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LABOR MARKET IMPACTS OF THE GREEN TRANSITION IN THE MENA

Shireen AlAzzawi and Vladimir Hlasny

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Authors:
Shireen AlAzzawi, Teaching professor, Santa Clara University

Vladimir Hlasny, Associate professor, Ewha Womans University, Seoul; Economic Affairs Officer, UN ESCWA

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LABOR MARKET IMPACTS OF THE GREEN TRANSITION IN THE MENA

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ABSTRACT

As the rising risks of climate change intensify the imperative for global decarbonization, economies worldwide are gravitating toward a green transition. This shift's impact on labor markets varies starkly between regions and countries. While advanced economies are experiencing steady growth in environmentally sustainable jobs, Middle East and North Africa (MENA) transitional economies, many long tethered to oil revenues including through remittances from their migrant workers, face mounting pressure to decouple their development from oil dependence. This paper provides the first careful assessment of green skills and jobs across the region using data from four MENA countries: Egypt (2018), Jordan (2016), Palestine (2020) and Tunisia (2014). Applying a skill greenness classification derived from the U.S. O*NET database to labor market surveys in these four countries, we estimate that fewer than 15% of MENA workers currently hold green jobs. Our analysis reveals that women are more likely to hold green occupations than men, even though in Egypt women are presently largely segregated into non-green sectors. More educated workers and those in higher economic strata show markedly higher green job shares. However, the difference between youth and prime-working age adults is surprisingly negligible. These findings point to the transformative potential of the green transition in the MENA developing countries while raising concerns that the green shift may exacerbate existing inequalities. Our study provides clear policy recommendations in crafting targeted interventions, from worker reskilling, job matching and labor mobility support, to enhanced access to finance and industry-academia partnerships, ensuring an inclusive, sustainable economic future for the region.

Keywords: Green jobs, Skills, Green transition, Decarbonization, MENA.
JEL Classification: J24, O14, O53, Q52.

RÉSUMÉ

Alors que les risques croissants liés au changement climatique renforcent l'impératif de la décarbonation mondiale, les économies du monde entier s'orientent vers une transition verte. L'impact de cette mutation sur les marchés du travail varie fortement d'une région et d'un pays à l'autre. Tandis que les économies avancées connaissent une croissance régulière des emplois respectueux de l'environnement, les économies en transition du Moyen-Orient et d'Afrique du Nord (MENA), longtemps dépendantes des revenus pétroliers, y compris par le biais des transferts des travailleurs migrants, subissent une pression accrue pour découpler leur développement de cette dépendance au pétrole. Cet article propose la première évaluation approfondie des compétences et emplois verts dans la région en utilisant des données de quatre pays MENA : l'Égypte (2018), la Jordanie (2016), la Palestine (2020) et la Tunisie (2014). En appliquant une classification de la « verdure » des compétences dérivée de la base de données américaine O*NET aux enquêtes sur le marché du travail dans ces quatre pays, nous estimons que moins de 15 % des travailleurs MENA occupent actuellement des emplois verts. Notre analyse révèle que les femmes sont plus susceptibles d'occuper des emplois verts que les hommes, même si en Égypte elles restent largement cantonnées à des secteurs non verts. Les travailleurs plus instruits et ceux appartenant à des strates économiques supérieures présentent des parts nettement plus élevées d'emplois verts. Toutefois, la différence entre les jeunes et les adultes en âge de travailler est étonnamment négligeable. Ces résultats mettent en évidence le potentiel transformateur de la transition verte dans les pays en développement de la région MENA, tout en soulignant le risque que ce virage accentue les inégalités existantes. Notre étude propose des recommandations politiques claires pour concevoir des interventions ciblées allant de la reconversion professionnelle, au soutien à la mobilité de la main-d'œuvre et à l'amélioration de l'accès au financement, jusqu'aux partenariats industrie-université, afin d'assurer un avenir économique inclusif et durable pour la région.

Mots-clés: Emplois verts, Compétences, Transition verte, Décarbonation, MENA.

الملخص

مع تصاعد المخاطر الناتجة عن تغيّر المناخ، تتزايد الحاجة العالمية إلى خفض الانبعاثات الكربونية، الأمر الذي يدفع الاقتصادات حول العالم نحو التحول الأخضر. يختلف تأثير هذا التحول على أسواق العمل بشكل واضح بين المناطق والدول. ففي حين تشهد الاقتصادات المتقدمة نمواً ثابتاً في الوظائف الصديقة للبيئة، تواجه اقتصادات منطقة الشرق الأوسط وشمال إفريقيا (مينا) الانتقالية، التي اعتمدت طويلاً على عائدات النفط بما في ذلك تحويلات العمال المهاجرين، ضغوطاً متزايدة لفصل مسارها التنموي عن الاعتماد على النفط. تقدم هذه الورقة أول تقييم دقيق للمهارات والوظائف الخضراء في المنطقة، بالاعتماد على بيانات من أربعة بلدان: مصر (2018)، الأردن (2016)، فلسطين (2020) وتونس (2014). ومن خلال تطبيق تصنيف خاص بخُضرة المهارات مشتق من قاعدة O*NET الأميركية على مسوح سوق العمل في هذه البلدان، نقدّر أن أقل من 15% من العمال في المنطقة يشغلون وظائف خضراء حالياً. تكشف نتائجنا أن النساء أكثر ميلاً لامتلاك وظائف خضراء مقارنة بالرجال، رغم أن النساء في مصر يتركزن بشكل كبير في قطاعات غير خضراء. كما أن العمال الأكثر تعليماً ومن ينتمون إلى الشرائح الاقتصادية الأعلى يتمتعون بنسبة أعلى بكثير من الوظائف الخضراء. ومع ذلك، فإن الفارق بين الشباب والبالغين في سن العمل الأساسي يكاد يكون معدوماً. تشير هذه النتائج إلى الإمكانات التحويلية للتحول الأخضر في بلدان مينا النامية، لكنها تثير أيضاً مخاوف من أن يزيد هذا التحول من حدة التفاوتات القائمة. تقدم دراستنا توصيات سياسية واضحة لتصميم تدخلات موجهة تشمل إعادة تأهيل العمال، ودعم التوفيق الوظيفي وحركية اليد العاملة، وتعزيز الوصول إلى التمويل، فضلاً عن الشراكات بين الجامعات والصناعة، بما يضمن مستقبلاً اقتصادياً شاملاً ومستداماً للمنطقة.

INTRODUCTION AND MOTIVATION

The escalating threats of climate change have heightened the necessity for global decarbonization, prompting countries around the world to increasingly adopt green transitions. National governments in the Middle East and North Africa (MENA) are increasingly committing themselves to climate action and green transition initiatives as part of their broader development plans. This commitment is reflected in various national strategies, announcements of Nationally Determined Contributions (NDCs) and regional collaborations. Over the last 3 years there has been a notable increase in the number of countries making announcements about "net-zero" plans, including the UAE and Oman by 2050, and Saudi Arabia, Kuwait and Bahrain by 2060 (WEF 2023).

Others have also made strong commitments to reducing greenhouse gas (GHG) emissions and increasing their renewable energy mix. Egypt's Vision 2030 strategy incorporates sustainability and environmental protection as core components, including substantial investments in renewable energy, particularly solar and wind power, with projects like the Benban Solar Park, expected to be one of the largest solar installations in the world (AfDB 2023). Jordan and Tunisia have also committed to climate action, with Jordan aiming for 10% of its energy to come from renewable sources by 2025 (Jordan Green Growth National Plan 2021-2025), and Tunisia setting a target to reduce its carbon intensity to 45% by 2030 compared to 2010 levels (Republic of Tunisia 2021), planning to generate 30% of its electricity from renewables by 2030.

While these commitments and policy transitions are commendable given the impending climate crisis, there is limited analysis of how such major transitions will affect economic sectors and labor markets. This shift will create both winners and losers, and the impact will differ significantly across world regions and their industries (Fragkos et al. 2021). While advanced economies, even in the Gulf, may witness growth in environmentally sustainable jobs (Dicce and Ewers 2021), the impact on transitional economies like those making up the bulk of the MENA region is less clear. Traditional fossil fuel industries that have been a backbone of the region's development trajectory, are likely to experience significant disruptions, with workers in these sectors potentially facing job losses and skill obsolescence as the demand for fossil fuels declines and industries either scale down or transform (Robertson and Acevedo 2024). Those without means to adapt may become vulnerable if the pool of domestic employment for them dwindles.

The MENA region's development trajectory has been deeply intertwined with fossil fuel revenues for decades. This dependence is direct in major oil exporters like Algeria, Libya, Saudi Arabia, and the UAE, and indirect in the rest of the region in two ways: first, for countries like Egypt that rely on their own fossil fuels for energy; and also second, through remittances for nations like Egypt, Jordan, and Palestine, whose migrant workers are employed in the oil-dependent Gulf Cooperation Council (GCC) countries.

Conversely, emerging green sectors such as renewable energy, sustainable construction, and eco-tourism are likely to thrive. These sectors not only offer new employment opportunities but also demand a distinct set of skills, creating pathways for those who possess these skills to thrive, while potentially leaving behind those who lack them.

The adjustment costs of the transition can be substantial when the skills required for new, expanding jobs do not align with those of the shrinking jobs. Studies indicate that the costs for workers to switch jobs depend heavily on the similarity of skills between occupations, with skill specificity being more closely linked to particular occupations rather than individual firms (Vona et al. 2018, 2019; Poletaev and Robinson 2008; Kambourov and Manovskii 2009; Gathmann and Schönberg 2010). Consequently, this may exacerbate social and economic instability, triggering a decline in investment and spending among financiers, entrepreneurs, and consumers due to uncertainty about the future. This could be particularly challenging in the MENA developing countries, given existing challenges such as high informality and precarious employment, low employment and participation rates among youth and women, displacement from natural disasters and conflicts, financial and debt crises, and the simultaneous technological transformations driven by the pushes for the fourth industrial revolution, digitalization and artificial intelligence.

The purpose of this paper is to understand the potential impact of the green transition on middle-income countries in the MENA, examining the differential impact by sector and socio-economic group and thus analyze how 'just' the green transition will be. We define and analyze the prevalence of green skills and green jobs within four MENA economies for which we have detailed occupational data. We examine the connection between green skills, jobs and sectors in the region, comparing their respective size and growth potential, and identifying those who may be adversely affected by the green transition as well as those most likely to benefit (Ferroukhi et al. 2022). To our knowledge, this is the first analysis that examines questions such as: How many jobs in the MENA currently can be classified as green jobs? Which workers are currently equipped for these jobs, and how will green transition affect different groups of workers? Which economic sectors are predominantly 'green', relying more on green skills? And what is the potential growth trajectory of these sectors over time? Ultimately, the study aims to provide recommendations on public policies that could mollify general anxiety about the transition by identifying the types of skills policymakers need to foster and the required economy-wide support mechanisms that can be conducive to a just transition towards decarbonization that leaves no one behind.

The remainder of the study is organized as follows. Section 2 reviews the relevant literature on the prevalence of green skills, green jobs, and the effect of de-carbonization of economy on various classes of workers, and the prevailing methodological approaches to delineating green jobs. Section 3 introduces the data and the method used in this study to classify jobs and workers as 'green,' and explains workers' propensity to be matched to green jobs as a function of their characteristics. Section 4 presents the empirical results of the classification across worker types, followed by the results of the probability models. Finally, Section 5 concludes with a summary of the main findings and a discussion of their implications and suggests fruitful policy responses.

LITERATURE REVIEW

Green transformation is projected to be a megatrend that will redraw the industrial and labor-market organization of economies worldwide, just as prior energy transitions and technological and trade shocks have done (Bartik et al. 2019; Hanson 2023; Altieri et al. 2016). Just as during those prior transformations, our understanding of the prospects and risks is constrained by the fuzzy delineation of green and non-green occupations.[1] This is despite a longstanding academic and policy debate over the criteria for greenness of occupations in private-sector enterprises (Renner et al. 2008; Georgetown–CEW 2010; Vona 2021). Prior studies have undertaken the identification of sustainable sectors, and the analysis of energy content of production (share of energy in costs). For instance, PWC (2023) has developed a Green Jobs Barometer of the sectors, and occupations in them, susceptible to the green transition. However, it has been recognized that the greenness of occupations varies greatly within narrow sectors rather than only across them. The US Bureau of Labor Statistics (BLS; 2013) promulgated an input–output definition considering whether the occupations serve to produce green goods and services and use green technologies and practices.

Compared to the green-output or green-process delineations of green occupations, recent studies have adopted a skill-content based approach. The former approaches are arguable sensitive to the delineation of green enterprises and occupation codes, and assumptions regarding their future classification as green. The skill content approach accounts flexibly for changes in workforce capacities and composition amid the gradual emergence of the green technology paradigm, and the emerging work tasks and task requirements of all occupations (LoBello et al. 2019). One approach has involved focusing on workers' possession of a critical number of green skills as well as those demanded by employers (ILO 2011a,b; CEDEFOP 2018; LinkedIn Economic Graph 2023). The European National Energy and Climate Plans (NECP) have emphasized the need for a transition to new skills and the development of these new skills, particularly soft 'green skills' such as collaboration, teaming, ethical judgement, and communication (Rotatori et al. 2021) for 'green jobs' in energy intensive industries (European Commission 2019). Jobs skills vary in the degree with which they should be updated in the decarbonization process (Branca et al. 2022).

Many studies have gone deeper in the analysis of occupations and adopted task-based measures of green employment that give a more nuanced view of the true 'green' content of occupations (Vona 2021). Workers' ability to perform green tasks (Lobsiger and Rutzer 2021), or the number of green tasks required of workers (Autor 2013; Autor and Dorn 2013; Dicarlo et al. 2016) were assessed. Dierdorff et al. (2009, 2011) adopted the task-based delineation of occupations and considered how

[1] The challenge of identifying occupations vulnerable to labor demand changes amid technology and trade shocks has been studied extensively (Goldin and Katz 1998; Autor et al. 2003; Autor and Dorn 2013; Lu and Ng 2013).

green activities and technologies affected the demand for, the context of, or even the task content of occupations (thus, broadly, the 'greening' of occupations as an output of decarbonization).

Most studies of occupational green-task content have been conducted in industrialized countries, especially the US (Walker 2013; Hartley et al. 2015; Consoli et al. 2016; Bowen et al. 2018; Vona et al. 2018, 2019; Upton and Yu 2021; Bergant et al. 2022; Suassay et al. 2022; WSJ 2023), but also the UK (PWC 2022), Germany (Böhringer et al. 2013), or groups of European countries (Bontadini and Vona 2020; Gilli et al. 2020; Serrano 2022).

Evidence from developing countries is weaker, not least because of sparser data. Bluedorn et al. (2023) used labor force surveys from 31 countries, mostly European countries but including two from the global south – Mexico and South Africa[2] – to study the implications of job greening for different socioeconomic groups, for workers' earnings, and for their dirty–to–green transition. De la Vega et al. (2024) developed a task-based green potential index for two-digit occupation groups in Argentina and estimated workers' likelihood of benefiting from the green transition.

Given our focus on the MENA developing countries, and our use of a task-based green-potential index, our undertaking can be viewed as most closely related to the data-driven skill-identification study by De la Vega et al. (2024). We provide an application to an understudied world region, the MENA, and we extend the methodological treatment by: 1) imputing job greenness at up to the 6 digit occupational-code level, which is a very detailed degree of granularity; and 2) devising a continuous metric rather than just a binary indicator for the green-potential.

[2] The included countries were AUT, BEL, BGR, CHE, CYP, CZE, DNK, ESP, EST, FIN, FRA, GBR, GRC, HRV, HUN, IRL, ISL, ITA, LTU, LUX, LVA, MLT, MEX, NOR, POL, PRT, ROU, SAR, SVK, SWE, USA.

METHODS

Our empirical strategy comprises three main steps. First, we define a set of green skills based on existing data on the prevalence of green tasks by occupation, using data from the US O*NET database (Peterson et al. 2001) based on the seminal work of Vona et al. (2018, 2019). Next, we cross-walk this US occupational classification-based data to ISCO occupational classifications using a set of mapping assumptions as in Scholl et al. (2023). We report the prevalence of green jobs by countries and for various industries and socioeconomic groups. Finally, third, we use regression analysis to study the determinants of workers attaining a green job at the individual level. These steps are motivated and described in the following subsections.

GREEN JOBS VS. GREEN SKILLS

The International Labor Organization defines green jobs as "decent jobs that contribute to preserving or restoring the environment". These jobs can be both in traditional sectors such as agriculture or manufacturing, or in new and emerging sectors such as renewables: solar and wind energy industries or in industries that enhance energy efficiency (ILO 2016, 2018). Thus, green jobs can produce goods or services that benefit the environment, but also 'non-green' jobs in 'non-green' sectors created due to greening[3] (Auktor 2020). The BLS initiated its "Green Jobs Initiative" in 2010 to gather information about size and industrial, occupational and geographic distribution of green jobs. The BLS relied on its "Green Goods and Services Survey" that it distributed to enterprises in such green product and service production activities, based on their North American Industrial classification system (NAICS). The survey uses an output and process approach that defines green jobs as either (a) jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources, or (b) jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources (BLS 2013).

This definition is however heavily dependent on how researchers define and delineate the green economy, as well as their assumptions about its growth trajectory (Deschenes 2013). Moreover, this methodology overlooks the complex and varied nature of skills and expertise required within occupations. It fails to account for the ways in which different types of knowledge contribute to human labor, which is a critical theme in task-based models commonly used in the literature to examine the role of skill-biased technological change (Autor et al. 2003; Acemoglu and Autor 2011; Autor and Dorn 2013; Beaudry et al. 2013) and international trade (Autor et al. 2013; Lu and Ng 2013) on labor market gains and losses.

[3] For example, industries along the supply chain that provide intermediate products such as cables, engines, metals, etc. to renewable energy firms.

The definition of green skills is, however, less straightforward. In principle, it ought to encompass those skills that are especially important within green occupations. However, there is no standard definition of such skills. One method that has been applied by Vona et al. (2018, 2019) in their seminal work relies on identifying green skills based on their importance in green jobs. To this end, Vona et al. (2018, 2019) utilize the 'Green Economy' program developed by the Occupational Information Network (O*NET) under the auspices of the US Department of Labor. The O*NET database is a rich source of information on skill requirements and tasks performed on the job, at the occupation level, thus facilitating the identification of the skill content of green jobs.

In this context green jobs are made up of three groups: (i) current occupations projected to experience high demand because of the shift towards sustainability in the economy; (ii) occupations anticipated to undergo substantial alterations in their task profiles as a result of this shift (labeled as 'green enhanced'); and (iii) newly emerging occupations within the green economy, labeled as 'new and emerging' (Dierdoff et al. 2009, 2011). A notable aspect of O*NET is its ability to provide a more nuanced understanding of the significance of green activities within various occupations. O*NET offers insights into both the tasks (the activities expected of workers in the workplace—demand side) and the skills (the abilities and competencies required by workers to carry out these tasks—supply side). Tasks are further categorized into "general" tasks, which are common across all occupations, and "specific" tasks, which are unique to each occupation. Additionally, for new and emerging and green-enhanced occupations, O*NET distinguishes between specific tasks that are related to green activities and those that are not.

GREENNESS SCORE

We follow Vona et al. (2018) and distinguish between tasks classified as green and non-green and calculate a greenness metric for each occupation. This metric helps pinpoint green general skills, which are general proficiencies particularly linked to greener occupations. We define Greenness as the ratio of green-specific tasks to the total specific tasks performed in occupation *k*:

$$\text{Greenness}_k = \frac{\#\text{green specific tasks}_k}{\#\text{total specific tasks}_k} \qquad (1)$$

This allows us to identify occupations requiring at least a minimal number of green skills, as well as the green-skill intensity of various jobs, following the framework suggested by Vona et al. (2018, 2019) and Vona (2021). The greenness measure based on the O*NET database thus relies on an assessment of the environmental relevance of the tasks conducted within each occupation. It allows us to produce a summary measure classifying jobs as green (i.e. environmentally friendly), brown (polluting), or grey (neutral). The O*NET classification is based on the System of Occupational Classification (SOC) at the detailed 8-digit level. Most countries outside the United States however rely on the International Standard Classification of Occupations (ISCO). The BLS provides a crosswalk between the less detailed 6-digit SOC and the ISCO 4-digit classification.

Cross-walking occupation codes between classifications

There are several complications associated with first cross-walking these greenness measures to the less detailed 6-digit SOC level, and then further to the 4 (or 2 digit) ISCO level to match with labor market surveys available for the MENA developing countries. To derive a 6-digit measure of Greenness[4] from the original 8-digit level scores by Vona et al. (2018), the Greenness score of occupations is combined across nested 8-digit SOC categories within each 6-digit SOC. Ideally, a weighted average based on the relative size of each 8-digit occupation group would be used, typically informed by employment data. However, due to the lack of such detailed information (BLS only publishes employment data at the 6-digit SOC), the 8-digit scores are averaged without weighting. This method assumes uniform distribution of 8-digit occupations within each 6-digit occupation. Vona et al. (2018) employ a similar method in their analysis, aggregating scores for 8-digit SOC categories into scores for each 6-digit SOC category, under the assumption that employees are evenly distributed across eight-digit occupations within each six-digit SOC occupation. They argue that since most of the variation in green skills occurs at the 6-digit level, this assumption is unlikely to significantly affect the resulting indicators, which is corroborated by empirical evidence.

Next, the crosswalk between the 6-digit SOC and the 4-digit ISCO classification available from BLS, together with employment data at the 6-digit SOC is used to translate the SOC measures to ISCO measures. The assumption of a uniform distribution of nested occupations from lower to higher levels, which was previously made when aggregating from SOC 8-digit to SOC 6-digit, is no longer necessary. Instead, greenness scores can be aggregated using employment weights.

The primary challenge in the crosswalking process arises from the complex many-to-many relationship between Standard Occupational Classification (SOC) and International Standard Classification of Occupations (ISCO). The crosswalk between SOC 6-digit and ISCO 4-digit is not straightforward: a single 6-digit SOC code can correspond to multiple ISCO 4-digit codes and, vice versa, a 4-digit ISCO code often encompasses multiple 6-digit SOC codes. If the mapping were one-to-one, determining a greenness score for a specific 4-digit ISCO occupation would involve averaging the scores of its corresponding 6-digit SOC occupations, utilizing employment weights for the 6-digit SOC. However, when a 6-digit SOC occupation is linked with multiple 4-digit ISCO occupations, its score is attributed multiple times across different 4-digit codes it associates with. The central issue with this many-to-many mapping lies in how to distribute the same 6-digit SOC code among the multiple 4-digit ISCO codes it aligns with.

Various options for implementing employment weighting within the context of the many-to-many mapping between SOC 6-digit and ISCO 4-digit are available. Our “greenness” measure uses a

[4] The methodology followed in this section follows closely that in Scholl et al. (2023) and we wish to thank the authors for kindly sharing their data and methods with us. However, our results differ slightly in that we use the O*NET 24.1 release which has updates to the green tasks by occupation. More importantly we use employment weights from each of the four countries to account for the employment weighted green indices.

frequency weight: the share of the 6-digit SOC occupations that is 'green', ignoring the size of that occupation in terms of employment. Thus "greenness" measures the average green intensity of the underlying SOC 8-digit occupations, within each 4-digit ISCO occupation group. We also compute two measures of the green intensity of employment: that is the average share of green tasks done by workers in each occupation. The "greenness_uw" measure is the uniformly weighted greenness score, assuming a uniform distribution of the 6-digit SOC employment whenever they map into multiple 4-digit ISCOs. Finally, we calculate an employment weighted "greenness_ew" score that uses the employment shares at the ISCO level for each country as weights.[5] When the employment-weighted indices (greenness_ew) are lower than the uniformly weighted measure (greenness_uw) this reflects the differences in relative employment in green and non-green ISCO 4-digit occupations containing SOC 6-digit occupations with multiple mappings. Furthermore, when comparing worker-focused (employment-weighted "greenness_ew") with occupation-focused (frequency-weighted "greenness") measures, if the employment-based measures produce higher average figures than those based on the frequency of occupations, it suggests that more individuals are employed in green SOC occupations compared to non-green ones in the underlying employment dataset.

This occupation-level information can be mapped to the nationally representative labor surveys from across the MENA region using the International Standard Industrial Classification (ISIC) of occupations (Doan et al. 2023), to classify jobs and individual workers as performing green-skill intensive tasks. This approach has already been successfully implemented by a number of studies (Rutzer et al. 2020; Lobsiger and Rutzer 2021; Elliott et al. 2021; Valero et al. 2021).

Individuals' propensity to hold green jobs

Following stylized evidence provided in existing studies, we form hypotheses regarding the socioeconomic groups particularly affected by economic decarbonization. We anticipate that younger cohorts, urban dwellers, and higher educated workers are more endowed with green/greening skills (IMF 2022). We also surmise that workers in important sectors with large energy footprints (such as construction, infrastructure, oil and gas, utilities, transportation, farming, etc.) are in the process of adjusting to the decarbonization drive.

Mapping of the green jobs and skills on labor surveys allows us to evaluate these hypotheses and report the prevalence of green jobs and green skills among the current workforce, disaggregating results by sex, age, region of residence within country, sector of employment, and educational attainment. Stylized facts on workers' and employers' other selected characteristics are reported.

Applying regression analysis to the merged microdata, we study the determinants of having a green job at the individual level. Differences in green job potential by individual and household characteristics such as gender, age, education, sector of employment, family background and region of residence will be

[5] The latter method is similar to that used by Dingel and Neiman (2020), and AlAzzawi (2023) to calculate teleworkability.

examined. This offers insight into the characteristics of individuals and households that have low green job potential and therefore allow a concise targeting strategy for policy makers looking to mitigate the impact of decarbonization on specific classes of workers and households.

DATA

Our analysis requires large microdata of skill content at the level of all occupation groups, and worker backgrounds and outcomes at the level of individual workers. To study the status quo and the potential for occupation greening across different socioeconomic groups and across the MENA, we assemble the necessary data from several public sources.

Microdata on individual workers' detailed occupation group – 2-to-6-digit groups – come from Labor Market Panel Surveys (LMPS) for Egypt (2018), Jordan (2016) and Tunisia (2014), and Labor Force Survey (LFS) for Palestine (2020). The Egyptian survey has the most detailed disaggregation of Standard Occupational Classification (SOC) codes, at 6 digits, the Jordanian is at the 4-digit level, while the Tunisian and Palestinian data are at the least detailed classification, at 2 digits only. We also attempted to use data from Iraq, Sudan and Mauritania, but the data on occupational classification is only available at the 1 -digit level and hence these would lead to extremely crude estimates that we chose not to report due to lack of reliability. Information on the skill content of detailed occupation groups is taken from the O*NET (2020) database version 24.1, which is the latest version to have the green task classification.

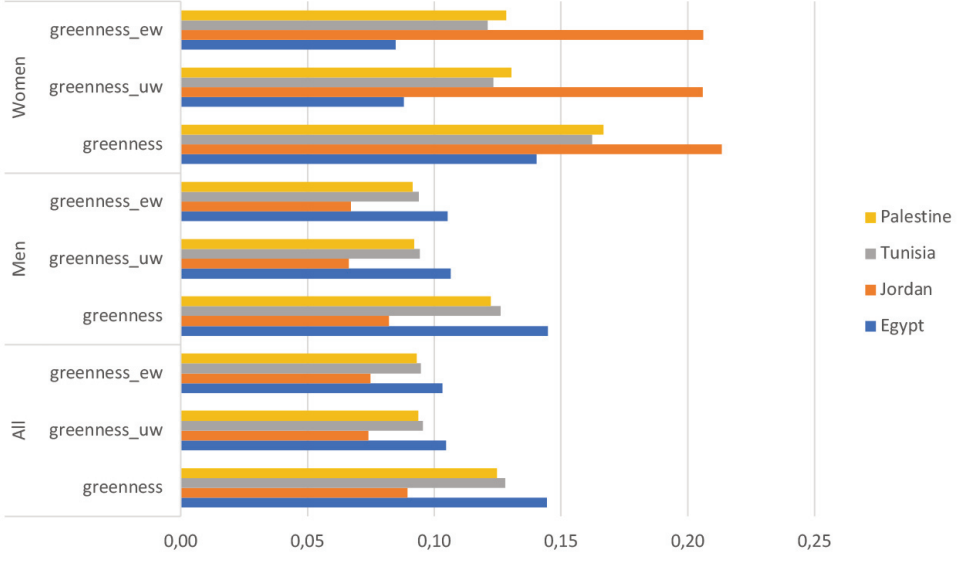
Finally worth noting, the nature of green jobs expected post-decarbonization will depend on the conditions in economic sectors at large, due to the evolving degree of competitiveness, engagement in global value chains, technology and regulation, among other factors. Furthermore, skills in high fossil footprint sectors are already showing signs of greening up (Elliott et al. 2021). These projection challenges are mitigated by the relatively short time window of our forecasting, and relatively broad categories of green/brown jobs. Nevertheless, we attempt to account for these prospects by using alternative definitions of job greenness and we provide qualitative analysis of the alternative prospective trajectories of decarbonization in view of local context.

RESULTS

DESCRIPTIVE ANALYSIS

Figure 1 presents the three greenness indicators for each country overall, as well as by workers' sex. The share of green occupations (greenness) is less than 15% in all four countries, and there is no apparent trend across the years under study. In fact, the newest dataset, for Palestine 2020, shows a very similar pattern of greenness as the oldest, for Tunisia 2014. This is lower than in Portugal, for example, where the share of green-employed workers was 17.9%–19.0% between 2011 and 2017 (Scholl et al. 2023). The share of green employment (greenness_ew and greenness_uw) is lower than occupation greenness by several percentage points in all four countries. This reflects the relatively low current share of green jobs and green employment in the region. Women have somewhat higher shares of green occupations and higher green employment overall compared to men, except in Egypt, where both shares are lower among women than among men. In Jordan, according to all greenness indicators, women's green shares (around 21%) are nearly three times as high as men's (7–8%). The situation is opposite in Egypt, where both shares are lower by 1–2 percentage points among women compared to men.

Figure 1. Greenness indices by country and workers' sex

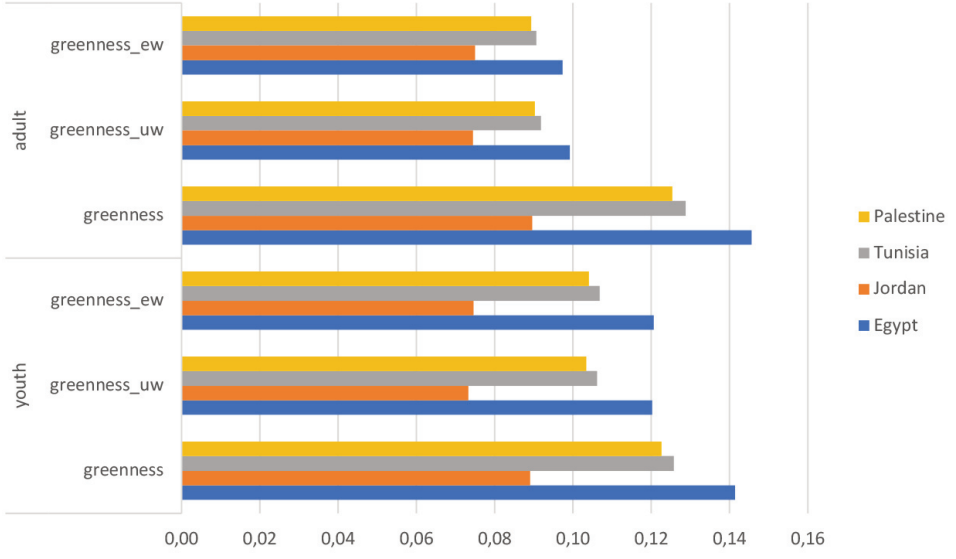


Source: Authors' calculations based on ELMPS 2018, JLMPS 2016, TLMPS 2014 and Palestine LFS 2020.

Figure 2 shows the greenness indicators by age group. Youth are defined as those 15 to 29, and adults are those 30 to 65 years old. For all countries, these shares mirror the country's averages with surprisingly very small differences slightly favoring prime working-age adults over youth. Figure 3 reports the greenness indices by formality status of employment. The general pattern shows that green

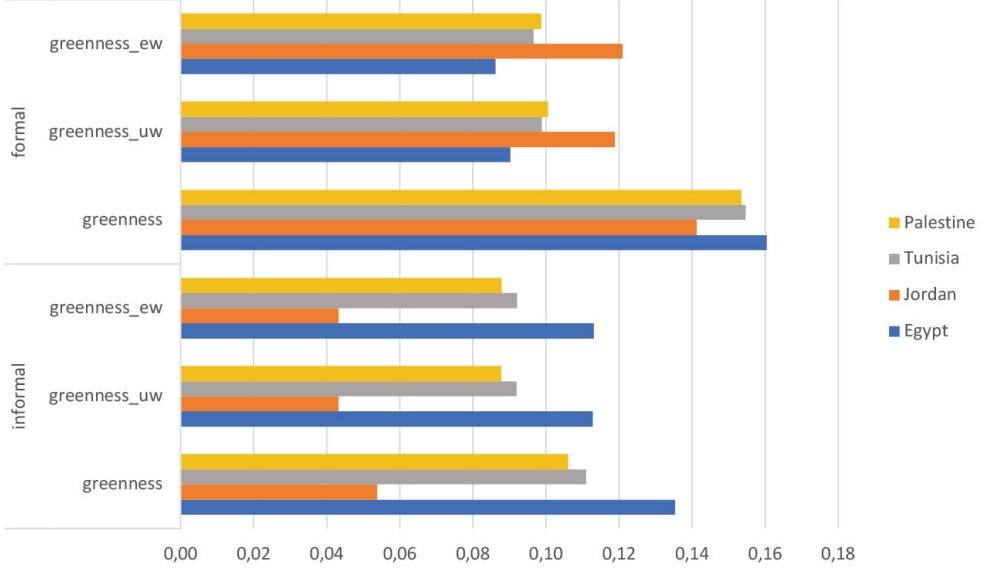
employment is higher in formal jobs, according to all indicators of greenness, but this is not the same across all countries. In Egypt, specifically, the share of green occupations is higher in formal jobs (by 2-3 percentage points), but the share of green employment is higher in informal jobs (again by 2–3 points). In the other three countries, the share of both green occupations and employment is higher in formal jobs – by 8–9 percentage points in Jordan – as may be expected if formal enterprises are earlier adopters of new technologies, environmental mandates and production standards.

Figure 2. Greenness indices by country and workers' age group



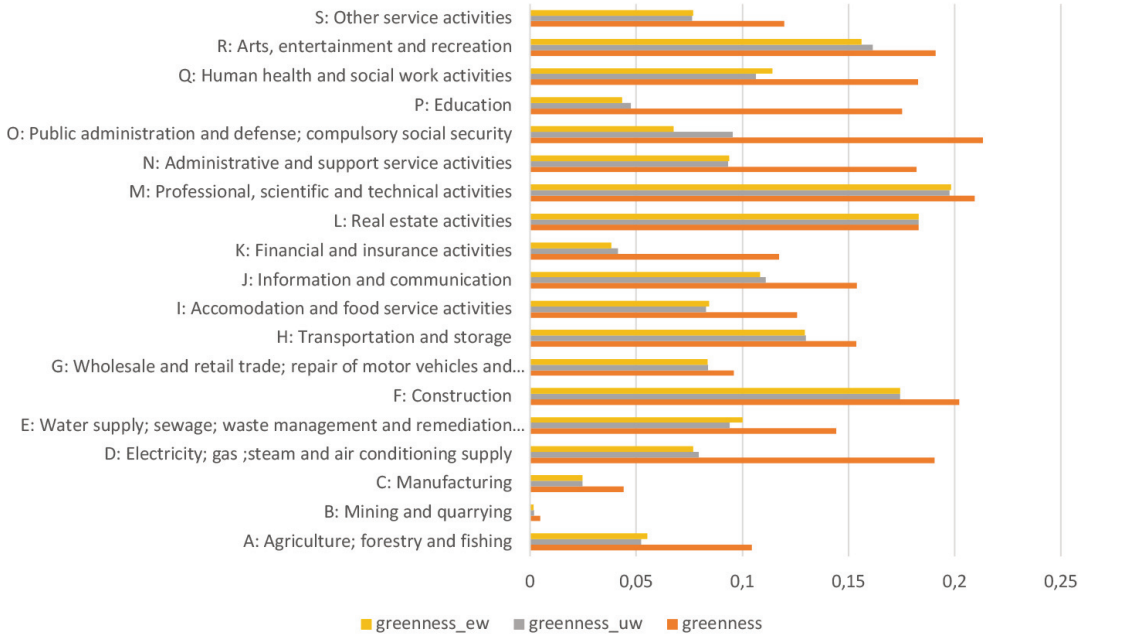
Source: Authors' calculations based on ELMPS 2018, JLMPS 2016, TLMPS 2014 and Palestine LFS 2020.

Figure 3. Greenness indices by country and workers' formality of employment



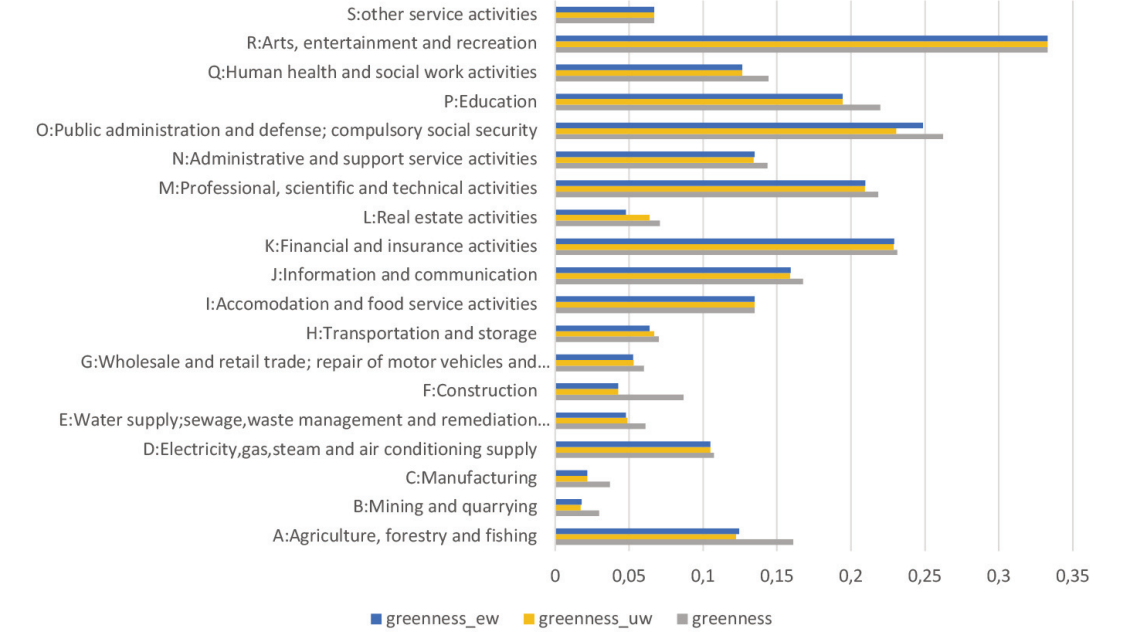
Source: Authors' calculations based on ELMPS 2018, JLMPS 2016, TLMPS 2014 and Palestine LFS 2020.

Figure 4. Greenness indices by industry, Egypt



Source: Authors' calculations based on ELMPS 2018.

Figure 5. Greenness indices by industry, Jordan



Source: Authors' calculations based on JLMPS 2016.

Examining the prevalence of green jobs and employment by industry is also of interest. This provides insights into the industries where the green-jobs potential may be higher. Figures 4 and 5 report the

greenness indices by industry for Egypt and Jordan, respectively, where we have detailed occupational classification. Some industries such as mining and quarrying have very low greenness indices as expected. Manufacturing also tends to have low greenness indices across all measures and for both countries. Others such as public administration and education in Egypt have high shares of green occupations but much lower shares of green employment. In Egypt, surprisingly, the construction and electricity industries have relatively high greenness scores, although employment greenness is lower than green intensity of occupations.

REGRESSION ANALYSIS

Which workers in each sector are currently equipped for green jobs? In this section we present regression analysis examining the present-day individual-level correlates of green intensity of workers' occupations and employment. The results in Table 1 include individual characteristics such as age, sex, education, region of residence, broad sector of employment (agriculture and mining, manufacturing and services (omitted baseline), as well as the institutional sector of employment. The results show different relationships for each country. For Egypt, greenness is positively associated with being female, having above intermediate education, living in Cairo (the omitted category), and working in the services sector. Hence, it appears that our previous finding that the green-employment share was lower among Egyptian women must have been due to women's concentration in less green sectors and formal occupations. In other words, Figures 1–4 must be viewed in tandem to infer the critical factors for workers' selection into green occupations, just as we observe through partialling out of related factors in multivariate regressions. Somewhat contrasting to Egypt, in Jordan it is youth, those with university or above education, and those working in government or the services sector who are more likely to be in green occupations.

Table 1. Regressions of greenness on worker characteristics

	Egypt	Jordan
Adult	0.000	0.009***
	(0.003)	(0.003)
Female	0.024***	-0.010
	(0.006)	(0.007)
Read & write	-0.006	-0.012*
	(0.006)	(0.006)
Less than intermediate	0.007	-0.028***
	(0.005)	(0.006)
Intermediate	0.006	-0.033***
	(0.004)	(0.006)
Above intermediate	0.031***	-0.032***
	(0.008)	(0.007)
University and above	0.063***	
	(0.005)	
Alex., Suez Canal, Egypt / North Jordan	-0.025***	-0.005*
	(0.006)	(0.003)

Urban Lower Egypt / South Jordan	-0.017***	-0.015***
	(0.006)	(0.004)
Urban Upper Egypt	-0.025***	
	(0.006)	
Rural Lower Egypt	-0.031***	
	(0.005)	
Rural Upper Egypt	-0.006	
	(0.005)	
Agriculture & mining	-0.041***	-0.034***
	(0.010)	(0.007)
Manufacturing	-0.060***	-0.034***
	(0.003)	(0.003)
Self-employed non-agricultural	-0.107**	
	(0.054)	
Employer	-0.144***	0.003
	(0.054)	(0.006)
Unpaid family worker non-agricultural	-0.153***	0.029*
	(0.055)	(0.017)
Irregular wage worker	-0.104*	-0.013**
	(0.054)	(0.005)
Informal private regular wage	-0.140***	-0.002
	(0.053)	(0.005)
Formal private regular wage	-0.122**	0.006
	(0.053)	(0.004)
Public enterprise	-0.087	0.005
	(0.054)	(0.011)
Government	-0.083	0.038***
	(0.053)	(0.004)
University		0.107***
		(0.007)
Post-graduate		0.190***
		(0.016)
Constant	0.229***	0.059***
	(0.054)	(0.007)
Observations	9,553	5,829
R-squared	0.124	0.239

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' calculations based on ELMPS 2018 and JLMPS 2016.

In Table 2, we examine the association with the industry of employment in more detail, as well as with household wealth. In Egypt, being in the construction, wholesale and trade, administrative services or public administration (including public services, defense and social security administration) is positively associated with greenness of occupations. Individuals from higher wealth strata are also more likely to have greener occupations. In Jordan, being in the construction, wholesale and trade, transportation, information and communication, financial services, real estate, professional and scientific activities, public

administration, education and arts is positively associated with greenness of occupations. Being in third wealth quintile or below is negatively associated with greenness of one's occupation. Of course, these present-day associations may not hold in the years to come, and are not predictive of any worker's likelihood of attaining a green job, due to the potentially endogenous selection into being in a specific industry, of a specific level of education and economic stratum, or even at a specific place of residence.

Table 2. Regressions of greenness on worker characteristics, with detailed industry and household wealth

	Egypt	Jordan
Adult	-0.003	0.009***
	(0.003)	(0.003)
Female	0.020***	-0.003
	(0.006)	(0.007)
Mining and quarrying industry	-0.120***	0.010
	(0.020)	(0.017)
Manufacturing industry	-0.080***	0.006
	(0.013)	(0.016)
Electricity, gas, steam & air conditioning supply	0.024	0.008
	(0.017)	(0.019)
Water supply, sewage, waste mgmt. & remediation	-0.004	0.039
	(0.016)	(0.025)
Construction	0.032**	0.044***
	(0.013)	(0.016)
Wholesale & retail trade, repair of motor veh. & motorc.	-0.068***	0.032**
	(0.013)	(0.016)
Transportation & storage	-0.036***	0.034**
	(0.013)	(0.017)
Accommodation & food service activities	-0.019	0.029
	(0.019)	(0.022)
Information & communication	-0.044**	0.042*
	(0.021)	(0.023)
Financial & insurance activities	-0.013	0.060***
	(0.025)	(0.021)
Real estate activities	-0.025	0.067*
	(0.124)	(0.035)
Professional, scientific & technical activities	-0.012	0.079***
	(0.019)	(0.019)
Administrative & support service activities	0.051***	0.025
	(0.019)	(0.022)
Public admin. & defense, compulsory social security	0.051***	0.072***
	(0.014)	(0.017)
Education industry	0.026	0.057***
	(0.017)	(0.018)
Human health and social work activities	0.028	0.026
	(0.017)	(0.019)

Arts, entertainment & recreation	0.050	0.160**
	(0.038)	(0.065)
Other service activities	-0.071***	-0.016
	(0.014)	(0.018)
Read & write	-0.000	-0.010*
	(0.005)	(0.006)
Less than intermediate	0.009*	-0.025***
	(0.005)	(0.006)
Intermediate	0.001	-0.030***
	(0.004)	(0.006)
Above intermediate	0.015*	-0.028***
	(0.008)	(0.007)
University and above	0.050***	
	(0.006)	
Alex., Suez Canal, Egypt / North Jordan	-0.017***	-0.009***
	(0.006)	(0.003)
Urban Lower Egypt / South Jordan	-0.008	-0.017***
	(0.005)	(0.004)
Urban Upper Egypt	-0.022***	
	(0.006)	
Rural Lower Egypt	-0.031***	
	(0.005)	
Rural Upper Egypt	-0.012**	
	(0.005)	
Self-employed non-agricultural	-0.022	
	(0.052)	
Employer	-0.058	0.004
	(0.052)	(0.006)
Unpaid family worker non-agricultural	-0.065	0.032*
	(0.053)	(0.017)
Irregular wage	-0.063	-0.019***
	(0.052)	(0.005)
Informal private regular wage	-0.076	-0.004
	(0.052)	(0.005)
Formal private regular wage	-0.062	-0.004
	(0.052)	(0.007)
Public enterprise	-0.036	-0.013
	(0.052)	(0.011)
Government	-0.058	0.011*
	(0.052)	(0.006)
Wealth quintile 2	0.002	0.005
	(0.004)	(0.004)
Wealth quintile 3	-0.009**	-0.012***
	(0.004)	(0.004)
Wealth quintile 4	-0.003	-0.013***
	(0.004)	(0.004)

Wealth quintile 5	0.010*	-0.006
	(0.005)	(0.004)
University		0.104***
		(0.007)
Post-graduate		0.178***
		(0.016)
Constant	0.197***	0.034*
	(0.051)	(0.018)
Observations	9,534	5,807
R-squared	0.190	0.265

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' calculations based on ELMPS 2018 and JLMPS 2016.

FUTURE RESEARCH DIRECTIONS

The results presented in this study have several limitations, notably in relation to inference from them, and comparability across surveys. In follow-up analysis we aim to apply more advanced approaches to controlling workers' latent predispositions and heterogeneity, for example by utilizing multiple survey rounds per country and a panel set-up. As a byproduct, this would allow us to ascertain the trends among workers of successfully adopting green skills, and for jobs greening up. This is not straightforward however, given that occupational codes are not comparable and the greenness index would not have cardinal properties across the rounds. This is why the present analysis was conducted cross-sectionally for each survey separately, but follow-up analysis should strive to harmonize occupational classification across countries and years, for example using a common denominator subset of occupation codes. Workers' past employment statuses – in the previous, pre-previous or 6-year prior jobs – could also be used. An instrumental variable approach should also be considered to test causality and facilitate prediction, conditional on finding valid and sufficiently strong instruments for one's socio-economic status, residence and employment choice.

CONCLUSIONS AND POLICY RECOMMENDATIONS

The process toward decarbonization of global economies raises risks of the associated painful market adjustments, including economic distress and gradual layoffs in specific industries and local labor markets (Hanson 2023; Li et al. 2023). This makes it essential to assess the vulnerabilities and track the fortunes of various groups of workers amid the economic transformation.

This study has found that the labor markets in four MENA developing countries are heterogeneous but generally lacking in green occupations. The share of green occupations is less than 15% in all four considered countries. A high number of workers and jobs remain stuck devoted to activities that rely on traditional resource and energy use. These workers are largely concentrated in lower-technology manufacturing and mining industries, rural areas and among poorer population strata. Women are somewhat more likely to choose green occupations in all countries, even in Egypt once we control for women's preexisting concentration in less green sectors and formal occupations (AlAzzawi and Hlasny 2025). More educated workers and those in higher economic strata have higher shares of employment in green occupations, but differences between youth and prime-working age adults are surprisingly small, especially in Egypt.

These broad findings raise concerns over the speed, effectiveness and fairness of the green transition in the region. Policymakers should intensify their efforts to facilitate the transition, while also preparing for potential negative consequences by implementing measures to cushion vulnerable workers and sectors. This preparation must consider what is feasible within the limited timeframe and existing fiscal constraints. Most importantly, policymakers should work with employers in the private and social sectors on creating enabling regulatory and policy environments (Pastorelli et al. 2022), allowing market mechanisms to support labor reallocation, enabling more efficient matching between currently unemployed or underemployed workers with emerging green occupations.

To ensure that the process is effective and fair, active labor market policies should be scaled up and better targeted to align the supply of and demand for green skills across local and sectoral labor markets. Bluedorn et al. (2023) found that, across 31 countries, workers rarely transition from more pollution-intensive to greener jobs. For effective implementation, environmental policies should be planned at the level of industry clusters (Sovacool et al. 2022) and should be strategically paired with sector-specific regulations or incentives that improve labor mobility and flexibility.

Our analysis highlights likely skill gaps among vulnerable worker groups, especially those with low educational attainment, rural populations, and older workers nearing retirement, who are at heightened risk of displacement due to the green transition. These groups have limited access to re/upskilling

opportunities. Existing evidence suggests persistent shortages in high-level technical skills, critical reasoning, and soft skills. Ensuring that workers at all life stages can access flexible, affordable pathways to retraining is critical, not only to improve their employment prospects but also to reduce long-term dependency on social assistance.

Public policy should respond proactively to current and emerging skills demands stemming from major sectoral transformations. There is an urgent need to promote green skills and to strengthen, scale, and systematize reskilling and upskilling programs. While both public and private universities have made important strides in advancing education for sustainable development (ESD) in recent years (El-Sherbiny et al. 2022), there remains significant potential to deepen industry–academia collaboration and to institutionalize lifelong learning, particularly through vocational and on-the-job training programs. This entails fostering stronger curriculum co-design between industry and educational institutions and embedding green skills development across education and training systems. These measures are key to narrowing projected skills gaps (Vona and Consoli 2015; Goolsbee et al. 2019) and achieving a truly 'just' transition (PWC 2022).

To support workforce transitions, policymakers should enhance and broaden non-contributory social protection systems that provide temporary income support to jobseekers and entrepreneurs, regardless of prior employment status or contribution history. Such safety nets are essential to reduce the risks of displacement and allow individuals to pursue reskilling or entrepreneurial opportunities in the green economy.

Last but not least, targeted support for green entrepreneurs should be expanded and better coordinated. This includes providing access to affordable financing through green loan facilities, offering time-bound tax incentives for start-ups, and investing in both physical and digital infrastructure needed to incubate and scale sustainable enterprises. Policymakers should also support entrepreneurs in adopting and integrating emerging green technologies, particularly in sectors with high potential for innovation and job creation.

With careful planning and inclusive policy design, the MENA developing countries can manage the decarbonization process more effectively and avoid the dislocations and inequities associated with past structural transformations.

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CMCI · 2 rue Henri Barbusse · F-13 241 Marseille cedex 01 · France
+ 33 (0) 4 91 31 51 95 · www.femise.org

ECONOMIC RESEARCH FORUM
منتدى البحوث الاقتصادية

21 Al-Sad Al-Aaly Street, Dokki, Giza, Egypt · PO Box: 12311
+202 333 18 600 · https://erf.org.eg/

IEMed.
European Institute of the Mediterranean

Carrer Girona, 20 · 08010 Barcelona · Spain
+34 93 244 98 50 · https://www.iemed.org/

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