Inter-American Development Bank

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DISCUSSION PAPER Nº
IDB-DP-00716

October 2019

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http://www.iadb.org

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Abstract

This study explores the labour impact of four scenarios of electricity generation in Chile, including three coal power phase-down scenarios. These scenarios would result in the creation of between 32 and 40 thousand direct and indirect jobs and between US$1.7 and US$1.8 billion in value added in 2030, compared to present-day situation Net numbers mask winners and losers. The most significative negative impact we find would be the progressive disappearance of 4 thousand jobs in coal power plants by 2030 or 2050 depending on the scenario. These impacts are not significative when compared to Chile's labor markets and GDP. Chile's economy routinely creates more than 40 thousand jobs per trimester, and US$1.7 billion is just 0.8% of GDP, while GDP is expected to grow at least 2.5% per year between today and 2030. At the national level, our results suggest that a careful planning and implementation of coal phase out could be able to mitigate its negative impacts, given that they will be small relative to the size of Chile's economy. In practice, whether the jobs created nationally match the skills available in the geographical location of current coal power plants is likely to play a key role. This study does not investigate this issue, but a separate technical note studies affected communities with more details and provides lessons learned from historic management of the labor impacts of policy reforms.

Introduction

The government of Chile is discussing options to progressively retire or transform coal power generation plants. To inform this discussion, four contrasting scenarios are being analyzed. One option considered by the scenarios is to replace coal-based generation with renewable electricity production by 2030 or 2050. Another option is to transform coal generators into gas or biomass generators by 2050.

With this type of ambitious reform comes the potential to create winners and losers (Gambhir et al., 2018; Garg and Steckel, 2017; ILO, 2018; Trebilcock, 2014; Vogt-Schilb and Hallegatte, 2017). The international evidence suggests that in general, the transition to clean electricity is expected to be a net job creator and can come with opportunities for new skilled jobs in the renewable sector, either *directly* in building and installing renewable power plants, and *indirectly* in the industry that supplies the parts required to do so (Garrett-Peltier, 2017; ILO, 2018; Vogt-Schilb and Hallegatte, 2017). However, there are at least three potential groups of people who could be negatively impacted by the transition (Garg and Steckel, 2017; ILO, 2018; Vogt-Schilb and Hallegatte, 2017). People working directly in coal power plants may have difficulty finding a job in other industries, given the training and experiences they received in the past. In addition, the workers in business that depend on coal power plants could also lose their job as an indirect consequence of the transition. Finally, the communities where coal power plants are currently implanted can also be negatively impacted by a phase down of coal power.

To shed some light on this issue, we use input-output analysis to quantify both direct and indirect job impacts of phasing down coal power in Chile. Direct jobs are the jobs in the power generation sectors (independently of the type contracting relationship between workers and the owners of power plants), while indirect jobs are jobs with the suppliers of power generators (for instance, jobs in the mining sector or the financial services sector). We consider four scenarios that are being discussed in Chile: keeping with the baseline Long Term Energy Planning (or PELP for *Planificación Energética de Largo Plazo*), which does not consider any retirement or transformation of existing coal power plants; replacing coal plants with hydropower, wind, and solar power plants by 2030 (Decarb2030) or by 2050 (Decarb2050); and reconverting coal plants, mainly in gas plants and biomass plants, by 2050 (Rencov2050). In addition to labor impacts, the input-output analysis allows to track impact on value added and investment, which we also report.

We find that all four scenarios are consistent with sustained job creation at the national level, adding between 32 and 40 thousand jobs by 2030, compared to the situation in 2017. We find that about four out of five (79% to 88%) of those jobs would be created directly in the electricity sector; and that the remaining indirect job creation would be split in the services, manufacturing, and water and other utility sectors. In particular, our results suggest that it is possible that Chile becomes coal-free while increasing direct and indirect employment from power generation.

When comparing the three scenarios that phase down coal to the PELP scenario, we find a net job creation. Our results suggest that by 2030, phasing out coal would lead to create 2 to 8 thousand additional jobs, depending on the scenario. Similar to what happens to the absolute number of job creation, the difference in indirect jobs represent less than 25% of the net difference and is dominated by jobs in services. The result is thus dominated by the simulated direct employment in renewable energy, that offsets the direct employment loss in coal power plants. These results are consistent with the existing literature in finding that a transition to renewable electricity is compatible with net job creation (Garrett-Peltier, 2017; ILO, 2018; Perrier and Quirion, 2016; Simas and Pacca, 2014).

In all scenarios with coal phase down, however, the positive net impact on jobs masks gross negative impacts in the coal power sector (between 400 and 4 thousand jobs in 2030). We find that the net impact of the mining sector is not significant (our data has one single mining sector, that encompasses coal mining where employment would be reduced, and other mining activities such as coper, lithium and rare earth where employment would be increased. The net impact is negligible).

We also find that phasing out coal power will generally result in more value added in the power generation sector. In 2030, we find that value added in the power generation sector will have grown between 1.6 billion dollars (in the PELP scenario) and 1.7 billion dollars (in the Reconv2050 scenario) above today's levels. The trend towards more value added in the power sector is driven by increasing electricity demand over time. The reason value added increases slightly with the switch to renewables is that according to the data we use, the cost structure of solar and wind includes more value added than coal, which includes a higher share of imported resources.

The data we use is a combination of international databases and national numbers (see methods below). It suggests that renewable energy technologies currently require more direct and indirect jobs to produce one unit of electricity (260 direct and indirect jobs per TWh for solar power and 250 for wind) than coal (220) or gas power plants (270). We take into account that as the cost of renewable electricity decreases over time, so will the number of jobs required; to 240 jobs per TWh in 2030 and 230 jobs per TWh for wind energy, and 210 and 190 respectively for solar energy.

Recent and precise statistics on the number of jobs required per technology are scarce, not least because the uptake of renewable energy is a very recent trend globally, and even more in Chile. Our numbers do not allow to distinguish jobs required in the construction process of new power plants and jobs required to maintain and operate existing power plants. On the one hand, an initial uptake of renewable power plants would likely require more construction jobs, that could turn out to be temporary. On the other hand, the windmills and solar panel may require to be replaced or heavily maintained after a few decades of use, giving the opportunity to smooth construction needs over time. This study does not provide any quantification of this issue. We have tested several data sources that all lead to the conclusions exposed in this paper (the results we show are based on the most conservative data sources against renewable energy). Nonetheless, our numbers are still imperfect estimates. Given that our estimates of numbers of jobs per unit of produced electricity are not very contrasted across technologies, small changes in any of them could be sufficient to change the balance, and lead to conclude to negative net impacts on jobs and value added.

The robust finding is that at the national level, the choice to phase out coal by 2030 or 2050, reconvert coal units to gas or biomass, or keep with the baseline PELP has a moderate impact on macroeconomic job projections by 2030. Over the three decarbonization scenarios, we find between 34 and 40 thousand jobs created by 2030 (in the Decarb2030 and Reconv2050 scenarios respectively), while the PELP has 32 thousand jobs created by 2030. Those are substantial numbers when compared to current direct and indirect jobs from power generation, that we estimate at 48 thousand in 2017. But at the national level, these are not very significative numbers. To put them in perspective, they correspond to creating over 12 years the number of jobs that the whole Chilean economy typically creates in a few months. For instance, between July and September 2018, 43 thousand jobs have been created in Chile (INE, 2018). The difference between the job numbers in the decarbonization scenarios and the PELP, between 3 thousand net destructions to 8 thousand net creations in 2030, is even smaller, and corresponds to the number of jobs typically created in a few days in Chile.

Similarly, our estimates of value added creation in the power sector by 2030 are substantial numbers prima facie, but they represent about 0.8% of Chile's GDP in 2017, while economic growth in Chile is expected to be more than 2% to 4% *per year* between now and 2030. In other words, the difference between the best and the worst-case scenario for value added in power generation, at about 0.3% of today's GDP, represents a drag or a boost of about one-month worth of GDP growth by 2030. To summarize, our results suggest that the question of the impact of Chile's decarbonization strategy on jobs and value added is not a macroeconomic one. Whether the net impact is positive or negative at the macroeconomic level, the transition out of coal will have a small aggregate impact on both jobs and value added.

Notwithstanding our results, it may still be important to identify and manage jobs lost from coal phase down in coal-related industrial sectors and communities. At the local level and for those directly impacted by the phase down, the consequences will be important. While macroeconomic numbers suggest that the impact of decarbonization strategies on jobs may be manageable, actually managing the impact will likely require the governments and the coal power companies to take specific steps. Compensatory policies may be needed at the local level (Altenburg et al., 2017; Gambhir et al., 2018; Green, 2018; Hallegatte et al., 2013; ILO, 2018), such as: (i) access to general-purpose social protection and workforce benefits, (ii) adjusting the timing of phase down to take advantage of the natural retirement of workers and smooth the impact on local job markets, (iii) implanting renewable power plants or the industry that supplies the parts in the same communities where coal is being phased down, or (iv) retraining to meet the additional demand on jobs in the renewable and manufacturing sectors from switching coal to renewables. An analysis of these policies and their impact on local-level impact is out of scope of the present study, but other studies have been commissioned by the government of Chile on these topics (Viteri Andrade, 2019).

Materials and methods

Scenarios of coal phase out

We analyze the effects of changing the electricity production sources on the value added and employment. The scenarios of installed capacity over time (in MW) per electricity generation technology we use are provided by the Energy Ministry of Chile. There are four scenarios: (i) Long Term Energy Planning (PELP), the existing projections of Chile's future electricity (Ministerio de Energía, 2018); (ii) Decarbonized by 2030 (Decarb2030); (iii) Decarbonized by 2050 (Decarb2050), and (iv) Decarbonized by 2050 with reconversion schedule (Reconv2050). For each scenario, we analyze the impacts of energy production change in 2030 and in 2050.

To project electricity production in each scenario in 2030 or 2050, we use the electricity generation capacity data from the Chilean government to estimate the total electricity production by different technologies (e.g. coal, natural gas). We first assume that the loading factor (GWh/MW) for each technology is the same as its loading factor in 2017. Then, we scale up or down the electricity output for all technologies to match the total electricity generation of the PELP scenario, so that all scenarios end up with the same total electricity generation. Figure 1 shows the estimated electricity production by technology types in different scenarios.

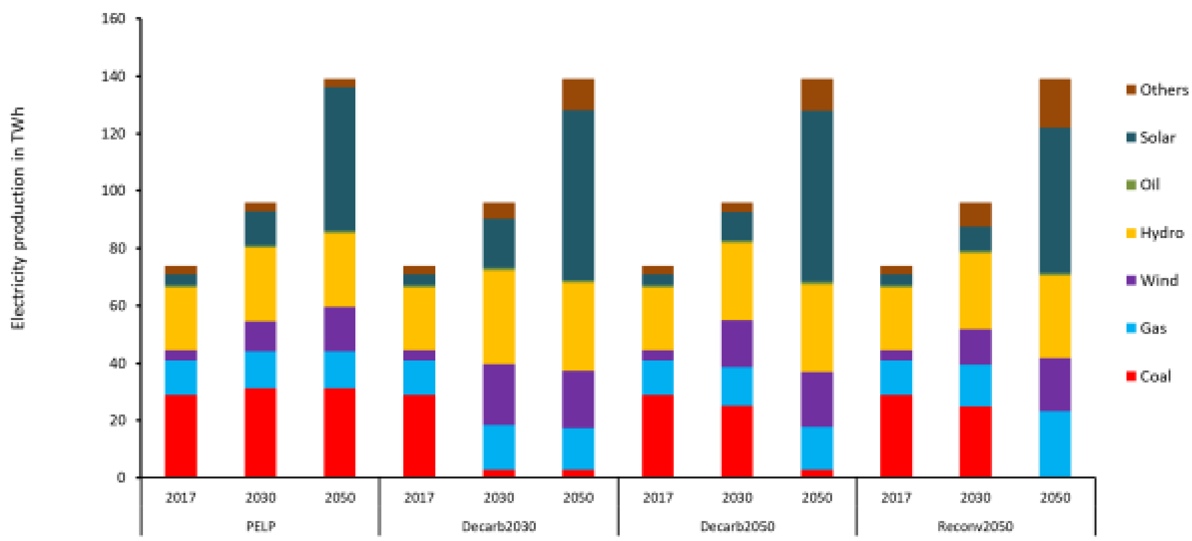

Figure 1: Electricity production by seven energy types under the four scenarios considered in this study. Note: Others includes biomass, waste incineration, and not classified elsewhere

Direct and indirect effects on employment and value added

We assess both direct and indirect effects of electricity production on employment and value added based on four different energy production scenarios for 2030 and 2050. The direct effect is the change in job demand associated with the change in the specific electricity generation sector. For example, reduction in electricity production from coal power plants may directly lead to a reduction in labor requirement in the sector. It may also cause an indirect effect to its upstream suppliers, such as coal mining and machinery production, thus leading to a reduction in the labor requirement in those sectors. On the other hand, an increase in renewable energy production may lead to an increase in labor requirement in its upstream supplying industries, such as steel industry and turbine production.

Here, we apply input-output analysis to capture both direct and indirect effects of changing electricity production on job requirements and value added in Chile. Input-output analysis is a popular tool to assess both direct and indirect effects of changing production and consumption of goods and services on the environment and economy (see appendix below for details).

Input output data

We constructed an input-output table for Chile using the GTAP Power database (Peters, 2016), which is an extension of the GTAP 9 database. The database includes input-output tables, employment compensation, fixed capital consumption and value added for 140 countries/regions and 68 economic sectors with detailed electricity generation subsectors such as coal, natural gas, fuel oil, wind, solar and hydropower.

We use GTAP power because there is no other input-output database that has such detailed electricity sectors. Most input-output databases only have one aggregate electricity sector for each country. The data used in the disaggregation of electricity sector are: electricity production (in GWh) by energy source (provided by the ministry of energy), total value of inputs to an aggregate electricity sector for each source (i.e. domestic and import), and type (i.e. basic and tax) for 2011 (Narayanan et al., 2012), and levelized cost of capital (i.e. annualized cost per GWh), operating and maintenance (O&M), fuel, and effective tax costs of electricity for select generating technologies and regions (from IEA/NEA and various sources).

The disaggregation that GTAP Power uses comprises two stages and focuses on the supply-side disaggregation. The first stage allocates total generation data from the technologies in the IEA energy balance to the technologies in the GTAP power Data. The second stage estimates new, balanced levelized input costs that are close to the original data, but are consistent with GTAP 9 database. Value is allocated to the full set of GTAP input costs based on expert assumptions and the balanced levelized input costs. Many balancing technics and optimization algorithms were used to derive the supply side table for disaggregated electricity sector. Detailed information on the GTAP power data disaggregation for levelized cost can be found in Petters (2016).

In addition to the IO tables, we collected labor statistics data from GTAP version 9. In the GTAP 9 database, employment for 57 economic sectors is separated into 5 job categories which are Technicians, Clerks, Officials and managers, Service and shop workers, and unskilled workers. In the GTAP data, labor splits were based on the study by Weingarden and Tsigas (2010) which consists of the number of workers by occupation and industry for 95 countries and imputed wages for 48 countries. Then, the data was expanded across all countries and all 57 GTAP commodities (see detail in Walmsley & Carrico (2016)).

However, the labor statistics data is only available in GTAP 9 database (57 sectors) but not in GTAP power database (68 sectors). Therefore, we need to estimate number of jobs by electricity sub-sectors. We use two steps. We first extract the labor statistics and labor compensation data for the electricity sector as a whole from GTAP 9 to estimate the wage and relative importance of five job categories in the electricity sector. And then, by using labor compensation data for all sub-electricity sectors from GTAP power database and the wages, we estimate the number of jobs in each sub-electricity sector. In addition, we correct the number of jobs and average compensation for the coal power generation subsector, using an ad-hoc survey of the coal power generator compagnies provided by the ministry of energy of chile.

The latest published GTAP database only has input-output tables for year 2011. Back in 2011, there was no data for solar power sector in Chile. Therefore, we could not obtain the input structure for Solar energy directly from GTAP power. Here, we tested using the input coefficient of the solar power sector from the average over LAC countries, and for Portugal, a country where solar power is more advanced. Both assumptions lead to similar results. We show here the results of using Portugal. The obtained LAC regional IO table as a reference for the Chilean Solar power sector.

We also updated the IO table to 2014 numbers, making use of a prerelease of GTAP 10. As one of the contributors to the GTAP database, we received the updated version of the GTAP version 10, which will be published in late 2018. The GTAP 10 database has the latest input-output tables for 2014. But the GTAP data version 10 has only 57 sectors, which is more aggregated than the GTAP power version 9 data, because the GTAP power version 10 is still under construction. In this project, we updated the GTAP power 2011 input-output tables to 2014 input-output tables based on the GTAP 10 data.

We then updated the electricity generation mix in the IO table to reflect the electricity mix in 2017. For electricity sectors, we assume that the input coefficients/structure for electricity sectors remain the same as their coefficients in 2011. Using the 2017 Chilean energy balance sheet from the Chilean statistic office and the 2014 Chilean input-output, we updated the GTAP power 2011 table to 2014 Chilean input-output table with 2017 energy mix assuming that the input coefficients (outside of the power generation sector) to produce one-unit sectoral output for electricity sectors remain the same.

Finally, we adjusted the IO table to reflect the recent decrease in the cost of renewable electricity, as well as projected further decreases in the future. The Chilean Ministry of Energy shared projections of the levelized cost of electricity per technology (Figure 14 in the appendix). We scaled down linearly all inputs coefficients for electricity generation subsectors to match costs in 2017, 2030 and 2050

Labor and capital cost of different electricity generation technologies

In this section, we first illustrate the share of labor in the direct and indirect cost for production of unit of electricity production. Figure 2 shows that, in 2017, to produce one MWh of coal power requires less labor compensation (7 USD per MWh) than hydro (11 USD per MWh) solar power (10 USD per MWh), and wind power (14 USD per MWh).

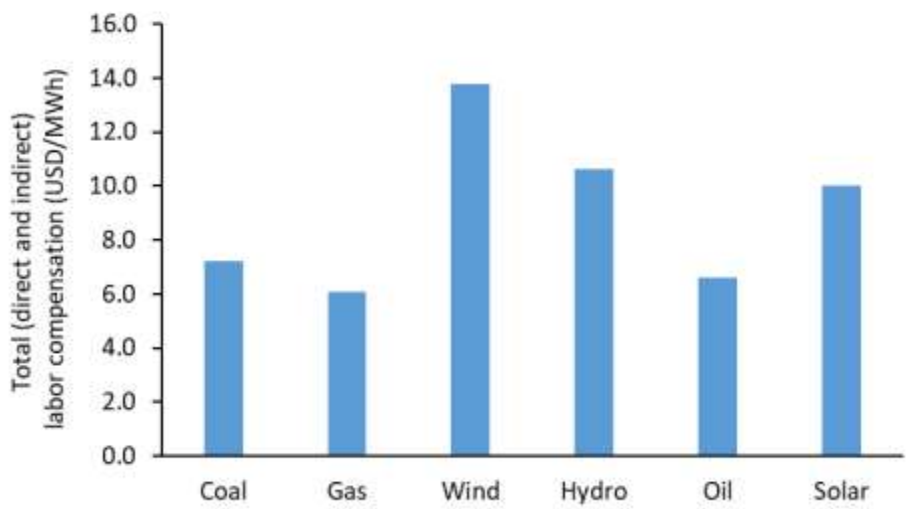

Figure 2: Total (direct and indirect) labor cost per MWh production of electricity with different technologies. Source: Authors calculations based on GTAP Power data and Chilean labor surveys

In terms of number of jobs per TWh produced, our estimates suggest that renewable energy technologies currently require slightly more direct and indirect jobs to produce one unit of electricity (260 direct and indirect jobs per TWh for solar power and 250 for wind) than coal (220) or gas power plants (270).

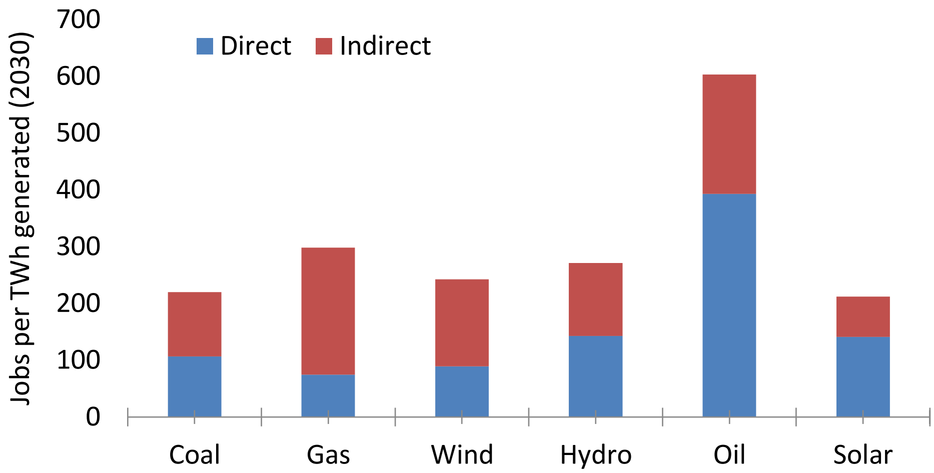

Figure 3: Total (direct and indirect) number of full-time equivalent jobs required per TWh of electricity production by technology. Source: Authors calculations based on GTAP Power data

As the price of technologies is reduced over time through learning by doing and research and development (see Figure 14 in the appendix), so will the number of jobs required to produce electricity using each technology. Figure 3 shows our assessment of labor required, in full time equivalent jobs, to produce one TWh of electricity using different technologies in Chile in 2030. The number of direct and indirect jobs required does not vary dramatically across technologies. In 2030, our estimate suggests that producing 1TWh of electricity using solar energy requires about 210 jobs, wind requires 240, while gas requires 300 and coal requires 220. Oil-based generation, which plays a marginal role in Chile's power sector, requires 600 direct and indirect jobs per TWh produced.

Another way to look at employment per technology is to assess the number of jobs created by MW of capacity installed. Because renewable energy is typically used with a lower load factor than fossil energy (due to intermittency issues), this metric is less favorable to wind and solar energy. We find that by 2030, each GW of coal capacity installed comes with 1500 direct and indirect jobs, while 1 GW of gas comes with 620 jobs, solar comes with 630 jobs per GW and wind comes with 620 jobs per GW (see figure 15 in the appendix).

When we look at the capital share of the total output (capital consumption or depreciation) in 2017, we see that renewables are somewhat more capital-intensive than fossil fuels. The capital input share is more than 35% of the total input (Figure 4). This means that switching to renewable energy would result in comparatively more investments. Note that renewables can be both more capital intensive and more labor intensive than fossil energies, because fossil energies are more resource-intensive (wind and solar radiation are free of charge while coal and gas come at a price) and lead to less profits and taxes than fossil fuel energy.

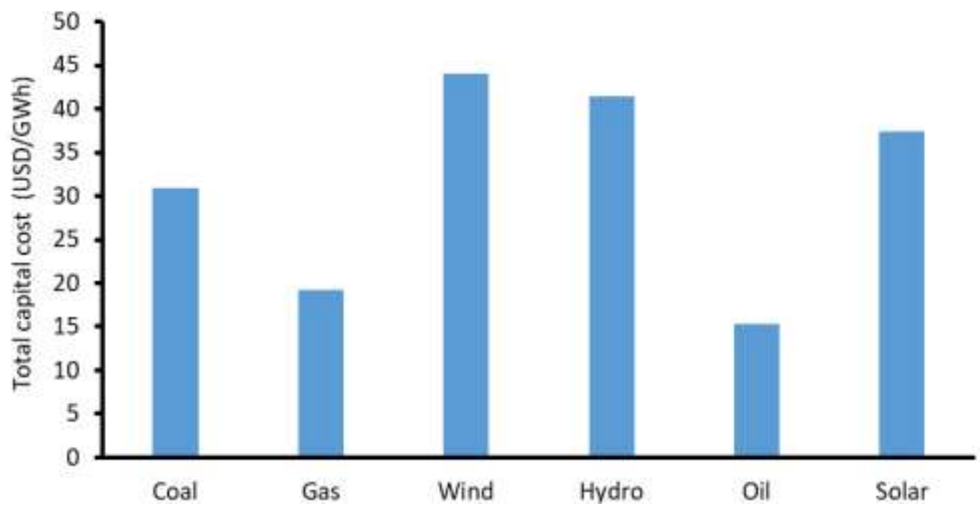

Figure 4: Total (direct and indirect) capital cost (depreciation and maintenance) per GWh production of electricity with different technologies. Source: Authors calculations based on GTAP Power data

Labor impacts of coal phase down scenarios

Impact of electricity production on labor and value added by 2030

We now move to the results of simulating different electricity generation mixes in 2030. Figure 5 shows the change in total labor compensation in 2030 based on four electricity production scenarios. Compared to the 2017 situation, all scenarios see an increase in total compensation by 2030. In all scenarios, the order of magnitude is the same, between 444 and 495 million USD above current levels. For comparison, our data suggests that total labor compensation associated with power generation in 2017 was USD 670 million. Changes by 2030 would represent about 70% of that, and changes between the best and worst scenario amount to 8% of current compensation. Relative to the power generation industry, those changes are thus significant, even though they are small than relative to the total economy.

Figure 6 show the same information in terms of number of jobs. Roughly speaking, all four scenarios see the addition of 32 to 40 thousand workers by 2030. Electricity production based on the decabon2030 may increase jobs in renewable electricity sectors, but the job decrease in coal power sector compensates for that. However, the difference in job impact between the PELP and descarbon2030 scenarios is relatively small, at about 8 thousand jobs, compared to the size of the Chilean job market.

This total gain masks winners and losers. The coal power industry and mining industry's employment concentrate the loss in total compensation, due to the closing down of coal power plant. When looking at impacts in 2030, the scenario that decarbonizes by 2030 is the one with the strongest negative impact on the coal sector. We estimate that 4 thousand jobs could disappear in coal power plants. The net impact in the mining sector is not significant (about 100 hundred jobs), because renewable energy requires metals from the mining sector, which compensates the loss of job for coal miners. The IO table we used does not allow to distinguish those two subsectors.

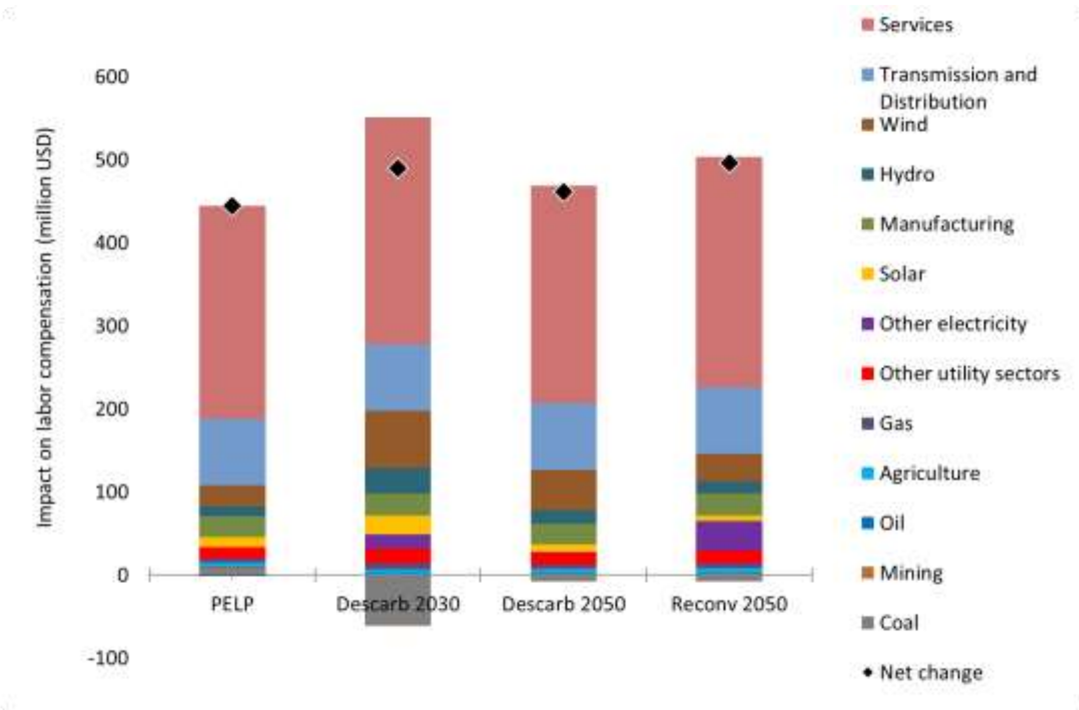

Figure 5: Total (direct and indirect) labor compensation change between in 2017 and 2030

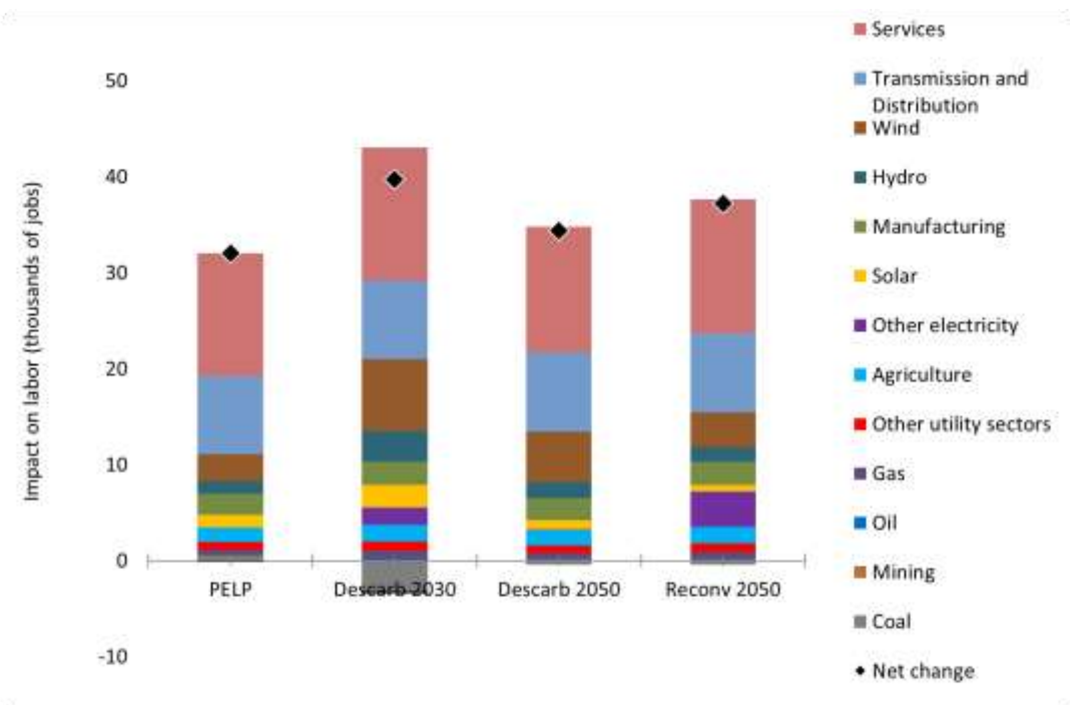

Figure 6: Net change in number of jobs by 2030 under four scenarios

Figure 7 shows the impacts of phasing out coal by 2030 on Chile's value added. As with job impacts on labor income, the difference in total value added between scenarios is modest, with all scenarios showing an increase of roughly 1.7 billion dollars in value added by 2030. For comparison, the current total value added associated with the power generation is estimated around 4 bn in Chile. The difference between the worst and the best scenario for value added in 2030, at about 115 million dollars, amounts to only 2.8% of current value added in the power sector. The impact on total GDP of Chile is even more modest. GDP in 2030 is projected to be around 395 billion dollars, the difference between those scenarios would thus amount to 0.03% of 2030 GDP.

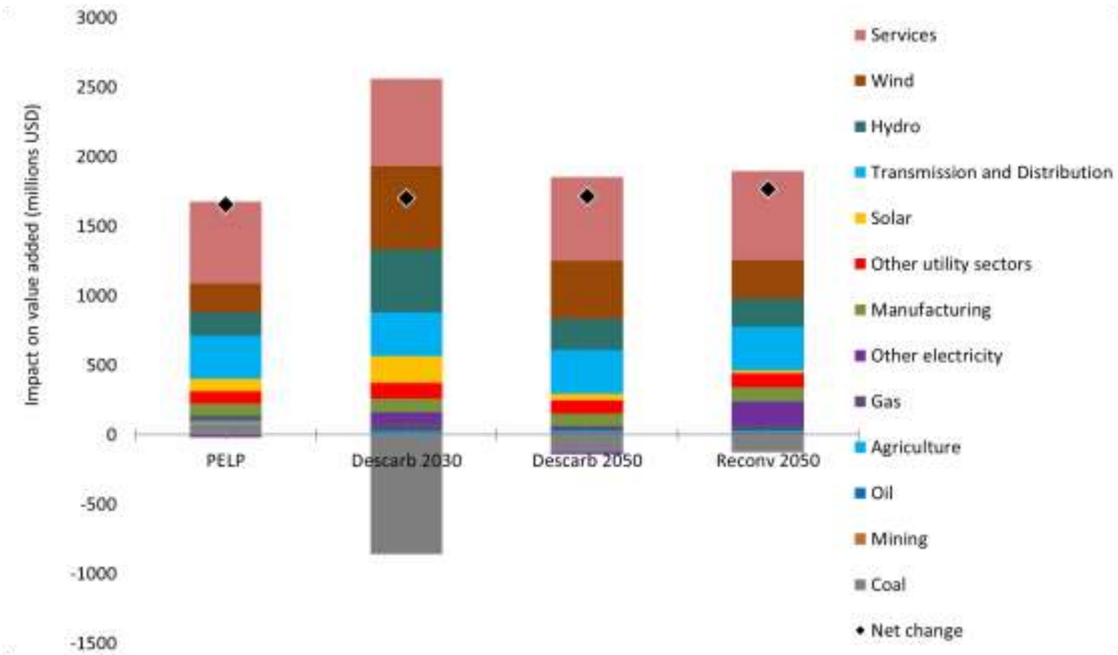

Figure 7: Impact on value added by2030 based on different scenarios

Impact of electricity production on labor and value added by 2050

The appendix shows results by 2050. In general, the results by 2050 are similar to the results by 2030, showing a small positive impact on aggregate labor and value added across scenarios. The difference between scenarios is very small, especially when expressed relative to total number of jobs expected by 2050 and total GDP expected by 2050.

Conclusions

The analysis presented here has several limitations. For instance, the IO tables we used rely on extrapolation of international data. In addition, they are not fine enough to assess precisely all the impacts of a coal phase out. For instance, we cannot distinguish coal mining from mining of lithium, copper, or rare earths – while the transition from the former to the latter could play a key role in allowing Chile to make the most of the global transition to zero net emissions. The data we rely upon also does not allow to distinguish between installation, operation and maintenance, and decommissioning of different types of power plants. Finer information on this side could be illuminating to understand precisely the job impact of the transition out of coal, the phasing in of renewable power, and their most appropriate timing.

Despite these limitations, our work provides several policy-relevant insights. In general, the labor and value-added impact of the transition will be small, if not negligible, for the Chilean economy. This suggest that the macroeconomic level is not the right scale at which to analyze this issue. However, those impacts are more substantial when compared to current employment and current value added in the power generation sector itself. Most importantly, even while the transition can create positive economic and labor impacts overall, the negative impacts on coal power plants jobs can be first and foremost difficult to endure for the very workers and the communities that will be directly affected. The fact that the impacts are small on a macroeconomic scale means that the government of Chile could in principle be able to manage the transition, as long as coal power phase down and renewable power phase in are planned in advanced and properly managed. A parallel study to this one is compiling lessons learned from historical experience on how to manage the job impact of the transition.

Acknowledgements

This paper benefited from the comments and suggestions of Guillermo Mont, Stephane Hallegatte and Julie Rozenberg; and funding from IDB project RG-E1563. The opinions expressed in this publication are those of the authors and do not necessarily reflect the point of view of the IDB, its directors, or the countries it represents.

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Appendix

Input-output Analysis

Input-output analysis has been frequently used to study both direct and supply chain effects of changing production and consumption in a country, a region or a sector. In this study, input-output analysis is applied to model the direct and indirect effects of changes in electricity production based on the four energy scenarios in Chile. This method captures both direct and indirect effects of changes in seven electricity production sub-sectors on employment compensation, number of labor demand, and the industrial value added. In this study, input-output analysis is selected due to its simplicity and transparency, compared with other economic system accounting methods such as computational general equilibrium model (CGE).

Input-output analysis is a modeling approach that relies on national or regional input-output tables. A country's input-output tables show the flows of goods and services and thus the interdependencies between suppliers and consumers along the production chain across upstream and downstream industries within an economy (Miller and Blair, 2009). The model consists of *n* linear equations depicting the production of an economy:

$$x_i = \sum_{j=1}^{n} z_{ij} + y_i \qquad (1)$$

where *n* is the number of sectors in an economy; $\boldsymbol{x_i}$ is the total economic output of the i^{th} sector; $\boldsymbol{y_i}$ is the final demand of sector *i*. $\boldsymbol{z_{ij}}$ is the monetary flow from the i^{th} sector to the j^{th} sector.

In matrix notation and for the economy as a whole, the Equation (1) can be written as:

$$x = Ax + y \qquad (2)$$

Technical coefficient matrix $A = (a_{i,j})$ is derived by dividing the inter-sectoral flows from sectors *i* to *j* (z_{ij}) by total input of sector *j* (x_j).

To solve for *x*, we get total output driven by final demand

$$x = (I - A)^{-1} y \qquad (3)$$

$(I - A)^{-1}$ is known as the Leontief inverse matrix, which shows the total production of each sector required to satisfy the final demand in the economy.

Both direct and indirect effects of changing electricity production on jobs and value added are simultaneously capture by the Leontief inverse matrix shows in Equation 4.

$$\Delta VA = VA_{coef} * (I - A)^{-1}\Delta q \quad (4)$$

where ΔVA is a vector of the total sectoral change in value added in all economic sectors; VA_{coef} is a vector of value added coefficients representing value added creation per unit of economic output; Δq is a vector of the change in sectoral total production. In this study, the changes only occurred in electricity production sectors and thus zeros are in non-electricity sectors.

Impact of electricity production on labor and value added by 2050

Here we show results by 2050. Our result shows phasing out coal by 2050 will benefit the total labor income in Chile. Similar to the result of decarb2030 scenario, coal power industry and mining industry's employment will be hit the most. However, the increase in labor income driven by the increase in renewable energy sectors will overcome the negative effect on coal power and its upstream supply chain.

Figure 10 shows a net benefit of switching from coal to renewables by 2030 (descarbon2030 scenario) in electricity sector by 2050 compared with the result from PELP scenario. Compared to the impact by 2030, the picture in 2050 is reversed: descarbon2030 scenario is slightly preferred than the PELP scenario when we look at long term effect by 2050. Similar to the situation in 2030, the differences between the scenarios are minimal.

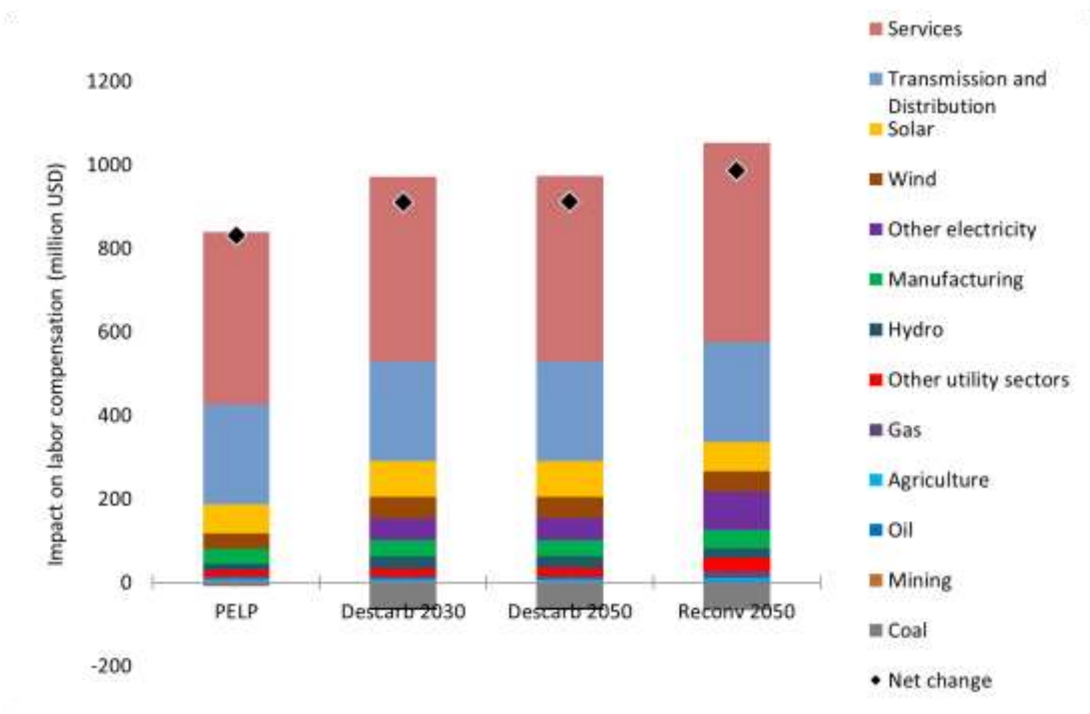

Figure 10: Net change in labor compensation by 2050 under four scenarios

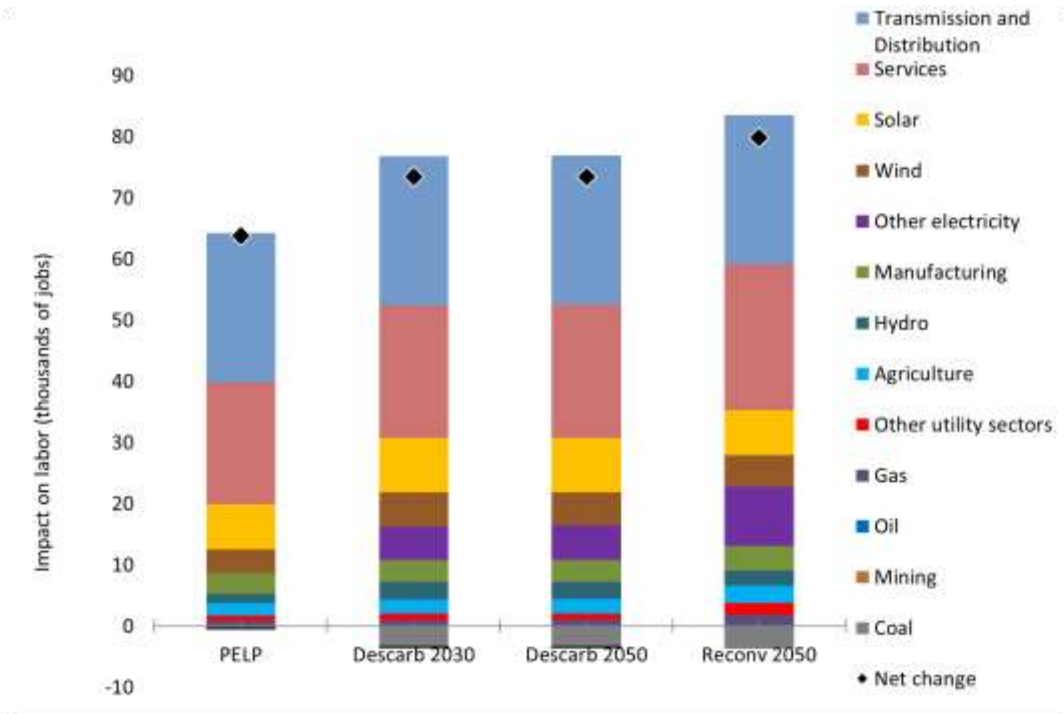

Figure 12: net change in labor demand by 2030 under four scenarios

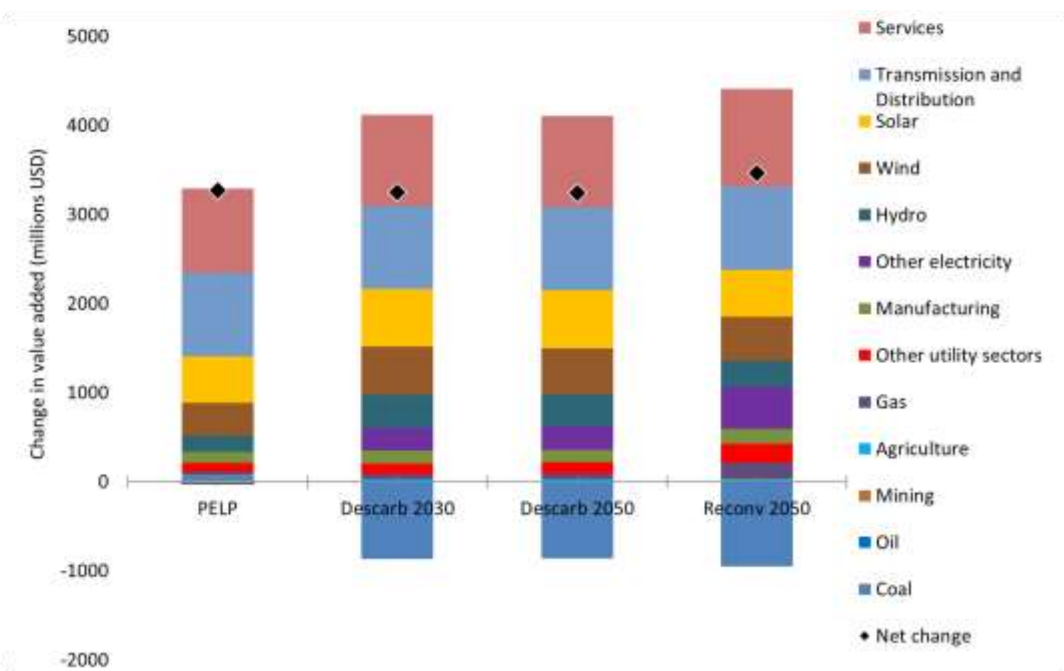

Figure 13: Impact on value added by2050 based on different scenarios

Figure 13 shows that the net change in value added is very similar between Descarbon2030 and Reconv2050 scenarios which both scenarios will lead to net economic benefit from switching fossil fuels to renewables.

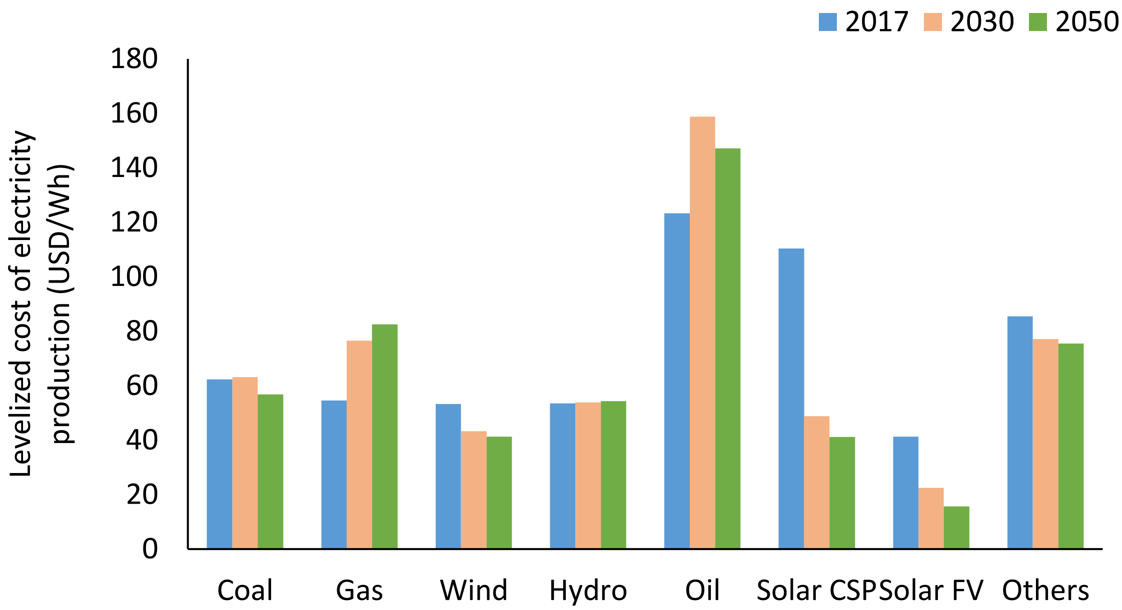

Figure 14: Assumptions on the levelized cost of generating electricity per technology. Source: Ministry of Energy

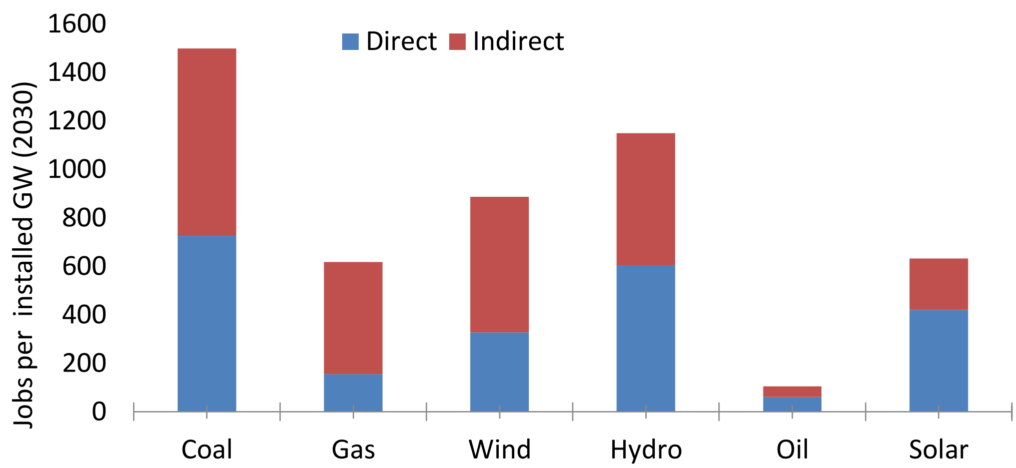

Figure 15: Number of jobs per of installed capacity and technology.