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A methodological framework for assessing the employment effects associated with energy efficiency interventions in buildings

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ABSTRACT

The global trend toward a low carbon, sustainable economy is widely acknowledged to create a large number of jobs across many sectors of the economy. The deployment of renewable and energy efficiency projects represent a large share of the so called green jobs and help retain current levels of employment especially in countries facing the socio-economic threat of increasing unemployment rates. These effects should be taken into account during the process of energy planning, but due to difficulties in their quantification this is not always feasible. This paper utilizes the *input–output analysis* and the *adjusted earnings gain approach* for assessing the employment effects associated with the implementation of energy saving interventions in the building sector, with a view to produce results that can be easily incorporated into cost–benefit analyses. The proposed framework, which comprises four basic steps, namely identification of all the potential changes in employment due to energy efficiency interventions, quantification of these employment effects in physical terms, calculation of the net present value of the estimated employment effects and monetization, has been implemented for three energy efficiency interventions widely implemented in Greek buildings. The results of the analysis clearly show that the exploitation of energy saving technologies in the Greek building stock generates significant employment benefits, ranging between €0.11 and 0.23 million per €1 million of investment in the base case scenario and reaching the 10–24% of the energy costs savings attributed to the implementation of these interventions throughout their entire lifetime.

1. Introduction

Environmental targets have long been perceived as lying in contradiction with economic growth (see for example [1]). Following Porter's Hypothesis regarding the relation between environmental protection and economic growth [2], this perception has started being contested. Nowadays, boosted by encouraging empirical evidence, policymakers all over the world strive to explore new win-win strategies combining faster economic growth with a better environment and a higher social welfare [3,4].

An increasing number of studies find that greater use of renewables and energy efficiency technologies result in positive economic effects through job creation, economic growth, increase of income etc. [4–7]; they also argue that these effects should be taken into consideration in energy planning and decision-making processes. However, some of these studies have been criticized for the accounting methods used, whereas objections have been raised over the overall efficacy of using public funds for implementing energy projects instead of other less labor-intensive activities [8–10].

Furthermore, for many economists the employment effects associated with energy investments do not constitute a positive (or negative) externality. They claim that in perfectly competitive markets, the existence of any unemployment rates represents temporary situations, in which individuals try to obtain additional skills, seek for a better position in the labor market, etc., and therefore unemployment does not represent any social cost [11,12]. However, these ideal conditions are far from the reality during the last 5–10 years, as unemployment has become one of the most serious problems that societies have to deal with [13,14]. Consequently, the creation of new jobs results in social benefits, which should be taken into account in decision-making processes.

Based on the above considerations, we have developed a methodological framework for assessing the employment benefits associated with conventional power generation technologies [15], and technologies based on renewable energy sources (RES)

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Nomenclature

A	the $n \times n$ matrix of technical coefficients in input–output analysis. A technical coefficient a_{ij} is defined as the amount of production of sector i used by sector j in order to produce one unit of output
b_{ij}	the elements of Leontief inverse matrix. They show the total required increase in the output of sector i to meet an increase of one unit in the final demand of sector j
B	employment benefits (expressed in €)
E_j	total employment (expressed in full-time equivalent jobs) in the economic sector j
e_i	the employment created in sector i per €1 of output
I	unit matrix
I_o	the potential income an individual had as unemployed (e.g. unemployment benefits, income from informal employment that cannot be continued)
ICE	increased consumption effects: employment occurring after the payback period of the energy saving investments, where the households will have additional income available for spending
INVE	investment effects: employment effects due to the construction and implementation of energy efficiency measures
L	the value of time (in €) that a person has at his or her disposal in cases that he or she is unemployed
NPVE_j	the net present value of the employment effects created in sector j during the entire lifetime of an energy efficiency intervention
OME	operation and maintenance effects: employment associated with the necessary operation and maintenance activities for the effective functioning of energy efficiency interventions
P	the probability a new job created in the economy to be covered by a worker that was previously unemployed
r	the discount rate used for estimating the net present value of the employment effects created during the lifetime of an energy efficiency intervention
RAE	reduced activity effects: job losses in traditional energy sectors of the economy due to the reduced energy needs of households and businesses
RES	renewable energy sources
S	an economic measure (in €) of health and psychology effects associated with unemployment (stigma effects)
T	the evaluation period of an energy efficiency intervention
W_j	the Type I employment multiplier for sector j in input–output analysis. It calculates the direct and indirect employment created by one new direct job in the sector j
W'_j	the Type II employment multiplier for sector j in input–output analysis. It calculates the direct, indirect and induced employment created by one new direct job in the sector j
WG	the income of an individual as a result of a new job (WG_n) or from the previous work (WG_o)
X_j	output (expressed in €) of the economic sector j
X	the vector of total output of the economy; each element of the vector describes the output of a specific sector
Y	the vector of final demand of the economy; each element of the vector describes the final demand for a specific sector

in Greece [16]. The present paper aims to extend and adjust this methodological framework for assessing the employment benefits associated with the implementation of energy efficiency interventions in the building sector, taking into account the entire lifetime of these interventions, with a view to produce results that can be easily incorporated into cost–benefit analyses.

As already mentioned, several studies provide quantitative estimates on the employment effects associated with investments in energy efficiency technologies and practices [4,5,17]. Various approaches have been implemented to this end: (i) indices and multipliers from specific case studies [6,18,19]; (ii) input–output analysis [4,5]; (iii) top-down models, such as econometric models or computable general equilibrium models [7]; and (iv) hybrid approaches, which combine two or more of the above approaches [20]. Some of these studies focus only on direct effects (i.e. the jobs created particularly in the construction industry for retrofitting homes, etc.) [21], while some others include in addition the indirect effects produced in the sectors of the economy that supply materials and services to the directly involved activities, as well as the induced effects resulting from spending the additional income that will be available to workers and/or households [5,20]. Indirect and induced effects are estimated only in studies using input–output analysis.

Moreover, some studies analyze only the gross employment effects of energy efficiency investments [22,23], although, the majority extends the analysis as to estimate the net effects on the economy, taking also into account the negative effects due to the reduced activity in traditional sectors of the economy, such as in the production of fossil fuels, in electricity generation, etc. [4,5,19,20]. Finally, since the additional income available to households due to the reduced energy bills can be recycled into the economy, some studies include also these effects into their analysis [5,20]. Table 1 summarizes quantitative estimates of the employment effects created by the implementation of energy saving interventions, derived from selected case studies reviewed and expressed per $1 million of investment in constant 2010 prices ($\$_{2010}$).

Obviously, fewer studies have attempted to translate in monetary terms the employment effects related to energy investments and, to our knowledge, none of them focuses on energy saving technologies. The techniques used to this end comprise: (i) state preferences approaches such as choice experiments [24,25]; (ii) revealed preferences methods based on the opportunity cost of labor [15,26,27]; and (iii) proxy methods based on the willingness to pay of the central government authorities for creating extra employment, revealed through various tax and subsidy schemes [15,17]. Despite the fact that there is a relative dearth of studies in this field, monetization could greatly facilitate the integration of employment effects associated with energy efficiency measures in decision-making processes and improve energy planning decisions.

The structure of this paper is as follows: first, the methodological framework developed for quantifying and monetizing the employment effects associated with energy efficiency interventions is presented; a description of energy interventions analyzed in the context of this study as well as relevant data and assumptions follows; then, the estimated employment effects attributed to energy interventions in question are given in both physical and monetary terms; finally, the main findings of the study are summarized and conclusions are drawn.