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Green potential of Europe's labour force: Relative share and possible skills imbalances*

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Abstract

Using a data-driven methodology that allows to quantify the importance of different skills in performing green tasks, we estimate the green potential for 26 European countries. By green potential we mean the share of employed persons in occupations characterised by skills that are important for the exercise of green tasks to total employment. For the countries considered, we estimate a green potential between 7.1% and 16.8%, with the manufacturing and energy & construction sectors having above-average and the resources and services sectors below-average shares. We further examine the green potential with regard to a possible shortage of skilled workers by means of indicators that reflect different dimensions of skills shortages. Estimates of skills shortages related to the green potential reveal considerable heterogeneity among the investigated countries. Nevertheless, occupations with a high green potential are generally characterised by a tense skilled labour situation. Looking at four occupational groups, results reveal that the need for skilled workers with high green potential is particularly pronounced for managers and professionals, while being lower for technicians and smallest for craft & related trades workers.

Keywords: green transition, labor market, skills shortage
JEL codes: J23, J24, Q52

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1 Introduction

Countries are making efforts for green growth.[1] The spectrum of possible measures to develop more sustainable production and consumption is broad and includes measures to reduce greenhouse gas emissions as well as measures to increase energy efficiency in the building and transport sector (Consoli, Marin, Marzucchi, & Vona, 2016). Green growth will thus shape the entire economy. Assessments of the extent of these developments go so far as to speak of a new industrial revolution (Bowen, Kuralbayeva, & Tipoe, 2018). The labour market will be particularly affected by green growth. For example, demand for workers who can perform green tasks may increase (Vona, Marin, Consoli, & Popp, 2018). Against this background, the question arises as to what proportion of the working population today already performs a job that can be characterized by skills that are critical for the exercise of green tasks and whether this so called green potential is actually sufficient to meet the current demand. Indications of a current shortage of skilled workers and the expected increase in demand for such workers suggest that the labour input for green activities becomes relatively expensive. This, in turn, may make a transition to a sustainable economy more expensive and may delay the transition due to increased political opposition. Therefore, it is very important for decision makers in politics to have information about the green potential of a country's workforce.

With this paper, we make two contributions in this direction. First, we estimate and compare the green potential of the labour force of different European countries. In doing so, we us a data-driven methodology established by Rutzer, Niggli, and Weder (2020) to estimate the green potential of occupations based on their skills

[1] Rodrik (2014, p. 469) defines green growth as "[...] a trajectory of economic development that is based on sustainable use of non-renewable resources and that fully internalizes environmental costs, including most critically those related to climate change."

and to aggregate the results from the occupation level to the country level.[2] While Rutzer et al. (2020) use the methodology for analyses of the US labor market, we now apply this approach to the analysis of European labor markets. Second, we analyze potential skills shortages with regard to occupations being able to perform green tasks.[3] In doing so, we employ an index composed of various indicators to identify possible shortages on the level of countries and occupational groups.

For the countries considered, our estimations for the year 2016 show that between 7.1% and 16.8% of all employed persons are in occupations with a high green potential. The share varies not only between countries, but also between sectors, with manufacturing as well as energy & construction having above-average, while resources and services yield below-average shares. Moreover, estimates of skills shortages related to the green potential via a composite index reveal considerable heterogeneity among the considered countries. Nevertheless, the vast majority shows signs of a tight skilled labour situation in relation to the green potential. Looking at four occupational groups that include occupations with high green potential, the need for skilled workers is particularly pronounced for managers and professionals, lower for technicians and smallest for craft & related trades workers.

To sum up, the analysis shows that in the countries under consideration a significant proportion of the working population is employed in an occupation with a high green potential. Though, the skilled labour situation in these occupations is

[2] In line with the work of Rutzer et al. (2020) and Vona et al. (2018), we mean by green potential of an occupation the ability to be able to perform green tasks. Whether persons belonging to an occupation are currently fulfilling green tasks or not is thereby irrelevant.

[3] Skills shortages refer to situations in which the supply of workers with a specific set of skills falls short of the demand of workers with that required set of skills for a given job under the current market conditions (e.g. pay and working conditions). The concept of skills shortages constitutes one dimension of the phenomenon of skills imbalances. Another dimension is represented by the concept of skills mismatches. This concept refers to situations in which the worker's skills either exceed or fall short of the required skills needed for a given job (e.g. mismatch in terms of the demanded qualification level, in terms of the demanded field-of-study or in term of the demanded set of skills) (McGuinness, Pouliakas, & Redmond, 2018; OECD, 2017).

already tense. For this reason, in an event of a transition towards a green economy, one should expect a further increase in demand for these occupations and the skills that characterise them. Hence, supply-side measures will be needed to satisfy the demand for occupations with high green potential.

The rest of the paper is structured as follows: Next, we review the literature on green jobs. Afterwards, we describe our methodology to estimate the green potential of occupations and how to measure skills shortages. Consequently, we estimate and compare the green potential of the workforce of several European countries. In doing so, we analyze potential skill shortages of occupations with a high green potential. Finally, we summarize our main findings and give some suggestions for future research.

2 Literature

The economics literature has recently addressed questions concerning the relation between green growth and the labour market. Several studies provide estimates of employment in green jobs and characterize green jobs in terms of the skills content.[4] The results show that the greening of an economy has indeed significant implications for the labour market: New jobs are emerging and existing jobs are subject to changes in terms of tasks and the skills required to conduct these tasks (Consoli et al., 2016).

Recent contributions to this literature (Bowen et al., 2018; Consoli et al., 2016; Rutzer et al., 2020; Vona et al., 2018) make use of task- and skill-based approaches[5]

[4] There is, however, no uniform definition of green occupations. The literature provides different approaches to define green jobs that are based on industry affiliation, the production method used or occupations and the associated skills and abilities (Bowen et al., 2018; Consoli et al., 2016; Martinez-Fernandez, Hinojosa, & Miranda, 2010).

[5] Other approaches use definitions of green industries to identify green occupations.

and are thus conceptually related to a rich literature that analyzes how labour market outcomes (such as employment and wages) are shaped by skills and tasks (see, for example, Acemoglu & Autor, 2011).[6]

These studies have in common that they focus on the US labour market and that they make extensive use of a database provided by the Occupational Information Network (O*NET). In particular, they use the definition of green occupations and green tasks developed within the framework of the *Green Economy* program.[7] The program further classifies green occupations into three sub-categories as

- *New & Emerging*, which contains occupations emerging as a result of the evolution towards a green economy;
- *Enhanced Skills*, which contains occupations experiencing a change in the composition of skills (new skills are added, existing skills are used to a greater/weaker extent);
- *Increased Demand*, which contains occupations that do not experience any change in the composition of skills and do not include green tasks, but are in increased demand due to the development towards a green economy.

This classification of occupations is used as a starting point in all the aforementioned works. However, as pointed out by Rutzer et al. (2020), the approaches differ

[6] According to Acemoglu and Autor (2011, p. 1045), "[...] a task is a unit of work activity that produces output (goods and services). In contrast, a skill is a workers endowment of capabilities for performing various tasks. Workers apply their skill endowments to tasks in exchange for wages, and skills applied to tasks produce output."

[7] Green economy is defined as an economy that "[...] encompasses the economic activity related to reducing the use of fossil fuels, decreasing pollution and greenhouse gas emissions, increasing the efficiency of energy usage, recycling materials, and developing and adopting renewable sources of energy." (Dierdorff et al., 2009, p. 3). The classification of occupations in "green jobs" and "other jobs" is carried out by experts based on the *potential* for making a contribution to greening the economy. However, past and current contributions to the green economy do not play a major role in defining an occupation as a "green job" or an "other job". See Dierdorff et al. (2009) for further details.

with regard to the definition of green occupations when applying to labour market data: While Consoli et al. (2016) and Bowen et al. (2018) form discrete groups of green and other occupations, the approaches of Vona et al. (2018) and Rutzer et al. (2020) allow to measure the extent of the green potential of an occupation on a continuous scale. As a result, the estimates of the green potential (measured as the share of employment in green occupations to total employment) for the entire US economy ranges between 10% and 20%, depending on the definition of green occupations used. Consoli et al. (2016) estimate that green occupations account for about 9.8% up to 12.3% of total employment. Compared to the other approaches, they use a narrow definition of green occupations: They count occupations as green if jobs belong to O*NET's categories *Green Enhanced Skills* and *Green Emerging*. Bowen et al. (2018) estimate that 19.4% of US workers could be part of the green economy.[8] In contrast to Consoli et al. (2016), they use a broader definition of green occupations. Besides jobs belonging to O*NET's occupational categories *Green Enhanced Skills* and *Green Emerging*, they also include occupations belonging to the category *Green increased demand*. In addition, they created a fourth group of occupations (*Green Rival*) for jobs that are similar to green jobs according to job-specific or worker-specific aspects. If occupations in this additional group were added, the green potential would rise significantly.[9] Bowen et al. (2018) find a considerable variation of the employment share across sectors, with sectors such as accommodation and food services, health care and education services with shares below 5%. On the other side are sectors such as manufacturing, utilities and construction with shares of 50% and above. Rutzer et al. (2020) estimate that around 12% of US workers

[8]Where green economy is understood as economic activity related to reducing fossil fuel usage, decreasing pollution and greenhouse gas emissions, recycling materials, increasing energy efficiency, and developing/adopting renewable energy sources (Bowen et al., 2018, p. 274).

[9]Employment in this additional occupational group account for 44% of total employment.

may have a high potential to perform green tasks.[10] This approach departs from the aforementioned approaches to identify green jobs in that it identifies jobs with green potential based on a data-driven methodology which assesses the potential of skills to carry out green tasks.

Taken together, all these studies have in common that they estimate the relative size of the green potential of the US labour force. However, what is missing so far is an assessment of the green potential of other countries' labour forces. Thus, the first contribution of this paper is to estimate and compare the green potential of the labour force of different European countries. In doing so, we not only analyze the relative share of employed persons in occupations with high green potential, as it is done in work focusing on the US labour market. Instead, we also analyze to which extent supply and demand for workers with the skills needed for green tasks are matched. This second contribution of our paper is important, because possible skills shortages are associated with various negative effects on the economy. These include productivity losses at the level of the economy as a whole. In addition, negative effects are also suspected at the level of the working population (e.g. persistent wage losses due to a bad match between the skills of an employee and the requirements of the occupied position). The transition to a green economy becomes all the more costly as the shortage of skilled labour becomes more pronounced (OECD & Cedefop, 2014). For this reason, it is important to find out to what extent occupations with high green potential are already showing signs of skills shortages. While the overall situation of skilled labour has already been examined for various occupations and countries (OECD, 2017), an analysis referring exclusively to the

[10]It should be noted that the analysis of Rutzer et al. (2020) uses a continuum to determine the green potential of occupations. Thus, an estimate of the green potential of the overall US workforce depends strongly on a chosen cut-off at which one classifies an occupation as potentially green. When setting the cut-off to 0.5, which corresponds to the value chosen in this paper (see Section 3.1 for a derivation of the cut-off value), the estimate shows that around 12% of the US workers are attributed as employed in an occupation with green potential.

green potential is still lacking. In order to close this gap, we analyze skills shortages for jobs with high green potential.

In this paper, we analyze skills shortages in occupations with high green potential based on indicators that examines skills shortages indirectly by using job-related indicators such as vacancy or unemployment rates (Holt, Sawicki, & Sloan, 2010; OECD, 2017).[11].

After this brief review of the literature, the next section deals with the methodological approach and the data. Some of the studies that are only briefly discussed in this chapter will be examined in more detail with regard to the methodology used to estimate the green potential in European labour markets.

3 Methodology and data

The section 3.1 provides detailed information about the identification and measurement of the green potential of occupations. The section 3.2 informs about the measurement of skills shortages by means of indicators that map different aspects of this phenomenon. Finally, section 3.3 describes the data basis.

3.1 Identification of jobs with green potential

To measure the green potential of the workforce of European countries, we first have to identify occupations with high green potential. For this we use a methodology developed in Rutzer et al. (2020). They used data from O*NET on skills and green tasks to train several machine learning algorithms allowing to predict the green

[11] A direct approach is to use survey techniques and ask employers directly about the perceived difficulty for recruiting workers to fill job vacancies. McGuinness et al. (2018) point out that the perceived recruitment difficulties of employers may be due to the fact that they are not able to meet the current market conditions, especially the required wage, or due to the location of a firm. This can lead to an overestimation of the skills shortage (in particular in the collection of data on the extent of skills shortages in the context of company surveys).

potential of occupations. The procedure in Rutzer et al. (2020) has been primarily developed to determine the green potential of US occupations classified according to the Standard Occupation Classification (SOC). However, in this research, we are interested in the green potential of the labour force of European countries. Statistical offices in Europe classify occupations in the Labour Force Surveys (LFS) according to the International Standard Classification of Occupations (ISCO). This classification system has been developed by the International Labour Organization (ILO) to provide an internationally comparable nomenclature.[12] By crossing SOC and ISCO-08, it is possible to assign O*NET skills to ISCO-08 occupations. Using the skill values assigned in this way as input in the trained model allows us to predict the green potential of ISCO-08 occupations.[13]

The result provides a list of 3-digit ISCO-08 occupations with the predicted values of green potential. The predicted green potential is normalized between 0 (occupation with the lowest green potential) and 1 (occupation with the highest green potential).

A summary of the results are shown in Table 1. It lists the ten occupations with the highest green potential estimates. As one can see, Engineering professionals have the highest green potential with a value of 1, followed by Physical and earth science professionals with a value of 0.76 and Production managers in agriculture, forestry and fisheries with a value of 0.76. The green potential of all occupations used in this study are shown in Table 3 in the Appendix.

We use these estimates at the occupational level to conduct a cross-country comparison of the green potential of the workforce of European countries. For this purpose, it is useful to divide the occupations into two groups: A group of occu-

[12]The current version, ISCO-08, is from 2008.

[13]Lobsiger and Rutzer (2021) already used the approach to estimate the green potential for Switzerland. The interested reader will refer to this paper for more detailed information on the procedure.

Table 1: Occupations with highest green potential

ISCO	Occupation	Green Potential
214	Engineering professionals (excluding electrotechnology)	1.00
211	Physical and earth science professionals	0.76
131	Production managers in agriculture, forestry and fisheries	0.76
210	Science and engineering professionals, nos	0.75
312	Mining, manufacturing and construction supervisors	0.75
215	Electrotechnology engineers	0.73
132	Manufacturing, mining, construction, and distribution managers	0.72
216	Architects, planners, surveyors and designers	0.71
112	Managing directors and chief executives	0.68
314	Life science technicians and related associate professionals	0.68
...	...	...

pations with high green potential and a group of other occupations. This division was carried out on an empirical basis: Namely, we set a threshold value so that the average green potential of the 3-digit ISCO-08 occupations corresponds to the average green potential of the original O*NET data. Although the choice of a cut-off is to some extent arbitrary, it is of practical use for a first quantitative analysis of the green potential in Europe. The two groups allow employees to be clearly assigned to one group and counted accordingly.

3.2 Measuring skills shortages

In addition to identifying the jobs with high green potential, we are also interested in showing how supply and demand for skilled workers in these occupations match or whether there are signs of shortages of skilled workers.

We measure skills shortages indirectly by means of an indicator system (see e.g OECD, 2017). The indicators used reflect the incidence and extent of a skills shortage. Indicators for measuring skills mismatches (e.g. qualification mismatch or a field-of-study mismatch OECD, 2017) are not considered. We compute the following indicators for job i and year t:

- *Rate of unemployment*: The rate of unemployment (ru_{it}) is defined as the number of unemployed persons (as defined by ILO) (u_{it}) divided by the number of economically active persons (l_{it})[14]: $ru_{it} = u_{it}/l_{it}$. The lower the rate of unemployment, the stronger the indications of a shortage of skilled workers.[15]

- *Rate of immigrant workers*: The rate of immigrant workers is defined as the number of immigrant workers in the labour force (immigrated in the last 10 years) (m_{it}) divided by the employed persons (e_{it}): $rm_{it} = m_{it}/e_{it}$. The higher the rate of immigrant workers, the stronger the indications of a shortage of skilled workers.

- *Employment growth*: In order to calculate employment growth, the number of employed persons in the year under review (e_{it}) is compared with the number of persons in employment in 2010 (e_{i2010}): $g_{it} = e_{it}/e_{i2010}$. Employment growth can further exacerbate an already tense skilled labour situation.

- *Replacement demand*: The replacement demand compares the employed persons of the cohort of 50-59 years old ($e_{it}^{50/59}$) with the employed persons of the cohort of 25-34 years old ($e_{it}^{25/34}$): $rd_{it} = e_{it}^{50/59}/(e_{it}^{25/34} + e_{it}^{50/59})$. A value of over 50% means that in the next few years more people will leave the labour market than have just entered it. This can be interpreted accordingly as an indication of an (increased) demand for skilled labour in the future.

- *Qualification level*: For the calculation of the qualification level, the employed persons with a diploma on the upper secondary or tertiary level (e_{it}^{*}) are compared with the total number of employed persons (e_{it}): $ql = e_{it}^{*}/e_{it}$. The underlying hypothesis is that the higher the qualification requirements, the

[14] The economically active persons consists of employed persons (e_{it}) and unemployed persons (u_{it}), i.e. $l_{it} = e_{it} + u_{it}$.

[15] The inverse of the unemployment rate is used so that an increase in the value can be interpreted as an increase in scarcity for each indicator.

less likely it is that in the event of an increased demand for skilled labour, non-skilled workers will be able to meet the demand.

In order to represent the information contained in the indicators examined in a single value, the indicators are combined into an index. For that task, the indicators have to be standardized (indicators may have different scales) and aggregated. We standardise the indicators by subtracting the mean and dividing by the standard deviation for each indicator: For indicator x_{it} for occupation i in year t, the standardized value results as follows: $\widetilde{x}_{it} = (x_{it} - \bar{x}_t)/s_t$, where $\bar{x}_t$ is the mean of x and s_t the standard deviation of x. To aggregate the individual indicators to a composite index, we sum up the values of the standardised indicators. We compute the skills shortage index (SSI) for occupation i in year t as follows: $SSI_{it} = \widetilde{ru}_{it} + \widetilde{rm}_{it} + \widetilde{g}_{it} + \widetilde{rd}_{it} + \widetilde{ql}_{it}$.

For the analysis of the occurrence and the extent of a shortage of skilled workers for jobs with a high green potential, we computed the above mentioned indicators and, based on these results, the SSI on the level of occupational groups (3-digit ISCO-08 nomenclature). We then aggregated the corresponding values on the 1-digit ISCO-08 level (occupational groups) and the overall economy by computing a weighted average of the values. The number of employed persons at the 3-digit level was used as the weight.

3.3 Data

Our analysis is based on two data sources: First, we use data from the O*NET database (v21.2) to estimate the green potential of occupations grouped according the the ISCO-08 nomenclature. For that, data from O*NET has been transferred to the ISCO classification. By means of machine-learning algorithms, the potential of 3-digit ISCO occupations to perform green tasks has then been estimated. Secondly, we use data from the EU labour force survey (EU-LFS) for the year 2016 provided by Eurostat.[16] The EU-LFS provides information on the structure of the labour force and employment behaviour patterns. Specifically, in addition to general socio-economic information (e.g. age), the data source contains information on employment (including information on the job exercised according to the ISCO-08 nomenclature), unemployment, highest educational attainment and migration status.

4 Results

In the following sections, we present and discuss the results of our analyses. We begin by presenting the results regarding the green potential of European countries' workforce (Section 4.1), followed by the results concerning the skilled labor situation in occupations with a high green potential (Section 4.2). We will first look at the situation at the level of countries (Section 4.2.1), then within countries at the level of professional groups (Section 4.2.2).

4.1 The green potential of European countries' workforce

We estimate the number of jobs with high green potential for each country by employing the share of employment with high green potential in total employment. As Figure 1 shows (the basic date are listed in Table 6 in the Appendix), the share of green potential in total employment varies considerably between countries with Norway having the highest share (16.8%) and Cyprus the lowest share (7.1%) in the year 2016. These figures fit into the results of the literature, even if they are at the lower end of the value range. We explain this observation with different countries

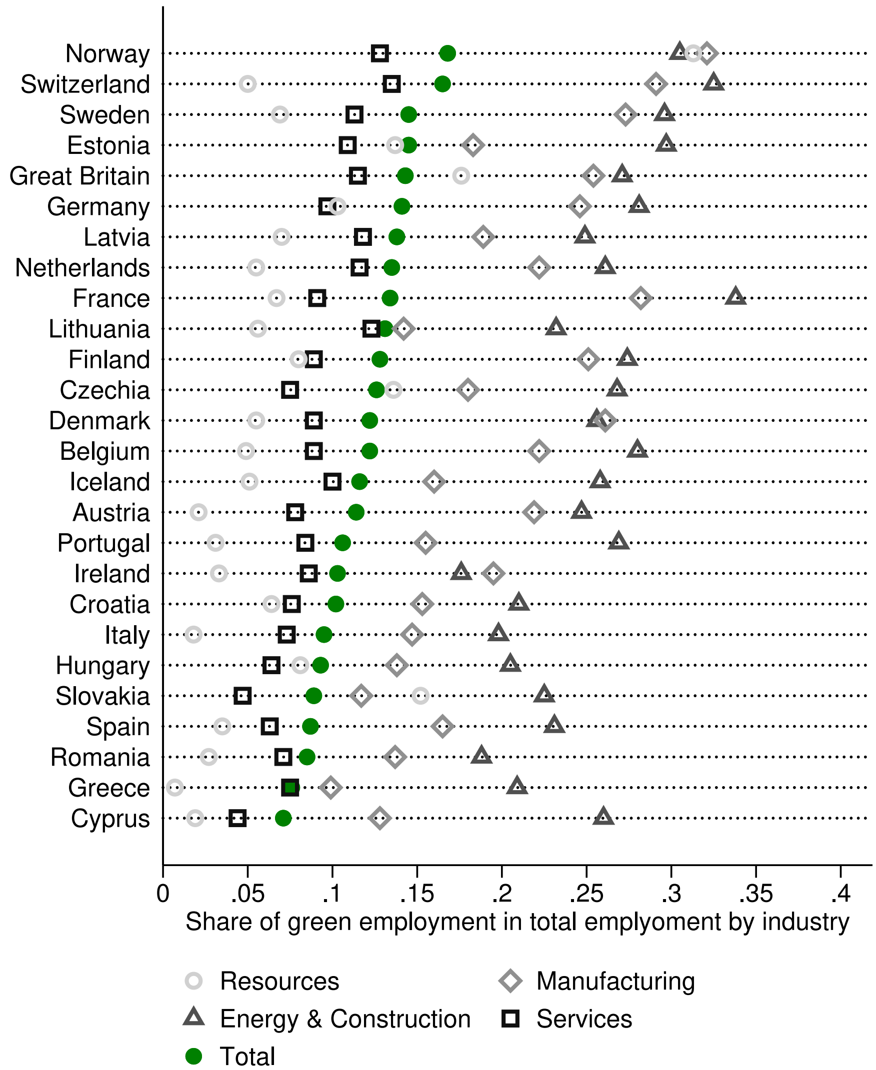
[16] In order to calculate the employment growth, we use also data for the year 2012.

under consideration (i.e. the US vs. European countries) and with differences in the procedure for the identification of green occupations. Our method evaluates the importance of different skills in performing green tasks. Thus, the green potential of occupations or the associated skills to perform green tasks is in the foreground, not the designation of a profession as green due to e.g. its industry affiliation.

The results also show that the shares of employment with high green potential in total employment vary not only between countries, but also between sectors within a country. In addition to the overall economic values, Figure 1 also shows the shares of employment in occupations with high green potential in total employment for the sectors resources, manufacturing, energy & construction and services.[17] Despite differences between the countries, clear patterns can be seen: On the one hand the services and resources sectors almost all have below-average shares of green employment in total employment. The manufacturing and energy & construction sectors, on the other hand, all have above-average shares of green employment in total employment. Norway is one exception, with the share of the resources sector amounting to 31.3%. This figure is therefore at a comparable level to the values for the manufacturing and the energy & construction sectors. Similarly, although not as extreme as in Norway, the shares for the resources sector are 17.6% for Great Britain, 15.2% for Slovakia and 13.6% for Czechia. According to our results, the resources sectors in these countries have a relatively high proportion of occupations that are characterised by skills that are important for the exercise of green tasks. This is interesting in the sense that the resources sector, which includes not only

[17] The sectors considered are aggregates from economic areas according to the industry classification NACE Rev. 2 (see Table 4 in the Appendix). The *resources* sector is made up of the economic areas agriculture, forestry and fishing (A) as well as mining and quarrying (B). The *manufacturing* sector corresponds to the economic area manufacturing (C). The sector *energy & construction* contains the economic areas electricity, gas, steam and air conditioning supply (D), water supply; sewage, waste management and remediation activities (E) as well as construction (F). The *services* sector encompasses the economic areas G-S.

Figure 1: Share of employment with high green potential in total employment by industry



Source: Own calculations based on EU-LFS (Eurostat), 2016. *Note*: The Figure indicates for each industry the share of green employment (made up of employed persons who pursue a job that has been identified as a job with green potential) as a percentage of total employment. The sectors considered are aggregates from economic areas according to the industry classification NACE Rev. 2 (see Table 4 in the Appendix). The *ressources* sector is made up of the economic areas A and B. The *manufacturing* sector corresponds to the economic area C. The sector *energy & construction* contains the economic areas D, E and F. The *services* sector encompasses the economic areas G-S.

agriculture but also mining, is not commonly considered to be green. This example, therefore, shows that our method of identifying green occupations is geared to the *potential* of carrying out green tasks and not to whether green tasks are currently being executed. This is in contrast to a strand of the literature, which estimates jobs (and call them green jobs) in economic sectors that produce goods and services that contribute to the protection of the environment or the conservation of natural resources (see literature discussed in Lobsiger & Rutzer, 2021).

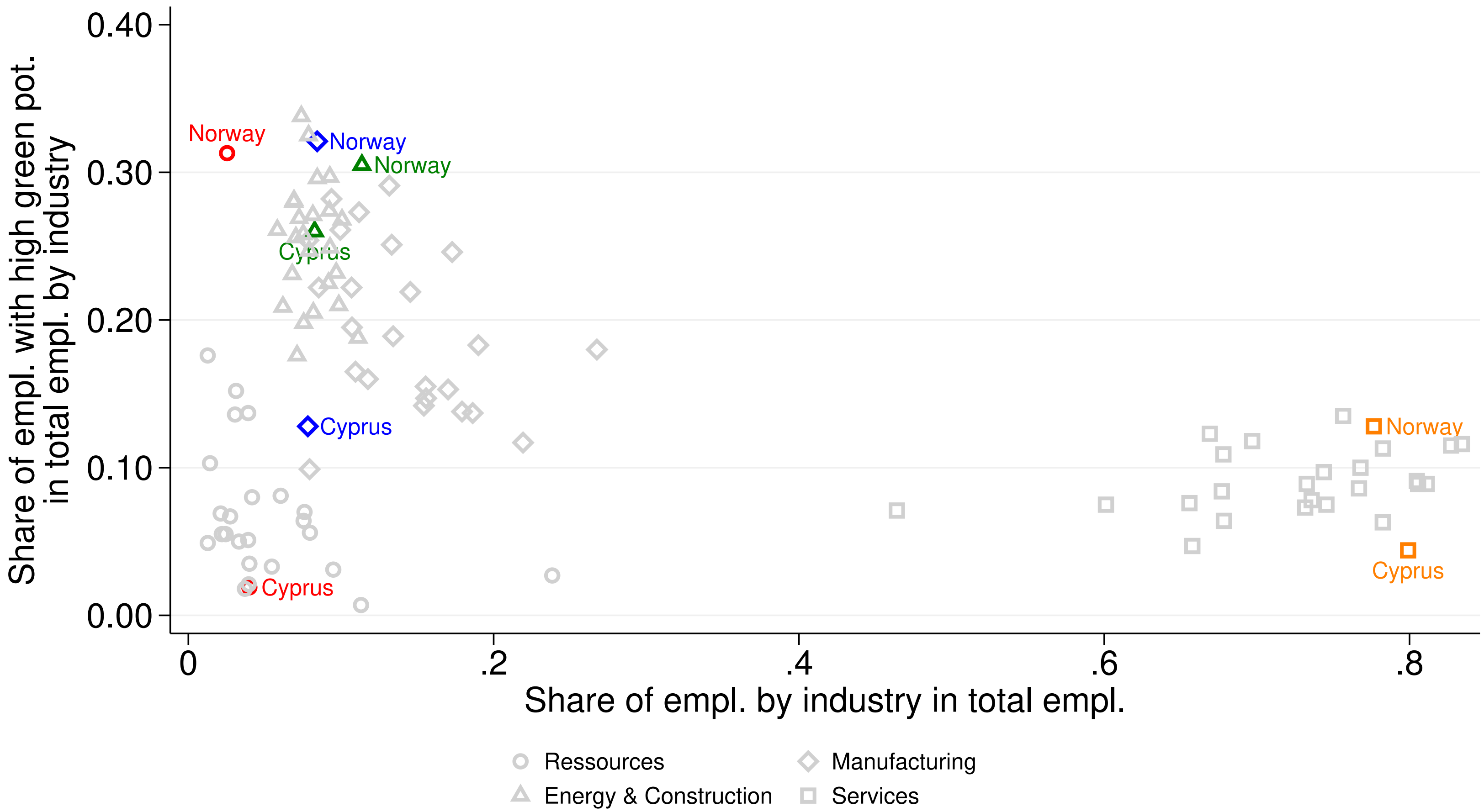
To explain the differences between countries, a decomposition of the green potential, measured as the share of employment in occupations with high green potential (g) in total employment (S), into two factors is helpful: The share of employees in high green potential occupations in total employment by sector (g/s) and employment in a sector as a proportion of total employment (s/S). More formally the $GreenPotential$ for country i can be calculated as follows:

$$GreenPotential_i = \frac{g_i}{S_i} = \sum_{j=1}^{n} \frac{g_{ij}}{s_{ij}} \cdot \frac{s_{ij}}{S_i}$$

j indicates the economic sector and S_i total employment in country i, which together make up the sum of employment in the sectors j ($\sum_{j=1}^{n} s_{ij}$). Figure 2 illustrates the interaction of the two factors: It compares the share of employment in occupations with high green potential in total employment per sector (y-axis) with the share of employment per sector in total employment (x-axis).

To explain Figure 2 in more detail, we have selected Norway and Cyprus, the two countries with the highest and lowest green potential, respectively. The Figure shows that Norway and Cyprus have almost similar shares of employment in the manufacturing sector. Norway has a slightly higher share in the energy & construction sector and a slightly lower share in the resources and services sectors. However,

Figure 2: Decomposition of the green potential



Source: Own calculations based on EU-LFS (Eurostat), 2016. *Note*: The sectors considered are aggregates from economic areas according to the industry classification NACE Rev. 2 (see Table 4 in the Appendix). The *ressources* sector is made up of the economic areas A and B. The *manufacturing* sector corresponds to the economic area C. The sector *energy & construction* contains the economic areas D, E and F. The *services* sector encompasses the economic areas G-S. Table 6 in the Appendix shows the sectoral structure in terms of employment.

compared with Cyprus, Norway has a significantly higher share of employment in all sectors in occupations with high green potential. In sum, the overall share of employees in occupations with high green potential is therefore decisive for the ranking in Figure 1.

4.2 Skills shortages

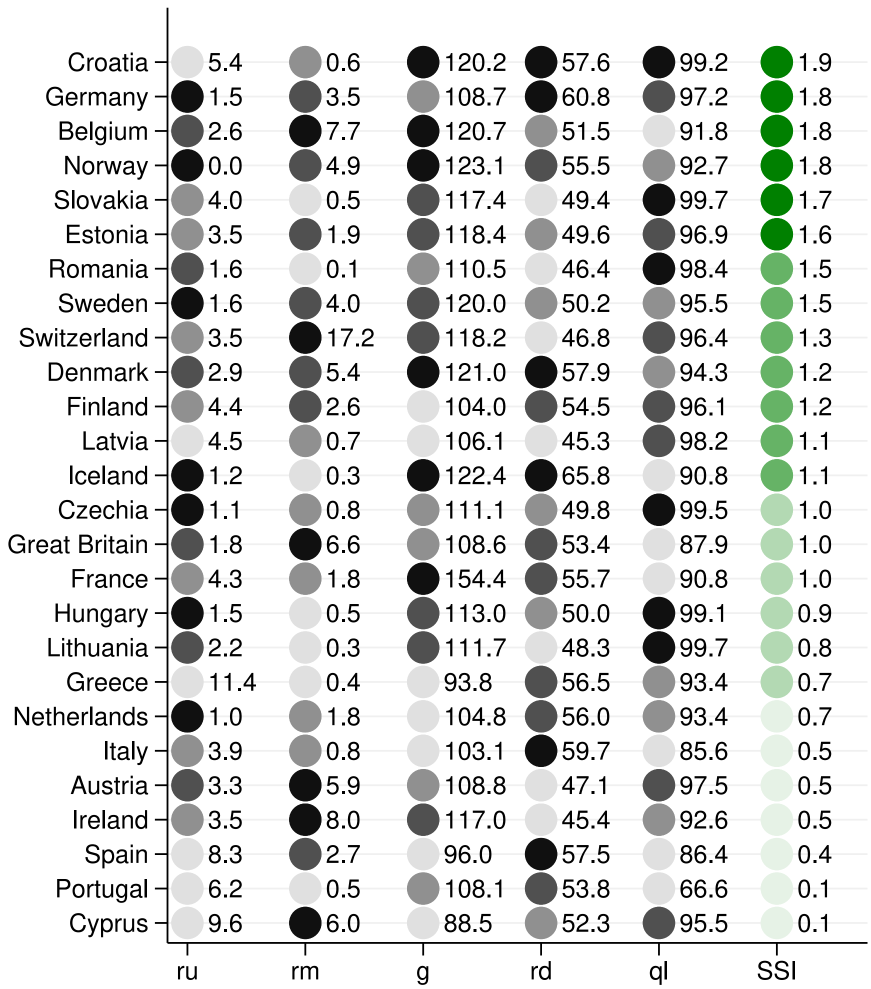
In the previous Section we have outlined the size of the green potential of the labour force for various European countries. Next, we analyze whether and to what extent occupations with high green potential are affected by skills shortages. The analysis is based on the indicators described in Section 3.2. In doing so, we first investigate differences at the country level. Then we go into more detail and look at different occupational groups.

4.2.1 By country

To derive an aggregate measure for each country, we compute a weighted average over all occupations with high green potential at the 3-digit level of the ISCO-08 nomenclature, where the number of employees are used as weights. Figure 3 provides an overview of the values of the individual indicators (ru: rate of unemployment, rm: rate of migration, g: employment growth, rd: replacement demand, ql: qualification level) and the skills shortage index (SSI) for each country considered. Countries are sorted by the SSI (in descending order). The shading of the dots indicates the extent of a skills shortage: The darker the colour, the more pronounced are the indications of a shortage of skilled workers.[18]

[18]The shading was assigned by dividing the values of the indicators and the SSI into quartiles. The distribution was determined individually for each indicator and for the SSI. With the exception of the unemployment rate, higher values are accompanied by a darker colouring. In the case of the unemployment rate, lower values indicate a shortage of skilled labour. Lower values are therefore accompanied by a darker colouring.

Figure 3: Skills shortage indicators and SSI of occupations with high green potential by country



Source: Own calculations based on EU-LFS (Eurostat), 2016. *Note*: Countries are sorted by the SSI (jobs with high green potential) (in descending order). The light-dark contrast was assigned by dividing the values of the indicators and the SSI into quartiles (the darker, the higher the value). The distribution was determined individually for each indicator and for the SSI. ru rate of unemployment, rm rate of migration, g employment growth, rd replacement demand, ql qualification level, SSI Skills shortage index of jobs with high green potential. For each country i the SSI is computed as follows: $SSI_i = \widetilde{ru}_{it} + \widetilde{rm}_{it} + \widetilde{g}_{it} + \widetilde{rd}_{it} + \widetilde{ql}_{it}$, where tilde stands for the standardization of the variables.

As Figure 3 indicates, the values of the SSI for the occupations with high green potential vary considerably between countries. The highest value is calculated for Croatia (1.9), the lowest value for Cyprus (0.1). Comparing the individual indicators with the SSI reveals expected correlations (see Table 2 below)[19]: Measured by the correlation between the individual indicators and the SSI, a low unemployment rate, high employment growth in recent years and high skill requirements are strong indications of a tight skilled labour situation. Somewhat less pronounced is the connection between a high migration rate and a high replacement demand and a tense skilled labour situation. It should be noted that this is an average view across all countries. In some countries, a high rate of migration is clearly associated with a strained skilled labor situation (see e.g. the case of Switzerland in Lobsiger & Rutzer, 2021).

Table 2: Correlations of SSI and skills shortage indicators for jobs with high green potential

	ru	rm	g	rd	ql
SSI (jobs with high green potential)	-0.47*	0.04	0.45*	0.03	0.48*
	(0.02)	(0.85)	(0.02)	(0.88)	(0.01)

Note: *ru* rate of unemployment, *rm* rate of migration, *g* employment growth, *rd* replacement demand, *ql* qualification level, *SSI* Skills shortage index of jobs with green potential. p-Values are reported in parantheses. Significance on the 5%-level is marked by a *.

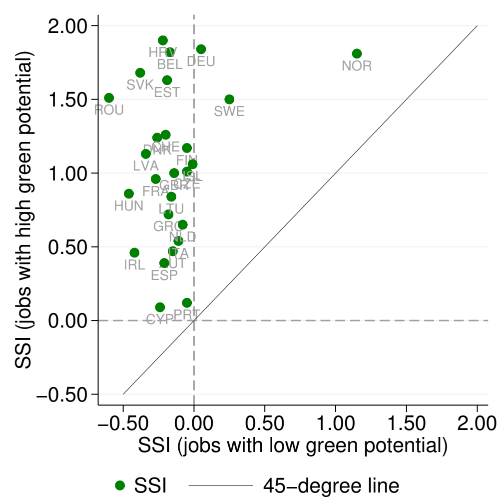
Source: Own calculations based on EU-LFS (Eurostat), 2016.

Until now we have focused on professions with high green potential. The question is how the skilled labour situation in occupations with high green potential compares to the skilled labour situation in the other occupations. This comparison helps to answer the question of the extent to which the skilled labour situation in occupations with a high green potential differs from that in other occupations or from an overall economic perspective. Figure 4 compares the SSI for the group of jobs with high

[19] Correlations of the individual indicators are shown in Table 5 in the Appendix

green potential with the SSI for the group of jobs with low green potential. To make the comparison clear, the Figure includes a 45-degree line. Countries for which the value of the SSI for the jobs with high green potential is higher than the value of the SSI for the jobs with low green potential are located above the 45-degree line, the other countries below. As Figure 4 indicates, the SSI for the occupations with high green potential is higher than the SSI for the occupations with low green potential for all considered countries. More precisely, the occupations with low green potential show on average a relaxed skilled worker situation, indicated by an SSI less than 0. In contrast, occupations with high green potential have average SSI values well above 0. This result indicates that the shortage of skilled workers is more pronounced in occupations with high green potential than in jobs with low green potential. As there are fewer people in employment in occupations with high green potential than in occupations with low green potential, the overall economic SSI is closer to the index score of occupations with low green potential. The descriptive statistics in Table 8 in the Appendix document this finding.

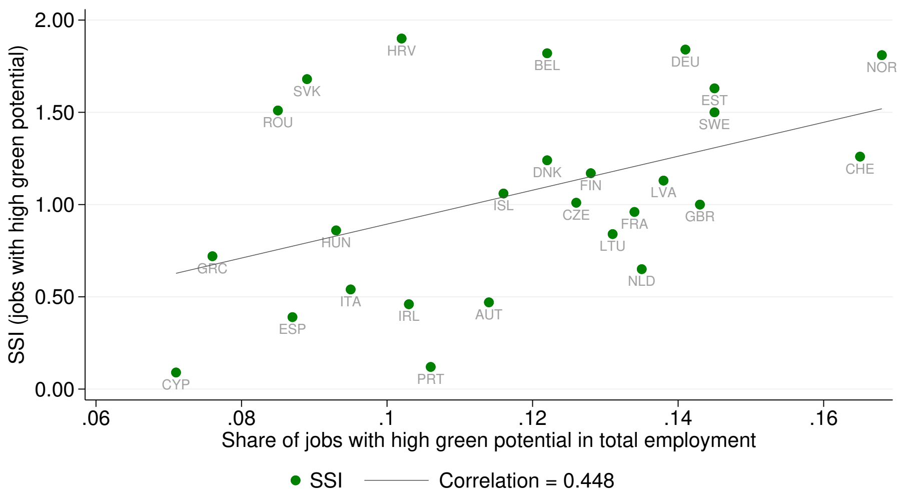
Figure 4: Comparison of SSI of jobs with high and low green potential by country



Source: Own calculations based on EU-LFS (Eurostat), 2016.

Next, we examine the extent to which the skilled labour situation is related to the share of the labour force in occupations with high green potential in the total labour force. One hypothesis is that the larger the share of employment in high green potential occupations in total employment (higher relative demand for the associated skills), the more strained the skilled labour situation in high green potential occupations becomes. This should be reflected in a positive correlation between the SSI and the share of employment in high green potential occupations. As Figure 5 shows, there is indeed a positive correlation between the SSI and the share of employment in high green potential occupations in total employment.

Figure 5: Correlation between SSI (jobs with high green potential) and employment share



Source: Own calculations based on EU-LFS (Eurostat), 2016.

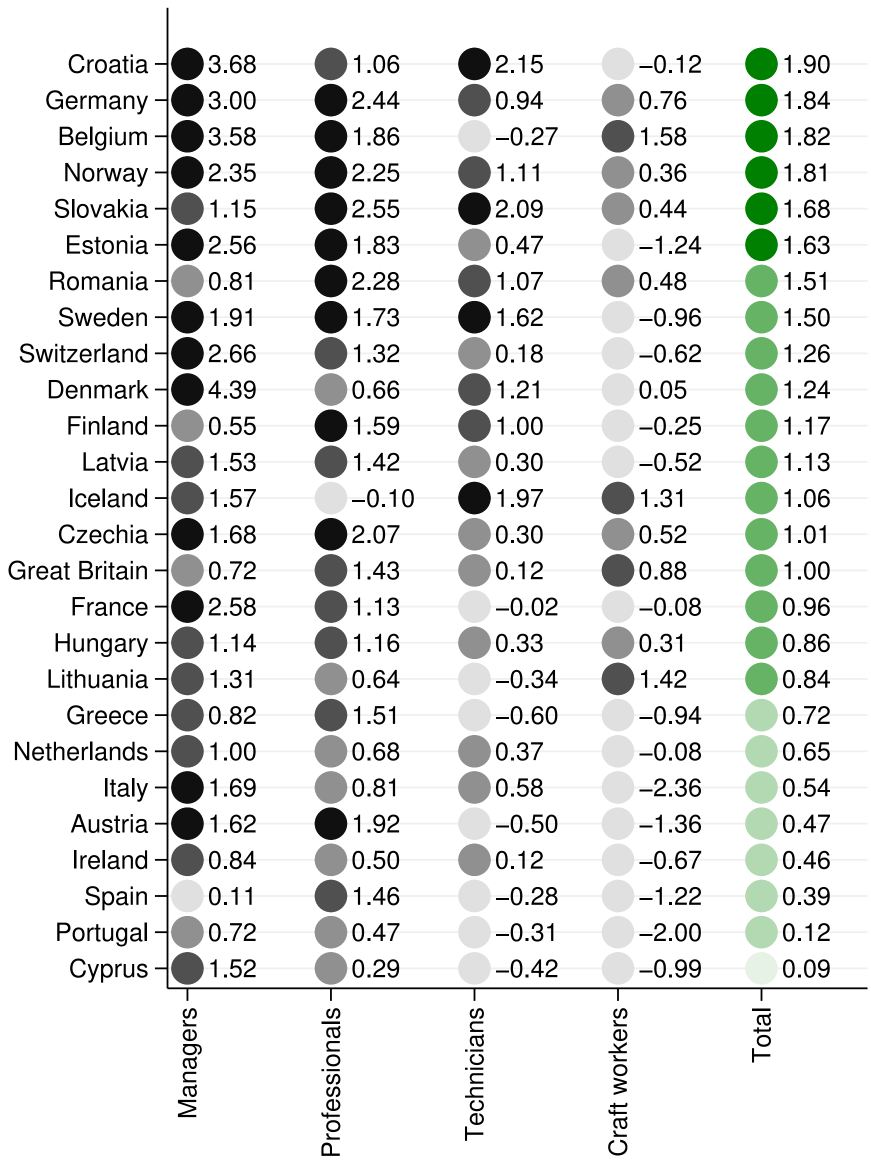
4.2.2 By country and occupational groups

In the previous Section, the skilled labour situation in occupations with high green potential was examined at the country level. Now we will focus on occupational groups. Figure 6 shows, in addition to the results of the SSI for occupations with high green potential on the country level, the SSI for occupations with high green potential differentiated according to the four occupational groups managers (1), professionals (2), technicians (3) and craft & related workers (7) (with the corresponding number of the ISCO-08 shown in brackets). These groups correspond to 1-digit level occupational groups of the ISCO-08 nomenclature. The 3-digit occupations belonging to the respective 1-digit occupational group can be found in Table 3 in the Appendix. The occupations with high green potential are marked in bold. Only those four occupational groups are considered which include occupations with high green potential.[20] As the results show, the need for skilled workers in occupations with high green potential is particularly pronounced for managers and professionals, lower for technicians and smallest for craft & related trades workers.

So far, the focus has been on occupations with high green potential within the four occupational groups managers, professionals, technicians and craft workers at the country level (see discussion around Figure 4). The question arises to what extent occupations with high and low green potential differ in terms of the skilled labor situation in the four considered occupational groups. As Figure 4 on the level of countries shows, the shortage of skilled workers tends to be more pronounced in occupations with high green potential than in occupations with low green potential. However, the following analysis cannot be directly compared with the analysis at the country level. While the analysis at the country level includes all occupations with low green potential, the present analysis is based on a selection of occupations with low green potential. Namely, those that can be assigned to the 1-digit occupational groups that contain at least one occupation with high green potential. Figure 7 elaborates the relationship between the skilled labour situation in occupations with high and low green potential for the four occupational groups considered. To make

[20] On the 1-digit level of the ISCO nomenclature, there are further occupational groups that are not considered in the analysis because they do not include occupations with high green potential (the corresponding number of ISCO-08 is shown in brackets): These are *Clerical support workers* (4), *Service and sales workers* (5), *Skilled agricultural, forestry and fishery workers* (6), *Plant and machine operators and assemblers* (8), and *Elementary occupations* (9).

Figure 6: SSI of occupations with high green potential by occupational groups and country



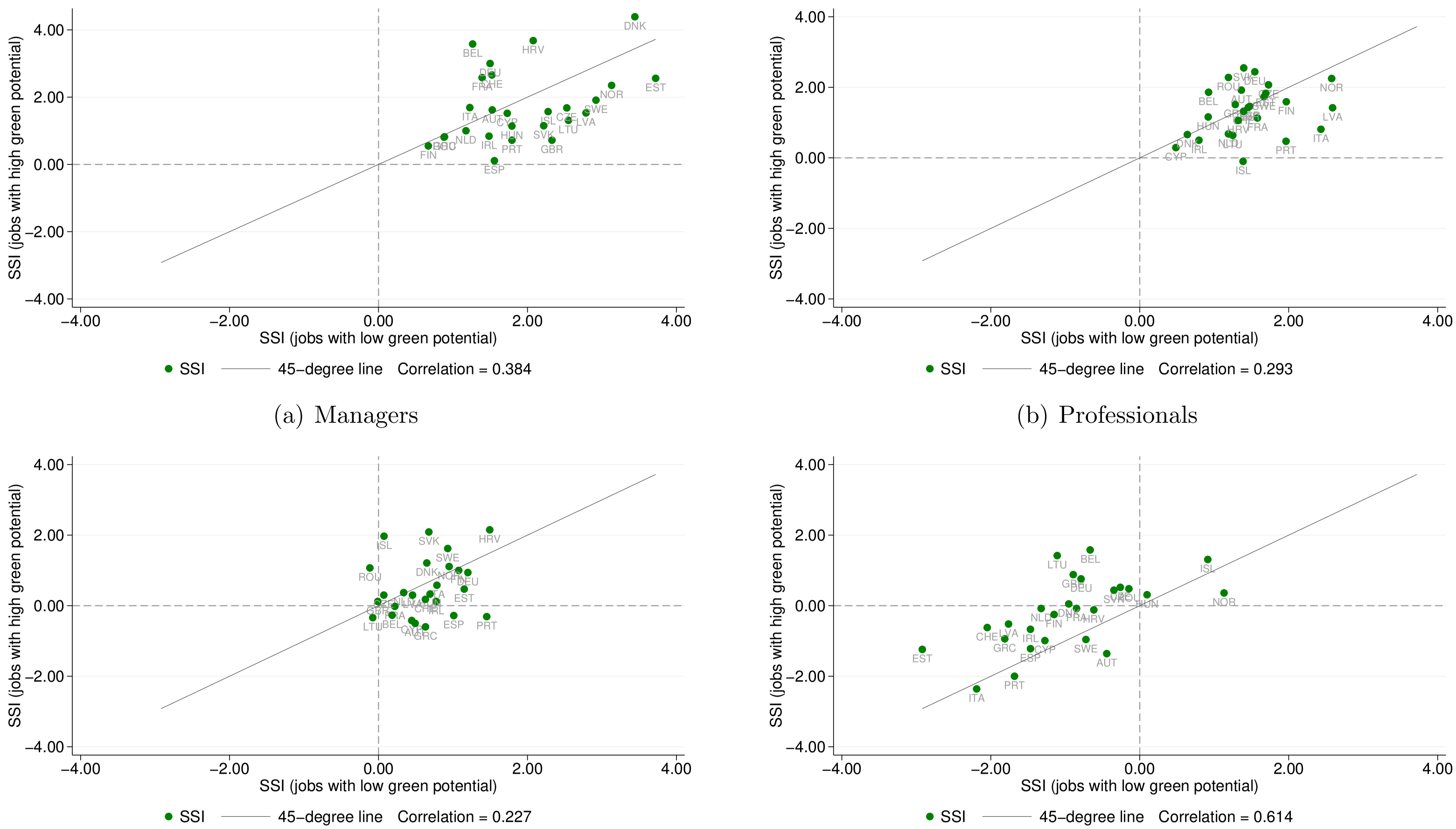
Source: Own calculations based on EU-LFS (Eurostat), 2016. *Note*: Countries are sorted by the SSI (Total) (in descending order). The light-dark contrast was assigned by dividing the values of the SSI for the occupational groups into quartiles (the darker, the higher the value). The distribution was determined by taking into account the index values of all occupational groups. The classification of the index values of the SSI (Total) was based on the distribution of the index values of all occupational groups.
Figure 6 shows the results on the level of ISCO 1-digit occupational groups. The 3-digit occupational groups that are part of the 1-digit occupational groups are shown in Table 3 in the Appendix.

the comparison clear, each Figure includes a 45-degree line. Countries, for which the value of the SSI of jobs with high green potential is higher than for jobs with low green potential, are located above the 45-degree line, the other countries below. Furthermore, each Figure includes a horizontal and a vertical dashed line that intersects the origin. Countries to the right of the vertical line and above the horizontal line are characterized by having a strained skilled labor situation for occupations with high and low green potential. For occupations within the occupational groups of managers (Panel a) and professionals (Panel b), all but one country[21] show high demand for occupations with high and low green potential, whereas occupations with low green potential tend to be relatively more affected by shortages of skilled workers than occupations with high green potential. The same tendency can be observed for the occupational group of technicians (Panel c). There, especially the skilled labour situation in occupations with low green potential is quite tense. However, a number of countries have a relaxed skilled labour situation for occupations with high green potential. In the occupational groups of craft workers (Panel d), the skilled labor situation in both occupational groups is relatively relaxed in the vast majority of countries, with occupations with high green potential tending to have a higher SSI than occupations with low green potential.

Overall, a strained skilled labor situation is not exclusively restricted to occupations with high green potential. On the contrary, occupations with low green potential are in many cases even more affected by a shortage of skilled workers than occupations with high green potential. This mixed picture is also shown in Figure 7 by the positive correlations between the index values of occupations with high and low green potential, which range from 0.23 (technicians) to 0.61 (craft workers).

[21] Iceland in the case of the occupational group of professionals.

Figure 7: Comparison of SSI of jobs with high and low green potential by professional group and country



(a) Managers

(b) Professionals

(c) Technicians

(d) Craft Workers

Source: Own calculations based on EU-LFS (Eurostat), 2016.

5 Discussion

Using a novel approach developed by Rutzer et al. (2020), we identify occupations with high green potential and estimate the green potential (measured as the share of green employment to total employment) of the overall workforce for 26 European countries. Furthermore, we estimate, by means of a composite index, the extent of a (possible) skills shortage for occupations with high green potential.

Our analysis shows that the overall green potential of the workforce varies considerably between the considered countries, but that in general, a significant portion of the working population is employed in occupations with high green potential. Furthermore, we find evidence for skills shortages with respect to jobs with high green potential. The occupational groups of managers and professionals are more strongly affected than technicians as well as craft and related workers. Although the shortage of skilled workers is not only a problem for occupations with high green potential, the results show that the extent of a skills shortage tends to be more pronounced for the jobs with high green potential than for the economy as a whole. In view of the expected increase in demand for these occupations and the skills that characterise these occupations, respectively, supply-side measures will be needed to satisfy demand.

However, our analysis of skills imbalances indicates only whether there exists a quantity mismatch between demand and supply of occupations with a high green potential. It does not show whether particular skills needed to perform green tasks are sufficiently available or not. Hence, in future research one may identify skills that are important to perform green tasks. This, in turn, would allow to identify potential mismatches of skills required to perform green tasks. Ultimately, it would then be possible to support political, administrative and economic circles in adapting vocational training to the needs of a green economy.

Appendices

Table 3: List of ISCO occupations with predicted greenness

ISCO	Job title	Predicted greenness
1	Managers	
131	**Production managers in agriculture, forestry and fisheries**	**0.76**
132	**Manufacturing, mining, construction, and distribution managers**	**0.72**
112	**Managing directors and chief executives**	**0.68**
110	**Chief executives, senior officials and legislators, nos**	**0.65**
111	**Legislators and senior officials**	**0.60**
142	**Retail and wholesale trade managers**	**0.57**
130	**Production and specialized services managers, nos**	**0.54**
100	**Managers, nos**	**0.53**
143	**Other services managers**	**0.53**
122	Sales, marketing and development managers	0.49
120	Administrative and commercial managers, nos	0.48
140	Hospitality, retail and other services managers, nos	0.46
133	Information and communications technology service managers	0.43
121	Business services and administration managers	0.43
134	Professional services managers	0.30
141	Hotel and restaurant managers	0.28
2	Professionals	
214	**Engineering professionals (excluding electrotechnology)**	**1.00**
211	**Physical and earth science professionals**	**0.76**
210	**Science and engineering professionals, nos**	**0.75**
215	**Electrotechnology engineers**	**0.73**
216	**Architects, planners, surveyors and designers**	**0.71**
213	**Life science professionals**	**0.59**
242	**Administration professionals**	**0.53**
212	Mathematicians, actuaries and statisticians	0.49
240	Business and administration professionals, nos	0.43
251	Software and applications developers and analysts	0.41
200	Professionals, nos	0.37
250	Information and communications technology professionals, nos	0.37
243	Sales, marketing and public relations professionals	0.36

Continued on next page

Table 3 – *Continued from previous page*

ISCO	Job title	Predicted greenness
252	Database and network professionals	0.35
241	Finance professionals	0.34
232	Vocational education teachers	0.28
225	Veterinarians	0.27
261	Legal professionals	0.25
262	Librarians, archivists and curators	0.24
231	University and higher education teachers	0.23
221	Medical doctors	0.23
220	Health professionals, nos	0.20
223	Traditional and complementary medicine professionals	0.20
260	Legal, social and cultural professionals, nos	0.19
226	Other health professionals	0.18
265	Creative and performing artists	0.15
222	Nursing and midwifery professionals	0.15
224	Paramedical practitioners	0.14
264	Authors, journalists and linguists	0.14
230	Teaching professionals, nos	0.13
233	Secondary education teachers	0.12
235	Other teaching professionals	0.12
263	Social and religious professionals	0.09
234	Primary school and early childhood teachers	0.08
3	Technicians and associate professionals	
312	**Mining, manufacturing and construction supervisors**	**0.75**
314	**Life science technicians and related associate professionals**	**0.68**
311	**Physical and engineering science technicians**	**0.58**
310	Science and engineering associate professionals, nos	0.49
313	Process control technicians	0.49
333	Business services agents	0.44
332	Sales and purchasing agents and brokers	0.43
343	Artistic, cultural and culinary associate professionals	0.40
315	Ship and aircraft controllers and technicians	0.33
300	Technicians and associate professionals, nos	0.32
352	Telecommunications and broadcasting technicians	0.30
350	Information and communications technicians, nos	0.29
330	Business and administration associate professionals, nos	0.28

Continued on next page

Table 3 – *Continued from previous page*

ISCO	Job title	Predicted greenness
351	Information and communications technology operations and user support technicians	0.27
335	Regulatory government associate professionals	0.25
331	Financial and mathematical associate professionals	0.24
340	Legal, social, cultural and related associate professionals, nos	0.20
342	Sports and fitness workers	0.15
320	Health associate professionals, nos	0.13
324	Veterinary technicians and assistants	0.13
321	Medical and pharmaceutical technicians	0.13
323	Traditional and complementary medicine associate professionals	0.11
325	Other health associate professionals	0.10
341	Legal, social and religious associate professionals	0.04
322	Nursing and midwifery associate professionals	0.02
334	Administrative and specialized secretaries	0.01
4	Clerical support workers	
411	General office clerks	0.23
430	Numerical and material recording clerks, nos	0.17
432	Material-recording and transport clerks	0.16
431	Numerical clerks	0.15
400	Clerical support workers, nos	0.11
410	General and keyboard clerks, nos	0.10
441	Other clerical support workers	0.09
420	Customer services clerks, nos	0.08
412	Secretaries (general)	0.07
422	Client information workers	0.07
413	Keyboard operators	0.06
421	Tellers, money collectors and related clerks	0.04
5	Service and sales workers	
522	Shop salespersons	0.24
521	Street and market salespersons	0.21
520	Sales workers, nos	0.20
541	Protective services workers	0.20
524	Other sales workers	0.18
513	Waiters and bartenders	0.18
514	Hairdressers, beauticians and related workers	0.17

Continued on next page

Table 3 – *Continued from previous page*

ISCO	Job title	Predicted greenness
512	Cooks	0.17
500	Service and sales workers, nos	0.17
510	Personal service workers, nos	0.14
516	Other personal services workers	0.12
511	Travel attendants, conductors and guides	0.11
515	Building and housekeeping supervisors	0.10
523	Cashiers and ticket clerks	0.09
531	Child care workers and teachers' aides	0.04
530	Personal care workers, nos	0.02
532	Personal care workers in health services	0.00
6	Skilled agricultural, forestry and fishery workers	
622	Fishery workers, hunters and trappers	0.43
612	Animal producers	0.43
620	Market-oriented skilled forestry, fishery and hunting workers, nos	0.41
610	Market-oriented skilled agricultural workers, nos	0.39
600	Skilled agricultural, forestry and fishery workers, nos	0.36
613	Mixed crop and animal producers	0.35
621	Forestry and related workers	0.34
611	Market gardeners and crop growers	0.33
634	Subsistence fishers, hunters, trappers and gatherers	0.33
632	Subsistence livestock farmers	0.23
630	Subsistence farmers, fishers, hunters and gatherers, nos	0.23
633	Subsistence mixed crop and livestock farmers	0.19
631	Subsistence crop farmers	0.15
7	Craft and related trades workers	
741	**Electrical equipment installers and repairers**	**0.51**
740	Electrical and electronic trades workers, nos	0.49
742	Electronics and telecommunications installers and repairers	0.48
754	Other craft and related workers	0.48
723	Machinery mechanics and repairers	0.46
710	Building and related trades workers, excluding electricians, nos	0.45
711	Building frame and related trades workers	0.45
731	Handicraft workers	0.44
712	Building finishers and related trades workers	0.44
720	Metal, machinery and related trades workers, nos	0.39

Continued on next page

Table 3 – *Continued from previous page*

ISCO	Job title	Predicted greenness
700	Craft and related trades workers, nos	0.35
721	Sheet and structural metal workers, moulders and welders, and related workers	0.34
713	Painters, building structure cleaners and related trades workers	0.32
722	Blacksmiths, toolmakers and related trades workers	0.31
752	Wood treaters, cabinet-makers and related trades workers	0.31
730	Handicraft and printing workers, nos	0.27
750	Food processing, wood working, garment and other craft and related trades workers, nos	0.24
751	Food processing and related trades workers	0.21
732	Printing trades workers	0.19
753	Garment and related trades workers	0.15
8	Plant and machine operators and assemblers	
811	Mining and mineral processing plant operators	0.39
813	Chemical and photographic products plant and machine operators	0.35
835	Ships' deck crews and related workers	0.31
821	Assemblers	0.27
834	Mobile plant operators	0.27
820	Assemblers, nos	0.24
830	Drivers and mobile plant operators, nos	0.23
800	Plant and machine operators and assemblers, nos	0.23
810	Stationary plant and machine operators, nos	0.22
833	Heavy truck and bus drivers	0.22
814	Rubber, plastic and paper products machine operators	0.20
812	Metal processing and finishing plant operators	0.19
816	Food and related products machine operators	0.18
832	Car, van and motorcycle drivers	0.18
818	Other stationary plant and machine operators	0.18
831	Locomotive engine drivers and related workers	0.17
815	Textile, fur and leather products machine operators	0.16
817	Wood processing and papermaking plant operators	0.15
9	Elementary occupations	
931	Mining and construction labourers	0.41
933	Transport and storage labourers	0.29
961	Refuse workers	0.27

Continued on next page

Table 3 – *Continued from previous page*

ISCO	Job title	Predicted greenness
930	Labourers in mining, construction, manufacturing and transport, nos	0.27
921	Agricultural, forestry and fishery labourers	0.22
950	Street and related sales and service workers, nos	0.21
951	Street and related service workers	0.21
952	Street vendors (excluding food)	0.21
960	Refuse workers and other elementary workers, nos	0.21
900	Elementary occupations, nos	0.21
941	Food preparation assistants	0.16
932	Manufacturing labourers	0.15
912	Vehicle, window, laundry and other hand cleaning workers	0.14
910	Cleaners and helpers, nos	0.14
911	Domestic, hotel and office cleaners and helpers	0.10
962	Other elementary workers	0.06

Table 4: Industry Classification (NACE Rev. 2)

Code	Economic Area
A	Agriculture, Forestry and Fishing
B	Mining and Quarrying
C	Manufacturing
D	Electricity, Gas, Steam and Air Conditioning Supply
E	Water Supply; Sewerage, Waste Management and Remediation Activities
F	Construction
G	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles
H	Transportation and Storage
I	Accommodation and Food Service Activities
J	Information and Communication
K	Financial and Insurance Activities
L	Real Estate Activities
M	Professional, Scientific and Technical Activities
N	Administrative and Support Service Activities
O	Public Administration and Defence; Compulsory Social Security
P	Education
Q	Human Health and Social Work Activities
R	Arts, Entertainment and Recreation
S	Other Service Activities
T	Activities of Households as Employers; Undifferentiated Goods and Services Producing Activities of Households for Own Use
U	Activities of Extraterritorial Organisations and Bodies

Table 5: Correlations of shortage indicators for jobs with high green potential

	ru	rm	g	rd	ql
ru	1.00				
rm	-0.06	1.00			
	(0.78)				
g	-0.47*	0.08	1.00		
	(0.02)	(0.68)			
rd	0.08	-0.28	0.02	1.00	
	(0.71)	(0.17)	(0.91)		
ql	-0.25	0.04	0.07	-0.33	1.00
	(0.23)	(0.85)	(0.74)	(0.10)	

Note: *ru* rate of unemployment, *rm* rate of migration, *g* employment growth, *rd* replacement demand, *ql* qualification level. p-Values are reported in parantheses. Significance on the 5%-level is marked by a *.

Source: Own calculations based on Eurostat (2016)

Table 6: Share of employment with high green potential in total employment by industry

Country	Ressources	Manufacturing	Engergy & Construction	Services	Total
Belgium	4.9%	22.2%	28.0%	8.9%	12.2%
Croatia	6.4%	15.3%	21.0%	7.6%	10.2%
Cyprus	1.9%	12.8%	26.0%	4.4%	7.1%
Czechia	13.6%	18.0%	26.8%	7.5%	12.6%
Denmark	5.5%	26.1%	25.6%	8.9%	12.2%
Estonia	13.7%	18.3%	29.7%	10.9%	14.5%
Finland	8.0%	25.1%	27.4%	8.9%	12.8%
France	6.7%	28.2%	33.8%	9.1%	13.4%
Germany	10.3%	24.6%	28.1%	9.7%	14.1%
Great Britain	17.6%	25.4%	27.1%	11.5%	14.3%
Greece	0.7%	9.9%	20.9%	7.5%	7.6%
Hungary	8.1%	13.8%	20.5%	6.4%	9.3%
Iceland	5.1%	16.0%	25.8%	10.0%	11.6%
Ireland	3.3%	19.5%	17.6%	8.6%	10.3%
Italy	1.8%	14.7%	19.8%	7.3%	9.5%
Latvia	7.0%	18.9%	24.9%	11.8%	13.8%
Lithuania	5.6%	14.2%	23.2%	12.3%	13.1%
Netherlands	5.5%	22.2%	26.1%	11.6%	13.5%
Norway	31.3%	32.1%	30.5%	12.8%	16.8%
Portugal	3.1%	15.5%	26.9%	8.4%	10.6%
Romania	2.7%	13.7%	18.8%	7.1%	8.5%
Slovakia	15.2%	11.7%	22.5%	4.7%	8.9%
Spain	3.5%	16.5%	23.1%	6.3%	8.7%
Sweden	6.9%	27.3%	29.6%	11.3%	14.5%
Switzerland	5.0%	29.1%	32.5%	13.5%	16.5%

Source: Own calculations based on Eurostat (2016)

Table 7: Skills shortage indicators and SSI (2016)

Country	ru	rm	g	rd	ql	Index
Austria	3.3%	5.9%	108.8%	47.1%	97.5%	0.47
Belgium	2.6%	7.7%	120.7%	51.5%	91.8%	1.82
Croatia	5.4%	0.6%	120.2%	57.6%	99.2%	1.90
Cyprus	9.6%	6.0%	88.5%	52.3%	95.5%	0.09
Czechia	1.1%	0.8%	111.1%	49.8%	99.5%	1.01
Denmark	2.9%	5.4%	121.0%	57.9%	94.3%	1.24
Estonia	3.5%	1.9%	118.4%	49.6%	96.9%	1.63
Finland	4.4%	2.7%	104.0%	54.5%	96.1%	1.17
France	4.3%	1.8%	154.4%	55.7%	90.8%	0.96
Germany	1.5%	3.5%	108.7%	60.8%	97.2%	1.84
Great Britain	1.8%	6.6%	108.6%	53.4%	87.9%	1.00
Greece	11.4%	0.4%	93.8%	56.5%	93.4%	0.72
Hungary	1.5%	0.5%	113.0%	50.0%	99.1%	0.86
Iceland	1.2%	0.3%	122.4%	65.8%	90.8%	1.06
Ireland	3.5%	8.0%	117.0%	45.4%	92.6%	0.46
Italy	3.9%	0.8%	103.1%	59.7%	85.6%	0.54
Latvia	4.5%	0.7%	106.1%	45.3%	98.2%	1.13
Lithuania	2.2%	0.3%	111.7%	48.3%	99.7%	0.84
Netherlands	1.0%	1.8%	104.8%	56.0%	93.4%	0.65
Norway	0.0%	4.9%	123.1%	55.5%	92.7%	1.81
Portugal	6.2%	0.5%	108.1%	53.8%	66.6%	0.12
Romania	1.6%	0.1%	110.5%	46.4%	98.4%	1.51
Slovakia	4.0%	0.5%	117.4%	49.4%	99.7%	1.68
Spain	8.3%	2.7%	96.0%	57.5%	86.4%	0.39
Sweden	1.6%	4.0%	120.0%	50.2%	95.5%	1.50
Switzerland	3.6%	17.2%	118.2%	46.8%	96.4%	1.26

Note: ru rat of unemployment, rm rate of migration, g employment growth, rd replacement demand, ql qualification level, $Index$ Skills shortage index of jobs with green potential.

Source: Own calculations based on Eurostat (2016)

Table 8: Summary statistics of SSI and skills shortage indicators (occupations with high green potential) (2016)

Variable	N	Mean	Std. Dev.	Median	Min	Max
ru	26	3.6%	2.7%	3.4%	0.0%	11.4%
rm	26	3.3%	3.8%	1.9%	0.1%	17.2%
g	26	112.7%	12.4%	111.4%	88.5%	154.4%
rd	26	52.9%	5.2%	52.8%	45.3%	65.8%
ql	26	93.7%	6.8%	95.5%	66.6%	99.7%
SSI (jobs with high green potential)	26	106.4%	54.0%	103.5%	9.0%	190.0%

Note: *ru* rate of unemployment, *rm* rate of migration, *g* employment growth, *rd* replacement demand, *ql* qualification level, *SSI* Skills shortage index.

Source: Own calculations based on Eurostat (2016)

Table 9: SSI by occupational goup and country

	Managers		Professionals		Technicians		Craft Workers	
Country	Index	Share	Index	Share	Index	Share	Index	Share
Austria	1.62	1.6%	1.92	3.8%	-0.50	4.5%	-1.36	1.6%
Belgium	3.58	3.6%	1.86	4.2%	-0.27	3.0%	1.58	1.3%
Croatia	3.68	2.4%	1.06	3.1%	2.15	3.5%	-0.12	1.2%
Cyprus	1.52	1.1%	0.29	3.0%	-0.42	1.8%	-0.99	1.2%
Czechia	1.68	2.5%	2.07	2.9%	0.30	5.5%	0.52	1.7%
Denmark	4.39	1.4%	0.66	5.8%	1.21	4.1%	0.05	0.8%
Estonia	2.56	6.5%	1.83	4.1%	0.47	2.5%	-1.24	1.4%
Finland	0.55	1.2%	1.59	7.3%	1.00	3.0%	-0.25	1.3%
France	2.58	3.3%	1.13	4.0%	-0.02	5.3%	-0.08	0.9%
Germany	3.00	2.5%	2.44	5.2%	0.94	4.9%	0.76	1.4%
Great Britain	0.72	5.5%	1.43	6.5%	0.12	1.4%	0.88	0.8%
Greece	0.82	1.5%	1.51	3.9%	-0.60	0.9%	-0.94	1.3%
Hungary	1.14	2.5%	1.16	3.5%	0.33	1.9%	0.31	1.4%
Iceland	1.57	5.5%	-0.10	3.7%	1.97	1.2%	1.31	1.2%
Ireland	0.84	3.5%	0.50	4.4%	0.12	1.5%	-0.67	0.8%
Italy	1.69	2.2%	0.81	3.0%	0.58	3.0%	-2.36	1.2%
Latvia	1.53	5.4%	1.42	5.2%	0.30	1.8%	-0.52	1.3%
Lithuania	1.31	4.8%	0.64	5.9%	-0.34	1.4%	1.42	1.0%
Netherlands	1.00	3.1%	0.68	7.2%	0.37	2.2%	-0.08	0.9%
Norway	2.35	4.9%	2.25	6.1%	1.11	4.0%	0.36	1.8%
Portugal	0.72	4.0%	0.47	3.2%	-0.31	2.2%	-2.00	1.2%
Romania	0.81	1.7%	2.28	4.2%	1.07	1.0%	0.48	1.6%
Slovakia	1.15	2.2%	2.55	1.4%	2.09	4.0%	0.44	1.4%
Spain	0.11	2.0%	1.46	3.6%	-0.28	1.8%	-1.22	1.3%
Sweden	1.91	2.4%	1.73	6.6%	1.62	4.3%	-0.97	1.2%
Switzerland	2.66	4.5%	1.32	6.7%	0.18	3.9%	-0.63	1.3%

Note: *Share* provides information about the share of green employment in the occupational group in total employment.

Source: Own calculations based on Eurostat (2016)

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