Comparison of Employment Impacts of Renewable and Fossil Energy Based Electricity Sectors: The Case of Turkey [1]

Yenilenebilir ve Fosil Enerjiye Dayalı Elektrik Sektörlerinin İstihdam Etkilerinin Karşılaştırılması: Türkiye Örneği

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ABSTRACT

Considering rapidly rising air pollution and unemployment problem in Turkey, renewable energy may be the most appropriate solution for both of the problems. While positive effect of renewable energy on the environement is widely acknowledged, there isn't sufficient research about its effect on employment statistics. For this reason, in this study, the net employment benefit of the renewable-based electricity sector, against the fossil-based electricity sector, is investigated through Input-Output methodology. The estimation is done for both manufacturing/installation and operation/maintenance phases of solar, wind, hydropower, bioenergy, geothermal, coal, petrol, and natural gas-based electricity sectors, including all of the direct, indirect, and induced effects. According to the estimation results of both approaches and both of the phases, renewable-based electricity sectors are more effective than fossil-based electricity sectors in terms of employment generation. Therefore, besides its claimed benefits in terms of environment, the renewable energy sector may be a major instrument in the sustainable development efforts in Turkey, considering its employment benefits too.

KEYWORDS

Sustainable Development, Input-Output, Renewable Energy, Green Employment

ÖZ

Türkiye'de hızla artan çevre kirliliği ve işsizlik sorunları göz önüne alındığında, yenilenebilir enerji her iki sorunla eşanlı mücadele bağlamında en uygun çözüm olabilir. Yenilenebilir enerjinin çevre üzerindeki pozitif etkisi noktasında yaygın bir uzlaşı bulunmasına rağmen, istihdam etkisi yeterince araştırılmamıştır. Bu doğrultuda çalışmamızda, yenilenebilir enerjiye dayalı elektrik sektörünün fosil bazlı elektrik sektörüne kıyasla net istihdam etkisi Girdi-Çıktı metodolojisi ile incelenmiştir. Analiz, güneş, rüzgar, hidroelektrik, biyoenerji, jeotermal, kömür, petrol ve doğal gaza dayalı elektrik sektörlerinin hem üretim/kurulum hem de işletme/bakım aşamaları için doğrudan, dolaylı ve uyarılmış etkilerinin tümünü içermektedir. Her iki yaklaşımın ve her iki aşamanın tahmin sonuçlarına göre, yenilenebilir enerjiye dayalı elektrik sektörlerinin, istihdam yaratma açısından fosil bazlı elektrik sektörlerine göre daha etkili olabileceği sonucuna varılmıştır. Bu nedenle, yenilenebilir enerji sektörü çevre açısından iddia edilen faydalarının yanı sıra, istihdam faydaları da dikkate alındığında Türkiye'deki sürdürülebilir kalkınma çabalarında önemli bir araç olabilir.

ANAHTAR KELİMELER

Sürdürülebilir Kalkınma, Girdi-Çıktı, Yenilenebilir Enerji, Yeşil İstihdam

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INTRODUCTION

The World Summit on Sustainable Development held in 2002 underlines three important aspects of Sustainable Development as the environmental, the economic, and the social ones and the economic one refers to sustained economic growth as a necessary condition of social wellbeing and satisfaction of basic human needs, while the social element refers to providing equality both in terms of income, political participation as well as social integration and cohesion of different groups (Rontos et. al., 2015). The environmental element refers to guaranteeing the provisioning capacity of the ecosystem for the current and future generations (Rontos et. al., 2015).

Looking at those three elements one can see that environmental damage and unemployment are two central problems that may threaten all of the central tenets of sustainable development. According to Stern Review (Stern, 2007), global warming as a mostly outcome of rising greenhouse gas emissions through fossil energy consumption will seriously disrupt the basics elements of life and sustainable development. Some of those disruptions are malnutrition due to limited food production, limited access to drinking water, health problems due to a polluted environment, loss of biodiversity, coastal floodings, and a variety of other environmental disasters.

While environmental problems have very long term dynamics and are analyzed from a much longer perspective, unemployment, on the other hand, is a much urgent problem in terms of satisfaction of human needs and sustainable development. It is because the high unemployment rate isn't solely a statistic about macroeconomics, rather it is a much bigger problem that affects the wellbeing of individuals in terms of malnutrition and other related health problems, psychological disorders such as depression and anxiety, alcohol, and drug addiction (Forstater, 1999; Dasgupta and Ray, 1986).

Moreover, the insufficiency of basic human needs due to unemployment reflects its symptoms at the social level through inequality of opportunity in education for current and next generations, domestic violence, terrorist activities, and crime (Vickrey, 1997; Dursun et. al., 2011). Studies investigated the relation between unemployment and crime for the case of Turkey show that unemployment has a significantly negative effect on the crime rates in Turkey (Ata, 2011; Aksu and Akkuş, 2010). Therefore, alleviating unemployment in Turkey may contribute to the social aspect of sustainable development efforts too.

Another important issue in sustainable development related to unemployment is internal migration. According to the 2006 World Bank report, one of the structural reasons for unemployment in Turkey is the internal migration of the agricultural labor force ongoing since the 1950s, from rural regions to cities in the hope to find a job (Akçoraoğlu, 2010). This type of structural unemployment arises due to a mismatch between the skills of the newly immigrated labor force and industrial requirements. This isn't only an issue for the unemployed, rather it is a broader problem that disrupts social cohesion and causes different types of unrest in society. According to Kar and Comertler(2007), associated with unemployment, internal migration and extreme population density in cities are important components of high crime rates and related social problems.

Besides the social perspective, unemployment is an economic problem of aggregate demand, deficiency of which is one of the most important problems for Keynesian economists. According to this tradition, in times of economic stagnation, waiting for the markets for their self-correction or implying supply-side policies may not be suitable (Bell and Randall, 2004). Rather, employment must be supported by the governments so that with the increasing purchasing power and the multiplier effect economies may recover from deficiency of demand and continue to economic growth and development (Tcherneva, 2008). Otherwise, the cost of waiting for self-correction may be an irreversible loss at employment and GDP.

The general experience shows the significance of high rates of economic growth against the unemployment problem (Islam, 2004). However, growth policies aimed to increase aggregate demand and stimulate employment may result in increased greenhouse gas emissions and environmental damage. This potential tradeoff between environmental policies and employment supportive policies has been an important concern in the literature (Chen, 2019; Moreno and Lopez, 2008; Pollin and Garret-Peltier 2009) Turkish experience, however, has been different. Despite the robust growth performance of the post-1980s period, neither unemployment rates nor pollution statistics have shown a strong downward trend in Turkey. Just the opposite, both unemployment and environmental pollution problems are worsening at the Turkish development experience since the 1980s.

From this perspective, the 1980s are an important turning point for Turkey. Until the 1980s, generally, import substitution policies are implemented in Turkey, but from the 1980s onwards the industrialization strategy has changed towards an export-oriented development regime, , to combine the Turkish economy to the international sphere (Ünal, 2016; Yıldırım and Sezgin, 2003). The argument was the greater liberalization of trade would eventually lead to a growth in economy and employment, however, growth in employment rates has never been achieved (Yıldırım and Sezgin, 2003).

While unemployment has been a chronic problem for the Turkish economy since the 1980s, this problem recently has deepened even more. In May 2020 unemployment rate in Turkey was 12,9% (Turkstat, 2020a), after 2019's highest rate of 14,7% (Turkstat, 2019a). Moreover, the youth unemployment rate in May 2020 was 24,9% (Turkstat, 2020a), after the 2019 record high of 26,1% (Turkstat, 2019a). Another important statistic about unemployment is those relatively high records occur despite Turkey's relatively low labor force labor participation rates. At 2019 labor force participation rate in Turkey stood at 62,3% while that rate was 80,3% in E.U. countries (OECD, 2019).

Moreover, beyond the rising unemployment problem, the current account deficit is another problem in Turkey. To keep economic growth sustainable in the Turkish economy, it is essential to have a healthy current account balance. But, Turkish growth periods are correlated with rising current account deficits, since imports in Turkey arise faster than exports when the economy is prospering (Ercan, 2007). Since the liberalization of the economy in the 1980s the current account deficit has a persistent structure in Turkey due to the saving gap and reliance on foreign sources in intermediate goods and energy (Özata, 2014).

An important part of that current account deficit in Turkey is the trade deficit that arises through fossil energy import. In 2019 the Turkish trade deficit has been 31,1 billion dollars (Turkstat, 2019b), comparing to the 41,1 billion dollars of fossil energy import at the same period (AA, 2019). Thus lowering the fossil energy import may increase Turkey's energy independence and minimize the trade deficit which subsequently feeds Turkey's persistent financial fragility, financial crisis, and unemployment problems.

Furthermore, due to rapid economic growth applied trough energy-intensive obsolete industries and imported fossil fuel environmental pollution, especially air pollution, intensifies in Turkey too. According to the World Bank (2019) per capita, CO_2 emission in Turkey raised more than seven-folds, from 0,61 tonnes in 1960 to 4,48 tonnes in 2014.

Accordingly, rich domestic renewable energy resources may help to both reduce the current account deficit and stress on the environment due to fossil energy consumption in Turkey. Therefore a well-planned renewable energy-based development strategy in Turkey may mitigate both environmental pollution, unemployment problem, and other socioeconomic problems at the same time. Consequently, any well-grounded analysis of the sustainable development for the case of Turkey must address the triple problem of environmental degradation, unemployment, and other socioeconomic problems. In this perspective abundant renewable energy resources, she has maybe a strong cure to this triple problem of Turkey.

While renewable energy has a wide variety of benefits, its employment effect compared to the fossil energy sector is still, however, doubtful (Cameron and Zwaan, 2015). It is because although renewable energy may create new jobs at the microeconomic level, at the macroeconomic level there may be employment loss or gain during the transition period from the fossil energy-based organization to a renewable energy-based organization due to structural and intra-industrial differences among the sectors.

In this perspective, this study aims to estimate net job change in Turkey, due to transitioning the electricity sector from the fossil energy-based structure to renewable energy-based structure. Therefore, the objective of this study is to estimate the net job change due to this transitioning period through the input-output methodology. The input-output method is a useful tool to estimate net employment change, but the insufficiency of the level of industrial disaggregation in the input-output tables limits its use. Since renewable energy is not included as a isolated sector in the Turkish input-output tables, the employment potential of the renewable energy sector cannot be analyzed by conventional input-output methods. In this study, this problem is addressed with the final demand and complete inclusion methods. In this way, the employment potentials of renewable and fossil energy-based electricity sectors are examined both for manufacturing/installation and operation/maintenance phases.

The paper is structured as follows. In section 2 the existing literature about the employment impact of the energy sector is reviewed. Section 3 explains the two different methodologies and basic assumptions employed in this study together with the datasets used. Section 4 presents a summary of the extensive results and discusses the sensitivity of results by comparing the two different approaches employed. Moreover, to double-check the sensitivity of results, the findings are compared to the results of other studies in the literature too. Finally, section 5 provides the main conclusions of the study.

1. LITERATURE REVIEW

With technological advancement, the efficiency of renewable energy technologies has been increasing day by day, which causes both costs to drop and the profitability of the sectors to rise significantly. (REN21, 2019)

In light of these developments, initial studies by the public institutions, industry associations, and non-governmental organizations about renewable energy aimed to raise awareness about the potential advantages of renewable energy over the fossil energy sector. Besides the environmental benefits of renewable energy sectors, initial studies intended to underline the potential employment boosting effect of the sector and attracting the public attention (Kammen, et. al.,2004).

In the last decade, however, the number of peer-reviewed academic studies has been increased rapidly. The types of employment that arise due to new spending are analyzed under three separate headings as, direct, indirect, and induced employment effects. Direct employment effect is the reaction of a given industry given a change in final demand for that specific industry, while indirect employment effect displays the reaction by entire supplying industries from a change in final demand for that specific industry (Henriques et al., 2016). On the other hand, for a particular industry, induced employment effect displays the reaction of the entire industries induced by diminished (expanded) spending of new household's income and inter-industrial transfers lost (created) from the direct and indirect employment effects of the variation in final demand (Henriques et al., 2016).

In general, two different approaches are used to estimate those employment effects in the energy sector. These are the employment factor approaches and input-output based models. Apart from these models, in some studies (Liera et al., 2013; Erdal, 2012; Hillebrand, 2006) different methodologies are employed such as supply chain analysis and surveys. The employment factor approach is the most widely used method in the literature since it can be used without detailed data and expertise. Studies based on the employment factor approaches, however, have a clear lack of authenticity in the results, since those studies by repetitively referencing to other studies disregard the country-specific features and differences (Cameron and Zwaan, 2015). This situation causes inflation of non-authentic studies of the employment factor approach in the literature.

Most of those studies come up with positive employment impact conclusion, although some studies (Böhringer et al., 2013; Cai et al., 2011; Wang et al., 2013; Cai et al., 2014; Sooriyaarachchi et al., 2015; Henriques et al., 2016; Behrens et al., 2016) claim neutral, mixed or even negative employment effect. However, with this method, only direct, and with some weak assumptions, indirect employment figures can be estimated (Mu et al., 2018).

Another important issue in the literature is the negligence of the distinction between the first phase of investment that includes the manufacturing and installation and the second phase of investment that includes operation and maintenance. Those two phases have different spending patterns, employment duration, and characteristics that must be considered separately. In the first phase, in general, employment opportunities are richer than the second phase but the duration of employment opportunities is longer in the second phase. Some studies that considered those two phases separately are Moreno and Lopez (2008), Markaki et al., (2013), Simas and Pacca (2014), and Henriques et al., (2016).

In the literature, a great number of studies investigate only the renewable energy sector in terms of employment and only a few studies (Garret-Peltier, 2017; Tourkolias et al., 2009) take into account the conventional fossil-based energy sector. This makes it very difficult to compare the employment effect of different energy technologies vis-à-vis (Cameron and Zwaan, 2015). Since this study includes petroleum, coal, and natural gas-based thermal power plants as well as, hydraulic, geothermal, wind, solar, and biofuel based power plants' employment generation estimations and comparisons of them, it covers an important gap in the literature.

Because of the different methodologies, scopes, and, datasets used to estimate different employment effects for a variety of different energy sectors, employment estimations vary widely in the literature. For this reason, testing the robustness of the estimations by comparing the estimations with other studies' estimations is important, however, in the literature, only one study intended to do that briefly for the Portuguese and Tunisian case (Cameron and Zwaan, 2015). Although in this study two different methodological approaches are used to test the sensitivity of the results, in the results and discussion section estimations found are compared for other countries' estimations to double-check the sensitivity.

An additional intriguing point in the literature is the concentration of studies on European and other developed countries cases which shows an important gap in the literature and the need for more evidence from developing countries too (Wei, et. al, 2010; Simas and Pacca, 2014). In the case of Turkey, studies were either employed weak methodologies, datasets, or both of them. For example, Çetin and Eğrican(2011) for each MWp installed capacity of solar energy systems assumed 37 to 46 direct employment in Turkey without any clear estimation or referencing to their assumption. Then by assuming multiplier effect two, one more time without any estimation or referencing, for each direct employment one indirect employment assumed.

Another study (Erdal, 2012) conducted only a telephone survey for a few operating renewable energy firms in Turkey to keep the statistics of employment without any estimation of employment at the manufacturing and installation phase and without any estimation of indirect and induced employment effects. The other two studies (Erdoğdu and Karaca, 2016; Karaca et. al, 2017) for the Turkish case used a computer application that prepared for the U.S.A. with an American input-output dataset and employment multipliers for estimation.

Therefore, even though, the vast majority of results show growth in the renewable energy sector has a positive impact on employment, this may be due to a specific economic structure of developed countries. Moreover, while project-based microeconomic data collected from developed countries may be partially useful for feasibility studies of developing countries' firms to estimate potential expenditures and employment needs of local projects, it may not be suitable for the macroeconomic planning needs. Since neglecting the differences in capital intensity, technological advancement, labor productivity, wage, renewable energy potential, and other differences across countries may cause biased estimations. A summary of studies in the literature can be seen in table 1.

Table 1 Summary of the literature

Study	*Region*	*Methodology*	*Sector*	*1st Phase*	*2nd Phase*	*Direct*	*Indirect*	*Induced*	*Brut*	*Net*
1)Çetin & Eğrican (2011)	Turkey	F.M.	S	14.59 P/MTL		x	x		x	
2)Erdal (2012)	Turkey	Survey	W, G		x	x			x	
3)Karaca, et. al. (2017)	Turkey	F.M.	All	x	x	x	x	x	x	
4)Erdoğdu & Karaca (2016)	Turkey	Comp. App.	S	23.42 P/MW	1,16 P/MW					
5)Singh & Fehrs (2001)	U.S.A.	Survey	W,S,B	3.8-35.5 P/MW		x			x	
6)Kammen et.al. (2004)	U.S.A.	Lit. Sum.	All	x	x	x	x	x	x	x
7)Moreno, Lopez (2008)	Asturias	F.M.	All	0.12-34.6 P/MW	0.01-6 P/MW	x			x	
8)Wei & Kammen (2010)	A.B.D.	F.M.	All	x	x	x	x	x	x	x
9)Garret-Peltier (2017)	A.B.D.	I-O	All	7.2-7.6 P/MUSD		x	x		x	x
10)Lehr et.al. (2016)	Tunisia	I-O	-	x		x	x		x	
11)Henriques et.al. (2016)	Portugal	I-O.	All	5.0-25.1 P/MW	0.05-0.41 P/MW	x	x	x	x	x
12)Cai et.al. (2011)	China	I-O F.M.	All	0.4-3,27 P/MWh		x	x		x	x
13)Oliveira et.al. (2014)	U.K.	I-O	All	x	x	x	x	x	x	
14)Markaki et.al. (2013)	Greece	I-O	All	17,6-20,8 P/MUSD	17-20 P/MUSD	x	x	x	x	
15)Schwartz et.al. (2009)	L.America	F.M.	S,W,B	x		x	x	x	x	x
16)Böhringer et.al. (2013)	Germany	I-O-C.G.E	Mixed	x		x	x	x	x	x
17)LIera et.al. (2013)	Spain	V.Chain	S	x	x	x	x		x	
18)Simas & Pacca (2014)	Brazil	I-O	W	13.5 P/MW	0,59 P/MW	x	x		x	
19)Lehr et.al.(2012)	Germany	I-O/P.R.	Mixed	x	x	x	x		x	x
20)Tourkolias&Mirasgedis(2011)	Greece	I-O	All	17.2-46.9 P/MW	8.4-135 P/MW	x	x	x	x	
21)Mu, et.al. (2018)	China	I-O-CGE	S, W	0.012-0.042 K/MW	0.003-0.002 P/MW	x	x	x	x	x
22)Neuwahl et.al. (2008)	E.U.	I-O	B	x		x	x	x	x	x
23)Markandya et.al. (2016)	E.U.	I-O- M.R.	Mixed	x		x	x		x	
24)Lund & Hvelplund (2012)	Denmark	I-O	S, G, B	x	x	x	x		x	
25)Hillebrand et.al. (2006)	Germany	I-O-S.M.	All	x		x	x	x		x
26)Heindl & Voigt (2012)	Germany	I-O	All	x	x	x	x	x	x	x
27)Chateau & Martin(2013)	OECD	I-O-CGE	All	x		x	x	x		x
28)Cai, et.al. (2014)	China	I-O	All	x		x	x		x	x
29)Blazejczak et.al. (2014)	Germany	I.O-SEEEM	All	x	x	x	x	x		x
30)Sooriyaarachchi, et.al. (2015)	S.Count.	F.M.	Mixed	x	x	x	x	x	x	x
31)Ortega, et.al.(2015)	E.U.	F.M.	S, W	x	x	x	x		x	
32)Lübbers, et.al.(2016)	Germany	I-O	B	x	x	x	x		x	
33)Behrens, et.al.(2016)	Portugal	I-O	Mixed	1.15 P/MW	x	x	x		x	x
34)Wang, et.al.(2013)	China	I-O	All	378-3222 P/GW	9.6-104.4 P/GWh	x	x		x	x
35)Zwaan, et.al. (2013)	M. East	F.M.	W,S	2.6-43 P/MW	0.1-1 P./MW	x	x		x	
36)Oliveira, et.al.(2013)	Portual	I.O-MOLP	All	x	x	x	x		x	
37)Caldes, et.al.(2009)	Spain	I-O	S	x	x	x	x		x	
38)Cansino, et.al.(2014)	Andalus.	I-O.-CGE	S	640 P/MW		x	x		x	
39)Dvorak, et.al.(2017)	Czechia	F.M.	All	0.7-25 P/MW		x	x		x	
40)Mills (2016)	Africa	F.M.	S	38P./10000G.E.K.		x			x	x
41)Rodriguez-Huerta, et.al.(2017)	Catalonia	F.M.	All	x		x	x		x	
42)Kis, et.al.(2018)	-	F.M.	All		17-94 P/PJ	x			x	
43)Bulavskaya & Reynes(2018)	Holland	I-O -CGE	All	x		x	x	x	x	x
44)Kahouli & Martin(2018)	France	I-O	W	6.03 P/MW	1.02 P/MW	x	x	x	x	
45)Chen, (2019)	China	I-O	S,W,B	100-286 P/MUSD		x	x		x	x
46)Cantore et.al.(2017)	Africa	F.M.	All	x		x	x		x	
47)Bohlmann et.al.(2019)	S.Africa	I.O- CGE	Mixed	x		x	x	x	x	x
48)Fanning et.al.(2014)	Wales	I-O	Wave	22.9-35.3 P/MW	0.02-0.8 P/MW	x	x	x	x	
49)Matumoto & Hondo(2011)	Japan	I-O	S,W	0,69-2.8 P/GWh		x	x		x	
50)Pollin & Garrett-Garret-Peltier (2009)	Ontario	I-O	S,W,B,H	14,2-16,4 P/MUSD		x	x		x	

Note: W: wind; S:Solar; B:Bioenergy; G:Geothermal; H:Hydraulic; F.M: Factor Multiplier; I-O:Input-Output; C.G.E: Computable General Equilibrium; M.R.:Multi-Region I-O; S.M.: Structural I-O; SEEEM: Sectoral Energy Economics I-O; G.Ç.-MOLP:Multi-Purpose I-O; MUSD: $1M; P:Person/Year; x: types of effect estimated in the study.

To sum up, most of those studies in the literature are non-authentic and based on the employment factor approach that does not cover all of the direct, indirect, and induced effects. Also, studies rarely consider the manufacturing and installation phase separately from the operation and maintenance phase. Furthermore, to be able to claim that renewable energy is more employment friendly than conventional energy sectors, fossil energy sectors must be compared vis-à-vis to renewable energy sectors which are done very rarely.

In this study by implying two different input-output methodologies based on Turkish input-output tables, renewable-based electricity sectors, and fossil-based electricity sectors are compared for three different employment effects for Turkey. Moreover, this is done for each of the two investment phases and for the eight different subsectors of electricity.

2. METHODOLOGY AND DATA

During the usual business operations of the modern capitalist era, which is getting more complex day by day, some companies produce basic and intermediate goods from raw materials while others produce the goods for the final consumption using those basic and intermediate goods. Within this dynamic structure, companies operating in every single field of the economy operate both as producer and consumer of the basic and intermediate goods. The input-output model is one of the most important economic tools for collectively analyzing these two-legged economic flows that occur during the production and consumption of cross-industry products and services.

From this perspective, input-output methods can be used in a wide range of fields with the help of input-output tables and other complementary datasets. Economic planning is one of the most common of those. With input-output methodology besides basic and intermediate goods, other factors of production such as the amount of labor to be used directly and indirectly can be predicted and planned too, for the targeted amount of final demand. The input-output methodology is designed to model the entire economy as an interdependence of products and services among numerous sectors and consumers, so that, by supplying the most complete picture of the system as a whole, it takes the snapshot of the economy (Wei et. al, 2010). It captures employment multiplier effects, as well as the macroeconomic outcome of switching among sectors, in another word, it accounts for losses in one sector (e.g. thermal power plants) initiated by the development of another sector (e.g. the solar energy) (Wei et. al, 2010).

The building of an input-output table is an extremely complicated and time-consuming operation, since collecting and arranging a tremendous volume of quantitative data causes an indispensable delay for the publication; accordingly, input-output tables are always historical documents in nature (Leontief, 1986). This limitation applies to our study and all other input-output based studies too. The latest input-output table prepared by the Turkish Statistical Institute for Turkey and used in our study covers the year 2012 and was only released at the end of December 2016 (Turkstat, 2016). Therefore, implications derived from input-output models should be assessed with precaution in the long term analysis.

Another important difficulty tied to input-output tables is the insufficiency of sectoral disaggregation at the national accounts. The Turkish input-output table is disaggregated as 64 industries and 64 products as per the European Union standardization (Turkstat, 2016). In those 64 industries, there isn’t any explicit category for renewable energy sectors. All kinds of electricity technologies were consolidated into the electricity sector and the electricity sector is further consolidated into the “Electricity, gas, steam and air conditioning” sector. Therefore there is no chance to readily compare the different technologies in the electricity sector. However, even though, there isn’t any explicit renewable energy-based electricity sector or even an electricity sector, those sectors are implicitly embedded in the “Electricity, gas, steam and air conditioning” sector.

To resolve this problem one may take spending in the energy sector as a demand shock as explained by Miller and Blair (2009). By creating a proxy demand vector that constitutes the manufacturing, construction, installation, and other costs of the sector and simulating the new investment in that sector, change in the number of jobs can be estimated (Garret-Peltier, 2017). The second method to overcome the insufficiency of data at input-output tables would be rearranging the already existing sectors and creating new sectors by separating them from other sectors as it explained again by Miller and Blair(2009) and implemented by Garret-Peltier(2017). In this study, we have used both of those approaches for the case of Turkey.

2.1. Final Demand Approach

Although the renewable energy sector is not considered as an independent industry in input-output tables, the outcomes of investment in the sectors could be estimated by utilizing the cost structure of the sector that derives from the production technic, and with this approach, the actual data in the national accounts and input-output tables can be utilized for a particular industry (Miller and Blair, 2009).

For example, “solar” or “geothermal” sectors are not distinguished as industries, rather services and other inputs making up the solar and geothermal sectors are implicitly included in input-output tables. To be able to abstract this information from existing tables, a proxy vector of demand that captures package of goods and services making up each industry is created, then additional spending treated as investments in these industries so that consequences of enlarging the renewable energy sector can be simulated (Garret-Peltier, 2017). If, for example, a vector of manufacturing and installation requirements of the solar energy sector from various other sectors and their weight in total expenditures obtained, the effect of stimulation in the solar energy sector can be estimated by this proxy demand vector.

The first step in this approach is finding the Leontief Inverse Matrix $(I-A)^{-1}$ with the help of the Turkish Input-output table released in December 2016 (Turkstat, 2016), and the MATLAB software. Then at the second stage, by post multiplying Leontief Inverse Matrix with the proxy demand vector(PDV) the change in the gross output(ΔX) containing the direct and indirect effects can be estimated. In the Matrices form the basic equitation is

$$\Delta X = (I - A)^{-1} \text{ x } \Delta PDV$$

Here PDV data reflect different cost structures of a variety of electricity sectors. PDV data for the manufacturing and installation phase is driven from data supplied by Garret-Peltier(2017) and data for the operation and maintenance phase is driven from the study of Tourkolias and Mirasgedis(2011) together with data supplied by American National Renewable Energy Laboratory (Nrel, 2018). When multiple datasets are available for any sector, arithmetic means are used.

The total changes in the gross output triggered by new investments in the electricity sectors trough proxy demand vectors are found. But, rather than the change in the gross output, to find the change in employment, Employment Requirement Matrix(ERM) is needed. The ERM matrix shows the total change in employment associated with a change at the gross output. The equation for ERM is as follows;

$$ERM: (E/O).(I-A)^{-1}$$

(E/O) matrix is formed by total employment/total output ratios at diagonal cells and zeros at other cells for each industry. The total number of employment for each industry is acquired from the Household Labor Force Survey (Turkstat, 2012a). By post multiplying the (E/O) matrix with Leontief Inverse Matrix, the ERM matrix is acquired.

ERM matrix shows the number of jobs created throughout the production circle. Each diagonal cell shows the number of jobs necessary for every single industry in the system to meet a million dollars of final demand for a given sector. Multiplying a given row of the employment requirements table by the vector of final demand shows the volume of jobs produced within the sector (Byun, 2010). Here multiplying proxy demand vector(PDV) with ERM gives the employment created both directly and indirectly at all sectors(ΔE) as shown in the following equation.

$$\Delta E = ERM. \Delta PDV$$

Up until now, the methodology shown is aimed to estimate the direct and indirect employment changes due to growth in the subsectors of the electricity industry, for both manufacturing/installation and operation/maintenance phases. Besides the direct and indirect effect, to estimate the induced effect, which is the outcome of changing household income, the household sector needs to be endogenized.

This requires the household sector to be added to the input-output table as an additional row and column which leads to a closed version of the input-output table, so that compensation of employees and household expenditures are integrated to the modeling (Henriques, et. al., 2016). Therefore, the household sector counted both as producer and consumer in the input-output modeling. With the newly updated input-output table, we apply the procedure already explained for both manufacturing/installation and operation/maintenance phases.

2.2. Complete Inclusion Approach

The findings reached through the final demand model may reflect some of the economic relations due to the nature of the methodology applied. As Miller and Blair(2009) explained; a new branch of economic activity within the economic structure not only demands input from other industries but also it will supply its products and services to other sectors. Consequently, the macroeconomic production structure will inevitably change completely. First of all, there will be a new column and row of input coefficients related to purchases by and sales of the new sector. Moreover, there might be changes in the A matrix, reflecting, for instance, the substitution of the newly available input for the one previously used (Miller and Blair, 2009).

In this respect, our study is taken a step further and the complete inclusion approach explained by Miller and Blair (2009) is implemented as a second model. With this methodology, the already existing 64x64 input-output table expanded by adding extra new rows and columns associated with different electricity sectors, so that a more detailed and disaggregated data set can be obtained. Although the total volume of economic activity does not change with the new data set, different electricity technologies, which all of them previously aggregated into the "Electricity, gas, steam and air conditioning" sector, can be analyzed in more detail.

Once again the input-output table released in December 2016 by Turkstat(2016) is used as the main data. As mentioned earlier, leaving aside the renewable energy-based electricity sectors, even the electricity sector is not taken as an independent industry in the Turkish input-output table. Therefore the first step is disassociating the electricity sector from the "Electricity, gas, steam and air conditioning" sector.

Due to the privatization of different branches of the electricity sector in the different regions of Turkey and a variety of tariffs applied by that privatized firms, the total financial size of the electricity sector couldn't be found readily. To estimate the financial magnitude of the sector, the total volume of electricity consumption data (Turkstat, 2012b) and the average unit price of electricity data (Turkstat, 2012c) both for the residential and industrial consumer are used.

With this calculation, the Turkish electricity sector is estimated to size up to 53.892.199.185 TL out of 122.290.921.000 TL sized "Electricity, gas, steam and air conditioning" sector. Therefore the electricity sector (ES) multiplier and remaining sector of "gas, steam and air conditioning"(RS) multiplier is found to be 0.440688 and 0.559311 respectively.

In the first step using those multipliers, w_1 and w_2, the input-output table is extended from 64x64 to the size of 65x65. The separation scheme of those two sectors is seen in table 2. Then at the following step electricity sector is further disaggregated into eight new subsectors similar to the one implemented in table 2, with a more complex disaggregation process. This disaggregation is based on the market share of different electricity sectors acquired from energy balance tables (Eigm, 2012).

Table 2 Two Sector Disaggregation Scheme

	Sector A	Sector B	Sector C	**Electricity Sector(ES)**	**Remaining Sector(RS)**	Sector …
Sector A	A_{aa}	A_{ab}	A_{ac}	A_{aES} = A_{aES} x w_1	A_{aRS} = Aa_{ES} x w_2	$A_{a..}$
Sector B	A_{ba}	A_{bb}	A_{bc}	A_{bES} = A_{bES} x w_1	A_{bRS} = A_{bES} x w_2	$A_{b..}$
Sector C	$A_{..a}$	$A_{..b}$	A_{cc}	$A_{..ES}$= $A_{..ES}$ x w_1	$A_{..\ RS}$ = $A_{..\ Electr.}$ x w_2	$A_{....}$
Electricity Sector	A_{FEa} = $A_{Electr.\ a}$ x w_1	A_{FEb} = $A_{Electr.b}$ x w_1	$A_{FE..}$ = $A_{Electr.\ ..}$ x w_1	$A_{FE\ FE}$= $A_{Electr.\ Electr.}$ x w_1 x w_2	$A_{FE\ YE}$ = $A_{Electr.\ Electr.}$ x w_2 x w_1	$A_{FE..}$= $A_{Electr.}$ x w_1
Remaining Sector	$A_{YE\ a}$ = $A_{Electr.\ a}$ x w_2	$A_{YE\ b}$ = $A_{Electr.\ b}$ x w_2	$A_{YE..}$ = $A_{Electr.\ ..}$ x w_2	$A_{YE\ FE}$ = $A_{Electr.Electr.}$ x w_1 x w_2	$A_{YE\ FE}$ = $A_{Electr.Electr.}$ x w_2 x w_1	$A_{YE..}$ = $A_{Electr...}$ x w_2
Sector …	$A_{..a}$	$A_{..b}$	$A_{...c}$	$A_{..FE}$ = $A_{..Electr.}$ x w_1	$A_{..\ YE}$ = $A_{..Electr.}$ x w_2	$A_{......}$

The basic assumption in this disaggregation step is newly disaggregated electricity sectors supply electricity proportionally to their market share to the other sectors of the economy. This is a fairly reasonable assumption since electricity is a homogenous source of energy regardless of its source. Therefore, this homogeneity of electricity yields a chance of a healthy comparative analysis. This is one of the reasons why the electricity sector is taken in the center of analysis, instead of the general energy sector. Since different industries may demand and supply different types of energy that prevents the implication of the disaggregation technic explained.

The newly created 72x72 input-output table isn't, however, ready to use. While due to this homogeneity newly created sectors assumed to supply electricity proportionally to their market share, their input demand from other sectors may differ one from the other, because of different production technics and technologies. Therefore, at this stage cost structure dataset for the manufacturing and installation phase supplied by Garret-Peltier (2017) used to rearrange the input demands of the electricity sectors. For the operation and maintenance phase, on the other hand, data supplied by Tourkolias and Mirasgedis(2011) together with the American National Renewable Energy Laboratory database (Nrel, 2018) used. According to the information gained from those databases, the cost structure of all electricity sectors is rearranged and two different input-output tables are created for both of the phases.

At the final stage, using the latest versions of the 72x72 input-output tables generated, Leontief Inverse Matrices $(I - A)^{-1}$ are created. Subsequently, the methodology applied at the Final Demand Approach repeated, and ERM: $(E/O).(I\text{-}A)^{-1}$ is created for both of the phases. To simulate the employment effects of one million dollars of spending (ΔY) in each of the electricity sectors, for the two different phases, the following equation is applied;

$\Delta E = ERM.\ \Delta Y$

After the effects of one million dollars spending estimated for both phases, the 72x72 input-output tables rearranged again to the size of 73x73 to endogenize the household sector as it was done in the Final Demand Approach. Repeating all of the previous procedures to the newly created matrix, the induced employment effect is captured besides the direct and indirect employment effects for both phases. After all of those procedures are done, plenty of results have been acquired that will be covered in the next section.

3. RESULTS AND DISCUSSION

Due to the use of different models, phases, sectors, and effects, multi-layered estimations have been achieved. However, the remarkable point among all of these results is, in all alternative estimates, electricity sectors based on renewable resources are always more effective than fossil-based electricity sectors in terms of employment creation. (Figure 1, Figure 2)

Fig. 1. Final Demand Approach Job Creation Estimates for $ 1 M Investment

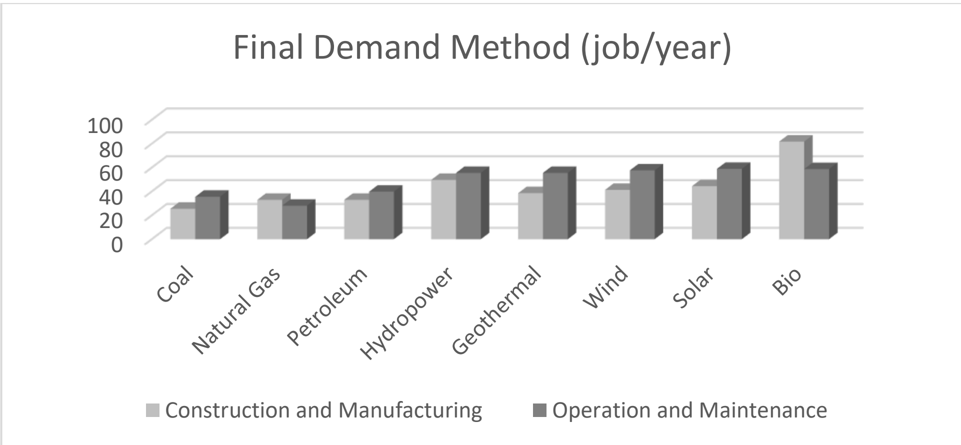
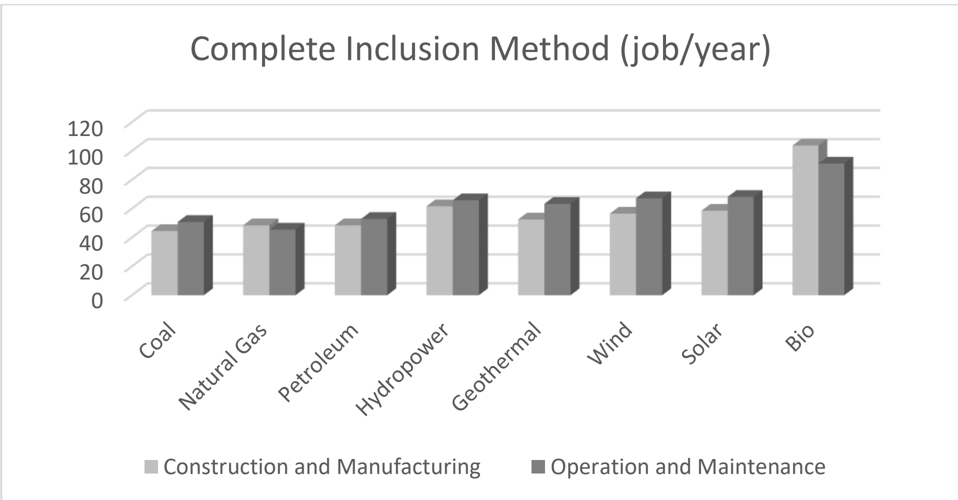


Fig. 2. Complete Inclusion Approach Job Creation Estimates for $ 1 M Investment



According to both approaches in the manufacturing and installation phase, bioenergy based electricity sector is the most effective sector followed by the hydroelectricity sector. In the fossil energy-based electricity sector there are two different subsectors, coal, and natural gas/petroleum, in contrast to the operation and maintenance phase where three fossil-based sectors are investigated. Since the cost structure of operation and maintenance phase natural gas and petroleum sectors are handled separately. For both approaches, the natural gas and petroleum sector have more capacity in terms of employment generation than the coal-based electricity sector.

Another marked point in the estimation results of the manufacturing and installation phase is the weight of the induced job effect in total. According to final demand approach estimation results, for all of the sectors, more than the %30 of newly created jobs comes from the induced employment effect. For the complete inclusion approach estimation results, however, this ratio is even higher than %50 for most of the sectors (Table 3)

Table 3 Manufacturing and installation Phase Employment Effect

Final Demand Method							
Type of Effect	*Coal*	*Nat.Gas/Petroleum*	*Hydraulic*	*Geothermal*	*Wind*	*Solar*	*Bio*
Direct + Indirect	13,97	13,91	25,77	24,21	26,57	26,07	50,25
Induced	11,57	19,06	23,90	14,35	14,76	18,31	31,50
Total	25,54	32,97	49,67	38,56	41,33	44,38	81,75
Complete Inclusion Method							
Direct	10,06	9,45	12,90	10,37	12,95	13,04	36,64
Indirect	7,85	7,83	13,12	11,13	13,17	13,05	26,35
Induced	26,48	31,1	35,55	30,92	30,37	32,39	40,78
Total	44,39	48,38	61,57	52,42	56,49	58,48	103,77

Note: Employment effects are per one million dollars spending and annual jobs.

For the operation and maintenance phase, bioenergy and solar energy-based electricity sectors are the most effective considering the estimation results of the final demand approach. For the complete inclusion method, however, bioenergy is by far the most effective sector which is followed by the solar energy sector. Similar to the manufacturing and installation phase, the induced effect is once again the most important element in the employment generation for both final demand and complete inclusion approaches (Table 4). This is particularly important since in the literature a substantial volume of studies does not consider the induced effect which may result in biased estimations.

Table 4 Operation and Maintenance Phase Employment Effect

Final Demand Approach								
Type of Effect	*Coal*	*Petroleum*	*Natural Gas*	*Hydraulic*	*Geothermal*	*Wind*	*Solar*	*Bio*
Direct + Indirect	13,23	12,22	12,54	15,76	15,76	16,35	13,76	19,43
Induced	22,32	15,84	27,30	39,77	39,77	41,31	45,13	39,30
Total	35,55	28,06	39,84	55,53	55,53	57,66	58,89	58,73
Complete Inclusion Approach								
Direct	10,08	9,46	9,50	12,90	10,38	12,96	13,05	36,65
Indirect	7,44	6,88	7,03	8,80	8,82	9,15	7,71	10,86
Induced	33,18	29,08	36,27	44,03	44,02	44,98	47,32	43,73
Total	50,70	45,42	52,80	65,73	63,22	67,09	68,08	91,24

Another point that draws attention in the estimation results is that bioenergy based electricity sector is among one of the two most effective sectors in all of the results. This may be due to its agricultural components of the sector which is highly labor-intensive. The fact that the agricultural sector in Turkey is the most labor-intensive sector (Table 5) makes the bioenergy based electricity sector come to the fore in terms of employment generation.

Table 5 Labor Intensity By Sectors

Sectors	*Total Revenue (Thousand TL)*	*Total Employment*	*Labor Intensity*
Agriculture, Forestry and fishing	178744670	6097000	0,0341
Mining and quarrying	32738610	113000	0,0034
Manufacturing	566448244	4420000	0,0078

Electricity, gas, steam, water sup. etc.	154720780	218000	0,0014
Construction	297839261	1709000	0,0057
Wholesale and retail trade	288644429	3502000	0,0121
Transportation and storage	272993907	1095000	0,0040
Accom. and food service activities	85421969	1206000	0,0141
Information and communication	68623700	238000	0,0034
Financial, insurance activities	73445666	264000	0,0035
Real estate activities	172460279	184000	0,0010
Prof., scientific, technical activities	70768082	507000	0,0071
Admin. And support service act.	66318490	924000	0,0139
Public administration and defense	91378512	1458000	0,0159
Education	72260125	1224000	0,0169
Human health and social work act.	71655470	808000	0,0112
Arts, entertainment and recreation	22436609	108000	0,0048
Other social, comm., personal service act.	32369686	748000	0,0231

Source: (Turkstat, 2016; Turkstat, 2012a.)

The distribution of newly created jobs is also important, which is mostly neglected in the literature since this distribution must match with the ability of the labor force in Turkey. Because it is impossible to discuss the immense volume of results associated with the distribution of newly created jobs for all of the sectors, all of the phases and for two different methodologies, the most effective sectors of fossil-based and renewable-based electricity sectors analyzed in table 6 for each section.

Original estimations of distribution of newly created jobs were in the form of 65x65 and 73x73 sectors. To simplify the results, however, they are aggregated to 19x19 form which is designed according to Turkstat's "Economic Activity by Years and Sex, Nace Rev.2" classification (Turkstat, 2016) and with the addition of the household, sector created in the analysis to capture the induced employment effects. Most of the newly created jobs arise in Electricity, gas, steam, water supply, sewerage, etc. sector due to the direct employment effect. Other sectors such as; Agriculture, Forestry and fishing sector, Manufacturing sector, Wholesale and retail trade sector, Transportation and storage sector are also important in the employment generation. In the fossil-based electricity sectors, however, Mining and quarrying sectors take an important place (Table 6).

Table 6 Distribution of newly created jobs for some sectors

Sectors	Fossil Energy				Renewable Energy			
	Final Demand		Complete Inclusion		Final Demand		Complete Inclusion	
	C.M. Nat. Gas/Pet.	*O.M Nat. Gas*	*C.M. Nat. Gas/Pet.*	*O.M Nat. Gas*	*C.M. Bio*	*O.M. Solar*	*C.M. Bio*	*O.M Bio*
Agriculture, Forestry and fishing (A)	1,39	2,07	2,30	2,75	37,01	2,99	22,33	3,18
Mining and quarrying (B)	2,92	4,07	1,65	2,32	0,10	0,05	0,09	0,07
Manufacturing (C)	7,38	2,59	5,13	2,44	5,77	8,12	4,30	4,75
Electricity, gas, steam, water supply, sewerage etc. (D+E)	0,12	0,18	9,61	9,68	0,14	0,19	37,84	36,86
Construction (F)	0,05	0,10	0,05	0,09	3,18	0,14	1,81	0,10
Wholesale and retail trade (G)	1,61	1,73	1,65	1,76	2,24	2,31	2,08	5,97
Transportation and storage (H)	2,29	0,77	1,51	0,66	0,68	0,71	0,63	2,75
Accommodation and food service activities (I)	0,35	0,54	0,57	0,70	0,63	0,84	0,08	0,84
Information and communication (J)	0,08	0,20	0,10	0,16	0,14	0,30	0,12	0,18
Financial, insurance activities (K)	0,15	2,23	0,14	1,31	0,17	3,78	0,16	0,23
Real estate activities (L)	0,06	0,11	0,09	0,12	0,1	0,55	0,10	0,25
Professional, scientific and technical activities (M)	0,25	1,71	0,23	1,04	2,26	0,69	1,35	0,36
Admin. And support service act. (N)	0,50	0,85	0,46	0,66	0,67	0,86	0,57	0,66
Public administration and defense (O)	0,03	0,05	0,05	0,05	0,68	0,07	0,07	0,07
Education (P)	0,09	0,16	0,14	0,19	0,16	0,25	0,19	0,21
Human health and social work act. (Q)	0,04	0,06	0,07	0,09	0,07	0,10	0,09	0,10
Arts, entertainment and recreation (R)	0,02	0,03	0,03	0,05	0,0432	0,05	0,05	0,05

Other social, community and personal service activities (S+T+U)	0,20	0,3	0,30	0,37	0,35	0,44	0,41	0,46
Household	15,34	22,006	24,19	28,24	27,89	36,35	31,73	34,05
Total	32,97	39,85	48,38	52,8	81,75	58,89	103,76	91,24

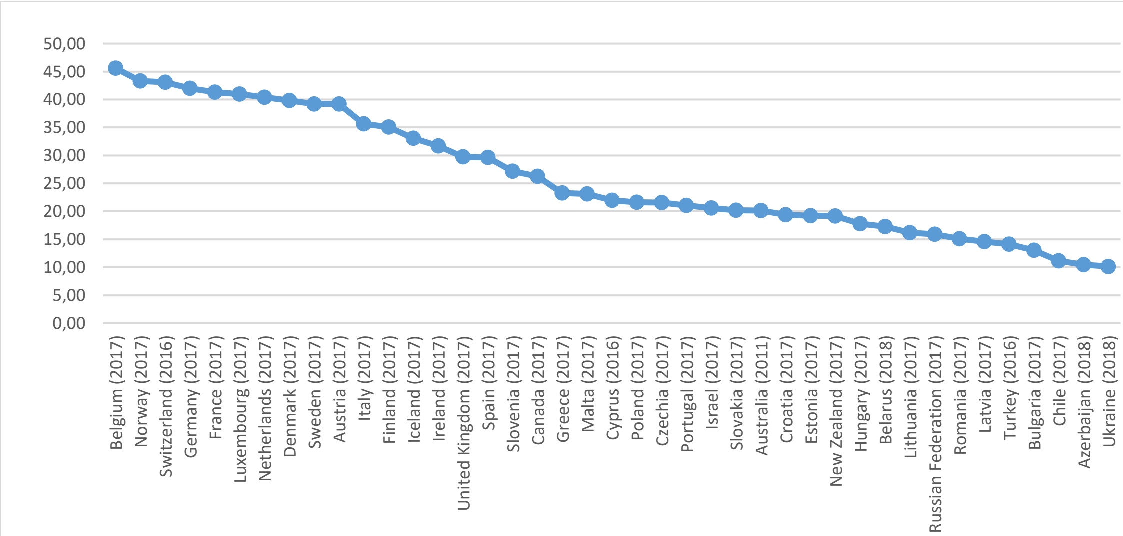
For the reason that studies in the literature mostly concentrated on developed countries and there is a limited amount of studies conducted for developing countries like Turkey, it will be useful to compare the results in the literature with the results that have been found. However, due to the excessive volume of results and heterogeneity among them, makes some limitation mandatory for sound comparison. Since some studies are associated with employment generation to the production capacity of powerplants in terms of GWh or production in terms of GWh, renders them readily incomparable to our study. Therefore, because our study measures employment generation resulting from new financial investments, similar studies opted for the comparison as seen in table 7.

Table 7 Comparisons of Results with Other Studies Results'

Study	*Meth.*	*Region*	*Sector*	*M.C. Dir.+Ind.*	*M.C. Dir.+Ind+ Induced*	*O.M. Dir.+Ind.*	*O.M. Dir.+Ind+ Induced*
Our Study	F.D.	Turkey	Hydropower	25,78	49,68	15,76	55,53
Our Study	F.D.	Turkey	Geothermal	24,21	38,57	15,76	55,53
Our Study	F.D.	Turkey	Wind	26,57	41,33	16,35	57,67
Our Study	F.D.	Turkey	Solar	26,07	44,39	13,76	58,89
Our Study	F.D.	Turkey	Bioenergy	50,25	81,75	19,43	58,74
Our Study	C.I.	Turkey	Hydropower	26,03	61,57	21,70	65,73
Our Study	C.I.	Turkey	Geothermal	21,51	52,42	19,20	63,22
Our Study	C.I.	Turkey	Wind	26,13	56,49	22,10	67,09
Our Study	C.I.	Turkey	Solar	26,10	58,48	20,75	68,08
Our Study	C.I.	Turkey	Bioenergy	63,01	103,77	47,51	91,24
Çetin, Eğrican (2011)	Fac.Mult.	Turkey	Solar	15,24	30,49	15,24	30,49
Erdoğdu, Karaca(2016)	Com.Soft.	Turkey	Solar	11,45	19,74	20,72	28,72
Markaki (2013)	I.O.	Greece	Wind 1	14,13	17,67	14,13	17,67
Markaki (2013)	I.O.	Greece	Wind 2	15,25	19	15,25	19
Markaki (2013)	I.O.	Greece	Solar	14,73	18,46	14,73	18,46
Markaki (2013)	I.O.	Greece	Hydropower	16,55	20,25	16,55	20,25
Markaki (2013)	I.O.	Greece	Geothermal	14,08	17,86	14,08	17,86
Markaki (2013)	I.O.	Greece	Bioenergy	17,25	20,81	17,25	20,81
Garret-Peltier(2017)	F.D.	U.S.A.	Wind	7,52	-	-	-
Garret-Peltier(2017)	F.D.	U.S.A.	Solar	7,24	-	-	-
Garret-Peltier(2017)	F.D.	U.S.A.	Bioenergy	7,65	-	-	-
Garret-Peltier(2017)	F.D.	U.S.A.	Geothermal	7,40	-	-	-
Garret-Peltier(2017)	F.D.	U.S.A.	Hydropower	7,53	-	-	-
Pollin(2009)	I.O.	Ontario	Hydropower	14.2	-	-	-
Pollin(2009)	I.O.	Ontario	Wind 1	14.7	-	-	-
Pollin(2009)	I.O.	Ontario	Wind 2	15,8	-	-	-
Pollin(2009)	I.O.	Ontario	Bioenergy	16.4	-	-	-
Chen(2019)	I.O.	China	Solar	100,1	-	-	-
Chen(2019)	I.O.	China	Wind	100,1	-	-	-
Chen(2019)	I.O.	China	Bioenergy	286,4	-	-	-

In general, it is seen that although the estimates reached in our study are higher, they are within the ranges of the literature findings. The reasons for the high employment estimates can be explained with a few factors. First, the fact that employment effects are higher in Turkey compared to other studies may indicate the differences in the labor intensity of the sectors among countries.

Fig. 3. Hourly labor costs for some countries in 2017 PPPs US dollars, latest year.



Source: (Ilostat, 2020)

Another important factor that may explain the higher employment estimates in our study compared to other studies is the lower labor costs in Turkey compared to developed countries (Figure 3). Lower wages may be an important factor explaining higher employment generation, since investors may prefer labor-intensive production technologies rather than high-cost capital-intensive production technologies. Especially considering Turkey's dependency on foreign countries in financial means or a significant reliance on imported inputs and weak capital goods sector, renders this option highly reasonable (Becker, 2016).

Additionally, a third factor may be particular production technologies, and the supply chain structure of the energy sectors in Turkey may cause a higher multiplier effect and employment effect. This factor, however, may be expected to be less probable compared to other factors that have mentioned, since rapid technological dissemination seen throughout the recent decades in the renewable energy sectors (Koengkan, et. al., 2019). Therefore differences in the production technologies among countries seem to be less plausible.

Nonetheless, high employment generation estimates are not sufficient to be able to fully utilize the employment benefits. The potential capacity of renewable resources in a region is also crucial. Since renewable resources are not the kind of sources to be imported. Therefore, to be able to fully exploit the employment benefits estimated, renewable resources must be sufficient and easily accessible.

In this case, Turkey is very rich in almost all types of renewable energy sources. Turkey with the 1000–1450 kWh/m² year value, excluding Spain, has more solar energy potential than all of the European Union countries (Cengiz and Mamiş, 2015). For wind energy, with the 166 TWh/year technical potential, Turkey is among the richest countries in Europe (Dursun and Gokcol, 2014). Considering Turkey is the seventh-largest agricultural producer in the world, the bioenergy may be a very important sector too (Rincon et. al., 2019). Moreover, in terms of hydropower potential, with 440 TWh/year, Turkey has the second richest resources in Europe after Norway (Yuksel, 2012). Therefore the employment generation potential of the renewable energy-based electricity sector in Turkey compared to the fossil energy-based electricity sector is not only on theoretical estimations. On the contrary, with these rich resource potential, renewable energy may be a strong engine for sustainable development in Turkey.

CONCLUSION

Environmental, economic, and social elements of sustainable development are tightly interconnected and high unemployment in Turkey negatively affects all of them. In this perspective, the renewable energy sector in Turkey, with her rich resources, may be an important prescription for the unemployment problem and other concerns of sustainable development.

From the microeconomic perspective, the renewable energy sector may be an important tool for the employment generation. Moreover, being a domestic resource may ease the current account deficit and other associated economic problems too. However, at the macroeconomic level, while new jobs are created in the renewable energy sector, other jobs may disappear in the conventional fossil energy sector. Therefore, two different methodologies were implemented to see the net employment effect of the transition from the fossil-based energy structure to a renewable-based energy structure.

According to both of the methodologies and for both of the phases, manufacturing/installation and operation/maintenance, all types of renewable-based electricity sectors are more effective than fossil-based electricity sectors in terms of employment generation. The interesting point among those finding is, the induced effect constitutes 35% to 75% of the total employment generation effect depending on the estimation method and phase. Taking into account that induced effect frequently disregarded in the literature, this is a particularly important finding.

Considering the unemployment rate in Turkey rose to a peak of 14,7% and the youth unemployment rate rose to a peak of 26,1% in 2019 (Turkstat, 2019a), those findings are particularly important. According to those estimations, the renewable energy sector may be an alternative way to growth and employment creation in Turkey without worrying about environmental degradation.

Moreover, according to estimation results, bioenergy is one of the two most effective sectors in terms of employment generation. This may be particularly helpful for the structural unemployment problem in Turkey, that arises due to skill mismatch between industry requirements and the newly immigrated labor force which is only equipped with agricultural skills. Furthermore, by providing jobs to residents of rural regions in Turkey, through the bioenergy sector, internal migration and associated socioeconomics problems may be mitigated too.

Also, the renewable energy sector may have other benefits too, such as political and geostrategic benefits in the context of energy independence. However, to utilize all of those benefits, policymakers must agree on the strategic importance of the sector and more support and subsidies should be granted to the sector. Since, despite the recent developments, the renewable energy sector has higher costs compared to fossil energy sectors. Besides, to absorb all of the estimated employment benefits and prevent job leakages to other competing countries domestic production must be supported in the manufacturing part of the sector.

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