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QUANTIFYING THE GREEN SKILLS POTENTIAL IN THE POLISH ECONOMY – AN EMPIRICAL ANALYSIS

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ABSTRACT: In this study, we employ a stepwise empirical approach to identify key occupational groups for green job (GJ) creation in Poland. We use the operating register of economic entities (REGON) and Polish Labor Force Survey (BAEL) data from the period 2015-2022. The changes in REGON reflect a proxy of changes in GJ stock in sectors of economic activity (PKD-2007). We estimate trends of green employment. Most sectors and many occupational groups have seen increases in GJ, except for agriculture, where the downward trend in employment has had a significant influence on the green labour market. Our findings will be useful when formulating policy recommendations for educational institutions, employment institutions, local governments, government institutions, investors, employers and students.

KEYWORDS: green skills, green jobs, potential for green skills creation, BAEL, KZiS

Introduction

The performance of work as an element of human economic activity is a major area of consideration in economics, as it creates socio-economic development to a considerable extent. The type of workers, their competencies, and to what extent they meet employers' demands determine the stability, competitiveness and adaptability of the economic system to changing socio-economic as well as climatic and geopolitical conditions (Dell'Anna, 2021). The green transformation is the current direction of change taking place both at the strategic level in the action planning of the institutions responsible for creating the future world order (UNDP, 2023; ILO, 2023), and at the operational level in individual economies, enterprises and individuals conducting individual tasks (EEA, 2023a).

The identification of green economy sectors and jobs, conducted to analyse changes in Poland's labour market, indicated a number of methodological problems regarding the definition of the green economy. The assumptions adopted make it possible to isolate sectors and classes that constitute the core of the green transformation. Moreover, defining green occupations allowed for statistical analysis of the data and inference of observed trends (Antczak & Gajdos, 2023).

Green occupations combine knowledge, skills and especially competencies that individuals need to thrive in a changing, environmentally conscious world. Green competencies are relevant across sectors and professions, covering a wide range of disciplines (CISL, 2020). Key elements of green competencies include environmental awareness (understanding environmental issues, climate change and the impact of human activities on nature), sustainable practices (knowledge of and ability to implement sustainable practices in various fields such as energy, agriculture, construction and manufacturing), renewable energy (skills related to the use and management of renewable energy sources such as solar, wind, hydro and geothermal energy), resource efficiency (competence in optimising resource use and minimising waste, including the principles of a closed loop economy), climate change adaptation and mitigation (understanding climate change mitigation strategies, both at individual and organisational levels), green technologies (knowledge of technologies that contribute to environmental sustainability, such as clean technologies, green infrastructure and environmentally friendly innovation), biodiversity conservation (skills related to the protection and restoration of biodiversity, including ecosystem management and conservation strategies), environmental policy and regulation (knowledge of environmental laws, policies and regulations at local, national and international levels), and communication and collaboration (skills for effective communication and cooperation needed to work on interdisciplinary and cross-sectoral environmental projects) (ETF, 2023).

Our analysis of green jobs across occupational groups adds further complexity to the research due to the difficulty in assessing the extent to which a job is green, let alone the greening of an occupation. The main aim of this paper is to identify the key occupations for creating a green employment economy and to assess the potential for green job creation in Poland. For the purpose of this article, it is assumed that green jobs combine three main components: ecological knowledge, skills and pro-environmental attitudes of employees based on their environmental awareness and sensitivity (Grigorescu et al., 2023). They are therefore crucial in any sector and organisation, regardless of the industry, that aims at sustainable and green development. We use a replicable stepwise method to accurately gauge the green economy's size and rate of growth and to identify the jobs associated with it.

The study was based on the following research questions:

1) What are the green employment trends in Poland for the period between 2015 and 2022?
2) How are green jobs occupationally diverse?
3) What is the occupational and sectoral potential for the creation of green jobs in Poland?

Green competencies are key to creating a workforce capable of meeting the challenges posed by climate change. They are not limited to specific jobs but are increasingly recognised as essential across industries and professions as organisations seek to operate more sustainably. Education that focuses on green competencies is essential to prepare individuals for the changing demands of a greener and more sustainable future. Answering the research questions above will help estimate and assess the potential for green jobs in the Polish economy from both occupational and sectoral perspectives.

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An overview of the literature

The analysis of the impact of the green transition on the labour market faces the fundamental problem of defining the green economy, green jobs, green competencies and green occupations. In any understanding of greenness in the labour market (narrow or broad), there is the problem of omitting sufficiently green jobs and including insufficiently green ones. The discussion in the literature on identifying green economic sectors indicates that analyses conducted on different definitions of 'greenness' lead not only to similar key conclusions but also to the identification of significant differences and determinants of change for different conclusions (Stanef-Puică et al., 2022; Antczak & Gajdos, 2023).

According to the ILO (International Labour Organization) definition, green jobs are a selected subset of decent jobs, employment in environmentally friendly processes, and employment in the production of green products and services (ILO, 2016). However, within this understanding, there is still no clear answer as to whether it is only a common part of three subsets at the same time or whether belonging to two selected subsets is sufficient. The European Training Foundation's (ETF, 2023) dynamic definition of job greening states that in the future, all jobs will be green through the process of acquiring green qualifications, Figure 1.

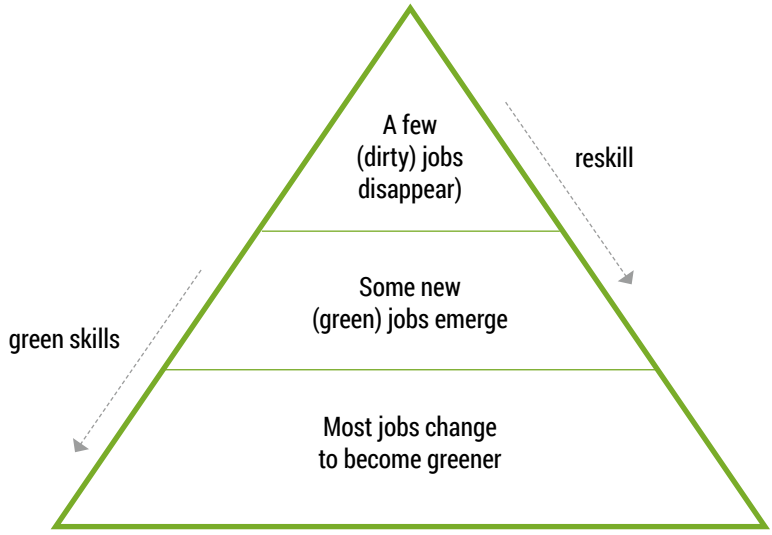

Figure 1. Green jobs in the ETF concept

Source: authors' work based on ETF (2023).

One of the first classifications relating to qualifications (and occupations) in the green economy is the O*NET base developed in the United States (Dierdorff et al., 2009) and adapted to European requirements by the European Commission in 2019 (European Commission, 2019). According to this classification, there are three categories of green jobs:

1. Existing jobs with increasing demand that do not require significant changes in tasks, skills, or knowledge (indirectly green).
2. Jobs with increased demand that require significant changes in tasks, skills, and knowledge (indirectly or directly green).
3. New and developing jobs, unique in terms of the tasks, skills, and knowledge necessary for the development of the green economy (directly green).

The European Commission also mentions other jobs that can have an impact on the greening of the economy, leading to the conclusion that all jobs have some element of 'greening'. Consequently, selected jobs are particularly relevant for the development of the green economy (European Commission, 2019).

It is clear that the green transformation requires the acquisition of skills at every level of education and, in particular, the acquisition of green attitudes that are consistent regardless of educational direction. The green transformation has a multifaceted effect on changing the demand for the work-

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force and its diverse competencies and skills. The projected change in the number of employed people without taking the green transition into account (baseline scenario) indicated an increase in the number of employed people in the European Union of around 3.7% between 2020 and 2030. Taking into account the changes resulting from the introduction of the European Green Deal (EGD) indicates that an increase in the number of employed people of around 4.9% between 2020 and 2030 should be expected (European Commission, 2021a; Igliński et al., 2022). In the cross-section of major occupational groups, the largest increase relative to baseline values will be observed among Craft and related trades workers – about 1.7 p.p. and Plant and machine operators and assemblers, Managers, and Elementary occupations –about 1.6 p.p. For Technicians and associate professionals, an increase of about 1.4 p.p. is projected; for Clerical support workers – about 1.1 p.p., Professionals – about 1.0 p.p., Service and sales workers – about 0.6 p.p., and Skilled agricultural, forestry and fishery workers – only about 0.2% (Cedefop, 2021).

By analysing selected elements of the core competencies identified above, for example, in the area of renewable energy related to the use and management of renewable energy sources, it is possible to identify areas of activity in which the green transition is causing significant employment growth. Between 2012 and 2022, global employment in the area of renewable energy increased by around 88% (from 7.3 million people to 13.7 million people). Between 2015 and 2022, there was an increase of 3.7 million people (about 37%). Over the past eight years, the number of people who work in the following areas increased: photovoltaic technology (by 77%; more than 2.1 million people), bioenergy (24%; 0.7 million people), hydropower (15%; about 0.3 million people), and wind energy (30%; about 0.3 million people). Only in the area of solar heating/cooling did employment decline (-25%; about 0.2 million people).

In 2022, with 5.55 million working people in the area of renewable energy, China was the global employment leader. The next big employment markets in this area are Brazil (1.40 million people), the United States (0.99 million people), India (0.99 million people), other Asian countries (1.92 million people), and the European Union (1.64 million people). Poland ranks seventh in the area of photovoltaic technology, behind China, India, the United States, Brazil, Japan and Vietnam, but ahead of Germany, Spain and Australia. In the area of biofuel production, it is tenth in the world. In the heat pump sector, it is fifth in Europe, behind France, Italy, Germany and Sweden (ILO, 2019; Gajdos et al., 2020; IRENA, 2023).

These historical and projected labour market changes related to the green transition and the differential impact of these changes on employment across sectoral, occupational and spatial dimensions indicate the relevance of an in-depth analysis of the national potential for green job creation that considers the occupational qualification cross-section.

Research methods

Based on the academic discussion on the definition of green jobs (ILO, 2016; European Commission, 2019), we have adopted the selection of classes (c) proposed by Antczak and Gajdos (2023) from the following sectors(s) of the economy: agriculture, forestry, hunting and fishing (A), manufacturing (C), electricity, gas, steam, hot water and air conditioning manufacturing and supply (D), water supply; sewerage, waste management and remediation activities (E), construction (F), accommodation and food service activities (I), professional, scientific and technical activities (M), administrative and support service activities (N), public administration and defence; compulsory social security (O), education (P), arts, entertainment and recreation activities (R), other service activities (S), Table 1.

In this stage of the empirical research, we estimated the values of green employment in the extracted classes and sectors of the green economy. The number of enterprises was determined based on the REGON database (the National Official Business Register, Statistics Poland, 2022a). The REGON is classified into individual sectors and divisions (classes) of PKD-2007, as its number in the sector is a direct determinant of employment (Grzywińska-Rąpca & Markowski, 2018). The employment values (overall and by voivodeship, in selected sectors) were extracted from the Labor Force Survey database (BAEL, Statistics Poland, 2022b). We took the classification status from 1 January 2016, when there were 16 voivodeships (i.e., NUTS-2 regions) (Statistics Poland, 2023).

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Table 1. Economy codes according to PKD-2007 for green jobs in Poland

Economy sectors	PKD 2007 – sections (S)	PKD 2007 – classes (C)	Description
AGRICULTURE	A	AGRICULTURE, FORESTRY, HUNTING AND FISHING	
		01	crop and animal production, hunting, including service activities
		02	forestry and logging
		03	fishing and aquaculture
INDUSTRY	C	MANUFACTURING	
		26	manufacture of computer, electronic and optical products
		27	manufacture of electrical equipment
		28	manufacture of machinery and equipment not elsewhere classified
		29	manufacture of motor vehicles, trailers and semi-trailers, excluding motor-cycles
		33	repair, maintenance and installation of machinery and equipment
	D	ELECTRICITY, GAS, STEAM, HOT WATER AND AIR CONDITIONING MANUFACTURING AND SUPPLY	
		35	electricity, gas, steam, hot water and air conditioning manufacturing and supply
	E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	
		36	water collection, treatment, and supply
		37	sewage disposal and treatment
		38	waste collection, processing, and neutralizing activities; materials recovery
		39	remediation activities and other waste management services
	F	CONSTRUCTION	
		41	construction of buildings
		42	works related to the construction of civil engineering
		43	specialized construction activities
SERVICES	I	ACCOMMODATION AND FOOD SERVICE ACTIVITIES	
		55.20	holiday and other short-stay accommodation
		56.29	other food service activities
	M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	
		71	architectural and engineering activities; technical testing and analysis
		72	scientific research and development
		73.11Z	advertising agencies activities
		73.20Z	market research and public opinion polling
		75	veterinary activities
	N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	
		81.30	landscape service activities
	O	PUBLIC ADMINISTRATION AND DEFENSE; COMPULSORY SOCIAL SECURITY	
		84	public administration and defense; compulsory social security

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Economy sectors	PKD 2007 – sections (S)	PKD 2007 – classes (C)	Description
SERVICES	P	EDUCATION	
		85.31B	general upper secondary schools
		85.31C	specialized upper secondary schools
		85.32A	technical secondary schools
		85.32B	basic vocational schools
		85.32C	special job-training schools
		85.41Z	post-secondary schools
		85.42A	initial teacher training institutions and colleges of social work
		85.42B/Z	higher education institutions
	R	ARTS, ENTERTAINMENT AND RECREATION ACTIVITIES	
		91.04	botanical and zoological gardens and nature reserves activities
	S	OTHER SERVICE ACTIVITIES	
		94.99	activities of other membership organizations not elsewhere classified
		95	repair and maintenance of computers and personal and household goods

Source: authors' work based on Antczak and Gajdos (2023).

In the next step of the analysis, we estimated the number of people employed by major, sub-major and minor occupational groups in the green economy. This was based on the estimated share of people employed in the green section in the total section and the occupational structure in the cross-section of minor occupational groups. In this part of the analysis, the voivodeship cross-section was omitted due to data availability limitations in the complex cross-sections of the economy, groups of occupations and voivodeships at the same time. The allocation of the volume of green jobs in every minor occupational group (GJ_o) was made according to the following formula:

$$GJ_{o,t} = \sum_{s=A}^{S} \frac{E_{c,t}}{E_{s,t}} \cdot E_{o,s,t} \quad (1)$$

where:
s = A, C, D, E, F, I, M, N, O, P, R, S,
$E_{c,t}$ and $E_{s,t}$ are the number of green jobs in classes (c) and number of employees in sectors (s), $E_{o,s,t}$ is the volume of employment,
index o – denotes code of the minor occupational group,
t – the time period.

The study includes data from 2015-2022, with data for 2022 estimated based on changes in REGON due to the lack of access to detailed 2022 LFS data at the time of the study. The analysis of the LFS data constructed in this way made it possible to obtain information for the key groups of occupations that are dominant in the green economy. Additionally, it made it possible to identify groups of occupations that are not key but are observed in this part of the economy (Arendt & Gajdos, 2018; Konfederacja Lewiatan, 2022). In the cross-section of occupation groups, the applicable Classification of Occupations and Specialties (COS) was used, which is coherent with the European ISCO classification. There are ten major groups in the COS (Table 2).

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Table 2. Structure of the Classification of Occupations and Specialties

Major Groups (code)	Number of groups		
	sub- major	minor	elementary
Managers (1)	4	11	31
Professionals (2)	6	31	99
Technicians and associate professionals (3)	5	20	87
Clerical support workers (4)	4	8	27
Service and sales workers (5)	4	13	39
Skilled agricultural, forestry and fishery workers (6)	3	9	17
Craft and related trades workers (7)	5	14	69
Plant and machine operators and assemblers (8)	3	14	41
Elementary occupations (9)	6	11	32
Armed forces occupations (0)	3	3	3
Total	**43**	**134**	**445**

Note: Group (0), Armed Forces Occupations, was omitted from the detailed analysis.
Source: authors' work based on Rozporządzenie (2021), Rozorządzenie (2022) and ILO (2024).

An estimated average annual least-squares growth rate (AGR) (World Bank, 2023) was used to compare trends across major occupational groups. A comparison of trends obtained from analysing data in economic sectors was also made. Finally, a comparative analysis of the results from the qualitative study of green jobs in the occupational cross-section was also carried out.

Results of the research

At the end of 2022, green sectors employed 5.55 million people (33.7% of total employment) – 74,100 people fewer than in 2015. The average number of green employees in Poland between 2015 and 2022 amounted to more than 5.5 million people (33.9% share of total employment from over 16 million employed people).

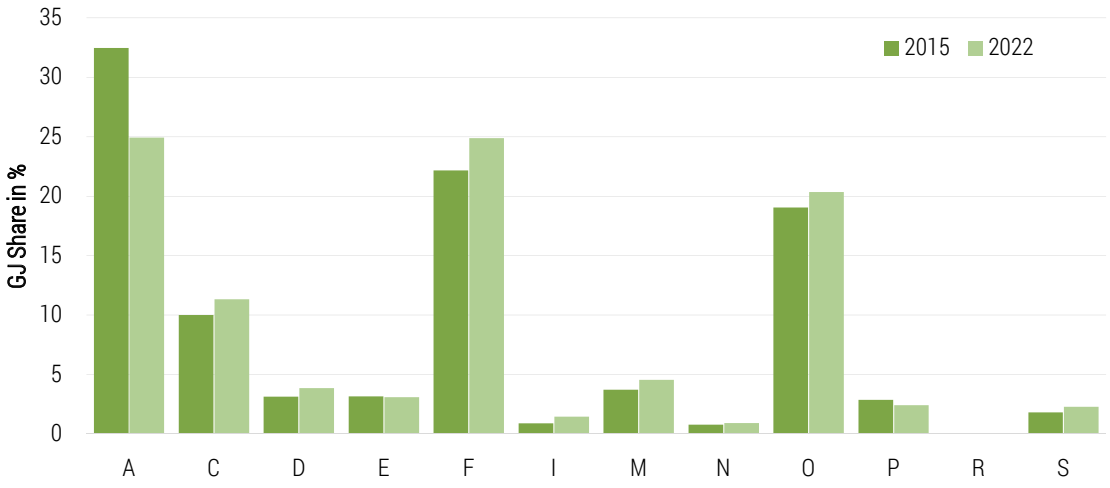

Figure 2. GJ employment shares in economic sectors in 2015 and 2022 [in %]
Source: authors' work based on Antczak and Gajdos (2023).

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The greatest share of green employment in 2015 and 2022 was observed in agriculture, forestry, hunting and fishing (A) (32.5% and 24.9%, respectively), construction (F) (22.2% and 24.9%), public administration and defence; compulsory social security (O) (19.0% and 20.3%) and manufacturing (C) (10.0% and 11.3%). A decrease in employment from 2015 to 2022 was noted in agriculture, forestry, hunting and fishing (A), water supply; sewerage, waste management and remediation activities (E), and education (P). The highest decrease was in the agriculture sector (-7.6 pp), while the highest increase was in the construction sector (+2.7 pp) (Figure 2).

The changes in the number and share of employees by economic sector are reflected in the dynamic changes in the number and structure of employees in the green economy by occupational group. The largest share of employees by major occupation group is observed for Skilled agricultural, forestry and fishery workers (29.2% and 26.8%) – mainly sector A, Craft and related trades workers (19.4% and 19.9%) – mainly sectors F and C, Technicians and associate professionals (12.0% and 12.9%) – mainly section C, and Professionals (12.2% and 12.7%) –mainly sectors O and C (Figure 3).

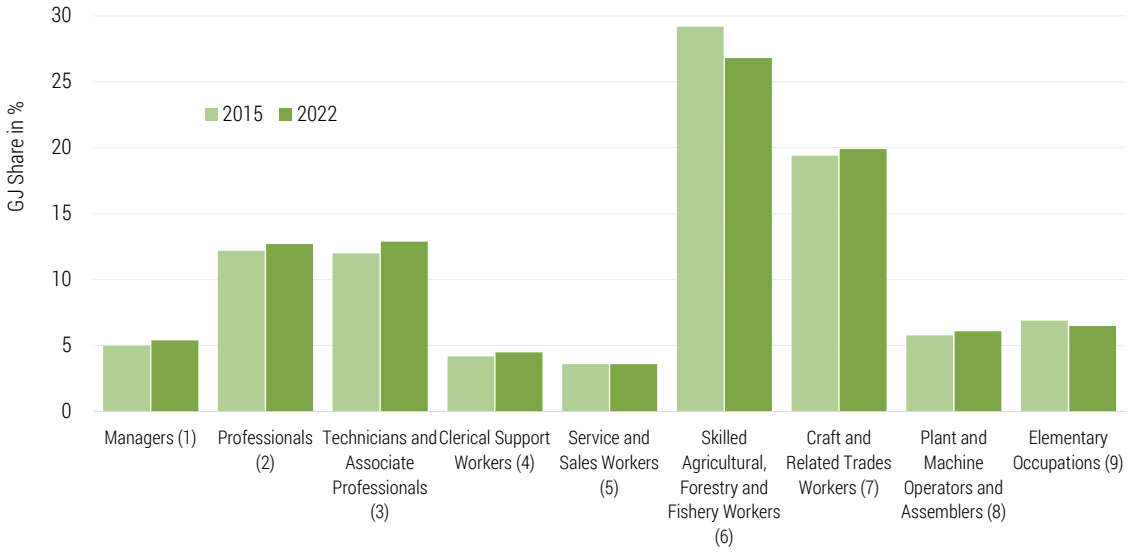

Figure 3. GJ employment shares in the major occupational groups in 2015 and 2022 [in %]

Between 2015 and 2022, the biggest decrease in the number of people employed was observed for Elementary occupations (–28.9%), although the number also decreased significantly for Skilled agricultural, forestry and fishery workers (–23.6%). Meanwhile, the biggest increase was for the following groups: Service and sales workers (+16.5%), Professionals (+15.1%) and Technicians and associate professionals (+13.9%). More than 10% growth was also observed for Managers and Clerical support workers. Most major occupational groups noted statistically significant annual increases in green jobs values during the period analysed. Between 2015 and 2022, the strongest downward trend (AGR) in GJ value was noted for Elementary occupations (-5.0%) and Skilled agricultural, forestry and fishery workers (3.2%). The highest growing positive slope was observed for Professionals (+2.1%), Service and sales workers (+2.0%) and Clerical support workers (+1.6%) (Table 3).

Data for the entire country show a downward weak trend (R^2=0.04) in green employment (AGR=–0.1%). However, the data in Figure 3 and Table 2 indicate that the negative GJ slope is determined by a very strong, decreasing trend for Skilled agricultural, forestry and fishery workers (R^2=0.72, AGR=–3.2%). The value of the slope for the trend without major Group 6 points to significant annual growth (AGR=+1.0%) in green employment (R^2=0.96) (Figure 4).

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Table 3. Occupational changes in the volume of green jobs between 2015 to 2022

Major Groups (code)	AGR in % 2015-2022	Change in % 2022/2015
Managers (1)	1.1*	13.2
Professionals (2)	2.1***	15.1
Technicians and Associate Professionals (3)	1.3*	13.9
Clerical Support Workers (4)	1.6	11.7
Service and Sales Workers (5)	2.0**	16.5
Skilled Agricultural, Forestry and Fishery Workers (6)	–3.2***	–23.6
Craft and Related Trades Workers (7)	1.1**	6.9
Plant and Machine Operators and Assemblers (8)	0.8*	7.3
Elementary Occupations (9)	–5.0***	–28.9
Total	**–0.1**	**–1.5**

Note: significance levels of the statistically significant slopes: * α = 0.10; ** α = 0.05; *** α = 0.01.

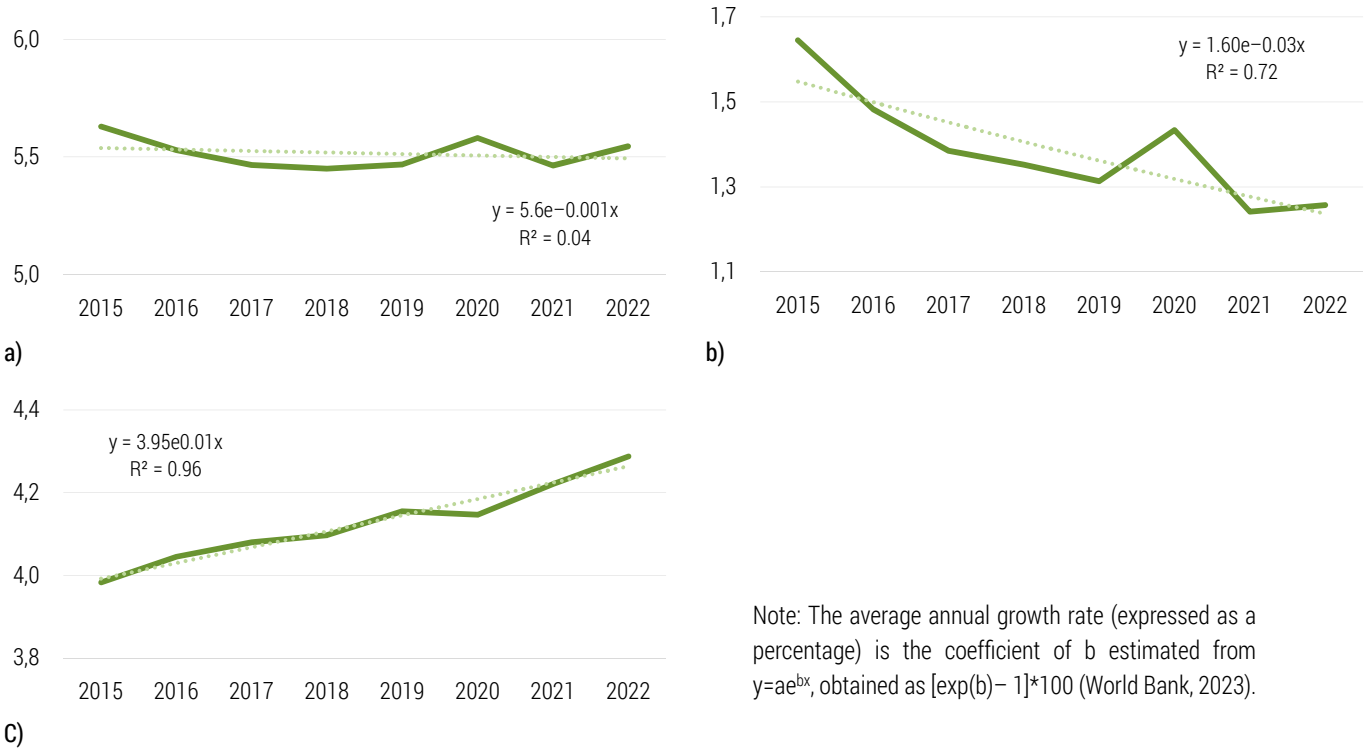

Figure 4. Green jobs trends in Poland in the period 2015–2022, in millions of people, a) green employment, b) green employment in six major occupational groups, c) green employment without six major occupational groups

Source: authors' work based on Antczak and Gajdos (2023).

Between 2015 and 2022, dynamic changes were observed in the number of people employed in the cross-section of minor occupational groups. In most of the major occupational groups, there are minor groups in which the number is growing significantly. Large increases were observed for Electrotechnology engineers (+74%), Electrical equipment installers and repairers (+52%), Real estate agents and property managers (+49%) and Electronics and telecommunications installers and repairers (+39%) (Table 4).

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Table 4. Occupational changes in the volume of green jobs between 2015 and 2022 (minor occupational groups) [in%]

Code	Minor groups	2022/2015
121	Business services and administration managers	20%
133	Information and communications technology service managers	6%
213	Life science professionals	21%
214	Engineering professionals (excluding electrotechnology)	9%
215	Electrotechnology engineers	74%
216	Architects, planners, surveyors and designers	34%
235	Other teaching professionals	12%
241	Finance professionals	24%
244	Real estate agents and property managers	49%
311	Physical and engineering science technicians	20%
422	Client information workers	15%
432	Material-recording and transport clerks	21%
522	Shop salespersons	36%
711	Building frame and related trades workers	6%
712	Building finishers and related trades workers	16%
741	Electrical equipment installers and repairers	52%
742	Electronics and telecommunications installers and repairers	39%
814	Rubber, plastic and paper products machine operators	16%
816	Food and related products machine operators	31%
834	Mobile plant operators	12%

Note: in this part of the analysis, apart from those working in Armed forces occupations (0), Group 6, i.e., Skilled agricultural, forestry and fishery workers, was also omitted due to the need to carry out an in-depth analysis of the separation of ecological agriculture from total agriculture (Antczak & Gajdos, 2023).

Discussion

According to the accepted definition, about one-third of the Polish labour market is green. Between 2015 and 2022, no clear trend in the change of the total number of employees in this part of the economy was observed. However, a cross-sectional analysis indicates that such an increase was observed in most sectors of the economy. At the end of 2022, in Poland, green sectors employed 5.6 million people (increased by 0.6 percentage points from 2015 to 2022), whereas employment in the EU's environmental goods and services sector reaches 5.1 million employees (+0.3 percentage points from 2015 to 2022). This rise, in the EU, was mainly the result of the creation of jobs related to renewable energy, energy efficiency and waste management (Ciliberto et al., 2021; Fernández Alvarez & Molnar, 2021; EEA, 2023b; Hanna et al., 2024). Similar to the EU's projections and in line with the above mentioned research, the results of our study indicate that the number of green jobs in Poland increased most strongly in Accommodation and food service activities (I), Other service activities (S) and Electricity, gas, steam, hot water and air conditioning manufacturing and supply (D). They increased less strongly but significantly in Professional, scientific and technical activities (M), Administrative and support service activities (N) and Construction (F). The increases, especially in the C, D, and M sectors, were driven by all sub-sectors, including real estate activities, architectural and engineering activities, narrow manufacturing, and construction. All of these branches recorded growth in the number of employees between 2015 and 2022, with the largest increase in the real estate activi-

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ties sub-sector (+46.4%) (European Commission, 2021). Overall, the Polish construction sector has a positive long-term outlook and under its 2021-2026 Recovery and Resilience Plan (RRP), Poland has allocated approximately EUR 7.0 billion for construction-related activities (European Commission, 2024).

The observed increases in the number of employees in the mentioned sectors were accompanied by a strong decrease in the number of employees in Agriculture, forestry, hunting and fishing (A). One of the main reasons for this decrease is the employment structure in Poland inherited from the times of the centrally-planned economy (Pietrzak et al., 2017; Usabiaga et al., 2022). However, due to the relatively high share of agricultural workers in total employment, the significant role of agriculture in the Polish economy, and most importantly, the growing share of organic crops and food market in agricultural production, the analysis of green jobs in section A should be limited to organic farming. In the period from 2006 to 2020, the average share of fully converted and under conversion to organic farming total utilised agricultural area was 3.3% and grew by 6.3% per year (Antczak, 2021; IJHARS, 2024). This compares to 6% and 5.6%, respectively, for the EU as a whole (European Commission, 2023). The value of organic crop sales in Poland is still relatively much lower than in the EU. In 2020, it accounted for 0.45% of the total value of food sold (compared to 4% for the EU) (Kociszewski et al., 2023). However, the organic food market is expected to rise by 9.4% per year, reaching approximately EUR 600 million by 2026 (Żakowska-Biemans, 2022). Therefore, a detailed analysis of ecological agriculture is planned in future research, and if this is not possible, agriculture will be omitted from cross-sectional analyses (Antczak & Gajdos, 2023).

Changes in the sectoral structure of the economy are strongly reflected in the demand for competencies and qualifications in Poland and in the whole EU. The development of a green economy is determined by the promotion and implementation of green solutions at various stages: education, design and management, financing, delivering, building, and producing and using all goods and services in the process of sustainable functioning of local communities and societies (ILO, 2023; UNDP, 2023; Arendt & Kwiatkowski, 2023; Antczak et al., 2023). Based on our results, it was confirmed that the green economy has seen the strongest decline in the number of Elementary occupations and Skilled agricultural, forestry and fishery workers. However, there has been a dynamic increase in the number of Professionals, Service and sales workers and Clerical support workers. Some studies argue that the greening of the economy demands new skills, competencies and qualifications linked to the creation of new markets and activities, but this depends on the extent to which direct, indirect and induced job creation are considered (Aceleanu et al., 2015; Pavlova, 2019; Auktor, 2021). Moreover, the green economy requires a workforce that is aware of the conditions and constraints of sustainable development (Gajdos & Lewandowska-Gwarda, 2022; ETF, 2023).

In turn, there has been a significant increase in the number of people employed in the construction industry, where, as noted above, green technologies play a special role in the creation of new infrastructure or in the modernisation of existing infrastructure. An increase in the number of construction workers has been observed, including Building frame and related trades workers (+6%) and Building finishers and related trades workers (+16%). The introduction of modern energy supply and consumption technologies (photovoltaic installations, heat pumps, energy storage) has seen particularly high growth in employment (Hanna et al., 2024). In Poland, this growth is especially concentrated in two occupational groups: Electrical equipment installers and repairers (+52%) and Electronics and telecommunications installers and repairers (+39%). In industry, green technologies are being implemented in the production of consumer goods and food products. Here, an increase was also observed in the number of Rubber, plastic and paper products machine operators (+16%) and Food and related products machine operators (+31%). Meanwhile, logistics has seen increased demand for Mobile plant operators (+12%) (IRENA, 2023; Gajdos, 2014). The medium groups included above are highlighted as important for the development of the green economy in scientific and practical studies (Konfederacja Lewiatan, 2022; Cedefop, 2021).

With reference to the "key elements of green competencies" described in the introduction, there has been a significant increase in the number of workers in many areas, at all levels of education, in most major occupational groups (European Commission, 2019). In the area of green economy management, the number of working Business services and administration managers (+20%) and Information and communications technology service managers (+6%) increased. In the area of biotechnology, more Life science professionals are working (+21%). Engineering professionals (excluding

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electrotechnology) (+9%) and Electrotechnology engineers (+74%) are working more in industry, especially with electricity technology. In design and construction, there has been an increase in the number of Architects, planners, surveyors and designers working (+34%). Additionally, in education, especially out-of-school education, more Other teaching professionals are working (+12%). Investment in green infrastructure is supported by a growing number of finance professionals (+24%), real estate agents, and property managers (+49%). In modern industries, there is an increasing demand for Physical and engineering science technicians (+20%), and in remote customer service and logistics, there is a need for Client information workers (+15%) and Material-recording and transport clerks (+21%). Despite the growth of online sales, even in traditional trade, which is also changing towards the use of green technologies and management processes, shop salespersons are on the rise (+36%) (Gajdos & Żmurkow, 2012; Miniszewski et al., 2020). The green economy requires access to a highly skilled workforce, which enables the implementation of modern green technologies (Qu et al., 2021; Godinho, 2022). A cluster of studies was identified around the issue of skills and typical education levels associated with green jobs, e.g. Consoli et al. (2016) suggested that "green jobs exhibit higher levels of education, work experience and job training" and "use more intensively high-level cognitive and interpersonal skills compared to non-green jobs". This is also supported by the findings of a study of Elliott and Lindley (2017) who observed that green industries "increased the quantity of workers demanded from the middle of the skill distribution at the same time as they reduced the quantity demanded for lower skilled workers". Finally, a German study found that "the share of university-degree staff is around three times as high as the national industry average" (Pegels & Lütkenhorst, 2014). In turn, some evidence directly suggests that green skills supply and demand should be carefully managed through policies supporting green job creation and coordination of training activities. For example, Allan and Ross (2019) classified jobs in the UK offshore wind sector by skill level and found that almost 90% of these jobs were in the high to medium skill categories.

Steps taken to support the green transition will create more green employment in the EU by 2030, mainly through applying circular economy principles and moving towards a low-carbon economy. Moreover, the EU aims to accelerate the green transition of its economy and also become carbon neutral by 2050. This is expected to boost job creation in the EU's green economy and, therefore further increase the share of green employment in the EU economy as a whole and especially in services on: producing renewable energy, manufacturing equipment needed to generate renewable energy, such as wind turbines and photovoltaic cells, manufacturing energy-efficient equipment, research and development (R&D) activities, installation, consultancy and management services (EEA, 2023b). Several analyses noted the potential to train and employ young people in these new "greening" areas while helping to address youth unemployment (Aceleanu et al., 2015; Sulich et al., 2020). It is therefore expected that, through policies, measures and investments, green employment will account for a higher share of total employment in the EU by 2030.

Conclusions

The green transformation and its impact on the labour market are one of the main currents of theoretical and practical research in the area of analyses of socio-economic phenomena. Despite the methodological problems mentioned, identifying green sectors, companies, professions, competencies, and jobs enables a detailed analysis of the processes taking place in the labour market. It also makes it possible to identify opportunities and threats that result from the mismatch between labour demand and supply.

This study provided a detailed analysis of trends in green employment. It took into account different economic sectors and major and minor groups of occupations. This made it possible to identify the potential for the creation of green jobs in Poland between 2015 and 2022. REGON and LFS data were used to estimate the number of employees in the green economy by minor groups of occupations according to the Classification of Occupations and Specialties. Approximately 5.5 million people worked in the green economy in Poland between 2015 and 2022, representing about 33% of the total workforce. Most sectors recorded statistically significant annual growth in the number of green jobs over the period, with the exception of agriculture and some other smaller sectors. In the cross-section of major occupational groups, a particular increase in the number of green jobs was observed for the

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following groups: Service and sales workers, Professionals, Technicians and associate professionals, Managers and Clerical support workers. In contrast, there was a decrease in the number of jobs for the Elementary occupations and Skilled agricultural, forestry and fishery workers groups. Many minor occupation groups saw a statistically significant increase in the number of green jobs. There was a significant increase in the number of people employed in the following areas: green economy management, information and communications technology, biotechnology, electricity technology, design and construction, out-of-school education, investment processes in green infrastructure, finance, real estate, modern industries, remote customer service and logistics, online sales, modern energy supply and consumption technologies (photovoltaic installations, heat pumps, energy storage), selected areas of manufacturing, and transport.

In summary, green skills are competencies and knowledge that are necessary for sustainable development in various fields. Therefore, the outcomes of this study will be useful policy-recommendation tools, especially for local governments, employers, and institutions, to identify surplus and deficit areas in terms of qualifications and professions. They will also help identify new directions in education, training, or courses while also making it possible to assess the market potential of local economies or respond to the shift to a greener economy. Finally, these outcomes can also guide the establishment of intervention funds.

Green jobs, on the other hand, are specific jobs that have a direct positive impact on the environment or are a tool for the transition to a more sustainable economy. Green skills in green jobs are key to supporting a workforce and economy that prioritises environmental responsibility and sustainability. Developing green skills can enable individuals to fill green jobs and contribute to a more sustainable future. The results will, therefore, be relevant when developing national green job assessments and formulating strategic labour, economic and educational policies.

One of the limitations of this study is the availability of the employment data collected. It was not possible to obtain open source statistical information for all the sectors and classes of economic activity analysed. Therefore, the values of green jobs were derived from BAEL. We based our estimates on the assumption that the number of units (from REGON) is directly related to the employment generated (the Pearson correlation between labour force data and the number of units was between 0.96*** in 2015 and 0.98*** in 2022, depending on the section). For this reason, changes in REGON-s explained the diversity of changes in employment. However, the methodology that was carried out and described in this study is replicable and can be used to estimate the stock of green jobs and identify the occupational, regional, and sectoral potential of climate-friendly employment.

As the extracted employment data only approximate the actual number of green jobs, these results serve as a starting point for a series of articles involving in-depth empirical research. After quantifying the green potential by extracting green occupation groups from the LFS, we plan to use a questionnaire survey approach to determine more precise values and the nature of green jobs in Poland (e.g. from gender, educational level, age or economic activity perspectives). A detailed analysis of ecological agriculture is also planned in future research. By using an approach based on real data, decision-makers and researchers can evaluate different policy scenarios, which will provide an opportunity to examine the economic impacts of policy changes or other interventions to promote green jobs.

The contribution of the authors

Conception, E.A. and A.G.; literature review, E.A.; acquisition of data, A.G; analysis and interpretation of data, E.A. and A.G; writing, E.A. and A.G., conclusions and discussion, E.A. and A.G.;

The authors have read and agreed to the published version of the manuscript.

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Artur GAJDOS • Elżbieta ANTCZAK

KWANTYFIKACJA POTENCJAŁU ZIELONYCH KOMPETENCJI W POLSKIEJ GOSPODARCE – ANALIZA EMPIRYCZNA

STRESZCZENIE: W niniejszym opracowaniu dokonaliśmy identyfikacji kluczowych grup zawodowych dla oszacowania potencjału tworzenia zielonych miejsc pracy w Polsce. Wykorzystaliśmy dane z krajowego rejestru podmiotów gospodarki narodowej (REGON) oraz dane z Badania Aktywności Ekonomicznej Ludności (BAEL). W proponowanej metodzie założyliśmy, że zmiany w REGON odzwierciedlają przybliżenie zmiany zasobu GJ w sektorach działalności gospodarczej (PKD-2007) i grupach zawodowych. Oceniliśmy trendy zielonego zatrudnienia w latach 2015-2022. Większość sektorów i wiele grup zawodowych odnotowała wzrost zielonego zatrudnienia, z wyjątkiem. m.in. rolnictwa. Co więcej spadające zatrudnienie w tym sektorze ma znaczący wpływ na zielony rynek pracy. Nasze ustalenia mogą być przydatne przy formułowaniu rekomendacji dla systemu edukacji, instytucji zatrudnienia, samorządów lokalnych, inwestorów, pracodawców i studentów.

SŁOWA KLUCZOWE: zielone kompetencje, zielone miejsca pracy, potencjał kreowania zielonych miejsc pracy, BAEL, KZiS

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