Appendix 2: Skills foresight – Making the transition

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1. Executive Summary

This report captures the analysis and findings of the Energy & Utility Skills (EU Skills) Phase 2 Foresight Research on Competency Analysis, Mapping and Audit of Re-skilling, Up-skilling and Cross-skilling Pathways for each Future role identified across the Water, Waste, Gas and Power Sectors. This research activity was aligned with another complimentary research activity which was the production of 'Day in the Life of' (DITLO) case studies, which aimed to provide a snapshot of the daily activities of a person performing each of these roles in 2030.

This report forms part of the second phase of a broader Foresight initiative conducted by EU Skills over the past two years with the aim of enabling the Energy and Utility Sector to anticipate and prepare for some of the key skills challenges on the horizon in 2030. This work has been overseen by an industry steering group, with representation from across the energy and utility sector, and has been funded by the UK Commission for Employment and Skills (UKCES) under the auspices of the Employer Investment Fund (EIF2).

The research process has consisted of a combination of extensive stakeholder engagement and wide ranging desk research, leveraging EU Skills market intelligence. This was underpinned by a comprehensive methodology for competency analysis, mapping and up-skilling that has potential to provide a robust, scalable and more sustainable analytical framework in the Future.

The research identified the functional and behavioural competencies required for these 'Future roles' and compared these competency requirements with those of existing 'Feeder roles'. This enabled detailed analysis of the competency gaps that would need to be filled in order to bridge the gap between the 'Feeder roles' and 'Future roles' studied. The competency gap concerned functional, technical and behavioural competencies. Finally, the second strand of work included an audit of availability of relevant up-skilling pathways to determine the extent to which existing training provision was likely to be sufficient to enable this transition.

The research provided strong validation of the Future and Feeder roles in each sector in that there was 'good to strong' overlap between Future and Feeder roles. There were key themes and commonalities across the Future roles, such as increased automation via adoption of smarter technologies resulting in greater data analytics and raised consumer awareness and interaction. **Additionally, the competence analysis exposed the breadth and depth of higher level skills requirements (particularly in the Water and Waste sectors); these are likely to be the areas presenting the greatest challenges in terms of efficient workforce attraction and utilisation.**

The Future Water Treatment Engineer Role had the lowest overall competency gap, with the Future competencies being more of a new combination of existing competencies, reflecting the skills continuum between key Feeder roles of process and network engineers and the Future role in question. **The Future Waste Sector role (Commercial Director of Resource Operations) was identified as a complex, broad role at a higher skill level; this Future**

role had the highest competency gap across functional, technical and behavioural competencies and suggests that they are associated with more than one Future role.

The Power and Gas Future roles had a similar level of 'medium' competency gap and common competency gaps across the Future roles, including real time monitoring, smart analytics and risk-based modelling. The research also identified key functional competencies which were common across all sectors: these included improved project management professionalism, stakeholder management, commercial awareness and customer orientation. **Behavioural competencies (such as resilience, a proactive approach, IT literacy etc.) were identified as being particularly important to the higher level roles in the Waste and Water sectors, but were also seen as being important to all Future roles in general.**

There is good availability and coverage of up-skilling pathways for the Future Water Treatment Engineer, particularly in terms of technical competencies. The critical up-skilling challenge is the commercial dimension of this role. There is technical competency (and some functional) overlap between the Water and Waste Future roles which provides options in terms of cross-skilling pathways. The Waste Management Sector Future role has the largest (and broadest) functional up-skilling requirement and there is strong availability and coverage.

It is well established that there is a gap in the up-skilling pathway for the Future Gas Network Planning role. It is critical that a pathway is developed and, at a more strategic level, there is a need for a concerted skills campaign in this area in particular. **A smarter, more sustainable model of competence acquisition and retention is urgently required in the Gas Sector.**

There is good availability and coverage of up-skilling for the Future Power Balancing Technician role, both in terms of power systems engineering as well as new sustainable and renewable power systems and technologies. There is a competence overlap between the Gas and Power Future roles, which provides potential cross-skilling pathways.

Availability and coverage is also good in terms of up-skilling in cross sector competencies, such as leadership and management, project management, supply chain management and environmental and social governance.

Across all sectors, behaviours were not core or explicit in terms of up-skilling provision and yet the research identified that new behavioural competences were critical for most Future roles. Indeed, behavioural competencies tend to be more stable; they are the core of any competency framework and tend to be a good predictor of Future performance. **This provides evidence for the need for a common cross sector behavioural competence framework.**

Most of the mapping results identified competencies that will not be required based on the Future roles competencies. Typically, between 25-50% of Feeder competencies would not be required. The extent of competence change is slightly greater for the higher level roles in Waste and Water. The Future Gas and Power roles are more evolutionary in terms of transition from current to Future roles.

The pace of competence evolution will not be the same for all roles and to some extent this will be determined by the nature of demographic, technology and market changes as well as inherent sector inhibitors such as conservatism (e.g. Gas and Power). The Water and Gas sectors have traditionally been poorer at workforce planning and up-skilling compared to the Waste and Power sectors. However, the research identified this was unsustainable due to demographic tensions and envisaged shortages within a more dynamic labour market. **The transfer of experience and competence across energy and utility contexts and sectors was seen as critical to addressing Future competency demands. This requires a more integrated cross-sector solution to meet Future competency and up-skilling requirements.**

2. Introduction

2.1 About EU Skills

We are an employer-led membership organisation that helps ensure the gas, power, waste management and water industries have the skills they need – now and in the future. Through a range of products and services we help employers attract new talent; develop their workforces; and assure a high level of competence across their businesses.

As the UK authority on professional development and employment in the energy and utilities industries, we help our members embrace new talent and technology to meet the challenges of a competitive global market. Market intelligence is central to our approach. From projecting skills gaps to benchmark standards, we provide the most accurate, up-to-date information on skills and employment in the energy and utilities sector.

Our partnerships with employers, government bodies and educational institutes help us support the UK's skills agenda, shape the future of the sector's workforce and ensure our stakeholders get the most from their investments.

2.2 Background to EU Skills Foresight Research

We understand that being prepared for the Future is just as important as being well equipped to manage the skills challenges of today. This report forms part of the second phase of a broader Foresight initiative conducted by EU Skills over the past two years with the aim of enabling the energy and utility sector to anticipate and prepare for some of the key skills challenges on the horizon in 2030.

EU Skills has already completed four Foresight reports for the Gas, Water, Waste Management and Power Sectors. These reports provide an overview of each sector, a detailed analysis of the key drivers and trends that will impact upon and shape these sectors during the period leading up to 2030. These reports also include a series of snapshots of what each sector, and its skills needs, could look like in 2030.

The second phase of the EU Skills Foresight research has been divided between two separate work streams. One work stream, the outputs of which are documented in this report, has focused on analysing the detailed competence requirements of a select number of 'Future' 2030 roles in the sector and those existing roles with the highest level of overlap. This has enabled us to identify specific gaps in the existing competence base and begin to assess the availability of the required upskilling pathways. A by-product of this research has been four 'Day in the Life of' case studies, painting a picture of what it might be like to actually perform each 'Future role' in 2030.

The other Phase 2 work stream has produced three cross sector reports which seek to provide a high level, overarching assessment of key themes selected by our Steering Group. These

reports explore how these themes are likely to transform the skills needs of the energy and utility sector up to 2030.[1]

2.3 Skills Foresight: Making the Transition

This report captures the analysis and findings of the Energy & Utility Skills (EU Skills) Phase 2 Foresight Research into Competency Analysis, Mapping and Audit of Up-skilling, Cross-skilling and Re-skilling Pathways for each 'Future role' identified in the Water, Waste, Gas and Power Sectors. The four 2030 Future roles are:

- Water Sector – Water Treatment Engineer
- Waste Sector – Commercial Director of Resource Operations
- Gas Sector – Gas Network Planner
- Power Sector – Power Balancing Technician

This strand of work was aligned with another complimentary strand of activity: the production of a 'Day in the life of' (DITLO) case study for each 'Future role' selected by the Steering Group. Section 4 of the report provides a synopsis of each of the Future roles. Section 3 of the report explains the methodology[2] that underpins this research and the associated principles, concepts and processes. A large competency knowledge base has been developed as a result of this research project.

The structure of this report is based on the following key research stages:

- Detailed breakdown of behavioural and technical competencies for each Future Role
- Shortlist of potential 'Feeder roles' for each Future role. Feeder roles are roles that, if up-skilled, could moves towards the Future role in question
- Selection of Feeder roles and breakdown of behavioural and technical competencies
- Mapping of competencies within each Future role to competencies within selected Feeder roles
- Production of a competency matrix for each Future roles that identifies competency gaps
- Conduct a re-skilling audit for each matrix
- Produce a skills road-map for the Future roles
- Draft a 'Future Roles: Making the Transition' report

[1] All Foresight reports are available to view at www.euskills.co.uk under 'Publications'

[2] The work reported makes use of the technologies and methodology of competence knowledge engineering and processing from Intelartes Sprl (www.intelartes.com) in the Sector Competence Knowledge Base, competence profiling and analysis. Intelartes is a partner of Dynamic Knowledge.

3. Methodology

3.1 Scope and definitions

This section first outlines some key definitions and principles behind the methodology and then provides an overview of the processes. Competency analysis, mapping and management is a complex multi-faceted domain. The purpose of enhancing the EU Skills methodology was to provide more rigour, consistency and sustainability to the delivered outcomes.

In terms of defining what we mean by 'competence', possibilities are many and varied. In the words of P.E. Elleström, *"there is such confusion and debate about the concept of competence that it is impossible to identify or impute a coherent theory or to arrive at a definition capable of accommodating and reconciling all the different ways the term is used".*[3] In this research context, competence is an occupational capability to perform a professional duty with required ability, knowledge and attitudes (behaviour).

Other key terms used in this research include 'ability', 'knowledge', 'attitudes' and 'duty'. 'Ability', in this context, is a capacity to conduct an activity or undertake a task for a professional duty. 'Knowledge' is cognitive awareness of 'know-what', 'know-why' and 'know-how'. 'Attitudes' are the behavioural traits shown in the professional context. 'Duty' is the purpose or context of such occupational capability.

Duty, ability, knowledge and behaviour

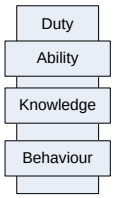

Figure 1 Competence Conceptualization

3.2 Gap, overlap and discrepancies in 'Feeder to Future' competence mapping

The comparison of competence profile is valued between a range of 0; 1. 1 means identical and 0 means totally different.

Gap of Competence Profile, *A* and *B*	$G = A - B$
Overlap of Competence Profile, *A* and *B*	$O = A \cap B$
Discrepancy of Competence Profile, *A* and *B*	$D = B - A$

[3] Elleström, P-E. (1997) 'The many meanings of occupational competence and qualification', Journal of European Industrial Training, Vol. 21, 6/7, pp. 266 – 273.

3.2.1 Conceptual perspectives on competence

Competence is a concept used in multiple contexts and applications and this inevitably leads to variations in interpretation and presentation.

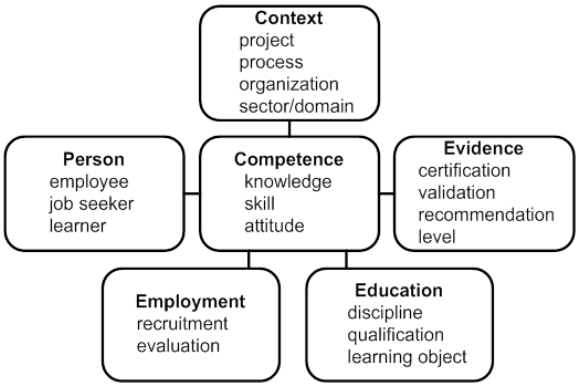

Figure 2: Analytical Perspective of Competences

In this research context, 'competence' is viewed from two perspectives: on the one hand, from an employment perspective and, on the other, from an educational perspective. The former captures competence in terms of the performance of a task, duty or activity. The latter is focused on the knowledge required for professional undertakings: 'know-what', 'know-why' and 'know-how'.

In this case, competence analysis of Future and Feeder roles is very much from an employment perspective. It is activity-oriented to identify abilities and behaviours enabling the successful performance of professional activities in a work context. The up-skilling, re-skilling and cross-skilling pathway analysis, however, takes an educational view of competence. It is focused on *knowledge* of a given subject matter in the curriculum and associated learning outcomes. Implicitly, there is potential for a gap to form between having and demonstrating the appropriate knowledge, on the one hand, and converting this into 'real life' ability to perform a task to an appropriate standard in an employment rather than an educational context.

Up-skilling is not limited to knowledge acquisition and formal qualification, but also includes the accumulation of operational experience. The identification, evidence and measurement of operational experience, however, are still open issues. The challenge is twofold:

- Lack of formal or institutionalised skill models
- Lack of formal means to evidence skills that are transferable from one context or sector to another

3.2.2 Key principles

The methodology used in this research aims to maximise:

- **Objectivity** in information collection and analysis
- **Scalability** in terms of scope
- **Consistency** if and when the process is repeated
- **Sustainability** to enable the re-use of and tracing of information sources used within the knowledge base

In order to achieve these aims, the following steps have been taken:

1. A structured approach to collecting and presenting information within uniform templates e.g. role specification template; competency data sheet (CDS) template etc.
2. Leveraging of existing EU Skills National Occupational Standards (NOS)[4], Power NOS and cross sector NOS (.e.g. project management) and other relevant competence frameworks, to inform and begin to build a sector knowledge base
3. Standard-based data analysis to reduce subjectivity within NOS
4. Knowledge-based data processing, based on industry consensus as specified within the NOS
5. Automation of the Sector Competence Knowledge Base, built from NOS and customised algorithms of knowledge extraction, data conversion, comparison and presentation[5]
6. Optimisation of consistency through automation of competence comparison in order to efficiently and consistently replicate competence analysis performed[6].

3.3 Data Comparability and Competence Modelling

In order to conduct this analysis, it is essential to make different job roles fundamentally comparable. The roles are specified in 'natural language' in terms of a range of different dimensions, including 'duty', 'knowledge' and 'behaviour'. There is no guarantee, however, that roles are expressed in the same 'units of measurement' semantically, due to the following variations in their specification:

- Natural language expressions
- Under-specification, with implicit assumptions and selectivity in explicit presentation
- Subjectivity, due to personal knowledge and experience of the contributor
- Viewpoints depending on the context
- Consistency in methodology

The role data needs 'normalisation' and NOS were selected as the terms of reference for building a knowledge base to aid comparison.

Two different dimensions of this research were conducted in parallel:

- Knowledge engineering to build a knowledge base (a process of NOS extraction, transformation and loading).
- Competence profiling and analysis

The knowledge engineering approach made it possible to perform knowledge-based competence profiling and analysis. The overall implementation process is captured in the diagram below.

[4] The EUS NOS and Power NOS are typically at operator level (and have different levels of currency) but still useful to build a knowledge base

[5] Thanks to the competence knowledge management technologies at Intelartes Sprl.

[6] Another area where consistency is crucial is competence interpretation with knowledge-based machine automation is a Future undertaking, given the limited scope of the current project.

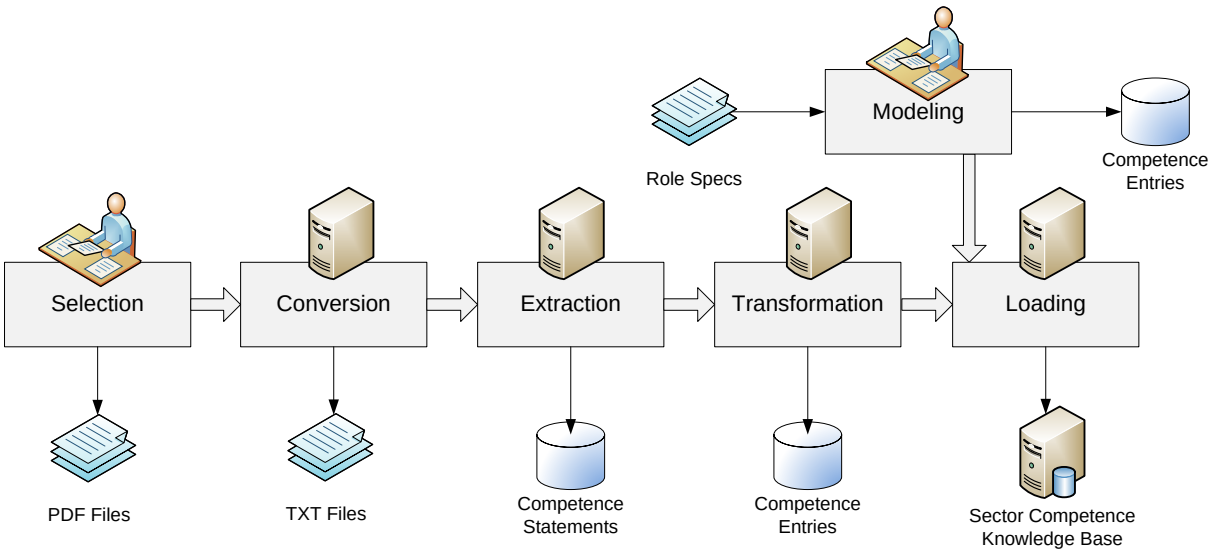

Figure 3 Knowledge Engineering of competence

3.3.1 Competence Modelling

A competence model is built from the 16 role specifications (4 Future Roles and 12 Feeder Roles). This Future Role Specific Competence Model (see Appendix 2 for detail) consists of:

- 75 generic activities
- 135 knowledge (know-what and know-how)
- 39 attitudes or behaviour traits
- 13 qualifications
- 29 experience of previous posts

They are loaded into the competence Knowledge Base, integrated with NOS competences and available for competence profiling and comparison (mapping). It is also implied from the identification of a Future Role Specific Competence Model that there is a need for Future sector NOS development (as well as a common behavioural framework aligned to Future of work and the work place).

3.4 Competency Profiling and Mapping

3.4.1 Description of Process

The roles are profiled and analysed within the conceptual scope of the Sector Competence Knowledge Base. The Sector Competence Knowledge Base consists of 4 subsets of knowledge: Gas, Power, Waste and Water with averages of 583 for duty, 3,627 abilities, 4,038 knowledge and 228 behaviours.

The process is made up of six steps.

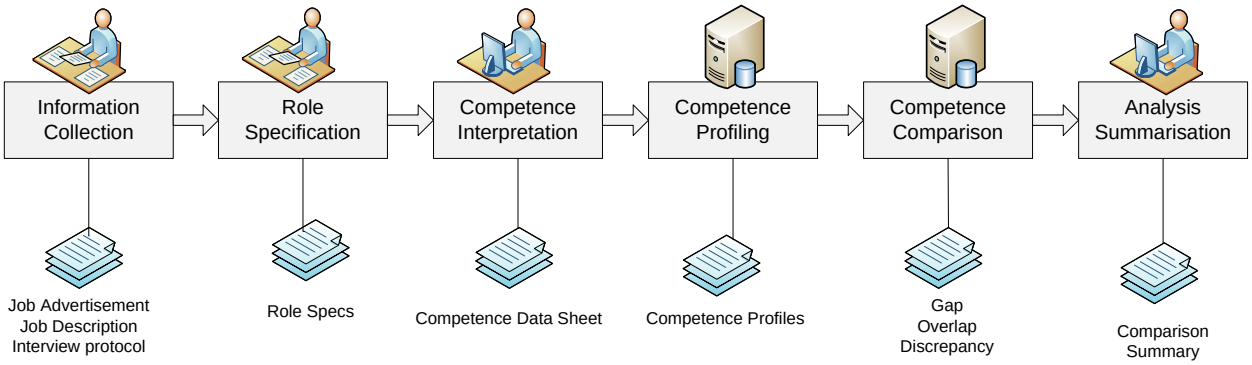

Figure 4: Process of Competence Engineering and Analysis

Competence comparison (mapping) consists of mapping each Future Role to 3 Feeder roles. Each role is interpreted in terms of four different types of Competency Data Sets (CDS):

- Cross Sector CDS (e.g. project management)
- Multi-Utility CDS
- Sector CDS (Gas or power, waste, or water)
- Future Role Specific CDS

It should be noted that there is no standard behavioural framework in each sector or across the Energy and Utility sector. Only broader government or commercial frameworks exist.

3.4.2 Competence Profiling and Mapping

The competence profile consists of lists of competencies in terms of:

- Duty
- Ability
- Knowledge
- Behaviour

Once the required behavioural, technical and functional competencies are all described in the same terms, any given 'Feeder Role' competence profile can be compared to any given Future Role profile to assess the extent to which there are gaps, overlaps or redundant or obsolete areas of competence. This enables us to understand how each Feeder Role may need to be re-skilled in order to perform the Future Role. This is also enables us to gain some idea of the cost of making the transition from one given Feeder Role to a given Future Role.

There are two outputs at this point: a graphical overview of Gap, Overlap and Discrepancy and a detailed representation of the competence match in an Excel Sheet.

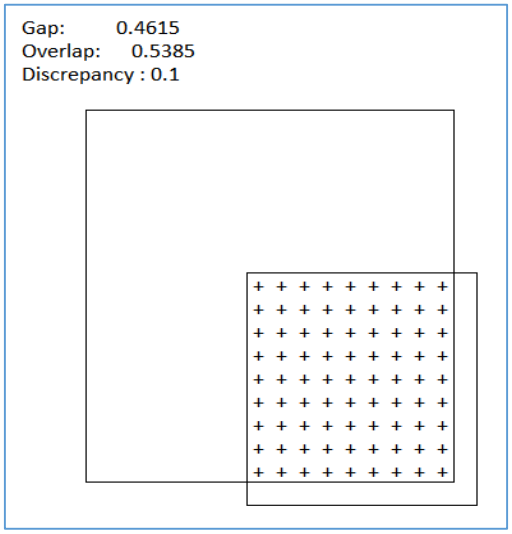

Figure 5: Competence Comparison of POWER BALANCING TECHNICIAN and ECRE

In addition, comparative bar charts provide a high level visual overview of the mapping results in terms of Duty, Ability, Knowledge and Behaviour. The red section of the bar represents the 'gap', the green section represents the 'overlap' and the yellow the 'discrepancy' (i.e. competencies that may no longer be required).

Power Balancing Technician (example)

Figure 6: Bar Chart Display of Mapping Results

3.4.3 Summarising the Analysis

As described above, a comprehensive process has been carried out in order to generate competence profiles, derived from the uniform and comparable competence knowledge base (based on customised algorithms). Visual representation reveals the extent of the competence gaps, overlaps and discrepancies. Next, high level manual analysis was carried out from a NOS-specific perspective and also from a Sector-specific perspective.

The NOS-specific perspective is described in more detail in Appendix 2 and results in two graphic representations of Functional Skill comparison and Operational Knowledge comparison for the Future and Feeder roles. An example is shown below. The red section represents the 'gap' and the green the 'overlap'.

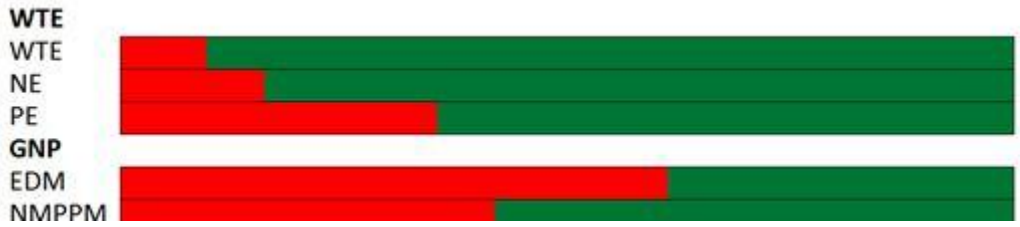

Figure 7: Bar Chart Display of Functional Skill Comparison

In addition, high level Sector-specific manual analysis, based on the Future Role-Specific Competency Model, was used to identify functional and technical knowledge and behaviours to aid gap analysis and the up-skilling audit (which has an Educational Competence angle).

3.5 Implications of this Methodology

The methodology and analysis undertaken have the following sustainability implications, besides job comparison or matching:

1. By turning NOS into NOS knowledge bases, together with knowledge processing, the approach used may help enforce, institutionalise or drive the adoption of the standards (making them re-usable and scalable).
2. It demonstrates a knowledge-based approach to data processing in workforce planning by taking stock of existing competences and comparing them with envisaged Future competences. There is potential to incorporate this learning into our Workforce Planning capability.
3. It also demonstrates a competence-based approach to career planning, defining goals via competence comparative gap and cost analysis.
4. The competence-based computation in this work also illustrates a possible approach to training, sourcing and management of competence requirements at an individual and organisational level.

4. Future Role Synopses

4.1 Introduction

A high level job description was developed for each Future role which provided some context as to what the 2030 operating environment, market structure, workplace[7] and technology trends[8] might mean for Future work and the worker.

The 'Day in the Life of' (DITLO) case studies were developed to reflect this and provide a supporting (and engaging) mechanism to facilitate discussion with industry around the likelihood and relevance of these factors and what this potentially meant for changes in Future work and the worker. Understanding the changes in work and functions is important before seeking to develop an understanding of what this means for competencies required of workers in order to perform the Future work. In some cases there may be new competencies but, typically, it will be more about new combinations of pre-existing competencies.

This section provides a synopsis of each of the Future roles. More detail is provided in the DITLO case studies in Appendix 1.

4.2 Water Future Role

A person performing this Future Water Treatment Engineer role will be responsible for designing, monitoring and refining water treatment processes. It is anticipated that this role will have changed significantly due to the rise of the grey water economy, resulting from the growing strain on available water resources and the imperative to reduce the environmental impact of purification and treatment processes.

The Water Treatment Engineer of 2030 is likely to require a broad base of biochemical knowledge and understanding as district and regional scale rain, flood and grey water recycling will interface seamlessly with an infrastructure of inter-linked bio-refineries (or Future related technologies), where more intensive and specific biological processes will be used to treat waste water and recover it as reusable water, bio-energy and biomaterials.

There will be a key emphasis of upstream assessment to enable grey water and rainwater sources to be harvested and brokered for domestic and industrial use but with sensitivity to urban water design and prototyping/modelling using a broader range of biological options and technologies.

The role is one of **process engineering** focused on biological processes in context of the grey economy. It is a complex role that has a **process dimension, a network dimension and**

[7] Reference The Digital Workplace Forum – a think tank on the Future of the workplace – www.**digitalworkplace**group.com

[8] This was derived from the Sector Foresight Reports and the analysis of trends, drivers and possible outcomes

commercial dimension. The network element will concern that non potable water is distributed and installed in to premises' in a safe and sustainable manner including providing advice to customers. This role would be much more field-based including managing a technical back office. The 'Day in the life' Water Treatment Engineer case study did not reflect the network dimension as strongly as the other two dimensions.

From a Health & Safety prospective we would expect the Water Treatment Engineer to have all the basic training and skills, but also a strong understanding of the Construction Design and Management regulations, to ensure plants are designed correctly and have the necessary safe operability.

The role will require engagement with a wide range of stakeholders within and beyond the water industry, including customers. It will involve technical input into projects, including the modelling and performance assessment of treatment facilities and their viability, project management and liaison with other offices and staff.

The research provided strong validation of this Future role and the likely critical up-skilling challenge will be the commercial dimension (e.g. stakeholder consultation) and biological processes. The Future Water Treatment Engineer is certainly a Level 4 or above role (based on QCF levels).

4.3 Waste Future Role

The Future Commercial Director of Resource Operations is a very externally focused, commercial role in buying 'waste' products from other organisations (private & public) from which their own organisation can derive value in an international[9] marketplace while meeting regulatory, environmental policies and regulations. The role will require the support of a range of commercial, brokerage and technical specialists to support the Commercial Director of Resource Operations within a city or geographic region.

The Commercial Director of Resource Operations would need to have a strong technical background to appreciate what is do-able technically but balanced by sustainability and environmental concerns. The role is also about understanding markets and then negotiating contracts. There is also a logistics component to the role as a lot of the cost will be in transportation and handling as well as reducing end-of-life waste.

This Future role may concern the extraction of particular materials or substances and selling these on to other brokers; they may use it in energy from waste plant operations. They will need to understand the relative benefits and disadvantages – economic or otherwise – of different processing options for different waste streams.

[9] There is a view that over time less waste will be transported across oceans as countries will increasingly need to retain their 'Future' resources.

Their role involves ensuring a healthy pipeline of these waste products and perhaps also negotiating and managing the sale to other parties of waste products that their own organisation generates (but that other organisations can derive value from).

It will require in-depth understanding of both waste policy and the varied markets for different materials and of waste policy, not only in the UK but also at a global level.

The research confirmed that this is a senior role requiring a broad base of expertise and experience. The competencies included within this future role may, in reality, encompass more than one job role. The Future Commercial Director of Resource Operations is certainly a Level 5/6 role.

4.4 Gas Future Role

A person performing this Future Gas Network Planner role will be responsible for overseeing and managing gas network maintenance and upgrading, including the assessment of applications for and addition of new input points. This role currently exists but is likely to evolve significantly up to 2030 as gas sources diversify and the number of network entry points proliferates, in addition to the standardised National Transmission System offtakes.

It is envisaged that biomethane injection will grow significantly subject to Government policy around financial incentives and reduction of regulatory hurdles. This will require news skills to be developed as current planners are unfamiliar with a more decentralised network with numerous small input points. This will introduce a future need to understand new health and safety policies and procedures, as well as the ability to relate these to different asset types and ensure that any risks are understood and contained effectively.

In 2030, a person performing this role is likely to be required to analyse gas quality and properties throughout the distribution network and to mitigate any risks that inconsistency might cause. It is likely that they will need to liaise with a range of different external stakeholders to plan network extensions and district or community scale networks. This Future role is more of a strategic planning role that requires a higher level of project management and commercial skills. Investment decisions in the Future will be based on much more detailed and complex information which combined with increased metrics will make decision-making more onerous and complex.

They are also likely to be required to manage a team of people and monitor progress in real time, logging all tasks and ensuring that they are progressed and completed in a timely manner. The Future Gas Network Planner is certainly a Level 4 role.

4.5 Power Future Role

A person performing this Future Power Balancing Technician role will be responsible for ensuring that power supply matches demand, using complex information flows from an increasingly smart grid, and managing an increasingly diverse and intermittent variety of generation technologies.

They will need to be aware of an increasingly diverse array of options for balancing supply with demand – for example, new storage technologies, influencing consumer usage of power through price incentives at times of low demand and the potential to transmit and trade energy internationally via sub-sea cabling.

The data on potential supply will also be highly complex, and require the person in this role to take into account a wider range of factors than at present, for example, looking at predicted weather patterns and their impact on a range of renewable generation technologies.

While the amount of information involved will become increasingly complex, it is expected that technologies will develop to help manage and balance this to some degree. The ability to use the relevant software and programmes will be an important element of the role, as will be an understanding of the complexity of power infrastructure and usage. Considerable change is envisaged at the distribution level with customers becoming more powerful and the potential for demand aggregators to fundamentally transform the market structure, enabling end consumers to trade their ability to consume or store power. Less change is envisaged at the transmission level.

The real-time nature of this role will require increase resilience and responsiveness which could bring new levels of stress and the need for more health monitoring. The Future Power Balancing Technician is a Level 3/4 role.

The key area of uncertainty lies in the level and adoption of increased automation and impact this has on required competencies, particularly behavioural competencies.

4.6 Key Themes and Commonalities

There are key themes and commonalities across the four Future roles in a number of areas:

- Rising adoption of intelligent network technologies and automation will both increase the amount and complexity of information and data, requiring greater analytical, communication (social and enterprise) and technology (ICT) skills
- There in an envisaged step change in the way the energy and utility sector interacts and engages with communities and consumers/customers; with the likelihood of consumers having increased power and options (e.g. new consolidators, smarter technology etc.) with strong communication preferences and increased switching tendencies
- The need for greater scenario planning, anticipation and responsiveness combined with enhanced critical thinking skills and personal resilient to cope with a range of different challenges e.g. customer preferences, climate change, energy security, data terrorism etc.
- All sectors will become more ‘demand-sensing’ which requires both the demand-side to better understand the supply-side and vice-versa. In addition there will be increased multi-utility interaction and integration.

- There will need to be stronger environmental and social governance and personal responsibility in this domain.
- Overall, this implies a greater breadth of required competencies for these Future roles.

5. Competency Analysis

5.1 Introduction

The sector Future roles were identified by the Foresight Steering Group based on the premise of converting the high level findings of the four Foresight Reports into a tangible plan of focused action. The Future job roles were selected on the premise that they are anticipated to be in high demand in 2030 and will require new competencies (or new combinations of competencies) that are not currently in high demand. A key focus should be on identifying higher level skills as these are likely to be areas that will present the greatest challenge in terms of efficient workforce attraction and utilisation.

Except for the Waste Sector, the Future Role titles have remained the same from the start to the end of the process. The Waste Sector title changed from 'Head of Resource Sustainability' to 'Commercial Director of Resource Operations' as a direct result of industry feedback.

The Methodology section described how the competency analysis and mapping views competence from an employment (rather than an educational) perspective. This concerns the skills, knowledge and attitudes (behaviours) in Future and current duties and tasks. It should be noted there is no standard behavioural framework in each sector or across the energy and utility sector. This only exists across broader Government or commercial frameworks.

Due to a lack of competence frameworks (at the right level[10]) and standardisation in the four sectors, there was inevitably a lack of standardised current job titles and role descriptions. The Feeder role competencies were therefore derived from a combination of i) information from interviews (which typically highlighted envisaged differences between Future and current roles); ii) desk research and iii) available job descriptions on company websites or online recruitment portals.

The DITLO case studies were developed in parallel with the Future and Feeder role competency analysis and mapping activity so both were aligned with industry feedback and desk research.

The identification of Future and Feeder roles competencies was based on the Methodology described and information extracted from a combination of analysis of the DITLO summaries, industry interviews, input from industry experts, existing industry competence frameworks (i.e. NOS extracted into a knowledge base) and web-based desk research. Across most of the Future roles, the additional requirement of the 'Future role' often consisted of a new combination of competencies rather than entirely new competencies.

For each Future and Feeder role, a competency role specification was developed in Excel format. Each role specification is based on a conceptual model of 7 elements of role title and

[10] The current EU Skills and Power NOS are at typically operator level but still useful from a knowledge base perspective

Standard Occupational Classification System coding, duty, ability, knowledge, behaviour, qualification and experience. The elements from all the specifications provide a Future Role Specific Competency Model (see diagram below) which are loaded into the competence Knowledge Base, integrated with National Occupational System competences and available for competence profiling and comparison (mapping). *Note: this represents the reality of what was captured from research and is unlikely to be complete but can inform the creation of a model in its own right.*

Activity	Knowledge	Behaviour	Qualification	Experience
Advise	3 D modeling	Action-oriented	APM Practitioner	Asset Intervention Manager
Analyse cost and effect	6 Sigma	Analytical	BEng	Biologist
Analyse data	Bidding, tendering and contracting	Articulate	BSc or Beng	Chemical Engineer
Analyse prices	biochemistry	Commerce-oriented	Chartered Quantity Surveyor	Chemist
Analyse quality	Biomethane injection	Communicative	CIWM	Civil Engineer
Analyse scenarios	Business continuity	Confident	CSCI	Distribution Engineers
Analyse the pro and con	CDM Regulations	Culture-aware	HNC, HND	Electrical control room engineer
Analyse to predict	Chemistry	Customer-oriented	Incorporated Engineer	Electrical distribution networks
Analyse viability	Circular economy	Detail-aware	MBA	Energy Demand Manager (National Grid)
Appreciate different points of view	Commercial brokering	Empathetic	Member of Gas Engineering & Management	Gas Network Controller

Table 1 Future Role Specific Competence Model

5.2 Water Sector

The Future Water Treatment Engineer role is one of **process engineering,** focused on complex biological processes in the context of the 'grey water economy'. There is a key emphasis on upstream assessment to enable grey water and rainwater resources to be harvested and brokered for domestic and industrial use, but with sensitivity to urban water infrastructure design and technical network challenges. Prototyping using a broader range of biological options and technologies will also be core to this role. This complex role will have a **process dimension, a network dimension and commercial dimension.**

The Future Water Treatment Engineer will typically work with a team of back-office specialists. Therefore, it is the mix of Future competencies required, rather than the roles, that may be more important.

The Future Water Treatment Engineer is certainly a **Level 4** and potentially even a **Level 5** (if a complex or large project such as a new development or smart-city) role based on SOC[11] Subgroup 21 (Science, Research, Engineering and Technology professionals).

5.2.1 Future and Feeder Roles

The research project validated three primary Feeder roles envisaged to have significant overlap with the Future Water Treatment Engineer role. The Feeder roles come from SOC Major Group 2 or Major Group 3 and the Skills Levels for Feeder roles were determined at **level 3 (to 4)** sub-group 31 (Science, engineering, and technology associate professionals).

Future Role	Feeder Roles

[11] Standard Occupational Classification 2010

Water Treatment Engineer	(Water) Process Engineer (or technician engineers - PE) Water Treatment Engineer Network Engineer (or technician engineers - NT)

Clearly, there will be many grades and educational backgrounds covered by these primary Feeder roles and up-skilling would need to reflect the continuum between process engineers at one extreme and network engineers at the other. The research also identified a broad range of secondary Feeder roles which were out of scope of this research. For example, as the role is focused on biological processes it could equally be undertaken by a Biologist or Chemist with appropriate development.

5.2.2 Future Role Competencies

A detailed competency specification of Future Water Treatment Engineer duties, activities, knowledge, behaviour, experience and qualifications was first produced. This competency specification was translated into a Future Role competency profile to match to Feeder Role competency profiles. In addition, a breakdown of functional and technical knowledge and behaviours (as shown in the table below) was extracted from the role competency specification and supporting information sources to aid gap analysis and the up-skilling audit (which has an 'Education for Competence' perspective).

Functional Knowledge	Technical Knowledge	Behaviours
Commercial & Contract Management Project Management Team Management Stakeholder Management Commercial Negotiation Decision Modelling Risk Analysis Data Analysis & Metrics Managing Financial Resources Complex problem solving Customer Service Management Personal Knowledge Management Understanding of: Data Analytics Commercial brokering in Utility sectors	(Utility) Supply chain Management Utility Network Planning & Management Risk Management & Reliability Engineering Water Sourcing Management (incl. upstream assessment & harvesting) Waste Water Treatment & Network Planning & Management Water Distribution Waste Management (incl. solid waste) Network Design & Modelling Customer Service Management in Multi-Utilities Managing legal and environmental issues Manage activity compliance (to various procedures & regulations) ***Plus understanding of:***	Analytical (i.e. cope with complexity) Commerce-orientated Customer-orientated Proactive Resilient Rigorous Persuasive Resourceful Empathetic Enthusiastic IT literate (high level) Technology-aware Numerate Think laterally Independent Critical thinking Result-orientated Organised

Consumer education, incentives & consultation Systems analysis & evaluation Customer Experience & Impact analysis Environmental & Social Governance	Waste Water Industry Operations Water/Waste Quality Regulations (Detailed) Chemical & Biological Characteristics & Process Circular Economy & Grey Water Recycling Water Science Fluid Dynamics Process Modelling Testing & Analysis Domestic & Industrial usage & regulations Renewable Energy Systems Multi-utility management Asset Management Environmental Compliance Sustainability (ESG) R&D in Waste Water Industry Weather Pattern Analysis Waste Water Technologies Water/Waste Urban design Materials & Composites	Spatial orientation Safety-focused

5.2.3 Future Role Competency Analysis

The competency analysis identified three key dimensions of the Future Water Treatment Engineer role: process, network and commercial. This role requires a high level (breadth and depth for example across waste and water processes and networks) of technical competence so it is envisaged that there will be key up-skilling requirements here. Environmental protection concerns raise the risk profile of this Future role. The bigger challenges were envisaged to come from the network part of operations rather than the process side and thus the Future Water Treatment Engineer would more likely come from the network discipline.

One of the primary roles is to design treatment plants to enable grey water and rain water sources to be harvested, as a replacement for the use of portable water sources for domestic and industrial uses. This requires a new capability in terms of upstream assessment required to ascertain the reliable yield of such sources and thus there viability (as well as sustainability requiring greater environmental understanding). This will also require significant discussion with customers about their needs (including keeping portable water separate from recycled) and whether the provision of such supplies is acceptable to them; for example industrial users may be more accepting of recycled water sources than domestic customers.

In addition to this role having key customer focused activity, stakeholders interviewed felt that greater influencing skills were needed (e.g. engaging with developers and town planners) as well as strong communication and negotiation skills. There was clear validation that new

behavioural competencies were required; however, some stakeholders interviewed felt that this would remain more of a technical role and that the 'sales' side of the process would be done by other people.

Some of the stakeholders interviewed believe that this type of Future Water Treatment Engineer role has been experimented with in the past but only at small scale operations or unique schemes (such as Olympic Park and O2 Stadium). There was also a view that there may only be a limited number of engineers available today that could take on this wide ranging role. This indicates that the Future competencies requirements may represent more than one specific role.

Other stakeholders interviewed felt that the social and technical challenges of introducing such a Future role would be achievable, but that there would not be rapid introduction of the concept because a water company's assets are long lived and are only slowly replaced. So this Future role would be more applicable to new developments and more of a pioneering role.

Most stakeholders interviewed felt critical experience in water process design and network operations was fundamental for this role and that typically a person in this role would be a Chartered Engineer or Scientist and probably have or be working towards Association for Project Management Practitioner and/or a Leadership and Management qualification.

In addition, as the interviews provided strong validation of the primary Feeder roles and their competencies (relative to some other sectors), it is unlikely that there will be other competencies not yet identified for the Future Water Treatment Engineer role. It is more about the likelihood and pace of when new competencies are required.

5.2.4 Feeder Role Competencies

As with the Future Role, a breakdown of functional and technical knowledge and behaviours (as shown in the table below) was extracted from the role competency specification and supporting information sources to aid gap analysis and the up-skilling audit (which has an Education for Competence perspective).

Feeder Roles	Functional Knowledge	Technical Knowledge	Behaviours
Network Engineer	Team Management Customer Service Management Logistics Project Management	Network Planning & Management Network Design & Modelling Waste/Water Network Management Waste Treatment Water Distribution Testing & Analysis Risk Management Accident Management ***Plus Understanding of:*** Waste/Water Industry Operations	Action-orientated Analytical Communicative Customer-orientated Logical Numerate Responsible Calm Independent Organised Resourceful

		Waste/water Quality Regulations Environmental Regulations Fluid Dynamics Quality Management Systems Domestic & industrial usage & regulations Process Modelling Materials	Spatial orientation Safety-focused
Process Engineer	Project Management Risk Management Team Management Complex Problem Analysis Understanding of: Risk-based modelling	Waste Treatment Water Treatment Process Modelling ***Plus Understanding of:*** Biochemistry Fluid Dynamics Water Science Testing & Analysis Renewable Energy Systems Network Design & Modelling Water Regulations Environmental regulations Health & Safety Regulations Quality Management Systems	Analytical Articulate Communicative Confident Customer-orientated Logical Numerate Persuasive Proactive Resilient Responsible Rigorous Independent Critical-thinking Resourceful Spatial orientation
Water Treatment Engineer	Project Management Risk Management Team Management Complex Problem Analysis	Water Treatment Design & Management Waste Water Treatment Testing & Analysis ***Plus Understanding of:*** Fluid Dynamics Biochemistry Process Modelling Water/Waste Quality Regulation Quality Management Systems Environmental regulations Health & Safety Regulations	Analytical Detail-aware Numerate Rigorous Independent Organised Resourceful Spatial orientation

5.3 Waste Sector

The Future Commercial Director of Resource Operations role is primarily an externally focused commercial role in buying 'waste' products from other organisations (private and public) from which their own organisation can derive value in an international marketplace while meeting

regulatory, environmental policies and regulations. The role will require the support of a range of commercial, brokerage and technical specialists to support the Future Commercial Director of Resource Operations within a city or geographical region.

The Future Commercial Director of Resource Operations is certainly a Level 5 (to 6) role based on SOC Subgroup 21 (Science, research, engineering and technology professionals).

5.3.1 Future and Feeder Roles

The research project validated three Feeder roles envisaged to have reasonable overlap with the Future Commercial Director of Resource Operations role from a broader initial list (some roles viewed as not having enough technical competencies to be considered, such as a commodity broker).

The Feeder roles are more likely to come from SOC Major Group 2 or Major Group 3 and the Skills Levels for Feeder roles Level 4 sub-group 31 (Science, engineering, and technology associate professionals).

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Future Role	Feeder Roles
Commercial Director of Resource Operations	Head of Sustainability (internal role - HS) Carbon Manager (CB) Senior Resource Efficiency & Waste Consultant (SREWC)

Clearly there will be many grades and educational backgrounds covered by these primary Feeder roles and up-skilling would need to reflect this. Stakeholders confirmed that key Feeders roles would be those with a strong technical and market/brokerage background. There are potentially other Feeder roles that should be considered in Future such as Waste/Water Strategic Planner, Waste Broker or other roles that develop in Waste Brokerage as this sector develops.

5.3.2 Future Role Competencies

A detailed competency specification of the Future Commercial Director of Resource Operations duties, activities, knowledge, behaviour, experience and qualifications was first produced. This competency specification was translated into a Future Role competency profile to match to the Feeder Role competency profiles. In addition a breakdown of functional and technical knowledge and behaviours (as shown in the table below) was extracted from the role competency specification and supporting information sources to aid gap analysis and the up-skilling audit (which has an Education for Competence perspective).

Functional Knowledge	Technical Knowledge	Behavioural
Stakeholder Management	Opportunity qualification & pipeline management	Action-orientated

Commercial & Contract management Project Management (Prince 2) Leadership & Management Commercial Negotiation Supply/Value Chain Management Whole life Costing & Cost Modelling Cost-effect Analysis Portfolio Management Managing Financial Resources Capital Investment Planning Complex problem solving Customer Service Management Personal Knowledge Management Understanding of: Public relations Thought leadership Commercial brokering Corporate Sustainability & responsible resourcing Customer education, incentives & consultation Consumer Psychology System analysis & evaluation Process improvement (6sigma)	Managing waste product supply chain Brokering & managing value streams Customer service management Customer sustainability strategy advise & support Resource sustainability & responsible sourcing New resource viability assessment Waste stream collection analysis & management Resource & Energy Planning Integrated resource management Cost reduction management Risk management & reliability engineering Managing a team of technical specialists Managing legal & environmental issues Manage activity assurance (to procedures & regulations) Risk-based modelling Process Modelling Understanding of: Commercial, statutory, & environmental policy & regulations Environmental Compliance Monitoring & incentives Regulatory & Policy Context Analysis Waste/Energy Markets & Standards Waste, water, material & carbon policies & regulations Waste Water Technologies Pricing & incentives Green Business Strategies International water policies Environmental Permitting Asset Management development lifecycle Sustainability innovation Chemical Analysis Material Science (incl. Composites) Biological processes Renewable energy systems such as Anaerobic Digestion processes Asset Management Ecology	Analytical (i.e. cope with complexity) Articulate Confident Customer-orientated Empathetic Commercial- orientated Strategy-orientated Entrepreneurial Finance-aware Culture-aware Resilient Innovative Networked Think Laterally Critical Thinking Resourceful Persuasive Proactive Resourceful Rigorous Networked Technology-aware IT-literate

	Research, development and innovation in materials and recycling technologies Lean/agile product design Customer psychology & buying behaviour Product & service design	

5.3.3 Future Role Competency Analysis

The competency analysis identified this external facing role had key commercial, brokerage, regulatory, sustainability and technical dimensions. Stakeholders interviewed felt this Future role required a high level of technical competence[12] due to the environmental risk level and breadth of technical knowledge required. This Future role would typically require key knowledge in terms of chemical analysis (new materials as well as material science and composites) and biological processes.

Some interviewed stakeholders felt that the Future Commercial Director of Resource Operations summary did not reflect the Future of producers 'designing-out' new materials and waste within products and processes as they become more responsible for resource efficiency. This may include new ownership models where people rent/lease rather than own to manage recycling and improve resource reuse. There would also be increased refurbishment; however, the level of change to more 'no-end of life waste' approaches within a fragmented and bureaucratic industry may restrict innovation and progress. Other stakeholders raised that fact that dense urban areas may pose particular challenges to collection and separation. Innovation in urban planning and design is likely to be required. This role requires a breath of understanding of waste and water management as well as resource sustainability in what will become a more integrated multi-utility marketplace.

This highlights the complexity of this role as well as its strong externally focused consultative nature and the need to be highly cognisant of market changes, challenges and opportunities. A broader set of functional competencies is required for this role such as stakeholder management, brokering and managing value streams (supply chain management), communication and negotiation, commercial and contract management.

Stakeholders interviewed felt that behavioural competencies were critical, such as customer-orientated, commerce-orientated, entrepreneurial, innovative, commercially aware, culturally aware, a high level of resilience, integrated into professional networks etc.

Experience in biological, chemical or multi-skilled engineering was seen as critical by stakeholders and that typically a person in this role would be a Chartered Engineer or Scientist and have or been working towards a Master in Sustainability or Logistics and Supply Chain Management.

[12] See CIWM/WAMITAB Hierarchy table for technical competence

In addition as the interviews identified that breadth of competencies and experience required for this role would not necessarily be covered by one role.

5.3.4 Feeder Role Competencies

As with the Future Role a breakdown of functional and technical knowledge and behaviours (as shown in the table below) was extracted from the role competency specification and supporting information sources to aid gap analysis and the up-skilling audit (which has an Education for Competence perspective).

Feeder Roles	Functional Knowledge	Technical Knowledge	Behaviours
Head of Sustainability	Project Management Financial Resource Management Supply Chain Management Team Management Environmental & Social Governance Complex Problem Analysis Understanding of: Personal Knowledge Management Cost-effect analysis	Resource Sustainability Environmental Modelling Real time monitoring systems Cost Modelling & Reduction Responsible Resourcing Green Business Strategies Process Modelling Resource & Energy Planning Carbon Policies & Regulations Understanding of: Utility Economics Waste Treatment ISO Standards Regulatory & Policy Context Analysis Renewable Energy Systems Waste Water Technologies Energy Security	Action-orientated Articulate Commerce-orientated Confident Culture-aware Enthusiastic Entrepreneurial Innovative IT literate Persuasive Resilient Strategy-orientated Think laterally Motivated Independent Results-orientated Networked
Senior Resource Efficiency and Waste Consultant	Project Management Financial Resource Management Quality Management Business Development Understanding of: Continuous Improvement Contract Management & Service Level Agreements Cost-effect analysis	Sustainable Recycling & Resource Management Waste Water Treatment Waste Water Network Management Energy & Resource Planning Process Modelling Cost Modelling & Reduction Understanding of: 3D Modelling & Simulation techniques Regulatory Frameworks Environmental Modelling	Analytical Articulate Commerce-orientated Confident IT literate Logical Persuasive Rigorous Results-orientated Organised Resourceful Networked

		Resource Sustainability Utility Economics Energy Storage ISO Standards Responsible Resourcing Green Business Strategies Regulatory & Policy Context Analysis Waste Water Industry Operations Waste Water Quality Regulations Carbon Policies & Regulations	
Carbon Manager	Project Management Team Management Commercial Negotiation Environmental & Social Governance Understanding of: Continuous Improvement Contract Management & SLAs Whole-life Costing Personal Knowledge Management	Responsible Resourcing Green Business Strategies Sustainable Recycling & Resource Management Energy Cost Reduction Management Understanding of: Carbon Policies & Regulations 3D Modelling & Simulation techniques Regulatory Frameworks Environmental Modelling Resource Sustainability Environmental Impact Assessment Renewable Energy Systems Asset Management	Action-orientated Commerce-orientated Communicative Customer-orientated Enthusiastic Numerate Persuasive Proactive Resilient Responsible Collaborative Motivated Independent Results-orientated Resourceful Networked

5.3.5 Other Competencies

There could also be a need for the Future Commercial Director of Resource Operations to have some understanding of product design and advanced manufacturing techniques.

5.4 Gas Sector

The Future Gas Network Planner role primarily concerns overseeing and managing gas network maintenance and upgrades, including assessments of applications for the addition of new input points, in the context of more diversified gas sources and entry points. This Future role is more of a strategic planning role that requires a higher level of project management and commercials skills.

This role would typically be part of a Network Planning team, within a Design or Planning or Asset Management Business Unit and liaise with operational planning, operational depots, and engineering policy, finance and network capacity teams.

The Future Gas Network Planner is a Level 4 role based on SOC Subgroup 21 (Science, research, engineering and technology professionals).

5.4.1 Future and Feeder Roles

The research validated three Feeder roles envisaged to have a strong overlap with the Future Gas Network Planner role. The Feeder roles come from SOC Major Group 2 or Major Group 3 and the Skills Levels for Feeder roles Level 3 sub-group 31 (Science, engineering, and technology associate professionals).

Future Role	Feeder Roles
Gas Network Planner	Network Maintenance Planning & Performance Manager (NMPPM) Network Planner (NP) Energy Demand Manager (EDM)

The Network Planner role is an existing role but expected to evolve significantly up to 2030 as gas sources diversify and the number of network entry points proliferates. The Energy Demand Feeder role is a role common to both Gas and Power sectors (e.g. National Grid).

Other Feeder roles identified were Asset Management or Data and Asset Health Managers but these were seen as being more senior strategic roles.

5.4.2 Future Role Competencies

A detailed competency specification of Future Gas Network Planner Role duties, activities, knowledge, behaviour, experience and qualifications was first produced. This was captured in Excel sheet format (appendix 3 if needed). This competency specification was translated into a Future Role competency profile to match to Feeder Role competency profiles. In addition, a breakdown of functional and technical knowledge and behaviours (as shown in the table below) was extracted from the role competency specification and supporting information sources to aid gap analysis and the up-skilling audit (which has an Education for Competence perspective).

Functional Knowledge	Technical Knowledge	Behaviours
Stakeholder Management Project Management Customer Service Orientation Cost Modelling Risk-based modelling Simulation & modelling (3D etc.) Real time monitoring Dynamic Management Information (MI) Reporting Capital Investment Planning Leverages modern ICT to deliver results Personal Knowledge Management Understanding of: Data analytics (i.e. incl. predictive & big data) Environment & social impact, sustainability & governance	Upstream assessment & planning Utility operational economics Anaerobic Digestion processes & management Gas Quality & Property Analysis across a network Gas sourcing & transportation Multi-network optimisation processes New input application & impact assessment Integrity Risk Assessment Managing safe operations on the network & more proactive planning Managing network strategic partnerships Manage activity compliance (to various procedures & regulations) Understanding of: Gas transmission & distribution Chemical properties of gas incl. shale, bio-methane Bio-methane injection Power to Gas Weather Pattern Analysis Asset Management Cost engineering & control? R&D in Energy & Utility sectors	Action-orientated Analytical Articulate Resilient Culture-aware Networked Customer-orientated Detail-aware Rigorous Proactive Technology-aware Confident IT Literate

5.4.3 Future Role Competency Analysis

The regulatory context is changing from one that was risk-based to a long term view based on value for money and more sustainable or environmentally accepted solutions. This will change the role and function of asset management as more traditional replacements and upgrades will be replaced by fabric upgrades using robotic technologies.

Those interviewed identified that the Future planner will need to be more commercially savvy, both understanding the gas quality specifications (wider range being adopted across the country) and regulations, flow impact of blending versus the connection point constraints with

associated connection costs and risks to downstream consumers. This requires good stakeholder management skills, ensuring all new stakeholders are aware of the implications, connection project planning and operational rules once established. In addition interviewed stakeholders identified the need for increase project management professionalism.

The Future role will require enhanced simulation and modelling capabilities to predict the impact of scenarios based on capacity constraints and other economic factors within a more decentralised generation and heat network. This will require greater proactivity as well as more enhanced personal networking skills to keep up with multi-utility (power/gas) developments and the regulatory cycle. The role will also include more risk-based modelling of the number and types of incidents that likely to occur which feeds into longer term investment planning. Future planners will need to be more open to rigorous questioning and debate.

Stakeholders felt changes across the business would be incremental as alternative sources become more commonplace. It was anticipated that there would be an increase in demand for modelling and analysis to ensure adequate capacity to accommodate a diverse range of sources of gas and also to enforce adherence to defined quality standards. Processes around connection applications will become more streamlined. However, the Future planner will have a greater volume of work requiring greater resilience and responsiveness. Gas network planning and gas supply will become more integrated with more real-time monitoring and feedback from network points. Increased 'smart' data flows may bring increased risk of stress and likely that Future planners will be subject to increased health monitoring.

Engineering experience, particularly of gas network analysis, was seen as critical by stakeholders. Typically, a person in this role would have an Engineering Qualification such as HNC degree or equivalent. A person in this role might be a Member of the Institution of Gas Engineering and Managers or working towards Incorporated Engineer status. A person in this Future role would also be expected to be working towards APM Practitioner or an equivalent qualification.

5.4.4 Feeder Role Competencies

As with the Future Role, a breakdown of functional and technical knowledge and behaviours (as shown in the table below) was extracted from the role competency specification and supporting information sources to aid gap analysis and the up-skilling audit (which has an Education for Competence perspective).

Feeder Roles	Functional Knowledge	Technical Knowledge	Behaviours
Network Maintenance Planning and Performance Manager	Quality Assurance Management Team Management Understanding of: Business Continuity Financial Resource Management Risk Management Contract Management & SLAs Procurement Cost Reduction/Control Management	Network Planning & Management Infrastructure Planning & Maintenance Gas Flow & Network Analysis Network Safety & Planning Continuous improvement techniques Incident Management Accident Management Remote Monitoring Techniques Understanding of: Gas Network Management Gas Quality & Property Analysis Health & Safety procedures	Action-orientated Analytical Communicative Confidence Detail-aware Empathic Enthusiastic Persuasive Proactive Resilient Responsible Rigorous Motivated Results-orientated Organised Supportive Constructive Resourceful Networked Safety-focused
Network Planner	Project Management Quality Assurance Management Understanding of: Cost control Risk Management Contract Management & SLAs	Network Planning & Management Gas Flow & Network Analysis Incident Management Infrastructure Planning & maintenance Real time monitoring Understanding of: 3D modelling & simulation solutions	Analytical Communicative Detail-aware IT literate Logical Numerate Responsible Collaborative Organised Supportive

		Biomethane injection Chemistry & chemical analysis Fluid Dynamics Health & Safety regulations AD process Gas Volume Analysis Input Application procedures Network Safety & Planning Gas Distribution & Transmission Planning & statutory regulations & procedures	
Energy Demand Manager	Project Management Risk Management Data Analytics Team Management Stakeholder Management Understanding of: Corporate Finance Utility Economics Complex Problem Analysis Decision Modelling Portfolio Management Capital Investment Management	3D Modelling & Simulation Techniques SMART Planning Risk-based Modelling Cost-effect Analysis Resource & Energy Planning Energy Security Management Understanding of: Chemical Analysis Energy Storage Gas Network Management Regulatory & Policy Context Analysis Renewable Energy Systems Multi-utility Management Asset Management Materials & Carbon Policies & Regulations	Action-orientated Analytical Enthusiastic Communicative Finance-aware IT literate Logical Numerate Persuasive Proactive Resilient Strategy-orientated Independent Results-orientated Networked

		Active Demand Management	

5.5 Power Sector

The Future Power Balancing Technician role primarily concerns ensuring that power supply matches demand, using complex informations flows from an increasingly smarter grid and a diverse and intermittent variety of generation technologies.

This role would typically be part of a planning and data analysis team within an Asset (Risk) Management business unit and liaise with network operations, energy demand and security managers, energy supply managers, regulatory, finance and risk management teams.

The Future Power Balancing Technician is a Level 3 or perhaps a Level 4 role based on SOC Subgroup 311 (science, engineering, and production technicians).

5.5.1 Future and Feeder Roles

The research project validated three Feeder roles envisaged to have significant overlap with the Future Power Balancing Technician role. The Feeder roles come from SOC Major Group 2 or Major Group 3 and the Skills Levels for Feeder roles Level 2/3, sub-group 31 (Science, engineering, and technology associate professionals).

Future Role	Feeder Roles
Power Balancing Technician	Electrical Control Room Engineer (ECRE) Transmission Control Engineer (TEC) Power Systems Analysis Engineer (PSAE)

The stakeholders identified that the Future Power Balancing Technician would be a cross over between a Control Room Engineer and Transmission Control Engineer. Some stakeholders felt the Power Systems Analysis Engineer was a senior role in its own right and not a Feeder role.

The research identified in the Future there could be new roles associated with this Future role such as Distribution System Operator. The Energy Demand Manager role (also a Feeder role in Gas) is increasingly addressing the longer term scenario planning for power and gas demand and supply.

5.5.2 Future Role Competencies

A detailed competency specification of Future Power Balancing Technician duties, activities, knowledge, behaviour, experience and qualifications was first produced. This was captured in Excel sheet format. This competency specification was translated into a Future Role competency profile to match to Feeder Role competency profiles. In addition, a breakdown of

functional and technical knowledge and behaviours (as shown in the table below) was extracted from the role competency specification and supporting information sources to aid gap analysis and the up-skilling audit (which has an Education for Competence perspective).

Functional Knowledge	Technical Knowledge	Behaviours
Stakeholder Management Commercial & Contract Management Customer Service Management (incl. incentives & rewards) Cost/Benefit Analysis Risk-based modelling Simulation & modelling (3D etc.) Real time monitoring Dynamic Management Information (MI) Reporting Leverages modern ICT to deliver results Personal Knowledge Management Understanding of: Data analytics (i.e. incl. predictive & big data) Social networking & communication channels Environment & social impact, sustainability & governance	Dynamic balancing on decentralised network Power Systems Engineering Smart Grid & Smart Technologies (from customers to forecasting) Active Demand Management (incl. new players such as demand aggregators) Energy Trading & variable pricing Balancing option analysis & impact assessment Options Analysis (incl. simulation) & predictive forecasting Managing & responding to emergencies Integrity Risk Assessment across distributed network Managing safe operations on the network & more proactive planning Managing network strategic partnerships Manage activity compliance (to various procedures & regulations) Understanding of: Smart Grid Demand Aggregation	Action-orientated Analytical Communicative Logical Numerate Resilient Customer-orientated Commercial-aware Detail-aware Rigorous Proactive Responsible Technology-aware IT Literate Technology-aware Calm Independent Results Orientated Organised

	Current renewables (incl. biomethane injection) Power to Gas options & cross sector R&D (i.e. network option analysis) Anaerobic digestion process Regulatory settlements & pricing mechanisms Distribution cost/efficiency parameter & downstream/customer implications Energy Security (within international marketplace) Asset Management Weather Forecasting; Climate impact on network asset Customer attitudes to usage & incentives R&D in Energy & Utility sectors Simulation/Emulation technologies to test/learn scenarios	

5.5.3 Future Role Competency Analysis

The Power Balancing Technician will require more sophisticated skills in interpreting forecasts and assessing the value of a wide range of different demand balancing products on offer in the marketplace. A person performing this role will also have the ability to make informed trade-offs between these different products. With increasing volumes of distributed generation, the technician may only be able to see the impact on demand, but not necessarily the data on how much power is being generated (unless this is communicated to them). It is envisaged that technologies will develop to manage complex data but the Future Power Balancing Technician will need to be able to use relevant smart network technologies alongside enhanced analytical skills and broader technical understanding of power engineering and utility market dynamics.

Options might include frequency response products, power purchase, using Short Term Operating Reserve and weighing up the costs and benefits of each of these options, looking at the constraints on the system and juggling these factors on a second by second basis.
We might see the arrival of "consolidators[13]" – signed up to by households to make the most of the smart grid – making/saving money for the consumer and for the control room. Consumers will be able to trade their right to take power from the grid between certain times or trade the power they generate, with an online 'go compare' type environment to allow them to find the consolidator who will offer them the best rate. The Future Power Balancing Technician will therefore be required to be both more customer and commercially aware.

The Technician in the Control Room may have to make an increasing number of more rapid commercial decisions about balancing supply and demand, choosing from a host of different offerings, which will fluctuate in terms of the value they offer from one minute to the next (a little like the stock market). The Future Power Balancing Technician would typically be working in a smaller team but the role would be more multi-faceted requiring greater proactivity, resilience and responsiveness. Managing safe operations on the network, efficiency performance and ensure working within regulatory framework will also be a key part of the role. Increased 'smart' data flows may bring increased risk of stress and it is therefore likely that the Future Power Balancing Technician will be subject to increased health monitoring.

Engineering experience particularly of network operations and field experience was seen as critical by stakeholders and that typically a person in this role would have an Engineering Qualification (electrical or power) such as HNC degree or equivalent.

5.5.4 Feeder Role Competencies

As with the Future Role a breakdown of functional and technical knowledge and behaviours (as shown in the table below) was extracted from the role competency specification and supporting information sources to aid gap analysis and the up-skilling audit (which has an Education for Competence perspective).

Feeder Roles	Functional Knowledge	Technical Knowledge	Behaviours
Control Room Engineer	Project Management Team Management Understanding of: Contract Management Customer Service Management Data Analytics	Power Distribution Incident Management Network Planning & Management Understanding of: Power & SMART Grid Health & Safety Regulations Network Safety & Planning	Analytical Communicative Detail-aware IT literate Proactive Resilient Responsible Rigorous Calm Independent

[13] Also called demand aggregators

	Quality Assurance Risk Management		Organised Results-orientated Safety-focused
Transmission Control Engineer	Project Management Understanding of: Data Analytics Quality Assurance	Power Systems Engineering Power Transmission Incident Management Power Supply & Demand Management Understanding of: Power Grid & SMART Grid Network Management 3D modelling & simulation techniques Regulatory Frameworks Safety & Environmental Regulations Real time monitoring systems Renewable Energy Systems Energy Security Front-end Engineering Design	Analytical Articulate Communicative Detail-aware IT literate Resilient Calm Results-orientated Safety-focused
Power Systems Analysis Engineer	Project Management Team Management Complex Problem Analysis Cost-effect analysis Understanding of: Contract Management Cost Modelling Customer Service Management Data Analytics Quality Assurance Risk Management	Power Transmission & Distribution Power Systems Engineering Front-end Engineering Design Incident Management Network Planning & Management Network Design & Modelling 3D Modelling & Simulation Understanding of: Power & SMART Grid Health & Safety Regulations Multi-utility Management Options Analysis & Predictive Forecasting	Analytical Detail-aware Empathic Enthusiastic IT literate Proactive Resilient Think-laterally Critical thinking Results-orientated Organised Resourceful

		Energy Security Resource Sustainability	

5.6 Common and Cross Sector Competencies

The competency analysis identified that there were common knowledge requirements across most Future Roles such as:

- Risk Management
- Asset Management
- Data Analytics
- Pricing & Incentives
- Real Time Monitoring
- Contract Management
- Stakeholder Management
- Quality Management
- Personal Knowledge Management
- Risk-based Modelling

The competency analysis identified there were a number of common cross sector competencies (i.e. functional) in:

- Project Management
- Supply Chain Management/Logistics
- Leadership & Development
- Customer Service Management
- Environmental & Social Governance
- e-skills/IT literacy – Future of the workplace

So a key part of the competency analysis research was identifying relevant competency frameworks (e.g. NOS) that could be leveraged to support the competency profiling and mapping (see Methodology in Section 3). This was critical to improving the quality of competency mapping, gap analysis and up-skilling pathway identification.

5.7 Competency Profiles

In each sector, Future and Feeder competency role specifications were developed as a result of the competency analysis[14]. These were then interpreted in the context of the competency knowledge base, in terms of cross sector, multi-utility, sector-specific and Future role specific competencies. From this, a competency profile consisting of four key dimensions of duty, ability, knowledge and behaviour was generated for each Future and Feeder role ready for mapping and interpretation.

[14] It should be noted the role specifications are inherently subjective due to the nature of information collection

The roles were profiled and analysed within the conceptual scope and the population of the sector competence knowledge base. These profiles are large files in Excel format not suitable for annexing to this report. The process is made up of six steps:

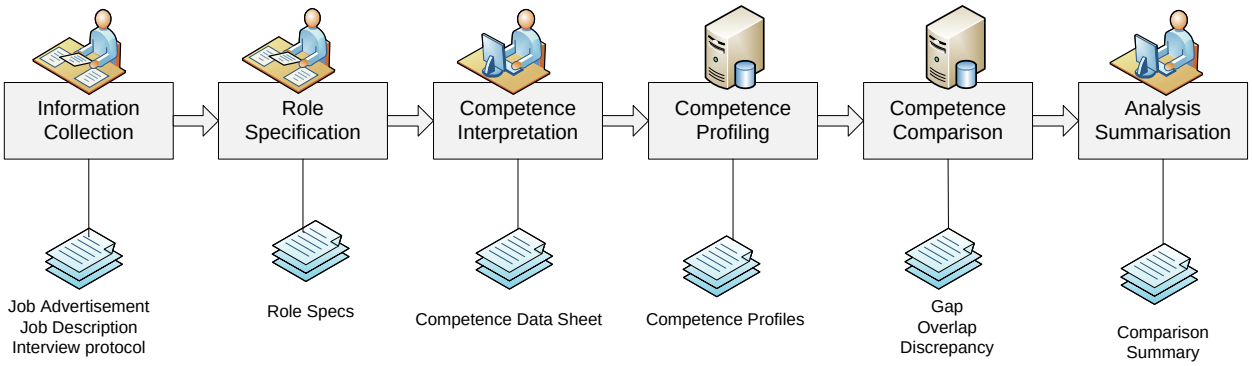

Figure 8: Process of Competence Engineering and Analysis

This process is described in more detail in the methodology section.

6. Mapping & Interpretation

6.1 Introduction

A competency mapping of each Future role to each selected Feeder role was completed to identify areas of overlap (i.e. competencies that will be readily available) and competency gaps, and in some cases which skills-sets these 'missing' competencies will be a natural extension of. As a bi-product, there is also an estimation of the Feeder competencies that will not be required (discrepancies) based on the Future competencies. In addition, a key focus is identifying higher level skills as there are likely to be areas that present the greatest challenges in terms of workforce planning.

Mapping of the competency profiles of Feeder roles to anticipated Future roles covered four key areas of duty, ability, knowledge and behaviour. The comparison reveals both differences and similarities. The comparison of competence profile is valued between a range of 0 and 1. 1 means identical and 0 means totally different.

Gap of Competence Profile, *A* and *B*	$G = A - B$
Overlap of Competence Profile, *A* and *B*	$O = A \cap B$
Discrepancy of Competence Profile, *A* and *B*	$D = B - A$

The comparison results in two outputs. One is a graphical overview of Gap, Overlap and Discrepancy. The graphical representation is required as the profiles are large files not suited for incorporation into a report. The other provides a detailed view of each competence and their key, indicating their origin in Excel format.

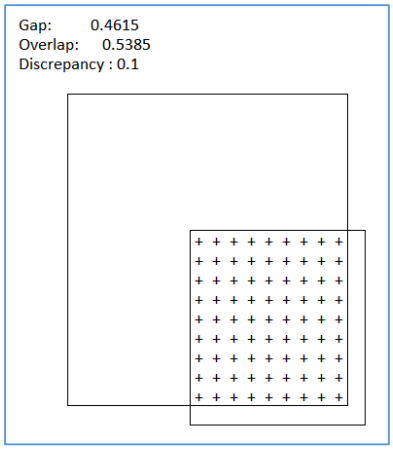

Figure 9: Competence Comparisons of POWER BALANCING TECHNICIAN and ECRE

In addition, comparative bar charts are provided to give a high level visual view of the mapping results for duty, ability, knowledge and behaviour. The red part is the gap, the green is the overlap and the yellow is the discrepancy.

Power Balancing Technician (example)

Figure 10: Bar Chart Display of Mapping Results

This process is described in more detailed in the methodology section (and Appendix 2) which includes the detailed mapping results in tabular format.

6.2 Water Future Role Mapping to Feeder Roles

6.2.1 Results of Mapping

The Future Water Treatment Engineer role was mapped to the three identified Feeder roles of (current) **Water Treatment Engineer**, **Process Engineer** and **Network Engineer**. As shown in the table below, the mapping provides strong validation of all the Feeder roles which is what was envisaged from discussions with interviewed stakeholders.

The Network Engineer Feeder role has the lowest competency gap and strongest overlap, although has the greatest knowledge gap mainly due to the process dimension of the Future role. The competency analysis identified that the Network Engineer might be the prime Feeder role. The Feeder Water Treatment Engineer and Process Engineer have a similar competency gap, with the Process Engineer having the lowest knowledge gap in total. The highest competency gap across all Feeder roles is behavioural as identified in the competency analysis. The closeness of all three Feeder roles validates views from stakeholder interviews that up-skilling would need to reflect the continuum between process engineers at one extreme, network engineers at the other and with the Water Treatment Engineer role somewhere in the middle.

This Future role has the lowest overall competency gap and range between Future and Feeder roles compared to other sector Future roles.

Mapping of Future Water Treatment Engineer to Feeder roles ranking:

Feeder Role		Gap	Overlap	Not Required
Water Treatment Engineer	Duty	0.38	0.62	0.43
Water Treatment Engineer	Ability	0.35	0.65	0.43
Water Treatment Engineer	Knowledge	0.26	0.74	0.54
Water Treatment Engineer	Behaviour	0.56	0.44	0.41
Total		***1.55***	***2.45***	***1.81***
Process Engineer	Duty	0.34	0.66	0.35
Process Engineer	Ability	0.42	0.58	0.41

Process Engineer	Knowledge	0.18	0.82	0.24
Process Engineer	Behaviour	0.60	0.40	0.54
Total		***1.54***	***2.46***	***1.54***
Network Engineer	Duty	0.30	0.70	0.47
Network Engineer	Ability	0.22	0.78	0.48
Network Engineer	Knowledge	0.32	0.68	0.44
Network Engineer	Behaviour	0.53	0.47	0.56
Total		***1.37***	***2.63***	***1.95***

In addition, comparative bar charts are provided to show a high level visual view of the mapping results for duty, ability, knowledge and behaviour. The red part is the gap, the green is the overlap and the yellow is the discrepancy (not required).

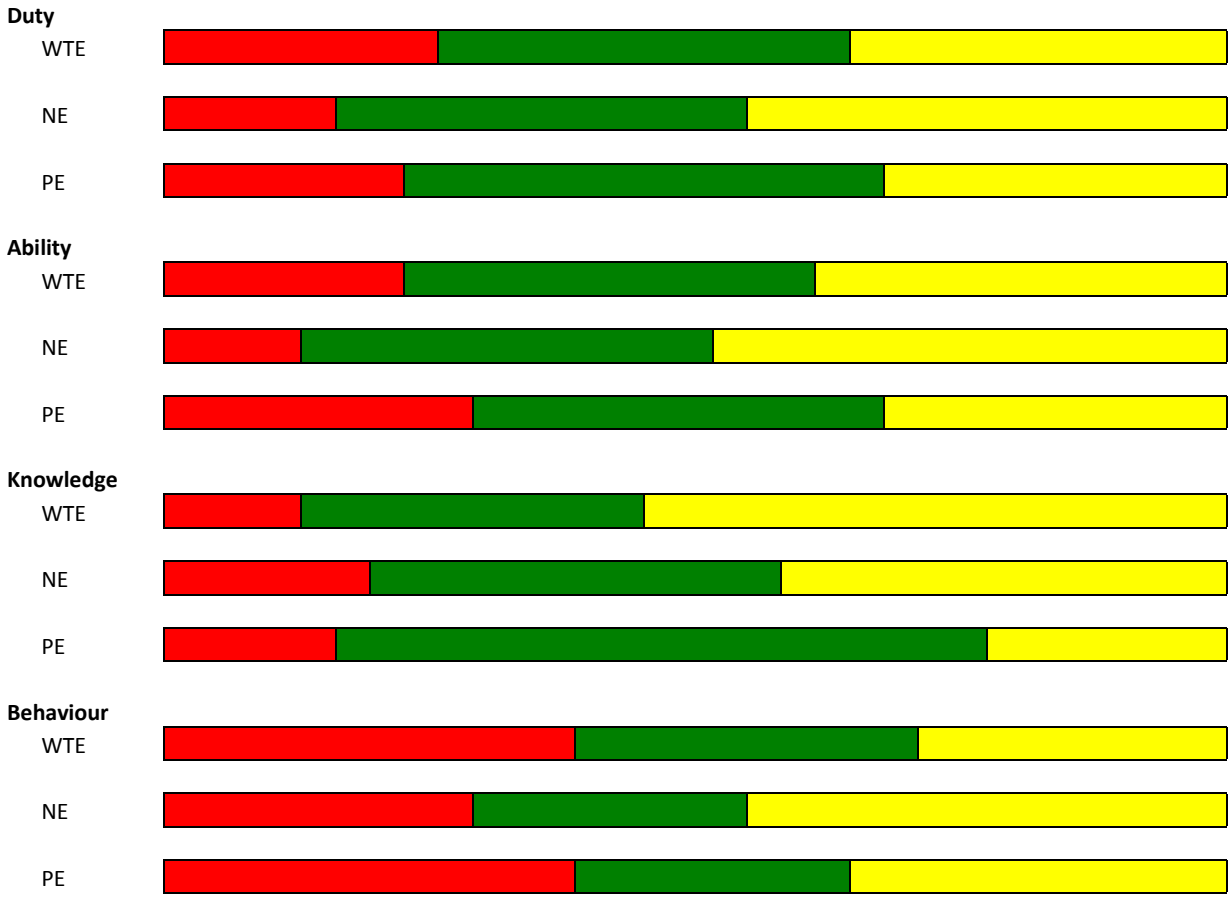

Figure 11: Bar Chart Display of Future WATER TREATMENT ENGINEER Mapping Results

6.2.2 Overview of Gap Analysis

As stated the mapping is of two large excel files that represent each Future and Feeder Role Competency. From this we have extracted a higher level view of the competency gaps in terms of functional and technical knowledge and behaviours (in tabular format) to aid gap analysis and the up-skilling audit (which as an Education for Competence perspective).

	Functional Knowledge	Technical Knowledge	Behavioural
Common to all Feeder roles	Commercial & Contract Management Project Management Leadership & Management Stakeholder Management Commercial Negotiation Decision Modelling Risk Analysis Data Analysis & Metrics Managing Financial Resources Complex problem solving Customer Service Management Personal Knowledge Management Understanding of: Data Analytics Commercial brokering in Utility sectors Consumer education, incentives & consultation Systems analysis & evaluation Customer Experience & Impact analysis	(Utility) Supply chain Management Utility Network Planning & Management Risk Management & Reliability Engineering Water Sourcing Management (incl. upstream assessment & harvesting) Waste Water Treatment & Network Management Waste Management (incl. solid waste) Customer Service Management in Multi-Utilities Managing legal and environmental issues Manage activity compliance (to various procedures & regulations) ***Plus understanding of:*** Waste Water Industry Operations (Detailed) Chemical & Biological Characteristics Water Science Domestic & Industrial usage & regulations Renewable Energy Systems Multi-utility management Asset Management Environmental Compliance Sustainability (ESG) R&D in Waste Water Industry Weather Pattern Analysis Waste Water Technologies Water/Waste Urban design Materials & Composites	Analytical (i.e. cope with complexity) Commerce-orientated Customer-orientated Proactive Resilient Rigorous Persuasive Resourceful Empathetic IT literate (high level) Think laterally Spatial orientation

Network Engineer		Process modelling Waste Water Treatment Construction Contract Management Analytical Science Water Distribution ***Plus Understanding of:*** Chemistry Water Quality Regulation Environmental Regulation& Law	
Process Engineer		Network Design & Modelling Construction Contract Management Managing Operational resources Water Distribution Waste Water Treatment Waste Water Network ***Plus Understanding of:*** Site Health and Safety and Construction Design and Management requirements Water & Water Quality Regulations	Depend on level & experience of process engineer - so may be other behavioural competencies here
Water Treatment Engineer		Network Design & Modelling Process Modelling Water Distribution Waste Treatment Waste Water Network Managing Operational resources ***Plus Understanding of:*** Waste Water Quality Regulations	

6.3 Waste Future Role Mapping to Feeder Roles

6.3.1 Results of Mapping

The Future Commercial Director of Resource Operations role was mapped to the three identified Feeder roles of **Head of Sustainability (internal role)**, **Senior Resource Efficiency and Waste Consultant** and **Carbon Broker**. As shown in the table below, the mapping provides fair validation of the Feeder roles as the research identified the Commercial Director of Resource Operations is a complex multi-faceted role and to a large degree a new type of role.

The Senior Resource Efficiency and Waste Consultant Feeder role has the lowest competency gap and strongest overlap primarily due to coverage in waste and resource efficiency knowledge. However, the relative gap between Senior Resource Efficiency and Waste Consultant and Head of Sustainability is minor although up-skilling will be required in different areas. The Head of Sustainability has the lowest behavioural competency gap.

The Carbon Manager has the greatest gap which is not surprising given the fact this role is focused on carbon rather than broader resource efficiency or sustainability areas.

This Future role has the highest overall competency gap between Future and Feeder roles (compared to other sector Future roles) which may in part indicate that the Future competencies may relate to more than one role and/or the Feeder roles need extending.

Mapping of Future Commercial Director of Resource Operations to Feeder roles ranking:

Feeder Role		Gap	Overlap	Not Required
Head of Sustainability	Duty	0.67	0.33	0.4
Head of Sustainability	Ability	0.58	0.42	0.35
Head of Sustainability	Knowledge	0.65	0.35	0.53
Head of Sustainability	Behaviour	0.43	0.57	0.21
Total		***2.33***	***1.67***	***1.49***
Senior Resource Efficiency & Waste Consultant	Duty	0.65	0.35	0.41
Senior Resource Efficiency & Waste Consultant	Ability	0.62	0.38	0.36
Senior Resource Efficiency & Waste Consultant	Knowledge	0.36	0.64	0.43
Senior Resource Efficiency & Waste Consultant	Behaviour	0.62	0.38	0.41
Total		***2.25***	***1.75***	***1.61***
Carbon Broker	Duty	0.66	0.34	0.39
Carbon Broker	Ability	0.61	0.39	0.30
Carbon Broker	Knowledge	0.65	0.35	0.52
Carbon Broker	Behaviour	0.64	0.36	0.39

Total	***2.56***	***1.44***	***1.6***

In addition, comparative bar charts are provided to provide a high level visual view of the mapping results for duty, ability, knowledge and behaviour. The red section is the gap, the green is the overlap and the yellow is the discrepancy (not required).

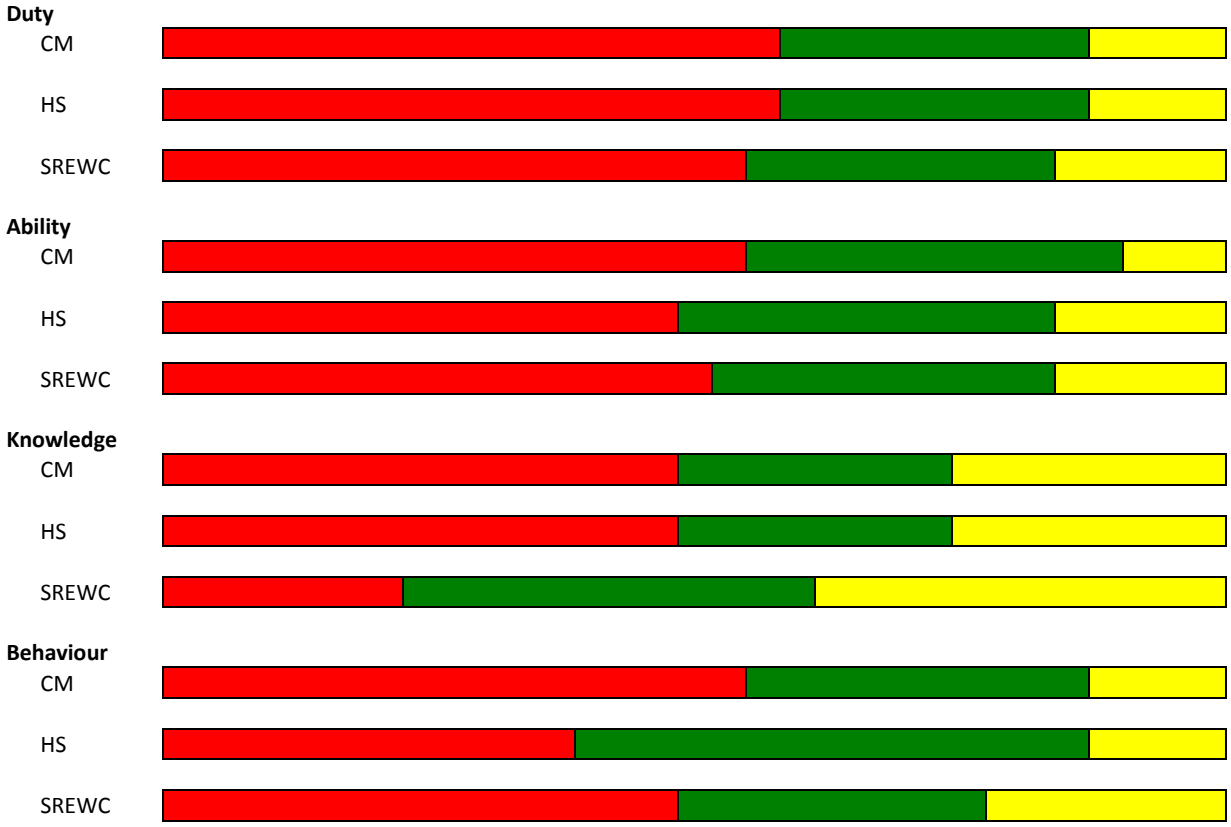

Figure 12: Bar Chart Display of Future COMMERCIAL DIRECTOR OF RESOURCE OPERATIONS Mapping Results

6.3.2 Overview of Gap Analysis

As stated the mapping is of two large excel files that represent each Future and Feeder Role Competency. From this we have extracted a higher level view of the competency gaps in terms of functional and technical knowledge and behaviours (in tabular format) to aid gap analysis and the up-skilling audit (which as an Education for Competence perspective).

	Functional Knowledge	Technical Knowledge	Behaviours
Common to all roles	Stakeholder Management Commercial & Contract management Project Management Leadership & Management Commercial Negotiation Supply Chain Management Whole life Costing Portfolio Management Managing Financial Resources Capital Investment Planning Complex problem solving Customer Service Management Personal Knowledge Management Understanding of: Public relations Commercial brokering Corporate Sustainability & responsible resourcing Customer education, incentives & consultation System analysis & evaluation Process improvement (6sigma)	Opportunity qualification & pipeline management Managing waste product supply chain Brokering & managing value streams Customer service management Customer sustainability strategy advise & support New resource viability assessment Waste stream collection analysis & management Cost reduction management Risk management & reliability engineering Managing a team of technical specialists Managing legal & environmental issues Manage activity assurance (to procedures & regulations) Understanding of: Commercial, statutory, & environmental policy & regulations	Action-orientated Customer-orientated Empathetic Commercial- orientated Strategy-orientated Entrepreneurial Finance-aware Culture-aware Resilient Innovative Networked Think Laterally Analytical (i.e. cope with complexity) Persuasive Resourceful Rigorous Technology-aware IT-literate

		Environmental Compliance Monitoring & incentives Waste/Energy Markets & Standards Waste, water, material & carbon policies & regulations International water policies Asset Management development lifecycle Sustainability innovation Chemical Analysis Material Science (incl. Composites) Biological processes Renewable energy systems such as Anaerobic Digestion processes Ecology R&D & innovation in materials, recycling technologies Lean/agile product design Customer psychology & buying behaviour	
Senior Resource Efficiency & Waste Consultant		***Key gap:*** Waste brokering & supply chain management within international market place plus depth/breath of chemical & biological processes	

Head of Sustainability (Internal)		**Key gap:** Waste water management & waste brokering & supply chain management within international market place	
Carbon Manager		**Key gap:** Understanding & experience of waste & resource management & waste brokering & supply chain management within international market place	

6.4 Gas Future Role Mapping to Feeder Roles

6.4.1 Results of Mapping

Gas Network Planner role was mapped to the three identified Feeder roles of (current) **Network Planner**, **Energy Demand Manager** and **Network Maintenance Planning and Performance Manager**. As shown in the table below, the mapping provides good validation of the Feeder roles which is what was envisaged from discussions with sector experts.

The Network Maintenance Planning and Performance Manager Feeder role has the lowest competency gap and strongest overlap in part due to range of duties but also key behaviours associated with the Future role. The Network Planner is very similar to the Network Maintenance Planning and Performance Manager Feeder role, in terms of the extent of the knowledge gap. The Energy Demand Manager has the largest gap, which may partially reflect the more strategic long term planning nature of this role (often covering gas and power sectors).

Mapping of Future Gas Network Planner to Feeder roles ranking:

Feeder Role		Gap	Overlap	Not Required
Network Planner	Duty	0.67	0.33	0.28
Network Planner	Ability	0.63	0.37	0.31
Network Planner	Knowledge	0.58	0.42	0.32
Network Planner	Behaviour	0.55	0.45	0.34
Total		***2.43***	***1.57***	***1.25***
Energy Demand Manager	Duty	0.75	0.25	0.42
Energy Demand Manager	Ability	0.74	0.26	0.50
Energy Demand Manager	Knowledge	0.69	0.31	0.30
Energy Demand Manager	Behaviour	0.60	0.40	0.43
Total		***2.78***	***1.22***	***1.65***
Network Planning & Maintenance Performance Manager	Duty	0.58	0.42	0.35
Network Planning & Maintenance Performance Manager	Ability	0.56	0.44	0.42
Network Planning & Maintenance Performance Manager	Knowledge	0.57	0.43	0.45
Network Planning & Maintenance Performance Manager	Behaviour	0.36	0.64	0.48
Total		***2.07***	***1.93***	***1.67***

In addition, comparative bar charts are provided to provide a high level visual view of the mapping results for duty, ability, knowledge and behaviour. The red part is the gap, the green is the overlap and the yellow is the discrepancy (not required).

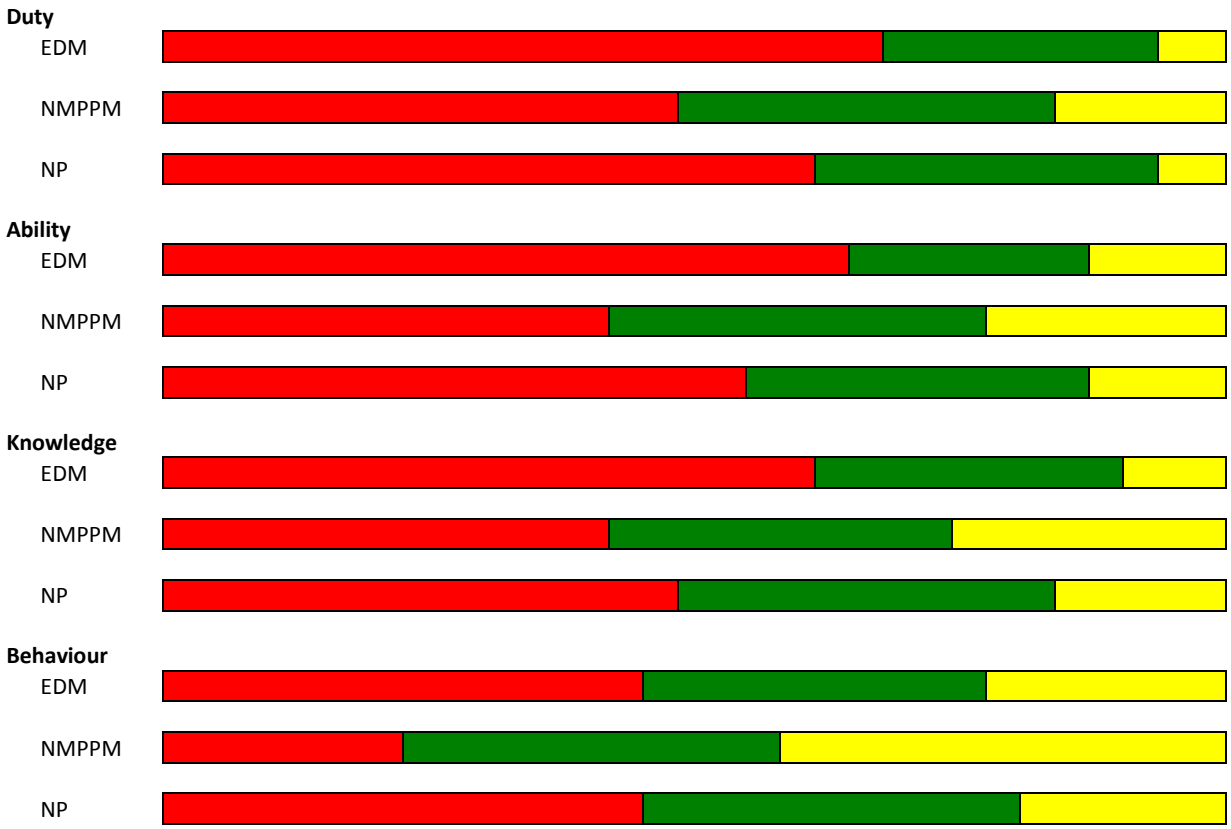

Figure 13: Bar Chart Display of Future GAS NETWORK PLANNER Mapping Results

6.4.2 Overview of Gap Analysis

As stated, the mapping is of two large excel files that represent each Future and Feeder Role Competency. From this, a higher level view of the competency gaps has been extracted in terms of functional and technical knowledge and behaviours (in tabular format) to aid gap analysis and the up-skilling audit (which as an Education for Competence perspective).

	Functional Knowledge	Technical Knowledge	Behaviours
Common to all roles	Stakeholder Management Project Management Customer Service Orientation Cost Modelling Risk-based modelling Simulation & modelling (3D etc.) Real time monitoring Dynamic Management Information (MI) Reporting Capital Investment Planning Leverages modern ICT to deliver results Personal Knowledge Management Understanding of: Data analytics (i.e. incl. predictive & big data) Environment & social impact, sustainability & governance	Upstream assessment & planning Utility operational economics AD processes & management Gas Quality & Property Analysis across a network Gas sourcing & transportation Multi-network optimisation processes New input application & impact assessment Integrity Risk Assessment Managing safe operations on the network & more proactive planning Managing network strategic partnerships Manage activity compliance (to various procedures & regulations) Understanding of: Gas transmission & distribution Chemical properties of gas incl. shale, bio-methane Bio-methane injection Power to Gas Weather Pattern Analysis Asset Management Cost engineering & control? R&D in Energy & Utility sectors	Action-orientated Analytical Articulate Resilient Culture-aware Networked Customer-orientated Detail-aware Rigorous Proactive Technology-aware Confident IT Literate

Network Maintenance Planning & Performance Manager		Utility Network Planning & Management Application of 3D drafting & GIS technologies Risk assessment of new input applications Understanding of: Gas quality analysis Fluid dynamics & pressure management Energy & environmental regulations & incentives Carbon reduction Energy Security Customer behaviour & influence	
Network Planner	Continuous improvement techniques	Connecting sources of unconventional Gas Incident management & risk assessment compliant to regulations & service agreements IMR techniques & NDE procedures Understanding of: Remote monitoring, governor interface technologies & ICT Commercial aspects of planning in multi-utility sector Energy & environmental regulations & incentives Demand-side dynamics (gas diversification) Energy Security Carbon reduction	

Energy Demand Manager (not a strong match as Feeder role)	Continuous Improvement	Utility Network Planning & Management Gas Management Gas Network Analysis Service Level Management Major Incident procedures Application of 3D drafting & GIS technologies Understanding of: Environmental Permitting Duty of Care Fluid dynamics & pressure management Gas qualify specifications & regulations Gas quality analysis Planning & statutory regulations & procedure Broader environmental & H&S regulations	

6.5 Power Future Role Mapping to Feeder Roles

6.5.1 Results of Mapping

The Future Power Balancing Technician role was mapped to the three identified Feeder roles of **Power Systems Analysis Engineer**, **Electrical Control Room Engineer** and **Transmission Control Engineer**. As shown in the table below, the mapping provides strong validation of two of the Feeder roles. The Power Systems Analysis Engineer mapping to the Future Power Balancing Technician role has the highest competency gap and correlates with sector feedback that this is a role in its own right, and a senior one.

The Transmission Control Engineer Feeder role has the lowest competency gap and strongest overlap. The Electrical Control Engineer Feeder role has a larger gap than the Transmission Control Engineer in duty and activities but a similar extent of knowledge and behavioural gaps.

This Future role has the highest range of competency gap of Future to Feeder roles compared to other sector Future roles.

Mapping of Future Power Balancing Technician to Feeder roles ranking:

Feeder Role		Gap	Overlap	Not Required
Power Systems Analysis Engineer	Duty	0.73	0.27	0.59
Power Systems Analysis Engineer	Ability	0.74	0.26	0.53
Power Systems Analysis Engineer	Knowledge	0.76	0.24	0.61
Power Systems Analysis Engineer	Behaviour	0.75	0.25	0.5
Total		***2.98***	***1.02***	***2.23***
Electrical Control Room Engineer	Duty	0.64	0.36	0.47
Electrical Control Room Engineer	Ability	0.69	0.31	0.54
Electrical Control Room Engineer	Knowledge	0.45	0.55	0.65
Electrical Control Room Engineer	Behaviour	0.46	0.54	0.1
Total		***2.24***	***1.76***	***1.76***
Transmission Control Engineer	Duty	0.42	0.58	0.49
Transmission Control Engineer	Ability	0.41	0.59	0.58
Transmission Control Engineer	Knowledge	0.43	0.57	0.62
Transmission Control Engineer	Behaviour	0.61	0.39	0.54

Total	***1.87***	***2.13***	***2.23***

In addition, comparative bar charts are provided to give a high level visual view of the mapping results for duty, ability, knowledge and behaviour. The red section is the gap, the green is the overlap and the yellow is the discrepancy (not required).

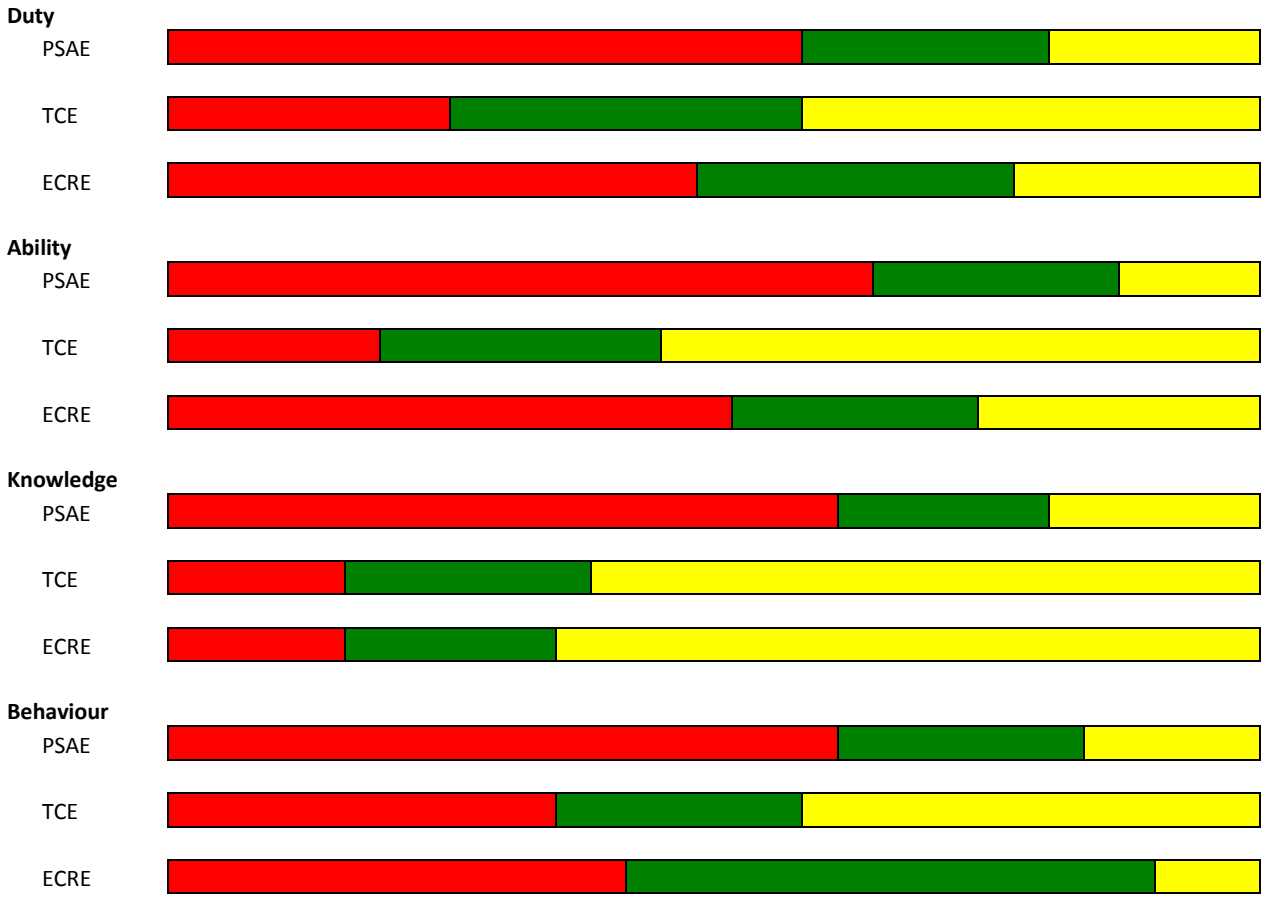

Figure 14: Bar Chart Display of Future POWER BALANCING TECHNICIAN Mapping Results

6.5.2 Overview of Gap Analysis

As stated, the mapping is of two large excel files that represent each Future and Feeder Role Competency. From this, we have extracted a higher level view of the competency gaps in terms of functional and technical knowledge and behaviours (in tabular format) to aid gap analysis and the up-skilling audit (which as an Education for Competence perspective).

	Functional Knowledge	Technical Knowledge	Behaviours
Common to all roles	Stakeholder Management Commercial & Contract Management Customer Service Management (incl. incentives & rewards) Cost/Benefit Analysis Risk-based modelling Simulation & modelling (3D etc.) Real time monitoring Dynamic Management Information (MI) Reporting Leverages modern ICT to deliver results Personal Knowledge Management Understanding of: Data analytics (i.e. incl. predictive & big data) Social networking & communication channels Environment & social impact, sustainability & governance	Dynamic balancing on decentralised network Power Systems Engineering Smart Grid & Smart Technologies (from customers to forecasting) Active Demand Management (incl. new players such as demand aggregators) Energy Trading & variable pricing Balancing option analysis & impact assessment Options Analysis (incl. simulation) & predictive forecasting Managing & responding to emergencies Integrity Risk Assessment across distributed network Managing safe operations on the network & more proactive planning Managing network strategic partnerships Manage activity compliance (to various procedures & regulations) Understanding of: Smart Grid Demand Aggregation Current renewables (incl. biomethane injection)	Action-orientated Analytical Logical Numerate Articulate Resilient Networked Customer-orientated Commercial-aware Detail-aware Rigorous Proactive Technology-aware Persuasive IT Literate

		Power to Gas options & cross sector R&D (i.e. network option analysis?) AD process Regulatory settlements & pricing mechanisms Distribution cost/efficiency parameter & downstream/customer implications Energy Security (within international marketplace) Asset Management Weather Forecasting; Climate impact on network asset Customer attitudes to usage & incentives R&D in Energy & Utility sectors Simulation/Emulation technologies to test/learn scenarios	
Transmission Control Engineer		Power Distribution Network Operations ***Understanding of:*** Energy Renewables Energy & environmental regulations & incentives	
Electrical Control Room Engineer		Power Transmission Front end engineering design Cost modelling ***Understanding of:*** Energy Renewables Energy & environmental regulations & incentives	

6.6 Summary & Cross Sector Analysis

As well as the mapping of Future and Feeder roles profiles, a manual analysis of functional and knowledge dimensions was completed across all 16 of the Future and Feeder role profiles (see Section 3). Owing to its very nature as a piece of foresight research, the competency assessments may not be comprehensive. However, they do validate the functional breadth of the different future roles, such as the Future Commercial Director of Resource Operations role versus the Power Balancing Technician role, for instance.

In addition, as captured in Section 6, a high level Sector-specific manual analysis, based on the Future Role Specific Competency Model, was used to identify functional and technical knowledge and behaviours to aid gap analysis and the up-skilling audit. This identified common knowledge gaps across most Future roles, including but not limited to customer service, stakeholder management, risk-based modelling, real-time monitoring and data analytics.

The Future Water Treatment Engineer Role has the lowest overall competency gap, with the Future competencies being more of a new *combination* of competencies rather than entirely new competencies in their own right. Existing competencies may need to be combined with new competencies, such as upstream assessment and harvesting. There are some new functional competencies concerned with the more commercial aspect of the role and new dimensions required in relation to behavioural competencies.

Unsurprisingly, as a complex role, the Future Waste Commercial Director of Resource Operations has the highest overall competency gap across functional, technical and behavioural competencies. In addition the research identified that there was a high level of technical competence required for this role and that potentially the required Future competencies relate to more than this one role. Key competencies identified concerned supply chain management, pipeline management, consumer psychology, ecology and portfolio management.

The Gas and Power Future roles have a similar level of 'medium' competency gap but the Power Future role has the largest range in competency gaps across its three Feeder roles. This is because the 'Power Systems Analysis' Engineer Feeder role is a more senior level role than is currently the case. The larger competency gap for these two Future roles is due to more functional and behavioural competencies with enhanced technical capabilities in risk-based modelling and simulation.

If we look across the four sectors, we can identify where the most significant gaps in existing competencies are:

- Key functional competencies common across all sectors were improved project management professionalism, stakeholder management, commercial awareness and customer service management
- The Waste Future role has a number of new competencies concerned with markets, brokering and value stream management as well as deeper understanding of regulations and environmental and social governance

- For both the Waste and Water Future roles, a significant gap concerns breadth and depth of chemical and biological processes, as well as environmental risk management
- The increase in decentralisation and smarter, more real-time demand-sensing, technological approaches requires new analytical, modelling and risk management competencies in the Gas and Power sectors
- Behavioural competencies (such as resilience, ability to 'think on your feet', IT literacy or e-skills etc.) were identified as being particularly important to the higher level roles in the Waste and Water sectors but also important to all Future roles. This provides evidence for the need for a common cross sector behavioural competence framework.

7. Re-skilling Pathways Audit

7.1 Introduction

On completion of the competency gap analysis between 'Future' and 'Feeder' roles for each sector, the next step was to audit the availability and coverage of re-skilling pathways. *Re-skilling has two key elements:*

Up-skilling	Promoting an existing employee into a skill-set at the next level up (e.g. from level 4 to 5)
Cross-skilling	Moving an existing employee from one skill-set to another at the same level (e.g. from one level 4 skill-set to another level 4 skill-set

The scope of the audit was to identify all existing re-skilling pathways that would enable an individual performing any of the Feeder roles to gain the necessary additional competencies to perform the Future role. The pathways were not to be limited to formal training/learning (which is often linked to a qualification).

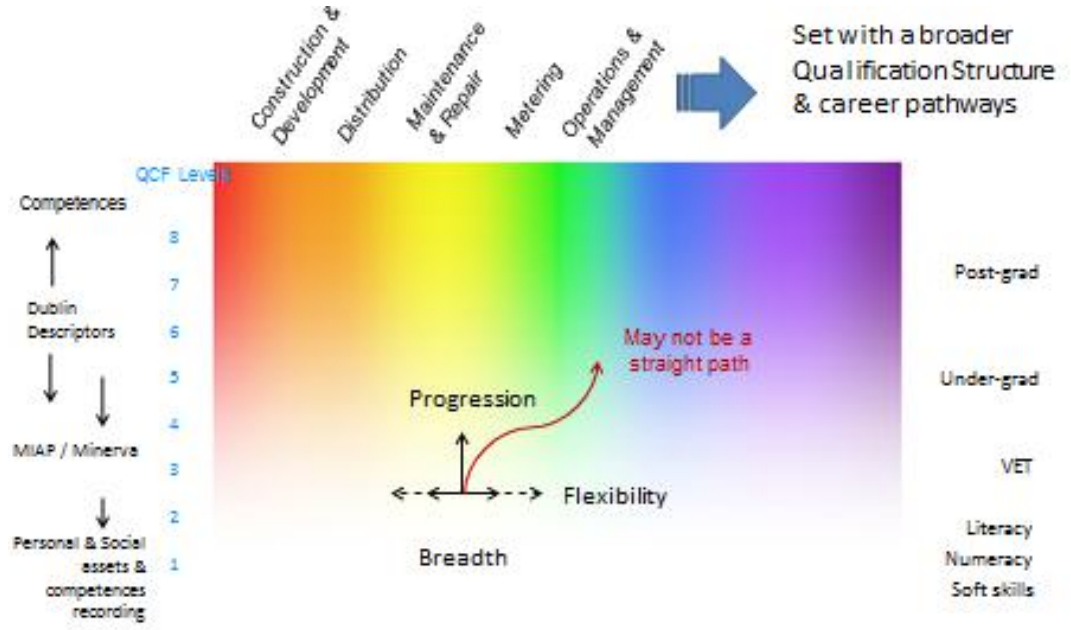

Figure 15: Breadth, Flexibility & Progression

As shown by the diagram above, when considering up/cross-skilling, the three dimensions of breath, flexibility and progression need to be considered. In assessing the extent of availability and coverage of up-skilling and cross-skilling pathways, consideration was given in terms of how well they met the criteria of modular, independent, flexible and verified solutions. In addition, the analysis should identify where there is inadequate up-skilling or cross-skilling pathways (i.e. gap analysis) that need to be developed. The skills pathway audit also included identifying, where possible, any new pathways that are in development. The scope of the re-

skilling pathway audit was based on identifying availability and coverage of key[15] re-skilling pathways across four key elements:

- QCF qualifications (which are often only knowledge based)
- Academic Qualifications (some of which have an work experience component)
- Vocational Qualifications (i.e. require demonstration of work competence)
- Occupationally directed work-based training (where information available).

This was collated in Excel format (see Appendix 4) for each sector in relation to the Future role as well as cross sector analysis (at a high level) in project management, supply chain management, leadership and management and environmental and social governance (ESG).

There can be multiple routes to acquiring a particular skill set and an up-skilling pathway can be implemented by different means (which are often a combination of learning through experience, exposure to others (i.e. peer2peer learning) and training and education).

In the methodology section (section 3) of this report it described why competence is viewed from an 'educational and training' context for the re-skilling audit and pathways. In this case the focus is on knowledge as subject matter[16] in the context of learning and its outcome. There is no sector adoption of a standard way to describe learning outcomes[17] only the more common approach of defining knowledge subjects or topics related to development, training and qualifications[18]. In addition the gap between current NOS and NOS needed for Future roles implies there will be in skill and knowledge up-skilling provision.

Of course, re-skilling is not only about knowledge acquisition and formal qualifications, but also the accumulation of operational experience. The lack of formal skills models and means to testify skills mean that the skills pathway audit was focused on the perspective of Education for Competence. However, the interviews provide additional (but subjective) insight into the experience requirements of Future roles (see section 4).

As stated early in the report there are no sector or cross sector behavioural frameworks but changing/enhancing behaviours was identified as key to most Future Roles, particularly those at higher levels such as Waste and Water roles. The identification of behavioural requirements related to qualifications and training that support ups-skilling are either not considered or rarely explicit. So, the up-skilling focuses more on functional and technical (operational) skills and knowledge.

Not all sectors are at the same level of maturity in terms of re-skilling pathways; with the Waste and Power sectors being the most mature with a longer term view of training and workforce investment. In the Water and Gas sectors there is a drive to minimise cost and rely on sub-contractors and no longer term workforce planning or investment in apprenticeships.

[15] The scope and tight timeframe of this research meant focused coverage; and there may well be other provision and re-skilling pathways that have not been identified
[16] Many training courses and qualifications typically provide a curriculum view rather than learning outcome view
[17] Such as the learning outcome standard
[18] Qualifications based on occupational standards (NOS) provide a more holistic view of competence

Stakeholders interviewed stated the risk was low in the short term but unlikely to be sustainable due to demographics tensions.

In addition in some sectors the envisaged re-skilling challenge, due to demographic changes, poor sector attractiveness[19] and lack of opportunity for cross sector mobility, also needs to be factored into the up-skilling Future provision.

7.2 Water Sector Re-skilling Audit

7.2.1 Re-skilling Availability and Coverage

The competency mapping of Future to Feeder Roles identified gaps in the skill-sets shown in in section 6. The mapping provides strong validation of the three Feeder roles but with the larger gap concerning behavioural competencies. As stated in section 5 Feeder roles were typically identified at Level 3 and the Future role at a minimum of Level 4.

The Future Water Treatment Engineer is a complex role with process, network and commercial dimensions. This role requires a high level of technical competence and a broad base of biochemical knowledge within a context of the grey economy and increased environmental and social risks. In addition this Future role technical risk level is higher due to Future environmental sustainability concerns. In addition, some stakeholders interviewed felt this role would remain more of a technical role and that the 'sales' side of the process would be done by other people.

The competency profiling of this Future role identified some new key functional competencies (some of which are cross sector) and new behaviours that would not be common to current Feeder roles (e.g. customer-orientation). Thus the re-skilling concerns a broader number of skill-sets need for different pathways depending on whether re-skilling is from a Network Engineer or Process Engineer or a Water Treatment Engineer. In effect the Future Water Treatment Engineer role relates to a new combination of technical competencies and some new functional and behavioural competencies.

The audit identified new qualifications in development; a key one being a new CABWI Level 4 Diploma in Water Industry Operations and Management. This new qualification will have multiple paths, structured in terms of mandatory units, operational pathways, business pathways as well as support units and alternative units. A qualification structured in this way will enable progression from the Feeder roles into the Future Water Treatment Engineer role. In addition, EU Skills has a programme of development of Higher Apprenticeships but Water has yet to be delivered, although it would be highly beneficial in terms of up-skilling potential.

Most stakeholders interviewed felt critical experience in water process design and network operations was fundamental for this role and that typically a person in this role would be a

[19] In sectors such as Power and Gas there is considerable poor public perception that these industries are attractive

Chartered Engineer or Scientist (particularly if working on larger scale projects) and probably have or be working towards Association of Project Management Practitioner and/or a Leadership and Management qualification.

A detailed Excel sheet of existing qualifications and training provision is provided in Appendix 4. There is good availability and coverage of up-skilling pathways for the Future Water Treatment Engineer, particularly in terms of technical competencies (e.g. breadth of waste and water processes and networks). The new CABWI Level 4 Diploma will also provide greater coverage of functional up-skilling in areas such as customer service, project management etc.)

There is cross over with the Waste Sector Future role up-skilling requirements, both in terms of functional skills and operational/technical knowledge. This is discussed in more detail in Section 7.6.

7.2.2 Analysis of Re-skilling Provision

In general there is good provision of more technical competency re-skilling pathways. There is a transition gap between level 3 and 4 but the new CABWI Level 4 Diploma should cover this. It may also be possible to influence the development of this new Diploma so it addresses some of the functional (e.g. stakeholder & commercial management) and behavioural competencies required for this Future role.

In addition, there is potential for additional pathways between Levels 3-4 and 4-5 to increase options and flexibility. Furthermore, there is plenty of coverage of cross-skilling pathways in Project Management, Leadership and Management which the sector could be more cognisant of.

There is some behavioural competency availability, such as accredited behavioural courses from Develop Training, but these are not based on any common framework.

Some stakeholders interviewed felt that individuals should be trained and developed in-house from a range of backgrounds. As raised in Section 5, a broad range of secondary Feeder roles are pertinent. For example, as the role is focused in part on biological processes it could equally be undertaken by a Biologist or Chemist with appropriate development. So, there is a need for further pathway analysis to cover a broader range of Feeder roles.

7.3 Waste Sector Re-skilling Audit

7.3.1 Re-skilling Availability and Coverage

The competency mapping of Future to Feeder Roles identified gaps in the skill-sets shown earlier in this report. The mapping provides reasonable validation of the Feeder roles but with the larger gap concerning functional and behavioural competencies. As stated in Section 5, Feeder roles were typically identified as being at Level 4 and the Future role at a minimum of Level 5.

The competency analysis identified this external facing role had key commercial, brokerage, regulatory, sustainability and technical dimensions. Stakeholders interviewed felt that this Future role required a high level of technical competence due to the environmental risk level and breadth of technical knowledge required. However, the breadth of technical competencies required across waste/water management, resource efficiency, and sustainable environmental management indicates the breadth of up-skilling required.

The competency analysis and research identified a high level of technical competence[20] requirement; in terms of Chartered Institution of Wastes Management/ WAMITAB (Awarding Organisation) Operator Competence Scheme this would be at the highest level. CIWM/WAMITAB Level 4 Certificate in Waste and Resource Management (code VRQ6a) is a key qualification here which many stakeholders felt was a foundational qualification for the Future Commercial Director of Resource Operations role. The mandatory units in this qualification provide good coverage of environmental protection, stakeholder management, legislation and principles of sustainable waste and resource management.

The breadth of functional competencies required for this Future role requires up-skilling in supply chain management, project management and environmental and social governance. As shown in Appendix 4 there are relevant pathways available here. There is also some bespoke behavioural training provision.

Experience in biological, chemical or multi-skilled engineering was seen as critical by stakeholders and that typically a person in this role would be a Chartered Engineer or Scientist and have or been working towards a Master in Sustainability or Logistics and Supply Chain Management. In addition, stakeholders interviewed were of the view that individuals in this Future role should also have, or be working towards, Advanced Project Management Practitioner status and/or a Leadership and Management qualification, alongside training in Lean/6Sigma.

There is strong availability and coverage (waste, resource efficiency, sustainable environmental management, technologies etc.) across the necessary upskilling and cross skilling pathways.

There is cross over with the Waste Sector Future role up-skilling requirements both in terms of functional skills and operational/technical knowledge. This is discussed more in section 7.6.

7.3.2 Analysis of Re-skilling Provision

There is good availability and coverage of up-skilling provision for this role. There is potential for a new transition qualification from levels 4 to 5/6. As stated earlier stakeholders interviewed felt a person in this role should have or be working towards a Masters in Sustainability and there is good coverage in this domain.

[20] See CIWM/WAMITAB Hierarchy table for technical competence

The CIWM/WAMITAB Level 4 Certificate in Waste and Resource Management was identified as a critical foundational qualification for this Future role. Feeder roles such as the Head of Resource Sustainability (internal role) and Carbon Manager would need to take this up-skilling pathway to move into the Future role.

The research identified that many stakeholders felt that the Future competencies would be covered by more than one role and the up-skilling provision would support this. In addition, this Future role may require more mandatory continuing professional development (CPD) to provide assurance of technical competencies associated with environmental risk.

7.4 Gas Sector Up-skilling Audit

The competency mapping of Future to Feeder Roles identified gaps in the skill-sets shown in section 6. The mapping provides good validation of the three Feeder roles but with the larger up-skilling gap concerning functional and behavioural competencies. As stated in section 5 Feeder roles were typically identified as being at Level 3 and the Future role at Level 4.

There is no real coverage of any of the behavioural competency requirements or related functional skills (such as high level modelling & simulation) derived from the real-time nature of the Future role. There is some good coverage of commercial, cost engineering and project management competencies.

Research identified a new Gas Network Technical qualification at level 3 with City and Guilds[21] which will probably cover some elements of Future Gas Network Planner technical competencies and provide a useful transition qualification.

It had been identified for some time that there is a gap in the up-skilling pathway for gas network planning at Level 4 to 5 which is critical to this Future role. In addition EU Skills has a development programme of Higher Apprenticeships. The Gas Higher Apprenticeship has yet to be delivered but it would be highly beneficial in terms of up-skilling. Any new pathway should consider the Future functional and behavioural competency requirements.

There is also poor coverage in terms of higher qualifications compared to other sectors. There is a Foundation Degree in Gas Transmission Engineering (Aston University) which covers some foundation knowledge (e.g. gas engineering principles) but does not address the up-skilling technically in gas planning and distribution as well as the functional and behavioural competencies of Future Gas Network Planner.

There is an MSs/PgDip in Gas Engineering and Management which does provide good coverage of up-skilling technical skills (e.g. distribution and transmission systems, gas flow & network analysis) as well as functional areas such as ‘Business and Gas Project Management’. However, there is no transition pathway to this qualification and is at two higher a level for Future Gas Network Planner role.

[21] At the time of research detailed information on this was not available

Engineering experience particularly of gas network analysis was seen as critical by stakeholders and that typically a person in this role would have an Engineering Qualification such as HNC degree or equivalent. A person in this role might be a Member of Gas Engineering & Managers or working towards Incorporated Engineer. A person in this Future role would also be expected to be working towards Association of Project Management Practitioner or equivalent qualification. They would also need to be skilled in 3D drafting and Geographic Information Systems (GIS).

The research interviews identified that up-skilling is more likely to be via internal work experience (e.g. shadowing, team working and mentoring) and training rather than qualifications.

7.4.1 Analysis and Comments

In this sector, there is an existing Network Planner role. Current Network Planners would typically enter at QCF Level 2 or 3 and then complete an Advanced Apprenticeship to develop operational skills (such as mains laying or services laying skills). In some cases graduates (who have often studied Civil Engineering or related disciplines or HNC) are recruited into network analysis roles and up-skilled on-the-job mentoring and internal training. There is, however, no formal Accreditation of Prior Learning/Experience (APL) competence certification route which would be highly beneficial in this sector.

Often current entrants will have had no formal training in the gas sector. There has been little demand (due to short term outsourcing approaches within the sector) for higher level qualifications but this will not address the sector demographic changes of the Future. In addition the nature of this 'conservative' sector means that there is a need for a skills campaign and new smarter models of competence acquisition and retention.

It had been identified for some time that there is a gap in the up-skilling pathway for gas network planning at level 4/5 which is critical to this Future role. This gap needs to be closed urgently and plans by EU Skills and Aston University to increase provision need to be accelerated. There is overlap between the Power and Gas Future role competencies and cross-sector up-skilling should be enabled.

7.5 Power Sector Re-skilling Audit

7.5.1 Re-skilling Availability & Coverage

The competency mapping of Future to Feeder Roles identified gaps in the skill-sets shown in section 6. The mapping provides good validation of two of the Feeder roles but with the larger gap concerning functional and behavioural competencies. As stated in section 5 Feeder roles were identified as typically at level 2-3 and the Future role at levels 3-4.

The research validates that this Future role will be a cross over between a Control Room Engineer and a Transmission Engineer; two of the Feeder roles with a strong overlap to the

Future role. The Power Systems Analysis Engineer Feeder role is a more senior role and thus not included in the skills pathway audit.

The National Skills Academy for Power had recently completed research on the availability and quality of training provision for the renewable power sector. This identified that there was reasonably good coverage except in certain areas pertinent to up-skilling this Future role, such as emergency management, project management and risk management. However, there are gaps in current provision such as health & safety, quality assurance, contracts, negotiations & agreements that raise concern in relation to the Future Power Balancing Technician role.

Pathways such as the Level 4 Diploma in Power Engineering (EAL) and Higher Apprenticeship in Power Engineering (National Skills Academy) provide good coverage in terms of up-skilling from Feeder roles to the Future role. However, they do not fully address the impact on skills and knowledge due to increased decentralisation in a more demand-led environment and increased adoption of smart technologies. In addition they do not address Future behavioural competencies required to support the Future pace and complexity of duties and tasks.

There is also good coverage in terms of higher qualifications covering both power engineering as well as renewable energy systems.

Engineering experience particularly of network operations and field experience was seen as critical by stakeholders and that typically a person in this role would have an Engineering Qualification (electrical or power) such as HNC degree or equivalent.

7.5.2 Analysis and Comments

There is good availability and coverage of up-skilling for the Future Power Balancing Technician role in this sector with key pathways to support the transition from levels 3-4. There is also coverage of both the power systems engineering as well as new sustainable and renewable power approaches and technologies.

The real time nature of this Future role will require increased resilience and responsiveness and this highlights the need for behavioural competencies to have increased importance in this sector.

There is a competence overlap between the Gas and Power Future roles which provides cross-skilling pathways. This should be investigated in more detail.

7.6 Skills Pathway Audit Summary

The re-skilling pathways audit identified the following key findings:

- There is good availability and coverage of up-skilling pathways for the Future Water Treatment Engineer particularly in terms of technical competencies. There is technical competency (and some functional) between the Water and Waste Future roles which provides cross-skilling pathways.

- The Future Commercial Director of Resource Operations role has the largest (and broadest) functional up-skilling requirement and there is strong availability and coverage.
- It had been identified for some time that there is a gap in the up-skilling pathway for Gas Network Planners at level 4/5 which is critical to this Future role. It is critical that this pathway is developed more extensively.
- At a more strategic level there is need for a skills campaign in the Gas sector and smarter more sustainable models of competence acquisition and retention.
- There is good availability and coverage of up-skilling for the Future Power Balancing Technician role both in terms of power systems engineering as well as new sustainable and renewable power approaches and technologies. There is competence overlap[22] between the Gas and Power Future roles which provides cross-skilling pathways.
- There is also good availability and coverage of common cross sector up-skilling in areas such as environmental and social governance.
- The new Water CABWI Level 4 Diploma in Water Industry Operations and Management qualification provides an excellent example of the Future design of skills pathways.
- For Future roles in Water and Gas there are some new pathways in development that need to be monitored as they are critical to Future up-skilling.

As outlined in the introduction the skills pathway audit focused on the perspective of Education for Competence; thus excluding the accumulation of experience. However, the competency analysis research clearly identified that although technical qualifications were key in some sectors (Waste and Water) that experience in most cases was considered more important that qualifications in terms of the Future roles.

[22] A more detailed mapping could be done in this area

8. Conclusions & Recommendations

8.1 Introduction

This report captures the analysis and findings of the Phase 2 Foresight research. This research has aimed to anticipate the detailed competency requirements of a selection of Future Roles in the energy and utility sector of 2030 and map these to the detailed competency requirements of a selection of Feeder roles, which currently exist in the sector. The research also aimed to identify gaps between these current and future competencies and assess the availability and quality of upskilling and cross skilling pathways to bridge this gap.

An element of this research was to test the overall methodology of selecting, analysing and comparing four Future roles and assessing the extent to whether the existing up-skilling pathways were 'fit for purpose' and to determine whether the approach could be replicated more widely. An implicit outcome of this project has been the development of a more robust methodology (see Section 3) that can provide a more sustainable skills solution for the sector.

In addition, the traditional methods of producing occupational competency standards are no longer fit for purpose in a more dynamic labour market where:

- An ageing and shrinking workforce is forcing changing work models and putting pressure on the supply of competence, e.g. profile in Power and Gas sectors
- Organisational structures are becoming flatter and thinner. This is leading to a move from role-based design and management to competency-based design and management. If we remove the role association and the assumed competences of the role we open a wider range of solutions for mapping
- Experience and knowledge are increasingly in demand; competence not capital is the constraint to business
- The transfer of experience and competence across contexts and sectors is critical and requires richer narrative descriptions of competences besides the formal definitions that can be profiled and mapped
- Training-centric or role-dedicated skill pathway planning typical fails to recognise the underlying principles in the face of the dynamic evolution of occupations and economic context (i.e. increase in portfolio work) and individuals personal aspirations and goals
- There is a growing trend for people to have a career and portfolio life which is conditioned by competence, experience, preference and availability. In context of EU Skill career portfolios across sectors could bring benefits.

8.2 Conclusions

Despite the lack of competency frameworks at the right level and no job title and description standardisation an EU Skills competency knowledge base was developed to support the competency profiling and mapping and skills pathway audit. In addition the natural

development of a Future Role Specific Competence model implies the need for the development of Future NOS (and knowledge base resulting from this project can be leveraged to support this).

The competence analysis of Future and Feeder roles takes the employment perspective. It is activity-oriented to identify abilities and behaviours for professional activities at work. The up-skilling audits and pathway analysis, however, seeks for insight or guidance on education and training. It is traditionally knowledge-oriented, focussed on *knowledge* as subject matter in the curriculum or development approach in the context of learning and its outcome.

A richer Future role synopsis and supporting DITLO case study was successfully derived as an outcome of the competency analysis. From this and other research activities (see section 5) Future and Feeder roles specifications were produced in each sector. The elements from all of these specifications provided a Future Role Specific Competency Model. This model was loaded into the competence knowledge base, integrated with NOS competencies to support competency profiling and mapping.

The competency profiling and mapping identified the following key findings:

- Good overall validation for all the Feeder roles; except for one in the Power Sector
- The Future Water Treatment Engineer Role has the lowest overall competency gap with the Future competencies being more of a new combination of existing competencies rather than entirely new competencies
- Not surprisingly, as a complex role, the Future Commercial Director of Resource Operations has the highest overall competency gap across functional, technical and behavioural competencies
- The Gas and Power Future roles have a similar level of 'medium' competency gap but the Power Future role has the largest range in competency gap across its three Feeder roles. This is because the Power Systems Analysis Engineer Feeder role is a more senior level role
- Key functional competencies common across all sectors were improved project management professionalism, stakeholder management, commercial awareness and customer orientation
- Behavioural competencies (such as resilience, proactive, IT literacy or e-skills etc.) were identified as being particularly important to the higher level roles in the Waste Management and Water sectors, but also important to all Future roles. This provides evidence for the need for a common cross sector behavioural competence framework.

The re-skilling pathways audit identified the following key findings:

- There is good availability and coverage of up-skilling pathways for the Future Water Treatment Engineer, particularly in terms of technical competencies. There is technical competency (and some functional) between the Water and Waste Future roles which provides cross-skilling pathways
- The Future Commercial Director of Resource Operations role has the largest (and broadest) functional up-skilling requirement and there is strong availability and coverage

- It had been identified for some time that there is a gap in the up-skilling pathway for Gas Network Planners at level 4/5 which is critical to this Future role. It is critical this pathway is developed and at a more strategic level there is need for a skills campaign and smarter more sustainable models of competence acquisition and retention
- There is good availability and coverage of up-skilling for the Future Power Balancing Technician role both in terms of power systems engineering as well as new sustainable and renewable power approaches and technologies. There is competence overlap[23] between the Gas and Power Future roles which provides cross-skilling pathways
- There is also good availability and coverage of common cross sector up-skilling in areas such as environmental and social governance.

8.3 Recommendations

8.3.1 Competency Analysis and Mapping Methodology and Outcomes

This research project demonstrated that competency analysis, mapping and management is a complex multi-faceted domain and that tools are needed to automate the processes. It also provides validation of the methodology and that it has the potential to be scaled and provide a more sustainable solution in the Future.

Although the focus of this research was role-based it is recommended that Future competency analysis and mapping is based on competency-based design and management. If we remove the role association and the assumed competences of the role we open a wider range of solutions for mapping. This includes the mapping of Future competency requirements to up-skilling pathways in a more integrated and standardised way (e.g. adoption of the learning outcome standard across the sectors).

The sector may wish to consider collaboration around development of a common cross sector behavioural competency framework. Behavioural competences are typically the more stable and context independent core of any competency model.

8.3.2 Skills Pathway Audit Approach and Outcomes

The approach is this research (see Section 3) was skills pathway auditing focused on the perspective of education for competence. Any further analysis needs to consider approaches that include 'experience' as well as knowledge acquisition and formal qualifications. There are new models entering the market to address this challenge (and those raised in the introduction) such as Global Experience Networks. There are four principle conditions to be met when fulfilling and connecting supply and demand – competence, experience, preference and availability.

[23] A more detailed mapping could be done in this area

Training-centric or role-dedicated skill pathway planning typical fail to recognise the underlying principles in the face of the dynamic evolution of occupations and economic context (i.e. increase in portfolio work) and individuals personal aspirations and goals.

In future, it will be important for the sector to assess potential for up-skilling pathways to be more modular, independent, flexible and verified. In addition, industry may wish to consider whether pathways should cover mandatory, operationally specific, business support and generic support pathways, whilst also addressing key behavioural competencies. The new Water CABWI Level 4 Diploma in Water Industry Operations and Management qualification provides an excellent example of the likely future design of up-skilling pathways.

This piece of in-depth research marks a first step for the energy and utility sector in understanding which upskilling and cross skilling pathways, some of which are currently under development, will be important for meeting future skills needs. This research has also enabled the sector to begin to understand the detail behind the high level strategic findings around the nature and extent of skills challenges up to 2030.