REN21

RENEWABLES 2024 GLOBAL STATUS REPORT

ECONOMIC AND SOCIAL VALUE CREATION

2024

REN21 MEMBERS

GOVERNMENTS

Australia
Austria
Brazil
Denmark
Dominican Republic
Georgia
Germany
India
Republic of Korea
Mexico
Morocco
Norway
Panama
Río Negro Province, Argentina
South Africa
South Australia State, Australia
Spain
United Arab Emirates
United States
Zimbabwe

PRESIDENT

Arthouros Zervos

EXECUTIVE DIRECTOR

Rana Adib

SCIENCE AND ACADEMIA

AEE – Institute for Sustainable Technologies (AEE-INTEC)
Council on Energy, Environment and Water (CEEW)
Fundación Bariloche (FB)
International Institute for Applied Systems Analysis (IIASA)
International Solar Energy Society (ISES)
National Renewable Energy Laboratory (NREL)
National Research University Higher School of Economics Russia (HSE)
South African National Energy Development Institute (SANEDI)
The Energy and Resources Institute (TERI)
University of Technology – Institute for Sustainable Futures (UTS)
World Resources Institute (WRI)

MEMBERS AT LARGE

Michael Eckhart
Rabia Ferroukhi
David Hales
Kirsty Hamilton
Peter Rae

INTER-GOVERNMENTAL ORGANISATIONS

Asia Pacific Energy Research Centre (APERC)
Asian Development Bank (ADB)
ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE)
Electric Power Council of the Commonwealth of Independent States (Executive Committee) (EPC)
European Commission (EC)
Global Environment Facility (GEF)
International Energy Agency (IEA)
International Renewable Energy Agency (IRENA)
Islamic Development Bank (IsDB)
Latin American Energy Organization (OLADE)
Regional Center for Renewable Energy and Energy Efficiency (RCREEE)
United Nations Development Programme (UNDP)
United Nations Environment Programme (UNEP)
United Nations Industrial Development Organization (UNIDO)
World Bank (WB)

INDUSTRY ASSOCIATIONS

Africa Minigrid Developers Association (AMDA)
Alliance for Rural Electrification (ARE)
American Council on Renewable Energy (ACORE)
Asia Pacific Urban Energy Association (APUEA)
Associação Lusófona de Energias Renováveis (ALER)
Chinese Renewable Energy Industries Association (CREIA)
Clean Energy Council (CEC)
Euroheat & Power (EHP)
European Heat Pump Association (EHPA)
European Renewable Energies Federation (EREF)
Global Off-Grid Lighting Association (GOGLA)
Global Solar Council (GSC)
Global Wind Energy Council (GWEC)
Green Hydrogen Organisation (GH_2)
Indian Renewable Energy Federation (IREF)
International Geothermal Association (IGA)
International Hydropower Association (IHA)
International Union of Railways / Union Internationale des Chemins de Fer (UIC)
Long Duration Energy Storage Council (LDES)
Portuguese Renewable Energy Association (APREN)
RE100 / Climate Group (RE100)
RES4Africa Foundation (RES4Africa)
Solar Heat Europe (SHE)
SolarPower Europe (SPE)
Union Internationale des Transports Publics (UITP)
World Bioenergy Association (WBA)
World Biogas Association
World Wind Energy Association (WWEA)

NON-GOVERNMENTAL ORGANISATIONS

350.org
African Association for Rural Electrification (Club-ER)
Asociación Ivy
CDP
Clean Cooking Alliance (CCA)
Climate Action Network International (CAN-I)
Coalition de Ciudades Capitales de las Americas (CC35)
Collaborative Labeling and Appliance Standards Program (CLASP)
Energy Cities
Energy Peace Partners
European Youth Energy Network (EYEN)
Fundación Renovables (FER)
Global Forum on Sustainable Energy (GFSE)
Global Women's Network for the Energy Transition (GWNET)
Green Economy Coalition (GEC)
Greenpeace International
Hydropower Sustainability Alliance
ICLEI – Local Governments for Sustainability
Institute for Sustainable Energy Policies (ISEP)
International Electrotechnical Commission (IEC)
International Institute for Sustainable Development (IISD)
Jeune Volontaires pour l'Environnement (JVE)
Mali Folkecenter (MFC)
Power for All
Power Shift Africa
Renewable Energy and Energy Efficiency Partnership (REEEP)
Renewable Energy Institute (REI)
Renewables Grid Initiative (RGI)
SLOCAT Partnership on Sustainable, Low Carbon Transport (SLOCAT)
Solar Cookers International (SCI)
Solutions for Our Climate (SFOC)
Sustainable Energy Africa (SEA)
Sustainable Energy for All (SEforALL)
The Global 100% Renewable Energy Platform (Global 100%RE)
Women Engage for a Common Future (WECF)
World Council for Renewable Energy (WCRE)
World Future Council (WFC)
World Wide Fund for Nature (WWF)

FOREWORD

The *Renewables 2024 Global Status Report's* fifth and final module explores the economic and social benefits of renewable energy. The evidence is clear: the transition to a renewables-based energy system has transformative potential for our economies and societies. Renewables offer opportunities for local industrialisation and economic development, creating jobs and improving livelihoods. It is key towards shaping a more inclusive and democratic energy system and economy.

This module offers global data and real-world stories on the power of renewables to foster local supply chains, manufacturing capacity and job creation, and promoting education and reskilling programmes for a transitioning workforce. The module also explores local and community ownership as well as democratic governance of renewable energy projects. It addresses capital flows for renewables development, financing mechanisms and fiscal policies, such as taxation incentives and subsidies. Additionally, the report investigates how renewable energy solutions contribute to climate change adaptation and resilience and to what extent these are reflected in current policies and financing mechanisms.

The report itself highlights and notes that there currently exists a lack of standard indicators and data gaps, which are key needs in setting the stage for a more informed, inclusive energy policy discussion. We need to have a better understanding of the social and economic benefits of renewables. This includes documenting existing policies and initiatives as well as identifying policy and closing such existing data gaps.

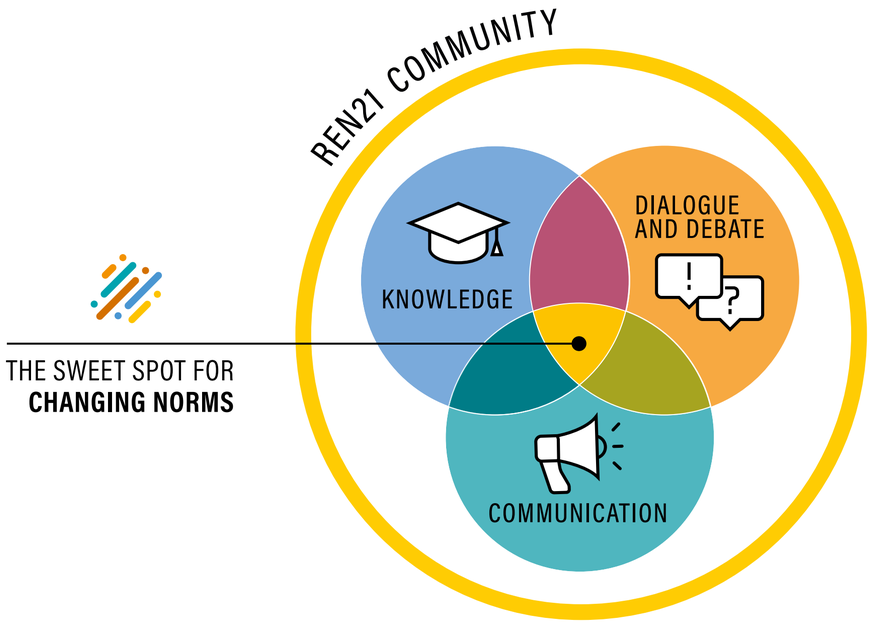
REN21 starts the process of compiling the evidence to strategically build on the economic and social benefits of renewables to properly inform decision-makers into collectively strengthening the case for renewables and help drive the global shift towards an equitable renewable energy future. This module reflects the inputs of over 130 experts, practitioners and communities worldwide through REN21's leveraging of its extensive global network and collaborative approach.

A heartfelt thank you to the REN21 team, authors, advisers, contributors and broader REN21 community at large for your collective input. We invite policymakers, industry leaders, and stakeholders to dive into this module and use it as a catalyst for action. I trust that this module will equip its readers with the insights and tools needed to empower policymakers, industry leaders and stakeholders to accelerate the transition to a renewables-driven world..

Sincerely,

Rana Adib
Executive Director, REN21

REN21
RENEWABLES NOW



RENEWABLE ENERGY POLICY NETWORK FOR THE 21st CENTURY

REN21 is unique. It is the only global, multi-stakeholder network dedicated to renewables.

We create an **enabling environment to support renewable energy uptake**. Together, we build knowledge, shape dialogue and debate, and communicate this information to strategically drive the deep transformations needed to make renewables the norm.

Shifting to renewables is more than a fuel switch; it requires engaging with market players and society at large. **REN21 works in close co-operation with its community**, providing a platform for all stakeholders to engage and collaborate.

Through these collective efforts, REN21 builds bridges and amplifies positive and sustainable energy solutions. Our goal: enable decision makers to **make the shift to renewable energy happen – now.**

20 YEARS OF REN21

This year marks two decades since the inception of REN21 – an opportunity to celebrate 20 years of instrumental contributions to the advancement, shaping and understanding of renewable energy worldwide. Established in 2004, REN21 emerged from the collective vision of global pioneers who convened to call for accelerated commitments towards renewable energy adoption. For two decades, REN21 has been pivotal in elevating renewables to the forefront of global agendas for leaders and decision makers across all stakeholder groups, enabling knowledge exchange, dialogue and debate about the global transition to renewables.

The 20th-anniversary celebration of REN21 is also the occasion to acknowledge REN21's flagship knowledge product, the *Renewables Global Status Report* (GSR). Since the GSR's first release in 2005, REN21 has published 18 editions of the report, crafted annually with the most up-to-date insights, facts and stories from thousands of contributors spanning diverse regions and sectors. The GSR has been central to fulfilling REN21's mission, becoming a reference for many and positioning REN21 as the global trusted voice on renewables.

20 YEARS OF CROWD-SOURCED, CROWD-OWNED DATA AND KNOWLEDGE

REN21's knowledge and data collection method is unique, drawing upon the organisation's global multi-stakeholder community of experts. Contributors from across the globe are invited to submit data, insights and stories on annual developments in renewable energy technologies, market trends, policies and local perspectives, resulting in a comprehensive and diverse dataset. REN21 performs rigorous data validation and fact-checking throughout the development of the GSR, ensuring accuracy and reliability.

Validation of the data is a collaborative and transparent process conducted through open peer reviews. Collectively, hundreds of experts contribute to making the GSR one of the most authoritative and comprehensive publications in the field of renewables. Alongside its wealth of key facts and figures, the GSR is openly accessible, fostering a shared language that shapes the sectoral, regional and global debate on the energy transition.

Supported by:

Federal Ministry for Economic Affairs and Climate Action

Federal Ministry for Economic Cooperation and Development

on the basis of a decision by the German Bundestag

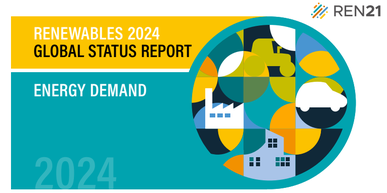
This report was commissioned by REN21 and produced in collaboration with a global network of research partners. Financing was provided by the German Federal Ministry for Economic Cooperation and Development (BMZ) and the German Federal Ministry for Economic Affairs and Climate Action (BMWK).

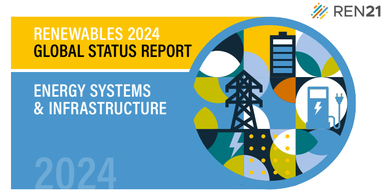
A large share of the research for this report was conducted on a voluntary basis.

RENEWABLES GLOBAL STATUS REPORT
2024 COLLECTION

Since 2005, REN21's *Renewables Global Status Report* has spotlighted ongoing developments and emerging trends that shape the future of renewables. It is a collaborative effort involving hundreds of experts. Structured as a collection of five publications, this year's 19th edition of the GSR reflects key trends in global energy.

In addition to exploring the role of renewables for economic and social value creation, the GSR provides a global overview of the renewables landscape and dives into different energy demand sectors, with dedicated modules on buildings, industry, transport and agriculture. The collection further includes a publication on renewable energy supply as well as a publication on the latest developments in renewable energy systems and infrastructure. Collectively, these five publications offer readers a systemic global overview of the current uptake of renewables.





ACKNOWLEDGEMENTS

REN21 DATA AND KNOWLEDGE TEAM

Jad Baba
Ana Díaz Vidal
Erin Hampton
Janne Luise Piper
Andrea Wainer
Glen Wright
Hend Yaqoob

SPECIAL ADVISERS

Janet L. Sawin
Freyr Sverrisson

CHAPTER AUTHORS

Yanika Meyer-Oldenburg
Jan Svoboda

LEAD TOPICAL CONTRIBUTORS

Joan Carling (Indigenous Peoples Rights International)
James Jenkins (Indigenous Clean Energy)
Rosilena Lindo (National Energy Secretariat of Panama)
Doug Miller (Energy Peace Partners)
Bessma Mourad (Energy Peace Partners)
Suzanne Renard (Énergie Partagée Investissement)
Felix Schaper (trend:research GmbH)

RESEARCH AND PROJECT SUPPORT

Nicolas Achury
Talia Contreras-Tapia

EDITING, DESIGN AND LAYOUT

Lisa Mastny (Editor)
weeks.de Werbeagentur GmbH (Design)

PRODUCTION AND COMMUNICATION

REN21 Secretariat, Paris, France

GLOBAL STATUS REPORT 2024 COLLECTION

ECONOMIC AND SOCIAL VALUE CREATION

For further details and access to the report, references and endnotes, visit **www.ren21.net/gsr-2024**

REPORT CITATION

REN21. 2024. *Renewables 2024 Global Status Report Collection, Economic and Social Value Creation* (Paris: REN21 Secretariat).

ISBN 978-3-948393-18-2

Comments and questions are welcome and can be sent to **gsr@ren21.net**.

ACKNOWLEDGEMENTS

OTHER CONTRIBUTORS

Mohammed Abdalghafoor (Sustainable Development Solutions Network); Ibrahim Abdulwahab (University of Ilorin); Hassan Aboughalma (Georenco); Damilola Adeyanju (The Climate Group); Florencia Agatiello (RELP); Bernd Ahlers (Biofuels); Nana Serwaa Antwi (Politecnico di Milano); Patrick Atouda Beyala (Soas University of London); Candost Aydin (Deutsche Gesellschaft für Internationale Zusammenarbeit – GIZ); Firas Balasmeh (FB GROUP); Nupur Bapuly (The Nature Conservancy); Claire Battelle (Independent consultant); Leïla Bensmain (University of Science and Technology Houari Boumediene); Jean-Philippe Bernier (Natural Resources Canada); Lakshmi Bhamidipati (United Nations Environment Programme); Gonzalo Bravo (Fundación Bariloche); Dirk Briese (trend:research GmbH); Iskander Buranov (Independent consultant); Ercument Camadan (Ascend Analytics); Thailys Campos Magalhães (Independent consultant); Agustin Carbo (Power for All); Sreenivas Chigullapalli (India Climate Collaborative); Karim Choukri (Hassan II University of Casablanca); Suani T. Coelho (University of São Paulo); Esmeralda Colombo (European Institute on Economics and the Environment); Dean Cooper (WWF); Penelope Crossley (University of Sydney Law School); Yerlan Dairbekov (United Nations Development Programme Kazakhstan); Sharon Denny (Global Futuremakers); Lena Dente (World Future Council); Zuzana Dobrotkova (Independent consultant); Isa Elegbede (Lagos State University); Mahmoud Abou Elenen (GE Vernova); Youssouf Eusman (Youngo Energy Working Group); Thomas Fees (Independent consultant); Eduardo García (Independent consultant); Stefan Gsänger (World Wind Energy Association); Ahmed Hamza H. Ali (Assiut University); Veryan Hann (University of Tasmania); Laury Haytayan (Natural Resource Governance Institute); Gabriela Hernández-Luna (Autonomous University of the State of Morelos); Rainer Hinrichs-Rahlwes (European Renewable Energies Federation); Soe Htike Aung (Independent consultant); Abdulwahab Ibrahim (University of Ilorin); Alok Jain (Trans-Consult); Pan Jiahua (Beijing University of Technology); József Kádár (Independent consultant); Shorai Kavu (Ministry of Energy and Power Development of Zimbabwe); Kamil Kaygusuz (Karadeniz Technical University); Nazar I. Khan (Independent consultant); Peter Konings (Asia Pacific Energy Group); Assem Korayem (TotalEnergies); Felix Kriedemann (REScoop.eu); Sivanappan Kumar (Naresuan University); Bharadwaj Kummamuru (World Bioenergy Association); Julia Le Maitre (University College Cork Environmental Research Institute); Alejandra Leon (World Bioenergy Association); Debora Ley (United Nations Economic Commission for Latin America and the Caribbean); Kevin Li (CarbonCare InnoLab); Todd Litman (Victoria Transport Policy Institute); Detlef Loy (Loy Energy Consulting); Senni Määttä (Radboud University Nijmegen); Jaideep N. Malaviya (Malaviya Solar Energy Consultancy); Lionel Mbanda (Global Youth Leadership Development Council); Leopoldo Micò (Solar Heat Europe / European Solar Thermal Industry Federation); Alan Miller (Sustana Cooling Partners); Jamia Millia Isamia (Independent consultant); Golnoosh Mir Moghtadaei (Enertime); Ekta Mishra (Patil Institute of Technology); Nicholas Mukisa (National Renewable Energy Platform); Mweetwa Mundia Sikamikami (TRiM BITPoP Engineering); Abubakar Musa Magaga (Nigerian Institute of Transport Technology); Jonathan Mhango (Independent consultant); Amon Mwadime (Africa Minigrid Developers Association); Paul Nduhuura (Makerere University Business School); Djakpou Ngansop Patrick Raoul (SDG7 Youth Constituency); Daya Ram Nhuchhen (City of Edmonton); Ifeanyi Jude Nwaegbe (Independent consultant); Jesse Nyokabi (Quaise Energy Africa); Victor Thomas Otieno (World Resources Institute); Olivier Ouellette (Natural Resources Canada); Peter Pluschke (former City of Nuremberg); Ramesh Poluru (Inclen Trust International); Liliana Proskuryakova (Hse University); Josep (Pep) Puig i Boix (European Association for Renewable Energy – EUROSOLAR); Pallav Purohit (International Institute for Applied Systems Analysis); Swasti Raizada (International Institute for Sustainable Development); Nizomiddin Rakhmanov (Independent consultant); Bard Rama (Independent consultant); Madan B. Regmi (United Nations); Oliver Reynolds (Global Off-Grid Lighting Association); Yasemin Erboy Ruff (CLASP); Tarek Safwat Kabel (University of Sadat City); Manel Sakhri (Independent consultant); Micheal Samanya (Makerere University Business School); Miguel Schloss (Surinvesst Ltda.); Bettina Schreck (United Nations Industrial Development Organization); Cecile Seguineaud (Independent consultant); Ali Shahhoseini (Qazvin Islamic Azad University); Ailly Sheehama (Independent consultant); Henry Shongwe (Renewable Energy Association of Eswatini); Wilson Sierra (University of the Republic of Uruguay); Jin Tanaka (UNISC International); Hannibal Tesfahunegn (Power for All); Lebeau Pemha Thina (International Association for Partnership and Emergence in Africa – AIPEA); Fouodji Toche Fabrice (Vista Organisation for Education and Social Development in Africa); Diocelina Toledo-Vazquez (Autonomous University of Morelos); Costas Travasaros (Prime Laser Technology); Kelly Trumbull (The Nature Conservancy); Ioannis Tsipouridis (RED PRO Consultants); Prachi Ugle (International Union for Conservation of Nature); Anant Wadhwa (Sustainable Energy for All); Marion Walker (Centre for Solar Energy and Hydrogen Research Baden-Württemberg); Amin Yahya-Khotbehsara (Qazvin Islamic Azad University); Noureddine Yassaa (Renewable Energy and Energy Efficiency Commission of Algeria); Nouralla Yassin Ahmed (United Nations Development Programme); Hameedullah Zaheb (Kabul University); Izmail Khuzmiev (Independent consultant)

TABLE OF CONTENTS

GLOBAL STATUS REPORT 2024 COLLECTION

ECONOMIC AND SOCIAL VALUE CREATION

FIGURES

TABLES

SNAPSHOTS

SIDEBARS

BOXES

LINKS TO MICROSITE

- → Energy Units and Conversion Factors
- → Data Collection and Validation
- → Methodological Notes
- → Glossary
- → List of Abbreviations

Reference Tables can be accessed through the GSR 2024 *Economic and Social Value Creation* Data Pack at

→ http://www.ren21.net/gsr2024-data-pack/ESVC

MODULE OVERVIEW

Trends and policies in energy access, affordability, financial flows, local supply chains, manufacturing, employment, education, local ownership, and renewables for climate adaptation and resilience.

7% of global GDP growth was due to the growth of renewables and enabling technologies.

16.2 million people worked in the renewable energy sector in 2023.

685 million people lacked access to electricity in 2022.

KEY FACTS

- Of the 71 countries without universal access to electricity in 2023, only 34 had targets for electricity access through renewables.
- The share of household investment in energy is increasing, from 9% in 2015 to 18% in 2023. The growth is mainly driven by investment in renewables.
- During the period 2019-2022, employment in the renewable energy sector grew roughly 15%, whereas jobs related to fossil fuels fell around 4%.
- China accounted for 75% of global investment in manufacturing for renewables and enabling technologies in 2023.
- As of mid-2024, 50 countries had recognised renewables as an adaptation measure in their Nationally Determined Contributions towards reducing emissions under the Paris Agreement.

The transition to renewable energy holds transformative potential for our economies and societies. Diverse renewable energy technologies can be deployed anywhere and at different scales, providing opportunities for local industrialisation and economic development, as well as significant social benefits: creating jobs, supporting livelihoods and laying the foundation for a more democratic and inclusive energy system. To realise this transformative potential, renewables must be affordable and accessible to all, with deployment and policies aimed at promoting local economic development worldwide.

This module of the *Renewables 2024 Global Status Report* (GSR) explores recent trends and policies around energy access and affordability, financial flows, local supply chains and manufacturing capacities, employment and education, local ownership, and renewables for climate change adaptation and resilience. This module also highlights the lack of standard indicators and aggregated data, especially from developing countries. Comprehensively tracking progress in the above areas is fundamental to fill data gaps and improve understanding about the social and economic benefits of renewables deployment.

RENEWABLES FOR ENERGY ACCESS AND AFFORDABILITY

As of 2022, around 685 million people still lacked access to electricity – 10 million more than in 2021, but projections for 2023 hint at a reversal of this trend; while 2.1 billion people in 2022 lacked access to clean cooking.[1] Renewables are a key solution for rapidly increasing access to electricity and clean cooking.[2]

An estimated 48 million people were connected to 21,500 mini-grids in 2022, with an investment cost of USD 29 billion, and a further 29,400 mini-grid projects were in planning stages.[3] Of these planned projects, which are expected to connect 35 million people at a cost of USD 9 billion, 99% are powered by solar photovoltaics (PV) and 95% are in Africa and South Asia.[4] Global sales of solar energy kits neared 9 million in 2023, including 5.5 million portable lanterns, 1.5 million multi-light systems and 1.7 million solar home systems.[5]

Energy poverty remains a challenge globally. In Europe, 10.6% of people were unable to adequately heat their homes in 2023, while in the United States, as of July 2024, 48 million people were unable to pay their annual energy bills in full.[6] Policies to tackle energy poverty include financial and policy support for the deployment of more energy efficiency appliances such as heat pumps and renewable energy installations, typically solar panels.[7]

The global weighted average levelised cost of electricity from new renewable energy projects fell across most technologies in 2023, ranging from a 12% decrease for solar PV to 3% for onshore wind power.[8] However, regional inequalities persist: the weighted average cost of capital for onshore wind and solar PV in 2022 ranged from around 10% in low-income countries to just 4% in high-income countries.[9]

CAPITAL FLOWS

The private sector is the main investor in renewable energy technologies, with commercial institutions, private companies and households contributing around three-quarters of the funding for clean energy[i] during the five-year period from 2018 to 2023.[10] Public finance accounted for around 24% of investment, with development finance institutions contributing 1%.[11] Governments represented an average of 37% of total energy investment during the period, while the share of renewables investment made by individual households doubled from 9% in 2015 to 18% in 2023.[12]

Of the 60 commercial banks largely responsible for funding fossil fuels, none had clear targets for renewable energy capacity as of mid-2024, and just 6 had targets for renewable power supply.[13]

Governments can leverage fiscal policies to promote renewable energy deployment. In 2023, just over half of carbon revenues worldwide – around USD 100 billion – were spent on climate and nature, including renewable energy.[14] Tax reductions and subsidies remain popular tools for policy makers to promote the uptake of renewables and enabling technologies at the consumer level. Many countries now offer tax breaks to promote the purchase of solar panels, heat pumps and electric vehicles. The development of distributed renewable energy has been supported in recent years using innovative financing and business models such as community projects, peer-to-peer trading, pay-as-you-go, results-based finance and financial aggregation.

Despite these advancements, public funding and support for clean energy, including renewables, is still only about one-tenth of the support dedicated to subsidising fossil fuel consumption.[16]

ECONOMIC DEVELOPMENT AND LOCAL VALUE CREATION

The deployment of renewable energy technologies offers opportunities for local economic development and job creation along the entire value chain. This includes value chain stages ranging from the extraction and processing of raw materials, to equipment manufacturing, project development, operation and maintenance, energy distribution and demand-side management.[17]

In 2023, a total of

16.2 million

people worked in renewable energy.

i The data source referred to in this context defines ‚clean energy' as comprising renewable power, grids and storage, energy efficiency and end-use, nuclear and other low-emissions fuels. ‚Clean energy' is used here due to a lack of disaggregated data on renewables. This applies to further mentions of ‚clean energy' throughout the module.

In 2023, growth in renewables and their enabling technologies[i] accounted for 7% of the growth in the global gross domestic product (GDP).[18] China continued to lead in manufacturing capacity, although its share of global investment in manufacturing of renewables and enabling technologies fell from 85% in 2022 to around 75% in 2023, with other Asian countries increasing their shares from 4.3% to 16%.[19]

Developed economies have continued to strengthen their policy and investment in renewables. The US Inflation Reduction Act spurred significant growth in these areas: as of mid-2024, 100 new manufacturing facilities were operational, under construction, or announced across the United States, and 53 additional facilities and expansion projects were in the pipeline.[20] In the European Union (EU), the Net-Zero Industry Act has set manufacturing capacity targets aiming to meet at least 40% of EU needs for clean energy technologies by 2030, and the Critical Raw Materials Act aims to boost domestic sourcing and processing of minerals and to promote local supply chains.[21] Globally, a range of initiatives to foster local manufacturing and supply chains for enabling technologies, such as electric vehicles, were announced or deployed in 2023, including in Brazil, Estonia, Hungary, Japan, Malaysia, Morocco and Thailand.[22]

Renewables continued to drive job creation, with a record 16.2 million direct and indirect jobs in 2023 – up from 13.7 million in 2022 – nearly half (46%) of them in China.[23] The solar PV sector led with 7.1 million jobs, followed by biofuels and hydropower.[24] Employment in the renewable energy sector grew roughly 15% during 2019-2022, while jobs related to fossil fuels fell around 4%.[25] Recognising that the renewables workforce remains predominantly male, in 2023 several countries implemented policies to support gender inclusion, including Nigeria, South Africa and the United States.[26]

Additional jurisdictions – including Australia, Cameroon, the EU, India, South Africa and the United Kingdom – implemented skilling and higher education programmes in 2023, aiming to address both the growing need for a skilled workforce for the deployment of renewables and the fossil fuel job losses.[27]

LOCAL OWNERSHIP AND ENERGY DEMOCRACY

In contrast to centralised energy systems based on fossil-fuelled power plants, renewables are inherently more localised and decentralised.[28] Renewable energy allows for decentralised deployment and diverse ownership structures, offering the potential to democratise the production and consumption of energy.[29]

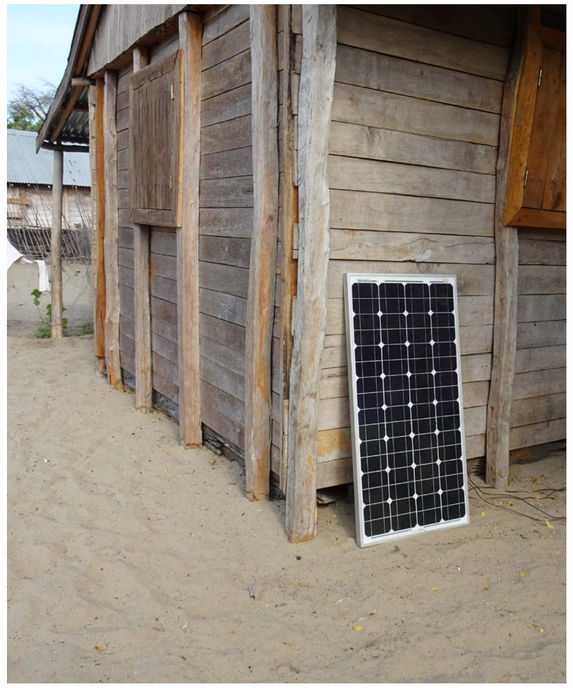
The European federation of energy communities, REScoop, gathers 2,500 co-operatives across Europe, representing around 2 million people.[30] In Germany, the largest ownership group for renewable energy projects is private individuals, which held around 30% of installed energy capacity in 2019.[31]

Community energy initiatives continued to progress in 2023, supported by the development of legal frameworks. In the EU, new efforts arose in Albania, Denmark, Greece, Italy, the Netherlands, Wales and other jurisdictions.[32] Community energy also garnered further attention in Australia, Brazil, the United States, and Canada, where Indigenous Peoples increasingly initiate, own and operate renewable energy and storage facilities.[33]

RENEWABLE ENERGY FOR CLIMATE ADAPTATION AND RESILIENCE

Integration of mitigation and adaptation efforts is crucial for effectively addressing the climate crisis.[34] The transition to renewable energy not only greatly reduces emissions but also contributes to climate adaptation and enhances climate resilience through diverse and decentralised energy solutions.[35]

During extreme weather events, renewables can power critical services such as water supply systems, healthcare facilities and early warning systems.[36] They also can support agricultural adaptation by powering irrigation systems and desalination plants, helping communities cope with water scarcity.[37] By providing reliable energy to remote and vulnerable communities, renewables can reduce people's vulnerability to climate change impacts, ultimately contributing to a more robust and adaptive energy system.[38]



i Growth in renewables and enabling technologies considers investment in renewable energy capacity, renewable energy manufacturing, heat pump sales and electric vehicles, fuel cells, and charging infrastructure sales.

RENEWABLES FOR ENERGY ACCESS AND AFFORDABILITY

Ensuring access to affordable, reliable, sustainable and modern energy for all is recognised as a key lever for development and is embodied by Sustainable Development Goal 7 (SDG 7).[39] (→ *See Box 1.*)

The lack of access to energy services takes diverse forms, from situations where energy is physically out of reach, to cases where energy services are available but are unaffordable to vulnerable households.[40]

Energy poverty is multi-faceted and context-specific. In high-income countries where there is universal access to electricity and clean cooking, energy poverty refers to cases where households cannot afford essential energy services in the home, such as heating, cooling, lighting or cooking.[41] In Europe, energy poverty measurement has focused on keeping homes warm, whereas data on cooling remain scarce.[42]

Other definitions classify households as energy poor if they spend more than 10% of their income on residential energy.[43] However, this metric does not capture cases where households deny themselves energy services due to affordability concerns, and may therefore underestimate the number of energy poor households.[44]

BOX 1. Sustainable Development Goal 7: Energy Access for All

The 2030 Agenda for Sustainable Development, adopted in 2015 by all United Nations (UN) Member States, has at its core 17 Sustainable Development Goals (SDGs). The SDGs are an urgent call to action on the world's most pressing challenges, such as poverty, inequality and climate change, with the aim of creating a sustainable future for all by 2030. In SDG 7, governments committed to providing universal access to affordable, reliable, sustainable and modern energy, which is crucial to support agriculture, business, education, health care, transport and climate action. Achieving this global goal requires accelerated electrification, increased investments in renewable energy technology and infrastructure, enhanced energy efficiency, and enabling policies and regulatory frameworks, particularly in developing countries.

Among the various targets of SDG 7, target 7.1 refers to the provision of universal access to electricity and clean cooking, 7.2 focuses on increasing the share of renewables in the global energy mix, and 7.3 aims to double the global rate of improvement in energy efficiency. SDG 7.a seeks to enhance international co-operation and investments that promote energy access, and 7.b calls for sustainable energy infrastructure expansions and technology upgrades in developing countries.

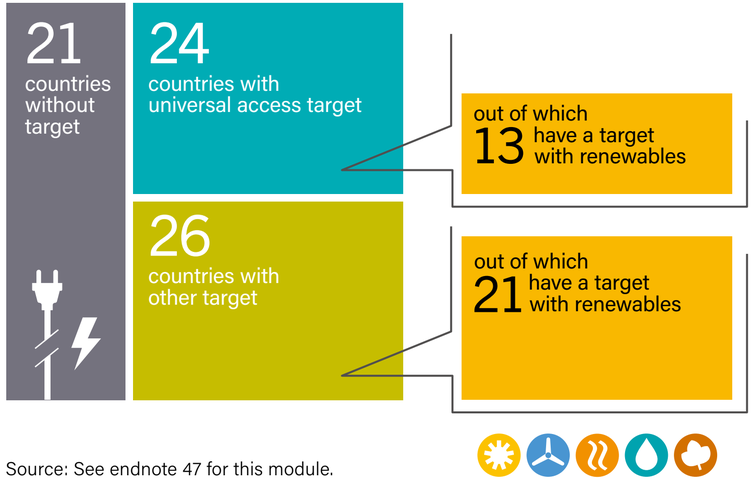
Despite some progress across the indicators, the current pace is insufficient to achieve any of the 2030 targets for SDG 7. Progress towards SDG 7 is slowed by challenges such as rising energy prices, the uncertain macroeconomic outlook, high levels of inflation, debt distress in an increasing number of countries, inequitable distribution of finance, supply chain bottlenecks and rising material costs.

Source: See endnote 39 for this module.

In 2022, the global number of people without access to electricity rose for the first time in decades to around 685 million, driven by the COVID-19 pandemic and high energy prices.[45] Data from 2023 suggest a reversal of this trend: by year's end, the number of people without electricity access was projected to decrease[i].[46] Of the 71 countries without universal access to electricity as of end-2023, only 34 had targets for electricity access through renewables.[47] (→ *See Figure 1.*)

685 million
people lacked access to electricity in 2022.

FIGURE 1.
Electricity Access Targets and Electricity Access Targets with Renewables in Countries with No Universal Access to Electricity, as of End-2023



Source: See endnote 47 for this module.

i Estimates of the number of people lacking access to electricity vary by source. Here, the latest consolidated data used are from the *2024 Tracking SDG7 Report*.

ELECTRICITY ACCESS

In 2023, most people without electricity access were in Sub-Saharan Africa, where four out of five people lacked access to electricity.[48] Overall, just 24 countries are home to 80% of the population without electricity access globally, with 20 of these in Africa and the rest in Asia.[49] Countries with the largest number of people lacking access are Nigeria (86 million people), the Democratic Republic of the Congo (DRC; 76 million) and Ethiopia (55 million).[50] Significant progress has occurred in Asia, mainly in Bangladesh, Pakistan, and India, which have achieved near-universal electricity access.[51]

Distributed renewable energy systems[i] offer a decentralised approach to improving electricity access in under-served areas. Off-grid solutions as well as mini-grids and microgrids are key enablers of distributed renewables. Solar energy kits, such as lanterns and solar home systems, are seen as the most cost-effective and viable solution to electrify an estimated 55% of households in the next five years and to reach universal access to affordable electricity by 2030 (SDG 7).[52] (→ *See Snapshot: Central African Republic.*)

i Energy systems are distributed if 1) the systems are connected to the distribution network rather than to the transmission network, which implies that they are relatively small and dispersed (such as small-scale solar PV on rooftops) rather than relatively large and centralised; or 2) generation and distribution occur independently from a centralised network.

SNAPSHOT CENTRAL AFRICAN REPUBLIC

DOUBLING NATIONAL POWER CAPACITY WITH THE DANZI SOLAR PLAN

In late 2023, the Central African Republic opened a new 25 megawatt (MW) solar park connected to a 30 megawatt-hour electricity storage system in the village of Danzi, just 18 kilometres from the capital Bangui.

The solar park, comprising 47,000 solar panels, supplies 250,000 people with renewable electricity, nearly doubling the national power generation capacity. The generated electricity is fed into the grid of the state-owned company Energie Centrafricaine (ENERCA), and the project is financed by the World Bank as part of the Emergency Project for Access to Electricity (Puracell). The Danzi solar plant is expected to replace more than 90% of the energy generated by diesel fuel and to reduce national emissions by a significant 670,674 tonnes of carbon dioxide (CO_2).

In 2023, the electrification rate in the Central African Republic was 16% overall, but it ranged from 35% in Bangui, to 8% in major provincial cities, to just 2% in rural communities. By 2030, the country aims to increase the overall electricity access rate to 50% using diversified power generation sources. Projects have included the Danzi solar plant as well as off-grid options for homes and public entities, mini-grids, and large-scale solar power. Since 2016, national electricity production has increased four-fold from 25 MW to 100 MW. This development signals the country's commitment to reducing its dependence on fossil fuels while greatly ramping up the use of renewable energy to promote sustainable development.

Source: See endnote 52 for this module.

Distributed renewables also provide solutions for displaced populations. With 80% of the 8.7 million refugees around the world lacking access to electricity and clean cooking solutions, distributed renewable energy solutions offer both environmental and financial benefits for refugee camps and promote resilient and productive livelihoods.[53]

Mini-grid solutions have helped provide electricity to populations in remote areas where grid expansion would be costly. As of 2022 (latest data available), an estimated 48 million people globally were connected to around 21,500 mini-grids, with an investment cost of USD 29 billion.[54] Successful increases in electrification have occurred in Bangladesh, Cambodia, and India, as well as in Nigeria, Rwanda, Tanzania, Uganda and others.[55] In South Sudan, where only 8.4% of the population had access to electricity as of 2022, twice as many people are connected through off-grid solutions than through the national grid.[56] Bangladesh has installed more than 6 million solar home systems nationwide, benefiting more than 18 million people – 11% of the population.[57]

Boosted by declining costs, 29,400 mini-grid projects (99% powered by solar PV) were planned as of 2023, with 95% of them located in Africa and South Asia.[58] These projects are expected to connect 35 million people at a cost of USD 9 billion.[59] However, mini-grids have the potential to connect up to 490 million people by 2030 through 217,000 new projects, requiring a USD 127 billion investment from development partners, governments and the private sector.[60] Increasing funding for mini-grid projects is key to achieving universal electricity access by 2030.[61]

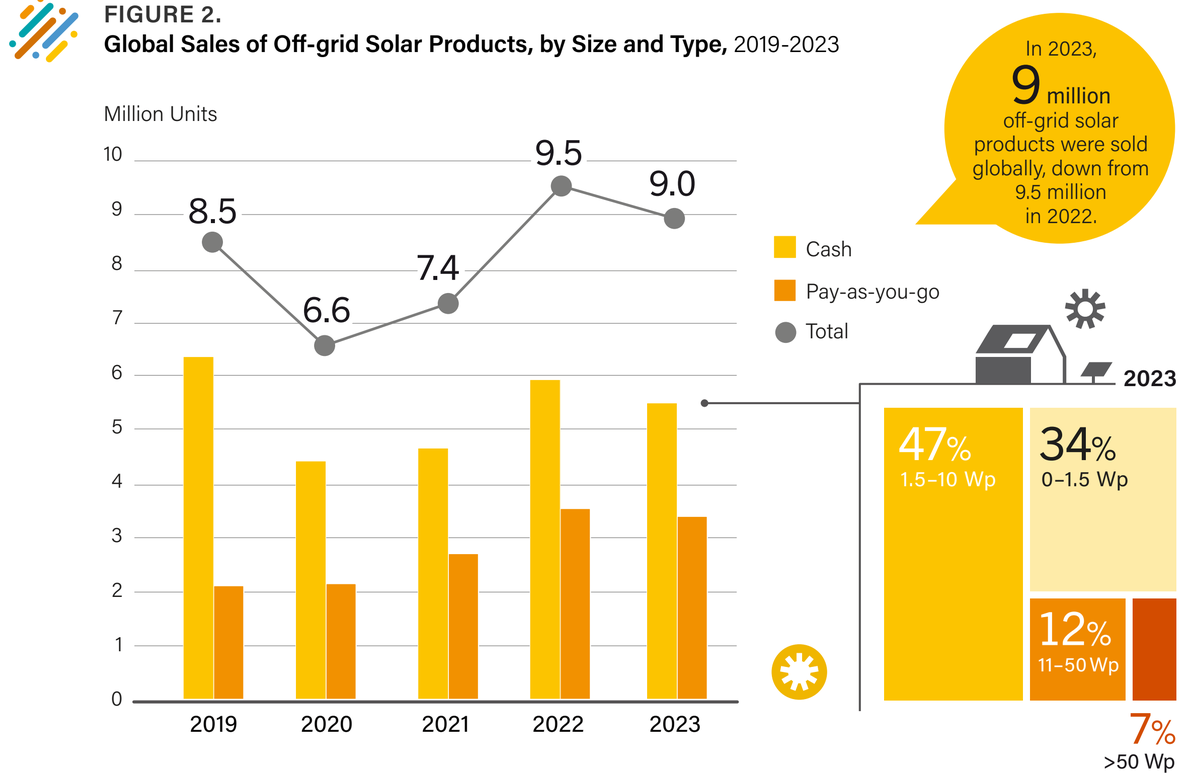
In 2023, global sales of solar energy kits reached nearly 9 million (→ *See Figure 2.*), out of which 5.5 million were portable lanterns, 1.5 million multi-light systems and 1.7 million solar home systems.[62] This was down from a total of 9.5 million off-grid solar products sold in 2022.[63]

Despite advancements using renewables, many regions struggle to achieve reliable electricity access.[64] Countries that have been the most successful in increasing their electrification rates have taken a comprehensive approach to planning, which involves both grid expansion in co-operation with national grid operators, as well as off-grid solutions, including mini-grids and solar home systems.[65] In Nigeria, the Electricity Act of 2023 regulates the power sector in its entirety and focuses strongly on electricity access.[66] Zambia's Rural Electrification Act emphasises both off-grid and on-grid solutions for electricity access.[67] In 2023, Angola developed a Rural Electrification Plan that includes solar, wind and micro-hydro technologies for supplying electricity to remote areas, and Mozambique approved its Renewable Energy Code to also focus on decentralised solutions for energy access.[68] Uganda revised its Energy Policy in 2023 and presented a vision to achieve universal access to energy services by 2040.[69]

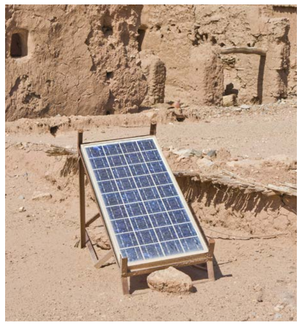
Investment in distributed renewable energy[i] has grown near-continuously over the past decade (except during the COVID-19 pandemic in 2020) and reached an all-time high of USD 558 million in 2021 (latest data available).[70] The average transaction size has also increased, reaching USD 3.7 million in 2021.[71] The majority of investments continue to originate from only a few major players.[72] In areas where markets are less developed, such as in southern Africa, public policy and development finance support remain crucial to driving investments.[73]

i Distributed renewable energy may also be defined as off-grid renewable energy and includes both stand-alone systems and mini-grids.

FIGURE 2.
Global Sales of Off-grid Solar Products, by Size and Type, 2019-2023



Source: See endnote 62 for this module.



In 2023, the World Bank announced that it would commit more than USD 1.4 billion to mini-grids over the next seven years through 38 projects in 29 countries, with the aim of decreasing the gap between what communities in remote areas can afford and the costs of providing off-grid electricity solutions.[74] This is expected to initiate close to USD 1 billion in co-financing from the private sector, governments and development partners.[75]

In eastern and southern Africa, the World Bank provided new or improved electricity access via on-grid and off-grid solutions to 25 million people through lending projects, policy support and technical assistance. Projects included Uganda's Energy for Rural Transformation Project and the Electricity Access Scale-up Project (EASP), the Malawi Electricity Access Project, the Solar Energy in Local Communities Project (SOLEIL) in Burundi and the Ethiopia Electrification Program (ELEAP), among others.[76] The World Bank's Accelerating Sustainable and Clean Energy Access Transformation (ASCENT) programme, announced in late 2023, sets a target of accelerating sustainable and clean energy access for 100 million people in up to 20 countries across eastern and southern Africa over the next seven years.[77]

In **Indonesia**, the government increased its 2023 budget for enhancing electricity access for poor households, with the funds going to the distribution of converter kits to fishers and farmers, subsidies for the upfront costs of new electric installations, the construction of 12 solar and micro-hydro power plants in under-serviced areas and setting up more than 31,000 solar street lighting systems.[78]

ACCESS TO CLEAN COOKING

As of 2023, an estimated 2.3 billion people worldwide – around a third of the global population – still relied on harmful fuels for cooking, including the burning of coal, charcoal, firewood, agricultural wastes and animal dung.[79] Air pollution related to these fuels contributes to around 3.7 million premature deaths annually, particularly among women and children.[80] The use of non-renewable wood fuels for cooking releases an estimated 1 gigatonnes of CO_2-equivalent annually, accounting for up to 4.3% of emissions from pan-tropical regions and around 2% of global emissions (roughly equal to those from the aviation sector).[81]

Nearly 1 billion people in Africa and around 1.2 billion people in developing Asia were living without access to clean cooking as of 2023.[82] Most of the countries with very low access rates were in Sub-Saharan Africa (29 countries with rates below 20%), followed by Asia (7 countries).[83] Between 2010 and 2022, Sub-Saharan African countries increased their access rate to clean cooking from 8% to around 15%; however, due to population growth, the absolute number of people without access increased by 220 million.[84] Each year, around 20 million additional people in the region lack access to clean cooking.[85]

Between 2019 and 2021, the only regions to maintain improvements in access to clean cooking were Eastern Asia and Latin America and the Caribbean.[86] India, China and Indonesia halved the number of people without clean cooking solutions between 2010 and 2022.[87] If current trends persist, Sub-Saharan Africa will be home to around six out of every ten people relying on harmful cooking fuels by 2030.[88] Events hampering progress included the COVID-19 pandemic as well as the recent global energy crisis, which led to an estimated 100 million people resorting to the traditional use of biomass for cooking.[89] Overall, the world remains off-track to achieve the 2030 target of universal access to clean cooking.[90]

In rural areas worldwide, the share of people using natural gas as their primary fuel has increased faster than the share using electricity, whereas in urban areas the reverse is true.[91] Between 2010 and 2023, 70% of the people who gained access to modern cooking facilities to replace traditional biomass did so using liquefied petroleum gas (LPG).[92] Biogas produced with the help of biodigesters is also increasingly popular.[93] In Africa, Kenya is a leading country in biogas policy and investment, with an estimated 17,000 household biogas digesters and 8,000 biogas plants in 2023.[94]

Clean cooking solutions based on renewable fuels and renewable electricity offer opportunities for fuel saving and co-benefits emerging from the supply chains of other sectors, such as agriculture.[95] Clean cooking also helps decrease forest degradation and air pollution and provides opportunities for climate adaptation, improving human health and well-being while fostering environmental recovery.[96] Globally, the roughly 4 million solar cookers distributed since 1990 have benefited an estimated 14.3 million people and avoided more than 5.8 million tonnes of CO_2 emissions annually.[97]

As of 2023,

2.3 billion

people did not have access to clean cooking.

Less than 10% of the people lacking access to clean cooking live in countries with the necessary policy frameworks and funding.[98] In early 2024, Pakistan called for applications to develop a National Clean Cooking Strategy.[99] Tanzania's Rural Electrification Agency outlined strategic plans for clean cooking in 2023.[100] In Uganda, the government is developing an Integrated National Clean Cooking Strategy.[101] At the 2024 United Nations Climate Change Conference in Dubai, United Arab Emirates (COP 28), international donors including the African Development Bank committed to directing around 20% of their energy sector investments to clean cooking.[102]

Historically, multilateral development finance institutions dominated financial commitments to clean cooking[i].[103] However, commercial financiers and bilateral donors have played a growing role.[104] In 2019 (latest data available), around USD 133.5 million was committed to clean cooking, with USD 56 million from private sources and USD 54 million from bilateral development finance institutions and international donors.[105]

The overall clean cooking investment portfolio continues to be dominated by a few large projects in a small number of countries, funded by a handful of capital providers.[106] Much of the finance has gone to projects in Bangladesh, India, Kenya and Uganda.[107] As part of the Global E-cooking coalition (GeCCo), the Solar-Electric Cooking Partnership (SOLCO) has pledged to leverage USD 100 million in financing across refugee-hosting countries in Africa for solar-electric cooking solutions.[108]

ENERGY AFFORDABILITY

Energy affordability can be measured as the cost of energy as a share of disposable income, or it can be based on self-reported metrics of indoor temperature comfort and housing conditions and the degree of difficulty faced in paying utility bills. In 2020, in addition to the 733 million people who did not have access to electricity, an estimated 447 million people globally did not use any electricity, despite having power connection.[109] In high-income countries, an increasing share of citizens have been affected by high energy prices and poor housing insulation.[110]

Addressing energy poverty can not only improve people's indoor comfort and well-being, but also reduce government spending on health and lead to higher levels of educational attainment, economic development, and a reduction in carbon emissions through energy efficiency improvements. Understanding and measuring energy poverty is essential for programmes that target the most vulnerable.[111]

In 2023, around 10.6% of Europeans could not adequately heat their homes – up 1.3% from 2022 – as a consequence of higher energy bills and the overall rise in the cost of living.[112] In 2023 and 2024, the **EU** included measures aimed at tackling energy poverty through energy efficiency improvements and support for vulnerable households in the Social Climate Fund, the revised Energy Efficiency Directive, the Commission's recommendation on energy poverty, the Energy Performance of Buildings Directive and the Electricity Market Reform.[113]

Policies addressing energy poverty can target root causes such as high energy bills and poorly insulated housing, combined with low income.[114] Supportive measures include building retrofits, use of insulation, replacement of inefficient appliances, and lowering energy bills through distributed renewable energy generation and self-consumption.[115] Policies can also directly support vulnerable households to afford energy bills through grants.[116] (→ *See Subsidies section.*)

In 2023, the Warmer Homes Schemes of the Sustainable Energy Authority of **Ireland** (SEAI) supported 47,900 home energy upgrades, enabling nearly 6,000 energy-poor households to receive free upgrades (such as heat pumps and solar panels) aimed at improving energy efficiency and reducing costs.[117] The Greener Homes Initiative in **Canada** provides grants and loans for vulnerable households to implement similar energy-efficient retrofits.[118]

As of July 2024, around 48 million people in the **United States** – or 23% of the population above 18 years old – reported an inability to pay their energy bills in full over the previous 12 months.[119] The Inflation Reduction Act (IRA) of 2022 initiated several programmes to help alleviate energy poverty, including the Home Electrification and Appliances rebates for low- and moderate-income households, the Home Efficiency Rebate Programme targeting low-income households for home retrofits, and the Greenhouse Gas Reduction Fund providing low-cost financing for renewable energy projects.[120]

The deployment of renewables can benefit households and businesses by reducing energy bills, especially in the face of high energy prices.[121] (→ *See Snapshot: Panama.*) During the recent energy crisis in Europe, more than half of small and medium-sized enterprises in six EU Member States reported that investing in local renewable energy projects, such as solar and wind power, was the best way to support them through the energy crisis.[122]

i The United Nations defines clean fuels and technologies for cooking as electricity, natural gas, LPG, biogas, alcohol fuels and solar cookers.

SNAPSHOT PANAMA

EMPOWERING CLIMATE-VULNERABLE COMMUNITIES THROUGH SOLAR ENERGY

As part of Panama's energy transition agenda, the initiative Operación Solar aims to increase the share of solar power in the country's total generation capacity from 6% in 2022 to 15% by 2030. Launched in 2024 by the National Energy Secretariat (SNE), the initiative focuses on installing decentralised solar PV systems in 663 homes and 10 schools across vulnerable communities, targeting areas heavily affected by climate change. The project aims to produce 585,000 kilowatt-hours (kWh) of solar energy per year – benefiting around 3,000 residents – and to reduce CO_2 emissions by 180,000 tonnes.

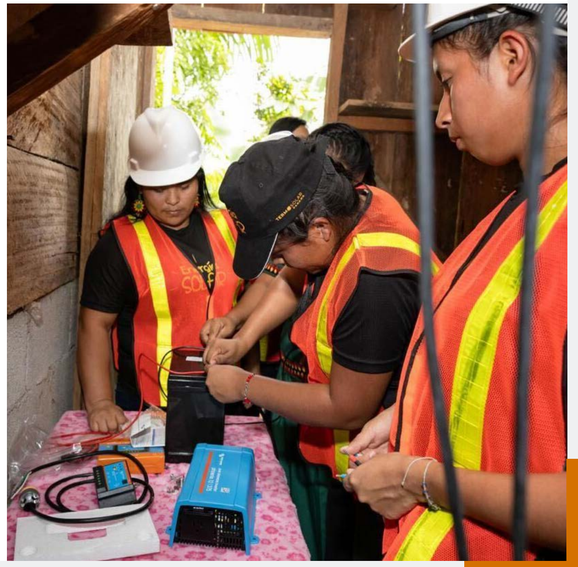
Operación Solar is designed to reduce energy costs for low-income families and to decrease reliance on national electricity subsidies, which have grown since the privatisation of Panama's electricity sector in 1998. The initiative targets four climate-vulnerable communities with limited access to affordable energy: Kuna Nega, Veracruz (near the Panama Canal), San Martín de Porres (in Santiago de Veraguas) and Las Lomas (in David-Chiriquí). The pilot phase, slated to end in late 2024, will evaluate the impact of the solar systems on community energy needs. Maintenance will be supported by distribution companies for the first two years, ensuring sustainability.

Key support for Operación Solar comes from diverse organisations providing funding and capacity building, including a USD 700,000 donation from the Municipality of Fuzhou in China as well as contributions from non-profits, academic institutions and private companies. Local banks are exploring concessional financing options for low-income households, while other organisations focus on local capacity building.

Through collaborations with universities, as of mid-2024 around 170 students had received training in solar design and installation, provided by the SNE and other partners. The SDG 7 Academy is training young leaders to raise community awareness about climate change and solar energy management. To ensure local ownership and leadership, workshops are being held to train families involved in Operación Solar to manage their own solar PV systems, and more than 150 professionals have graduated from the programme already.

Through a STEM programme designed to build capacities, Operación Solar collaborates with Sustainable Energy for All, which provides fully funded scholarships for young professionals who intern with the initiative. This support accelerates the pilot project implementation while also enhancing the skills of women for the energy transition. In addition, the project collaborates with SNE's Solar Champions programme, which provides training in solar PV installation and maintenance to Indigenous women from Ngäbe-Buglé, a region with among the highest energy access gaps in the country. The 280-hour programme, conducted in the local language, includes financial capacity building to promote economic empowerment. As of mid-2024, a total of 85 women had graduated from the programme, with 24 of them working in solar companies and 11 having their own micro-enterprises. Where possible, the graduates are involved in installing Operación Solar systems, fostering a synergistic approach between the two projects.

Source: See endnote 121 for this module.



CAPITAL FLOWS

SOURCES OF RENEWABLE ENERGY INVESTMENT

Typically, the **private sector** has driven investment decisions related to energy assets, with corporations providing on average 48% of total energy investment between 2018 and 2023 and households 15%; **governments and state-owned enterprises** contributed 37%.[123] However, this varies greatly by country: in emerging and developing economies, governments provided near 50% of investment on average, compared to only 15% in advanced economies.[124]

Renewable energy has enhanced the role of citizens in energy investments. Driven by increasing investments in rooftop solar, buildings efficiency, and electric vehicle purchases, households (mainly wealthier) have become key actors in energy investment decisions, doubling from a 9% share of total investment in 2015 to 18% in 2023.[125]

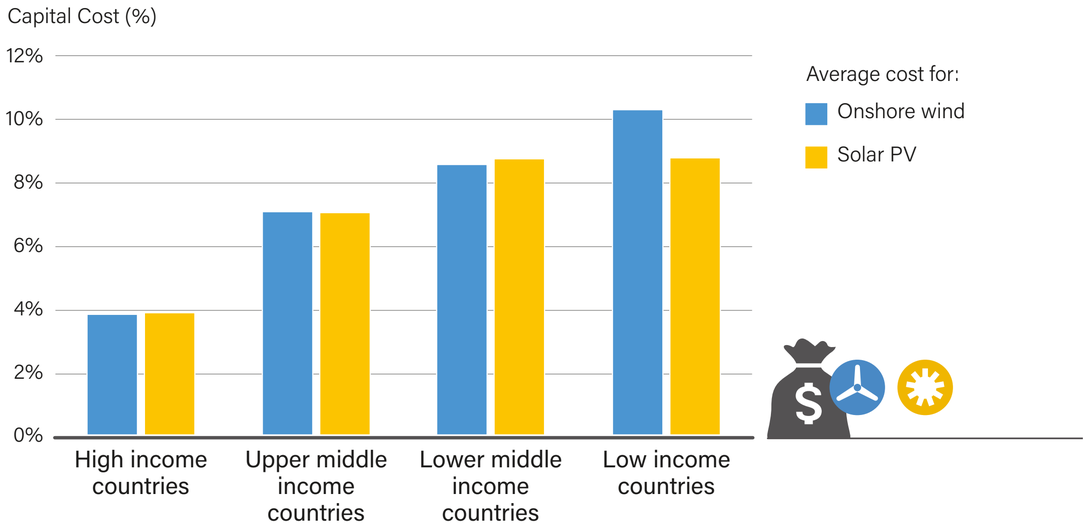
The growing deployment of renewable technologies has driven innovations that both improve production efficiency and lower costs.[126] Large cost reductions in renewables in the past decade have increased their competitiveness compared to fossil fuels. In 2023, the **global weighted average levelised cost of electricity (LCOE)** from newly commissioned renewable projects fell across most technologies, including solar PV (down 12%), hydropower (7%), offshore wind (7%), onshore wind (3%) and concentrating solar power (CSP; 4%).[127]

In 2023, an estimated 81% of the total utility-scale renewable power projects added during the year had lower costs than their fossil fuel-fired alternatives.[128] This means that renewable energy is already leading to cost savings. As of 2023, the total renewable power deployed globally since 2000 had saved an estimated USD 409 billion in fuel costs in the power sector.[129] Such cost savings allow countries, particularly small island developing states (SIDS), to invest more in required climate change adaptation measures.[130]

However, the LCOE alone does not determine whether an investment decision is made. The upfront cost of renewable energy deployment can be significant for countries and communities with limited resources, requiring financial and technical support.[131]

The distribution of investment over time is an important factor in decisions as well. **Capital expenditure** for renewable energy projects is concentrated in the deployment phase; projects require a large upfront investment but then typically have low operating costs and no fuel costs (in the case of solar and wind). Given the capital intensity of renewables, access to capital is an essential building block of energy transitions everywhere. However, access to funds is uneven worldwide, which could lead to a two-speed energy transition.[132] In 2022, the weighted average cost of capital for onshore wind power and solar PV neared 10% in low-income countries and 4% in high-income economies.[133] (→ *See Figure 3.*)

FIGURE 3.
Weighted Average Cost of Capital for Onshore Wind Power and Solar PV, by Country Income Level, 2022



Source: See endnote 133 for this module.

In 2022, there was a gap of over
4 percentage points
in the cost of capital for onshore wind and solar PV between low- and high-income economies.

FISCAL POLICY FOR RENEWABLES: TAXATION AND SUBSIDIES

Fiscal policy can be mobilised for renewable energy in two main ways. Firstly, the revenue from certain fiscal instruments (especially fossil fuel taxes) can be used to enhance spending on renewables. Secondly, that extra fiscal space generated can be used in the form of tax reductions or subsidies for renewable energy.

Taxation and Public Budgets

In 2023, the income from carbon pricing instruments globally surpassed USD 100 billion, a record high, growing from USD 26 billion in 2015.[134] The number of such instruments, including carbon taxes and emission trading systems, increased from 38 in 2015 to 74 in 2023.[135] However, income from energy-related fiscal policies represents only a small part of total public revenues. In the Euro area, energy taxes contributed 4.8% of public revenues in 2019.[136]

Carbon pricing can be a tool to raise revenues that can then be used for renewable energy finance in developing countries.[137] Carbon pricing can be a tool to raise revenue that can then be used to finance projects of renewable energy in developing countries. However, since this revenue is volatile and will fluctuate and diminish in the long term, countries may establish a dedicated fund to support renewable energy. This fund can be financed by carbon revenues as well as other sources, ensuring its long-term sustainability.[138]

In 2023, around 52% of carbon revenues worldwide were used for climate and nature expenditures (including renewables).[139] **Germany** is dedicating a lot of its carbon revenue to energy efficiency in buildings, decarbonising industry, electromobility and renewable energy through the Climate and Transformation Fund (KTF).[140] In the **United States**, close to 90% of the revenue from the Regional Greenhouse Gas Initiative (RGGI)[i] is being applied to energy efficiency, electrification, greenhouse gas abatement, and clean and renewable energy.[141] **Japan** is using the entirety of revenues from its carbon tax to support low-carbon innovation, energy saving for small and medium-sized enterprises and financial assistance for local projects in energy savings and renewables.[142] In **Denmark**, a tax on air passengers is being used to finance the transition to greener practices in the aviation industry.[143] The government's proposed average tax of DKK 100 (USD 14.35) on air travel would help finance the industry's green transition, which aims to enable all domestic flights to use 100% sustainable fuels by 2030.[144]

Tax Reductions and Tax Breaks for Renewables

Tax reductions have become an increasingly popular policy choice to encourage the deployment of renewable energy and enabling technologies. Subsidies are mainly consumer facing, aimed at making these technologies accessible to households. While some countries (such as Iceland) are subsidising imports, others (such as Italy) are using subsidies to increase local manufacturing competitiveness (→ *see Local Value Creation section*).

i The RGGI is a co-operative effort among the US states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont and Virginia to cap and reduce CO_2 emissions from the power sector.

In 2023, at least two countries implemented **tax breaks or value-added tax (VAT) incentives** to promote the uptake of **electric vehicles. China** committed to a CNY 520 billion (USD 72.3 billion) package of tax breaks over four years for electric vehicles and other green cars.[145] So-called new energy vehicles purchased in 2024 and 2025 will be exempted from the purchase tax of as much as CNY 30,000 (USD 4,170) per vehicle.[146] In **Iceland**, the government committed to VAT incentives totalling USD 74 million (ISK 10.2 billion) on imported electric cars; although this amount will decrease in 2024, a total of USD 55 million (ISK 7.5 billion) will be provided to the Energy Fund (Orkusjóður) to continue supporting energy conversion projects.[147]

Tax breaks were also put in place in 2023 to support solar PV deployment and heat pumps in the residential sector. In **Belgium**, buildings less than 10 years old can benefit from a reduced VAT (from 21% to 6%) on solar panels, solar water heaters and heat pumps.[148] In the **United Kingdom**, VAT rates on heat pumps, solar panels for residential accommodations and battery storage were reduced to 0% for a five-year period.[149] In **Ireland**, a zero VAT rate was approved for the supply and installation of solar panels.[150]

Other important tax breaks in 2023 included **Portugal**'s tax exemption for decentralised renewable electricity networks and **Italy**'s National Recovery and Resilience Plan, where tax breaks are awarded to manufacturers that build their solar modules in the EU.[151]

SUBSIDIES

In 2023, countries spent USD 616 billion in **fossil fuel subsidies**, the second highest amount on record although down from the USD 1.2 trillion in direct subsidies in 2022.[152] This is despite global agreements at two recent UN Climate Change Conferences (COP 26 and COP 27) to accelerate efforts to phase out inefficient fossil fuel subsidies, and the agreement at COP 28 to transition away from fossil fuels.[153]

A large portion of these subsidies can be labelled as "inefficient" in their distribution, as they are not sufficiently targeted at vulnerable communities. Only 14% of fossil fuel subsidies in 2023 were aimed at uses related to lower-income households, and the poorest 20% of consumers received only 10% of the total.[154] Moreover, these subsidies can be draining for public budgets in developing economies, increasing public deficits. In Senegal, fuel subsidies represented 4% of the GDP in 2022.[155]

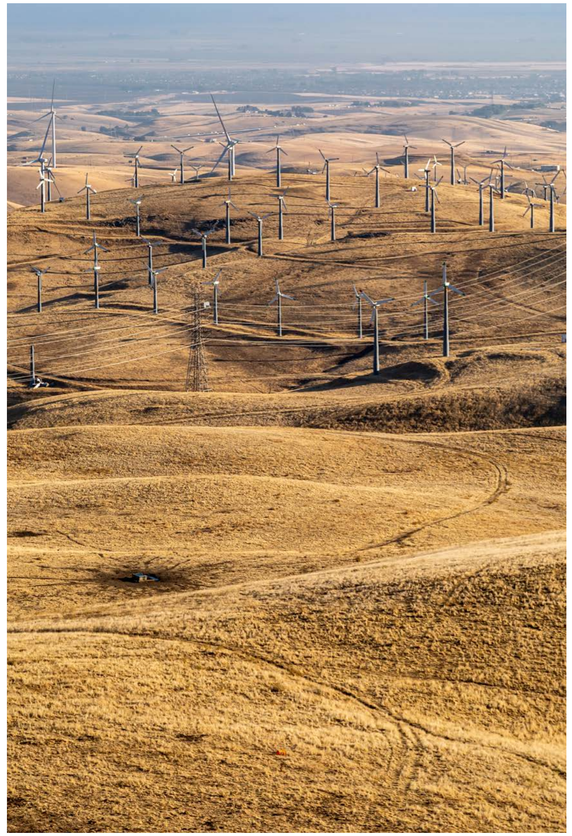
Globally, **public support for clean energy** (including renewables) in 2023 was one-tenth the amount of subsidies allocated for fossil fuel consumption.[156] In developing countries, the average public support for renewable energy between 2016 and 2023 was less than 2.5% (or one-fortieth) the amount of public fossil fuel subsidies (USD 10.3 billion for renewables versus USD 438 billion for fossil fuels).[157]

In 2023, several countries put in place subsidy programmes targeted at vulnerable communities, with a focus on farmers. In **Poland**, a new programme provides subsidies totalling USD 250 million (PLN 1 billion) to farmers and energy co-operatives in rural communes, with the aim of financing biogas and hydropower plants, solar PV installations, wind turbines and energy storage facilities integrated with these plants.[158] In the **United Kingdom**, the Improving Farming Productivity Grant will for the first time include grants of between USD 19,630 and USD 130,880 (GBP 15,000 and GBP 100,000) towards solar equipment on farms.[159] **Greece** implemented a USD 219 million (EUR 200 million) "Photovoltaics on the Roof" programme that subsidises PV installations for households up to 75% and farmers up to 60%.[160] The savings on energy bills will approach USD 3,291 (EUR 3,000) per year, which will improve affordability (→ *see Affordability section*). In the **United States**, the 2023 budget of the Department of Agriculture allocates USD 300 million in grants, loans and debt forgiveness to rural electricity providers in the transition to clean energy sources including renewable energy, in addition to USD 6.5 billion in loans for rural electric utilities.[161]

In 2023, public support for clean energy (including renewables) was

1/10th

the amount of fossil fuel consumption subsidies.



Also in 2023, the government of **Switzerland** allocated USD 700 million (CHF 600 million) in subsidies to solar PV in the form of one-time payment for small PV systems (KLEIV) to all system operators as well as auctions for large PV systems of 150 kW or more, receiving a high one-time payment covering up to 60% investment costs.[162] In **Ireland**, the support scheme for Renewable Heat (SSRH) was expanded, increasing the maximum support for heat pump installation from 30% to 40%, and continuing the USD 3.8 million (EUR 3.5 million) support scheme for biomass applications for another 15 years.[163]

In Asia, **India** aims to add 30 gigawatts (GW) of rooftop solar capacity with a USD 9 billion scheme that covers between 40% and 60% of project costs for households.[164] **Japan**, as part of its Sixth Strategic Energy Plan, announced new feed-in-tariff rates that apply for new residential, commercial and industrial solar installations in 2024 and 2025.[165]

SOURCES AND FLOWS OF FINANCE

Between 2018 and 2023, nearly three-quarters (74%) of the funding for clean energy came from **commercial actors** such as private companies and households.[166] Public finance accounted for around 24%, and development finance institutions contributed 1%.[167] However, the distribution of financing varies by region. In China, the government's share of financing is high at more than 35%, whereas in advanced economies the share is below 23%.[168]

As key providers of finance, **commercial banks** can shift capital flows away from fossil fuels and towards renewables. Fossil fuel financing[i] by the world's top 60 private banks totalled USD 705.8 billion in 2023, 9% less than in 2022.[169] However, efforts to shift financing towards renewable energy are lagging. Of the top 60 private banks, only 6 had financial targets for renewable power supply and none had clear targets for renewable energy capacity, while 1 had robust restrictions on oil and gas expansion and 3 had restrictions on coal expansion.[170]

Alternative Business and Financing Models

Traditional financing models rely heavily on commercial banks and government subsidies, making them less-suited for off-grid or mini-grid projects.[171] The growing use of innovative financing and business models as well as financial aggregation have helped support the development of distributed renewable energy in recent years. In the developed world, community finance and peer-to-peer trading have emerged more readily, whereas in the developing world pay-as-you-go (PAYG) and results-based financing (RBF) are more commonly applied. Digitalisation continues to further the development of different models including peer-to-peer and PAYG.[172] (→ *See also Snapshot: France in the Community Energy section.*) In developing countries, the so-called PURE model, or "productive use of renewable energy", has also gained attention.[173] (→ *See Box 2 and Snapshot: Togo.*)

i Lending and underwriting to the fossil fuel sector.

BOX 2. Productive Use of Renewable Energy

In addition to well-established peer-to-peer trading and PAYG models, the "productive use of renewable energy" model, or PURE, has gained traction as a way to increase access to sustainable and affordable energy as well as support livelihoods and foster development.

PURE is a way to support the expansion of energy access while helping communities generate revenue. The idea is that providing funding and investment for renewable energy solutions alone is not sufficient to foster local value creation if there is no electricity demand in the first place. In other words, local businesses must be given financial tools such as loans and subsidies to purchase equipment to create electricity demand that would further foster the development of more renewable energy projects.

Examples of PURE include cooling solutions (such as refrigerators), water pumps for agriculture, charging devices, fishing lights, communication devices (phones with internet), and mini-grids for productive use and businesses. PURE can not only boost clean electricity use but also support low-carbon economic growth, create employment opportunities, increase income for rural communities and contribute to the economic empowerment of women. Estimates suggest that market opportunities in the PURE sector in the coming decade could total as much as USD 864 billion.

Source: See endnote 173 for this module.

SNAPSHOT TOGO

SUPPORTING PRODUCTIVE USE OF RENEWABLE ENERGY THROUGH PROJECT CIZO

Project CIZO ("sun" in Togolese) aims to electrify some 600,000 off-grid households using the pay-as-you-go model and a range of demand-side subsidies, such as long-term tax exemptions. Among the goals of the programme is to provide cheap solar kits to more than 2 million citizens by 2025. As of June 2023, the project provided some 134,431 solar kits. More broadly, the project aims to support off-grid communities, healthcare centres, households, and small farms by enabling productive use of renewable energy, improving energy access and boosting livelihoods in rural areas. Solar irrigation pumps provided by the project provide water to irrigate fields while allowing farmers to save money on electricity.

The project is led by the Togolese Rural Electrification and Renewable Energies Agency (AT2ER) and is funded by the African Development Bank, the EU-Africa Infrastructure Trust Fund, the Sustainable Energy Fund for Africa, and the government of Togo, which together contributed USD 32.3 million. By September 2023, the project had installed 122 solar water heaters in health centres and provided electricity to 87 peripheral care units. In total, 153 immersion and surface pumps have been deployed on farms.

Source: See endnote 173 for this module.

Peer-to-peer trading models – in which a direct contract is made between the energy generator and the energy user via a decentralised transaction – have been in place for a number of years, with early trading platforms in Germany, the Netherlands, the United Kingdom and the United States.[174] A flurry of academic literature has addressed technology options to facilitate this model (such as blockchain) as well as challenges with guaranteeing security and high-quality electricity delivery, ensuring fair and impartial energy sharing among community members, time-lags in reaching agreements on the ultimate supply of energy and predicting system behaviour for grid operators.[175]

Pay-as-you-go (PAYG) models have attracted increasing financing for renewables, particularly for off-grid solar PV in developing countries.[176] This structure allows users to purchase an off-grid energy system with an initial down payment, followed by period payments ranging from six months to eight years, ultimately shifting the upfront costs of purchasing a system while avoiding risks such as system failure.[177] The existing mobile money ecosystem in East Africa, particularly in Kenya, Rwanda, and Tanzania, has facilitated use of the PAYG model there.[178] Successful providers include Angaza, Bboxx, d.light and M-KOPA.[179] Koolboks, initiated in 2020, has been offering PAYG options in Kenya and Nigeria for solar-powered refrigerators.[180] In 2023, M-KOPA secured more than USD 250 million in debt and equity to fund its expansion beyond Ghana, Kenya and Nigeria to include South Africa.[181]

Result-based financing, or RBF, involves a mechanism through which a funder makes payments only upon achievement of pre-defined results, thereby linking financing more directly with outputs and outcomes.[182] In the energy sector, RBF may be used for projects with verifiable results, such as households provided with a working electrical connection, or private sector companies, community organisations and public providers that deliver basic energy services.[183] RBF has been used in the energy sector for around a decade, focused largely on energy access projects in Africa, although examples also exist in South-East Asia and in Latin America and the Caribbean.[184] Early RBF for solar PV was focused on smaller solar energy kits such as multi-light systems, although more recently the focus has shifted to larger-capacity solar home systems.[185] The model has also been applied to clean cooking – primarily improved biomass cookstoves.[186]

In mid-2023, the Universal Energy Facility, a multi-donor RBF facility managed by Sustainable Energy for All, signed multiple grant agreements with mini-grid companies in the DRC, Madagascar and Sierra Leone for a total of USD 10.4 million to develop 29 mini-grids with a combined capacity of some 3.7 MW.[187] Beyond the Grid Fund for Africa (BGFA) offers RBF for private energy companies with a track record of successfully implementing sustainable energy projects in Sub-Saharan Africa.[188] In June 2024, a USD 5.4 million (EUR 5 million) RBF agreement was signed between BGFA and Nuru Sasa (DRC) to establish a new mini-grid in the country.[189]

Financial aggregation refers to the grouping of small-scale energy assets (such as distributed renewable energy) into portfolios to achieve scale and attract larger investments.[190] It can be in the form of securitisation of future cash flows and the aggregation of these into pooling structures, typically special purpose vehicles (SPVs).[191] Until recently, financial aggregation for distributed renewables was rare, although early examples were applied in Kenya (by Bboxx in 2015 and Brighter Life Kenya 2 in 2022) as well as in Sierra Leone (by Winch Energy in 2021) and in Uganda.[192] In 2023, two new securitisation structures for off-grid solar were announced: a USD 130 million transaction pooling payments from SunKing customers in Kenya, and the expansion of d.light's securitisation beyond Kenya into Tanzania, bringing total financing to USD 490 million.[193]

Alternative business and financial models have supported the uptake of distributed renewables in recent years.

ECONOMIC DEVELOPMENT AND **LOCAL VALUE CREATION**

Renewable energy deployment reached an all-time high in 2023.[194] Renewables and enabling technologies[i] accounted for 7% of the growth in global GDP that year.[195] Opportunities for local economic development and job creation exist along all stages of the renewables value chain, from materials extraction and processing, to equipment manufacturing, project development, project operation, and energy distribution and use.[196]

POLICIES SUPPORTING LOCAL SUPPLY CHAINS AND MANUFACTURING CAPACITY

Local renewable energy manufacturing – including the production of solar panels, wind turbines, and their facilities and components, as well as batteries and electric vehicles – offers opportunities for low-carbon economic development.[197] Along the first stages of the supply chain, countries that are rich in the minerals needed for manufacturing renewable energy technologies can foster significant economic development through the exploitation and processing of minerals, provided that value is added to local supply chains and that potential harmful environmental and social impacts are mitigated through appropriate safeguards and policies.[198] The extraction, production, and processing of energy transition minerals, as well as the manufacturing of renewable energy technologies, can foster local industries, create employment, develop export partnerships, generate revenue and grow economies.[199]

In 2023, policies aimed at diversifying the renewable energy supply chain increased, with some countries focusing on securing their supply chains, manufacturing capacities, and sources of renewable energy components and materials.

In the **United States**, the Inflation Reduction Act has reshaped both global and domestic renewable energy supply chains by offering an array of incentives, including domestic content and workforce requirements as well as manufacturing tax credits for siting projects in energy communities.[200] Since its inception in mid-2022, the IRA has boosted local manufacturing in the country. As of mid-2024, 100 new **manufacturing facilities** for renewable energy and enabling technologies were operational, under construction or announced; 53 facilities started expansion or had planned expansion projects; and the restart of 5 previously abandoned plants was announced.[201] Most of the facilities (68%) are battery manufacturing plants, followed by solar PV (42%), zero-emission vehicles (16%), fuelling equipment (15%), electrolysers (10%), wind power (5%) and critical minerals (4%).[202] Out of the USD 491 billion in IRA investments since the third quarter of 2022, a total of USD 67 billion was invested in manufacturing.[203] Battery manufacturing represented 62% of the total, solar 18%, wind power 8%, zero-emission vehicles 7%, critical minerals 3%, electrolysers 2% and fuelling equipment 0.5%.[204]

i Growth in renewables and enabling technologies considers investment in renewable energy capacity, investment in renewable energy manufacturing, heat pump sales and electric vehicle, fuel cell, and charging infrastructure sales.

European countries have taken steps to strengthen their domestic supply chains for renewable energy technologies and related components. **France** set a target to produce 1 million heat pumps by 2027 and to train 30,000 installers.[205] The **United Kingdom** plans to spend USD 210 million (GBP 160 million) through the Floating Offshore Wind Manufacturing Investment Scheme to kick-start investment in the port infrastructure projects needed to deliver the country's floating offshore wind ambitions.[206]

The European Commission's Green Deal Industrial Plan, adopted in 2023, aims to elevate EU clean technology manufacturing (including renewable energy). Proposed initiatives include the Net-Zero Industry Act, which sets non-binding manufacturing capacity targets and aims to ensure that by 2030, the EU can internally produce at least 40% of its own needs for clean energy technologies[i] including renewable energy, and storage.[207] Also under the Green Deal Industrial Plan , the Critical Raw Materials Act aims to boost domestic sourcing and processing of mineral resources and to enhance local supply chains.[208]

Japan, India and **South Africa** have announced industrial policy initiatives to boost their domestic manufacturing sectors.[209] Japan plans to spend USD 14 billion (JPY 2 trillion) over the coming decade on green transformation to promote local production of storage batteries, semi-conductors and equipment to produce hydrogen, among others.

Electric vehicle manufacturing capacity has received both policy and investment attention. In 2023, several jurisdictions – including **Brazil, China, Estonia, Hungary, Malaysia, Morocco, Thailand** and the **EU** – announced new policies to advance electric vehicle manufacturing capacity, including batteries.[210] **France** set a target to produce 1 million electric vehicles by 2027, **Malaysia** set a target to reach 90% local production of electric vehicles by 2050, and **Morocco** is set to sign a USD 2 billion deal with electric vehicle battery producers to build a major manufacturing plant locally.[211]

In addition to policies aimed at fostering local sourcing and manufacturing, several countries and jurisdictions – such as **Australia, Canada,** the **EU, France, Germany, Italy, Japan,** the **Republic of Korea,** the **United Kingdom,** the **United States** and **Zambia** – have established dialogues, memoranda of understanding and other policy agreements on the trade of critical minerals.[212] The **EU** set up a Minerals Security Partnership Forum to co-operate in the area of critical raw materials.[213] The EU also concluded a partnership with **Namibia,** which had signed a provisional agreement to supply rare earth minerals to the region.[214] Later in 2023, the EU signed two other strategic partnerships in the supply of critical raw materials with the **DRC** and **Zambia**.[215]

Also during the year, **China** announced restrictions on the export of gallium and germanium as well as controls on the export of graphite, the largest electric vehicle battery component by weight.[216] In addition, China announced a ban of the export of rare earth extraction and separation technologies.[217] The Russian Federation introduced a temporary ban on the export of precious metal waste and scrap containing critical minerals.[218] In Africa, **Ghana, Nigeria** and **Zimbabwe** put in place bans on the export of certain raw minerals including lithium, and Namibia banned completely the export of unprocessed lithium and other critical minerals.[219]

The renewable energy transition requires innovation and technological development. Patents in renewable energy technologies can be used to measure the leading countries and the pace of innovation. The speed of energy patents has decreased in recent years, for both fossil fuel and renewable energy technologies.[220] In 2023, 150 renewable energy patents were registered worldwide, well below the 4,603 in 2020 and the record high of 7,152 in 2010.[221] Just 6 countries held 97.2% of total renewable energy patents in 2023, a shift from the more diverse landscape in 2020, when 22 countries held 97.2% of patents.[222] Historically, China has led in patents for renewables, with 47% of the global total in 2022.[223] Completing the top six in 2023 were the Republic of Korea, the United States, Japan, Taiwan and Spain.[224]

INVESTMENT IN MANUFACTURING CAPACITY

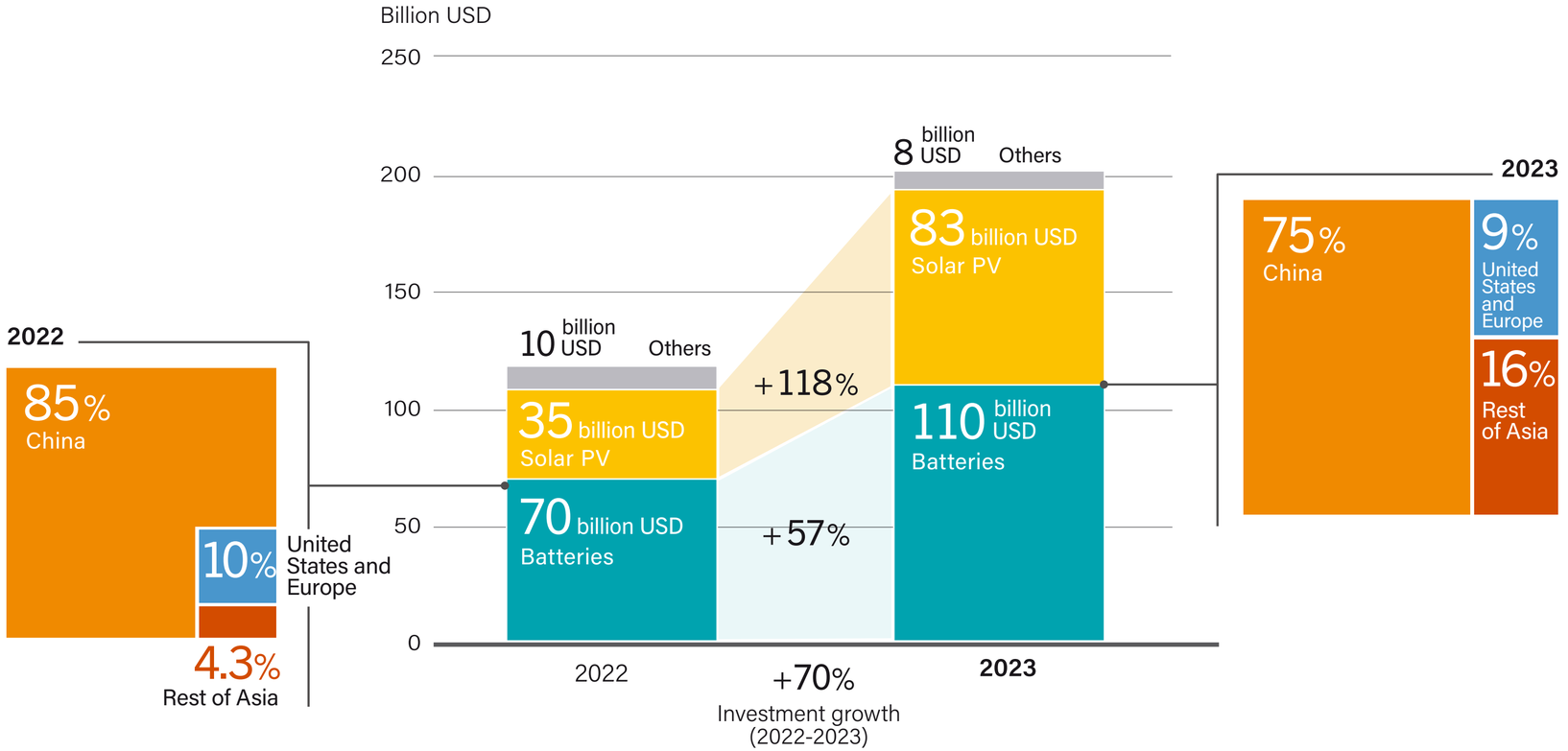
Investment in manufacturing capacity for renewable energy technologies has expanded rapidly, driven by supportive policies, ambitious corporate strategies and consumer demand.[225] The global energy crisis following the Russian Federation's invasion of Ukraine created a further impetus to develop manufacturing capacity to strengthen energy security and diversify supply chains.[226]

In **China,** investment in renewable energy manufacturing capacity has been supported by consistent policy signals in its successive Five-Year Plans coupled with a long-term industrial strategy focused on technology manufacturing.[227] In 2023, **China** accounted for 75% of global investment in manufacturing for renewables and enabling technologies, down from 85% in 2022.[228] **Europe** and the **United States** decreased their investment shares, falling from 10% in 2022 to 9% in 2023, while other Asian countries (**Japan, India,** the **Republic of Korea** and countries in South-East Asia) increased their combined investment share from 4.3% to 16%.[229] (→ *See Figure 4.*)

Several countries announced **industrial policy initiatives** to boost their domestic manufacturing sectors in 2023.

i Clean energy technologies are defined in the context of the Net-Zero Industry Act as solar PV and solar thermal, electrolysers and fuel cells, sustainable biogas/ biomethane, onshore wind and offshore renewable technologies, battery/storage technologies, heat pumps and geothermal energy, grid technologies, biogas, carbon capture and storage, and some nuclear technologies.

FIGURE 4.
Investment in Manufacturing of Renewable Energy and Enabling Technologies, by Type and Region, 2022 and 2023



Note: Rest of Asia comprises India, Japan, the Republic of Korea and South-East Asia.

Note: Others compromises wind energy, heat pumps and electrolysers

Source: See endnote 229 for this module.

In the **United States**, the IRA began to have a marked impact on investment in 2023, including in manufacturing capacity. Between August 2022 and March 2023, major manufacturers of electric vehicles and batteries announced USD 52 billion in forthcoming investments.[230] In the **EU**, there were early signs of increased investment in manufacturing capacity thanks in part to the Net-Zero Industry Act of March 2023.[231] In **India**, the Production Linked Incentive entered its second phase in late 2022, increasing incentives for domestic manufacturing of solar PV modules to USD 2.4 billion, up from USD 600 million in the first phase.[232] **Australia, Canada** and the **Republic of Korea** also began offering public support for renewable energy technology and battery manufacturing during the year, which is expected to spur further investment.[233]

In the 2022 update to its National Determined Contribution (NDC)[i] under the Paris Agreement, Australia announced investments of up to USD 2 billion (AUD 3 billion) from the new National Reconstruction Fund to support renewables manufacturing and the deployment of low emission technologies – broadening Australia's industrial base, bolstering regional economic development and boosting private investment in abatement.[234]

The growth of manufacturing and deployment of renewables and other technologies related to the energy transition, also increased attention towards respecting human rights along these supply chains.[235] (→ *See Sidebar 1.*)

i The Paris Agreement requires each country to develop, submit, and update its Nationally Determined Contributions (NDCs), which outline their plans to reduce emissions and adapt to climate change impacts. NDCs reflect each nation's commitment to mitigating climate change.

SIDEBAR 1. Protecting Human Rights in the Energy Transition

The global shift to renewable energy presents significant opportunities for economic development and enhanced democratic governance. However, like any large-scale industrial activity, the renewable energy industry faces challenges in ensuring human rights protection across its value chain. From the extraction of the materials required for energy-related infrastructure such as copper or lithium, to the manufacturing and siting of renewable energy facilities, risks of human rights violations have emerged, including poor working conditions, child labour, forced displacement, and livelihood losses for local communities and especially Indigenous Peoples.

Decision makers in governments, international organisations and industry have increasingly taken action to address such risks. The "Guiding Principles on Business and Human Rights (UNGPs)" developed by the United Nations in 2011 provided an international framework for responsible business practices and addressing human rights violations in supply chains. In September 2024, the UN Secretary-General's Panel on Critical Energy Transition Minerals released a series of principles and actionable recommendations relating to equity, transparency, investment, sustainability and human rights targeting the mining sector and specifically related to the energy transition.

In 2022, the United States enacted a law that bans US companies from importing products containing polysilicon fabricated in Xinjiang, China unless they can prove that no forced labour was involved in the production process, in response to accusations of forced labour of companies located in this area. In 2024, the EU adopted its Corporate Sustainability Due Diligence Directive (CSDDD) mandating companies to take responsibility for ensuring that human rights are respected in their supply chains. In 2023, the Ministry of Labour and Social Affairs of Germany initiated the Branchendialog Energiewirtschaft, a multi-stakeholder body (comprising companies, non-governmental organisations, associations, and unions) aimed at supporting companies to identify and address human rights violations risks in value chains.

In 2022, Sierra Leone enacted legislation that formally integrates the principle of Free, Prior, and Informed Consent (FPIC) into national law. This principle guarantees that Indigenous Peoples and local communities have the right to approve or reject projects affecting their lands, ensuring that industrial developments do not proceed without the effective consent of those who are most impacted.

Non-governmental organisations have drawn attention to the importance of guaranteeing human rights along the value chain in the renewable energy sector. For example, the Business and Human Rights Resource Centre (BHRRC) produces its annual *Renewable Energy & Human Rights Benchmark* report on assessing the human rights practices of companies in the renewable energy value chain, as well as an *Investor Toolkit* that aims to guide investors in the energy sector on integrating human rights considerations into decision-making processes.

The renewable energy industry itself is taking steps to address these risks. The Solar Stewardship Initiative (SSI) has established a sustainability framework for solar PV products to ensure that they are sourced and produced in line with internationally recognised labour, environmental and human rights standards. The SSI launched an Environmental, Social and Governance (ESG) standard in 2023, and in 2024 it opened a traceability standard for public consultation.

The Hydropower Sustainability Standard looks at the environmental, social and governance performance of hydropower projects. In 2023, the first certification was awarded to Sebzor hydropower project in Tajikistan, and three other projects were also certified. Also that year, the Hydropower Sustainability Alliance became the multi-stakeholder, independent body that oversees the HS Certification System.

In 2023, the Global Battery Alliance launched a proof-of-concept of the "battery passport". When fully operational, the passport will consist of a digital document that tracks key data such as a battery's carbon footprint, material sourcing, production emissions, and compliance with labour and environmental standards.

In the mining sector, initiatives such as the multi-stakeholder organisation Responsible Mining Assurance (IRMA) play a crucial role in ensuring respect for human rights and environmental standards. In December 2023, during the UN Climate Change Conference in Dubai (COP 28), a variety of groups – including non-governmental organisations, industry players and multi-stakeholder organisations – co-signed a call to action for transparency in the renewable energy sector, including principles for good governance and respect for human rights.

Source: See endnote 235 for this module.

RENEWABLE ENERGY EMPLOYMENT

Employment in the renewable energy sector reached a new record of 16.2 million direct and indirect jobs in 2023, an increase from 13.7 million in 2022.[236] During the period 2019-2022, employment in the renewable energy sector grew roughly 15%, whereas jobs related to fossil fuels fell around 4%.[237]

By renewable energy technology, the number of employees in solar energy increased the fastest worldwide, rising a record 45% from 4.9 million in 2022 to 7.1 million in 2023.[238] This growth, led mainly by China (→ *see Figure 5*), resulted in the solar PV workforce being the largest among the renewable technologies in 2023, followed by liquid biofuels (2.8 million jobs) and hydropower (2.32 million).[239] Wind energy had the fourth largest number of employees among renewable energy technologies, at 1.46 million in 2023, but growth was very low compared to the previous year.[240]

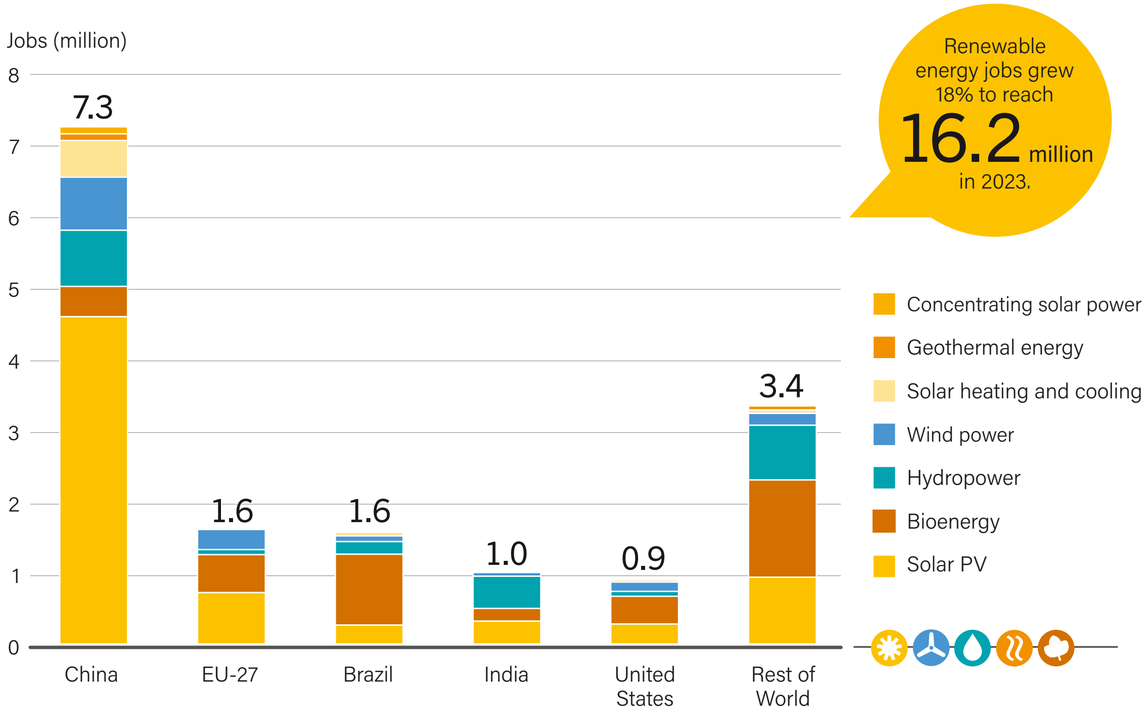
Regionally, Asia continued to host 65% of the renewable energy labour force in 2023.[241] China had by far the highest number of employees in the sector – rising from 5.6 million in 2022 to 7.3 million in 2023 – accounting for 45% of all jobs in renewables worldwide.[242] China's success in the sector and in building an integrated renewable energy supply chain is due mainly to the provision of infrastructure and to industrial policy, as well as low labour costs.[243] By region and technology, Asia was home to most of the jobs in solar PV (77%) in 2023, followed by Europe (10.7%) and the Americas (8.6%).[244] Asia also led in wind power employment (59%), followed by Europe (22%), the Americas (17.6%) and Africa and Oceania (1.4%).[245]

The increase in jobs in renewables also has been fostered by policy measures, as countries have increasingly adopted industrial policies to boost domestic job creation in the sector. In the **United States**, the IRA is estimated to have created in its first year around 100,000 renewable energy jobs across the country, 60% of them in the renewables manufacturing sector.[246] The **EU**'s Net-Zero Industry Act, proposed as part of the European Green Deal, will likely boost renewable energy employment in the region by fostering a sustainable industrial base and prioritising local production.[247] In **Australia,** the Queensland Energy and Jobs Plan was updated in 2023 to include new training centres for workers in government-owned power plants and allocates USD 100 million (AUD 150 million) for Job Security Guarantee.[248]

To ensure not only the quantity but also the quality of renewable energy jobs, targeted policies, as well as engagement with communities and labour unions, are required.[249] The quality of jobs includes ensuring adequate salaries, high standards of occupational safety and health, protection of workers' rights, provision of social protection, and permanent rather than temporary jobs.[250]

So far, policies for employment in the energy sector have tended to be **gender blind**.[251] In 2021 (latest data available), 32% of employees in the renewable energy sector were women, with a higher share of 40% in the solar industry.[252] As of January 2023, women held 11% of ministerial roles in energy sectors across 190 countries.[253] Additionally, there is a gender pay gap in the energy sector, with women's salaries 20% lower than those of men in the same position.[254] Given these numbers, gender-specific challenges in the energy field persist.[255]

FIGURE 5.
Global Renewable Energy Employment, by Technology and Region, 2023



Source: See endnote 239 for this module.

Against this backdrop, in 2023 some governments were offering **equality and diversity programmes.** The US Department of Energy launched the 2023 Equity Action Plan for advancing equity and equal opportunities for all in the energy sector.[256] The US Agency for International Development also launched an initiative on "Growing Green Jobs for Women" in the energy sector in Nigeria.[257] In Africa, the Women for Green Jobs Platform supports job placement for women in Ethiopia, Kenya, Malawi, Nigeria, Sierra Leone and Uganda.[258] Also during the year, South Africa put in place a nine-month training programme, the Management Development Program for Women in Renewable Energy.[259]

Education and Reskilling

In general, growth in renewable energy demand has been faster than the growth in the skilled labour force in sectors relevant to the energy transition, such as manufacturing, installation, and scientific and technical activities, as well as in reskilling options for workers in fossil fuel industries who may lose their jobs. A growing global shortage of qualified labour was already apparent in the renewables sector between 2010 and 2023.[260] Subsequently, some companies in the sector have suffered from a labour shortage, particularly during the construction and manufacturing phases.[261] Many renewable energy projects rely heavily on construction personnel, such as for the installation of solar panels.[262]

It is expected that more than half of the job losses associated with fossil fuels between 2022 and 2030 could be transferred to other sectors through retraining and qualification.[263] For some professions, it may be relatively easy to reskill a person working in the fossil fuel sector for a job in the renewable energy field.[264] However, in some segments, such as coal mining, it is more challenging to reskill workers for a renewable energy job.[265] Moreover, new employment opportunities in renewable energy will not necessarily be in the same locations as fossil fuel jobs. Therefore, those who gain jobs in the renewables sector will often not be the same ones who lose their positions in the fossil fuel sector.

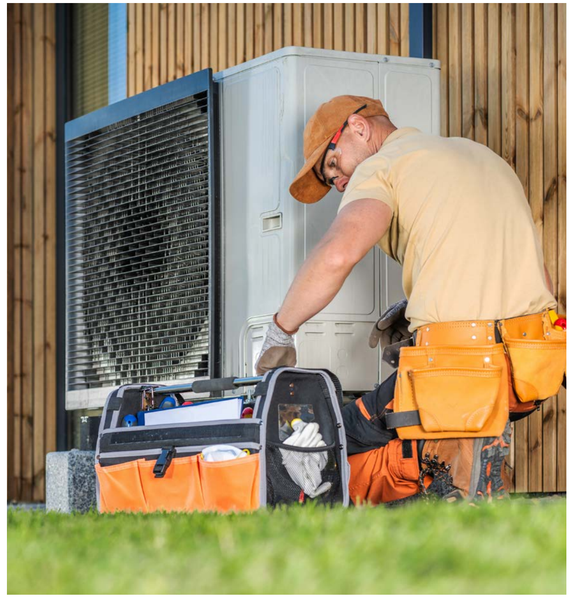
To address the needs of the workforce shift for the energy transition, a variety of governments, businesses, industry associations and other stakeholders have initiated educational and skills training programmes.[266]

In 2023, the EU took strong steps in key energy industries such as wind energy, batteries and heat pumps.[267] As part of the proposed Net-Zero Industry Act, the EU is setting up Net-Zero Academies for reskilling and upskilling selected industries, including the renewable energy sector.[268] In early 2024, the European Commission also developed an action plan for mitigating skills shortages among 42 sectors of the economy, including energy-related jobs (electrical engineers, electrical engineering technicians, building and related electricians, electrical mechanics and fitters, environmental engineers) in energy-related sectors (energy industries including batteries, heat pumps and wind power).[269]

India has initiated exchange programmes with the **United States** and other countries to tailor training curricula for its domestic renewable energy industry workforce.[270] The **Australian** government is also building a renewable energy workforce; this includes convening a Jobs and Skills Summit and commissioning Jobs and Skills Australia to conduct a capacity study of the workforce needed for a renewable energy transition.[271] In addition to governments, some companies have sought to (re)train workers to qualify them for jobs in the renewable energy sector.[272] (→ *See Snapshot: South Africa.*)

The **United Kingdom** announced USD 6.54 million (GBP 5 million) in Heat Training Grants to support training in low-carbon heating, which are expected to support around 10,000 training opportunities in England for technicians to become certified heat pump installers.[273] During the period from April 2023 to March 2025, the grants will help to deliver accredited skills training and support to installers across the energy efficiency and heat pump sectors.[274]

Within higher education, the proportion of degree programmes focused on renewable energy at public universities rose from 16% in 1999 to 34% in 2019 (and at private universities to 39%); however, there is still a large imbalance compared to fossil fuel-focused training: in 2019, 68% of energy degrees focused on fossil fuels, while only 32% concentrated on renewables.[275] To address this issue, **Cameroon** set up renewable energy departments at 11 state universities in 2023, aiming to generate jobs and accelerate the realisation of the Sustainable Development Goals.[276]



SNAPSHOT SOUTH AFRICA

TRANSFORMING KOMATI COAL POWER PLANT INTO A RENEWABLE ENERGY HUB

At the end of 2022, the Komati coal-fired power plant in Mpumalanga, South Africa, was shut down after decades of operation. The owner company Eskom has developed a Just Energy Transition (JET) Strategy to achieve both converting the power station to run on renewable energy and doing so in a just manner. The plan is to have a renewable power generation site supplied with 150 MW of solar PV power, 70 MW of wind power and 150 MW of battery storage capacity.

To facilitate the transition project, the World Bank approved a concessional loan of USD 497 million, which is divided into three areas: USD 33.5 million for decommissioning the power plant;
USD 416 million for repurposing with solar, wind, batteries and a synchronous condenser; and
USD 47.5 million for minimising adverse socio-economic impacts due to the shutdown and creating new opportunities for the community.

Prior to the closure, Eskom conducted a socio-economic impact study and engaged with employees, labour unions, and the community, but it has been criticised for engaging in this process at a very late stage of advancement of the project.

A training facility has been set up with the aim of reskilling and upskilling Eskom employees as well as members of the community with the necessary knowledge in the field of renewable energy.

The Komati training facility intends to create employment opportunities for workers in the coal mining industry and for young people living in the coal mining areas. The training facility was developed in co-operation with the Global Energy Alliance for People and Planet (GEAPP) and the South African Renewable Energy Technology Centre (SARETEC). As part of the Cape Peninsula University of Technology, SARETEC is the first national technology centre for renewable energy in South Africa and supports the energy transition with specialised and accredited training. However, progress on the project has been hampered by delays in funding since the decommissioning.

Source: See endnote 272 for this module.

© PAUL BOTES| gettyimages

LOCAL OWNERSHIP AND ENERGY DEMOCRACY

Renewable energy allows for decentralised deployment and local ownership and therefore has the potential to democratise how energy is consumed and produced.[277] In contrast to centralised, dispatchable fossil-fuelled power plants, renewables can be more localised and decentralised.[278]

The transition to renewable energy can incentivise a more participatory model of energy governance, reinforced by the growing number of citizen renewable energy initiatives or energy communities.[279] The increasing number of these renewable energy initiatives has led to rising prosumerism[i] and a diverse ownership structure, as seen in Germany, where private individuals owned around 30% of the total renewable energy capacity in 2019.[280] (→ *See Snapshot: Germany.*)

Even though community energy faces challenges regarding competition in a profit-driven energy market, mostly with bigger energy companies, renewables play an important role in the democratisation of the energy system.[281] Supportive policies, community energy supporting networks and financing schemes are key enablers for a transition to a renewables-based decentralised and democratic energy system.[282] (→ *See Snapshot: France.*)

In Germany, private individuals owned around

30%

of the total renewable energy capacity in 2019.

i Prosumerism is a model where an entity both produces and consumes energy. This allows them to participate in energy trading by selling any excess energy they generate and purchasing additional energy from the grid when needed.

SNAPSHOT GERMANY

OWNERSHIP STRUCTURE OF RENEWABLE ENERGY CAPACITY

The expansion of renewable energy in Germany over the past decade has led to a dynamic and diverse ownership structure, with private individuals maintaining a significant share of installed capacity despite the growing involvement of larger investors and energy supply companies.

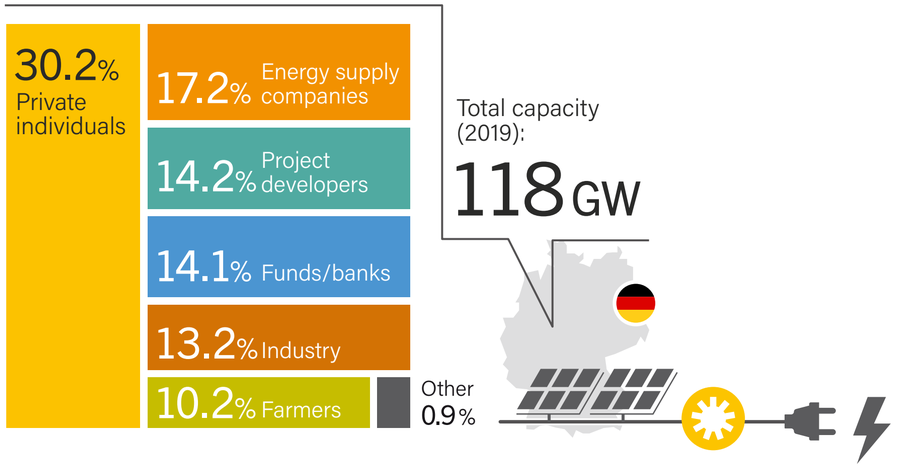
As of 2019, private individuals owned 30.2% of all renewable energy installed capacity in the country, making them the largest ownership group. (→ *See Figure 6.*) This group includes both individuals and households with small-scale installations, such as rooftop solar panels, as well as members of energy co-operatives, where several private owners pool resources to invest in larger projects. Despite a gradual decline in their overall share over the past decade, private individuals continue to dominate, particularly in solar PV, where they are the primary owners.

Meanwhile, other ownership groups, such as funds/banks (14.1% in 2019) and energy supply companies (17.2%), have increased their share, especially in large-scale projects such as offshore wind power and utility-scale solar installations. Farmers owned 10.2%, of the total installed renewable energy capacity in 2019, maintaining a consistent presence in recent years, and industry actors owned around 13%.

The ownership structure in Germany varies considerably by renewable energy technology. Solar PV has the most diverse ownership, with private individuals (the largest group) accounting for more than 30% of the capacity in 2019, and significant investments driven by subsidies. In onshore wind, the share of private ownership has fallen nearly 10%, while energy supply companies have expanded their stake, growing their wind energy portfolios. Ownership of offshore wind power has fluctuated, with funds and banks dominating in 2014 but energy supply companies regaining shares in 2015. In biogas, farmers have been the dominant owners since 2004, with a share of nearly 75% in 2019, due largely to the use of agricultural byproducts as input materials. Hydropower remains highly centralised, with large energy supply companies owning more than half, whereas private individuals held just around 6% of the total capacity in 2019.

The large ownership of renewable energy by private individuals, even as bigger companies increase their stakes, highlights the shift towards a more decentralised energy system compared to the historically centralised fossil fuel model.

FIGURE 6.
Ownership Structure of Renewable Energy Installed Capacity in Germany, by Ownership Group, 2019 (Without Pumped Storage)



Note: Private indivudals refer to individuals and households with small-scale installations as well as members of energy co-operatives, where several private individuals collectively own a renewable energy installation.

Energy supply companies include regional and national public and private supply companies. Project developers include companies primarily engaged in the development, operation and sale of renewable energy projects. A clear categorisation is not possible for all companies, as some operate across multiple areas.

Source: See endnote 280 for this module.

COMMUNITY ENERGY

Community energy refers to energy projects that are initiated, owned or operated by a local community for the benefit of the community. Projects typically involve renewable energy sources such as solar, wind, and biomass, and aim to increase local energy resilience, reduce carbon footprints and provide economic benefits to the community.[283] Community energy projects have gained attention due to their social and economic benefits, beyond the environmental ones, ranging from creating local jobs and social cohesion to increasing energy literacy, improving efficiency, reducing energy costs and tackling energy poverty.[284] Engagement in community energy projects is also recognised as increasing community support for renewable energy initiatives, helping to accelerate the energy transition.[285]

Within the community energy movement, energy communities are legal entities (usually co-operative organisations) where citizens, local authorities and/or businesses come together to produce, distribute, share or manage energy. They are defined and supported under legal frameworks such as the **EU**'s Clean Energy Package.[286]

In 2023, several countries and organisations in the EU advanced frameworks, funding and support tools for energy communities, including a guidebook for guiding communities towards inclusivity[i].[287] **Italy,** through its Energy Agency (GSE) published rules for operating energy communities as well as incentives, including a provision for integrating already-deployed solar PV systems into the incentive scheme.[288] Wales launched a publicly owned energy company focused on supporting renewable energy communities through grants.[289] **Albania** adopted a new law on the promotion of the use of renewable energy that includes simplified procedures for energy communities, as well as provisions to organise renewable energy communities as legal entities.[290] **Denmark** allocated a USD 620,000 (DKK 4.2 million) grant to nine local energy communities.[291] **Greece** unlocked USD 46 million (EUR 42 million) for the development of local energy communities operating through net metering or virtual net metering.[292]

In addition, crowdfunding platforms have emerged in some European countries to help match interested individual investors with potential community project owners.[293] For example, WeShareSolar in **the Netherlands** provides access to financing and manages administrative tasks, while also working together with banks and ultimately reducing the cost of capital for rooftop solar projects.[294] Citizen-led co-operative initiatives, such as the financial vehicles of Energie Samen in the Netherlands and Energie Partagée Investissement in France, are also active to mobilise funding.[295]

The continuous growth of the European association of citizen energy co-operatives, REScoop.eu, shows the increasing importance of citizen-owned and co-operative renewable energy entities in the region.

Under the REScoop.eu definition, energy co-operatives are characterised by a co-operative governance structure (one member, one vote regardless of the number of shares owned) and a non-profit business model (benefits are reinvested and dividends are capped). In 2023, the network consisted of 2,500 European energy co-operatives encompassing 2 million citizens.[296]

In **Brazil,** the "community solar" project (through co-operatives) of the energy organisation RevoluSolar provides an example of how an energy community approach can benefit the entire community.[297] The initiative started by equipping 30 families in the Brazilian favela Babilônia with access to renewable energy, who decided to invest the profits generated in training and local job creation, leading to better living conditions and protection from rising energy prices.[298] In Belgium, 34 energy co-operatives joined forces in 2022 to form "Seacoop", based on the concept of acquiring a 20% share of new offshore wind parks in **Belgium** and then supplying 20% of the electricity generated to households and small and medium-sized enterprises in the country via co-operative suppliers.[299]

In the **United States,** a majority of states (41 plus the District of Columbia) had at least one community solar project by 2022, with New York, Minnesota and Massachusetts leading in installed capacity.[300] These states have public incentives in place for community solar, but also have utility support that helps facilitate individual participation in community projects.[301]

In **Australia,** public funds support the development of community solar: USD 66.6 million (AUD 100 million) has been allocated into community solar banks across the various Australian states.[302] The 2023 budget includes incentives under the Powering Australia plan aimed at making renewables cheaper to Australian homes and businesses. Examples include USD 224.3 million for the Community Batteries for Household Solar grants programme to deploy 400 community-scale batteries for up to 100,000 households; USD 102.2 million for Community Solar Banks for 25,000 Australians living in apartments, rentals and low-income households; and USD 83.8 million to develop and deploy First Nations Community Microgrid projects.[303]

Community ownership also can benefit Indigenous communities.[304] (→ *See Snapshot: Canada.*)

i The guidebook describes inclusion as "when all people are valued and able to participate and contribute to their fullest without any discrimination based on their gender, sexual orientation, social class, political beliefs, race, ethnicity, nationality, religion, age, and / or disability." It further states: "Inclusion is about ensuring that diversity of knowledge, perspectives, information, and ideas are welcomed and being used. What's more, inclusion is focused on fostering the structure, system, processes, culture, behaviour, and mindset that embrace and respect all people in all their diversity."

SNAPSHOT FRANCE

CO-OPERATIVE FUNDING FOR CITIZEN ENERGY

Energie Partagée Investissement (EPI) is a French co-operative investment fund specifically targeting citizen-led renewable energy projects. EPI operates under the umbrella of Energie Partagée, an organisation that brings together projects and stakeholders of the community energy movement in France.

Energie Partagée was founded in 2010 with the mission of empowering local communities to play a central role in the transition to renewables (through both renewable energy generation and energy efficiency projects) and raising awareness about energy consumption reduction. Over time, the organisation has evolved into a national network and several regional networks supporting community-led renewable energy initiatives across France. Sharing resources and tools, and organising workshops and events for knowledge exchange, the network builds local capacity and provides support on the regulatory, technical and financial aspects of initiating and piloting renewable energy projects.

Through the label "citizen project", Energie Partagée awards renewable energy projects that belong to local communities and create benefits for the community. The label is awarded to projects that fulfil specific criteria, organised along five axes: strong presence of local public and private players; use of local skills and mobilisation of the local community; shared governance and transparent decision-making processes; environmental protection; and the mobilisation of ethical and socially responsible finance.

More broadly, citizens' projects as envisioned by Energie Partagée strive to raise environmental awareness, help citizens to reduce energy consumption, contribute to fighting energy poverty and engage citizens to discuss and drive the energy transition. As of 2024, the network counted 372 projects, involving more than 32,000 citizen-shareholders and producing around 1.5 terawatt-hours per year of wind power, solar PV, geothermal energy, biomass and biogas.

The co-operative investment fund EPI raises funds from individuals who purchase shares in the fund (at a price of USD 135 or EUR 123) and invests in renewable energy projects labelled as citizen projects. While the fund has historically focused on investing at the construction phase to minimise risks, it is increasingly also investing at earlier stages, providing project developers with the necessary funding to cover upfront costs such as feasibility studies and permitting processes.

The governance of the fund includes the shareholders as well as a directory board composed of the cooperative energy producer and provider Enercoop, the co-operative bank La Nef, and a consulting company working on sustainable development.

As of June 2024, EPI had financed more than 135 citizen-led projects, for a total of USD 44 million (EUR 40 million), of which around USD 11 (EUR 10 million) was invested in 2023. Projects are financed in the form of equity. Until 2017, as the first projects financed were slowly starting their operations, no dividends were yet distributed to EPI shareholders. From 2017, the price of the share started increasing every year (from an initial EUR 100), and since 2023 investors started to receive dividends as well.

While the fund aims to provide benefits of around 4% yearly, citizens who invest their savings in EPI are usually committed to the purpose of the fund, which extends beyond the immediate return on investment (for instance, with shares being offered to children by their grandparents). Data from the organisation suggest that local economic benefits are 2.5 times higher when renewable energy projects are owned by energy communities as compared to traditional economic actors, and that people engaged in the community energy movement reduce their energy consumption around 20% in average.

Challenges remain to unlock the full potential of citizen projects. Energy communities are typically small local initiatives, while funding needs for energy projects are huge, and administrative and technical requirements for access to finance and permitting processes are tailored for bigger industry players. Supporting structures such as Energie Partagée can help greatly in developing citizen-led energy initiatives, but they also require funding and political support to build local capacities.

Source: See endnote 282 for this module.

SNAPSHOT CANADA

ADVANCING INDIGENOUS LEADERSHIP IN RENEWABLE ENERGY

Canada is a global leader in renewable electricity generation, with a continuous increase in renewable energy projects, many of which are situated on traditional Indigenous territories or reserve lands. The non-profit organisation Indigenous Clean Energy (ICE) is dedicated to advancing Indigenous-led capacity building and collective action in Canada's energy transition. By promoting energy efficiency initiatives, youth training and mentorship programmes, ICE empowers Indigenous communities, which make up 5% of Canada's total population, to take a leading role in the country's renewable energy development.

In 2022, nearly 20% of Canada's electricity-generating infrastructure involved partnerships or benefits, and thus economic participation, for Indigenous Peoples, with the majority of this infrastructure focused on renewable energy production. This corresponds to around 600 renewable energy projects with Indigenous participation, including off-grid community projects, while half of them have a capacity of over 1 MW. Projects include hydro, wind, solar, and bioenergy, and the average Indigenous ownership share is around 50%.

The growing involvement of Indigenous Peoples in renewables in Canada is due in large part to sufficient financing and adjustments in the national and provincial legal and political framework. Many Indigenous-led renewable energy projects benefit from federal grants that enable smaller projects to make it through pre-construction stages.

Policy changes at the provincial level, such as through Ontario's Green Energy Act, have incentivised Indigenous participation by defining a minimum threshold for Indigenous involvement and embedding this in procurement processes. The Alberta region in western Canada has deregulated power purchase agreements, which has enabled Indigenous communities to own and operate power generation facilities. Indigenous participation in renewable projects is legally mandated in Canada, meaning that proceeding with projects on Indigenous land without the involvement of communities poses significant legal risks for utilities, potentially leading to legal challenges, project delays and reputational risks. Based on this legal and policy framework, Indigenous leaders engage in negotiations with utility companies and developers to ensure that their communities are not only participants but also operators and beneficiaries of renewable energy projects.

On an international level, the United Nations Declaration on the Rights of Indigenous Peoples, adopted by the UN General Assembly in 2007, affirms key principles such as **free, prior** and **informed consent** to mitigate any breaches of rights to Indigenous property, land, resources and self-determination.

Indigenous ownership and involvement in renewable energy projects empower Indigenous Peoples to promote economic development. At the same time, it can enhance leadership skills, self-sufficiency and business capabilities in communities usually lacking such opportunities and where suicide rates tend to be around three times higher than among non-Indigenous people. ICE asserts that merely receiving shares and benefits from renewable energy projects does not equate to actively managing a project and engaging fully in the economy.

ICE's capacity building programmes play a crucial role in advancing economic development. The 20/20 Catalyst Program equips Indigenous leaders with the skills needed to champion renewable energy projects. The recent Off-Diesel Initiative supports communities transitioning from diesel dependency to renewable solutions. ICE's Bringing It Home initiative helps scale energy efficiency projects through hands-on training, while the Generation Power programme encourages Indigenous youth to explore careers in renewables. The ImaGENation initiative supports young leaders by providing resources to renewable energy projects rooted in their cultural identities.

The success stories emerging in Canada exemplify the potential for renewable energy to drive community empowerment and economic development. The Oneida Energy storage project is a 250 MW battery storage initiative that will be the largest in Canada and has been developed by the Six Nations of the Grand River Development Corporation together with a Canadian energy storage company. The project aims to enhance the reliability and affordability of the province's renewable electricity grid by storing energy during low-demand periods for use during peak times. The Metalake biofuel facility in northern Saskatchewan, 100% owned and led by the Meadow Lake Tribal Council, exemplifies a successful Indigenous-led initiative that uses a beehive system bioenergy model to produce renewable energy. It enables economic benefits for local agricultural producers through power purchase agreements while promoting sustainable practices in the region.

As Canada continues to develop its renewable energy sector, the experiences from ICE, along with the country's current national and provincial legal and regulatory frameworks, can inform the policies globally that strengthen Indigenous leadership and participation in renewable energy projects.

Source: See endnote 304 for this module.

FEATURE: RENEWABLE ENERGY FOR CLIMATE ADAPTATION AND RESILIENCE

To tackle the climate crisis, **mitigation and adaptation** efforts must go hand in hand. The shift to renewables is not only a key strategy for mitigating climate change by greatly reducing emissions, but also presents opportunities to enhance both climate change adaptation[i] and **resilience**[ii].[305] Renewable energy supports both adaptation and resilience in various ways. (→ *See Table 1.*) In nearly all settings where they are deployed, renewables offer mitigation-adaptation synergies, as they can power energy-intensive climate adaptation solutions, such as air conditioning, desalination and irrigation, without compromising their mitigation strategies.[306]

Given the potential of renewables for distributed and decentralised energy solutions, they can provide remote communities with consistent energy supply during extreme weather events and natural disasters.[307] This is key for maintaining critical infrastructure and preventing disruptions to vital services, allowing communities to decrease their vulnerability to climate change risks and build self-reliance.[308] Many remote communities still rely on small-scale fossil fuel systems that are vulnerable to extreme weather events.[309] For example, around 200 remote Indigenous communities in Canada use diesel as their main source of heating and power, which exposes these communities to volatile fuel prices and high costs of transporting the fuel by barge, plane or ice road.[310]

Natural disasters such as floods can impair conventional power, water and other resources.[311] Off-grid solutions – including solar water pumps, solar lighting, solar-powered communication devices, irrigation and cooling systems – can enhance climate resilience by ensuring reliable energy and supporting critical services such as cooling in healthcare facilities during outages.[312] (→ *See Table 1.*) Already, distributed off-grid solar technologies have provided power to millions of homes and businesses in climate-vulnerable regions across sub-Saharan Africa, South Asia and South-East Asia.[313] In Bangladesh, 2,226 solar irrigation systems have been installed around the country.[314]

i Adaptation involves making adjustments in ecological, social or economic systems in response to current or expected effects of climate change.

ii Resilience refers to the ability to withstand, anticipate, respond to and recover from the impacts of long-term and immediate extreme climate events while minimising harm to societal well-being, the economy and the environment.

Off-grid solutions do not depend on long-distance transmission lines or infrastructure, making them more resilient to extreme weather events such as floods, high winds and cyclones.[315] They are also less prone to blackouts during heatwaves and remain unaffected by shifts in rainfall patterns, unlike large-scale hydropower, which can be vulnerable during droughts.[316] Moreover, with no reliance on fuel supply chains, off-grid solutions can maintain power to critical services even if fuel transport is interrupted or prices spike during crises.[317] The compact and distributed design of products such as solar energy kits and irrigation systems enables them to be easily relocated if extreme climate events result in forced migration.[318]

The potential of distributed and decentralised renewables also becomes evident when looking at grids. Traditional electricity grids are vulnerable to natural disasters due to their centralised nature and reliance on extensive infrastructure, which can lead to widespread blackouts.[319] Against this background, renewable energy-powered mini-grids and microgrids offer significant community and environmental benefits, not only in remote areas but also in urban contexts that are increasingly impacted by the effects of climate change.[320] Even if connected to a central grid, mini-grids and microgrids can be "islanded" to operate independently from large transmission and distribution lines in case of extreme weather events.[321]

The Peruvian non-governmental organisation EcoSwell, which develops participatory renewable energy projects for local vulnerable communities, installed a solar PV-based micro-grid at a local medical centre in Talara, providing an uninterrupted power supply.[322] Other projects included building a 13 kW solar and wind-based hybrid micro-grid for a community of 40 families in Nazca in southern Peru, residential energy consultations and PV system installations, and a solar distiller to overcome critical water scarcity.[323] In Boston, United States, where sea levels have risen more than 20 centimetres since 1950, neighbourhood organisations have developed distributed microgrids.[324] This has allowed communities to foster self-sufficiency and address the challenges of rising sea levels and flooding.[325] However, the initiative faces obstacles due to a lack of financing and a monopolised utility system.[326]

TABLE 1.
Renewable Energy Solutions for Climate Change Adaptation and Resilience

Climate change impacts	Associated risks	Adaptation potential of renewable energy solutions
Increase in drought and floods	Water shortage	Solar-powered desalination
		Renewables-powered pumping system
	Degraded water quality	Renewable energy-based water purification and sanitation systems
		Floating photovoltaics to reduce evaporation
	Limited water supply for agricultural use	Renewables-powered irrigation systems
Rising temperatures	Increase in heat-related diseases	Renewables-based cooling and cold-chain systems for housing and healthcare facilities
	Food loss	Agrivoltaics for electricity production and farming providing overhead protection and shade
	Stable freshwater supply	Renewables-powered irrigation systems
Extreme weather events (e.g., storms)	Forced displacement	Decentralised off-grid electricity generation in disaster-hit regions and beyond
	Health risks	Renewables-powered early warning systems
		Renewables-powered emergency services and healthcare facilities
	Energy supply disruption	Renewables-powered mini- and microgrids for electricity supply, including in remote communities
	Communication service disruption	Solar-powered portable chargers to keep communication devices operational
Sea-level rise	Flooding and coastal erosion	Renewables-powered water pumps to manage water levels
		Hydropower plants and reservoirs for flood prevention
	Saltwater intrusion	Renewables-powered purification and wastewater systems

Note: This table highlights general concepts. Adaptation needs are diverse and context-dependent, and renewable energy solutions must be tailored to local needs.

Source: Adapted from IRENA, 2021. See endnote 312 for this module.

Renewable energy infrastructure can further enhance climate change adaptation and resilience by simultaneously leveraging a diverse range of renewable energy sources and technologies, such as wind, solar and geothermal energy.[327] This can help safeguard against potential disruptions from climate impacts, ensuring reliable energy access.[328]

While producing energy, resilient renewables infrastructure can also deliver multiple non-energy services, strengthening adaptation and resilience beyond energy supply and optimising resource use.[329] For instance, agrivoltaics offer shade and protection from the sun and therefore allow land to be used not only for energy generation but also for more resilient food production.[330] This enhances food security while reducing water evaporation.[331] By-products from biogas facilities can be repurposed to create organic fertiliser, contributing to sustainable agriculture.[332] Additionally, water harvesting from hydropower dams offers a dual benefit by providing both renewable energy and an essential water supply, which is particularly valuable in regions facing water scarcity.[333]

As of mid-2024,

50

countries

recognised renewables as an adaptation measure in their NDCs.

ENABLING FRAMEWORK FOR RENEWABLES-BASED CLIMATE ADAPTATION AND RESILIENCE

Systematically integrating renewables into well-designed adaptation policy instruments allows for supporting both emission reductions and climate resilience. As of mid-2024, 50 countries had recognised renewables as an adaptation measure in their Nationally Determined Contributions[i].[334]

Only 3 countries in Europe referred to the adaptation benefits of renewables in their NDCs, 4 in the Caribbean, 3 in Latin America, 8 in Asia, and 4 in Oceania, while 19 out of the 50 countries referring to renewables for adaptation in their NDCs were in Africa.[335] Nine of the countries that included renewables-based solutions as adaptation strategies were in the Middle East, where most of the identified targets and mentions refer to renewables-based solutions to climate-induced drought and water scarcity, such as solar-powered desalination.[336] As countries prepare for a new round of updates in 2025, leading up to COP 30, this presents an opportunity for countries to reassess their adaptation strategies and incorporate renewable energy solutions to strengthen climate resilience.[337]

Of the 50 countries that considered renewables' potential for climate adaptation in their NDCs, 24% were small island developing states in the Caribbean, the Pacific, the Atlantic and the Indian Ocean. SIDS are highly vulnerable to climate change due to their limited land area, reliance on marine resources, remote geography and fragile ecosystems, exacerbating their exposure to rising sea levels and extreme weather events.[338]

Antigua and Barbuda has announced that all homes built after 2025 must have back-up renewable energy generation and storage systems to foster climate adaptation and enable a climate-resilient development pathway.[339] By 2030, the island country aims to power 100% of both its water supply infrastructure and its health and emergency shelter facilities using grid-interactive renewable sources.[340] **Micronesia** aims to power all its water solutions with 100% renewable energy and to strengthen the resilience of its energy system through domestically produced renewables, safeguarding against climate change-induced disruption of global supply chains.[341] As part of **Dominica**'s NDC, the government has announced to establish community off-grid mini-grid and microgrid renewables-based power supply systems in vulnerable coastal communities that are periodically without electricity due to storms and hurricanes.[342] The Pacific Islands' Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP) promotes renewable energy in small Pacific islands, enhancing energy security and reducing dependence on imported fossil fuels vulnerable to supply chain disruptions.[343]

i Nationally Determined Contributions (NDCs) are climate action plans submitted by countries every five years under the Paris Agreement, outlining their commitments to reduce greenhouse gas emissions and adapt to the impacts of climate change. The data presented here draws from both the NDC 2021 updates and the original 2016 versions, as some countries had not yet made revisions as of mid-2024.

A number of African countries have committed to concrete renewables-based adaptation measures. In its updated NDC from 2023, **Egypt** outlined plans for renewables-powered desalination to produce 4 million cubic metres of water daily, benefiting 33 million people.[344] **South Africa**'s Renewable Energy Independent Power Producer Procurement Program (REIPPPP) has integrated solar and wind energy, enhanced rural electrification, and reduced reliance on coal, which mitigates risks from extreme weather events affecting coal supply chains.[345] **Ghana** plans to increase the use of renewable energy to back the strengthening and full-scale deployment of both its disease surveillance systems as well as climate early warning systems.[346] **Uganda** aims to rehabilitate climate-proof electricity transmission infrastructure through renewable off-grid energy solutions.[347] **Ethiopia**'s Climate-Resilient Green Economy (CRGE) strategy has integrated hydropower, geothermal and wind energy, reducing dependence on climate-sensitive biomass and ensuring a more secure energy future.[348]

Canada has launched three initiatives: the Clean Energy for Rural and Remote Communities programme, the Indigenous Off-diesel Initiative, and the Northern Responsible Energy Approach for Community Heat and Electricity programme.[349] Together, these efforts support renewable energy and capacity building projects in over 160 communities across the country, aiming to strengthen climate resilience and energy independence by promoting low-carbon solutions driven by the communities themselves.[350]

In the **Philippines**, solar microgrids have been deployed in island and coastal areas to ensure continuous power during typhoons, reducing dependence on fossil fuels and aiding faster post-disaster recovery.[351]

While renewable energy infrastructure allows for various adaptation benefits, it is not immune to climate change impacts, such as extreme weather conditions.[352] Accounting for climate resilience and fostering the ability of renewable energy infrastructure to anticipate, absorb, accommodate and recover from the effects of a potentially hazardous climatic event is therefore critical.[353] Climate vulnerability and resilience assessments are needed at different stages of renewable energy infrastructure planning, including at the design, siting and infrastructure development stages.[354] As of 2021, around a quarter of the member countries and associate members of the International Energy Agency did not have a national climate or energy plan aimed at enhancing the climate resilience of energy systems.[355]

Overall, the potential of renewables for supporting climate adaptation and resilience is still scarcely recognised in policy making, despite a number of countries adopting concrete measures and plans in recent years.[356] The effectiveness of policies on renewables-based adaptation, set out in NDCs and beyond, remains under-researched. Moreover, research on similar policies introduced at the local level is lacking. Consolidated, up-to-date data on the role of renewables in enhancing adaptation and resilience is essential, not only regarding climate resilience but also in the context of peace and conflict and community resilience more broadly.[357] (→ *See Box 3.*)

In climate adaptation finance, renewables are increasingly being considered as a solution for adaptation and resilience, although support is minute compared to mitigation projects. In 2022, development finance for projects focused on climate change adaptation through renewable energy was around USD 126 million, supporting, for example, solar energy for isolated grids and stand-alone systems.[358] (→ *See Sidebar 2.*)

BOX 3. Renewable Energy for Lasting Peace and Resilience

Limited energy access is often a significant challenge in fragile and conflict-affected states (FCAS), impeding development and hindering recovery. Renewable energy has the potential to foster lasting peace and resilience by expanding energy access, promoting economic stability and enhancing social cohesion, particularly in FCAS. Access to reliable energy sources can improve community safety and empower local economies, reducing tensions arising from resource scarcity, displacement and competition over natural resources exacerbated by climate change.

Energy Peace Partners (EPP) researches the peacebuilding impact of renewable energy and has identified a positive and statistically significant correlation between access to electricity and peace. Their research also indicates that increased access to electricity leads to lower future conflict levels in FCAS. In line with these findings, EPP has developed an impact management system to track and measure the peace benefits of renewable energy projects. Thorough data collection and research are crucial to inform potential investors and project developers about the benefits of renewable energy solutions beyond environmental considerations.

Source: See endnote 357 for this module.

SIDEBAR 2. Climate-related Development Finance and Renewables

In 2022, 32.9% of allocable bilateral Official Development Assistance (ODA) globally had climate-related objectives. This was a significantly higher share than for energy finance, where more than 80% of ODA was climate-related. Climate-related development finance commitments for renewable energy reached USD 9.5 billion in 2022, representing 7% of total climate-related assistance. Mitigation-related projects for renewables received USD 8.1 billion, while adaptation-only projects received USD 126 million, with projects targeting both objectives amounting to USD 1.2 billion. Regionally, most renewable energy projects were in Africa (327 projects), followed by Asia (287 projects).

Mitigation was the principal objective of 65% of the renewable energy projects, and was a significant objective in an additional 29% of the projects. **Adaptation**, on the other hand, was the principal objective in 7% of the projects and a significant objective in another 28%.

Regarding flow types, finance flows linked to mitigation came 50% in the form of grants, with 45% of the funds being channelled through debt instruments and 5% as equity. In contrast, adaptation-related finance was largely funded on a grant basis (78.5%) , debt instruments (12.7%) and through equity and shares (8.9%).

Adaptation finance programmes have begun to also support renewable energy infrastructure. The largest project in 2022 was the EU-funded Energy Plus: Energy for Climate Resilience' initiative in **Pakistan**, with USD 34 million (EUR 31 million) supporting the development of resilient hydropower facilities and fostering adaptation through integrated planning (including energy and biodiversity management).

The Africa Adaptation Acceleration Program (AAAP), a joint initiative of the African Development Bank and the Global Center on Adaptation (GCA), aims to mobilise USD 25 billion by 2025 to enhance climate adaptation across Africa. The programme focuses on closing the adaptation finance gap and supports initiatives in climate-smart agriculture, infrastructure resilience, including renewable energy infrastructure and innovative financial instruments.

Source: See endnote 358 for this module.

ENDNOTES | ECONOMIC AND SOCIAL VALUE CREATION

1 International Energy Agency *et al.*, "Tracking SDG 7: The Energy Progress Report", 2024, https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2024.

2 International Energy Agency *et al.*, "Tracking SDG 7: The Energy Progress Report", 2024, https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2024.

3 Energy Sector Management Assistance Program, "Expanding Mini-grids for Economic Growth", 2022, https://www.esmap.org/sites/default/files/2022/MG%20Kenya%202023/booklet%2025%20feb%20rev.pdf.

4 Energy Sector Management Assistance Program, "Expanding Mini-grids for Economic Growth", 2022, https://www.esmap.org/sites/default/files/2022/MG%20Kenya%202023/booklet%2025%20feb%20rev.pdf.

5 GOGLA, "Global Off-Grid Solar Market Data", May 2024, https://www.gogla.org/wp-content/uploads/2024/05/GOGLA_Sales-and-Impact-ReportH2-2023_FINAL.pdf.

6 European Commission Directorate-General for Energy, "In Focus: Protecting and Empowering Energy Consumers", 18 June 2024, https://energy.ec.europa.eu/news/focus-protecting-and-empowering-energy-consumers-2024-06-18_en; US Census Bureau, "Household Pulse Survey", accessed 13 September 2024, https://www.census.gov/data-tools/demo/hhp/?measures=ENERGYBILL&areaSelector=040.

7 European Commission, "Commission Recommendation (EU) 2023/2407 of 20 October 2023 on energy poverty", 2023, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202302407.

8 International Renewable Energy Agency, "Renewable Power Generation Costs in 2023", 2024, https://www.irena.org/Publications/2024/Sep/Renewable-Power-Generation-Costs-in-2023.

9 International Energy Agency, "Reducing the Cost of Capital", 2024, https://iea.blob.core.windows.net/assets/227da10f-c527-406d-b94f-dbaa38ae9abb/ReducingtheCostofCapital.pdf.

10 International Energy Agency, "World Energy Investment 2024", 2024, https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf

11 International Energy Agency, "World Energy Investment 2024", 2024, https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf.

12 International Energy Agency, "World Energy Investment 2024", 2024, https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf.

13 Reclaim Finance, "Sustainability Policy Tracker", accessed 20 September 2024, https://sustainabilitypolicytracker.org.

14 I4CE, "Maximising Benefits of Carbon Pricing Through Carbon Revenue Use: A Review of International Experiences", 2024, https://www.i4ce.org/en/publication/maximising-benefits-carbon-pricing-through-carbon-revenue-use-review-international-experiences-climate.

15 Abba Lawan Bukar *et al.*, "Peer-to-Peer Electricity Trading: A Systematic Review on Current Developments and Perspectives", *Renewable Energy Focus* 44 (March 2023): 317-33, https://doi.org/10.1016/j.ref.2023.01.008; International Renewable Energy Agency and Climate Policy Initiative, "Global Landscape of Renewable Energy Finance 2023", 2023, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Feb/IRENA_CPI_Global_RE_finance_2023.pdf; Sustainable Energy for All, "Universal Energy Facility to Grant Up to USD 10.4 Million for Renewables in Democratic Republic of the Congo, Madagascar and Sierra Leone", 6 July 2023, https://www.seforall.org/press-releases/universal-energy-facility-to-grant-up-to-usd-104-million-for-renewables-in; United Nations Development Programme, "Mainstreaming Financial Aggregation for Distributed Renewable Energy", 2024, https://www.undp.org/sites/g/files/zskgke326/files/2024-03/undp-gef-mainstreaming-financial-aggregation-for-distributed-renewable-energy.pdf.

16 International Energy Agency, "From Taking Stock to Taking Action", 2024, https://www.iea.org/reports/from-taking-stock-to-taking-action.

17 Carol Zhou and Yiran He, "How Decarbonizing the Renewable Value Chain Supports Multiple SDGs", World Economic Forum, 24 June 2024, https://www.weforum.org/agenda/2024/06/decarbonizing-renewable-value-chain-supports-multiple-sdgs.

18 BloombergNEF, "Energy Transition Investment Trends 2024", 2024, https://about.bnef.com/energy-transition-investment; International Renewable Energy Agency, "Advancing Renewables-Based Clean Cooking Solutions", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Mar/IRENA_Renewables-based_clean_cooking_2024.pdf; World Bank, "World Bank Open Data", 2024, https://data.worldbank.org.

19 International Energy Agency, "Advancing Clean Technology Manufacturing", 2024, https://iea.blob.core.windows.net/assets/7e7f4b17-1bb2-48e4-8a92-fb9355b1d1bd/CleanTechnologyManufacturingRoadmap.pdf.

20 Adam Aston, Hannah Perkins and RMI Staff, "On the Climate Bill's Second Birthday, Surging Successes – But a Split Reality", RMI, 16 August 2024, https://rmi.org/on-the-climate-bills-second-birthday-surging-successes-but-a-split-reality.

21 European Commission, "Net-Zero Industry Act", 2024, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/net-zero-industry-act_en; European Commission, "Critical Raw Materials Act", 2024, https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en.

22 International Energy Agency (IEA), "Subsidy on New Energy Vehicle 2023", 25 May 2023, https://www.iea.org/policies/17536-subsidy-on-new-energy-vehicle-2023; David Pilling, "Morocco's Carmaking Sector Revs up for EV Era", *Financial Times*, 5 October 2023, https://www.ft.com/content/8549619c-9c23-4a00-88ab-dfdac92a22ca; IEA, "Tax Incentive for Manufacturer of Electric Vehicle Charging Equipment", https://origin.iea.org/policies?type[]=Government+spending+in+charging+infrastructure; IEA, "Incentives for EVs' Battery Cells", 25 May 2023, https://www.iea.org/policies/17350-incentives-for-evs-battery-cells; IEA, "Electric Vehicles", 2024, https://www.iea.org/energy-system/transport/electric-vehicles.

23 International Renewable Energy Agency and International Labour Organization, "Renewable Energy and Jobs: Annual Review 2024", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf.

24 International Renewable Energy Agency and International Labour Organization, "Renewable Energy and Jobs: Annual Review 2024", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf.

25 International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

26 Marlène Buchy and Shristi Shakya, "Gender Equality and Social Inclusion in a Just Energy Transition", ThinkTwenty (T20) India 2023 – Official Engagement Group of G20, 2023, https://t20ind.org/research/gender-equality-and-social-inclusion-in-a-just-energy-transition; US Embassy and Consulate in Nigeria, "USAID Power Africa Launches 'Growing Green Jobs' for Women in the Energy Sector in Nigeria", 28 September 2023, https://ng.usembassy.gov/usaid-power-africa-launches-growing-green-jobs-for-women-in-the-energy-sector-in-nigeria; Engineering News, "Renewable Sector Leadership Programme to Develop Skills for Gender Diverse Future", 25 August 2023, https://www.engineeringnews.co.za/print-version/renewable-sector-leadership-programme-to-fevelop-skills-for-gender-diverse-future-2023-08-25; US Department of Energy, "DOE Equity Action Plan", 2023, https://www.energy.gov/justice/doe-equity-action-plan.

27 European Commission, "The Green Deal Industrial Plan: Putting Europe's Net-Zero Industry in the Lead", 31 January 2023, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_510; European Commission, "The Net-Zero Industry Act", https://single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act_en; International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

28 International Renewable Energy Agency, "World Energy Transitions Outlook 2023: 1.5°C Pathway", 2023, https://www.irena.org/Publications/2023/Jun/World-Energy-Transitions-Outlook-2023.

29 Cléa Flache, Hugo Chirol and Léa Legras, "From Energy Crisis to Energy Democracy", Green European Journal, 15 September 2023, https://www.greeneuropeanjournal.eu/from-energy-crisis-to-energy-democracy.

30 REScoop, "About Us", accessed 20 September 2024, https://www.rescoop.eu/about-us.

31 Institut für Trend- und Marktforschung, "Anteile Einzelner Marktakteure an Erneuerbaren Energien-Anlagen in Deutschland (4. Auflage)", 27 September 2024, https://www.trendresearch.de/studien/16-0188-2.pdf.

32 Sergio Matalucci, "Italy Publishes Operating Rules for Energy Communities", pv magazine International, 26 February 2024, https://www.pv-magazine.com/2024/02/26/italy-publishes-operating-rules-for-energy-communities; KPMG Albania, "New Law on 'Promotion of the Use of Energy from

Renewable Sources'", 4 May 2023, https://kpmg.com/al/en/home/insights/2023/05/new-law-on--promotion-of-the-use-of-energy-from-renewable-source.html; Angela Skujins, "Denmark Supports First Energy Communities", pv magazine International, 22 December 2023, https://www.pv-magazine.com/2023/12/22/denmark-supports-first-energy-communities; Ilias Tsagas, "Greece to Support Local Energy Communities with €42 Million of Funding", pv magazine International", 14 December 2023, https://www.pv-magazine.com/2023/12/14/greece-to-support-local-energy-communities-with-e42-million-of-funding; United Nations Framework Convention on Climate Change, "Crowdfunding for Community Solar Projects | The Netherlands", accessed 14 March 2024, https://unfccc.int/climate-action/momentum-for-change/financing-for-climate-friendly-investment/crowdfunding-for-community-solar-projects.

33 ICA Coop, "Replication Project: Revolusolar from Brazil", accessed 7 February 2024, https://globalyouth.coop/en/projects/replication-project/brazil/revolusolar; Energy Sage, "The Top Community Solar States in 2023", 6 December 2023, https://www.energysage.com/community-solar/comparing-top-community-solar-states; Australian Government, Department of Climate Change, Energy, the Environment and Water, "Community Solar Banks", accessed 14 March 2024, https://www.dcceew.gov.au/energy/renewable/community-solar-banks; Government of Canada, Canada Energy Regulator, "Market Snapshot: Indigenous Ownership of Canadian Renewable Energy Projects Is Growing", 28 June 2024, https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2023/market-snapshot-indigenous-ownership-canadian-renewable-energy-projects-growing.html.

34 Global Center on Adaptation, "Three Ways That Clean Energy Innovation and Climate Change Adaptation Can Work in Lockstep", 26 January 2024, https://gca.org/three-ways-that-clean-energy-innovation-and-climate-change-adaptation-can-work-in-lockstep.

35 International Renewable Energy Agency, "Bracing for Climate Impact: Renewables as a Climate Change Adaptation Strategy", 2021, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Aug/IRENA_Bracing_for_climate_impact_2021.pdf.

36 Makena Ireri, "How Off-grid Solar Solutions Are Key to Climate Adaptation and Resilience", Sustainable Energy for All, 14 November 2022, https://blogs.worldbank.org/en/energy/how-grid-solar-solutions-are-key-climate-adaptation-and-resilience.

37 International Renewable Energy Agency, "Bracing for Climate Impact: Renewables as a Climate Change Adaptation Strategy", 2021, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Aug/IRENA_Bracing_for_climate_impact_2021.pdf.

38 Clean Energy Group, "Clean Energy for Resilient Communities: Expanding Solar Generation in Baltimore's Low-Income Neighborhoods", 2014, https://www.cleanegroup.org/wp-content/uploads/Clean-Energy-for-Resilient-Communities-Report-Feb2014.pdf.

39 **Box 1** from the following sources: United Nations, "THE 17 GOALS | Sustainable Development", accessed 3 September 2024, https://sdgs.un.org/goals; United Nations Sustainable Development, "Ensure Access to Affordable, Reliable, Sustainable and Modern Energy", accessed 2 September 2024, https://www.un.org/sustainabledevelopment/energy; United Nations Environment Programme, "GOAL 7: Affordable and Clean Energy", 10 February 2017, https://www.unep.org/explore-topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-7.

40 International Energy Agency (IEA), "Executive Summary – Strategies for Affordable and Fair Clean Energy Transitions", 2024, https://www.iea.org/reports/strategies-for-affordable-and-fair-clean-energy-transitions/executive-summary; IEA *et al.*, "Tracking SDG7: The Energy Progress Report, 2024", 2024, https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2024.

41 European Commission Directorate-General for Energy, "Energy Poverty", accessed 18 September 2024, https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-poverty_en.

42 International Energy Agency (IEA), "Executive Summary – Strategies for Affordable and Fair Clean Energy Transitions", 2024, https://www.iea.org/reports/strategies-for-affordable-and-fair-clean-energy-transitions/executive-summary.

43 UK Government Web Archive, "Hills Fuel Poverty Review", accessed 21 September 2024, https://webarchive.nationalarchives.gov.uk/ukgwa/20130103045732/http://www.decc.gov.uk/en/content/cms/funding/fuel_poverty/hills_review/hills_review.aspx.

44 International Energy Agency, "Strategies for Affordable and Fair Clean Energy Transitions", 2024, https://www.iea.org/reports/strategies-for-affordable-and-fair-clean-energy-transitions.

45 International Energy Agency *et al.*, "Tracking SDG 7: The Energy Progress Report", 2024, https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2024.

46 Laura Cozzi *et al.*, "Access to Electricity Improves Slightly in 2023, But Still Far from the Pace Needed to Meet SDG7", International Energy Agency (IEA), 15 September 2023, https://www.iea.org/commentaries/access-to-electricity-improves-slightly-in-2023-but-still-far-from-the-pace-needed-to-meet-sdg7; IEA *et al.*, "Tracking SDG 7: The Energy Progress Report", 2024, https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2024.

47 **Figure 1** from REN21, "REN21 Policy Database", 2024.

48 Laura Cozzi *et al.*, "Access to Electricity Improves Slightly in 2023, But Still Far from the Pace Needed to Meet SDG7", International Energy Agency, 15 September 2023, https://www.iea.org/commentaries/access-to-electricity-improves-slightly-in-2023-but-still-far-from-the-pace-needed-to-meet-sdg7.

49 International Energy Agency, "World Energy Outlook Special Report – A Vision for Clean Cooking Access for All", 2023, https://iea.blob.core.windows.net/assets/212dda1e-63ec-4f42-a530-f2ef3da74fdf/AVisionforCleanCookingAccessforAll.pdf.

50 Sustainable Energy for All, "Deep Dive Analysis: Tracking SDG7: The Energy Progress Report 2023", https://www.seforall.org/system/files?file=2023-09/SEforALL-TRACKING_SDG7_Data_Analysis-2023.pdf.

51 Sustainable Energy for All, "Deep Dive Analysis: Tracking SDG7: The Energy Progress Report 2023", https://www.seforall.org/system/files?file=2023-09/SEforALL-TRACKING_SDG7_Data_Analysis-2023.pdf.

52 GOGLA, "Off-Grid Solar Market Trends Report 2022", 25 October 2022, https://documents1.worldbank.org/curated/en/099235110062231022/pdf/P175150063801e0860928f00e7131b132de.pdf. **Snapshot: Central African Republic** from the following sources: Jean Marie Takouleu, "CAR: The Country's Second Photovoltaic Solar Power Plant (25 MWp) Inaugurated at Danzi", Afrik21, 22 November 2023, https://www.afrik21.africa/en/car-the-countrys-second-photovoltaic-solar-power-plant25-mwp-inaugurated-at-danzi; World Bank, "With the Support of the World Bank, a New Solar Park in the Central African Republic Expands Access to Clean Energy", 17 November 2023, https://www.worldbank.org/en/news/press-release/2023/11/17/with-the-support-of-the-world-bank-a-new-solar-park-in-the-central-african-republic-expands-access-to-clean-energy; African Energy Council, "World Bank-backed Solar Park in Central African Republic", 18 November 2023, https://africanenergycouncil.org/world-bank-backed-solar-park-in-central-african-republic; Africa Energy Portal, "Central African Republic Inaugurates Largest Solar Power Plant in Central Africa", 24 November 2023, https://africa-energy-portal.org/news/central-african-republic-inaugurates-largest-solar-power-plant-central-africa.

53 Energypedia, "Energy Access for Refugees", accessed 18 September 2024, https://energypedia.info/wiki/Energy_Access_for_Refugees; Global Platform for Action, "Sustainable Mini-grids in Refugee Camps: A Case Study of Rwanda", 14 April 2020, https://www.humanitarianenergy.org/news/latest/minigrid-MahamaCamp-Rwanda.

54 Energy Sector Management Assistance Program, "Mini-grids for Half a Billion People", 2022, https://documents1.worldbank.org/curated/en/099635009232259510/pdf/P1751510dd4ab407e083a6098d1905fa94f.pdf.

55 Energy Sector Management Assistance Program, "Mini-grids for Half a Billion People", 2022, https://documents1.worldbank.org/curated/en/099635009232259510/pdf/P1751510dd4ab407e083a6098d1905fa94f.pdf.

56 Energy Sector Management Assistance Program, "Pathways to Electricity Access Expansion in South Sudan | Off-Grid and Mini-Grid Market Assessment", 2023, https://www.esmap.org/node/29565.

57 United Nations Framework Convention on Climate Change, "Bangladesh First NDC (Updated Submission)", 2 June 2022, https://unfccc.int/documents/497161.

58 Energy Sector Management Assistance Program, "Mini-grids for Half a Billion People", 2022, https://documents1.worldbank.org/curated/en/099635009232259510/pdf/P1751510dd4ab407e083a6098d1905fa94f.pdf.

59 Energy Sector Management Assistance Program, "Mini-grids for Half a Billion People", 2022, https://documents1.worldbank.org/curated/en/099635009232259510/pdf/P1751510dd4ab407e083a6098d1905fa94f.pdf.

60 Energy Sector Management Assistance Program, "Mini-grids for Half a Billion People", 2022, https://documents1.worldbank.org/curated/en/099635009232259510/pdf/P1751510dd4ab407e083a6098d1905fa94f.pdf.

61 Energy Sector Management Assistance Program, "Expanding Mini-grids for Economic Growth", 2022, https://www.esmap.org/sites/default/files/2022/MG%20Kenya%202023/booklet%2025%20feb%20rev.pdf.

62 GOGLA, "Global Off-Grid Solar Market Data", May 2024, https://www.gogla.org/wp-content/uploads/2024/05/GOGLA_Sales-and-Impact-ReportH2-2023_FINAL.pdf. **Figure 2** from idem.

63 GOGLA, "Global Off-Grid Solar Market Data", May 2024, https://www.gogla.org/wp-content/uploads/2024/05/GOGLA_Sales-and-Impact-ReportH2-2023_FINAL.pdf.

64 International Energy Agency *et al.*, "Tracking SDG 7: The Energy Progress Report", 2024, https://trackingsdg7.esmap.org/data/files/download-documents/sdg7-report2024-0611-v9-highresforweb.pdf.

65 Energy Sector Management Assistance Program, "Mini-grids for Half a Billion People", 2022, https://documents1.worldbank.org/curated/en/099635009232259510/pdf/P1751510dd4ab407e083a6098d1905fa94f.pdf.

66 FAOLEX, "Electricity Act 2023", 2023, https://www.fao.org/faolex/results/details/en/c/LEX-FAOC218782.

67 FAOLEX, "Rural Electrification Act", https://www.fao.org/faolex/results/details/en/c/LEX-FAOC219949.

68 FAOLEX, "Executive Decree No. 78/23 approving the General Guidelines for the preparation of the Rural Electrification Plan", https://www.fao.org/faolex/results/details/en/c/LEX-FAOC221956; FAOLEX, "Ministerial Order No. 119/2023 approving the Renewable Energy Code", 2023, https://www.fao.org/faolex/results/details/en/c/LEX-FAOC223421.

69 Ministry of Energy and Mineral Development, "Energy Policy for Uganda 2023", 2023, https://www.globalrightsalert.org/sites/default/files/2024-02/Energy%20Policy%20for%20Uganda%202023-14082023docx_230911_114502%20%281%29.pdf.

70 Climate Policy Initiative, "Global Landscape of Climate Finance 2023", 2023, https://www.climatepolicyinitiative.org/wp-content/uploads/2023/11/Global-Landscape-of-Climate-Finance-2023.pdf.

71 International Renewable Energy Agency and Climate Policy Initiative, "Global Landscape of Renewable Energy Finance 2023", 2023, https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Feb/IRENA_CPI_Global_RE_finance_2023.pdf.

72 Climate Policy Initiative, "Global Landscape of Climate Finance 2023", 2023, https://www.climatepolicyinitiative.org/wp-content/uploads/2023/11/Global-Landscape-of-Climate-Finance-2023.pdf.

73 International Renewable Energy Agency and Climate Policy Initiative, "Global Landscape of Renewable Energy Finance 2023", 2023, https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Feb/IRENA_CPI_Global_RE_finance_2023.pdf.

74 World Bank, "Solar Mini Grids Could Sustainably Power 380 Million People in Africa by 2030 – If Action Is Taken Now", 27 February 2023, https://www.worldbank.org/en/news/press-release/2023/02/26/solar-mini-grids-could-sustainably-power-380-million-people-in-afe-africa-by-2030-if-action-is-taken-now.

75 World Bank, "Solar Mini Grids Could Sustainably Power 380 Million People in Africa by 2030 – If Action Is Taken Now", 27 February 2023, https://www.worldbank.org/en/news/press-release/2023/02/26/solar-mini-grids-could-sustainably-power-380-million-people-in-afe-africa-by-2030-if-action-is-taken-now.

76 World Bank, "Transforming Lives Through Energy Access in Eastern and Southern Africa", 21 November 2023, https://www.worldbank.org/en/results/2023/11/21/transforming-lives-through-energy-access-afe-1123-in-eastern-and-southern-africa.

77 World Bank, "100 Million People in Eastern and Southern Africa Poised to Receive Access to Sustainable and Clean Energy by 2030", 28 November 2023, https://www.worldbank.org/en/news/press-release/2023/11/28/100-million-people-in-afe-eastern-and-southern-africa-poised-to-receive-access-to-sustainable-and-clean-energy-by-2030.

78 International Energy Agency, "Increase in 2023 Electricity Access Enhancement Budget", 17 November 2022, https://www.iea.org/policies/16830-increase-in-2023-electricity-access-enhancement-budget.

79 International Energy Agency, "World Energy Outlook Special Report – A Vision for Clean Cooking Access for All", 2023, https://iea.blob.core.windows.net/assets/212dda1e-63ec-4f42-a530-f2ef3da74fdf/AVisionforCleanCookingAccessforAll.pdf.

80 International Energy Agency, "Low-cost Solutions Can Give Billions Access to Modern Cooking by 2030, But the World Is Failing to Deliver", 2023, https://www.iea.org/news/low-cost-solutions-can-give-billions-access-to-modern-cooking-by-2030-but-the-world-is-failing-to-deliver.

81 Clean Cooking Alliance, "Fueling a Sustainable Future: The Importance of Clean Cooking for a Healthy Environment", 5 June 2023, https://cleancooking.org/news/fueling-a-sustainable-future-the-importance-of-clean-cooking-for-a-healthy-environment.

82 International Energy Agency, "World Energy Outlook Special Report – A Vision for Clean Cooking Access for All", 2023, https://iea.blob.core.windows.net/assets/212dda1e-63ec-4f42-a530-f2ef3da74fdf/AVisionforCleanCookingAccessforAll.pdf; REN21, "Renewables 2023 Global Status Report: Economic and Social Value Creation Module", 2023, https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_EconSocialValueCreation_Full_Report_with_endnotes_web.pdf.

83 International Energy Agency, "World Energy Outlook Special Report – A Vision for Clean Cooking Access for All", 2023, https://iea.blob.core.windows.net/assets/212dda1e-63ec-4f42-a530-f2ef3da74fdf/AVisionforCleanCookingAccessforAll.pdf.

84 International Energy Agency, "World Energy Outlook Special Report – A Vision for Clean Cooking Access for All", 2023, https://iea.blob.core.windows.net/assets/212dda1e-63ec-4f42-a530-f2ef3da74fdf/AVisionforCleanCookingAccessforAll.pdf.

85 International Renewable Energy Agency, "Tracking SDG7: The Energy Progress Report 2023", 2023, https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Jun/Tracking_SDG7_energy_progress_2023.pdf.

86 International Renewable Energy Agency, "Tracking SDG7: The Energy Progress Report 2023", 2023, https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Jun/Tracking_SDG7_energy_progress_2023.pdf.

87 International Energy Agency, "Executive Summary – A Vision for Clean Cooking Access for All", 2023, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all/executive-summary.

88 International Energy Agency, "Executive Summary – A Vision for Clean Cooking Access for All", 2023, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all/executive-summary.

89 International Energy Agency, "World Energy Outlook Special Report – A Vision for Clean Cooking Access for All", 2023, https://iea.blob.core.windows.net/assets/212dda1e-63ec-4f42-a530-f2ef3da74fdf/AVisionforCleanCookingAccessforAll.pdf.

90 International Renewable Energy Agency, "Tracking SDG7: The Energy Progress Report 2023", 2023, https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Jun/Tracking_SDG7_energy_progress_2023.pdf.

91 International Renewable Energy Agency, "Tracking SDG7: The Energy Progress Report 2023", 2023, https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Jun/Tracking_SDG7_energy_progress_2023.pdf.

92 International Energy Agency, "Executive Summary – A Vision for Clean Cooking Access for All", 2023, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all/executive-summary.

93 Richard Wetaya, "East Africa: Smallholder Farmers Adopt Bio-digesters to Build Climate Resilience and Get Clean Energy for Cooking", 2023, https://allianceforscience.org/blog/2023/05/east-africa-smallholder-farmers-adopt-bio-digesters-to-build-climate-resilience-and-get-clean-energy-for-cooking.

94 Richard Wetaya, "East Africa: Smallholder Farmers Adopt Bio-digesters to Build Climate Resilience and Get Clean Energy for Cooking", 2023, https://allianceforscience.org/blog/2023/05/east-africa-smallholder-farmers-adopt-bio-digesters-to-build-climate-resilience-and-get-clean-energy-for-cooking.

95 International Renewable Energy Agency, "Advancing Renewables-Based Clean Cooking Solutions", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Mar/IRENA_Renewables-based_clean_cooking_2024.pdf.

96 Clean Cooking Alliance, "Fueling a Sustainable Future: The Importance of Clean Cooking for a Healthy Environment", 5 June 2023, https://cleancooking.org/news/fueling-a-sustainable-future-the-importance-of-clean-cooking-for-a-healthy-environment.

97 Solar Cookers International, "Distribution of Solar Cookers", accessed 12 July 2024, https://www.solarcookers.org/partners/distribution-solar-cookers.

98 International Energy Agency, "Executive Summary – A Vision for Clean Cooking Access for All", 2023, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all/executive-summary.

99 fundsforNGOs, "Call for Applications to Develop a National Clean Cooking Strategy in Pakistan", 23 November 2023, https://www2.fundsforngos.org/latest-funds-for-ngos/call-for-applications-to-develop-a-national-clean-cooking-strategy-in-pakistan.

100 Nelly Mtema, "REA Outlines Plans to Scale Up Clean Cooking", Daily News, 19 August 2023, https://dailynews.co.tz/rea-outlines-plans-to-scale-up-clean-cooking.

101 Climate & Clean Air Coalition, "Uganda – Support for Integrated National Clean Cooking Strategy", accessed 2 April 2024, https://www.ccacoalition.org/projects/uganda-support-integrated-national-clean-cooking-strategy.

102 Stockholm Environment Institute, "The Quiet Triumph of COP28: Clean Cooking", 7 February 2024, https://www.sei.org/features/cop28-clean-cooking.

103 Sustainable Energy for All, "Energizing Finance: Understanding the Landscape 2021", 2021, https://www.seforall.org/system/files/2021-10/EF-2021-UL-SEforALL.pdf.

104 Sustainable Energy for All, "Energizing Finance: Understanding the Landscape 2021", 2021, https://www.seforall.org/system/files/2021-10/EF-2021-UL-SEforALL.pdf.

105 Sustainable Energy for All, "Energizing Finance: Understanding the Landscape 2021", 2021, https://www.seforall.org/system/files/2021-10/EF-2021-UL-SEforALL.pdf.

106 Sustainable Energy for All, "Energizing Finance: Understanding the Landscape 2021", 2021, https://www.seforall.org/system/files/2021-10/EF-2021-UL-SEforALL.pdf.

107 International Renewable Energy Agency, "Renewables-Based Electric Cooking: Climate Commitments and Finance", 2023, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Dec/IRENA_Renewables-based_electric_cooking_2023.pdf.

108 Global Platform for Action, "Solar-Electric Cooking Partnership (SOLCO) Pledge for the Global Refugee Forum 2023", 12 December 2023, https://www.humanitarianenergy.org/news/latest/solar-electric-cooking-partnership-solco-pledge-for-the-global-refugee-forum-2023.

109 Brian Min *et al.*, "Beyond Access: 1.18 Billion in Energy Poverty Despite Rising Electricity Access", World Bank, 12 June 2024, https://blogs.worldbank.org/en/opendata/1-18-billion-around-the-world-are-unable-to-use-electricity.

110 European Commission Directorate-General for Energy, "Energy Poverty", accessed 12 July 2024, https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-poverty_en.

111 International Energy Agency, "Strategies for Affordable and Fair Clean Energy Transitions", 2024, https://www.iea.org/reports/strategies-for-affordable-and-fair-clean-energy-transitions.

112 European Commission Directorate-General for Energy, "In Focus: Protecting and Empowering Energy Consumers", 18 June 2024, https://energy.ec.europa.eu/news/focus-protecting-and-empowering-energy-consumers-2024-06-18_en.

113 European Commission Directorate-General for Energy, "Energy Poverty", accessed 12 July 2024, https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-poverty_en.

114 Interreg Europe, "Tackling Energy Poverty with Low-Carbon Interventions. A Policy Brief from the Policy Learning Platform on Low-Carbon Economy", 2022, https://www.interregeurope.eu/sites/default/files/2022-06/Policy%20brief%20on%20tackling%20energy%20poverty%20with%.

115 European Commission, "Commission Recommendation (EU) 2023/2407 of 20 October 2023 on energy poverty", 2023, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202302407.

116 European Commission, "Commission Recommendation (EU) 2023/2407 of 20 October 2023 on energy poverty", 2023, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202302407.

117 Sustainable Energy Authority of Ireland, "Government Supported 47,900 Home Energy Upgrades Through SEAI in 2023", 7 March 2024, https://www.seai.ie/news-and-events/news/47900-home-energy-upgrade; Sustainable Energy Authority of Ireland, "Guide to Home Energy Upgrades", accessed 12 July 2024, https://www.seai.ie/plan-your-energy-journey/for-your-home/guide-to-upgrades.

118 Natural Resources Canada, "Canada Greener Homes Grant", 5 July 2024, https://natural-resources.canada.ca/energy-efficiency/homes/canada-greener-homes-initiative/canada-greener-homes-grant/canada-greener-homes-grant/23441.

119 US Census Bureau, "Household Pulse Survey", accessed 12 July 2024, https://www.census.gov/data-tools/demo/hhp/?measures=ENERGYBILL&areaSelector=040.

120 Kayleigh Rubin, Molly Freed and Ashna Aggarwal, "1 in 7 Families Live in Energy Poverty. States Can Ease That Burden.", RMI, 18 December 2023, https://rmi.org/1-in-7-families-live-in-energy-poverty-states-can-ease-that-burden.

121 **Snapshot: Panama** from the following sources: Rosilena Lindo, National Energy Secretariat of Panama, personal communication with REN21, 30 May 2024; International Renewable Energy Agency (IRENA), "Energy Profile: Panama", July 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Central%20America%20and%20the%20Caribbean/Panama_Central%20America%20and%20the%20Caribbean_RE_SP.pdf; International Energy Agency, "Panama", 2021, https://www.iea.org/countries/panama; Sustainable Energy for All, "Republic of Panama Joins Growing List of Countries Committed to Carbon-Free Energy", 23 June 2023, https://www.seforall.org/news/republic-of-panama-joins-growing-list-of-countries-committed-to-carbon-free-energy; Republic of Panama, "Resolución de Gabinete N.°5 de 5 de enero de 2022 – Se aprueba la ENGED", Gaceta Oficial Digital, No. 29451-A, viernes 7 de enero de 2022. Última actualización: 7 de enero de 2022, 19:08", 7 January 2022, https://vlex.com.pa/vid/resolucion-gabinete-n-5-879677458#:~:text=Que%20aprueba%20la%20estrategia%20nacional%20de%20generaci%C3%B3n%20distribuida,p%C3%BAblicas%2C%20universidades%2C%20empresas%20y%20asociaciones%20del%20sector%20privado; Nanda Singh, "Operación Solar: Inicia el piloto para instalar cientos de sistemas fotovoltaicos en Panamá", Energía Estratégica, 27 February 2024, https://www.energiaestrategica.com/operacion-solar-inicia-el-piloto-para-instalar-cientos-de-sistemas-fotovoltaicos-en-panama; IRENA, "Renewables Readiness Assessment: Panama", 2018, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/May/IRENA_RRA_Panama_2018_En.pdf; United Nations Industrial Development Organization, International Center on Small Hydro Power, "World Small Hydropower Development Report 2022", 2022, https://www.unido.org/sites/default/files/files/2023-08/CENTRAL%20AMERICA-2022.pdf; International Monetary Fund, "Panama: Second Review Under the Arrangement Under the Precautionary and Liquidity Line – Press Release; Staff Report; and Statement by the Executive Director for Panama", August 2022, https://www.imf.org/en/Publications; Adrien Deroubaix *et al.*, "Large Uncertainties in Trends of Energy Demand for Heating and Cooling Under Climate Change", *Nature Communications* 12, no. 1 (31 August 2021): 5197, https://doi.org/10.1038/s41467-021-25504-8; Josiah L. Kephart *et al.*, "City-Level Impact of Extreme Temperatures and Mortality in Latin America", *Nature Medicine* 28, no. 8 (August 2022): 1700-1705, https://doi.org/10.1038/s41591-022-01872-6; Marta Videras Rodríguez *et al.*, "Impact of Global Warming in Subtropical Climate Buildings: Future Trends and Mitigation Strategies", *Energies* 13, no. 23 (January 2020): 6188, https://doi.org/10.3390/en13236188; Sophie Kronk, David Chen and Dr Ariel Espino, "Spatial & Temporal Dimensions of Urban Growth in Panama City", McGill University, April 2015, https://www.mcgill.ca/pfss/files/pfss/spatial_temporal_dimensions_of_urban_growth_in_panama_city.pdf; Sarah Ruiz and Christina Shintani, "Drought, Climate, and the Panama Canal", Woodwell Climate, 20 February 2024, https://www.woodwellclimate.org/drought-panama-canal-7-graphics; Mirta Rodríguez, "Panamá despliega la 'Operación solar' para 'democratizar la energía'", La Estrella de Panamá, March 2024, https://www.laestrella.com.pa/economia/panama-despliega-la-operacion-solar-para-democratizar-la-energia-XA6266660; Noemí Ruíz, "Secretaría de Energía entregará paneles solares a familias en Operación Solar", 15 March 2024, https://www.telemetro.com/nacionales/secretaria-energia-entregara-paneles-solares-familias-operacion-solar-n5972770; Sustainable Energy for All, "SEforALL Partners with Government of Panama to Launch STEM Traineeship in Panama", 6 May 2024, https://www.seforall.org/news/seforall-partners-with-government-of-panama-to-launch-stem-traineeship-in-panama; Nora Hampl, "Consume Less or Grow Sustainably? Matching Energy Systems with Indigenous Worldviews in Panama", *Regional Studies*, Regional Science 9, no. 1 (31 December 2022): 412-424, https://doi.org/10.1080/21681376.2022.2081598.

122 Beyond Fossil Fuels, "Renewable Energy as a Path to Resilience", July 2023, https://beyondfossilfuels.org/2023/07/10/renewable-energy-as-a-path-to-resilience.

123 International Energy Agency, "World Energy Investment 2024", 2024, https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf.

124 International Energy Agency, "World Energy Investment 2024", 2024, https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf.

125 International Energy Agency, "World Energy Investment 2024", 2024, https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf.

126 International Renewable Energy Agency, "Renewable Power Generation Costs in 2023", 2024. https://www.irena.org/Publications/2024/Sep/Renewable-Power-Generation-Costs-in-2023.

127 International Renewable Energy Agency, "Renewable Power Generation Costs in 2023", 2024. https://www.irena.org/Publications/2024/Sep/Renewable-Power-Generation-Costs-in-2023.

128 International Renewable Energy Agency, "Renewable Power Generation Costs in 2023", 2024. https://www.irena.org/Publications/2024/Sep/Renewable-Power-Generation-Costs-in-2023.

129 International Renewable Energy Agency, "Renewable Power Generation Costs in 2023", 2024. https://www.irena.org/Publications/2024/Sep/Renewable-Power-Generation-Costs-in-2023.

130 Commonwealth of Dominica, "Updated National Determined Contribution", 4 July 2022, https://unfccc.int/documents/513679.

131 United Nations, "Renewable Energy – Powering a Safer Future", accessed 26 September 2024, https://www.un.org/en/climatechange/raising-ambition/renewable-energy.

132 Megan Rowling, "UN Climate Chief Warns of 'Two-speed' Global Energy Transition", Climate Home News, 24 September 2024, https://www.climatechangenews.com/2024/09/24/un-climate-chief-warns-of-two-speed-global-energy-transition.

133 International Energy Agency, "Reducing the Cost of Capital", 2024, https://iea.blob.core.windows.net/assets/227da10f-c527-406d-b94f-dbaa38ae9abb/ReducingtheCostofCapital.pdf. **Figure 3** from International Renewable Energy Agency, "Renewable Power Generation Costs in 2022", 2023, https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Aug/IRENA_Renewable_power_generation_costs_in_2022.pdf.

134 Financial Times, "The Path to Global Carbon Pricing", 2024, https://www.ft.com/content/0a4ac951-5b95-4527-82fc-0ec587483ac5; I4CE, "Maximising Benefits of Carbon Pricing Through Carbon Revenue Use: A Review of International Experiences", 2024, https://www.i4ce.org/en/publication/maximising-benefits-carbon-pricing-through-carbon-revenue-use-review-international-experiences-climate.

135 I4CE, "Maximising Benefits of Carbon Pricing Through Carbon Revenue Use: A Review of International Experiences", 2024, https://www.i4ce.org/en/publication/maximising-benefits-carbon-pricing-through-carbon-revenue-use-review-international-experiences-climate.

136 European Central Bank, "Fiscal Policies to Mitigate Climate Change in the Euro Area", 2022, https://www.ecb.europa.eu/press/economic-bulletin/articles/2022/html/ecb.ebart202206_01~8324008da7.en.html.

137 I4CE, "Maximising Benefits of Carbon Pricing Through Carbon Revenue Use: A Review of International Experiences", 2024, https://www.i4ce.org/en/publication/maximising-benefits-carbon-pricing-through-carbon-revenue-use-review-international-experiences-climate.

138 International Energy Agency, "Strategies for Affordable and Fair Clean Energy Transitions", 2024, https://www.iea.org/reports/strategies-for-affordable-and-fair-clean-energy-transitions.

139 I4CE, "Maximising Benefits of Carbon Pricing Through Carbon Revenue Use: A Review of International Experiences", 2024, https://www.i4ce.org/en/publication/maximising-benefits-carbon-pricing-through-carbon-revenue-use-review-international-experiences-climate.

140 German Federal Government, "170 Billion Euros for Energy Supplies and Climate Protection", 27 July 2022, https://www.bundesregierung.de/breg-en/news/climate-and-transformation-fund-2066034.

141 RRGI, "The Investment of RGGI Proceeds in 2021", 2023, https://www.rggi.org/sites/default/files/Uploads/Proceeds/RGGI_Proceeds_Report_2021.pdf.

142 I4CE, "Maximising Benefits of Carbon Pricing Through Carbon Revenue Use: A Review of International Experiences", 2024, https://www.i4ce.org/en/publication/maximising-benefits-carbon-pricing-through-carbon-revenue-use-review-international-experiences-climate.

143 "Denmark Introduces Green Tax on Air Passengers from 2025", *Reuters*, 15 December 2023, https://www.reuters.com/business/aerospace-defense/denmark-introduces-green-passenger-tax-air-travel-2023-12-15.

144 "Denmark Introduces Green Tax on Air Passengers from 2025", *Reuters*, 15 December 2023, https://www.reuters.com/business/aerospace-defense/denmark-introduces-green-passenger-tax-air-travel-2023-12-15.

145 Qiaoyi Li and Liz Lee, "China Unveils $72 Billion Tax Break for EVs, Other Green Cars to Spur Demand", *Reuters*, 21 June 2023, https://www.reuters.com/business/autos-transportation/china-announces-extension-purchase-tax-break-nevs-until-2027-2023-06-21.

146 Qiaoyi Li and Liz Lee, "China Unveils $72 Billion Tax Break for EVs, Other Green Cars to Spur Demand", *Reuters*, 21 June 2023, https://www.reuters.com/business/autos-transportation/china-announces-extension-purchase-tax-break-nevs-until-2027-2023-06-21.

147 International Energy Agency, "Tax Reduction for Electric Vehicle Purchase", 27 June 2024, https://www.iea.org/policies/17371-tax-reduction-for-electric-vehicle-purchase.

148 International Energy Agency, "VAT Reduction on Solar Panels, Solar Water Heaters and Heat Pumps", 3 June 2024, https://www.iea.org/policies/16689-vat-reduction-on-solar-panels-solar-water-heaters-and-heat-pumps.

149 James McCusker, "Removing VAT on Battery Storage Significant for Energy Reduction Targets", Sunergy Renewables, 15 December 2023, https://sunergyrenewables.com/removing-vat-on-battery-storage-significant-for-energy-reduction-targets.

150 "Government Approves Zero VAT Rate for the Supply and Installation of Solar Panels", The Journal, 5 April 2023, https://www.thejournal.ie/solar-panels-ireland-2-6037579-Apr2023.

151 Sergio Matalucci, "Italy Offers Fiscal Breaks to PV Projects Built with EU-Made Solar Modules", pv magazine International, 5 March 2024, https://www.pv-magazine.com/2024/03/05/italy-offers-fiscal-breaks-to-pv-projects-built-with-solar-modules-made-in-eu.

152 International Energy Agency, "Strategies for Affordable and Fair Clean Energy Transitions", 2024, https://www.iea.org/reports/strategies-for-affordable-and-fair-clean-energy-transitions.

153 ActionAid, "How the Finance Flows: Corporate Capture of Public Finance", 2024, https://actionaid.org/publications/2024/industries-fuelling-climate-crisis-are-draining-public-funds-global-south-new.

154 International Energy Agency, "From Taking Stock to Taking Action", 2024, https://www.iea.org/reports/from-taking-stock-to-taking-action.

155 ActionAid, "How the Finance Flows: Corporate Capture of Public Finance", 2024, https://actionaid.org/publications/2024/industries-fuelling-climate-crisis-are-draining-public-funds-global-south-new.

156 International Energy Agency, "From Taking Stock to Taking Action", 2024, https://www.iea.org/reports/from-taking-stock-to-taking-action.

157 ActionAid, "How the Finance Flows: Corporate Capture of Public Finance", 2024, https://actionaid.org/publications/2024/industries-fuelling-climate-crisis-are-draining-public-funds-global-south-new.

158 International Energy Agency, "Energy for the Countryside Programme", 7 August 2024, https://www.iea.org/policies/17237-energy-for-the-countryside-programme.

159 UK Government, "Environment Secretary Announces Further £45 Million for Farming Innovation as He Sets Out Commitment to Champion British Agriculture", 30 November 2023, https://www.gov.uk/government/news/environment-secretary-announces-further-45-million-for-farming-innovation-as-he-sets-out-commitment-to-champion-british-agriculture.

160 Greek Ministry of Environment and Energy, "Kostas Skrekas: 'Our Fixed Goal, Affordable Energy Prices for Everyone'", 24 March 2023, https://ypen.gov.gr/kostas-skrekas-statheros-mas-stochos-prosites-times-energeias-gia-olous.

161 International Energy Agency, "Rural Clean Energy Initiative & Support to Rural Energy Transition", 30 November 2022, https://www.iea.org/policies/16609-rural-clean-energy-initiative-support-to-rural-energy-transition; US Office of Management and Budget, "Budget of the U.S. Government, Fiscal Year 2023", 2022, https://www.whitehouse.gov/wp-content/uploads/2022/03/budget_fy2023.pdf.

162 International Energy Agency, "2023 Subsidies for Large-scale Solar PV", 12 May 2023, https://www.iea.org/policies/17476-2023-subsidies-for-large-scale-solar-pv.

163 International Energy Agency, "Support Scheme for Renewable Heat – Expanded Grants", 11 May 2023, https://www.iea.org/policies/17361-support-scheme-for-renewable-heat-expanded-grants.

164 Uma Gupta, "Indian Government Approves $9 Billion Rebate Scheme for Residential PV", pv magazine International, https://www.pv-magazine.com/2024/03/01/india-government-approves-9-billion-rebate-scheme-for-residential-pv.

165 International Energy Agency, "Sixth Strategic Energy Plan – 2050 Carbon Neutral", 31 October 2022, https://www.iea.org/policies/14391-sixth-strategic-energy-plan-2050-carbon-neutral; Emiliano Bellini, "Japan Unveils 2024 Feed-in Tariff Levels for Residential, Commercial PV", pv magazine International, 21 March 2024, https://www.pv-magazine.com/2024/03/21/japan-unveils-2024-feed-in-tariff-levels-for-residential-commercial-pv.

166 International Energy Agency, "World Energy Investment 2024", 2024, https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf.

167 International Energy Agency, "World Energy Investment 2024", 2024, https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf.

168 International Energy Agency, "World Energy Investment 2024", 2024, https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf.

169 Rainforest Action Network *et al.*, "Banking on Climate Chaos 2024", accessed 20 September 2024, https://www.bankingonclimatechaos.org.

170 Reclaim Finance, "Sustainability Policy Tracker", accessed 20 September 2024, https://sustainabilitypolicytracker.org.

171 Boipelo Motlhowa, "Powering Africa's Rural Future with Innovative Finance", ESI Africa, 16 May 2024, https://www.esi-africa.com/magazine-article/powering-africas-rural-future-with-innovative-finance.

172 International Energy Agency, "The Potential of Digital Business Models in the New Energy Economy", 7 January 2022, https://www.iea.org/articles/the-potential-of-digital-business-models-in-the-new-energy-economy.

173 **Box 2** from Benson Ireri and H.E Hon. Mutula Kilonzo Jnr., "A New Solution to Power Africa: Productive Use of Renewable Energy", World Resources Institute, 2 February 2024, https://www.wri.org/insights/productive-use-renewable-energy-africa, and from Powering Renewable Energy Opportunities, "Powering Prosperity: The Socio-economic Benefits of the Productive Use of Renewable Energy (PURE) in Africa", 2024, https://www.preo.org/wp-content/uploads/2024/02/PREO_M&E_REPORT_16_February_2024.pdf. **Snapshot Togo** from TogoFirst, "CIZO Program: Over 130,000 Solar Kits Distributed at June 2023", 21 September 2023, https://www.togofirst.com/en/energy/2109-12576-cizo-program-over-130-000-solar-kits-distributed-at-june-2023, and from Energy Sector Management Assistance Program, "Accelerating the Productive Use of Electricity", 2023, https://documents1.worldbank.org/curated/en/099092023192023389/pdf/P1751521d3f58f6f1307c1499619e141b8baef6de8dd.pdf.

174 REN21, "Renewables 2017 Global Status Report", 2017, https://www.ren21.net/gsr-2017.

175 Abba Lawan Bukar *et al.*, "Peer-to-Peer Electricity Trading: A Systematic Review on Current Developments and Perspectives", *Renewable Energy Focus* 44 (March 1, 2023): 317-333, https://doi.org/10.1016/j.ref.2023.01.008.

176 International Renewable Energy Agency and Climate Policy Initiative, "Global Landscape of Renewable Energy Finance 2023", https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Feb/IRENA_CPI_Global_RE_finance_2023.pdf.

177 International Renewable Energy Agency and Climate Policy Initiative, "Global Landscape of Renewable Energy Finance 2023", https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Feb/IRENA_CPI_Global_RE_finance_2023.pdf.

178 International Renewable Energy Agency and Climate Policy Initiative, "Global Landscape of Renewable Energy Finance 2023", https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/Feb/IRENA_CPI_Global_RE_finance_2023.pdf.

179 "The Weekend Read: A Bump in the Road for Pay-as-You-Go Solar and Self-Sustainability", pv magazine International, 19 October 2019, https://www.pv-magazine.com/2019/10/19/the-weekend-read-a-bump-in-the-road-for-pay-as-you-go-solar-and-self-sustainability.

180 Tage Kene-Okafor, "Koolboks' $2.5M Seed Round to Scale Solar Refrigeration Across Africa", TechCrunch, 18 August 2022, https://techcrunch.com/2022/08/18/paris-based-koolboks-closes-2-5m-seed-round-to-scale-solar-refrigeration-across-africa.

181 Seth Onyango, "M-KOPA Brings Pay-as-You-Go Solar Panels to South Africa", TechCabal, 22 November 2023, https://techcabal.com/2023/11/22/m-kopa-expands-to-south-africa-with-pay-as-you-go-solar-panels.

182 Organisation for Economic Co-operation and Development, "Results-Based Funding", 2014, https://www.oecd.org/dac/peer-reviews/Results-based-financing-key-take-aways-Final.pdf.

183 Energy Sector Management Assistance Program, "Results-Based Funding for Energy Sector Development", accessed 7 June 2024, https://www.esmap.org/Results_Based_Funding.

184 GOGLA, "Unlocking Off-Grid Solar: How Results-Based Financing Is Driving Energy Access and Powering Productivity", November 2023, https://www.gogla.org/wp-content/uploads/2023/11/How-Results-Based-Financing-is-driving-energy-access-and-powering-productivity.pdf.

185 GOGLA, "Unlocking Off-Grid Solar: How Results-Based Financing Is Driving Energy Access and Powering Productivity", November 2023, https://www.gogla.org/wp-content/uploads/2023/11/How-Results-Based-Financing-is-driving-energy-access-and-powering-productivity.pdf.

186 Loughborough University, UKaid and Energy Sector Management Assistance Program, "Clean Cooking: Results-Based Financing as a Potential Scale-up Tool for the Sector", October 2021, https://mecs.org.uk/wp-content/uploads/2021/10/Clean-cooking-results-based-financing-as-a-potential-scale-up-tool-for-the-sector.pdf.

187 Sustainable Energy for All, "Universal Energy Facility to Grant Up to USD 10.4 Million for Renewables in Democratic Republic of the Congo, Madagascar and Sierra Leone", 6 July 2023, https://www.seforall.org/press-releases/universal-energy-facility-to-grant-up-to-usd-104-million-for-renewables-in.

188 Beyond the Grid Fund for Africa, "Funding Rounds", accessed 11 June 2024, https://beyondthegrid.africa/funding-rounds.

189 Lia, "Mini-Grid Deployments Scaling Up Access to Clean Electricity in the Democratic Republic of the Congo", Beyond the Grid Fund for Africa, 4 June 2024, https://beyondthegrid.africa/news/mini-grid-deployments-scaling-up-access-to-clean-electricity-in-the-democratic-republic-of-the-congo.

190 United Nations Development Programme, "Mainstreaming Financial Aggregation for Distributed Renewable Energy", 2024, https://www.undp.org/sites/g/files/zskgke326/files/2024-03/undp-gef-mainstreaming-financial-aggregation-for-distributed-renewable-energy.pdf.

191 United Nations Development Programme, "Mainstreaming Financial Aggregation for Distributed Renewable Energy", 2024, https://www.undp.org/sites/g/files/zskgke326/files/2024-03/undp-gef-mainstreaming-financial-aggregation-for-distributed-renewable-energy.pdf.

192 United Nations Development Programme, "Mainstreaming Financial Aggregation for Distributed Renewable Energy", 2024, https://www.undp.org/sites/g/files/zskgke326/files/2024-03/undp-gef-mainstreaming-financial-aggregation-for-distributed-renewable-energy.pdf.

193 United Nations Development Programme, "Mainstreaming Financial Aggregation for Distributed Renewable Energy", 2024, https://www.undp.org/sites/g/files/zskgke326/files/2024-03/undp-gef-mainstreaming-financial-aggregation-for-distributed-renewable-energy.pdf.

194 REN21, "Renewables 2024 Global Status Report: Energy Supply", 2024, https://www.ren21.net/wp-content/uploads/2019/05/GSR2024_Supply.pdf.

195 BloombergNEF, "Energy Transition Investment Trends 2024", 2024, https://about.bnef.com/energy-transition-investment; International Renewable Energy Agency, "Advancing Renewables-Based Clean Cooking Solutions", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Mar/IRENA_Renewables-based_clean_cooking_2024.pdf; World Bank, "World Bank Open Data", 2024. https://data.worldbank.org.

196 Carol Zhou and Yiran He, "How Decarbonizing the Renewable Value Chain Supports Multiple SDGs", World Economic Forum, 24 June 2024, https://www.weforum.org/agenda/2024/06/decarbonizing-renewable-value-chain-supports-multiple-sdgs.

197 Sustainable Energy for All, "Renewable Energy Manufacturing Initiative", accessed 26 September 2024, https://www.seforall.org/programmes/un-energy/REMI.

198 United Nations Environment Programme, "What Are Energy Transition Minerals and How Can They Unlock the Clean Energy Age?" 19 February 2024, https://www.unep.org/news-and-stories/story/what-are-energy-transition-minerals-and-how-can-they-unlock-clean-energy-age.

199 Sustainable Energy for All, "Africa Renewable Energy Manufacturing – Opportunity and Advancement", accessed 26 September 2024, https://www.seforall.org/programmes/un-energy/South-South-Cooperation/aremi.

200 Black & Veatch, "IRA Renewables Impact: At a Glance", accessed 2 April 2024, https://www.bv.com/perspectives/ira-renewables-impact-at-a-glance.

201 Adam Aston, Hannah Perkins and RMI Staff, "On the Climate Bill's Second, Surging Successes – But a Split Reality", RMI, 16 August 2024, https://rmi.org/on-the-climate-bills-second-birthday-surging-successes-but-a-split-reality.

202 Adam Aston, Hannah Perkins and RMI Staff, "On the Climate Bill's Second Birthday, Surging Successes – But a Split Reality", RMI, 16 August 2024, https://rmi.org/on-the-climate-bills-second-birthday-surging-successes-but-a-split-reality.

203 Clean Investment Monitor, accessed 15 September 2024, https://www.cleaninvestmentmonitor.org.

204 Adam Aston, Hannah Perkins and RMI Staff, "On the Climate Bill's Second Birthday, Surging Successes – But a Split Reality", RMI, 16 August 2024, https://rmi.org/on-the-climate-bills-second-birthday-surging-successes-but-a-split-reality.

205 La Maison Élysée, "Conseil de planification écologique", 24 September 2023, https://www.elysee.fr/emmanuel-macron/2023/09/25/conseil-de-planification-ecologique.

206 UK Government, "Floating Offshore Wind Manufacturing Investment Scheme", 30 March 2023, https://www.gov.uk/government/publications/floating-offshore-wind-manufacturing-investment-scheme.

207 European Parliament, "Net-Zero Industry Act: Boosting Clean Technologies in Europe", 20 November 2023, https://www.europarl.europa.eu/news/en/headlines/economy/20231031STO08721/net-zero-industry-act-boosting-clean-technologies-in-europe.

208 International Renewable Energy Agency, "Renewable Energy and Jobs: Annual Review 2023", 2023, https://www.irena.org/Publications/2023/Sep/Renewable-energy-and-jobs-Annual-review-2023.

209 International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

210 International Energy Agency(IEA), "Subsidy on New Energy Vehicle 2023", 25 May 2023, https://www.iea.org/policies/17536-subsidy-on-new-energy-vehicle-2023; David Pilling, "Morocco's Carmaking Sector Revs Up for EV Era", Financial Times, 5 October 2023, https://www.ft.com/content/8549619c-9c23-4a00-88ab-dfdac92a22ca; IEA, "Tax Incentive for Manufacturer of Electric Vehicle Charging Equipment", 15 September 2024, https://origin.iea.org/policies?type[]=Government+spending+in+charging+infrastructure; IEA, "Incentives for EVs' Battery Cells", 25 May 2023, https://www.iea.org/policies/17350-incentives-for-evs-battery-cells; IEA, "Electric Vehicles", 2024, https://www.iea.org/energy-system/transport/electric-vehicles.

211 La Maison Élysée, "Conseil de planification écologique", 24 September 2023, https://www.elysee.fr/emmanuel-macron/2023/09/25/conseil-de-planification-ecologique; Ministry of Economy of Malaysia, "National Energy Transition Roadmap", 2023, https://www.ekonomi.gov.my/sites/default/files/2023-09/National%20Energy%20Transition%20Roadmap_0.pdf; Aya Benazizi, "Study: Morocco Is Becoming an 'Electric Vehicle Manufacturing Hub'", Morocco World News, 1 September 2022, https://www.moroccoworldnews.com/2022/09/351097/study-morocco-is-becoming-an-electric-vehicle-manufacturing-hub.

212 International Energy Agency, "Critical Minerals Policy Tracker – Data Tools", accessed 2 April 2024, https://www.iea.org/data-and-statistics/data-tools/critical-minerals-policy-tracker.

213 European Commission, "EU and International Partners Agree to Expand Cooperation on Critical Raw Materials", 4 April 2024, https://ec.europa.eu/commission/presscorner/detail/en/IP_24_1807.

214 European Commission, "COP27: European Union Concludes a Strategic Partnership with Namibia on Sustainable Raw Materials and Renewable Hydrogen", 7 November 2022, https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6683.

215 European Commission, "Global Gateway: EU Signs Strategic Partnerships on Critical Raw Materials Value Chains with DRC and Zambia and Advances Cooperation with US and Other Key Partners to Develop the 'Lobito Corridor'", 25 October 2023, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_5303.

216 FTI, "China's Export Controls on Critical Minerals – Gallium, Germanium and Graphite", 19 December 2023, https://www.fticonsulting.com/insights/articles/chinas-export-controls-critical-minerals-gallium-germanium-graphite; Reuters, "China Ups Critical Minerals Heat with Graphite Controls", 24 October 2023, https://www.reuters.com/markets/commodities/china-ups-critical-minerals-heat-with-graphite-controls-2023-10-24.

217 Gracelin Baskaran, "What China's Ban on Rare Earths Processing Technology Exports Means", Center for Strategic and International Studies, 8 January 2024, https://www.csis.org/analysis/what-chinas-ban-rare-earths-processing-technology-exports-means.

218 Russian Government, "Government Introduces Temporary Ban on Export of Precious Metal Waste and Scrap", 31 October 2023, http://government.ru/en/docs/49949.

219 Liesl Peyper, "Africa Warned Against Imposing Export Bans on Minerals", Miningmx, 9 February 2024, https://www.miningmx.com/news/markets/55860-africa-warned-against-imposing-export-bans-on-critical-minerals.

220 International Energy Agency, "Energy Technology Patents Data Explorer", accessed 14 September 2024, https://www.iea.org/data-and-statistics/data-tools/energy-technology-patents-data-explorer.

221 International Energy Agency, "Energy Technology Patents Data Explorer", accessed 14 September 2024, https://www.iea.org/data-and-statistics/data-tools/energy-technology-patents-data-explorer.

222 International Energy Agency, "Energy Technology Patents Data Explorer", accessed 14 September 2024, https://www.iea.org/data-and-statistics/data-tools/energy-technology-patents-data-explorer.

223 International Energy Agency, "Energy Technology Patents Data Explorer", accessed 14 September 2024, https://www.iea.org/data-and-statistics/data-tools/energy-technology-patents-data-explorer.

224 International Energy Agency, "Energy Technology Patents Data Explorer", accessed 14 September 2024, https://www.iea.org/data-and-statistics/data-tools/energy-technology-patents-data-explorer.

225 International Energy Agency, "The State of Clean Technology Manufacturing: An Energy Technology Perspectives Special Briefing", May 2023, https://iea.blob.core.windows.net/assets/0a421001-6157-436d-893c-c37eeab54967/TheStateofCleanTechnologyManufacturing.pdf.

226 International Energy Agency, "The State of Clean Technology Manufacturing: An Energy Technology Perspectives Special Briefing", May 2023, https://iea.blob.core.windows.net/assets/0a421001-6157-436d-893c-c37eeab54967/TheStateofCleanTechnologyManufacturing.pdf.

227 International Energy Agency, "The State of Clean Technology Manufacturing: An Energy Technology Perspectives Special Briefing", May 2023, https://iea.blob.core.windows.net/assets/0a421001-6157-436d-893c-c37eeab54967/TheStateofCleanTechnologyManufacturing.pdf.

228 International Energy Agency, "Advancing Clean Technology Manufacturing", 2024, https://iea.blob.core.windows.net/assets/7e7f4b17-1bb2-48e4-8a92-fb9355b1d1bd/CleanTechnologyManufacturingRoadmap.pdf.

229 International Energy Agency, "Advancing Clean Technology Manufacturing", 2024, https://iea.blob.core.windows.net/assets/7e7f4b17-1bb2-48e4-8a92-fb9355b1d1bd/CleanTechnologyManufacturingRoadmap.pdf. **Figure 4** from idem.

230 International Energy Agency, "The State of Clean Technology Manufacturing: An Energy Technology Perspectives Special Briefing", May 2023, https://iea.blob.core.windows.net/assets/0a421001-6157-436d-893c-c37eeab54967/TheStateofCleanTechnologyManufacturing.pdf.

231 International Energy Agency, "The State of Clean Technology Manufacturing: An Energy Technology Perspectives Special Briefing", May 2023, https://iea.blob.core.windows.net/assets/0a421001-6157-436d-893c-c37eeab54967/TheStateofCleanTechnologyManufacturing.pdf.

232 International Energy Agency, "The State of Clean Technology Manufacturing: An Energy Technology Perspectives Special Briefing", May 2023, https://iea.blob.core.windows.net/assets/0a421001-6157-436d-893c-c37eeab54967/TheStateofCleanTechnologyManufacturing.pdf.

233 International Energy Agency, "The State of Clean Technology Manufacturing: An Energy Technology Perspectives Special Briefing", May 2023, https://iea.blob.core.windows.net/assets/0a421001-6157-436d-893c-c37eeab54967/TheStateofCleanTechnologyManufacturing.pdf.

234 Australian Government, Department of Industry, Science, Energy and Resources, "Australia's Nationally Determined Contribution Communication 2022", 2022, https://unfccc.int/sites/default/files/NDC/2022-06/Australias%20NDC%20June%202022%20Update%20%283%29.pdf.

235 **Sidebar 1** from the following sources: REN21, "Renewable Energy and Sustainability Report", 2023, https://www.ren21.net/wp-content/uploads/2019/05/REN21-RESR-2023_LowRes.pdf; German Federal Ministry of Labour and Social Affairs, "Potential Human Rights Risks Supply and Value Chains", 2023, https://www.csr-in-deutschland.de/SharedDocs/Downloads/EN/potential-human-rights-risks-along-supply-and-value-chains.pdf; Laura T. Murphy and Nyrola Elimä, "In Broad Daylight: Uyghur Forced Labour and Global Solar Supply Chains", Sheffield Hallam University, 2021, https://www.shu.ac.uk/helena-kennedy-centre-international-justice/research-and-projects/all-projects/in-broad-daylight; United Nations Development Programme, "United Nations Principles on Business and Human Rights", accessed 3 July 2024, https://www.undp.org/sites/g/files/zskgke326/files/migration/in/UNGP-Brochure.pdf; German Federal Ministry of Labour and Social Affairs, "Branchendialog Energiewirtschaft", accessed 3 July 2024, https://www.csr-in-deutschland.de/DE/Wirtschaft-Menschenrechte/Umsetzungshilfen/Branchendialoge/Energiewirtschaft/energiewirtschaft.html; Business & Human Rights Resource Centre, "Renewable Energy & Human Rights Benchmark 2023", 2023, https://www.business-humanrights.org/en/from-us/briefings/renewable-energy-benchmark-2023; Global Battery Alliance, "Battery Passport", https://www.globalbattery.org/battery-passport.

236 International Renewable Energy Agency, "Renewable Energy and Jobs – Annual Review 2024", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf.

237 International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

238 International Renewable Energy Agency, "Renewable Energy and Jobs – Annual Review 2024", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf.

239 International Renewable Energy Agency, "Renewable Energy and Jobs – Annual Review 2024", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf. **Figure 5** from idem.

240 International Renewable Energy Agency, "Renewable Energy and Jobs – Annual Review 2024", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf.

241 International Renewable Energy Agency, "Renewable Energy and Jobs – Annual Review 2024", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf.

242 International Renewable Energy Agency, "Renewable Energy and Jobs – Annual Review 2024", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf.

243 International Renewable Energy Agency, "Renewable Energy and Jobs – Annual Review 2024", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf.

244 International Renewable Energy Agency, "Renewable Energy and Jobs – Annual Review 2024", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf.

245 International Renewable Energy Agency, "Renewable Energy and Jobs – Annual Review 2024", 2024, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf.

246 Ryan Kennedy, "'IRA Creates 100,000 Clean Energy Jobs and Attracts $110 Billion in Private Investments'", pv magazine USA, 22 January 2024, https://pv-magazine-usa.com/2024/01/22/ira-creates-100000-clean-energy-jobs-and-attracts-110-billion-in-private-investments.

247 European Commission, "The Net-Zero Industry Act", accessed 2 April 2024, https://single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act_en.

248 Queensland Government, "Energy and Jobs Plan", September 2022, https://www.epw.qld.gov.au/__data/assets/pdf_file/0031/32989/queensland-energy-and-jobs-plan-overview.pdf.

249 International Renewable Energy Agency, "Renewable Energy and Jobs – Annual Review 2023", 2023, https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Sep/IRENA_Renewable_energy_and_jobs_2023.pdf.

250 R. Hanna, P. Heptonstall and R. Gross, "Job Creation in a Low Carbon Transition to Renewables and Energy Efficiency: A Review of International Evidence", *Sustainability Science* 19 (2024): 125-150, https://doi.org/10.1007/s11625-023-01440-y.

251 Marlène Buchy and Shristi Shakya, "Gender Equality and Social Inclusion in a Just Energy Transition", ThinkTwenty (T20) India 2023 – Official Engagement Group of G20, 2023, https://t20ind.org/research/gender-equality-and-social-inclusion-in-a-just-energy-transition.

252 REN21, "Renewables 2023 Global Status Report: Economic and Social Value Creation", 2023, https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_EconSocialValueCreation_Full_Report_with_endnotes_web.pdf.

253 UN Women, "Gender Equality in the Sustainable Energy Transition", 10 November 2023, https://www.unwomen.org/en/digital-library/publications/2023/05/gender-equality-in-the-sustainable-energy-transition.

254 REN21, "Renewables 2023 Global Status Report: Economic and Social Value Creation", 2023, https://www.ren21.net/wp-content/uploads/2019/05/GSR2023_EconSocialValueCreation_Full_Report_with_endnotes_web.pdf.

255 International Renewable Energy Agency, "Women as Key Players in the Decentralised Renewable Energy Sector: Beneficiaries, Leaders, Innovators", 8 March 2023, https://www.irena.org/Events/2023/Mar/Women-as-Key-Players-in-the-Decentralised-Renewable-Energy-Sector; US Department of Energy, "The Equality in Energy Transitions Initiative", 8 January 2024, https://www.energy.gov/ia/articles/equality-energy-tranistions-initiative.

256 US Department of Energy, "DOE Equity Action Plan", 2023, https://www.energy.gov/justice/doe-equity-action-plan.

257 US Embassy and Consulate in Nigeria, "USAID Power Africa Launches 'Growing Green Jobs' for Women in the Energy Sector in Nigeria", 28 September 2023, https://ng.usembassy.gov/usaid-power-africa-launches-growing-green-jobs-for-women-in-the-energy-sector-in-nigeria.

258 SHORTLIST, "Energy Jobs in Africa", accessed 12 June 2024, https://www.shortlist.net/women-for-green-jobs.

259 Engineering News , "Renewable Sector Leadership Programme to Develop Skills for Gender Diverse Future", 25 August 2023, https://www.engineeringnews.co.za/print-version/renewable-sector-leadership-programme-to-fevelop-skills-for-gender-diverse-future-2023-08-25.

260 Roman Vakulchuk and Indra Overland, "The Failure to Decarbonize the Global Energy Education System: Carbon Lock-in and Stranded Skill Sets", *Energy Research & Social Science* 110 (April 2024): 103446, https://doi.org/10.1016/j.erss.2024.103446.

261 International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

262 International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

263 International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

264 International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

265 International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

266 International Energy Agency, "Skills Development and Inclusivity for Clean Energy Transitions", 2022, https://iea.blob.core.windows.net/assets/953c5393-2c5b-4746-bf8e-016332380221/Skillsdevelopmentandinclusivityforcleanenergytransitions.pdf.

267 International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

268 European Commission, "The Green Deal Industrial Plan": Putting Europe's Net-zero Industry in the Lead", 31 January 2023, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_510; European Commission, "The Net-Zero Industry Act", accessed 15 September 2024, https://single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act_en.

269 European Commission, "Commission Actions Tackle Labour and Skills Shortages in EU", 19 March 2024, https://ec.europa.eu/commission/presscorner/detail/en/ip_24_1507.

270 International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

271 International Energy Agency, "World Energy Employment 2023", 2023, https://iea.blob.core.windows.net/assets/ba1eab3e-8e4c-490c-9983-80601fa9d736/World_Energy_Employment_2023.pdf.

272 **Snapshot: South Africa** from the following sources: Eskom, "As Komati Coal-Fired Power Station Reaches End of Life, Renewable Energy Project Takes Shape", 31 October 2022, https://www.eskom.co.za/as-komati-coal-fired-power-station-reaches-end-of-life-renewable-energy-project-takes-shape; SA News, "Komati Power Station Repurposing Forges Ahead", 21 June 2023, https://www.sanews.gov.za/south-africa/komati-power-station-repurposing-forges-ahead; Thabo Molelekwa, "Training Ramps Up at Komati", Oxpeckers, 21 June 2023, https://oxpeckers.org/2023/07/training-at-komati; Bloomberg News, "How South Africa Botched Its First Coal Power-plant Transition", 30 September 2023, https://www.mining.com/web/how-south-africa-botched-its-first-coal-power-plant-transition; Theresa Smith, "Reskilling Coal Workers to Start Mpumalanga Training Centre", ESI Africa, 23 August 2022, https://www.esi-africa.com/renewable-energy/reskilling-coal-industry-workers-to-start-at-mpumalanga-training-centre; My Broadband, "Komati Economy Hammered as Eskom Power Plant's Solar and Wind Transition Gets Delayed", 23 July 2023, https://mybroadband.co.za/news/energy/501239-komati-economy-hammered-as-eskom-power-plants-solar-and-wind-transition-gets-delayed.html.

273 UK Department for Energy Security and Net Zero, "Thousands of Heat Pump Installers to Be Trained for Fraction of the Price", 4 July 2023, https://www.gov.uk/government/news/thousands-of-heat-pump-installers-to-be-trained-for-fraction-of-the-price.

274 UK Department for Energy Security and Net Zero, "Thousands of Heat Pump Installers to Be Trained for Fraction of the Price", 4 July 2023, https://www.gov.uk/government/news/thousands-of-heat-pump-installers-to-be-trained-for-fraction-of-the-price.

275 Roman Vakulchuk and Indra Overland, "The Failure to Decarbonize the Global Energy Education System: Carbon Lock-in and Stranded Skill Sets", *Energy Research & Social Science* 110 (April 2024): 103446, https://doi.org/10.1016/j.erss.2024.103446.

276 Elias Ngalame, "Ministry Opens Door to Renewable Energy Training in Region", University World News, 7 September 2023, https://www.universityworldnews.com/post.php?story=20230903214431858.

277 Cléa Flache, Hugo Chirol and Léa Legras, "From Energy Crisis to Energy Democracy", Green European Journal, 15 September 2023, https://www.greeneuropeanjournal.eu/from-energy-crisis-to-energy-democracy.

278 International Renewable Energy Agency, "World Energy Transitions Outlook 2023: 1.5°C Pathway", 2023, https://www.irena.org/Publications/2023/Jun/World-Energy-Transitions-Outlook-2023.

279 Cléa Flache, Hugo Chirol and Léa Legras, "From Energy Crisis to Energy Democracy", Green European Journal, 15 September 2023, https://www.greeneuropeanjournal.eu/from-energy-crisis-to-energy-democracy.

280 **Snapshot: Germany** from Institut für Trend- und Marktforschung, "Anteile Einzelner Marktakteure an Erneuerbaren Energien-Anlagen in Deutschland (4. Auflage)", 27 September 2024, https://www.trendresearch.de/studie.php?s=693. **Figure 6** from Idem.

281 Transnational Institute, "MYTH #4 – Decentralised Energy Will Decarbonise & Democratise the Energy System", 2023,

https://www.tni.org/files/2023-09/Factsheet%20No.4%20_%20TNI%20_%20Energy%20Transition%20Mythbusters%202023%20_%20300823.pdf.

282 **Snapshot: France** from the following sources: Énergie Partagée, "Les Chiffres Clés de L'énergie Citoyenne", accessed 15 September 2024, https://energie-partagee.org/decouvrir/energie-citoyenne/chiffres-cles; Énergie Partagée, "Le Mouvement Énergie Partagée", accessed 15 September 2024, https://energie-partagee.org/decouvrir/le-mouvement; Énergie Partagée, "Énergie Partagée Investissement", accessed 15 September 2024, https://energie-partagee.org/decouvrir/le-mouvement/energie-partagee-investissement; Suzanne Renard, Energie Partagée Investissement, personal communication with REN21, September 2024.

283 Vida Rozite *et al.*, "Empowering People – The Role of Local Energy Communities in Clean Energy Transitions", International Energy Agency, 9 August 2023, https://www.iea.org/commentaries/empowering-people-the-role-of-local-energy-communities-in-clean-energy-transitions.

284 Vida Rozite *et al.*, "Empowering People – The Role of Local Energy Communities in Clean Energy Transitions", International Energy Agency, 9 August 2023, https://www.iea.org/commentaries/empowering-people-the-role-of-local-energy-communities-in-clean-energy-transitions.

285 REScoop.Eu, "Implementing Solutions for a Low Carbon (Energy) Future", accessed 2 July 2024, https://www.rescoop.eu/news-and-events/events/implementing-solutions-for-a-low-carbon-energy-future; International Renewable Energy Agency, "Community Energy Toolkit", 2021, https://www.irena.org/-/media/Files/IRENA/Coalition-for-Action/IRENA_Coalition_Energy_Toolkit_2021.pdf.

286 European Commission Directorate-General for Energy, "Energy Communities", accessed 15 September 2024, https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-communities_en.

287 European Commission, "Guiding Energy Communities Towards Inclusivity", CORDIS, accessed 2 April 2024, https://cordis.europa.eu/article/id/450215-guiding-energy-communities-towards-inclusivity.

288 Sergio Matalucci, "Italy Publishes Operating Rules for Energy Communities", pv magazine International, 26 February 2024, https://www.pv-magazine.com/2024/02/26/italy-publishes-operating-rules-for-energy-communities.

289 Sarah George, "Wales Launches Publicly Owned Energy Company with Focus on Community Renewables", edie, 7 August 2023, https://www.edie.net/wales-launches-publicly-owned-energy-company-with-focus-on-community-renewables.

290 KPMG Albania, "New Law on 'Promotion of the Use of Energy from Renewable Sources'", 4 May 2023, https://kpmg.com/al/en/home/insights/2023/05/new-law-on--promotion-of-the-use-of-energy-from-renewable-source.html.

291 Angela Skujins, "Denmark Supports First Energy Communities", pv magazine International, 22 December 2023, https://www.pv-magazine.com/2023/12/22/denmark-supports-first-energy-communities.

292 Ilias Tsagas, "Greece to Support Local Energy Communities with €42 Million of Funding", pv magazine International, 14 December 2023, https://www.pv-magazine.com/2023/12/14/greece-to-support-local-energy-communities-with-e42-million-of-funding.

293 United Nations Framework Convention on Climate Change, "Crowdfunding for Community Solar Projects | The Netherlands", accessed 14 March 2024, https://unfccc.int/climate-action/momentum-for-change/financing-for-climate-friendly-investment/crowdfunding-for-community-solar-projects.

294 United Nations Framework Convention on Climate Change, "Crowdfunding for Community Solar Projects | The Netherlands", accessed 14 March 2024, https://unfccc.int/climate-action/momentum-for-change/financing-for-climate-friendly-investment/crowdfunding-for-community-solar-projects.

295 Energie Samen, accessed 15 September 2024, https://energiesamen.nu/pagina/35/financiering.

296 REScoop, "About Us", accessed 15 September 2024, https://www.rescoop.eu/about-us.

297 ICA Coop, "Replication Project: Revolusolar from Brazil", accessed 7 February 2024, https://globalyouth.coop/en/projects/replication-project/brazil/revolusolar.

298 Vida Rozite *et al.*, "Empowering People – The Role of Local Energy Communities in Clean Energy Transitions", International Energy Agency, 9 August 2023, https://www.iea.org/commentaries/empowering-people-the-role-of-local-energy-communities-in-clean-energy-transitions.

299 Chris Vrettos *et al.*, "Not (Just) for Hippies: Energy Communities Should Be the Drivers of the EU's Re-Industrialisation", Euro News, 3 June 2024, https://www.euronews.com/business/2024/06/03/not-just-for-hippies-energy-communities-should-be-the-drivers-of-the-eus-re-industrialisat.

300 Energy Sage, "The Top Community Solar States in 2023", 6 December 2023, https://www.energysage.com/community-solar/comparing-top-community-solar-states.

301 Energy Sage, "The Top Community Solar States in 2023", 6 December 2023, https://www.energysage.com/community-solar/comparing-top-community-solar-states.

302 Australian Government, Department of Climate Change, Energy, the Environment and Water, "Community Solar Banks", accessed 14 March 2024, https://www.dcceew.gov.au/energy/renewable/community-solar-banks.

303 The Hon Ed Husic MP, Minister for Industry and Science, "Improving Energy Security, Reliability and Affordability", 24 October 2022, https://www.minister.industry.gov.au/ministers/husic/media-releases/improving-energy-security-reliability-and-affordability.

304 **Snapshot: Canada** from the following sources: Government of Canada, Indigenous Services, "Suicide Prevention in Indigenous Communities", 11 December 2019, https://www.sac-isc.gc.ca/eng/1576089685593/1576089741803; Natural Resources Canada, "Governments of Canada and Ontario Working Together to Build Largest Electricity Battery Storage Project in Canada", 10 February 2023, https://www.canada.ca/en/natural-resources-canada/news/2023/02/governments-of-canada-and-ontario-working-together-to-build-largest-electricity-battery-storage-project-in-canada0.html; Invest Canada, "Cleantech", 17 February 2023, https://www.investcanada.ca/industries/cleantech; Government of Canada, "Indigenous Peoples and Communities", 12 January 2009, https://www.rcaanc-cirnac.gc.ca/eng/1100100013785/1529102490303; Government of Canada, Canada Energy Regulator, "Market Snapshot: Indigenous Ownership of Canadian Renewable Energy Projects Is Growing", 28 June 2024, https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2023/market-snapshot-indigenous-ownership-canadian-renewable-energy-projects-growing.html; Indigenous Clean Energy (ICE), "About ICE", accessed 29 September 2024, https://indigenouscleanenergy.com/about-ice; James Jenkins, ICE, "Our Story", accessed 29 September 2024, https://indigenouscleanenergy.com/about-ice/our-story; ICE, personal communication with REN21, September 2024; Indigenous Peoples Rights International, personal communication with REN21, September 2024; Mohan B. Kumar and Michael Tjepkema, "Suicide Among First Nations People, Métis and Inuit (2011-2016): Findings from the 2011 Canadian Census Health and Environment Cohort (CanCHEC)", Statistics Canada, 28 June 2019, https://www150.statcan.gc.ca/n1/pub/99-011-x/99-011-x2019001-eng.htm; United Nations, "United Nations Declaration on the Rights of Indigenous Peoples", accessed 29 September 2024, https://www.un.org/development/desa/indigenouspeoples/declaration-on-%20the-rights-of-indigenous-peoples.html.

305 Global Center on Adaptation, "Three Ways That Clean Energy Innovation and Climate Change Adaptation Can Work in Lockstep", 26 January 2024, https://gca.org/three-ways-that-clean-energy-innovation-and-climate-change-adaptation-can-work-in-lockstep.

306 International Renewable Energy Agency, "Bracing for Climate Impact: Renewables as a Climate Change Adaptation Strategy", 2021, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Aug/IRENA_Bracing_for_climate_impact_2021.pdf.

307 Clean Energy Group, "Clean Energy for Resilient Communities: Expanding Solar Generation in Baltimore's Low-Income Neighborhoods", 2014, https://www.cleanegroup.org/wp-content/uploads/Clean-Energy-for-Resilient-Communities-Report-Feb2014.pdf.

308 Clean Energy Group, "Clean Energy for Resilient Communities: Expanding Solar Generation in Baltimore's Low-Income Neighborhoods", 2014, https://www.cleanegroup.org/wp-content/uploads/Clean-Energy-for-Resilient-Communities-Report-Feb2014.pdf.

309 International Energy Agency, "Policy Preparedness for Climate Resilience – Climate Resilience Policy Indicator", accessed 23 September 2024, https://www.iea.org/reports/climate-resilience-policy-indicator/policy-preparedness-for-climate-resilience.

310 International Energy Agency, "Policy Preparedness for Climate Resilience – Climate Resilience Policy Indicator", accessed 23 September 2024, https://www.iea.org/reports/climate-resilience-policy-indicator/policy-preparedness-for-climate-resilience.

311 UN-Water, "Water and Disasters", accessed 2 October 2024, https://www.unwater.org/water-facts/water-and-disasters.

312 Makena Ireri *et al.*, "How Off-grid Solutions Are Key to Climate Adaptation and Resilience", Sustainable Energy for All, 14 November 2022, https://blogs.worldbank.org/en/energy/how-grid-solar-solutions-are-key-climate-adaptation-and-resilience.

313 Tamara Mahoney, "Powering Adaptation and Climate Justice: The Critical Role of Off-Grid Solar Technologies",

GOGLA, 4 September 2023, https://www.gogla.org/reports/powering-adaptation-and-climate-justice.

314 United Nations Framework Convention on Climate Change, "Bangladesh First NDC (Updated Submission)", 2 June 2022, https://unfccc.int/documents/497161.

315 Tamara Mahoney, "Powering Adaptation and Climate Justice: The Critical Role of Off-Grid Solar Technologies", GOGLA, 4 September 2023, https://www.gogla.org/reports/powering-adaptation-and-climate-justice.

316 Tamara Mahoney, "Powering Adaptation and Climate Justice: The Critical Role of Off-Grid Solar Technologies", GOGLA, 4 September 2023, https://www.gogla.org/reports/powering-adaptation-and-climate-justice.

317 Tamara Mahoney, "Powering Adaptation and Climate Justice: The Critical Role of Off-Grid Solar Technologies", GOGLA, 4 September 2023, https://www.gogla.org/reports/powering-adaptation-and-climate-justice.

318 Tamara Mahoney, "Powering Adaptation and Climate Justice: The Critical Role of Off-Grid Solar Technologies", GOGLA, 4 September 2023, https://www.gogla.org/reports/powering-adaptation-and-climate-justice.

319 Center for Climate and Energy Solutions, "Microgrids", accessed 2 October 2024, https://www.c2es.org/content/microgrids.

320 Center for Climate and Energy Solutions, "Microgrids", accessed 2 October 2024, https://www.c2es.org/content/microgrids.

321 Center for Climate and Energy Solutions, "Microgrids", accessed 2 October 2024, https://www.c2es.org/content/microgrids.

322 EcoSwell, "Renewable Energy", accessed 28 September 2024, https://www.ecoswell.org/renewable-energy.

323 EcoSwell, "Renewable Energy", accessed 28 September 2024, https://www.ecoswell.org/renewable-energy.

324 Diana Gastelum, "The Role of Microgrids in Building Climate Resilience in Boston's Frontline Communities", Climate-XChange, 7 January 2022, https://climate-xchange.org/2022/01/the-role-of-microgrids-in-building-climate-resilience-in-bostons-frontline-communities.

325 Diana Gastelum, "The Role of Microgrids in Building Climate Resilience in Boston's Frontline Communities", Climate-XChange, 7 January 2022, https://climate-xchange.org/2022/01/the-role-of-microgrids-in-building-climate-resilience-in-bostons-frontline-communities.

326 Diana Gastelum, "The Role of Microgrids in Building Climate Resilience in Boston's Frontline Communities", Climate-XChange, 7 January 2022, https://climate-xchange.org/2022/01/the-role-of-microgrids-in-building-climate-resilience-in-bostons-frontline-communities.

327 United Nations Environment Programme, "The Sectoral Solution to Climate Change", 12 July 2020, https://www.unep.org/interactive/sectoral-solution-climate-change.

328 United Nations Environment Programme, "The Sectoral Solution to Climate Change", 12 July 2020, https://www.unep.org/interactive/sectoral-solution-climate-change.

329 International Renewable Energy Agency, "Bracing for Climate Impact: Renewables as a Climate Change Adaptation Strategy", 2021, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Aug/IRENA_Bracing_for_climate_impact_2021.pdf.

330 Global Center on Adaptation, "Three Ways That Clean Energy Innovation and Climate Change Adaptation Can Work in Lockstep", 26 January 2024, https://gca.org/three-ways-that-clean-energy-innovation-and-climate-change-adaptation-can-work-in-lockstep.

331 International Renewable Energy Agency, "Bracing for Climate Impact: Renewables as a Climate Change Adaptation Strategy", 2021, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Aug/IRENA_Bracing_for_climate_impact_2021.pdf.

332 International Renewable Energy Agency, "Bracing for Climate Impact: Renewables as a Climate Change Adaptation Strategy", 2021, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Aug/IRENA_Bracing_for_climate_impact_2021.pdf.

333 International Renewable Energy Agency, "Bracing for Climate Impact: Renewables as a Climate Change Adaptation Strategy", 2021, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Aug/IRENA_Bracing_for_climate_impact_2021.pdf.

334 REN21, "REN21 Policy Database", 2024.

335 REN21, "REN21 Policy Database", 2024.

336 REN21, "REN21 Policy Database", 2024.

337 Maggie Overholt *et al.*, "What Are Nationally Determined Contributions (NDCs) and Why Are They Important?" World Resources Institute, 8 May 2024, https://www.wri.org/insights/nationally-determined-contributions-ndcs-explained.

338 United Nations, "About Small Island Developing States", accessed 28 September 2024, https://www.un.org/ohrlls/content/about-small-island-developing-states.

339 United Nations Framework Convention on Climate Change, "Antigua and Barbuda First NDC (Updated Submission)", 2 September 2021, https://unfccc.int/documents/497048.

340 United Nations Framework Convention on Climate Change, "Antigua and Barbuda First NDC (Updated Submission)", 2 September 2021, https://unfccc.int/documents/497048.

341 United Nations Framework Convention on Climate Change, "Micronesia (Federated State of) First NDC", 2 June 2022, https://unfccc.int/documents/497482.

342 United Nations Framework Convention on Climate Change, "Dominica First NDC", 2 June 2022, https://unfccc.int/documents/497439.

343 United Nations, "SIDS Lighthouses Initiative (SIDS LHI)", accessed 28 September 2024, https://sdgs.un.org/partnerships/sids-lighthouses-initiative-sids-lhi.

344 United Nations Framework Convention on Climate Change, "Egypt's Updated First Nationally Determined Contribution 2030 (Second Update)", 26 June 2023, https://unfccc.int/documents/630376.

345 Department of Mineral Resources and Energy, Republic of South Africa, "Renewable Energy Independent Power Producer Procurement (REIPPP) Programme", 2024, https://www.dmre.gov.za/energy-resources/reippp-programme.

346 United Nations Framework Convention on Climate Change, "Ghana First NDC (Updated Submission)", 2 June 2022, https://unfccc.int/documents/497515.

347 United Nations Framework Convention on Climate Change, "Uganda's Updated NDC", 12 September 2022, https://unfccc.int/documents/613827.

348 Habtewold Woubishet *et al.*, "Ethiopia's Climate Resilient Green Economy Strategy (2011-2019): Implementation Progress Assessment Report – Sectoral Overview Appendices", World Bank, 2020, https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099431306152210191/P17111608a30af0b00ab1705840c391dc04.

349 International Energy Agency, "Policy Preparedness for Climate Resilience – Climate Resilience Policy Indicator", 2022, https://www.iea.org/reports/climate-resilience-policy-indicator/policy-preparedness-for-climate-resilience.

350 International Energy Agency, "Policy Preparedness for Climate Resilience – Climate Resilience Policy Indicator", 2022, https://www.iea.org/reports/climate-resilience-policy-indicator/policy-preparedness-for-climate-resilience.

351 Power Philippines, "Microgrid Systems Bill Signed Into Law", 25 January 2022, https://powerphilippines.com/microgrid-systems-bill-signed-into-law.

352 International Energy Agency, "Climate Resilience – Power Systems in Transition", 2020, https://www.iea.org/reports/power-systems-in-transition/climate-resilience.

353 REN21, "Renewable Energy and Sustainability Report", 2024, https://www.ren21.net/renewable-energy-and-sustainability-report-2024.

354 World Bank, "Embedding Climate Resilience Into Energy Projects", 2023, https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099082923131118522/P1764760bf735200c0890f05d7ea45e4933.

355 REN21, "Renewable Energy and Sustainability Report", 2024, https://www.ren21.net/renewable-energy-and-sustainability-report-2024.

356 International Renewable Energy Agency, "Bracing for Climate Impact: Renewables as a Climate Change Adaptation Strategy", 2021, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Aug/IRENA_Bracing_for_climate_impact_2021.pdf.

357 **Box 3** from the following sources: Energy Peace Partners, "Measuring the Peace Impacts of Renewable Energy", accessed 2 October 2024, https://www.energypeacepartners.com/peace-impacts; Doug Miller and Bessma Mourad, Energy Peace Partners, personal communication with REN21, September 2024; Energy Peace Partners, "Renewable Energy and Peace: Empirical Analysis of Global Data", 2023, https://static1.squarespace.com/static/5cc327c55acb9b00019d816a/t/650b5190bf74dd685461153e/1695240594680/Final_Peace+Impacts+of+RE+White+Paper_Sept+20+2023.pdf; Energy Peace Partners, "Renewable Energy as a Tool For Peace: Emerging Opportunities and New Challenges", 28 June 2024, https://www.energypeacepartners.com/blog/re-as-a-tool-for-peace.

358 **Sidebar 2** from the following sources: Global Center on Adaptation, "The Netherlands and GCA Join Forces to Scale Africa's Adaptation Transformation", 15 September 2023, https://gca.org/news/the-netherlands-and-gca-join-forces-to-scale-africas-adaptation-transformation; Global Center on Adaptation, "Africa Adaptation Acceleration Program", 2022,

https://gca.org/wp-content/uploads/2022/11/2022_AAAP-Progress.pdf; Aga Khan Foundation, "Energy Plus: AKF and EU Launch €31m Programme to Improve Access to Clean Energy for 350,000 People in Northern Pakistan", 15 July 2024, https://www.akf.org.uk/energy-plus-akf-and-eu-launch-e35m-programme-to-improve-access-to-clean-energy-for-350000-people-in-northern-pakistan.

359 Organisation for Economic Co-operation and Development, "Official Development Assistance for Climate in 2022: A Snapshot", May 2024, https://one.oecd.org/document/DCD(2024)20/en/pdf.

PHOTO CREDITS

Page 06 ©medinegurbet; pexels.com
Page 07 ©Saffa_O; shutterstock.com
Page 09 ©Geoff Sperring; shutterstock.com
Page 10 ©Jenson; shutterstock.com
Page 11 ©Operación Solar
Page 12 ©Los Muertos Crew; pexels.com
Page 13 ©marimos; shutterstock.com
Page 13 ©manfredxy; shutterstock.com
Page 14 ©Teerayuth Mitrsermsarp; shutterstock.com
Page 14 ©Warren Parker; shutterstock.com
Page 15 ©PradeepGaurs; shutterstock.com
Page 16 ©Gwoeii; shutterstock.com
Page 16 ©Tukio; shutterstock.com
Page 17 ©Elen Marlen; shutterstock.com
Page 17 ©WH_Pics; shutterstock.com
Page 18 ©Manuel Soler Mayor; shutterstock.com
Page 19 ©vicentegarridoj; shutterstock.com
Page 20 ©Operación Solar
Page 20 ©Operación Solar
Page 21 ©Markus Spiske; unsplash.com
Page 22 ©Mārtiņš Zemlickis; pexels.com
Page 23 ©Pit Stock; shutterstock.com
Page 23 ©Melanie Hobson; shutterstock.com
Page 24 ©kaninw; shutterstock.com
Page 25 ©YMK Films; shutterstock.com
Page 26 ©Pavlo Glazkov; shutterstock.com
Page 26 ©imagesef; shutterstock.com
Page 26 ©KRISS75; shutterstock.com
Page 27 ©Halfpoint; shutterstock.com
Page 28 ©humphery; shutterstock.com
Page 30 ©Joan Sullivan/Climate Visuals Countdown
Page 32 ©CRS PHOTO; shutterstock.com
Page 32 ©Virrage Images; shutterstock.com
Page 33 ©PAUL BOTES; gettyimages
Page 34 ©Odd Man; shutterstock.com
Page 34 ©clicksabhi; shutterstock.com
Page 35 ©Altrendo Images; shutterstock.com
Page 35 ©Harald Lueder; shutterstock.com
Page 36 ©ND700; shutterstock.com
Page 37 ©Frankie_Nikki; Energie Partagée Investissement
Page 39 ©Dr. Ingmar Koehler; shutterstock.com
Page 40 ©Hussain Warraich; shutterstock.com
Page 41 ©Nature_island_beauty; shutterstock.com
Page 42 ©MDV Edwards; shutterstock.com
Page 43 ©BOULENGER Xavier; shutterstock.com
Page 43 ©BOULENGER Xavier; shutterstock.com
Page 43 ©BOULENGER Xavier; shutterstock.com
Page 54 ©Space-kraft; shutterstock.com

COPYRIGHT & IMPRINT

Renewable Energy Policy Network for the 21st Century

REN21 RENEWABLES NOW

REN21 Secretariat
158 ter rue du Temple
75003 Paris
France

REN21

RENEWABLES 2024
GLOBAL STATUS REPORT

ECONOMIC AND SOCIAL VALUE CREATION

2024

ISBN 978-3-948393-18-2

REN21 Secretariat
158 ter rue du Temple
75003 Paris
France

www.ren21.net