

# Renewable Energy and Jobs

## Annual Review 2022



In collaboration with



International  
Labour  
Organization

© IRENA 2022

Unless otherwise stated, material in this publication may be freely used, shared, copied, reproduced, printed and/or stored, provided that appropriate acknowledgement is given of IRENA as the source and copyright holder. Material in this publication that is attributed to third parties may be subject to separate terms of use and restrictions, and appropriate permissions from these third parties may need to be secured before any use of such material.

ISBN: 978-92-9260-364-9

**Citation:** IRENA and ILO (2022), *Renewable energy and jobs: Annual review 2022*, International Renewable Energy Agency, Abu Dhabi and International Labour Organization, Geneva.

## ABOUT IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

[www.irena.org](http://www.irena.org)

## ABOUT ILO

The only tripartite U.N. agency, since 1919 the ILO brings together governments, employers and workers of 187 Member States, to set labour standards, develop policies and devise programmes promoting decent work for all women and men.

[www.ilo.org](http://www.ilo.org)

## ACKNOWLEDGEMENTS

Under the guidance of Rabia Ferroukhi (Director, Knowledge, Policy and Finance Centre), this report was authored by Michael Renner, Celia García-Baños and Arslan Khalid (IRENA). Hydropower jobs estimates are based on modelling contributed by Maximilian Banning and Philip Ulrich (GWS). Future jobs projections draw on analytical work by Gondia Seck, Bishal Parajuli and Xavier Casals (IRENA) based on modelling of the energy transition undertaken by Cambridge Econometrics. IRENA expresses gratitude for valuable contributions made by colleagues at the International Labour Organization (ILO), including Moustapha Kamal Gueye, Marek Harsdorff, Camila Pereira Rego Meireles, Casper Edmonds and Shreya Goel. The authors also thank IRENA national focal points for country data, and Renata Grisoli (UNDP) for data on Brazil's bioethanol workforce.

For further information or to provide feedback, go to [publications@irena.org](mailto:publications@irena.org)

Download from [www.irena.org/publications](http://www.irena.org/publications)

## DISCLAIMER

This publication and the material herein are provided “as is”. All reasonable precautions have been taken by IRENA to verify the reliability of the material. However, neither IRENA nor any of its officials, agents, data providers or other third-party content providers provide a warranty of any kind, either expressed or implied, and they accept no responsibility or liability for any consequence of use of the publication. The information contained herein does not necessarily represent the views of the Members of IRENA. The mention of specific companies or certain projects or products does not imply that they are endorsed or recommended by IRENA in preference to others of a similar nature that are not mentioned. The designations employed and the presentation of material herein do not imply the expression of any opinion on the part of IRENA concerning the legal status of any region, country, territory, city or area, or the authorities thereof, or concerning the delimitation of frontiers or boundaries.

## IRENA HEADQUARTERS

Masdar City, P.O. Box 236

Abu Dhabi, United Arab Emirates

[www.irena.org](http://www.irena.org)

# FOREWORD

With the extreme weather events witnessed across the globe in recent years, the heavy costs of climate change are becoming increasingly visible to all, strengthening the already compelling case for our transition to a low-carbon future powered by renewable energy.

As with the global economy, the renewable energy sector faces lingering supply chain disruptions from the COVID-19 crisis and volatile energy prices stemming from trade disputes and geopolitical rivalries.

Our responses to these immediate and long-term challenges bring to the fore the role of workforce development. This remains an essential component of the energy transition that should be addressed in the context of a broad policy framework comprising industrial policies, education and skills training, labour market policies, enterprise development, diversity and inclusion strategies, regional revitalisation and social protection measures, based on social dialogue.

This ninth edition of IRENA's *Renewable energy and jobs: Annual review* shows that the number of people either directly or indirectly employed in the renewable energy sector has continued to grow, from 12 million in 2020 to 12.7 million in 2021. Solar photovoltaics, with a third of these jobs, remains the most dynamic renewable industry.

Close to two thirds of all renewable energy jobs are based in Asia, with China alone accounting for 42% of the global total. This reflects the region's strengths in installation markets and equipment manufacturing. To secure jobs and other socioeconomic benefits worldwide, more countries across the globe need to pursue policies to boost their domestic capabilities.

As the number of jobs in the renewable energy sector continues to rise, it is essential to ensure that these posts provide decent livelihoods in terms of wages, occupational health and safety and workplace conditions, job security and other rights at work.

A successful and just energy transition must reflect the needs and interests of communities and regions, offer social protection for those most affected, and ensure that poor households and the most vulnerable members of societies are not priced out of the energy market by measures intended to reflect the environmental costs of fossil fuels. Such a perspective can ensure that the move from old to new energy systems is just, both in terms of jobs and other pressing social and economic needs in societies around the world.

Encouraging advances have been made in workforce gender equity – with women accounting for one-third of all renewable energy jobs. Additional progress is essential. As the transition gathers pace our focus must remain on fostering workforce diversity in ways that offer equal opportunities across the board, not only in terms of gender but for youth, minorities and marginalised groups.

This report shines a spotlight on the extended renewables value chain. On the upstream side, growing scrutiny of industry practices in the mining and processing of commodities critical to renewable energy is required. This includes environmental and labour standards as well as impacts on local communities, local content, value added and domestic manufacturing. Meanwhile, at the other end of the value chain, measures are needed to handle decommissioned equipment and materials with greater care and responsibility.

As the transition gains momentum, the multiple benefits of pursuing renewable energy are becoming increasingly clear – ranging from greater climate stability to new economic opportunities and jobs. If we are to lock in these benefits for the long term, we must act with urgency to significantly ramp up the pace of our transition to a sustainable energy future.



**Francesco  
La Camera**

*Director-General  
International Renewable  
Energy Agency*



**Guy Ryder**

*Director-General  
International Labour  
Organization*





# TABLE OF CONTENTS

Foreword .....	3
Figures, tables and boxes .....	6
Abbreviations .....	7
Key facts .....	8
Key observations .....	9

## INTRODUCTION .....10

### CHAPTER 1

RENEWABLE ENERGY EMPLOYMENT BY TECHNOLOGY .....	14
1.1 Solar photovoltaic .....	16
1.2 Wind .....	20
1.3 Hydropower .....	23
1.4 Liquid biofuels .....	25
1.5 Off-grid renewables .....	27

### CHAPTER 2

RENEWABLE ENERGY EMPLOYMENT IN SELECTED COUNTRIES .....	29
2.1 Leading countries .....	32
2.2 Other countries .....	47

### CHAPTER 3

UPSTREAM AND DOWNSTREAM ASPECTS .....	53
3.1 A changing supply chain landscape ..	53
3.2 Logging and mining for the energy transition: other impacts ....	56
3.3 A circular economy approach to renewable energy materials .....	60
• Can experience with managing e-waste help in managing renewables waste? .....	61
• Recycling opportunities in wind and solar .....	64

### CHAPTER 4

DECENT JOBS AND SOCIAL PROTECTION FOR A JUST TRANSITION .....	66
4.1 Challenges and opportunities .....	66
4.2 A just transition for households and workers .....	68
• What does the energy transition entail for jobs, workers, economies and regions? .....	68
• Assessing the impacts of the energy transition on jobs in different places .....	69
• Just transition policies to guide countries' responses .....	70
• Financing just transition policies ...	70

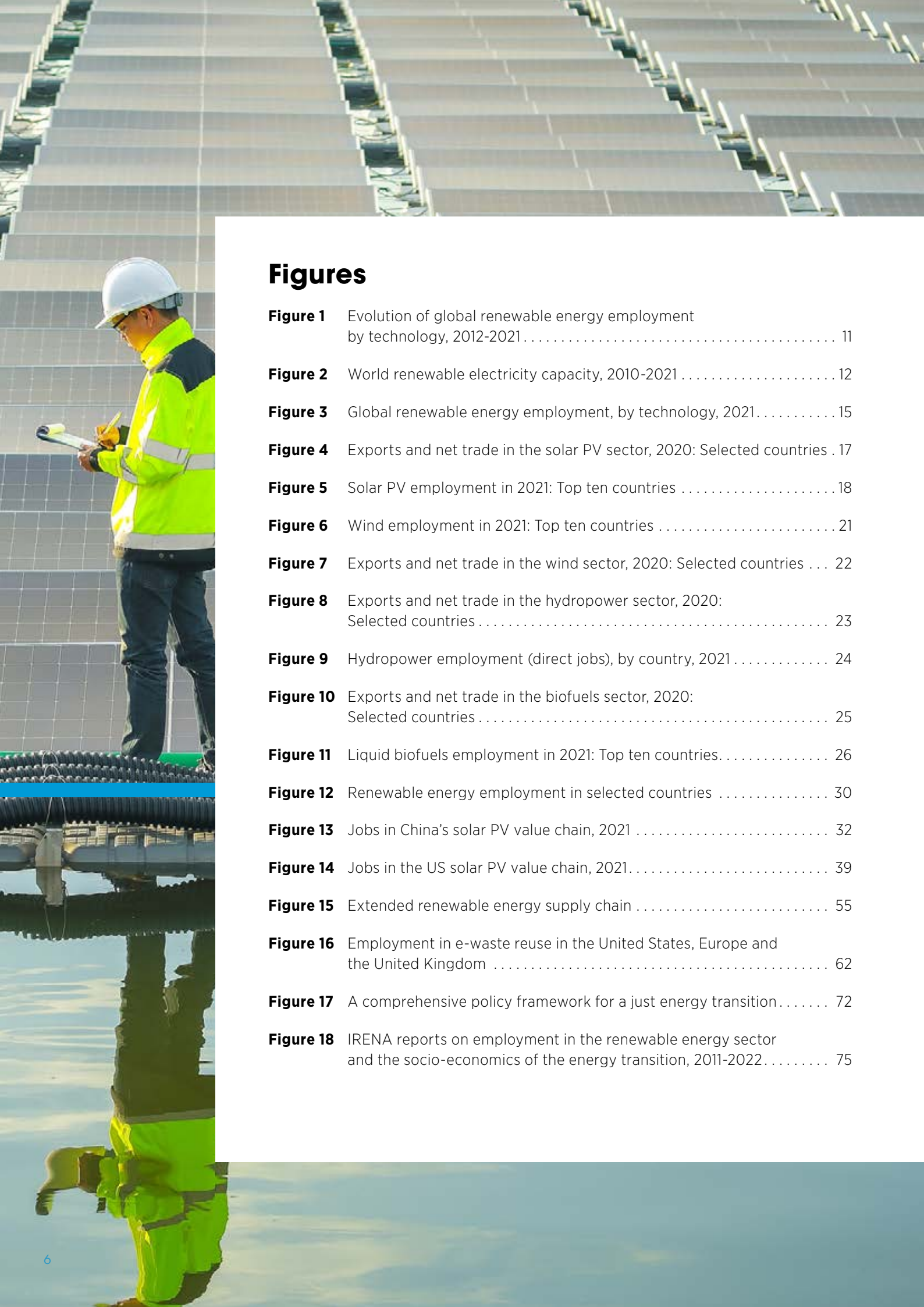
### CHAPTER 5

TAKE-AWAYS AND THE WAY FORWARD .....	71
5.1 An all-encompassing approach to policy making .....	71
5.2 Future job estimates and socio- economic footprints .....	73

References .....	77
------------------	----







## Figures

<b>Figure 1</b>	Evolution of global renewable energy employment by technology, 2012-2021 .....	11
<b>Figure 2</b>	World renewable electricity capacity, 2010-2021 .....	12
<b>Figure 3</b>	Global renewable energy employment, by technology, 2021 .....	15
<b>Figure 4</b>	Exports and net trade in the solar PV sector, 2020: Selected countries ..	17
<b>Figure 5</b>	Solar PV employment in 2021: Top ten countries .....	18
<b>Figure 6</b>	Wind employment in 2021: Top ten countries .....	21
<b>Figure 7</b>	Exports and net trade in the wind sector, 2020: Selected countries ...	22
<b>Figure 8</b>	Exports and net trade in the hydropower sector, 2020: Selected countries .....	23
<b>Figure 9</b>	Hydropower employment (direct jobs), by country, 2021 .....	24
<b>Figure 10</b>	Exports and net trade in the biofuels sector, 2020: Selected countries .....	25
<b>Figure 11</b>	Liquid biofuels employment in 2021: Top ten countries .....	26
<b>Figure 12</b>	Renewable energy employment in selected countries .....	30
<b>Figure 13</b>	Jobs in China's solar PV value chain, 2021 .....	32
<b>Figure 14</b>	Jobs in the US solar PV value chain, 2021 .....	39
<b>Figure 15</b>	Extended renewable energy supply chain .....	55
<b>Figure 16</b>	Employment in e-waste reuse in the United States, Europe and the United Kingdom .....	62
<b>Figure 17</b>	A comprehensive policy framework for a just energy transition .....	72
<b>Figure 18</b>	IRENA reports on employment in the renewable energy sector and the socio-economics of the energy transition, 2011-2022 .....	75



# Tables

**Table 1** Estimated number of direct and indirect jobs in renewable energy worldwide, by industry, 2020–2021 (thousand jobs)..... 31

# Boxes

**Box 1** Solar PV: A gender perspective..... 19

**Box 2** Employment in Decentralised Renewable Energy.....28

**Box 3** State-level efforts to develop local offshore wind supply chains in the United States ..... 42

**Box 4** Balsa logging and community livelihoods..... 57

**Box 5** Mineral mining for the renewable energy transition: Job and community impacts ..... 58

**Box 6** Measures to promote a circular economy approach in renewable energy ..... 63

**Box 7** Energy transition jobs potential to 2030 and 2050 ..... 74



# Abbreviations

<b>ASM</b>	artisanal and small-scale mining
<b>CdTe</b>	cadmium telluride
<b>CSP</b>	concentrated solar power
<b>DRE</b>	decentralised renewable energy
<b>EOL</b>	end-of-life
<b>EU</b>	European Union
<b>EU-27</b>	27 Member States of the European Union
<b>GW</b>	gigawatt
<b>IEA</b>	International Energy Agency
<b>ILO</b>	International Labour Organization
<b>IREC</b>	Interstate Renewable Energy Council
<b>MW</b>	megawatt
<b>O&amp;M</b>	operations and maintenance
<b>PV</b>	photovoltaic
<b>R&amp;D</b>	research and development
<b>SGRE</b>	Siemens Gamesa Renewable Energy
<b>USDA-FAS</b>	US Department of Agriculture Foreign Agricultural Service
<b>US DOE</b>	US Department of Energy

## KEY FACTS

**12.7 million** ➤ **Worldwide employment** in renewable energy in 2021, up from 12 million in 2020. Close to two-thirds of all jobs are in Asia, and China alone accounts for 42% of the global total. It is followed by the European Union and Brazil with 10% each, and the United States and India with 7% each.

**4.3 million** ➤ **Jobs in solar photovoltaic (PV)** in 2021, the fastest-growing sector, accounting for more than a third of the total renewable energy workforce.

**1.3 million** ➤ **Jobs in wind power** in 2021. Countries are building the industrial base and infrastructure needed to support growing offshore installations.

**2.4 million** ➤ **Direct jobs in hydropower** in 2021. Two-thirds of these jobs were in manufacturing, 30% related to construction and installation and about 6% to operation and maintenance.

**2.4 million** ➤ **Jobs in biofuels** in 2021, with the vast majority in feedstock operations. Biodiesel output and employment are rising while ethanol is ebbing.

**38.2 million** ➤ **Worldwide employment in renewable energy in 2030** under an ambitious energy transition scenario with front-loaded investments.

预览已结束，完整报告链接和二维码如下：

[https://www.yunbaogao.cn/report/index/report?reportId=5\\_31747](https://www.yunbaogao.cn/report/index/report?reportId=5_31747)

