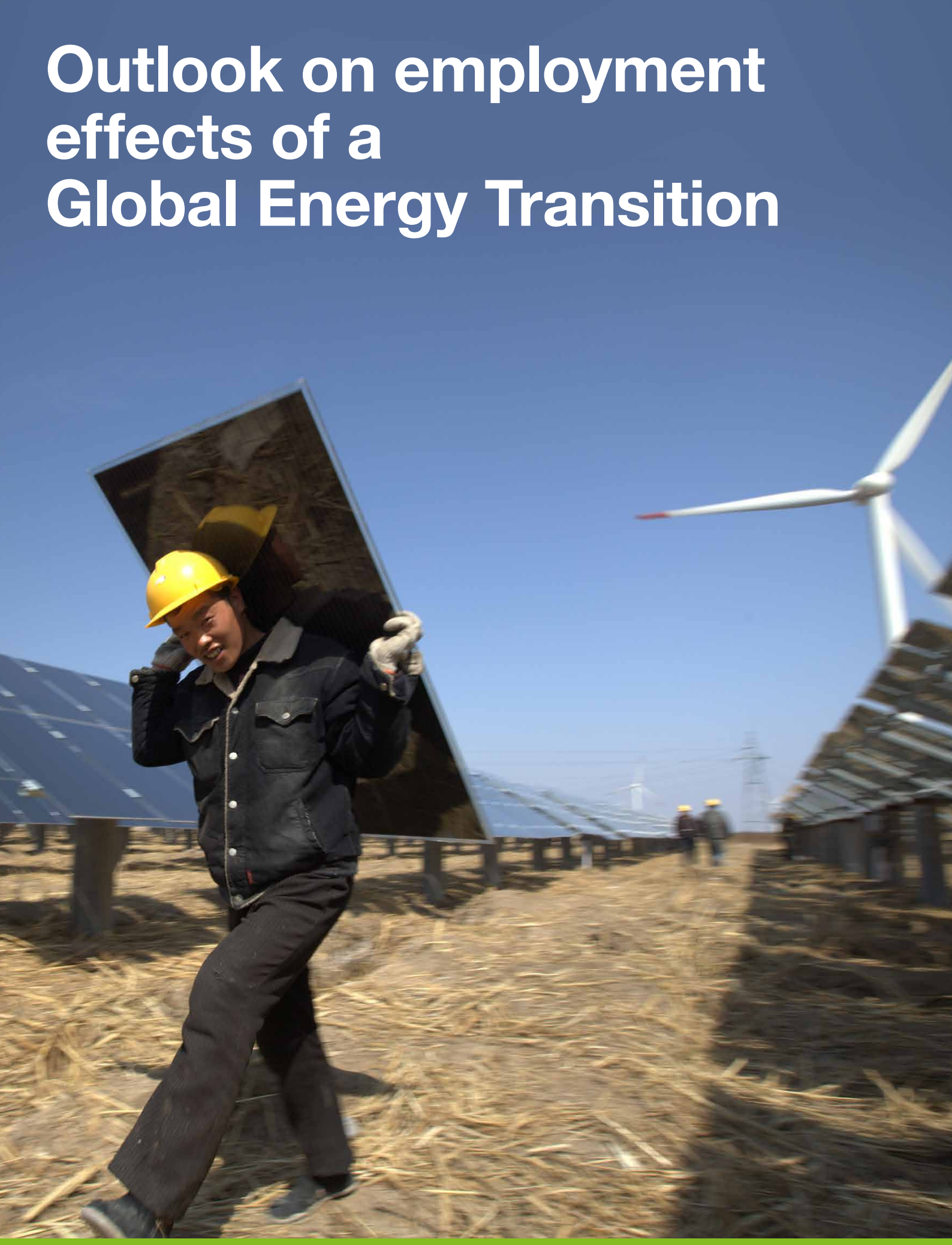
Outlook on employment effects of a Global Energy Transition



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Outlook on employment effects of a Global Energy Transition

Prepared for Greenpeace Foundation, Germany

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The Institute for Sustainable Futures (ISF) is an interdisciplinary research and consulting organisation at the University of Technology Sydney. ISF has been setting global benchmarks since 1997 in helping governments, organisations, businesses and communities achieve change towards sustainable futures. We utilise a unique combination of skills and perspectives to offer long term sustainable solutions that protect and enhance the environment, human wellbeing and social equity.

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Imprint

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1 Executive Summary

The transition to a 100% renewable energy system will lead to changes in the type and location of jobs in the energy sector, but overall the transition has a positive impact on the number of jobs in the energy sector.

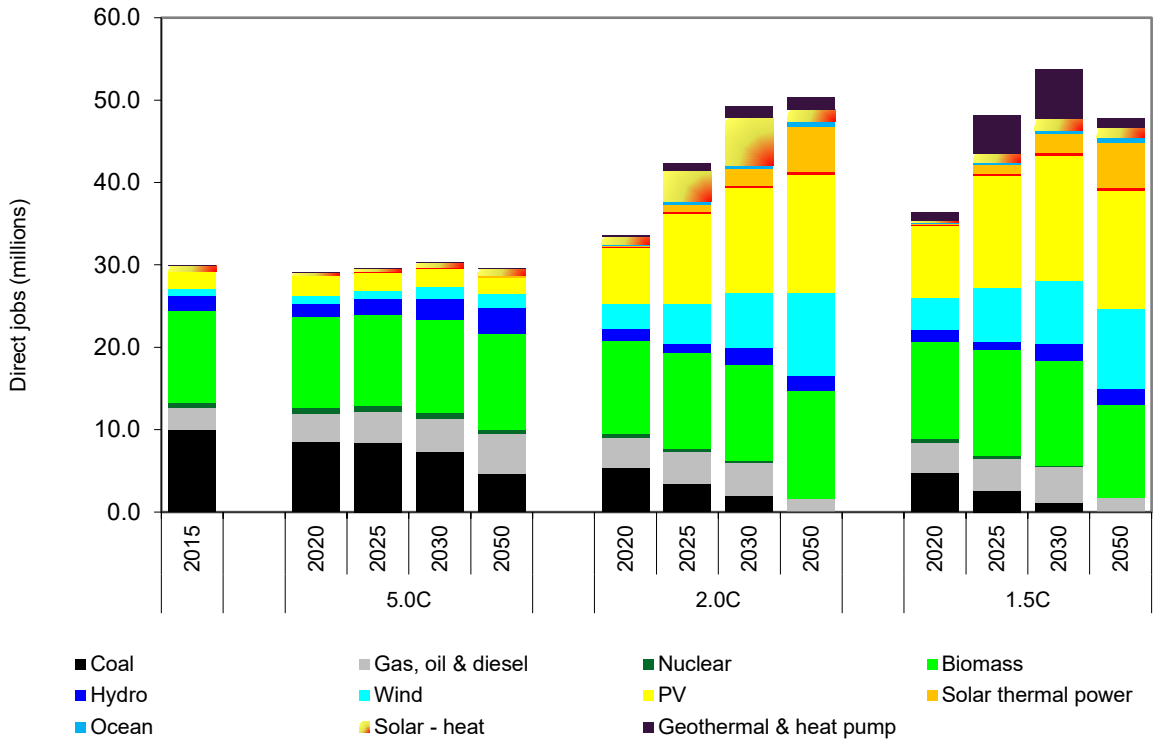
Global employment by technology

Under two renewable energy scenarios that limit global warming to 2.0°C and 1.5°C, it is projected that there will be more energy-sector jobs compared to an energy system that is based on fossil fuels.

The projection of direct jobs in the energy-sector out until 2050 is shown in Figure A. This compares employment under a 2.0°C and 1.5°C Scenario to a reference case 5.0°C Scenario. The types of jobs include a range of occupations in the manufacturing, construction, operations and maintenance, fuel and heat supply, from fossil fuel and renewable energy technologies.

Global employment in the energy sector (millions)			
	5.0°C	**2.0°C**	**1.5°C**
2025	29.6	42.3	48.1
2030	30.3	49.2	53.8
2050	29.5	50.4	47.8

Figure A: Global employment under 3 scenarios



The 2.0°C and 1.5°C Scenarios are projected to generate more energy-sector jobs globally at every stage of the projection compared to the 5.0°C Scenario. Under the 1.5°C Scenario employment increases faster, as new renewable energy is installed earlier than in the 2.0°C Scenario. By 2050, both scenarios project around 47-50 million jobs in the energy sector, compared to around 30 million in the reference case.

Strong growth in renewable energy will lead to an increase of 66% in total energy-sector jobs by 2025 under the 1.5°C Scenario and 44% under the 2.0°C Scenario. Employment numbers remain stable under the 5.0°C Scenario.

Renewable energy account for more than 80% of jobs in the energy sector by 2025 in the 1.5°C and 2.0°C Scenarios. Solar PV has the greatest share of jobs, followed by biomass, wind, and solar thermal.

Occupational breakdown of employment

To plan for a just transition, it is important to understand the occupations and locations at which jobs are likely to be lost or created.

Jobs will increase across all major occupation categories between 2015 and 2025 in the 1.5°C Scenario, as jobs lost in fossil fuels are replaced with growth in jobs in renewable energy.

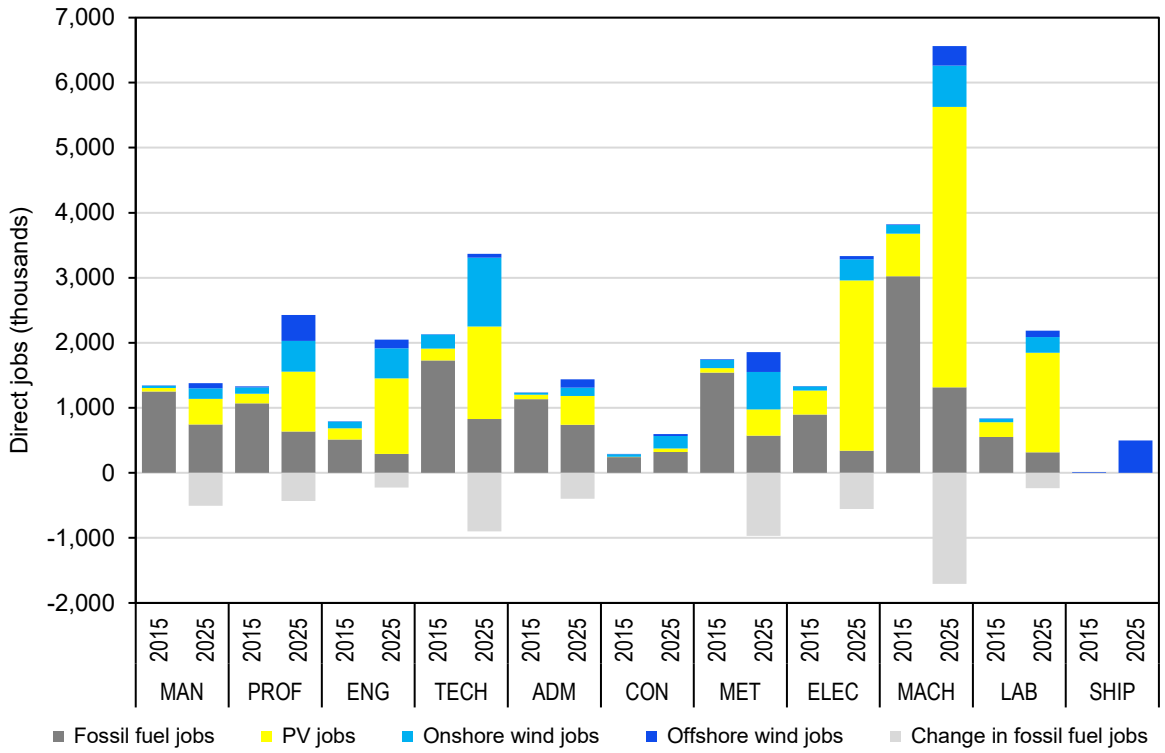
The breakdown of specific occupations for key renewable energy technologies (solar PV, onshore wind, offshore wind) and fossil fuels (coal and gas) is shown in Figure B.

However, these results are not uniform across regions. For example, China and India will both experience a reduction in the number of jobs for managers and clerical and administrative workers.

Change in occupation between 2015 and 2025 in the 1.5°C Scenario

OCCUPATION	Total increase	% difference
MANAGERS	35,000	3%
PROFESSIONALS	1,100,000	83%
ENGINEERS	1,260,000	159%
TECHNICIANS	1,235,000	58%
CLERICAL & ADMINISTRATIVE	200,000	16%
CONSTRUCTION TRADES	310,000	107%
METAL TRADES	110,000	6%
ELECTRICIANS	1,995,000	150%
MACHINISTS & ASSEMBLERS	2,740,000	72%
LABOURERS	1,350,000	162%
TOTAL	**10,335,000**	**70%**
SHIP CREW	490,000	4000%

Figure B: Global occupational breakdown between 2015 and 2025 in 1.5C scenario



Conclusion

The occupational employment analysis was developed in 2018 to improve the database for the 'just transition' concept. Not only is the number of jobs that will be created or lost as a result of a global or regional energy transition important, but also the specific occupations that will be to develop a socially sound transition. This analysis breaks new grounds because very little information has been available. However, the results indicate that even within the seven occupation types, job losses are the exception and almost all trades will gain more jobs.

Very specialized jobs, such as machine operators in coal mines, will be lost and there will be no replacement. Therefore, a detailed analysis of all sectors is required to identify those highly specialized tasks and to develop re-training possibilities.

The results indicate that an energy transition towards 100% renewable energy will have net positive employment impact for close to all job categories. However, a long-term plan for an orderly fossil-fuel phase-out is required for regions. This includes a transition plan for employees which are 10 years or less away from retirement.

The Paris Climate Agreement needs a fossil fuel phase-out within the next decades, thus fossil fuel industries need to stop training of young employees as they will have to be retrained later on.

Furthermore, the training of engineers, technicians and trades people needs to be re-organized to match the requirements of the renewable energy industry.

One of the major societal concerns and impacts that needs to be managed is the impact of energy transition on workers. Workers especially in coal producing regions and their union and political representatives understandably worry about job losses and their futures. The results illustrate both that jobs will be created in energy transition but also that just transition planning and investment will be essential to manage this transition fairly for workers. While workers in the offshore oil industry can make a transition to offshore wind as the example of the North Sea Oil and Gas industry demonstrates.

Some job types (e.g. managers, administrative staff) experience very modest growth but there is major growth in labourers, electricians, engineers, construction trades and machinists and assemblers.

Whilst there is strong growth in the overall number of machinists and assemblers, there is a very large number of construction jobs in the renewable industry. However, operation and maintenance jobs for solar and especially at on- and offshore wind farm are substantial but require a very different skillset as in coal mining related jobs. , Qualitative case studies undertaken to supplement the quantitative modelling highlights that many of the large-scale renewable energy projects are not in same regions as the coal power generation and mining. Consequently, it does not follow that the job created will simply substitute for the lost jobs. Thus, renewable energy expansion plans from governments, require careful siting for centralized renewable energy projects including regional employment effects.

One of the clearest lessons from past coal and industrial transitions is that early planning and investment is essential to avoid major social impacts at a regional level. The employment modelling demonstrates the jobs will be created but just transition plans need to be developed for an orderly fossil-fuel phase-out which includes:

- Social compacts: high level political frameworks and multi-stakeholder governance for fossil-fuel phase out
- Planning frameworks for closure: regional, industry and company level agreements are needed to plan for site remediation, worker redeployment, early-retirements, re-training and support
- Economic diversification and local energy programs to create demand for labour as transition occurs within these regions
- Just transition funds and authorities to organise and coordinate investment and plans.
- Early retirement plans for workers close to the retirement age.

The ISF occupational employment modelling is first-of-its-kind work – building heavily on studies by IRENA – and will need further work to generate more specific understanding of the types and locations of jobs. All the major job categories grow but within these groupings that will grow and groupings that will decline – it is important to understand these patterns to identify both where

training for growth needs to occur and adjustment support needs to focus. If these results show jobs will grow as the transition to 100 per cent renewable energy systems takes place they also underline the importance of just transition plans.

Figure C provides an overview about the employment developments by occupational breakdown. The data on the left shows the employment situation and data on the right the requirements of the future energy market in regard to the various job categories for the 1.5°C Scenario.

All eleven job categories – from managers to labourers – increase in numbers significantly. Within each category, training programs are required in order to facilitate a just and fair transition.

The data available on the detailed employment requirements for renewable energies are very limited. Although there are some data for solar PV and onshore and offshore wind, there are almost none for concentrated solar power plants or geothermal energy. Furthermore, occupational surveys of the heating and energy efficiency sectors are required.

Figure C: Global occupational breakdown between 2015 and 2025 in 1.5C scenario

In addition to this report, the Institute for Sustainable Futures (ISF) at the University of Technology Sydney, in collaboration with the Institute for Advanced Sustainability Studies (IASS) Potsdam, an in-depth case study report has been finalized in February 2019. The case-study report investigates just transition pathways away from existing coal industries and identify enablers and measures that have proven successful (or unsuccessful). Four case studies focussed on coal-dependent communities and their efforts and challenges in the structural change process in Germany, Poland, South Africa and Indonesia. It aims to understand enablers and barriers to economic restructuring in the energy sector and identify and compare measures that ensure a just socio-economic transition for the workers and local communities involved.

2 Introduction

The transition to a 100% renewable energy system is not just a technical task, but a socially and economically challenging process. It is imperative that the transition is managed in a fair and equitable way. One of the key concerns is the employment of workers in the fossil fuel industries and the impacts on regions where the economy is dependent on coal, oil or gas (UNFCCC 2016; ILO 2015). However, it should be noted that the just transition concept is concerned, not only with workers' rights, but also with the broader community (Smith 2017; Jenkins et al. 2016; Sovacool 2014).

Although it is acknowledged that a just transition is important, little is known about the impacts that the transition will have on the number of jobs that will be lost and created within particular occupations and locations as the technologies shift. National statistical agencies often classify and collect data on occupations within the fossil fuel sectors but not within the renewable energy sectors (ABS 2017).

This study aims to understand the impacts of a transition to a 100% renewable energy system, to better understand the potential social and economic aspects of the transition. This can provide a basis for further research at a local level, and highlight where action will be needed to ensure a just transition for fossil fuel workers and regions.

The two key dimensions of the study are:

- **Total employment in the energy sector:** The total number of jobs are projected out until 2050 based on 5.0°C, 2.0°C, and 1.5°C Scenarios. This projection is the total number of **direct** jobs in electricity, heating, and fuel production sectors, across 12 fossil fuel and renewable technologies. The calculations are based on employment factors in construction, manufacturing, operations and maintenance and fuel supply. These calculations are based on the methodology previously developed by the Institute for Sustainable Futures, University of Technology Sydney (UTS-ISF) and is updated with recent data on employment.
- **Occupational breakdown of employment:** The share of specific occupations is calculated based on the results from the total employment calculations for five technologies: solar PV, onshore wind, offshore wind and coal and gas. This is calculated for 2015 and compared to the 2025 for the 2.0°C, and 1.5°C Scenarios, to understand which occupations are likely to see jobs lost or new jobs created. This is a new methodology developed by UTS-ISF for this study.

Projected employment (both total employment and occupational breakdown) is calculated for 10 world regions and global results are an aggregate of the regional results.

This report presents and overview of the methodology, followed by results for global employment and for 10 world regions. This is followed by a discussion. This study is funded by the German Greenpeace Foundation as part of a broader project on Just Transitions. This report presents the results of the modelling aspect of the projects and separate report presents four case studies on just transitions in coal-dependent regions.

3 Methodology

The methodology outlined in this section comprises of two dimensions: the total employment in the energy sector and the occupational breakdown. The methodology for analysing the total employment in the energy sector was first developed in 2009 for the Greenpeace Energy [R]evolution study (see Rutovitz et al., 2015; Rutovitz and Atherton, 2009). This methodology has been updated for this study in order to understand the types of occupations in key technologies, to attempt to understand where labour is likely to be required in the renewable energy transition, and where job losses are likely to occur.

The key benefit of this methodology is that it calculates direct employment only, and does not include indirect employment as is common for many macro-economic models of the energy sector.

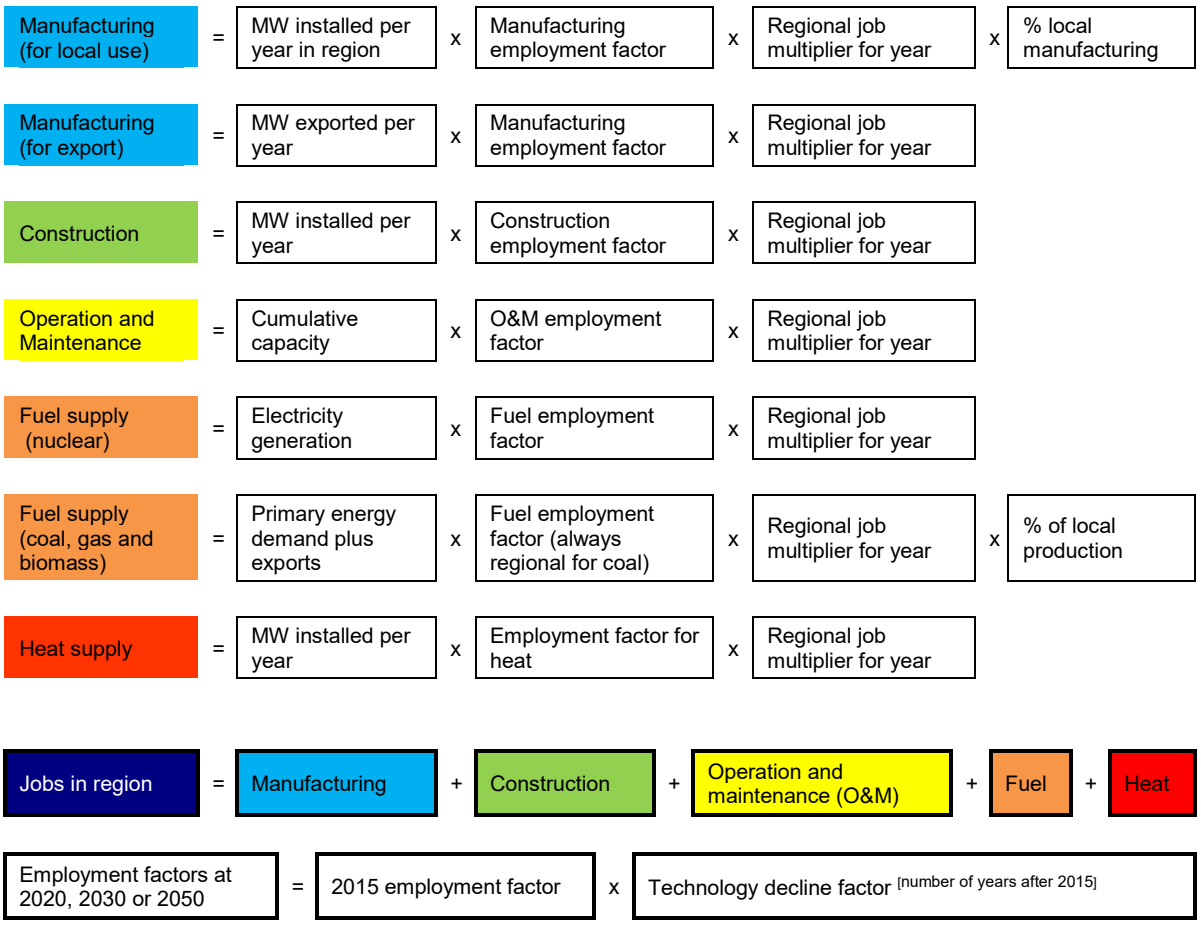
3.1 Total employment in the energy sector

3.1.1 Overview of methodology

This study projects the total employment in the energy sector against three scenarios: A 1.5°C and 2.0°C Scenario for 100% renewable energy and a reference case 5.0°C Scenario.

Employment is projected for each of scenarios from 2015 until 2050 for ten world regions. The calculations are based on a series of employment multipliers and the projections for energy use and capacity. Only direct employment is included, namely jobs in construction, manufacturing, operations and maintenance, and fuel supply associated with electricity generation and direct heat provision. An overview of the total employment methodology is given in Figure 1.

Figure 1: Total employment calculation: methodological overview



The main inputs for the quantitative employment calculations are outlined below.

For each scenario (1.5°C, 2.0°C and 5.0°C):

- the electrical and heating capacity that will be installed each year for each technology;
- the primary energy demand for coal, gas, and biomass fuels in the electricity and heating sectors;
- the amount of electricity generated per year from nuclear power, oil, and diesel.

For each technology:

- 'employment factors', or the number of jobs per unit of capacity, separated into manufacturing, construction, operation, and maintenance, and per unit of primary energy for fuel supply;
- for the 2020, 2030, and 2050 calculations, a 'decline factor' for each technology, which reduces the employment factors by a certain percentage per year. This reflects the fact that employment per unit decreases as technology efficiencies improve.

For each region:

- the percentage of local manufacturing and domestic fuel production in each region, to calculate the proportions of jobs in manufacturing and fuel production that occur in the region;
- the percentage of world trade in coal and gas fuels, and traded renewable components that originates in each region.
- a 'regional job multiplier', which indicates how labour-intensive the economic activity is in that region compared with the OECD, is used to adjust the OECD employment factors when local data are not available.
- a set of 'decline factors' for each technology, based on the projected costs for that region in the Reference Scenario.

The figures for the increase in electrical capacity and energy use from each scenario are multiplied by the employment factors for each of the technologies, and then adjusted for regional labour intensity and the proportion of fuel or manufacturing that occurs locally.

A range of data sources were used for the model inputs, including the International Energy Agency, US Energy Information Administration, BP Statistical Review of World Energy, US National Renewable Energy Laboratory, International Labour Organization, World Bank, industry associations, national statistics, company reports, academic literature, and the UTS-ISF's own research.

These calculations only take into account direct employment; for example, the construction team required to build a new wind farm. They do not include indirect employment; for example, the extra services provided in a town to accommodate the construction team.

The calculations do not include jobs in energy efficiency because this is beyond the scope of this project. The large number of assumptions required to make these calculations means that employment numbers are only estimates, especially for regions where few data exist. However, within the limits of data availability, the figures presented are representative of employment levels under the given scenarios.

3.1.2 Energy scenarios

The energy scenarios used for this modelling were developed by UTS-ISF, in partnership with the German Aerospace Centre (DLR), Institute for Engineering Thermodynamics, Department of Systems Analysis and Technology Assessment (STB), and funded by the Leondardo DiCaprio Foundation (Teske, 2019).

The ISF/DLR scenario was developed to achieve the climate target agreed in the Paris Climate Agreement from 2015 to limit anthropologic climate change to a maximum of 1.5°C or 2.0°C degrees above the pre-industrial levels. This projection is more ambitious than other published scenarios, for example the IEA scenario projects the global development of renewable power and electric mobility under the assumption that current policies will not change.

Renewable power generation – in particular solar PV and wind – are the most cost competitive electricity generation technologies compared to all other power generation technologies for installations and are projected to increase their market share. The scenarios are undertaken for ten regions, based on their renewable energy resource potential.

The 5.0°C Scenario (reference scenario):

The reference scenario only takes into account existing international energy and environmental policies and is based on the International Energy Agency (IEA) World Energy Outlook. Its assumptions include, for example, continuing progress in electricity and gas market reforms, the liberalization of cross-border energy trade, and recent policies designed to combat environmental pollution. The scenario does not include additional policies to reduce GHG emissions. Because the IEA's projections only extend to 2040, we extrapolate their key macroeconomic and energy indicators forward to 2050. This provides a baseline for comparison with the 2.0°C and 1.5°C Scenarios.

The 2.0°C Scenario:

The first alternative scenario aims for an ambitious reduction in GHG emissions to zero by 2050 and a global energy-related CO_2 emission budget of around 590 Gt between 2015 and 2050. This scenario is close to the assumptions and results of the Advanced E[R] scenario published in 2015 by Greenpeace. However, it includes an updated base year, more-coherent regional developments in energy intensity, and reconsidered trajectories and shares of the deployment of renewable energy systems. Compared with the 1.5°C Scenario, the 2.0°C Scenario allows for some delays due to political, economic, and societal processes and stakeholders.

The 1.5°C Scenario:

The second alternative scenario aims to achieve a global energy-related CO_2 emission budget of around 450 Gt, accumulated between 2015 and 2050. The 1.5°C Scenario requires immediate action to realize all available options. It is a technical pathway, not a political prognosis. It refers to technically possible measures and options without taking into account societal barriers. Efficiency and renewable potentials need to be deployed even more quickly than in the 2.0°C Scenario, and avoiding inefficient technologies and behaviours are essential strategies for developing regions in this scenario.

Key results of the global long-term energy scenarios show that the efficiency and uptake of renewable energy are two sides of the same coin. All sectors, including transport, industry, and all commercial and residential buildings, must use energy efficiently and from a huge range of renewable energy technologies. Compared with the 5.0°C Scenario, which was defined using assumptions from the IEA, the alternative scenarios require more stringent efficiency levels. The 1.5°C Scenario involves the even faster implementation of efficiency measures than in the 2.0°C Scenario and the decelerated growth of energy services in all regions, in order to avoid a further strong increase in fossil fuel use after 2020.

Total final energy demand is estimated based on assumptions about the demand drivers, specific energy consumption, and the development of energy services in each region. In the 5.0°C Scenario, the global energy demand will increase by 57% from 342 EJ/yr in 2015 to 537 EJ/yr in 2050. In the 2.0°C Scenario, the final energy will be 19% lower than the current consumption and will reach 278 EJ/yr by 2050. The final energy demand in the 1.5°C Scenario will be 253 EJ, 26% below the 2015 demand, and in 2050, will be 9% lower than in the 2.0°C Scenario.

Global electricity demand will significantly increase in the alternative scenarios due to the electrification of the transport and heating sectors, which will replace fuels, but will also be due to a moderate increase in the electricity demand of 'classical' electrical devices on a global level. In the 2.0°C Scenario, the electricity demand for heating will be about 12 600 TWh/yr from electric heaters and heat pumps, and in the transport sector, there will be an increase of about 23 400 TWh/yr due to electric mobility. The generation of hydrogen (for transport and high-temperature process heat) and the manufacture of synthetic fuels for transport will add an additional power demand of 18 800 TWh/yr. The gross power demand will thus rise from 24 300 TWh/yr in 2015 to 65 900 TWh/yr in 2050 in the 2.0 °C Scenario, 34% higher than in the 5.0°C Scenario. In the 1.5°C Scenario, the gross electricity demand will increase to a maximum of 65 300 TWh/yr in 2050.

Global electricity generation from renewable energy sources will reach 100% by 2050 in the alternative scenarios. 'New' renewables—mainly wind, solar, and geothermal energy—will contribute 83% of the total electricity generated. The contribution of renewable electricity to total production will be 62% by 2030 and 88% by 2040. The installed capacity of renewables will reach about 9 500 GW by 2030 and 25 600 GW by 2050. The proportion of electricity generated from renewables in 2030 in the 1.5°C Scenario is assumed to be 73%. The 1.5°C Scenario will have a generation capacity of renewable energy of about 25 700 GW in 2050.

From 2020 onwards, the continuing growth of wind and PV to 7 850 GW and 12 300 GW, respectively, will be complemented by the generation of up to 2 060 GW of solar thermal energy, as well as limited biomass-derived (770 GW), geothermal (560 GW), and ocean-derived energy (around 500 GW) in the 2.0°C Scenario. Both the 2.0°C and 1.5°C Scenarios will lead to the generation of high proportions (38% and 46%, respectively) of energy from variable power sources (PV, wind, and ocean) by 2030, which will increase to 64% and 65%, respectively, by 2050. This will require a significant change in how the power system are operated. The main findings of the power sector analysis are summarized in the section below.

Final energy demand for heating will increase by 59% in the 5.0°C Scenario, from 151 EJ/yr in 2015 to around 240 EJ/yr in 2050. Energy efficiency measures will help to reduce the energy demand for heating by 36% in 2050 in the 2.0°C Scenario, relative to that in the 5.0°C case, and by 40% in the 1.5°C Scenario.

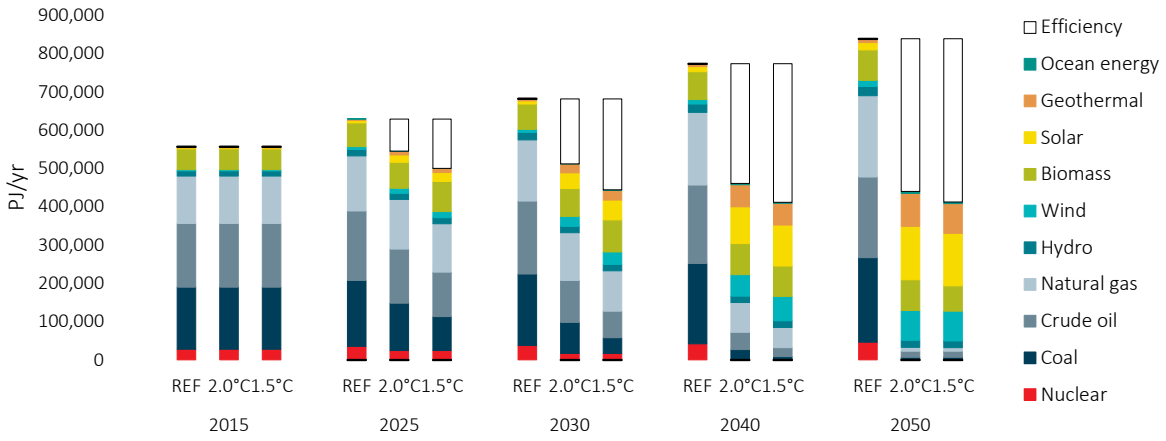
Global heat supply: In 2015, renewables supplied around 20% of the final global energy demand for heating, mainly from biomass. Renewable energy will provide 42% of the world's total heat demand in 2030 in the 2.0°C Scenario and 56% in the 1.5°C Scenario. In both scenarios, renewables will provide 100% of the total heat demand in 2050. This will include the direct use of electricity for heating, which will increase by a factor of 4.2–4.5 between 2015 and 2050 and will constitute a final share of 26% in 2050 in the 2.0°C Scenario and 30% in the 1.5°C Scenario.

Global primary energy demand in the 2.0°C Scenario will decrease by 21% from around 556 EJ/yr in 2015 to 439 EJ/yr. Compared with the 5.0°C Scenario, the overall primary energy demand will decrease by 48% by 2050 in the 2.0°C Scenario (5.0°C: 837 EJ in 2050). In the 1.5 °C Scenario, the primary energy demand will be even lower (412 EJ) in 2050 because the final energy demand and conversion losses will be lower.

Global primary energy supply: Both the 2.0°C and 1.5°C Scenarios aim to rapidly phase-out coal and oil, after which renewable energy will have a primary energy share of 35% in 2030 and 92% in 2050 in the 2.0°C Scenario. In the 1.5°C Scenario, renewables will have a primary share of more than

92% in 2050 (this will include non-energy consumption, which will still include fossil fuels). Nuclear energy is phased-out in both the 2.0°C and 1.5°C Scenarios. The cumulative primary energy consumption of natural gas in the 5.0°C Scenario will sum to 5580 EJ, the cumulative coal consumption will be about 6360 EJ, and the crude oil consumption to 6380 EJ. In the 2.0°C Scenario, the cumulative gas demand is 3140 EJ, the cumulative coal demand 2340 EJ, and the cumulative oil demand 2960 EJ. Even lower fossil fuel use will be achieved under the 1.5°C Scenario: 2710 EJ for natural gas, 1570 EJ for coal, and 2230 EJ for oil. In both alternative scenarios, the primary energy supply in 2050 will be based on 100% renewable energy (Figure 2).

Figure 2: Global projections of total primary energy demand (PED) by energy carrier



3.1.3 Employment factors

Employment factors were used to calculate the number of jobs required per unit of electrical or heating capacity, or per unit of fuel. The employment factors differ depending on whether they involve manufacturing, construction, operation and maintenance, or fuel supply. Information about these factors usually comes from OECD countries because that is where most data are collected, although local data were used wherever possible. For job calculations in non-OECD regions, regional adjustments were made when a local factor was not available (see 3.1.4). The employment factors used in the calculations are shown in Table 1.

Table 1: Summary of employment factors

	Construction/ installation	Manufacturing	Operations & maintenance	Fuel – Primary energy demand
	Job years/ MW	**Job years/ MW**	**Jobs/MW**	
Coal	11.4	5.1	0.14	Regional
Gas	1.8	2.9	0.14	Regional
Nuclear	11.8	1.3	0.6	0.001 jobs per GWh final energy demand
Biomass	14.0	2.9	1.5	29.9 Jobs/PJ
Hydro-large	7.5	3.9	0.2	
Hydro-small	15.8	11.1	4.9	
Wind onshore	3.0	3.4	0.3	
Wind offshore	6.5	13.6	0.15	
PV	13.0	6.7	0.7	
Geothermal	6.8	3.9	0.4	
Solar thermal	8.9	4.0	0.7	
Ocean	10.3	10.3	0.6	
Geothermal – heat	6.9 jobs/ MW (construction and manufacturing)			
Solar – heat	8.4 jobs/ MW (construction and manufacturing)			
Nuclear decommissioning	0.95 jobs per MW decommissioned			
Combined heat and power	CHP technologies use the factor for the technology, i.e. coal, gas, biomass, geothermal, etc., increased by a factor of 1.5 for O&M only.			

Coal fuel supply:

The employment factors for coal are particularly important to have at the regional level, because employment per tonne varies significantly across the world regions and because coal plays a significant role in energy production in many countries. In Australia and the USA, coal is extracted at an average rate of more than 9000 tonnes per person per year, whereas in Europe, the average coal miner is responsible for less than 1000 tonnes per year. China has relatively low per capita productivity at present, with 650 tonnes per worker per year, but the annual increases in productivity are very high. India and Eurasia have significantly increased their productivity since a similar analysis was performed in 2015. Local data were also used for gas extraction in every region except India, the Middle East, and Non-OECD-Asia. The calculation of coal and gas employment per petajoule (PJ) drew on data from national statistics and company reports, combined with production figures from the BP Statistical Review of World Energy 2018 (BP-SR 2018) or other sources. Data were collected for as many major coal-producing countries as possible, and coverage was obtained for 90% of the world coal production.

Table 2: Employment factors used for coal fuel supply (mining and associated jobs)

	Employment factor Jobs per PJ	Tonnes per person per year (coal equivalent)
World average	36.2	943
OECD North America	3.5	9 613
OECD Europe	36.2	942
OECD Pacific	3.6	9 455
India	33.6	1 016
China	52.9	645
Africa	13.7	2 482
Eastern Europe/Eurasia	36.0	948
Non-OECD Asia	6.5	5 273
Latin America	12.5	2 725
Middle East	Uses world average because no employment data was available	

3.1.4 Regional adjustments

The employment factors used in this model for energy technologies other than coal mining were usually for OECD regions, which are typically wealthier than other regions. A regional multiplier was applied to make the jobs per MW more realistic for other parts of the world. In developing countries, there are generally more jobs per unit of electricity because those countries have more labour-intensive practices. The multipliers change over the study period, consistent with the projections for GDP per worker. This reflects the fact that as prosperity increases, labour intensity tends to fall. The multipliers are shown in Table 3.

Table 3: Regional multipliers used for the quantitative calculation of employment

	2015	2020	2030	2040	2050
OECD (North America, Europe, Pacific)	1.0	1.0	1.0	1.0	1.0
Latin America	3.4	3.4	3.4	3.1	2.8
Africa	5.7	5.7	5.5	5.2	4.8
Middle East	1.4	1.5	1.4	1.4	1.2
Eastern Europe/Eurasia	2.4	2.4	2.2	2.0	1.8
India	7.0	5.5	3.7	2.7	2.2
Developing Asia	6.1	5.2	4.1	3.5	3.1
China	2.6	2.2	1.6	1.3	1.2

Source: Derived from ILO (2013) Key Indicators of the Labour Market, eighth edition software, with growth in GDP per capita derived from IEA World Energy Outlook 2018 and World Bank data.

3.1.5 Local employment factors

Local employment factors were used where possible. These region-specific factors were:

- *OECD Americas*—gas and coal fuel, photovoltaics (PV) and offshore wind (all factors), and solar thermal power (construction and operation and maintenance (O&M)
- *OECD Europe*—gas and coal fuel, offshore wind (all factors), solar thermal power (construction and O&M), and solar heating
- *OECD Pacific*—gas and coal fuel
- *Africa*—gas, coal, and biomass fuel
- *China*—gas and coal fuel, and solar heating
- *Eastern Europe/Eurasia*—gas and coal fuel
- *Developing Asia*—coal fuel
- *India* – coal fuel and solar heating
- *Latin America*—coal and biomass fuels, onshore wind (all factors), nuclear (construction and O&M), large hydro (O&M), and small hydro (construction and O&M).

3.1.6 Local manufacturing and fuel production

Some regions do not manufacture the equipment (e.g., wind turbines or solar PV panels) required for the introduction of renewable technologies. This model includes estimates of the percentages of renewable technology that are made locally and assumes that the percentage of local manufacturing will increase over time as the industry matures. Based on this, the jobs involving the manufacture of components for export were calculated for the region in which the manufacturing occurs. The same applies to coal and gas, because they are traded internationally, so the jobs in fuel supply were calculated regionally, based on historical data.

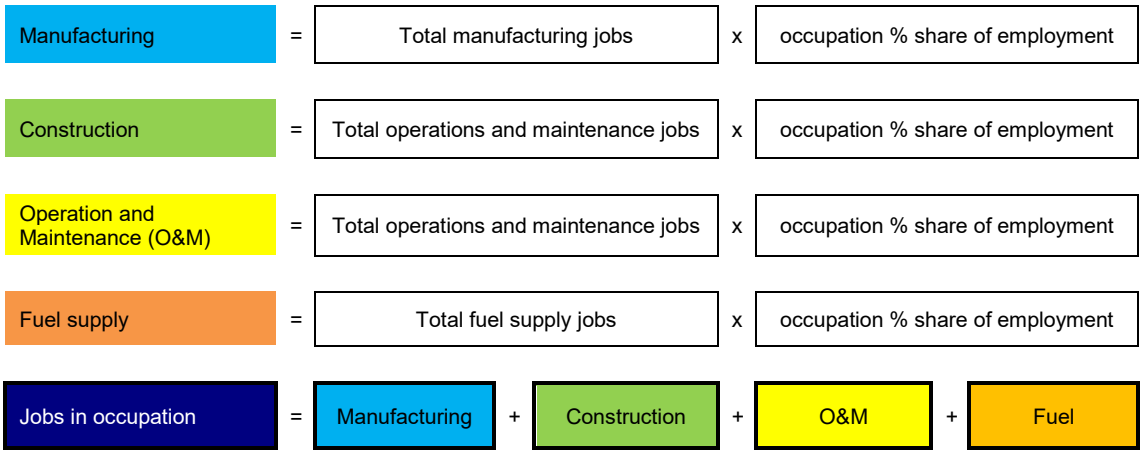
3.2 Occupational employment modelling

Quantitative employment studies at the level of technology and project phases (manufacturing, construction, O&M and fuel supply) are useful when providing estimates of aggregate job creation. However, more disaggregated, granular data on the locations and types of occupations are required to plan a just transition to renewable energy. For example, it is necessary to know how many electricians are currently employed in fossil fuel industries and how many will be employed in the renewable energy sectors. Although our projections cannot predict the future, key trends can be established. For example, we can direct our focus to areas of the workforce in which an increase in the supply of labour will probably be required, and to areas where the effects of dislocation will be greatest.

3.2.1 Overview of methodology

The occupational employment modelling framework used in this study was developed for renewable energy (solar PV, onshore wind, offshore wind) and fossil fuels (coal and gas). The framework is applied to the results of the employment modelling discussed in Section 3.1.1, broken down by construction, manufacturing, operations & maintenance and fuel supply.

Figure 3: Quantitative employment calculation: methodological overview



3.2.2 Renewable energy share of employment

The share of employment in renewable energy was based on three primary studies conducted by the International Renewable Energy Agency (IRENA), that classified and measured the occupational composition of renewable energy industries. Through surveys of around 45 industry participants across a range of developed and developing nations, IRENA estimated the percentages of person–days for the various occupations across the solar PV and onshore and offshore wind farm supply chains (IRENA 2017a, IRENA 2017b, IRENA 2018). Figure 4 is an example (in this case, for solar PV manufacturing).

The IRENA studies are most detailed estimates of the occupational compositions of employment in solar PV and onshore wind projects. However, further work is required to directly match renewable energy job levels against existing fossil fuel sectors and to generate data on mid- and low-skill jobs, which are of primary interest from a just transition perspective. ISF has extended the application of IRENA's work in two key ways:

1. **Mapping IRENA's job categories against the International Standard Classification of Occupations (ISCO)**: IRENA uses its own occupational classification system, which does not match the ISCO, which is the basis for national statistical agency data. For example, 'regulation and standardization experts' is not a category in the ISCO. Consequently, the IRENA job categories have been mapped and translated across to the ISCO to facilitate comparisons between renewable energy technologies and fossil fuel sectors. The best fit for each of the occupations in the IRENA studies has been identified at one-digit, two-digit, three-digit, and four-digit levels of the ISCO.

2. **Unpacking mid- and low-skill job categories in IRENA's study:** Some of the categories in the IRENA studies contain jobs that are of particular interest from a just transition perspective. Specifically, IRENA combines:
    - 'Factory workers' for solar PV and onshore and offshore wind manufacturing
    - 'Ship crews' for offshore wind construction and operation and maintenance
    - 'Construction workers' for solar PV, onshore wind farm construction, and operation and maintenance.

These categories combine a range of technicians, trades, machinery operators, drivers, and assemblers, and labourers.

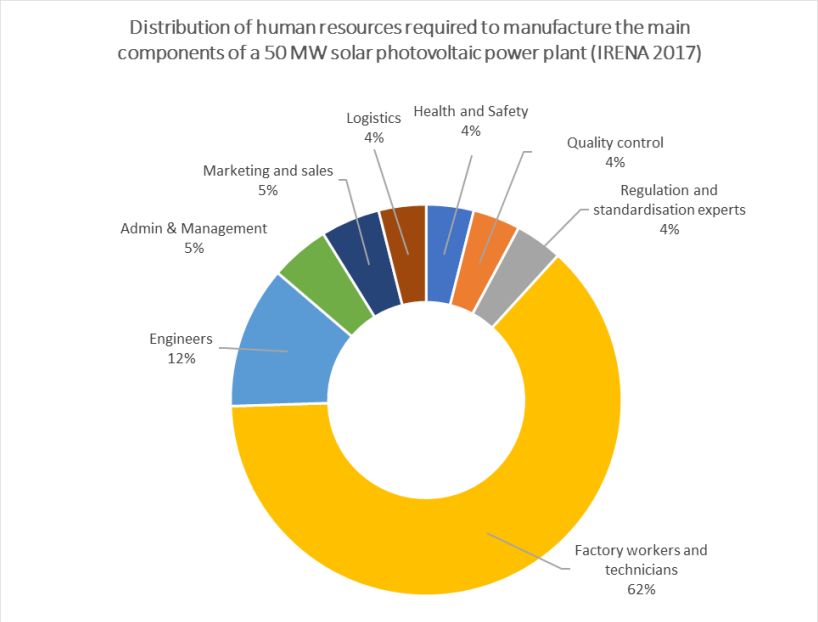


Figure 4: Distribution of human resources required to manufacture the main components of a 50 MW solar photovoltaic power plant (IRENA 2017a)

Mapping IRENA's job categories against the International Standard Classification of Occupations (ISCO)

The job categories used in the IRENA studies have been mapped against the International Standard Classification of Occupations (ISCO), for construction, manufacturing and O&M for solar PV, onshore and offshore wind.

As an example, Table 4 shows the occupational hierarchy for solar PV construction and how it is matched against ISCO. ISCO classifies occupations from a one-digit level (left) to a four-digit level (right). Each level is more detailed than the previous one in terms of the labour force required for the type of work. This methodology has been transferred to an occupational hierarchy that has been constructed for solar PV, onshore wind, and offshore wind using IRENA and other data sources to map jobs against the ISCO. The result is a matrix with percentages allocated to each occupation at the one-, two-, three-, and four-digit levels of aggregation.

Table 4: Occupational hierarchy, solar PV construction

ILO 1-digit		ILO 2-digit		ILO 3-digit		ILO 4-digit	
1 Managers	1.7%	Production and specialised service MANAGERS (13)	1.7%	Manufacturing, Mining, Construction and Distribution MANAGERS (132)	1.7%	Supply, distribution and related MANAGERS (1324)	1.7%
2 Professionals	12.0%	Science & engineering PROFESSIONALS (21)	4.4%	Physical, life & earth science PROFESSIONALS (211)	0.1%	Geotechnical experts (2114)	0.1%
				Life Science PROFESSIONALS (213)	2.1%	Environmental Protection Professionals (2133)	2.1%
		Health Professionals (22)	4.4%	Engineering PROFESSIONALS (214)	1.0%	Mechanical Engineers (2144)	0.8%
				Electrotechnology Engineers (215)	0.8%	Civil Engineers (2142)	0.3%
				Other Health Professionals (226)	4.4%	Electrical engineers (2151)	0.8%
		Business & administrative PROFESSIONALS (24)	3.4%	Finance PROFESSIONALS (241)	2.6%	Environmental and Occupational Health and Hygiene Professionals (2263)	4.4%
						Financial Analysts (2413)	1.9%
				Administration PROFESSIONALS (242)	0.8%	Accountants (2411)	0.7%
						Policy Administration Professionals (2422)	0.8%
3 Technicians and Associate Professionals	27.8%	Business and Administration Associate Professionals (33)	0.6%	Business Services Agents (333)	0.7%	Real Estate Agents and Property Managers (3334)	0.7%
		Science and engineering TECHNICIANS and supervisors (31)	24.9%	Physical and science engineering TECHNICIANS (311)	11.9%	Civil Engineering Technicians (3112)	7.0%
		Information & Communications Technicians (35)	2.1%			Electrical Engineering Technicians (3113)	4.9%
				Mining, Manufacturing & Construction Supervisors (312)	13.0%	Construction supervisors (3123)	13.0%
4 Clerical Support Workers	0.3%	Numerical and Material Recording Clerks (43)	0.3%	ICT Operations & Support Technicians (351)	2.1%	ICT Operations Technicians (3511)	2.1%
				Numerical Clerks (431)	0.3%	Accounting and bookkeeping clerks (4311)	0.2%
7 Craft and related trades workers	31.6%	Electrical and Electronics TRADES Workers (74)	31.6%	Electrical Equipment Installers and Repairers (741)	31.6%	Payroll Clerks (4313)	0.2%
						Building Frame & Finisher Trades (711 & 712)	9.9%
						Sheet & Structural Metal Workers (721)	7.9%
8 Plant and machine operators and assemblers	22.0%	Assemblers 821	9.8%	Assemblers 821	9.8%	Electricial Equipment Installers (741)	13.8%
						Mechanical Machinery Assemblers (8211)	4.2%
		Drivers and mobile plant OPERATORS (83)	12.1%	Heavy Truck and Bus Drivers (833)	4.3%	Electrical Assemblers (8212)	5.6%
						Truck and lorry drivers (8332)	4.3%
				Mobile Plant OPERATORS (834)	7.8%	Earthmoving Plant Operators (8342)	3.5%
9 Elementary occupations	4.3%	Labourers in Mining, Construction, Manufacturing and Transport (93)	4.3%	Mining & Construction Labourers (931)	4.3%	Crane, Hoist and Related Plant Operators (8343)	4.3%
						Civil Engineering Labourers (9312)	4.3%

Unpacking mid- and low-skill job categories in IRENA's study

To determine the occupational breakdown for factory workers, industry data from the Benchmarks of Global Clean Energy Manufacturing study by the Clean Energy Manufacturing Analysis Centre was combined with the occupational framework from the Australian census (CEMAC 2017). The International Standard Classification of Industries (ISIC) used for the CEMAC study were translated across to the Australian New Zealand Standard Classification of Industry framework (which is based on the international classification standard) (Australian Bureau of Statistics & Statistics New Zealand 2013).

Data from the Australian census on the occupational composition of these manufacturing sectors were then used to derive the breakdown of employment (Australian Bureau of Statistics 2017). The census includes a comprehensive stocktake of employment, with data at one-, two-, three- and four-digit levels for each industry. The Australian–New Zealand Standard Classification of Occupations is based on the ISCO. Clean Energy Manufacturing Analysis data on the relative share of the value added by component was used to weight the shares of employment. The Australian manufacturing sectors used are not wind or solar PV manufacturing activities, but as the Clean Energy Manufacturing Analysis Centre notes, 'Large portions of the wind energy supply chain connect well to core manufacturing industries' (CEMAC 2017). An overview of how the share of occupations for factory workers was derived (based on ISIC categories used by CEMAC and equivalent ANZSIC classifications) is shown in Table 5.

Table 5: Wind and solar PV manufacturing–study methodology

Technology	Component	ISIC Industry Category	Equivalent ANZSIC Classification
Wind	Nascelles	Machinery & Equipment Manufacturing, not elsewhere classified	22 Fabricated metal product manufacturing 222 Structural Metal Product Manufacturing 2221 Structural Steel Fabricating
	Blades	Manufacturing not elsewhere classified	22 Fabricated metal product manufacturing 222 Structural Metal Product Manufacturing 2221 Structural Steel Fabricating
	Towers	Fabricated metal product manufacturing	22 Fabricated metal product manufacturing 222 Structural Metal Product Manufacturing 2221 Structural Steel Fabricating
	Steel	Basic metal manufacturing	21 Primary Metal and Metal Product Manufacturing 211 Basic Ferrous Metal Manufacturing 2110 Iron Smelting & Steel Manufacturing
	Generators	Electrical machinery & apparatus manufacturing,	24 Machinery & Equipment Manufacturing 243 Electrical Equipment Manufacturing 2439 Other Electrical Equipment Manufacturing
Solar PV	Modules Cells Wafers	Computers, Electronic and Optical Equipment Manufacturing	24 Machinery & Equipment Manufacturing 243 Electrical Equipment Manufacturing 2439 Other Electrical Equipment Manufacturing

To clarify construction worker categories for onshore wind and PV construction, and for the operation and maintenance of solar PV, five interviews were conducted with project managers who were currently overseeing or had recently completed construction projects.

3.2.3 Fossil fuel share of employment

The framework for fossil fuels was derived from labour statistics from the Australian 2016 national census for coal mining, gas supply, and coal and gas generation (Australian Bureau of Statistics 2017). Although these data are specific to Australia, these statistics provide the best source of data, and regional multipliers applied in the modelling of total employment can adjust the results to account for economic differences between regions.

3.2.4 Final framework

The final framework is shown in Table 6. This is based on a composite profile for each technology using a mix of one-, two-, three-, and four-digit levels of occupation, depending on which best illustrates the breakdown of jobs and allows comparison to be made across technologies. Choices have been made based on the proportion of jobs and the labels that are most readily understandable to readers (noting that the categories used in the ISCO do not always correspond to popularly used titles). Note, for example, that 'Managers' is a one-digit category, but trades are broken down into construction trades, metal trades, and electricians because this provides more meaningful descriptions.

In the example shown in Table 6, it is notable that wind and solar farms employ higher proportions of professionals and technicians for their operations and maintenance than coal mining, and similar or higher proportions of elementary occupations, but much lower proportions of machinery operators and drivers.

Table 6: Occupational compositions for renewable and fossil fuel technologies

		Solar PV			Onshore Wind			Offshore wind			Fossil fuels		
ISCO	Name	Construction	Manufacturing	O&M	Construction	Manufacturing	O&M	Construction	Manufacturing	O&M	Coal mining	Gas supply	Coal and gas generation
1	MANAGERS	1.0%	4.2%	6.3%	1.7%	7.6%	1.5%	2.2%	4.6%	3.0%	6.7%	16.8%	13.0%
2	PROFESSIONALS (LEGAL, FINANCE, SCIENTIFIC)	5.0%	12.7%	4.4%	10.6%	11.3%	11.6%	7.0%	26.0%	15.8%	10.0%	14.7%	6.7%
2	ENGINEERS (INDUSTRIAL, ELECTRICAL, CIVIL)	3.8%	14.3%	14.7%	1.8%	8.7%	27.0%	6.2%	6.3%	7.7%	0.0%	5.6%	8.5%
3	TECHNICIANS & ASSOCIATE PROFESSIONALS	7.2%	6.3%	26.2%	27.8%	6.5%	46.9%	0.1%	3.5%	25.1%	7.5%	10.5%	22.5%
4	CLERICAL & ADMINISTRATIVE WORKERS	3.3%	4.9%	1.3%	0.3%	4.6%	4.7%	0.2%	9.2%	8.4%	5.1%	18.8%	12.1%
7	CONSTRUCTION TRADES	0.8%	0.0%	0.0%	9.9%	2.5%	0.0%	0.0%	2.0%	5.5%	0.0%	13.9%	1.6%
7	METAL TRADES	1.8%	7.9%	0.0%	7.9%	28.4%	0.0%	0.0%	23.3%	0.0%	16.3%	0.0%	12.1%
7	ELECTRICIANS	14.2%	21.6%	32.3%	13.8%	4.0%	4.1%	0.2%	3.3%	5.5%	5.5%	0.0%	11.2%
8	PLANT & MACHINE OPERATORS & ASSEMBLERS	55.6%	10.6%	0.0%	21.9%	18.3%	0.0%	12.9%	15.0%	20.0%	46.4%	13.2%	6.0%
9	LABOURERS (MANUFACTURING, CONSTRUCTION & TRANSPORT)	7.4%	17.5%	14.7%	4.3%	8.2%	4.1%	0.8%	6.7%	8.9%	2.6%	6.5%	6.4%
	SHIP CREW							70.3%					

3.2.5 Methodology and limitations

- At the aggregate level, it is assumed that rising labour productivity over time will reduce the labour intensity (i.e., less FTE/MW) that is applied in the construction, manufacture, and operation and maintenance of each renewable energy technology. No assumptions have been made about changes to the relative labour intensity between occupations. Over time, we would expect that the proportion of less-skilled jobs would fall as a result of mechanization. Therefore, the share of less-skilled jobs is likely to be overestimated.
- IRENA estimates a single global figure for each occupation, averaged from surveys of industry participants across different global markets. In practice, there are variations in labour intensity and the compositions of jobs across supply chains between different regions (broadly speaking, supply chains in lower-wage nations are more labour intensive). ISF takes account of regional conditions in the job factors applied at the level of major sub-sectors (construction, manufacturing, operation and maintenance), but not at the disaggregated level. Therefore, it is likely that the proportion of less-skilled jobs is overestimated for rich economies and underestimated for less-developed economies.
- The breakdown of the category of ‘construction workers’ is based on interviews with some Australian solar and wind project managers. The project managers had overseen recent projects and provided detailed estimates of the contributions of different jobs. Nonetheless, the breakdowns are based on a limited sample, and further research is required to generate more-accurate estimates.

4 Results

The global aggregated results are presented below, followed by the ten regions which make up the global summary. For each, the total employment is given by technology for the 5.0°C and 1.5°C Scenario. The breakdown by sector (construction, manufacturing, O&M and fuel supply) and the 2.0°C scenario is given in the Appendices. For the occupational breakdown only the 1.5°C Scenario results are given between 2015 and 2025, as the 2.0°C results are very similar.

4.1 Global results

4.1.1 Total employment

The 2.0°C and 1.5°C scenarios result in more energy sector jobs globally at every stage of the projection.

- There are 48.1 million energy sector jobs in the 1.5C scenario in 2025, 42.3 million in the 2.0C scenario and 29.6 million in the 5.0C scenario.
- In 2030, there are 53.8 million jobs in the 1.5C scenario, 49.2 million jobs in the 2.0C scenario and 30.3 million in the 5.0C scenario.
- In 2050, there are 47.8 million jobs in the 1.5C scenario, 50.4 million jobs in the 2.0C scenario and 29.5 million in the 5.0C scenario.

Figure 5: Global total employment under 3 scenarios

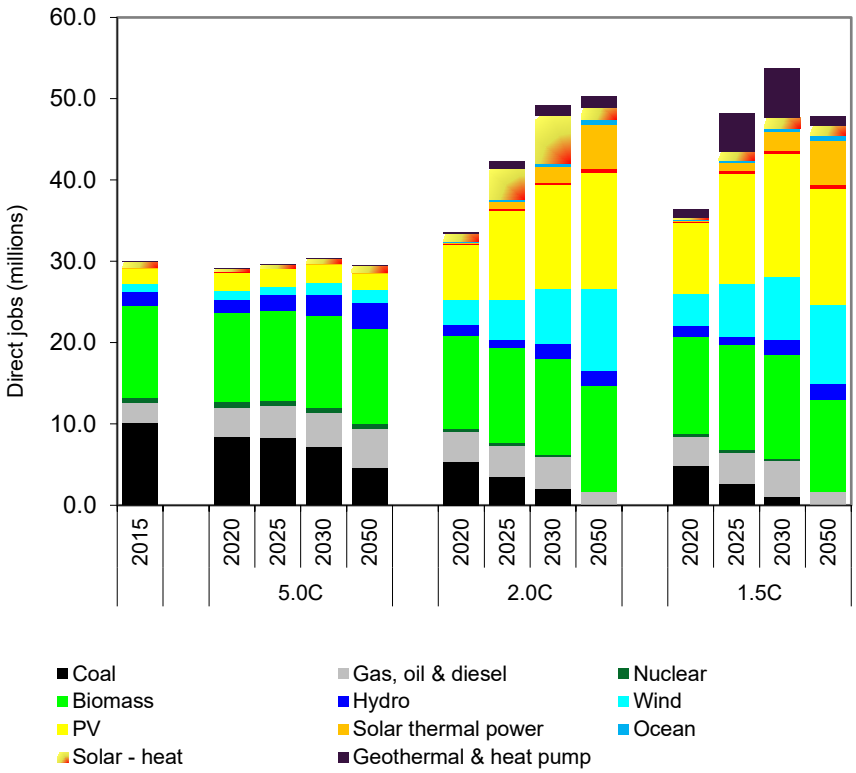


Figure 5 shows the change in job numbers under all scenarios for each technology between 2015 and 2050, and the number of jobs in the 1.5C and 5.0C Scenarios is shown in Table 7.

Strong growth in renewable energy leads to an increase of 61% in total energy sector jobs in the 1.5C scenario and 41% in total energy sector jobs in the 2.0C scenario by 2025.

Jobs in the 5.0C Scenario remain quite stable to 2050.

Renewable energy accounts for 94% of energy sector jobs at 2030 in the 1.5C scenario, with PV having the greatest share (26%), followed by biomass, wind, and solar heating.

Table 7: Global total employment (thousand jobs) in 5.0C and 1.5C scenarios

		5.0C				1.5C			
Technology	**2015**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
Coal	10,070	8,460	8,380	7,254	4,652	4,788	2,568	1,080	69
Gas, oil & diesel	2,571	3,503	3,820	4,112	4,812	3,686	3,934	4,366	1,643
Nuclear	661	706	667	647	555	406	312	221	13
Renewable	**16,663**	**16,481**	**16,739**	**18,310**	**19,503**	**27,502**	**41,334**	**48,116**	**46,105**
Biomass	*11,196*	*11,058*	*11,106*	*11,334*	*11,652*	*11,827*	*12,882*	*12,777*	*11,321*
Hydro	*1,702*	*1,623*	*1,925*	*2,586*	*3,191*	*1,421*	*1,027*	*1,966*	*1,892*
Wind	*970*	*986*	*971*	*1,396*	*1,702*	*3,851*	*6,469*	*7,705*	*9,764*
PV	*1,964*	*2,314*	*2,229*	*2,259*	*1,865*	*8,767*	*13,616*	*15,142*	*14,225*
Geothermal power	*27.5*	*25.5*	*33.2*	*35.2*	*33.5*	*94.7*	*285*	*348*	*459*
Solar thermal power	*23.0*	*34.4*	*47.0*	*106*	*185*	*160*	*1,057*	*2,334*	*5,452*
Ocean	*2.5*	*3.0*	*4.1*	*9.7*	*21.6*	*123*	*279*	*427.0*	*620.8*
Solar - heat	*710*	*389*	*383*	*549*	*816*	*212*	*1,025*	*1,390*	*1,207*
Geothermal & heat pump	*67.7*	*47.16*	*40.586*	*34.9*	*37.3*	*1,047*	*4,695*	*6,027*	*1,166*
Total jobs (thousands)	**29,964**	**29,150**	**29,606**	**30,323**	**29,522**	**36,383**	**48,149**	**53,783**	**47,831**

4.1.2 Occupational breakdown for fossil fuels, solar PV and wind

The breakdown of specific occupations for key renewable energy technologies (solar PV, onshore wind, offshore wind) and fossil fuels (coal and gas) is shown in Figure 6 and Table 8. There is an increase in jobs across all occupations between 2015 and 2025 in the 1.5 degree scenario, as jobs lost in fossil fuels are replaced with growth in jobs in renewable energy.

Figure 6: Global occupational breakdown between 2015 and 2025 in 1.5C scenario

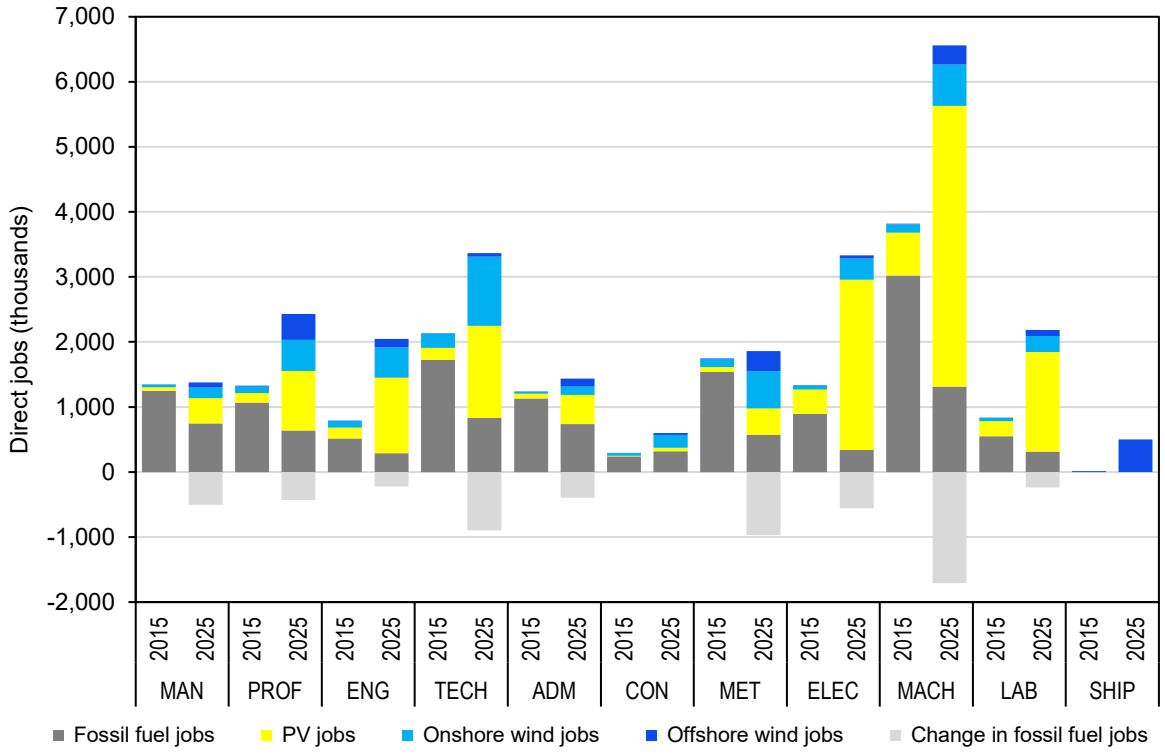


Table 8: Jobs created and lost between 2015 and 2025 under the 1.5 degree scenario

	Jobs created or lost				Total jobs		Difference in jobs	
	Fossil fuels	Solar PV	Wind - onshore	Wind - offshore	Total jobs in 2015	Total jobs in 2025	Total difference	% difference
MANAGERS	- 505,000	355,000	130,000	75,000	1,345,000	1,380,000	35,000	3%
PROFESSIONALS (LEGAL, FINANCE, SCIENTIFIC)	- 430,000	770,000	375,000	385,000	1,330,000	2,430,000	1,100,000	83%
ENGINEERS (INDUSTRIAL, ELECTRICAL, CIVIL)	- 225,000	990,000	365,000	125,000	790,000	2,050,000	1,260,000	159%
TECHNICIANS & ASSOCIATE PROFESSIONALS	- 900,000	1,240,000	840,000	55,000	2,130,000	3,365,000	1,235,000	58%
CLERICAL & ADMINISTRATIVE WORKERS	- 395,000	375,000	100,000	120,000	1,235,000	1,440,000	200,000	16%
CONSTRUCTION TRADES	80,000	45,000	155,000	30,000	290,000	600,000	310,000	107%
METAL TRADES	- 970,000	335,000	450,000	295,000	1,750,000	1,860,000	110,000	6%
ELECTRICIANS	- 560,000	2,250,000	260,000	45,000	1,335,000	3,330,000	1,995,000	150%
PLANT & MACHINE OPERATORS & ASSEMBLERS	- 1,700,000	3,360,000	505,000	290,000	3,820,000	6,560,000	2,740,000	72%
LABOURERS (MANUFACTURING, CONSTRUCTION & TRANSPORT)	- 235,000	1,300,000	190,000	95,000	835,000	2,185,000	1,350,000	162%
TOTAL	**- 5,845,000**	**11,300,000**	**3,370,000**	**1,510,000**	**14,900,000**	**25,195,000**	**10,335,000**	**70%**
SHIP CREW	-	-	-	490,000	12,000	500,000	490,000	4000%

The occupations with the highest number of projected jobs are plant and machine operators and assemblers, followed by electricians. Labourers (including in manufacturing construction and transport), engineers (including industrial, electrical and civil), technicians (including electrical, mechanical, civil, and IT technicians) and other professionals (e.g. legal, scientific and finance) also have a significant number of jobs.

The occupations that will have the largest increase in jobs from 2015 to 2025 are labourers, engineers and electricians, which all have more than a 150% in jobs.

The findings are similar are similar in the 2°C Scenario, with an increase in all occupations except for managers and metal trades, which will experience minor reductions in overall jobs (3% each).

However, the results are not uniform across regions, as changes in occupation will be affected by whether the share of importers or exporters of technologies and fuels in the region. A summary of the percentage increase or decrease across the occupations is shown for the ten regions in **Error! Not a valid bookmark self-reference.**.

For example, China foresees a 10% reduction in jobs overall and around 30% reduction in metal trades and plant and machine operators between 2015 and 2025. These numbers are largely due to the current high numbers of people employed in coal mining in China, as well as the assumed increases in productivity which impact total employment results on which the occupational breakdown is based. India also may see a reduction in jobs, as it is projected both China and India will have a reduction in the number of managers and clerical and administrative workers. The detailed breakdown by region is provided in the following sections.

Table 9: Jobs created or lost between 2015 and 2025 by region under the 1.5 degree scenario

	OECD North America	Latin America	OECD Europe	Africa	Middle East	Eastern Europe/Eurasia	India	Non-OECD Asia	China	OECD Pacific	Global
MANAGERS	138%	57%	26%	13%	42%	19%	-14%	36%	-24%	40%	3%
PROFESSIONALS (LEGAL, FINANCE, SCIENTIFIC)	383%	185%	113%	186%	119%	52%	133%	194%	1%	172%	83%
ENGINEERS (INDUSTRIAL, ELECTRICAL, CIVIL)	414%	306%	199%	201%	179%	190%	140%	200%	82%	214%	159%
TECHNICIANS & ASSOCIATE PROFESSIONALS	236%	189%	65%	140%	153%	84%	46%	125%	-5%	138%	58%
CLERICAL & ADMINISTRATIVE WORKERS	165%	63%	50%	24%	47%	32%	-7%	53%	-13%	52%	16%
CONSTRUCTION TRADES	145%	75%	137%	202%	64%	74%	107%	93%	124%	115%	107%
METAL TRADES	258%	76%	44%	50%	112%	-27%	33%	83%	-36%	76%	6%
ELECTRICIANS	489%	556%	165%	237%	500%	245%	157%	346%	24%	206%	150%
PLANT & MACHINE OPERATORS & ASSEMBLERS	390%	456%	53%	326%	502%	62%	166%	649%	-29%	178%	72%
LABOURERS (MANUFACTURING, CONSTRUCTION & TRANSPORT)	475%	395%	209%	220%	221%	166%	181%	266%	48%	210%	162%
TOTAL	**327%**	**237%**	**87%**	**159%**	**168%**	**66%**	**90%**	**199%**	**-10%**	**152%**	**70%**
SHIP CREW	4150%		731%					68465%	1462%	8742%	4000%

The following Figures 6 and 7 illustrate the employment changes between 2015 and 2025 under the 1.5°C and 2.0°C Scenarios. Across all eight employment groups, the net effect of the energy transition is positive or stable.

Figure 7: Employment changes between 2015 and 2025 under the 1.5°C Scenario

Figure 8: Employment changes between 2015 and 2025 under the 2.0°C Scenario

4.2 OECD North America

4.2.1 Total employment

The 2.0°C and 1.5°C scenarios result in more energy sector jobs in OECD North America at every stage of the projection.

- There are 3.9 million energy sector jobs in the 1.5°C scenario in 2025, 3.3 million in the 2.0°C scenario and 1 million in the 5.0°C scenario.
- In 2050, there are 3.1 million jobs in the 1.5°C scenario, 3.1 million jobs in the 2.0°C scenario and 1.4 million in the 5.0°C scenario.
- Strong growth in renewable energy leads to an increase of 330% in total energy sector jobs in the 1.5C scenario and 264% in total energy sector jobs in the 2.0C scenario by 2025.
- Renewable energy accounts for 94% of energy sector jobs at 2030 in the 1.5C scenario, with PV having the greatest share (40%), followed by wind and biomass.

Figure 9: OECD North America total employment under 3 scenarios

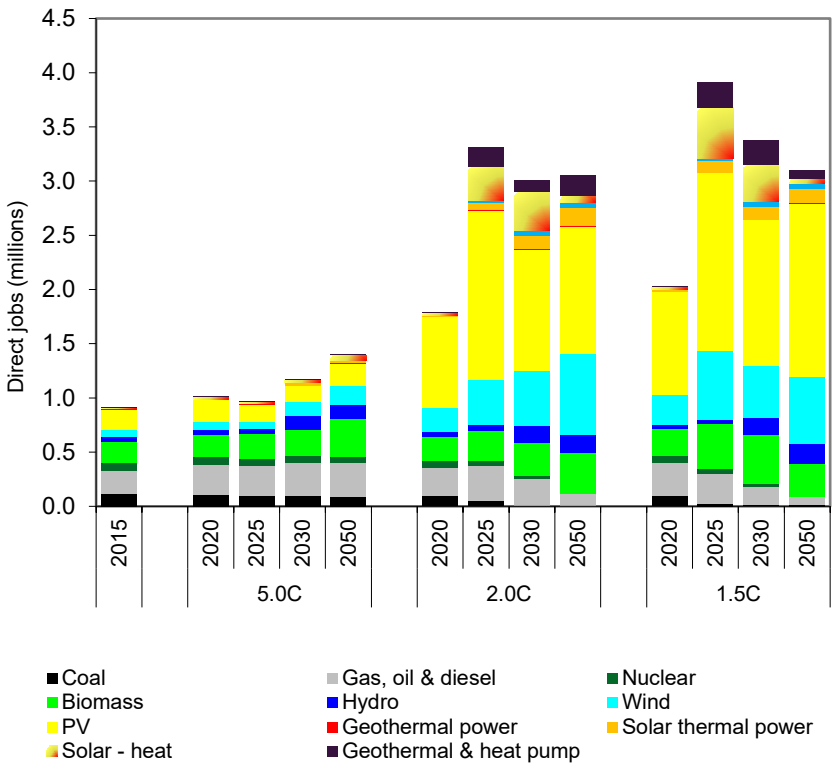


Table 10: OECD North America total employment (thousand jobs) in 5.0C and 1.5C scenarios

		5.0C				1.5C			
Technology	**2015**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
Coal	116	106	98	102	85	99	30	8	11
Gas, oil & diesel	212	278	277	296	316	303	269	175	82
Nuclear	73	70	65	64	57	70	51	27	0
Renewable	**508**	**558**	**529**	**709**	**936**	**1,551**	**3,561**	**3,167**	**3,006**
Biomass	*195*	*210*	*226*	*246*	*347*	*242*	*409*	*452*	*299*
Hydro	*45*	*41*	*51*	*129*	*134*	*42*	*41*	*158*	*184*
Wind	*65.8*	*71.0*	*63.0*	*124.2*	*168.7*	*272*	*639*	*478*	*620*
PV	*188.3*	*209.4*	*159.9*	*153.0*	*208.7*	*951*	*1,634*	*1,342*	*1,594*
Geothermal power	*2.4*	*1.9*	*2.8*	*2.5*	*2.3*	*2.4*	*4.5*	*7.1*	*9.5*
Solar thermal power	*0.7*	*0.7*	*1.4*	*23.8*	*27.6*	*16.5*	*114.6*	*114.7*	*133.0*
Ocean	*0.1*	*0.2*	*1.1*	*1.9*	*2.3*	*2*	*19*	*46.7*	*42.4*
Solar - heat	*10*	*23*	*23*	*28.6*	*45.5*	*23*	*467*	*347*	*43*
Geothermal & heat pump	*0.9*	*0.04*	*0.093*	*0.1*	*0.1*	*0*	*233*	*222*	*82*
Total jobs (thousands)	**909**	**1,012**	**970**	**1,171**	**1,395**	**2,024**	**3,910**	**3,377**	**3,099**

4.2.2 Occupational breakdown for fossil fuels, solar PV and wind

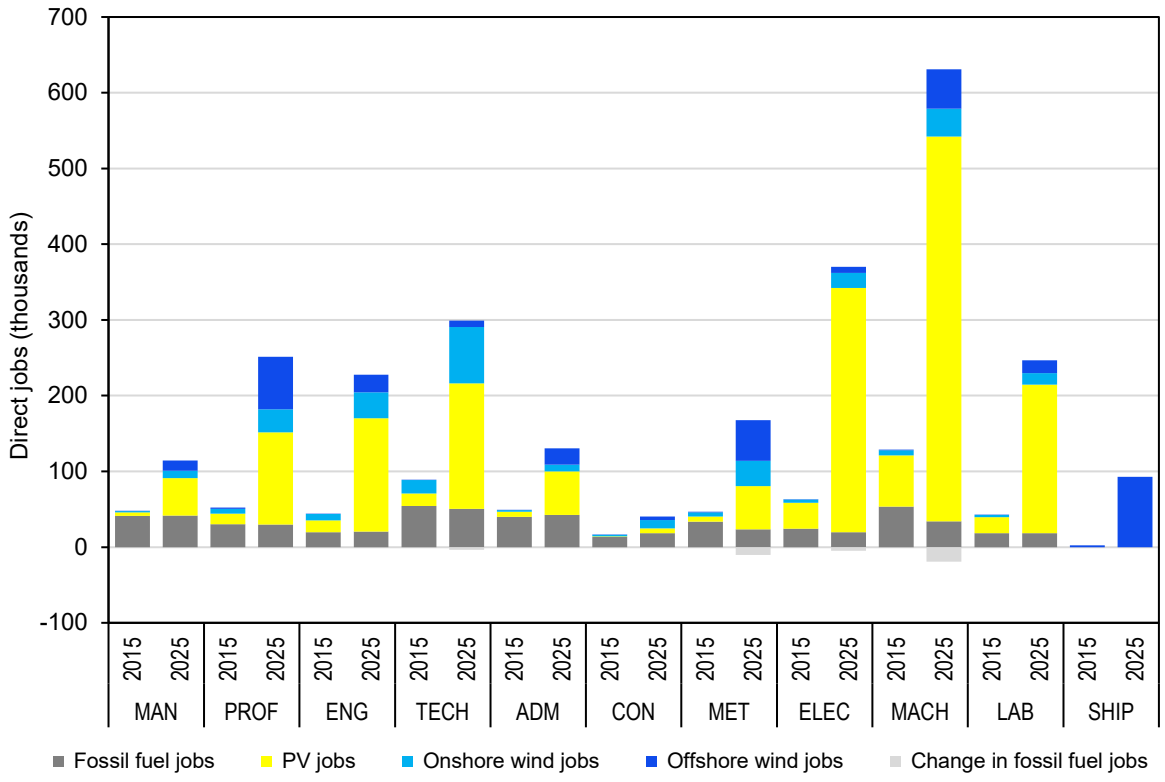
There is an increase in jobs across all occupations between 2015 and 2025 in the 1.5 degree scenario.

The occupations with the highest number of projected jobs are plant and machine operators and assemblers, followed by electricians. The occupations that will have the largest increase in jobs are electricians and labourers, with more than 450% increase.

Table 11: Occupational breakdown (thousand jobs) in between 2015 and 2025 in 1.5C scenario

	Total jobs		Change in jobs				Difference	
Occupation	**2015**	**2025**	**Fossil**	**PV**	**Wind - onshore**	**Wind - offshore**	**Total**	**%**
Managers	48.0	114.5	0.7	44.3	8.2	13.3	66.5	138%
Professionals	52.0	251.5	-0.6	107.9	24.1	68.0	199.5	383%
Engineers	44.2	227.5	0.6	134.2	26.0	22.4	183.2	414%
Technicians	88.9	299.1	-3.7	149.4	56.0	8.5	210.2	236%
Clerical & administrative	49.1	130.3	2.5	50.6	6.9	21.2	81.2	165%
Construction trades	16.5	40.5	5.0	5.3	9.0	4.7	24.0	145%
Metal trades	46.8	167.6	-10.2	50.6	27.9	52.6	120.8	258%
Electricians	62.8	370.2	-4.7	288.4	15.8	7.8	307.3	489%
Machinists & assemblers	128.9	630.8	-19.3	440.2	30.1	51.0	502.0	390%
Labourers	42.9	246.6	0.1	175.0	12.2	16.4	203.7	475%
Total	**580.1**	**2,478.5**	**-29.6**	**1,445.9**	**216.2**	**265.9**	**1,898.4**	**327%**
Ship crew	2.2	93.0	-	-	-	90.8	90.8	4150%

Figure 10: OECD North America occupational breakdown between 2015 and 2025 in 1.5C scenario



4.3 Latin America

4.3.1 Total employment

The 2.0°C and 1.5°C scenarios result in more energy sector jobs in Latin America at every stage of the projection.

- There are 3 million energy sector jobs in the 1.5C scenario in 2025, 2.7 million in the 2.0C scenario and 1.8 million in the 5.0C scenario.
- In 2050, there are 3.6 million jobs in the 1.5C scenario, 3.5 million jobs in the 2.0C scenario and 2.5 million in the 5.0C scenario.
- Strong growth in renewable energy leads to an increase of 100% in total energy sector jobs in the 1.5C scenario and 75% in total energy sector jobs in the 2.0C scenario by 2025. By 2030, energy jobs are more than double 2015 levels.
- Renewable energy accounts for 92% of energy sector jobs at 2030 in the 1.5C scenario, with biomass having the greatest share (27%), followed by PV, hydro, solar heating and wind.

Figure 11: Latin America total employment under 3 scenarios

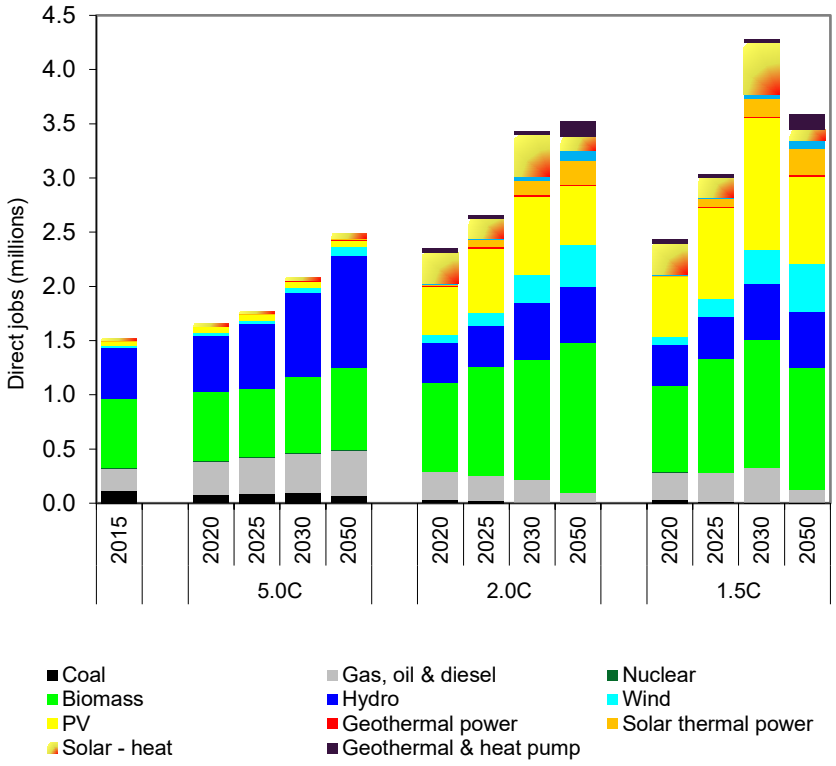


Table 12: Latin America total employment (thousand jobs) in 5.0C and 1.5C scenarios

		5.0C				1.5C			
Technology	**2015**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
Coal	113	80	86	96	71	29	14	2	2
Gas, oil & diesel	208	305	335	359	414	253	264	324	123
Nuclear	7	10	10	10	11	3	3	3	0
Renewable	**1,191**	**1,260**	**1,336**	**1,620**	**1,988**	**2,151**	**2,752**	**3,947**	**3,468**
Biomass	*634*	*632*	*630*	*698*	*749*	*801*	*1,057*	*1,173*	*1,125*
Hydro	*472*	*518*	*592*	*781*	*1,041*	*372*	*380*	*524*	*512*
Wind	*21.8*	*29.3*	*32.1*	*44.6*	*74.9*	*81*	*166*	*315*	*446*
PV	*37.9*	*54.8*	*56.1*	*58.7*	*60.9*	*545*	*845*	*1,215*	*806*
Geothermal power	*2.0*	*2.4*	*2.6*	*4.4*	*2.6*	*7.4*	*10.0*	*11.0*	*9.8*
Solar thermal power	*2.0*	*2.0*	*3.7*	*5.7*	*9.1*	*12.0*	*69.9*	*166.9*	*248.1*
Ocean	-	-	-	-	*9.2*	*10*	*9*	*37.4*	*74.4*
Solar - heat	*22*	*21*	*21*	*28.3*	*41.2*	*282*	*186*	*472*	*101*
Geothermal & heat pump	*0.0*	-	-	-	-	*40*	*29*	*32*	*146*
Total jobs (thousands)	**1,518**	**1,655**	**1,768**	**2,085**	**2,484**	**2,436**	**3,032**	**4,275**	**3,593**

4.3.2 Occupational breakdown for fossil fuels, solar PV and wind

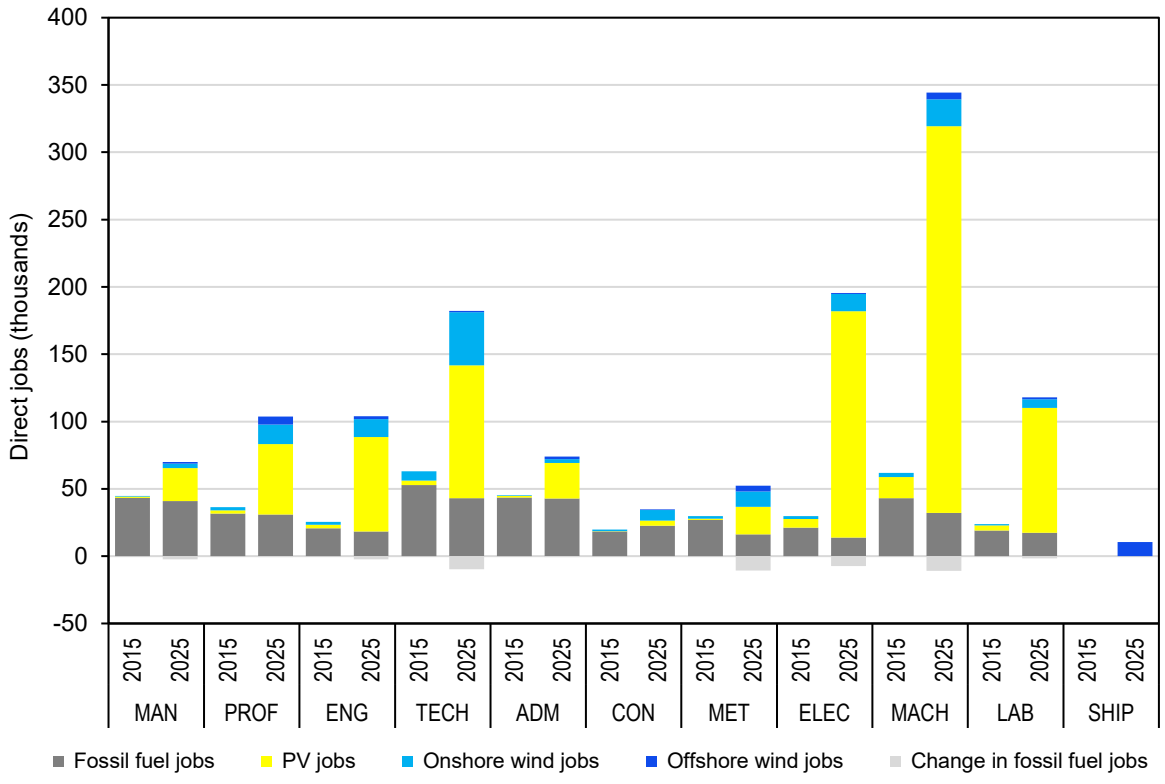
There is an increase in jobs across all occupations between 2015 and 2025 in the 1.5 degree scenario.

The occupations with the highest number of projected jobs are plant and machine operators and assemblers, followed by electricians. The occupations that will have the largest increase in jobs are electricians with more than 550% increase and plant and machine operators and assemblers with 450% increase.

Table 13: Occupational breakdown (thousand jobs) in between 2015 and 2025 in 1.5C scenario

	Total jobs		Change in jobs				Difference	
Occupation	**2015**	**2025**	**Fossil**	**PV**	**Wind - onshore**	**Wind - offshore**	**Total**	**%**
Managers	44.7	70.0	-2.3	23.6	2.8	1.2	25.3	57%
Professionals	36.4	103.8	-0.7	50.1	12.1	6.0	67.4	185%
Engineers	25.6	103.9	-2.3	67.6	10.8	2.2	78.3	306%
Technicians	63.0	182.2	-9.8	95.3	32.7	1.0	119.2	189%
Clerical & administrative	45.2	74.0	-0.6	25.1	2.4	1.8	28.7	63%
Construction trades	19.8	34.7	4.4	3.5	6.6	0.4	14.9	75%
Metal trades	29.7	52.4	-10.8	19.4	9.8	4.3	22.7	76%
Electricians	29.8	195.4	-7.3	161.7	10.6	0.7	165.6	556%
Machinists & assemblers	61.9	344.3	-11.0	271.7	16.8	4.9	282.4	456%
Labourers	23.8	117.9	-1.6	88.8	5.3	1.5	94.1	395%
Total	**379.9**	**1,278.5**	**-42.1**	**806.8**	**109.9**	**24.0**	**898.6**	**237%**
Ship crew	-	10.4	-	-	-	10.4	10.4	

Figure 12: Latin America occupational breakdown between 2015 and 2025 in 1.5C scenario



4.4 OECD Europe

4.4.1 Total employment

The 2.0°C and 1.5°C scenarios result in more energy sector jobs in OECD Europe at every stage of the projection.

- There are 2.9 million energy sector jobs in the 1.5C scenario in 2025, 2.7 million in the 2.0C scenario and 1.1 million in the 5.0C scenario.
- In 2050, there are 2.4 million jobs in the 1.5C scenario, 2.5 million jobs in the 2.0C scenario and 1.3 million in the 5.0C scenario.
- Strong growth in renewable energy leads to an increase of 134% in total energy sector jobs in the 1.5C scenario and 116% in total energy sector jobs in the 2.0C scenario by 2025. By 2030, energy jobs are 2.5 times 2015 levels.
- Renewable energy accounts for 94% of energy sector jobs at 2030 in the 1.5C scenario, with PV having the greatest share (36%), followed by wind, biomass and solar thermal.

Figure 13: OECD Europe total employment under 3 scenarios

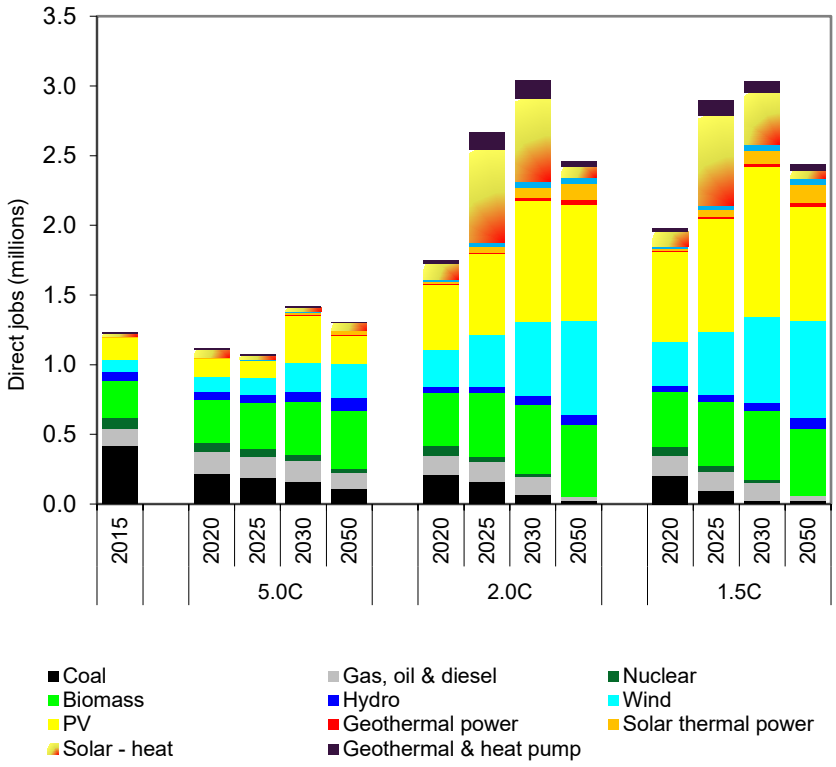


Table 14: OECD Europe total employment (thousand jobs) in 5.0C and 1.5C scenarios

		5.0C				1.5C			
Technology	**2015**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
Coal	421	217	188	161	113	208	92	25	23
Gas, oil & diesel	123	156	152	146	110	137	141	126	33
Nuclear	73	70	58	47	32	69	39	22	-
Renewable	**619**	**673**	**674**	**1,061**	**1,053**	**1,569**	**2,626**	**2,858**	**2,383**
Biomass	*268*	*303*	*325*	*380*	*415*	*392*	*463*	*495*	*485*
Hydro	*62*	*59*	*62*	*71*	*93*	*46*	*47*	*61*	*74*
Wind	*91.6*	*107.0*	*118.6*	*203.4*	*242.6*	*311*	*456*	*615*	*702*
PV	*153.5*	*129.7*	*121.6*	*344.2*	*205.7*	*647*	*808*	*1,078*	*817*
Geothermal power	*2.1*	*2.1*	*2.3*	*2.8*	*3.9*	*8.0*	*12.2*	*19.2*	*30.3*
Solar thermal power	*3.9*	*4.1*	*4.7*	*18.1*	*24.6*	*15.0*	*49.9*	*91.1*	*124.2*
Ocean	*0.8*	*1.3*	*1.5*	*4.0*	*5.5*	*13*	*32*	*49.1*	*45.6*
Solar - heat	*24*	*57*	*31*	*29.8*	*58.7*	*112*	*650*	*368*	*57*
Geothermal & heat pump	*13.1*	*9.27*	*7.987*	*7.3*	*4.5*	*25*	*109*	*82*	*47*
Total jobs (thousands)	**1,236**	**1,117**	**1,072**	**1,416**	**1,308**	**1,982**	**2,899**	**3,031**	**2,438**

4.4.2 Occupational breakdown for fossil fuels, solar PV and wind

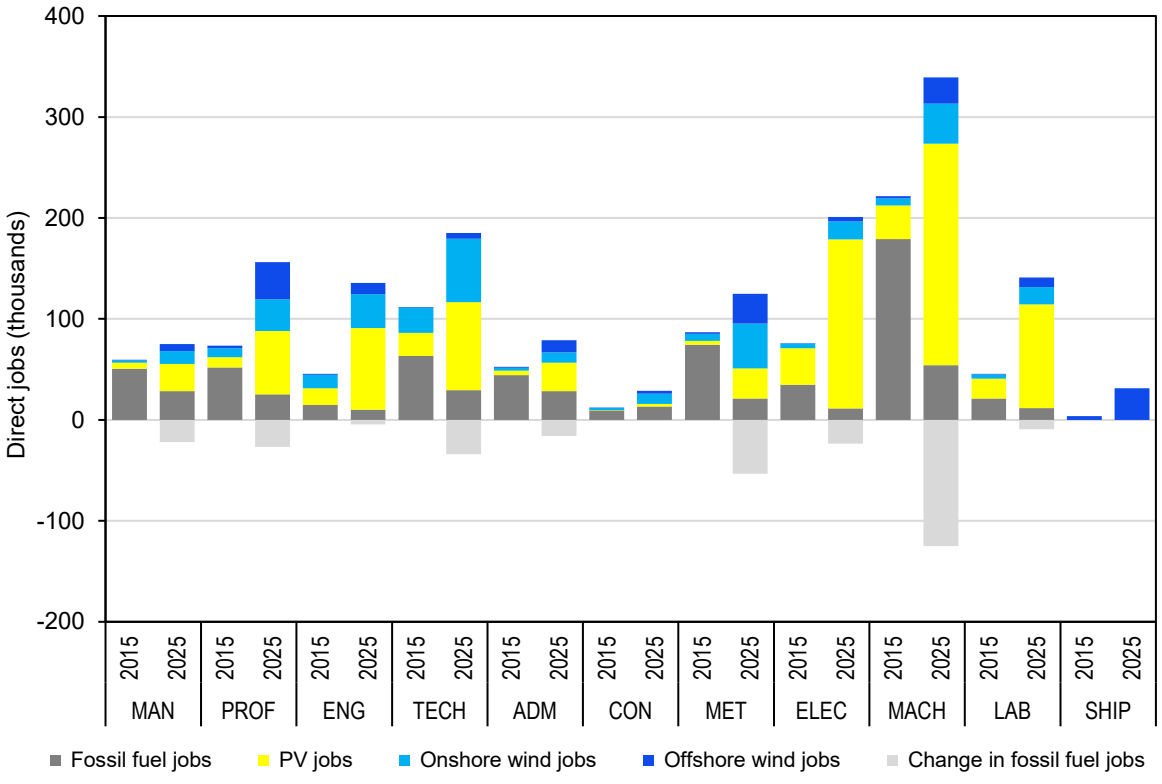
There is an increase in jobs across all occupations between 2015 and 2025 in the 1.5 degree scenario.

The occupations with the highest number of projected jobs are electricians, followed by plant and machine operators and assemblers. The occupations that will have the largest increase in jobs are labourers and engineers, with around 200% increase.

Table 15: Occupational breakdown (thousand jobs) in between 2015 and 2025 in 1.5C scenario

	Total jobs		Change in jobs				Difference	
Occupation	**2015**	**2025**	**Fossil**	**PV**	**Wind - onshore**	**Wind - offshore**	**Total**	**%**
Managers	59.5	75.1	-22.0	20.8	10.4	6.5	15.6	26%
Professionals	73.5	156.4	-26.6	52.5	22.6	34.3	82.8	113%
Engineers	45.5	135.7	-4.5	64.0	20.5	10.2	90.2	199%
Technicians	111.8	184.9	-33.9	64.4	37.6	5.1	73.2	65%
Clerical & administrative	52.6	79.0	-16.1	23.9	7.2	11.4	26.4	50%
Construction trades	12.1	28.6	4.0	2.2	7.8	2.6	16.6	137%
Metal trades	87.0	125.0	-53.3	26.0	37.6	27.8	38.0	44%
Electricians	76.0	201.1	-23.5	131.3	13.0	4.2	125.1	165%
Machinists & assemblers	221.6	339.2	-124.9	186.3	32.6	23.7	117.6	53%
Labourers	45.6	140.9	-9.4	82.8	13.2	8.6	95.3	209%
Total	**785.1**	**1,465.9**	**-310.3**	**654.1**	**202.7**	**134.2**	**680.8**	**87%**
Ship crew	3.8	31.2	-	-	-	27.5	27.5	731%

Figure 14: OECD Europe occupational breakdown between 2015 and 2025 in 1.5C scenario



4.5 Africa

4.5.1 Total employment

The 2.0°C and 1.5°C scenarios result in more energy sector jobs in Africa at every stage of the projection.

- There are 8.6 million energy sector jobs in the 1.5C scenario in 2025, 7.9 million in the 2.0C scenario and 7.9 million in the 5.0C scenario.
- In 2050, there are 11.7 million jobs in the 1.5C scenario, 13.1 million jobs in the 2.0C scenario and 9.6 million in the 5.0C scenario.
- Strong growth in renewable energy leads to an increase of 24% in total energy sector jobs in the 1.5C scenario and 13% in total energy sector jobs in the 2.0C scenario by 2025. By 2030, energy jobs are almost double 2015 levels.
- Renewable energy accounts for 94% of energy sector jobs at 2030 in the 1.5C scenario, with biomass having the greatest share (53%), followed by solar PV, wind, and solar heating.

Figure 15: Africa total employment under 3 scenarios

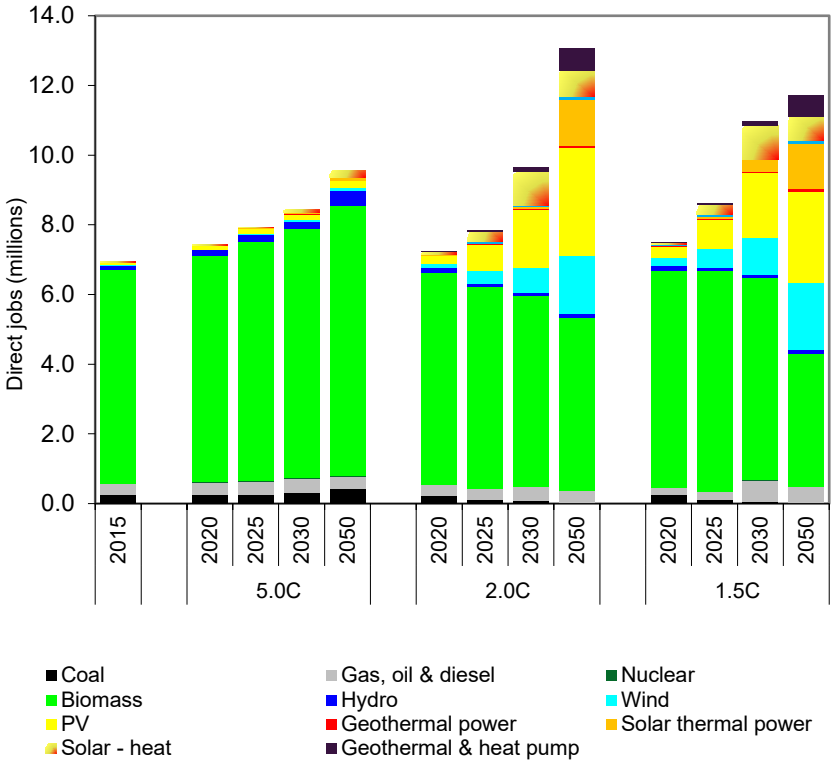


Table 16: Africa total employment (thousand jobs) in 5.0C and 1.5C scenarios

		5.0C				1.5C			
Technology	**2015**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
Coal	249	265	259	312	423	258	93	60	3
Gas, oil & diesel	312	334	362	392	352	189	253	607	473
Nuclear	7	19	27	28	26	6	6	5	-
Renewable	**6,367**	**6,827**	**7,288**	**7,697**	**8,762**	**7,058**	**8,269**	**10,300**	**11,242**
Biomass	*6,128*	*6,495*	*6,878*	*7,138*	*7,750*	*6,225*	*6,332*	*5,808*	*3,835*
Hydro	*143*	*155*	*188*	*230*	*436*	*144*	*73*	*94*	*103*
Wind	*18.7*	*25.5*	*30.1*	*35.1*	*66.7*	*226*	*569*	*1,046*	*1,923*
PV	*66.3*	*108.3*	*141.1*	*165.1*	*208.0*	*323*	*806*	*1,862*	*2,621*
Geothermal power	*3.7*	*4.8*	*7.9*	*11.5*	*14.8*	*23.7*	*49.2*	*39.8*	*61.9*
Solar thermal power	*1.4*	*11.5*	*17.0*	*35.3*	*90.8*	*1.8*	*53.7*	*342.6*	*1,311.4*
Ocean	*-*	*-*	*-*	*0.0*	*0.0*	*28*	*60*	*21.6*	*95.1*
Solar - heat	*6*	*27*	*26*	*82.8*	*195.5*	*64*	*281*	*968*	*666*
Geothermal & heat pump	*-*	*0.00*	*-*	*-*	*-*	*21*	*44*	*118*	*626*
Total jobs (thousands)	**6,934**	**7,444**	**7,935**	**8,428**	**9,563**	**7,511**	**8,620**	**10,973**	**11,718**

4.5.2 Occupational breakdown for fossil fuels, solar PV and wind

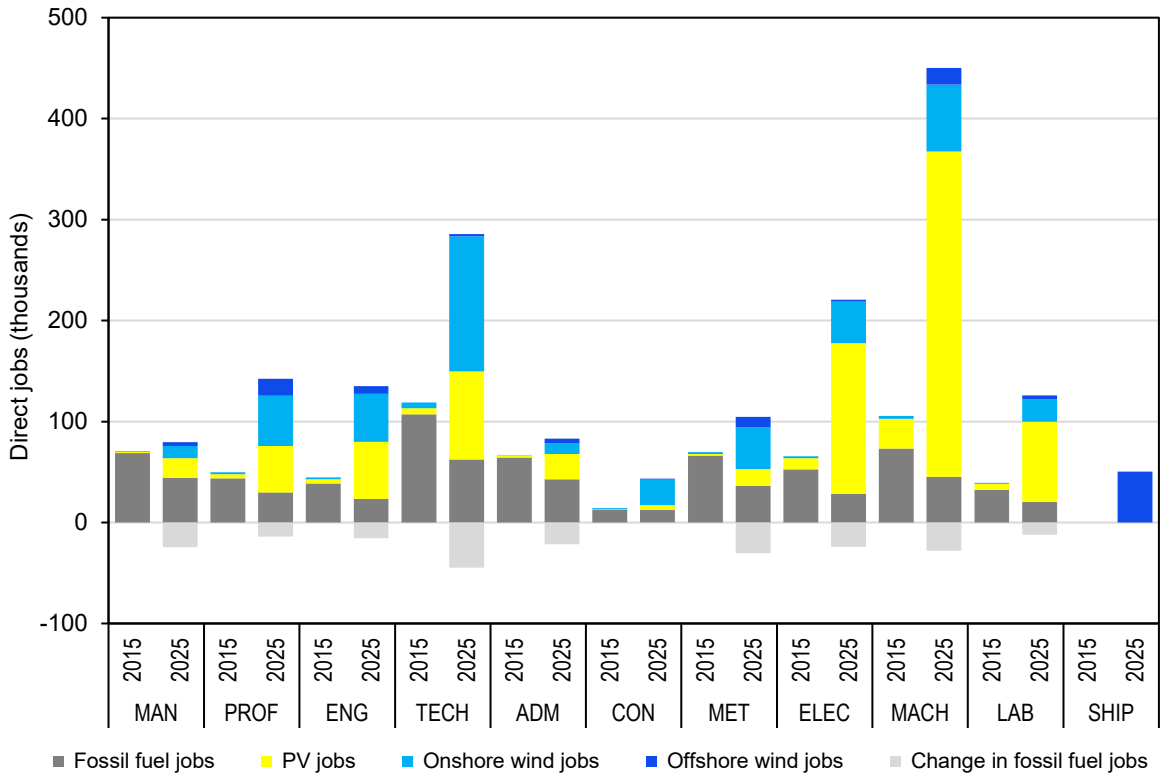
There is an increase in jobs across all occupations between 2015 and 2025 in the 1.5 degree scenario.

The occupations with the highest number of projected jobs are plant and machine operators and assemblers, followed by technicians. The occupations that will have the largest increase in jobs are plant and machine operators and assemblers, with more than 300% increase and electricians and labourers with more than 200%.

Table 17: Occupational breakdown (thousand jobs) in between 2015 and 2025 in 1.5C scenario

	Total jobs		Change in jobs				Difference	
Occupation	**2015**	**2025**	**Fossil**	**PV**	**Wind - onshore**	**Wind - offshore**	**Total**	**%**
Managers	70.7	79.5	-24.6	18.0	11.7	3.7	8.9	13%
Professionals	49.8	142.5	-14.0	42.0	47.6	17.0	92.6	186%
Engineers	44.8	134.9	-15.4	52.5	45.6	7.5	90.1	201%
Technicians	118.8	285.5	-44.8	81.0	128.2	2.2	166.7	140%
Clerical & administrative	67.0	83.0	-21.6	22.9	10.3	4.4	16.0	24%
Construction trades	14.4	43.4	-0.1	3.9	24.2	1.0	29.0	202%
Metal trades	69.7	104.6	-30.4	15.2	39.7	10.4	34.9	50%
Electricians	65.5	220.6	-24.1	137.7	39.7	1.8	155.0	237%
Machinists & assemblers	105.6	450.2	-27.9	292.5	63.6	16.4	344.6	326%
Labourers	39.3	125.9	-12.1	73.5	21.4	3.8	86.6	220%
Total	**645.5**	**1,670.0**	**-214.9**	**739.3**	**431.9**	**68.2**	**1,024.5**	**159%**
Ship crew	-	50.4	-	-	-	50.4	50.4	

Figure 16: Africa occupational breakdown between 2015 and 2025 in 1.5C scenario



4.6 Middle East

4.6.1 Total employment

The 2.0°C and 1.5°C scenarios result in more energy sector jobs in the Middle East at every stage of the projection.

- There are 1 million energy sector jobs in the 1.5C scenario in 2025, 1 million in the 2.0C scenario and 0.5 million in the 5.0C scenario.
- In 2050, there are 1.8 million jobs in the 1.5C scenario, 1.6 million jobs in the 2.0C scenario and 0.7 million in the 5.0C scenario.
- Strong growth in renewable energy leads to an increase of 225% in total energy sector jobs in the 1.5C scenario and 196% in total energy sector jobs in the 2.0C scenario by 2025. By 2030, energy jobs are more than 3.5 times 2015 levels.
- Renewable energy accounts for 83% of energy sector jobs at 2030 in the 1.5C scenario, with PV having the greatest share (32%), followed by wind and solar thermal.

Figure 17: Middle East total employment under 3 scenarios

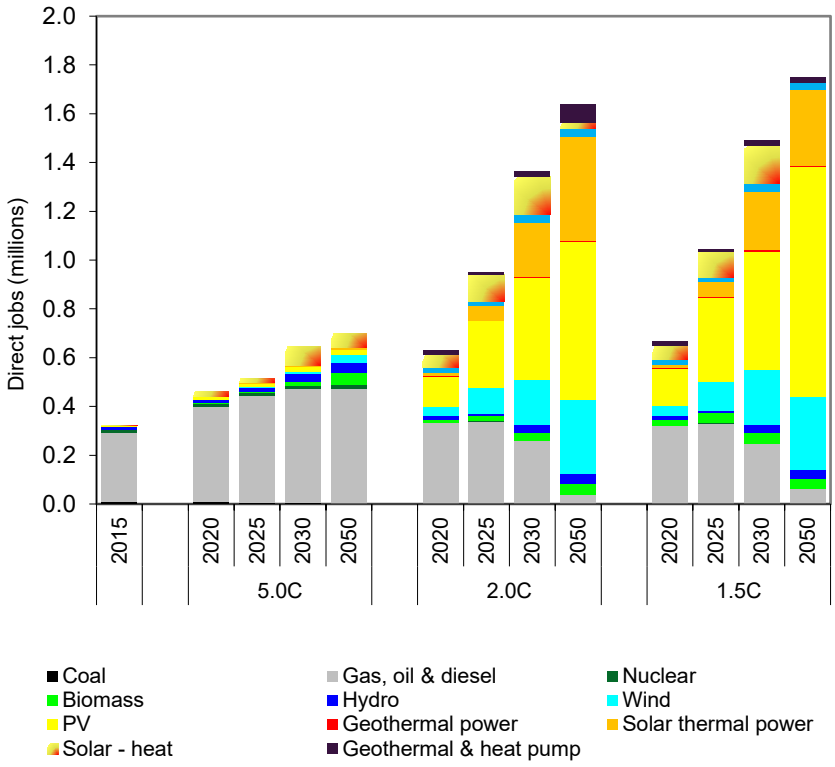


Table 18: Middle East total employment (thousand jobs) in 5.0C and 1.5C scenarios

		5.0C				1.5C			
Technology	**2015**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
Coal	12	9	4	3	2	1	1	1	-
Gas, oil & diesel	279	391	439	470	472	322	330	246	62
Nuclear	12	12	12	14	13	0	0	0	-
Renewable	**18**	**49**	**61**	**158**	**212**	**341**	**714**	**1,243**	**1,690**
Biomass	*2*	*4*	*7*	*13*	*50*	*21*	*44*	*44*	*39*
Hydro	*11*	*11*	*13*	*34*	*41*	*18*	*7*	*34*	*41*
Wind	*0.9*	*2.4*	*5.9*	*10.5*	*30.9*	*42*	*118*	*226*	*299*
PV	*3.0*	*10.7*	*12.2*	*17.3*	*23.0*	*153*	*343*	*480*	*944*
Geothermal power	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*2.1*	*4.1*	*8.2*	*4.6*
Solar thermal power	*1.0*	*2.3*	*4.8*	*6.3*	*7.4*	*14.7*	*64.2*	*241.2*	*307.9*
Ocean	-	-	-	-	-	*18*	*16*	*34.8*	*30.1*
Solar - heat	*1*	*18*	*18*	*77.1*	*60.2*	*57*	*108*	*153*	-
Geothermal & heat pump	-	*0.00*	-	-	-	*17*	*10*	*21*	*24*
Total jobs (thousands)	**321**	**460**	**517**	**645**	**700**	**665**	**1,046**	**1,490**	**1,752**

4.6.2 Occupational breakdown for fossil fuels, solar PV and wind

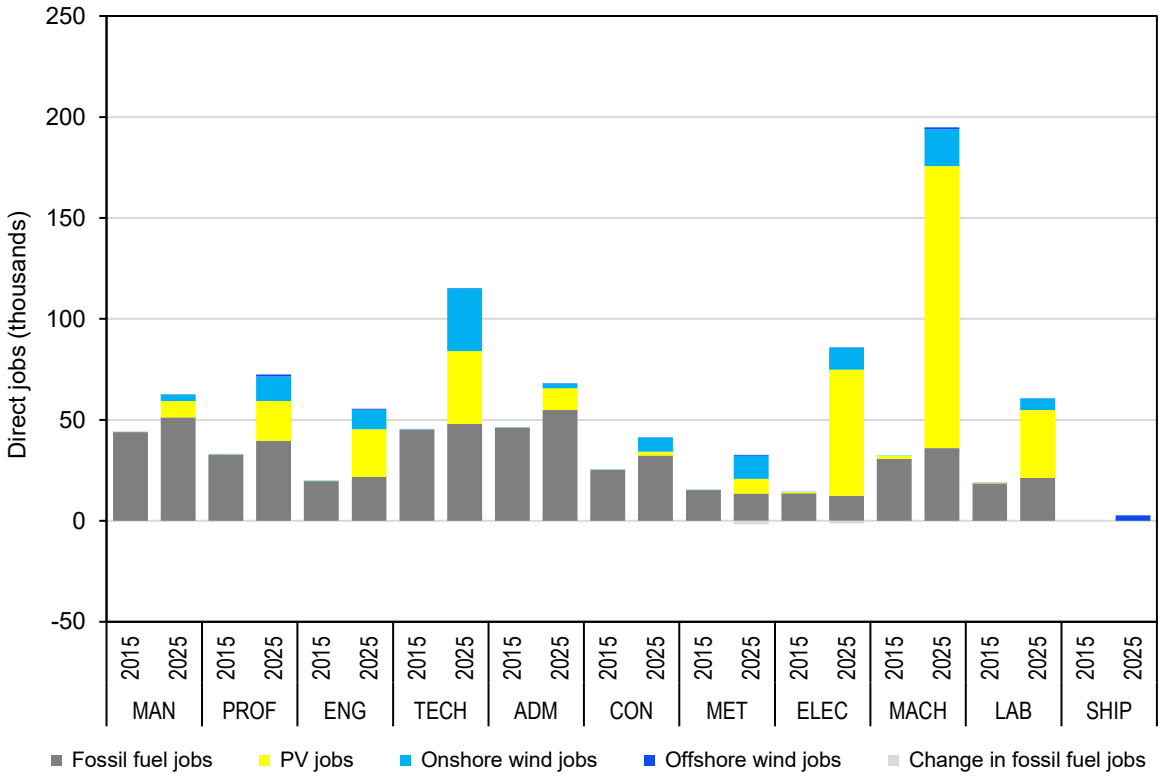
There is an increase in jobs across all occupations between 2015 and 2025 in the 1.5 degree scenario.

The occupations with the highest number of projected jobs are plant and machine operators and assemblers, followed by electricians. The occupations that will have the largest increase in jobs are plant and machine operators and assemblers and electricians, with a 500% increase.

Table 19: Occupational breakdown (thousand jobs) in between 2015 and 2025 in 1.5C scenario

	Total jobs		Change in jobs				Difference	
Occupation	**2015**	**2025**	**Fossil**	**PV**	**Wind - onshore**	**Wind - offshore**	**Total**	**%**
Managers	44.0	62.6	7.4	7.9	3.1	0.2	18.7	42%
Professionals	33.1	72.5	6.9	19.4	12.1	0.9	39.3	119%
Engineers	19.9	55.5	2.1	23.4	9.7	0.4	35.6	179%
Technicians	45.5	115.3	3.1	35.8	30.8	0.2	69.8	153%
Clerical & administrative	46.3	68.2	8.6	10.7	2.4	0.2	21.9	47%
Construction trades	25.2	41.3	7.3	1.8	6.9	0.1	16.0	64%
Metal trades	15.4	32.7	-1.7	7.2	11.3	0.6	17.3	112%
Electricians	14.3	85.9	-1.3	62.0	10.8	0.1	71.5	500%
Machinists & assemblers	32.4	194.8	5.2	138.3	18.0	0.9	162.4	502%
Labourers	18.9	60.7	2.7	33.3	5.6	0.2	41.8	221%
Total	**295.0**	**789.5**	**40.2**	**340.0**	**110.6**	**3.8**	**494.5**	**168%**
Ship crew	-	2.7	-	-	-	2.7	2.7	

Figure 18: Middle East occupational breakdown between 2015 and 2025 in 1.5C scenario



4.7 Eastern Europe / Eurasia

4.7.1 Total employment

The 2.0°C and 1.5°C scenarios result in more energy sector jobs in Eastern Europe / Eurasia at every stage of the projection.

- There are 2.8 million energy sector jobs in the 1.5C scenario in 2025, 2.4 million in the 2.0C scenario and 1.3 million in the 5.0C scenario.
- In 2050, there are 3 million jobs in the 1.5C scenario, 3 million jobs in the 2.0C scenario and 1.2 million in the 5.0C scenario.
- Strong growth in renewable energy leads to an increase of 128% in total energy sector jobs in the 1.5C scenario and 90% in total energy sector jobs in the 2.0C scenario by 2025. By 2030, energy jobs are more than double 2015 levels.
- Renewable energy accounts for 81% of energy sector jobs at 2030 in the 1.5C scenario, with PV having the greatest share (27%), followed by biomass, wind and solar heating.

Figure 19: Eastern Europe / Eurasia total employment under 3 scenarios

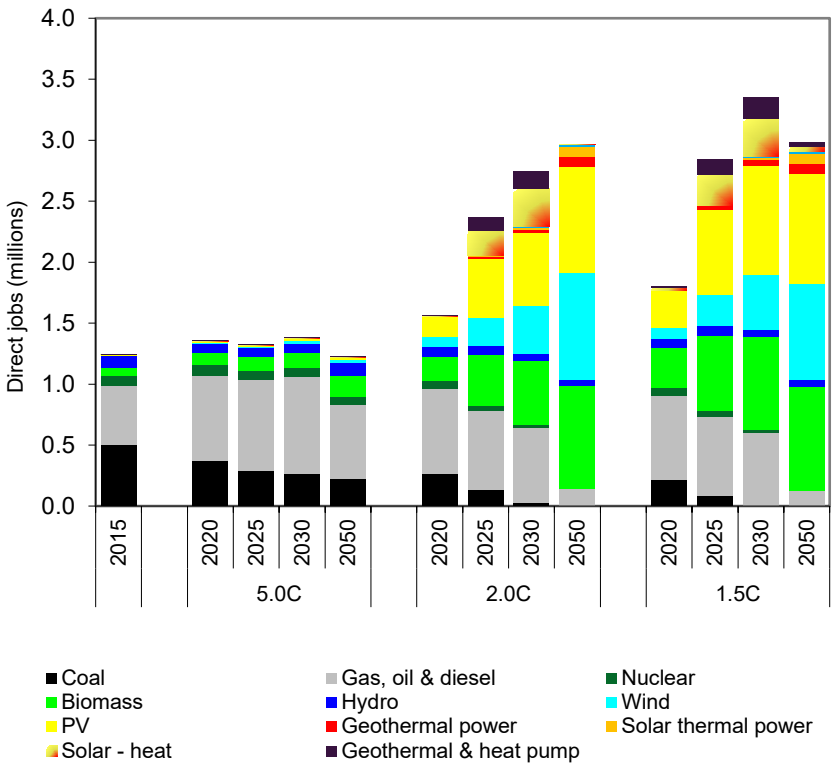


Table 20: Eastern Europe / Eurasia total employment (thousand jobs) in 5.0C and 1.5C scenarios

		5.0C				1.5C			
Technology	**2015**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
Coal	507	372	292	265	224	216	87	5	1
Gas, oil & diesel	477	699	740	792	606	688	644	599	126
Nuclear	82	86	82	76	65	65	50	26	-
Renewable	**178**	**197**	**211**	**246**	**329**	**836**	**2,057**	**2,719**	**2,858**
Biomass	*66*	*98*	*108*	*121*	*171*	*327*	*620*	*756*	*853*
Hydro	*95*	*77*	*78*	*79*	*106*	*77*	*76*	*58*	*56*
Wind	*6.6*	*8.3*	*9.7*	*22.3*	*30.9*	*90*	*253*	*454*	*787*
PV	*7.6*	*9.8*	*9.6*	*18.8*	*12.1*	*301*	*699*	*889*	*909*
Geothermal power	*0.8*	*1.3*	*1.5*	*1.5*	*1.5*	*4.7*	*33.9*	*48.8*	*74.2*
Solar thermal power	-	-	-	-	-	*0.2*	*1.7*	*22.3*	*81.2*
Ocean	-	-	-	*0.1*	*0.1*	-	*3*	*9.2*	*21.7*
Solar - heat	*1*	*1*	*3*	*2.6*	*6.0*	*24*	*249*	*309*	*43*
Geothermal & heat pump	*0.8*	*1.02*	*0.875*	*0.8*	*0.9*	*12*	*123*	*173*	*33*
Total jobs (thousands)	**1,244**	**1,354**	**1,324**	**1,379**	**1,224**	**1,804**	**2,839**	**3,350**	**2,984**

4.7.2 Occupational breakdown for fossil fuels, solar PV and wind

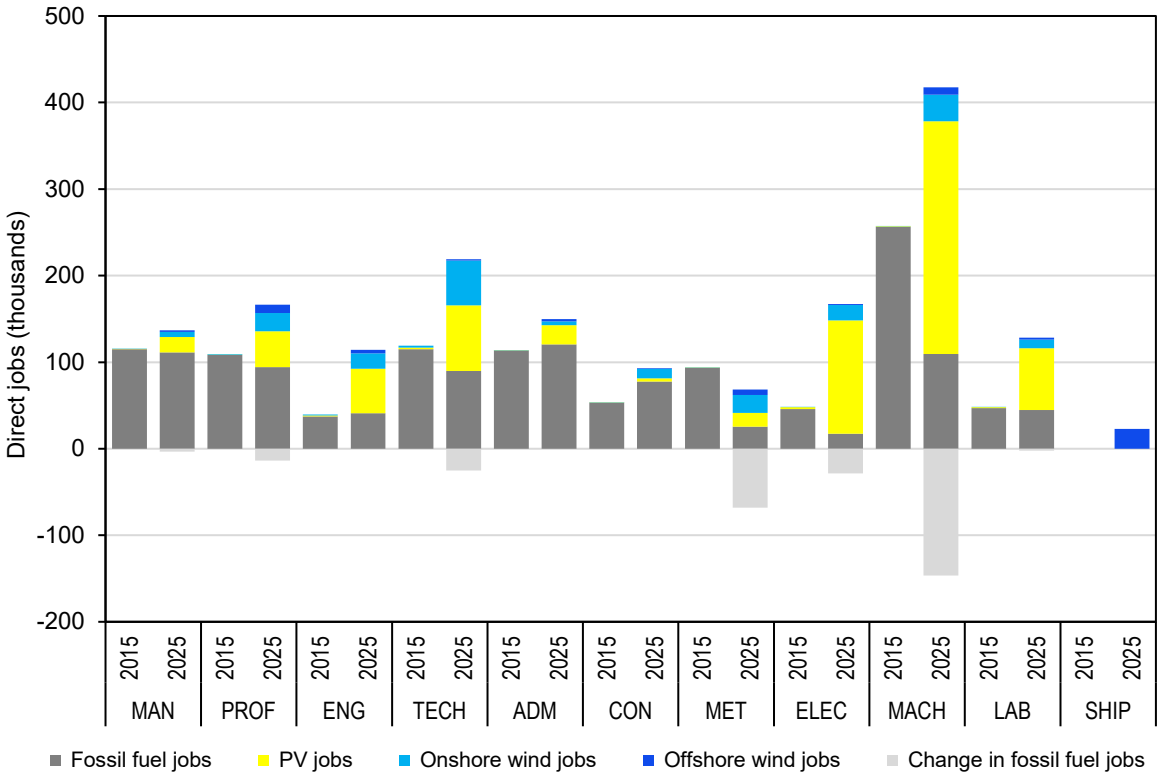
There is an increase in jobs across all occupations between 2015 and 2025 in the 1.5 degree scenario, except metal trades which have a 27% decrease.

The occupations with the highest number of projected jobs are plant and machine operators and assemblers, followed by electricians. The occupations that will have the largest increase in jobs are electricians and labourers, with more than 450% increase.

Table 21: Occupational breakdown (thousand jobs) in between 2015 and 2025 in 1.5C scenario

	Total jobs		Change in jobs				Difference	
Occupation	**2015**	**2025**	**Fossil**	**PV**	**Wind - onshore**	**Wind - offshore**	**Total**	**%**
Managers	115.4	136.9	-3.4	17.2	5.8	2.0	21.5	19%
Professionals	109.4	166.5	-13.8	41.0	20.3	9.6	57.1	52%
Engineers	39.4	114.2	3.7	50.5	16.7	3.9	74.8	190%
Technicians	119.2	218.9	-25.3	74.1	49.5	1.5	99.7	84%
Clerical & administrative	113.8	149.8	7.2	21.9	4.3	2.7	36.0	32%
Construction trades	53.4	93.1	24.6	3.5	10.9	0.7	39.7	74%
Metal trades	93.9	68.5	-68.0	15.7	20.6	6.3	-25.3	-27%
Electricians	48.4	167.1	-28.5	129.0	17.2	1.1	118.7	245%
Machinists & assemblers	257.5	417.6	-146.7	268.2	30.0	8.6	160.1	62%
Labourers	48.2	128.3	-2.1	70.3	9.6	2.2	80.1	166%
Total	**998.5**	**1,660.9**	**-252.5**	**691.4**	**184.9**	**38.5**	**662.4**	**66%**
Ship crew	-	22.9	-	-	-	22.9	22.9	

Figure 20: Eastern Europe / Eurasia occupational breakdown between 2015 and 2025 in 1.5C scenario



4.8 India

4.8.1 Total employment

The 2.0°C and 1.5°C scenarios result in more energy sector jobs in India at every stage of the projection.

- There are 8.7 million energy sector jobs in the 1.5C scenario in 2025, 7.4 million in the 2.0C scenario and 5.1 million in the 5.0C scenario.
- In 2050, there are 6.6 million jobs in the 1.5C scenario, 7.6 million jobs in the 2.0C scenario and 3.5 million in the 5.0C scenario.
- Strong growth in renewable energy leads to an increase of 61% in total energy sector jobs in the 1.5C scenario and 38% in total energy sector jobs in the 2.0C scenario by 2025.
- Renewable energy accounts for 95% of energy sector jobs at 2030 in the 1.5C scenario, with PV having the greatest share (36%), followed by wind, biomass and solar heating.

Figure 21: India total employment under 3 scenarios

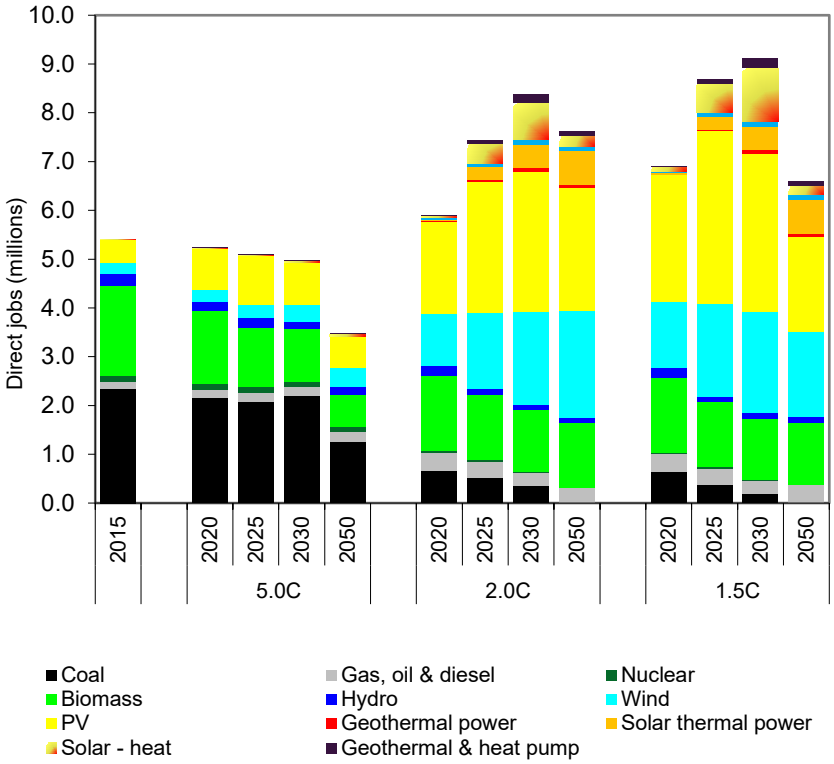


Table 22: India total employment (thousand jobs) in 5.0C and 1.5C scenarios

		5.0C				1.5C			
Technology	**2015**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
Coal	2,339	2,150	2,082	2,208	1,266	633	373	198	6
Gas, oil & diesel	159	180	184	169	206	365	338	261	378
Nuclear	104	109	112	116	91	37	32	28	-
Renewable	**2,807**	**2,803**	**2,713**	**2,474**	**1,902**	**5,866**	**7,948**	**8,631**	**6,226**
Biomass	*1,864*	*1,495*	*1,221*	*1,083*	*659*	*1,539*	*1,333*	*1,251*	*1,271*
Hydro	*228*	*197*	*190*	*140*	*170*	*197*	*103*	*111*	*106*
Wind	*237.7*	*247.0*	*283.3*	*350.4*	*371.5*	*1,353*	*1,907*	*2,079*	*1,738*
PV	*458.0*	*839.0*	*993.5*	*864.1*	*650.9*	*2,597*	*3,541*	*3,242*	*1,962*
Geothermal power	*1.4*	*0.8*	*0.8*	*0.7*	*0.3*	*10.6*	*34.0*	*66.1*	*65.0*
Solar thermal power	*6.6*	*3.4*	*4.7*	*5.0*	*6.6*	*34.4*	*266.7*	*470.9*	*691.9*
Ocean	-	-	*0.0*	*1.1*	*0.9*	*31*	*73*	*120.9*	*100.5*
Solar - heat	*12*	*21*	*20*	*29.7*	*42.6*	*99*	*603*	*1,087*	*192*
Geothermal & heat pump	-	*0.38*	*0.284*	*0.2*	*0.1*	*5*	*87*	*203*	*99*
Total jobs (thousands)	**5,409**	**5,241**	**5,091**	**4,967**	**3,465**	**6,902**	**8,690**	**9,117**	**6,610**

4.8.2 Occupational breakdown for fossil fuels, solar PV and wind

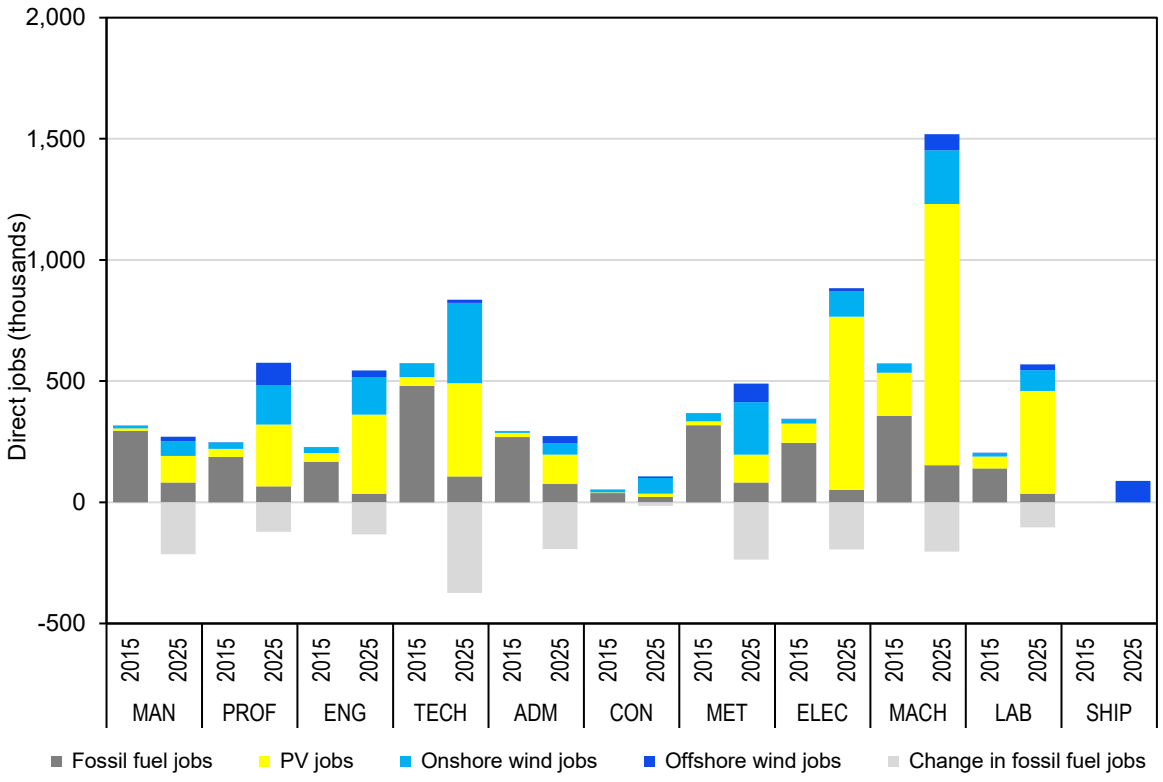
There is an increase in jobs across all occupations between 2015 and 2025 in the 1.5 degree scenario, except managers which decrease 14% and clerical and administrative workers which decrease 7%.

The occupations with the highest number of projected jobs are plant and machine operators and assemblers. The occupations that will have the largest increase in jobs are labourers with a 180% increase.

Table 23: Occupational breakdown (thousand jobs) in between 2015 and 2025 in 1.5C scenario

	Total jobs		Change in jobs				Difference	
Occupation	**2015**	**2025**	**Fossil**	**PV**	**Wind - onshore**	**Wind - offshore**	**Total**	**%**
Managers	315.0	270.6	-213.7	99.3	52.1	18.0	-44.4	-14%
Professionals	247.1	576.5	-121.3	221.4	134.7	94.6	329.4	133%
Engineers	226.8	543.9	-132.9	292.2	128.8	29.0	317.1	140%
Technicians	573.3	836.4	-373.5	348.7	274.1	13.9	263.1	46%
Clerical & administrative	293.7	273.9	-192.9	103.3	38.9	30.9	-19.8	-7%
Construction trades	51.7	107.0	-15.1	11.0	52.3	7.1	55.3	107%
Metal trades	367.5	489.5	-236.6	99.0	184.1	75.5	122.1	33%
Electricians	343.6	883.6	-194.4	635.3	87.5	11.5	539.9	157%
Machinists & assemblers	572.0	1,519.6	-203.0	898.7	185.2	66.8	947.6	166%
Labourers	202.9	569.4	-103.8	374.2	72.4	23.6	366.5	181%
Total	**3,193.6**	**6,070.3**	**-1,787.2**	**3,083.0**	**1,210.3**	**370.7**	**2,876.8**	**90%**
Ship crew	-	87.9	-	-	-	87.9	87.9	

Figure 22: India occupational breakdown between 2015 and 2025 in 1.5C scenario



4.9 Non-OECD Asia

4.9.1 Total employment

The 2.0°C and 1.5°C scenarios result in more energy sector jobs in Non-OECD Asia at every stage of the projection.

- There are 6.5 million energy sector jobs in the 1.5C scenario in 2025, 5.4 million in the 2.0C scenario and 4.3 million in the 5.0C scenario.
- In 2050, there are 6.3 million jobs in the 1.5C scenario, 7.2 million jobs in the 2.0C scenario and 4.3 million in the 5.0C scenario.
- Strong growth in renewable energy leads to an increase of 118% in total energy sector jobs in the 1.5C scenario and 83% in total energy sector jobs in the 2.0C scenario by 2025. By 2030, energy jobs are more than double 2015 levels.
- Renewable energy accounts for 88% of energy sector jobs at 2030 in the 1.5C scenario, with PV having the greatest share (31%), followed by biomass, solar heating and wind.

Figure 23: Non-OECD Asia total employment under 3 scenarios

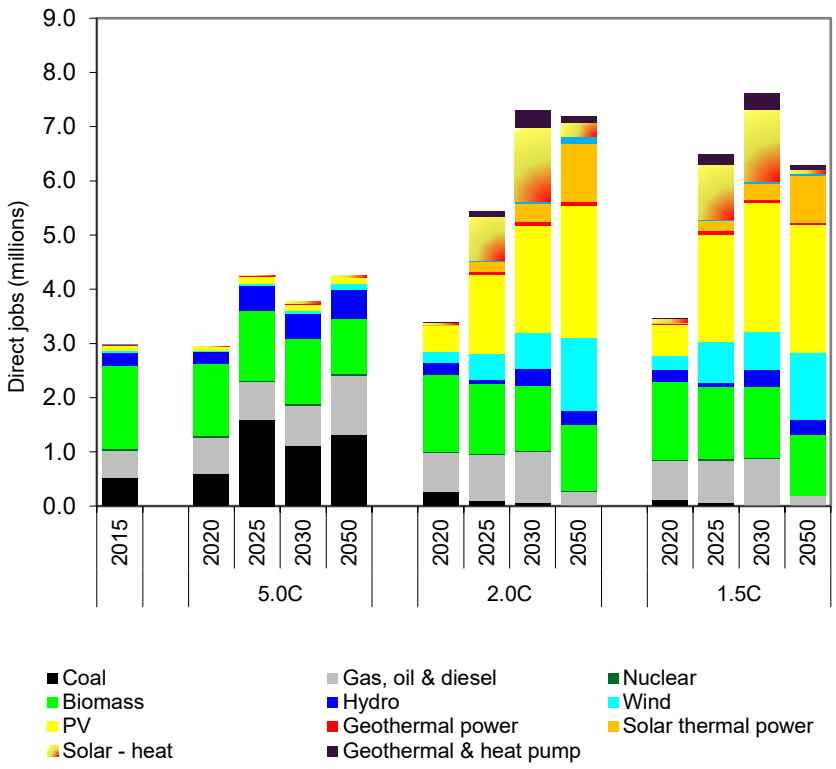


Table 24: Non-OECD Asia total employment (thousand jobs) in 5.0C and 1.5C scenarios

		5.0C				1.5C			
Technology	**2015**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
Coal	514	608	1,587	1,113	1,309	119	59	11	8
Gas, oil & diesel	514	665	716	748	1,104	720	788	869	172
Nuclear	20	19	20	22	22	20	20	19	13
Renewable	**1,926**	**1,660**	**1,934**	**1,887**	**1,827**	**2,593**	**5,624**	**6,722**	**6,086**
Biomass	*1,544*	*1,343*	*1,276*	*1,212*	*1,021*	*1,434*	*1,332*	*1,302*	*1,129*
Hydro	*238*	*205*	*460*	*455*	*541*	*215*	*84*	*313*	*268*
Wind	*29.3*	*25.6*	*46.7*	*52.0*	*103.9*	*270*	*747*	*713*	*1,247*
PV	*100.8*	*67.7*	*130.5*	*117.6*	*113.0*	*565*	*1,980*	*2,365*	*2,346*
Geothermal power	*11.3*	*8.6*	*11.9*	*8.4*	*5.2*	*23.6*	*72.1*	*64.7*	*48.3*
Solar thermal power	*1.6*	*0.2*	*0.1*	*0.6*	*1.0*	*20.0*	*175.8*	*295.2*	*852.7*
Ocean	*0.4*	*0.3*	*0.3*	*0.2*	*0.1*	*4*	*25*	*37.5*	*53.7*
Solar - heat	-	*9*	*8*	*40.7*	*42.2*	*58*	*1,022*	*1,332*	*61*
Geothermal & heat pump	-	*0.00*	-	-	-	*3*	*185*	*300*	*79*
Total jobs (thousands)	**2,973**	**2,951**	**4,257**	**3,769**	**4,262**	**3,452**	**6,491**	**7,621**	**6,279**

4.9.2 Occupational breakdown for fossil fuels, solar PV and wind

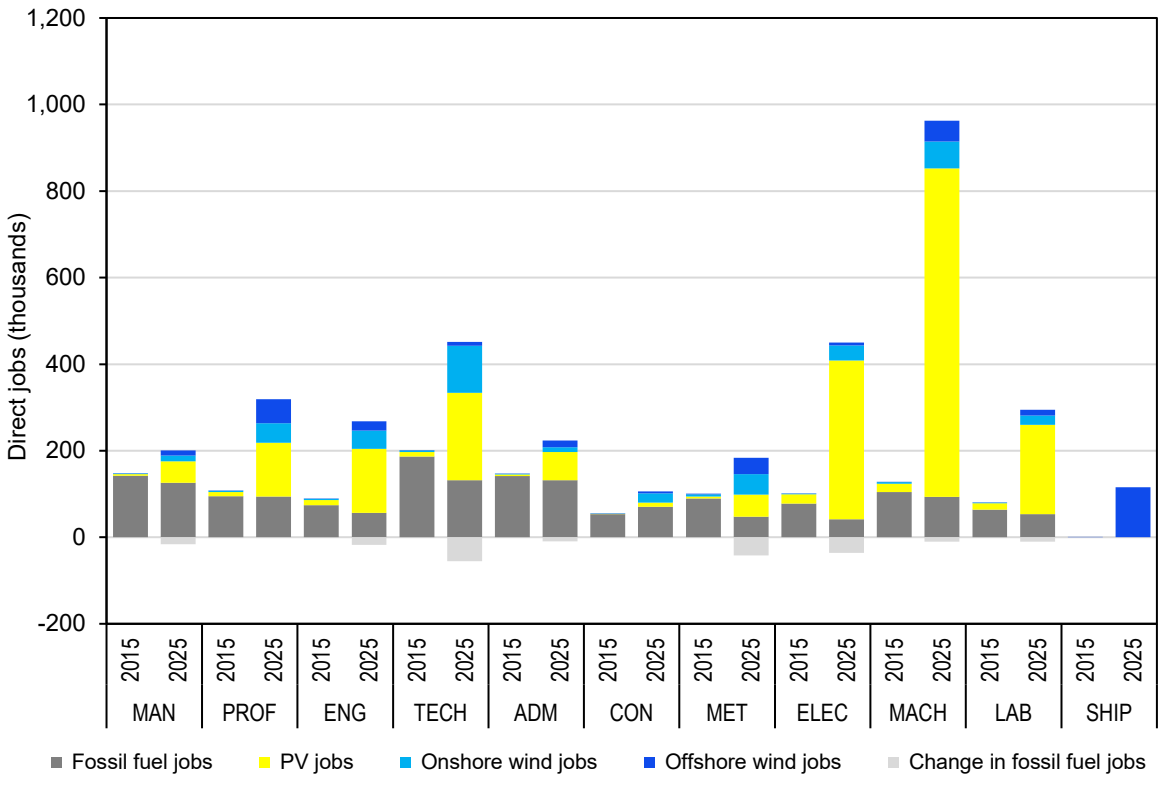
There is an increase in jobs across all occupations between 2015 and 2025 in the 1.5 degree scenario.

The occupations with the highest number of projected jobs are plant and machine operators and assemblers, followed by electricians. The occupations that will have the largest increase in jobs are electricians and labourers, with more than 450% increase.

Table 25: Occupational breakdown (thousand jobs) in between 2015 and 2025 in 1.5C scenario

	Total jobs		Change in jobs				Difference	
Occupation	**2015**	**2025**	**Fossil**	**PV**	**Wind - onshore**	**Wind - offshore**	**Total**	**%**
Managers	48.0	114.5	-16.0	45.3	12.3	11.1	52.8	36%
Professionals	52.0	251.5	-0.6	114.4	42.6	54.0	210.4	194%
Engineers	44.2	227.5	-17.5	136.1	39.0	21.0	178.5	200%
Technicians	88.9	299.1	-55.0	192.3	104.9	8.5	250.8	125%
Clerical & administrative	49.1	130.3	-9.4	61.0	9.8	15.7	77.1	53%
Construction trades	16.5	40.5	16.6	9.7	20.8	3.8	51.0	93%
Metal trades	46.8	167.6	-41.7	45.6	43.0	36.4	83.3	83%
Electricians	62.8	370.2	-36.0	344.8	33.8	6.1	348.9	346%
Machinists & assemblers	128.9	630.8	-10.5	738.6	59.0	47.0	834.1	649%
Labourers	42.9	246.6	-10.2	191.3	20.3	12.9	214.3	266%
Total	**580.1**	**2,478.5**	**-180.3**	**1,879.2**	**385.7**	**216.6**	**2,301.2**	**199%**
Ship crew	2.2	93.0	-	-	-	115.8	115.8	68465%

Figure 24: Non-OECD Asia occupational breakdown between 2015 and 2025 in 1.5C scenario



4.10 China

4.10.1 Total employment

The 2.0C and 1.5C scenarios result in more energy sector jobs in China at every stage of the projection compared to the 5.0C scenario, but see an overall decrease of 8% by 2050.

- There are 9.6 million energy sector jobs in the 1.5C scenario in 2025, 8.7 million in the 2.0C scenario and 6.3 million in the 5.0C scenario.
- In 2050, there are 8.3 million jobs in the 1.5C scenario, 7.9 million jobs in the 2.0C scenario and 4.7 million in the 5.0C scenario.
- Growth in renewable energy leads to an increase of 7% in total energy sector jobs in the 1.5C scenario and a decrease of 3% in total energy sector jobs in the 2.0C scenario by 2025.
- Jobs in the 5.0C Scenario drop to 30% below 2015 levels by 2025 and then decrease to half of 2015 levels.
- Renewable energy accounts for 79% of energy sector jobs at 2030 in the 1.5C scenario, with PV having the greatest share (23%), followed by wind, biomass and solar heating.

Figure 25: China total employment under 3 scenarios

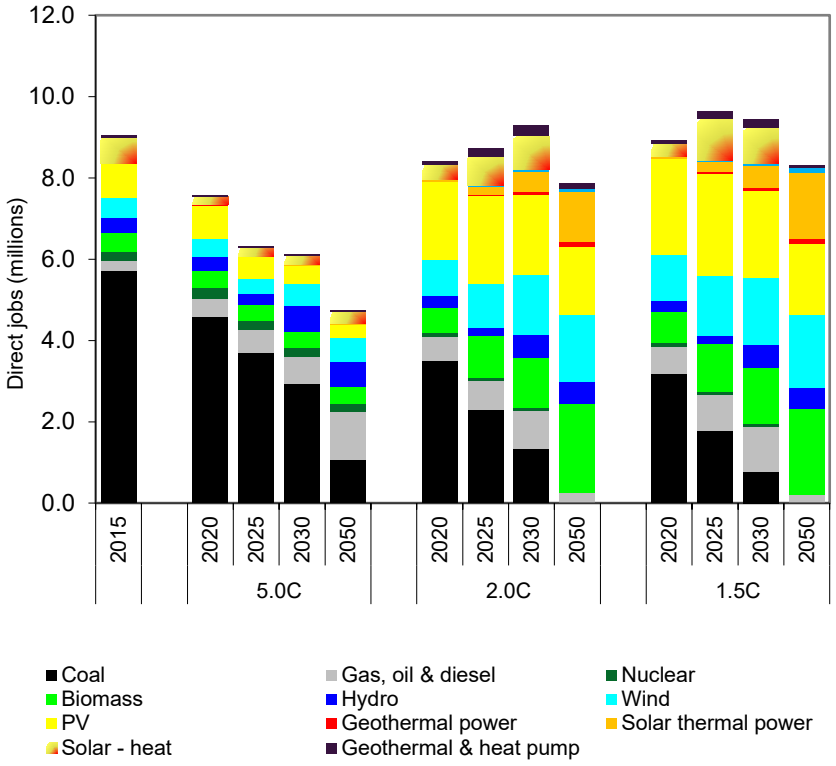


Table 26: China total employment (thousand jobs) in 5.0C and 1.5C scenarios

		5.0C				1.5C			
Technology	**2015**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
Coal	5,719	4,581	3,705	2,921	1,066	3,178	1,795	765	17
Gas, oil & diesel	235	443	560	687	1,186	664	865	1,115	175
Nuclear	231	266	235	224	194	91	79	72	-
Renewable	**2,857**	**2,289**	**1,823**	**2,274**	**2,300**	**5,002**	**6,908**	**7,484**	**8,132**
Biomass	*452*	*421*	*375*	*379*	*414*	*759*	*1,179*	*1,364*	*2,136*
Hydro	*386*	*340*	*270*	*650*	*611*	*285*	*196*	*589*	*519*
Wind	*486.4*	*458.4*	*369.0*	*535.9*	*583.1*	*1,126*	*1,476*	*1,626*	*1,797*
PV	*837.7*	*817.9*	*539.7*	*447.8*	*338.9*	*2,358*	*2,508*	*2,155*	*1,722*
Geothermal power	*2.0*	*1.4*	*1.3*	*1.3*	*1.0*	*9.0*	*55.8*	*74.7*	*142.2*
Solar thermal power	*5.8*	*9.9*	*9.9*	*10.5*	*15.9*	*44.1*	*237.5*	*550.3*	*1,620.9*
Ocean	*0.6*	*0.5*	*0.6*	*1.0*	*1.1*	*13*	*31*	*49.6*	*129.1*
Solar - heat	*634*	*204*	*226*	*221.9*	*303.7*	*320*	*1,039*	*864*	-
Geothermal & heat pump	*51.7*	*36.46*	*31.088*	*26.3*	*31.4*	*88*	*185*	*211*	*65*
Total jobs (thousands)	**9,043**	**7,579**	**6,322**	**6,106**	**4,746**	**8,936**	**9,648**	**9,436**	**8,323**

4.10.2 Occupational breakdown for fossil fuels, solar PV and wind

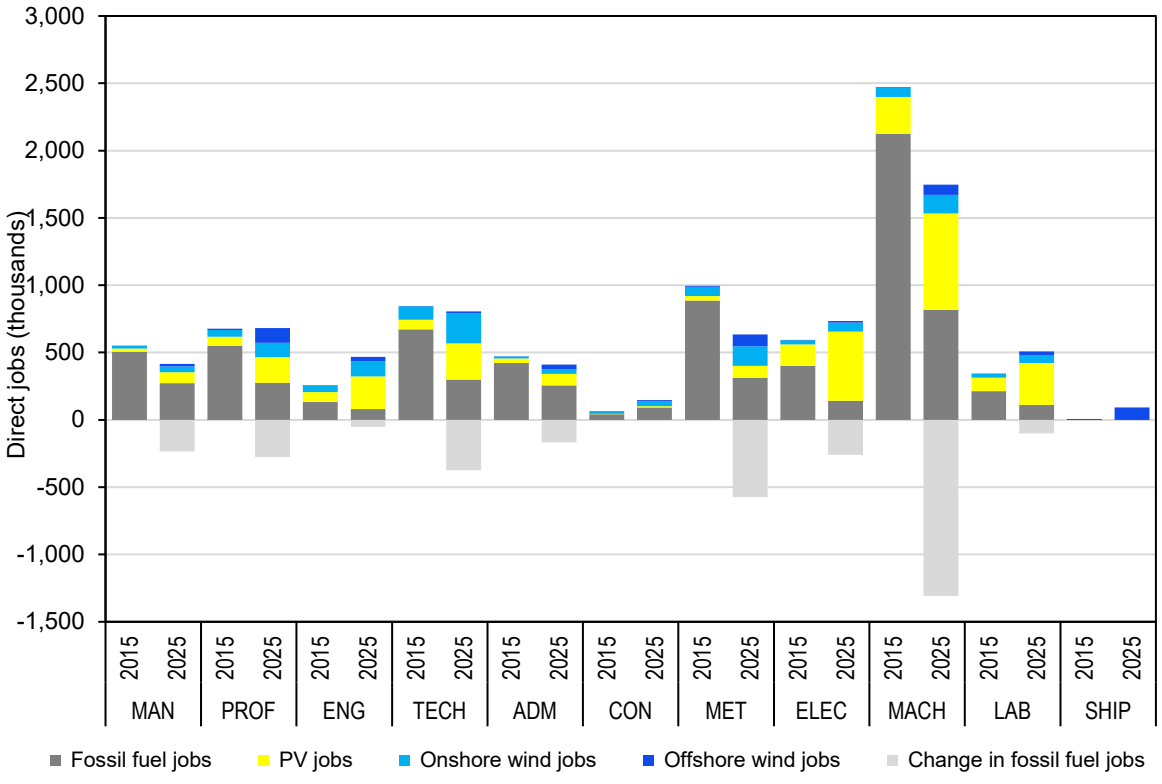
There is an increase in jobs across half of occupations between 2015 and 2025 in the 1.5 degree scenario, but a decrease in half. Overall there is a 10% decrease in the number of jobs. .

The occupations with the highest number of projected jobs are engineers, whereas plant and machine operators and assemblers have the largest total. The occupations that will have the largest increase in jobs are construction trades.

Table 27: Occupational breakdown (thousand jobs) in between 2015 and 2025 in 1.5C scenario

	Total jobs		Change in jobs				Difference	
Occupation	**2015**	**2025**	**Fossil**	**PV**	**Wind - onshore**	**Wind - offshore**	**Total**	**%**
Managers	551.1	416.4	-233.4	57.6	22.2	18.9	-134.7	-24%
Professionals	676.1	681.1	-275.5	122.8	57.5	100.2	5.0	1%
Engineers	257.4	467.8	-52.8	167.7	65.4	30.1	210.3	82%
Technicians	845.5	806.6	-373.1	197.4	123.2	13.6	-38.9	-5%
Clerical & administrative	472.2	411.3	-167.8	55.7	18.5	32.8	-60.9	-13%
Construction trades	65.3	146.0	50.4	5.3	17.7	7.4	80.7	124%
Metal trades	995.8	634.0	-573.6	55.3	75.3	81.2	-361.8	-36%
Electricians	592.9	734.1	-259.1	355.7	32.6	12.0	141.3	24%
Machinists & assemblers	2,473.0	1,746.3	-1,308.0	443.0	68.9	69.4	-726.6	-29%
Labourers	343.1	508.1	-100.9	210.3	30.7	24.9	164.9	48%
Total	**7,272.4**	**6,551.8**	**-3,293.9**	**1,670.8**	**511.9**	**390.5**	**-720.6**	**-10%**
Ship crew	5.9	92.7	-	-	-	86.8	86.8	1462%

Figure 26: China occupational breakdown between 2015 and 2025 in 1.5C scenario



4.11 OECD Pacific

4.11.1 Total employment

The 2.0°C and 1.5°C scenarios result in more energy sector jobs in OECD Pacific at every stage of the projection.

- There are 1 million energy sector jobs in the 1.5C scenario in 2025, 0.9 million in the 2.0C scenario and 0.3 million in the 5.0C scenario.
- In 2050, there are 1 million jobs in the 1.5C scenario, 1 million jobs in the 2.0C scenario and 0.4 million in the 5.0C scenario.
- Strong growth in renewable energy leads to an increase of 159% in total energy sector jobs in the 1.5C scenario and 136% in total energy sector jobs in the 2.0C scenario by 2025. By 2030, energy jobs are 2.5 times 2015 levels.
- Renewable energy accounts for 94% of energy sector jobs at 2030 in the 1.5C scenario, with PV having the greatest share (46%), followed by wind, biomass and solar heating.

Figure 27: OECD Pacific total employment under 3 scenarios

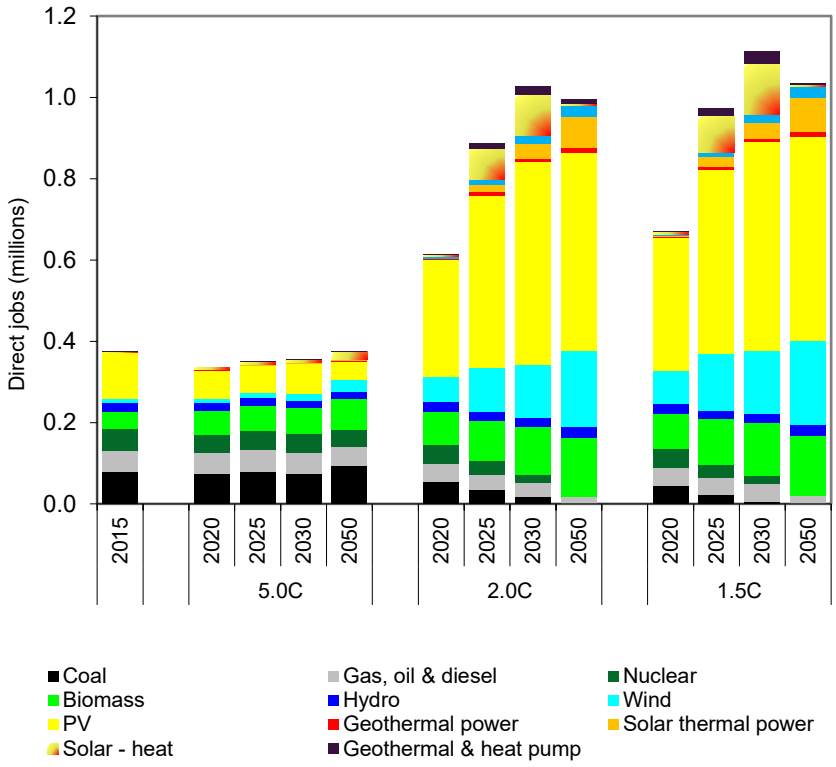


Table 28: OECD Pacific total employment (thousand jobs) in 5.0C and 1.5C scenarios

		5.0C				1.5C			
Technology	**2015**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
Coal	80	74	79	74	93	45	23	5	0
Gas, oil & diesel	53	52	54	52	46	44	41	44	19
Nuclear	52	46	45	45	44	46	33	19	-
Renewable	**191**	**165**	**171**	**184**	**192**	**535**	**877**	**1,046**	**1,016**
Biomass	*43*	*57*	*62*	*65*	*75*	*86*	*113*	*130*	*149*
Hydro	*21*	*19*	*20*	*17*	*17*	*25*	*20*	*24*	*27*
Wind	*11.3*	*11.8*	*13.0*	*17.4*	*29.2*	*81*	*139*	*154*	*205*
PV	*111.0*	*67.1*	*64.4*	*72.1*	*44.0*	*327*	*453*	*514*	*504*
Geothermal power	*1.7*	*2.1*	*2.1*	*2.2*	*2.1*	*3.2*	*9.4*	*8.6*	*13.3*
Solar thermal power	*0.1*	*0.1*	*0.5*	*0.7*	*1.6*	*0.9*	*23.3*	*38.4*	*81.3*
Ocean	*0.5*	*0.6*	*0.6*	*1.4*	*2.4*	*4*	*11*	*20.3*	*28.3*
Solar - heat	*2*	*7*	*8*	*7.5*	*20.2*	*6*	*91*	*126*	*3*
Geothermal & heat pump	*1.1*	*-*	*0.258*	*0.2*	*0.2*	*1*	*18*	*31*	*5*
Total jobs (thousands)	**376**	**337**	**350**	**355**	**376**	**670**	**974**	**1,114**	**1,035**

4.11.2 Occupational breakdown for fossil fuels, solar PV and wind

There is an increase in jobs across all occupations between 2015 and 2025 in the 1.5 degree scenario.

The occupations with the highest number of projected jobs are plant and machine operators and assemblers, followed by technicians. The occupations that will have the largest increase in jobs are engineers, electricians and labourers, with more than 200% increase each.

Table 29: Occupational breakdown (thousand jobs) in between 2015 and 2025 in 1.5C scenario

	Total jobs		Change in jobs				Difference	
Occupation	**2015**	**2025**	**Fossil**	**PV**	**Wind - onshore**	**Wind - offshore**	**Total**	**%**
Managers	18.8	26.3	-7.4	10.3	2.8	1.7	7.5	40%
Professionals	19.6	53.4	-5.7	21.8	8.8	8.8	33.8	172%
Engineers	17.9	56.3	-3.5	29.6	9.2	3.0	38.4	214%
Technicians	37.7	89.8	-11.1	40.5	21.3	1.4	52.2	138%
Clerical & administrative	17.8	27.0	-6.6	10.7	2.4	2.7	9.2	52%
Construction trades	4.0	8.7	-1.0	1.4	3.6	0.7	4.6	115%
Metal trades	20.5	36.1	-9.0	8.7	9.4	6.5	15.6	76%
Electricians	34.2	104.9	-5.8	69.3	6.2	1.0	70.7	206%
Machinists & assemblers	64.0	177.9	-14.9	110.7	11.1	6.9	113.9	178%
Labourers	19.9	61.5	-3.3	38.5	4.3	2.2	41.7	210%
Total	**254.5**	**641.9**	**-68.3**	**341.6**	**79.1**	**35.0**	**387.4**	**152%**
Ship crew	0.1	13.2	-	-	-	13.1	13.1	8742%

Figure 28: OECD Pacific occupational breakdown between 2015 and 2025 in 1.5C scenario

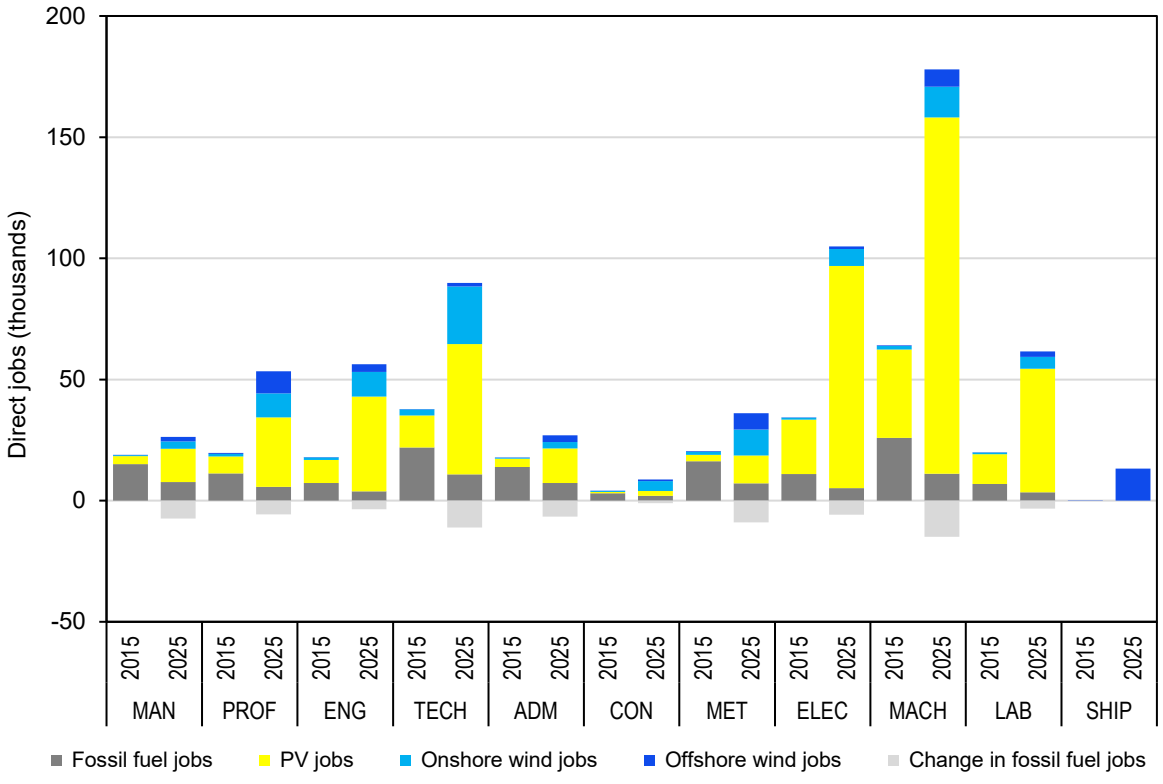


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Table 30: Global total employment (thousand jobs)

		5.0C				2.0C				1.5C			
	2015	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
By sector													
Construction and installation	4,975	4,737	5,319	5,447	4,324	6,531	9,775	11,980	14,523	8,088	11,939	13,808	14,313
Manufacturing	2,859	2,579	2,821	2,976	2,476	4,903	6,395	7,591	8,580	6,063	7,834	8,726	8,555
Operations and maintenance	3,615	4,343	4,757	5,237	6,202	4,563	6,843	9,481	16,123	4,579	7,857	10,957	16,423
Fuel supply (domestic)	17,271	16,542	15,748	15,516	15,366	16,064	14,342	12,840	8,214	16,007	14,494	12,648	6,168
Coal and gas export	466.5	512.4	536.5	562.4	302.9	380.3	287.0	197.0	-	387.1	305.2	227.2	-
Solar and geothermal heat	778	436	424	584	853	1,183	4,669	7,126	2,934	1,259	5,719	7,417	2,372
Total jobs (thousands)	**29,964**	**29,150**	**29,606**	**30,323**	**29,522**	**33,624**	**42,311**	**49,215**	**50,372**	**36,383**	**48,149**	**53,783**	**47,831**
By technology													
Coal	10,070	8,460	8,380	7,254	4,652	5,337	3,436	1,969	58	4,788	2,568	1,080	69
Gas, oil & diesel	2,571	3,503	3,820	4,112	4,812	3,691	3,915	4,014	1,602	3,686	3,934	4,366	1,643
Nuclear	661	706	667	647	555	406	307	221	13	406	312	221	13
Renewable	**16,663**	**16,481**	**16,739**	**18,310**	**19,503**	**24,189**	**34,652**	**43,011**	**48,698**	**27,502**	**41,334**	**48,116**	**46,105**
Biomass	*11,196*	*11,058*	*11,106*	*11,334*	*11,652*	*11,381*	*11,704*	*11,747*	*13,038*	*11,827*	*12,882*	*12,777*	*11,321*
Hydro	*1,702*	*1,623*	*1,925*	*2,586*	*3,191*	*1,422*	*1,051*	*1,945*	*1,856*	*1,421*	*1,027*	*1,966*	*1,892*
Wind	*970*	*986*	*971*	*1,396*	*1,702*	*3,012*	*4,872*	*6,750*	*10,072*	*3,851*	*6,469*	*7,705*	*9,764*
PV	*1,964*	*2,314*	*2,229*	*2,259*	*1,865*	*6,829*	*10,952*	*12,727*	*14,258*	*8,767*	*13,616*	*15,142*	*14,225*
Geothermal power	*27.5*	*25.5*	*33.2*	*35.2*	*33.5*	*89.7*	*238.5*	*320.9*	*459.5*	*94.7*	*285*	*348*	*459*
Solar thermal power	*23.0*	*34.4*	*47.0*	*106*	*185*	*148.2*	*882.2*	*1,950.7*	*5,404.8*	*160*	*1,057*	*2,334*	*5,452*
Ocean	*2.5*	*3.0*	*4.1*	*9.7*	*21.6*	*123*	*284*	*443.8*	*676.3*	*123*	*279*	*427.0*	*620.8*
Solar - heat	*710*	*389*	*383*	*549*	*816*	*971*	*3,758*	*5,788*	*1,469*	*212*	*1,025*	*1,390*	*1,207*
Geothermal & heat pump	*67.7*	*47.16*	*40.586*	*34.9*	*37.3*	*212*	*911*	*1,338*	*1,464*	*1,047*	*4,695*	*6,027*	*1,166*
Total jobs (thousands)	**29,964**	**29,150**	**29,606**	**30,323**	**29,522**	**33,624**	**42,311**	**49,215**	**50,372**	**36,383**	**48,149**	**53,783**	**47,831**

Table 31: OECD North America total employment (thousand jobs)

		5.0C				2.0C				1.5C			
	2015	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
By sector													
Construction and installation	162	153	101	193	234	635	1,055	746	838	761	1,143	822	995
Manufacturing	112	109	82	161	190	400	826	697	768	506	966	749	831
Operations and maintenance	334	359	379	388	436	363	580	762	968	363	646	826	961
Fuel supply (domestic)	282	359	375	392	479	360	360	337	234	368	454	411	188
Coal and gas export	9.4	8.5	8.6	8.7	11.1	4.7	2.4	-	-	3.3	1.7	-	-
Solar and geothermal heat	10	23	24	29	46	24	489	461	247	23	700	569	124
Total jobs (thousands)	**909**	**1,012**	**970**	**1,171**	**1,395**	**1,787**	**3,311**	**3,004**	**3,055**	**2,024**	**3,910**	**3,377**	**3,099**
By technology													
Coal	116	106	98	102	85	100	54	9	0	99	30	8	11
Gas, oil & diesel	212	278	277	296	316	252	316	242	116	303	269	175	82
Nuclear	73	70	65	64	57	70	53	26	0	70	51	27	0
Renewable	**508**	**558**	**529**	**709**	**936**	**1,365**	**2,888**	**2,728**	**2,938**	**1,551**	**3,561**	**3,167**	**3,006**
Biomass	*195*	*210*	*226*	*246*	*347*	*221*	*277*	*314*	*383*	*242*	*409*	*452*	*299*
Hydro	*45*	*41*	*51*	*129*	*134*	*43*	*50*	*150*	*159*	*42*	*41*	*158*	*184*
Wind	*65.8*	*71.0*	*63.0*	*124.2*	*168.7*	*226*	*414*	*511*	*748*	*272*	*639*	*478*	*620*
PV	*188.3*	*209.4*	*159.9*	*153.0*	*208.7*	*834*	*1,565*	*1,113*	*1,168*	*951*	*1,634*	*1,342*	*1,594*
Geothermal power	*2.4*	*1.9*	*2.8*	*2.5*	*2.3*	*2.8*	*5.3*	*9.1*	*14.3*	*2.4*	*4.5*	*7.1*	*9.5*
Solar thermal power	*0.7*	*0.7*	*1.4*	*23.8*	*27.6*	*12.0*	*67.0*	*116.0*	*168.5*	*16.5*	*114.6*	*114.7*	*133.0*
Ocean	*0.1*	*0.2*	*1.1*	*1.9*	*2.3*	*3*	*22*	*52.8*	*50.0*	*2*	*19*	*46.7*	*42.4*
Solar - heat	*10*	*23*	*23*	*28.6*	*45.5*	*23*	*307*	*359*	*55*	*23*	*467*	*347*	*43*
Geothermal & heat pump	*0.9*	*0.04*	*0.093*	*0.1*	*0.1*	*0*	*182*	*102*	*193*	*0*	*233*	*222*	*82*
Total jobs (thousands)	**909**	**1,012**	**970**	**1,171**	**1,395**	**1,787**	**3,311**	**3,004**	**3,055**	**2,024**	**3,910**	**3,377**	**3,099**

Table 32: Latin America total employment (thousand jobs)

		5.0C				2.0C				1.5C			
	2015	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
By sector													
Construction and installation	226	211	222	361	410	501	583	791	744	577	816	1,228	907
Manufacturing	113	109	132	195	223	133	188	343	429	152	278	559	499
Operations and maintenance	531	597	671	736	893	673	891	1,071	1,306	670	930	1,194	1,434
Fuel supply (domestic)	593	687	692	734	878	701	770	809	770	701	786	790	506
Coal and gas export	33.3	30.1	30.3	30.6	39.2	18.1	9.0	-	-	14.5	7.2	-	-
Solar and geothermal heat	22	21	21	28	41	323	215	418	269	323	215	504	246
Total jobs (thousands)	**1,518**	**1,655**	**1,768**	**2,085**	**2,484**	**2,350**	**2,655**	**3,432**	**3,518**	**2,436**	**3,032**	**4,275**	**3,593**
By technology													
Coal	113	80	86	96	71	34	20	7	2	29	14	2	2
Gas, oil & diesel	208	305	335	359	414	259	230	206	95	253	264	324	123
Nuclear	7	10	10	10	11	3	3	3	0	3	3	3	0
Renewable	**1,191**	**1,260**	**1,336**	**1,620**	**1,988**	**2,054**	**2,402**	**3,217**	**3,422**	**2,151**	**2,752**	**3,947**	**3,468**
Biomass	*634*	*632*	*630*	*698*	*749*	*812*	*1,004*	*1,108*	*1,383*	*801*	*1,057*	*1,173*	*1,125*
Hydro	*472*	*518*	*592*	*781*	*1,041*	*372*	*380*	*524*	*512*	*372*	*380*	*524*	*512*
Wind	*21.8*	*29.3*	*32.1*	*44.6*	*74.9*	*71*	*121*	*255*	*395*	*81*	*166*	*315*	*446*
PV	*37.9*	*54.8*	*56.1*	*58.7*	*60.9*	*447*	*595*	*728*	*538*	*545*	*845*	*1,215*	*806*
Geothermal power	*2.0*	*2.4*	*2.6*	*4.4*	*2.6*	*7.4*	*10.0*	*11.0*	*14.4*	*7.4*	*10.0*	*11.0*	*9.8*
Solar thermal power	*2.0*	*2.0*	*3.7*	*5.7*	*9.1*	*12.0*	*69.9*	*135.8*	*216.7*	*12.0*	*69.9*	*166.9*	*248.1*
Ocean	*-*	*-*	*-*	*-*	*9.2*	*10*	*9*	*37.4*	*92.4*	*10*	*9*	*37.4*	*74.4*
Solar - heat	*22*	*21*	*21*	*28.3*	*41.2*	*282*	*186*	*385*	*130*	*282*	*186*	*472*	*101*
Geothermal & heat pump	*0.0*	*-*	*-*	*-*	*-*	*40*	*29*	*33*	*139*	*40*	*29*	*32*	*146*
Total jobs (thousands)	**1,518**	**1,655**	**1,768**	**2,085**	**2,484**	**2,350**	**2,655**	**3,432**	**3,518**	**2,436**	**3,032**	**4,275**	**3,593**

Table 33: OECD Europe total employment (thousand jobs)

		5.0C				2.0C				1.5C			
	2015	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
By sector													
Construction and installation	144	104	99	323	263	343	419	633	675	470	546	723	620
Manufacturing	103	95	93	223	182	390	497	696	676	504	633	816	686
Operations and maintenance	379	395	405	414	419	409	502	616	757	407	558	713	810
Fuel supply (domestic)	573	456	437	418	381	468	459	369	236	465	403	329	218
Coal and gas export	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar and geothermal heat	37	67	39	37	63	144	794	726	117	137	759	450	104
Total jobs (thousands)	**1,236**	**1,117**	**1,072**	**1,416**	**1,308**	**1,753**	**2,670**	**3,041**	**2,461**	**1,982**	**2,899**	**3,031**	**2,438**
By technology													
Coal	421	217	188	161	113	211	164	68	23	208	92	25	23
Gas, oil & diesel	123	156	152	146	110	138	136	127	31	137	141	126	33
Nuclear	73	70	58	47	32	69	39	22	-	69	39	22	-
Renewable	**619**	**673**	**674**	**1,061**	**1,053**	**1,336**	**2,331**	**2,824**	**2,407**	**1,569**	**2,626**	**2,858**	**2,383**
Biomass	*268*	*303*	*325*	*380*	*415*	*381*	*456*	*497*	*515*	*392*	*463*	*495*	*485*
Hydro	*62*	*59*	*62*	*71*	*93*	*46*	*47*	*61*	*74*	*46*	*47*	*61*	*74*
Wind	*91.6*	*107.0*	*118.6*	*203.4*	*242.6*	*265*	*373*	*530*	*669*	*311*	*456*	*615*	*702*
PV	*153.5*	*129.7*	*121.6*	*344.2*	*205.7*	*464*	*578*	*873*	*838*	*647*	*808*	*1,078*	*817*
Geothermal power	*2.1*	*2.1*	*2.3*	*2.8*	*3.9*	*8.3*	*11.8*	*18.4*	*30.7*	*8.0*	*12.2*	*19.2*	*30.3*
Solar thermal power	*3.9*	*4.1*	*4.7*	*18.1*	*24.6*	*15.4*	*39.1*	*69.2*	*117.3*	*15.0*	*49.9*	*91.1*	*124.2*
Ocean	*0.8*	*1.3*	*1.5*	*4.0*	*5.5*	*13*	*32*	*49.2*	*45.7*	*13*	*32*	*49.1*	*45.6*
Solar - heat	*24*	*57*	*31*	*29.8*	*58.7*	*117*	*667*	*596*	*75*	*112*	*650*	*368*	*57*
Geothermal & heat pump	*13.1*	*9.27*	*7.987*	*7.3*	*4.5*	*27*	*127*	*130*	*42*	*25*	*109*	*82*	*47*
Total jobs (thousands)	**1,236**	**1,117**	**1,072**	**1,416**	**1,308**	**1,753**	**2,670**	**3,041**	**2,461**	**1,982**	**2,899**	**3,031**	**2,438**

Table 34: Africa total employment (thousand jobs)

		5.0C				2.0C				1.5C			
	2015	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
By sector													
Construction and installation	300	335	374	439	560	522	1,027	1,802	3,080	652	1,193	2,416	2,758
Manufacturing	202	193	201	224	267	232	313	518	1,127	208	332	807	1,160
Operations and maintenance	183	261	327	404	650	258	474	900	2,892	268	585	1,088	3,343
Fuel supply (domestic)	6,193	6,574	6,945	7,208	7,845	6,102	5,684	5,306	4,580	6,260	6,153	5,552	3,164
Coal and gas export	50.2	54.2	62.5	70.5	45.0	37.9	29.7	21.4	-	36.4	30.6	24.7	-
Solar and geothermal heat	6	27	26	83	196	85	326	1,090	1,387	85	325	1,085	1,293
Total jobs (thousands)	**6,934**	**7,444**	**7,935**	**8,428**	**9,563**	**7,237**	**7,855**	**9,637**	**13,066**	**7,511**	**8,620**	**10,973**	**11,718**
By technology													
Coal	249	265	259	312	423	231	117	80	3	258	93	60	3
Gas, oil & diesel	312	334	362	392	352	311	319	409	371	189	253	607	473
Nuclear	7	19	27	28	26	6	6	5	-	6	6	5	-
Renewable	**6,367**	**6,827**	**7,288**	**7,697**	**8,762**	**6,689**	**7,414**	**9,143**	**12,692**	**7,058**	**8,269**	**10,300**	**11,242**
Biomass	*6,128*	*6,495*	*6,878*	*7,138*	*7,750*	*6,072*	*5,774*	*5,469*	*4,973*	*6,225*	*6,332*	*5,808*	*3,835*
Hydro	*143*	*155*	*188*	*230*	*436*	*144*	*88*	*80*	*90*	*144*	*73*	*94*	*103*
Wind	*18.7*	*25.5*	*30.1*	*35.1*	*66.7*	*117*	*380*	*723*	*1,691*	*226*	*569*	*1,046*	*1,923*
PV	*66.3*	*108.3*	*141.1*	*165.1*	*208.0*	*214*	*733*	*1,660*	*3,079*	*323*	*806*	*1,862*	*2,621*
Geothermal power	*3.7*	*4.8*	*7.9*	*11.5*	*14.8*	*27.4*	*48.3*	*39.8*	*61.9*	*23.7*	*49.2*	*39.8*	*61.9*
Solar thermal power	*1.4*	*11.5*	*17.0*	*35.3*	*90.8*	*0.8*	*3.6*	*59.1*	*1,315.8*	*1.8*	*53.7*	*342.6*	*1,311.4*
Ocean	-	-	-	*0.0*	*0.0*	*28*	*60*	*21.6*	*95.1*	*28*	*60*	*21.6*	*95.1*
Solar - heat	*6*	*27*	*26*	*82.8*	*195.5*	*64*	*282*	*971*	*731*	*64*	*281*	*968*	*666*
Geothermal & heat pump	-	*0.00*	-	-	-	*21*	*45*	*118*	*656*	*21*	*44*	*118*	*626*
Total jobs (thousands)	**6,934**	**7,444**	**7,935**	**8,428**	**9,563**	**7,237**	**7,855**	**9,637**	**13,066**	**7,511**	**8,620**	**10,973**	**11,718**

Table 35: Middle East total employment (thousand jobs)

		5.0C				2.0C				1.5C			
	2015	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
By sector													
Construction and installation	46	47	57	68	67	162	337	568	691	182	398	646	906
Manufacturing	43	40	55	49	41	49	97	114	135	48	107	135	179
Operations and maintenance	60	76	90	104	149	89	155	284	676	98	167	321	612
Fuel supply (domestic)	119	228	249	301	384	215	204	193	36	214	215	182	30
Coal and gas export	51.9	49.6	47.7	45.6	-	43.1	35.2	27.5	-	49.6	40.6	31.7	-
Solar and geothermal heat	1	18	18	77	60	74	123	178	102	74	118	174	24
Total jobs (thousands)	**321**	**460**	**517**	**645**	**700**	**631**	**952**	**1,365**	**1,640**	**665**	**1,046**	**1,490**	**1,752**
By technology													
Coal	12	9	4	3	2	1	1	1	-0	1	1	1	-0
Gas, oil & diesel	279	391	439	470	472	331	337	257	39	322	330	246	62
Nuclear	12	12	12	14	13	0	0	0	-	0	0	0	-
Renewable	**18**	**49**	**61**	**158**	**212**	**299**	**613**	**1,106**	**1,600**	**341**	**714**	**1,243**	**1,690**
Biomass	*2*	*4*	*7*	*13*	*50*	*13*	*23*	*33*	*42*	*21*	*44*	*44*	*39*
Hydro	*11*	*11*	*13*	*34*	*41*	*18*	*7*	*34*	*43*	*18*	*7*	*34*	*41*
Wind	*0.9*	*2.4*	*5.9*	*10.5*	*30.9*	*37*	*106*	*184*	*302*	*42*	*118*	*226*	*299*
PV	*3.0*	*10.7*	*12.2*	*17.3*	*23.0*	*124*	*273*	*417*	*648*	*153*	*343*	*480*	*944*
Geothermal power	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*2.1*	*4.1*	*8.2*	*5.0*	*2.1*	*4.1*	*8.2*	*4.6*
Solar thermal power	*1.0*	*2.3*	*4.8*	*6.3*	*7.4*	*14.1*	*60.4*	*217.4*	*426.6*	*14.7*	*64.2*	*241.2*	*307.9*
Ocean	-	-	-	-	-	*18*	*16*	*34.8*	*32.0*	*18*	*16*	*34.8*	*30.1*
Solar - heat	*1*	*18*	*18*	*77.1*	*60.2*	*57*	*112*	*157*	*26*	*57*	*108*	*153*	-
Geothermal & heat pump	-	*0.00*	-	-	-	*17*	*11*	*21*	*76*	*17*	*10*	*21*	*24*
Total jobs (thousands)	**321**	**460**	**517**	**645**	**700**	**631**	**952**	**1,365**	**1,640**	**665**	**1,046**	**1,490**	**1,752**

Table 36: Eastern Europe/ Eurasia total employment (thousand jobs)

		5.0C				2.0C				1.5C			
	2015	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
By sector													
Construction and installation	89	60	51	82	82	290	578	594	910	447	813	817	876
Manufacturing	48	27	25	44	43	95	174	243	509	115	226	323	475
Operations and maintenance	266	276	277	276	281	292	470	679	1,199	338	580	895	1,232
Fuel supply (domestic)	592	673	616	589	631	644	641	627	346	633	646	661	324
Coal and gas export	247.7	315.7	351.1	384.9	179.2	232.2	190.2	148.0	-	234.4	202.7	170.8	-
Solar and geothermal heat	2	2	4	3	7	8	313	450	1	36	372	482	76
Total jobs (thousands)	**1,244**	**1,354**	**1,324**	**1,379**	**1,224**	**1,562**	**2,366**	**2,742**	**2,965**	**1,804**	**2,839**	**3,350**	**2,984**
By technology													
Coal	507	372	292	265	224	271	131	27	1	216	87	5	1
Gas, oil & diesel	477	699	740	792	606	689	654	614	141	688	644	599	126
Nuclear	82	86	82	76	65	65	43	26	-	65	50	26	-
Renewable	**178**	**197**	**211**	**246**	**329**	**537**	**1,539**	**2,076**	**2,823**	**836**	**2,057**	**2,719**	**2,858**
Biomass	*66*	*98*	*108*	*121*	*171*	*203*	*413*	*525*	*841*	*327*	*620*	*756*	*853*
Hydro	*95*	*77*	*78*	*79*	*106*	*77*	*76*	*58*	*56*	*77*	*76*	*58*	*56*
Wind	*6.6*	*8.3*	*9.7*	*22.3*	*30.9*	*82*	*230*	*397*	*874*	*90*	*253*	*454*	*787*
PV	*7.6*	*9.8*	*9.6*	*18.8*	*12.1*	*161*	*486*	*596*	*871*	*301*	*699*	*889*	*909*
Geothermal power	*0.8*	*1.3*	*1.5*	*1.5*	*1.5*	*4.8*	*17.3*	*27.1*	*76.4*	*4.7*	*33.9*	*48.8*	*74.2*
Solar thermal power	-	-	-	-	-	*0.2*	*1.5*	*13.8*	*81.6*	*0.2*	*1.7*	*22.3*	*81.2*
Ocean	-	-	-	*0.1*	*0.1*	-	*3*	*9.2*	*21.7*	-	*3*	*9.2*	*21.7*
Solar - heat	*1*	*1*	*3*	*2.6*	*6.0*	*3*	*201*	*309*	*1*	*24*	*249*	*309*	*43*
Geothermal & heat pump	*0.8*	*1.02*	*0.875*	*0.8*	*0.9*	*6*	*112*	*141*	-	*12*	*123*	*173*	*33*
Total jobs (thousands)	**1,244**	**1,354**	**1,324**	**1,379**	**1,224**	**1,562**	**2,366**	**2,742**	**2,965**	**1,804**	**2,839**	**3,350**	**2,984**

Table 37: India total employment (thousand jobs)

		5.0C				2.0C				1.5C			
	2015	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
By sector													
Construction and installation	1,787	1,766	1,759	1,703	946	1,749	2,250	2,375	2,412	2,311	2,712	2,423	1,952
Manufacturing	865	833	868	863	525	1,524	1,935	2,116	1,883	1,945	2,308	2,225	1,600
Operations and maintenance	475	720	818	927	1,034	720	1,222	1,728	2,472	688	1,542	2,056	2,295
Fuel supply (domestic)	2,270	1,901	1,625	1,445	917	1,853	1,549	1,237	547	1,853	1,439	1,122	471
Coal and gas export	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar and geothermal heat	12	21	20	30	43	49	488	921	294	105	690	1,291	290
Total jobs (thousands)	**5,409**	**5,241**	**5,091**	**4,967**	**3,465**	**5,895**	**7,446**	**8,377**	**7,608**	**6,902**	**8,690**	**9,117**	**6,610**
By technology													
Coal	2,339	2,150	2,082	2,208	1,266	665	517	358	6	633	373	198	6
Gas, oil & diesel	159	180	184	169	206	365	334	261	298	365	338	261	378
Nuclear	104	109	112	116	91	37	32	28	-	37	32	28	-
Renewable	**2,807**	**2,803**	**2,713**	**2,474**	**1,902**	**4,828**	**6,563**	**7,730**	**7,304**	**5,866**	**7,948**	**8,631**	**6,226**
Biomass	*1,864*	*1,495*	*1,221*	*1,083*	*659*	*1,540*	*1,351*	*1,264*	*1,346*	*1,539*	*1,333*	*1,251*	*1,271*
Hydro	*228*	*197*	*190*	*140*	*170*	*197*	*103*	*111*	*106*	*197*	*103*	*111*	*106*
Wind	*237.7*	*247.0*	*283.3*	*350.4*	*371.5*	*1,078*	*1,556*	*1,901*	*2,184*	*1,353*	*1,907*	*2,079*	*1,738*
PV	*458.0*	*839.0*	*993.5*	*864.1*	*650.9*	*1,888*	*2,694*	*2,883*	*2,523*	*2,597*	*3,541*	*3,242*	*1,962*
Geothermal power	*1.4*	*0.8*	*0.8*	*0.7*	*0.3*	*9.7*	*33.1*	*65.1*	*64.5*	*10.6*	*34.0*	*66.1*	*65.0*
Solar thermal power	*6.6*	*3.4*	*4.7*	*5.0*	*6.6*	*36.3*	*262.8*	*463.3*	*686.2*	*34.4*	*266.7*	*470.9*	*691.9*
Ocean	*-*	*-*	*0.0*	*1.1*	*0.9*	*31*	*74*	*121.7*	*100.9*	*31*	*73*	*120.9*	*100.5*
Solar - heat	*12*	*21*	*20*	*29.7*	*42.6*	*43*	*414*	*740*	*210*	*99*	*603*	*1,087*	*192*
Geothermal & heat pump	*-*	*0.38*	*0.284*	*0.2*	*0.1*	*5*	*74*	*181*	*84*	*5*	*87*	*203*	*99*
Total jobs (thousands)	**5,409**	**5,241**	**5,091**	**4,967**	**3,465**	**5,895**	**7,446**	**8,377**	**7,608**	**6,902**	**8,690**	**9,117**	**6,610**

Table 38: Non-OECD Asia total employment (thousand jobs)

		5.0C				2.0C				1.5C			
	2015	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
By sector													
Construction and installation	473	496	1,505	1,024	1,068	702	1,510	2,065	2,425	701	1,964	2,192	2,151
Manufacturing	311	280	739	504	534	495	671	946	1,203	525	814	970	1,029
Operations and maintenance	391	404	411	577	807	417	775	1,203	2,444	413	909	1,419	2,307
Fuel supply (domestic)	1,728	1,718	1,573	1,624	1,812	1,705	1,555	1,403	753	1,707	1,576	1,409	652
Coal and gas export	69.8	45.1	20.6	-	-	39.2	17.9	-	-	45.1	20.6	-	-
Solar and geothermal heat	-	9	8	41	42	35	912	1,682	359	61	1,207	1,631	140
Total jobs (thousands)	**2,973**	**2,951**	**4,257**	**3,769**	**4,262**	**3,394**	**5,441**	**7,299**	**7,184**	**3,452**	**6,491**	**7,621**	**6,279**
By technology													
Coal	514	608	1,587	1,113	1,309	264	104	66	9	119	59	11	8
Gas, oil & diesel	514	665	716	748	1,104	716	840	939	255	720	788	869	172
Nuclear	20	19	20	22	22	20	20	19	13	20	20	19	13
Renewable	**1,926**	**1,660**	**1,934**	**1,887**	**1,827**	**2,393**	**4,477**	**6,275**	**6,907**	**2,593**	**5,624**	**6,722**	**6,086**
Biomass	*1,544*	*1,343*	*1,276*	*1,212*	*1,021*	*1,427*	*1,285*	*1,196*	*1,216*	*1,434*	*1,332*	*1,302*	*1,129*
Hydro	*238*	*205*	*460*	*455*	*541*	*215*	*84*	*313*	*268*	*215*	*84*	*313*	*268*
Wind	*29.3*	*25.6*	*46.7*	*52.0*	*103.9*	*203*	*486*	*662*	*1,350*	*270*	*747*	*713*	*1,247*
PV	*100.8*	*67.7*	*130.5*	*117.6*	*113.0*	*473*	*1,445*	*1,980*	*2,439*	*565*	*1,980*	*2,365*	*2,346*
Geothermal power	*11.3*	*8.6*	*11.9*	*8.4*	*5.2*	*16.1*	*63.5*	*69.8*	*58.9*	*23.6*	*72.1*	*64.7*	*48.3*
Solar thermal power	*1.6*	*0.2*	*0.1*	*0.6*	*1.0*	*19.7*	*175.6*	*325.6*	*1,085.3*	*20.0*	*175.8*	*295.2*	*852.7*
Ocean	*0.4*	*0.3*	*0.3*	*0.2*	*0.1*	*4*	*25*	*46.7*	*131.0*	*4*	*25*	*37.5*	*53.7*
Solar - heat	-	*9*	*8*	*40.7*	*42.2*	*32*	*812*	*1,358*	*238*	*58*	*1,022*	*1,332*	*61*
Geothermal & heat pump	-	*0.00*	-	-	-	*3*	*100*	*324*	*121*	*3*	*185*	*300*	*79*
Total jobs (thousands)	**2,973**	**2,951**	**4,257**	**3,769**	**4,262**	**3,394**	**5,441**	**7,299**	**7,184**	**3,452**	**6,491**	**7,621**	**6,279**

Table 39: China total employment (thousand jobs)

		5.0C				2.0C				1.5C			
	2015	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
By sector													
Construction and installation	1,633	1,518	1,107	1,215	651	1,383	1,703	2,062	2,388	1,727	2,011	2,182	2,785
Manufacturing	1,018	870	605	696	451	1,474	1,550	1,754	1,688	1,928	2,006	1,968	1,934
Operations and maintenance	861	1,094	1,211	1,241	1,375	1,174	1,527	1,926	3,034	1,155	1,676	2,106	3,003
Fuel supply (domestic)	4,845	3,857	3,142	2,706	1,933	3,934	3,031	2,470	630	3,718	2,731	2,106	536
Coal and gas export	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar and geothermal heat	686	240	257	248	335	434	919	1,077	143	408	1,224	1,075	65
Total jobs (thousands)	**9,043**	**7,579**	**6,322**	**6,106**	**4,746**	**8,400**	**8,730**	**9,290**	**7,882**	**8,936**	**9,648**	**9,436**	**8,323**
By technology													
Coal	5,719	4,581	3,705	2,921	1,066	3,506	2,294	1,335	17	3,178	1,795	765	17
Gas, oil & diesel	235	443	560	687	1,186	585	711	926	238	664	865	1,115	175
Nuclear	231	266	235	224	194	91	79	72	-	91	79	72	-
Renewable	**2,857**	**2,289**	**1,823**	**2,274**	**2,300**	**4,217**	**5,645**	**6,956**	**7,627**	**5,002**	**6,908**	**7,484**	**8,132**
Biomass	*452*	*421*	*375*	*379*	*414*	*632*	*1,021*	*1,226*	*2,194*	*759*	*1,179*	*1,364*	*2,136*
Hydro	*386*	*340*	*270*	*650*	*611*	*285*	*196*	*589*	*519*	*285*	*196*	*589*	*519*
Wind	*486.4*	*458.4*	*369.0*	*535.9*	*583.1*	*871*	*1,097*	*1,458*	*1,672*	*1,126*	*1,476*	*1,626*	*1,797*
PV	*837.7*	*817.9*	*539.7*	*447.8*	*338.9*	*1,937*	*2,161*	*1,976*	*1,668*	*2,358*	*2,508*	*2,155*	*1,722*
Geothermal power	*2.0*	*1.4*	*1.3*	*1.3*	*1.0*	*8.0*	*36.0*	*63.9*	*119.7*	*9.0*	*55.8*	*74.7*	*142.2*
Solar thermal power	*5.8*	*9.9*	*9.9*	*10.5*	*15.9*	*36.8*	*183.7*	*515.6*	*1,232.0*	*44.1*	*237.5*	*550.3*	*1,620.9*
Ocean	*0.6*	*0.5*	*0.6*	*1.0*	*1.1*	*13*	*31*	*49.9*	*79.2*	*13*	*31*	*49.6*	*129.1*
Solar - heat	*634*	*204*	*226*	*221.9*	*303.7*	*342*	*700*	*810*	-	*320*	*1,039*	*864*	-
Geothermal & heat pump	*51.7*	*36.46*	*31.088*	*26.3*	*31.4*	*92*	*220*	*267*	*143*	*88*	*185*	*211*	*65*
Total jobs (thousands)	**9,043**	**7,579**	**6,322**	**6,106**	**4,746**	**8,400**	**8,730**	**9,290**	**7,882**	**8,936**	**9,648**	**9,436**	**8,323**

Table 40: OECD Pacific total employment (thousand jobs)

		5.0C				2.0C				1.5C			
	2015	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**	**2020**	**2025**	**2030**	**2050**
By sector													
Construction and installation	115	46	44	39	43	245	314	344	361	261	343	358	362
Manufacturing	45	22	21	17	20	110	144	163	161	131	164	174	161
Operations and maintenance	133	162	167	170	158	167	247	312	375	179	266	339	425
Fuel supply (domestic)	75	90	95	99	105	80	90	87	83	88	91	86	79
Coal and gas export	4.2	9.3	15.7	22.1	28.4	5.1	2.6	-	-	3.6	1.8	-	-
Solar and geothermal heat	3	7	8	8	20	7	89	122	15	7	109	156	8
Total jobs (thousands)	**376**	**337**	**350**	**355**	**376**	**615**	**886**	**1,027**	**995**	**670**	**974**	**1,114**	**1,035**
By technology													
Coal	80	74	79	74	93	54	35	18	0	45	23	5	0
Gas, oil & diesel	53	52	54	52	46	45	38	35	17	44	41	44	19
Nuclear	52	46	45	45	44	46	33	19	-	46	33	19	-
Renewable	**191**	**165**	**171**	**184**	**192**	**470**	**781**	**956**	**978**	**535**	**877**	**1,046**	**1,016**
Biomass	*43*	*57*	*62*	*65*	*75*	*81*	*100*	*117*	*145*	*86*	*113*	*130*	*149*
Hydro	*21*	*19*	*20*	*17*	*17*	*25*	*20*	*24*	*27*	*25*	*20*	*24*	*27*
Wind	*11.3*	*11.8*	*13.0*	*17.4*	*29.2*	*61*	*109*	*129*	*187*	*81*	*139*	*154*	*205*
PV	*111.0*	*67.1*	*64.4*	*72.1*	*44.0*	*288*	*423*	*500*	*487*	*327*	*453*	*514*	*504*
Geothermal power	*1.7*	*2.1*	*2.1*	*2.2*	*2.1*	*3.1*	*9.2*	*8.5*	*13.6*	*3.2*	*9.4*	*8.6*	*13.3*
Solar thermal power	*0.1*	*0.1*	*0.5*	*0.7*	*1.6*	*0.9*	*18.6*	*34.8*	*74.8*	*0.9*	*23.3*	*38.4*	*81.3*
Ocean	*0.5*	*0.6*	*0.6*	*1.4*	*2.4*	*4*	*11*	*20.4*	*28.4*	*4*	*11*	*20.3*	*28.3*
Solar - heat	*2*	*7*	*8*	*7.5*	*20.2*	*6*	*76*	*101*	*4*	*6*	*91*	*126*	*3*
Geothermal & heat pump	*1.1*	*-*	*0.258*	*0.2*	*0.2*	*1*	*12*	*21*	*10*	*1*	*18*	*31*	*5*
Total jobs (thousands)	**376**	**337**	**350**	**355**	**376**	**615**	**886**	**1,027**	**995**	**670**	**974**	**1,114**	**1,035**

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