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The transition in play: Worldwide employment trends in the electricity sector

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Abstract

Electricity generation from renewable sources has been touted as a win-win solution for the advancement towards both environmental sustainability and decent work for all. This paper analyses the employment effects of electricity generation by different sources on a worldwide scale as observed since the year 2000. It finds that the additional generation from renewable, non-hydro, energy sources has been related to higher job creation in the electricity sector when compared to other energy sources, notably fossil fuel-based technologies. As predicted, renewables also help reduce GHG emissions. Estimating the economy-wide effects through employment multipliers provide more evidence that developing renewable energy has positive environmental and employment impact throughout the entire economy.

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1. Introduction

Human-induced greenhouse gas (GHG) emissions are the primary cause of current climate change (IPCC, 2013). A quarter of all emissions result from the burning of coal, natural gas and oil for electricity and heat. Electricity and heat production is the largest single source of global greenhouse gas emissions. Replacing fossil fuel-based energy sources by renewables like solar or wind can contribute to the mitigation of climate change while maintaining or increasing energy supply (IPCC, 2014). Transitioning to a low-carbon and resource-efficient economy, by, among others, increasing the reliance on renewables will have implications on the world of work and society akin to that of an industrial revolution (Bowen et al., 2016).

Greater reliance on renewable energy sources for electricity can be positive for employment, as suggested by individual studies on the labour requirements of renewables compared to fossil-fuel based energy production (Wei et al., 2010), literature reviews (Bowen and Kuralbayeva, 2015) or projections based on energy demand and these labour requirements (Rutovitz and Atherton, 2009). Though projections and studies at the level of individual technologies exist, few, if any, analyses exist on the observed employment trends in the energy sectors in the past for developing countries and the world as a whole. This is surprising given that many countries have been investing in and adopting and expanding renewable energy sources with particularly strong growth in the past 10 years (Frankfurt School and UNEP, 2016; IRENA, 2016). Where such ex-post historical studies exist, they are limited to specific country contexts or to developed economies (Cameron and van der Zwaan, 2015).

This paper matches the trends in employment in the energy sector with renewable- and non-renewable energy production to estimate the extent to which renewable energy production has led to job creation in the energy sector when compared to energy production from non-renewable energy sources. Findings suggest a positive impact of renewables, both in the specific electricity generation sector and in the whole economy. These findings provide evidence of the employment and environmental benefit of transiting to electricity generation from renewable sources.

2. Climate change and the labour market

Shifting modes of production away from greenhouse gas emissions is urgent if the world economy is to advance towards sustainability (Barbier and Markandya, 2013; UNEP, 2011). Greenhouse gas emissions are the primary cause for climate change (IPCC, 2013), and the burning of fossil fuels for energy production is one of the major sources of GHG emissions. The burning of fossil fuels – e.g. coal, natural gas and oil – for the production of electricity and heat is the single largest contributor to GHG emissions (IPCC, 2014). Promoting the production of electricity from renewable energy sources will contribute to reducing GHG emissions while maintaining energy supply. Renewable energy sources include wind, solar, biomass, hydropower, tidal and geothermal. Shifting electricity production to these energy sources can limit warming of the Earth's atmosphere to less than 2°C above pre-industrial levels (IEA, 2017).

Transition towards a low-carbon economy is akin to an industrial revolution (Bowen et al., 2016; ILO, 2012), with important implications for the world of work (Bowen and Kuralbayeva, 2015). Shifting to low-carbon energy sources in electricity would benefit employment if each additional GWh of electricity produced from renewable energy sources required more – and better – employment than an equivalent GWh of electricity produced from non-renewable sources. Costs for renewable energy sources are already low enough to make the decarbonization of electricity economically sustainable, at least when it comes to the installation of new electricity generation (IRENA, 2015).

Identifying technologies that promote both a decarbonization of electricity production and employment can be useful for advancing towards an economy that is both environmentally and socially sustainable, thus contributing to the achievement of Sustainable Development Goal 7 (Affordable and Clean Energy) and Goal 8 (Decent Work and Economic Growth) (Poschen, 2015; UN General Assembly, 2015).

Wei et al. (2010) synthetize results from 15 studies and find that all non-fossil fuel technologies, including renewables, create more jobs per unit of energy than coal and natural gas. Taking into account the life-span, energy production, construction and manufacturing and operation and maintenance associated to each technology, they find that solar photovoltaic requires 0.87 person-years per GWh, landfill gas requires 0.72, small hydro 0.27, geothermal 0.25, solar thermal 0.23, biomass 0.21 and wind 0.17. These labour requirements compare to 0.11 for coal, 0.11 for natural gas and 0.14 for nuclear. Importantly, these are average labour requirements associated to each technology, with large variation observed for each technology when there is more than one study. Three studies, for example, serve as the basis for the labour requirements for solar photovoltaic, presenting values of 1.42, 0.95 and 0.23 person-years per GWh. This evidence suggests, at least at the level of the specific technology, that renewable energy sources create more jobs per GWh than non-renewable energy sources.

In reviewing the employment factors for wind and solar energy technologies, however, Cameron and van der Zwaan (2015) note several limitations in the current state of knowledge in this matter. First, only few studies yield truly original research as many studies rely on references from previous studies. Second, many studies are not peer reviewed. Third, many studies focus on employment in renewable energy, but do not offer comparisons with conventional or fossil fuel-based technologies. Fourth, they note that very few studies consider the scale of energy production, even though it is very likely that employment factors vary as specific technologies increase electricity generation. They estimate, for example, that Germany's jobs/GWh associated to wind and solar photovoltaic electricity production decreases as the generation increased between 2007 and 2011. Finally, they note that very few studies of renewables' employment potential have been carried out in emerging or developing countries.

Despite these limitations, Cameron and van der Zwaan (2015) note that most of the, still limited, available evidence points to higher employment factors in renewable compared to non-renewable energy sources.

This paper contributes to the debate on the employment creation associated to a transition towards low-carbon electricity production. It takes advantage of the historic trends on employment in the electricity sector and the renewable and fossil fuel-based electricity production to estimate the observed employment impact of electricity generation across the world. In doing so, the estimates provided in this paper expand the coverage and do not suffer the limitation of using the estimates of studies drawn for limited or specific countries to estimate employment impacts for the world. Rather, this paper draws on the observed energy and employment trends for each of more than 130 countries. To our knowledge, it is the first study to establish these relationships on a global scale.

It is important to note that changes in the production structure of electricity towards renewable energy sources do not only create jobs in the electricity sector (direct effects), but also produce effects in other sectors (indirect effects). Indeed, the electricity sector is linked to other economic sectors (WEF and IHS CERA, 2012). In the United Kingdom in 2010, for example, for each job created in the electric power generation, transmission and distribution sector, 5.27 jobs are created in other sectors, ranking 4th amongst 127 economic sectors (the extraction of crude petroleum and natural gas and mining of metal ores has the highest employment multiplier, at 10.1) (Wild, 2014). In Scotland, in 2013, the employment multiplier of the electricity sector was 2.5, ranking fifth among 98 sectors (Scottish Government, 2016). In the United States, each job created in the construction of new solar PV or wind facilities, two additional jobs are created in other sectors, and for each job created in the operation of wind for renewables, two additional jobs are created in other industries. These multipliers are somewhat similar to those associated to fossil-fuel based energy sources (WEF and IHS CERA, 2012).

Once the electricity is produced, the employment impact on downstream industries (those who rely on electricity) is likely to be similar whether the energy source is renewable or not. It may differ, however, in upstream industries, those which provide inputs to the energy sector. If these indirect effects associated to renewable energy sources are higher than those of fossil fuel-based energy sources, the economy-wide employment impacts would be even higher than those estimated by the direct effects on the electricity sector. If, by contrast, they are lower in renewables when compared to fossil-fuel based energy, the indirect effects may offset any positive direct employment effect. Given the relevance of indirect effects, we also estimate the employment multipliers for different energy sources at the global scale.

Similar indirect effects accrue for carbon emissions. Though it is clear that renewable sources for electricity generation have low, zero or potentially negative GHG emissions per GWh produced when compared to coal or natural gas, the provision of inputs has, itself, a carbon footprint. These indirect effects, associated to the construction and maintenance or provision of inputs to each energy source need to be accounted for to get a clear picture of the employment and environmental effects associated to the addition and increase of renewables to the energy mix.

This paper, thus, identifies the historical trends in employment and GHG emissions in the electricity sector, and explores the employment and GHG emissions multipliers for both renewable and fossil fuel-based energy sources for electricity generation.

3. Data and Methods

To estimate worldwide trends in employment in the electricity sector, this study combines employment data for the electricity sector (ISIC rev. 4 section D and ISIC rev. 3 section E) from ILO's Trends Econometric Models (ILO, 2017) with the total electricity generation from the Enerdata, Global Energy & CO_2 database (Enerdata, 2016) and the shares of generation by source from World Bank's World Development Indicators (WDI, World Bank, 2017). In particular, we use, for each country, their total electricity production from coal, natural gas, nuclear, hydroelectric and other renewables for every year since 2000 to 2014 and the employment in the electricity sector for that period.

We merge the employment and electricity-generation data to construct trends for the 15-year period covering 2000 to 2014[1] for 133 countries[2], for a total of 1 958 year-country observations.[3] This includes 46 developed and 87 emerging and developing countries.

We regress employment estimates for the NACE section E (for years 2000 to 2008) or D (for years 2009 to 2014) sector in country *c* and year *t* on electricity generation from fossil fuel-based technologies (*Coal*, *NGas*, *Oil*), from nuclear (*Nuclear*), from hydroelectric sources (*Hydro*) and from other renewable (*Ren*) energy sources. We add country fixed effects to control for time-invariant country characteristics (*Cntry*), and add a linear term for the year (*year*), to control for any general trends in employment in the sector. We also control for population, GDP and other variables to limit the impact of the break in the NACE definitions (*Control*, see below for more details). More systematically, we estimate:

$$Emp_{c,t} = \beta_1 Coal_{c,t} + \beta_2 NGas_{c,t} + \beta_3 Oil_{c,t} + \beta_4 Nuclear_{c,t} + \beta_5 Hydro_{c,t} + \beta_6 Ren_{c,t} + \sum_{g=1}^{G} \theta_g Control_g + \sum_{c=1}^{C} \varphi_c Cntry_c + \omega year_t + \varepsilon_{c,t}$$

Given this specification, estimates β_j represent the average increase (decrease) in employment in the electricity sector[4] associated with an increase in one GWh in electricity production from source *j*, after accounting for the general trends in the sector. It is possible that some coefficients are negative if additional generation from a particular source is more labour efficient and generates fewer employment than the general trend. It is also possible when this labour efficiency is such that it tends to replace labour inefficient GWh sources or if electricity generation from a particular energy source draws its labour from indirect effects (e.g. contracting services).

We estimate an equivalent model estimating GHG emissions from the electricity sector, to identify the energy sources that can simultaneously reduce GHG emissions and increase employment. Formally and following a similar specification, we estimate, for GHG emissions:

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1 The results presented in this paper hold if other shorter (e.g. 2008-2014) periods are considered (see Annex). Results also hold if longer (e.g. 1990-2014) periods are considered (results not shown). The current paper is based on the 15-year period between 2000 and 2014 to reduce the within-country variability which may increase the likelihood of country-specific omitted-variable bias as a result of the increased within-country variability in the sample.

2 133 countries include all countries with complete data on the employment, energy-source and controls used in the analysis. Suriname is excluded from the GHG models lost due to lack of GHG emissions data.

3 Some countries (Lybia, Montenegro, South Korea, Turkmenistan, Uzbekistan and Yemen) do not have all the information available for each of the 15 years between 2000 and 2014.

4 More accurately, employment in the electricity, gas, steam and hot water (air conditioning) supply sector.

$$GHG_{c,t} = \beta_1 Coal_{c,t} + \beta_2 NGas_{c,t} + \beta_3 Oil_{c,t} + \beta_4 Nuclear_{c,t} + \beta_5 Hydro_{c,t} + \beta_6 Ren_{c,t} + \sum_{g=1}^{G} \theta_g Control_g + \sum_{c=1}^{C} \varphi_c Cntry_c + \omega year_t + \varepsilon_{c,t}$$

This data and specification offers worldwide coverage and a long temporal horizon, but at the cost of three important issues.

First, the ISIC rev. 4 section D industry includes, in addition to electricity, gas, steam and air conditioning supply in the same section. Worldwide data is only available for the entire section, it being impossible to disaggregate between the section's different groups: 351 for electricity power generation, transmission and distribution, 352 for manufacture of gas, distribution of gaseous fuels through mains and 353 for steam and air conditioning supply. The models, then, assume that either all employment in the ISIC code D sector is related to electricity, that employment in the gas, steam and air conditioning supply are small compared to electricity, or – most likely – that trends for the gas, steam and air conditioning supply do not affect the relationship between electricity generation by source and employment in the sector.

Second, the ISIC classification available since 1990 (revision 3) was revised in 2002 (revision 3.1) and 2008 (revision 4). The shift from revision 3 to revision 3.1 does not affect the estimation of employment in the electricity sector as section E remains unchanged. The shift from revision 3 and 3.1 to revision 4, however, implies an important change. Table 1 describes the industry classification structure for the electricity generation sector. ISIC Rev.3 included, under Section E, electricity, gas, steam and water supply. ISIC Rev.4 eliminates water supply (and joins it with wastewater treatment in Section E). ISIC Rev.4 adds air conditioning supply to the electricity sector, which was not considered in ISIC Rev.3. The change in the definition affects our estimates if the trends in the water supply sector follows different trends than those that remained. We check the sensitivity of the results to this break in the series by estimating the models on those countries that implemented both definitions in the transition years and find that the overall conclusions shown here do not change.

Table 1: The electricity sector in the ISIC revisions 3, 3.1 and 4 industry classifications

Level	ISIC Rev.3	ISIC Rev.3.1	ISIC Rev.4
Section	E: Electricity, gas, steam and water supply	E: Electricity, gas, steam and water supply	D: Electricity, gas, steam and air conditioning supply
Division	40: Electricity, gas, steam and hot water supply	40: Electricity, gas, steam and hot water supply	35: Electricity, gas, steam and air conditioning supply
	41: Collection, purification and distribution of water	41: Collection, purification and distribution of water	
Groups	401: Production, collection and distribution of electricity	401: Production, collection and distribution of electricity	351: Electric power generation, transmission and distribution
	402: Manufacture of gas; distribution of gaseous fuels through mains	402: Manufacture of gas; distribution of gaseous fuels through mains	352: Manufacture of gas; distribution of gaseous fuels through mains
	403: Steam and hot water supply	403: Steam and hot water supply	353: Steam and air conditioning supply
	410: Collection, purification and distribution of water		

Source: (1990, 2002, 2008) (UN, 1990), 3.1 (UN, 2002) and 4 (UN, 2008).

Third, the electricity generation data does not distinguish between different electricity-generating technologies, particularly in the renewables sector, which are known to have different employment requirements (see, for example, Wei et al. 2010 or Cameron and van der Zwaan 2015).

To estimate the sensitivity of the world analysis to these and other limitations, we add controls for water and sanitation (the percentage of households with access to clean water and sanitation).

The results in the previous specification are limited to the direct employment effects of different electricity generation sources. Indirect employment effects are captured with the notion of multipliers and estimated using input-output tables and the Leontief inverse.[5] It signals the amount of jobs created in other, non-electricity, sectors (indirect) for each job created in the electricity sector (direct) (Miller and Blair, 2009).

We calculate worldwide employment multipliers for each energy source using Exiobase v3, a multi-regional input-output table (MRIO) (Tukker et al., 2013; Wood et al., 2014). Exiobase provides data for 2011 for 44 countries and the rest of the world in five different regions,[6] and 163 industries. Exiobase distinguishes production of electricity by coal, gas, nuclear, hydro, wind and other sources including biomass. It also includes, among others, satellite accounts for employment, enabling the calculation of employment multipliers and GHG emissions, enabling the calculation of direct and indirect emissions. The availability of employment and emissions accounts, the differentiation of electricity production by energy source and the multi-regional character of Exiobase enable the calculation of employment multipliers for the economy that created jobs in the electricity sector (e.g. the number of jobs created in non-coal-based-electricity in Spain for each coal-based electricity job created in the country) and also across borders (e.g. the number of jobs created in other countries for each coal-based electricity job created in Spain).[7]

Following standard practice in the calculation of multipliers (Bacon and Kojima, 2011; Miller and Blair, 2009), we estimate the employment multipliers by first estimating the Leontief inverse of the MRIO, which provides the output multipliers for each industry. Multiplying the employment vector for each industry with the Leontief inverse yields the indirect effects on employment associated to an increase in final demand. Given the units of the MRIO, this is an increase equivalent to one million euros worth of output. We calculate the employment multiplier effect as the ratio between the indirect and direct effects, yielding the number of jobs created in other industries, both within the country and outside.[8]

We follow a similar procedure to estimate emissions multipliers, by using the vector of GHG emissions available in Exiobase's environmental accounts.

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5 We limit the estimation to Type 1 multipliers since we focus on direct and indirect effects only and do not explore induced effects which are caused by the added endogeneity of household behaviour.

6 As a multi-regional input-output table, Exiobase provides a model for the world economy. The within-country industry-by-industry transactions are mapped, alongside industry-by-industry trade across all countries and regions in the table. The table includes country-specific data for each EU-28 country, the United States, Japan, China, Canada, Korea, Brazil, India, Mexico, the Russian Federation, Australia, Switzerland, Turkey, Taiwan, Norway, Indonesia and South Africa. The table distinguishes the Rest of the World into five different regions: Asia and the Pacific, Latin America and the Caribbean, Europe, Africa and the Middle East.

7 Simas (2014) provides more details on the methodology and data sources to estimate the sector-specific employment in Exiobase.

8 Wiebe (2018) provides a detailed account of the use of Exiobase to estimate direct and indirect employment effects.

4. Results

4.1 Trends in employment in the electricity sector: 2000-2014

In the 15-year period between 2000 and 2014, world electricity output increased by 54%, from 15,158 TWh to 23,635 TWh (one TWh is equivalent to one thousand GWh). This global growth is driven almost exclusively by developing and emerging countries. Electricity production more than doubled (132% increase) in developing and emerging economies; it increased by 12% in developed economies. Globally, total output from coal, natural gas, hydro and renewables increased, with little change observed in nuclear and an 18% decline oil-based electricity (Table 2).

The growth in coal masks a decline of 10% of this energy source in developed countries. Electricity generation from coal has been largely substituted by natural gas (production up by 72%) and, to a lesser extent, renewables (production up by 471%) (Houser et al., 2017). Electricity generation more than doubled in developing and emerging countries, led by more coal (up 187%), natural gas (up 110%), and hydro-based energy sources (up 95%). Renewables increased dramatically, by 564% from 2000 to 2014, albeit from a very small base (Table 2).

Table 3 shows that the share of coal-based electricity increased from 39% of total worldwide electricity production in 2000 and 41% in 2014, masking a decline in developed countries of seven percentage points. Electricity production from renewables, in turn, increased from practically zero in 2000 to 6% in 2014. Owing to the growth in coal in developing countries and natural gas globally, and to a small extent, hydro and renewables, and to their specific decline, the share of nuclear and oil in electricity production decreased by seven and six percentage points, respectively, during the period.

Table 2 and Table 3 highlight an important change in the sources of energy for electricity production. In parallel, modes of production and global linkages have affected how and where electricity is generated. The coal industry, for example, has experienced rising automation, overcapacity, industry consolidation, regional shifts and the substitution by natural gas which has resulted in job losses in the sector (IRENA, 2017). It is not impossible, then, that additional generation from fossil-fuel related sources has led to job losses, as a result of the increased productivity of the sector.

Table 2: Total electricity generation by energy source, 2000-2014, TWh

	World			Developed			Developing		
	2000	2014	Δ%	2000	2014	Δ%	2000	2014	Δ%
Coal	5 913	9 569	61.8	3 764	3 391	-9.9	2 149	6 178	187.4
Oil	1 175	963	-18.0	668	469	-29.9	506	495	-2.3
Natural Gas	2 715	5 067	86.6	1 658	2 843	71.5	1 057	2 225	110.4
Nuclear	2 570	2 508	-2.4	2 273	1 991	-12.4	297	518	74.2
Hydroelectric	2 571	3 837	49.3	1 304	1 367	4.9	1 267	2 470	94.9
Renewable	214	1 420	564.3	168	962	471.4	45	458	908.7
Total	**15 158**	**23 365**	**54.1**	**9 836**	**11 022**	**12.1**	**5 322**	**12 343**	**131.9**
N countries	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*	*133*

Note: Data for 133 countries. Totals considering all countries with available electricity generation information available in the Appendix. One TWh is equivalent to 1000 GWh.
Source: Own calculation based on World Development Indicators and Enerdata, Global Energy & CO_2.

Table 3: Shares of electricity generation by energy source, 2000-2014, per cent

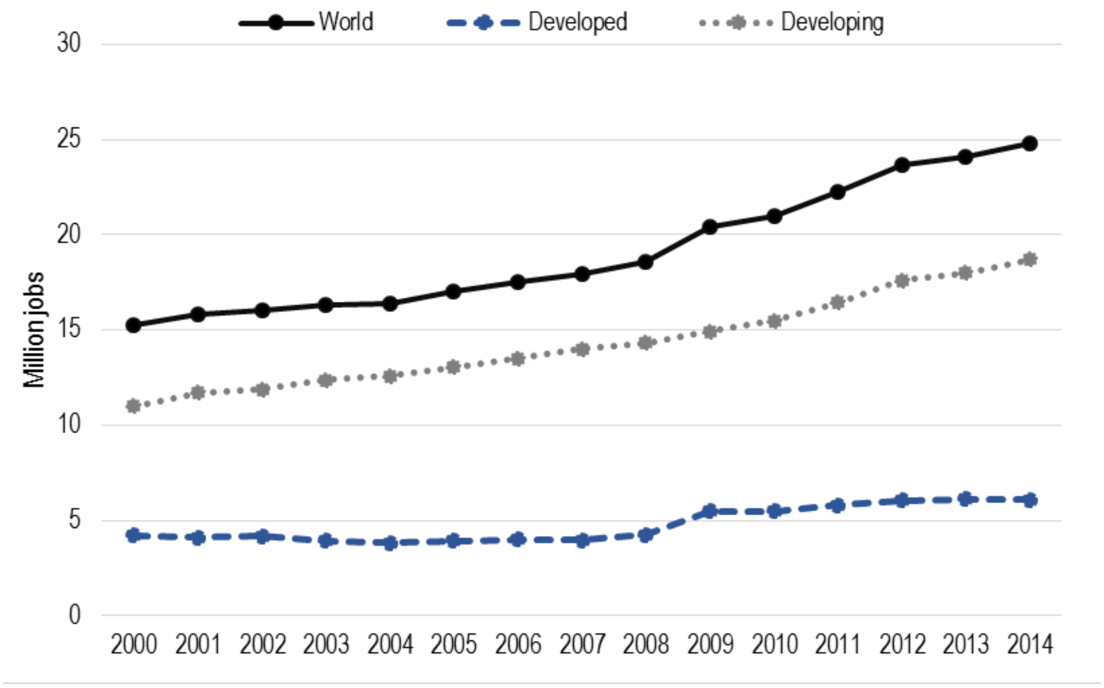
	World		Developed		Developing	
	2000	2014	2000	2014	2000	2014
Coal	39	41	38	31	40	50
Oil	8	4	7	4	10	4
Natural Gas	18	22	17	26	20	18
Nuclear	17	11	23	18	6	4
Hydroelectric	17	16	13	12	24	20
Renewable	1	6	2	9	1	4
Total	**100**	**100**	**100**	**100**	**100**	**100**
N countries	*133*	*133*	*133*	*133*	*133*	*133*

Note: Data for 133 countries. Totals considering all countries with available electricity generation information available in the Appendix.
Source: Own calculation based on World Development Indicators and Enerdata, Global Energy & CO2.

Over this same 15-year period, employment in the electricity generation sector increased by more than 63%. Slightly more than 15 million jobs existed worldwide in the sector in 2000; by 2014, almost 25 million people were employed in the electricity generation sector (NACE section D). (Note that, as discussed earlier, the NACE industry category includes electricity generation alongside heat, steam, water and sanitation and air condition and that there is a break in the series in 2008). Employment growth is driven, almost exclusively, by a practically constant growth in developing and emerging economies, adding, on average, 534 800 jobs a year to the sector.[9]

[9] Figure 1 provides estimates for the 133 countries with employment, energy-source and GDP data. The appendix provides a comparable figure for the 181 countries with available employment data. It suggests that 25.6 million people were employed in the sector in 2014, up from 15.8 million people in 2000.

Figure 1: Employment in the electricity sector, 2000-2014, total, million jobs



Note: Total employment in the NACE rev. 3 and rev.3.1 section E sector (between 2000 and 2008) and the NACE rev.4 section D sector (between 2008 and 2014). See Table 1 and the respecting discussion on the scope of the industries considered and the change between NACE rev.3, rev.3.1 and rev.4. Data for 133 countries. Totals considering all countries with available employment available in the Annex.
Source: Own calculation based on ILO Trends Econometric Models.

Total employment trends, however, do not say much about how changes in the electricity production sector – and growth in generation by specific energy-source relate to employment. Table 4 shows the results of a country-fixed effects regression model relating employment in the electricity sector to electricity generated by different energy sources between 2000 and 2014, for the world, developed and developing/emerging countries.

Regression results show that, worldwide, additional generation from renewables, by contrast, has been related to the highest job per TWh generated when compared to other energy sources. Net of the average growth of the sector – 2.2 jobs per year and 0.0002 per unit GDP – for each TWh generated from non-hydro renewable sources, an average of 1.6 jobs have been created in the electricity sector in each country.

Each additional TWh produced from coal, oil and natural gas create comparatively fewer jobs on a worldwide scale, at 0.6, 0.1 and 0.3 jobs over the global average trend. Electricity from hydroelectric power tends to be associated with fewer jobs in the sector, probably the result of the low labour requirements associated to the large-scale hydroelectric power-based electricity (Wei et al., 2010).

In developed countries, only generation in non-hydro renewables is related to employment growth in the electricity sector between 2000 and 2014 over and above the general trend. Each TWh generated by natural gas, hydroelectric power, nuclear power and coal in developed countries is associated to fewer jobs created than the average between 2000 and 2014. This is probably the result of the fact that any increase in generation in developed countries has been through more efficient modes of production.

This is the case for natural gas, for example, which is associated to 0.1 fewer jobs per additional TWh. Indeed, natural gas generates electricity at a much lower labour intensity when compared to coal (Houser et al., 2017).

In developing and emerging countries, coal and natural gas have also created more jobs than the average trend (at roughly an average of 0.4 jobs per TWh of additional generation), but far below the employment creation associated to the increased generation from renewables, at an average of 12 jobs/ initial TWh with diminishing effects such that job creation becomes null when generation reaches 324 TWh (-3.70E-08 x 324 324 = 0.012). Nuclear energy in developing and emerging countries seems particularly job-friendly, but this result is driven by the fact that only 13 developing and emerging countries had nuclear energy with large investments made by a small subset of countries.[10]

Table 4: Employment in the electricity sector by energy source, 2000-2014.

	World	Developed	Emerging/Developing
	Employment	Employment	Employment
Coal	0.000572***	-2.78e-05	0.000304***
	(0.000145)	(0.000242)	(0.000105)
Oil	-8.83e-05	-0.000212	-0.00127
	(0.000221)	(0.000431)	(0.000808)
Natural Gas	-0.000288	-0.000711*	-7.24e-05
	(0.000429)	(0.000367)	(0.000779)
Nuclear	-0.000608*	-0.00107***	0.0115***
	(0.000317)	(0.000230)	(0.00352)
Hydro	-0.000800	-0.000722**	-0.00135
	(0.000677)	(0.000307)	(0.00104)
Renewables	0.00161**	0.00144***	0.00166
	(0.000679)	(0.000255)	(0.00176)
Year	2.209***	2.994***	0.574
	(0.711)	(0.957)	(0.837)
Sanitation	0.0873	0.918	0.862
	(1.078)	(5.955)	(1.028)
Water	-0.883	2.929	-0.637
	(0.905)	(7.979)	(1.108)
GDP	0.000163	-0.000795	0.00205
	(0.000628)	(0.000484)	(0.00173)
Total Population	0.00199***	7.80e-05	0.00200***
	(0.000169)	(0.00477)	(0.000156)

[10] This result is driven mainly by the Russian Federation. Excluding the Russian Federation from the analysis cuts the estimate for nuclear energy in half. The only other countries with electricity production from nuclear power in developing and emerging countries between 2000 and 2014, with the respective percentage of total nuclear electricity production in 2014 in parenthesis were Ukraine (48.6), Bulgaria (33.8), Armenia (31.8), Romania (17.9), the Russian Federation (17.0), South Africa (5.5), Pakistan (4.8), Argentina (4.1), Mexico (3.2), India (2.8), Brazil (2.6), China (2.3) and, since 2011, Iran (1.6).

Constant	10.68 (95.95)	-188.2 (429.0)	-105.1 (99.63)
Country FE	*YES*	*YES*	*YES*
R-squared	*0.751*	*0.565*	*0.859*
No. countries	*133*	*46*	*87*
No. Observation	*1958*	*694*	*1264*

* $p<0.05$, ** $p<0.01$, *** $p<0.001$.
Notes: Robust standard errors in parenthesis. Coefficients for coal, oil, natural gas, nuclear, hydro and renewables refer to the impact on employment in the electricity sector associated to a one-GWh increase in generation net of yearly growth. The dependent variable is the country and year-specific total employment in the NACE rev. 3 and rev.3.1 section E sector (between 2000 and 2008) and the NACE rev.4 section D sector (between 2008 and 2014). See Table 1 and the respecting discussion on the scope of the industries considered and the change between NACE rev.3, rev.3.1 and rev.4. The percentage of people with access to water and sanitation are included as controls for changes in employment in the water and sanitation subsector of the NACE rev.3 and rev.3.1 section E sector and the fact that the NACE rev.4 sections D and E are combined in the ILO Trends Econometric Models between 2009 and 2014. Data for 133 countries.
Source: Own calculation based on ILO Trends Econometric Models, World Development Indicators and Enerdata, Global Energy & CO_2.

Table 5 analyses GHG emissions from the electricity sector as related to increase in generation from different energy sources. Predictably, additional electricity generation from fossil-fuel based industries is related to higher GHG emissions than the average trend. A GWh from fossil fuel-based sources in developing and emerging economies is related to higher emissions than in the developed world, probably as a result of less efficient technology being used. Additional electricity generation from hydroelectric sources is related to increases in GHG emissions in developing countries, which may be the result of the emissions related to the construction and maintenance of facilities. Importantly, additional electricity generation from renewables is related to fewer emissions, which may be the result of the CO_2 sequestration potential associated to biomass power (but which may not result in general sequestration as biomass does not create additional sequestration potential if biomass for energy replaces agricultural-sector production).

Table 5: GHG emissions from the electricity sector by energy source, 2000-2014.

	World	Developed	Emerging/Developing
	CO2	CO2	CO2
Coal	0.00107***	0.000880***	0.00109***
	(1.72e-05)	(8.16e-05)	(2.28e-05)
Oil	0.000740***	0.000782***	0.00122***
	(0.000121)	(0.000115)	(0.000250)
Natural Gas	0.000486***	0.000368***	0.000480***
	(7.74e-05)	(7.09e-05)	(9.65e-05)
Nuclear	-7.38e-05	-5.73e-05	0.000531
	(5.24e-05)	(5.36e-05)	(0.000771)
Hydro	-2.74e-06	-0.000292	0.000451***
	(7.81e-05)	(0.000315)	(0.000110)
Renewables	-0.000621	-0.000239*	-0.00308***
	(0.000449)	(0.000128)	(0.000428)
Year	0.329*	0.743***	-0.230
	(0.167)	(0.243)	(0.140)
Sanitation	-0.272	-2.125**	-0.266
	(0.219)	(0.918)	(0.239)
Water	-0.240	1.817	0.0428
	(0.167)	(1.454)	(0.197)
GDP	7.01e-05	-2.11e-05	0.000382
	(9.17e-05)	(7.84e-05)	(0.000334)
Total Population	0.000203*	-0.000548	0.000340***
	(0.000118)	(0.000443)	(5.09e-05)
Constant	36.48**	84.12	-14.07
	(16.43)	(77.62)	(15.35)
Country FE	*YES*	*YES*	*YES*
R-squared	*0.989*	*0.922*	*0.996*
No. countries	*132*	*46*	*86*
No. observations	*1792*	*626*	*1166*

*p<0.05, **p<0.01, ***p<0.001.

Notes: Robust standard errors in parenthesis. Coefficients for coal, oil, natural gas, nuclear, hydro and renewables refer to the impact on employment in the electricity sector associated to a one-GWh increase in generation above and net of yearly growth. The dependent variable is the country and year-specific total employment in the NACE rev. 3 and rev.3.1 section E sector (between 2000 and 2008) and the NACE rev.4 section D sector (between 2008 and 2014). See Table 1 and the respecting discussion on the scope of the industries considered and the change between NACE rev.3, rev.3.1 and rev.4. The percentage of people with access to water and sanitation are included as controls for changes in employment in the water and sanitation subsector of the NACE section E sector and the fact that the NACE rev.4 sections D and E are combined in the ILO Trends Econometric Models between 2009 and 2014. Data for 132 countries.
Source: Own calculation based on ILO Trends Econometric Models, World Development Indicators and Enerdata, Global Energy & CO_2.

The appendix provides estimates for employment, broken down for the period before and after the break in the NACE definitions. The results remain largely the same, signalling that the break in the series does not bias the results in Table 4.

4.2 Employment and emissions multipliers within and across borders

The results in the previous section are limited to the direct employment effects of different electricity generation sources. They speak to the number of jobs created in the electricity sector for each GWh increase in generation by source. But the electricity sector is linked to other economic sectors (WEF and IHS CERA, 2012), with comparatively large multipliers observed in the United Kingdom (Wild, 2014), the European Union (Stehrer and Ward, 2012) and Malta (Cassar, 2015), for example.

A shift in the production of electricity towards renewables will affect other industries, as the input structure for electricity generation will change. Once the electricity is produced, the employment impact on downstream industries (those who rely on electricity) are likely to be similar whether the energy source is renewable or not. They may differ, however, in upstream industries - those which provide the input to the energy sector. Renewables like wind or solar may require fewer employment in the form of support and maintenance services, when compared to coal or natural gas, which support the mining sector and transportation jobs that provide the raw material. In this case, the overall and positive employment effects of renewables seen in the previous section may be offset by the employment effects in other industries. These indirect effects can be calculated in the form of employment multipliers, which portray the number of jobs in other industries associated to demand growth in one specific industry. It can be interpreted as the indirect effects of job creation in a particular sector (e.g. the number of jobs created in other sectors of the economy following a one-million EUR increase in demand for wind power electricity generation).

Garret-Peltier (2017) estimates the multiplier effects for fossil-fuel-based and renewable energy sources in the United States. She finds that a USD 1 million increase in the renewable energy sector creates 7.5 full-time equivalent jobs across the entire economy. In comparison, a USD 1 million increase in resource efficiency creates 7.7 jobs and such an investment in fossil-fuel based energy supports 2.7 jobs.

Table 6 shows estimates for the multiplier effects for different energy sources across the different countries and regions in Exiobase for the 2011 reference year. Indirect effects distinguish between the indirect effects in the local economy (e.g. the effect of an additional job in coal-based electricity generation in Italy on other Italian sectors), and the indirect effects in other economies (e.g. the effect of an additional job in coal-based electricity generation in Italy on jobs in other countries).

Results suggest that the indirect employment multipliers for the non-hydro renewable-based electricity sector are higher than fossil-fuel based electricity in 10 of the 15 largest economies and have higher cross-border multipliers in 11 of the 15 largest economies. Non-hydro renewables stimulate more employment locally (a finding that is consistent with Garrett-Peltier, 2017) and more employment internationally when compared to fossil fuel-based energy sources.[11]

[11] Given the specificities of Exiobase and other data sources, multipliers calculated from it may not necessarily compare to multipliers calculated with other data sources, which may explain why specific results shown here compare to those estimated by Garrett-Peltier (2017). Tukker et al. (2013), Wood et al. (2014) and Simas et al. (2014) provide details on the construction of Exiobase and the employment estimates.

Table 6: Employment multipliers for the energy sector by selected energy sources, selected countries and regions, 2011

	Indirect local employment effect												Indirect cross-border employment effect											
	Coal	NGas	Nuclr	Hydro	Wind	Petr+	Bio+	SolarP	SolarT	Tide+	Geot	NEC	Coal	NGas	Nuclr	Hydro	Wind	Petr+	Bio+	SolarP	SolarT	Tide+	Geot	NEC
Australia	2.5	2.7	0.0	1.1	0.6	0.7	0.1	0.0	0.0	0.0	0.0	0.0	14.8	36.3	0.0	27.8	44.4	57.9	94.5	68.7	79.7	0.0	75.8	75.8
Brazil	31.8	23.5	14.7	1.4	38.1	27.4	12.5	0.0	0.0	0.0	0.0	43.0	11.2	15.7	5.9	1.3	10.4	21.4	5.3	0.0	0.0	0.0	0.0	20.2
Canada	2.0	6.0	1.4	1.3	1.1	1.8	1.3	0.4	0.0	0.3	0.0	0.9	7.6	15.0	5.9	2.1	27.5	36.7	29.6	52.8	0.0	57.3	0.0	44.5
China	31.9	7.3	18.9	22.1	22.3	14.9	2.2	2.5	0.4	0.4	5.2	19.6	7.5	88.4	9.9	5.3	11.7	54.2	117.5	103.1	30.7	30.7	52.4	33.9
France	6.8	3.1	3.1	5.6	6.0	5.5	7.2	7.8	0.0	8.4	0.0	7.6	31.2	52.2	2.7	5.7	10.0	41.5	21.4	27.9	0.0	42.7	0.0	32.5
Germany	5.6	8.4	2.9	3.8	4.1	9.0	6.0	4.5	0.0	0.0	0.3	6.1	7.8	8.4	2.6	7.2	4.0	16.2	5.9	6.3	0.0	0.0	60.5	9.5
Great Britain	5.1	2.0	3.1	3.3	4.3	2.7	4.8	2.6	0.0	0.0	0.0	2.7	11.1	3.2	5.7	25.2	13.9	23.1	20.8	51.0	0.0	0.0	0.0	48.6
India	28.8	39.5	7.4	8.7	10.2	30.7	0.8	0.8	0.0	0.0	0.0	0.7	6.1	17.0	17.1	6.9	24.8	35.3	98.3	66.0	0.0	0.0	0.0	61.9
Italy	6.1	6.8	0.0	5.4	4.6	6.5	6.7	5.4	0.0	0.0	4.5	4.9	15.9	11.3	0.0	7.5	12.9	15.0	15.1	11.3	0.0	0.0	17.6	22.2
Japan	1.5	6.7	4.5	6.9	4.4	5.9	8.2	4.8	0.0	0.0	4.8	7.4	77.4	7.7	3.9	6.6	21.9	9.5	7.1	22.0	0.0	0.0	18.3	10.3
Korea	8.7	7.8	5.6	8.9	7.6	8.4	9.9	7.8	0.0	0.0	0.0	8.7	19.1	32.5	6.1	40.1	59.3	28.7	50.6	59.1	0.0	0.0	0.0	30.3
Mexico	7.0	13.8	16.9	13.3	23.7	32.7	25.0	31.8	0.0	0.0	26.7	16.7	52.6	8.6	18.3	9.8	37.4	15.6	35.0	11.7	0.0	0.0	22.5	51.4
Russian Fed.	21.0	19.8	4.9	7.1	30.1	19.7	4.1	0.0	0.0	0.0	3.8	6.0	23.0	17.0	18.2	19.2	32.4	49.2	107.0	0.0	0.0	0.0	74.3	87.1
Spain	5.4	7.1	2.0	3.0	3.1	2.4	4.2	2.7	0.9	0.0	0.0	1.2	14.4	11.5	3.2	5.8	5.1	16.5	17.4	12.7	30.7	0.0	0.0	32.2
United States	1.3	6.2	0.8	1.8	4.3	15.9	7.2	59.6	115.4	0.0	23.2	59.6	0.6	1.6	0.3	0.7	1.4	9.2	1.7	15.8	34.6	0.0	7.1	18.2
RoW-Asia and the Pacific	115.4	113.9	19.3	31.3	13.4	31.2	16.6	21.6	0.0	0.0	15.1	10.7	26.9	20.2	63.1	23.4	67.7	41.4	80.8	69.3	0.0	0.0	69.0	68.2
RoW-L. America & the Caribbean	17.5	23.8	9.7	8.6	11.6	25.2	13.8	0.2	0.0	0.0	11.3	16.6	17.6	16.2	17.7	4.4	27.7	14.7	29.4	37.5	0.0	0.0	28.0	23.7
RoW-Europe	151.0	157.6	44.2	66.5	148.9	69.3	182.7	0.6	0.0	0.0	30.9	22.3	14.1	46.5	9.8	18.2	35.1	45.2	41.5	40.5	0.0	0.0	41.6	50.6
RoW-Africa	129.8	68.9	0.0	59.9	155.0	95.1	105.8	116.8	0.0	0.0	71.6	0.0	29.2	7.7	0.0	11.0	49.2	18.0	56.4	22.6	0.0	0.0	35.7	0.0
RoW-Mid. East	3.8	5.3	0.2	2.5	5.3	4.3	11.3	0.2	0.0	0.0	0.0	0.5	18.5	3.0	72.5	22.3	72.2	6.8	39.6	76.9	0.0	0.0	0.0	74.3

Note: The interpretation of the indirect employment multiplier is such that, for each million EUR of increased demand in each energy sector, an additional number of jobs equivalent to the size of the multiplier are created in other economic sectors in the country or region (local) or in other countries or regions (cross-border). The full array of countries and energy sources is available in the Annex. Only the countries with a total GDP among the 15-highest in the world are listed, alongside the rest-of-the-world regions as defined in Exiobase.

Source: Own calculation based on Exiobase v3.

Table 7: GHG emissions multipliers for the energy sector by selected energy sources, countries and regions, 2011

	Indirect local GHG emissions effect											
	Coal	NGas	Nuclr	Hydro	Wind	Petr+	Bio+	SolarP	SolarT	Tide+	Geot	NEC
Australia	2'572'174	1'763'077	0	59'118	13'838	10'457	3'008	2'102	2'452	0	2'338	2'320
Brazil	160'470	806'843	73'324	19'028	155'355	766'732	105'573	0	0	0	0	628'573
Canada	534'889	4'072'252	33'353	26'064	66'751	96'946	76'979	77'725	0	76'819	0	86'453
China	2'039'895	741'741	207'356	403'262	272'667	210'937	33'815	32'035	5'118	5'123	88'129	281'161
France	335'478	92'160	59'231	88'016	89'119	115'974	148'112	106'526	0	137'720	0	137'041
Germany	765'949	284'492	53'819	52'891	72'480	148'184	132'326	76'065	0	0	4'954	100'951
Great Britain	1'548'634	779'923	257'215	23'093	210'073	413'816	246'309	16'348	0	0	0	17'330
India	1'117'646	667'221	21'348	46'574	31'575	159'494	6'525	6'831	0	0	0	6'054
Italy	187'989	489'774	0	95'958	76'281	123'550	105'604	89'581	0	0	71'790	86'013
Japan	86'765	472'694	340'306	150'570	25'739	346'702	460'601	30'889	0	0	86'287	213'641
Korea	999'334	993'714	77'162	169'778	142'641	151'690	176'969	146'336	0	0	0	737'357
Mexico	35'005	157'642	106'449	224'359	131'433	569'477	131'553	253'962	0	0	152'262	121'631
Russian Fed.	335'829	271'101	62'872	72'147	318'205	194'354	53'546	0	0	0	42'630	63'277
Spain	578'472	380'490	81'154	106'587	118'373	53'196	83'486	68'524	4'764	0	0	6'894
United States	12'642	2'287'689	6'260	13'172	31'173	120'618	51'636	381'792	570'341	0	156'721	377'742
RoW-Asia and the Pacific	1'297'660	1'998'033	45'897	104'912	37'664	100'554	43'271	78'215	0	0	46'078	34'412
RoW-L. America & the Caribbean	71'985	148'547	45'863	43'954	63'146	124'292	60'408	2'098	0	0	76'160	82'490
RoW-Europe	876'632	1'601'634	152'239	259'563	1'214'173	144'420	1'165'877	2'327	0	0	53'773	41'877
RoW-Africa	383'070	896'215	0	191'777	606'763	570'090	311'044	335'905	0	0	156'065	0
RoW-Mid. East	275'601	1'268'588	27'837	154'067	298'975	905'626	951'017	28'117	0	0	0	60'347

	Indirect cross-border GHG emissions effect											
	Coal	NGas	Nuclr	Hydro	Wind	Petr+	Bio+	SolarP	SolarT	Tide+	Geot	NEC
Australia	161'742	343'477	0	314'457	479'450	623'487	668'653	741'756	942'729	0	838'923	822'952
Brazil	263'240	678'010	173'068	49'410	305'583	1'103'748	271'911	0	0	0	0	1'577'380
Canada	122'934	765'892	87'505	32'656	390'479	525'210	419'894	600'906	0	481'238	0	583'482
China	225'131	3'119'974	194'291	100'905	243'636	1'400'884	680'948	887'238	142'425	142'425	440'082	886'352
France	661'313	330'852	50'344	130'063	296'123	523'711	351'733	921'274	0	1'241'293	0	874'593
Germany	330'648	201'736	56'583	220'524	96'925	548'529	137'080	176'926	0	0	351'514	287'702
Great Britain	994'957	185'101	92'178	238'765	165'258	305'046	233'264	428'362	0	0	0	425'210
India	611'050	280'153	185'302	87'408	305'663	443'655	652'216	708'124	0	0	0	608'258
Italy	2'254'595	222'366	0	172'832	272'853	449'468	399'455	233'813	0	0	379'296	745'605
Japan	298'824	300'542	37'357	99'336	277'380	516'685	86'362	281'974	0	0	194'699	159'899
Korea	2'306'897	6'254'569	99'177	604'581	824'042	1'240'289	733'252	822'948	0	0	0	1'359'320
Mexico	1'440'288	3'206'916	329'375	204'657	632'755	1'275'841	629'272	1'164'607	0	0	435'665	758'627
Russian Fed.	164'102	192'901	130'316	136'400	321'332	346'436	704'654	0	0	0	701'951	626'365
Spain	545'203	217'704	64'148	133'675	106'917	828'609	318'159	211'804	412'849	0	0	442'724
United States	21'853	47'880	9'264	20'437	33'763	428'132	26'870	304'690	846'496	0	172'963	440'073
RoW-Asia and the Pacific	598'492	838'375	1'118'576	451'151	1'196'486	1'114'435	1'193'123	1'197'173	0	0	1'145'062	1'202'001
RoW-L. America & the Caribbean	449'429	447'832	403'427	123'473	582'514	454'917	495'151	259'625	0	0	744'581	602'091
RoW-Europe	259'306	1'398'656	133'157	237'750	520'980	781'276	718'101	274'174	0	0	614'941	808'107
RoW-Africa	602'844	170'793	0	233'842	1'402'420	555'004	1'121'238	507'966	0	0	955'794	0
RoW-Mid. East	209'469	44'144	1'024'258	268'304	1'068'453	148'627	604'579	1'065'072	0	0	0	1'101'531

Note: The interpretation of the indirect GHG emissions multiplier is such that, for each million EUR of increased demand in each energy sector, an additional (kg CO2-eq) GHG emissions equivalent to the size of the multiplier are created in other economic sectors in the country or region (local) or in other countries or regions (cross-border). The full array of countries and energy sources is available in the Annex. Only the countries with a total GDP among the 15-highest in the world are listed, alongside the rest-of-the-world regions as defined in Exiobase.

Source: Own calculation based on Exiobase v3.

5. Conclusions

The decarbonisation of electricity production is a key step to mitigate climate change; around 25 per cent of GHG emissions coming from fuel input to electricity and heat production (IEA, 2016). Relying on CO2-neutral energy sources to produce electricity can reduce global GHG emissions. Countries committed to specific targets along these lines in their Nationally Determined Contributions in the COP21 Paris Agreement. Changing the energy mix in electricity production will necessarily reallocate electricity generation away from the most emitting source (e.g. coal) to either less emitting sources (e.g. natural gas) or to carbon-neutral sources (e.g. nuclear, hydro and non-hydro renewables). Employment will naturally follow.

The effects of such a transition on employment have been discussed, evidence suggesting favourable employment outcomes associated to generation from non-hydro renewables (e.g. solar photovoltaic and wind). This evidence, however, tends to rely on a handful of empirical papers or scenarios (Cameron and van der Zwaan, 2015). This paper provides alternative – and complementary – evidence to previous findings by linking decades-long trends in employment in the electricity generation sector to the sources of electricity generation itself and by analysing the indirect linkages. Results show that increases in generation from non-hydro renewables favour employment in the electricity sector, with important differences observed in developed and developing countries. Non-hydro renewables offer higher indirect employment effects as well.

Some limitations need to be considered in interpreting these results. First, the linkage between employment and electricity generation used in this paper is indirect, as data on the specific sub-sector employment trends are not available. Second, this paper speaks to overall jobs impact of additional electricity generation, ignoring the distributional impacts of replacing current fossil-fuel based electricity generation away from fossil fuels. These distributional impacts on employment, modelled by the ILO in its World Employment and Social Outlook (2018), will be important and will require support for displaced workers, through training, for example (Louie and Pearce, 2016). Fourth, this paper speaks only to absolute job numbers, but says nothing about job quality, primarily as a result of the dearth of world job quality indicators at the industry level. Houser et al. (2017) notes how jobs related to the coal industry – and coal mining in particular – are different from those opened by the solar PV electricity generation, offering, for example, lower average wages. Finally, this paper offers results at the world level and country-specific trajectories may differ. Further research should explore how this shifting energy matrix has played out for employment and job quality at the country level, with particular attention to developing countries.

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Appendix

Table 8: Total electricity generation by energy source, 2000-2014, all countries, TWh

	World			Developed			Developing		
	2000	2014	Δ%	2000	2014	Δ%	2000	2014	Δ%
Coal	5942	9604	61.6	3784	3423	-9.5	2158	6181	186.4
Oil	1188	969	-18.5	669	469	-29.9	520	500	-3.8
Natural Gas	2749	5102	85.6	1682	2863	70.2	1067	2239	109.9
Nuclear	2570	2508	-2.4	2273	1991	-12.4	297	518	74.2
Hydroelectric	2609	3876	48.6	1328	1392	4.8	1280	2484	94.0
Renewable	217	1430	558.0	172	972	465.3	45	458	908.7
Total	**15276**	**23490**	**53.8**	**9909**	**11110**	**12.1**	**5367**	**12379**	**130.7**

Note: Data for 137 countries. One TWh is equivalent to 1 000 GWh.
Source: Own calculation based on World Development Indicators and Enerdata, Global Energy & CO_2.

Table 9: Shares of electricity generation by energy source, 2000-2014, all countries per cent

	World		Developed		Developing	
	2000	2014	2000	2014	2000	2014
Coal	39	41	38	31	40	50
Oil	8	4	7	4	10	4
Natural Gas	18	22	17	26	20	18
Nuclear	17	11	23	18	6	4
Hydroelectric	17	16	13	13	24	20
Renewable	1	6	2	9	1	4
Total	**100**	**100**	**100**	**100**	**100**	**100**

Note: Data for 137 countries.
Source: Own calculation based on World Development Indicators and Enerdata, Global Energy & CO2

Table 6: Employment in the electricity sector by energy source, 2000-2008.

	World Employment	Developed Employment	Emerging/Developing Employment
Coal	0.000571***	-7.00e-05	0.000382***
	(4.96e-05)	(0.000221)	(0.000114)
Oil	-0.000500	-0.000389	4.08e-05
	(0.00111)	(0.000700)	(0.00118)
Natural Gas	-0.000207	0.000174	0.00121**
	(0.000910)	(0.000343)	(0.000516)
Nuclear	0.000213	0.000355	0.00583
	(0.000590)	(0.000243)	(0.00371)
Hydro	4.48e-05	-0.000216	6.19e-05
	(0.000428)	(0.000287)	(0.000603)
Renewables	-0.00150	0.000757*	0.00330
	(0.00205)	(0.000415)	(0.00480)
Year	1.321*	3.297***	0.230
	(0.786)	(0.999)	(0.739)
Sanitation	0.644	2.973	0.0588
	(1.579)	(4.350)	(1.535)
Water	0.558	-0.385	1.184
	(1.298)	(6.041)	(1.340)
GDP	-8.77e-05	-0.00143**	-0.000596
	(0.000667)	(0.000668)	(0.00144)
Total Population	0.000447*	-0.01000**	0.000127
	(0.000257)	(0.00461)	(0.000407)
Constant	-42.10	276.3	-23.95
	(72.61)	(417.8)	(81.64)
Country FE	*YES*	*YES*	*YES*
R-squared	*0.649*	*0.488*	*0.830*
No. countries	*133*	*46*	*87*
No. Observation	*1172*	*409*	*763*

*p<0.05, **p<0.01, ***p<0.001.

Notes: Robust standard errors in parenthesis. Coefficients for coal, oil, natural gas, nuclear, hydro and renewables refer to the impact on employment in the electricity sector associated to a one-GWh increase in generation. The dependent variable is the country and year-specific total employment in the NACE rev. 3 and rev.3.1 section E sector. The percentage of people with access to water and sanitation are included as controls for changes in employment in the water and sanitation subsector of the NACE rev.3 and rev.3.1 section E sector. Data for 133 countries.

Source: Own calculation based on ILO Trends Econometric Models, World Development Indicators and Enerdata, Global Energy & CO_2.

Table 7: Employment in the electricity sector by energy source, 2009-2014.

	World Employment	Developed Employment	Emerging/Developing Employment
Coal	0.000201*	0.000104	6.45e-05
	(0.000102)	(0.000157)	(6.57e-05)
Oil	3.42e-05	3.39e-05	-0.00119**
	(0.000324)	(7.75e-05)	(0.000583)
Natural Gas	-0.000295	-0.000153	-0.00221**
	(0.000208)	(0.000151)	(0.000873)
Nuclear	-0.000798***	-0.000842***	0.00919***
	(0.000129)	(0.000120)	(0.00325)
Hydro	0.000246	-6.99e-05	-0.00101
	(0.000261)	(0.000230)	(0.000695)
Renewables	-5.61e-05	-0.000548	0.00126
	(0.000261)	(0.000387)	(0.00174)
Year	-0.407	0.364	-0.698
	(1.141)	(0.580)	(1.625)
Sanitation	-1.975	5.764	-1.049
	(4.486)	(6.021)	(4.096)
Water	-3.886	6.574	-3.592
	(4.653)	(7.571)	(4.186)
GDP	0.00152**	0.000539	0.00896**
	(0.000684)	(0.000387)	(0.00340)
Total Population	0.00780***	0.00774**	0.00654***
	(0.00102)	(0.00320)	(0.000743)
Constant	-52.23	-1,435	-211.5
	(272.4)	(949.5)	(272.3)
Country FE	*YES*	*YES*	*YES*
R-squared	0.810	0.646	0.852
No. countries	*131*	*46*	*85*
No. Observation	*757*	*258*	*499*

*p<0.05, **p<0.01, ***p<0.001.

Notes: Robust standard errors in parenthesis. Coefficients for coal, oil, natural gas, nuclear, hydro and renewables refer to the impact on employment in the electricity sector associated to a one-GWh increase in generation. The dependent variable is the country and year-specific total employment in the NACE rev. 4 section D sector. The percentage of people with access to water and sanitation are included as controls for changes in employment in the water and sanitation sector combined in the ILO Trends Econometric Models between 2009 and 2014. Data for 131 countries. Lybia and Turkmenistan do not have complete data for the period 2009-2014 but are included in the general model and the 2000-2008 model.

Source: Own calculation based on ILO Trends Econometric Models, World Development Indicators and Enerdata, Global Energy & CO_2.

Table 12: Indirect Employment multipliers for the energy sector by selected energy sources, all countries and regions

	Indirect local employment effect												Indirect cross-border employment effect											
	Coal	**NGas**	**Nuclr**	**Hydro**	**Wind**	**Petr+**	**Bio+**	**SolarP**	**SolarT**	**Tide+**	**Geot**	**NEC**	**Coal**	**NGas**	**Nuclr**	**Hydro**	**Wind**	**Petr+**	**Bio+**	**SolarP**	**SolarT**	**Tide +**	**Geot**	**NEC**
AT	2.8	4.3	0.0	3.1	2.9	4.5	4.7	3.8	0.0	0.0	5.0	3.8	16.3	14.6	0.0	6.6	17.3	26.8	17.0	42.1	0.0	0.0	45.2	21.4
BE	1.2	0.6	1.8	1.8	2.1	1.0	3.3	3.5	0.0	0.0	0.0	1.5	16.6	4.7	4.4	49.4	14.9	31.8	13.8	15.1	0.0	0.0	0.0	19.2
BG	12.8	21.3	18.6	22.7	27.5	28.1	46.8	21.1	0.0	0.0	0.0	0.0	165.1	62.6	50.3	55.4	51.8	50.3	49.0	52.0	0.0	0.0	0.0	0.0
CY	0.0	0.0	0.0	0.0	7.5	2.6	8.5	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	17.6	9.0	16.0	0.0	0.0	0.0	0.0
CZ	8.3	4.9	4.2	6.8	6.7	7.6	8.3	6.3	0.0	0.0	0.0	4.7	10.8	19.6	5.0	12.8	29.5	44.3	22.5	9.5	0.0	0.0	0.0	13.3
DE	5.6	8.4	2.9	3.8	4.1	9.0	6.0	4.5	0.0	0.0	0.3	6.1	7.8	8.4	2.6	7.2	4.0	16.2	5.9	6.3	0.0	0.0	60.5	9.5
DK	1.9	0.8	0.0	15.0	1.4	3.9	2.8	14.2	0.0	0.0	0.0	0.0	14.6	8.4	0.0	7.3	10.0	50.4	19.1	4.9	0.0	0.0	0.0	0.0
EE	9.4	9.1	0.0	9.6	6.4	9.0	9.9	0.0	0.0	0.0	0.0	7.5	11.1	26.8	0.0	24.9	23.2	33.1	17.6	0.0	0.0	0.0	0.0	23.6
ES	5.4	7.1	2.0	3.0	3.1	2.4	4.2	2.7	0.9	0.0	0.0	1.2	14.4	11.5	3.2	5.8	5.1	16.5	17.4	12.7	30.7	0.0	0.0	32.2
FI	2.0	2.1	2.1	2.2	2.5	2.3	3.4	4.8	0.0	0.0	0.0	2.7	29.8	31.1	12.5	17.0	43.2	46.5	20.9	46.5	0.0	0.0	0.0	42.3
FR	6.8	3.1	3.1	5.6	6.0	5.5	7.2	7.8	0.0	8.4	0.0	7.6	31.2	52.2	2.7	5.7	10.0	41.5	21.4	27.9	0.0	42.7	0.0	32.5
GR	4.5	2.5	0.0	2.0	2.3	3.1	7.8	5.0	0.0	0.0	0.0	0.0	8.0	9.5	0.0	5.5	6.5	12.6	26.0	3.4	0.0	0.0	0.0	0.0
HR	8.0	16.9	0.0	9.3	10.8	11.8	45.1	0.0	0.0	0.0	0.0	0.0	15.3	13.9	0.0	11.6	20.3	22.7	27.2	0.0	0.0	0.0	0.0	0.0
HU	9.0	11.8	4.1	4.7	6.0	7.9	15.6	0.1	0.0	0.0	0.0	6.8	12.8	15.6	5.6	38.9	26.6	43.2	20.6	27.5	0.0	0.0	0.0	45.2
IE	0.8	1.2	0.0	0.6	0.4	1.3	0.6	0.0	0.0	0.0	0.0	0.0	10.3	11.8	0.0	17.9	6.6	27.4	33.8	0.0	0.0	0.0	0.0	0.0
IT	6.1	6.8	0.0	5.4	4.6	6.5	6.7	5.4	0.0	0.0	4.5	4.9	15.9	11.3	0.0	7.5	12.9	15.0	15.1	11.3	0.0	0.0	17.6	22.2
LT	0.0	16.5	0.0	12.4	13.1	17.6	18.8	0.0	0.0	0.0	0.0	0.0	0.0	30.3	0.0	29.2	30.7	40.1	39.3	0.0	0.0	0.0	0.0	0.0
LU	0.0	0.0	0.0	0.2	0.2	0.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	4.4	0.0	78.4	74.1	93.9	67.1	83.4	0.0	0.0	0.0	0.0
LV	0.8	22.0	0.0	10.8	7.0	4.6	13.4	0.0	0.0	0.0	0.0	0.0	138.1	22.3	0.0	11.9	74.0	110.2	58.6	0.0	0.0	0.0	0.0	0.0
MT	0.0	0.0	0.0	0.0	0.0	1.0	0.6	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.4	120.9	52.8	0.0	0.0	0.0	0.0
NL	1.0	1.8	0.2	1.4	0.3	2.1	0.8	1.4	0.0	0.0	0.0	0.4	3.5	5.4	3.6	46.3	3.7	21.5	3.7	43.3	0.0	0.0	0.0	5.8
PL	14.2	7.4	0.0	4.2	4.1	4.9	17.0	0.0	0.0	0.0	0.0	4.0	13.7	45.3	0.0	50.7	48.0	53.0	35.5	0.0	0.0	0.0	0.0	56.4
PT	6.8	8.0	0.0	4.5	4.5	5.7	7.2	3.9	0.0	0.0	4.1	0.0	13.5	16.3	0.0	6.7	7.4	18.7	16.2	41.8	0.0	0.0	43.5	0.0
RO	31.7	27.0	16.9	19.4	105.6	62.4	96.5	14.2	0.0	0.0	0.0	195.7	12.6	13.9	3.2	6.0	2.0	14.9	10.3	26.6	0.0	0.0	0.0	0.0
SE	0.2	0.2	1.6	1.8	0.5	0.0	1.9	0.0	0.0	0.0	0.0	0.0	73.8	73.3	19.7	18.7	60.2	73.8	35.2	27.7	0.0	0.0	0.0	81.4
SI	9.2	5.6	4.4	5.5	0.0	3.4	13.0	5.9	0.0	0.0	0.0	0.0	14.2	31.3	9.1	12.4	0.0	44.8	23.6	23.2	0.0	0.0	0.0	0.0
SK	7.9	12.1	5.7	6.3	3.3	8.0	11.5	8.4	0.0	0.0	0.0	6.6	28.5	33.0	7.5	11.4	62.7	39.7	23.8	16.5	0.0	0.0	0.0	34.1
GB	5.1	2.0	3.1	3.3	4.3	2.7	4.8	2.6	0.0	0.0	0.0	2.7	11.1	3.2	5.7	25.2	13.9	23.1	20.8	51.0	0.0	0.0	0.0	48.6
US	1.3	6.2	0.8	1.8	4.3	15.9	7.2	59.6	115.4	0.0	23.2	59.6	0.6	1.6	0.3	0.7	1.4	9.2	1.7	15.8	34.6	0.0	7.1	18.2
JP	1.5	6.7	4.5	6.9	4.4	5.9	8.2	4.8	0.0	0.0	4.8	7.4	77.4	7.7	3.9	6.6	21.9	9.5	7.1	22.0	0.0	0.0	18.3	10.3
CN	31.9	7.3	18.9	22.1	22.3	14.9	2.2	2.5	0.4	0.4	5.2	19.6	7.5	88.4	9.9	5.3	11.7	54.2	117.5	103.1	30.7	30.7	52.4	33.9
CA	2.0	6.0	1.4	1.3	1.1	1.8	1.3	0.4	0.0	0.3	0.0	0.9	7.6	15.0	5.9	2.1	27.5	36.7	29.6	52.8	0.0	57.3	0.0	44.5
KR	8.7	7.8	5.6	8.9	7.6	8.4	9.9	7.8	0.0	0.0	0.0	8.7	19.1	32.5	6.1	40.1	59.3	28.7	50.6	59.1	0.0	0.0	0.0	30.3
BR	31.8	23.5	14.7	1.4	38.1	27.4	12.5	0.0	0.0	0.0	0.0	43.0	11.2	15.7	5.9	1.3	10.4	21.4	5.3	0.0	0.0	0.0	0.0	20.2
IN	28.8	39.5	7.4	8.7	10.2	30.7	0.8	0.8	0.0	0.0	0.0	0.7	6.1	17.0	17.1	6.9	24.8	35.3	98.3	66.0	0.0	0.0	0.0	61.9
MX	7.0	13.8	16.9	13.3	23.7	32.7	25.0	31.8	0.0	0.0	26.7	16.7	52.6	8.6	18.3	9.8	37.4	15.6	35.0	11.7	0.0	0.0	22.5	51.4
RU	21.0	19.8	4.9	7.1	30.1	19.7	4.1	0.0	0.0	0.0	3.8	6.0	23.0	17.0	18.2	19.2	32.4	49.2	107.0	0.0	0.0	0.0	74.3	87.1
AU	2.5	2.7	0.0	1.1	0.6	0.7	0.1	0.0	0.0	0.0	0.0	0.0	14.8	36.3	0.0	27.8	44.4	57.9	94.5	68.7	79.7	0.0	75.8	75.8
CH	0.0	0.5	1.2	1.5	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	45.5	5.2	6.0	56.8	59.3	25.5	54.5	0.0	0.0	0.0	0.0
TR	8.6	14.5	0.0	4.9	4.9	7.7	6.2	0.0	0.0	0.0	4.7	5.3	23.4	20.5	0.0	8.3	17.2	29.9	50.1	0.0	0.0	0.0	26.1	24.1
TW	4.3	4.5	3.6	8.8	11.7	7.4	10.3	51.4	0.0	0.0	0.0	9.9	48.3	114.7	8.8	31.7	35.3	28.8	33.2	0.3	0.0	0.0	0.0	27.7
NO	1.2	1.2	0.0	0.4	1.0	1.1	1.5	0.0	0.0	0.0	0.0	1.2	77.9	27.4	0.0	1.4	39.8	77.9	64.4	0.0	0.0	0.0	0.0	72.4
ID	81.3	53.6	0.0	472.2	0.0	261.1	30.0	1009.5	0.0	0.0	513.7	0.0	3.0	2.3	0.0	17.4	0.0	10.5	102.4	1.3	0.0	0.0	18.1	0.0
ZA	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.9	0.0	59.5	72.6	47.4	66.8	66.8	47.4	0.0	0.0	0.0	0.0

WA	115.4	113.9	19.3	31.3	13.4	31.2	16.6	21.6	0.0	0.0	15.1	10.7	26.9	20.2	63.1	23.4	67.7	41.4	80.8	69.3	0.0	0.0	69.0	68.2
WL	17.5	23.8	9.7	8.6	11.6	25.2	13.8	0.2	0.0	0.0	11.3	16.6	17.6	16.2	17.7	4.4	27.7	14.7	29.4	37.5	0.0	0.0	28.0	23.7
WE	151.0	157.6	44.2	66.5	148.9	69.3	182.7	0.6	0.0	0.0	30.9	22.3	14.1	46.5	9.8	18.2	35.1	45.2	41.5	40.5	0.0	0.0	41.6	50.6
WF	129.8	68.9	0.0	59.9	155.0	95.1	105.8	116.8	0.0	0.0	71.6	0.0	29.2	7.7	0.0	11.0	49.2	18.0	56.4	22.6	0.0	0.0	35.7	0.0
WM	3.8	5.3	0.2	2.5	5.3	4.3	11.3	0.2	0.0	0.0	0.0	0.5	18.5	3.0	72.5	22.3	72.2	6.8	39.6	76.9	0.0	0.0	0.0	74.3

Note: The interpretation of the indirect employment multiplier is such that, for each million EUR of increased demand in each energy sector, an additional number of jobs equivalent to the size of the multiplier are created in other economic sectors in the country or region (local) or in other countries or regions (cross-border). Countries are listed by their 2-letter ISO code. Rest of the world regions include Asia and the Pacific (WA), Latin America and the Caribbean (WL), Rest of Europe (WE), Africa (WF) and the Middle East (WM).

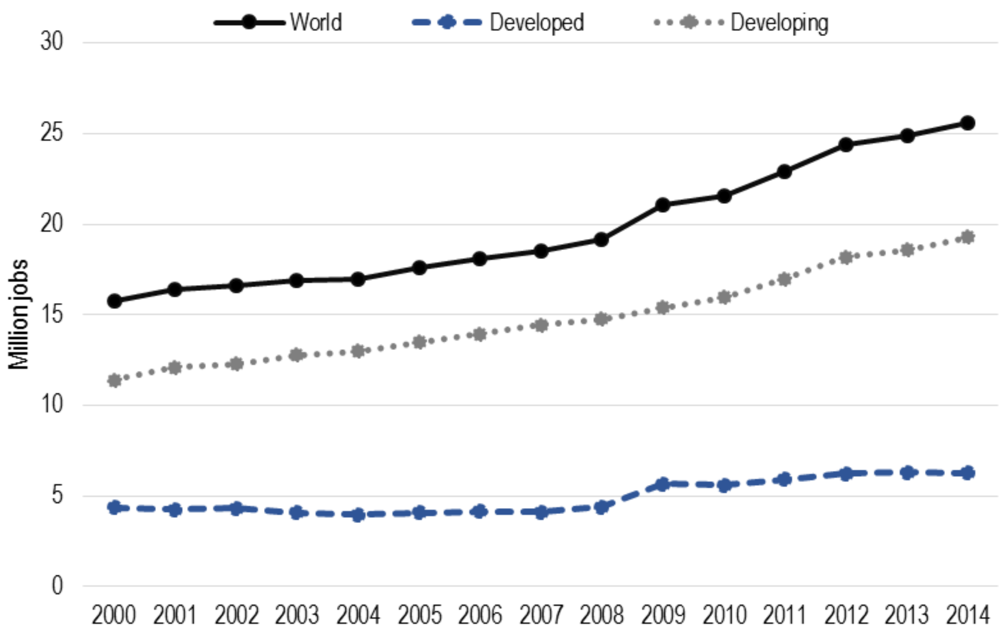
Source: Own calculation based on Exiobase v3.

Table 13: GHG emissions multipliers for the energy sector by energy source, all countries and regions, 2011

	Indirect local GHG emissions effect												Indirect cross-border GHG emissions effect											
	Coal	NGas	Nuclr	Hydro	Wind	Petr+	Bio+	SolarP	SolarT	Tide+	Geot	NEC	Coal	NGas	Nuclr	Hydro	Wind	Petr+	Bio+	SolarP	SolarT	Tide+	Geot	NEC
AT	83'933	1'513'199	0	399'710	84'005	744'448	1'375'135	51'113	0	0	53'752	399'382	1'307'957	570'373	0	186'314	257'790	584'470	613'961	513'440	0	0	500'568	401'801
BE	29'311	12'413	33'591	49'045	49'056	28'268	54'319	75'673	0	0	0	35'507	821'952	469'457	54'487	590'197	219'680	590'352	211'830	211'132	0	0	0	337'911
BG	438'013	202'161	249'817	215'432	131'153	231'484	234'815	88'716	0	0	0	0	1'640'892	814'877	715'024	786'603	813'303	721'463	873'581	636'975	0	0	0	0
CY	0	0	0	0	6'594	10'697	5'778	9'205	0	0	0	0	0	0	0	0	36'355	1'075'600	53'671	93'870	0	0	0	0
CZ	884'389	279'532	101'018	126'656	98'250	140'117	358'425	107'461	0	0	0	199'408	1'224'989	2'731'983	170'007	289'828	584'475	1'304'307	1'839'269	149'154	0	0	0	2'296'168
DE	765'949	284'492	53'819	52'891	72'480	148'184	132'326	76'065	0	0	4'954	100'951	330'648	201'736	56'583	220'524	96'925	548'529	137'080	176'926	0	0	351'514	287'702
DK	309'536	213'727	0	117'444	217'886	190'676	197'976	107'154	0	0	0	0	329'939	399'337	0	403'517	273'701	1'419'590	507'832	345'107	0	0	0	0
EE	806'505	260'971	0	37'908	33'208	34'826	499'102	0	0	0	0	169'203	237'957	806'909	0	1'171'333	742'175	1'164'131	457'270	0	0	0	0	712'894
ES	578'472	380'490	81'154	106'587	118'373	53'196	83'486	68'524	4'764	0	0	6'894	545'203	217'704	64'148	133'675	106'917	828'609	318'159	211'804	412'849	0	0	442'724
FI	90'906	98'306	77'142	72'103	59'668	52'213	111'347	108'525	0	0	0	71'701	3'248'184	8'920'633	244'749	328'585	769'669	1'242'675	957'078	839'911	0	0	0	753'545
FR	335'478	92'160	59'231	88'016	89'119	115'974	148'112	106'526	0	137'720	0	137'041	661'313	330'852	50'344	130'063	296'123	523'711	351'733	921'274	0	1'241'293	0	874'593
GR	400'210	211'405	0	67'687	74'813	58'927	124'681	55'445	0	0	0	0	220'916	4'795'805	0	180'306	213'500	1'334'806	627'020	30'548	0	0	0	0
HR	115'060	642'447	0	149'656	361'077	173'032	178'068	0	0	0	0	0	519'594	273'141	0	336'598	652'172	601'470	964'341	0	0	0	0	0
HU	89'467	219'924	40'309	39'676	52'086	68'402	146'287	415	0	0	0	58'649	233'600	379'775	81'219	812'378	494'565	826'476	443'393	225'361	0	0	0	850'796
IE	11'390	29'634	0	6'702	9'077	21'738	3'857	0	0	0	0	0	140'174	148'770	0	273'670	95'882	398'695	357'014	0	0	0	0	0
IT	187'989	489'774	0	95'958	76'281	123'550	105'604	89'581	0	0	71'790	86'013	2'254'595	222'366	0	172'832	272'853	449'468	399'455	233'813	0	0	379'296	745'605
LT	0	241'776	0	57'544	58'641	84'756	293'833	0	0	0	0	0	0	393'998	0	267'111	278'866	363'835	361'766	0	0	0	0	0
LU	0	271	0	44'827	54'320	2'386	81'199	28'675	0	0	0	0	0	586'982	0	551'259	518'062	491'962	497'352	577'067	0	0	0	0
LV	2'965	379'498	0	53'120	25'530	13'875	62'683	0	0	0	0	0	1'861'535	515'563	0	280'384	1'187'683	1'616'336	1'027'874	0	0	0	0	0
MT	0	0	0	0	0	10'968	20'837	174'112	0	0	0	0	0	0	0	0	0	962'710	511'629	1'214'272	0	0	0	0
NL	35'599	158'269	3'332	20'902	5'137	59'287	16'392	20'834	0	0	0	8'012	74'388	72'658	42'522	543'316	44'465	296'149	47'676	504'406	0	0	0	70'284
PL	992'286	98'869	0	48'683	47'983	55'216	104'047	0	0	0	0	45'059	459'457	519'942	0	504'517	476'490	542'618	400'754	0	0	0	0	557'327
PT	85'786	99'779	0	53'389	54'579	78'713	83'865	21'192	0	0	44'264	0	387'103	427'358	0	95'764	97'263	333'988	195'087	365'041	0	0	447'062	0
RO	1'676'416	1'206'362	66'251	99'947	308'287	489'204	314'657	34'688	0	0	0	463'727	446'906	4'403'932	60'378	95'494	28'414	834'050	218'952	236'095	0	0	0	173
SE	13'302	12'879	34'231	36'057	13'152	1'046	58'253	162	0	0	0	1'018	498'776	493'049	213'334	195'049	455'892	525'309	373'405	211'500	0	0	0	512'694
SI	350'504	87'809	131'321	140'603	0	11'722	108'895	81'119	0	0	0	0	206'688	931'800	128'319	203'699	0	1'041'802	467'476	702'790	0	0	0	0
SK	211'097	275'543	65'628	78'024	71'872	186'013	148'111	132'872	0	0	0	126'468	827'573	660'722	132'999	195'163	543'704	711'918	350'196	355'549	0	0	0	500'778
GB	1'548'634	779'923	257'215	23'093	210'073	413'816	246'309	16'348	0	0	0	17'330	994'957	185'101	92'178	238'765	165'258	305'046	233'264	428'362	0	0	0	425'210
US	12'642	2'287'689	6'260	13'172	31'173	120'618	51'636	381'792	570'341	0	156'721	377'742	21'853	47'880	9'264	20'437	33'763	428'132	26'870	304'690	846'496	0	172'963	440'073
JP	86'765	472'694	340'306	150'570	25'739	346'702	460'601	30'889	0	0	86'287	213'641	298'824	300'542	37'357	99'336	277'380	516'685	86'362	281'974	0	0	194'699	159'899
CN	2'039'895	741'741	207'356	403'262	272'667	210'937	33'815	32'035	5'118	5'123	88'129	281'161	225'131	3'119'974	194'291	100'905	243'636	1'400'884	680'948	887'238	142'425	142'425	440'082	886'352
CA	534'889	4'072'252	33'353	26'064	66'751	96'946	76'979	77'725	0	76'819	0	86'453	122'934	765'892	87'505	32'656	390'479	525'210	419'894	600'906	0	481'238	0	583'482
KR	999'334	993'714	77'162	169'778	142'641	151'690	176'969	146'336	0	0	0	737'357	2'306'897	6'254'569	99'177	604'581	824'042	1'240'289	733'252	822'948	0	0	0	1'359'320
BR	160'470	806'843	73'324	19'028	155'355	766'732	105'573	0	0	0	0	628'573	263'240	678'010	173'068	49'410	305'583	1'103'748	271'911	0	0	0	0	1'577'380
IN	1'117'646	667'221	21'348	46'574	31'575	159'494	6'525	6'831	0	0	0	6'054	611'050	280'153	185'302	87'408	305'663	443'655	652'216	708'124	0	0	0	608'258
MX	35'005	157'642	106'449	224'359	131'433	569'477	131'553	253'962	0	0	152'262	121'631	1'440'288	3'206'916	329'375	204'657	632'755	1'275'841	629'272	1'164'607	0	0	435'665	758'627
RU	335'829	271'101	62'872	72'147	318'205	194'354	53'546	0	0	0	42'630	63'277	164'102	192'901	130'316	136'400	321'332	346'436	704'654	0	0	0	701'951	626'365
AU	2'572'174	1'763'077	0	59'118	13'838	10'457	3'008	2'102	2'452	0	2'338	2'320	161'742	343'477	0	314'457	479'450	623'487	668'653	741'756	942'729	0	838'923	822'952
CH	0	8'450	12'944	16'229	247	613	22'559	699	0	0	0	0	0	486'108	82'123	106'250	544'167	588'675	328'714	544'702	0	0	0	0
TR	149'249	464'951	0	50'789	54'050	68'488	61'455	0	0	0	34'871	61'781	499'220	342'816	0	155'069	685'466	1'287'889	1'408'732	0	0	0	1'358'154	1'000'048
TW	362'097	447'845	234'993	582'990	641'396	557'092	668'287	650'269	0	0	0	668'229	10'136'265	4'147'542	185'946	663'755	804'461	1'232'919	647'560	2'105	0	0	0	578'745
NO	11'823	38'912	0	6'628	30'542	11'304	136'025	0	0	0	0	11'921	442'560	281'944	0	20'571	380'000	441'823	966'977	0	0	0	0	414'692
ID	12'922	9'028	0	76'469	0	53'759	6'910	170'876	0	0	83'834	0	23'414	13'799	0	125'068	0	92'486	452'754	7'925	0	0	109'400	0
ZA	761'907	0	2'947	4'224	946	3'381	3'375	942	0	0	0	0	261'908	0	447'277	419'284	220'110	440'907	443'272	218'732	0	0	0	0
WA	1'297'660	1'998'033	45'897	104'912	37'664	100'554	43'271	78'215	0	0	46'078	34'412	598'492	838'375	1'118'576	451'151	1'196'486	1'114'435	1'193'123	1'197'173	0	0	1'145'062	1'202'001
WL	71'985	148'547	45'863	43'954	63'146	124'292	60'408	2'098	0	0	76'160	82'490	449'429	447'832	403'427	123'473	582'514	454'917	495'151	259'625	0	0	744'581	602'091
WE	876'632	1'601'634	152'239	259'563	1'214'173	144'420	1'165'877	2'327	0	0	53'773	41'877	259'306	1'398'656	133'157	237'750	520'980	781'276	718'101	274'174	0	0	614'941	808'107
WF	383'070	896'215	0	191'777	606'763	570'090	311'044	335'905	0	0	156'065	0	602'844	170'793	0	233'842	1'402'420	555'004	1'121'238	507'966	0	0	955'794	0
WM	275'601	1'268'588	27'837	154'067	298'975	905'626	951'017	28'117	0	0	0	60'347	209'469	44'144	1'024'258	268'304	1'068'453	148'627	604'579	1'065'072	0	0	0	1'101'531

Note: The interpretation of the indirect GHG emissions multiplier is such that, for each million EUR of increased demand in each energy sector, an additional (kg CO2-eq) GHG emissions equivalent to the size of the multiplier are created in other economic sectors in the country or region (local) or in other countries or regions (cross-border). Countries are listed by their 2-letter ISO code. Rest of the world regions include Asia and the Pacific (WA), Latin America and the Caribbean (WL), Rest of Europe (WE), Africa (WF) and the Middle East (WM).
Source: Own calculation based on Exiobas

Figure 2: Employment in the electricity sector, 2000-2014, total, million jobs



Note: Total employment in the NACE rev. 3 and rev.3.1 section E sector (between 2000 and 2008) and the NACE rev.4 section D sector (between 2008 and 2014). See Table 1 and the respecting discussion on the scope of the industries considered and the change between NACE rev.3, rev.3.1 and rev.4. Data for 181 countries.
Source: Own calculation based on ILO Trends Econometric Models.