Towards a Skills Taxonomy for a Multinational Energy Technology Company

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ROA Report

Colophon

Content

1 Urgency of the research

Due to digitalization and decarbonization, the jobs and the skills that are demanded for these jobs change rapidly over time. This leads to challenges related to reskilling and strategic workforce recruitment choices. In response to the transformation in the energy market, energy technology companies are streamlining and innovating their portfolio and products. This leads to significantly changing skill demands.

As part of its strategy to make its workforce ready for the future – i.e., having the right skills at the right place at the right time – a multinational energy technology company engaged in a research cooperation with the Research Centre for Education and Labour of Market Maastricht University School of Business and Economics for research in the field of reskilling, strategic workforce choices, future skills and structural change tackling challenges related to decarbonization & digitalization.

Aim

In order to know the future skills needs, we first need to know what skills are needed today. The aim of the research – which was organized as a co-creation exercise with the company in question – we report on in this study was threefold:

1. To provide a **systematic overview of the current skills demand** at the company by identifying skills patterns in job vacancies.
2. To document to what extent vacancies for jobs result from **replacement of personnel or job growth** and document the distribution of **internal versus external hires**.
3. To provide a **comprehensive skills framework** and taxonomy of the most important skills for jobs at the company.

What does the company learn from this?

This project provides the company with three key output. First, using text description of past vacancies, dictionaries of skills description and input from interviews with HR practitioners (see Chapter 2 for description of our approach), we deliver a systematic overview of the top 20 most distinctive skills for each job-group at the company (e.g., Sales or Finance). This can be used by HR to 1) analyze what skills are currently asked in the recruitment process, 2) reflect on the extent to which such skills are in line with the

company's requirements and 3) adjust future job descriptions in accordance to upcoming skills needs.

Second, the comprehensive skills framework and taxonomy we develop provides a widely used common language, developed at a high level of aggregation, which makes it implementable across all job-groups and business units at the company.

Third, this project informs HR on the nature of vacancies: 1) the extent to which they result from replacement of personnel or job growth (addition of new personnel for jobs in growing demand), and 2) the extent to which these are filled via internal versus external hires, hereby providing insights on what skills are available within the organization and what skills have to be acquired from outside.

O*NET skills classification as an anchor

In so doing, we take the O*NET skills classification as our starting point, in which we anchor the skills patterns we derive from vacancies at the company. The O*NET skills taxonomy describes the knowledge, skills and abilities for thousands of occupations in the US (https://www.onetcenter.org). It is the most **commonly used** and overarching taxonomy of skills we are aware of. It is used in academic research to describe and understand the changing demand for skills[1], in personnel planning[2], and by international organization such as OECD[3] and World Economic Forum.[4]

Content of report

In this report, we describe our approach for retrieving skills from the vacancy data at the multinational energy technology company, how to read the output we generated with our analyses, and how we come to a comprehensive skills framework (Chapter 2). We then report on the most distinctive skills per jobs (Chapter 3). As an additional output for the company, we delivered two accompanying datasets with extensive descriptions of skills per jobs and a comprehensive skills framework for use as part as their strategic HR policy.

1   Acemoglu, D., & Restrepo, P. (2018). Automation and new tasks: The implications of the task content of production for labor demand. *Journal of Economic Perspectives*, 33(2), 3-30.
2   Converse, P., Oswadl, F., Gillespie, Field, K., & Bizot, E. (2004). Matching individuals to occupations using abilities and the O*NET: Issues and an application in career guidance. *Personnel Psychology*, 57(2), 451-487.
3   Arntz, M., Gregory, T., & Zierahn, U. (2016). *The risk of automation for jobs in OECD countries: A comparative analysis.*
4   World Economic Forum (2021). *Building a Common Language for Skills at Work: A Global Taxonomy*. http://www3.weforum.org/docs/WEF_Skills_Taxonomy_2021.pdf

2   Approach

The multinational energy technology company we conducted this research for currently has a catalogue where competencies are listed for each job-group. This is a very extensive catalogue with overlapping components, but that lacks a common language across jobs-groups and company units. With the new taxonomy we aim to create one common language that is future-oriented and company-specific. We aim to make the taxonomy as comprehensive as possible, while at the same time keeping the items generic enough such that they are applicable across the different job-groups and business areas.

An extension of O*NET for this multinational energy technology company

O*NET distinguishes among six major skill categories (Basic Skills, Complex Problem Solving Skills, Resource Management Skills, Social Skills, System Skills and Technical skills). These skills fall apart in sub skill category, and then in specific skill category, which are described in the O*NET classification. For example, technical skills fall apart in 7 sub skills. One such sub skill is technology design and it consists of two specific skills Design to cost, and Technology design. Technology design is then described as "Job requires generating or adapting equipment and technology to serve user needs".

With the O*NET as a starting point, we created a taxonomy that was further developed and specified based on the existing competency catalogue, expert interviews with the company's HR-managers and team-discussions. Based on the input that was received from these qualitative interviews, the taxonomy was expanded and altered. Additional categories such as Agile, Lean, Inclusion, Sustainability and Consultative selling were added, and descriptions were altered to make them more company-specific.

After expanding this taxonomy, the main skill categories are named Social, management and leadership skills, Analytical, creative thinking and problem solving skills, Resource management skills, Technical skills and Learning skills to encompass the subcategories. We add the category Personality traits to reflect the growing demand for soft skills in the economy.[5] Appendix B gives a flavor of how this taxonomy looks like, and how it has been implemented in an interactive dashboard for use for HR purposes within the company.

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5   Deming, D. J. (2017). The growing importance of social skills in the labor market. *The Quarterly Journal of Economics*, 132(4), 1593-1640.

Using text-mining techniques, we scan the texts of all job vacancies posted by the company in the period October 2018 – October 2020, a database filled with 9.551 vacancies for 7.950 job openings. We do this to identify the skills mentioned in the job descriptions to unravel the current skills-needs. Job descriptions in vacancies do not always follow a well-structured pattern: they are composed of a lot of text, parts of which refer to the skills needed to perform the job. The challenge to the researcher is to identify these skills. Using O*NET as the starting point would not suit the purpose as the skills there are too generic compared to the skills in a specific company such as the company in question. The challenge for the researcher, then, is to infer the skills need from the text of job descriptions itself. When doing so, we are generally less interested in the parts of the vacancy text with general information about the company, but more interested in the information that is specific to job advertised. To merely measure how frequently certain words appear in a job description, would be insufficient, since the general information is often similar across multiple vacancies. To circumvent this issue, we use text mining analysis on the vacancy texts, to extract the most distinctive skills for each job-group.[6] Skills are identified as pairs of words from the vacancies that we have matched to a lexicon of skills. We use a statistical measure to identify these most distinctive skills. This statistical measure is the frequency of a term (pair of terms in our case) adjusted for how rarely it is used in the complete set of vacancy texts. Then, for each job-group, we manually label the top 20 skills identified by us with one of the main skills categories we adapted from the O*NET taxonomy.

Co-creation taxonomy categories

The outcomes for each job-group were checked by representatives from the company, and if necessary adjusted to ensure that all skills are labelled with the correct category. As a result, the category Learning Skills was included in the category Analytical, creative thinking and problem solving skills. Some representatives chose to assign certain skills to a different category, because in the context of their respective job-group it better fits to the skills needs as they see it. This final classification is used for shaping our output.

Example outcome

An example of the results can be found in Figure 1 where we describe the 20 most distinctive skills for 'site engineering' jobs. Two of the most distinctive skills pertain to working independently, which is part of personality traits in O*NET (purple colored). 10 of the top 20 most distinctive skills for site engineering pertain to the technical domain (yellow colored).

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6   See Appendix A for details on the methodology we used.

Figure 1 Site Engineering. Top 20 skills with a link to the taxonomy

Site Engineering- Distinctiveness (TF-IDF)

Taxonomy category
- Social, management and leadership skills
- Technical skills
- Personality traits
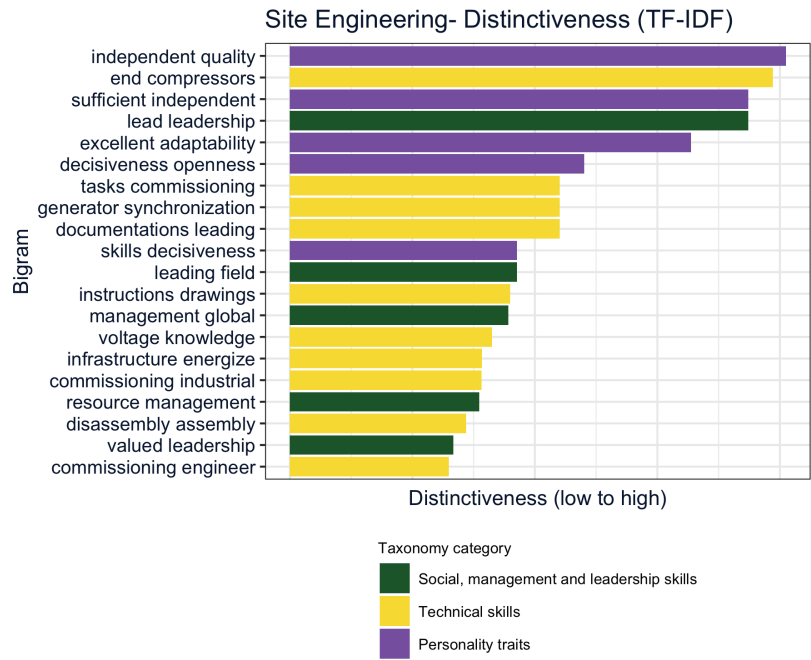
3 Findings

In this chapter all findings are presented. We first display the skill demand at the company as they appear in vacancies and according to the classification we developed. For 5 job-group we display the top 20 most distinctive skills. Here, we display the job-groups Customer Services – Service Operations & Delivery, Engineering - General Engineering, Finance – Accounting, Information Technology - General IT Management and Manufacturing - Process Planning & Industrial Engineering. The complete set of all job-groups was provided to the company. Then, we discuss the extent to which vacancies results from replacement of personnel or job growth and document the distribution of internal versus external hires. All details are provided to the company in our supplementary material.

Skills in jobs

The top 20 most distinctive skills found in the job descriptions for the 5 job groups are represented in the graphs below. As these speak for themselves, we do not provide for an extensive description of what the graphs show, but it is clear that they show a great variety of skills both within and across jobs.

Service Operations & Delivery- TF-IDF

Engineering - General Engineering

General Engineering- TF-IDF

Bigram (y-axis):
- technical support
- product design
- machinery design
- management acceleration
- design engineer
- gas turbine
- performance design
- solid mechanics
- thermodynamics aerodynamics
- aerodynamics fluid
- gas turbines
- mechatronics mechanical
- axial compressors
- automation mechatronics
- repair turbomachinery
- application progressed
- professionalism capable
- interacting management
- mechanical engineering
- electrical engineering

Distinctiveness (low to high)

Taxonomy category
- Social, management and leadership skills
- Analytical, creative thinking and problem solving skills
- Technical skills
- Personality traits

Finance - Accounting

Accounting- TF-IDF

Bigram (y-axis):
- financial statements
- experience accounting
- accounting standards
- accounting reporting
- accounting controlling
- consolidation system
- balance sheet
- complex accounting
- accounting department
- accounting financial
- accounting topics
- internal controls
- external auditors
- dps management
- management ciss
- applications interfaces
- drives digitization
- risk controlling
- hedge accounting
- accordance ifrs

Distinctiveness (low to high)

Taxonomy category
- Social, management and leadership skills
- Analytical, creative thinking and problem solving skills
- Resource management skills
- Technical skills

Information Technology - General IT Management

General IT Management- TF-IDF

Taxonomy category

- 🟩 Social, management and leadership skills
- 🟦 Analytical, creative thinking and problem solving skills
- 🟧 Resource management skills
- 🟨 Technical skills

Manufacturing - Process Planning & Industrial Engineering

Process Planning & Industrial Engineering- TF-IDF

Taxonomy category

- 🟩 Social, management and leadership skills
- 🟦 Analytical, creative thinking and problem solving skills
- 🟧 Resource management skills
- 🟨 Technical skills

Appendix A: Detailed approach

Taxonomy

The aim of this research is to develop a comprehensive taxonomy of the most important skills needed for jobs at a multinational energy company. The company currently has a catalogue with relevant competencies for their jobs, which is very extensive and has overlapping components. Therefore, with the new taxonomy, based on O*NET (see Chapter 2), we aim to create one common language that is future-oriented and company-specific. We aim to make the taxonomy as comprehensive as possible, while at the same time keeping the items generic enough such that they are applicable across the different job-groups and business areas.

There are a number of skills and personality traits that enable a worker to adequately perform a task. These tasks are changing over time due to for example, structural changes, energy transition, etc. Jobs are bundles of tasks that workers are required to perform. In this project, we are looking at skills (developed capacities to perform a job) and personality traits (relatively constant during adulthood, e.g., conscientiousness. Additionally, needed in times of change, resilience). These skills and personality traits are elaborated in this taxonomy.

A widely agreed upon taxonomy does not exist, therefore the taxonomy was created based on the O*NET, which is a scientific source widely used for occupation information. To further develop the taxonomy, we conducted expert-interviews with HR-personnel from the company and each item of their competency catalogue was analyzed. This process resulted in a generic, but company-specific taxonomy.

Text-mining vacancy data the company provided ROA with a corpus (dataset containing the full text of all vacancies) of vacancy data ranging from the first of October 2018 until the 30th of September 2020. In this data, each row represents one vacancy and contains information about, among others:

- the job (title, description, how many positions are available, contract type, experience level and whether the job results from job growth or a replacement)
- the geographical location (country, city, language) and
- organizational information (job-group, job-sub-group, organization, business unit).

The data has vacancies for 78 job-sub-groups that all belong to one of the job-groups. To understand the current skills demand, we analyze the job descriptions for each job-sub-group and search for mentions of skills. However, job descriptions are composed of many different types of information, not just skills. In the data, the job descriptions are located in one column and are unstructured. Every description has a different set-up. This makes it challenging to extract the information that is needed. For this reason, a creative approach was needed.

Cleaning

The data cleaning comprises several steps. First, each vacancy is characterized by a number of openings. We weight the number of vacancies for this number of openings to get a true reflection of the skill demand. If a vacancy has for example 3 job openings, this vacancy will get a weight of 3 in the data. Second, we clean the job descriptions by making all letters lowercase and removing mentions, URLs, emoji, punctuations and numbers that are surrounded by whitespaces (this allows us to keep skills like 3D-printing or office360 in the corpus). Third, we remove all stop words, any superfluous whitespaces and sentences that are well-known marketing phrases.

Finally, we exclude a number of outliers. These outliers are vacancies that consist of less than 58 characters (based on the cleaned text) in its job description, these fall out of a normal distribution and generally do not have job descriptions that list skills needed for the job. After consulting with the project-team, any vacancies from specific organizations are excluded, since these are not in the scope of this project. Also, we exclude a vacancy that asks for 150 employees, which would affect the data too much.

This leaves us with a total of 9.551 vacancies for 7.950 job openings. The total corpus of text we analyze consists of 2.500.843 words.

Extracting distinctive terms

When looking for the necessary skills in a job description, we are generally less interested in the text areas that contain general information about the company, but more interested in the information that is specific to that vacancy. To merely look at how frequent certain words appear in a job description, would be insufficient, since the general information is often similar across multiple vacancies. Figure A.1 shows an example of a vacancy that was analyzed in this project. The red-colored items contain general information that does not list any skills needed to do the job. The rest of the text does contain information that could be classified as skills and will be more unique for every vacancy. The green items are the skills that are extracted by our procedure. Below we explain the rest of the procedure to get to this result.

Figure A.1 Example vacancy

Job title: ████████████████████

███████████████Site Engineering

████████ provides answers to the toughest questions: we build infrastructure where there is no infrastructure.

We energize the world, help industries run smoothly and create the digital tomorrow.

Our on-site implementation team supports the resource management of ████████████████ in ███████████████████████████████████ divisions from high-end compressors, turbines and generators to virtual power plants. Our engineers carry out on-site implementation of worldwide projects and also engage in office-related engineering activities at ████████████████.

What kind of tasks will you have?

- Commissioning of industrial gas turbines, generator synchronization
- Keeping contact with customers and project management
- Reporting, keeping up to date documentations
- Leading field service team after certification

What makes you stand out?

- Electrical or Mechanical engineer (BsC or MsC)
- Control system knowledge ████████ preference)
- High voltage knowledge
- English language skill (up to intermediate)
- Knowledge of MS Office applications
- Provide on site trainings
- Flexibility, commonly the rotations are 2 months long
- Mechanical and electrical knowledge
- Self-sufficient, independent, quality-oriented personality
- Team player mindset, excellent adaptability
- Ability to lead, leadership skills
- Decisiveness
- Openness to other cultures

What else should you know?

- Graduates are welcome and no previous experience is required
- ████████ provides technical and expert support in our regional training centres
- Working with an international team
- Competitive benefit package (basic salary, bonus, daily allowance)
- ████████ follows EU guidelines and business standards for workers abroad

Why ████████?

In addition to providing a competitive benefit package and a modern, international work environment, we are respectful inclusive and diverse. We worship performance, celebrate individual contributions and different ways of thinking. Places of work ████████ and international sites (with time off in ████████ between rotations/projects)

To extract the specific information, we use the statistical measure tf-idf (term frequency – inversed document frequency). This measure identifies how distinctive a term (or rather a bigram, a pair of words, in our case) is to a job-sub-group in the corpus of all job-sub-groups. Tf-idf measures how frequent a term occurs, adjusted for how rarely it's used. This statistic will give a higher value to terms that are more unique to a job-sub-group and a lower value to terms that are common in the entire corpus.

Emsi Skills

Now that we can measure how distinctive a certain term is for each job-sub-group, the next step is to further condense these lists. These lists still contain information that would not be classified as a skill. We need to extract the skills and ensure minimum human interaction. To solve this, we use the Emsi Skills list.[7] Emsi Skills is an initiative from a team of economists and labor market analysts that aims towards using skills as a common language between three parties: potential employees, potential employers and programs looking to connect those two. By analyzing resumes, job descriptions from vacancies and online profiles, Emsi Skills has gathered over 30.000 skills. This extensive list of skills is freely available online via an API.

We use this list combined with the skills we defined in our taxonomy (with its synonyms derived from WordNet, a lexical database created by Princeton University) to create a custom skills-database. Using this skills-database, we extract the terms that were derived from the vacancy texts that have a (at least partial) match with items in the skills database. This results in a filtered list of skills coming directly from the company's job descriptions.

Matching the skills to the taxonomy

To categorize the skills from the job descriptions to the taxonomy, the top 20 skills for each job-sub-group was manually labelled with one of the main categories of the taxonomy. This labelling was also checked and sometimes adjusted by specialists of each job-sub-group at the company. The results are all presented in graphs such as Figure A.2.

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7   https://skills.emsidata.com/

Figure A.2 Site Engineering. Top 20 skills with a link to the taxonomy

Site Engineering- Distinctiveness (TF-IDF)

Taxonomy category

■ Social, management and leadership skills

■ Technical skills

■ Personality traits
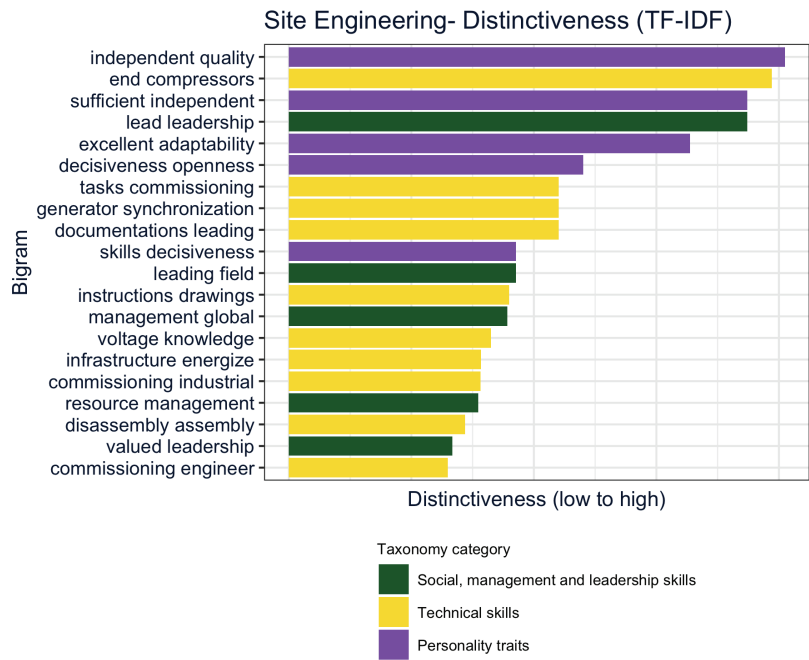
Appendix B: First implementations at the company

The company is using the output of this research to further tailor it to the company's needs based on the feedback they have received from the representatives of each job-group. Figure B.1 displays an overview of taxonomy-wide changes the company made. These changes mainly relate to adjusting the titles of the taxonomy categories.

Figure B.1   Taxonomy-wide changes

Tailoring the research-based Vacancy Analysis result into the ▮▮▮▮▮▮▮ Skills Taxonomy

Vacancy Analysis Skills Taxonomy

▮▮▮▮▮▮ Skills Taxonomy

Skill Taxonomy Categories
- Social / Personal / Interpersonal skills
- Management and Leadership skills
- Analytical, creative thinking and problem-solving skills
- Learning skills
- Technical skills
- Resource management skills
- Personality Traits

→ Connection
→ Thinking & Creativity
→ Digital, Technical, Domain Skills
→ Drive

The research-based Skill Taxonomy Categories were reviewed, adjusted and streamlined for use i▮▮▮▮▮▮ ▮▮▮▮▮▮ed on the feedback of the reviewees.

- Social, Interpersonal, Management and Leadership into **Connection**
- Analytical, Creative Thinking and Problem-Solving Skills with Learning Skills into **Thinking & Creativity**
- Technical Skills and Resource Management Skills into **Digital, Technical & Domain Skills**
- Personality Traits was renamed into **Drive**

3 Taxonomy Categories – "**Drive**", "**Connection**", "**Thinking & Creativity**" were identified as **overarching categories**.

Those **comprise skills that are applicable across** ▮▮▮▮▮▮▮▮▮, taking from the various ▮▮▮▮▮ related projects and ▮▮▮▮▮▮▮▮▮▮▮▮▮activities. The **Category** "**Digital, Technical & Domain Skills**" is **specific to certain domains and areas in** ▮▮▮▮▮ ▮▮▮▮▮ such as the ▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮ an▮▮▮▮▮▮▮▮▮

The company also created a dashboard to inform their employees about the findings of this research and how to use the dashboard to access this information. An example of this dashboard is depicted in figure B.2.

Figure B.2 Dashboard. Most distinctive skills for each job-group
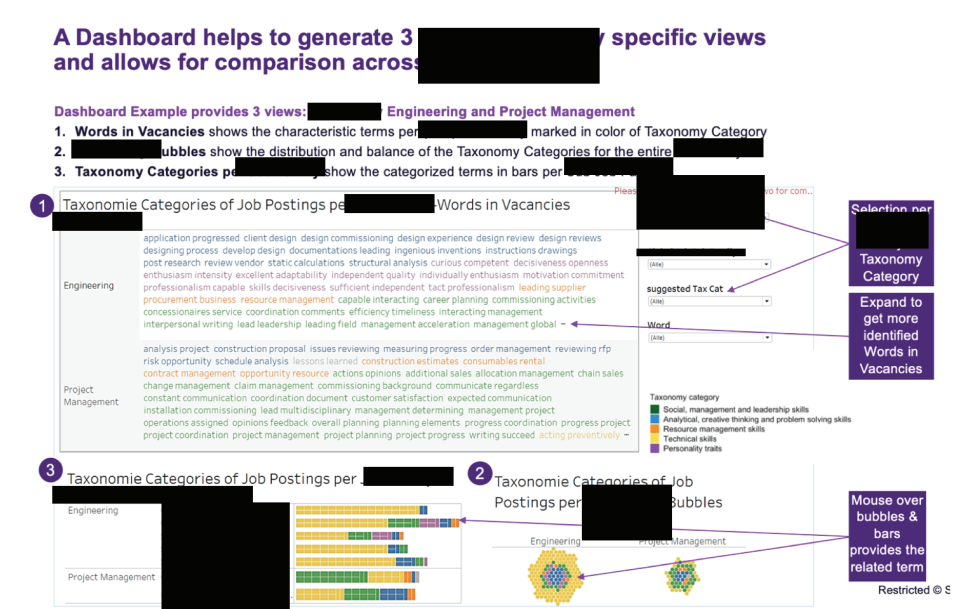
In figure B.3 shows the guide the company created to help interpret the results and motivate (a.o.) HR-personnel to help them use the findings and derive further actions to tackle challenges related to strategic workforce planning.

Figure B.3 Guide for results-interpretation and potential for action

Guiding questions help to reflect the displayed Vacancy Analysis results, interpret meaning and help derive further actions

1. Words in Vacancies show the characteristic terms p[...] marked in color of Taxonomy Category

- How do the terms translate in my area in tasks and skills?
  - identified terms are not always straight forward and need some association / reflection about their context-related meaning

Which terms seem and should be most important within the [...]

- Which of those terms – translated into tasks and skills - will also be critically important in the future?
- Which of those terms need to be highlighted as they are critical, which ones are critically missing and need to be considered for future Job Descriptions and People Development in this area?

2. [...] **Bubbles show the distribution and balance of the Taxonomy Categories for the entire** [...]

- Does the distribution / balance in th[...] reflect reality and support the future?
  - Do we put the right focus on the balance, and do we communicate this in a transparent and attractive way?
  - Is the balance of e.g technical, analytical and social skills healthy?
  - How does the balance need to look like to support the Energy transition (strengthen the core / transform the future)?
  - For which areas do we need to adjust / increase learning & development activities?

3. [...] **Taxonomy Categories per** [...] **show the categorized terms in bars per** [...]

- Does the distribution / balance across the [...] eflect reality and support the future?
  - as above plus
  - How can development acros[...] be made possible, considering the different balance of skill categories?

How does the distribution / balance change across [...] and the [...]

- How can communication and collaboration be improved across [...] given the distribution / balance of terms / skills?
- How can development acros[...] e made possible, considering the different balance of skill categories?