



Employment creation in EU related to renewables expansion

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HIGHLIGHTS

- Labour intensities are quantified for each activity related to energy technologies.
- Renewable technologies have higher labour intensity and domestic job content relative to fossil fuels.
- Clean energy transition leads to job creation in electricity, construction and biofuels.
- The net impact of renewable energy expansion on EU jobs is positive.
- 1.3% of EU jobs would be reallocated among sectors due to low-carbon transition in 2050.

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ABSTRACT

Expansion of renewable energy is a key element in the EU Energy and Climate policy framework, as it contributes to Greenhouse Gas reduction and improved energy security, while they can also create employment opportunities. There has been an intense debate on the quantification of these employment effects. Most studies have focused on estimating gross employment impacts and ignored the effects between different sectors, while they commonly use aggregate data and sectoral classification. This paper investigates the net employment impacts from the projected transformation of the EU energy sector towards Renewable Energy Sources (RES), by combining the employment factor approach and general equilibrium analysis. Detailed, up-to-date data at a very disaggregated level are used to compare the labour intensities of RES relative to fossil fuels and assess the employment impacts of the recent Clean Energy Package proposals. RES technologies are estimated to be on average more labour intensive and have a higher domestic job content relative to fossil fuels. The low-carbon transition would lead to the net creation of 200,000 direct jobs in energy sectors. Direct RES jobs represent about 1% of the EU workforce in 2050 and are mostly created in the construction of solar photovoltaics, the supply and production of advanced biofuels and in the manufacturing and installation of wind turbines. In contrast, employment would be eliminated in conventional energy supply sectors, especially in coal mining (which is a labour intensive activity), refineries and refuelling stations. The economy-wide general equilibrium modelling confirms the positive employment impacts of RES expansion and shows that the low-carbon transition would lead to the reallocation of 1.3% of the EU's workforce across sectors by 2050.

1. Introduction

The deployment of Renewable Energy Sources (RES) in the energy mix is a central element in the European Union (EU) Energy and Climate Policy Framework [1], as RES can contribute to the reduction of greenhouse gas (GHG) emissions, the improvement of energy self-sufficiency, and the creation of employment opportunities [2]. Renewable energy technologies have been widely deployed in most of EU Member States (MS) and have proven their potential to replace fossil fuels in several sectors. The economic and financial crisis of the Euro area combined with high energy costs that impact the competitiveness

of the EU industries have intensified the policy debate about the impacts of RES expansion on employment and growth [3]. The promotion of jobs and economic growth is a key priority for the European Commission (EC) and is a theme that cuts across all areas of policy making. In addition to the adoption of the Energy and Climate Policy Framework [1], the EU has presented the Green Employment Initiative [4], a funding mechanism to help EU countries with employment opportunities and challenges in the transition to a greener economy. Employment in clean energy sectors has become an important issue politically as a way to reduce unemployment, while ensuring a sustainable economic growth path [5].

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RES costs have rapidly declined through economies of scale, investment in Research and development (R&D) and practical technological experience, with wind turbines and solar Photovoltaics (PV) having already reached grid parity in several countries. Massive RES deployment combined with acceleration of energy efficiency improvements constitute key ingredients for the EU energy decarbonisation [6]. Employment creation induced by transitioning to renewables represents a keystone of the transition to a low-carbon economy [7]. Climate policies would lead to jobs being created in RES industries, while some employment in carbon-intensive sectors would be substituted, or eliminated without replacement, and many existing jobs would be redefined as greened methods and profiles [8].

Labour markets in EU countries are dynamic, while technological advances and globalisation patterns are reflected in structural labour demand changes, with growth and decline across sectors and regions due to business, individual and political decisions. Labour supply is also dynamic as workers enter and leave the labour force, i.e. due to education and retirement decisions. However, there are specific limitations as to how dynamic labour markets can be, as barriers prevent workers moving from declining to growing industries, due to skill shortages or mismatches, difficulties in geographic relocation and demographic factors. Effective labour market policies can contribute to the successful low-carbon transition by facilitating structural labour market change towards clean energy sectors. In this context, a critical issue worth exploring is whether RES technologies are more labour intensive than fossil fuels in delivering the same amount of energy when considering jobs in related activities, including manufacturing of equipment, installation, Operation & Maintenance (O&M) and fuel supply.

The literature on employment effects of low-carbon transition is abundant. Analysis by Pollin et al. [9] has shown that the employment creation from investing in energy efficiency is 2.5–4 times larger than that for oil and gas, while Wei et al. [10] demonstrated that both RES and energy efficiency are more labour-intensive compared to fossil fuel supply sectors per unit of energy. The employment impacts of the EC Energy Roadmap 2050 are analysed in [11], which estimated that decarbonisation can lead to job creation. The Impact Assessment of the Energy Efficiency Directive [12] demonstrated that the achievement of the European Clean Energy targets could create between 400,000 and 900,000 new jobs in 2030 depending on underlying modelling and scenario assumptions. Markandya et al. [13] estimated that the EU's energy transition created 530,000 jobs over 1995–2009, while Mathiesen et al. [14] showed that the transition towards a 100% renewable energy system in Denmark would create additional jobs and growth.

Macro-economic models (including Computable General Equilibrium-CGE) are commonly used to assess job impacts from RES development, which are driven by changes in costs and incomes of economic agents [15]. Studies using macro-economic models are inconclusive about the sign of total job impacts with most projecting net job creation [16], others showing job losses [17], while in others job impacts depend on specific model and scenario assumptions [18]. Several studies conclude that net job impacts from RES expansion strongly depend on prevailing market conditions. In case that a RES-based economy requires additional resources, and if the economy already produces at its production possibilities frontier [19], prices of primary factors (labour and capital) would increase implying that other economic activities may be crowded out. In contrast, more flexible market conditions can lead to job creation, while higher labour supply can increase production possibilities. IRENA [20] suggests that the net employment impacts of RES expansion depend on labour and industrial policies, the ability to take advantage of export markets and the multiplier effects on the economy.

The paper aims to assess the employment impacts induced by ambitious RES deployment and identify the channels through which RES jobs are generated in the EU. The potential employment impacts of the low-carbon transition are assessed in-depth, considering impacts in the

entire activity chain of energy-related technologies (which is commonly not considered in relevant studies). The analysis captures both positive (job creation in RES-related sectors) and negative employment impacts (displaced jobs in conventional energy forms) of low-carbon transition by 2050. A detailed appraisal of current EU energy-related jobs and a comparison of the labour intensity of RES relative to fossil fuels including all related activities are performed. The paper quantifies direct job impacts of RES deployment at a disaggregated level by combining labour intensities of activities and technologies with detailed energy system projections. The bottom-up analysis based on employment coefficients is coupled with a top-down analysis with the macro-economic GEM-E3¹ model to evaluate the overall job impacts from RES expansion in the EU economy. The integration of detailed employment factor estimates for all energy technologies into the GEM-E3 allows the coherent evaluation of direct, indirect and induced employment impacts of RES expansion. This approach ensures increased transparency and consistency with real-world estimates but also captures supply chain, indirect and induced impacts with a robust macro-economic framework. The innovative elements of GEM-E3 (i.e. explicit representation of clean energy technologies, detailed representation of energy system and technologies, coverage of financing options) overcome limitations of conventional model-based assessments. The analysis is fully consistent with the scenarios developed for the EC Clean Energy Package [2], reflect the most recent EC proposals and include comprehensive projections for RES deployment at a high level of sectoral, country and technology granularity.

The rest of the paper is structured as follows. Section 2 includes a discussion on methodologies commonly used to estimate employment impacts of RES and summarises our methodological approaches. Section 3 quantifies the current jobs in RES and fossil fuels. Section 4 discusses the employment impacts of RES expansion and the key factors determining them. Last section concludes.

2. Methodologies to estimate employment impacts of renewable energy expansion

2.1. Definition of renewable energy jobs

The first reference to the employment benefits of sustainable development is found in the EC White Paper [21]. The EC [22] defines green jobs as “jobs that depend on the environment or are created, substituted or redefined in the transition process towards a greener economy”. An increasing body of literature is dedicated to the effects of RES expansion on employment. Articles by Wei et al. [10] and Cameron et al. [23] reviewed the literature to determine employment factors for RES and fossil fuel-based technologies, defined as the number of jobs generated per unit of produced electricity. The ‘proximity’ of a created job to a specific technology (i.e. how directly it can be attributed to a certain investment) indicates a major distinction between studies on employment impacts, regarding the type of jobs they consider [24]. The following classification of employment is proposed in the literature:

- **Direct jobs.** Those directly derived from RES manufacturing, onsite installation, O&M and all activities related to fuel supply.
- **Indirect jobs** refer to the supply chain effects of RES-related activities and are associated with activities like equipment supply, extraction and processing of raw materials (e.g. to produce copper and steel for wind turbines), marketing and selling, administration, or the work performed by regulatory bodies, consultancy firms and research organisations.
- **Induced jobs** are created due to the total economic impacts of RES expansion. They arise from economic activities of direct and indirect

¹ http://www.e3mlab.ntua.gr/e3mlab/GEM%20-%20E3%20Manual/GEM-E3_manual_2015.pdf.

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