this project is seeking the address the technical, organisational, and commercial challenges with such an approach.

Project name: FUSION

- Funding mechanism: Network Innovation Competition, £5.3m
- Network partner(s): SP Energy Networks
    - Project FUSION is working directly with project TRANSITION (SSEN in partnership with ENWL) and project EFFS (WPD), two other awarded NIC 2017 projects focussing on the Distribution System Operator transition.
- Further details on this project are in section 6.1.3

Project name: Real Time Fault Level Monitoring Stage 2

- Funding mechanism: Network Innovation Allowance, £1.98m
- Network partner(s): SP Energy Networks (lead), UK Power Networks
- Further details on this project are in section 5.3

Project name: Environmentally Acceptable Wood Pole Pre-treatment Alternatives to Creosote (APPEAL)

- Funding mechanism: Network Innovation Allowance, £0.33m
- Network partner(s): SP Energy Networks (lead), Scottish and Southern Energy and UK Power Networks
- Further details on this project are in section 6.2.5

Project name: THOR Hammer Tester

- Funding mechanism: Network Innovation Allowance, £1.3m
- Network partner(s): SP Energy Networks (lead), UK Power Networks, Northern PowerGrid
- Further details on this project are in section 6.2.5

4.7 Examples of innovation deployed from other DNOs

This section provides some key example innovation projects that we are deploying as solutions in RIIO-ED1 and ED2 that were previously demonstrated by other DNOs and we are deploying using the "Fast Follower" approach. For a full list of projects we have evaluated for deployment see Appendix V and for more details on our Fast Follower process see section 8.3.

Technology: On Load Tap Changers

Original Project: Smart Street, Electricity North West

About the project:

- The increase in distributed generation is causing new issues that we now need to manage. We are experiencing growing daily voltage rise and voltage drop issues that have not been seen in the past.
- On-load tap changer (OLTC) transformers are one solution to these voltage issues, avoiding unnecessary network upgrades or any impact on customers' supply.
- Our RIIO-ED2 Load Investment plan includes a total of 19 deployments of OLTC across SPM and SPD[16] and more detail on this project can be found in section 6.2.4.

Technology: Thermal imaging for identifying cable fault locations

Original Project: "TOUCAN - Thermal imaging Observation techniques for Underground Cable Networks", Scottish and Southern Energy Networks (SSEN)

About the project:

- Project investigated the use of thermal imaging cameras to quickly identify faults.
- We have now deployed the solution as BAU – this was achieved by utilising our network of Innovation Champions who organised SSEN lead workshops for our operational staff.

Technology: Transformer Oil Regeneration

About the project:

- Transformer Oil Regeneration is a novel approach designed to slow transformer ageing, reducing the need for asset or oil replacement.
- Building on the learning from previous trials by Electricity North West, UK Power Networks, Northern PowerGrid and National Grid, we are trialling the solution on one grid transformer (plus two smaller auxiliary transformers) during RIIO-ED1 and deploying the solution on a further two Grid Transformers in SPM in RIIO-ED2.
- We have been representing the UK in terms of advancing learning in this area through international CIGRE and IEC working groups.

[16] See ED2-LRE-SPEN-002-CV2-EJP - HV and LV Network Reinforcement for more details

5 We transition our proven innovation into Business as Usual

As a network operator, we have been driving innovation using innovation stimulus funding streams since the start of DPCR5. **This section describes the key successes that will be proven innovation embedded as BAU for RIIO-ED2**.

Innovation projects that have fed into the successful development of each solution, both undertaken by us and other networks, are linked throughout for reference. Table 6 below summarises the areas after which each journey from development to BAU deployment is described and illustrated.

Table 6: Summary of Innovation Areas transitioned to RIIO-ED2 Business as Usual

Proven Innovation transition to Business as Usual
A Flexible Network
Active Network Management
Fault Level Monitoring
Cable Temperature Monitoring
Digitalisation: Embracing the Revolution

5.1 A Flexible Network

Distribution networks will be a key enabler to Net Zero. They will be required to operate more flexibly and with greater levels of utilisation, to accommodate both the decentralisation of generation and the electrification of heat and transport.

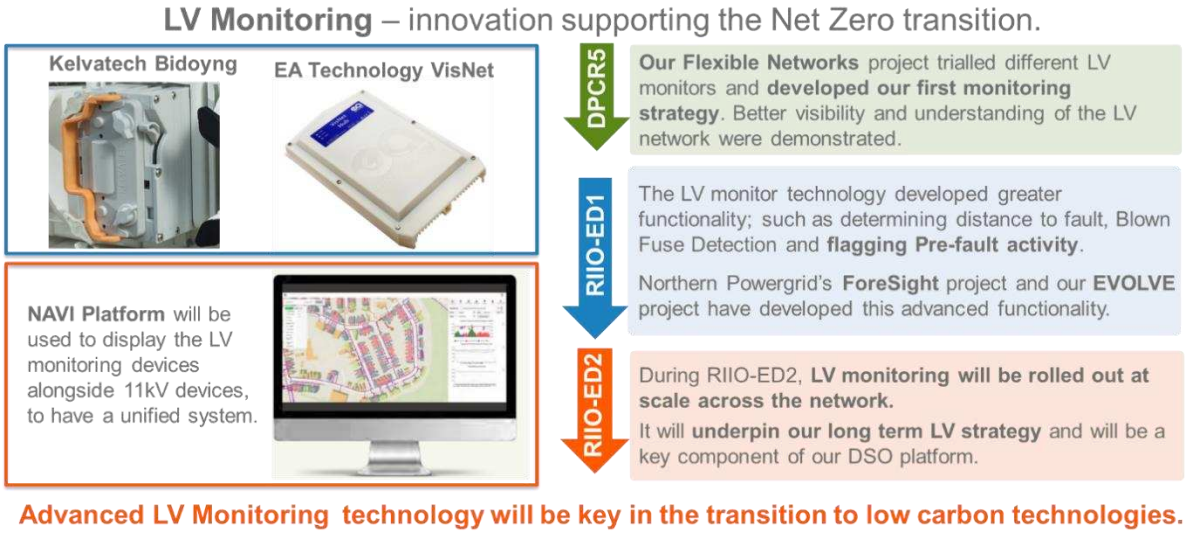
Flexible Networks for a Low Carbon Future[17], a Low Carbon Network Fund (LCNF) Tier 2 project, provided network operators with economic solutions to increase and enhance the capability of the networks. **The techniques adopted by SP Energy Networks and other DNOs in RIIO-ED1 include**:

- Enhanced network monitoring methodology and based on this network data, improved DNO planning and operations tools and practices that are optimised for future low carbon networks. The load forecasting and risk characterisation tool is integrated into the existing network planning tool for annual primary network review in SP Energy Networks. Learning outcomes for Flexible Networks were included in development of the our RIIO-ED1 Network Monitoring Strategy.
- Novel technology measures for improved performance of the network such as:
    - dynamic thermal ratings of assets – enhanced thermal rating of suitable primary transformers has increased ratings by typically 14%, deferring the requirement for substation reinforcement. This technique was adopted for 10 additional primary transformers in RIIO-ED1,
    - voltage optimisation – facilitating an increase in solar PV capacity of 90% in the trial. This will enable significantly increased volumes of generation to connect at 11kV and/or Low Voltage (LV), and
    - flexible network control – enabling an increased capacity of around 10% on suitable networks.

During RIIO-ED1, both ourselves and other DNOs have continued to invest in the development of secondary substation monitoring solutions. We demonstrated the benefits that can be achieved through better visibility and understanding of the LV network. This gave us confidence to roll out secondary substation monitoring as part of our RIIO-ED1 business plan to deliver benefits through reduced network reinforcement requirements, and to continue developing this technology ready for full network deployment. **Through our Totex funded EVOLVE project, we are investing £2.5m in RIIO-ED1 to install over 2,000 secondary substation monitors.**

[17] Our "Flexible Networks for a Low Carbon Future" project (https://www.smarternetworks.org/project/spt2003)

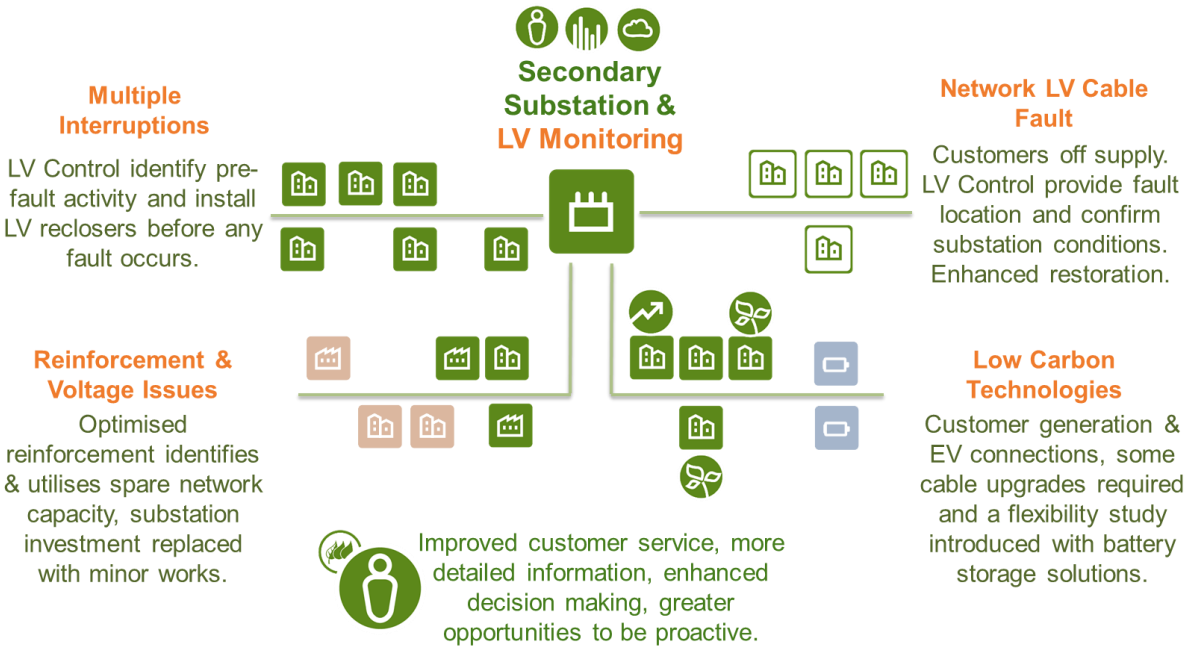
Our EVOLVE project has taken the learning from our Flexible Networks project, and also adopted learning from projects such as the Northern PowerGrid ForeSight[18] NIA project and the UK Power Networks SYNAPS[19] NIA project, to develop substation monitors with advanced functionality. The latest monitors are now capable of measuring Distance to Fault, Blown Fuse Detection and flagging Pre-fault activity on the network. This functionality provides additional benefits to customers through reducing the number and duration of power cuts. We plan to invest in rolling out this advanced functionality as part of our business plan, with **proposals to rollout LV Monitors to 14,100 secondary substations during the RIIO-ED2 period**.



While the monitors installed in the substations form part of our overall strategy, we also need to turn the data that they generate into actionable information. Our strategy is for SP Energy Networks to 'own our data' and utilise corporate applications, as opposed to 3rd party data platforms. We have an 'internalisation' strategy also applied to other data sources and devices such as LV auto-reclosers, Link Box Temperature Sensors, and Primary Substation Power Quality Monitors.

This model aims to utilise a suite of telecommunications solutions, developed through our Secondary Telecommunications NIA project, to send data to our internal Strategic Data Integration Fabric (SDIF) data repository. From here, data is shared with corporate applications such as Network Analysis and View (NAVI) (developed under our **NCEWS**[20] NIA Project), SAP asset management system, ESRI geographical information system, and our PowerOn network management system. The objective is to have a unified secondary LV & 11kV solution from a systems & communications perspective – **this is our vision of the "Smart LV network of tomorrow".**

[18] Northern PowerGrid "FORESIGHT – LV pre-fault recognition and management" project (https://www.smarternetworks.org/project/nia_npg_007)
[19] UK Power Networks "SYNAPS Fault Detection, Classification & Location Solution" (https://www.smarternetworks.org/project/nia_ukpn0037)
[20] Our Network Constraint Early Warning Systems (NCEWS) project (https://www.smarternetworks.org/project/nia_spen0016)



Integrating secondary substation data into a wider holistic view of all data from multiple technologies & sources to complement one another results in deeper understanding of the LV Network. This is essential for the DSO, as an enabler for a smart grid and operation of actively controlled LV Networks. It facilitates increased engagement with communities and 3rd parties to share data and create opportunities.

5.2 Active Network Management

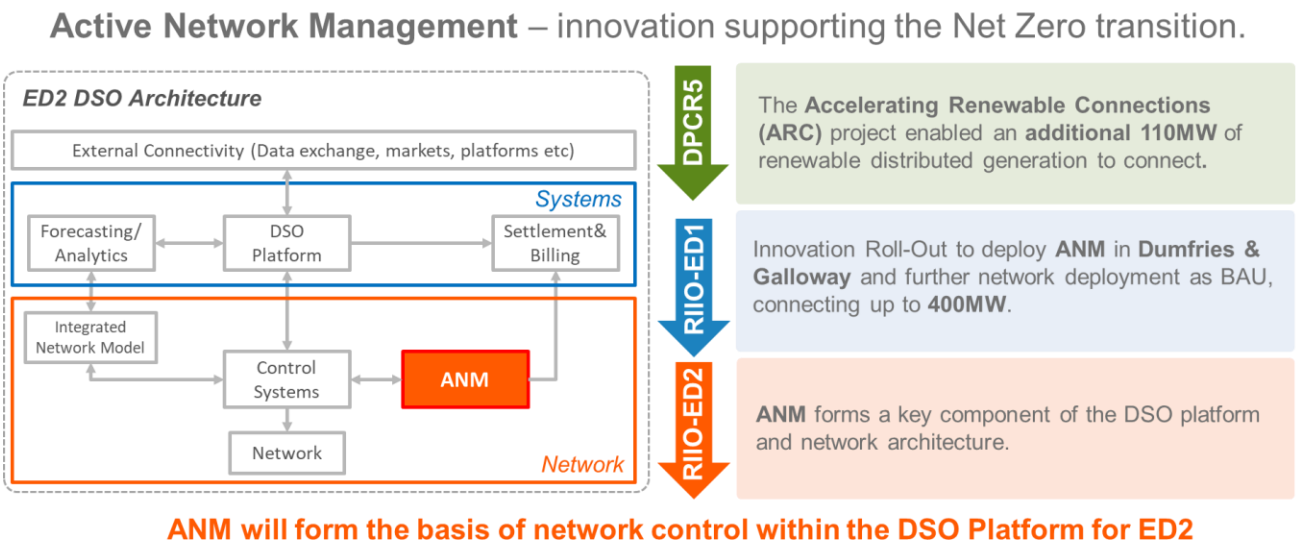
Another of our flagship innovations is Active Network Management (ANM). **ARC**[21], our Low Carbon Network Fund (LCNF) Tier 2 project, addressed the problem of network constraints restricting the connection of renewable generation. The Scottish Government had targets for at least 500MW of local and community based renewable generation by 2020. However, the network in some DNO areas had reached network limits as a consequence of a large volume of renewable generation that had already connected. This meant that the network and capacity available for future connections, which traditionally would be facilitated through a programme of network reinforcement, was substantially constrained.

The ARC project implemented a range of flexible technical and commercial solutions to accelerate the process and time to connect for distributed generation including:

- Empowerment of customers and improvement of their ability to 'optioneer' potential connection opportunities ahead of formal connection application through provision of improved network information and identification of a range of alternative connection solutions
- Review of internal design policies and processes to facilitate the connection of distributed generation and inform on advancements required to deploy the application of flexible connection solutions.
- Identification and implementation of necessary network enablers in order to facilitate flexible connection solutions and connection trials
- Trial the application of a range of flexible connection solutions that demonstrate how additional distributed generation can be enabled within network limits in network areas considered to be at full capacity

The successful completion of this project has resulted in the Active Network Management (ANM) technology **being implemented as BAU** in the Berwick and Dunbar networks, part of the SP Distribution area. This has provided over **110MW of renewable generation connections** far more quickly and cost effectively than would otherwise have been possible.

Further to this, we have leveraged Innovation Rollout Mechanism (IRM) funding and are currently delivering the **Integrated Network Constraint Management for Dumfries and Galloway**[22] project. This project, scheduled for completion within RIIO-ED1, is rolling out ANM as proven technology across the whole Dumfries and Galloway region, facilitating the connection of a further **200MW of renewable generation**, resulting in savings of **£40m** for customers. Furthermore, we are extending the benefits of this scheme with an additional **£1.5m of Totex funding**, to rollout ANM in our SP Manweb region too, aiming to connect a further **175MW – 215MW**.



[21] Accelerating Renewable Connections (ARC) – (https://www.smarternetworks.org/project/spt2004)
[22] Integrated Network Constraint for Dumfries and Galloway (https://www.spenergynetworks.co.uk/pages/dumfries_and_galloway_integrated_network_management.aspx)

In RIIO-ED2, ANM will form the basis of network control within our DSO platform. The technology will be instrumental in enabling the management of network constraints by monitoring and managing exports from distributed generation on our network.

As well as resulting in fewer constraints for existing distributed energy resources, the technology enables the **faster, cheaper** connection of new ones. By improving access to heavily congested parts of our network, ANM will directly support the move to a **smarter, more flexible network** and the **low carbon future.**

5.3 Fault Level Monitoring

Fault Level – the short circuit current that will flow through the network in the event of a fault – is increasing at Distribution voltages as a direct result of the increased connection of generation at Distribution voltage levels. Accommodating these new generation connections into areas of network that are already limited by fault level capacity is a significant challenge.

When generators connect to the network they increase the maximum energy released during a fault. The network has a safe fault level design limit which cannot be exceeded without replacing the limiting equipment or splitting up the network. In areas where there is little fault level headroom for new connections, this can prevent the low cost and timely connection of low carbon generation onto the network.

Until now we have relied on network modelling to determine fault level. These models need to be kept up to date with network changes and they do not reflect the fault level fluctuations a network will experience during a typical day or year. The models are a mathematical representation of network behaviour at any one time, and modellers rely on information supplied by Transmission Network Operators (TNOs), the DNOs themselves and Customers (end users).

SP Energy Networks has been progressing ground-breaking innovation to be able to measure and manage fault level challenges in real-time. These will give us greater visibility of network fault level and enable us to accommodate more generation while triggering fewer equipment replacements or network reconfigurations. The capability to measure actual fault level is significantly improving our understanding of the network constraints and allows us to make better informed decisions.

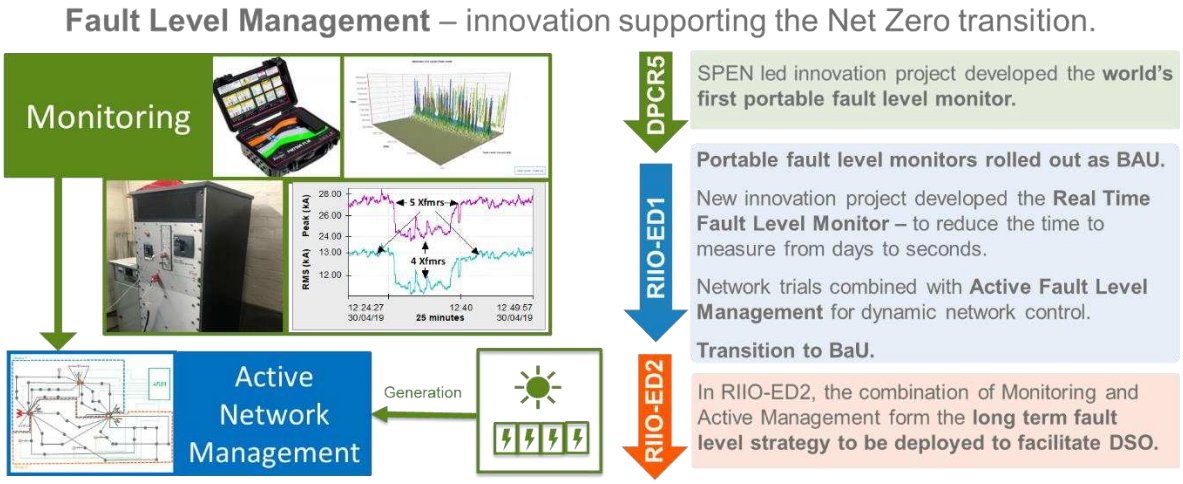
The development started in April 2013 with the IFI funded project, **Outram Fault Level Monitor**[23]. This project set out to provide a portable instrument that could successfully measure FL on a distribution network with repeatability and reliability. **This resulted in the world's first commercially available portable Fault Level Monitor (FLM)**. This works by measuring natural disturbances on the network (large loads switching on/off, switching events, and so on) to measure various characteristics of the network and calculate the fault level.

Having first been successfully demonstrated on our network, the FLM is now being used as **Business as Usual**. During RIIO-ED1, with monitors deployed across both our SP Manweb and SP Distribution regions.

The information provided by these monitors will provide a direct input into network design studies. However, a disadvantage of relying on the presence of natural disturbances on the network is that it is necessary to wait a period of time (days or weeks) before reliable results can be obtained. Therefore, the next goal identified was the ability to measure fault level in real-time in a cost effective and practical way. To achieve this, SP Energy Networks instigated a new innovation funded project to develop a **Real Time Fault Level Monitor (RTFLM)**[24]. As a result, two prototype RTFLMs were deployed within our SP Manweb region, in the city centres of Chester and Liverpool.

Network trials of these prototypes have been highly successful. For the first time, it has been possible to measure the changes in the fault level at 11kV and 33kV in real-time – a really exciting moment for the industry. Continued development of these devices, to support the transition from prototype to final product, and establish data accuracy and reliability in a variety of network conditions, is now the focus of the existing innovation project.

[23] Outram Fault Level Monitor Project (https://www.smarternetworks.org/project/ifi1007)
[24] Real Time Fault Level Monitoring (RTFLM) – Stage 1 project (https://www.smarternetworks.org/project/nia_spen0015)



The availability of real time fault level measurements becomes transformational when the measurements can be used to dynamically control the network, by combining with Active Network Management technology, which is the objective of our **Active Fault Level Management (AFLM)**[25] project.

As described earlier, the concept of ANM is to automatically control generator export onto the network to avoid network constraints. This same concept can be applied to existing network areas that are restrained by fault level, for example by utilising capacity that is available during normal operating conditions but becomes unavailable during abnormal conditions. The ANM platform can take real-time information on key network parameters and constrains capacity during abnormal conditions to maintain safe operation. Capacity is automatically and fairly constrained according to pre-agreed principles of access. Following completion of the first two phases, the first live trial for AFLM is planned for 2021, in the Warrington area of our SP Manweb region.

Combining this technology with the RTFLM will enable many more applications of the technology, maximising the potential benefits by basing the AFLM decisions on actual measurements rather than predefined limits. By facilitating more timely connection of renewable generation and deferment of network reinforcement costs, **this combined solution will be instrumental in enabling the low carbon transition.**

5.4 Cable Temperature Monitoring

In our LCNF project **Temperature Monitoring of Windfarm Cables**[26]**,** we monitored the temperature of three 33kV windfarm cables along their entire length. The objective of the project was to determine dynamic cable ratings for three cable circuits (3 - 33kV) and assess the impact that increased renewable generation from the three windfarms would have on these circuits.

From this analysis, we were able to determine that further network capacity was available, and **we increased the allowed generation capacity** as a result, enabling the windfarm to generate more low carbon electricity.

This project will help inform future cable rating calculations for other projects which could negate or postpone the requirement for upgrading/reinforcing the distribution system.

5.5 Digitalisation: Embracing the Revolution

Our lives are becoming more and more digital. Digitalisation is a process of converting information from a normal form into a digital format. For example, many of our daily lives have been impacted recently by increased home working during the Covid-19 pandemic – resulting in a greatly increased number of video-

[25] Active Fault Level Management (https://www.smarternetworks.org/project/nia_spen0014)
[26] Temperature Monitoring of Windfarm Cables (https://www.smarternetworks.org/project/nia_spen0003)

conferencing meetings rather than face-to-face ones. For a business, digitalisation can provide an advantage of doing things **faster, better and at lower cost**.

At SP Energy Networks, we have been embracing this revolution with a number of key innovation projects. Through digitalisation and harnessing the power of data, we will create the step change needed to deliver the cleaner future at the pace our customers require.

Our previous and ongoing innovation priorities in this area can be summarised as follows: -

- Big Data Handling - the collection, communication, processing, and security of the large amounts of data which can be gathered from Distribution Networks
- Network Visibility - the ability to have a full and accurate picture of the distribution network showing its current state in real time, e.g. by use of monitoring equipment
- Real-time Analytics - the analysis of the data in close-to-real time (for example, as collected via monitoring) in order to understand the data and what it tells us about the state of the network
- Data Integration - the use of data from diverse sources and their combination into one platform
- Whole-systems Modelling - The creation of one integrated model which takes in data from many sources and provides diverse functionality for end users
- DNO/SO Interfacing - methods to improve interaction, co-ordination and whole system planning between the DNO and the SO

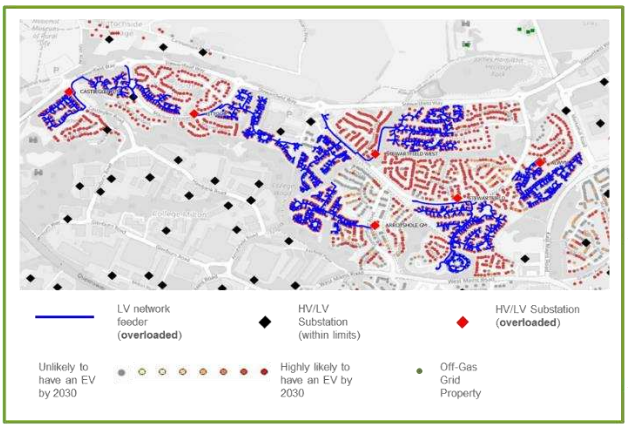
Building on relevant learning from other DNO projects such as FALCON[27] and Low Carbon London[28] which explored the concept of integrating data from DNO systems to build an 'Integrated Network Model', we undertook the NIA project **Data Intelligence for Network Operations (DINO)[29]** which evaluated different ways of managing, analysing and visualising data by addressing the specific use-case of handling alarms from Network Controllable Points (NCP), which represents a real "too much data" problem.

Learnings from the DINO project was successfully transferred into SP Energy Networks' procurement process for the **BaU funded** enterprise IT and data integration system; **Strategic Data Integration Fabric (SDIF)**. SDIF includes the creation of a fully integrated network model which will provide consistency of understanding for data sets across the business – including geospatial, connectivity, asset, and telemetry. **This is a strategic platform on which we can build a digital future**.

In our NIA project **Network Constraint Early Warning System (NCEWS)[30]** we built a LV connectivity model that can be imported into a variety of analysis tools, rather than having to build the model in each tool. Neural networks, pattern matching, and other Artificial Intelligence (AI) techniques have been applied to the model to predict network behaviour. **We are applying the model in BaU in our NAVI platform**.

[27] Western Power Distribution "Flexible Approaches for Low Carbon Optimised Networks (FALCON)" project (https://www.smarternetworks.org/project/prj_395)
[28] UK Power Networks "Low Carbon London" project (https://www.smarternetworks.org/project/edft2001)
[29] Our "Data Intelligence for Network Operators (DINO) Phase 1" project (https://www.smarternetworks.org/project/nia_spen0009)
[30] Our Network Constraint Early Warning System (NCEWS) project (https://www.smarternetworks.org/project/nia_spen0016)

NAVI (NCEWS) – innovation supporting the Net Zero transition.



RIIO-ED1

NCEWS innovation project built a LV connectivity model that is technology agnostic.

Network Analysis and View (NAVI) platform shows LV circuit connectivity.

Embedding NCEWS within NAVI provides full network visibility.

RIIO-ED2

NAVI is a key component of our **Engineering Net Zero - Network Model**.

Underpinning LV network investment in Looped services and LV Mains.

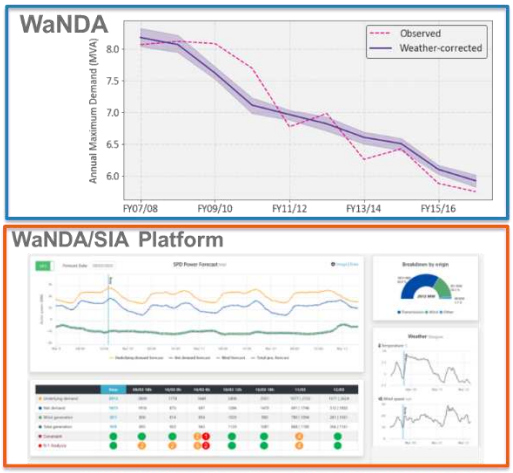
Effective management of the LV network for ED2 is ever more critical with LCT uptake

By annotating related datasets to the platform, we are providing users with a complete view of the network in one place, helping us move towards the goal of a central data management tool.

Furthermore, NCEWS and NAVI have been key components of our **Engineering Net Zero Network Model** – forecasting the impact of future increased demand on our LV network as part of our RIIO-ED2 business planning.

Also, key to our net zero modelling, our NIA project **Weather Normalised Demand Analytics (WANDA)**[31] has improved our capability to accurately forecast future local demand and the level of network investment that is required as a consequence. Load forecasts were previously based on historic power flows through substations with no adjustment made for the effect of weather in the local area. This results in additional uncertainty when making investment decisions that could lead to under or over investment in individual network areas. WANDA uses an advanced numerical weather prediction model, together with an embedded generation model to improve the accuracy of future demand prediction. Building on the success of the innovation project, **we invested in WANDA as a BaU tool to improve our planning for future demand.** We have used WANDA to improve the accuracy of the future demand forecast for primary substations used to develop our RIIO-ED2 investment plan.

WaNDA – innovation supporting the Net Zero transition.



RIIO-ED1

A £200k trial of WaNDA realised benefits of £2.3m to date. WaNDA analyses weather patterns and customer behaviour to forecast future local demand and the level of network investment required.

The SIA platform creates operational forecasts (1-7 days) to manage issues & gain visibility of flexibility requirements.

Enhanced transformer ratings are a novel benefit from combining the two projects.

RIIO-ED2

The combined **WaNDA/SIA** system will be a key component in the **DSO platform**, influencing any future network investment.

WaNDA is expected to return a **saving of £3m in ED2.**

WaNDA allows us to **forecast future local demand** corrected for weather variations.
WaNDA has been used as a key input for **DFES modelling in RIIO-ED2**.

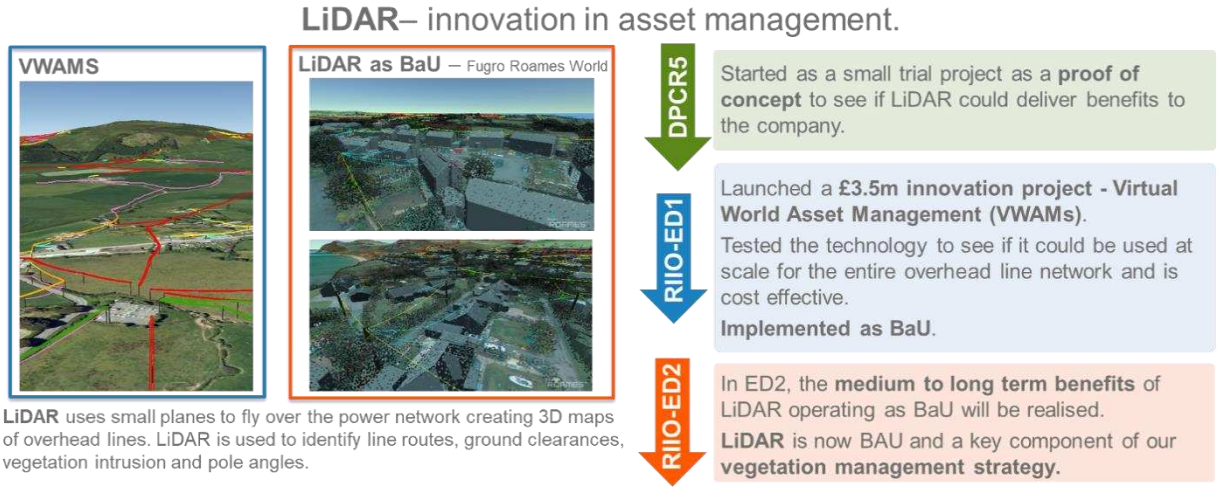
Another example where we are using data analytics to predict future demand is our NIA project **Electric Vehicle Uptake Modelling (EV-Up)**[32]**.** EV-Up uses different demographic data sets including household ability to park and charge at home; income and behaviours; household mileage. Combining these data sets together

[31] Our "Weather Normalised Demand Analytics" project (https://www.smarternetworks.org/project/nia_spen0022)
[32] Our "Electric Vehicle Uptake Modelling (EV-Up)" project (https://www.smarternetworks.org/project/nia_spen_0037)

in a transparent methodology, enables improved understanding of the network areas expected to experience increased domestic demand. **This project, including its Heat-Up[33] extension, have been used extensively as part of our Distribution Future Energy Scenario modelling that have informed our RIIO-ED2 load investment proposals.**

We are using **Totex funding** to undertake a pilot trial of **Building Information Modelling (BIM)** in our major projects team. BIM is a project execution method that's largely concerned with both work process and information flow. It's used by businesses who plan, design, construct, operate and maintain buildings and physical infrastructure. Building information models create and manage information digitally across a construction project's life cycle. The benefits that BIM is expected to bring include: Improved project 'design and build' team collaboration and workflow efficiency; reduced administration and co-ordination of tasks through workflows; improved cost estimating and forecasting.

Moving on to digitalisation in Asset Management, as part of our NIA project **Virtual World Asset Management (VWAMs)[34],** we developed techniques to provide a 3-Dimensional geographical model of our overhead line network. The data analytics trialled in the project showed a high degree of accuracy in identifying vegetation and structural intrusions, ground clearance and asset location. Detailed investigation into the benefits of the solution and how best it could generate benefits for the business and stakeholders showed public safety and customer service benefits in addition to internal efficiencies. **We have rolled out VWAMS as a BaU solution**, improving vegetation management; monitoring of conductor ground clearance; and OHL condition assessment.



[33] Our "EV-Up" project was extended to include our "Heat-Up" project https://www.spenergynetworks.co.uk/pages/heatup.aspx

[34] Our "Virtual World Asset Management (VWAMS)" project (https://www.smarternetworks.org/project/nia_spen0002)

6 We have a strong existing innovation portfolio (RIIO-ED1 Progress)

Our existing portfolio of innovation projects is building on our past success, to continue to embrace the changes needed to facilitate the low carbon transition, and ensure we are delivering value for our customers.

This portfolio is made up of both Totex and stimulus funded projects and demonstrates our commitment and intention to deliver innovation through both Totex and stimulus funds.

This section presents some highlights from our existing portfolio and the benefits we expect it to deliver.

6.1 Funded through Totex

In addition to our innovation stimulus projects, we have a number of highly innovative incentives ongoing that we fund through Totex allowances.

6.1.1 PACE Project

As part of our strategic partnership with the Scottish Government, for the decarbonisation of transport, project PACE is working in collaboration with local authorities and Transport Scotland to install 180 public chargers, specifically targeting areas where the commercial market has not yet seen EV infrastructure realised and there is no expected change in the short to medium term.

With funding matched between the Scottish Government and SP Energy Networks, this project pilots an innovative DNO-led model where the DNO is involved in the various stages of deploying universally accessible public EV charger infrastructure, including costs and delivery timescales. For more information on this project, please see “Section 2: Track Record – Innovation” of our main business plan document.

6.1.2 Green Economy Fund

The Green Economy Fund is a way of SP Energy Networks investing in the communities that we serve to support the Scottish and the UK Government’s Energy Ambitions.

SP Energy Networks have committed to contribute up to **£20m** over a two-year period to support initiatives that will benefit the people of Scotland and support Scotland’s ambitious green energy plans and local economic growth. The following areas have been identified as priority for this fund:

- Renewable and low carbon innovative solutions
- Transport – promoting the uptake and infrastructure provision of Electric Vehicles or other low carbon solutions
- Heat - provision of affordable energy for consumers – addressing fuel poverty
- Local energy systems – creation of local energy solutions to match generation and demand
- Learnings and data to assess future impact of low carbon economy
- Low carbon job creation

So far, 35 projects have been selected for funding. Many of these projects are forward thinking, incremental innovation in the areas of heat pump schemes, electric vehicles, and energy efficiency. Other projects have provided significant support to vulnerable people, or to improving the availability of education for development of renewable technology.

6.1.3 Flexibility Tendering

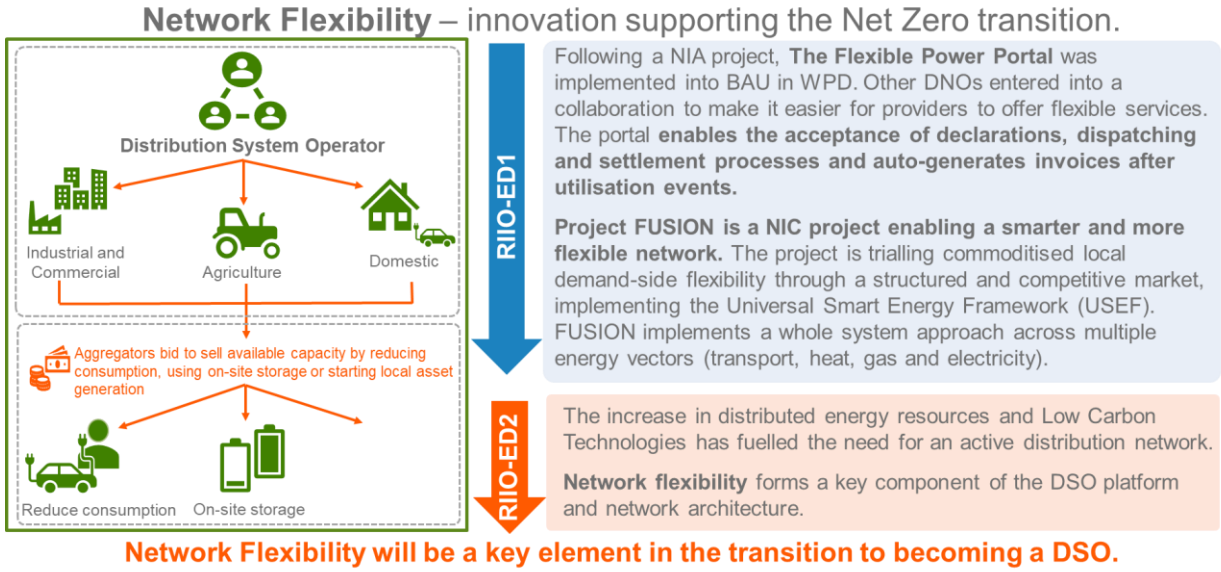
The energy market in the UK is evolving radically with `prosumers increasingly engaged in generation, flexibility, and supply of their own energy. All this activity is having a direct impact upon the operation and design of the network. Distribution Network Operators (DNOs) can make use of this flexibility to develop a grid modernisation strategy that takes account of the cultural shift in how energy is generated and consumed;

consequently securing the provision of affordable, reliable and safe power within an electrical grid that is dominated by distributed energy resources and multiple fuel technologies.

Our **FUSION**[35] project (funded by NIC) will allow DNOs to make use of the inherent flexibility that is available within a region by implementing a whole system approach across multiple energy vectors (transport, heat, gas electricity). This will be developed within a fixed frame of network parameters and demonstrate how flexibility across each energy vector can be optimised as part of a services market, to mitigate network constraints, provide a valid alternative to conventional network reinforcement and enable an agile market which can accommodate for future uncertainty in regional development.

The project will engage with multiple industry participants and stakeholders to realise the value of their flexibility by implementing an open access commercially structured market place which will allow multiple energy users to offer demand or generation services to the DNO, to alleviate network issues in real time and reduce network losses.

In addition to delivering project FUSION, we are also investing **Totex** funding and collaborating with other DNOs to implement the **Flexible Power Portal**. This will enable us to automate some of the processes needed for dispatching, billing, and settling flexibility services. These platforms can facilitate the growth of the services market by clearly setting out our service requirements and provide a secure mechanism for us to coordinate and communicate with our service providers.



This project is just commencing the trial stage and is influencing the pricing strategy for RIIO-ED2. It will be considered as BAU by the start of RIIO-ED2.

[35] Our "FUSION" project (https://www.smarternetworks.org/project/spden01)

6.2 Funded using innovation stimuli

This section describes some highlights from our innovation programme funded through stimulus mechanisms, and the expected customer benefits in RIIO-ED2.

6.2.1 Electric vehicle charging infrastructure

Electric Vehicles (EV) are a critical part of Net Zero. As the sale of new petrol- and diesel-powered vehicles is expected to end in 2030 in the UK, EVs will soon eclipse fossil-fuelled transport. These EVs will need an extensive and reliable power network to meet their demand for recharging. In our Distribution Future Energy Scenarios (DFES), we expect to see an additional 1.8m EVs in use by our customers by 2030.

While EVs are sold commercially, we see that innovation has part to play in the network reliability and acceleration of the infrastructure to enable EV uptake across domestic, public, and fleet charging.

Specifically, there is a need to accurately forecast the uptake and share information on where EV infrastructure is needed most and where the electricity network has existing capacity. This is why we felt it important to establish two projects which will support a co-ordinated, accurate and accelerated uptake of EV charge point infrastructure.

Charge[36] is a flagship NIC project aiming to reduce the length of time it takes to bring large-scale charge point schemes to fruition. Charge is, for the first time, merging transport and electricity network planning to create an overarching map of where EV charge points will be required and where they can be best accommodated by the electricity grid. Finishing in 2023, we expect it to deliver benefits to charge point operators (by making use of identified existing capacity), the EV drivers (who can use time signals and reduced costs from operators to charge at lower costs) and network operators (who can reduce their costs through efficient use of network assets and planning reinforcement more accurately).

6.2.2 Working with our vulnerable customers

Building on a separate, ongoing project funded by BEIS, we invested NIA funding in the **Bethesda Home Hub** project that aims to use a customer-driven flexibility model to support customers who have a need to keep electricity bills to a minimum.

The overall aim of the scheme is to make it easier and cheaper for the community to use locally generated electricity – in this case, from a small, local hydro power station. The BEIS project is aiming to run a trial of the Energy Local 'Home Hub' – this device is designed to be installed in residential homes within the local area of Bethesda, North Wales. The Home Hub kit is made up of a small wireless control hub and a SmartPlug. It may also include a temperature and humidity monitor. It allows the homeowner to use their Energy Local Dashboard to control the smart plug to help schedule appliances and take advantage of low-cost locally generated electricity.

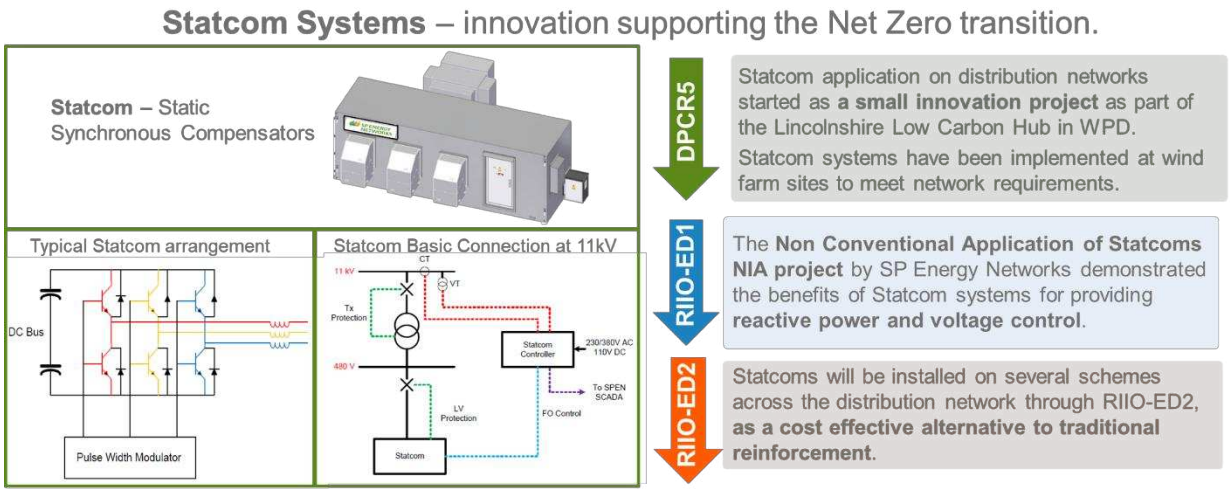
We have joined the project to support the concept of customer driven flexibility to reduce demand on the network during peak times. Participating customers will be informed when electricity is cheapest to use (during times of lower demand or higher generation output) and encouraged to use electricity at those times. Live trials of this scheme are expected to start in 2021.

6.2.3 Power Electronics

We have set a priority strategy to enhance network control and flexibility and implement automation for new and legacy assets. One of the main enablers of the flexible networks is the **use of power electronic technologies** which have been increasingly growing in different industries (not only Energy sector). The market demand together with advancement in software and semi-conductors have made power electronics technology a new, very attractive solutions to wide range of applications.

SP Energy Networks has given special focus to development and deployment of power electronic applications as part of its innovation strategy – **this has been spotlighted later**. We have been carrying out an extensive trial and design of power electronic applications at various voltage levels. **StatComs**[37] are an example of this technology that is embedded within our plans for RIIO-ED2.

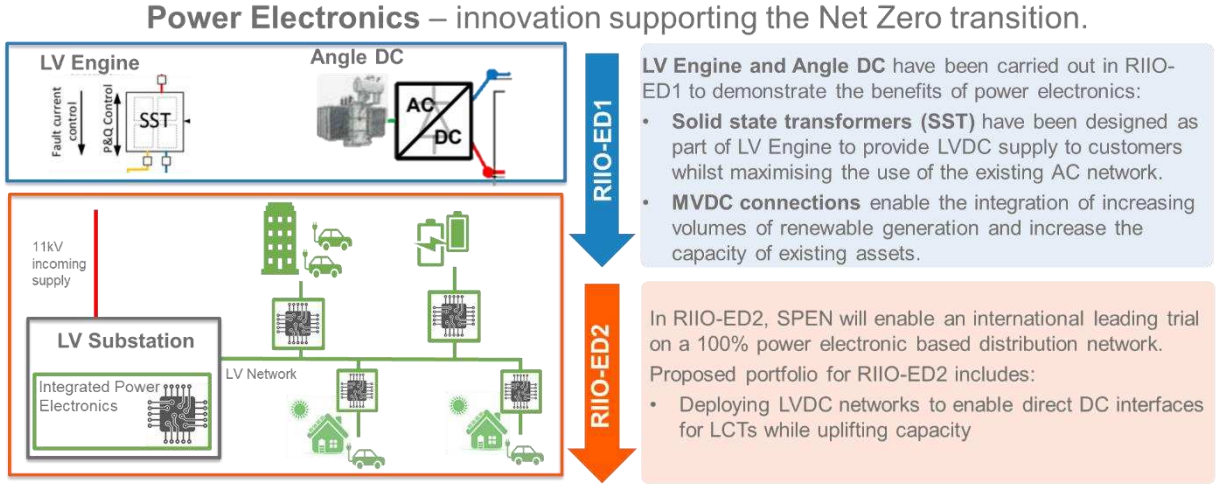
[36] Our "CHARGE" project (https://www.spenergynetworks.co.uk/pages/charge.aspx)
[37] Our "Technical Review of Non-Conventional StatCom Applications" project (https://www.smarternetworks.org/project/nia_spen0018)



Statcom devices will be installed for voltage control facilitating the low carbon transition

In these developments, we have been carrying out several flagship innovations projects with over **£44m** (including our Transmission project, PHOENIX) allocated budget to specifically enhance power electronic technologies and bring live demonstration of grid deployments at all voltage levels. This investment will potentially **deliver up to £1.2b saving to GB electricity customers and 1,500 ktCO2 reduction by 2050**. These projects, funded through the Network Innovation Competition (NIC) mechanism, include **ANGLE-DC**, **PHEONIX and LV ENGINE** as well as supporting NIA funded projects to leverage further learning.

The **LV Engine** project is a network trial of Smart Transformers to facilitate the connection of Low Carbon Technologies (LCTs), such as electric vehicle chargers and solar panels, whilst representing value for money for our customers. Many LCTs operate on a direct current (DC) voltage which requires conversion from AC. LV Engine intends to design a Smart Transformer which can provide a LV DC supply to our customers for the first time. The innovative technology being developed through this project is being deployed at 18 locations in RIIO-ED2 as part of our HV and LV Network Reinforcement[38].



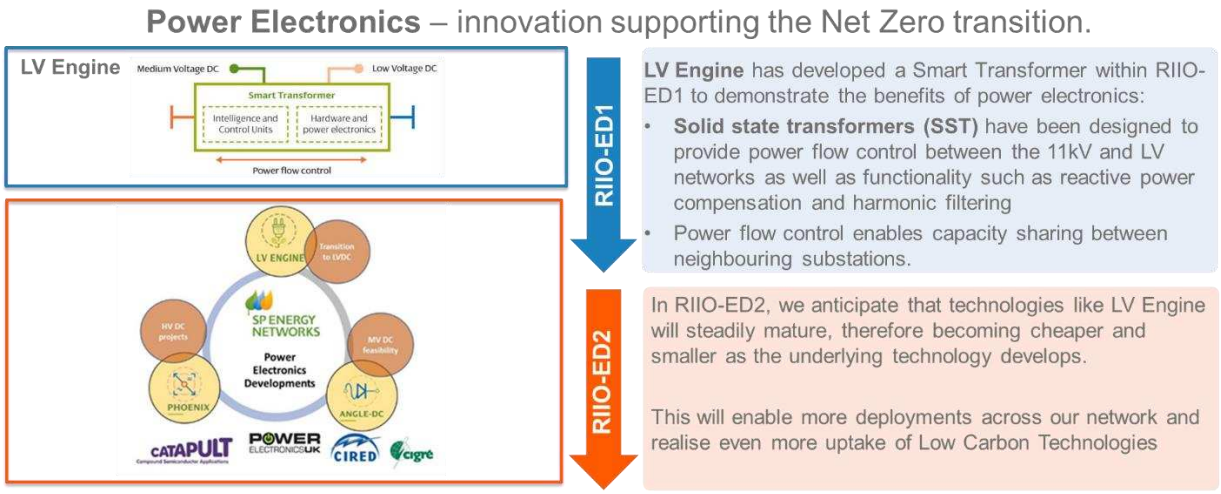
Power electronics will facilitate **higher capacity** on existing assets, **greater control and flexibility**.

Through active engagement within last decade, we have worked with our UK and international partners to exchange the knowledge and learnings. In addition to running flagship innovation projects delivering cutting edge power electronic products, we actively lead and contribute to international working groups focusing on power electronics (such as the LV DC CIRED working group and the Cigre MVDC working group).

[redacted]

[38] See ED2-LRE-SPEN-002-CV2-EJP - HV and LV Network Reinforcement for more details

[redacted]



6.2.4 Managing voltage issues

The increase in distributed generation is causing new issues that we now need to manage. We are experiencing growing daily voltage rise and voltage drop issues that have not been seen in the past. Distributed generation, such as residential solar panels, are already the main cause of overvoltage issues, however in the future the widespread use of EVs and heat pumps could also cause more under voltage issues at LV. These issues require more automation and voltage regulation capabilities at a distribution level than was required in the past.

On-load tap changer (OLTC) transformers are one solution to these voltage issues, avoiding unnecessary network upgrades or any impact on customers' supply. Electricity North West (ENWL) has successfully demonstrated their benefits in the **Smart Street**[39] project.

We have added this to our toolbox as a fast follower solution to facilitate the integration of Low Carbon Technologies (LCTs) that may cause voltage issue. OLTC transformers offer voltage regulation to maintain system voltage within regulated limits leading to an improved quality of supply.

In addition, OLTCs help reduce energy losses by operating at a lower voltage allowing individual customers to save **an average £70 annually from their electricity bills**. Furthermore, we would expect to see reduced carbon emissions by allowing faster connection of LCTs and deferring network reinforcement, supporting emission reduction targets. The solution requires less planning and onsite works than conventional reinforcement and will reduce road works and planned supply interruptions.

6.2.5 Managing aging assets

Wooden utility poles are used extensively across the GB electricity distribution network to support overhead line conductors and other associated plant. Traditionally the wooden poles are treated with creosote as a preservative, providing each pole with an approximate lifespan of 55 years. There are millions of these poles in GB. However, it is now recognised that creosote is hazardous to the environment and research is currently underway to identify an environmentally friendly alternative.

Creosote for amateur use was banned in the UK in 2003 and industrial creosote now has to conform to certain formulation restrictions. Eventually, a full ban will occur which will cause severe disruption to the supply of timber overhead line supports and render UK energy provision more expensive unless a replacement preservative type, which can provide similar efficacy, is in place.

One solution to this problem was explored with our **Operational Assessment of Composite Poles**[40] project**.** This project investigated the use of composite (as opposed to wood) poles in an operational setting. While the project focussed on composite poles, the learning was equally applicable to engineered poles of other

[39] Electricity North West "Smart Street" project (https://www.smarternetworks.org/project/enwt205)
[40] Operational Assessment of Composite Poles project (https://www.smarternetworks.org/project/nia_spen0019)

materials, such as plastic or concrete. The learning from the project was that such poles present operational issues, such as:

- The existing stay terminations are not compatible with composite poles
- The existing drilling practices are not compatible with composite poles
- The top of composite poles can only be accessed via a mobile working platform and cannot be climbed using spikes or ladders

While the above does not rule out engineered poles from operational use, resolving the above would increase operational costs. Therefore, the preferred strategy is to continue to use wooden utility poles.

One commercially available, environmentally friendly alternative to Creosote treatment for wood utility poles is Copper Biocide. We have been using Copper Biocide poles in public areas since 2015 – however there is strong evidence that these poles have a significantly shorter service life than poles treated with Creosote. A more long-lasting alternative is therefore still required.

To achieve this, our industry leading **APPEAL** project[41] is aiming to investigate the best environmentally friendly alternative to creosote to maximise the life of electricity poles. Accelerated aging tests of wooden timber stakes, treated with environmentally friendly alternatives to creosote, are currently in progress, the results of which will directly inform future procurement policy for overhead line supports. Early results are showing great promise, and if successful, **customers will benefit from a greener energy system while avoiding a significant increase in cost.**

While this work is ongoing, early estimations are that any alternative found may not be as long lasting as the existing creosote solution and therefore issues with decayed poles are likely to increase. Assessment of wood pole condition is typically obtained using a hammer sounding test that is very subjective in nature. Various technology has been developed over the years to create a more scientific assessment method, with a calculated Residual Strength Value (RSV), however all have either cost, efficiency, or technical issues.

To address this problem, in 2020 we instigated **the THOR Hammer project**[42]. The project involves the evaluation of a highly promising seismic pole tester device that has originally been developed in New Zealand. For maximum value to the industry, this project is being delivered collaboratively with two other UK DNOs (Northern PowerGrid and UK Power Networks). If the project is successful, a practical technique will become widely available that will allow an RSV to be calculated across a wood pole network at a large scale, meaning that it can be used to make better decisions when determining the replacement time for a wooden pole. This also links to our digitalisation strategy by creating a digital record of the condition, location, and pole depth for each structure, vastly improving data quality, and enabling better informed asset management decisions to be made.

[41] Environmentally Acceptable Wood Pole Pre-treatment Alternatives to Creosote (APPEAL) project (https://www.smarternetworks.org/project/nia_spen0008). UK Power Networks, Scottish and Southern Energy and Northern PowerGrid are collaborators.
[42] Our "THOR Hammer" project (https://www.smarternetworks.org/project/nia_spen_0039). UK Power Networks and Norther PowerGrid are collaborators.

7 Our RIIO-ED2 Innovation Strategy and Delivery Plans

This section is specifically focussed on our innovation strategy and delivery plans for RIIO-ED2.

Ofgem have refocussed NIA for RIIO-ED2 onto two specific themes:

- Energy System Transition
- Consumer Vulnerability

We have developed our strategy by adopting these themes, identified the focus areas within them, and aligned with our wider Future System Strategy[43]. When developing the strategy, we set ourselves the following objectives:

1. Ensure alignment with both Ofgem's focus areas and the ENA Innovation Strategy
2. Ensure alignment with the wider Future System Strategy, by aligning with the specific strategies of our relevant business areas
3. Create a holistic innovation strategy that is independent of any specific funding mechanisms.

We will deliver projects within these themes through either Totex or Stimulus funding; the intention is for any innovation with a sole focus on efficiency savings will be funded through Totex only.

The Energy System Transition is essential to facilitate Net Zero. It includes adapting to the decentralisation of generation, the uptake of Low Carbon Technologies (LCTs), and decarbonising our existing network. **Network Modernisation, Digitalisation, DSO, Whole Energy System and Sustainability are the focus areas we have identified for innovation to enable the Energy System Transition.**

We welcome the increased focus on Consumer Vulnerability for RIIO-ED2. We recognise that we have a social responsibility to ensure everyone benefits from Net Zero, and no one is left behind. We have **aligned this part of the strategy closely with our Customer Vulnerability RIIO-ED2 commitments** and it is designed to build upon the strong work we do as part of our business as usual delivery.

Customers will benefit from a greener energy system while we keep costs as low as possible.

We have engaged with our Stakeholders throughout the process of developing the areas beneath the high-level themes, to support the development of innovation planning for RIIO-ED2. This activity is underpinned by our values – delivering value to customers, delivering a smarter more flexible network, and delivering a sustainable network – with safety and sustainability central to everything.

[43] Please refer to Annex 4A.1: Future System Strategy

7.1 How we derived our Innovation Framework

7.1.1 Why innovation stimulus is important

We fully support the Ofgem requirement that networks undertake more innovation through Business as Usual (BAU). Nonetheless there is a significant and growing requirement for innovation stimulus funding for projects which are not incentivised via Totex but are essential to facilitate the energy system transition and ensure that vulnerable customers are not left behind.

Innovation Stimulus makes up an important aspect of our portfolio allowing us to pursue lower Technology Readiness Level (TRL) concepts that have potential benefits but higher risk. The impact of not receiving Innovation Stimulus would mean that the type of projects described above that would be funded using those mechanisms, would become very difficult to fund due to the identified risk with lower TRL concepts which must be mitigated in order to be integrated safely into our network. This will create a funding gap for technology with the potential to bring significant network and customer benefits in the future.

7.1.2 How we allocate Totex and/or stimulus funding

We have updated our innovation process for RIIO-ED2. As mentioned previously, the objective was to form a holistic process, that is independent of funding mechanism, and is applied to all innovation.

We have identified three key stages of innovation as follows:

Innovation Mechanism	Description	Funding Source	Requirements
Research and Development	Low-mid Technology Readiness Level (TRL) projects which would require significant development prior to BAU adoption.	NIA (or other innovation stimulus)	Alignment to NIA & other stimulus Governance
Transitional Innovation	Mid-to-high TRL projects which may be jointly funded by Innovation Stimulus and Totex.	NIA (or other innovation stimulus) or Totex.	Alignment to NIA & other stimulus Governance
Incremental Innovation	High TRL projects (i.e. primarily levels 8 or 9) which have identified business benefits that can be claimed through BP incentives and mechanisms.	Totex funded	Appropriate level of benefits identified to be realised through Totex incentives or savings

The criteria for an innovation project to be funded via either BAU or allowance funding is outlined below:

- BAU (Totex) funding: higher Technology Readiness Level (TRL), benefit within RIIO-ED2 and greater certainty of success.
- Allowance funding (NIA and other innovation stimulus): lower TRL, benefit beyond RIIO-ED2, less certainty of success, collaborative large-scale projects, and decarbonised energy system.

This is illustrated in our process diagram below.

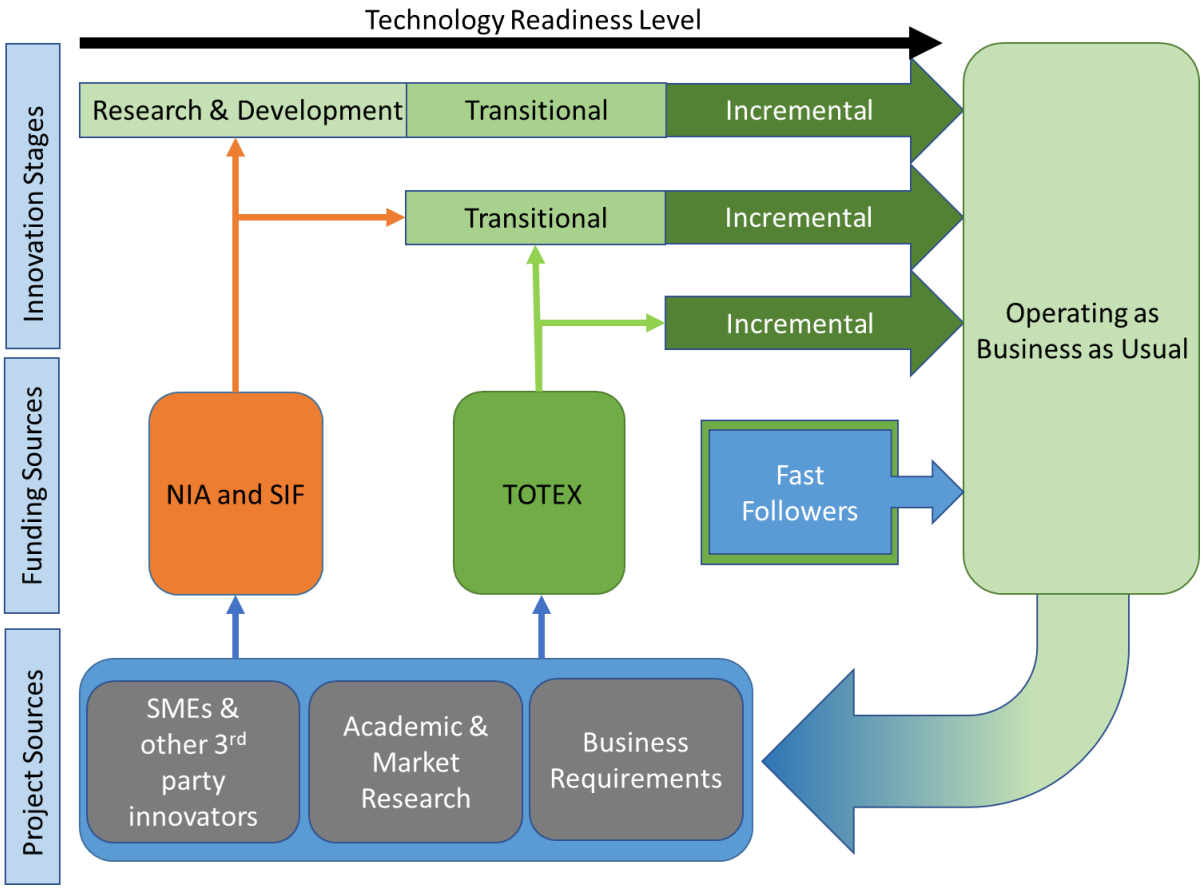


Figure 1 RIIO-ED2 Innovation Process: stages of innovation and primary funding streams

New projects can be sourced either externally (SME's and other 3rd party innovators, academia, or market research) or internally (from business requirements, or requirements we have identified to meet our obligations to customers).

Once the need for a project has been identified, the funding mechanism will then be identified based on:

- the TRL level
- the stage of innovation
- the potential benefits the project will realise.

Once a project has been approved for funding, the next step is to deliver the project, working closely with the relevant business functions, abiding by project governance (covered in detail later in this document) and utilising our network of Innovation Champions to ensure a clear route to BAU implementation upon successful completion.

Once successful innovation is embedded into BAU, it is possible for the solution go around the cycle again, should the solution need to be updated incrementally in the future.

We also have a Fast Follower process to ensure we are building on new innovation proven by other networks than ourselves. This process is covered in detail later in Section 8.3.

7.2 Our RIIO-ED2 Strategic Areas

The focus areas for innovation that we have identified within the high-level themes of Energy System Transition and Consumer Vulnerability are illustrated below. In addition, we have "spotlighted" five key innovation areas, covered in more detail in a later section.

Our industry is constantly evolving. New ideas, developments and technology are being developed continually; this makes it difficult to see what all future projects might be as we develop our plans for RIIO-ED2. We have set out our high-level strategies for each area and will align innovation projects appropriately.

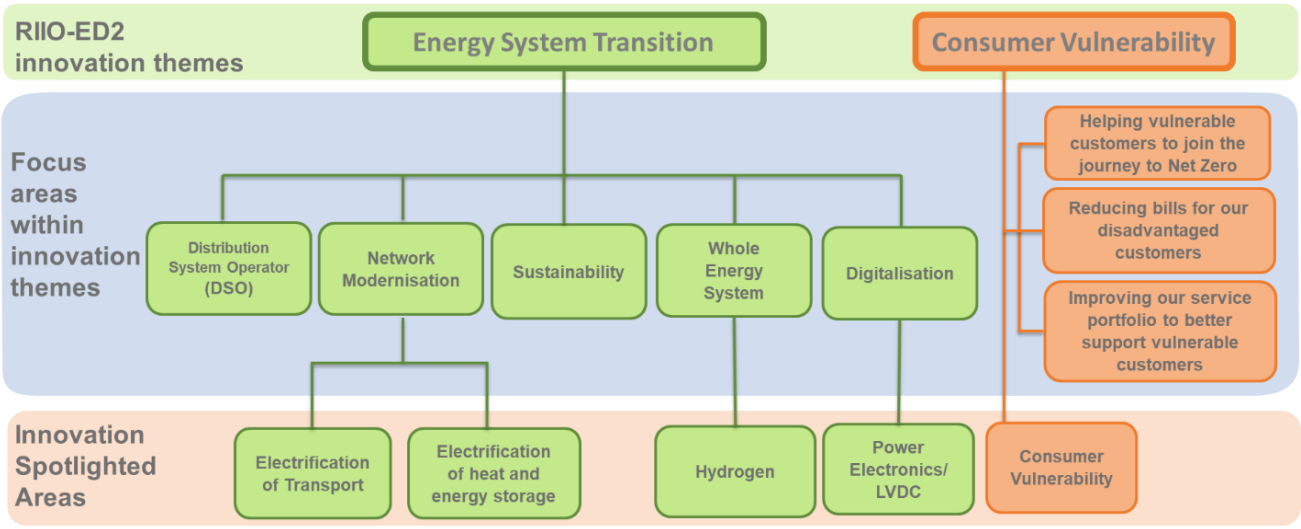


Figure 2: Innovation Themes and Focus Areas

Note: we have listened to our Stakeholders and are avoiding the adoption of a siloed approach to the Energy System Transition and Consumer Vulnerability themes. For this reason, we will undertake a Consumer Vulnerability impact assessment for all Energy System Transition projects. We will also undertake a Consumer Vulnerability impact assessment for all Totex funded DRIVE innovation campaigns. For more details on this approach, see section 7.4.

Alignment with the new ENA Innovation Strategy is key to ensure there are no barriers for collaboration, both within our sector and also cross sector. To illustrate this alignment, our focus areas have been mapped to the relevant areas of the ENA Innovation Strategy below.

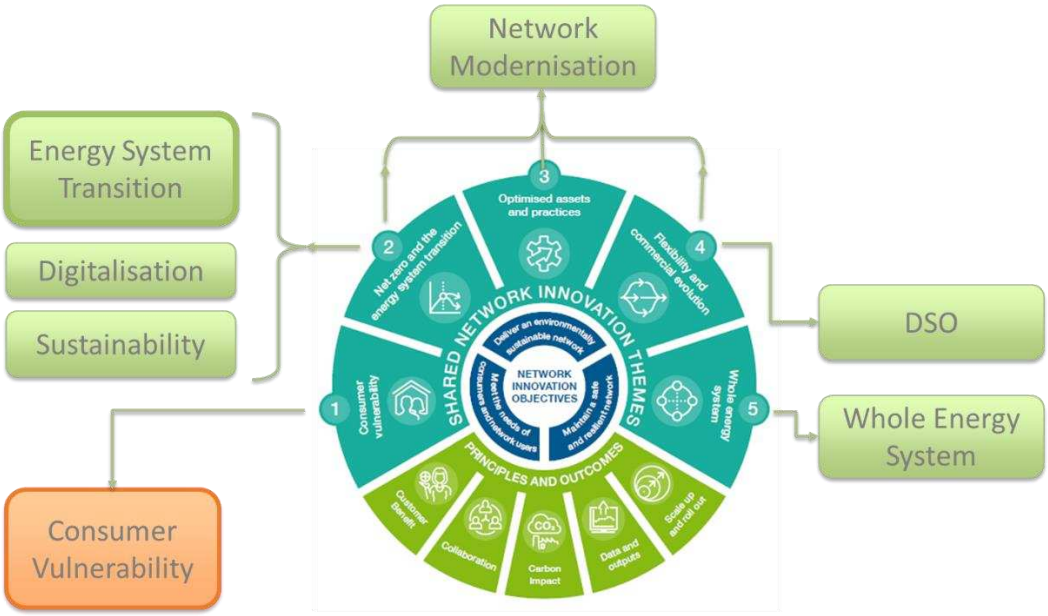


Figure 3: Alignment of Innovation Focus Areas with Energy Networks Association Innovation Strategy

7.2.1 Energy System Transition

Our innovation focus areas are discussed in more detail in the following sections, where we outline how we believe innovation should support the development of each strategic area.

Eligibility for NIA will be project specific and dependent upon both full alignment with the Energy System Transition theme and funding eligibility criteria.

Network Modernisation

The rapid uptake of LCTs and the decentralisation of generation is putting ever greater pressures on our aging electricity distribution network.

We need to modernise the network to cope with the challenges and the key enablers are the network design tools to support the transition. We will develop industry leading techniques to optimise our assets and practices to meet the challenges that we face from rapid decarbonisation and the associated changing demand and generation patterns.

Primarily we must modernise our network to ensure that we:

- Facilitate and enable the electrification of heat and transport
- Facilitate the efficient connection of low carbon electricity generation and storage
- Facilitate the adoption of flexibility and smart systems

The innovation focus areas we have identified for each of the points above are described in the following tables.

Network Modernisation Sub-Topics
Optimal Network Design
Optimised Assets & Practices
Reliability and Resilience

Optimal network design

We must continue to move from deterministic to probabilistic approaches with network design. Electricity System Restoration (Black Start) policy must also be considered.

Objectives	Innovation Focus
1. **Facilitate and enable the electrification of heat and transport** **Electrification of heat and transport will overload our network in many places. We need to continue to innovate to develop commercial models and technical solutions to enable the transition in the most cost-effective way**	• Planning tools to evaluate the impact of the electrification of heat and transport to a granular local level and share this information with stakeholders in the planning process • Smart control systems in combination with techniques like electrical and thermal storage to increase utilisation of our assets • Whole system, cross vector coordination and planning, considering gas, heat networks, and transport.
2. **Facilitate the efficient connection of low carbon electricity generation and storage** **The forecast tripling of capacity by 2030 means that we need innovative tools and processes to provide design solutions and offer connections**	• Self-service tools for customers to enable them to review connection opportunities and self-quote. • Further develop alternative connection options such as ANM so they can be routinely offered at lower voltage levels • Further develop system voltage optimisation techniques which have potential to enable greater capacity for distributed generation
3. **Facilitate the adoption of flexibility and smart systems**	• Design tools that can accurately and automatically assess the potential for DSR to meet network requirements down to a granular local level.

Demand side response and beyond the meter services will be an essential part of the DSO toolkit in managing the energy system transition	• DSO Interface; the real-time interface between DSO systems and multiple aggregators/service providers • Aggregator/service provider platforms • Smart domestic control systems • Integration of domestic thermal and electrical storage • Direct load control techniques • Variable time of use tariffs

Optimised Assets and Practices
We will develop industry leading techniques to optimise our assets and practices to meet the challenges that we face from rapid decarbonisation and the associated changing demand and generation patterns.

Theme	Innovation Focus
1. **Improve the visibility of customers and their behaviour** **With increasing demand for electricity driven by LCT uptake together with the increasing role of customer flexibility, it is becoming ever more important for us to understand and predict customer behaviour.**	We will innovate to improve our capabilities in the following time frames: - a) Near to real-time, to enable dynamic operational dispatch of energy resources. b) Longer term planning and scenario analysis incorporating customer flexibility estimation.
2. **Enable digitalisation for network and system optimisation** **Digitalisation in all aspects of our business is essential to facilitate the energy system transition.**	Examples where we intend to innovate to realise the benefits of digitalisation under this theme include: • Building on the learning from our transmission digital substations to apply to distribution substations, to perform network optimisation, control, and protection functions.

Reliability and resilience
As GB decarbonises heat and transport, customers will become more reliant on electricity for their energy needs and any unplanned outage, supply interruptions or wider disruption will have ever increasing impact. The changes to GB energy mix and the closure of coal-fired power stations introduces challenges to resilience and network stability. **These are becoming a key priority in the energy system transition challenge**. Through our innovation projects we aim to focus on different aspects of system security and stability.

The loss of large synchronous generation has also created an urgent need to backfill essential grid services. We will be collaborating with the ESO and using innovation to assess the risks and find innovative solutions to mitigate the risks posed through loss of grid services.

We will innovate to improve the Electricity System Restoration (ESR – formally known as “Black Start”) plans by building on the **Distributed Re-Start**[44] project, including developing a new procedure and strategy for innovative ancillary services coming from different sources such as DERs, and storage and innovative methods for restorative action schemes.

A large **solar flare** has the potential to cause devastating damage to our electricity networks with resulting social and economic consequences. These events are rare; however, scientists believe that such an event will occur but are unable to predict when. We plan to use innovation, building on the findings from academic research, to develop equipment specifications and network designs which are more resilient to the effects of solar flares.

The reliability and resilience theme aligns with the energy system transition challenges of:

- Maintaining system security and stability: under conditions of lower system strength, and increased network dynamics and interactions
- Challenges related to increased network dynamics and Electricity System Restoration

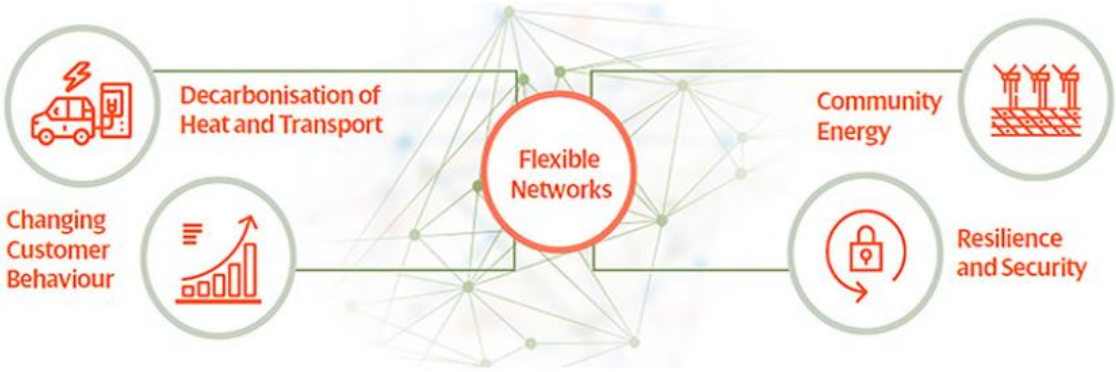
[44] “Black Start from Distributed Energy Resources” project (https://www.smarternetworks.org/project/nic_esoen01)

Theme	Innovation Focus
1. Distribution wide visibility and contingency scenario analysis **Following the 09 August 2019 power outage, Ofgem recommended that consideration is given to the value of DG visibility for network resilience**	We will innovate to develop capabilities that help provide DNOs • With full distribution wide visibility • Ability to develop a high volume of contingency scenario analysis in real-time
2. Enhanced ancillary services **In the past decade, with the reduction in grid services, innovative solutions are required to provide faster and alternate sources of grid services. This forms a key part of the ESO's innovation portfolio. We have and will collaborate with the ESO in future to enable enhanced ancillary services on our network.**	We have pioneered the application of hybrid synchronous condensers through our **Phoenix[45] H-SC** transmission NIC project: • Building on learning from Phoenix we will identify the optimum location and rating of H-SC on our 132kV and 33kV distribution networks • The ESO are establishing requirements for virtual synchronous machines to enable enhanced ancillary services from various connected converter-based assets. We will collaborate with the ESO to enable the development of VSM in RIIO-ED2. We will build on the learning from the **Darsalloch WF** trial which is a world-first demonstration of VSM capability under black start conditions.
3. Reduce and mitigate unplanned supply interruptions including wider disruptions **As part of this theme it is important that we consider the increasing potential for low frequency demand disconnection (LFDD) and black start in a system increasingly reliant on intermittent generation.**	• New and improved techniques to reduce the number and duration of interruptions such as fault prediction and diagnosis. • Solutions to protect more customers from low frequency demand disconnection (LFDD). • Techniques to embed black start capability into distribution networks planning
4. Solar flare resilience **A large solar flare could cause damage to equipment, particularly transformers resulting in power outages for days or weeks.**	• Develop specifications for transformers with enhanced resilience • Build and test prototypes • Undertake a risk assessment based on customer impact to develop a roll-out plan for enhanced transformers • Develop requirements for a strategic 'recovery transformer' reserve

[45] Our "Phoenix – System Security and Synchronous Compensators" project (https://www.smarternetworks.org/project/spten03)

Distribution System Operator (DSO)

To tackle the climate emergency and deliver Net Zero carbon targets, a significant proportion of customer transport and building heating will be electrified. We are also going to see a further leap in renewable generation capacity as fossil fuel power stations close, and experience more dynamic and complex power flows as customers become increasingly active participants in the energy system. If we do not continue to adapt to meet our customers' evolving needs, these changes will push the distribution network and wider system beyond what it is currently designed for – this would lead to higher costs and a poorer service for all customers.



The magnitude of these changes means there is a clear need for us to deliver a set of functions, activities, and enablers to meet our customers' evolving needs, deliver Net Zero, and ensure the continued safe, reliable and efficient operation of the distribution network and wider energy system for all customers.

Most of these functions and activities are evolutions of existing business-as-usual activities, whilst others are new. These functions and activities in turn require new enabling tools, processes, and capabilities.

This is what Distribution System Operator (DSO) is to us: the set of functions, activities, and enablers that we plan to deliver, so that we can continue to serve our customers and communities. They include delivering smarter and more agile network infrastructure, making extensive use of services delivered by our customers, being a neutral facilitator of an open and accessible distribution energy resources (DER) services market, and coordinating DER services to deliver a safe, efficient, and reliable whole system. These must be delivered at a pace that meets our customers' needs.

At SP Energy Networks, we have already published our DSO Strategy[46]. Within this strategy, we have outlined the four functions needed for a DSO to meet system challenges and deliver the safe, efficient, reliable, and decarbonised operation of the distribution network and wider energy system at least cost to customers. As shown below, the strategy has also identified six key enablers that underpin these DSO functions.

[46] https://www.spenergynetworks.co.uk/pages/distribution_system_operator.aspx

Given their importance, we have already started to deliver these enablers. However, this is a fast developing and new area for a DNO, and an area that, without innovation, will push the distribution network and wider system beyond what it is currently designed for – this would lead to higher costs and a poorer service for customers. For these reasons, innovation in these areas is critical, and our strategy will be to focus our efforts on the DSO enablers, to ensure that we can complete the transition to DSO at the required pace for the country to meet Net Zero targets.

In RIIO-ED2 we will innovate to develop: -

- The DSO functions directly
- The DSO enablers

DSO functions
We have identified priority themes within the DSO functions where we will focus our innovation activity.

Theme	Innovation Focus
1. **Enable domestic flexibility and local energy markets** **It is essential that customers become engaged in the energy system transition and become 'prosumers'.**	We will develop new, engaging solutions that are attractive to consumers, for example: improving visibility and accessibility of information.
2. **Trial and implement arrangements to support network management and flexibility** **As new commercial models arise, and third-party involvement increases we will develop the technical and business process solutions to support them.**	We will develop novel technical and commercial arrangements designed to increase the availability and capability of demand side response solutions.
3. **Maximise the opportunities from smart meters, data, and network charging reforms** **We will innovate to support new business models and opportunities for third parties**	We will improve methods of sharing operational information and data, and further explore opportunities for customers to interact with us.
4. Develop flexible connection arrangements to facilitate customer choice **Through flexible connections we can increase the capacity for LCT to connect to the network**	We will extend flexible connection options to lower voltage levels, for example: to facilitate heat pump and electric vehicle charger connections.
5. Identify regulatory barriers and make recommendations for reform **Some existing regulations could potentially adversely affect the energy system transition.**	We will work pro-actively with other network operators and regulators to identify areas that require reform and suggest changes.

DSO Enablers
The specific benefits of delivering each enabler are documented within the DSO Strategy. The table below outlines the areas of focus for innovation within each enabler. There are synergies with some of our other innovation themes, in particular Digitalisation and Whole System Approaches.

Enabler	Innovation Focus
1. Expanded network monitoring, telecommunications, and control **• Monitoring gives greater real-time visibility of the network.** **• Control means we can quickly and remotely make changes to the network.** **• A reliable, secure, and low latency communication network enables this monitoring and control.** **These are especially needed on the LV network, to accommodate decarbonisation and more active prosumers.**	This is a key area for innovation. Ongoing innovation in this area includes the **EVOLVE**, **LV Engine** and **Fault Level Management** projects. Future innovation will focus on the development of new technology or methods to support this enabler.
2. Enhanced forecasting and modelling **Detailed forecasting means we can understand how our customers' demand and generation requirements will change in different areas of the network.** **Enhanced modelling means we can understand the network impact of those customer changes and assess possible network interventions.**	We are already making progress in this area with our **EV-Up**, **WANDA** and **Enhanced Network Forecasting** projects. Future innovation will likely focus on increased modelling capabilities, utilising ever more complex systems to assess increasingly holistic scenarios and maximise the benefit of this work.
3. Data and digitalisation **Data is the key to fully unlocking the value of the network for our customers. So that data delivers this value, we are undergoing a digitalisation transformation to make the data visible,** **accessible, and interoperable. Together, data and digitalisation underpin all network activities, from allowing us to make more informed operational decisions to helping markets better understand network opportunities.**	We are already making progress in this area with our **SDIF** and **NCEWS** projects. In addition, we are implementing the **Flexible Power Portal**, and have digitised our **Network Asset Management System (NAMS)**. Future innovation will look to build on this work to fully unlock the benefits of data to support this enabler.
4. Increased whole system coordination **Network planning coordination across distribution, transmission, and other energy vectors. This is needed as customers change their energy consumption vectors (e.g. increasingly using electricity rather than petrol/** **diesel for their car) with the move to Net Zero.** **Operational coordination, especially the use of DER services, between distribution and the ESO. This is needed given the growing dependency on DER services by us and the ESO, and the resulting distribution to transmission operational interactivity.**	We are already making progress in this area with our **FUSION, Distributed ReStart,** and **ANM** projects, and also via our active participation in the **Open Networks** project. Future innovation will look to continue breaking new ground as we transition to DSO.

5. Holistic conflict management regime **Given the magnitude and breadth of the changes on the distribution network, we are evolving existing activities and plan to undertake new activities. A number of these involve interacting more closely with our customers, other network parties and other markets. This could give rise to real or perceived conflicts of interest – these must be addressed.**	We are already making progress in this area by leading industry work to create a transparent process to value flexibility services. Based on this, we were the first DNO to publish site-specific pricing in our flexibility tenders, showing the market exactly what the value was to the network. This promotes transparency and reduces perceptions of conflict of interest by enabling our reinforcement versus flexibility decisions to be audited. Our innovation focus will be to continue with our leading position in this area.
6. Organisational change **The extent of activities and enablers that need to be delivered to ensure the continued safe, reliable, and economical service is significant. We are working to have the right organisational structure and the right people to successfully deliver these.**	As with all of the other areas, we are already making progress. We have set up a new DSO business team with an independent head. This is to provide confidence to the market for our flexibility service procurement decisions. Our Innovation Board ensures clear alignment with all of our innovation activities, with Energy System Transition and Consumer Vulnerability challenges.

The increasing demands placed on the network will continue to drive the need to innovate to deliver solutions more **quickly** and **cost effectively.** Enablers 1, 2, 3 and 4 are areas where technology, methods and ideas are advancing rapidly – digital solutions will be developed between now and 2028 that we have not yet envisaged. It is therefore essential that we are able to find innovative ways to adopt this new technology during RIIO-ED2. The innovation stimulus allows us to enable these new solutions as and when they start to develop.

Digitalisation

The EDTF's report concludes that *'data and digitalisation, while not the sole enablers of energy system transition, are essential to unlock the decentralisation and decarbonisation dividends for the benefit of consumers.'*

Our Digitalisation Strategy[47] maps out how we are transforming traditional network operations with digital innovation. In this section we highlight where innovation both as part of BaU and under the innovation stimulus will support and enable digitalisation.

During RIIO-ED1 we invested significant BAU funds to roll out our **Network Asset Management System (NAMS)**. This went live on 08 January 2018 and is now fully operational across all parts of SP Energy Networks. By digitalising a number of systems, it is helping us meet our responsibilities to our customers, shareholders and Ofgem by ensuring our information is robust and accurate. It enables slicker, more responsive resource management, reduces paperwork, enables easier reporting, and has refocussed our efforts on delivering more value-added business activities, such as forward planning. Through BAU in RIIO-ED2 we will continue to invest in new and improved functionality and performance improvements.

We have aligned our innovation strategy closely with our wider Digitalisation Strategy and looked to see where innovation can accelerate progress. The innovation focus areas that we have identified are described in the following tables.

Digitisation Sub-Areas
Monitoring and controlling the network
Developing options to manage peaks in load
Improving mastery of our data

Monitoring and controlling the network
We are already taking big steps in digitalising our transmission network which puts us in an excellent position to do the same on our distribution network.

Theme	Innovation Focus
1. Improved visibility and control on the LV network **We require new toolsets to gain visibility of changing power flows and greater control to maintain network operations. As greater volumes of LCT connect, the power flows in the LV network become more complex and the traditional approach to passive LV network management is no longer appropriate.**	The roll-out of monitoring including secondary substation monitoring, full smart meter deployment, link box monitoring, together with LV control devices will enable the improvements required. However, the corresponding vast increase in data points means that we need to develop digital solutions to help us manage the LV network. Accordingly, two specific areas where we envisage innovation will be required are in the ongoing development of our **NAVI** platform, and in developing enhancements to our **Network Management System**.
2. Using data and analytics to optimise network planning **By more accurately predicting future constraints on the network we can efficiently plan interventions. We need to be able to appraise the effectiveness of non-conventional techniques as an alternative to network reinforcement. We need to automate these processes to keep pace with the increasing uptake of LCTs.** **Our objective is to drive assets to their capacity and make use of flexibility,**	Eventually smart meters will provide us with a wealth of data together with the monitoring that we already have and will install on the network. Having this real-time and historical data can help us to forecast and plan more accurately – provided that we develop the appropriate data analytics and modelling tools. Our innovation will focus on: - • Enhanced modelling capabilities, • Improved network connectivity models • Better data analysis techniques • Modelling the new options for managing demand We will leverage benefits from using third party data sets as we have already demonstrated in our **EV-Up** and **WANDA** projects.

[47] https://www.spenergynetworks.co.uk/userfiles/file/RIIO-T2_SP_Energy_Networks_Digitalisation_Strategy.pdf?v=1.3

targeting reinforcement only where it is necessary and cost effective.	
3. Increasing real-time visibility and autonomous operation **Digitalisation drives a more reliable network. It will help us to reduce the number of faults and to manage them more effectively.**	We are already making progress and believe that even better results can be achieved through innovation in RIIO-ED2 focussed on a number of areas including: • Fault prediction at LV and 11kV – improving existing techniques and developing new techniques, e.g. based on early stage academic research currently underway. • Quicker diagnosis – developing data analytics techniques that exploit the increased real-time data available • Reducing the impact – reducing the customers affected and restoring the network quicker, through remote switching controlled automatically by digital systems
4. Developing the control room of the future **As part of the energy system transition, the control room must evolve to meet the emerging needs of a DSO including the ability to interact with a far greater number of market participants than we have today.**	Through a PNDC collaborative project, we have started to explore the requirements for the control room of the future. This is an area where continued innovation will be required through RIIO-ED2. Specific focus areas include: - • Increased automation to facilitate a greatly increased number of control actions • The ability to support restoration of the network from renewable resources should it be required • The potential for digital twin technology to support network optimisation

Developing options to manage peaks in load

In future we must manage power flows to avoid causing network constraints. Advances in technology will allow us to manage them in a more effective and economic manner. This includes understanding and influencing behaviour beyond the meter.

Theme	Innovation Focus
1. Demand forecasting **In order to manage peak demand, we need to better understand and forecast demand. The ability to accurately forecast demand is becoming more critical and at the same time it is becoming more complex due to decentralisation and the increase in LCTs including weather dependent distributed generation.**	We are in the early stages of developing demand forecasting tools for both operational and planning time horizons. In RIIO-ED2 we will continue to develop and improve these innovative solutions to better understand at a granular level where network congestion may arise allowing the opportunity for effective and efficient management. This includes developing a better understanding of the impact that LCTs have on the ADMD of homes as one of the enablers for influencing behaviour beyond the meter.
2. Active Network Management **We are already implementing ANM schemes at 11kV and higher voltages as a cost-effective way to connect additional renewable generation to the network.** In future, we anticipate that ANM will become an important technique at LV	Our innovation will focus on developing the operational forecasting, scheduling, dispatch, and smart grid control tools that a DSO requires. We will enhance existing platforms to provide a granular level of monitoring and control at LV feeder level which will be required to manage the uptake of LCTs. We will develop the functional specifications, control algorithms, and detailed interface requirements.

and for managing demand and fault level in addition to generation.	Through innovation we will develop a DSO Interface, which is the real-time interface between DSO systems and multiple aggregators/service providers, ensuring that data received, and control actions implemented are coordinated with the actions taken by network management equipment.
3. Influencing behaviour beyond the meter **We have calculated that a home with an EV and a heat pump could have an ADMD of 11.4kW if not managed. Typical networks are designed for an ADMD of 2.0kW. This would overload large sections of the network. We need to be able to influence behaviour beyond the meter as part of the solution.** Customers need to be engaged in the transition and become flexible prosumers	This is a significant area of innovation focus for us in RIIO-ED2. Areas where innovation will be required include: - • Aggregator/service provider platforms • Smart domestic control systems • Integration of domestic thermal and electrical storage • Direct load control techniques • Variable time of use tariffs Customer behaviour is a major consideration. Research and analysis of customer behaviour across different demographic groups form an important part of these innovation projects.

Improving mastery of our data

Ensuring the accuracy, efficiency and security of our network data assumes ever greater importance as we and third parties develop greater reliance on it. We need to continue to make improvements in this area as we work towards having a fully complete data set for our networks.

Theme	Innovation Focus
1. Accurate data capture **We understand the importance of prompt and accurate data capture into our corporate systems.**	We intend to innovate to improve both the speed and quality of data capture through techniques like using GPS to capture asset coordinates, and direct data entry into corporate systems from mobile devices in the field.
2. Integrated models and data sets **By integrating measurements from across our network we can pinpoint live network issues and conduct detailed post fault analysis.** **This is becoming increasingly important as the energy system transitions.**	We will innovate to develop a fully **integrated network model**. Building on our SDIF platform and including geospatial, connectivity, asset, and telemetry. Uses and benefits from **data analytics** are expected to increase. We intend to implement a general-purpose platform that can quickly deploy analytics applications. We will do this efficiently by sharing the Iberdrola group's global resources. We have embarked on a **System Health Map** project in transmission that will aggregate distributed monitoring data to generate meaningful asset information. We intend to extend this concept to distribution in RIIO-ED2.
3. Digital engineering **Increasingly, work is planned and managed in an entirely digital environment. This allows us to update our asset systems efficiently.** In future we want to achieve seamless integration of asset datasets from design and construction into asset lifecycle maintenance.	We intend to extend our trial of building information management (**BIM**) from transmission to major distribution projects. Leveraging the increased monitoring and communications capability of assets, together with our SDIF platform, we intend to explore the benefits and efficiencies that **digital twin** technology could bring to asset management.

Whole Energy System

The whole energy system can be considered to include:

- Electricity transmission and distribution networks
- Gas transmission and distribution networks
- Heat and heat networks
- Transport
- Water, waste, and telecommunications utilities
- Generation and distributed energy resources
- Local energy systems

Enabling the decarbonisation of heat and transport at the lowest cost to consumers requires all parts of the energy system to work together. We will collaborate with others on innovation initiatives developing and evaluating options to decarbonise heat and transport.

Hydrogen is one area of innovation, particularly for both the gas and transport sectors, and we will seek to support innovation in this area as a priority for cross-sector collaboration.

Further focus areas are described in the table below.

Theme	Innovation Focus
1. Joined up approaches to regional network planning and forecasting **We need to better understand the interaction between gas and electricity networks through joint forecasting and planning.**	Develop novel planning methods. In conjunction with gas networks and working with cities and devolved administrations to understand local needs and differences. We intend to develop multi-vector analysis techniques to assist regions to develop their net zero pathways.
2. Distribution and transmission network coordination **In future, resources at the distribution level will support the national system in managing network constraints and balancing. We need to develop appropriate interfaces that move beyond the current sector-specific operation and planning practices.**	• Enhancing data communication and visibility across TO-DNO boundary for better utilisation of DERs • Accurate forecasting of demand through load modelling and forecasting techniques • Establishment of islanding models to better manage local generation and demand under system restoration conditions building on the **Distributed ReStart** project.
3. Hydrogen **The hydrogen economy has a big part to play in the future low-carbon economy. It is a whole energy system issue with implications for renewable generation, electricity networks, gas networks and transport.**	Under a range of scenarios hydrogen could play a significant role in decarbonising the heat and transport sectors. Networks need to develop an understanding of the significant impacts on demand and potential benefits of large-scale hydrogen production, from electrolysis and/or steam methane reformation. **For more information, please see our "Innovation Spotlight" on Hydrogen in Section 7.3.**
4. Whole system co-ordinated cost benefit analysis **There are examples where investment to enable demand side flexibility benefits not only the networks, but also other parts of the whole energy system, for example, by reducing requirements for new generating plant. By developing coordinated cost benefit analysis, we will be able to identify the most efficient investment and realise overall financial benefits for customers.**	Working with partners from other parts of the whole energy system and drawing on academic expertise we will seek to develop co-ordinated cost benefit analysis techniques that consider wider benefits extending to, for example, benefits in the generation sector and population health benefits.

Sustainability

The UK has set ambitious climate change targets for a sustainable, Net Zero future. To achieve these targets, we must reduce our impact on the environment, and adapt our network to manage the effects of climate change whilst delivering sustainable value to customers. We aim to be a leader in this area and our actions to become a sustainable network operator will drive our supply chain and support our customers and communities to become more sustainable.

Our commitment to comply with environmental legal requirements has been the motivation of many sustainable innovation projects that have been developed throughout RIIO-ED1. An example of this is Novel Transformer Bunding, which uses High-Density Polyethylene (HDPE) in place of traditional reinforced concrete bunds. This innovative solution will be used to repair, replace, or retrofit bunds, preventing oil pollution. As well as providing environmental and cost benefits, the HDPE bunding is a low carbon alternative to concrete bunding. For more detail see our **Annex 4C.3: Environmental Action Plan**.

In RIIO-ED2, we will use innovation to implement pilot projects to trial new innovative approaches, processes, and technologies. Successful outcomes will be incorporated into existing business processes following approval by the Executive Sustainability Steering Group (ESSG). The ESSG was established to demonstrate the importance of the Sustainability agenda within our business and facilitate the achievement of our sustainability targets.

We have aligned the innovation strategy with the Sustainability Business Strategy, identifying where innovation can be used to accelerate the business' transition to NetZero.

To achieve this, we have considered the three pillars of sustainability:

- **Environmental sustainability:**

  Minimising the environmental impacts of our assets and activities

- **Economic sustainability:**

  The efficient and responsible use of resources to ensure we can operate in a sustainable manner

- **Social Sustainability:**

  Employee, stakeholder, and community engagement to achieve social sustainability and maintain social well-being.

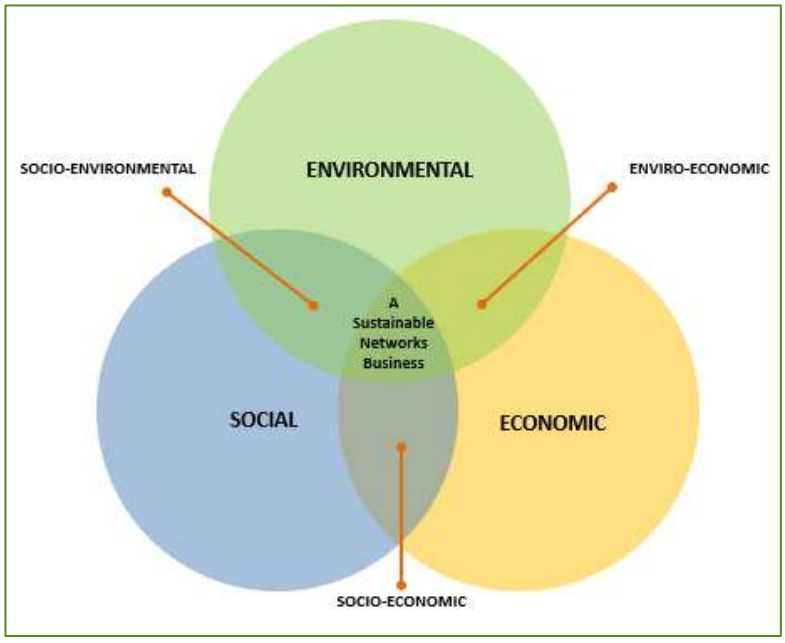


Figure 4: Environmental, Social and Economic Sustainability

Environmental Sustainability
Minimising the environmental impacts of our assets and activities.

Theme	Innovation Focus
1. Business Carbon Footprint reduction **We will deliver efficient and economic actions to reduce our scope 1 & 2 business carbon footprint by 37.8% from a 2018/19 baseline, in line with a verified Science Based target.**	We will deploy innovative approaches to achieve significant environmental and customer benefits in areas including: - • Building and substation energy consumption • SF6 leakage • Network Losses • Operational transport
2. Sustainable resource use **We will divert 100% of our waste from landfill by 2030, excluding hazardous waste.**	To embed the principles of a circular economy and ensure efficient use of resources within our business, we need to find innovative solutions. To do this, we must ensure that: - • The materials required for network construction and operation come from sustainable sources. • All end-of-life assets being reused or recycled into new products to meet out zero waste ambitions. Along with other LNOs, including those in the gas and water sectors, we are considering the potential for a national Asset Recycling and Reuse Centre (ARRC) that would help drive forward innovation in this area. Innovation projects will be used to reduce and re-use waste. THOR Hammer[48] is an example of an innovation project which has the potential to reduce the number of wooden poles which need to be replaced during RIIO-ED2.
3. Land and biodiversity improvement **We will implement a Biodiversity & Natural Capital Action Plan to identify processes and priorities to guide local operation implementation and increase environmental value across our network.**	We aim to create a Biodiversity and Natural Capital Action Plan to increase environmental value across our network. We will innovate to develop, embed, and trial a robust enhancement methodology to protect the ecosystems we operate within and mitigate the ecological impacts of construction.
4. Pollution Prevention **We will target zero environmental regulatory interventions and notifiable breaches.**	We will innovate to minimise any negative effects our assets could have on the environment and communities as far as is reasonably practicable. The priority impacts for RIIO-ED2 include: - • Use of hazardous materials • Oil leaks • Construction site and substation drainage systems • Noise Novel HDPE transformer bunding instead of traditional reinforced concrete bunds. This solution will be used to repair, replace, or retrofit bunds, preventing oil pollution. This provides environmental and cost benefits. Operational assessment of composite poles[49] and project APPEAL[50] have both generated learnings that will reduce our dependency on hazardous Creosote treated poles.

[48] Our "THOR Hammer" project (https://www.smarternetworks.org/project/nia_spen_0039)
[49] Our "Operational Assessment of Composite Poles" project (https://www.smarternetworks.org/project/nia_spen0019)
[50] Our "APPEAL" project (https://www.smarternetworks.org/project/nia_spen0008)

Economic Sustainability
The efficient and responsible use of resources to ensure we can operate in a sustainable manner

Theme	Innovation Focus
1. Work practices and systems **As we enter this rapid period of change, the traditional ways of doing things will have to change.**	We will develop innovative solutions to provide the high level of service our customers and stakeholders expect. This will include: - • Digitisation of our workforce • Improved understanding of customer needs • Adoption of the latest technologies
2. Ensure future skill requirements and workforce resilience **To maximise the benefits of new solutions we need to ensure that we have required skill and expertise within the business to deploy these technologies. 30% of our existing workforce are expected to retire by 2030.The unprecedented speed of change coupled to the challenges of an aging workforce mean that we need to find innovative solutions**	• We need innovative approaches to help train a new generation of Power Engineering professionals capable of driving the transformation towards a more dynamic and flexible smart energy system. • As expertise leaves the business we will innovate using techniques like virtual reality (VR) and augmented reality (AR) to support training and ongoing technical support. • Introducing a data and analytics skillset.
3. Sustainable procurement **Our aim is to achieve procurement that has the most positive environmental, social, and economic impacts on a whole life basis**	We will work to embed sustainable procurement in our business processes in line with the guidance in ISO 20400. We will ensure ethical behaviour which is in alignment with our culture and values. Creating opportunities for small business while ensuring efficient management of customer funding.

Social Sustainability
Employee, stakeholder, and community engagement to achieve social sustainability and maintain social well-being.

Theme	Innovation Focus
1. Local communities **We aim to be a socially responsible member of the local communities we serve.**	Our extensive stakeholder engagement activities allow us to build strong partnerships, influence industry policy and deliver innovation which meets customer expectations in areas such as: - • Community energy schemes • Support for fuel poor • Engaging on the investments we make • Public safety • Visual amenity
2. Our supply chain **We will further enhance environmental sustainability standards and performance metrics in our contracts and will collaborate with our supply chain to target more than 80% of RIIO-ED2 suppliers (by value) meeting these standards.**	We will collaborate with suppliers to: • Minimise environmental impacts • Set enhanced environmental standards • Drive industry-wide environmental improvements As part of the prequalification and tender processes for contracts, we will trial an innovative model that requires suppliers to commit to sustainability requirements. For example: • Labour standards • Energy carbon emissions • Use of recycled materials We have implemented Go Supply which is a free procurement platform for suppliers to assess their sustainability credentials. We will collaborate with suppliers who do not meet out minimum sustainability criteria to improve their skills and knowledge to become compliant. We have become a Supply Chain Sustainability School Partner and developed requirements for all new contracts to undertake relevant sustainability and environmental training, this will be continued in RIIO-ED2.

For more information, please see Annex 1.3: Sustainability Strategy and Annex 4C.3: Environmental Action Plan.

7.3 Our "Spotlighted" Innovation Areas

The focus areas for innovation that we have identified within the high-level themes of Energy System Transition and Consumer Vulnerability have been presented in the previous section.

In addition, we have "spotlighted" five key innovation areas. These areas also support Ofgem's two high-level innovation themes - energy system transition and consumer vulnerability – but are strategically aligned with the whole system challenges that the industry faces. Innovation in these five areas will help deliver a safe, reliable, and efficient energy system for our customers.

1. **Consumer vulnerability** – innovation will help ensure a Just Transition and that no customer is left behind. The impact on consumers in (or potentially in) vulnerable situations will be assessed for all innovation projects.
2. **Hydrogen** – Given the potential for hydrogen to both drive and negate network investment, there is benefit in increasing industry's understanding of hydrogen's impact and the role in can play in the Net Zero transition.
3. **Electrification of transport** – facilitating the uptake of domestic EVs has been a major focus of electricity innovation projects in recent years, however there are other transport systems that will require decarbonisation, such as railways. Innovation will support this decarbonisation, helping it to happen at a quicker pace and at lower cost to customers.
4. **Electrification of heat** – the heat sector is the largest contributor to UK carbon emissions, and the government's Ten-Point Plan for a Green Industrial Revolution includes installing 600,000 heat pumps per year by 2028. Innovation will help enable this electrification whilst reducing its cost impact.
5. **Power electronics and low voltage direct current (LVDC)** – Power electronics and LVDC could help more efficiently accommodate network growth, primarily by enabling more effective use of existing network capacity. This would reduce the number of LV network interventions, so reducing disruption and cost for our customers.

Each of these areas are presented in detail in this section.

7.3.1 Consumer Vulnerability

Our customers are at the heart of our business - this applies to our innovation activities as much as it does to our business as usual delivery. We recognise that we have a social responsibility when looking ahead to and investing in Net Zero as all of our customers – not just the immediate beneficiaries - are paying for it.

The way we deliver the Energy System Transition is crucial. We recognise that there is a concern that the transition to Net Zero may widen the gap between those who are able to follow the market changes and those who cannot without additional support.

We therefore need to enable a just Energy System Transition to Net Zero and ensure that no one is left behind. As a result, we want to enable all consumers to make the transition to Net Zero and benefit from Low Carbon Technology, removing identified barriers to achieve this. In addition, we want to mitigate any risk of vulnerable consumers being negatively impacted by the transition to Net Zero.

Finally, we want to innovate in RIIO-ED2 to be a service leader in the UK, seeking to minimise our impact on communities and provide bespoke support to customers in vulnerable circumstances.

We see that consumer vulnerability is not a static term but can be temporary, sporadic or permanent and accounts for a huge spectrum of conditions and circumstances including health issues (mental or physical/short and long term); emotional distress or bereavement, low basic skills or limited English. Furthermore, it can extend beyond the individual or household to those supporting them (including roles such as carers). We want to innovate to support all forms of vulnerability however we can, recognising different groups and clusters can present different challenges and needs.

In full support of Ofgem's prerogative to set Consumer Vulnerability as an innovation focus, our innovation activities will seek to align to our Customer Vulnerability Strategy and support the delivery of our RIIO-ED2 commitments. In all areas, we will learn from the successes already seen by our business and industry on these issues and seek to maximise value. We will look to develop low TRL and unproven concepts and accelerate to BAU implementation to benefit customers.

We see that many of the opportunities and needs must be progressed holistically with different partners and consortiums so we may better understand different vulnerability groups, their behaviours and needs and then achieve the best outcome.

To this end, we have three key aims:

- **Helping Vulnerable Customers to join the journey to Net Zero**
- **Reducing bills for our disadvantaged customers**
- **Improving our service portfolio to better support Vulnerable Customers**

Helping Vulnerable Customers on the journey to Net Zero

Our aim is to help our vulnerable customers on the journey to Net Zero and to support them overcoming additional barriers that others may not face. While we will ensure that all our strategic work streams will address the needs of vulnerable consumers, we also intend to pay attention to different vulnerable customers, understand their needs and behaviours and develop solutions as part of a consortium of those who represent their interests.

We know that the different vulnerable customer groups may not necessarily be those that are registered in our PSR and different vulnerabilities may emerge in the future. In addition, we know Net Zero could produce additional vulnerabilities if not carefully managed. Part of our strategy will be to look ahead and address potential vulnerability that may be experienced by customers in the future during the Net Zero transition.

To support this aim, we intend to:

1. Explore how different vulnerable consumers interact with different Low Carbon Technologies in the current market and then explore if/how this can change
2. Remove identified barriers to participating in the Low Carbon economy (such as Low Carbon Technologies or flexibility), working in partnerships to maximise the outcome
3. Improve the engagement of vulnerable customer groups with technology and behaviours which enable Net Zero

Our outcome of this aim in RIIO-ED2 would be a clear change in uptake of Low Carbon Technologies and engagement in markets from Vulnerable Customer groups.

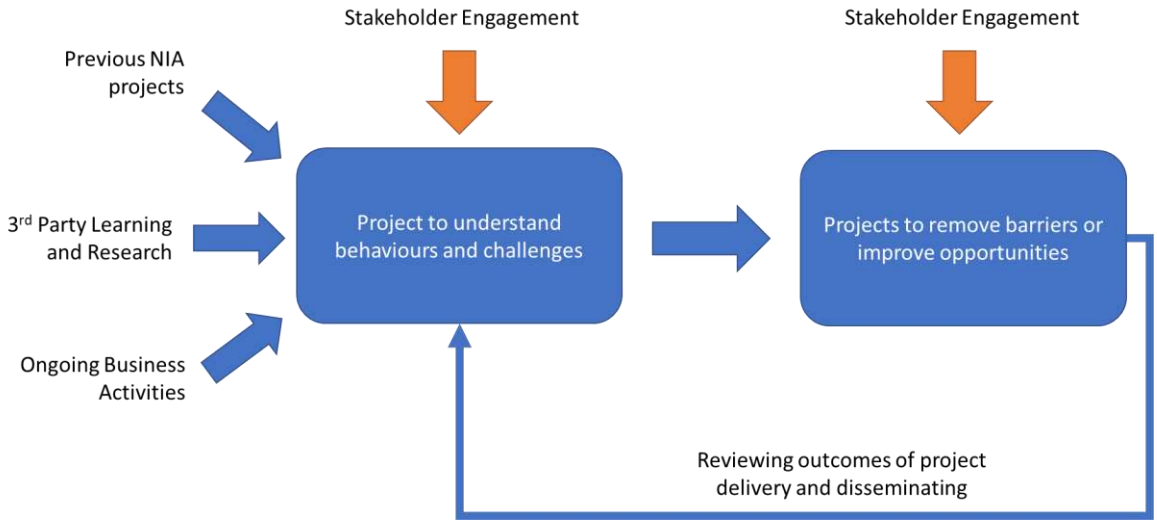


Figure 5 Innovation Process for the Vulnerable Consumer Net Zero Transition

Reducing bills for our vulnerable customers

We are aware that a portion of our vulnerable customers are either experiencing fuel poverty or high costs as a result of their circumstances. We see that there could be opportunities where we can be a part of the solution to support such customers where the key outcome is reducing their overall energy costs.

- **To this end, we aim to identify, develop, and deploy methods and processes which could help produce a tangible saving to connected customers through their household bill (either connection charges or retail).**
- **We envisage that any developed solution could be a part of a wider offering or holistic solution to support vulnerable customers. This strategic aim aligns with our wider business commitment to reduce disadvantaged household bills.**

One example of this is developing technical solutions which could adjust the voltage at consumer premises, which in turn has the potential to impact the total energy consumption (and therefore total cost of energy consumption). We know that previous projects have already been able to demonstrate a linear relationship between energy consumption and voltage reduction[51] that we would intend to explore through alternative solutions using power electronics.

Improving our service offering to vulnerable customers

A significant part of our ongoing business as usual activities is delivering on a wide range of services to our customers which are continually reviewed and challenged through user groups to ensure we provide what our customers need and through the best possible methods. We will seek to elevate this work through innovation in two keyways: **Engagement and Data.**

As we **engage** with our consumers and their representative, we intend to explore new methods and strategies to engage our customers. Especially given the impact seen from COVID-19, we look to learn from what we have delivered so far and how our customers have responded to this.

We also intend to build upon our **existing platforms and data sets** to find new ways by using data and AI to identify those who are vulnerable and the support they need from us.

We will also aim to apply similar process to build on our vulnerability map and help promote self-identification of vulnerability. We will seek to take our Vulnerability Map to the next level to forecast vulnerability using different data sets and resources. We see that impact of major events such as COVID-19 or Brexit could have a detrimental effect by widening the pool of vulnerable consumers and we intend to be proactive to identify where vulnerability could emerge.

[51] Smart Street Closedown Report, page 27 - https://www.enwl.co.uk/globalassets/innovation/smart-street/smart-street-key-docs/smart-street-closedown--report.pdf

As we seek to deploy more LV monitoring, automation, and control, we will also seek to identify how we can better support vulnerable consumers with this new technology and data. This can range from smarter detection of vulnerable consumer behaviour to seeking to reduce customer bills via voltage control. We will also seek to collaborate with 3rd parties to maximise how we can interact beyond the metering boundary.

Building on our existing toolsets, we plan to integrate our network and customer datasets in way that has not previously been explored. We see this novel approach will enable us to correlate vulnerability by asset and support the identification of impact during planned outages.

We see both of these strategic aims as part of the bigger picture to build resilient communities and build up social innovation. A major part of our service strategy will be seeking to ultimately reduce the cost of energy to the end customer, either from use of system or retail consumption.

We see that the network of the future can be one where no network outage results in a customer off supply; in the immediate future, we will continue to seek to reduce the number and length of power interruptions that our customers experience. Part of the solution to realise this is the deployment of LV smart technology.

Innovation Case Study – Customer Vulnerability Behavioural Datasets

As part of our core activities, we operate and maintain our priority services register which allows us to ensure that different vulnerable groups can be properly notified and cared for as we maintain our network reliability. It is known that there is a gap in regional data between the supplied statistical data and the PSR, with PSR data relying on positive notification from end-user. Unregistered vulnerable consumers do not receive the support or benefits that they are entitled to.

Vulnerable customer behaviour is thought to highly vary within each cluster as stakeholder engagement has previously shown and clustering groups for nominal behaviour is difficult to model. Better identification of vulnerable customers, or at least their probability, would allow utilities to potentially better target PSR awareness campaigns and inform network outage restoration plans.

Building on learning within RIIO-ED1, we would want to explore the possibility of developing methods to identify vulnerable customer behaviours and therefore identify possible clusters across our network to allow more PSR registrations (from focused campaigns) and new data to inform outage planning.

We will build on our previous experience using advanced data analytics and AI techniques, combined with monitoring data, to identify and quantify forms of vulnerable consumer behaviours or at least their probability. Once identified and validated, a regular data query can be run to identify other instances of behaviours. This would all be done in a secured environment to protect the incoming data sensitivity.

Using combined data sources with analytical techniques, it is possible that emerging behaviour datasets could be proven then identified across the network. In addition to the identified use cases for benefits, this information will likely have additional applications to support vulnerable consumers.

For additional information, please see Annex 4B.1: Vulnerability Strategy.

Estimated Funding required (per project – est. two per year)	
Feasibility Study: £150k	Network Integration £300k

7.3.2 Innovation Spotlight: Decarbonisation of Heat

SP Energy Networks fully support the UK Government and Scottish Government ambitions to decarbonise heat.

In 2016, 37% of the total UK CO2 emissions came from heating. The transition to a low carbon economy can only be realised by the decarbonisation of heat.

The Scottish statutory target of 75% carbon reductions by 2030 means that 50% of homes must be converted to low carbon technology. The UK Government Ten Point Plan for a green Industrial Revolution plans to increase heat pump installations from 40,000 installations a year in 2020 to 600,000 installations a year by 2028.

Our FES indicate that up to 1.1m heat pumps are expected to be connected to our network by 2030 in the Net Zero scenarios.

In 2017, the peak heat demand in the UK was four times that of the peak electricity demand. To put this potential impact into perspective, the additional demand from heat pumps in the high scenario in SPD (taking account of flexibility) is approximately 1.5GW. By comparison, the additional demand from electric vehicles in the high scenario (taking account of flexibility) is around 230MW.

Facilitating the uptake of low carbon technology such as Heat Pumps has been a growing focus of electricity innovation projects in recent years. This has been done due to this significant increase in demand on the network, but there is also a potential source of demand side flexibility.

We have already seen the impact of the electrification of heat on our network. In 2019, due to an outage on the local gas distribution network, our Falkirk network saw a peak increase in demand by 269% at an ambient air temperature of 6 Celsius. This peak would have been higher in lower air temperatures.

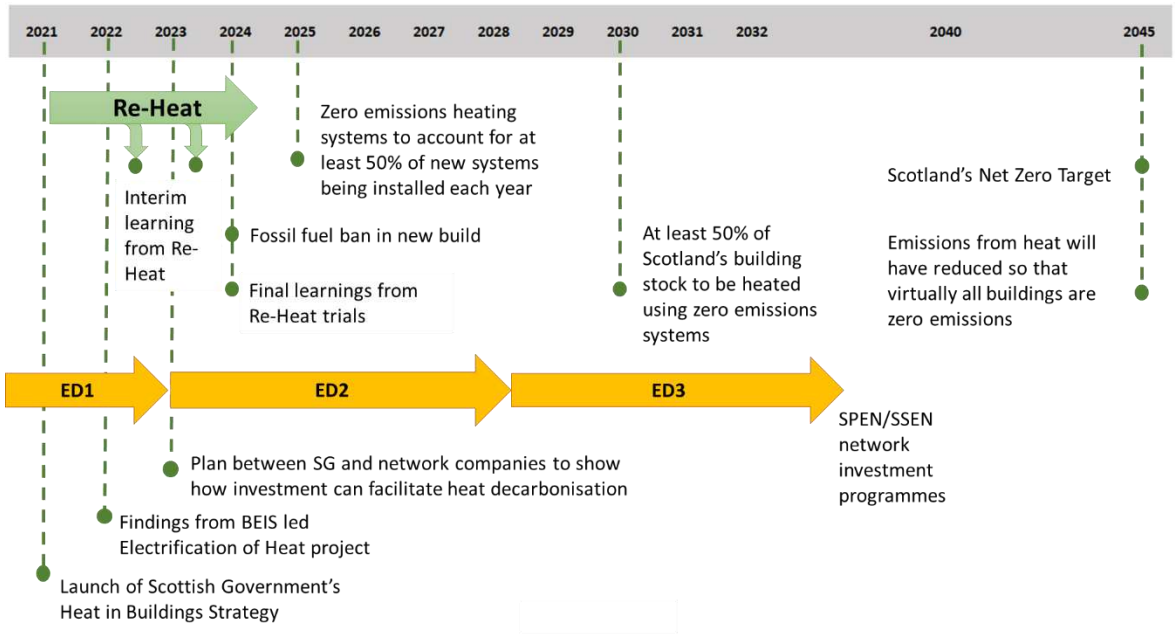
Our innovation strategy to support the electrification of heat focusses on: -

- Innovative network and customer flexibility solutions that will avoid or defer traditional network reinforcement, reducing cost and disruption for our customers.
- Further research to understand all the barriers that fuel poor households face, and particularly those faced by vulnerable groups when making the transition to low carbon heat. We want to help ensure a fair and just transition.
- Working collaboratively to address this whole system challenge including with the Scottish Government Heat Electrification Partnership, local authorities, gas networks, community groups, energy retailers, and aggregators.

Below are two examples of the innovation we are undertaking under NIA in RIIO-ED1:

- **Heat-Up**: Our Heat-Up project will predict, model, and understand where and when heat pumps, and other forms of electrified heating, will come online across the SPEN distribution areas. We are confident the project learnings will enable us to develop evidence of the impact of heat pump domestic retrofits across our electricity network and identify the areas of our network requiring intervention.
- **Re-Heat:** Our Re-Heat project, supported by the Scottish Government, is carrying out a large-scale trial of domestic heat pumps with thermal stores and smart controls to reduce the peak electricity demand. The solution will keep load within the network limits and maximise the use of green electricity, while maintaining customer comfort. We believe that rolling out this solution could avoid or defer reinforcement in 606 clusters across SPD saving £54m by 2040. Re-Heat will be trialled in 150 homes across East Ayrshire, East Dunbartonshire, and Highland council areas, primarily in off-gas grid areas. We expect that by making heat load flexible, reductions in customers' bills by £136 per annum could be realised.

The timeline below illustrates the pace the industry must move at in order for the energy sector to reach Net Zero targets.



Proposed areas for further innovation in RIIO-ED2

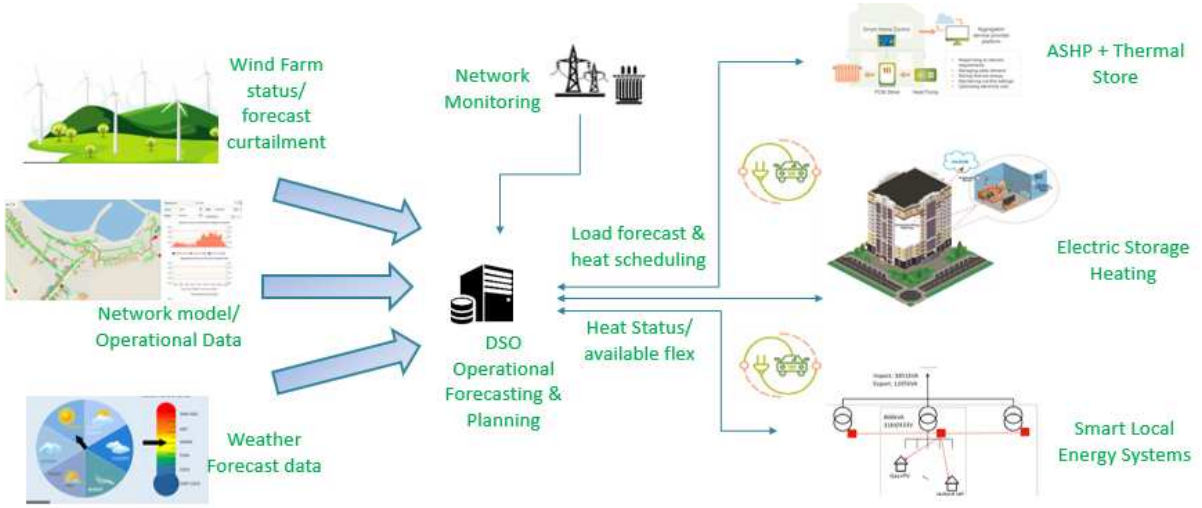
We intend to develop an innovative DSO network management scheme to manage peak demand and dispatch presently constrained wind.

Method

We will develop a network management scheme to mitigate peak demand and unlock curtailed wind energy. The demand response solution will build upon our Re-Heat and Flexible Tower Block NIA projects, and the SSEN/ESO 4D-Heat project.

Benefit

- Managing peak demand can save £28m network investment across SPD region by 2040.
- Constrained wind payments may be reduced by £24m per annum.
- Significant CO2 savings



Estimated Funding required	
Feasibility Studies: £500k	Technology Test and Demonstrations £5m

7.3.3 Innovation Spotlight: Decarbonisation of Transport

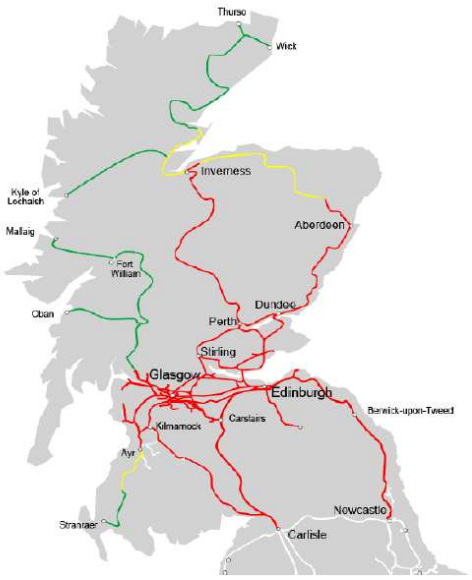
Decarbonisation of transport is essential to facilitate the transition to a low carbon economy.

Facilitating the uptake of EVs has been a major focus of electricity innovation projects in recent years and rightly so because they will cause a significant increase in demand on the network as well as being a potential source of demand side flexibility.

However, there are other important aspects of the transport system that will require to be decarbonised with associated network challenges that need to be addressed through innovation:

- HGVs
- Buses
- Railways
- Shipping
- Aviation

In this section we focus on just one of these sectors, Railways, showing two examples of the innovation required that we plan to undertake.



Railway Electrification and Alternative Traction

Government targets require removal of diesel passenger trains from the Scottish network by 2035 and the UK network by 2040.

Electrified network (some 1,616 kilometres (single track kilometres) to be electrified, sections of route could potentially include discontinuous electrification) and the electrification of some freight only lines may be subject to review

Alternative traction - transition solution (e.g. partial electrification and/or the use of alternative technology prior to electrification)

Alternative traction - permanent solution (i.e. the use of battery or alternative traction)

https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf

Problem Statements

- It is expected that discrete electrification solutions will be connected to the distribution network
- Traditional electrification solutions may not be suitable as they require significant amounts of electrical equipment and have a high cost
- The loads are very peaky and single phase located in rural areas with potentially weak networks
- Network Rail requires a high level of security of supply

[redacted]

Estimated Funding required

Feasibility Study: £200k Network Demonstration £3m

Rail Distribution Networks

[redacted]

We intend to work in collaboration with Network Rail to develop these opportunities. In addition to technical innovation, commercial innovation will be required in order to develop new models for connection agreements.

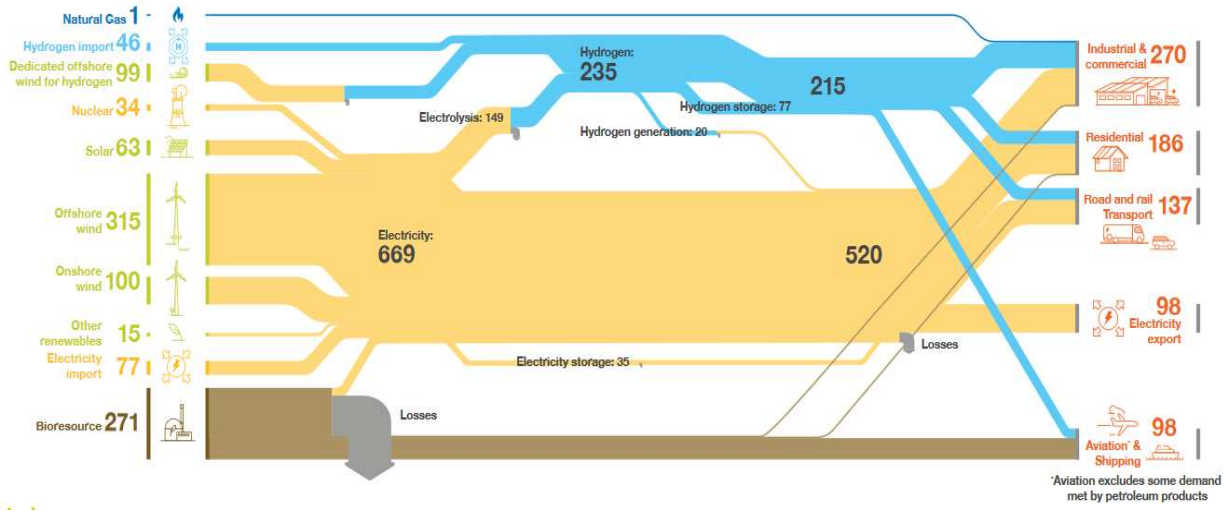
Estimated Funding required	
Feasibility Study: £300k	Network Demonstration £5m

7.3.4 Innovation Spotlight: Hydrogen

Hydrogen is complementary to electrification. It can be used in the difficult to electrify sectors, going directly to customers. Hydrogen is also a viable storage option.

The Committee on Climate Change's '*Hydrogen in a low-carbon economy'* report found that hydrogen can make an important contribution to long-term decarbonisation, stating that hydrogen should be viewed as a credible option in the next stage of the UK's energy transition. The report found that hydrogen could replace natural gas in parts of the energy system, where electrification is not feasible or is prohibitively expensive. Examples include HGV transport and industrial heat.

National Grid FES Leading the Way Scenario is illustrated below. It shows the key role Hydrogen is expected to play in the decarbonisation of Industrial & Commercial, Residential and Transport Sectors – and the resultant impact on the requirement for clean electricity.



Our focus is in the enabling of Green Hydrogen – this is hydrogen created using electricity generated from renewable energy sources. The Electrolysis process used to make green hydrogen requires electricity. We must find innovative ways to meet this new demand and facilitate growth in this area. Scottish Power has recently employed a dedicated Hydrogen Director, underlining the important role that we see for hydrogen.

Key existing activity - SP Manweb Region

Liverpool City, central to our SP Manweb region, is a central hub for the development of Hydrogen technology. Some key targets in this region include:

- Net zero carbon by 2040
- meet the city regions hydrogen demand from transport, industry and heat from clean hydrogen produced within the city region from 2023
- deliver a network of at least eight zero-carbon refuelling stations (hydrogen and electric) across the city region by 2025
- To replace all methane with **hydrogen** from the city region's gas grid by 2035
- Lead Local Enterprise Partnership for North West Cluster on Hydrogen

The Net Zero North West partnership is aiming to become the UK's first low carbon industrial cluster by 2030. The North West has been identified as the only region that already has all the elements to achieve this - including renewables, hydrogen, carbon capture usage and storage, nuclear and smart grids. There are 8 projects identified, representing over £4bn in investment, aiming to save 10 million tonnes of carbon.

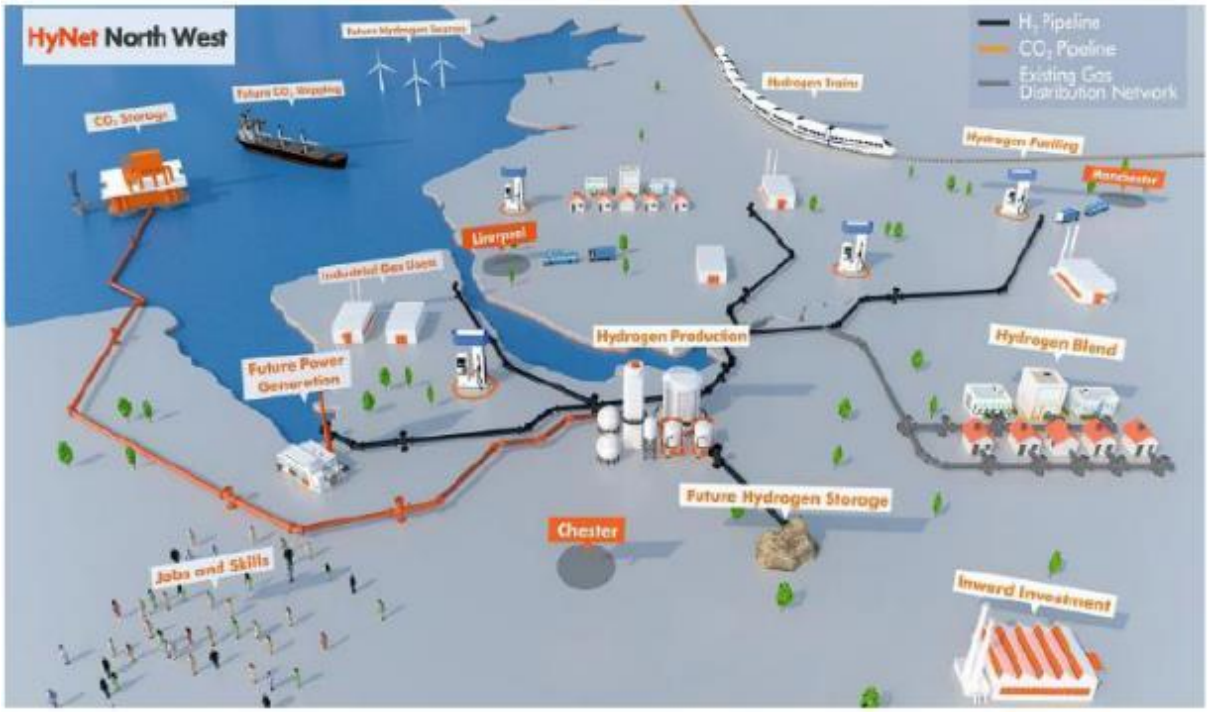
SP Energy Networks already have specific commitments in five of these project areas via BAU activities, including:

[redacted]

[redacted]

- [redacted]

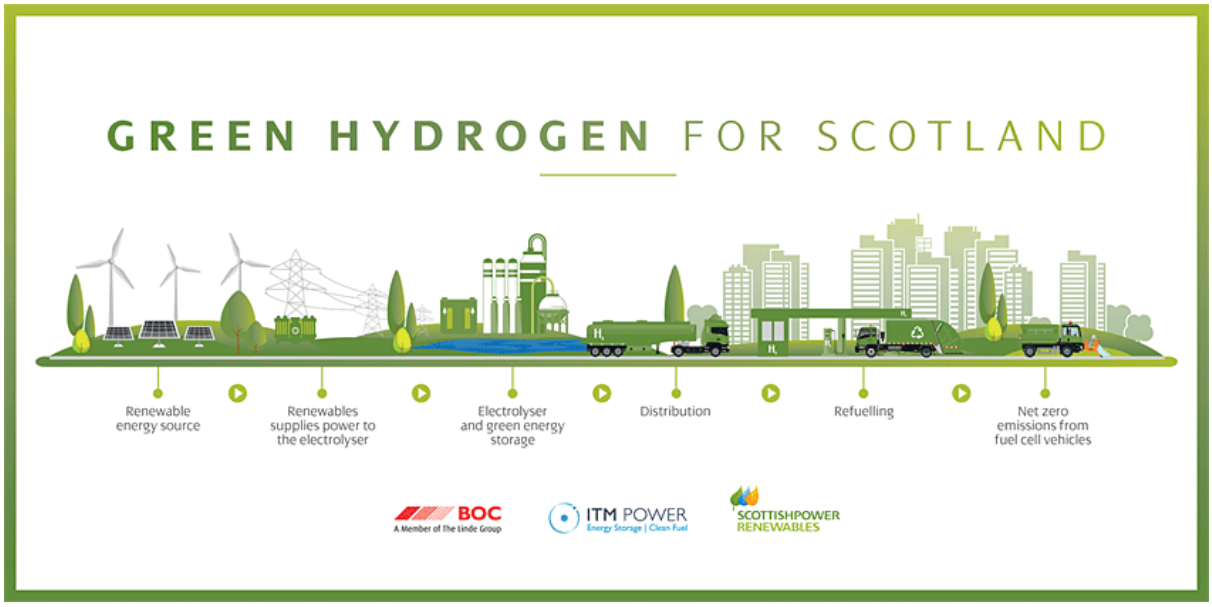
This activity will form the basis for the UK's first Hydrogen Network, based in the North West:



Key existing activity - SP Distribution Region
A pioneering strategic partnership has been established to create new green hydrogen production facilities with clusters of refuelling stations across Scotland. 'Green Hydrogen for Scotland' – a partnership of ScottishPower Renewables, BOC, and ITM Power – brings together industry-leading names in the renewables and clean fuel industries. The new facilities planned by 'Green Hydrogen for Scotland' will ensure zero emission fuel is readily available to organisations such as local authorities and others with fleets of heavy vehicles.

The partnership's first project, 'Green Hydrogen for Glasgow', is designed to provide carbon-free transport and clean air for communities across the city, which wants to become the first net-zero city in the UK by 2030.

A proposed green hydrogen production facility located on the outskirts of the city will be operated by BOC, using wind and solar power produced by ScottishPower Renewables to operate a 20MW electrolyser, delivered by ITM Power. The project aims to supply hydrogen to the commercial market within the next two years.



Our positioning as a DNO:

- We believe hydrogen will be key vector for grid services and supply within the next ten years and will look to innovate to enable these changes.
- We believe hydrogen enabling projects will be a key source of innovation funding over the next 3-5 years
- We will support projects with strategic partners that will look to replace natural gas with hydrogen on the generation side
- We lead projects that will determine how energy from hydrogen will be best deployed to the grid.
- We support projects with strategic partners that investigate and trial the storage of hydrogen across scales.
- We lead projects that will inform how storage vectors will contribute to our grids security and flexibility and increase capacity for renewable generation connected to our network.
- We will position ourselves to respond quickly to any changes in our governance particularly around the ownership of energy storage assets.
- Future projects mapped out according to strategy evolution.
- We have representation at all meaningful forums and consultation in this area – representing network interests in this space.

Key areas for innovation:

Generating	Storing	Deploying
Gas from On/offshore Constraint (at source)	Cavern Storage vs Gas Network Injection analysis	Inter-seasonal capture and deployment modelling
Multisource Hydrogen (Grid Hydrogen after the substation)	Storage optimised for demand response vs inter-seasonal storage	Hydrogen as a vector for flexibility services

More detail about our ambitious plans for innovation are presented below.

SGN Hydrogen for Fife Project
Est. value £97.5k (NIA)
As greater amounts of embedded generation connect into the distribution network there becomes a necessity for either large network upgrades or more flexible smarter use of the network. Presently there is significant curtailment of renewable power both within SPEN and across other licensees due to constraints that occur within the network.

The collaborative project with SGN comprised a feasibility study and review of the energy system optimisation to explore how the gas and electricity network, both present and future, could maximise local energy generation, distribution, and efficiency in the Fife region.

This study showed that there may be significant benefits in network planning through use of Hydrogen as a cross vector energy solution.

SPEN Green Hydrogen and its Potential in a Whole System Energy Network Proposal

[redacted]

RIIO-ED2 Innovation Opportunities
So far, the majority of funded network innovation projects have been confined to transportation and domestic heating.

SPEN propose to invest innovation funding into advancing the viability of hydrogen storage and generation on our network:

- The commonly cited alternative for short term storage for response services is batteries which are expensive and subject to an uncertain and competitive global supply chain. Hydrogen is a suitable low carbon alternative.
- The current Net Zero model of excess intermittent renewables requires long term storage of energy, and at present the low carbon alternative for inter-seasonal storage is pumped hydro which is both costly to construct and maintain, and incurs a huge environmental cost through the necessary flooding. Hydrogen stored in salt caverns represents an attractive and economic alternative

The UK government is committed to hydrogen playing a role in the net zero energy transition, evident by BEIS setting up a Hydrogen working group.

There is a strong global portfolio of projects that look at how power from renewables can be stored as hydrogen, including Hydrogen for Fife project led by SGN which we participated in. Less is been done looking at the whole cycle.

One of significance is by Engie and Siemens in France - an existing industrial gas turbine will be upgraded to convert stored hydrogen into electricity and thermal energy.

The project's total budget is close to €15.2M, of which €10.5M will be contributed entirely by the European Union under the Horizon 2020 program. In 2023 they will demonstrate viability of up to 100 percent hydrogen for carbon-free energy production from stored excess renewable energy. Key part of the project is that excess heat from the process will be utilised for an industrial application creating an extra value stream. Scotland, aligning with Scottish Power's wider activity in this area, would be an ideal location for a UK trial:

Estimated Funding required (multiple projects)	
Feasibility Studies: £1m	Technology Test and Demonstrations £20m

7.3.5 Innovation Spotlight: Power Electronics

Our innovation ambition on Power Electronics as a Key Enabler During RIIO-ED2

By the end of RIIO-ED2, we will have developed and enhanced our innovation portfolio to enable an internationally leading trial, deploying a 100% power electronic based distribution network.

A changing landscape with new technologies
In the context of a net zero network during/post the COVID-19 pandemic, we face the challenge of delivering a reliable and secure network with an intermittent generation mix and a significantly altered demand profile. The way we produce electricity is still changing; we are expecting an additional 40GW of renewable energy and up to 75GW of UK offshore wind by 2050.

Furthermore, the way we consume electricity has also changed. The peak demand in the winter/spring weeks in 2020 was as low as our minimum summer demand in recent years, with a typical drop of 20%-40% across the network. Weekday electricity usage in residential areas now mimics previous typical weekend profiles. Such unusually light power flow over the electricity network presents voltage issues and risks the security of supply.

Meanwhile, uncertainties around the pace of the economic recovery, the uptake of electric vehicles and the transition to electrified heat could put significant pressure on aged assets. Finally, we are committed to reducing carbon emissions with Net Zero targets in place since 2019 to Net Zero and a Green Recovery pathway

This all demonstrates a need for engineering innovation.

Power Electronics is a game changer
The technology which can manage these competing needs and enable a robust energy transition is power electronics. Since RIIO-ED1, SP Energy Networks has targeted power electronics, as we saw it as the vital game changer across the board for renewable power connection, energy storage, hydrogen production and heating electrification.

The penetration of power electronics is set to accelerate rapidly at the distribution level as changes in electricity demand create pressure to increase capacity on the low voltage (LV) network [1]. This is not just within DNO networks, but also from our customers – technologies such as EV chargers and PV inverters all contain power electronics.

As UK DNOs, we have already explored different opportunities with power electronics including smart transformers, soft open points, and on-line tap changers. We see that in RIIO-ED2, power electronics will only be used more to deliver control, flexibility and support the uptake of LVDC supply.

A growing market
Globally, power electronics is a market forecasted to grow significantly due to the number of applications and demand. The technology is used in multiple industries such as the automotive and aerospace on a massive scale. We see that there are multiple applications in the utility space where power electronics can realise greater control and flexibility which defer network reinforcement while managing the uptake of low carbon technologies and that there is an innovation opportunity to be exploited.

Therefore, there is a need for the DNOs to work together with the supply chain to develop solutions which can realise a net zero future. Innovation with a strong focus on power electronics will therefore be vital to secure our position in the green energy transition, whilst simultaneously supporting the GB business and the development of its supply chain.

Our *growing expertise*
SP Energy Networks have been working with key stakeholders at national and international level to ensure that we are leaders in steering innovation in the field of power electronics. Supported by a strong track record, we are proud of our ongoing portfolio of power electronic innovation which includes medium voltage DC conversion, low voltage DC conversation and power quality monitoring.

We represent the UK in providing expertise to **CIGRE B4 (Power Electronics) and C6 (Distributed Resources)** working groups and we are coordinating the international medium voltage power electronic

industrial standards under **CIGRE C6/B4**. We plan to continue this strong commitment to the power electronics sector during RIIO-ED2 with the support of fellow DNOs.

Working closely with UKRI (UK Research and Innovation) and its organisations such as the Compound Semiconductor Catapult at Newport and Drive the Electric Revolution (an £80m initiative), we have ensured that our innovation strategy in RIIO-ED2 has taken into account technology advancements and is based on business needs. The strategy maximises impact through a holistic approach which incorporates all product development stages from concept-level R&D to the supply chain and implementation.

Our RIIO-ED1 Existing Initiatives to uplift the TRL and upskill our staff

The application of Power Electronics in electricity networks continues to increase:

- Power electronic systems already in use for renewable generation and transmission assets
- New generation of PE systems needed at distribution level:
    - Soft Open Point (SOP)
    - Solid State Transformer (SST)
    - MVDC/LVDC
    - DC charging
    - Energy storage

Looking ahead, our planned portfolio of power electronic applications during RIIO-ED2, under Network Innovation Allowance include:

- Optimising power electronic devices and infrastructure.
- Develop and test the control algorithm with telecommunication infrastructure and cyber security considerations.
- Commercial validation regarding the hardware/software interface; business proposition for network companies and renewable developers.

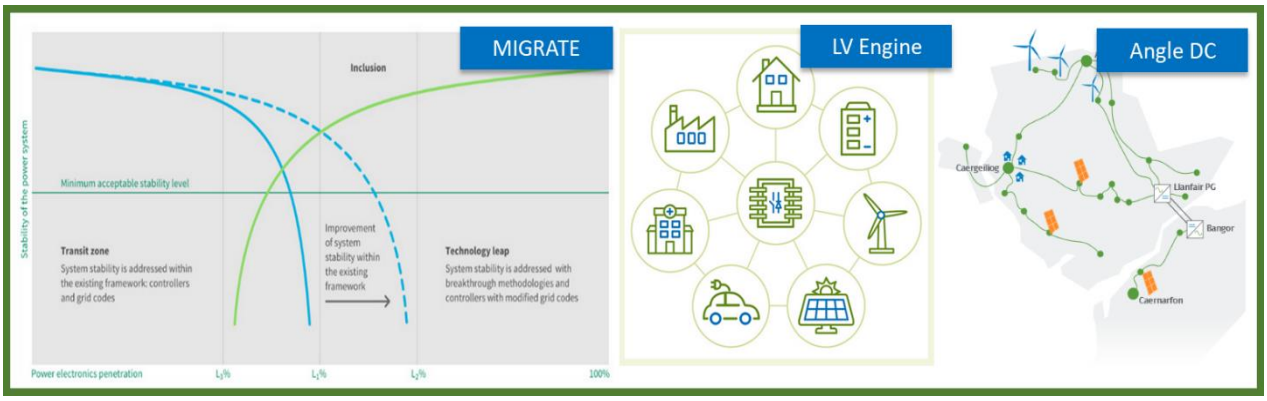


Figure 6 Ongoing power electronics-based innovation projects within SP Energy Networks

Promoting competition

Given the wide-ranging applications for power electronics in all areas of renewable energy generation, transmission and distribution, businesses in every sector of the energy market are turning their attention to component design.

In 2011, the Department for Business, Innovation & Skills estimated that the UK spend on power electronics for smarter electricity grids would exceed **£60 billion before 2035** [2]. Companies which directly manufacture wind turbines or solar PV systems are already comfortably ahead of the curve in this market due to their experience with power electronic devices for these systems; businesses that delay investment in power electronics are therefore likely to bear a much larger cost when they do inevitably join the market.

As the deployment of power electronic devices shifts and accelerates into the distribution network, we believe that SP Energy Networks should be supporting UK innovators by leading the way in offering integrated

expertise from component design through to servicing and support. We will ensure to accommodate this approach as we build project consortiums, deliver innovative solutions, and disseminate our learnings and findings.

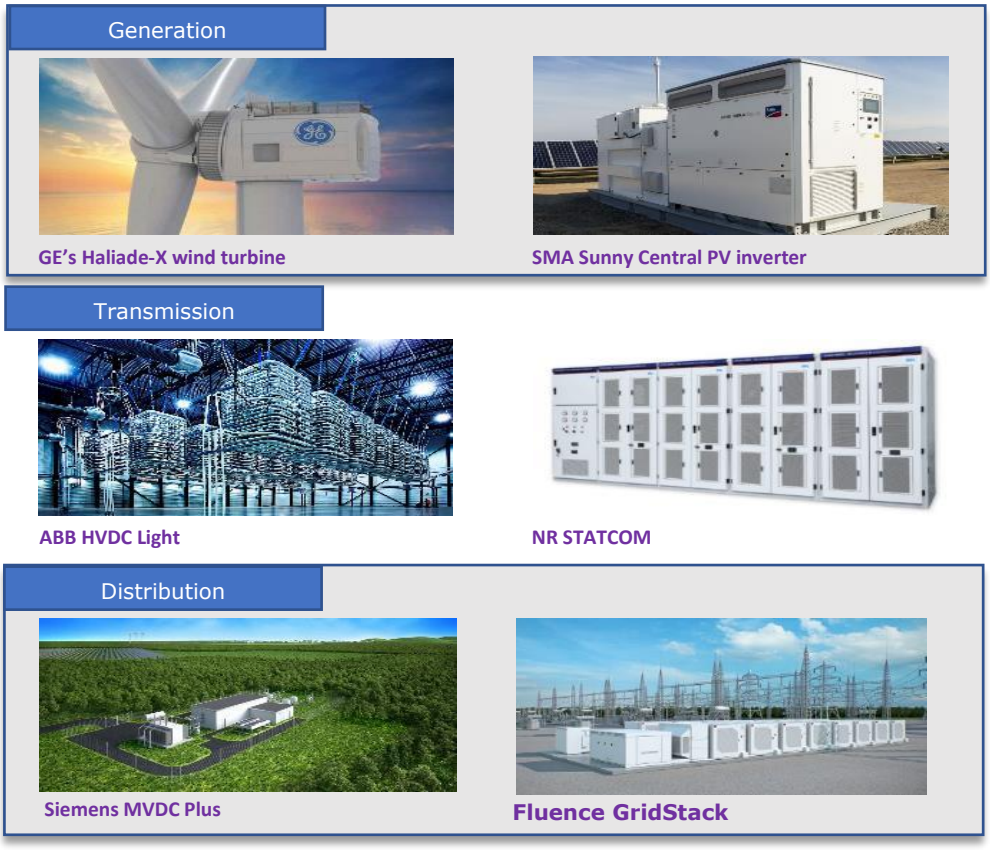


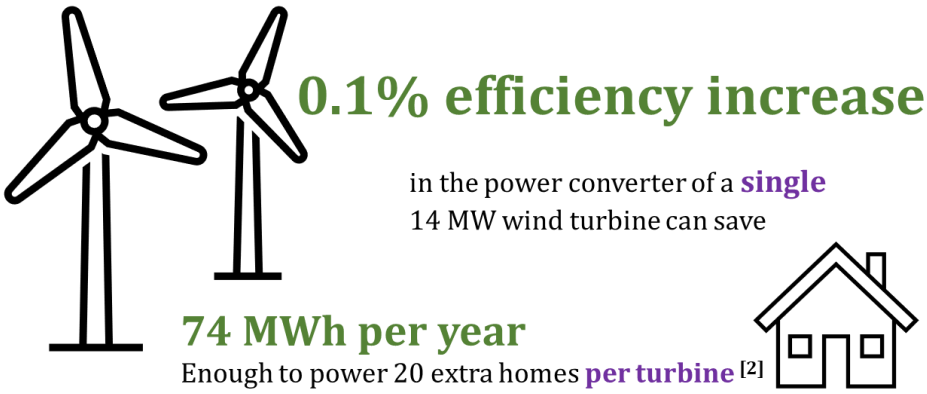
Figure 7 Key competitor entries into the power electronics market at generation, transmission, and distribution levels.

Growing the future – academic synergy

In light of the current and anticipated market state, we at SP Energy Networks see significant advantages to working much more closely with researchers and entrepreneurs to support power electronics innovation and research. We aim to establish ourselves as leaders in this respect, with our main goals being to understand and optimise component design, reduce losses, and improve safety and reliability.

[redacted] These new devices are much more efficient than traditional silicon-based power electronics, which is critical not only for energy and cost savings, but also for significant reductions in component heating which will be vital in converter-dominated networks.

Between 2000 and 2010, SP Distribution and SP Manweb recorded annual distribution network losses of between 3.9% and 7.3%, equivalent to an average **loss of 2.3 TWh per year** [3]. Based on average wholesale



electricity pricing, this equates to a cost of approximately £1 billion over this 10-year period [4]. Therefore, supporting the exploitation of more efficient power electronic materials could have a direct benefit on our current network losses. This piece of work is therefore essential to help implement our 2015 Losses Strategy and reduce costs to the business and our customers [5]. Strong investment at the component level will enable our UK energy business to tap into the £135 billion global power electronics market [2].

Estimated Funding required	
Feasibility Study: £900k	Hardware Design, Testing and Network Demonstration £10m

Further detail on this topic, including additional project examples and the potential network benefits that Power Electronics will enable, and the references specific to this section, is presented in Appendix II.

7.4 Breakdown of our proposed RIIO-ED2 innovation investment

Within this section previously we have described our innovation delivery plan and how it is strategically aligned with the Energy System Transition and Consumer Vulnerability themes. We have then spotlighted five areas which we believe have strategic importance in tackling whole system challenges. We have given examples of projects that we propose to undertake, and the likely value of these projects based on current or previous examples – these represent our overall ambition for innovation spend in RIIO-ED2.

7.4.1 Stakeholder Engagement

We have engaged with and been guided by our Stakeholders on the development of our RIIO-ED2 innovation strategy. The two primary elements of this engagement were:

1. A targeted workshop on Innovation as part of the Future System Strategy workstream.
    - This workshop was conducted via Microsoft Teams, and discussion was facilitated via the presentation of tailor-made content to provide stakeholders with the background information required to answer the questions they were asked.
    - Feedback was collected via both detailed minuting of the session and also through on-screen survey questions.
    - Stakeholders attending the workshop represented the following groups:
        - Academia
        - Community energy
        - Consumers
        - Energy Consultants
        - Energy Networks
        - Manufacturers
        - Think Tanks
2. A collaborative engagement activity undertaken with the Energy Innovation Centre (EIC).
    - EIC Industry Partners agreed to collaborate and develop a stakeholder survey to secure the insights of third parties innovating across the energy sector and beyond. The aim was to use these insights to inform the development of DNO business plans for RIIO-2 and to provide GDNs and TOs with ongoing feedback to inform their modus operandi.
    - The EIC developed a 10-minute survey which was shared with Cadent Gas Limited, Wales & West Utilities, Northern Gas Networks, UK Power Networks, SP Energy Networks, National Grid Electricity Transmission, Northern PowerGrid, and Scottish and Southern Electricity Networks. All questions were thoroughly discussed and agreed.
    - The survey was distributed to the EIC's innovation community, as well as specifically targeted stakeholders such as private test facilities and larger innovators. The survey was also promoted by all partners and at Utility Week Live.
    - A total of 167 responses were received.

The outputs from all of the above activity have been evaluated and used to inform the development of our innovation strategy.

Key messages that our stakeholders told us from the targeted workshop were to:

- not to adopt a siloed approach to the Energy System Transition (EST) and Consumer Vulnerability (CV) themes – both areas of focus should be considered when considering the impact of most innovation activities
- develop a clear thread between innovation projects to ensure long term benefits
- be more ambitious with our innovation programme in RIIO-ED2 compared with RIIO-ED1.

We agree with our stakeholders' ambition – innovation is more important than ever if we are going to facilitate Net Zero, and maintain safety and reliability, for our customers in the most efficient ways. That is why we commit to keeping innovation at the core of everything we do in RIIO-ED2.

These messages were consistent throughout both our targeted Stakeholder Engagement activity and also within the collaborative engagement activity undertaken with the EIC. Some of the key messages from the EIC activity were as follows:

- 72% of respondents believe that environmental/social benefits should always be a targeted outcome of innovation
- 87% of respondents believe that network companies should develop their culture to increase their innovation capabilities in RIIO-2
- 60% of respondents said that DNOs should ask for an increase in NIA funding compared to RIIO-1 levels, as significant innovation is needed to support the Energy System Transition and Consumer Vulnerability themes stated by Ofgem
- 87% of respondents believe network companies should continue to collaborate with organisations like the EIC to accelerate innovation

We have listened to our stakeholders' views. For RIIO-ED2, following engagement with our stakeholders we made the following commitment (please see Annex 1.1 for our full list of commitments):

- Commitment #5:
    - We will deliver £87m of savings for our customers in RIIO-ED2 by embedding learnings from innovation projects into business as usual (BAU) and adopting best practice from successful industry trials. We will keep innovation at the core of everything we do, to continue to deliver benefits for our customers and the wider energy system.

In addition to the above, during RIIO-ED2, we are:

- Building on the success of DRIVE and further developing our innovation culture
- Considering the impact on Consumer Vulnerability for all innovation projects, including Totex-funded DRIVE campaigns
- Delivering a holistic innovation strategy that is independent of funding route, with robust processes to ensure proven innovation is deployed as business as usual
- Delivering innovation with a focus on whole system challenges, as highlighted via our spotlighted innovation areas in Section 7.3

Further details on the above activity can be found in Annex 3.1: Co-creating our RIIO-ED2 business plan with our stakeholders, and Annex 3.1c: ED2 Triangulation Record – network of the future. The feedback we have received from our stakeholders has strategically informed our innovation investment ambitions which are summarised below.

7.4.2 RIIO-ED2 Totex innovation expenditure

This Annex document has primarily focused on the breakdown of our innovation activity around the Ofgem innovation themes of Energy System Transition and Consumer Vulnerability – however the scope for innovation across the wider business is broader than that. This section presents some highlights from this wider activity and the Totex investment we will need to deliver this.

Our DRIVE initiative (see Section 0) is now fully BAU and is our mechanism for ensuring that we continually challenge ourselves to work better. Our aim is to target three campaigns per year. The scope of each campaign will be determined at the time between the DRIVE working group and our Executive team, and could target improvements in any of the following example areas:

- Improvements to safe working
- Reducing our Carbon Footprint
- Improving Customer Service
- Finding ways of working more efficiently

As described previously, all members of staff are invited to contribute ideas and solutions to the campaigns when they are launched, and successful ideas will be transitioned into Totex funded innovation projects. In theory there will be no funding cap for the best ideas, particularly any delivering efficiency benefits within the regulatory period, however based on previous expenditure we estimate that we will invest **£1.2m** into DRIVE campaigns in RIIO-ED2.

In addition to the above, we have a dedicated Business Change team tasked with identifying and delivering business-wide improvements. This team will identify any processes that are not working to maximum efficiency and work with the relevant departments to implement an improved solution. This team consists of ten full time staff with a track record of delivering significant business efficiency improvements, representing a total investment of **£5m** in RIIO-ED2.

Our Digitalisation Team is also investing Totex to both build on previous innovation stimulus funded projects, along with some new initiatives, and maximise the benefits of innovation for the business. This programme of work is embedded within our Digitalisation Strategy[52] and interfaces with the Digitalisation elements of this Innovation Strategy. It is also recognised that overall business efficiency is influenced significantly by operational IT systems. Our non-operational IT business plan includes significant investment during RIIO-ED2 to deliver a significant transformation for the business on an even greater scale than ever before. It is expected that this combined activity will require **£55.7m** investment within RIIO-ED2, for more detail please see Annex 4C.1: IT and Digitalisation Strategy.

These activities are all targeted at business improvements that will help us achieve our business goals. Some will directly interface with the innovation themes presented in this Annex and others are innovation targeted at business efficiency. These activities represent **£61.9m Totex innovation investment within RIIO-ED2.**

7.4.3 NIA Funding Request

This section specifically addresses our proposal for Network Innovation Allowance (NIA) in RIIO-ED2. This section should be considered in conjunction with our delivery plan that we have previously detailed within this Annex.

We have listened to our Stakeholders and are avoiding the adoption of a siloed approach to the EST and CV themes by undertaking a CV impact assessment for all EST projects. **We will also undertake a CV impact assessment for all Totex funded DRIVE innovation projects.**

Our current assessment of the total innovation opportunity indicates that funding of £84m is required, as shown in Table 7. **We intend to leverage over half of this funding from outside NIA**.

We see potential for the total innovation opportunity to grow beyond our current assessment over the course of RIIO-ED2. Therefore, we support the availability of a reopener to increase our initial NIA funding allowance in the event of additional identified opportunities beyond our current assessment, as stated below.

We propose and request the following with respect to the availability of NIA in RIIO-ED2:

- **£35m total allowance**, awarded as a single allowance and without the requirement for a reopener, for the duration of RIIO-ED2. This will provide us with the certainty and flexibility to invest in the right innovations at the right time to maximise the impact. **While this represents an almost two-fold increase on RIIO-ED1 investment levels, we believe it is proportional to both the proposed increase in Totex investment, the challenges posed by Net Zero, and our commitment to a clearer, open and more flexible approach to innovation**.
- The NIA commitment is supported by our track record in efficiency and new learnings. For example, we will lead and share the learnings on power electronic technology at the national level, representing a £400m per annum sector with national importance.
- We are avoiding the adoption of a siloed approach to the EST and CV themes by undertaking a CV impact assessment, and a positive CV impact will be targeted for all EST projects. **To demonstrate our commitment to a just transition to Net Zero, we also plan to dedicate £4.3m of NIA to specific CV issues**, in addition to the remaining £30.7m for EST.
- As NIA will primarily be targeted at low to middle Technology Readiness Level projects, **we propose to maintain the level of compulsory contribution at 10%**. This does not factor in additional Totex

[52] https://www.spenergynetworks.co.uk/userfiles/file/RIIO-T2_SP_Energy_Networks_Digitalisation_Strategy.pdf?v=1.3

spend on jointly funded NIA/Totex projects. As any Totex funded innovation is entirely at our risk, we believe this approach provides the best balance of sharing the inherent risk within innovation projects without impeding progress, which must continue to accelerate to enable Net Zero.

- We support the availability of a NIA reopener to increase our initial £35m NIA funding allowance in the event of additional identified opportunities beyond our current assessment.
- **We anticipate that our approach will yield a £4 return from for every £1 NIA invested as we look to RIIO-ED3 and beyond.**

Our overall funding for innovation in RIIO-ED2 will come from a number of different sources including our Totex allowances, innovation stimulus such as Network Innovation Allowance and the Strategic Innovation Fund, and wider funding opportunities. We have therefore structured our NIA funding request to best enable our overall ambition.

It should be noted that there will be significant cross over between each of the areas listed – for example, the **electrification of transport and heat** are whole energy system challenges but have been captured under "Network Modernisation" due to where our focus will be to meet these challenges.

We have separate strategies for both Sustainability[53] and Consumer Vulnerability[54] that are outside the scope of this innovation strategy – any Totex spend in relation to these has been excluded from the table. **A positive impact will always be targeted for both of these areas from any innovation project.**

The breakdown of our NIA funding request against the focus areas is presented below:

Table 7: Breakdown of NIA Funding Request

Overall Summary	Comments	Total ambition £m	Proposed split between Totex & other funding sources / NIA	Proposed NIA £m
Network Modernisation	Includes Transport, Heat, Storage and facilitating Generation, and part of Power Electronics	32.7	63% / 37%	£12.0
DSO	Includes part of Power Electronics	8.5	47% / 53%	£4.5
Digitalisation		14.25	71% / 29%	£4.1
Whole Energy System	Includes Hydrogen	22	61% / 39%	£8.5
Sustainability		1.6	0% / 100%	£1.6
Consumer Vulnerability		4.5	4% / 96%	£4.3
Total		**£84m**	58% / 42%	**£35m**

A more detailed breakdown of our proposed innovation spend is provided in Appendix III. This has been established using a bottom-up approach to identifying the level of investment required in each area. For each of the areas listed above, an assessment of the existing market was undertaken and example projects identified (examples of these are provided in Section 7.3). An assessment of these projects was then undertaken to establish the most appropriate funding mechanism:

- NIA funding: projects that are seeking to develop solutions to existing challenges (for example, electrification of transport and heat), that have the potential to move quickly and we have a high confidence that we can deliver utilising our existing innovations resources
- SIF or other external funding sources: generally larger, more collaborative projects (for example, whole energy system challenges) that are likely to be instigated at a slower pace due to the need for input from multiple project partners
- Totex: high-TRL level projects, that can move quickly and have a higher likelihood of success

[53] Annex 1.3: Sustainability Strategy and Annex 4C.3: Environmental Action Plan
[54] Annex 4B.1: Vulnerability Strategy

This assessment was then extrapolated from the real project examples to provide a most likely funding source for other project concepts. The outcome of this analysis was the **£35m minimum NIA investment** program that we have a high confidence that we can deliver within the RIIO-ED2 period.

7.4.4 Strategic Innovation Fund (SIF) Alignment

Ofgem published the SIF Governance document[55] on 25/08/21. This document sets out the governance and administration of the SIF for RIIO-2, including the project eligibility criteria which is summarised below:

SIF project eligibility criteria:

1. Projects must address the Innovation Challenge set by Ofgem.
2. Projects must have clearly identified potential to deliver a net benefit to gas or electricity consumers (whomever is paying for the innovation).
3. Projects must involve network innovation.
4. Projects must not undermine the development of competitive markets.
5. Projects must be innovative, novel and/or risky.
6. Projects must include participation from a range of stakeholders.
7. Projects must provide value for money and be costed competitively.
8. Projects must be well thought through and have a robust methodology so that they are capable of progressing in a timely manner.

During the course of RIIO-ED2 we will submit proposals for the SIF to support the ambitions described in Table 7. Our justification for requesting availability of a NIA reopener in addition to SIF is to have the ability to address innovations needs that fall outside the scope of SIF challenges.

In May 2021, Ofgem published its Innovation Vision[56], which informs markets regarding where Ofgem has identified the need for significant innovation. It highlights priority areas needed to achieve the multi-vector transition to net zero across power, heat, and transport. As such, the SIF challenge areas (Eligibility Criterion 1 above) will be aligned with this, to address whole system challenges using a collaborative approach. Our strategy has been developed with this in mind to ensure we are well placed to engage with the SIF and develop industry leading innovation in these areas.

The first round of innovation challenges has now been issued, to be led by electricity transmission or gas transmission/distribution operators. The four innovation challenge areas that have been set by Ofgem (with the support of UKRI) are: Whole system integration; Data and digitalisation; Zero emission transport; Heat.

Our initial assessment suggests that our innovation strategy is well aligned with this first round of challenge areas. This is assessment is based on the following:

- Our innovation strategy has a whole system focus throughout, specifically:
    - Whole Energy System is identified as one of our key focus areas (Figure 2 and Section 7.2.1)
    - Whole system challenges are the focus of our spotlighted innovation areas (Section 7.3)
- Digitalisation is identified as one of our key focus areas (Figure 2 and Section 7.2.1)
- Electrification of Transport (to enable Zero emission transport) is one of our spotlighted innovation areas (Section 7.3.3)
- Electrification of Heat is one of our spotlighted innovation areas (Section 7.3.2)

While it is recognised that these challenges will differ each year and may not be fully representative of the first challenge areas that will be set at the start of RIIO-ED2, we believe that our alignment with this first round of challenges at this stage makes us well placed for future alignment. We will continue to review our innovation strategy to ensure this alignment is maintained.

[55] https://www.ofgem.gov.uk/publications/sif-governance-document
[56] https://www.ofgem.gov.uk/publications/ofgem-innovation-vision-2021-2025

8 How we deliver, report, and integrate our innovation projects

SP Energy Networks has a well-established innovation process across both its transmission and distribution licenses. Our innovation process has matured over the last decade through the low carbon network incentive and RIIO NIC, NIA and IRM mechanisms. As innovation becomes ever more critical to the sustainability of the business and transmission and distribution sector we have greatly improved upon this process based on feedback from our stakeholders, 3rd parties, regulator Ofgem and experience of our employees developing and delivering innovation projects.

Several case studies giving examples of how we have applied this process and the associated tracking of benefits are presented in Appendix IV.

8.1 How we deliver innovation projects

Innovation projects within SP Energy Networks go through 6 key phases, with intermediate gate reviews as shown below:

- Inception Phase
- Creation Phase
- Delivery Phase
- Bridging Phase
- Transition Phase
- Business as Usual

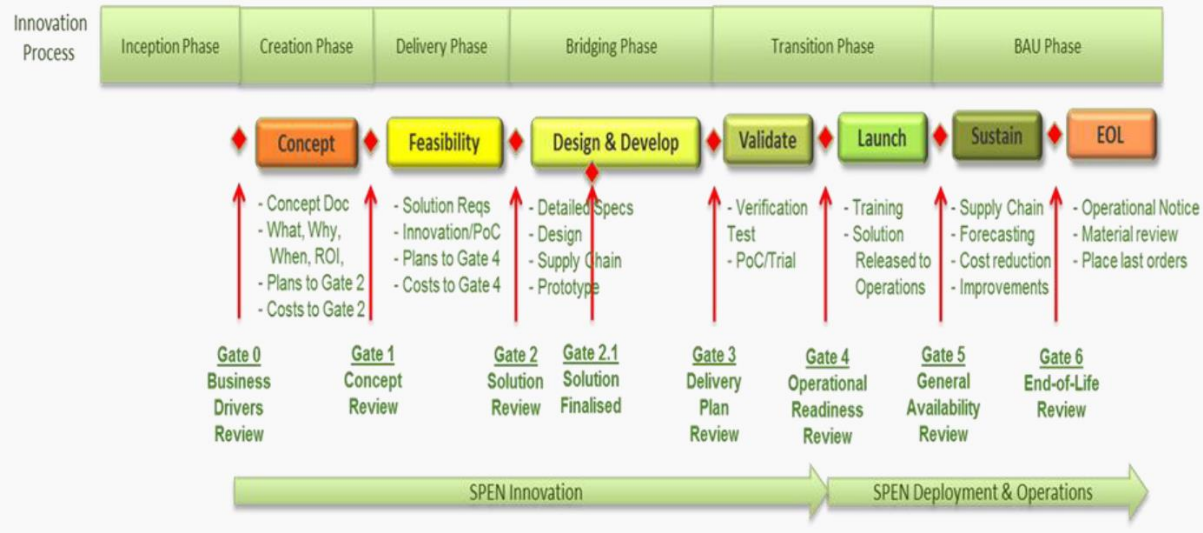


Figure 8 Innovation Process Map

A brief description of each of the phases and the steps taken by the innovation delivery and governance team to ensure the innovation investment is a right balance between risk and benefits is provided in this section. We have greatly improved upon the process in line with Ofgem's expectations for RIIO-ED2 with the aim of:

- Enabling more innovation through business as usual by establishing a holistic process for all innovation activity
- Focussing our innovation stimulus efforts on transformative innovation projects with longer term impact: Aligned with Ofgem's high level themes of Energy System Transition and Consumer Vulnerability challenges
- Development of industry-wide approaches for increasing general visibility of impact created through application and implementation of innovative projects through increased public reporting, development of collaborative innovation strategies and tracking of innovation benefits

- Continuous reviews and improvement of the innovation portfolio and projects to ensure we balance and optimise our innovation efforts evenly across challenges and levels of risk
- Gap analysis of innovation incentives and projects, to make sure projects are aligned to their original objectives and are on-track to deliver benefits
- Increased collaboration across different sectors of the energy system to share and adopt learnings that drive transition
- Increased third-party engagement through a transparent assessment process of third-party proposals and feedback procedures
- Empower our consumers through increased engagement with community energy incentives, non-profit organisations and using innovation to address the needs of those in vulnerable situations.

8.1.1 Project Inception

We engage with different stakeholders and 3rd parties to collect ideas and solutions for different energy system transition challenges. This engagement is a crucial step for us to ensure we test the market and a broad range potential project partners to identify the right innovative solution for the given set of challenges.

Independent of whether an innovation project proposal originates through engagement with external suppliers and 3rd parties or is a solution developed internally through our own business process, it goes through a detailed approvals procedure before Totex and/or innovation funding is spent to create and deliver the project.

Category	Score Criteria			
	0	4	7	10
Alignment to Strategy & Importance The degree of: -Alignment with the innovation strategy -Importance of the project to the company	-Lack of alignment with innovation strategy -Project does not seem to be important	-Somewhat aligned to innovation strategy -Project appears to be somewhat important	-Supports innovation strategy -Project seems to be important	-Considerable alignment to innovation strategy -Project looks very important
End User & Strategic Benefits The degree to which the project: -Offers greater benefits to the end user -Offers discrete benefits from other projects -Offers strategic benefits to the company	-Provides no new benefits to the end user -Provides no discrete benefits from other projects -Offers little or no strategic benefits	-Provides modestly differentiated benefits to the end user -Provides modestly differentiated benefits from other projects -Offers modest strategic benefits	-Provides reasonably differentiated benefits to the end user -Provides reasonably differentiated benefits from other projects -Offers reasonable strategic benefits	-Provides highly differentiated benefits to the end user -Provides highly differentiated benefits from other projects -Offers significant strategic benefits
Scalability -Scale of potential roll out -Ease of roll out -Likelihood of completed project leading to further projects	-Offers little or no scope to roll out across the business -Requires very complex roll out -Offers little or no scope to lead to further projects	-Can be rolled out to limited parts of the business -Requires fairly complex roll out -Offers modest scope to lead to further projects	-Can be rolled out reasonably widely across the business -Requires reasonably straightforward roll out -Offers reasonable scope to lead to further projects	-Can be widely rolled out across the business -Requires straightforward roll out -Offers significant scope to lead to further projects
Synergies & Core Competencies -Ability to leverage synergies with existing systems and working practices -Availability of required resources (skills, capability & experience)	-Limited or no ability to leverage synergies with existing systems and working practices -Required resources are not available and cannot be acquired	-Modest opportunity to leverage synergies with existing systems and working practices -Required resources are not available but some can be acquired	-Good opportunity to leverage synergies with existing systems and working practices -Required resources are available but all are not fully accessible	-Strong opportunity to leverage synergies with existing systems and working practices -Required resources are available and accessible
Technical Feasibility -Degree of technical complexity -Size of technical gap	-Highly complex technical solution -Very large technical gap	-Fairly complex technical solution -Large technical gap	-Somewhat complex technical solution -Modest technical gap	-Straightforward technical solution -Modest technical gap
Cost Benefit Analysis for integration to BaU -Degree of definition of cost benefit analysis -Positive cost benefit analysis	-No cost benefit analysis -Little / no benefits relative to cost of project implementation (negative CBA)	-Poorly defined cost benefit analysis -Modest benefits relative to cost of project implementation (neutral / modestly positive CBA)	-Reasonably defined cost benefit analysis -Reasonable benefits relative to cost of project implementation (positive CBA)	-Well defined cost benefit analysis -Significant benefits relative to cost of project implementation (very positive CBA)
Recommendation:			**Total Score:**	

Figure 9 Innovation project scoring criteria for project approval

The six main criteria to check the eligibility of an innovation project for innovation expenditure are as follows:

- Alignment with business and industry innovation strategy and priority
- End user and strategic benefits
- Scalability
- Synergies and core competencies

- Technical Feasibility
- Cost Benefit Analysis projection for business as usual roll-out.

The project must score at least 4 or above in all criteria and above 7 in at least 3 categories including compulsory categories of 1, 2 and 5 (where applicable) in the initial analysis to be presented to the innovation governance board within the business for further interrogation and approval.

Avoiding Duplication

In RIIO-ED2 in project creation phase especially for projects funded through the innovation stimulus; the first priority is to ensure the project is unique and avoids unnecessary duplication across the industry. This is achieved through a combination of direct contact with the Licensed Network Operators and through the investigation of projects using the Energy Networks Association (ENA) Smarter Networks Portal. Where we find that there is overlap with the proposal and existing or previous Licensed Network Operators projects we endeavour to extract the learning from those projects prior to making a decision to precede with a project or the Business as Usual adoption should the learning be sufficient to do so.

8.1.2 Project Creation

The project creation phase involves following 3 key elements of the innovation process

- Business buy-in
- Business Sponsorship
- Innovation Board Approval

Business Buy-In

It is important for the ultimate success and roll-out of any innovation project that there is a business pull to integrate the learning from the projects upon successful completion. While some innovation projects, due to the inherent risk of the intended benefits not being realised, may not reach the roll-out stage, it is still important to have the intent and process in place for roll-out at the project creation phase.

In order to ensure business, buy in, a detailed internal review process is undertaken prior to presentation to the innovation board for approval. The project proposal is circulated among the business teams responsible for roll-out and/or or effected by the roll-out of the innovation project. All comments and feedback are collected through the innovation process. The innovation proposal is then updated and modified as required for presentation to the innovation board. If a proposal fails to meet the criteria of business buy in it needs to be re-evaluated by the project proposal team again to ensure it meets the right level of requirements.

Business Sponsorship

To ensure that projects created are fit for purpose we need to ensure that the expected Business as Usual sponsors/owners of the solution approve of the planned approach, partnership, and its deliverables. There are two types of sponsor/owner, the Business Sponsor, and the System Sponsor:

- Business Sponsor – The internal stakeholder within our business who will benefit from the outcome of the project if it is successful and delivered into business as usual. Their needs tend to focus on the creation of policy, financial approval, and the realisation of benefits.
- System Sponsor - The internal stakeholder within our business who will likely be responsible for operating and maintaining the solution if it is successful and delivered into business as usual. Their needs tend to focus the more practical aspects such as standards and specifications for procurement and operating and maintaining the equipment.

Depending upon the project, the Business and System Sponsors can be a single Sponsor performing both rolls.

Innovation Board Approval

Only once the essential requirements of the project and its ownership have been defined can the project plan be completed and approved. The internal approval process is via the project sponsors and by our Innovation Board. This approval precedes the registration and signing of any legal documents associated with the project.

Innovation Board (IB): This group consists of several SP Energy Networks Directors and Senior Managers. The IB is responsible for the approval of large-scale innovation projects and the projects with a long lead time to adoption. The IB is also responsible for facilitating projects transition into Business as Usual and tracking the overall performance of our portfolio of innovation projects. The IB is primarily responsible for:

- Setting the innovation strategy
- Ensuring alignment of innovation priorities with wider stakeholders and other sectors
- Tracking delivery and expenditure in overall innovation portfolio
- Stage gated review of innovation projects and facilitating their transition into Business as Usual
- Approving Project Partners and Collaborators, and engaging with other sectors
- Registration of Projects and start of project reporting

All approved innovation projects are registered through the Energy Networks Association (ENA) Smarter Networks Portal; this process provides visibility to the wider industry, stakeholders, and consumers alike of our intentions. Prior to formal registration, a summary document is uploaded onto the ENA "Huddle" page - for fellow Licensed Network Operators, this also gives them an opportunity to register any concerns or desire to collaborate on the project prior to registration.

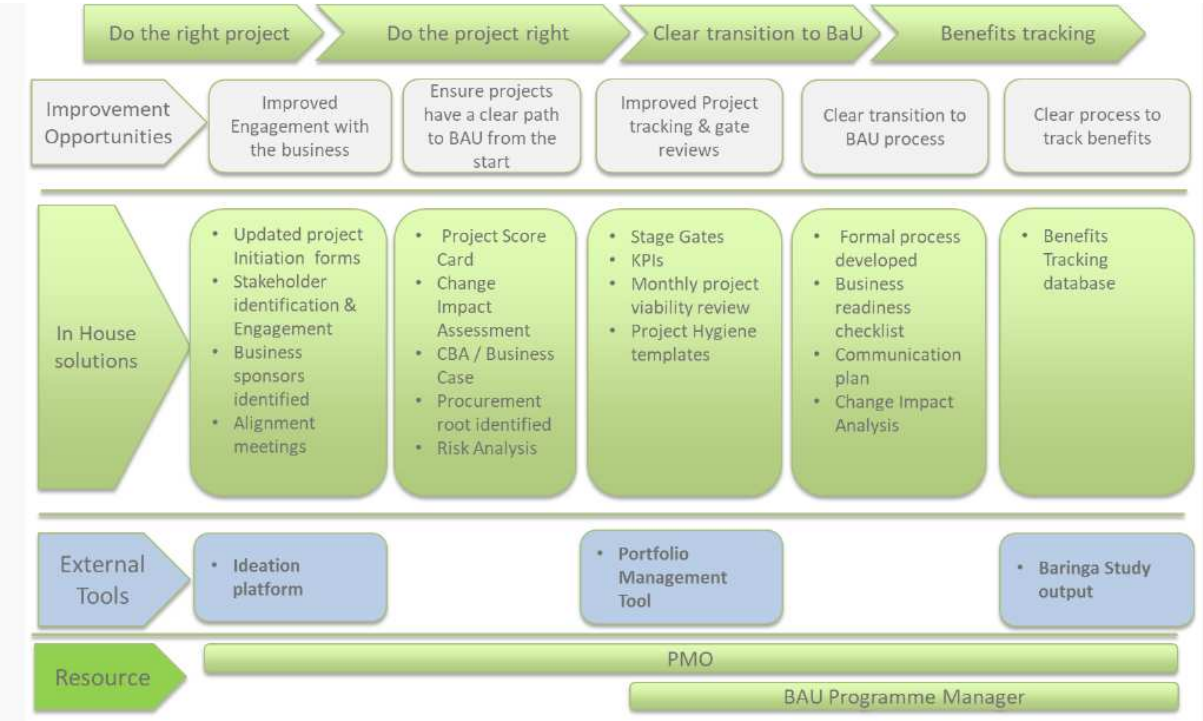


Figure 10 Innovation project delivery key considerations and elements

8.1.3 Project Delivery

The delivery of innovation projects is substantially different from every day conventional projects. There are extra layers of challenges encompassed into innovation projects due to the inherent complexity and unpredictability of attempting something new. From inception and creation through to delivery and transition to Business as Usual, the key elements of project delivery phase are as follows:

- Successful Delivery Criteria
- Stage gate reviews
- Project Steering groups
- Multi-disciplined teams
- Project portfolio management
- Benefits tracking and reporting

Successful delivery Criteria

The successful delivery criteria and key performance indices (KPIs) are defined for each project at the project inception and creation stage. These are the key criteria of assessment of successful delivery of any innovation project. The fixed set of success criteria and KPIs may vary from project to project but overall, they will cover the following:

- Inclusion of a technical, process or method performance metric to enable assessment if the proposal has been a success
- The realisation of the network owner and Societal benefits defined in the business case
- The delivery of essential outputs such as policies, financial approvals, standards, specification, dissemination, and training
- Adequate knowledge dissemination within and outside the company

Stage Gate Reviews

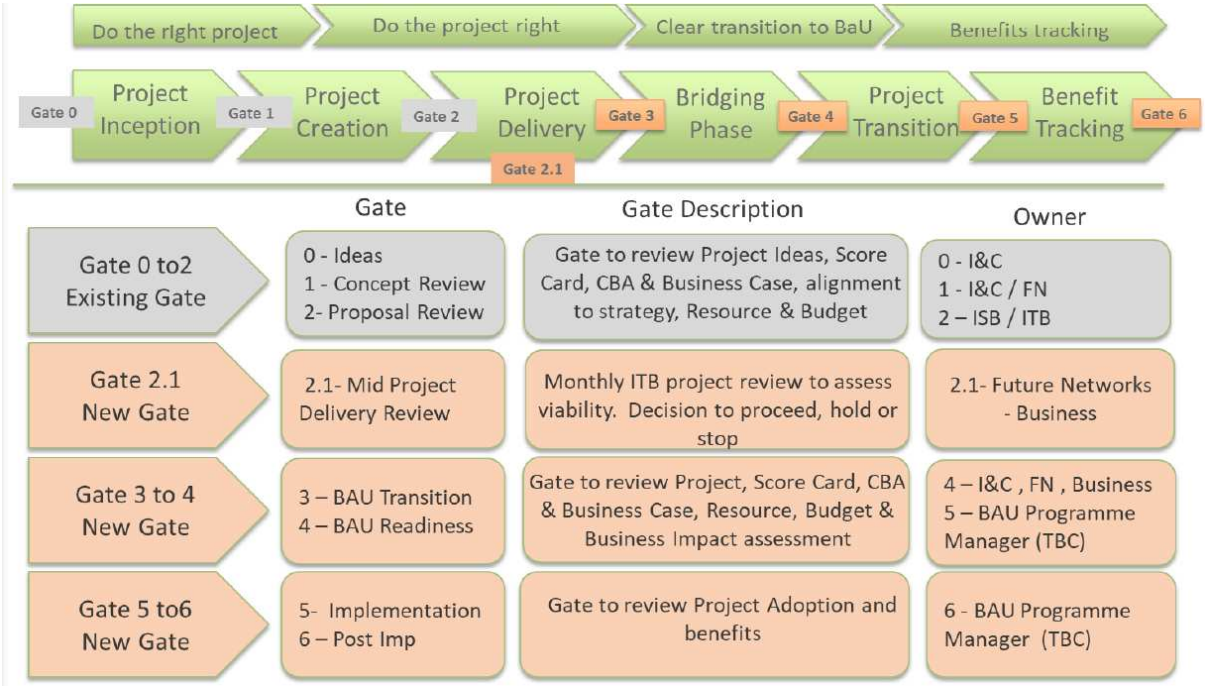


Figure 11 Stage gates and review process

Along with definition of successful delivery criteria and KPIs, it is critical to have stage gate reviews of innovation projects. Innovation projects are based on a set of assumptions during the definition and initial benefits estimation phase. As the project progresses through the delivery phase it is even more important that the gate reviews are conducted, and the review findings are used to improve the overall deliverability of the project.

The various stage gate reviews undertaken as part of the overall innovation process are shown in above. In summary stage gates ensure:

Gates 0 to 2

- At project inception only projects that have potential to deliver benefits and mitigation measures available for identified risks are taken forward.

Gate 2.1

- Projects are delivered in time and on budget
- The project delivery meets the right levels of quality and is on track to deliver the perceived benefits. Any issues identified with same are rectified and/or the project deliverables are modified to bring it back on track to deliver benefits.

- There is adequate gap analysis to allow the project steering board to take measures to resolve any resource, budget issues. The gap analysis also allows for addition or removal of any project objectives that might be required and deemed appropriate.
- Allow for stopping any project that proves to be too risky for successful completion during project delivery stage. This will ensure that projects can be stopped into other innovation activities that have more potential to deliver benefits.

Gate 3 to 4

- After project delivery and during bridging phase stage reviews allow to critically assess if the project in question was a success and whether there is sufficient ground for roll-out.

Gate 5 to 6

- During project transition the stage gates allow for assessment for the roadmap, budget, processes, resources, and governance in place to ensure successful roll-out of the solution and resulting benefits are tracked and reported.

8.1.4 Project Steering Groups

Project Steering groups in place for every project to ensure it stays on track as well as providing advice and guidance into the vital aspects of the project. These include project planning, allocating resources and managing budgets. These features are pivotal into shaping the outcomes of a successful project. The project steering group for most NIA projects is the IB. SIF projects and some key NIA project have individual steering boards.

The project steering boards generally comprise of senior managers and technical experts from different parts of the business. The steering board depending on the nature of the project may also have members from 3rd parties and suppliers. The project steering board is primarily responsible for stage gate reviews of innovation projects. All steering board decisions are minuted, recorded and followed up at the next steering board meeting.

8.1.5 Multi-disciplined teams

In RIIO-ED2 SP Energy Networks will form multidisciplinary teams with representatives from business core teams that will be responsible for creation of new innovation projects, delivery, and ultimate integration in business as usual. The multidisciplinary teams will be strongly interlinked for knowledge transfers and learning process from one team to the other thus minimising the risk of loss of communication, information, and failure to handover to the operational business for projects moving to BAU. The overall project and stakeholder management of the innovation multi-disciplinary teams will be the responsibilities of central project management and communication management functions.

The concept of multi-disciplinary teams will involve individuals from different teams from around the business to bring in new ideas for innovation and also relay back the findings as the project progresses back to their teams.

8.1.6 Project portfolio management

Overall project portfolio management is one of the key elements for the success of individual projects and overall innovation program. It achieves following objectives:

- It provides an overview of the project progress on individual projects and puts it in the context of the overall innovation portfolio delivery progress and assessment
- It allows the innovation board to take a step back from the details of progress on individual projects and assess the alignment of the overall portfolio with innovation strategy
- It also allows the innovation board to evaluate the number and scale of projects in different project delivery stages - it thus enables the board to plan and allocate resources and put processes in place to support all ongoing innovation projects
- It enables spending and budget allocation to be tracked across different innovation themes or across funding streams.
- It enables effective reporting and benefits tracking

- It provides an opportunity for gap analysis and promotion of innovation projects in areas lacking focus, aligning projects better to the strategic focus for innovation and for changing business priorities
- It allows for re-prioritisation of the overall innovation programme and better alignment with wider sectors and research and development work

There is a precedent set by SP Energy Networks already in RIIO-ED1 for successful portfolio management, this process will be further enhanced in RIIO-ED2 for portfolio management across all innovation focus areas and themes.

8.2 Benefits tracking and reporting

There will be stage gated benefits tracking and reporting at every phase of the innovation project.

Innovation Review and Roll-Out

The real value of any innovation project is in its actual implementation and roll-out. It is where the value for our consumers is created, where the innovation investment is paid back to the consumers and where the quantitative and qualitative benefits are realised.

The innovation process within SP Energy Networks ensures that there is a thorough review of all innovation projects led by us after completion. The stage gate review at this stage reviews the following aspects of the project:

- Any change or update in business case for the project
- Estimated benefits to be generated based on the learning from the project
- Resources and process in place to enable roll-out
- Technical feasibility and change in technology readiness level (TRL) after completion of the project
- Impact assessment of the project on different aspects of business
- Assessment of accurate timing and opportunity for the roll-out

Project Bridging and Transition Phase

The ultimate goal of each innovation project is their transition and/or adoption of the learning into Business as Usual.

The consideration and steps necessary to transition successful innovation projects to business as usual are built into the fabric of each project at the initiation stage. The following checks and steps are undertaken to ensure successful roll-out of innovation projects:

Business Sponsorship

- The Business and System Sponsors are identified for the solution should it make the transition to Business as Usual. Throughout the project and upon its closure the sponsorship of the project is periodically reviewed to ensure the right parties continue to be involved with the project. Ultimately the decision to progress with the Business as Usual adoption resides with the Sponsors, so it is essential that they are correctly identified, and they are satisfied with each of the other essential elements prior to transition taking place.

Successful Delivery Criteria

- The solution must be a success before it can be considered for adoption, due to the nature of innovation there is a risk at the project initiation that the solution will perform differently to what was initially expected. It is therefore vital that we continually review project performance against Success Criteria, with a thorough final review undertaken prior to proposing its Business as Usual adoption.

Realisation of Benefits

- Prior to adoption it is essential that the initial business case is revisited and as many of the assumed benefits and costs as possible are replaced with actual findings uncovered through the project. This

analysis is undertaken using an industry approved cost benefit analysis tool to assess the transfer to Business as Usual within our existing regulatory framework, as well as the adoption by other Licensed Network Operators.

Financial Approval

- Within a regulated industry a major challenge for all innovation projects is the timely identification of relevant funding for the solution upon Business as Usual adoption. Funding for such adoption will likely require the removal of funding from tried and tested solutions and processes. This decision needs to be made by following stringent financial investment processes, the requirements of which need to be factored into the project deliverables. This process highlights the need for certainty of the solutions performance and the benefits it is expected to delivery compared to the existing and alternative approaches. The financial approval at this stage signifies investment through the Totex allowance to enable roll-out of the innovation project,
- An approval process is initiated through the project the business change steering group (BCSG) and relevant technical and process review groups to assign funds to enable innovation roll-out. Depending on the level of risk involved in the roll-out of the project, external funding may be requested to avoid significant negative impact on the business allowance. However, as the business has also adequate processes and methods in place to mitigate manageable project risks, where possible innovation roll out will be funded through the business as usual Totex allowance.

Policy Standards and Specifications

- The ability to adopt an innovative solution is largely dependent on its ability to be absorbed by the business and this can only happen if the business has mandate and support to do so. It is imperative that the documents created to facilitate Business as Usual adoption are professionally authored and approved by the relevant authority as part of the project as follows:
    - Policy: These set the mandate for change, either through the update of existing policies or through the creation of new policies, be they internal to SP Energy Networks or wider industry.
    - Standards: To provide the business with the ability to understand the technical criteria of the solution, the methods, processes, and practices essential to operating and maintaining the solution.
    - Specifications: To outline the precise requirements of the new solution, essential to its procurement. Their production undertaken by the person(s) with the greatest understanding of the solution, which in most instances is the project delivery team.

Training and Knowledge Dissemination

- The transition of the innovative solution by the business and wider industry is underpinned through the delivery effective training and dissemination. Prior to the closure and adoption, it is essential that all necessary training and dissemination material has been completed and shared accordingly. The dissemination of projects and findings is not exclusive to successful projects that are to be transitioned to Business as Usual, in many ways it is more important to share failures and shortcomings of projects and solutions to ensure others do not invest resources pursuing the same approach.

Project Roll-Out Roadmap

- The innovation roll-out for large scale and transformative projects which have a larger impact on different parts of the business require a well-thought-out roll-out roadmap to be created, including:
    - Suppliers review to enable business procurement process to procure the best fit solution
    - Gap analysis in business processes, infrastructure and services that need an update and identification of resource requirements.
    - Roll-out timeline and strategy identifying key milestones and prioritising work streams within the roll-out plan

Project roll-out roadmap is a useful tool that enables business hand-over of critical applications developed through the innovation process and ensures that the steps for roll-out are clearly defined and documented.

8.2.1 Benefits Tracking and Reporting Process

The final stage of the innovation project delivery process is associated with quantifying and tracking the multiyear benefits realised by the project and particularly applies to those projects and solutions that transitioned into Business as Usual. This stage is not necessarily a component of the project, but it is essential that it is given consideration and a strategy for undertaking it is in place ahead of the projects closure.

Why is Benefit Tracking important?

- First and foremost, it ensures that Business as Usual adoption has taken place and the realisation of benefits from the innovation is enduring
- Internally it helps justify the benefit adopting innovation has to the business and our consumers, and by doing so strengthens our commitment to delivering innovation
- Externally there are formal requirements to report the enduring benefits delivered by innovation. Doing so plays a vital role in justifying the GBs ongoing commitment to supporting innovation within our industry and the economic benefits it creates

How do we do it?

In the ideal world the benefit from innovation should be measurable on an ongoing basis, unfortunately though this is not always possible, so our approach is split in two categories:

- Measurable Benefits - Where the solution delivers a measurable change in the business performance on an enduring basis our approach utilises these measurements alongside the cost of the solutions deployment to quantify the benefits
- Forecasted Benefits - Where the benefits cannot be measured on an enduring basis our existing approach to quantifying the benefits is based on the detailed cost benefit analysis undertaken at the projects transition to Business as Usual. Wherever possible the cost benefit analysis tool is modified to enable the compiler to identify the benefits achieved by inputting the cost and volume of the solutions deployment in any given year. The modified Cost Benefit Analysis (CBA) tool built by the project team uses this information to automatically calculate the benefit delivered over the course of the life of the solution.

The benefits tracking and reporting is done at key stages of the project, namely at the onset of the project, during mid-delivery period and at the end of the project before business as usual implementation. The innovation process has evolved significantly in this aspect over recent years. It is important that we are transparent to our consumers and wider stakeholders regarding the benefits generated though innovation, the significance of each innovation project in tackling energy system transition challenges and creating value for our consumers.

In RIIO-ED2 we will also publicly report our qualitative and quantitative benefits using the sector-wide generic method for benefits tracking and reporting which we developed with the ENA.

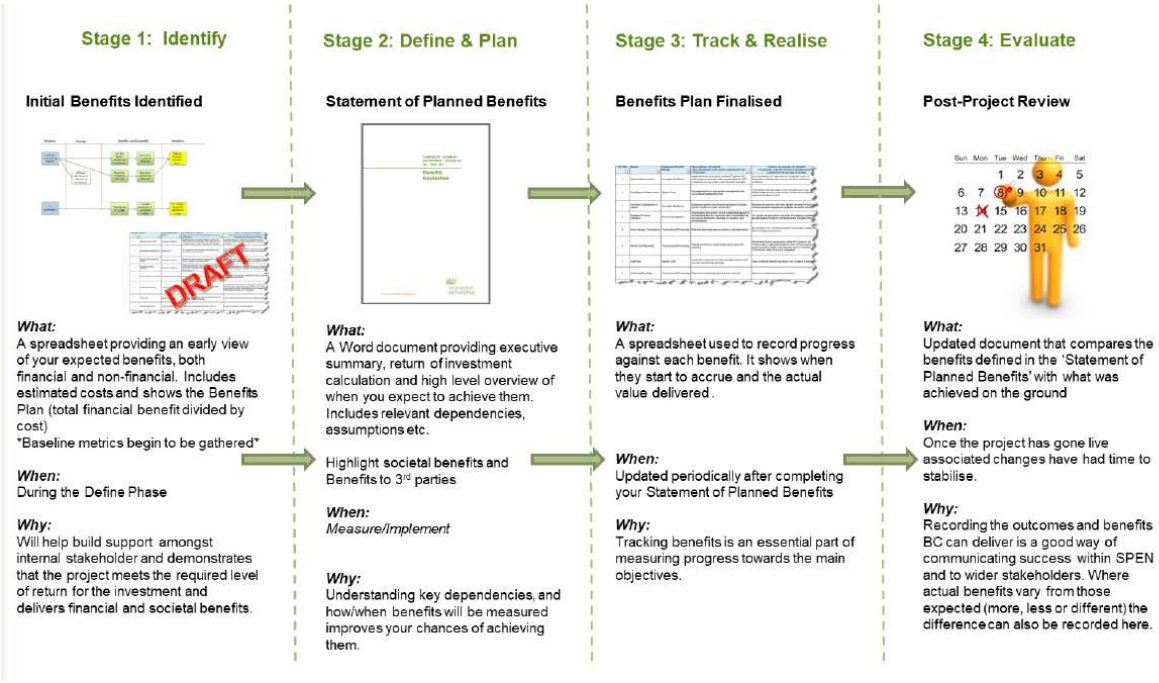


Figure 12 Benefits Tracking and Reporting Methodology

8.2.2 Benefits Tracking and Reporting Methodology

The benefits tracking and reporting methodology followed at different phases of the innovation project delivery is shown above and described below.

Identify

The initial benefits projected for the business and wider stakeholders is assessed in this stage. A CBA process is implemented to calculate the financial and societal benefits to be generated through execution of the innovation project.

Define and Plan

The benefits identified are summarised in a statement of planned benefits and published for review by the innovation board and wider stakeholders. The statement of planned benefits can also be a summary of benefits according the innovation theme.

The statement of planned benefits also provides a timeline and progress forecast for realisation of benefits. As the initial benefits estimation has certain assumptions associated with it, the statement of benefits also provides a timeline if and when these assumptions can be tested during the project delivery phase.

The document also includes a risk assessment that highlights the risks to overall delivery, success of the project and ultimate realisation of benefits. The risk matrix and scores are maintained and updated throughout the project through regular project meetings.

Track and Realise

The project delivery team tracks the benefits and the risk scores throughout the delivery, bridging and transition phase and reports it to the project steering board. The estimation of benefits at this stage is also provided in the annual summary reports and will be provided in the industry wide benefits report in RIIO-ED2.

Evaluate

At the end of the project before integration into business as usual the CBA process is repeated based on the learning throughout the project. If the outcome of this process highlights the perceived benefits do not provide a business case or any societal benefit and/or the risk score remains high the project may be referred for further work or stopped all together. This is one of the expected outcomes from innovation projects.

In the cases where the innovation projects do deliver benefits, the risk score for implementation is substantially reduced throughout the lifecycle of the project. In this case a further year on year benefits tracking projection is created and included in the project roll-out roadmap for future tracking and reporting of benefits.

8.2.3 Managing Innovation Benefits throughout the innovation process

In RIIO-ED2 there is even a greater need to publish benefits through a unified benefit tracking and reporting mechanism. This will exist in addition to our internal benefits tracking process to provide GB stakeholders and consumers a better picture and more transparency regarding use of innovation funding in our industry to create benefits. Over the last 6 months in 2019 following Ofgem's sector specific consultation decision in May 2019 the GB network owners both gas and electricity have worked together with the ENA to develop the ENA benefits tracking framework, as part of the Energy Networks Innovation Process (ENIP)[57]. The purpose of creating an ENA Benefits Reporting Framework is to:

- Enable consistent and transparent measurement of innovation costs and benefits delivered across GB
- Demonstrate progress against innovation strategies, both individual network and sector wide
- Report on innovation that has been transferred to Business as Usual (BAU), both within the network working on a project and how it has been adopted across other networks where relevant
- Ensure mechanisms are clear so that Ofgem can incorporate these into the relevant RIIO-2 innovation governance documents

In order to develop this Framework, the ENA and its Members have committed to continue engaging with wider stakeholders, to ensure that the way benefits are reported are transparent, and relevant. As well as the participating Members, the existing EIC Framework underwent significant stakeholder engagement with a range of key industry parties including Ofgem, BEIS, Ofwat, Sustainability First, Energy UK and Citizens Advice. The feedback from these sessions was very useful and significantly shaped the format of the Framework.

8.3 Fast Follower Process

An important concept of the NIA funding is that all learning from each project is disseminated and shared by every DNO, this is to prevent duplication of projects and ensure customer money is invested to gain best value. For this reason, we have a robust process in place to evaluate every innovation project undertaken by the electricity and gas sectors under network innovation funding streams within the business.

To meet this objective, we developed the "Fast Follower" tool, which is a database management system that is linked up the ENA Smarter Networks Portal. The tool allows for each project undertaken by the electricity and gas network owners, operators, and systems operators to be reviewed centrally, and has the following features:

- Capability to review projects using a pre-defined approach
- Download reference documents
- Request information from across the business
- Score the individual projects on roll-out feasibility.

This database is designed to be applied for innovation projects for which we have not had direct involvement with delivery.

The Fast Follower is a powerful tool that helps the reviewers and innovation board gain a quick overview of the industry activities. The tool can be further developed to create dashboards and be better linked to the industry wide strategy. It can be developed to keep track of innovation projects actual roll out statistics and net benefits generated. The tool can also be extended to include projects from other sectors (where a public database is available) in the reviewing process, thus providing better opportunity to collaborate with other sectors' meeting, conference, and knowledge dissemination activities.

Fast Follower provides a quick and easy to access snapshot view of all the projects that are Completed and Live (ongoing) projects that are linked to the industry wide and business innovation strategy. Periodic reviews of the innovation projects on the database allows the business to:

- Identify potential projects for collaboration with other network owners

[57] https://www.energynetworks.org/creating-tomorrows-networks/network-innovation

- Rate projects and create a priority list
- Identify projects for potential roll out
- Raise queries regarding projects
- Understand the learning from projects and how they could be adjusted to suit our business
- Create a list of top 20 projects to review/follow on a regular basis so that as they become more successful the learning and ideas can be “fast followed”

Form | Search Results

Name	Review Cou	Status	Lead Sector	Funding Me	Technologies	Short Name	Project Id	Reference
Carbon Tracing	1	Complete	ElectricityDistr	NIA	Carbon Emission Reduction Technologies	Carbon Tracing	0058055c-d4cd	NIA_WPD_022
FREEDOM - Flexible Residential Energy Efficiency Demand Optimisation	1	Complete	ElectricityDistr	NIA	Heat Pumps, Gas Distribution Networks,	FREEDOM	0158055c-d4cd	NIA_WPD_023
Multi Asset Demand Execution (MADE)	0	Live	ElectricityDistr	NIA	Demand Response, Electric Vehicles, Hea	MADE	024953d1-db6a	NIA_WPD_040
Time Series Data Tool Feasibility Study	1	Complete	ElectricityDistr	NIA		Time Series Da	0258055c-d4cd	NIA_WPD_024
SF6 Alternatives	2	Complete	ElectricityDistr	NIA	Environmental	SF6 Alternative	0358055c-d4cd	NIA_WPD_025
Zero-2050: South Wales (Whole system analysis)	0	Live	ElectricityTran	NIA	Carbon Emission Reduction Technologies	Zero-2050	037daea2-13fe	NIA_NGTO040
DEDUCE (Determining Electricity Distribution Usage with Consumer Elec	1	Complete	ElectricityDistr	NIA	Network Monitoring, Comms & IT, Measu	DEDUCE	0458055c-d4cd	NIA_WPD_026
Substation Time Synchronisation to Safeguard the Network	0	Live	ElectricityTran	NIA	Resilience	Version 1	04cea5d3-5c31	NIA_NGTO025
Carbon Portal	1	Complete	ElectricityDistr	NIA			04fde54f-1848	NIA_WPD_031
Optimisation of Energy Forecasting - analysis of datasets of metered en	1	Complete	ElectricityDistr	NIA	Asset Management	Optimisation c	0557055c-d4cd	NIA_NGSO000
GB Non-renewable Embedded Generation Forecasting Study	1	Complete	ElectricityDistr	NIA	Asset Management	GB Non-renew	0657055c-d4cd	NIA_NGSO000
OHL (Overhead Line) Power Pointer	0	Live	ElectricityDistr	NIA	Active Network Management, Distribute	OHL Power Po	071b7350-4e56	NIA_WPD_038
Assessing the stability of small-scale inverter connected PV generation	1	Complete	ElectricityDistr	NIA	Asset Management	Assessing the	0757055c-d4cd	NIA_NGSO000
Solar PV Monitoring Phase 3	0	Live	ElectricityTran	NIA			0877de7c-fede	NIA_NGSO000
Integrated substation Condition Monitoring (ISCM)	0	Live	ElectricityDistr	NIA	Asset Management	Integrated sub	0957055c-d4cd	NIA_NPG_002
Intelligent Network meshing switch	0	Live	ElectricityDistr	NIA	LV & 11kV Networks	Mesh Switch	09638829-3705	ENWL 023
PCB Sniffer	0	Live	ElectricityDistr	NIA	Asset Management, Environmental and H	PCB Sniffer	098b1734-5294	NIA_WPD_042
Smart Data	1	Complete	ElectricityDistr	NIA	LV & 11kV Networks and Modelling	Smart Data	0a57055c-d4cd	NIA_NPG_003
Development of An Improved Distribution Load Estimates Methodology	1	Complete	ElectricityDistr	NIA	Modelling and Distributed Generation	Development	0b57055c-d4cd	NIA_NPG_004
Optimisation of weather data to improve energy forecasting	0	Live	ElectricityTran	NIA			0b7d142f-7dc5	NIA_NGSO001
Activating Community Engagement (ACE)	1	Complete	ElectricityDistr	NIA		Activating Con	0c57055c-d4cd	NIA_NPG_005
Resilient Homes	0	Live	ElectricityDistr	NIA	Community Schemes, Energy Storage and	Resilient Hom	0c5d98f5-38b2	NIA_NPG_026
Switchgear Enhanced Rating	0	Live	ElectricityDistr	NIA	Asset Management and Condition Monit	SER	0cbf4289-8ffb-	NIA_NPG_030
EPRI Research Collaboration on Electric Transportation (P18)	0	Complete	ElectricityTran	NIA	Electricity Transmission Networks	EPRI Research	0d015db9-4d0	NIA_NGTO007

Figure 13 The Fast Follower tool

Inside the database, the search tab shows a snapshot view of all the projects on the ENA portal, it also counts how many reviews each project has had. The review form gives you the option to decide on the action from the project:

- Adopt
- Abandon
- Review Later

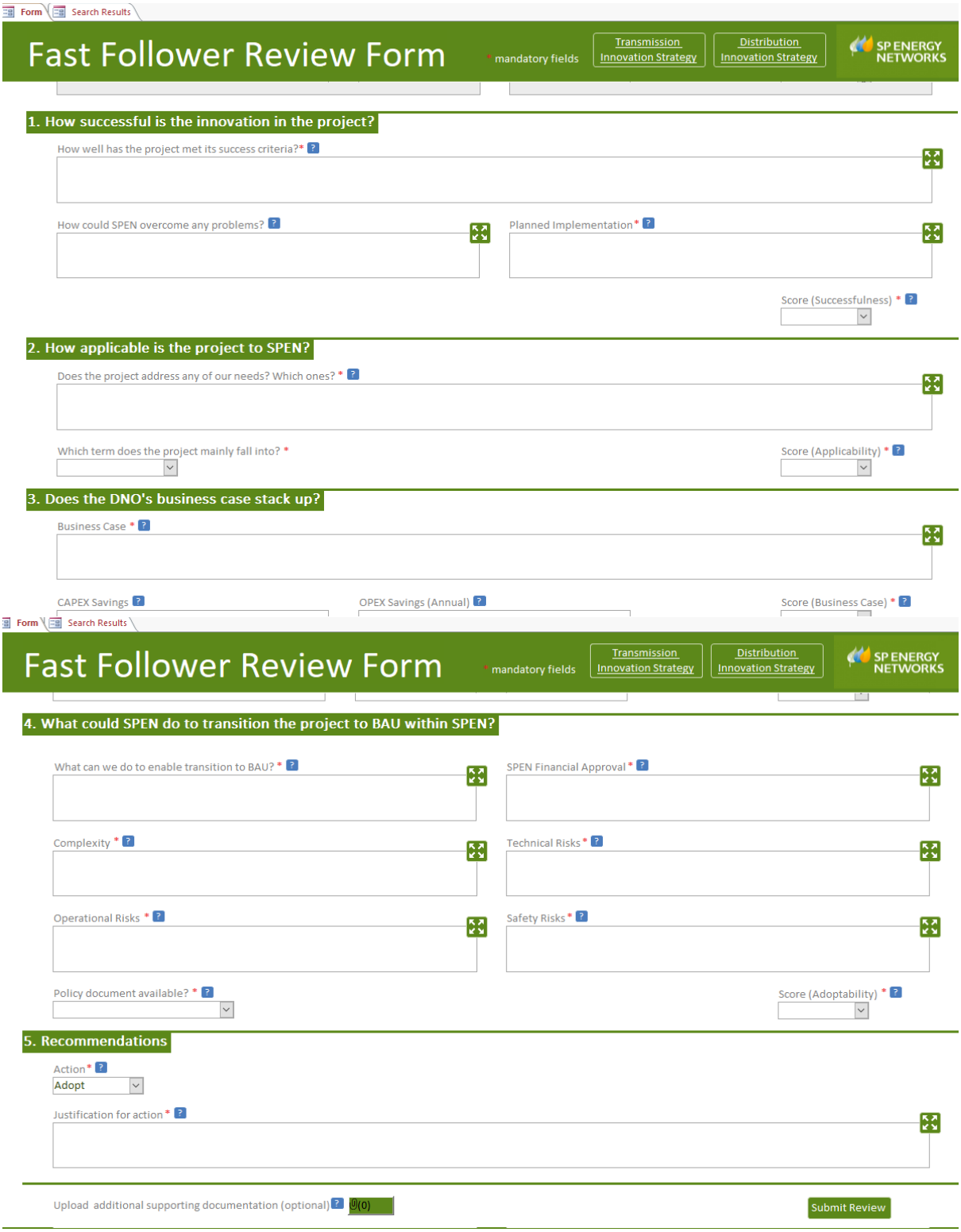


Figure 14 The fast follower review form has various questions related to the project to allow the user to thoroughly evaluate the project.

The projects that are identified as ‘adopt’, proceed to the next stage in our business’ innovation process; they are passed on to the relevant department or contact in the business (such as an Innovation Champion based in the relevant business area) to be assessed to determine if it can provide sufficient benefits to the business as part of BAU. After this stage, if the project has been further identified for adoption, it returns to the Future Networks team who will coordinate to ensure that it is developed as a BAU solution within the business.

The projects that have been identified as ‘abandon’ are often projects that have had little success within the parent DNOs business or have been abandoned early. These projects may not have been implemented in the parent DNO’s business or may not be applicable to our network.

The review later option is convenient to have as it can be used when a project is not yet complete, although the benefits to our business can already be seen. It can also be used to highlight a requirement for a second review by a technical specialist. The project will then move to either an adopt or an abandon decision, if it is reviewed as an adopt position it will then go through the relevant channels to become BAU. This tool is used regularly and was used extensively during our industry wide review of innovation projects as part of RIIO-ED2 planning.

A summary of the project portfolio review that we undertook as part of our strategic planning for RIIO-ED2, including Fast Followers, is presented in Appendix V.

Appendix I: Innovation references within Engineering Justification Papers

			Solution cost with/without innovation		Total RIIO-ED2 Totex Savings £m		
EJP Reference	**EJP Description**	**What is the innovation?**	**Without £m**	**With £m**	**SPEN Total**	**SPM only**	**SPD Only**
ED2-LRE-SPD-024-CV1-EJP - Stranraer Primary Reinforcement	Stranraer Primary Reinforcement	Installation of ±7.5MVAr STATCOM	4.541	2.467	**2.074**		2.074
ED2-LRE-SPM-003-CV1-EJP - Lister Drive 132kV Reinforcement	Lister Drive 132kV GSP Reinforcement	Combination of RTT monitoring, Flexibility, and automation	9.067	0.778	**8.289**	8.289	
ED2-LRE-SPM-004-CV1-EJP – Aberdyfi-Harlech 33kV Reinforcement	33kV Aberdyfi – Harlech Reactive Power Compensation	Installation of ±10MVAr STATCOM with MSC	9.083	4.75	**4.333**	4.333	
ED2-LRE-SPM-010-CV1-EJP - Newtown Morda 33kV Reinforcement	33kV Newtown - Morda Reactive Power Compensation	Installation of ±10MVAr STATCOM at Newtown and 5MVAr MSC at Morda.	15.004	3.994	**11.010**	11.010	
ED2-LRE-SPEN-002-CV2-EJP - HV and LV Network Reinforcement	LV and HV Network Reinforcements	LV Monitoring, RTTR, LV Engine, OLTC	134.309	119.126	**15.183**	8.956	6.227
ED2-LRE-SPEN-001-CV3-EJP - Fault Level Monitoring and Management	Fault Level Monitoring and Management	RTFLM for 16 SPM and 22 SPD sites, plus 2 SPM and 1 SPD AFLM sites	45.18	2.400	**42.780**	12.365	30.415
ED2-NLR(A)-SPEN-002-ENV-EJP - CV22 Environmental - Oil Pollution	Environmental - Oil Pollution	Novel Transformer Bunding	16.957	13.457	**3.500**	1.372	2.128
		TOTALS	234.141	146.972	**87.169**	**46.325**	**40.844**

Notes: In the table above, to determine the savings resulting from the deployment of innovation in each case, where the innovative solution has been selected within the EJP via the optioneering process, the cost of that solution has been compared with the lowest cost, technically feasible non-innovative approach from the same paper.

Appendix II: Extended spotlight: Power Electronics

Growing control

Power electronics have the advantage of being highly controllable, and each power electronic device must come with its own controller. This generates significant issues of interoperability, network coordination and cyber security. In addition, the control methods currently used in power converters for HVDC transmission and renewable energy connection were designed for strong grids, dominated by synchronous generation. This conventional grid-following approach is reliant on a stiff-voltage at the point of connection and so is vulnerable to voltage stability problems if it is employed in weaker, converter-dominated networks with a lower short circuit level [7].

New grid-forming control methods have been proposed to provide improved voltage support and grid strengthening, but so far these methods have not been tested in real electricity networks and so require significant extra validation before they can be implemented at network level.

As well as uncertainty surrounding the control of individual distributed energy resources (DERs), there is an ongoing question of how best to coordinate the different levels of the distribution network. A hierarchical control structure limits the distance and number of communication paths that must be implemented, but the vertical

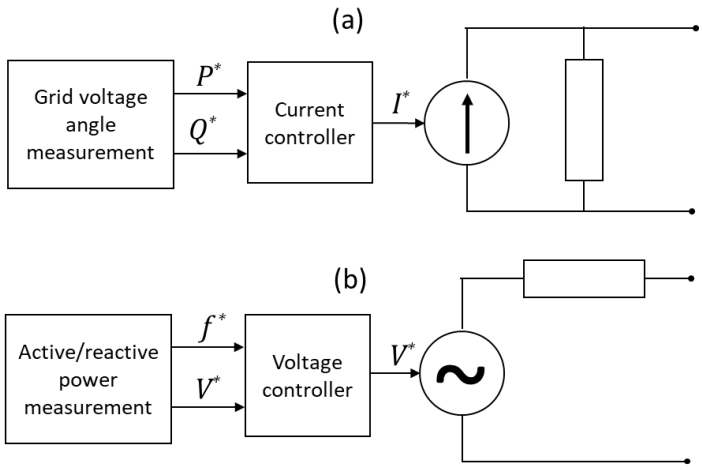


Figure 15: Inverter control strategies: (a) grid-following control and (b) grid-forming control.

command structure is less flexible for coordinating actions of multiple agents on the system.

A master-slave approach can have more horizontal communication paths, but very robust design is needed to avoid conflicts in the actions demanded of individual agents. In either of these approaches, communication may operate over a combination of wired (e.g. DSL, fibre optic) and wireless (e.g. high-frequency radio waves, Wi-Fi, 5G) channels. Significant research will be required to determine the optimum arrangement of these options to balance performance and cost, whilst also maintaining network security.

A recent study by the Infrastructure Transitions Research Consortium (ITRC) at the University of Oxford and the Centre for Risk Studies at the Cambridge Judge Business School reported that a cyber-physical attack on the London electricity network could **cost up to £111 million per day and affect 1.5 million people** [8]**.** Attacks at a national scale would be even more catastrophic. Cyber-security investment will therefore be vital to safeguard our customers as the scale of interoperability and control communications on the network increases.

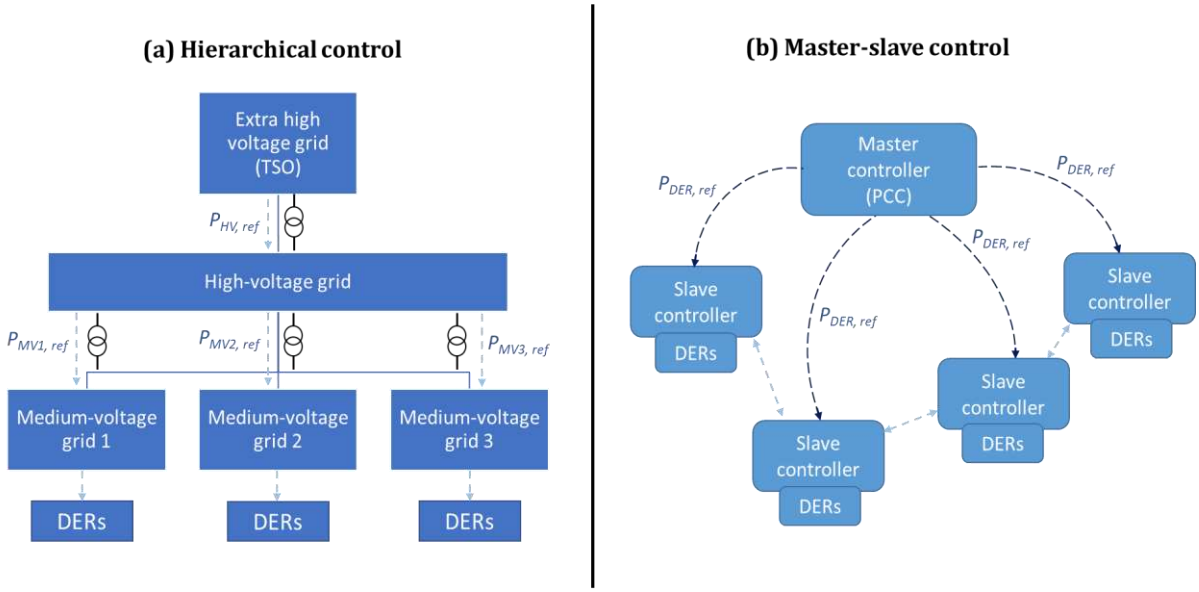


Figure 16: Different options for the structure of network coordination and control.

Evidently, the development and verification of a consistent control algorithm must also consider existing telecommunication infrastructure and the input/output protocols. Extra research into the integration of network-level control algorithms will therefore be critical as more power electronic devices are connected to the distribution network.

Overall, our investment in converter control research must cover all aspects of novel control design, testing (including simulation, hardware-in-the-loop, and full-scale network implementation) and integration within the existing infrastructure.
Key collaborations for this work will be with National Centres such as the Alan Turing Institute and the National Physics Laboratory who have particular expertise in monitoring devices (such as micro PMU), data collection and secure integration with existing infrastructure.

The Alan Turing Institute

NPL National Physical Laboratory

Estimated Funding required	
Feasibility Study: £600k	Initial Design, Specifications, Testing and Trial £6m

Growing innovation
As highlighted by the UK government, although we are an innovative nation, we need to do more to ensure the benefits of technological invention can be commercialised for our society. Fundamentally, a great *idea* does not guarantee great *innovation*, and many promising ideas fail to make it to the commercial market due to the so-called 'valley of death' between R&D and industrial applications. Forming a robust safety net to protect research from being wasted in this way requires dedicated resources and strong partnerships between academia and industry.

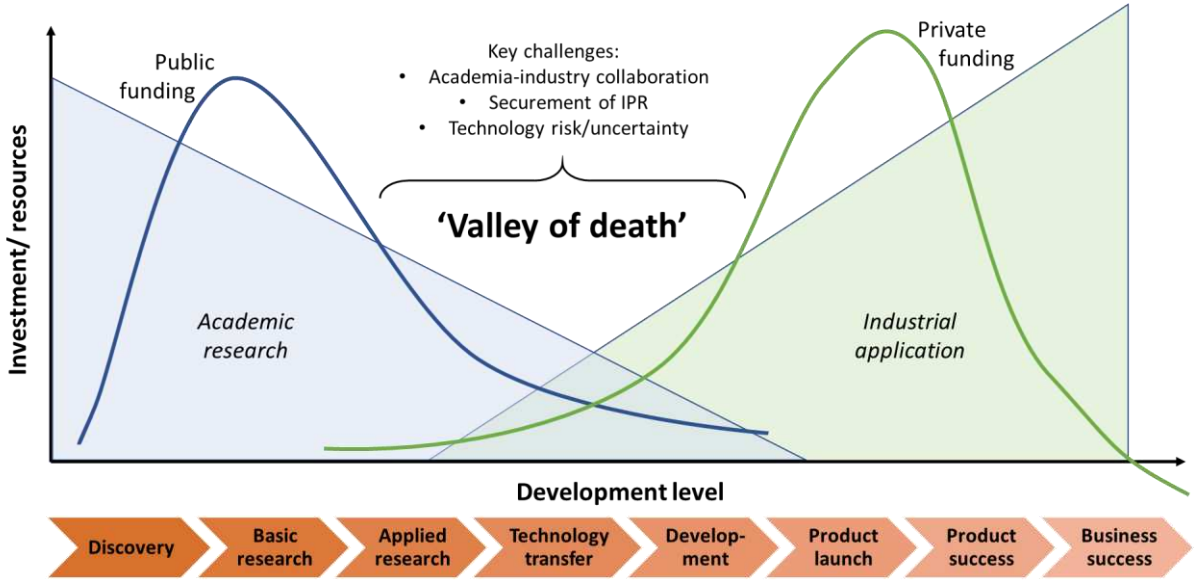


Figure 17: The 'valley of death' and the technology innovation process.

By definition, the process of innovation (which is nonroutine and uncertain) is fundamentally different to everyday business practices (which value repeatability and predictability).

Successful innovation within an established business such as SP Energy Networks therefore requires an intentional, top-down commitment of time, resources, and trust. To this end, we propose the development of specialised innovation projects to ensure we have sufficient resources and technology to sustain valuable innovations through the difficult mid-life period of technology readiness.

This will include processes to further protect and commercialise the IPR generated though our research collaborations, building on the framework of and teams to record and disseminate innovations to our customers and the wider public. Where appropriate, this will build on the NIA Governance and Energy Networks Innovation Process (ENIP) document to support a clear and transparent manner for working with collaborators on IPR.

We will also utilise industrial forums such as the Energy Networks Association, the Energy Innovation Centre and the Supergen hub to upskill and improve the public acceptance along the innovation project delivery. We are currently working with UKRI (via InnovateUK) on the Power Electronic Skills for Future Workforce which will further boost innovation development skills within the business. Strong support to academic partners will continue to integrate the latest industrial experience into higher education and apprenticeship courses. The innovation of power electronics will be **an integrated part of the planning and operation of a modern distribution network**.

EIC Together we innovate

ena energynetworks association

Supergen Energy Networks

UKRI Innovate UK

Estimated Funding required	
Feasibility Study: £300k	Project Delivery £3m

References relating to this spotlighted area:

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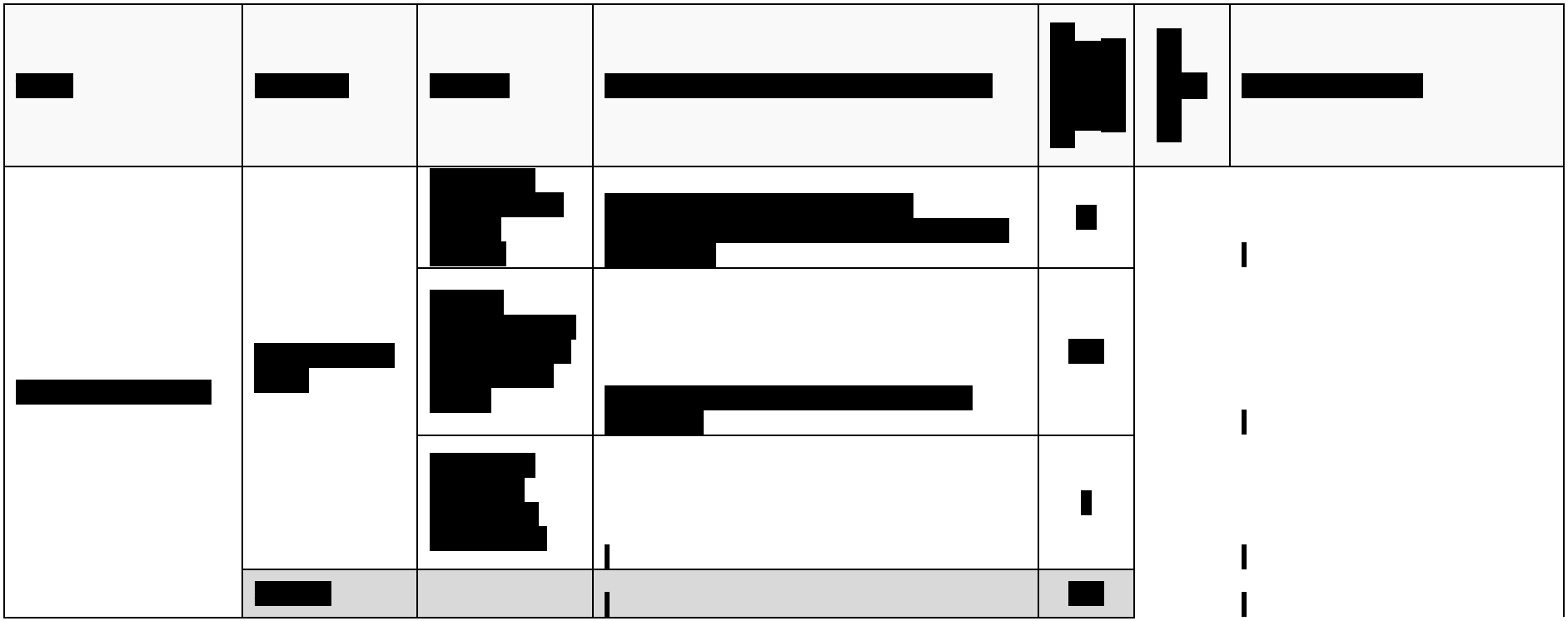
[7] T. Ackermann, T. Prevost, V. Vittal, A. J. Roscoe, J. Matevosyan and N. Miller, "Paving the Way: A Future Without Inertia Is Closer Than You Think," in IEEE Power and Energy Magazine, vol. 15, no. 6, pp. 61-69, November 2017, doi: 10.1109/MPE.2017.2729138.
[8] E. J. Oughton, D. Ralph, R. Pant, E. Leverett, J. Copic, S. Thacker, et al., "Stochastic counterfactual risk analysis for the vulnerability assessment of cyber-physical attacks on electricity distribution infrastructure networks", Risk Anal., vol. 39, no. 9, pp. 2012-2031, September 2019.

Appendix III: Detailed breakdown of proposed NIA innovation spend

This Appendix presents a detailed breakdown of proposed spend on our priority innovation areas in RIIO-ED2. The proposed spend has been built up from our analysis of each innovation theme that considered the type of projects we expect to develop and benchmarked them against similar existing projects to estimate overall spend. Examples of specific projects are listed where known; however, this cannot be an exhaustive list at this stage. Proposed NIA funding has only been allocated where it is required to support areas that are fundamental to the Energy System Transition and supporting Consumer Vulnerability. Themes, sub-themes, objectives, and further information on proposed project areas should all be referenced to the information presented in Section 7.

While this table/summary represents a thorough and reasonable bottom-up approach; we are expecting the NIA investment to be an evolving process, representing the advancement of technology, and changing customers' expectations.



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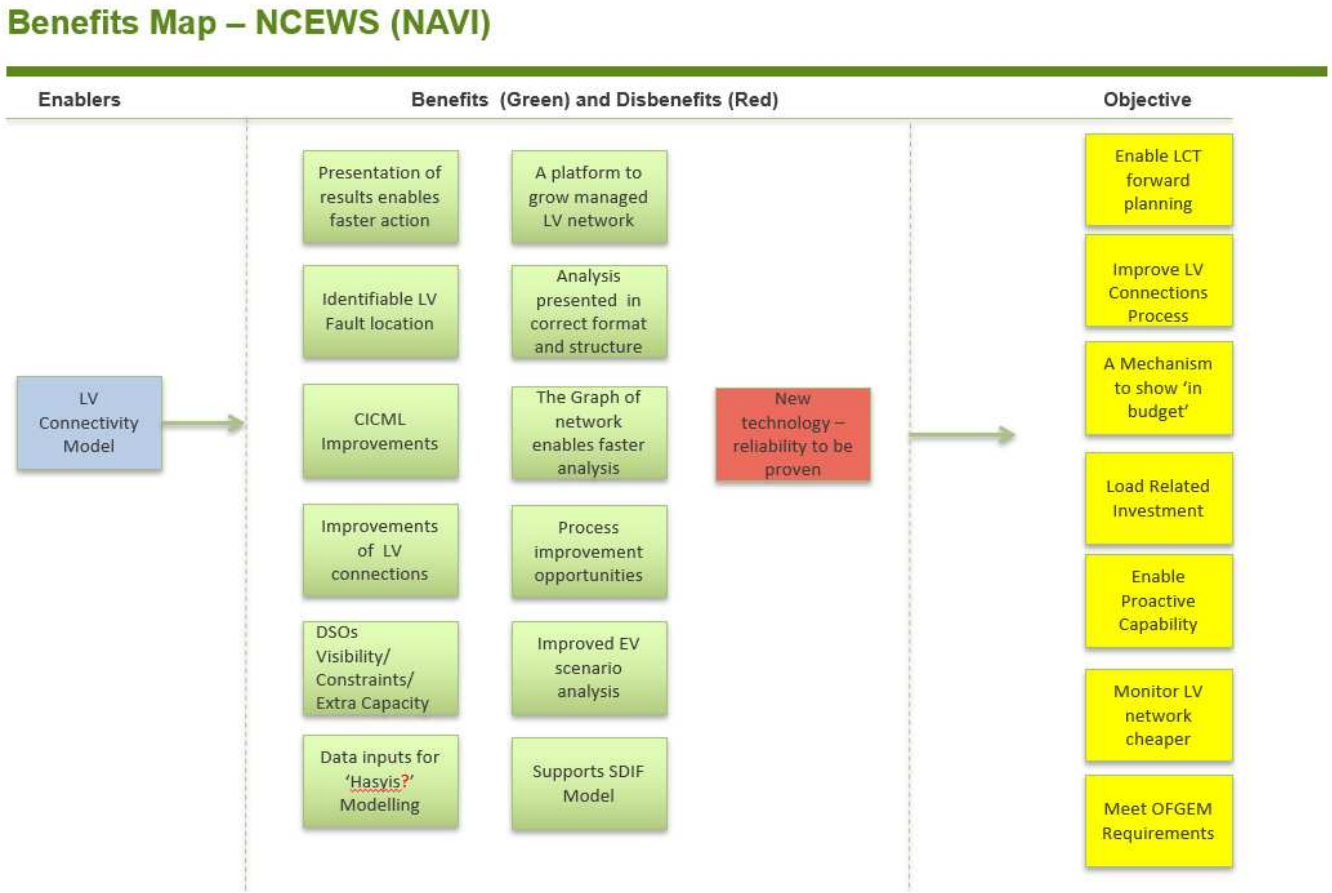
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]		

Appendix IV: Benefits tracking case studies

This appendix provides some examples showing how our benefits tracking process has been applied.

Example 1: Benefits Map for a live project "Network Constraint Early Warning Systems Phase 2 (NCEWS2)" (https://www.smarternetworks.org/project/nia_spen_034)



Approval Date: 13/06/2019

Description of benefit *Short description of the benefit achieved from the Initiative or project*	Source or reason for benefit *For example, a new IT function or business process compared to the old ways of working*	Detail of saving *Explain the saving*	Measure Post Go-Live	Incentive, Efficiency, Environme	Financial Impact *per annum (K)*	Owner	Facilitator
Presentation of LV data enables faster action	More efficient and effective way to identify faults on LV network will reduce investigative time.	Saving in resource time, potential saving in costs of third party service for fault location	Improved response times for fault management against previously measured baseline		TBC - will be tracked over course of the trial	Dylan Oliver	Caroline Loughran
Smart Meter data points to different location from connectivity model (North)	More efficient and effective way to identify faults on LV network will reduce restoration and repair times.	Reduced CML penalty due to quicker resolution of faults	CML benefit will be estimated as 30 minutes per customer (£6.08)		TBC - will be tracked over course of the trial	Dylan Oliver	Caroline Loughran
NAVI data contributes to narrowing down of fault location	More targetted excavation than would have been the case without NAVI information	Saving in resource time, potential saving in costs of third party service for fault location	Reduced excavation costs		TBC - will be tracked over course of the trial	Dylan Oliver	Caroline Loughran
Smarter fault identification leads to reductions in manpower commitments	More efficient and effective way to identify faults on LV network will reduce investigative time.	Saving in resource time, potential saving in costs of third party service for fault location	Improved response times for fault management against previously measured baseline		TBC - will be tracked over course of the trial	Dylan Oliver	Caroline Loughran
Smarter response to fault will generate improved scores	Faults identified more efficiently and demonstrating to customers our intelligent use of available intelligence from Smart Meters	Improved scores result in greater Customer Service reward	Improvement in BMCS scores for faults involving Smart Meters		TBC - will be tracked over course of the trial	Dylan Oliver	Caroline Loughran
Improved EV scenario analysis	More efficient and effective way to obtain complete data set in required format will reduce scenario setup time and allow analysis phase to begin much quicker.	Saving in resource time (average of 2-3 days per sub station extract) Accuracy - better geographical representation - compared to excel tool	Estimate time saving with before benchmark, measure after in trial period Estimated time saving x number of uses of data extract to models/tools		Used on adhoc basis so unable to confirm until reviewed during trial period	Milana Plecas	Caroline Loughran
Improved analysis for EV Re-opener	More efficient and effective way to obtain complete data set in required format will reduce scenario setup time and allow analysis phase to begin much quicker.	Saving in resource time (average manual effort of 2-3 days per sub station extract - 161 were in the project)	Estimate time saving with before benchmark, measure after in trial period Estimated time saving x number of uses of data extract to models/tools		£108,138.72	Milana Plecas	Caroline Loughran
Improved analysis for Charge Project	More efficient and effective way to obtain complete data set in required format will reduce scenario setup time and allow analysis phase to begin much quicker.	Saving in resource time (average manual effort of 1 day per circuit - 100 will be in the project)	Estimate time saving with before benchmark, measure after in trial period Estimated time saving x number of uses of data extract to models/tools		£21,338.15	Geoff Murphy	Caroline Loughran
Improved analysis for Charge Project continued	More efficient and effective way to obtain complete data set in required format will reduce scenario setup time and allow analysis phase to begin much quicker.	Saving in resource time should additional circuits be identified to be analysed, above the initial 100 mentioned above (average manual effort of 1 day per circuit)	Estimate time saving with before benchmark, measure after in trial period Estimated time saving x number of uses of data extract to models/tools		TBC - will demend on the projects need for additional s/stn data. Will be tracked if/when the additional data is required.	Geoff Murphy	Caroline Loughran
Improvements of LV connections application process	More accurate and effective way to visually assess circuits and ADMD breakdown which will assist with connections applications.	Improvements to accuracy of application as have improved data sets to be fed into existing tools. Time saving as all data available in one place.	Estimate time saving with before benchmark, measure after in trial period Measure number of LV connections/month & % those using new tool Estimated time saving x number of uses of data extract to models/tools Application response time quicker. Increased number of applications processed. Accuracy improvements		£4,493.10 (N) £5,252.44 (S)	?? (N) Neil Woodcock (S)	Caroline Loughran
Improvements of LV connections application process	A more efficient and effective way to process new connection applications on the LV network using export to WinDebut/Excel Modelling Tool will reduce investigative time.	Current processing time of 15 minutes to 4 hours per application (depending on complexity) will be reduced using WinDebut/Excel Modelling tool export from platform.	Estimate time saving with before benchmark, measure after in trial period Measure number of LV connections/month & % those using new tool Estimated time saving x number of uses of data extract to models/tools Application response time quicker. Increased number of applications processed. Accuracy improvements			?? (N) Neil Woodcock (S)	Caroline Loughran
		Current processing time of 15 minutes to 4 hours per	Estimate time saving with before benchmark, measure after in trial period Measure number of LV connections/month & % those using new tool			?? (N)	

Example 2: Benefits Map for a live project "Real Time Fault Level Monitoring Stage 2"
(https://www.smarternetworks.org/project/nia_spen_0050rtflmstage2)

Benefits Realisation Schedule

Project: Real Time Fault Level Monitoring and Active Fault Level Management Projects
Date: November 2019
Version 1.0 DRAFT

Benefits Manager:
Blackbelt :
Approval Date:

Fault Level is one of the greatest network challenges for both SPM and SPD. Distribution Fault Level is increasing with the uptake of LCTs.
These two innovation projects are being run concurrently and while each is individually beneficial, maximum benefit to the network will be realised through implementation of both.
The two solutions are complementary. RTFLM provides the monitoring, based on which the AFLM can take real-time control actions. RTFLM is particularly an enabler for AFLM in SPD.
The ambition is to defer between a third and a half of the investment requirements that will be required in ED2 using traditional approaches by implementing these solutions.

Financial savings calculated for ED2. Total avoided reinforcement costs split equally across the five years of ED2 to show annual benefit. **Note that increasing network capacity increases use of the network and therefore increases income, these figures are not shown here.**

Ref No	Name	Summary Benefit Group	Description of benefit *Short description of the benefit achieved from the Initiative or project*	Source or reason for benefit *For example, a new IT*	Detail of saving *Explain the saving*	Measure Post Go-Live	Incentive, Efficiency, Environme	Financial Impact *per annum (K)*	Owner	Facilitator	Planned I Date
FL001	**10% SPD**	Network Capacity	Release of 10% FL headroom in restricted areas of SPD network	Deferred network reinforcement costs	Traditional approach would require: 4 new GSP's	FL headroom released in each area fully implemented without major network reinforcement	Efficiency	£1,600	NP&R	NP&R	E
FL002	**15% SPD**	Network Capacity	Release of 15% FL headroom in restricted areas of SPD network	Deferred network reinforcement costs	Traditional approach would require: 6 new GSP's	FL headroom released in each area fully implemented without major network reinforcement	Efficiency	£2,400	NP&R	NP&R	
FL003	**10% SPM**	Network Capacity	Release of 10% FL headroom in restricted areas of SPM network	Deferred network reinforcement costs	Traditional approach would require: 1 new GSP + 10 RMUs	FL headroom released in each area fully implemented without major network reinforcement	Efficiency	£2,000	NP&R	NP&R	E
FL004	**15% SPM**	Network Capacity	Release of 15% FL headroom in restricted areas of SPM network	Deferred network reinforcement costs	Traditional approach would require: 2 new GSP + 25 RMUs	FL headroom released in each area fully implemented without major network reinforcement	Efficiency	£3,400	NP&R	NP&R	
	ADDITIONAL POTENTIAL										
FL005	**10% SPD + Flexibility**	Network Capacity	Release of 10% FL headroom in restricted areas of SPD network	Deferred network reinforcement costs	AFLM is a key enabler for potential flexibility contracts with generation customers. If successful, this will release additional CAPEX savings	FL headroom released in each area fully implemented without major network reinforcement	Efficiency	£800	NP&R	NP&R	
FL006	**15% SPD + Flexibility**	Network Capacity	Release of 15% FL headroom in restricted areas of SPD network	Deferred network reinforcement costs		FL headroom released in each area fully implemented without major network reinforcement	Efficiency	£2,600	NP&R	NP&R	
FL007	**10% SPM + Flexibility**	Network Capacity	Release of 10% FL headroom in restricted areas of SPM network	Deferred network reinforcement costs		FL headroom released in each area fully implemented without major network reinforcement	Efficiency	£1,000	NP&R	NP&R	
FL008	**15% SPM + Flexibility**	Network Capacity	Release of 15% FL headroom in restricted areas of SPM network	Deferred network reinforcement costs		FL headroom released in each area fully implemented without major network reinforcement	Efficiency	£2,600	NP&R	NP&R	

Example 3: Benefit tracking for a project in transition "Weather Normalised Demand Analytics (WANDA)"
(https://www.smarternetworks.org/project/nia_spen0022)

Assumptions														
Cancel / Defer Split														
Avg Deferal Time														
CoC														
WaNDA Uncertainty														
SIA Uncertainty														
	ED1			ED2					ED3					Total
	Y6	Y7	Y8	Y1	Y2	Y3	Y4	Y5	Y1	Y2	Y3	Y4	Y5	Total
Overall														
Investment	- 607	- 25	- 25	- 25	- 25	- 25	- 25	- 25						- 782
Spend Deferred	-	-	-	615	615	615	615	615						3,075
Spend Reoccurrence	-	-	-	-	-	-	-	-	- 154	- 154	- 154	- 154	- 154	- 769
Total	**- 607**	**- 25**	**- 25**	**590**	**590**	**590**	**590**	**590**	**- 154**	**- 154**	**- 154**	**- 154**	**- 154**	**1,524**
WaNDA														
Investment	- 384	- 25	- 25	- 25	- 25	- 25	- 25	- 25						- 559
Spend Deferred	-	-	-	515	515	515	515	515						2,575
Spend Reoccurrence	-	-	-	-	-	-	-	-	- 129	- 129	- 129	- 129	- 129	- 644
Total	**- 384**	**- 25**	**- 25**	**490**	**490**	**490**	**490**	**490**	**- 129**	**- 129**	**- 129**	**- 129**	**- 129**	**1,372**
SIA														
Investment	- 223	-	-	-	-	-	-	-						- 223
Spend Deferred	-	-	-	100	100	100	100	100						500
Spend Reoccurrence	-	-	-	-	-	-	-	-	- 25	- 25	- 25	- 25	- 25	- 125
Total	**- 223**	**-**	**-**	**100**	**100**	**100**	**100**	**100**	**- 25**	**- 25**	**- 25**	**- 25**	**- 25**	**152**

Example 4: Benefit tracking for a project in transition "SINE Post"
(https://www.smarternetworks.org/project/nia_spen0012)

	Total Savings from PQMs - 2021						
Month	Alarm Received Time	Circuit Description	Section	Fault Restoration Time (mins)	Average Fault Restoration Time (mins)	Customer Numbers	Saving
Jan	30/01/2021 05:26	BIRRELL ST WYND:BRAEHEAD HOUSE	BRAEHEAD HOUSE KIRKCALDY S/S TO	54	63	264	£475.20
Feb	12/02/2021 05:46	ST NINIANS:ST VALERY DRIVE	STIRLING HIGH A - WHITEHILL PLAC	27	63	1227	£8,834.40
	16/02/2021 14:47	COMMON FARM:WRIGHT	COMMON FARM:WRIGHT	46	63	583	£1,982.20
	23/02/2021 02:42	BISHOPBRIGGS:MELVILLE GARDENS	LOMOND DRIVE B/BRIGGS, FINE FARE	59	63	661	£528.80
Mar	07/03/2021 06:02	PINWHERRY:ABSW 586	PINWHERRY PRY TO 686 ABSW	47	82	262	£1,834.00
	15/03/2021 15:03	KILMACOLM IEC:OLDHALL DR	FLORENCE DR - HAZELMERE RD	32	82	558	£5,580.00
	16/03/2021 08:56	JACKTON:OCEIN DRIVE JACKTON	JACKTON NOJA TERMINAL POLE	128	51	276	£0.00
	27/03/2021 20:02	AVENUE END RD:CRAIGENDMUIR	SGD - STATION ROAD ABSW	41	51	952	£1,904.00
Apr	27/04/2021 07:32	RAVENSPARK:BIGGS WATERFALL K/W	WOOD GREEN SPUR	16	51	17	£119.00
May	15/05/2021 13:38	MENSTRIE; KING O MUIR DRIVE	MENSTRIE Primary, KING O MU	13	63	2755	£27,550.00
TOTAL							£48,807.60

Appendix V: Review summary of innovation project portfolio including fast followers

Key: -

BAU/Ready for BAU
Future BaU potential
Informs further innovation
Stakeholder Engagement

Project ID	Project	Overview
LCNF_SPEN_02	Accelerating Renewable Connections (ARC)	Flexible DG Connections
LCNF_SPEN_01	Flexible Networks - Enhanced Primary Transformer Rating	Increase in firm capacity
LCNF_SPEN_01	Flexible Networks - Probabilistic load forecasting	Probabilistic load forecasting
NIC_ENW_02	CELCIUS	Enhanced secondary transformer rating
NIC_ENW_02	CLASS	HV Voltage management to alter demand
BAU	EVOLVE	Secondary substation monitoring
BAU	Flexibility Portal	Flexibility tendering Alternative to reinforcement
NIA_ENWL005	Asset Risk Optimisation	Optimising Asset Risk
NIA_SSEPD_0021	TOUCAN (Thermal imaging Observation techniques for Underground Cable Networks)	Use of Thermal Cameras - rolled out as BAU using innovation champions
NIC	Charge	Low cost EV connections aligned with Transport Network. Smart EV Connections.
NIC	LV Engine	HV/LV Solid State Transformers
NIC	Fusion	DSO Flexibility and Market Platform Development
NIC	Angle DC	HV-DC Link
NIC	Distributed ReStart	Black start restoration using distribution connected generation
NIC_ENW_01	Smart Street	On load tap changer for secondary transformers
NIA_SPEN_0022	Weather Normalised Demand Analytics (WANDA)	The techniques developed will facilitate more accurate estimates of future load, and therefore inform efficient investment plans.
NIA_ENWL_0003	Review of Engineering Recommendation P2/6	industry wide review - ENA working group - Sets the standards for design and operation of distribution networks.
NIA_WPD_0008	Improved Statistical Ratings for OHL	ENA working group - National standards update - finished last year
NIA_SPEN_0003	Enhanced Real-Time Cable Temperature Monitoring	Resulted in increased capacity for 33kV wind farm connection. Follow up project - TORNESS

NIA_SPEN_0044	400kV Dynamic Cable Rating Retrofit Project utilising RPMA Communications Technology	finding a cost effective retrofit DCR solution with supporting communications technology that can be deployed easily.
NIA_SPEN_0032	Transition to Dynamic Cable Rating	Increased capacity facilitating increased renewable generation.
NIA_SPEN_0002	Virtual World Asset Management	Use of LiDAR to improve the management of our overhead line assets, and enhance digitalisation
NIA_SPEN_0016	Network Constraint Early Warning Systems (NCEWS)	Now embedded within our NAVI platform to identify available capacity on our LV network.
NIA_SPEN_0034	NCEWS 2	takes learning from NCEWS - Improved management of the LV network to facilitate EV charging and heat pumps etc. Implemented in the NAVI platform
NIA_SPEN_0012	SINE Post	Real time calculation of distance to fault on 11kV networks resulting in reduced duration of customer interruptions. Implemented in the SDIF
NIA_SPEN_0015 NIA_SPEN_0050 RTFLM Stage 2	Real Time Fault Level Monitoring (RTFLM) - Stages 1 and 2	Reduces/defers the investment in new switchgear required to address increasing network fault levels. Stage 1: Proof of concept stage complete. Stage 2 underway: Extended trials and independent evaluation of the technology. Now on the path for transition to BAU ready for ED2.
NIA_SPEN_0014	Active Fault Level Management (AFLM)	Reduces/defers the investment in new switchgear required to address increasing network fault levels. Phase 3 of 3 underway, on the path for transition to BAU ready for ED2.
NIA_SPEN_0018	Technical Review of Non-conventional StatCom Applications	Study to look at potential for using StatComs instead of reinforcement in Dumfries - Found there are situations where this would be more cost effective. Solution is now to be deployed more widely as BAU.
NIA_SPEN_0026	Link box monitoring	Addresses an important safety/asset health issue. Technology is ready for BAU rollout
NIA_SPEN_0030	Project Zebedee	Device will reduce requirements for customer outages
NIA_SPT_1506	Development of a Standard 33kV Damped Harmonic Filter Design	to standardise harmonic filters being installed at substations to prevent a bespoke design being done each time
NIA_SPT_1610	Innovative Approach for Transmission Harmonic Issues	Harmonic filters at grid level instead of individual wind farms Based on learnings from this project, there is a project going forward for RIIO-2
NIA_SPT_1602	UAV Platform Development for Automated Asset Condition Diagnosis	Paved the way for the use of UAV's which is now BAU.
NIA_UKPN0036	Timed Connection Software Development	Develop and deliver a long-term enduring solution to analysing the network for opportunities for timed connections. The software solution will identify the discrete periods in a 24-hour timescale when the typical peak demand on network is and how much additional load can be accommodated within and outside these periods. We will test and pilot the tools with a small dedicated team.
NIA_SSEN_0036	Social Constrained Managed Zones (CMZs)	Aimed at aiding smaller community organisations to take part in the CMZ process
NIA_SSEN_0047	TraDER	How trades can be implemented on the ANM scheme e.g. changes to Last In First Out (LIFO) connection order,

NIA_UKPN 0052	Energy Exchange	better management of connection queues, allowing generation who have non-firm connections to trade with others to reduce the extent they are curtailed, enabling the exchange of access rights between users
NIA_UKPN 0038	Real Time Thermal Ratings – Cables	One of the solutions under consideration in the ED2 plan
NIA_SPEN _0023	Connected worker phase 1 - Field Data Automated	Improving the accuracy and automating the process for capturing asset data
NIA_SPEN _037	EV Up (and Heat Up)	EV uptake forecasting and ASHP uptake forecasting
NIA_SPEN _0046	Enabling Monitoring and Control of Underground Assets	Communications solutions for monitoring hard to reach assets
NIA_SPEN _0039	THOR Hammer	Improved accuracy for condition assessment of wood poles – also links to digitalisation
NIA_SPEN _0036	A holistic intelligent control system for flexible technologies	A common control system for DC Links, Smart Transformers etc.
NIA_SPEN _038	System Health Map	Collates multiple existing separate data sources from the Transmission Network into one centralised platform. This platform uses trending and analytics to allow early intervention and an overall improvement in asset management
NIA_SPEN _0051	All terrain low ground pressure access vehicle	To enable lower cost, and improved safety of transmission tower works
NIA_SPT_ 1603	Trialling Long-Lasting Tower Paints	Successfully assessed the performance of alternative paints.
NIA_SPEN _0017	Secondary Communications Phase 2 - Consultancy Engagement	Consultancy report - informs plans for ED2 – next stage is trials of different technologies
NIA_SPEN _0029	Secondary Substation Communications - Phase 3	Informs telecommunications strategy to be included in ED2 business plan
NIA_SPEN _0033	CALISTA	Caledonian University PhD study - building models for cable asset lifespan - determine remaining lifespan of cables Informs investment requirements for ED2
NIA_SPEN _0035	TRV	Informs what kind of circuit breakers need to be bought in RIIO-2. Reduces costs by avoiding over-engineering.
NIA_SPT_ 1504	Managing Uncertainty in Future Load Related Investment	informs RIIO-2 business plan
NIA_SPT_ 1604	Introduction of environmentally friendly alternatives to SF6	working with sustainability - informs efficient RIIO-2 business plan
NIA_SPT_ 1606	Reuse of existing concrete assets	working with sustainability - Informs efficient investment plans for RIIO-2
NIA_SPT_ 1608	Reducing Energy Losses from Transmission Substations	working with sustainability - need technology & changes in behaviour - workshop next month
NIA_SPEN _0019	Operational Assessment of Composite Poles	Composite poles are one of the alternatives to creosote and it is essential that the DNOs understand the operational implications of adopting these.
NIA_SPEN _0008	APPEAL	Industry leading project to evaluate more environmentally friendly alternatives to Creosote wood pole preservative. Decaying wood stakes within a fungal cellar (samples in the ground for 1year – approximately equivalent to 10 years)- tells us which preservatives work best - impact on ED2 plans and directly informs future policy

NIA_SPEN_0040	Improving Storm resilience and readiness through data analytics	An analytic model which will allow effective management of resources during storm resources
NIA_SPEN_0042	Novel temporary earthing and bonding solutions	Study and report on best practices for temporary earthing and bonding
NIA_SPEN_0043	Bethesda Home Hub	Exploring a method to look to customers to shift their electricity usage to times of the day or night when demand on the network is traditionally lower
NIA_SPEN_0049	iDentify	Artificial Intelligence and Augmented Reality in conjunction with mobile Apps have the potential to improve asset management and reduce costs within the networks sector.
NIA_SPEN_0047	A Transition to LVDC - Phase 2	Gain an understanding of how SPENs LVAC cables & network apparatus behave and perform when energised with LVDC
NIA_SPEN_0052	A Substation Of the Future	Install non-SF6 Stand Alone Panels, as part of the re-design of a secondary substation to account for the non-SF6 Panel & low carbon TX
NIA_SHET_0032	Project Totem	Build and validate a PSCAD model of the GB transmission network
NIA_SPEN_0013	Interoperable LV Automation	Has the potential to reduce the duration of customer interruptions due to LV faults.
NIA_SPEN_0020	Instrument for the identification of Live and Not Live HV and LV cables	Device to determine if cable is live/ not live and HV / LV without damaging cable - prototype being developed for testing in the district
NIA_SPEN_0024	Endbox G38 stage 2	Monitoring level of G38 in end boxes - addresses a safety/asset health issue
NIA_SPEN_0031	Radiometric Arc Fault Location RAFL 2	Device will reduce the duration of customer outages on the 11kV network by identifying faults quicker
NIA_NGET_0088	Transformer Research Consortium	Consortium - we are members along with UKPN & National Grid. Enhances asset management of transformers potentially extending transformer life and avoiding failures. Evaluation of Transformer Oil Regeneration is an example of one of the outputs and this is being deployed as BAU in ED2.
NIA_NPG_0001	Vonaq Utility Pole Strength Measurement	Superseded by THOR - highlighted what solution needed to be
NIA_SSEPD_0006	Ultrapole	Superseded by THOR - highlighted what solution needed to be
NIA_UKPN0013	Underground HV Cable Research	CALISTA project is building on the learnings from this project
NIA_SPT_1601	Power 2 Tower: Stage 1 Energy Harvesting Feasibility	A low TRL concept which is already showing promising results.
NIA_SPEN_0001	Smart Building Potential Within Heavily Utilised Networks	informed RUGGEDISED which leverages EU Horizon 2020 funding
NIA_SPEN_0005	Portable Radiometric Arc Fault Locator	directly impacts RAFL2
NIA_SPEN_0009	DINO	Informed NCEWS project and NCEWS-2 and SDIF
NIA_SPEN_0021	Endbox G38 Level Detection	informed stage 2

NIA_SPEN_0028	Transition to LVDC	DC has the potential to reduce future requirements for network reinforcement. This project may be the precursor to a NIC bid in 2020.
NIA_SPEN_1801	Blockchain	Landscaping of potential for Blockchain in the industry. Has informed new collaborative project with UKPN and National Grid
NIA_NGET_0154	Work Stream 7	led to open networks
NIA_SPT_1302	Enhanced Weather Modelling for Dynamic Line Ratings	Academic project that has informed further projects in this area
NIA_SPT_1303	IEC 61850 Integration of Substation Protection and Control - Test Facility	informed FITNESS
NIA_SPT_1304	Smart Transmission Zone	informed FITNESS
NIA_SPT_1307	Investigation Into the Development of an MVDC Demonstration Project	informed ANGLE DC
NIA_SPT_1309	Low Frequency Electricity Transmission Technology Evaluation	informed ANGLE DC
NIA_SPT_1501	Medium Voltage DC (MVDC)	informed ANGLE DC
NIA_SPT_1502	Distributed Photonic Grid Instrumentation	informed FITNESS
NIA_SPT_1503	Protection Settings to Cater for the Evolving Transmission Network	informed FITNESS
NIA_SGN_0035	Beyond Visual Line of Site	Follow on project being done by UKPN - Benefits demonstrated, adding to the case for a change in legislation. Will directly inform future Drone inspection technology.
NIA_SGN_0138	East Neuk Power to Hydrogen	Desktop study of constrained wind to H2 potential
NIA_SPEN_0045	SAFE HD	PhD project looking at heat uptake modelling
NIA_NGSO0018	RecorDER	blockchain-based asset register, enabling parties to use and reference a shared data set of generation and flexibility resources.
NIA_UKPN_0047	HV Feeder Monitoring	Pre-fault prediction on 11kV OHL - potential area for future innovation
NIA_SPEN_0041	Proof of Concept Tarmac Reinstatement Tester	Proof of concept project
NIA_SPEN_0054	Transmission OHL crossing drop Stage 1	Avoiding distribution cable undergrounding during transmission reconductoring
NIA_SPEN_0053	Project Synthesis	Effective Regional Inertia Monitoring and Automatic Control with a Whole System Approach
NIA_SPEN_1802	Project SIARA	Project SIARA (System Integrity And Restorative Actions) will explore the feasibility of deploying wide area protection and control (WAPC) in SPT network using routable R-GOOSE
NIA_WWU_0025	Project Future Wave Phase 2	A collaborative cross-vector project intended to empower customers and increase customer engagement in their energy choices. Informed FutureWave Phase 3,

NIA_SPT_1605	Cable diagnostics for HVDC cables	University of Strathclyde research which informs future asset condition assessment of the increasing quantity of DC cables. Joint with SSEN.
NIA_SPEN_0007	SUSCABLE 2	Has confirmed that there are higher temperature insulating materials available which could provide increased cable capacity. The onus is now on manufacturers to develop products.
NIA_NGN_142	CONCUR	Customer service project - bring up standard of customer service
NIA_SPEN_0048	The Chatter Tool	Using data from customer feedback and social media to supplement stakeholder engagement.
NIA_SPT_1505	Trial of Open Innovation Model in the Utilities Sector	Leveraged funding from a Scottish Executive initiative. Successfully increasing the innovation capability of SPEN.
NIA_NGGD_0072	Project Future Wave Phase 3	A collaborative cross-vector project intended to empower customers and increase customer engagement in their energy choices. Learning can be extracted and utilised going forward.

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