

Energy Networks Association

Open Networks Workstream 3 Product 5
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- **The Open Networks Project is a major industry initiative that will transform the way our energy networks operate, underpinning the delivery of the smart grid.** The project seeks to enable the uptake of new smart energy technologies by more and more homes, businesses, and communities in the UK. Allowing customers to take advantage of these new technologies to take control of their energy will lower costs and secure the energy we rely on every day. Find out more on Open Networks [here](#).
- Innovation is a key consideration for electricity network operators as we transform to a smarter, more economical, more flexible energy system that can support decarbonisation and build an efficient and smart cleaner energy system fit for Britain's home and businesses.
- It is important that as network operators we continue to 'learn by doing' to support the transformation and delivery of a smart grid.
- **The purpose of this presentation is to provide an update on the framework developed under Open Networks Workstream 3 Product 5** in collaboration with the Power Networks Demonstration Centre (PNDC) that sets the approach to map the Electricity Distribution System Operation innovation activities that the network community have either delivered or have underway. This will enable the identification of innovation opportunity areas to prioritise to facilitate the delivery of a smart grid.

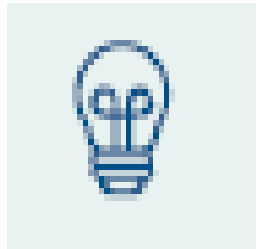
What is Workstream 3 Product 5?



Purpose

The purpose of Open Networks Work stream 3 Product 5 is **to identify Electricity Distribution system Operation (DSO) innovation gaps/ opportunity areas** to inform scope for existing innovation projects and potential future trials.

Description



Workstream 3 Product 5 continues the innovation pathway mapping work that started in 2018 under Workstream 3 Product 7. **The aim of this product is to ensure that Open Networks maintains visibility of innovation within the Electricity Distribution System Operation space and help inform the network operators innovation activities to facilitate the delivery of a smart grid.**

Find out more on the former work in 2018: <http://www.energynetworks.org/assets/files/ON-PRJ-WS3-P7.pdf>

Collaborating with the **Power Networks Demonstration Centre (PNDC)**



Who are the PNDC?

The PNDC is a venture founded by government, industrial and academic partners with 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.

Find out more: <https://www.pndc.co.uk/>



What is the PNDCs role?

The PNDC are collaborating with the Open Networks Project Workstream 3 Product 5.

The PNDC are leading the Electricity Distribution System Operation innovation mapping, assessment and prioritisation in partnership with the Product 5 team. The Product 5 team is built up of representatives from network operators.

Progress Update – Deliverable 1

Task	Comments	Status
Literature review of documentation on SO transition	DNO and ESO representatives confirmed most relevant and recent documents	✓
Review pre-existing innovation frameworks to identify their applicability to this work	Multiple frameworks have already been developed in previous Open Networks' activities	✓
Collate information and data on innovation projects	Primarily using the SmarterNetworks Portal	✓
Design and issue survey to SO representatives to capture information on non-Ofgem funded projects	Survey issued and awaiting feedback. Only gap is ESB Networks and IDNOs	✓
Propose initial framework options to be considered to WS3 Product 5 team	Feedback received and incorporated into the framework presented today	✓
Present framework proposal to gather feedback from wider stakeholder audience	Tested at the ENA Innovation Managers Meeting and the Open Networks Workstream 3 Meeting	✓

Progress Update - DSO Roadmap Capture (1)

- The Product 5 team agreed a list of background roadmap documentation and previous innovation project analysis
- The following categories of documents were identified:
 - Open Networks SO documentation
 - UK SO transition roadmaps
 - UK DNO and ESO innovation strategies
 - Previous reviews of innovation projects
 - International DSO projects and strategies
- The PNDC team has completed a literature review to inform the project framework and to identify opportunities to leverage previous work

1 - High level electricity networks vision
A vision for Scotland's electricity and gas networks
2 - Review of innovation projects and innovation strategies
A Review and Synthesis of the Outcomes from Low Carbon Networks Fund Projects
Innovation in regulated electricity distribution networks: A review of the effectiveness of Great Britain's Low Carbon Networks Fund
An Independent Evaluation of the LCNF
Summary of the Low Carbon Networks Fund learning
Electricity Network Innovation Strategy
A strategy for a Modern Digitalised Energy System-Energy Data Taskforce report
3 - International DSO strategy and projects
TSO – DSO Report: An Integrated Approach to Active System Management
Flexibility in The Energy Transition: A Toolbox for Electricity DSOs
D6.2 Evaluation on project results related to a number of models and roadmaps
Mapping of DSO Projects: A report for the Customer-Led Distribution System Project
Grid Modernization: Distribution System Concept of Operations
4 - ENA Open Networks DSO vision
Modelling the DSO transition using the Smart Grid Architecture Model
Future Worlds: Developing change options to facilitate energy decarbonisation, digitisation, and decentralisation
Future World Impact Assessment
DSO Definition and R&R (Roles and Responsibilities)
DSO Functional and System Requirements
Open Networks Project – DSO Transition: Roadmap to 2030
Least Regret Analysis - common functions across 'Future Worlds'
5 - UK SO's DSO transition roadmaps
Supporting a Smarter Electricity System: Our Transition to DSO
Distribution System Operator: Next steps and emerging thinking
Powering the North West's future: Transitioning to a Distribution System Operator – a collaborative approach
Distribution System Operator (DSO) Update
SPEN DSO Vision
Future Roadmap: A smart grid for all: Our transition to Distribution System Operator
DSO forward plan
DSO transition December 2017 update
DNO to DSO Evolution (Website)
Greater Access to the Distribution Network in Northern Ireland-Consultation Document
Facilitating Whole Electricity System Outcomes: How the ESO is working with stakeholders to transform the energy landscape
Whole Electricity System thinking: How the ESO can support a transition that delivers consumer value
Network Development Roadmap
Future of balancing services
6 - UK SO's innovation strategy
System Operator Innovation Strategy: A refresh for 2019/20 and how we performed over the last year
Our Innovation Strategy - ENWL
Innovation strategy - NPG

Screenshot of agreed list of background documentation for literature review

Framework Options Considered

Framework Option	Comments	Adopt
DSO Roadmap to 2030 framework <ul style="list-style-type: none"> 3 high-level development areas 33 innovation targets 	<ul style="list-style-type: none"> A lot of crossover with DSO Functional and System Requirements Challenging to combine with other framework categories Useful high-level DSO transition timelines outlined 	✓
EA Technology – Summary of LCF Fund Learning <ul style="list-style-type: none"> 11 solution areas 6 RIIO outputs 	<ul style="list-style-type: none"> Not DSO specific Lacks DSO specific detail to identify detailed gaps 	✗
UKERC Review and Synthesis of LCNF Outcomes <ul style="list-style-type: none"> 4 policy drivers 2 functional areas with 10 sub-topics 	<ul style="list-style-type: none"> Not DSO specific Lacks DSO specific detail to identify detailed gaps Policy drivers have significant crossover with Key Enablers 	✗
DSO Functional and System Requirements framework <ul style="list-style-type: none"> 8 DSO functions 12 underlying competencies 	<ul style="list-style-type: none"> DSO specific Good level of granularity for mapping and future gap analysis Leveraging existing framework allows for continuity 	✓
Future Worlds Key Enablers <ul style="list-style-type: none"> 8 key enablers with 21 sub categories 	<ul style="list-style-type: none"> Included to support least regrets investments Independent mapping required, separate to DSO functions 	✓
Electricity Networks Innovation Strategy framework <ul style="list-style-type: none"> 5 key innovation themes 31 challenge categories 	<ul style="list-style-type: none"> Not DSO specific Commonly used framework by all of Open Networks Various levels of categorization can be used, e.g. 5 innovation themes Challenging to combine with other framework categories without disrupting continuity of Open Networks DSO framework 	✓

Leveraging and building on pre-existing frameworks

DSO Functions
1. System Co-ordination
2. Network Operation
3. Investment Planning
4. Connections and Connection Rights
5. System Defence and Restoration
6. Service/Market Facilitation
7. Service Optimisation
8. Charging

DSO Organisational Competencies
1. Forecasting
2. Regulatory Codes & Frameworks
3. Commercial Relationships & Whole System Pricing
4. Whole System Coordination
5. Power System Analysis
6. Contractual Arrangements & Service Compliance
7. Dispatch
8. Outage Planning
9. Data Management
10. Settlement
11. Customer Account Management
12. Change Management

DSO Competencies \ DSO Functions	Forecasting	Regulatory Codes & Frameworks	Regulatory System Pricing & Whole	Commercial Relationships & Whole System Coordination	Whole System Coordination	Power System Analysis	Contractual Arrangements & Service Compliance	Dispatch	Outage Planning	Data Management	Settlement	Customer Account Management
System Co-ordination												
Network Operation												
Investment Planning												
Connections and Connection Rights												
System Defence and Restoration												
Service /Market Facilitation												
Service Optimisation												
Charging												

Example mappings for SO innovation project

Three Data Sources

1. Ofgem funded projects

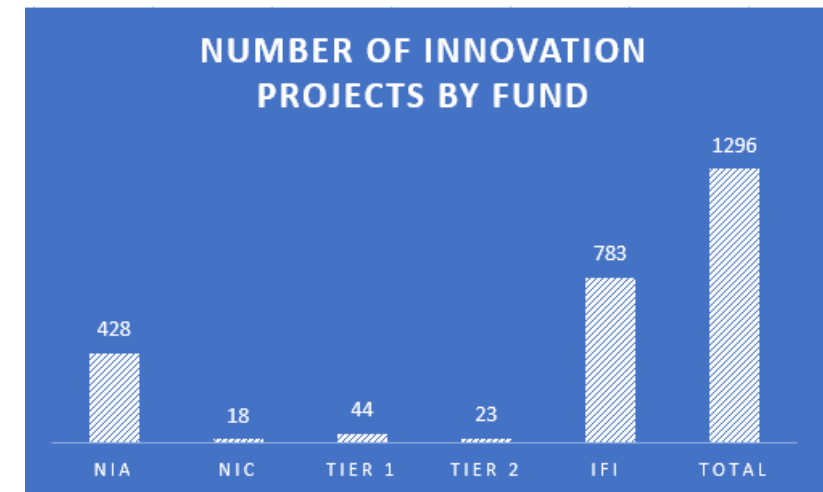
- SmarterNetworks Portal used as a comprehensive source of Ofgem innovation projects
 - **1296 innovation projects identified**
 - **£1.3B total spend**

2. Pre-processed Data

- [Electricity Network Innovation Strategy](#)
 - Data files generated by Navigant in previous work
 - Used to classify projects based on innovation themes
 - Previous categorisation helps with filtering projects based on DSO relevance – **6 projects identified in the March 2018 publication**

3. Non-Ofgem funded projects

- Agreed questionnaire structure with Open Networks Workstream 3 Product 5 team
- Information requested matches SmarterNetworks Portal download fields
- Additional information on Key Enablers requested
- Questionnaire issued to network operators to capture non-Ofgem funded innovation activity



Key Stats from Initial Project Data Collection

- **Electricity Networks Innovation Strategy**
 - Useful background data files were generated during this work
 - Innovation projects were categorised based on innovation themes and challenges
- **It is proposed to update background files with projects added since this work was completed**
 - This output will be useful in the next update of the Electricity Networks Innovation Strategy
- This project will use this to quantify the number of DSO related innovation projects that have been completed in each of the 5 innovation themes

Funding Mechanisms		ENW	SSEN	NG	NPG	SPEN	UKPN	WPD	Number of new & underway projects
NIA	Number of <u>new</u> projects	7	10	47	10	16	23	14	347
	Number of <u>underway</u> projects	8	13	19	6	22	6	11	
	Number of <u>uncovered</u> projects	0	14	107	1	11	1	1	
NIC	Number of <u>new</u> projects	0	1	0	0	1	1	1	17
	Number of <u>underway</u> projects	1	3	3	0	4	1	1	
LCNF	Number of <u>new</u> projects	1	0	0	0	0	0	0	5
	Number of <u>underway</u> projects	1	2	0	0	0	0	1	
Total		18	43	176	17	54	32	29	369

Number of new projects since the publication of the Electricity Network Innovation Strategy, March 2018 publication that require categorisation

The following project outcomes are expected from the proposed framework

- Shortlist of DSO related innovation projects
- Quantified level of innovation activity and summary of total innovation funding applied to date mapped against DSO functions
- Quantified level of innovation activity and summary of total innovation funding applied to date mapped against key enablers

Opportunities for innovation (Combined assessment route and outcome examples in slide 14-19)

- A heat-map visualising the number of DSO innovation projects against DSO Functions and Competencies (see example in next slide)
- List of DSO projects that should be reassessed when defining future innovation projects
- List of underdeveloped DSO functions and competencies

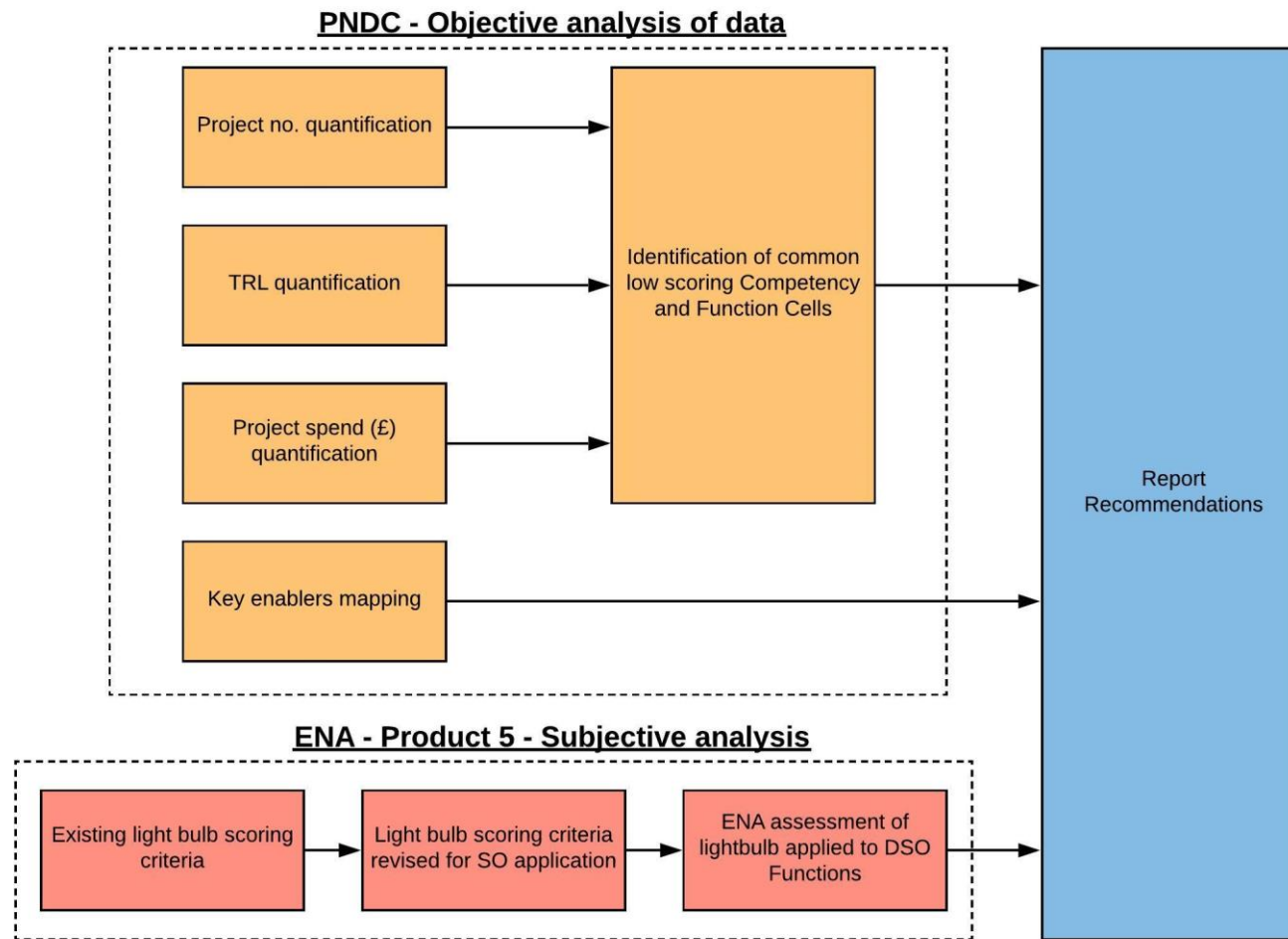
Innovation pathways and learning continuity

- Demonstration of learning continuity with a map of DSO project parent<>child relationships
- Timeline of DSO innovation projects (grouped by DSO functions) (Outcome example in slide 20)

If agreeable to utility representatives (scope variation required)

- Refreshed Electricity Networks Innovation Strategy background files created by Navigant
- Number of DSO innovation projects that have been completed in each Innovation Strategy theme

Flowchart of Combined Assessment for Future Innovation Opportunities



Motivation for proposed process:

1. Independent Objective and Subjective paths follows same approach implemented in the Electricity Network Innovation Strategy.
2. Parallel approach can be accommodated within project timeline.
3. Parallel approach implements independence and avoids bias influencing industry assessment.
4. Provides industry 'know-how' to balance & sanity check the data analysis.

Actionable output:

- Objective analysis = areas where investment should be targeted.
- Subjective analysis = the starting point for innovation in corresponding functional area.

Identification of common low scoring competencies

Combined Assessment for Future Innovation Opportunities

Summary of objective quantification assessment (slide 15-18):

- Three quantifications metrics implemented: number of projects, project TRL on completion (max & average), and project spend.
- The 'cut-off' threshold for what is considered 'low' will be proposed on completion of the project mapping once the range has been established. In the example (using mock data) included in this presentation the following cut-offs have been proposed (these will change during the actual assessment):
 - Number of projects: less than 2
 - TRL on completion (max): less than 4
 - TRL on completion (average): less than 4
 - Project spend: less than £250k

Using this assessment of the three quantification metrics this objective example assessment suggests that the innovation gap is within **Function = Service Optimisation & Competency = Forecasting.**

Summary of Key Enablers mapping (slide 19):

The High-Level enablers to be developed are 'Changes to industry structure' and 'Wider enablers'.

(A deeper level review on the 21 Key Enablers will be presented when the project reviewing process has completed.)

Risk & mitigation:

The objective analysis may not show common innovation gaps across the three different metrics. Mitigation = assess where largest deviations exist in quantification metrics and assess metrics in isolation or look at alternatives techniques for metric assessment.

Mock List of DSO Relevant Innovation Projects

Project ID	DSO Functions	Competencies	Key Enablers	TRL at Start	TRL at completion	Project Value/Budget
1	Service/Market Facilitation	Commercial Relationships & Whole System Pricing	E1,E3, E4, E5	TRL 4	TRL 6	£110k
2	Network Operation	Forecasting	E16, E17, E18, E19	TRL 7	TRL 8	£200k
3	Investment Planning	Regulatory Codes & Frameworks	E1, E2, E20	TRL 3	TRL 5	£80k
4	Network Operation	Power System Analysis	E15, E20	TRL 6	TRL 7	£100k
5	Service Optimisation	Forecasting	E15, E16, E20	TRL 2	TRL 4	£150K
6	System Defence and Restoration	Whole System Coordination	E1	TRL 3	TRL 7	£60k
7	Network Operation	Power System Analysis	E3, E20	TRL 7	TRL 8	£85k
8	System Coordination	Forecasting	E5, E6	TRL 3	TRL 6	£120k
9	System Coordination	Dispatch	E7, E8, E9, E10	TRL 5	TRL 8	£135k
10	Connections and Connection Rights	Contractual Arrangements & Service Compliance	E9, E10	TRL 4	TRL 7	£250k

- A mock list of classified DSO relevant projects is used to produce outcome examples of PNDC objective assessment
- The following slides will show the ‘Project no. quantification’, ‘TRL quantification’, ‘Project Spend (£) quantification’, and ‘Key Enablers mapping’ process and potential outcomes, based on the mock data

Project no. Quantification – Heatmap Example

- Number of projects mapped against DSO functions and Competencies
- Example heatmap visualising the quantified level of innovation activity
- ‘Cut-off’ threshold for no. of projects is 2 in this example, so the underdeveloped DSO functions and competencies are the areas that have only 1 project, i.e. the pale pink area.
- Heatmap visualisation (i.e. the tiers and the colouring) and the ‘cut-off’ threshold to be finalised at a later stage, when the reviewing process has completed

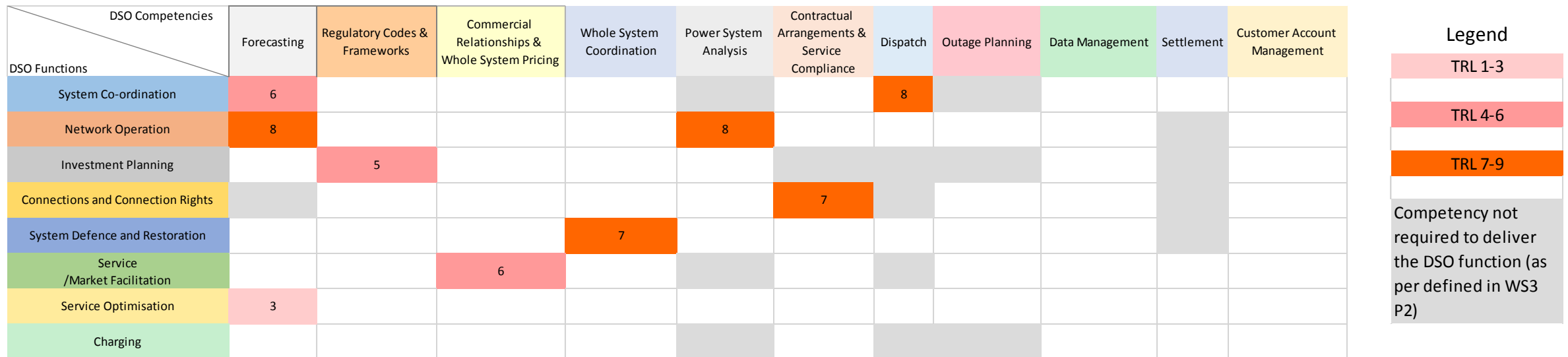
DSO Functions \ DSO Competencies	Forecasting	Regulatory Codes & Frameworks	Commercial Relationships & Whole System Pricing	Whole System Coordination	Power System Analysis	Contractual Arrangements & Service Compliance	Dispatch	Outage Planning	Data Management	Settlement	Customer Account Management
System Co-ordination	1						1				
Network Operation	1				2						
Investment Planning		1									
Connections and Connection Rights						1					
System Defence and Restoration				1							
Service /Market Facilitation			1								
Service Optimisation	1										
Charging											

Legend

- no. of projects < 2
- 2 ≤ no. of projects ≤ 5
- no. of projects > 5
- Competency not required to deliver the DSO function (as per defined in WS3 P2)

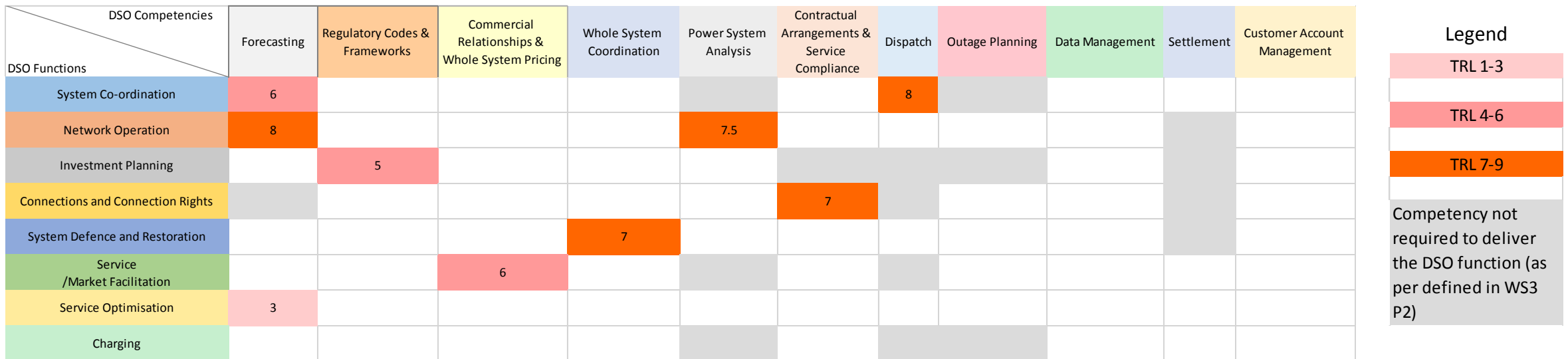
TRL Quantification – Heatmap Example(1)

- By assuming all the innovation projects deliver as planned and ‘TRL on completion’ is an accurate prediction. The ‘TRL at completion’ data will be used to map against DSO functions and competencies
- Maximum value of ‘TRL at completion’ for all the projects attributes to one function and one competency area is presented in the heatmap example below
- ‘Cut-off’ threshold for TRL is 4 in this example, so the underdeveloped DSO functions and competencies are the areas that have TRL lower than 4, i.e. the pale pink area
- The ‘cut-off’ threshold to be finalised at a later stage, when the reviewing process has completed



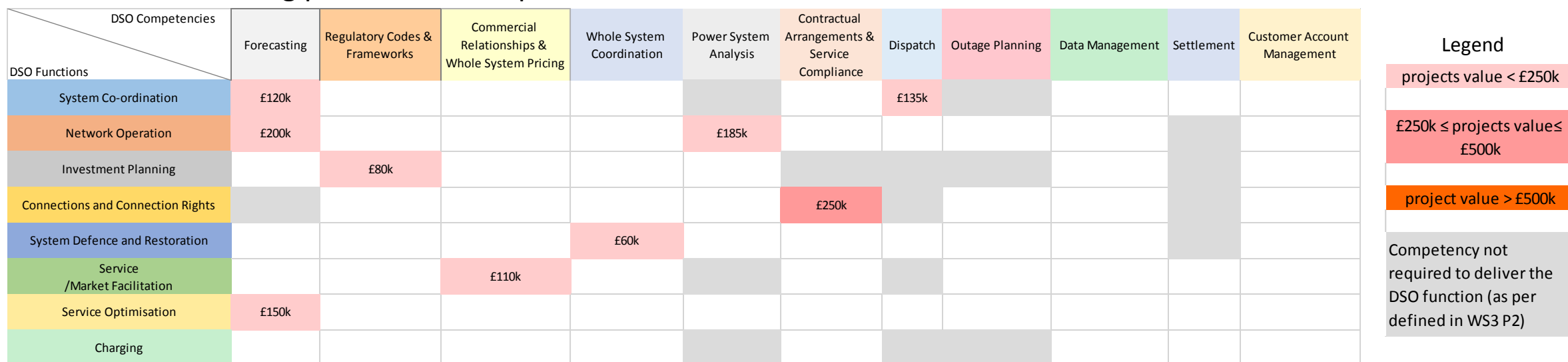
TRL Quantification – Heatmap Example(2)

- Average value of ‘TRL at completion’ for all the projects attributes to one function and one competency area is presented in the heatmap example below
- ‘Cut-off’ threshold for TRL is 4 in this example, so the underdeveloped DSO functions and competencies are the areas that have TRL lower than 4, i.e. the pale pink area
- The ‘cut-off’ threshold to be finalised at a later stage, when the reviewing process has competed



Project Spend (£) Quantification – Heatmap Example

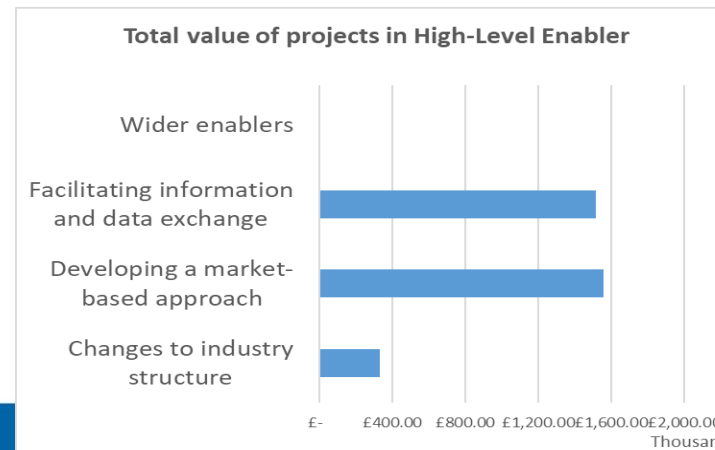
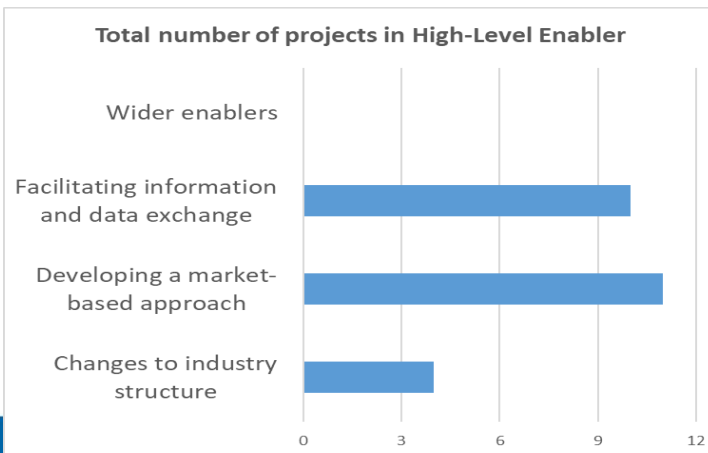
- Total spend of projects that attributes to each DSO function and competency
- Example heatmap visualising the quantified level of project number
- ‘Cut-off’ threshold for project spend is £250k in this example, so the underdeveloped DSO functions and competencies are the areas that has a total spend lower than £250k, i.e. the pale pink area
- Heatmap visualisation (i.e. the tier and the colouring) and the ‘cut-off’ threshold to be finalised at a later stage, when the reviewing process has completed



Key Enablers Mapping Example

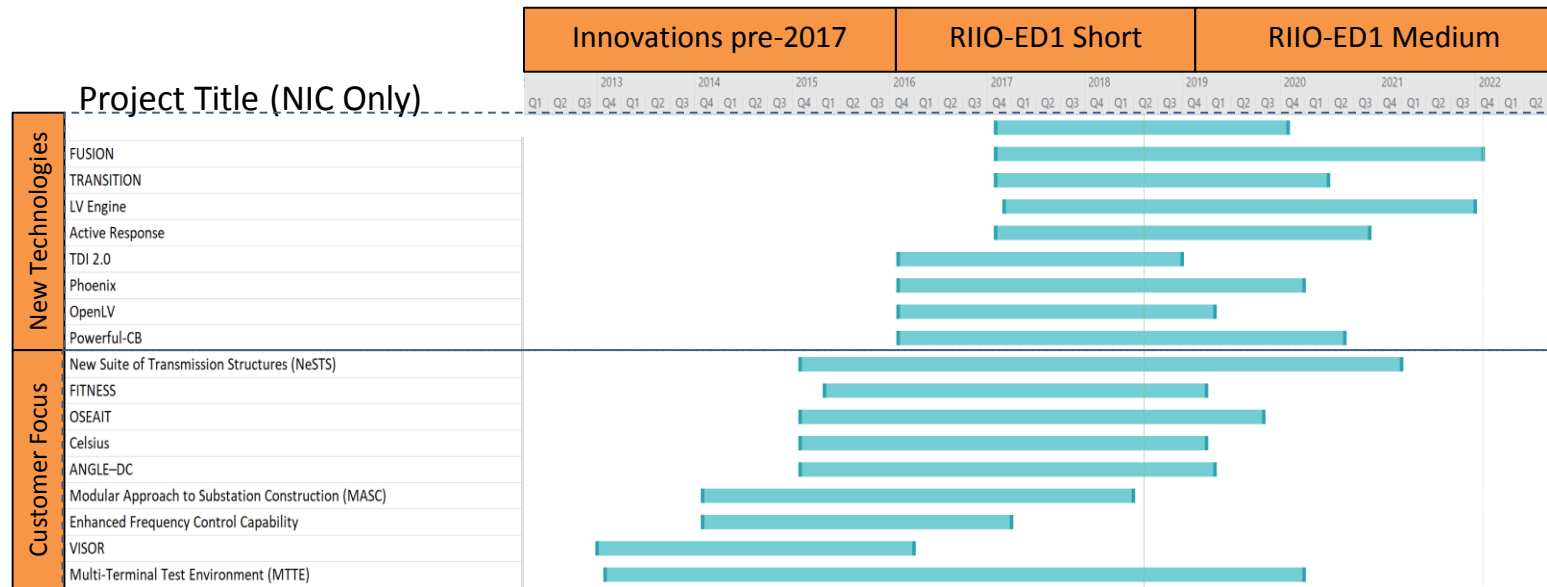
- 4 high-level Enablers and 21 Key Enablers, the 4 high-level Key Enablers are:
 - Changes to industry structure (E1-E2)
 - Developing a market-based approach (E3-E11)
 - Facilitating information and data exchange (E12-E20)
 - Wider enablers (E21)
- DSO relevant innovation projects mapped against Key Enablers
- Quantified level of innovation activity and summary of project spend (£) generated as a result of the mapping process
- Examples of Key Enablers mapping based on the mock data are presented in the figures

High-level Enablers	Enablers	
Changes to industry structure	<u>E1 - Regulation and policy changes</u>	
	<u>E2 - Organisational changes</u>	
	<u>E3 - Market engagement</u>	
Developing a market-based approach	Contract requirements	<u>E4 - Specification of technical need</u>
		<u>E5 - Engagement with potential service providers</u>
		<u>E6 - Scalability of DSO services</u>
		<u>E7 - Open access for all potential providers</u>
		<u>E8 - Defined payment mechanism</u>
		<u>E9 - Mechanism to quantify service delivery</u>
	<u>E10 - Settlement arrangement</u>	
	<u>E11 - Funding</u>	
Facilitating information and data exchange	Communications infrastructure	<u>E12 - Communication infrastructure</u>
		<u>E13 - Interoperability and common data format</u>
		<u>E14 - Cyber security</u>
	IT systems	<u>E15 - Determining the ability of DERs to provide system services</u>
		<u>E16 - Forecasting DER outputs over various timescales on the distribution network</u>
		<u>E17 - Enabling active network management</u>
		<u>E18 - Increasing operational efficiency</u>
		<u>E19 - Providing congestion management services on the distribution network</u>
		<u>E20 - Network visibility and control</u>
	<u>E21 - Wider enablers</u>	



Innovation Pathways - Timeline of DSO innovation projects

- Timeline of DSO innovation projects, grouped by DSO functions



Example visualization of Innovation Project Timeline for NIC projects

Observations & Recommendations

- Existing mapping frameworks used by the ENA across multiple completed pieces of work differ significantly based on the project context and outputs
- Aligning Smarter Networks portal data fields with an updated list of project data might facilitate continuity across future work and support in future assessments of Electricity Distribution System Operation