IRENA
International Renewable Energy Agency

Renewable energy targets in 2022

A guide to design

ISBN: 978-92-9260-480-6

Citation: IRENA (2022), *Renewable energy targets in 2022: A guide to design,* International Renewable Energy Agency, Abu Dhabi.

ABOUT IRENA

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

ACKNOWLEDGEMENTS

This report was developed under the guidance of Rabia Ferroukhi (Director, IRENA Knowledge, Policy and Finance Centre) and Ute Collier, and authored by Diala Hawila, Faran Rana, Abdullah Abou Ali and Arslan Khalid (IRENA), Costanza Strinati and Sufyan Diab (former IRENA colleagues), Miquel Muñoz Cabré (Stockholm Environment Institute), David Jacobs (IET Consulting) and Toby Couture (E3 Analytics), with valuable contributions from Adrian Whiteman, Nazik Elhassan, Sonia Rueda Silva, Emanuele Bianco, Jinlei Feng, Imen Gherboudj, and Gerardo Escamilla (IRENA), Paola Pérez (Tufts University) and Michelle Benaderet (Boston University).

Valuable review and feedback were provided by IRENA colleagues Aleksandra Prodan, Álvaro López-Peña, Arieta Gonelevu Rakai, Badariah Yosiyana, Binu Parthan, Camilo Ramirez Isaza, Elizabeth Njoki Wanjiru, Ines Jacob, Joong Yeop Lee, José Torón, Kamlesh Dookayka, Kamran Siddiqui, Karanpreet Kaur, Margaret Suh, Nadia Mohammed, Petya Icheva, Paul Komor, Simon Benmarraze, Toyo Kawabata, Wilson Matekenya and Zoheir Hamedi. Valuable external review was provided by Katarina Uherova Hasbani (AESG). The report was edited by Justin French-Brooks. Cover image credits: shutterstock.com and freepic.com.

IRENA is grateful for the generous support for this report provided by the Walloon government.

For further information or to provide feedback: **publications@irena.org.**
Available for download: **www.irena.org/publications.**

DISCLAIMER

CONTENTS

FIGURES

TABLES

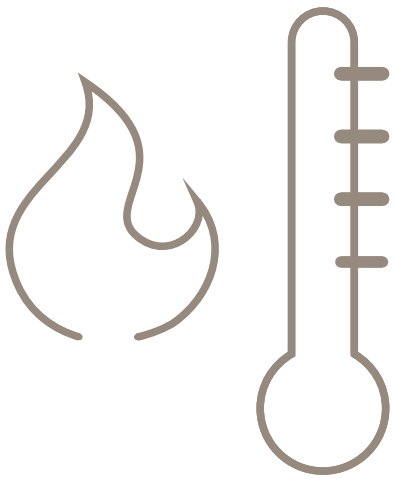
BOXES

ABBREVIATIONS

CSP	concentrated solar power
ETS	emissions trading system
EV	electric vehicle
FCV	fuel cell vehicle
FIT	feed-in tariff
GIS	geographic information system
GDP	gross domestic product
GHG	greenhouse gas
JETS	Just Energy Transition Partnership
LCOE	levelised cost of electricity
LDC	least developed countries
LPG	liquefied petroleum gas
MENA	Middle East and North Africa
NDC	Nationally Determined Contribution
PV	photovoltaic
RPS	renewable portfolio standards
SDG	Sustainable Development Goal
SIDS	small island developing states
SWH	solar water heater
TFEC	total final energy consumption
TPES	total primary energy supply
WETO	World energy transitions outlook

UNITS OF MEASURE

Gt	gigatonne
GW	gigawatt
GWh	gigawatt hour
kg	kilogram
kt	kilotonne
kW	kilowatt
kWh	kilowatt hour
Mtce	million tonnes of coal equivalent
MW	megawatt
MWh	megawatt hour
TW	terawatt



SUMMARY FOR POLICY MAKERS

GLOBAL DEVELOPMENTS CONTINUE TO SIGNAL WHY URGENT CHANGE IS NEEDED

The summer of 2022 has given the world a glimpse of a future in which the fight against climate change has been lost.

Temperatures are on the rise. July 2022 was the 46th consecutive July and the 451st consecutive month with temperatures exceeding the average for the 20th century (National Centers for Environmental Information, 2022). Heatwaves caused wildfires of unprecedented severity in Europe and the United States. Drought frequency and duration have increased by nearly a third since 2000 and water restrictions have been imposed in numerous jurisdictions, including in France, the United States and southwest China. Climate change is negatively affecting harvests and pushing up food prices globally, leaving 18 million people in Africa facing the risk of severe hunger (World Economic Forum, 2022). In Pakistan, which contributes less than 1% of annual global greenhouse gas (GHG) emissions, major climate-induced flooding left almost one-third of the country submerged, washing away half the country's crops and causing significant food shortages (BBC News, 2022).

Multiple crises and the conflict in Ukraine reveal the fragility of a fossil fuel-based energy system.

Food prices were already high globally, as the world grapples with record-high inflation and energy prices, partly due to the conflict in Ukraine. In the European Union, electricity prices rose to historic levels in 2022.

Meanwhile, some 2.4 billion people still relied on traditional biomass for cooking in 2020 and 733 million people remained without access to electricity. In many countries, where there is access to electricity it is unreliable, slowing down socio-economic development.

At the same time, supply chain disruptions, permitting and licensing issues, along with other political and regulatory barriers are impeding the development of urgently needed renewable energy projects. The focus of renewable energy policy on cost-competitiveness has led to the concentration of supply chains in a small number of countries. Trade issues and COVID-related lockdowns have disrupted the supply of key components and equipment from those countries to the rest of the world, demonstrating the vulnerability of this model and the value of localisation.

These developments show the need for immediate action to increase ambition for renewable energy deployment, for climate goals, energy security and affordability, and to ensure universal basic rights such as access to energy, food and water. Recent developments also show that greater ambition is needed for the development of local supply chains that can contribute to energy security.

This report sets out to support governments in designing renewable energy targets that can help achieve the pressing objectives of reducing GHG emissions from burning fossil fuels, increasing resilience to climate impacts, limiting the dependence on energy imports, and achieving universal access to clean, affordable and reliable energy. While the report focuses mainly on national-level renewable energy targets, the lessons and insights apply to targets adopted by other levels of government.

CLIMATE PLEDGES MADE TO DATE SHOULD BE SIGNIFICANTLY ENHANCED TO UNLOCK THE FULL POTENTIAL OF RENEWABLE ENERGY, WHICH REMAINS LARGELY UNTAPPED

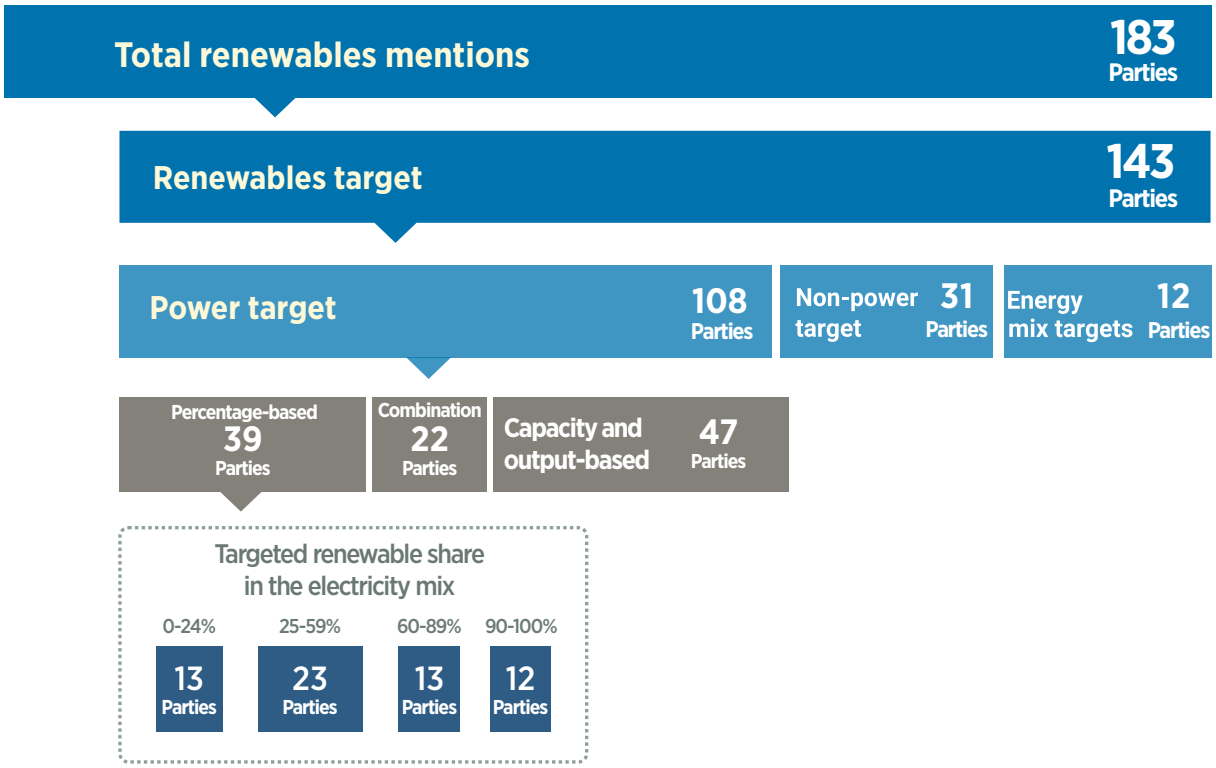
Almost all countries have signed the Paris Agreement and submitted Nationally Determined Contributions (NDCs), but the collective level of ambition of the commitments made to date is still not enough to limit global temperature rise to 1.5°C.

Since the signing of the Paris Agreement, 194 Parties have submitted NDCs. Since COP26 in November 2021, 24 countries had updated their NDCs (up to 16 October 2022), 8 out of which have updated their NDCs following the Glasgow Climate Pact that requested Parties to revisit and strengthen the 2030 targets in their NDCs by the end of 2022.

Renewable energy is one of the key components of the energy transition, but not all countries have included targets for their deployment in their NDCs. As of 16 October 2022, 183 Parties had included renewable energy components in their NDCs, of which only 143 had a quantified target. Of these targets, 108 focus on power and only 31 have targets for heating and cooling, transport or cooking. Only 12 Parties had committed to a percentage of renewables in their overall energy mixes.

Of the 108 Parties that had defined targets for renewables in the power sector in their NDCs, 47 presented them only in the form of additions – mostly in the form of capacity (GW) and a few in terms of output (GWh). Of the 61 Parties with targets defined as a share of the power mix, 13 commit to achieving a renewable energy share lower than 24%, 23 commit to a share between 25% and 59%, 13 commit to shares between 60% and 89%, and 12 committed to shares between 90% to 100% (see Figure S1). The design elements of renewable energy targets are detailed further in Chapter 3 of this report.

Figure S1 Renewable energy targets in NDCs (as of 16 October 2022)

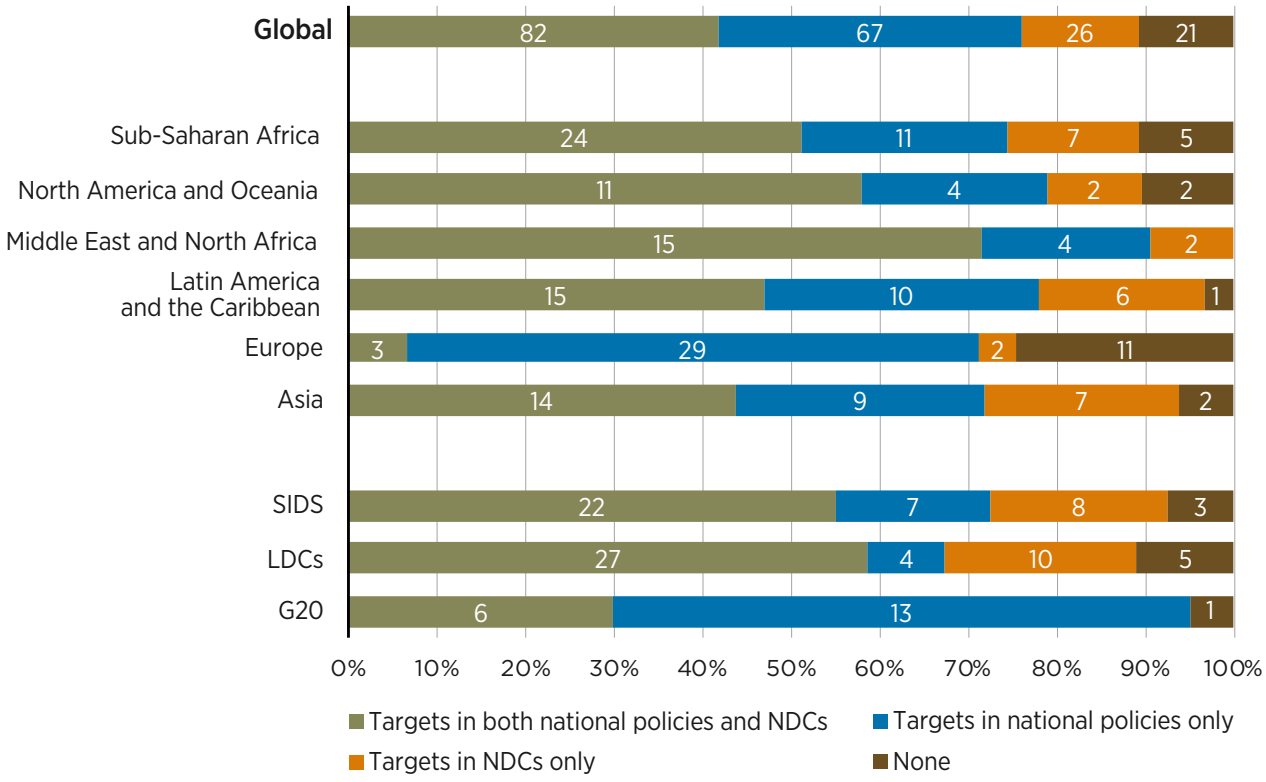


Commitments are being made outside the NDC process and beyond the 2030 time horizon. As of October 2022, 137 countries, 116 regions and 237 cities had made net zero commitments for 2050 as reported by the Net Zero Tracker. Private companies have also made such pledges. Almost 700 out of the 2 000 largest publicly traded companies globally have or are considering a net zero target. Together these 700 companies represent more than half of their cohort's total annual revenue in 2020 (Net Zero Tracker, 2022). However, many of them have not backed up these targets with operational plans and strategies, leaving open the question of whether they would be realised (Energy Tracker Asia, 2022a).

For renewable energy targets in NDCs to become reality, they need to be aligned with renewable energy targets set in national energy plans and laws.

As of mid-October 2022, 82 countries had set renewable targets in the power sector in both national policies and NDCs, while 67 had set them only in national plans and 26 only in NDCs, and 21 countries party to the Paris Agreement had not made any specific commitments (Figure S2). In most countries, renewable energy targets in NDC pledges do not align with those included in national energy plans.

Figure S2 Number of countries with renewable power targets in NDCs and national energy plans, by region and country grouping



Aligning renewable energy targets in NDCs and national energy plans would increase the effectiveness and credibility of both, and reinforce clear signals to investors, developers and other players across the supply chain, thus enabling further development of the renewable energy sector.

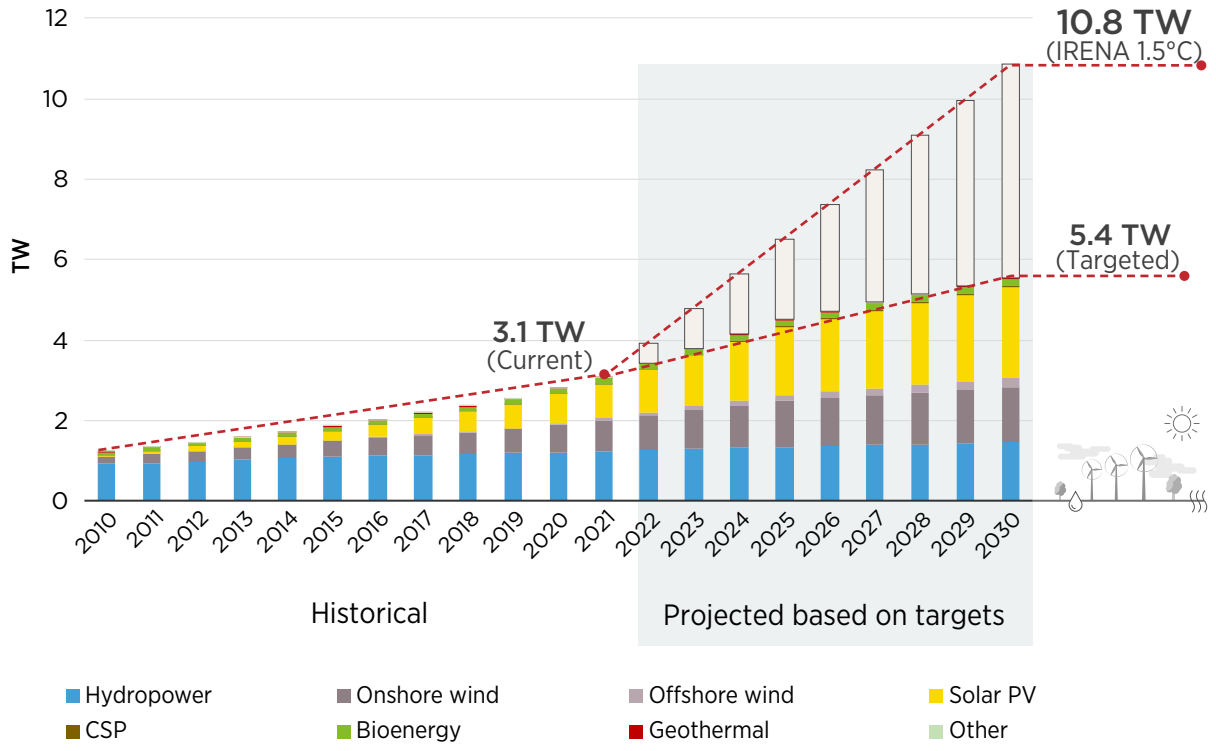
In some cases, this will involve establishing or updating national targets. In other cases, it will mean including existing national targets in the next round of NDCs.

For renewable energy targets to be useful, they need to be ambitious enough to guide deployment on a path that exceeds historical trends and current deployment levels.

In IRENA's 1.5°C Scenario, half of the total energy consumed comes from electricity by 2050, 90% of which is renewables based. As such, targets in the power sector, along with electrification targets for end uses, play a major role in decarbonising the energy sector. In order to keep the world on track to achieving the energy transition as per IRENA's 1.5°C Scenario by 2050, the level of ambition of renewable energy power targets set in national plans and strategies for 2030 needs to at least double. In fact, non-ambitious targets may effectively act as a cap on renewables, hindering rather than promoting their deployment.

IRENA's quantification of renewable energy targets in the power sector globally finds that existing targets aim to increase the total renewable capacity stock to 5.4 terawatts (TW) by the end of this decade, which is half of the 10.8 TW needed according to IRENA's 1.5°C Scenario (Figure S3).

Figure S3 Global cumulative renewable power, installed capacity, historical trends and future projections



Notes: CSP = concentrated solar power; PV = photovoltaic.

This is readily achievable, as the current targets are below the market pace and lag recent deployment levels. To meet the targets set for 2030, totalling 5.4 TW, countries would be aiming for an additional 2.3 TW by 2030, equivalent to average yearly additions of 259 gigawatts (GW) in the next nine years. This is below the capacity installed in the past two years. In 2020 and 2021, despite the complications that resulted from the pandemic and consequent supply chain disruptions, the world installed almost 261 GW each year.

Globally, the renewable electricity capacity targeted for 2030 remains concentrated in a few regions and technologies.

IRENA's quantification of renewable energy targets in the power sector shows that Asia (including China and India), with aggregated targets totalling 2.6 TW in 2030 (from 1.5 TW installed in 2021) makes up around half of the global targeted capacity. Europe and North America and Oceania have targets to increase their renewable electricity capacity by almost 80% compared to 2021 levels, totalling 1 261 GW and 908 GW by 2030 respectively (Figure S4).

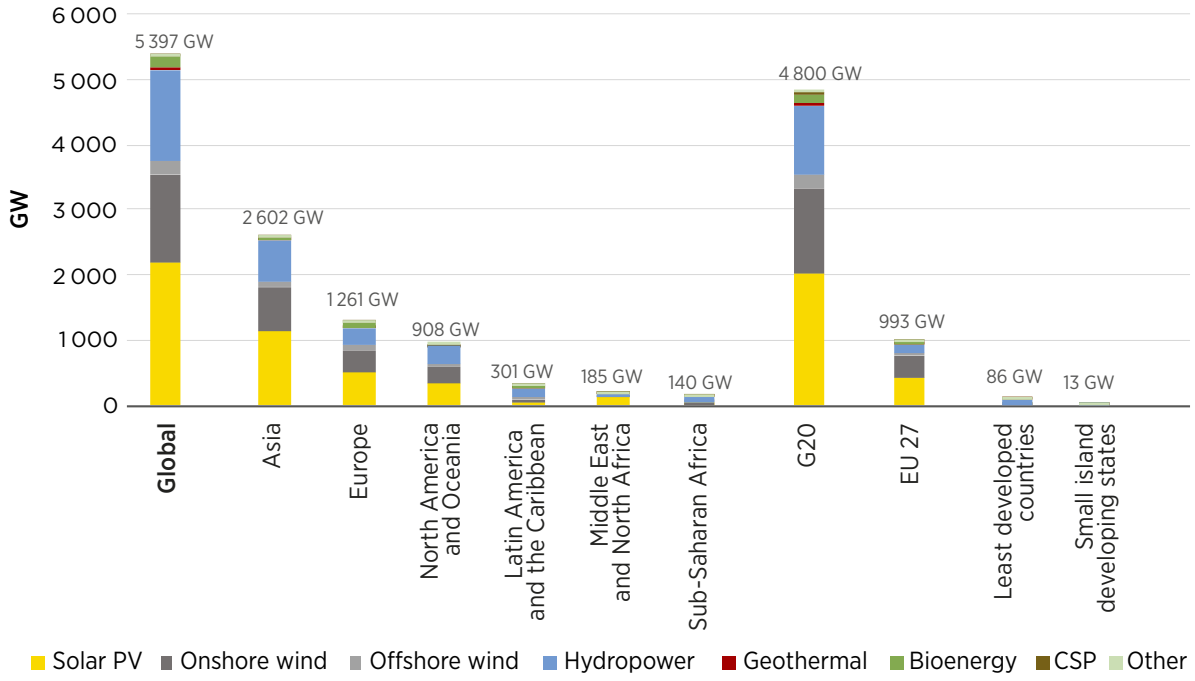
The Middle East and North Africa (MENA) account for just 3% of global deployment targets for 2030 (or 185 GW, up from 37 GW in 2021), despite the region's high potential and the unsatisfied need for reliable and secure energy in many countries. Sub-Saharan Africa accounts for just 2.6% of global targets for 2030, aiming for capacity of 140 GW by 2030 (up from around 43 GW in 2021). Sustainable renewable energy is integral to Africa's future, which currently hosts 77% of the world's population without electricity access.

The countries targeting the highest level of deployment are all part of the G20, making up almost 90% of the global aggregate targeted capacity. Although least developed countries (LDCs) and small island developing states (SIDS) make up a small share of past renewable deployment, their aggregate targeted capacity totals 86 GW and 13 GW respectively, both doubling their current renewable capacity.

Countries' renewable power targets mostly entail installing solar PV, onshore wind and offshore wind by 2030. Large shares of solar PV, onshore wind and offshore wind are expected, given the dramatic drop in the cost of these technologies – an 88%, 68% and 60% drop in their levelised cost of electricity (LCOE), respectively, between 2010 and 2021.

Targets need to be set and ambition needs to increase in end uses – heating and cooling, cooking, and transport – in both NDCs and national energy plans.

Figure S4 Aggregate targeted renewable electricity capacity by 2030 by region, country grouping, and technology



Stronger commitments are needed to drive the energy transition in end uses including harder-to-abate sectors (*e.g.* heavy industry). Heating and cooling, and transport account for about 80% of global energy demand, yet only 31 countries have set renewable energy targets for these end uses in their NDCs.

When it comes to national energy plans, only 40 countries had renewable heating and cooling targets by mid-2022, most of which are in Europe. Of these, 30 countries had set their targets as a percentage of all energy needed for heating and cooling without specifying the technology and 10 had set targets for specific technologies. A handful of countries in sub-Saharan Africa have set targets for specific technologies (*e.g.* solar water heaters), including Kenya, Niger and Zimbabwe.

For the use of renewables in transport, only 33 countries have renewable energy targets in their national energy plans, focusing on biofuels. For example, in the European Union, countries should reach at least a 3.5% share of advanced biofuels in their overall 14% target for transport by 2030. Globally, policy support has focused on road transport, mainly in the form of mandates and incentives to support the production and use of biofuels. Countries such as India, Indonesia and Zimbabwe have set biofuel targets that aim to gradually increase the renewable share of transport fuels. Policy support for renewable energy use in aviation and shipping remains modest.

TARGETS NEED TO BE DESIGNED TO SERVE COUNTRY OBJECTIVES, AND THEIR DESIGN SHOULD CONSIDER THE SPECIFIC CONTEXT

The main function of targets is to signal the country's long-term political commitment to renewable energy, which is required to attract the investment needed to develop the sector. The more detailed, specific and credible the target is, the more likely it is to drive deployment, including through increased market confidence. This can ultimately translate into lower costs of capital and hence more project development.

The main objectives behind the drive for renewable energy deployment in the country need to be put at centre stage of target setting. These may include GHG emission and pollution reduction, energy access, energy security, reliability and affordability, industry policies and socio-economic development goals.

Target design should also consider the specific context of the respective jurisdiction. The factors to consider while designing targets include resource availability and the technical potential of various technologies to select the most suitable energy mix; future energy needs across all end uses (considering energy efficiency targets) to avoid shortages or at the same time ensure resources are not wasted on overcapacity; the level of development of the renewable energy sector and existing infrastructure to make sure the targets are achievable within the set timeframe.

While designing targets, decisions need to be made regarding their statistical basis, scope and coverage in terms of sectors and end uses, indicators, technology specificity and modalities for implementation (Figure S5). These key design elements for targets are explained below and are discussed in further detail in Chapter 3.

- The **statistical** basis relates to whether targets are determined as a share of a mix relative to a baseline (*e.g.* share of energy supply, electricity generation mix, percentage of vehicles) or a fixed absolute amount (*e.g.* capacity added, number of solar water heaters installed). Although targets expressed as a share of the mix may provide more clarity on the level of ambition on climate goals, as they imply phasing out (or opting out) fossil fuel-based energy and systems, they can be difficult to implement and monitor. Absolute amount targets can provide clearer commitment from policy makers and more certainty for market participants and investors as they stipulate a specific quantity that must be installed or produced by a specified time. Section 3.2 provides further details.
- The **scope and coverage** relate to whether the target covers the entire energy sector or specific end uses such as heating and cooling, transport and cooking. While the former provides a comprehensive view of the impact of the target with regard to climate goals and energy security, the latter may provide a clearer signal for the development of local supply chains for specific technologies. Many countries have used a combination of both. Section 3.3 provides further details.
- Targets can be set based on a range of **indicators** that vary in terms of scope and coverage. For percentage-based targets covering the whole energy sector, a decision is needed on whether they apply to total final energy consumption (TFEC) or total primary energy supply (TPES). For percentage-based targets in the power sector, a decision is needed on whether they represent a share of the generation or installed capacity. In end uses, a decision is needed on whether they represent a share of the total

number of systems added by/after a given year (*e.g.* bans on combustion engine vehicle sales in the European Union and the state of California by 2035 correspond to a target of 100% of vehicles added after 2035 to be EVs) or a share of the total in use by a given year (*e.g.* Paris's ban on all combustion engine vehicles by 2030 corresponds to 100% of vehicles on the street to be electric). For amount-based targets covering the power sector, a decision is needed on whether they are capacity-based (*e.g.* GW of installed capacity) or output-based (*e.g.* GWh of electricity produced). For end use sectors, a decision is needed on whether they represent a number of systems (*e.g.* solar water heaters) or output (*e.g.* tonnes of green hydrogen produced). These design elements are discussed in Sections 3.4 and 3.5.

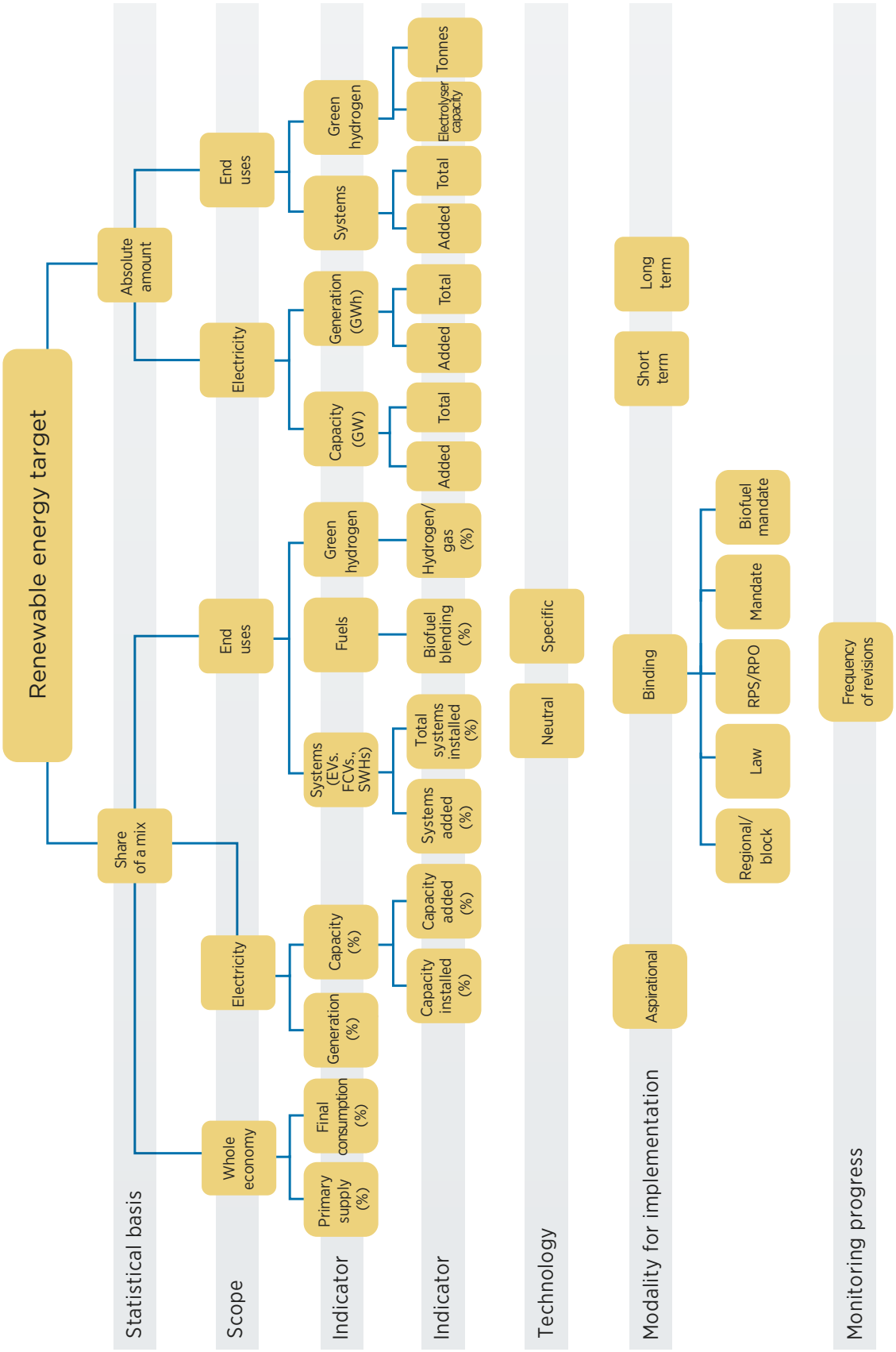
- **Technology specificity** relates to whether the target should be technology-neutral or technology-specific. While technology-neutral targets can be strategic in the early stages of renewable energy development, as they allow markets to identify the most cost-effective technologies, technology-specific targets can enable further diversification of the energy mix, with benefits such as resilient systems and fewer integration issues. They can also enable the development of local value chains for selected technologies. Section 3.6 provides further details.
- **Modalities** for target implementation relate to whether the target is mandatory or aspirational, short to medium term or long term, and determine the process for its review and revision. Section 3.7 provides further details.

Aspirational targets are often common in markets and jurisdictions in the early stages of renewable energy development. As experience and know-how on technology costs, performance and other technology dynamics improve, and capacities of institutions covering energy data and policies develop, aspirational targets should be updated and become more binding. However, mandatory or binding targets require specific compliance and enforcement mechanisms (*e.g.* fines or penalties if the target is not achieved) and the designation of an entity that is responsible for achieving them.

Long-term targets provide a key signal to project developers, investors, service providers and manufacturers about the overall direction and long-term opportunities in a particular market, while short- to medium-term targets can introduce a sense of urgency and motivate stakeholders to act. Ideally, a balanced approach should be taken where long-term targets are translated into a series of short- to medium-term targets.

In addition, linking renewable energy targets to regular monitoring of market conditions is a key design element that allows for timely adaptation to changes in policy objectives and priorities, market dynamics, renewable energy costs and learning curves. Periodic revisions are also important as data collection and energy balances improve. In many cases, monitoring and adjustment can allow for an increase in ambition.

Figure S5 Key decisions for renewable energy target setting



Notes: EV = electric vehicle; FCV = fuel cell vehicle; SWH = solar water heaters.

INTRODUCTION

The summer of 2022 has given the world a glimpse of a future in which the fight against climate change has been lost.

Temperatures are on the rise. July 2022 was the 46th consecutive July and the 451st consecutive month with temperatures exceeding the average for the 20th century (National Centers for Environmental Information, 2022). Heatwaves caused wildfires of unprecedented severity in France, Greece, Spain, Portugal and the United States. Drought frequency and duration has increased by nearly a third since 2000. In the summer of 2022 almost half of US states experienced droughts, the Horn of Africa experienced its worst drought in more than 40 years, Italy and France faced their worst drought since the 1950s and water restrictions were implemented in numerous jurisdictions. Climate change is negatively affecting food harvests and pushing up prices globally, leaving 18 million people facing the risk of severe hunger in the Ethiopia, Somalia and parts of Kenya (World Economic Forum, 2022). Pakistan, which contributes less than 1% of annual global greenhouse gas (GHG) emissions, suffered one of its most severe heatwaves in March, after which the country experienced 190% more rain compared to its 30-year average from June to August, causing major flooding in almost one-third of the country, washing away half the country's crops and causing significant food shortages (BBC News, 2022).

Food prices were already high globally, as the world grapples with record-high inflation and energy prices, partly due to the conflict in Ukraine. In the European Union electricity prices rose to historical levels. Significant year-on-year increases in electricity wholesale prices were registered in EU countries in the first quarter of 2022, in Spain and Portugal (411%), Greece (343%), France (336%) and Italy (318%) (European Commission, 2022a) and in Germany prices reached almost six times the level of the same time the year before (Bloomberg.com, 2022).

Meanwhile, 733 million people remain without access to electricity and some 2.4 billion people still rely on traditional biomass for cooking (IRENA *et al.*, 2022a). In many countries where there is access, electricity is unreliable, slowing down socio-economic development.

At the same time, renewable energy projects that are urgently needed to help address the energy crisis are facing hurdles such as increasing costs, supply chain disruptions, permitting and licensing issues, and other political and regulatory barriers. The cost of shipping renewable energy equipment and the price of many of the raw materials used for their production have been rising since the start of 2021. By March 2022 the price of aluminium had doubled, copper had risen by 70%, steel had increased by 50% and freight costs had risen almost fivefold (IEA, 2022). The price of polysilicon reached USD 40/kilogram (kg) in the first quarter of 2022, up from USD 6.80/kg in 2020 (Fitch Solutions, 2022). As such, the installation costs of wind and solar have increased, reversing the long-term trend of decreasing costs seen in recent decades. The focus of renewable energy policy on cost-competitiveness has led to the concentration of supply chains in a number of countries. Trade issues and COVID-related lockdowns have disrupted the supply of key components and equipment from those countries to the rest of the world, demonstrating the vulnerability of this model and the value of localisation.

These developments show the need for immediate action to increase ambition for renewable energy deployment, for climate goals, energy security and affordability, and to ensure universal basic rights such as access to energy, food and water. Recent developments also show that greater ambition is also needed for the development of local supply chains that can contribute to energy security.

This report sets out to support governments in designing renewable energy targets that can help achieve the pressing objectives of reducing GHG emissions from burning fossil fuels, increasing resilience to climate impacts, limiting the dependence on energy imports, and achieving universal access to clean, affordable and reliable energy. While the report focuses mainly on national-level renewable energy targets, the lessons and insights apply to targets adopted by other levels of government.

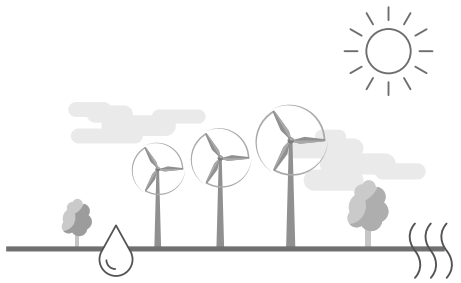
The first chapter presents an overview of the latest updates in climate commitments made ahead of the 27th Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) – COP27. It focuses on the Nationally Determined Contributions (NDCs) under the Paris Agreement, updated ahead of COP27, which outline each signatory's commitments to mitigation and adaptation, indicating the pathway that the world will follow as it undertakes enhanced climate action and net zero emissions.

For renewable energy targets set within NDCs to materialise, they need to be reflected in national energy plans. But, to date, there is a mismatch between the renewable energy component in NDCs and the renewable energy targets set at the national level. Chapter 2 shows this mismatch, after presenting the latest trends in targets and an analysis of the level of ambition in renewable power targets globally by quantifying them.

Chapter 3 draws on IRENA's *Renewable Energy Target Setting* report and presents the design elements of targets to achieve policy objectives related to the climate and beyond, within the specific contexts of resource availability, the level of development of the renewable energy sector, and the future energy mix.

Finally, recommendations for the way forward in target setting and monitoring are provided in Chapter 4.

1



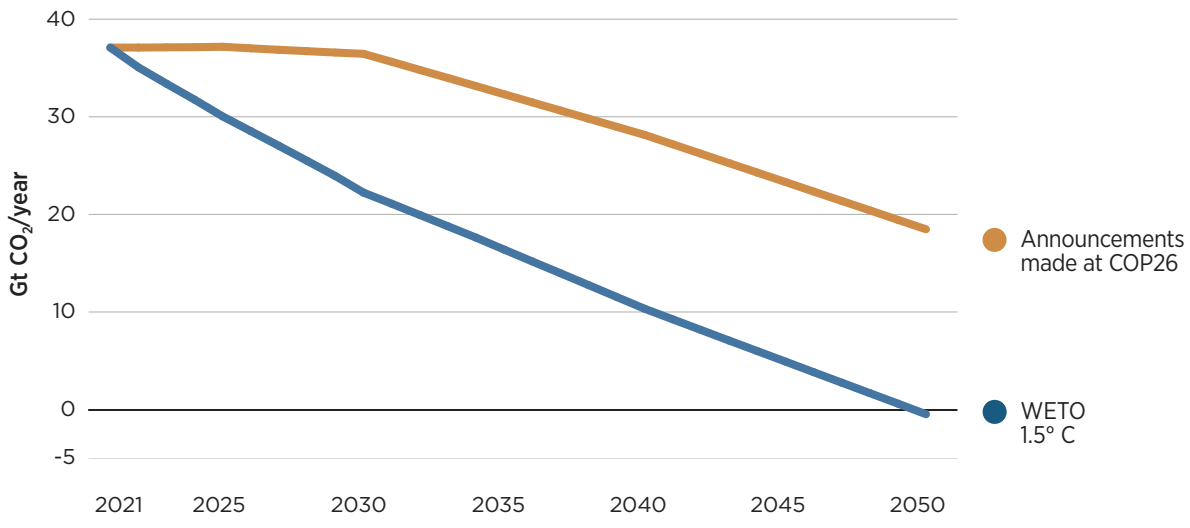
1 NDCS AND OTHER COMMITMENTS TOWARDS CLIMATE OBJECTIVES

By COP26 in 2021, updated NDCs and other commitments, such as net zero targets, were predicted to be able to reduce emissions by 20% by 2030 compared to business as usual (*i.e.* prior to the submission of the first round of NDCs following the Paris Agreement), with the potential to limit warming to 2.1°C (UNEP, 2021).

In addition, COP26 witnessed a number of significant announcements, including a pledge by over 100 countries to cut their methane emissions by 30% by 2030. The International Energy Agency (IEA) finds that these commitments, along with the NDCs and net zero targets, would be adequate to limit the increase in global temperatures to 1.8°C by the end of the century, if achieved (IEA, 2021). In addition, a number of countries made pledges on coal phase-out and phase-down and ending coal and gas exploitation, while over 130 countries agreed to halt and reverse deforestation. Globally, these pledges represent crucial steps in the right direction, but they are not enough to meet the 1.5°C target.

Figure 1.1 shows two trajectories for (estimated) future global CO_2 emissions based on COP26 announcements (the orange line) and IRENA's World Energy Transitions Outlook (WETO) 1.5°C Scenario, which outlines a pathway for limiting global temperature rise to 1.5°C and bring CO_2 emissions to net zero by 2050 (the blue line). The area between the two lines represents the gap between a 1.5°C scenario and the pledges made at COP26. In 2030, under the COP26 announcement scenario, global CO_2 emissions are estimated to reach 37.5 gigatonnes (Gt), but to reach the 1.5°C target, emission levels would need to be further reduced to 22.2 Gt in that year.

FIGURE 1.1 CO_2 emission trajectories based on COP26 announcements and the WETO 1.5°C Scenario



Note: The "Announcements made at COP26" trajectory includes all NDCs and long-term strategies or net zero targets communicated by Parties as of 12 November 2021. To estimate emissions for the trajectory, "optimistic" data, i.e. the lowest emission level of the full implementation of the NDC (conditional and unconditional), have been applied.
Source: IRENA (2022a)

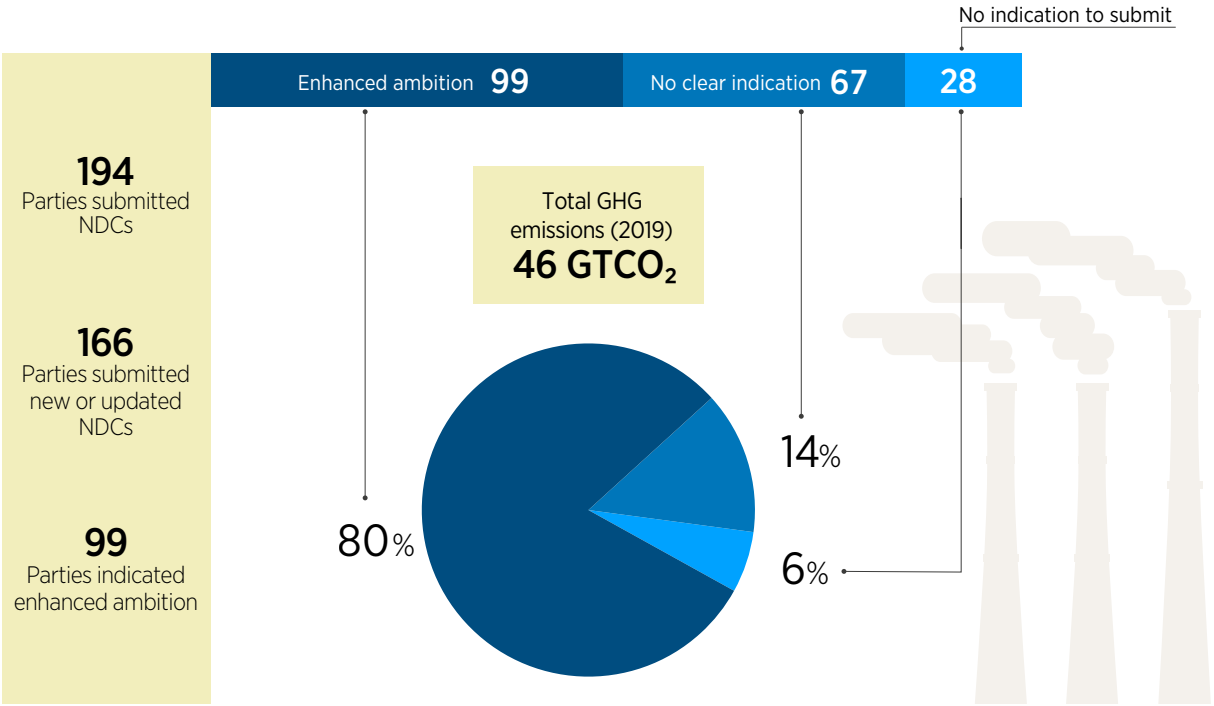
1.1 MOMENTUM FOR GLOBAL CLIMATE ACTION AND UPDATES ON NDCS SINCE COP26

The "Glasgow Climate Pact", one of the major outcomes of COP26, called on Parties to review and strengthen their NDCs by the end of 2022, in order to limit the global temperature increase to below 1.5°C. Against this backdrop and building on the most recent announcements made since COP26, this section provides an overview of the latest NDC commitments and some of the main agreements made ahead of COP27.

Since COP26 in November 2021, 24 Parties had updated their NDCs (up to 16 October 2022). This includes six Parties from the G20: Australia, the Federative Republic of Brazil (Brazil), India, Indonesia, Republic of Korea, and the United Kingdom. Almost all of these Parties had in fact submitted updated NDCs in 2020-2021 ahead of COP 26,[1] but shared further updated NDCs to either communicate enhanced targets or further expand on means of implementation. Only three of these Parties have specific renewable energy targets, although some Parties made other commitments to clean energy; for example Australia has committed to invest around USD 20 billion in its grid infrastructure to unlock higher penetration of renewables, in addition to investments in manufacturing and deployment of renewables.

By 16 October 2022, 193 Parties had ratified the Paris Agreement and 194 had submitted NDCs.[2] Of the 166 Parties that submitted new or updated NDCs, only 99 Parties representing 81% of global GHG emissions submitted enhanced ambitions.[3] Of the remaining Parties that submitted new or updated NDCs in 2022, 67 Parties (accounting for a further 14% of global emissions in 2019) submitted NDCs with either the same emission reduction targets, increased emissions compared to their first NDCs, or emission reduction targets that are not comparable with their initial NDCs (Climate Watch, 2022). These are shown in Figure 1.2.

FIGURE 1.2 NDCs by ambition and share of global emissions (as of 16 October 2022)



Source: Climate Watch (2021) updated as of 16 October 2022. Note: The European Union and its 27 member States communicated one joint NDC which for this report has been counted as one NDC representing 28 Parties.

[1] *Excluding India which had submitted its prior NDC in 2016.*

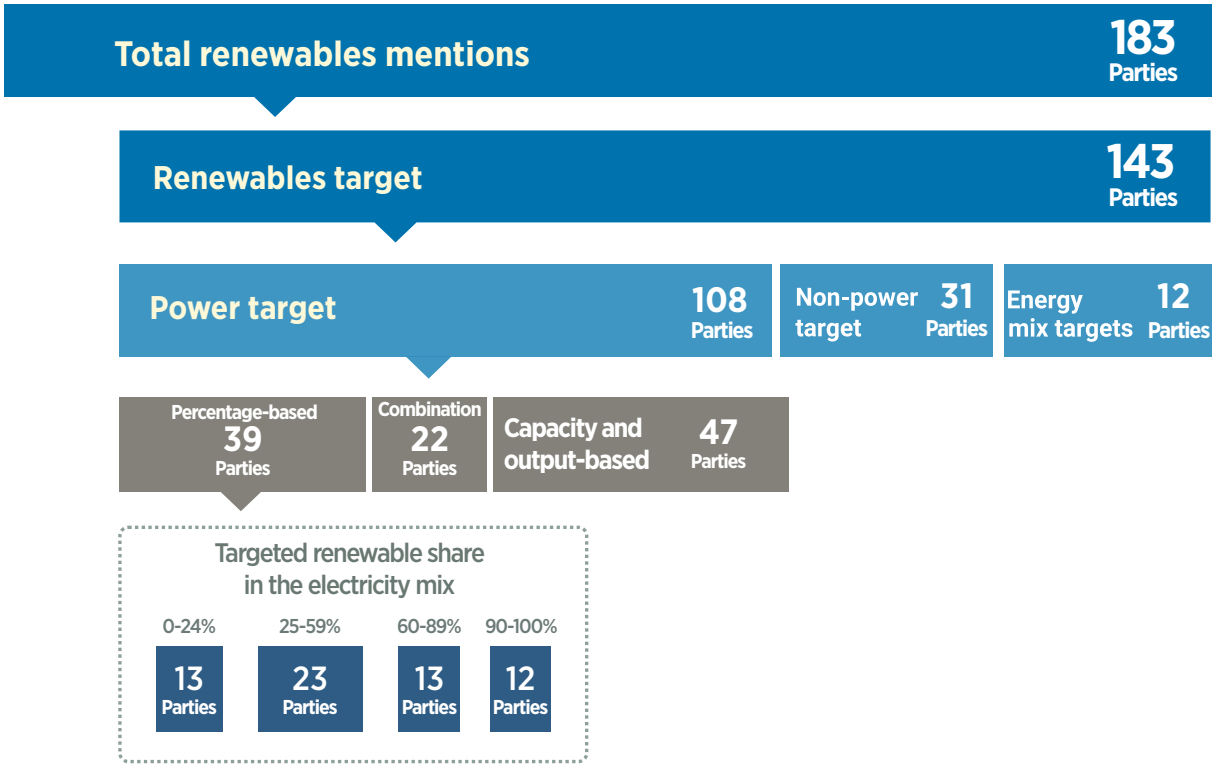
[2] *As of 16 October 2022, Eritrea had not ratified the Paris Agreement but had submitted an NDC.*

[3] *These countries revised their emission targets upwards compared to targets submitted previously.*

Renewable energy plays a key role in IRENA's 1.5°C Scenario, with its share of the world's total final energy consumption (TFEC) needing to grow from 19% in 2019 to 38% in 2030 (IRENA, 2022a). Yet the renewable energy targets in NDCs are nowhere near that. As of 16 October 2022, 183 Parties had included renewable energy components in their NDCs, of which only 143 had a quantified target. Of these targets, 108 focus on power and only 31 explicitly mention heating and cooling, transport, or cooking. Only 12 Parties had committed to a percentage of renewables in their overall energy mixes. They include the Bahamas, China, Eswatini, the European Union, Ghana, Indonesia, Jamaica, the Maldives, Mauritius, Nepal, Pakistan and Paraguay.

Of the 108 Parties that had defined targets for renewables in the power sector in their NDCs, 47 presented them in the form of additions – mostly in the form of capacity (GW) and a few in terms of output (GWh). Commitments to add renewable power (in terms of capacity or output) deliver many benefits – namely providing long-term clarity on the trajectory of the renewable energy sector, increasing investor confidence, and building a local industry with its associated socio-economic benefits. However, a target in this form does not give a clear indication of progress towards achieving climate goals. By comparison, targets defined as a share of the electricity mix provide more clarity on the ambition with regard to climate goals, as they take account of phasing out or choosing to opt out of fossil-based power (see Section 3.2). Naturally, this only applies where the target covers a considerable share of the total electricity mix. Of the 61 Parties with targets defined as a share of the power mix, only 12 commit to shares between 90% to 100%, and 13 commit to shares between 60% and 89%, 23 commit to a share between 25% and 59%, and 13 commit to achieving a renewable energy share lower than 24% (see Figure 1.3).[4] The difference between percentage-based targets and amount-based targets and the way they serve different policy objectives are detailed further in Chapter 3 of this report.

FIGURE 1.3 Renewable energy targets in NDCs (as of 16 October 2022)



Source: Climate Watch (2021) updated as of 16 October 2022. Note: The European Union and its 27 member States communicated one joint NDC which for this report has been counted as one NDC representing 28 Parties.

[4] *Note that 22 Parties define targets in terms of both capacity/output and share of the power mix.*

1.2 NET ZERO TARGETS AND COMMITMENTS

Commitments are being made outside the NDC process and beyond the 2030 time horizon. Many jurisdictions at the national, subnational and city level, in addition to private corporations, have made net zero commitments, and renewable energy is poised to play a pivotal role in the achievement of these targets.

At the **national level**, the Net Zero Tracker[5] reported that 137 countries had announced they were considering net zero targets (as of October 2022). Of these countries, seven declared that they have achieved their net zero target, 17 have translated net zero targets into law, 40 have stated net zero in policy documents, 16 have made a pledge or declaration to reach net zero, and 57 are having ongoing discussions on adopting net zero targets (Net Zero Tracker, 2022). Table 1.1 shows the jurisdictions with net zero pledges as of October 2022. They include pledges described as achieving net zero, carbon neutrality, climate neutrality and zero carbon.[6]

Such targets are also being adopted at a faster rate at the **subnational and city level.** Out of the 713 regions and 1 177 cities covered by the Net Zero Tracker, 116 regions and 237 cities had net zero targets. At the city level, six have passed net zero targets into law, while 107 have stated them in policy documents and 36 in proposed documents, while 88 have made some form of declaration or pledge (Net Zero Tracker, 2022).

Private companies have also made such pledges. Corporations can have a significant impact on the energy transition, especially those involved in high-emitting activities and sectors such as industry and oil and gas. Almost 700 of the more than 2 000 companies covered in an analysis by Net Zero Tracker have announced net zero targets (Box 1.1). However, many of them have not backed up these targets with operational plans and strategies, leaving open the question whether these would be realised (Energy Tracker Asia, 2022a).

©Aerovista Luchtfotografie@Shutterstock.com

[5] *A collaboration between four organisations – The Energy & Climate Intelligence Unit (ECIU), the Data-Driven EnviroLab (DDL), the NewClimate Institute and Oxford Net Zero – funded by the European Climate Foundation (ECF), ClimateWorks Foundation and the IKEA Foundation.*

[6] ***Net zero** is a state where a balance between anthropogenic GHG emissions and removals is achieved. This can be achieved through reducing and avoiding emissions, and then implementing solutions to capture the remaining ones at the point of generation, or by removing them from the atmosphere. **Climate neutrality** – synonymous to net zero – means achieving a balance between emissions and removals of GHGs from the atmosphere. **Carbon neutrality** describes a state in which the GHG emissions released to the atmosphere by a stakeholder (individual, organization, company, country, etc.) have been reduced or avoided and the remaining ones are compensated with carbon credits. Source: (UNFCCC, 2022). **Zero carbon** - Zero carbon means that no carbon emissions are being produced from a product or service. It concerns the emissions produced from a product or service – it means no carbon is given off at all. Source: (National Grid ESO, n.d.).*

TABLE 1.1 Jurisdictions with net zero pledges, divided into high emitters (G20), low emitters (LDCs and SIDS) and others according to the Net Zero Tracker by October 2022

	G20/High emitters	LDCs and SIDS	Other
Achieved		• Benin • Bhutan • Cambodia • Comoros • Guyana • Madagascar • Suriname	
In law	• Canada • Denmark • European Union • France • Germany • Japan • Republic of Korea • Russian Federation • United Kingdom	• Fiji	• Hungary • Ireland • Luxembourg • New Zealand • Portugal • Spain • Sweden
In policy document	• Australia • China • Saudi Arabia • Türkiye • United States	• Antigua and Barbuda • Barbados • Belize • Lao People's Democratic Republic • Liberia • Maldives • Marshall Islands • Nepal • Saint Kitts and Nevis • Seychelles • Singapore • South Sudan	• Armenia • Austria • Belgium • Cabo Verde • Chile • Costa Rica • Croatia • Ecuador • Finland • Greece • Iceland • Italy • Latvia • Lithuania • Malta • Monaco • Panama • Peru • Romania • Slovenia • Sri Lanka • Ukraine • Uruguay

Notes: LDCs = least developed countries; SIDS = small island developing states.
Source: Net Zero Tracker (2022).

Declaration/ pledge 	• Argentina • Brazil • India • South Africa	• Malawi • Bahrain	• Andorra • Colombia • Estonia • Israel • Kazakhstan • Malaysia • Nigeria • Thailand • United Arab Emirates • Viet Nam
Proposed/ in discussion 	• Indonesia • Mexico • Pakistan	• Afghanistan • Bangladesh • Burkina Faso • Burundi • Central African Republic • Chad • Dominican Republic • Eritrea • Ethiopia • Gambia • Grenada • Guinea • Guinea-Bissau • Haiti • Jamaica • Kiribati • Lesotho • Mali • Mauritania • Mauritius • Mozambique • Myanmar • Nauru • Niger • Niue • Palau • Papua New Guinea • Rwanda • Saint Vincent and the Grenadines • Samoa • Sao Tome and Principe • Senegal • Sierra Leone • Solomon Islands • Somalia • Sudan • United Republic of Tanzania • Timor-Leste • Togo • Tonga • Trinidad and Tobago • Tuvalu • Vanuatu • Yemen • Zambia	• Bulgaria • Cyprus • Lebanon • Federated States of Micronesia • Namibia • Nicaragua • Slovakia • Switzerland • The Bahamas

Box 1.1 Net zero targets announced by companies as of August 2022

According to the Net Zero Tracker, which tracks over 2 000 of the largest publicly traded companies in the world (representing USD 42 trillion in annual revenue in 2020), almost 700 companies (representing USD 21 trillion in annual revenue) have or are considering a net zero target.

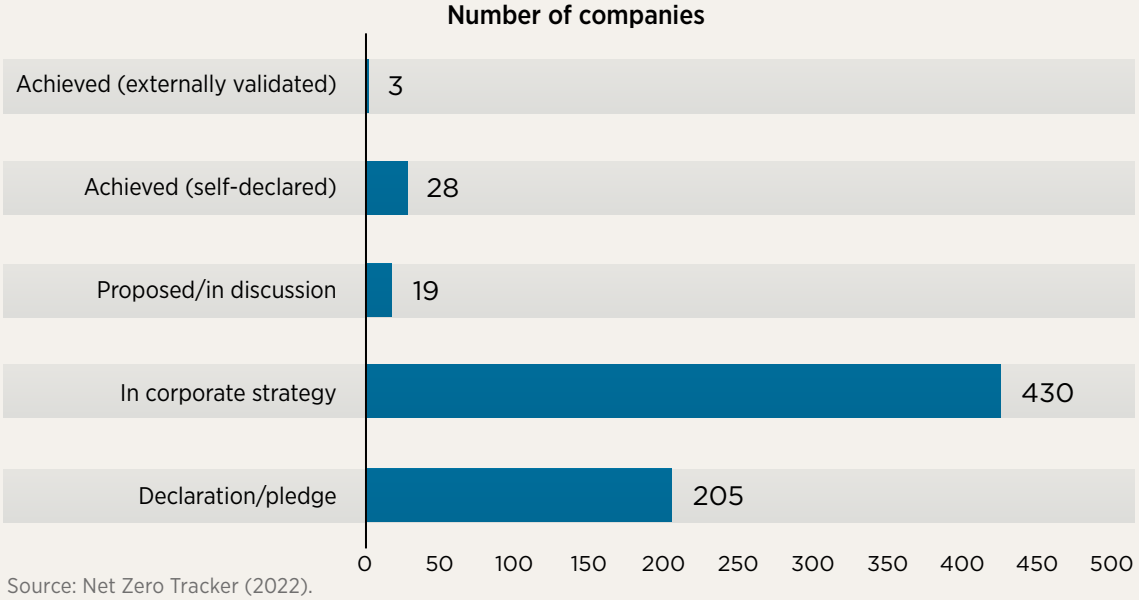
While most targets are set for dates in the future up to 2050, about 31 companies claim to have already achieved net zero, of which three are externally validated while the rest have self-declared reaching net zero. The externally validated targets include Salesforce (an American cloud-based software company with around USD 17 billion in annual revenue), ITC (an Indian conglomerate with a diversified presence across industries such as hotels, software and agribusiness and annual revenue of around USD 5.5 billion) and the Goodman Group (an Australian commercial and industrial property group with annual revenue of around USD 1.1 billion). These companies are using carbon credit offsets, while Salesforce further claims to rely on CO_2 removal methods such as nature-based and carbon capture-based removal. The company has also declared that it is operating on 100% renewable energy as of 2021 (Salesforce, 2021).

About 430 companies have net zero targets as part of their corporate strategy. These include some of the highest grossing firms globally, which are also among the firms with highest GHG emission footprint, for example Walmart, Royal Dutch Shell, Aramco, Amazon, Toyota, BP and Exxon.

Company-based net zero targets have varying emissions coverage. More than 80% of the targets cover Scope 1 (direct emissions resulting from sources that are owned or controlled by the company) and Scope 2 emissions (emissions from generation of purchased electricity). However, many companies, especially the top 10 highest grossing companies, have targets that either do not cover, or only partially cover, Scope 3 emissions (i.e. indirect emissions as a consequence of the company's activities, but which occur from sources not owned or controlled by the company).[7]

Finally, there are 205 companies that have made a net zero pledge, but have yet to outline their plans in their corporate strategy, while an additional 18 are still discussing the possibility of a net zero target. Figure 1.4 shows the status of companies' net zero targets as of August 2022.

FIGURE 1.4 Companies net zero targets by status as of August 2022



Source: Net Zero Tracker (2022).

[7] *Some examples of Scope 3 activities are extraction and production of purchased materials; transport of purchased fuels; and use of sold products and services (WBCSD and WRI, n.d.).*

1.3 FOSSIL FUEL PHASE-OUT (PHASE-DOWN) TARGETS

Transitioning to a low-carbon future as laid out in IRENA's 1.5°C Scenario requires not only scaling up renewables, but also phasing out (or phasing down) existing carbon-intensive generation, such as from coal, natural gas and oil. Fossil fuel phase-out (and phase-down) has gained further political traction in 2022, as countries seek to increase their energy security and reduce their dependence on imported oil and gas with the conflict in Ukraine.

Targets for coal phase-out have been adopted by several countries, mainly in Europe, with the addition of Canada and New Zealand. Table 1.2 presents all 22 economies that have adopted coal phase-out plans to date. However, these countries account for less than 4% of global electricity generation (Alvarez, 2021). Major existing and new coal players in the Asia Pacific region and in Africa are expected to drive future coal demand unless a broader coal phase-out is adopted.

Many of these commitments were made at COP26, when more than 40 countries (and around 150 organisations) signed a pledge to phase out (or phase down) coal (UNFCCC, 2021). The pact included 23 countries that pledged, for the first time, to cease building and issuing permits for new coal-fired plants domestically and to eventually transition away from coal. Five of the top 20 countries in the world that produce electricity using coal are among them: Poland, Indonesia, Korea, Viet Nam and Ukraine. However, these countries have yet to follow up their pledge with specific targets, timelines for phase-out or plans at the national level (Europe Beyond Coal, 2022).

Furthermore, European countries including Austria, Germany, Greece, Poland and the Netherlands are among the first to revert back to coal in a bid to secure energy supplies as gas imports from the Russian Federation have declined amid the sanctions introduced in 2022 (Daily News Egypt, 2022).

TABLE 1.2 Coal-phase out commitments and plans of selected countries

Country	Share of coal in electricity mix in 2021	Deadline	Comments
Bulgaria	37.2%	2038 or 2040	The 20th EU country to announce a coal phase out date
Canada	6%	2030	Only for electricity generation. This is part of Canada's goal to reach net-zero emissions by 2050
Croatia	9.7%	2033	Croatia announced to phase out coal by 2033 at COP26
Czech Republic	40%	2030	The 22nd EU country to announce a coal exit date
Denmark	16%	2028	In 2017, Denmark was among the first signatories to the Powering Past Coal Alliance (PPCA), declaring a phase out coal by 2030. This has now been brought forward to 2028
Finland	4.4%	2029	The use of coal in power generation will be banned after May 2029
France	1.1%	2022	Coal phase out initially planned by 2023, and later moved to by 2022. In 2019, the coal phase-out was legislated through the Energy and Climate Law
Germany	27.8%	2030	Earlier phase out plans by 2038 were brought forward to 2030 to reach further alignment with the UN Paris climate agreement 1.5°C requirements

Greece	12.4%	2028	Lignite-fired power plants will be ceased by 2023. Only one plant remaining until 2028, which is currently being constructed and whose fate is unclear. The conversion to fossil gas is being considered
Hungary	8.5%	2025	Coal phase-out plans outlined at the United Nations Climate Action Summit in New York in September 2019 to be brought forward from 2030 to 2025 by the closing of its last coal power plant of 884 MW capacity
Ireland	13.2%	2025	End coal power use by 2025. In 2018, the parliament passed a bill to sell the country's shares in coal, peat, oil and gas, making Ireland the world's first country to divest from all fossil fuels
Italy	5.1%	2025	Coal phase-out by 2025 as part of the National Energy Strategy
Montenegro	40.3%	2035	No plans to build new coal plants although the existing Plevlja I plant will be retrofitted for district heating. A cap-and-trade system for major CO_2 emitters was introduced in Feb 2020
The Netherlands	14.6%	2029	All coal-fired power plants will shut by the end of 2029. Three of the five remaining plants will operate for less than half of their expected lifetime
New Zealand	6.2%	2037	Ban new low- and medium-temperature coal boilers and phase out existing coal boilers by 2037
North Macedonia	32.6%	2030	Coal phase out has been delayed from 2027 to 2030
Romania	18.3%	2032	The country plans to phase-out hard coal and lignite power production by 2032 in its National Resilience and Recovery Plan announced in September 2021. This plan aims to cut coal capacity by more than three quarters by 2025
Slovakia	7%	2030	The environmental policy strategy of the Slovak Republic published in 2019 states a coal phase-out by 2030
Slovenia	24.6%	2033	Coal phase out by 2033 as per the national coal phase out strategy adopted in February 2022
Spain	2.2%	2030	The country also joined the Powering Past Coal Alliance in February 2021
United Kingdom	2.1%	2024	First country in the world to announce a coal phase-out policy. It is considering an emission limit on coal power stations from October 2025 onwards. Since the United Kingdom introduced a carbon tax for power plants in 2013, installed coal capacity and coal power generation has already sharply decreased
Viet Nam	46.6%	2040	At COP26, the Prime Minister declared to phase out coal fired power plants by the 2040s in order to meet its "net zero by 2050" commitment. Viet Nam's National Strategy on Climate Change up to 2050, issued in 2022, specified that Vietnam do not develop new coal-fired power projects after 2030 and gradually reduce the scale of coal power capacity after 2035

Sources: Europe Beyond Coal (2022); Government of Canada (2021); New Zealand *et al.* (2022); Energy Tracker Asia (2022b); Our World in Data (2022); USDA and GAIN (2022).

At COP26, South Africa's Just Energy Transition Partnership (JETP) was launched, a joint initiative supported by the European Union, France, Germany, the United Kingdom and the United States. It aims to help decarbonise South Africa's energy sector, which is currently dependent on coal for more than 70% of its electricity needs. The partnership is founded on the recognition that a transition away from coal must be carried out in a just and equitable manner, to prevent and manage certain transition risks such as the displacement of jobs or other impacts on livelihoods. Six months on from its launch, the JETP is now developing an investment plan to support the just transition objectives (Box 1.2).

Box 1.2 Six-month progress update on South Africa's Just Transition Partnership

South Africa's Just Energy Transition Partnership (JETP) was launched at COP26 to support the decarbonisation of the country's energy sector, thereby helping meet its NDC target of keeping annual GHG emissions in the range of 350-420 million tonnes of CO_2-eq by 2030. Supported by the European Union, France, Germany, the United Kingdom and the United States, USD 8.5 billion were committed to be mobilised in the first round of financing. This deal to finance a just transition is first of its kind and can be used as a model for climate action, encouraging further international co-operation through increased financial and technical assistance directed at developing countries.

Following the announcement, an Independent Partners Group, chaired by the United Kingdom, and a Presidential Climate Finance Task Team have been set up to oversee the JETP's governance. The JETP secretariat has been further established to provide a technical and coordination function. Consultations with related government representatives and development finance institutions have been ongoing, with a view to informing the development of an investment plan and financing package, while embedding just transition elements into the programme.

Further discussions are ongoing to identify the financing instruments suited to South Africa's climate goals and investment needs, while keeping in mind the current fiscal situation. A combination of concessional loans, grants and debt guarantees is likely, supported with technical assistance. The JETP workplan aims to finalise the investment plan by COP27. In addition, five working groups have been established to deliver the technical experience and expertise to develop the investment plan, covering distinct topics: finance, power, hydrogen, transport, and implementation.

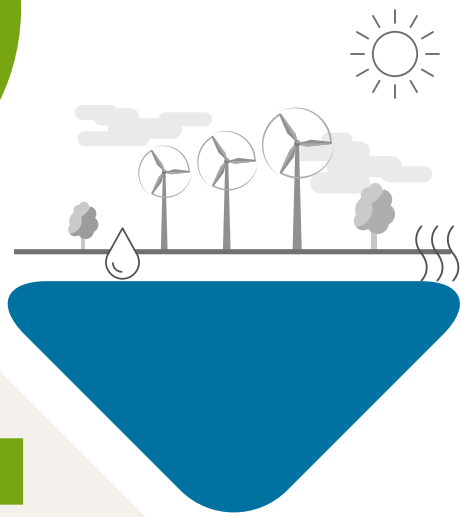
Building on the efforts of South Africa's JETP, as announced in the G7 Chair's Summary on Climate Neutrality, further JETPs are being developed in other countries, including India, Indonesia, Senegal and Viet Nam.

Sources: COP26 (2022); G7 (2022).

Although the United States – in addition to Australia, China and India – did not take part in the coal phase-out pledge at COP26, the country took part in a ministerial-level joint communiqué in May 2022, whereby G7 countries committed to make progress towards phasing out unabated coal power but did not specify a date yet for doing so. The countries also committed to decarbonising their electricity sectors by 2035, shifting road vehicle sales to zero-emission vehicles, and halting public financing for overseas fossil fuel projects by 2030. The communiqué was released against the backdrop of the conflict in Ukraine, which has reignited efforts – in Europe, in particular – to urgently switch to more sustainable energy sources (Carbon Brief, 2022).

Other related commitments made include targets for the phase-out of internal combustion engine vehicles. These are discussed together with targets for electric vehicles (EVs) in Section 2.1.1.

2



2 RENEWABLE ENERGY TARGETS IN NATIONAL PLANS

By the middle of 2022, 176 countries had in place some sort of renewable energy target at the national and/or subnational (*e.g.* state or city level).[8] Of these, 12 had targets that expired in 2020 (IRENA, 2022b); these are included in the analysis, as they still contribute to achieving the energy transition. This is a significant increase from just 43 countries in 2005 (IRENA, 2015). Renewable energy targets have become increasingly diverse as policy makers have set out to adapt them to the unique circumstances of their jurisdictions and encourage investment in specific sectors or technologies.

Targets perform a range of functions in policymaking and can be grouped into three main stages, formulation, implementation and evaluation, as illustrated in Figure 2.1 (Box 2.1).

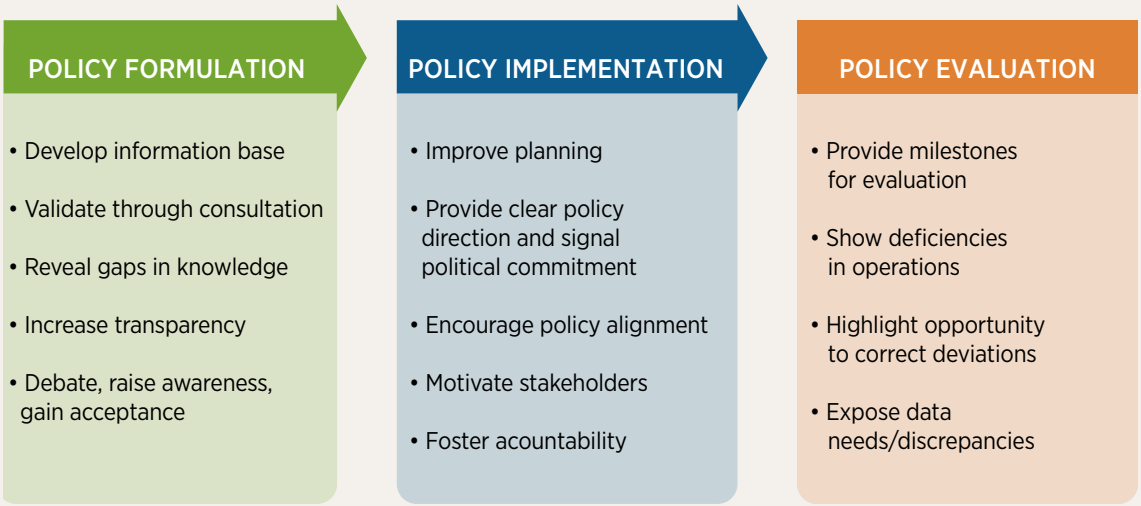
Box 2.1 The main functions of renewable energy targets

At the **policy formulation stage**, targets play an important knowledge and exploratory function. They can enhance the transparency of the policymaking process and help develop a knowledge base. Target formulation can also include intense political discourse and engagement. By fostering a sense of co-ownership, stakeholder participation can increase robustness and efficacy.

At the **policy implementation stage,** targets can indicate political commitment, signal a long-term trajectory for policy direction and investment, support planning and encourage stakeholders to take action. They can further improve alignment and coordination of policies across different sectors and market segments. Targets with clearly assigned responsible entities can also help foster accountability.

At the **evaluation stage**, targets serve as a benchmark through which the effectiveness of various policies is measured. Monitoring and evaluation can expose deficiencies in operations and planning, while highlighting opportunities for correction and adaptation.

FIGURE 2.1 Role of targets at different stages of policy-making



Source: (IRENA, 2015)

[8] *IRENA analysis encompasses all national-level targets for renewable power generation as per the country's national laws, official strategies and plans. Targets in NDCs are considered separately as these can often be conditional or non-binding.*

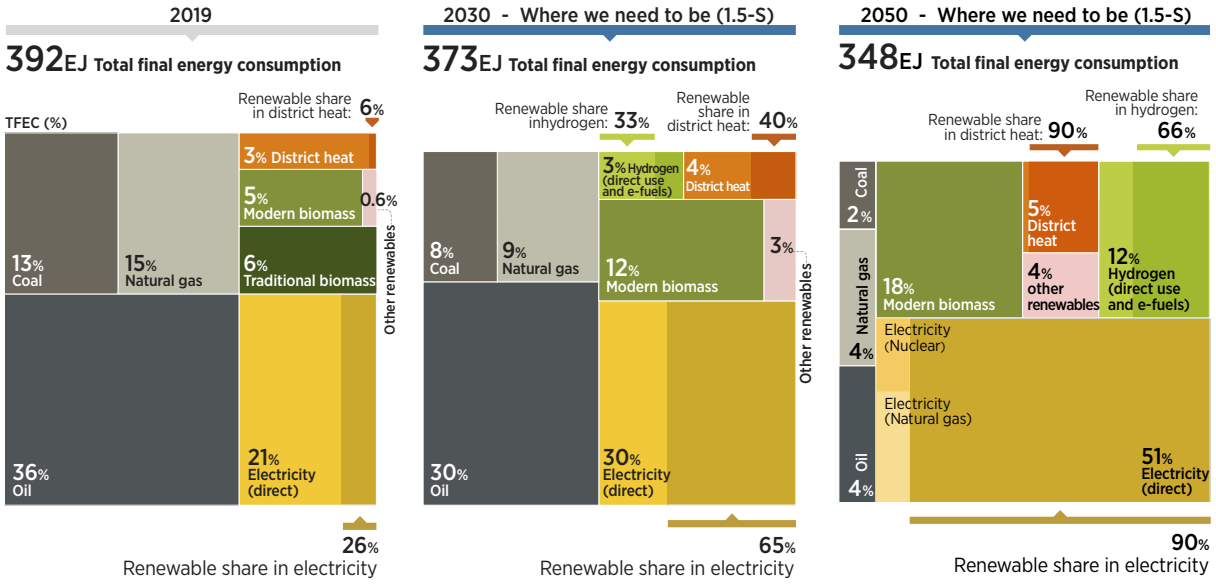
The first section of this chapter presents the trends in renewable energy targets as of mid-2022. It shows innovation in target design, and the increasing diversity in the way targets are framed to cover different end uses and multiple policy objectives. These aspects of renewable energy target design are covered in Chapter 3.

One trend that has sustained over the years is the prevalence of targets in the power sector. A quantification of these targets is presented in Section 2.2, to analyse the current level of ambition in comparison to where we need to be in order to limit the rise in the average global temperature to 1.5°C, as per IRENA's analysis in the 2022 World Energy Transitions Outlook (WETO).

2.1 TRENDS IN RENEWABLE ENERGY TARGETS

Renewable energy targets remain focused mainly on the power sector. In IRENA's 1.5°C Scenario, half of TFEC is in the form of electricity by 2050, 90% of which is renewables-based. By 2030 almost a third of TFEC is electricity, almost two-thirds renewables-based (Figure 2.2). As such, targets in the power sector, along with electrification targets for end uses, play a significant part in decarbonising the energy sector. Trends in the adoption of renewable power and electrification targets are discussed in Section 2.1.1. The section also discusses targets for peaking power, an emerging trend to support the integration of higher shares of variable renewable energy into the system. Targets for rural electrification using off-grid technologies are also discussed.

FIGURE 2.2 The role of renewable energy in the energy transition



Source: IRENA (2022a).

The decarbonisation of the power sector alone will not be sufficient to put the world on a climate-safe pathway: 20% of the emission reductions needed in the energy sector will have to come from the accelerated use of renewables in end uses such as heating and cooling, as well as transport (IRENA, 2022a). Section 2.1.2 gives an overview of targets for the direct use of renewables in end uses, focusing on targets for specific technologies and solutions, for example green hydrogen and clean cooking.

Another trend in renewable energy targets is their increased adoption at varying levels of governance, including the supranational level (such as the European Union), the state, city and even community level. This trend is explored in Section 2.1.3.

Finally, targets for socio-economic benefits from renewable energy deployment, including jobs and development of local industries, are highlighted in Section 2.1.4.

2.1.1 MOST COUNTRIES STILL FOCUS THEIR TARGETS ON THE POWER SECTOR

Targets for renewable power at the national and state level

By mid-2022, 149 countries had targets for renewable power. Of these, 125 countries have set targets as a share of the electricity mix: 15 countries (mostly SIDS) are aiming for 100% renewables, 13 (mostly in Europe and SIDS) are targeting shares above 80%. There are 35 countries aiming for a share of renewables in their electricity mix between 50% and 79%, which include 10 countries in Europe, seven countries in sub-Saharan Africa,[9] six in SIDS[10], six in Latin America,[11] three in MENA (Mauritania, Morocco and Saudi Arabia), and three in Asia (Kazakhstan, Philippines and Sri Lanka). Some countries' targets are further complemented by state level targets. For example, United States' federal level target is supplemented by various state-level targets such as California's target for 60% of electricity to be from renewables by 2030.

Some countries have set targets in the form of installed capacity, either mentioning specific technologies or remaining technology-neutral. For example, Ethiopia set a target of 25 GW by 2030, of which 22 GW is to be hydropower, 2 GW wind and 1 GW geothermal. Other countries have set both. The People's Democratic Republic of Algeria, for example, is targeting a 27% share for renewable electricity generation by 2030, translating into 22 GW of installed capacity. The attributes of each of these target design elements are discussed in Chapter 3.

Targets for the electrification of end uses

As the electrification of end uses gains importance in the energy transition, an increasing number of countries are setting targets for the deployment of heat pumps, EVs and charging stations. Coupled with targets for high shares of renewables in the electricity mix, electrification targets can play an essential role in the decarbonisation of heating and cooling and transport. Moreover, the electrification of end uses can enhance grid flexibility through demand response management.

For **heating and cooling**, the European Commission's REPowerEU plan includes a target to double the rate of deployment of heat pumps (European Commission, 2022b). Before that, the United Kingdom adopted a target to install 600 000 heat pumps a year in homes and in public buildings by 2028 (Government of the United Kingdom, 2020a).

Electrification targets require comprehensive policymaking, as demonstrated in Ecuador. In 2019 the government launched a nationwide initiative to transition 3.5 million households away from liquefied petroleum gas (LPG) to induction electric stoves, to meet their cooking needs (Box 2.2)

In the **transport** sector, EV targets and internal combustion engine bans have proliferated in recent years, particularly in Europe and Asia. By the end of 2020 about 37 countries had an EV target and/or a target to ban internal combustion engine vehicles (15 of which were in Europe and 13 in Asia) (REN21, 2021a). In the last year, seven additional countries have enacted similar targets or bans (REN21, 2022). Germany has increased its previous target by committing to putting at least 15 million fully electric and hybrid vehicles on the road by 2030, and maintained a previous target of building 1 million charging stations (Energy Monitor, 2022). To date, these have been incentivised through a wide mix of fiscal measures in the form of grants, subsidies, tax incentives and other benefits. The United States is also set to enact a target that calls for all new vehicles sold in 2030 to be zero-emission vehicles, such as plug-in hybrid electric, battery electric or fuel cell electric vehicles (The White House, 2021). In 2019 the first internal combustion engine phase-out target in China was announced by the Hainan province, aiming to ban fossil fuel car sales by 2030 (Science X, 2019). Moreover, targets for the electrification of railways combined with renewable electricity have been set by railway operating companies in Europe and India (International Railway Journal, 2019).

[9] *Eritrea, Eswatini, Guinea, Guinea-Bissau, Namibia, Niger and Rwanda.*

[10] *Cabo Verde, Cook Islands, Mauritius, Samoa, Sao Tome and Principe, and Solomon Islands.*

[11] *Belize, Bolivia, Chile, Nicaragua, Panama and Peru.*

However, realising the positive impact of electrification will need a simultaneous increase in renewable power generation. For example, the Russian Federation plans to ramp up its EV fleet by setting a target for the annual production of 220 000 EVs by 2030. As the renewable electricity generation target is set at only 2% by 2030, much of the EV fleet could be powered by fossil fuel-based electricity. To date, only nine countries that have an EV target have also set a 100% renewable power target (REN21, 2022).

Targets for peak power

Some countries have defined targets specifically for peak generation. Guinea-Bissau's National Plan of Action for Renewable Energy, for instance, sets an ambition for renewable energy capacity to reach 72 MW by 2030, representing 52% of peak demand (in terms of MW) and 72% of total electricity demand (in terms of share of production) (ECREEE, 2017).

The use of renewables and battery storage for "peaking" power is starting to gain ground, as several jurisdictions, mainly in the United States, start to seek ways to reduce reliance on natural gas plants to meet peak electricity demand and ease the integration of variable renewable energy into the grid. In August 2020 Massachusetts became the first state to adopt a so-called "Clean Peak Standard", which refers to an additional target to the state's existing renewable portfolio standard (RPS) of 33% by 2025. The standard requires 1.5% of total peak electricity demand to be procured from eligible clean peak sources, including renewables, storage and demand response. The minimum requirement is scheduled to increase by 1.5 percentage points per year up to 16.5% by 2030 (Commonwealth of Massachusetts, 2022).

Targets for rural electrification with off-grid renewables

Rural electrification targets specifying off-grid renewables continue to be widespread, in a bid to close the access gap that still exists for 733 million people, of which 568 million reside in sub-Saharan Africa (IRENA *et al.*, 2022). As of August 2022, renewable energy targets for rural electrification were implemented in almost 30 countries, mostly focusing on off-grid solar photovoltaic (PV). Nearly half of these countries are in West Africa, where all countries have set a target. In contrast, Central Africa has the fewest countries with renewables-based rural electrification plans (IRENA and AfDB, 2022).

2.1.2 AN INCREASING NUMBER OF COUNTRIES ARE IMPLEMENTING TARGETS FOR RENEWABLES IN END USES (TRANSPORT, CLEAN COOKING, HEATING AND COOLING)

Although **heating and cooling** account for about 50% of global total primary energy demand (IRENA, IEA and REN21, 2020), only 40 countries had renewable heating and cooling targets by mid-2022, most of which are in Europe.

Of those, 30 countries have set their targets as a percentage of all energy needed for heating and cooling without specifying the technology, and 10 have set targets for specific technologies. For example, India has a solar water heating (SWH) target of 14 GWth (20 million m^2 of solar receptors) by 2022. A handful of countries in sub-Saharan Africa have set similar targets, such as Kenya, Niger, Nigeria, Senegal and Zimbabwe.

Ecuador presents an interesting case that showcases the need for comprehensive policymaking to achieve targets (Box 2.2). In 2019 the government launched a nationwide initiative to transition 3.5 million households away from liquefied petroleum gas (LPG) to induction electric stoves, to meet their cooking needs.

For the use of renewables in **transport**, only 33 countries have targets. Policy support has focused on road transport, mainly in the form of mandates and incentives to promote the production and use of biofuels[12]

[12] *Although bioenergy brings many benefits, it can also cause negative environmental, economic and social impacts such as loss of biodiversity, deforestation and reduced food security. A robust policy framework is needed to minimise the potential negative impacts. IRENA's report, Bioenergy for the Transition: Ensuring Sustainability and Overcoming Barriers, studies potential sustainability aspects and analyses the elements of the policy framework required, including setting sustainability-based targets and long-term plans; ensuring sustainability governance supported by regulations, certification schemes and cross-sector coordination; and integrating bioenergy policymaking with the Sustainable Development Goals (IRENA, 2022c).*

(in addition to the deployment of EVs running on renewable electricity). Some of those targets increase gradually, such as in India (see Section 3.4.3). Another example is Zimbabwe, where the biofuel policy of 2020 sets out a target for ethanol blending of 20% by 2030 and biodiesel blending of 2% starting from 2020 when available (Government of Zimbabwe, 2020). Indonesia has a target for biodiesel blending and bioethanol of 30% and 20% respectively, by 2025 (USDA, 2018). There are plans to increase the biodiesel target to 40%, although these have not yet materialised into any legislation or policy (Christina, 2022).

The aviation and shipping sectors have received modest policy attention. The International Maritime Organization and the International Civil Aviation Organization are two international organisations that have adopted GHG emission reduction targets for international shipping and aviation in 2030, respectively (International Civil Aviation Organization, 2017; International Maritime Organization, n.d.). Some regional and national governments have set targets for sustainable aviation fuels. In its Fit for 55 packages, the European Union has proposed blending 5% sustainable aviation fuels (SAF) into general aviation fuel by 2030. Other countries, including Finland, Indonesia, the Kingdom of Sweden, the United Kingdom and the United States, have set specific targets for the aviation sector. For instance, Finland has set a target for a 30% biofuel share in aviation to support its goal of carbon neutrality by 2035 (Biofuels International, 2019).

Targets for clean cooking

According to the latest SDG7 Tracking report, about 2.4 billion people were still without access to clean cooking in 2020, more than 80% of whom reside in one of the 20 countries with the lowest access to clean fuels. In seven of these countries, the Democratic Republic of the Congo, Ethiopia, Madagascar, Mozambique, Niger, Tanzania and Uganda, less than 5% of the population have access to clean fuels and technologies. Unless efforts are ramped up significantly, this access deficit will continue to grow as population growth outpaces the rate at which clean cooking access is provided (IRENA *et al.*, 2022).

In a bid to achieve the Sustainable Development Goals by 2030, countries are increasingly adopting targets for clean cooking.[13] These include targets for the adoption of efficient cookstoves and a transition to renewables-based clean cooking options, including the use of electricity and biogas.

Ghana, for example, has set a target of installing 3 million improved cookstoves by 2030, Kenya has framed its target as achieving a 57.7% rate of adoption of improved cookstoves among households by 2030 and Rwanda is aiming for 100% access to higher-efficiency cookstoves than currently used by 2030 (IRENA, 2022b). Rwanda is also aiming to almost halve the share of households using wood and other biomass fuels from 83% to 42% by 2024 (SEforAll, 2018).

IRENA, supported by the government of the United Arab Emirates under the Beyond Food initiative, is studying how countries that have clean cooking targets in their NDCs can meet them through electrification (Box 2.3).

[13] *Although the report focuses on renewable energy targets, targets for improved and more efficient cookstoves are also included as these are widely adopted to support clean cooking goals.*

Box 2.2 Ecuador's targets and policy measures to transition to electric cooking

Ecuador's plan to transition 3.5 million households relying on liquefied petroleum gas (LPG) for their cooking needs to induction electric stoves was part of the strategy to transition to electric cooking and water heating in a country where renewables, predominantly hydropower, account for more than 60% of the electricity mix (IRENA, 2022d).

The Energy Efficiency Programme provided a tariff subsidy to 13% of the population, consisting of a zero tariff rate for the consumption of electricity up to 80 kilowatt hours (kWh) per month for the purpose of using induction cookers, and up to 20 kWh for water heating systems. The scheme involves visits to verify the use of the induction cooker or the electrical water heater.

Despite the subsidised tariffs, electric cookers still met resistance from some consumers. In addition to cultural habits that may take some time to change, electric stoves require the use of induction appliances, which are more costly and limited in terms of size and application.

But more importantly, there is a misconception among consumers that the use of induction cookers increases electricity bills and that LPG remains more affordable. LPG is still subsidised and is sold at an official price of USD 1.6 for a 15 kg cylinder (enough for a month in a family of four members). The LPG state subsidy was not removed as was planned, and in 2021 it amounted to approximately USD 860 million, and this number is expected to increase in 2022 with the rise in global energy prices.

In addition, the eligibility of a household to receive the zero-rate subsidy for up to 80 kWh depends on showing an increase in power consumption following the installation of cookstoves, compared to the average consumption in the year before the installation. Other factors might contribute to evening out consumption (*e.g.* reduced consumption due to fewer people in the household or the retirement of other less efficient appliances). At the same time, some households might have increased consumption due to reasons other than the use of the cookstoves, but are still eligible for the subsidy even if they continue to use gas for cooking. This highlights the need for coordinated policy measures to support target achievement.

Source: 247newsagency.com (2022).

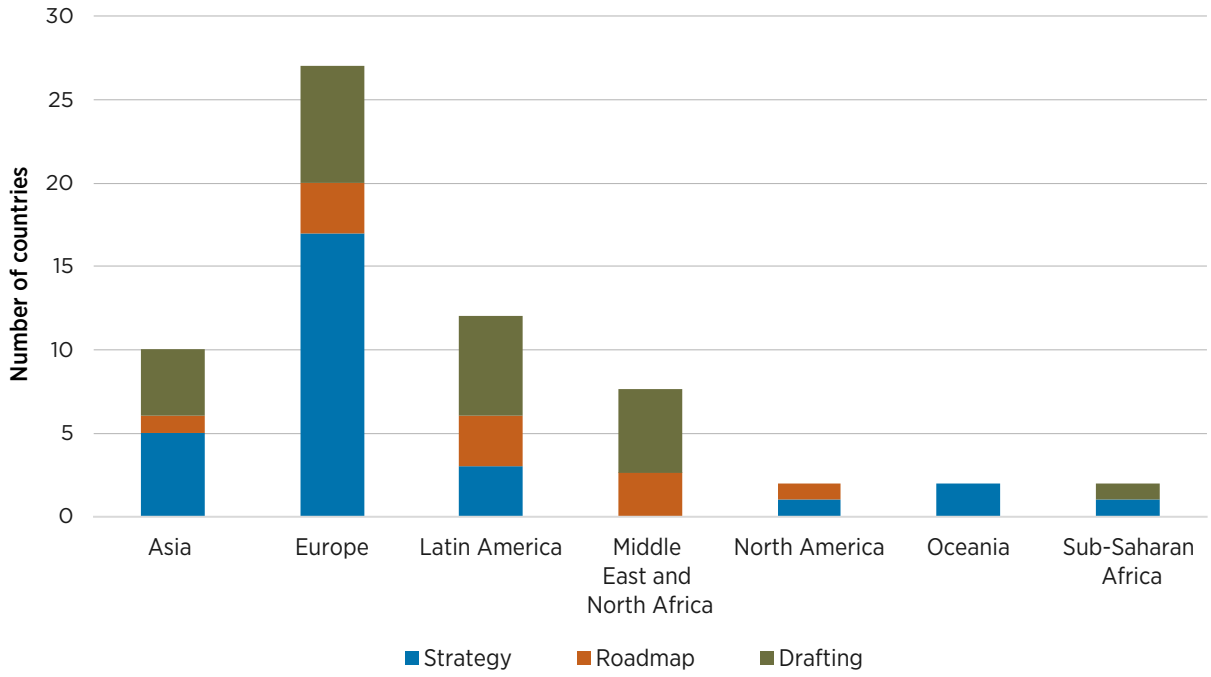
Box 2.3 IRENA's Beyond Food initiative: Clean cooking and climate action through electrification

On 4 March 2022, at Expo 2020 Dubai, IRENA launched a new initiative, "Beyond Food: A partnership to empower people and communities through clean cooking and sustainable energy", supported by the United Arab Emirates government, looking at the role of women, enterprises and clean cooking, as well as finance facilitation and climate action. Under the initiative, IRENA is assessing efforts towards achieving clean cooking commitments in Nationally Determined Contributions (NDCs) and national energy plans by IRENA member states that are also Parties to the Paris Agreement. The aim is to support them to meet their NDC commitments and achieve SDG7. IRENA is also developing a country engagement and finance facilitation strategy for the clean cooking energy transition based on electrification. The outcomes will be combined with and build on IRENA's ongoing and potential climate action support to Paris Agreement Parties, enhancing and implementing their climate pledges through NDCs and long-term low-emission development strategies

Targets for green hydrogen

Green hydrogen[14] plays a major role in decarbonising hard-to-electrify sectors, such as the production processes of basic chemicals and primary steel. Long-haul transport (shipping and aviation) can also benefit from hydrogen derivatives, namely ammonia and synthetic fuels. In IRENA's 1.5°C Scenario, green hydrogen accounts for around 8% of total energy consumption (Figure 2.2). By October 2022 more than 60 countries had developed or were preparing hydrogen strategies, from just one country (Japan) in 2017 (Bianco *et al.*, 2022). Countries with hydrogen strategies as of October 2022 are shown in Figure 2.3.

FIGURE 2.3 Hydrogen strategies, including those in preparation as of June 2022

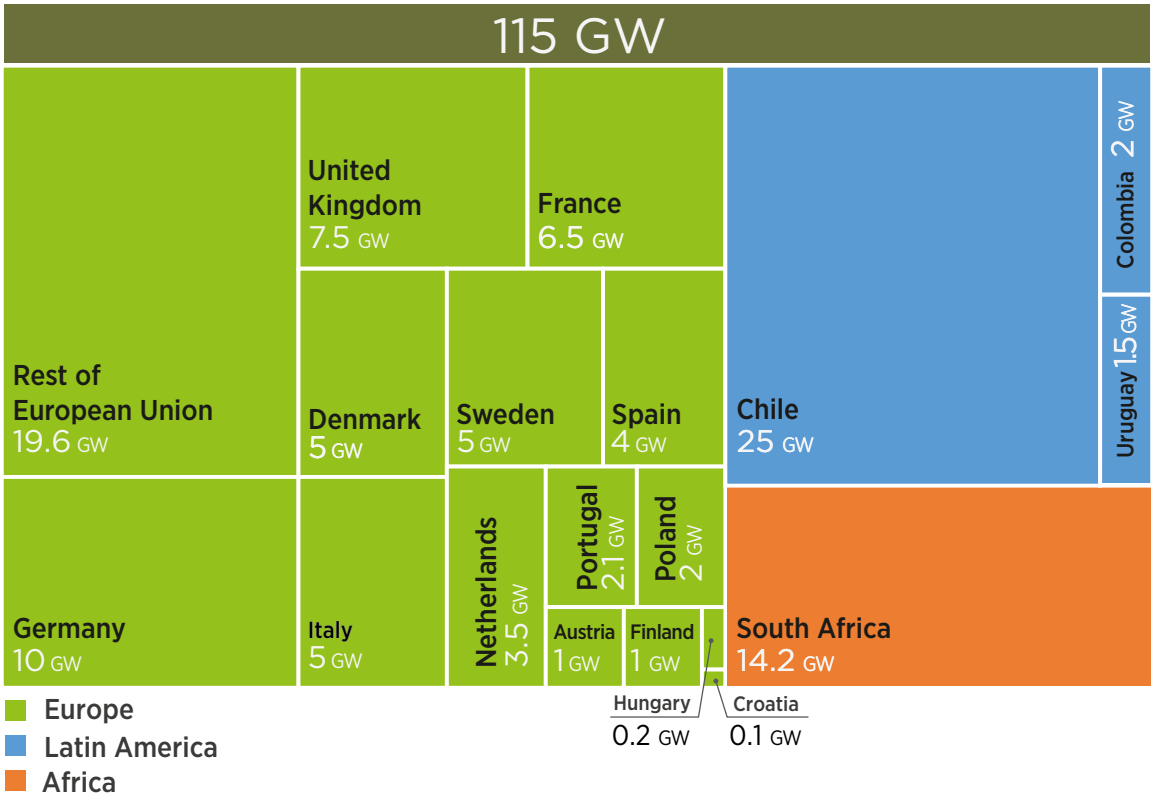


Note: "Strategy" indicates an official final document approved by the government. "Roadmap" indicates the publication of a preliminary document. "Drafting" is for countries for which there is an official announcement that a strategy is being developed.

[14] *Namely hydrogen produced using only renewable energy. While many production pathways may exist, for the sake of this report green hydrogen refers to hydrogen produced by renewables-fuelled electrolysis.*

As part of their strategies, several countries have adopted targets for green hydrogen, most commonly framed in terms of electrolyser capacity (Section 3.5.2). The total installed capacity of electrolysers in these targets is around 100 GW by 2030 (Figure 2.4)

FIGURE 2.4 Total electrolyser 2030 targets, globally, as of September 2022



Note: When a strategy presents a target range, the mid-point has been selected. "Rest of European Union" target refers to the REPowerEU target (65 GW) minus the sum of EU member states' own targets.

The EU REPowerEU package sets a target to domestically produce 10 million tonnes of renewable hydrogen, in addition to 10 million tonnes of imports by 2030, with a view to replacing natural gas, coal and oil in hard-to-abate industries and the transport sector. The increase in the production of green hydrogen translates into a need to increase the installed capacity of electrolysers to 65 GW in 2030 (current capacity is less than 1 GW) (European Commission, 2022b).

Other common targets included in strategies are for the share of green hydrogen in total hydrogen or gas demand. France, for example, has set a target specifying that 10% of the gas in the supply mix should be renewable by 2030. In Spain, the government developed a hydrogen strategy that sets a minimum 25% green hydrogen contribution to the total hydrogen consumed by all industries in 2030, both as an energy carrier and as a feedstock. Relative to current hydrogen consumption in Spain, this amounts to around 125 000 tonnes per year (IRENA, 2022f) (IRENA, 2021).

Strategies can also set socio-economic targets. These include targets for increased revenues, investment and exports, positive impact on gross domestic product (GDP), and most commonly, job creation. Expectations for job creation in the hydrogen sector can be found in the strategies of Canada, the Republic of Colombia, France and Italy (IRENA, forthcoming).

2.1.3 TARGETS DETERMINED AT THE CITY LEVEL ARE BECOMING INCREASINGLY COMMON

As local leadership grows, local governments and cities are playing an increasingly vital role in speeding up the energy transition, as many have announced renewable energy targets (and net zero targets as mentioned in Section 1.1.2). At the end of 2021 about 925 cities in 73 countries had adopted renewable energy targets in the power and/or other end-use sectors (REN21, 2022).[15]

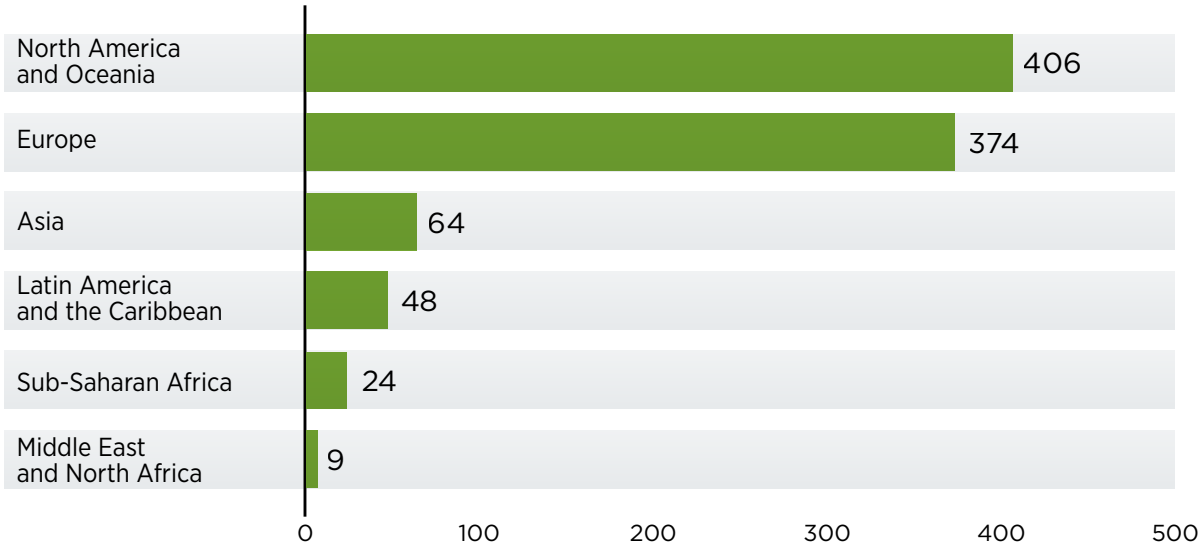
Consistent with global trends, most city-level renewable energy targets apply to the power sector, although cities are increasingly enacting targets for transport (mainly on electric mobility) and heating and cooling. By the end of 2020 about 617 cities had 100% renewable energy targets in place, mainly for the power sector, and at least 125 cities had already achieved their target of 100% renewable electricity. (REN21, 2021b).

Many jurisdictions are trying to accelerate the transition to cleaner modes of transport by combining their policies to encourage electric and other clean forms of transport. About 100 cities had e-mobility targets by the end of 2021 (REN21, 2022), while a growing interest in hydrogen for transport in cities in East Asia, Australia, California and Europe is resulting in targets for renewable hydrogen-powered transport. In addition, many cities have enacted policies to discontinue the sale of, or completely ban the entry of, internal combustion engines by a certain date. For example, Amsterdam has announced that petrol- and diesel-powered vehicles would be prohibited from entering the city by 2030, with a non-electric bus ban already in place in 2022 (REN21, 2021b).

City-level targets in the heating sector are also growing. By the end of 2021 some 170 renewable heating targets were active at the city level, mainly across Europe and the United States. In addition, bans on the use of natural gas, oil, or coal for space and water heating had been passed or proposed in more than 59 cities across 13 countries (REN21, 2022).

City-level targets are more prevalent in high-income countries. North America and Oceania (together) and Europe account for 80% of all city-level renewable energy targets, the first having 406 targets and the second having 374 targets. Asia (64), Latin America (48), sub-Saharan Africa (24) and MENA (9) make up the rest. Figure 2.5 presents an overview of city-level targets by region. Relatively smaller cities with populations under 500 000 make up almost three-quarters of the cities with renewable energy targets; examples include Bakata (Burkina Faso), Hanover (Germany), Takarazuka (Japan) and Santa Cruz (California), although large cities such as Beijing, Cape Town, Dubai and Frankfurt have also set renewable energy targets (REN21, 2022).

FIGURE 2.5 Number of cities with renewable energy targets, by region as of the end of 2021



Source: REN21 (2022).

[15] *While these targets are often limited to "municipal operations", some cities are also applying them city-wide.*

Private companies are increasingly adopting renewable energy targets, with many aiming for a 100% renewable energy share. Some of these have come together to form a global network, the RE100 (Box 2.4).

Box 2.4 Renewable energy targets at the company level – the RE100

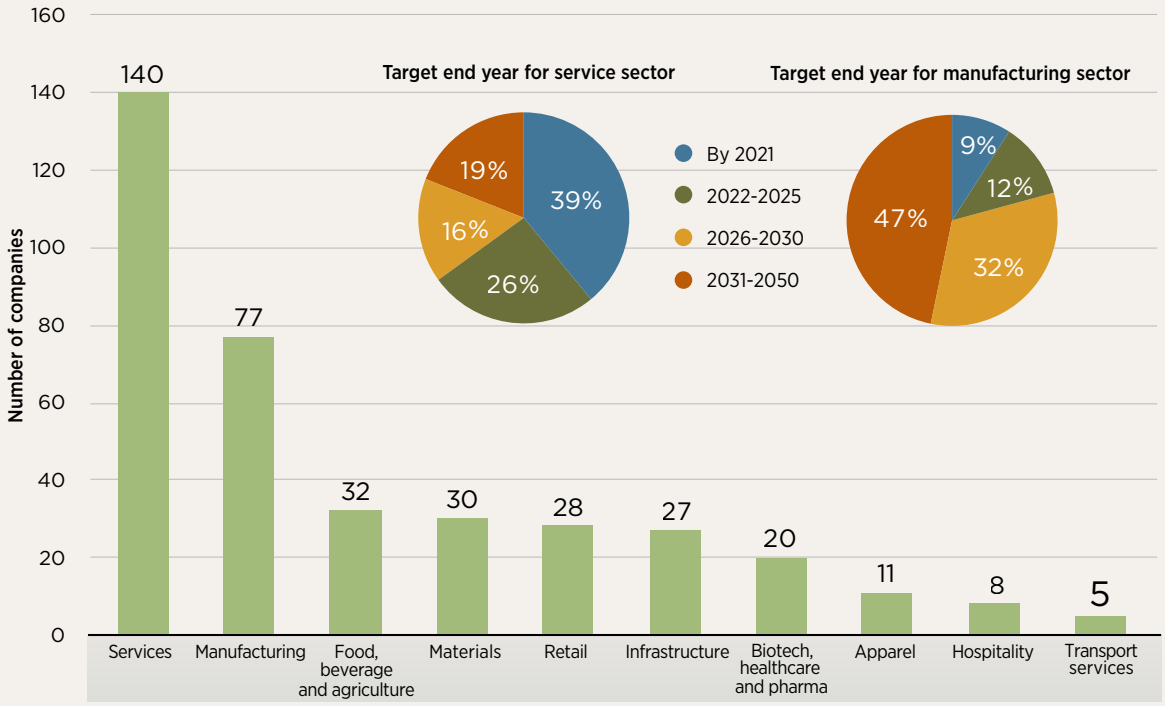
The RE100 is a global network bringing together hundreds of businesses that have made a commitment to run on 100% renewable energy. As of August 2022, a total of 370 companies are part of the network and together they consumed 340 terawatt hours (TWh) of electricity in 2020 (more than United Kingdom), of which 45% was reported to be from renewable sources. The network is growing fast, with most new members coming from the Asia Pacific region, particularly Japan and the Republic of Korea.

The sectoral composition of companies with 100% renewable energy targets is skewed towards the service sector, although the representation of the manufacturing sector is growing fast. As Figure 2.6 shows, 140 companies from the service industry with an average 71% renewable electricity share have set such targets. They include multinational firms such as Accenture, Barclays and Deloitte. About 77 companies have set similar targets in the manufacturing sector, with a current average renewable energy share of 32%. They include companies such as Apple and General Motors.

The timelines for the targets differ between regions and sectors. Companies in Asia Pacific typically have targets for well beyond 2030 as it may be relatively more difficult to procure renewable electricity in the region. By sector, most firms in the manufacturing and materials sectors have set targets for 2030 and beyond. In contrast, companies in the service sector have mainly set targets for 2025 or earlier.

As the share of renewables is lower in the manufacturing sector to begin with, the longer timelines show the need for further research and development to deploy feasible and commercial solutions for their decarbonisation. Going 100% renewable can therefore pose more challenges in hard-to-decarbonise sectors. For example, the ALTANA Group produces chemical products and has 48 facilities and 65 research and service laboratories globally. Although the corporation has a 100% renewable energy target and has so far achieved 96% renewable power across its operations worldwide, the remaining 4% continues to come from gas-based plants and is only expected to be renewables-based by 2040.

FIGURE 2.6 Companies with 100% renewable energy targets by sector, as of August 2022



Source: RE100 (n.d.)

2.1.4 COUNTRIES ARE INCREASINGLY SETTING TARGETS FOR SOCIO-ECONOMIC DEVELOPMENT FROM RENEWABLE ENERGY DEPLOYMENT

A global energy transition based on renewables under IRENA's 1.5°C Scenario leads to an increase in world GDP that is 2.4% greater (on average) than that under the Planned Energy Scenario over the next decade. Economy-wide employment is 0.9% higher on average. In addition, IRENA's Energy Transition Welfare Index, with its five dimensions – economic, social, environmental, distributional and energy access – shows that the 1.5°C pathway improves global welfare significantly (IRENA, 2022a). In Africa, the energy transition under IRENA's 1.5°C Scenario predicts 6.4% higher GDP, 3.5% higher economy-wide jobs and a 25.4% higher welfare index than that realised under current plans, on average up to 2050 (IRENA and AfDB, 2022).

But these continent-level benefits mask large disparities between regions and countries, and they do not occur automatically. They need a comprehensive set of policies, including industrial and labour policies, and measures for education and training, and public financing, among others. This is why setting a target for the socio-economic benefits that the energy transition aims to achieve in a given country is very important. Such a target can provide a clear direction with regard to the policies that need to be implemented to ensure a just and inclusive energy transition. Morocco and South Africa were among the first countries to set such objectives at their early stages of renewable energy development, and pioneered policy measures and auction design to serve those objectives. Their cases are detailed in the IRENA report *Renewable energy auctions: Status and trends beyond price* (IRENA, 2019a).

More recently, policy makers in the United States have been working to provide workforce training and grow manufacturing. Goals have been set for at least 300 000 additional diverse solar employees and 1 GW per year of new US PV manufacturing capacity. The focus is also on removing barriers to equitable solar access and supporting a diverse and inclusive workforce. A goal has also been set for 100% of US energy consumers to be able to choose residential or community solar that does not increase their electricity cost (Moreno, n.d.). In 2021 President Biden set a GHG reduction target by 2030 that aims to create well-paid union jobs and secure US leadership on clean energy technologies (Box 2.5). The United Kingdom's strategy to speed the transition to net zero, support green jobs and improve infrastructure is outlined in the Ten Point Plan for a Green Industrial Revolution. In order to create and sustain up to 250 000 green jobs, the government intends to mobilise GNP 12 billion in public investment and potentially up to three times that amount from the private sector. The government's net zero strategy plans to support the transition with cross-cutting action. This includes reforming the skill development sector so that trainers, employers and students are motivated and prepared to contribute to the shift to net zero (Government of the United Kingdom, 2020b).

Targets are also being set to develop local supply chains, as the disruptions, increase in prices, trade conflicts and conflict in Ukraine have emphasised the importance of energy security and independence. One of the European Commission's industry strategies, the European Solar Initiative, is targeting an annual production of 20 GW by 2025. Around EUR 8-10 billion would be needed, reflective of the EUR 8 billion trade deficit in solar equipment in the European Union. Incentives will be required to enable bigger market shares for EU-manufactured solar products. In addition, the bloc's wider climate agenda to protect its manufacturing sector may be helpful, with potential carbon footprint restrictions for imported solar products. This has already succeeded in protecting local solar manufacturing in France and would help establish a level playing field with lower-cost imported products (Fitch Solutions, 2022).

Box 2.5 The US government's socio-economic aims for the deployment of renewables

In the United States, policy makers are aiming to maximise the opportunities presented by a transition to clean energy, to support well-paid union jobs and working communities, advance environmental justice and protect public health.

To develop the goal, the administration analysed how every sector of the economy can spur innovation, unleash new opportunities and create benefits. The target builds on leadership from various stakeholders including businesses, investors, healthcare organisations and communities.

The US 2030 target to reduce emissions also aims to support the long-term goals of achieving a carbon-free electricity sector by 2035 and a net-zero economy by 2050, while achieving socio-economic objectives that include:

- Job creation. Meeting the 2030 target of reduced emissions is intended to create millions of well-paid union jobs, for example in constructing transmission lines, in EV manufacturing and charging infrastructure installation, developing green hydrogen and carbon capture in cement and steel production, and in agricultural applications of carbon innovation.
- Local manufacturing. The objective is to strengthen domestic supply chains and position the United States as an exporter of clean energy products, such as EV batteries.

Source: The White House (2021).

2.2 QUANTIFICATION AND ANALYSIS OF RENEWABLE ENERGY TARGETS IN THE POWER SECTOR

Approximately 90% of global electricity needs have to be supplied by renewables by 2050 – up from around 26% in 2019 – to put the world on a climate-safe pathway (IRENA, 2022a). This section provides an in-depth analysis of targets adopted in the power sector to date, and how they fair in putting the world on the path to achieving climate goals.

2.2.1 RENEWABLE POWER TARGETS ARE HALFWAY MET GLOBALLY, BUT THEY ARE CONCENTRATED IN FEW REGIONS AND TECHNOLOGIES

To analyse the level of ambition in renewable power targets currently in place, IRENA has undertaken an exercise to quantify them (currently active and expired) by country, and then aggregate them by region and by technology. The quantification methodology is explained in Box 2.6.

Box 2.6 Methodology for quantifying renewable power targets and assumptions for major renewable energy players

IRENA's quantification exercise aims to provide estimates of the total renewable capacity that would be installed should countries successfully meet their targets.

In cases where targets are expressed in terms of fixed capacity (*e.g.* Brazil and Viet Nam), figures are used as is. In cases where the target is expressed as a share of the power mix (*e.g.* Japan has a 2030 renewable energy generation target of 36-38%), the total electricity generation in the target year is obtained or derived from data provided in official documents. Where this is not possible, it is projected based on a 10-year historical cumulative annual growth rate (CAGR). The quantity of renewable energy generation in the target year is then obtained by multiplying the overall electricity generation by the target share.

Next, the technology-specific shares in the renewable electricity mix are calculated. When technology-specific targets are not available, the mix is estimated according to the share of each technology in capacity additions over the last five years (2017-2021 period). Finally, IRENA's capacity factor data are used to convert generation (MWh) into capacity (MW).

Subnational targets are only taken into account for major renewable energy players (*e.g.* Australia and the United States) as in these cases respective sub-national governments have their own targets that are driving deployment, even when the federal target is relatively small.

Data are obtained from national statistics, policies and planning documents such as roadmaps and national electricity outlooks. Certain assumptions and approximations are made to account for the gaps and ambiguities in available data. These are made on a country-by-country basis to reflect local conditions where possible. Further details on the methodology are presented in Annex 1.

Aggregated quantified targets by region

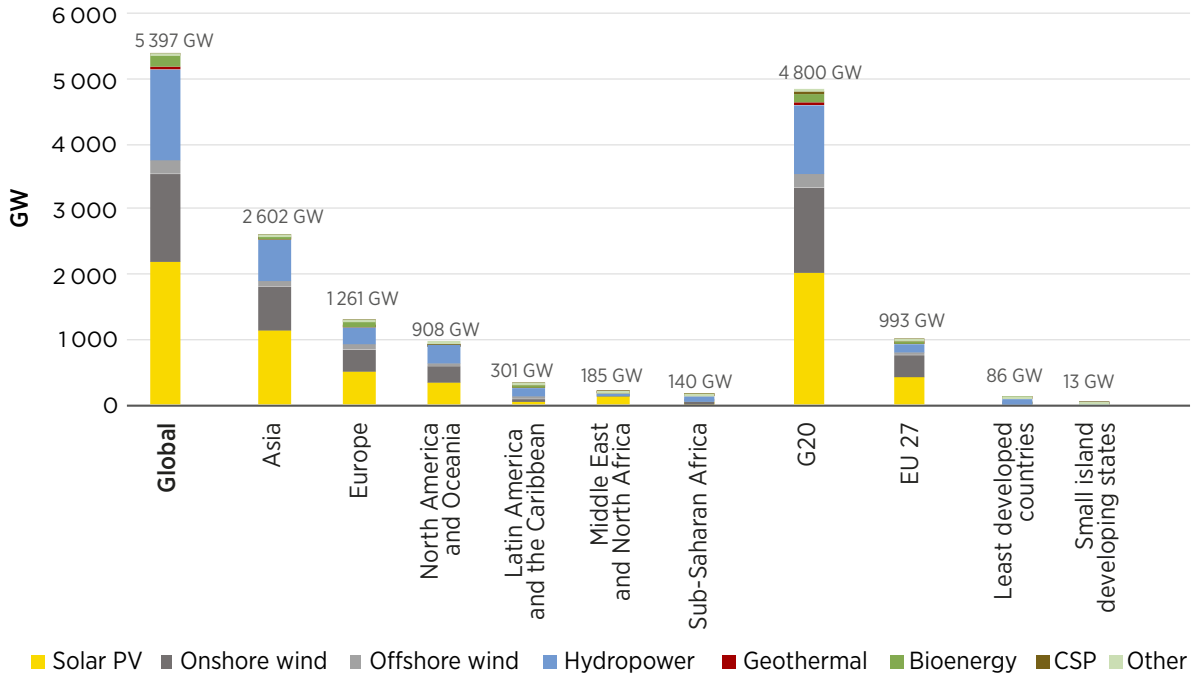
The quantification exercise finds that the achievement of all renewable power targets set in national energy plans would result in 5.4 TW of renewable installed capacity by 2030.[16] As shown in Figure 2.7, the majority is in Asia (particularly China and India), which has aggregated targets totalling 2.6 TW in 2030 (from an installed total of 1.5 TW in 2021). Europe and North America and Oceania together have targets to increase their renewable energy capacity by 78-80% compared to today's levels, totalling to 1 261 GW and 908 GW by 2030 respectively.

MENA accounts for just 3% of global targets by 2030 (or 185 GW, up from installed capacity of 37 GW in 2021), despite the region's high potential and unsatisfied need for reliable and secure energy in many countries.

Finally, sub-Saharan Africa accounts for just 2.6% of global targets by 2030, with a target capacity of 140 GW by 2030, up from around 43 GW already installed in 2021. Sustainable renewable energy is fundamental to Africa's future, as it currently hosts 77% of the world's population with no electricity access (IRENA *et al.*, 2022). Countries in this region therefore have a strong imperative to harness their renewable energy potential, close the access deficit and boost the region's welfare and economic development.

The countries targeting the highest level of deployment are all part of the G20, making up 89% of the global target. Finally, although LDCs and SIDS make up a small share of past renewable deployment, their aggregated targets total 86 GW and 13 GW respectively, both doubling their current renewable capacity stock.

FIGURE 2.7 Aggregate targeted renewable electricity capacity by 2030 by region, country grouping and technology

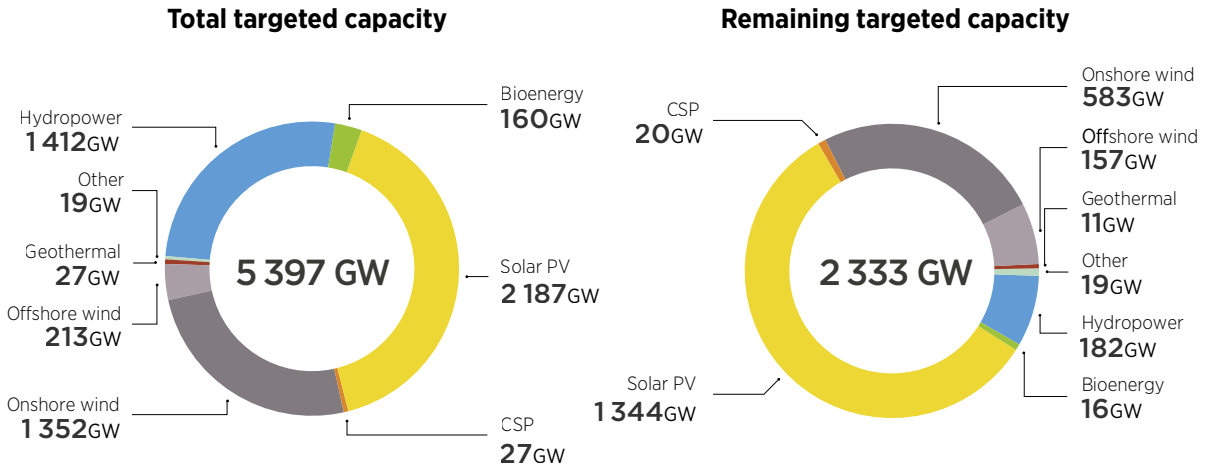


[16] *It is important to note that not all renewable power capacity added globally is "driven" by renewable energy targets, strictly speaking. A lot of renewable capacity is simply being added by households, small and medium-sized enterprises and industries for self-consumption (on-site use), while other capacity is being built to respond to market demand (rather than in response to government-set targets), such as the investments occurring under corporate power purchase agreements. Also, jurisdictions like the US state of Texas have not revised their renewable energy target since having far surpassed it 2010, as investment is occurring even in the absence of mandatory targets due in part to increasingly low-cost renewables.*

Quantified targets by technology

Figure 2.8 shows the quantified targets by technology. The left pie chart shows the mix of different technologies should all countries reach their targets successfully, while the right-hand side shows the remaining targeted capacity over the 2022-2030 period, *i.e.* the difference between aggregate targeted capacity and current installed capacity.

FIGURE 2.8 Aggregate targeted renewable electricity capacity by 2030, by technology, total target capacity (left) and remaining target capacity (right)



As shown, the targets mostly aim to install solar PV, onshore wind and offshore wind by 2030 (right-hand side) corresponding to 2 187 GW, 1 352 GW and 213 GW respectively. The large shares of solar PV, onshore and offshore wind are expected, given the dramatic drop in the cost of these technologies – an 88%, 68% and 60% drop in the levelised cost of electricity (LCOE), respectively, between 2010 and 2021 (IRENA, 2022g).

Although the figure shows a relatively low percentage of offshore wind, many countries have recently committed to deploying volumes that were not necessarily included in those targets. For this exercise, even in the case where countries have implemented policy instruments aiming for a certain level of deployment, such as the announcement of an auction, the volume in question is not accounted for as it is not officially included as part of a target. But recently, a number of offshore wind targets have been announced, particularly in United States and in Europe, to help phase out fossil fuels and to reduce reliance on energy imports from the Russian Federation. The United States has set a federal target of 30 GW offshore wind by 2030, while Germany and the United Kingdom have recently raised their offshore wind targets to install 80 GW by 2030 collectively (from a combined 60 GW previously). In addition, in May 2022 at the Offshore Wind Summit, Belgium, Denmark, Germany and Netherlands made a joint pledge to increase the combined North Sea offshore wind capacity of the four countries to 150 GW by 2050 (Bulijan, 2022).[17]

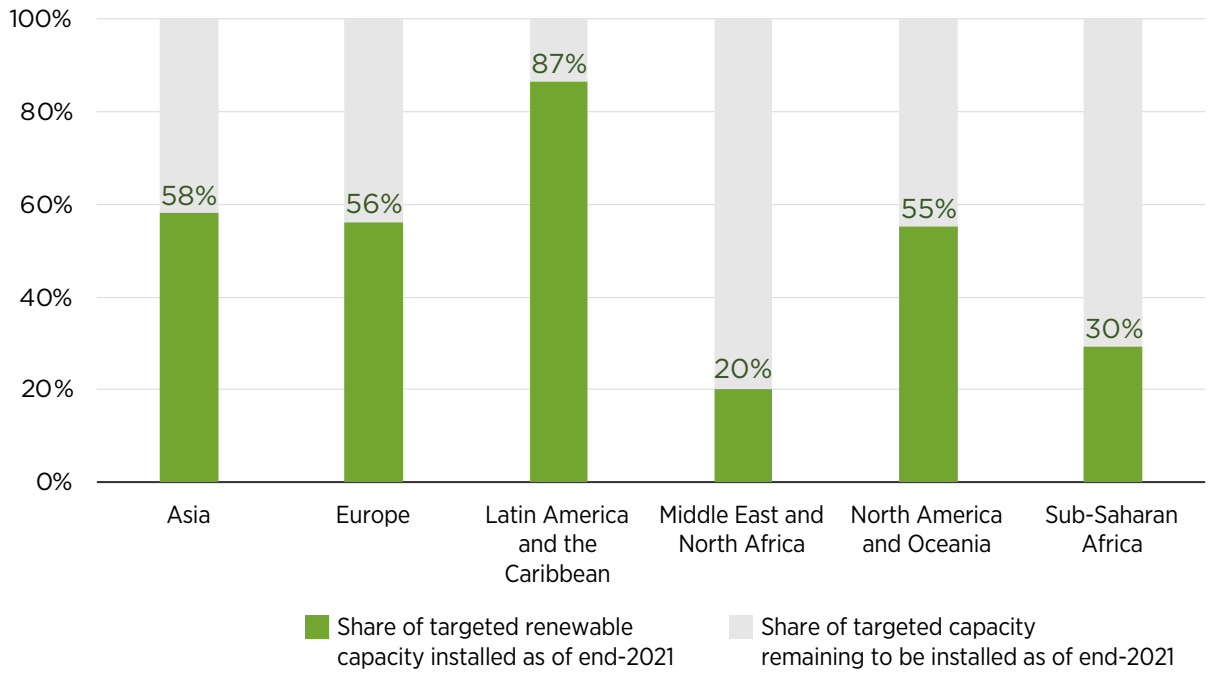
Although relatively few countries have targets for additional hydropower capacity, many will continue to rely on hydropower as an important part of their electricity mix. This explains why it continues to make up a significant share of the aggregate target capacity by 2030.

[17] *As this is a pledge at this stage and has yet to be translated into national policy documents, this estimate was not included in the analysis.*

Regional progress on aggregated quantified targets

Based on the global renewable energy capacity installed to date, the world has already achieved 57% of its targeted capacity for 2030. In fact, most regions are above the halfway mark to achieving their targets (Figure 2.9). Latin America and the Caribbean already have an achievement rate of 87%, driven by recent capacity additions in Brazil. Progress remains below the halfway mark in sub-Saharan Africa and MENA, which have an achievement rate of 30% and 20% respectively.

FIGURE 2.9 Progress made on aggregated targets for 2030, by region, as of 2021



IRENA further analysed the achievement of targets that were expiring by 2020. That year, the world's renewable energy capacity reached 2.8 TW. Almost all (88%) of the global target capacity for 2020 had been met. This was driven by a handful of countries such as China, the United States and major European economies, while most of the other countries had in fact missed their targets.

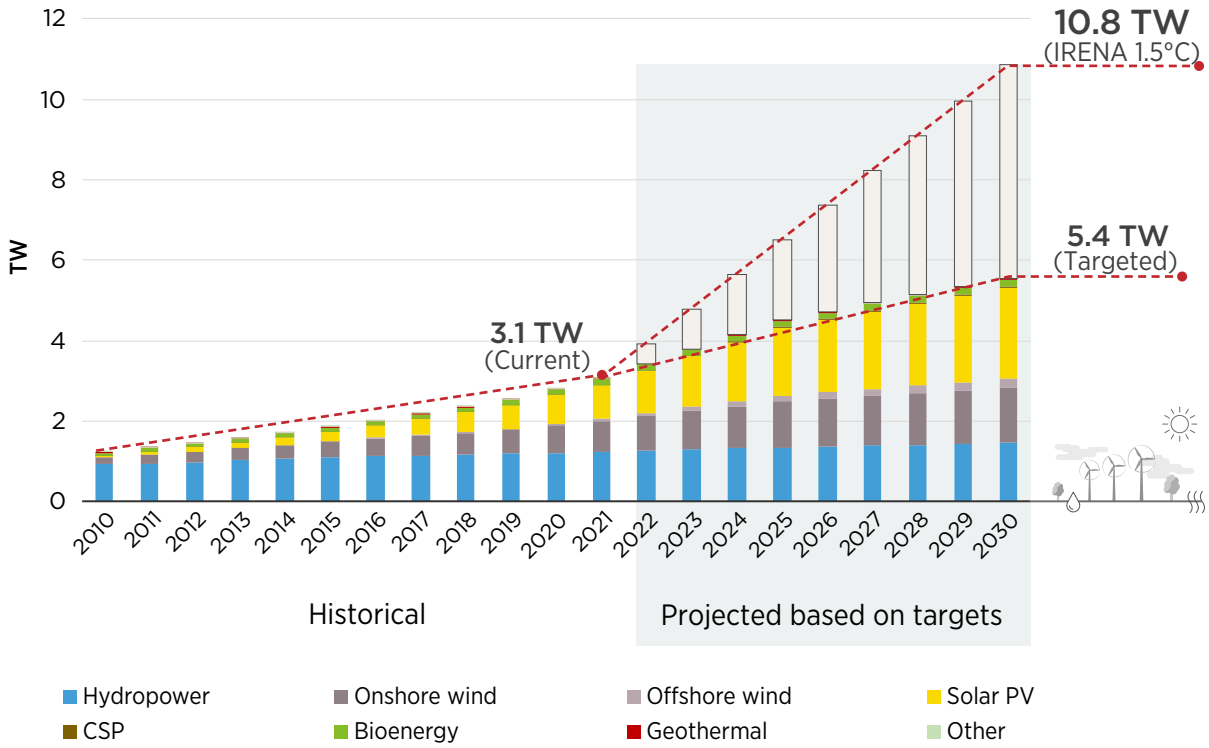
2.2.2 EXISTING RENEWABLE ELECTRICITY TARGETS CAN BE MET, BUT ARE NOT SUFFICIENTLY AMBITIOUS TO MEET CLIMATE GOALS

The world has made remarkable progress in deploying renewable energy capacity in the power sector, with global installed capacity growing from just above 750 GW in 2000 to over 3 TW in 2021 (IRENA, 2022h). A large part of the deployment to date can be attributed targets, together with policy instruments and financial incentives that, among other things, have contributed to the cost-competitiveness of renewable energy technologies. Figure 2.9 shows the cumulative renewable power installed capacity to date, together with future projections based on historical trends.

First of all, the graph shows that we are well on our way to achieving the targets set. But at the same time, it shows that the existing targets are not ambitious when compared to current deployment rates. For targets to be meaningful, they need to be more ambitious than the current trajectory.

To meet the targets set by 2030, totalling 5.4 TW, countries would be targeting an additional 2.3 TW by 2030, equivalent to average yearly additions of 259 GW over the next nine years. This is a slight increase compared to the average since the Paris Agreement in 2015 of 233 GW installed capacity a year, but below the annual installed capacity in the past two years. In 2020 and 2021, despite the complications that resulted from the pandemic and consequent supply chain disruptions, the world installed more than 260 GW each year.

FIGURE 2.10 Global cumulative installed capacity of renewable power, historical trends and future projections

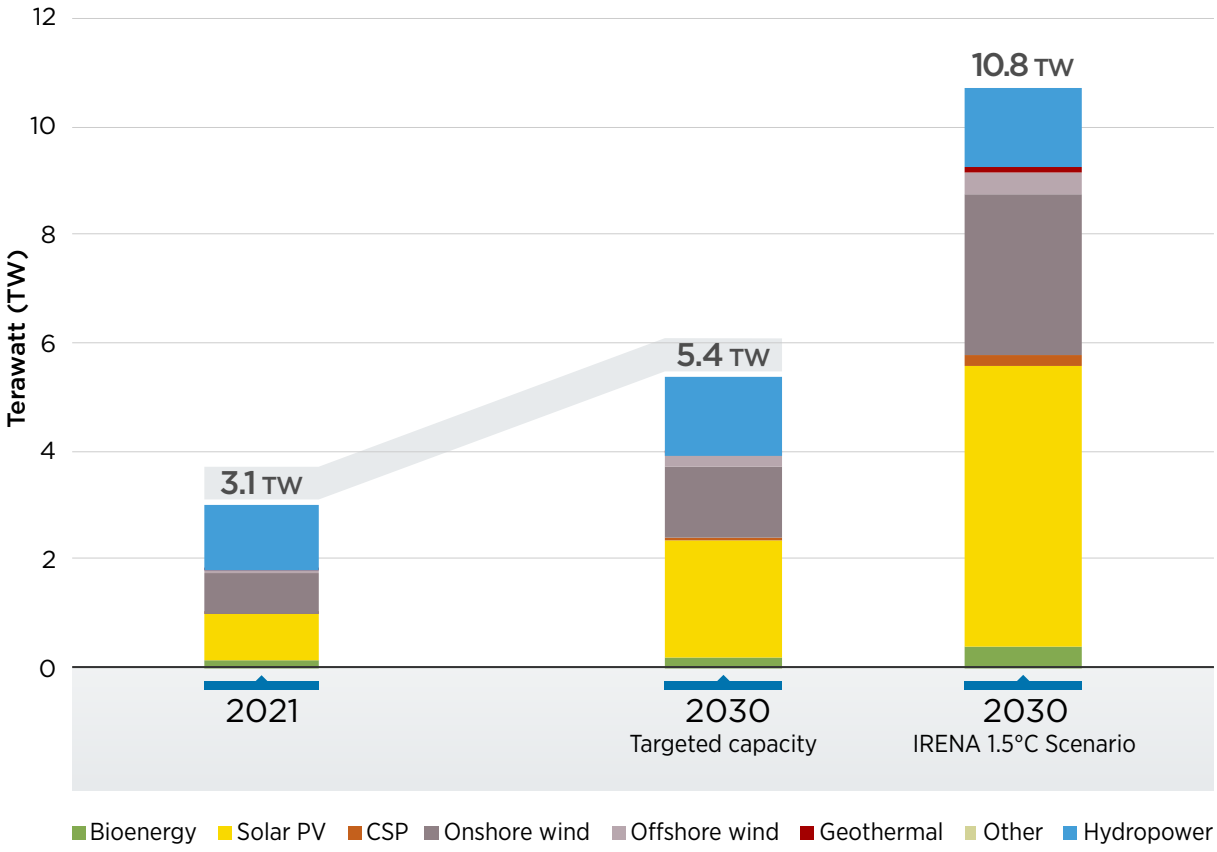


Notes: CSP = concentrated solar power; PV = photovoltaic. "Others" include ocean energy, off-grid renewable energy mini-grids and stand-alone systems.

More importantly, Figure 2.10 also shows that the set targets are nowhere near where they need to be to put the world on track to meeting the 1.5°C Scenario. The implementation of all targets would bring the total installed capacity to 5.4 TW globally, about half of the 10.8 TW needed by 2030 in IRENA's 1.5°C Scenario. The average yearly additions of 259 GW targeted until 2030 are less than a third of the annual capacity of 860 GW that needs to be added to meet the 1.5°C Scenario.

Figure 2.11 shows the installed capacity by technology in 2021, the capacity reached if all targets are achieved by 2030, and what is needed to keep the world on track with the 1.5°C Scenario by 2030, by technology. Considerably higher targets would be needed for solar PV and onshore wind, which fall short of the needed capacity by 3 TW and 1.6 TW, respectively. CSP targets should be more than seven times higher, while those for geothermal need to almost quadruple, and offshore wind targets need to be nearly doubled.

FIGURE 2.11 Global renewable power installed capacity in 2021, targeted capacity by 2030 and level needed as per IRENA's 1.5°C Scenario



Renewable energy targets need to be made more ambitious to account for all the deployment driven by parallel policy instruments (*e.g.* auctions) and the pledges made in net zero and fossil fuel phase-out and phase-down announcements, as well as NDCs.

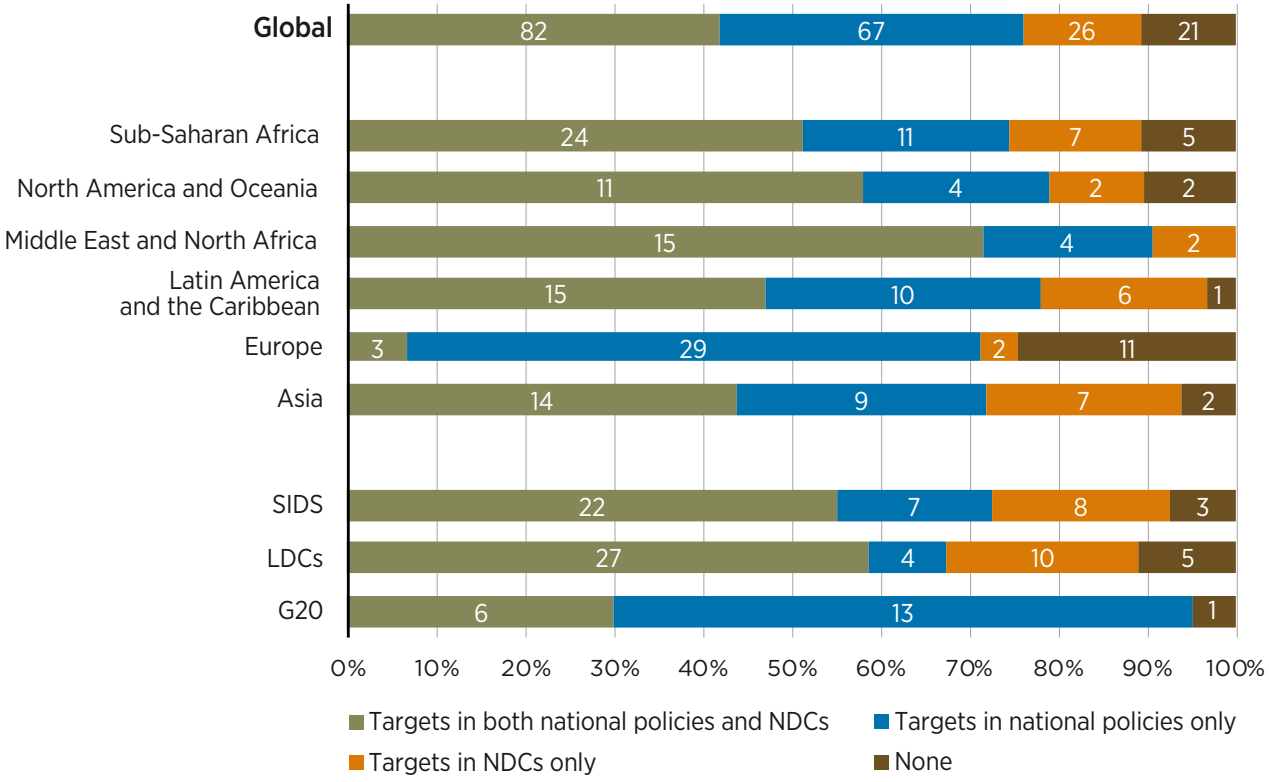
2.2.3 RENEWABLE POWER TARGETS IN NATIONAL ENERGY PLANS DO NOT ALIGN WITH THOSE IN NDCS

Although most of the NDCs presented have higher ambitions for renewable energy (Section 1.1.1), NDCs are still non-binding pledges, even when they are unconditional.[18] Therefore, translating pledges made in NDCs into action will depend in part on how well these commitments are integrated into more binding national policies and plans. This section focuses on the power sector and compares the renewable power targets in NDCs and those in national energy plans to identify the incidence of mismatch between the two, with deeper analysis of the SIDS.

[18] *Several countries included targets/commitments as part of their NDCs that are conditional on receiving international climate finance to plug the incremental cost gap. Many such pledges remain non-binding due to limited international climate finance flows.*

Figure 2.12 shows that as of October 2022, 82 countries had set renewable power targets in both national policies and NDCs, while 67 had set them only in national plans, 26 only in NDCs, and 21 countries had made no commitments specific to renewable power. Sub-Saharan Africa has the highest number of countries with renewable energy targets only in their NDCs, many of which are LDCs. This highlights the importance of NDCs for those countries as a primary document for creating a national low-carbon strategy.

FIGURE 2.12 Number of countries with renewable power targets in NDCs and national energy plans, by region and country grouping



The comparison of renewable energy targets in national laws and official strategies released as of mid-2022 with renewable energy targets in NDCs as of October 2022 finds that in many cases, pledges made in NDCs have not been incorporated into long-term policy and planning. An earlier IRENA analysis (of NDCs submitted up to 2020) found that in 178 of the 194 countries that were analysed (92%), a mismatch was found between renewable energy targets in NDCs and those featuring in national laws and official strategies and plans.[19] However, the latest NDC submissions are addressing this mismatch.

Although this may partly be due to temporal differences in the enactment of national legislation and NDCs,[20] translating pledges in NDCs into binding legislation can mainstream them into long-term policy and planning. This can help mobilise the required institutional, regulatory and financial infrastructure of countries in pursuit of a low-carbon development strategy.[21]

[19] *Mismatches can be found in both directions, i.e. cases in which NDCs are more ambitious than national plans and cases in which NDCs are less ambitious than national plans.*

[20] *In many cases, the temporal lag exceeds five years.*

[21] *The development of Long-Term Low Emissions Development Strategies (LT-LEDS) also presents an opportunity for countries to build their NDC ambitions into long-term planning.*

Renewable energy targets in NDCs and national policies for SIDS

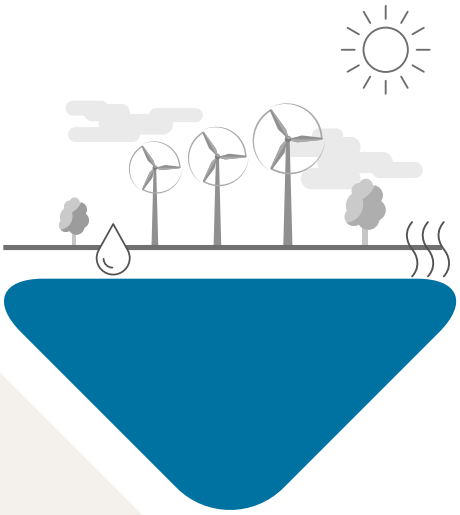
IRENA has quantified the renewable capacity contributions mentioned by the SIDS in their NDCs and national policy documents. The analysis finds that out of the 40 SIDS that have submitted an NDC to date, 32 have a quantifiable renewable energy target. Almost all of the SIDS with targets in their NDCs have focused them on the power sector (30), while only two have set specific targets in end uses such as transport and heating and cooling, and three have set their targets as a percentage of the whole energy mix.

In the power sector, many SIDS have committed to 100% renewables in their electricity mix by or before 2030 in their NDCs. Although climate is a major driver for renewables deployment in these countries, increased ambition is also driven by energy security, and other socio-economic benefits, which are adversely affected by the high cost of importing fossil fuels. However, these targets remain conditional on international support in the form of financing, technology transfer and technical assistance.

IRENA's quantification of targets shows that as per the NDCs, in the power sector the SIDS have committed to reaching 11.5 GW of installed renewable capacity by 2030, up from 5.2 GW in 2021. The unconditional targets total 5.5 GW, while the conditional targets are estimated to be equivalent to 6 GW. This means substantial international support is needed in the form of financial and technical assistance, capacity building and technology transfer to help SIDS achieve their renewable energy targets.

Based on all national targets as per national policy documents, laws, official strategies and plans, total renewable electricity capacity in SIDS would reach almost 13 GW by 2030, which is 1.5 GW higher than the target capacity in NDCs, including both conditional and unconditional targets. What this shows is that most of the targets set in NDCs remain aspirational and would only be reached with considerable support from the international community.

3



3 KEY CONSIDERATIONS FOR TARGET SETTING

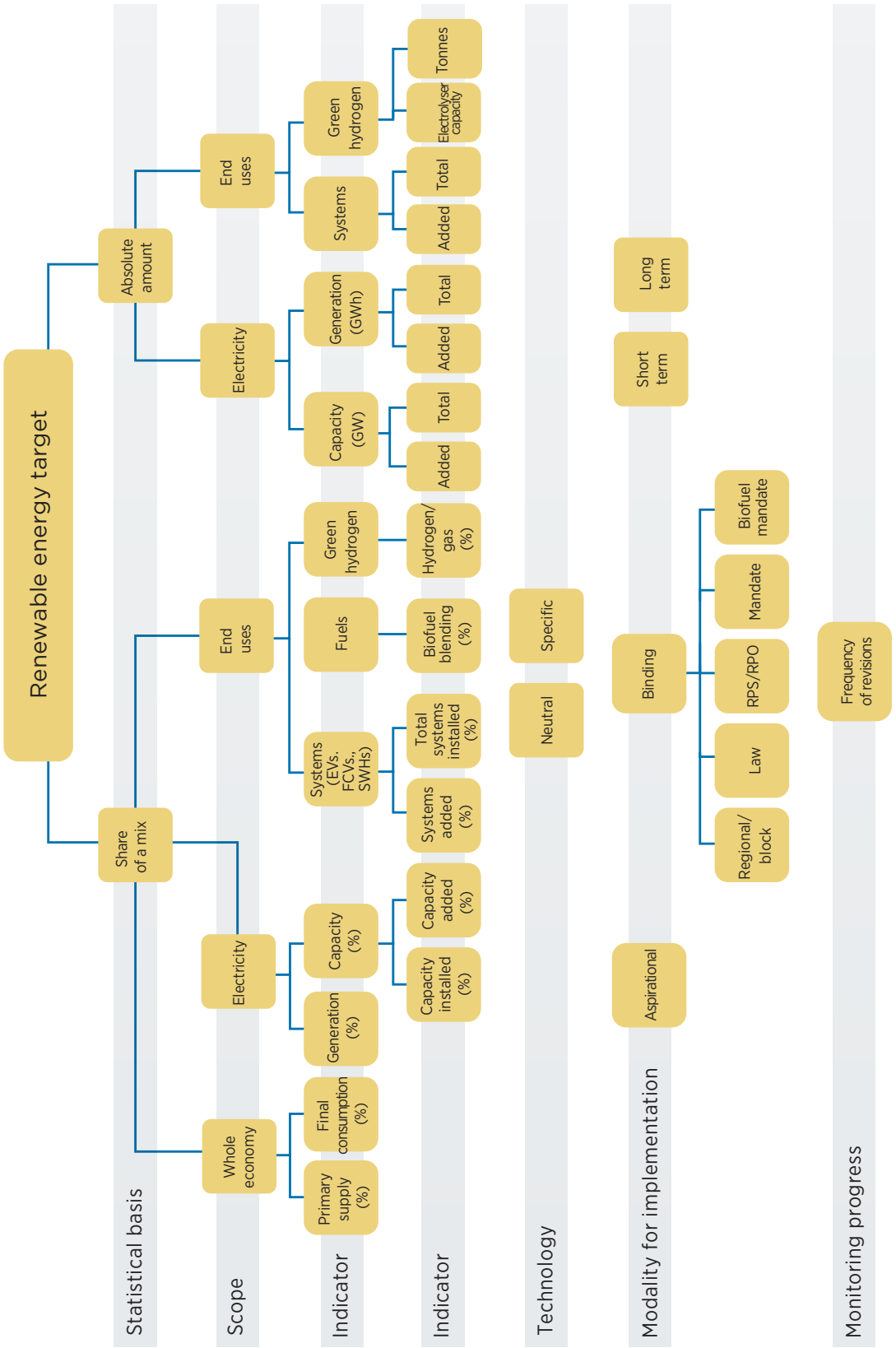
The objectives for renewable energy deployment and development differ widely from one jurisdiction to another, and these differences should be kept at centre stage when designing targets. Equally important for target setting is the current context in which targets are being considered, *vis-à-vis* the existing energy mix and structural dependencies of the country, its future energy demand, existing infrastructure and its technical and economic potential. These considerations are discussed in Section 3.1.

Questions to be answered while setting targets include the following: what is the statistical basis for the target, is it set relative to a baseline or is it an absolute amount that would be added (Section 3.2)? What is the scope of the target in terms of sector coverage and end uses mentioned (Section 3.3), and what is the main indicator by which the baseline and the target are defined (Sections 3.4 and 3.5)? Will specific technology choices be pursued (Section 3.6)? What is the timeline and other modalities for implementation and how often are they reviewed (Section 3.7)?

A wide range of options should be examined, keeping in mind the overall policy objectives and existing capacities. These are illustrated in Figure 3.1.

Although this analysis is dedicated to renewable energy targets, it includes other transition-related technologies such as heat pumps and EVs. These solutions must be accounted for when setting renewable energy targets as 1) they must be considered in the demand for renewable power – otherwise if they run on fossil fuel-based power they cannot be considered as decarbonisation solutions, and 2) they must be considered when setting targets for "competing" renewable energy solutions, such as biofuels and solar water heaters (SWHs), to maximise the usefulness of investment in enabling conditions, such as infrastructure, and to avoid stranding assets.

FIGURE 3.1 Key decisions for renewable energy target setting



Notes: EV = electric vehicle; FCV = fuel cell vehicle; SWH = solar water heater.

3.1 OBJECTIVES AND CONTEXT FOR RENEWABLE ENERGY TARGET SETTING

Renewable energy targets must be set to achieve broader policy objectives and they should be adapted to the specific situation of the jurisdiction where they will be implemented.

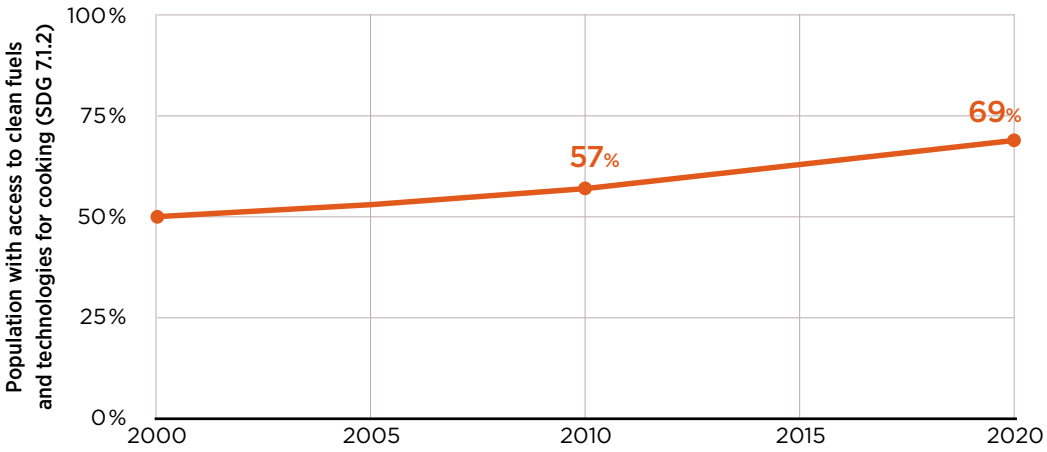
3.1.1 POLICY OBJECTIVES THAT SHAPE RENEWABLE ENERGY TARGETS

The main factors driving renewable energy development in a jurisdiction should have a strong role in shaping the way targets are set. These include:

- **Achieve climate commitments**. Given the urgency of decarbonisation to stay within a global temperature increase of 1.5°C, renewable energy targets need to be aligned with climate targets, including NDCs, GHG or carbon emission reduction targets, targets for phasing out and phasing down fossil fuels, and net zero targets. Such targets need to be matched with renewable energy (and energy efficiency) targets.[22] For instance, France has set a target of reducing carbon emissions by 40% by 2030 compared with 1990 levels. This target includes an embedded renewable energy target of 33% as a share of final energy consumption by 2030.
- **Increase energy access and reduce energy poverty**. The 2022 publication *Tracking SDG 7: The Energy Progress Report* showed that the world is not on track to achieve any of the targets under SDG7. Although the number of people lacking electricity access fell from 1.2 billion globally in 2010 to 733 million in 2020, progress has been slowing down due to the complexity of reaching unserved populations and the impacts of COVID-19. Moreover, in many countries even where there is access, it is very unreliable. With population growing at a pace that is faster than that of improvements in access to clean cooking, some 2.4 billion people still lacked access in 2020. Based on these trends, it is estimated that 670 million people will still lack access to electricity by 2030 and 2.1 billion people will still lack access to clean cooking, unless global efforts are improved (IRENA *et al*., 2022). Figure 3.2 shows the targets for universal access to electricity and clean cooking and the progress made toward these targets by 2020.

[22] *Although it should be noted that some countries also rely on carbon capture technologies.*

FIGURE 3.2 Percentage of population with access to electricity and clean cooking to reach the targets set in SDG7



Source: IRENA *et al.* (2022).

- **Enhance energy security**. Energy security and independence were put back at the forefront of policy priorities after the fossil fuel shortages and price increases experienced as the world economy picked up following the COVID-19 crisis, and then more so after the outbreak of conflict in Ukraine (Box 3.1). This is especially the case for Europe and other countries that are net importers of fossil fuels. Globally, the increased focus on energy security has amplified the need to transition as fast as possible to a more secure and reliable energy system based on renewables that shields industry and consumers from geopolitical pressures and fuel price volatility while also being compatible with ambitious climate goals.

Box 3.1 Increase in ambition of renewable energy targets in the European Union REPowerEU

Until 2022 Europe relied on the Russian Federation for 40% of its fossil gas and 27% of its imported oil, valued at around EUR 400 billion a year (Fisher, 2022). The conflict and resulting sanctions have raised concerns regarding energy security and energy costs that have put extremely high financial pressure on consumers and businesses. Some European manufacturing facilities even began reducing operations as electricity prices soared to record highs (France24, 2022).

In response, the European Commission first announced its REPowerEU strategy in March 2022 with the goal of reducing Russian gas imports by two-thirds by the end of 2022 and entirely by 2030. The strategy focuses on three key topics: securing non-Russian supplies of oil and gas, improving energy efficiency, and expanding the use of renewable energy.

If the proposal is adopted, the European Union's 2030 target for renewables would increase from the current 40% to 45% of the energy mix. The REPowerEU plan would bring total renewable energy generation capacity to 1 236 GW by 2030 (including 600 GW solar PV and 510 GW wind), 15% higher than the 1 067 GW envisaged under Fit for 55. In addition, the EU REPowerEU package proposes a target of 10 million tonnes of domestic renewable hydrogen production and 10 million tonnes of imports by 2030. This translates into the need to increase the installed capacity of electrolysers to 65 GW in 2030 (the EU hydrogen strategy originally set a target of 6 GW of electrolyser capacity and 1 million tonnes of green hydrogen production by 2024, to be scaled up to 40 GW electrolyser capacity by 2030) (European Commission, 2022b).

Germany has also increased its ambition. It aims to speed up its shift to renewable power and is looking to reach 100% renewable electricity supply by 2035. Germany is aiming for 80% wind and solar power by 2030. This involves tripling its solar and offshore wind capacity to 200 GW and 30 GW respectively, and doubling onshore wind energy capacity to 110 GW (Brooks, 2022).

- **Maximise socio-economic benefits**. IRENA has been studying the socio-economic impacts of renewable energy since 2011, addressing jobs, local economic value creation, improved livelihoods, gender and welfare. The latest analysis finds that a global energy transition based on renewables under IRENA's 1.5°C Scenario can lead to a boost in GDP that is 2.4% greater (on average) than that of the Planned Energy Scenario over the next decade. Economy-wide employment is 0.9% higher on average by 2050. The socio-economic benefits are potentially more pronounced in Africa, where an energy transition based on renewables has the potential to support industrialisation and socio-economic development and improve welfare (Box 3.2). The global estimates mask disparities among regions and countries, depending on country conditions, dependencies and policy implementation.

Box 3.2 Potential socio-economic impacts of the energy transition in Africa with a comprehensive policy framework

Although it might be difficult to transition away from carbon-intensive energy sources, with the implementation of an appropriate policy basket the energy transition presents tremendous promise for Africa.

IRENA's 1.5°C Scenario pathway predicts on average 6.4% higher gross domestic product (GDP), 3.5% higher economy-wide jobs and a 25.4% higher welfare index than what can be achieved under current plans, up to 2050.

Jobs added in the transition to renewables outweigh those lost by phasing out traditional energy. Every million US dollars invested in renewables between 2020 and 2050 creates at least 26 job-years; every million invested in energy efficiency creates more than 22 job-years annually; and for energy flexibility, the number is 18.

These continent-level benefits hide large disparities between regions and countries. Although all African regions benefit from the transition in terms of GDP, the impact varies across regions based on the existing economic structure and the availability of economic, financial and institutional factors and transition-related skills. The effect on GDP ranges from an additional 1.6% on average above existing plans (Planned Energy Scenario) in West Africa to an additional 15.4% in Central Africa (with 4.9% higher GDP in North Africa, 10% in East Africa and 10.1% in Southern Africa). Differences between countries at the regional level also exist, such as between fossil fuel producers and importers, large and small economies, etc.

Economy-wide job creation also varies, from 1.4% additional jobs compared to the Planned Energy Scenario in 2050 in North Africa to 6.7% in Central Africa (with 2.0% additional jobs in West Africa, 2.9% in Southern Africa and 4.1% in East Africa).

The welfare improvement under the 1.5°C Scenario over the Planned Energy Scenario ranges from 14.6% in North Africa to 39.6% in Southern Africa (19% in East Africa, 22% in West Africa and 33.8% in Central Africa).

Source: IRENA and AfDB (2022).

3.1.2 CONTEXT FOR SETTING RENEWABLE ENERGY TARGETS

Renewable energy target setting needs to consider the given context in terms of current and future energy demand, level of development of the renewables sector, and existing resource potential.

Energy demand across all end uses. Renewable targets need to consider the overall energy demand, its forecast and any changing patterns in all sectors of the economy. The different end uses, including electricity, heating and cooling, and transport, need to be considered in conjunction, with careful consideration of how sector coupling and energy efficiency would affect the future energy mix.

Level of development of the renewable energy sector and needed infrastructure. The targets within the determined timeframe need to be implementable. This is where the current level of development of the renewable energy sector and needed infrastructure play a key role. The targets need to take into consideration the available skillset within local institutions and industry, and the availability of relevant services (supply chain, construction, maintenance, etc.) and resources required for physical infrastructure development.

Technical potential. Setting renewable energy targets requires clarity on the technical potential of various technologies on the ground to select the most suitable energy mix. This is conducted through resource assessments and suitability analyses for specific technologies. Box 3.3 provides an overview of IRENA's work on resource assessment.

Box 3.3 IRENA's work on resource assessment

The Global Atlas for Renewable Energy is a free web-based platform that provides users with data and tools to assess their renewable energy potential. The initiative, coordinated by IRENA, is aimed at closing the gap between countries that have access to the necessary data and expertise to evaluate the potential for renewable energy deployment in their countries and those that lack these elements.

Suitability assessment is a GIS-based multicriteria analysis that maps the suitable areas for planning utility-scale solar PV or wind projects. The methodology combines high-quality resource data with data on infrastructure and land features, including road and transmission line networks, topography, protected areas and population density, to estimate the degree of suitability of every parcel of land. This service can support energy ministries and departments with planning energy generation and transmission expansion or setting renewable energy targets.

Zoning assessment identifies the best zones within a country for planning utility-scale solar PV or wind projects. These zones are further characterised with attributes that include potential installed capacity, hourly energy generation profiles, distances to transmission and road infrastructure and LCOE. This service can support countries in developing and implementing their national energy masterplan.

Site assessment is a cost-effective pre-feasibility analysis that supports countries in finding economically viable sites for solar (PV, parabolic trough collector, central receiver system and linear Fresnel) and wind project development. The service relies on site-specific resource profiles, industry standard energy yields and financial assessment methodologies to establish a range of tariffs and levelised costs of a site for potential investment on ground measurements and subsequent development. Through this service, IRENA has assisted authorities – ministries and public utilities in several countries in Africa, Latin America and SIDS – in the selection and screening of more than 140 promising sites for solar and wind power projects.

The SolarCity Simulator is an innovative tool designed to support member countries in assessing their potential for rooftop solar PV installations by testing different policy instruments, incentive schemes and installation scenarios that could lead to potential economic savings and socio-environmental benefits. The methodology relies on a robust power generation model to calculate the annual energy production based on the city's solar resource profile and 3D building footprints, and a simplified financial model to establish a range of economic indicators, such as payback, equity internal rate of return (EIRR) and investment cash flow. All these indicators are employed to further identify the suitable rooftops for solar PV installation in the city and assess their technical and economic potential. Through this service, IRENA has assisted local authorities in several cities (Antigua and Barbuda, Chongli in China, Ulaanbaatar in Mongolia, Port Louis in Mauritius, Burgunj in Nepal, three markets in Nigeria, Castries in Saint Lucia, Victoria in Seychelles, Kasese in Uganda, and Abu Dhabi in United Arab Emirates) to promote environmentally friendly energy. More information can be found on **Solar Simulators: Application to Developing Cities.**

Macroeconomic context. At a first glance, it might seem as if countries in difficult macro-economic situations with limited financial capacity might need to reduce their ambitions. However, ambitious targets can drive deployment and socio-economic development as outlined in Box 3.2. Section 2.2.3 showcases many SIDS that are among the LDCs that have set ambitious targets and that rely on international cooperation to achieve them by tying them to conditional NDCs.

As mentioned, the main objectives for renewable energy targets will affect their design vis-à-vis deciding on their statistical basis, scope and coverage in terms of sectors and end uses, indicators, technology specificity, and modalities for implementation. These are discussed in the subsequent sections.

3.2 THE STATISTICAL BASIS FOR RENEWABLE ENERGY TARGETS

When setting renewable energy targets, a decision needs to be made on whether they should be determined as a share of the mix relative to a baseline (with indicators discussed in Section 3.4), or a fixed absolute amount (with indicators discussed in Section 3.5) or a combination of both. The findings are summarised in Table 3.1.

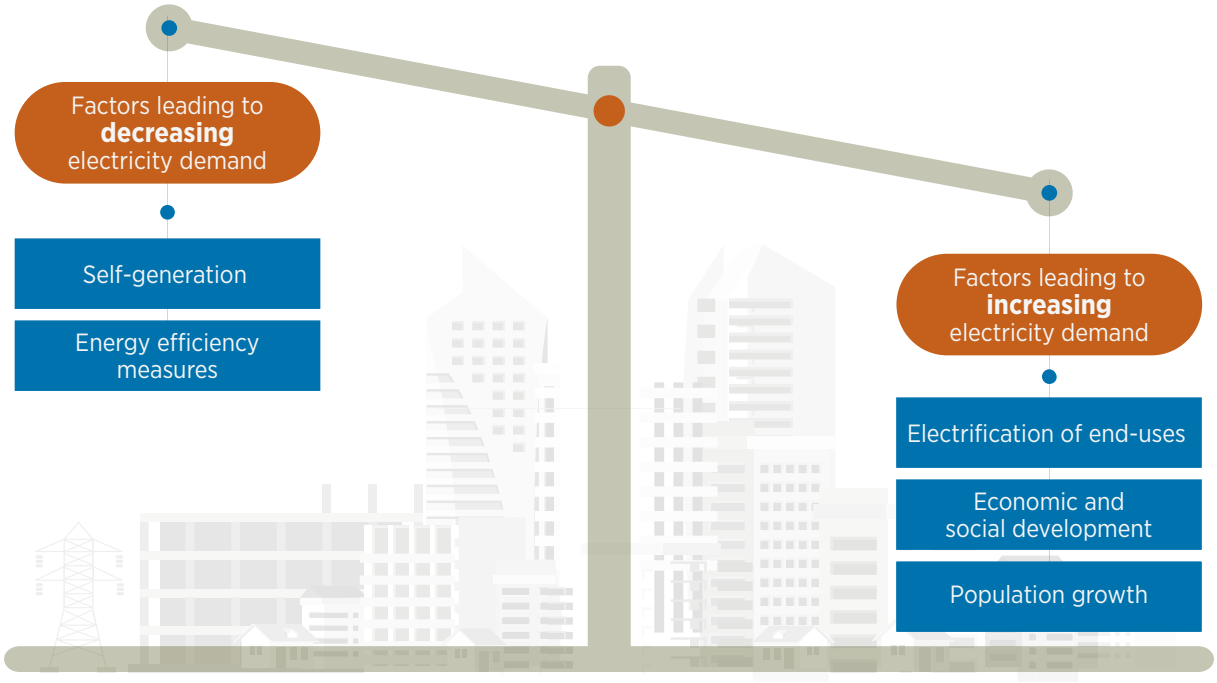
Some of the benefits of renewable energy, such as energy security and emissions and pollution reduction, among others, only materialise if the energy produced actually displaces (imported) fossil fuels. **Targets presented as a share of the mix** can provide greater clarity on the level of ambition regarding climate goals, as they account for phasing out (or opting out)[23] fossil fuel-based energy and systems. Naturally, this only applies when targets are set to cover a considerable share of the overall mix with renewables. Saudi Arabia's Vision 2030, for example, has a target for 50% of electricity to be from renewables by 2030. Nigeria's National Renewable Energy Action Plan sets a renewable energy target of 43% of installed capacity in 2030, representing 29% of final electricity consumption.

Such targets also give better clarity on reducing energy imports for countries that are net importers of fossil fuels. Many SIDS are net importers of fossil fuels and have set 100% renewable power targets, including Antigua and Barbuda, Barbados, Dominica, Grenada, Marshall Islands, Saint Kitts and Nevis, Samoa, Tonga and Vanuatu.

Targets set as a percentage can also give a clear indication of the steps towards achieving universal access to energy. As discussed in Section 3.1.1, the percentage of the population with access to electricity and clean cooking is used as a metric for the targets set in SDG7.

However, when setting targets as a percentage of a mix, energy demand can be hard to predict due to traditional variables that influence forecasts (*e.g.* population, economy, weather). Determining future electricity demand, for example, must consider many components of the energy transition (Figure 3.3). On the one hand, energy efficiency and conservation, together with the growing uptake of decentralised solutions, are expected to reduce the demand for (centrally produced) electricity. For example, in Australia, electricity demand from the grid contracted a few years ago due to the decline of manufacturing and an increase in the adoption of rooftop solar and energy-efficient appliances (Wood, 2013).

FIGURE 3.3 Factors affecting future electricity demand



[23] *Opting out of fossil fuel-based energy and systems refers to a country with growing energy demand that has decided to stop adding further fossil fuel sources of energy, and instead to add renewables. This has the effect of gradually reducing the fossil fuel-based share of the energy mix.*

An overestimation of future demand may lead to overproduction and curtailment, or lead to the displacement of other generation technologies at an undesirable cost to the system. Conversely, a sharp increase in electricity demand can be expected in the medium and long term due to electrification of end uses, in particular residential heating and transport.

In addition, when it comes to implementing targets in the form of a percentage of the energy mix, unexpected changes in demand patterns or changes in the baseline calculation can give a false indication of the progress made (See Box 3.4).

Box 3.4 The European Union 2020 renewable energy targets

In 2008 the European Union set the target of 20% of gross final energy consumption to come from renewables by 2020.

The European Union met its 2020 target, with renewable energy consumption reaching 22.1% in 2020. This was driven mainly by energy efficiency and energy savings and sustained growth in electricity generation from renewables. In transport and heating, the share of renewables also increased in the same period, although at a lower rate.

It is important to note that total gross final energy consumption decreased considerably between 2019 and 2020 (down 8%) primarily as a result of measures put in place to contain COVID-19. At the same time, power generation from renewable source was prioritised due to lower operational costs and preferential dispatch: renewable energy consumption as a share of total energy consumption then increased from 19.9% in 2019 to 22.1% in 2020, with an increase of 2.2 percentage points in just one year.

Although decarbonisation goals might have been met that year, this may have given a false sense of being on track to meeting renewable energy targets. Moreover, the methodology for setting the baseline for percentage-based targets might create discrepancy in reporting. This has been an issue especially in countries or situations where the data quality and availability at the time of baseline setting were still subject to improvements. Changes in data quality are common, especially for countries with a developing resource base for renewable energy. Several countries throughout European Union and the Western Balkans region saw their share of renewable energy revised upward following a thorough evaluation of biomass use in households. This meant that many governments throughout the region were able to demonstrate compliance with the EU targets without introducing new policies or measures to encourage renewables. In the case of Croatia, for instance, national statistics prior to 2010 had registered a biomass share in gross final energy consumption of 5.4%; after the revised statistical analysis, the share of biomass doubled to 10.8% (IRENA, 2019b).

Furthermore, targets that are set as a share of the mix can be difficult to implement and monitor for progress.

For all these reasons, some countries have translated their targets from percentages to absolute terms. Morocco, for example, set a target of 52% renewable electricity capacity by 2030 (20% solar, 20% wind, 12% hydro). This was translated into around 10 GW to be added by 2030, consisting of 4 560 MW of solar, 4 200 MW of wind and 1 330 MW of hydropower.

Framing the target in absolute terms can also be easier to plan, implement and monitor compared to share-of-mix targets. Once the target quantity is fixed (and not dependent on demand), policy makers can aim to achieve that amount using a range of instruments, such as auctions, feed-in-tariffs and so on. Monitoring also becomes easier when fixed quantities are involved.

Perhaps more importantly, an absolute amount target can provide clearer commitment from policy makers and more certainty for market participants and investors as it stipulates a specific quantity that must be supplied (*e.g.* MW of power or number of SWHs installed) or produced (*e.g.* MWh generated) by a specified time. A target in this form provides a more absolute signal regarding the potential market size to the local industry providing equipment and services, which can encourage investment in different segments of the supply chain. In some cases, it can help leverage existing capacity to support the transition of the economy away from fossil fuels. Norway, for example, set a target to develop 30 GW of offshore wind capacity by 2040, which would allow it to build on the know-how of its existing energy industry.

TABLE 3.1 Decision on the statistical basis of targets

Objective	Share of mix	Fixed absolute amount
Ambition with regard to climate goals	Gives an indication on the phase-out or opt-out of fossil fuels	Only indication on the amount of renewable energy or systems added
Universal access to energy	Provides clarity on the percentage of people who would remain without access to energy	Does not explicitly account for the increase in population
Energy security	Gives an indication on the level of dependency on imported fuels	Does not replace imports if energy demand is growing at the same pace
Support the development of a local industry	Targets change with energy demand, may lead to uncertainty for stakeholders More difficult to analyse the socio-economic impacts (*e.g.* job losses)	Provide a clear signal to the industry for the development of local supply chains. Easier to estimate the socio-economic benefits (*e.g.* jobs)
Ease of implementation and monitoring	Harder to plan, implement and monitor due to uncertainties and difficulties in data collection, in addition to possible changes in underlying assumptions (*e.g.* evolution of demand) and baseline calculations	Easier to plan, implement and monitor can be translated directly to quantitative policies

3.3 THE SCOPE OF TARGETS – SECTOR COVERAGE AND END USES

As shown in Section 2.1, most jurisdictions around the world continue to focus their renewable energy targets on the power sector. However, achieving decarbonisation in line with the objectives of the Paris Agreement will require a more holistic approach, including targets for all end uses and covering all sectors of the economy.

For climate and energy security goals, targets can be set for the energy sector as a whole, aligning them with targets for emission reductions and energy import minimisation. For this purpose, the design of the target may use a primary energy or final energy basis (see Section 3.4.1).

Once the overall target for the energy sector has been defined and aligned with wider goals, the target can be broken down into the various sectors and end uses such as the power sector, transport, and heating and cooling including in industry, taking into account electrification plans (see Box 3.5 for the example of the United Kingdom's Net Zero Strategy).

Additional sub-targets can also be defined, such as for green hydrogen in the industrial sector, as in France's target for 10% of the industrial hydrogen mix to be produced using renewable electricity by 2023, up to 40% by 2028, which can then be linked to specific policies. Sector-specific targets and policies can increase opportunities for socio-economic benefits related to industrial development, since specific markets and technologies can be targeted more directly. In the access context, targets for clean cooking and electrification using off-grid renewables are needed.

Table 3.2 presents the benefits of setting targets that cover the whole economy and those that cover specific end uses and sectors.

TABLE 3.2 Decision on the scope of targets – sector coverage and end uses

		Coverage of whole economy	Sector or end use specific
Objective	**Ambition with regard to climate goals**	Provides a comprehensive picture of the impact of the targets	Provides more detailed and targeted understanding to different stakeholders
	Energy security	Provides a comprehensive picture of the impact on the whole economy	Can help ensure energy security for key sectors (*e.g.* industry)
	Support the development of a local industry	Can be perceived as vague and might not be specific enough to incentivise the development of supply chains	May provide a clearer signal for the development of local supply chains for specific technologies (*e.g.* green hydrogen, EVs)
	Ease of implementation and monitoring	Can be harder to plan, implement and monitor	Can be easier to plan, implement and monitor as they can be more easily linked to specific policies
	Energy access	Not applicable	Provides targets specific to clean cooking and electrification

Box 3.5 The United Kingdom's Net Zero Strategy

The United Kingdom's Net Zero Strategy aims to take cross-cutting action to accelerate decarbonisation across seven pillars of the economy, including: power, fuel supply (including hydrogen), industry, heat and buildings, transport, natural resources, waste and greenhouse gas removal. The strategy lays out the broad strands of the road to net zero, while also identifying key quantitative targets for the activities along each strand.

The strategy is complemented by several sectoral and sub-sectoral plans and strategies:

- The Heat and Buildings Strategy pushes the adoption of heat pumps with an eventual ban on fossil-fuelled boilers by 2025 in newbuild homes.
- The Hydrogen Strategy sets the approach for a hydrogen sector, with 10 GW of low-carbon hydrogen production capacity by 2030.
- The Industrial Decarbonisation Strategy provides an overview of targeted measures to facilitate emission reductions in industry, with the hope of positioning the United Kingdom as a hub for low-carbon production, innovation and trade.
- Several transport sector commitments have been adopted, including the decarbonisation of buses, railways, private vehicles, shipping and aviation.
- The decarbonisation of the power sector is envisaged through 40 GW of offshore wind (of which 1 GW floating), supported by smart flexibility systems, carbon capture and hydrogen.

Source: UK Government (2021).

3.4 THE INDICATOR USED FOR TARGETS WHEN THEY ARE DEFINED AS A SHARE OF A MIX

When targets are set as a share of a mix, a decision needs to be made regarding the indicator that is used. This is the case whether the target covers the whole energy mix (Section 3.4.1), the electricity sector only (Section 3.4.2) or other end uses (Section 3.4.3). The findings are summarised in Table 3.3.

3.4.1 SHARE OF RENEWABLES IN THE ENERGY MIX

When determining renewable energy targets as a share of the energy mix, a decision needs to be made on whether they apply to total primary energy supply (TPES) or total final energy consumption (TFEC).

Primary energy supply statistics have traditionally been used in energy systems dominated by fossil fuels and they refer to the total supply of energy in its raw, or unprocessed form (*e.g.* one kilogram of coal). Belarus, for example, has a target of 8% of its TPES to be from renewable energy production by 2025 and Brazil is targeting a 48% renewable share (36% excluding hydropower) in its TPES by 2029. China also uses this metric in its Five-Year Plans for Renewable Energy (Box 3.7).

If the goal is climate-related, a target that reduces the supply of fossil fuels in their raw form would have more potential to reduce emissions across the whole process of energy conversion to consumption, including inefficiencies. Primary energy supply targets are also helpful when the goal is to reduce energy imports to increase security. For example, in 2015 India set a target for a 10% reduction in crude oil imports by 2022, with the potential for it to be scaled up to a 50% reduction by 2030 (Sarkaritel, 2015). Such a target is precise in the reduction amount because it gives a baseline value with a baseline year and a target year, and it is also specific to both the energy flow (imports) and the product(s) (crude oil) in the energy balance. This target would impact the whole economy since it would reduce the country's imported supply of oil. But its impact relates to the policies in place that would determine whether the curtailed oil demand would be met by renewables, for example, or by increasing energy efficiency.

However, there are challenges related to the methodology used to calculate the primary energy equivalent of some fuels when using primary energy as a statistical basis for setting a renewable energy target. Gathering energy statistics for the electricity sector on the basis of the physical energy content method[24] tends to exaggerate the share of coal, oil, fossil gas, nuclear and biomass in the overall energy mix, as around 60-70% of the primary energy would be lost in the conversion process for these fuels (IRENA, 2015).

Final energy consumption refers to the energy supplied to final consumers in the form of electricity, heat, etc. and excludes conversion losses from transforming primary energy supply into final energy consumption. Typically, most renewable energy data is accounted for in TFEC. As such, the share of renewables in the energy mix would appear greater when looking at the TFEC, as the primary supply would also include inefficiencies in fuel conversions.

Formulating targets as a percentage of TFEC is necessary to determine sector-specific or end-use specific targets (discussed in Section 3.3). For example, Portugal has a target for a 47% share of renewables in its TFEC by 2030, which translates into an 80% renewables share in electricity, 20% in transport and 38% in heating and cooling. Similarly, Croatia has a target for 36.4% renewables in TFEC, 63.8% in electricity, 13.2% in transport and 36.6% in heating and cooling.

TABLE 3.3 Decision on the indicator for share of total energy targets – TPES or TFEC

		Primary supply	Final consumption
Objective	**Climate goals and energy demand/ security**	Can give a clear indication of reduction in fossil fuel use and imports including losses	Might give a sense of over-accomplishment as inefficiencies in fuel conversions are not accounted for
	Translation to end-use specific targets	Translation to specific sectors and end uses not straightforward	Can be translated to specific targets by end use or sector, which is one step closer to translating into policies
	Monitoring and reporting	More suitable for energy systems dominated by fossil fuels	Reduces risk of error from using the physical energy content methodology used to calculate the primary energy equivalent of some fuels

©Irin-k@Shutterstock.com

[24] *In the power sector, the fuels used in thermal power plants (oil, coal, oil, fossil gas or biomass) can be measured easily. However, for non-thermal electricity generation (e.g. hydropower, nuclear or wind facilities), the input of fuels, or primary energy equivalent, must be calculated using assumptions that can result in distortions between fuels. For example, under the physical energy content method, while the efficiency of nuclear power plants is estimated to be 33%, that of hydropower plants is estimated to be 100%. As such, 1 GWh of electricity generated would be associated with a primary energy equivalent of 3 GWh for nuclear and only 1 GWh for hydropower.*

3.4.2 SHARE OF RENEWABLES IN ELECTRICITY

When deciding on the indicator for the share of renewables in electricity, the key decision is whether the share is of generation or installed capacity. Key advantages related to each option are presented in Table 3.4.

A target in the form of share of electricity generation can be used to implement targets covering the whole economy (set as a share of TFEC – see Section 3.3). This is the case of Portugal, where the target of a 47% share for renewables in TFEC by 2030 has been translated into an 80% renewable share in electricity generation (along with 20% in transport and 38% in heating and cooling). This can be further translated into absolute amounts of installed capacity. For example, Portugal's target of an 80% renewable share in electricity has been translated into 9 GW of onshore wind capacity, 0.3 GW of offshore wind, 9 GW of solar PV and 0.3 GW of CSP installed by 2030 (Section 3.5.1).

In addition, targets in the form of share of electricity generation are more effective, as projects that sit idle or get curtailed would not be included while monitoring progress. China, for example, has moved from using added capacity to percentage of additional generation from non-fossil fuels[25] to better ensure climate and energy security goals are actually met (Box 3.6). Brazil has set a target of 81% renewables in total electricity generation by 2029, specifying a 34% share excluding hydropower to ensure a diversification of the mix and energy security in dry seasons. It is important to note that, as TFEC implies, these targets are not based on "busbar" generation, but rather on actual electricity sales. In other words, after grid losses. In terms of monitoring and the statistical basis of target compliance (such as in US RPS targets), most target compliance is based on the actual percentage of final electricity sales (which is the share of final electricity consumption). In countries where grid losses are quite high, this can be quite significant.

Targets in the form of share of installed capacity, whether it is in the form of percentage of total installed or percentage of added capacity, are easier to quantify, monitor and translate into policies. Morocco's example is a case in point, where the target for 52% of installed capacity to be renewable by 2030 is translated into targets for installed capacity of different technologies (4 560 MW of solar, 4 200 MW of wind and 1 330 MW of hydropower). Several rounds of auctions have been achieved, whereby around 2 500 MW have already been awarded (IRENA and AfDB, 2022). South Africa also translated its target in its 2019 Integrated Resource Plan of 41% of renewable capacity by 2030 to 17 742 MW of wind, 8 288 MW of solar PV, 4 600 MW of hydropower and 600 MW of CSP and uses auctions to achieve them, among other instruments (Owusu-Mante, 2020).

TABLE 3.4 Decision on the indicator for share of electricity – generation or installed capacity

Objective	Share of generation	Share of capacity
Climate and energy security	Renewable power plants that are idle or curtailed are not included in reported progress	Capacity is accounted for even if power is not generated when needed and fossil-based generation is prioritised
Implementation	Can be complicated to translate into policies	Easy to translate into procurement processes that can be designed to ensure project delivery by the target date
Monitoring and reporting	Complicated to monitor and report on progress due to data uncertainties and changing demand patterns	Easy to monitor and report on progress

[25] *China's non-fossil fuel capacity includes nuclear power. China had a total installed capacity of about 55 GW of nuclear power at the end of 2021 with plans to expand to 70 GW by 2025, and between 120 GW to 150 GW in 2030 (Nikkei Asia, 2022).*

3.4.3 SHARE OF RENEWABLES IN END USES

As discussed in Section 3.4.1, a target in the form of the share of renewables-based systems, fuels or hydrogen as part of the total gives a clean indication of the plans to phase out (or not opt for in the case of hydrogen) fossil-based alternatives.

For systems such as EVs, FCEVs and SWHs, one important decision is whether to frame the target as a share of the total number of systems in use by or after a given year, or as a share of the systems added during or after the time frame (Table 3.5). As an example of the latter, bans on combustion engine vehicle sales, such as the European Union's and the state of California's by 2035, effectively mean a target of 100% of vehicles added after 2035 are to be EVs or FCEVs. Paris on the other hand, is banning all combustion engine cars by 2030, meaning 100% of cars on the street must be EVs or FCEVs. This type of design is more suited to achieving climate and pollution goals, and energy security when fossil fuels are imported, as it mandates the phase-out of all combustion engine cars, whereas the sales option only helps indicate the direction of the future market for EVs. Although information on additional systems is very important for consumers, car manufacturers and distributors, and for planning the city infrastructure, it does not give a clear indication of the percentage of combustion vehicles that will be retired. For both design options, it is important to give industry players enough time to adjust to the target (*e.g.* in case of a ban on combustion engine vehicles), and to complement the target with other policies in order to minimise socio-economic losses.

For fuels and gas, targets can only be designed as a blending percentage, meaning biofuel and biogas or green hydrogen, respectively. Such a target helps both climate and energy security goals. Blending targets can be increased in ambition gradually after their introduction. India, for example, first introduced an ethanol blending target of 1% in 2014, then increased it to 5% in 2018/19, and then again to 10%. The latest target was achieved five months before the deadline (2022), prompting a decision to bring forward the target of reaching 20% by 2030 to 2025/26. In addition to benefits related to climate and reduced pollution, this target aims to cut import bills by USD 4 billion a year, enable the better use of damaged food grains and increase farmers' incomes and investment opportunities. However, one big challenge is that India would need to increase sugarcane cultivation, using more arable land and groundwater, thereby impacting food security at a time when India ranked 101 out of 116 countries according to the World Hunger Index 2021. In addition, existing vehicles that are compatible with 5-10% ethanol blended petrol would need investment in additional retrofitting and calibration and stock replacement (The Times of India, 2022).

For **hydrogen**, as governments increasingly set strategies and targets for its use, targets are being set for the percentage that would be renewables-based. This is the case in France, for example.

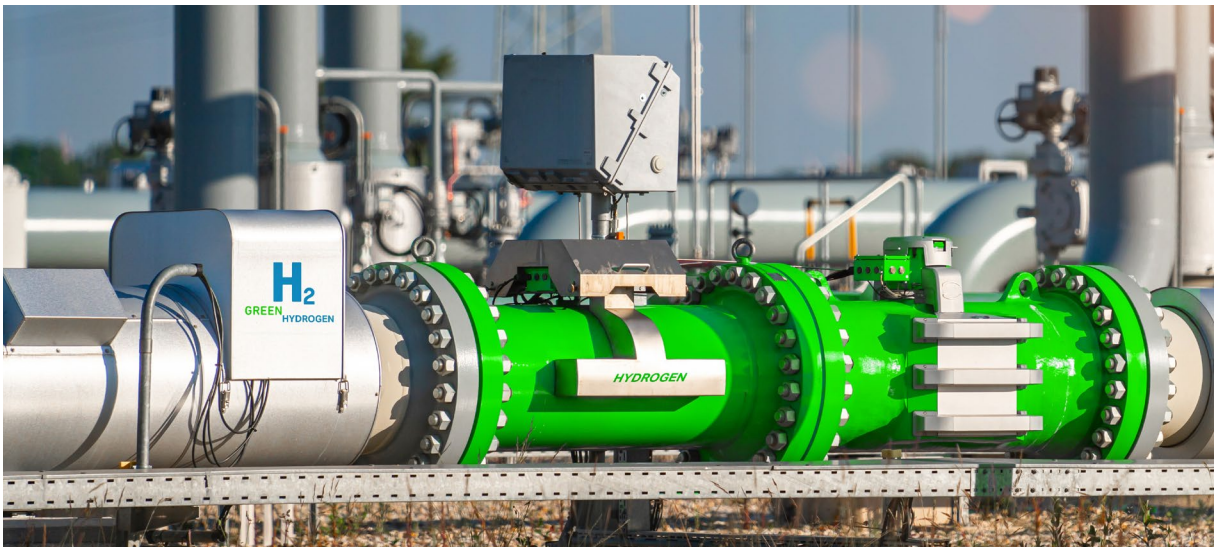


TABLE 3.5 Decision on the indicator for the share of renewables in end-use targets

Objective	Share of the total by timeline	Share of the added after the timeline
Ambition with regard to climate goals	Clear indication of impact as these targets specify the phase-out or opt out of fossil-based solutions	These targets give a partial idea of the impact as they only apply to systems added after the target date
Energy security	Clear indication of impact as these targets specify the phase-out or opt out of fossil-based solutions	These targets give a partial idea of the impact as they only apply to systems added after the target date
Support the development of local industry	Clearer idea of the impacts gives opportunity for planning a smooth transition and minimising losses	Better indication to the manufacturers and distributors of new systems but lacks clarity to players in other parts of the supply chain (*e.g.* petrol stations)
Ease of implementation and monitoring	Harder to plan, implement and monitor due to uncertainties and difficulties in data collection	Easier to plan, implement and monitor – can be translated directly to quantitative policies

3.5 THE INDICATOR USED FOR TARGETS WHEN THEY ARE DEFINED AS AN ABSOLUTE AMOUNT

3.5.1 AMOUNT OF ELECTRICITY – CAPACITY-BASED VERSUS OUTPUT-BASED

When designing targets for an absolute amount of renewable electricity, the key decision is whether to frame the target as capacity-based (*e.g.* MW for electricity sector capacity) or output-based (*e.g.* MWh for electricity generation) or a combination of both. The advantages of each are summarised in Table 3.6.

On the one hand, **capacity-based targets** may be easier to monitor and track than targets set in output terms, especially from distributed technologies such as solar rooftop PV. For example, in 2015 India set a target of 100 GW of solar capacity by 2022, 60 GW of which was to come from utility-scale projects and the rest from solar rooftop mounted on commercial, industrial and residential buildings (howindialives.com, 2022).

Also, capacity targets can be easier to translate into policies and measures such as auctions, as in the case of Morocco and South Africa, or volume-limited feed-in tariffs (FITs) such as in Malaysia, which are often formulated in capacities. The United Kingdom has also set targets in the form of installed capacity, and is targeting 70 GW of solar by 2035 and 50 GW of offshore wind by 2030. In July 2022, 11 GW of offshore wind were auctioned in one round (IHS Markit, 2022).

On the other hand, **output-based targets** enable the focus to be on production (measured in terms of electricity sales) rather than capacity. This approach provides more accurate information regarding the effectiveness of the target as it does include any plants that are kept idle or curtailed. It also incentivises the efficient operation of power plants, which contributes to lowering the LCOE. Output-based targets also enable the translation from percentage-based generation targets into absolute quantities. For example, Burkina Faso is planning for 27% of electricity generation to be from renewables by 2030, equivalent to 685 GWh.

Some jurisdictions have framed their renewable energy targets in both capacity and output terms, linking one to the other using capacity factors. Uganda's SE4All Action Agenda, for instance, has a target for 18 800 GWh of electricity to be generated from renewables in 2030, representing 96% of total electricity production, which implies reaching almost 3 GW of installed renewable energy capacity by 2030.

One last decision to make is whether the target is for the amount to be added by a given timeline, or whether it is for the total amount by that timeline. The former gives a clearer signal of the future market, while the latter takes into consideration any potential retirement of plants (similar to what was presented for systems in Table 3.5).

Finally, absolute amount targets can be used in the energy access context, for power in the form of installed capacity of off-grid technologies, such as Niger's target of 100 MW of off-grid renewables by 2030 or Uganda's target of 700 kW of solar home systems by 2017; or the number of solar home systems/lanterns/kits installed. Ghana's National Renewable Energy Action Plan, for example, included the targets for installing 100 000 solar home systems and 2 million solar lanterns by 2020. While a target expressed as an absolute amount is easier to plan, monitor, fund and achieve, it does not give an indication of the effectiveness of the target, in terms of whether these systems will be used and maintained, or not. It also does not provide any information on the share of people remaining without access to energy.

TABLE 3.6 Decision on the indicator for power targets - Capacity based vs. output based

		Capacity targets (MW)/number of solar home systems/kits/lanterns	Output targets (MWh)
Objective	**Energy demand/ security**	No clear indication, as added capacity could remain idle	Clearer indication of effectiveness in meeting demand, while encouraging efficient operation
	Implementation	Easily translated to capacity-based policies such as auctions, FITs	Can be converted into capacity terms for translation to capacity-based policies using capacity factors Policies can be designed to procure energy
	Monitoring	Monitoring progress is simpler, especially for distributed generation	Monitoring could be complicated (*e.g.* generation by household solar systems)
	Universal access to electricity	Clear indication of market size but not very clear on the effectiveness of the target and the number of people remaining without access	Might be better to ensure systems are connected, maintained, and used

3.5.2 AMOUNT OF RENEWABLE ENERGY FOR END USES – NUMBER OF SYSTEMS OR CAPACITY INSTALLED VERSUS OUTPUT

Targets for renewables in end uses are becoming more widespread. These can be framed as the **total number of systems** to be introduced by a given timeline, which is the most common way of setting targets for SWHs. For example, the Seychelles' Sustainable Development Strategy includes the installation of 1 000 SWHs by 2030 and the development of five pilot biogas plants.

Targets for end uses framed as the number of systems are popular for renewables-based clean cooking. For example, the Renewable Energy Policy for Uganda aimed to install 100 000 household biogas systems by 2017. Most biogas programmes,[26] such as the National Biogas Programme in Viet Nam, the National Programme of Biodigesters of Burkina Faso, and Kenya's Biogas Programme, use the number of biodigesters as a metric for deployment. But in other contexts, an indicator for biogas targets can be the volume produced, such as the European Union's 2030 biomethane proposed target (IRENA, IEA and REN21, 2020).

[26] *It is worth noting that it is more common for such programmes (which generally also come with a budget) to have specific targets, which are different to policies and strategies with targets.*

When it comes to fuels, as more countries set targets for green hydrogen, a decision needs to be made on whether targets are to be framed as **installed electrolyser capacity** (*e.g.* Colombia's 1-3 GW by 2030, France's 7 GW by 2030), or **output**, in term of tonnes of green hydrogen produced (*e.g.* Japan's target of 300 kt by 2030), or both (such as the Netherlands' 3-4 GW electrolyser capacity and 141 kt by 2030). As discussed in Box 3.1, the EU REPowerEU package proposes a target of 10 million tonnes of domestic renewable hydrogen production and 10 million tonnes of imports by 2030, translated into an installed electrolyser capacity of 65 GW in 2030 (European Commission, 2022b).

Although framing green hydrogen targets as tonnes of green hydrogen gives more clarity on the amount available, imported or exported, supporting climate and energy security goals, it might be difficult to estimate the size of the electrolysers and infrastructure needed at this early stage of development of the sector. As such, framing green hydrogen targets in terms of electrolyser capacity can be more straightforward and can be simpler to define and implement until the technology picks up and enough data are collected to help calculate estimates. These considerations are summarised in Table 3.7.

TABLE 3.7 Decision on the indicator for green gas targets – output or capacity/unit based

		Output targets (kilo tonnes of green hydrogen or cubic meters of biogas)	Unit and capacity targets (electrolyser capacity, number of biodigesters)
Objective	Energy demand/ security/access	Clearer indication of effectiveness in meeting demand, while encouraging efficient operation	No clear indication, as added capacity could remain idle
	Implementation	Could be difficult to estimate, especially at early stages of development (for green hydrogen)	Easily translated to capacity-based policies such as auctions, or programmes built on the number of systems to deploy

3.6 TECHNOLOGY SPECIFICITY OF TARGETS

The issue of whether renewable energy targets (and renewable energy policy more broadly) should be technology-neutral or technology-specific frequently comes up in the policy debate. At the beginning of the 2000s, policy makers around the world started following a cost-based remuneration approach, which resulted in technology-specific support and technology-specific targets (Jacobs, 2014). In addition, integrated resource plans used for power system planning are typically developed using least-cost system optimisation and result in technology-specific deployment trajectories, which need to be translated into targets for different technologies. As such, countries using integrated resource planning cannot adopt a technology-neutral approach. The choice between technology-specific and technology-neutral targets carries certain trade-offs, as summarised in Table 3.8.

Technology-neutral targets can allow for more simplicity and flexibility at the design stage, and as such they could be an attractive option for countries at the early stages of renewable energy market development. Iran (Islamic Republic of), for example, has set a target of 7 500 MW of installed renewable energy capacity by 2030. Objectives for emission reductions or fossil fuel savings can be met with generation from any renewable energy technology that fulfils certain minimum criteria (*e.g.* resource availability, compatibility with demand patterns). In the early stages of deployment in 2009, the Emirate of Abu Dhabi (United Arab Emirates) started with an aspirational target of 7% of power generation to be from renewables by 2020. As the market evolved, the UAE Energy Strategy 2050 announced more technology-specific targets.

Another reason why technology-neutral targets can be strategic in the early stages of renewable energy development is that they allow markets to identify the most cost-effective technologies. However, this can crowd out other emerging technologies, limit diversification of technologies in the market and potentially increase the costs of reaching the target in the long run by increasing the costs of balancing the system, or by delaying cost reductions and innovation in other technologies.

Technology-specific targets avoid the competition between technologies by assigning targets for each technology. By promoting the simultaneous development of a range of different options through specific targets, policy makers can enable more technologies to emerge and to grow. Such diversification could lead to benefits such as resilient systems and fewer integration issues.

Although encouraging less mature technologies through technology-specific targets may increase the cost of achieving a given renewable energy target in the short term, they enable the development of local value chains of these technologies. For example, the technology-specific targets in Morocco and South Africa, together with policies that were put in place to support local industries, have led to the development of solar and wind sectors in various segments of the value chain, with socio-economic benefits such as income and jobs (IRENA, 2019a).

However, the design of technology-specific targets could be more resource intensive, as several factors and assumptions need to be weighed in, such as resource availability and evolution of markets conditions, technology prices and technology capabilities. In addition, specific targets might be challenging and subject to political meddling.

TABLE 3.8 Decision on technology specificity of targets

		Technology-neutral targets	Technology-specific targets
Objective	**Simplicity of target design and implementation**	Simpler to design. Technology shares determined by markets with more flexibility	More resources are needed in design to determine the technology shares
	Short-term costs	Market selects least-cost technology	Deployment of less mature (or high-cost technologies) increases short term costs
	Long-term costs	Crowding out of less mature technologies may increase long term costs	Technologies mature, value chains are built – lower long-term costs
	Technology diversification	Less diverse systems could be less resilient, flexible and sustainable	More diverse power systems which are more resilient and flexible
	Development of local industries	The signal to private sector is less clear	Clear signals to private sector to invest in the value chain of a particular technology

3.7 MODALITIES FOR TARGET IMPLEMENTATION

Key decisions regarding the design of targets relate to the modalities for their implementation. These include whether targets are mandatory or aspirational, short term or long term, and the process for their review and revision.

3.7.1 SHORT- TO MEDIUM-TERM AND LONG-TERM TARGETS

In the current discussions on climate and sustainable development goals, the years 2030 and 2050 are used as short- to medium-term and long-term target years, using 2020 as a baseline. IRENA, for example, analyses the pathways for staying within 1.5°C by 2030 as medium term, which aligns with most of the targets set at the national level (quantified in Chapter 2), and 2050 as long term, which is used as a target year in most 100% renewable electricity and net zero pledges. Short- to medium-term targets and long-term targets both have benefits, summarised in Table 3.10.

Short- to medium-term targets can introduce a sense of urgency and motivate stakeholders to act. They enable faster implementation and more effective learning and can coincide with electoral cycles. The periodic nature, mostly in the form of five-year planning, allows for a minimum level of flexibility and adjustment.

China and India, among others, use five-year plans to frame the development of their energy sectors. Since announcing its first medium- and long-term strategy on renewable energy in 2007, China has periodically revised its renewable energy targets in its Five-Year Plans (FYPs). The latest is discussed in Box 3.6.

Box 3.6 China's 14th Five-Year Plan

China announced its 14th Five-Year Plan (FYP) for renewable energy in 2022, presenting the renewable energy roadmap for 2021-2025. The 14th plan focuses on energy security, while helping China achieve the climate commitments in its Nationally Determined Contribution: installing 1 200 GW of solar and wind power capacity, ensuring 25% of energy consumption will be met by non-fossil fuels by 2030 and achieving carbon neutrality by 2060.

The 14th FYP target of supplying 25% of China's energy from non-fossil sources by 2030 is unchanged from the 13th FYP. But according to the 14th FYP, more than half of the increase in electricity demand will be filled by renewables. The new plan aims for a total renewable energy output of at least 1 000 million tonnes of coal equivalent (Mtce) by 2025 – up from 680 Mtce in 2020 – equivalent to an annual increase of at least 64 Mtce.

The 2021-2025 plan entails an increase in the share of renewables from 15.9% in 2020 to 20% by 2025 and details a series of targets, as shown in Table 3.9.

TABLE 3.9 Indicators for achieving China's 14th FYP

	End of 2020 Actual	2025 target in 14FYP	2030 NDC target
Non-fossil fuel share of total energy consumption	15.9%	20%	25%
Renewable energy output	680 Mtce	1000 Mtce	Wind and solar capacity 1++200 GW
Renewable energy (excluding electricity)	60 Mtce	60 Mtce	
Renewable electricity	2 210 TWh	3 300 TWh	
Renewable electricity share	28.8%	33%	
Non-hydro renewable electricity share	11.4%	18%	

China has exceeded its renewable energy targets in the last three FYPs, especially for solar and wind , which were set as capacity increases, with no clear indication on the effectiveness of those plants in terms of actual generation. The 14th plan is more ambitious in the sense that it imposes a requirement for new renewable generation to make up more than 50% of the increase in demand. This has been estimated as being equal to an increase in generation from wind and solar of around 150 TWh annually over the 14th FYP period of 2021-2025.

Source: Hu Min (2022).

Long-term targets provide a key signal to investors, developers, manufacturers and service providers regarding the opportunities available in a jurisdiction in the long run. In particular, investments that are capital-intensive, such as in manufacturing, would be far less likely to occur without clear long-term government-led commitments. In the power sector, network planning and expansion is resource-intensive, and requires long-term visibility. Moreover, to build the human capacity needed in the value chain (*e.g.* logistics, installation, operations, supply, finance and other related sectors), a short-term target of five years is most likely not sufficient.

Short- and long-term targets both have their merits. To have the best of both worlds, policy makers could consider a balanced combination of broad, long-term targets, articulated into a series of short- to medium-term targets. Setting short- to medium-term targets by backcasting a long-term trajectory can reconcile short-term goals with long-term objectives. In an attempt to strike this balance, a growing number of jurisdictions have introduced "stepped" or "tiered" renewable energy targets. This generally involves setting a long-term, overarching objective combined with a series of interim steps. In Canada, for example, Alberta's Renewable Electricity Act sets interim targets to track progress under its Renewable Electricity Act. In February 2019 the minister of energy established interim targets of 15% by 2022, 20% by 2025 and 26% by 2028 to reach 30% renewable electricity by 2030. The Republic of Kazakhstan (Kazakhstan) has set a target of 6% renewable energy share of power generation by 2025, 23% by 2035 and 50% by 2050. Malaysia has set a target of 31% renewable energy share in the power mix by 2025 and 40% by 2035.

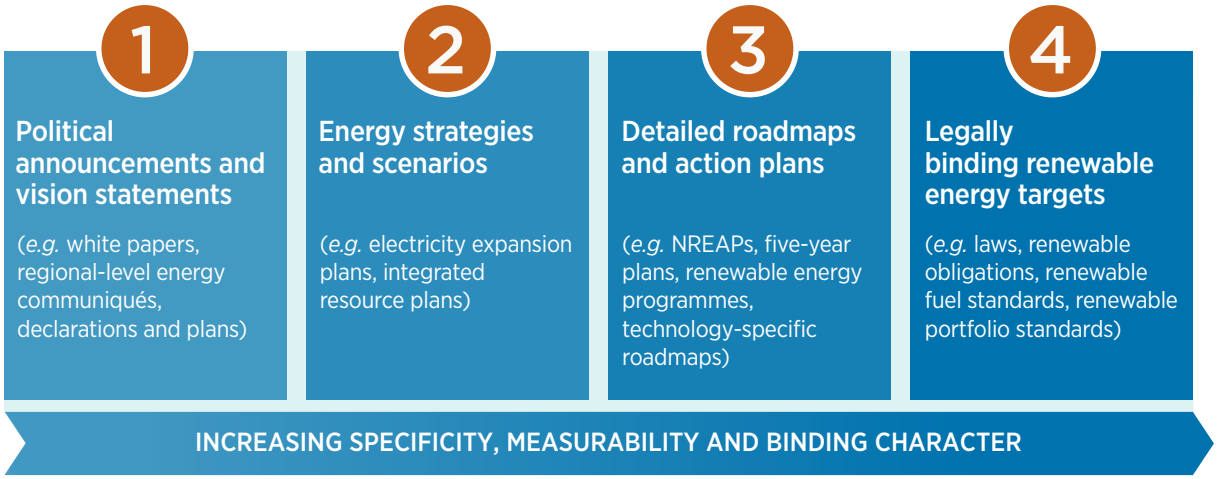
TABLE 3.10 Decision on long-term and short-term targets

Objective	Long-term targets	Short-term targets
Flexibility for adjustment	Adjustments and revisions might reduce investor confidence in the absence of action on the ground	Flexibility, assessment and adjustment are built into the design
Effectiveness in Implementation	May not create a sense of urgency	Compel action from institutions and stakeholders
Sector and industry development	Strong signals to developers, investors and manufacturers about long-term future opportunities	Could encourage stakeholders to develop the industry but limited in impact

3.7.2 MANDATORY AND ASPIRATIONAL TARGETS

There is a wide variety of target types, ranging from aspirational statements to energy strategies and action plans, up to fully articulated targets, accompanied by clear, quantifiable and legally binding obligations (Figure 3.4). As markets mature, renewable energy targets tend to improve in their specificity and measurability, and they tend to become more binding.

FIGURE 3.4 Spectrum of renewable energy targets



Note: NREAP = national renewable energy action plan.
Source: IRENA (2015).

Aspirational targets are often common in markets and jurisdictions in the early stages of renewable energy development. At this stage, the objective is to start mobilising the industry and provide a signal regarding the future trajectory of the country. As experience and know-how on technology costs, performance and other technology dynamics improve, and the capacity of institutions covering energy data and policies develops, aspirational targets can be updated and become more binding.

When designing **mandatory or binding** targets, it is important to determine specific enforcement and compliance mechanisms: who is responsible for achieving the target, the government itself or a publicly owned or private utility? Are there any fines or penalties for not complying? What entity is responsible for collecting the fines or penalties? Can exceptions for non-compliance be made (such as due to force majeure)?

In most countries, the obligation to meet targets is typically imposed on governments themselves, either in the form of national renewable energy action plans, power development plans, or national energy and climate plans. In such cases, targets are considered binding when they pass into law. This means that the targets have been ratified by the executive or legislative body, which gives them credibility in the eyes of potential investors. At the same time, embedding the targets in law makes it harder for any future government, or a governing party, to repeal the targets. But it is still not clear how binding such a plan is if a country does not belong to a certain bloc – such as the European Union – or group of countries where a member country would be held accountable or penalised for not meeting its targets. The European Union's mechanism for penalising member states that do not meet their emission reduction targets is described in Box 3.5.

One effective way of making targets binding is assigning them to specific entities through regulatory measures and policy instruments. In the case of electricity, utilities can be mandated to increase electricity generation from renewables through renewable portfolio standards (RPS) as in the United States of America and the Philippines, or renewable portfolio obligations (RPO) as in India. As a further example, market-based approaches, such as a cap-and-trade programme, set a limit on emissions from particular sectors (see Box 3.7). In the transport sector, binding targets in the form of biofuel blending mandates are

the responsibility of fuel distributors. At the heart of designing binding targets is adequate reporting and monitoring, combined with clear consequences such as financial penalties for non-compliance. As such, a growing number of targets worldwide, including in the European Union and in the United States of America, include various forms of financial penalty (Box 3.7).

Naturally, binding targets can be more effective in achieving aspirations, developing local value chains and creating jobs, as they give a stronger signal to developers, investors and manufacturers about the certainty of opportunities available in a given market.

Box 3.7 Compliance with renewable energy targets and renewable portfolio standards in the European Union, the United States and the Philippines

Members of the European Union that fail to meet their climate targets have to pay an "excess emissions penalty", which is equivalent to the fines paid under the EU Emissions Trading System (EU ETS). If a member state fails to pay this penalty, the excess emissions are deducted from the ETS allowances to be auctioned by that member state. The Commission instead auctions these allowances and the revenues are to be invested in a fund dedicated to research and development into and support for renewable energy, energy efficiency and energy conservation in the European Union (EURACTIV Press Release Site, n.d.).

Binding RPS targets exist in 30 US states plus the District of Columbia and range from low (8.5% by 2026 in the state of Ohio) to ambitious targets (80% by 2040 in New Mexico, and 100% by 2045 in Hawaii). Since targets in the United States of America are primarily imposed on utilities, annual reporting is a core part of compliance with US RPS policies. Utilities are required to submit annual reports to the regulator detailing how much renewable electricity they have either generated themselves, purchased from third Parties (such as independent power producers) or procured in other ways, such as through renewable energy certificates (RECs). The total has to amount to a minimum threshold, typically framed as a percentage of final retail electricity sales. For any shortfall against their legally binding target, load-serving entities are required either to pay a fine or pay the alternative compliance payment (Barbose, 2021).

In the case of the Philippines, the RPS law stipulates that the country's 35% renewables target is imposed on distribution utilities, electric cooperatives and retail electricity suppliers. In addition, the Philippines provides different guidelines for companies serving customers in on-grid as well as those serving customers in off-grid areas (Philippine Electricity Market Corporation, n.d.)

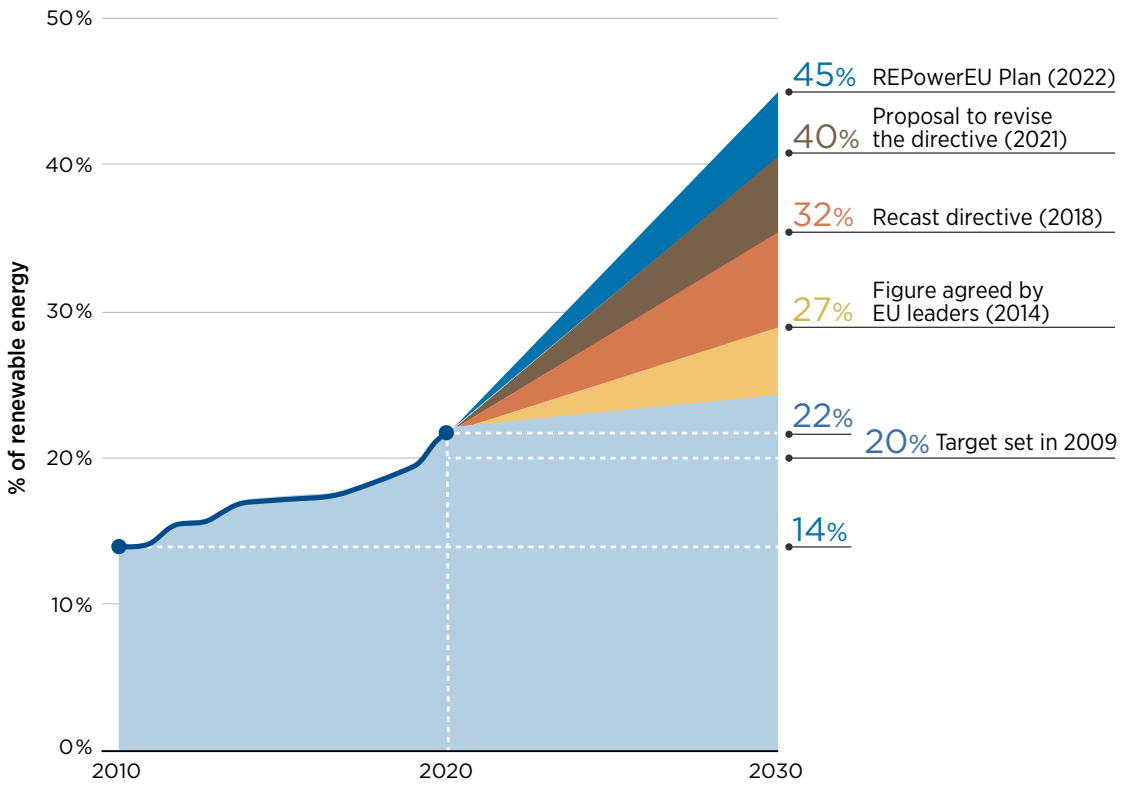
3.7.3 THE PERIODIC REVIEW AND REVISION OF TARGETS

A key design element of renewable energy targets is to link them to regular monitoring of progress to allow for timely adaptation to changes in policy objectives and priorities, market dynamics, renewable energy costs and learning curves. Periodic revisions are also important as data collection and energy balances improve. Regular monitoring enables the tracking of progress against targets, leading to target adjustments that can allow for an increase in ambition in many cases.

Many countries and jurisdictions have raised their targets over time, such as China's Five-Year Plans and the updates made in the European Union. In 2018, building on the 20% target for 2020, the EU Renewable Energy Directive established a new target of at least 32% of energy to be renewable by 2030, with a clause for a possible upward revision by 2023. But in July 2021 the European Commission presented a proposal to increase the target to at least 40% from renewable energy sources in the European Union's gross final energy consumption by 2030. And most recently in May 2022 the Commission published the REPowerEU

plan to reduce European Union's dependence on imported fuels from The Russian Federation before 2030 by speeding up the energy transition. The Commission proposes to increase the target of renewables in power, buildings, industry and transport to 45% by 2030 (Figure 3.5).

FIGURE 3.5 Evolution of renewable energy targets in the European Union

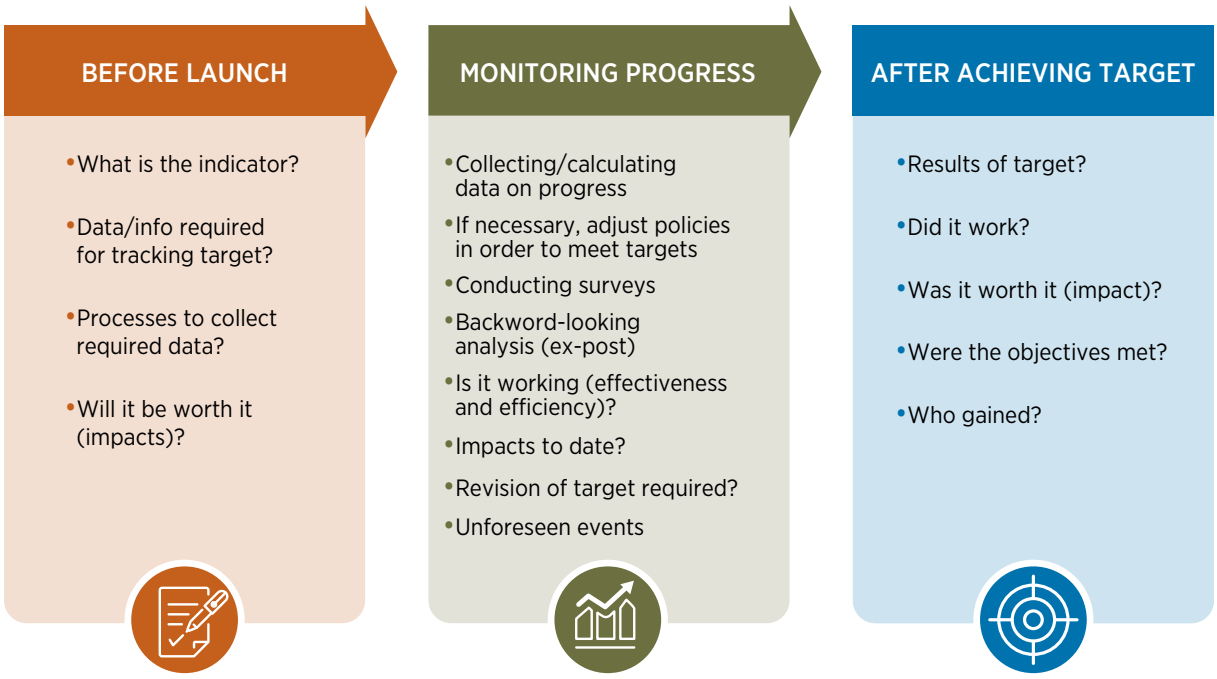


Note: References to directive denote the EU Renewable Energy Directive.
Source: European Commission (2022c)

For jurisdictions to track progress towards goals (and of course to set related targets and develop renewable energy policies), the availability of accurate, timely and accessible renewable energy statistics is essential. Figure 3.6 illustrates the data needed before setting the target, while monitoring progress and after achievement of the target.

The challenges faced while collecting renewable energy data and statistics vary from one jurisdiction to another. These can include the absence of a clear mandate for data collection, and a lack of human resources, technical knowledge or funding. In some jurisdictions, challenges may be addressed by expanding and adapting existing processes for the collection and management of energy data and statistics. In other jurisdictions, new procedures and protocols for renewable energy data collection might be needed.

FIGURE 3.6 Data needed before the setting of the target, while monitoring the progress and after the achievement of the target



Source: IRENA (2016).

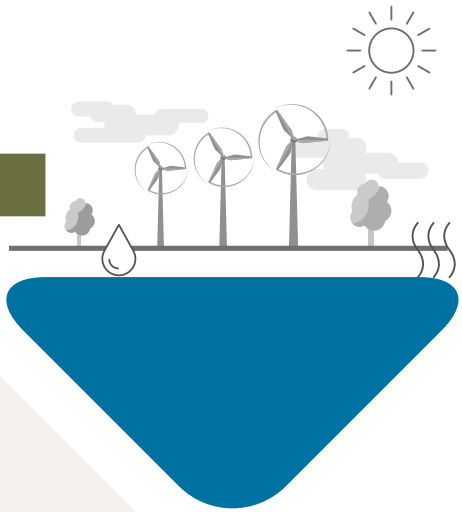
Key requirements for effective data management needed for target setting and monitoring of progress include appropriate legal and institutional frameworks, properly defined data requirements, appropriate data collection mechanisms, and the availability of skilled personnel and procedures for the analysis, review and validation and dissemination of data.

Some examples of data collection objectives and the data that might be required to meet these objectives are given in Table 3.11.

TABLE 3.11 Examples of data collection objectives and data needs

Objective	Examples of required data
To measure progress towards a renewable energy target (as a share of final energy consumption)	Annual energy balance showing renewable energy consumption, including its share of heat and electricity consumption
To monitor short-term trends in the markets for renewable energy	Quarterly renewable capacity statistics, investment statistics, cost and price statistics
To monitor and adjust a feed-in tariff programme for rooftop solar PV installations	Monthly statistics on new rooftop solar PV installations, electricity prices and solar panel costs
To monitor energy access, measured as the share of the population with an electricity supply	Annual statistics on the number of households connected to the national electricity grid and sales of solar home systems
To measure energy security	Annual energy balance showing net imports of energy as a share of final consumption, by sector

4



4 CONCLUSIONS AND RECOMMENDATIONS

Global developments show the need for immediate action to increase ambition on renewable energy deployment, as well as the development of local renewable energy industries to enhance energy security and maximise socio-economic benefits. Governments must move rapidly in designing targets that can help achieve the pressing objectives of reducing GHG emissions from burning fossil fuels, limiting dependence on energy imports, achieving universal access to clean, affordable and reliable energy, and meeting other socio-economic goals.

Pledges made to date, including in Nationally Determined Contributions (NDCs) under the Paris Agreement, should be significantly enhanced to unlock the full potential of renewable energy, which will be crucial to achieving climate goals.

Decision makers at the national, subnational, city and corporate levels need to increase the level of ambition of the commitments to renewable energy in their climate pledges (including net zero pledges). Net zero targets must be backed by concrete plans to develop and deploy renewable energy in all end uses. Renewable energy deployment targets need to increase sharply to reflect long-term pathways towards net zero emissions.

The current energy crisis should not halt the progress towards implementing fossil fuel phase-out (or phase-down) plans and schedules. As much as possible, countries should avoid backtracking on their targets for coal phase-out (or phase-down) and should follow up their pledges with more specific targets, plans and timelines for a full phase-out. International collaboration will be essential to carry out the transition away from fossil fuels in a just and equitable manner, to prevent and manage certain transition risks such as the displacement of jobs or other impacts on livelihoods. South Africa's Just Energy Transition Partnership supported by the European Union, France, Germany, the United Kingdom and the United States can serve as a model for such collaboration.

For renewable energy targets in NDCs to become reality, they need to be aligned with renewable energy targets set in national energy plans and laws. This would increase the effectiveness and credibility of both, and reinforce clear signals to investors, developers and other players across the supply chain, thus supporting the deployment and development of the renewable energy sector. In some cases, this will involve establishing or updating national targets. In other cases, it will mean incorporating existing national targets into the next round of NDCs.

For renewable energy targets to be useful, they need to be ambitious enough to guide deployment on a path that exceeds historical trends and current deployment levels.

In order to keep the world on track to achieving carbon neutrality by 2050, the level of ambition of renewable energy power targets set for 2030 needs to at least double. At the same time, more targets need to be set for renewables in heating and cooling, and transport.

Ambitious targets should be more widespread, as they are currently concentrated in G20 members (accounting for almost 90% of global aggregated renewable power targets). With further international collaboration and support, more ambitious targets can be set in the rest of the world. One region with high renewable energy resource potential and relatively low renewable energy targets is sub-Saharan Africa, where renewable energy is fundamental to the region's future and 77% of the world's population without electricity access live; yet it accounts for just 2.6% of global targets by 2030.

Targets in the power sector continue to focus on solar PV and onshore wind. To harness the full potential of renewable energy resources and support the development of less mature technologies such as concentrated solar power, dedicated targets should be set. Similarly, sector- and technology-specific targets need to be set for end uses, such as for the use of green hydrogen in industry.

Targets need to be designed to serve country objectives, and their design should consider the specific context.

The main function of targets is to signal a country's long-term political commitment to renewable energy, which is required to attract the investment needed – public and private – to develop the sector. The more detailed, specific and credible the target is, the more likely it will be to drive deployment, including through increased market confidence. This can ultimately translate into lower costs of capital and hence more project development.

The main objectives driving the country's renewable energy deployment need to be put at the centre stage of target setting. These may include GHG emission and pollution reduction, energy access, security, reliability and affordability, and socio-economic development goals.

The design of targets should also consider the specific context. The factors to consider when designing targets include resource availability and the technical potential to select the most suitable energy mix, future energy needs across all end uses to avoid shortages and at the same time ensure resources are not wasted on overcapacity, and the level of development of the renewable energy sector and needed infrastructure to make sure the targets are achievable within the set timeframe.

While designing targets, decisions need to be made regarding their statistical basis, scope in terms of sectors and end uses covered, indicators, technology specificity and modalities for implementation.

To achieve the objectives of reducing GHG emissions and fossil fuel imports:

Targets should be presented as a share of the energy mix, covering the whole energy sector to account for phasing out (or opting out of) fossil fuel-based energy and systems and provide more clarity on the level of ambition on climate goals and reducing energy imports (for countries that are importers of fossil fuels).

Targets that reduce the supply of fossil fuels in their raw form (defined as a share of primary energy supply) have more potential to reduce energy imports and emissions across the whole process of energy conversion to consumption, including inefficiencies. Examples include China's target to supply 25% of its energy from non-fossil sources by 2030 in its 14th Five-Year Plan (2022) and India's target set in 2015 to reduce crude oil imports by 10% by 2022, with the potential to be scaled up to a 50% reduction by 2030.

However, using primary energy as a statistical basis for setting a renewable energy target poses a problem related to the methodology used to calculate the primary energy equivalent of renewables. To overcome this, they can be translated into targets as a share of final energy consumption.

Once the overall target for the energy sector has been defined and aligned with wider emission reduction and energy import minimisation goals, the target can be broken down into the various sectors and end uses, such as the power sector, transport, and heating and cooling, taking into account electrification plans. For example, Portugal's target of a 47% share of renewables in its final consumption by 2030 translates into a share of 20% in transport, 38% in heating and cooling, and 80% renewables in electricity. Additional sub-targets can also be defined, which can then be linked to specific policies such as France's target for 10% green hydrogen use in industry. When setting such targets, energy demand must be predicted taking into consideration traditional variables that influence forecasts (*e.g.* population, economy, weather), in addition to many components of the energy transition, such as energy efficiency targets and measures and increased electrification of end uses, among other factors.

In the power sector, targets in the form of the renewable share of electricity generation are more effective for the objectives of emission reductions or fossil fuel savings than the renewable share of installed capacity, as projects that sit idle or get curtailed are not included when monitoring progress.

Moreover, the objectives of emission reductions or fossil fuel savings can be met with generation from any renewable energy technology that fulfils certain criteria (*e.g.* resource availability, compatibility with demand patterns). As such, technology-neutral targets can be used, especially in countries at early stages of renewable energy market development, as they allow for greater simplicity and flexibility in the design and allow markets to identify the most cost-effective technologies. However, technology-neutral targets can crowd out other emerging technologies, limiting diversification of the mix and potentially increasing the long-term costs of reaching the target by delaying innovation and cost reductions in other technology areas, or by increasing the costs of balancing the system.

In end uses, for systems such as EVs, FCVs and SWHs, framing the target as a share of the total number of systems in use by a given year (*e.g.* Paris's ban on all combustion-engine cars by 2030, meaning 100% of cars on the street must be EVs) is more suitable for achieving climate and pollution goals, and energy security when fossil fuels are imported, as it includes the phase-out of fossil fuel options (*e.g.* all combustion engine cars).

©NikomMaelao Production@Shutterstock.com

To maximise the socio-economic benefits from the development of local industries for renewable energy:

Percentage-based renewable energy targets should be translated into absolute targets in order to provide clearer commitment from policy makers and more certainty for market participants and investors, as they stipulate specific quantities that must be installed (*e.g.* MW of power or number of solar water heaters) or produced (*e.g.* MWh generated) by a specified time. This is the case for Portugal, where the 80% target for renewables in electricity generation by 2030 was translated into 9 GW of onshore wind capacity, 0.3 GW of offshore wind, 9 GW of solar PV and 0.3 GW of CSP installed capacity.

Defining technology-specific targets enables the development of local value chains for these technologies. For example, the technology-specific targets in Morocco and South Africa, together with policies that were put in place to support local industries, have led to the development of solar and wind sectors in various segments of the value chain, with socio-economic benefits such as the generation of income and jobs.

A target in this form can also help leverage existing capacity to support the transition of the economy from fossil fuels. Norway, for instance, set a target to develop 30 GW of offshore wind capacity by 2040, which allows it to build on the know-how of its existing energy industry.

For systems such as EVs, FCVs and SWHs, framing the target as a share of all the systems added from a specific date can give an indication on the future market for these systems (*e.g.* for EVs). Examples include the bans on combustion engine vehicle sales in the European Union and the state of California by 2035, meaning that 100% of those added after 2035 are to be EVs. This is very important to mobilise suppliers of these technologies throughout their supply chains.

To achieve universal access to energy:

Targets should be presented as a share of the percentage of the population with access to electricity and clean cooking to account for changing demographics, such as population growth, and provide information on the share of people remaining without access. Separate targets are needed specific to electrification and clean cooking using renewables. Such targets need to be translated into an absolute amount of capacity or number of systems to deploy.

For electricity access, capacity-based targets in the form of installed capacity of off-grid technologies are easier to plan, monitor, fund and achieve, but they do not give an indication of the effectiveness of the target, in terms of whether these systems will be used and maintained, or not. Examples include Niger's target for 100 MW of off-grid renewables by 2030 and Uganda's target for 700 kW of solar home systems by 2017. Output-based targets enable the focus to be on production rather than capacity, which provides more accurate information regarding their effectiveness. Targets can be framed in both capacity and output terms, with one being linked to the other through capacity factors. Uganda's SE4All Action Agenda aims for 18 800 GWh of electricity to be generated from renewables in 2030, representing 96% of total electricity production, which implies reaching almost 3 GW of renewable energy installed capacity by 2030.

For renewables-based clean cooking, targets framed as the total number of systems to be introduced by a given deadline are popular as they are simpler to define, monitor and implement than percentage-based targets. Most of the biogas programmes, such as the National Biogas Programme in Viet Nam, the National Programme of Biodigesters of Burkina Faso, and Kenya's Biogas Programme, use the number of biodigesters as a metric for deployment.

A balanced combination of long-term targets, articulated into a series of short- to medium-term targets, is ideal for achieving a combination of policy objectives.

Long-term targets provide an indication of the country's climate commitments and are a key signal to developers, investors, service providers and manufacturers as to the long-term opportunities available in a given market. In particular, capital-intensive investments, such as in manufacturing, would be far less likely to occur without clear long-term commitments. In the power sector, network planning and expansion are time-intensive processes and they also benefit from long-term visibility. Furthermore, to build the human capacity required over time in the financial, logistics, installation, operations, supply and related sectors, a short-term renewable energy target of three to five years is unlikely to be sufficient.

Short- to medium-term targets can introduce a sense of urgency and motivate stakeholders to act. They enable more effective implementation and rapid learning from the policy process and can coincide with investment and electoral cycles. In the case of five-year plans (*e.g.* China's), the periodic nature of five-year planning allows for a high level of flexibility and adjustment.

Setting short- to medium-term targets by backcasting a long-term trajectory can reconcile short-term goals with long-term objectives. A growing number of jurisdictions have introduced "stepped" or "tiered" renewable energy targets which involves setting a long-term overarching objective combined with a series of interim steps. These include Alberta (Canada) and Kazakhstan.

Aspirational targets should become binding.

Targets are considered mandatory or binding when they pass into law. This means that the targets have been ratified by the executive or legislative body, which gives them credibility in the eyes of potential investors and makes it harder for any future government, or a governing party, to repeal the targets.

At the heart of designing binding targets is adequate reporting and monitoring, combined with clear and specific compliance and enforcement mechanisms (*e.g.* fines or penalties if the target is not achieved) and the designation of an entity that is responsible for achieving them. One effective way of making targets binding is assigning them to specific entities through regulatory measures and policy instruments.

In the case of electricity, utilities can be mandated to increase electricity generation from renewables through renewable portfolio standards (RPS) as in the United States and the Philippines, or renewable portfolio obligations (RPO) as in India. In the transport sector, binding targets in the form of biofuel blending mandates are the responsibility of fuel distributors. As another example, market-based 1approaches, such as a cap and trade programme, set a limit on emissions from particular sectors.

A key design principle of renewable energy targets is to link them closely to regular monitoring of market conditions to allow for timely adaptation to changes in policy objectives and priorities, market dynamics, renewable energy costs and learning curves.

For jurisdictions to track progress towards goals (and of course to set related targets and develop renewable energy policies), the availability of accurate, timely and accessible renewable energy statistics is essential.

Periodic revisions are important as data collection and energy balances improve. In many cases, monitoring and adjustment can allow for an increase in ambition. Many countries and jurisdictions have raised their targets over time, such as in China's Five-Year Plans and the updates made in the European Union.

ANNEX 1: METHODOLOGY

All targets in the power sector are quantified in terms of capacity in megawatts (MW). While renewable energy targets in the power sector – in both NDCs and national energy plans – are typically expressed in terms of fixed capacity (in MW), in many countries they may be cited as a percentage of the electricity mix (*e.g.* 45% renewable energy share of electricity generation), and in some cases they may be a combination of both.

The estimation method for these three cases is described below:

1. In case a country expresses fixed targets in terms of MW, the target is taken as is.
2. In case the target is expressed as a share (*e.g.* Country A plans to reach 68% share of renewable energy in the electricity generation mix by 2030), the following steps are followed:
   - **a.** Overall electricity generation is obtained (if available in official national data) or approximated based on a 10-year historical cumulative annual growth rate (CAGR).[27] Given that for some countries (e.g. many SIDS), baseline generation may be very low, resulting in a very high growth rate that may not be realistic to project into the future, a growth rate of 1-2% is often assumed.
   - **b.** The overall renewable energy generation in the target year is obtained by multiplying the targeted share with the overall electricity generation.
   - **c.** Next, the technology-specific share of the renewable electricity mix is obtained (if available in official national data) or estimated. The shares are assumed to equal the share of a technology-specific capacity addition as a proportion of the overall renewable capacity added over the last five years. For example, for a technology like solar, the capacity added between 2017 and 2021 is divided by the overall renewable capacity added during this period. This share is assumed to be the same as the technology-specific share in the renewable electricity mix in the target year. Note that some adjustments are inevitable to account for a baseline capacity for technologies that have had no recent deployment (which is often the case for hydropower and bioenergy).
   - **d.** Once the technology-specific generation in target year is obtained, the following formula is used to calculate the MW equivalent of the target. Capacity factor data is obtained from IRENA's costs database.

$$Capacity\ (MW) = \frac{Capacity\ factor * Time\ (h)}{Actual\ energy\ generation\ (MWh)}$$

3. In cases where targets are expressed as both a share of the electricity mix and fixed capacity, *e.g.* "Country A plans to reach a 68% share of renewable energy share by 2030; specific measures include the addition of 30 MW of solar PV", it is assessed whether the fixed capacity target alone will be enough to reach the targeted share. In case it will not be enough, the share-based target is estimated and adjusted based on the fixed capacity target.

Note: Certain assumptions and approximations are made to account for the gaps and ambiguities in available data. These are made on a country-by-country basis to reflect local conditions where necessary.
Data on energy generation and renewable energy capacity can be found on IRENA's website here.
Data on renewable energy costs can be found here.

[27] *Unless this information is available in official policy documents of the country being analysed.*

ANNEX 2: RENEWABLE ENERGY TARGETS IN NATIONAL ENERGY PLANS

The renewable energy targets presented in this Annex were collected as of September 2022 using desktop research and were shared with IRENA Member States for verification. The targets presented are those mentioned in laws, policies, and strategies at the country and state level when applicable.

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Antigua and Barbuda		National	The national energy policy targets a 100% renewable energy in the electricity supply by 2030.	✔
Arab Republic of Egypt (the)		National	Egypt's 2035 Integrated Sustainable Energy Strategy sets the target of 42% of electricity generation from renewable sources by 2035 as follows: 22% from solar PV, 14% from wind, 4% from CSP and 2% from hydropower.	✔
Argentine Republic (the)		National	Argentina's Law 27191 sets the target of a share of renewables of at least 20% of total electricity consumption by 31 Dec 2025.	✔
Australia		National	Expired Target (in 2020)	
	Northern Territory	Subnational	50% of electricity from renewable sources by 2030	
	Tasmania	Subnational	100% of electricity from renewable sources by 2022	
	Queensland	Subnational	50% of electricity from renewable sources by 2030	
	Victoria	Subnational	50% of electricity from renewable sources by 2030	
	South Australia	Subnational	Target Achieved (in 2018)	
Commonwealth of the Bahamas		National	The Bahamas national energy policy sets the target of increasing the percentage of renewables in the energy mix to 30% by 2030.	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Barbados		National	Barbados's National Energy Policy sets the target of 100% share of RE by the year 2030. This translates to 625 MW of renewable installed capacity (excluding 200 MW of storage), including 310 MW of solar, 91.2 MW of wind, and 15 MW of Biomass and Waste-To-Energy.	✔
Republic of Belarus		National	8% share of renewable energy production in the TPES in 2025	
Belize		National	The 2012 National Sustainable Energy Strategy sets the target of generating over 50% of electricity from renewable energy by 2033. The strategy also establishes the target to increase hydropower from 55 MW to 70 MW by 2033 and to supply 5 MW of electricity from municipal solid waste.	
Bolivarian Republic of Venezuela (the)		National	Expired Target (in 2019)	
Bosnia and Herzegovina		National	Share of RES in the final consumption (43.62 %), Share of RES in electricity (68.6 %), Share of RES in transport (8.9 %) and Share of RES in heating and cooling (58.57 %) by 2030.	✔
Brunei Darussalam		National	30% renewable energy share of total capacity in the power generation mix	
Burkina Faso		National	Burkina Faso's Plan d'Action National des Energies Renouvelables (PANER) sets the target of 36% renewable energy in total installed capacity by 2030. This translates to 318 MW of renewable installed capacity, including 100 MW of small hydropower, 205 MW of solar and 13 MW of bioenergy. The PANER also aims to reach 27% renewable energy in the power generation mix (excluding electricity imports) by 2030, for a total of 685 gigawatt hours (GWh).	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Canada		National	Canada has a target to generate 90% of electricity from non-emitting sources (like conventional hydropower, wind, solar, and nuclear) by 2030.	
Central African Republic (the)		National	Adding 65 MW of solar PV capacity by 2024	✔
Commonwealth of Dominica (the)		National	Dominica's National Energy Policy sets the 100% Renewable Energy Generation target by 2030.	✔
Cook Islands (the)		National	Cook Islands' Economic Development Strategy sets the target of increasing the percentage of electricity generation from renewable energy to 60 percent by 2030.	
Co-operative Republic of Guyana (the)		National	Guyana's Green State Development Strategy sets a target of 100% Renewable Energy Generation by 2040.	✔
Czech Republic (the)		National	Share of RES in the final consumption (22.0 %), Share of RES in electricity (16.9 %), Share of RES in transport (14.0 %) and Share of RES in heating and cooling (30.7 %) by 2030	
Democratic People's Republic of Korea (the)		National	No national renewable energy targets were identified.	
Democratic Republic of Sao Tome and Principe (the)		National	The NREAP sets the target of 72% of installed electricity generation capacity (MW) from renewable sources, consisting of 49% from solar (47 MW), 18% from hydropower (17.30 MW), and 5% from biomass (4.68 MW). These targets will be maintained until 2050.	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Democratic Republic of the Congo (the)		National	The unsustainable share of fuelwood for cooking in the main urban centers (Kinshasa, Lubumbashi, Goma and Bukavu) of the country to be reduced [in equal proportion to the benefit of renewable energy resources] by 10% by 2031.	✔
Democratic Republic of Timor-Leste (the)		National	50% of its energy needs from renewable energy by 2030.	
Democratic Socialist Republic of Sri Lanka (the)		National	70% of electricity from renewable sources (including large hydro power) by 2030	
Dominican Republic (the)		National	Dominican Republic's Law 57-07 on Renewable Energy (supported by the 2008 Renewable Energy Regulating Decree No. 202-08) sets the 25% Renewable Energy Generation target by 2025.	
Federal Democratic Republic of Ethiopia (the)		National	Ethiopia sets the goal of 25 GW of power capacity by 2030, of which 22 GW would be hydro, 2 GW wind and 1 GW Geothermal.	
Federal Republic of Germany (the)		National	80% renewables share in the power mix by 2030. 110 GW of onshore wind capacity by 2030 and 160 GW by 2040. 30 GW of offshore wind power installed by 2030, 40 GW by 2035 and 70 GW by 2045. The new coalition government has increased the solar target to 200 GW installed by 2030, from 100 GW previously.	
Federal Republic of Nigeria (the)		National	NEP and NEMP, approved by the Federal Executive Council (FEC) on 27th April 2022, projected electricity demand of not less than 100 GW by 2030 at 7% GDP growth with a 20% renewable share. This translates to a renewable energy capacity of not less than 20 GW by 2030.	✔
Federal Republic of Somalia (the)		National	No national renewable energy targets were identified.	

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Federated States of Micronesia (the)		National	Expired Target (in 2020)	
Federative Republic of Brazil (the)		National	According to Brazil´s planning tools, it is estimated that: (i) the share of renewable energies in the Brazilian energy mix will likely increase, reaching a level of 48% in 2031; and (ii) the installed capacity of Brazilian electricity generation will likely reach a level of renewability of 83% in 2031. These numbers do not constitute targets, but estimates. Also, The National Biofuels Policy (RenovaBio) has targets for decarbonization, particularly in the transport sector, based on the adoption of biofuels and environmental efficiency of biofuel production. The targets are approved every year by the National Energy Policy Council (ministerial board) for the upcoming 10 years.	✔
French Republic (the)		National	Share of RES in the final consumption (33 %), Share of RES in electricity (40 %), Share of RES in transport (15 %) and Share of RES in heating and cooling (38 %) by 2030. 20.1 GW of Solar PV capacity by 2023. 24.1 GW of Onshore Wind capacity by 2023. 2.4 GW of Offshore Wind capacity by 2023. 25.7 GW of Hydropower capacity by 2023.	
Gabonese Republic (the)		National	Gabon's Vision 2025 Strategic Plan aims at reaching 80% electricity production from hydropower in 2020, up from 40% in 2010, including 735 MW of hydropower capacity. The plan also contemplates the potential for an additional 1 204 MW of hydropower by 2030 to become a net exporter of electricity.	
Georgia		National	Renewable energy sources to supply 27.4% of total energy demand by 2030	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Grand Duchy of Luxembourg (the)		National	Share of RES in the final consumption (25 %), Share of RES in electricity (33.6 %), Share of RES in transport (25.6 %) and Share of RES in heating and cooling (30.5 %) by 2030.	
The Hellenic Republic (Greece)		National	Share of RES in the final consumption (35 %), Share of RES in electricity (61 %), Share of RES in transport (19 %) and Share of RES in heating and cooling (43 %) by 2030. 7.66 GW of Solar PV capacity by 2023. 7.05 GW of Wind capacity by 2023. 2.4 GW of Offshore Wind capacity by 2023. 25.7 GW of Hydropower capacity by 2023.	✔
Grenada		National	Grenada's Vision 2030 sets a 100% renewable energy target for both the electricity and transport sectors 2030.	
Hashemite Kingdom of Jordan (the)		National	Increasing power generation from renewables to more than 35% by 2030	✔
Hungary		National	Share of RES in the final consumption (21 %), Share of RES in electricity (21.3 %), Share of RES in transport (16.9 %) and Share of RES in heating and cooling (28.7 %) by 2030.	
Iceland		National	Expired Target (in 2020)	
Independent State of Papua New Guinea (the)		National	Papua New Guinea's National Energy Policy sets the target of 100 % power from renewable sources by 2050. This includes 1 906 MW of hydropower (mostly from the Purari Hydropower Project), 100 MW of solar by 2030, 100 MW of wind power by 2030, and 100 000 solar home systems by 2020	✔
Independent State of Samoa (the)		National	Pathway for Development of Samoa sets the target of 70% electricity generation from renewable energy sources by 2031.	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Ireland		National	80% renewables in electricity consumption by 2030. 8 GW of onshore wind capacity by 2030 . 5 GW of offshore wind power installed by 2030. 2.5 GW of Solar PV installed by 2030.	
Islamic Republic of Afghanistan (the)		National	Afghanistan Renewable Energy Policy sets a target for deploying 4500 – 5000 MW of renewable energy capacity by 2032, which is equivalent to 95% of the total energy mix.	
Islamic Republic of Iran (the)		National	7500 MW of renewable energy installed capacity by 2030	
Islamic Republic of Mauritania (the)		National	50% share of renewables in electricity mix by 2030	✔
Islamic Republic of Pakistan (the)		National	Pakistan intends to have 20% of its generation capacity from renewable energy by 2025 and 30% by 2030	✔
State of Israel (the)		National	30% renewables electricity generation by 2030	
Jamaica		National	Jamaica's Integrated Resource Plan (IRP) sets out annual capacity additions from 2018 to 2037. By 2037, the following capacity additions are expected to be added to current levels: - 1260 MW solar/wind - 74 MW hydro, waste to energy, Biomass	✔
Japan		National	Japan's 6th Strategic Energy Plan sets out a new 2030 renewable energy generation target of 36-38%, an increase against its previous target of 22-24%. 14-16% solar, 11% hydropower, 5% wind, 5% biomass, and 1% geothermal. The projected electricity demand in 2030 is 934 billion kWh (or 934 TWh).	✔
Kingdom of Bahrain (the)		National	10% renewables electricity generation by 2035, 710 MW of renewable energy installed capacity by 2030	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Kingdom of Belgium (the)		National	40% renewables in electricity consumption by 2030. 100% renewables in electricity consumption by 2050. 4.3 GW of onshore wind power capacity by 2030. 4 GW of offshore wind capacity by 2030.	
Kingdom of Bhutan (the)		National	The Alternative Renewable Energy Policy sets a target of 20 MW of renewable electricity generation capacity. This includes technology-specific targets of 5 MW of solar PV, 5 MW of wind, 5 MW of biomass, and 5 MW of other technologies by 2025.	✔
Kingdom of Cambodia (the)		National	35% renewable energy (including hydro) share of the generation mix by 2050, of which 12% will come from solar PV.	✔
Kingdom of Denmark (the)		National	Share of RES in the final consumption (55 %), Share of RES in electricity (100 %), Share of RES in transport (19 %) and Share of RES in heating and cooling (59.9 %) by 2030. 10.15 GW of onshore/offshore wind power installed capacity by 2030. 7.8 GW of solar energy installed by 2030.	
Kingdom of Eswatini (the)		National	Eswatini Government set the target of 50% RE in the electricity mix by 2030	✔
Kingdom of Lesotho (the)		National	Lesotho's Renewable Energy Policy sets the target of adding additional renewable energy generation capacity of 200 MW by 2030.	✔
Kingdom of Morocco (the)		National	Morocco announced during the 21st session of the UNFCCC's Conference of the Parties (COP21) a further planned increase in the renewables capacity to reach 52% of the total by 2030 (20% solar, 20% wind, 12% hydro). To meet the 2030 target, the country aims to add around 10 GW of RE capacities between 2018 and 2030, consisting of 4560 MW of solar, 4200 MW of wind, and 1330 MW of hydropower capacity.	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Kingdom of Norway (the)		National	Expired Target (in 2020)	
Kingdom of Saudi Arabia (the)		National	According to Saudi Arabia Vision 2030, the target is to increase the domestic generation capacity from renewable energy to 50% by 2030	
Kingdom of Spain (the)		National	Share of RES in the final consumption (42 %), Share of RES in electricity (74 %), Share of RES in transport (11 %) and Share of RES in heating and cooling (31 %) by 2030. 50.3 GW of onshore and offshore wind capacity by 2030. 39.2 GW of Solar PV installed by 2030. 7.3 GW of CSP installed by 2030.	
Kingdom of Sweden (the)		National	100% of electricity generated from renewable sources by 2040	
Kingdom of Thailand (the)		National	Increase renewable energy share to 30% of total final energy consumption in the form of electricity (5.75%), heat (21.20%) and biofuel (3.22%).	✔
Kingdom of the Netherlands (the)		National	Share of RES in the final consumption (27 %) and Share of RES in electricity (70 %) by 2030. 6.1 GW of onshore wind capacity by 2030. 11.5 GW of offshore wind power installed by 2030. 27 GW of Solar PV installed by 2030.	
Kingdom of Tonga (the)		National	Tonga's Climate Change Policy sets the target of 100% of power generation from renewables by 2035.	
State of Kuwait (the)		National	15% renewables electricity generation by 2030, 4.3 GW of renewable energy installed capacity by 2030	✔
Kyrgyz Republic (the)		National	No national renewable energy targets were identified.	✔
Lao People's Democratic Republic (the)		National	30% renewable energy share of total energy consumption by 2025	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Lebanese Republic (the)		National	According to Lebanon National Renewable Energy Action Plan (NREAP) 2021-2025, the target is to supply 30% of the total electricity consumed in 2030 from renewable sources.	
State of Libya (the)		National	Libya's Strategic Plan for Renewable Energies sets the target of 22% of electricity generation from renewable sources by 2030. Libya aims to achieve this target through 3,350 MW of solar PV, 850 MW of wind power and 400 MW of CSP by 2030.	✔
Malaysia		National	31% renewable energy share in the power mix by 2025 and 40% by 2035	✔
Mongolia		National	30% renewable capacity share by 2030	
Montenegro		National	Expired Target (in 2020)	
Nepal		National	No national renewable energy targets were identified.	
New Zealand		National	90 % of electricity from renewable sources by 2025.	
Niue		National	Niue's Strategic Energy Road Map sets the target of 80% renewable energy generation by 2025.	
Oriental Republic of Uruguay (the)		National	Expired Target (in 2015)	
People's Democratic Republic of Algeria (the)		National	27% renewables electricity generation by 2030, 22 GW of renewable energy installed capacity by 2030	✔
People's Republic of Bangladesh (the)		National	Bangladesh's National Solar Energy Action Plan aims for up to 40 GW to be installed by 2041.	
People's Republic of China (the)		National	China's 14th Five Year Plan on Renewable Energy Development sets the target of 33% for the share of renewable energy (15% for Hydro and 18% for Non-hydro renewables) in final electricity consumption by 2025.	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Plurinational State of Bolivia (the)		National	Bolivia's Electrical Plan – 2025 sets the target of increasing the generation of hydropower to 70% of the total electricity generation by 2025. An additional 183 MW of renewables other than hydropower are also projected to be added as follows: 100 MW of geothermal, 53 MW of wind power, 20 MW of solar, and 10 MW of bioenergy and waste. The Plan also includes targets for 1 599 MW of hydropower and 5 552 MW of very large (GW scale) hydropower projects.	
Portuguese Republic (the)		National	Share of RES in the final consumption (47 %), Share of RES in electricity (80 %), Share of RES in transport (20 %) and Share of RES in heating and cooling (38 %) by 2030. 9 GW of onshore wind capacity by 2030. 0.3 GW of offshore wind power installed by 2030. 9 GW of Solar PV installed by 2030. 0.3 GW of CSP installed by 2030.	
Principality of Andorra (the)		National	75% of energy from renewable sources in national energy mix by 2030	
Principality of Liechtenstein (the)		National	No national renewable energy targets were identified.	
Principality of Monaco (the)		National	No national renewable energy targets were identified.	
State of Qatar (the)		National	20% renewables electricity generation by 2030, 1.8 GW of renewable energy installed capacity by 2030	✔
Republic of Albania (the)		National	Share of RES in the final energy demand (54.4%), Share of RES in electricity (178.1 % *), Share of RES in transport (34.6%) and Share of RES in heating and cooling (16.6%) as projected with additional measures for 2030. * Values over 100% are due to electricity exports.	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of Angola (the)		National	Angola is targeting to reach 800 MW of generation from renewable energy, including 100 MW of solar, 100 MW of wind, 500 MW of biomass, and 100 MW small hydropower by 2025.	✔
Republic of Armenia (the)		National	The Government of Armenia aims to increase the share of solar power generation by at least 15 % of total generation by 2030. For that purpose, solar PV plants with a total installed capacity of 1,000 MW will be constructed, including 300 MW, by 2024. Some increase in wind capacity is also expected.	✔
Republic of Austria (the)		National	45%-50% of the total energy consumption from renewable sources by 2030. 100% of the total electricity consumption from renewables by 2030. 9.7 GW of solar PV capacity by 2030.	
Republic of Azerbaijan (the)		National	The Ministry of Energy has set a target to increase the share of the installed capacity of renewable energy to 30% of the country's overall energy balance by 2030.	✔
Republic of Benin (the)		National	843 MW by 2030, breakdown available	
Republic of Botswana (the)		National	100 MW of solar PV by 2023	
Republic of Bulgaria (the)		National	Share of RES in the final consumption (27.09%), Share of RES in electricity (30.33%), Share of RES in transport (14.20 %) and Share of RES in heating and cooling (42.60%) by 2030	✔
Republic of Burundi (the)		National	No national renewable energy targets were identified.	
Republic of Cabo Verde (the)		National	Cabo Verde's Electricity Sector Master Plan, 2018-2040, sets the target of a 54% renewable energies penetration rate by 2030. This translates to 251.8 MW of renewable installed capacity, including 160.6 MW of solar and 91.2 MW of wind.	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of Cameroon (the)		National	No national renewable energy targets were identified.	✔
Republic of Chad (the)		National	30% renewables in electricity generation by 2030. 330 MW of renewables capacity by 2030 .	✔
Republic of Chile (the)		National	70% of electricity generated by renewable sources by 2030.	
Republic of Colombia (the)		National	Target announced by Colombia's Mines and Energy minister in July 3rd, 2019 to reach 1500 MW of installed capacity for Solar and Wind combined by 2022, from a current 50 MW.	✔
Republic of Costa Rica (the)		National	By 2035, the PEG2020 plans on having the following renewable energy installed capacity in Costa Rica: 2,255 MW of hydropower, 359 MW wind power, 296 MW geothermal, 250 MW solar PV, and 53 MW bioenergy by 2035.	✔
Republic of Côte d'Ivoire (the)		National	Côte d'Ivoire's Plan d'Action National des Energies Renouvelables (PANER) sets a target of 57% of renewable energy installed capacity by 2030, representing 42% of electricity generation. The PANER plans on reaching 2 632 MW of installed capacity in 2030, including 1 592 MW from large hydropower, 485 MW of bioenergy, 424 MW of solar, and 131 MW from small hydropower.	
Republic of Croatia (the)		National	Share of RES in the final consumption (36.4%), Share of RES in electricity (63.8%), Share of RES in transport (13.2 %) and Share of RES in heating and cooling (36.6%) by 2030	✔
Republic of Cuba (the)		National	Cuba's energy policy set the goal of generating 24 percent of its power from renewable energy by 2030.	

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of Cyprus (the)		National	Share of RES in the final consumption (22.9%), Share of RES in electricity (30.3%), Share of RES in transport (14.1 %) and Share of RES in heating and cooling (39.4%) by 2030	✔
Republic of Djibouti (the)		National	100% renewables electricity generation by 2030	✔
Republic of Ecuador (the)		National	Ecuador's Electricity Master Plan (PME) 2022-2031 plans the following capacity additions during the 2022-2031 period: 3,636 MW of hydropower, 50 MW of geothermal, 200 MW of solar PV, 160 MW of wind, and an additional 144 MW of technology to be determined.	✔
Republic of El Salvador (the)		National	El Salvador's Masterplan for the Development of Renewable Energy 2012 estimates the following capacity additions by 2026: 60 MW of wind power, 90 MW of solar PV, 200 MW of solar thermal, 60-89 MW of geothermal, 162.7 MW of small hydropower (smaller than 20 MW), 45 MW of biomass and 35 MW of biogas.	
Republic of Equatorial Guinea (the)		National	No national renewable energy targets were identified.	
Republic of Estonia (the)		National	Share of RES in the final consumption (42 %), Share of RES in electricity (40 %), Share of RES in transport (14 %) and Share of RES in heating and cooling (63 %) by 2030.	
Republic of Fiji (the)		National	Fiji's Green Growth Framework targets renewable energy share in electricity generation to be around 99% by 2030.	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of Finland (the)		National	Share of RES in the final consumption (54 %), Share of RES in electricity (53 %), Share of RES in transport (45 %) and Share of RES in heating and cooling (61 %) by 2030. 5.5 GW of wind energy (irrespective of whether onshore or offshore) installed capacity by 2030. 1.2 GW of solar energy installed by 2030.	
Republic of Ghana (the)		National	Ghana's Renewable Energy Master Plan aims for 447.5 MW of utility scale solar, 200 MW of distributed solar, 20 MW of Standalone Solar PV, 25 MW of solar street lighting, 325 MW of utility scale wind, 2 MW of Standalone Wind Systems, 72 MW of utility scale biomass, 50.1 MW of waste to energy utility scale, 150.03 MW of Small/ Medium Hydro Plants, 50 MW of wave power and 12 MW of Hybrid Mini-Grids by 2030. Electricity generation capacity from renewables is projected to reach 1353.63 MW by 2030.	
Republic of Guatemala (the)		National	The Guatemala National Energy policy (2013-2027) sets a target to achieve 80% of electricity generation from renewable resources by 2027.	✔
Republic of Guinea (the)		National	Guinea's Sustainable Energy Action Plan contemplates reaching 70% electricity generation from hydropower in 2017, as well as an additional 1 598 MW of hydropower and 5 MW of solar PV by 2025.	
Republic of Guinea-Bissau (the)		National	Guinea-Bissau's National Plan of Action for Renewable Energy (PANER) plans to reach 72 MW of renewable energy by 2030, representing 52% of peak demand and 72% of total electricity demand. This includes an additional 53 MW of hydropower, 15 MW of solar PV, 2 MW of wind and 2 MW of bioenergy.	
Republic of Haiti (the)		National	Expired Target (in 2020)	

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of India (the)		National	To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel -based energy resources by 2030, with the help of transfer of technology and low-cost international finance including from Green Climate Fund (GCF).	✔
Republic of Indonesia (the)		National	Indonesia's Electricity Supply Business Plan (RUPTL) sets out an electricity generation capacity addition target of 40.6 GW for the period 2021-2030, of which 51.6% will come from renewable sources, while fossil fuels will provide 48.4%. Specifically, 9.272 GW of Hydro, 4.680 GW of Solar PV, 3.355 GW of Geothermal, 1.118 GW of Mini-Micro Hydro, 1.310 GW of Unspecified New Renewables, 0.590 GW of Bioenergy and 0.597 GW of Onshore Wind.	✔
Republic of Iraq (the)		National	Raise the share of clean energy of the total energy mix to 33% by 2030	✔
Republic of Italy (the)		National	Share of RES in the final consumption (30 %), Share of RES in electricity (55 %), Share of RES in transport (22 %) and Share of RES in heating and cooling (33.9 %) by 2030. 18.4 GW of onshore wind capacity by 2030 . 0.9 GW of offshore wind power installed by 2030. 52 GW of Solar PV installed by 2030. 0.88 GW of CSP by 2030.	
Republic of Kazakhstan (the)		National	6% renewable energy share of power generation by 2025, 23% by 2035 and 50% by 2050. 4.6 GW of wind power capacity by 2030.0.5 GW of solar power capacity by 2030.	
Republic of Kenya (the)		National	Kenya's Action Agenda sets the goal of reaching 80% renewable energy capacity by 2030, with specific technology targets as follows: 5.5 GW of geothermal, 3 GW of hydropower, 1.2 GW of solar PV, 1.5 GW of wind and 610 MW of bioenergy by 2030.	

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of Kiribati (the)		National	Kiribati's Integrated Energy Roadmap (KIER) sets different goals for the islands. The goal for Tarawa is a 45% reduction in fossil fuel use by 2025. 23% of this goal will be achieved through deployment of renewable energy and 22% through improvements in energy efficiency. The goal for Kiritimati is a 60% reduction in fossil fuels by 2025. 40% is to be achieved through deployment of renewable energy and 20% through improvements in energy efficiency. The goal for the Outer Islands is a 60% reduction in fossil fuel use in all rural public infrastructure, including Southern Kiribati Hospital and ice plants, (40% through deployment of renewable energy and 20% through improvements in energy efficiency) by 2025. The goal for rural public and private institutions (*e.g.* Boarding schools, the Island Council, private amenities and households) is to meet of 100% electricity demand with renewable energy by 2025.	✔
Republic of Korea (the)		National	Korea's 9th Basic Plan for Long-term Electricity Supply and Demand 2020-2034 sets the target of installing 77.8 GW of renewable energy out of a total of 193 GW of installed generating capacities by 2034. By 2030, the country will install 58 GW renewable energy out of a total of 173 GW capacity (mainly solar and wind).	
Republic of Latvia (the)		National	Share of RES in the final consumption (50 %), Share of RES in electricity (60 %), Share of RES in transport (7 %) and Share of RES in heating and cooling (57.59 %) by 2030.	

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of Liberia (the)		National	Liberia's National Renewable Energy Action Plan sets a goal of 95% renewable electricity capacity by 2030, totalling 1 011 MW, including 503 MW of bioenergy, 456 MW of hydropower and 52 MW of solar PV.	
Republic of Lithuania (the)		National	Share of RES in the final consumption (45 %), Share of RES in electricity (45 %), Share of RES in transport (15 %) and Share of RES in heating and cooling (67.2 %) by 2030.	
Republic of Madagascar (the)		National	Madagascar's Energy Policy (2015-2030) sets the targets of 85% renewable electricity generation by 2030, of which 75% is from hydropower, 5% from wind power and 5% from solar PV. Energy consumption in 2030 is expected to be 7900GWh, with 70% energy access.	
Republic of Malawi (the)		National	No national renewable energy targets were identified.	
Republic of Maldives (the)		National	No national renewable energy targets were identified.	
Republic of Mali (the)		National	Mali's Plan d'Action National d'Energies Renouvelables (PANER) sets a goal of 58.3% of renewable energy in total installed capacity by 2030 representing 37.1% of the electricity generation mix. The PANER aims for 1 416 MW of renewable energy installed capacity by 2030, including 731 MW of medium and large hydropower, 528 MW of solar, 107 MW of small hydropower, 30 MW of bioenergy and 20 MW of wind.	✔
Republic of Malta (the)		National	Share of RES in electricity (11 %), Share of RES in transport (15 %) and Share of RES in heating and cooling (26 %) by 2030.	

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of Mauritius (the)		National	Mauritius Roadmap 2030 for the electricity sector set the target for share of RE to 60 % by year 2030. The roadmap aims for 863.35 MW of renewable energy installed capacity by 2030, including 60 MW of Hydro, 9.35 MW of onshore wind, 233 MW of Solar Energy - Rooftop, 32 MW of Solar Energy - Floating PV, 106 MW of Solar Energy - Utility, 340 MW of Renewable Energy Hybrid Facilities (REHF), 10 MW of Waste to Energy, 50 MW of Offshore wind, 20 MW of Marine and 3 MW of landfill gas generation.	✔
Republic of Moldova (the)		National	27% of energy from renewable sources in gross final energy consumption by 2030 (Under discussion and pending agreement with ECS)	✔
Republic of Mozambique (the)		National	Share of renewable energies in the total energy production will be 48% by 2024	✔
Republic of Namibia (the)		National	Namibia's National Renewable Energy Policy sets scenarios ranging from 49% to 70% renewable electricity by 2030. The 70% scenario includes reaching 830 MW of solar PV, 1546 MW of Wind, 40 MW of Biomass and 650 MW of Battery Storage.	✔
Republic of Nauru (the)		National	Expired Target (in 2020)	
Republic of Nicaragua (the)		National	The Nicaragua Electricity Generation Expansion Plan 2016-2030 sets a target to generate 51% of electricity production from renewable energy sources by 2016, and to increase this percentage to 55% by 2018, 70% by 2027, and 73% by 2030. This includes an additional capacity from 2016 onwards as follows: 293 of hydropower, 143 MW of wind power, 138 MW of biomass, 135 MW of geothermal and 74 MW of solar PV.	

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of North Macedonia (the)		National	Share of RES in the final consumption (38%), Share of RES in electricity (66%), Share of RES in transport (10%) and Share of RES in heating and cooling (45%) by 2030	✔
Republic of Palau (the)		National	Palau's Executive Order No. 403 sets the target of 45% renewable energy generation by 2025.	✔
Republic of Panama (the)		National	Panama's National Energy Plan 2015-2050 included a target for 73.3% of renewable electricity generation by 2050.	✔
Republic of Paraguay (the)		National	Paraguay's Revised National Development Plan sets the goal of hydropower accounting for 28% of all energy consumption by 2030 and 42% of all final energy consumption coming from biomass by 2030. Also, increase non-conventional renewable energy generation by 0.0175% by 2030 (including non-conventional hydropower).	✔
Republic of Peru (the)		National	The National Energy Plan for 2014-2025 sets a target of over 60% renewable electricity by 2021, including 5% from renewables other than hydropower. The Plan also projects 6 697–7 100 MW of hydropower capacity by 2025 of and 802 MW of other renewable energy sources.	
Republic of Poland (the)		National	Share of RES in the final consumption (23 %), Share of RES in electricity (31.8 %), Share of RES in transport (14 %) and Share of RES in heating and cooling (28.4 %) by 2030. 9.6 GW of onshore wind capacity by 2030. 5.9 GW of offshore wind power installed by 2030. 7.2 GW of Solar PV installed by 2030.	

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of Rwanda (the)		National	Rwanda's Sustainable Energy for All Action Agenda has set a target of 60% of renewable energy share in electricity generation mix by 2030.	
Republic of San Marino (the)		National	No national renewable energy targets were identified.	
Republic of Senegal (the)		National	30% of renewable energy in the energy mix to be maintained until 2030	✔
Republic of Serbia (the)		National	Targets are under discussion	✔
Republic of Seychelles (the)		National	Seychelles' Sustainable Development Strategy sets the target of 15% renewable electricity by 2030. The Strategy also includes technology-specific targets as follows: 6 MW of wind, 3.2 MW of solar PV, 0.75 MW of micro-hydropower, 5 pilot biogas plants and 1 000 solar water heaters.	✔
Republic of Sierra Leone (the)		National	Sierra Leone's renewable energy policy targets 84% of renewable energy contribution to final energy consumption by 2030.	
Republic of Singapore (the)		National	Increase solar energy deployment to at least 2 GWp by 2030 (3% of 2030 projected electricity demand); 1.5 GWp by 2025 (2% of 2025 projected electricity demand).	
Republic of Slovenia (the)		National	Share of RES in the final consumption (35 %), Share of RES in electricity (61 %), Share of RES in transport (19 %) and Share of RES in heating and cooling (43 %) by 2030. 7.66 GW of Solar PV capacity by 2023. 7.05 GW of Wind capacity by 2023. 2.4 GW of Offshore Wind capacity by 2023. 25.7 GW of Hydropower capacity by 2023.	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of South Africa (the)		National	South Africa's 2019 IRP sets the goal of 39.7% of renewable electricity by 2030. This is to be achieved through the installation of 17 742 MW of wind, 8 288 MW of solar PV, 4 600 MW of hydropower and 600 MW of CSP.	
Republic of South Sudan (the)		National	No national renewable energy targets were identified.	
Republic of Suriname (the)		National	No national renewable energy targets were identified.	✔
Republic of Tajikistan (the)		National	At least 10% of generation in total energy balance from RES (mainly from solar and wind energy).	✔
Republic of the Congo (the)		National	No national renewable energy targets were identified.	
Republic of the Gambia (the)		National	The Gambia's 2015 National Renewable Energy Action Plan (NREAP) sets the goal of 49.6% of renewable energy capacity for 2020, including 44 MW of hydropower, 17 MW of solar PV and 7 MW of wind. It also sets the target of 38.9% of renewable energy capacity for 2030, including 50 MW of solar PV and 20 MW of wind power.	
Republic of the Marshall Islands (the)		National	Marshall Islands Electricity Roadmap sets the target of 100% energy generated from renewable energy sources by 2050. This translates to 130.1 MW of renewable installed capacity (excluding storage), including 80.6 MW of solar and 49.5 MW of wind.	

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of the Niger (the)		National	Niger's Plan d'Actions National des Energies Renouvelables (PANER) sets the renewable energy target of 28% installed capacity and 57% electricity generation mix by 2030. This is achieved through 280 MW of renewables by 2030, including 130 MW of hydropower and 150 MW of solar PV. The PANER also includes the target of 100 MW of off-grid renewables by 2030, including 60% pure renewables and 40% hybrid systems. The PANER also sets the target of supplying 91 455 households with SWHs by 2030.	✔
Republic of the Philippines (the)		National	35% renewable energy of the total generation mix by 2030; 50% by 2040 or equivalent to 52.8 GW of additional renewable energy capacities by 2040	✔
Republic of the Sudan (the)		National	20% share of renewable in electricity mix by 2030 (excluding hydro.)	✔
Republic of the Union of Myanmar (the)		National	No national renewable energy targets were identified.	
Republic of Trinidad and Tobago (the)		National	Expired Target (in 2021)	✔
Republic of Tunisia (the)		National	Tunisia's National Renewable Energy Action Plan sets a target of 30% renewables electricity generation in 2030. This is to be achieved through 3 815 MW of renewables by 2030, including 1 755 MW of wind power, 1 510 MW of solar PV, 450 MW of CSP and 100 MW of biomass.	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of Türkiye (the)		National	Türkiye has already exceeded its target of 38.8% of power generation from renewables set out under the Eleventh Development Plan (2019-2023). According to the Ministry of Energy and Natural Resorces' Strategic Plan (2019), Installed capacity of wind power will reach 11,883 MW, Installed capacity of solar power will reach 10,000 MW, and installed capacity of geothermal and biomass power will reach 2,884 MW by 2023.	✔
Republic of Uganda (the)		National	Uganda's SE4All Action Agenda plans for 18 800 GWh of electricity generated from renewables in 2030, representing 96% of total electricity production. This implies reaching 3 040-3 080 MW of renewable energy installed capacity by 2030, including 2 410 MW of hydropower, 383 MW of small hydropower, 140 MW of solar home systems, 62-92 MW of mini-grids, 20 MW of grid-connected solar PV, 9-19 MW of other off-grid PV and 16.5 MW of biomass.	
Republic of Uzbekistan (the)		National	25% of Uzbekistan electricity needs will come from renewable power by 2026. 4 GW of Solar PV installed by 2026. 4 GW of wind capacity installed by 2026.	✔
Republic of Vanuatu (the)		National	Vanuatu's National Energy Road Map sets the target of 100% of electricity from renewable sources by 2030.	✔
Republic of Yemen (the)		National	15% renewables electricity generation by 2025, 714 MW of renewable energy installed capacity by 2025	✔
Republic of Zambia (the)		National	Zambia's SEforALL Action Agenda plans for 30% (excluding large hydropower) electricity generated from renewables in 2030.	

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Republic of Zimbabwe (the)		National	Zimbabwe's National Renewable Energy Policy sets a renewable energy target of 16.5% of electricity demand by 2025 and 26.5% by 2030. It further specifies that the 2030 target is to be achieved through 2 100 MW of renewable energy capacity, including 1 575 MW of solar PV, 275 MW of bioenergy, 150 MW of small hydropower and 100 MW of wind. The policy also includes 250 000 SWHs, 8 000 domestic biodigesters and 288 institutional biodigesters.	✔
Romania		National	-1	✔
Russian Federation (the)		National	2 % of electricity from renewable sources by 2030 and 12.5 % of electricity from renewable sources by 2050	✔
Saint Kitts and Nevis		National	No national renewable energy targets were identified.	✔
Saint Lucia		National	Saint Lucia's National Energy Transition Strategy sets the target of 35% of electricity generated by renewable sources by 2025.	✔
Saint Vincent and the Grenadines		National	Expired Target (in 2020)	✔
Slovak Republic (the)		National	Share of RES in the final consumption (19.2 %), Share of RES in electricity (27.3 %), Share of RES in transport (14 %) and Share of RES in heating and cooling (19 %) by 2030. 250 MW of onshore wind capacity by 2030. 870 MW of Solar PV installed by 2030. 1641 MW of Hydropower installed by 2030.	

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Socialist Republic of Viet Nam (the)		National	Onshore wind power 16,121 MW (11%) by 2030; 55,950 MW (14.4%) by 2045 Offshore wind power 7,000 MW (4.8%) by 2030; 66,500 MW (16.6%) by 2045 Large-scale solar power 11,166 MW (6%) by 2030; 76,000 MW (19.6%) by 2045 Biomass and other forms of RE 1,230 MW (0.8%) by 2030; 5,210 MW (1.3%) by 2045 Pumped hydroelectricity and storage 2,450 MW (1.7%) by 2030; 28,950 MW (7.5%) in 2045 By 2025, 100% of its buses using electricity and green energy By 2030, the use of electricity and green energy for all transportation at least 50% and 100%	✔
Solomon Islands		National	The Solomon Islands National Energy Policy sets the target of 79% of power generation from renewables by 2030.	
State of Eritrea (the)		National	Eritrea's "Podium of Renewable Energy" sets the goal of 50% power supply from renewable energy by 2030	
State of Palestine (the)		National	10% renewables electricity generation by 2030	✔
Sultanate of Oman (the)		National	According to Oman Vision 2040, the target is 20% renewable energy consumption percentage of total consumption by 2030	
Swiss Confederation (the)		National	No national renewable energy targets were identified.	
Syrian Arab Republic (the)		National	10% renewables electricity generation by 2030	✔
Togolese Republic (the)		National	Togo's first renewable energy development law plans for reaching 50% renewables in the national energy mix by 2030.	✔

COUNTRY NAME	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
Turkmenistan		National	No national renewable energy targets were identified.	
Tuvalu		National	Expired Target (in 2020)	
Ukraine		National	25% of total energy mix from renewables by 2035	
Union of the Comoros (the)		National	No national renewable energy targets were identified.	
United Arab Emirates (the)		National	44% renewables electricity generation by 2050	✔
United Kingdom of Great Britain and Northern Ireland (the)		National	UK's Energy Security Strategy sets the target of 50 GW of operating offshore wind capacity by 2030 (including up to 5 GW floating offshore wind capacity). The strategy also sets the target of up to 70 GW solar capacity by 2035.	✔
United Mexican States (the)		National	Mexico's General Climate Change Law sets a goal for Mexico to generate 35 percent of its electricity from clean energy sources by 2024.	
United Republic of Tanzania (the)		National	The Power System Master Plan (2020 Update) indicates power generation consisting 5,690.4 MW (28.15%) of hydro; 800 MW (3.96%) of wind; 715 MW (3.54%) of solar; and 995 MW (4.93%) of geothermal of power generation by 2044.	✔
United States of America (the)		National	30 GW offshore wind by 2030. 25 GW of Solar, Onshore Wind, and Geothermal by 2025.	
	Arizona	Subnational	15% of electricity from renewable sources by 2025	
	California	Subnational	60% of electricity from renewable sources by 2030, 100% clean electricity by 2045	

COUNTRY NAME

	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
United States of America (the)	Colorado		Subnational	100% clean energy by 2050 for utilities serving 500,000 or more customers
	Connecticut	Subnational	48% renewable generation share of electricity sales by 2030, 100% clean electricity by 2040	
	Delaware	Subnational	40% renewable generation share of electricity sales by 2035	
	Hawaii	Subnational	100% of electricity from renewable sources by 2045	
	Illinois	Subnational	50% renewable generation share of electricity sales by 2040, 100% clean energy by 2050	
	Indiana	Subnational	10% clean energy by 2025	
	Maine	Subnational	100% renewable generation share of electricity sales by 2050	
	Maryland		Subnational	50% of electricity from renewable sources by 2030, 100% clean electricity by 2040
	Massachusetts	Subnational	50% clean energy by 2030, 75% clean energy by 2040, 100% Net-zero emissions energy by 2050	
	Michigan	Subnational	100% carbon neutrality (Economy-wide includig energy sector) no later than 2050	
	Minnesota	Subnational	100% clean electricity by 2040	
	Nebraska	Subnational	100% clean electricity by 2050	

COUNTRY NAME

	State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
United States of America (the)	Nevada	Subnational	50% of electricity from renewable sources by 2030, 100% clean electricity by 2050	
	New Hampshire	Subnational	25.2% of electricity from renewable sources by 2025	
	New Jersey	Subnational	50% renewable generation share of electricity sales by 2030	
	New Mexico	Subnational	80% of electricity from renewable sources by 2040; 100% clean electricity by 2045	
	New York	Subnational	70% of electricity from renewable sources by 2030; 100% clean electricity by 2040	
	North Carolina		Subnational	100% clean electricity by 2050
	Ohio	Subnational	8.5% of electricity from renewable sources by 2026	
	Oregon	Subnational	100% of clean electricity sales by 2040	
	Rhode Island		Subnational	100% of electricity from renewable sources by 2033
	Texas	Subnational	10 GW of newly installed renewable energy capacity by 2025 (goal achieved)	
	Utah	Subnational	20% of electricity from renewable sources by 2025	
	Vermont	Subnational	75% of electricity from renewable sources by 2032	
	Virginia	Subnational	100% of electricity from renewable sources by 2045 for Phase II utilities and 2050 for Phase I utilities.	
	Washington	Subnational	100% clean electricity by 2045	
	Washington, D.C.	Subnational	100% of electricity from renewable sources by 2032	
	Wisconsin	Subnational	100% clean electricity by 2050	

COUNTRY NAME		State	Jurisdiction of targets	Details of target	Verified target by IRENA's Focal Point
	United States of America (the)	Iowa	Subnational	Expired Target (in 2010)	
		Kansas	Subnational	Expired Target (in 2020)	
		Missouri	Subnational	Expired Target (in 2021)	
		Montana	Subnational	Expired Target (in 2015)	
		North Dakota	Subnational	Expired Target (in 2015)	
		Oklahoma	Subnational	Expired Target (in 2015)	
		Pennsylvania	Subnational	Expired Target (in 2021)	
		South Carolina	Subnational	Expired Target (in 2021)	
		South Dakota	Subnational	Expired Target (in 2015)	
		West Virginia	Subnational	Repealed (in 2015)	

REFERENCES

247newsagency.com (2022), "Subsidy for efficient cooking in Ecuador", 247newsagency.com, https://247newsagency.com/opinion/113696.html (accessed 17 August 2022).

Alvarez, C. F. (2021), "Coal phase-out by 21 nations only accounts for 3.2% of global power. What about the others?", Energy Post, https://energypost.eu/coal-phase-out-by-21-nations-only-accounts-for-3-2-of-global-power-what-about-the-others/ (accessed 22 August 2022).

Barbose, G. (2021), "U.S. Renewables Portfolio Standards 2021 Status Update: Early Release", https://eta-publications.lbl.gov/sites/default/files/rps_status_update-2021_early_release.pdf.

BBC News (2022), "How Pakistan floods are linked to climate change", https://www.bbc.com/news/science-environment-62758811 (accessed 5 September 2022).

Bianco, E. *et al* (2022), "Industrial and innovation policy can speed up the Green Hydrogen transition", Industrial Analytics Platform, https://iap.unido.org/articles/industrial-and-innovation-policy-can-speed-green-hydrogen-transition (accessed 18 August 2022).

Biofuels International (2019), "Finnish government targets 30% biofuels share in aviation fuel", Biofuels International Magazine, https://biofuels-news.com/news/finnish-government-targets-30-biofuels-share-in-aviation-fuel/ (accessed 11 August 2022).

Bloomberg.com (2022), "German Power Prices Soar to Record as Energy Crisis Deepens", https://www.bloomberg.com/news/articles/2022-08-15/german-power-prices-soar-to-record-as-energy-crisis-deepens (accessed 19 August 2022).

BNEF (2021), 2H 2021 Hydrogen Market Outlook: China Drives a Gigawatt, BNEF.

Brooks, C. (2022) "Germany launches full-scale renewable power transition in Easter Package", IHS Markit, https://cleanenergynews.ihsmarkit.com/research-analysis/germany-launches-fullscale-renewable-power-transition-in-easte.html (accessed 3 September 2022).

Bulijan, A. (2022), "Four EU Countries Set Joint Target of 150 GW of Offshore Wind by 2050", OffshoreWind.biz, https://www.offshorewind.biz/2022/05/18/four-eu-countries-set-joint-target-of-150-gw-of-offshore-wind-by-2050/ (accessed 25 August 2022).

Carbon Brief (2022), "G7 countries commit to working towards coal phase-out", Carbon Brief, https://www.carbonbrief.org/daily-brief/g7-countries-commit-to-working-towards-coal-phase-out/ (accessed 11 August 2022).

Christina, B. (2022), "Indonesia runs road test for biodiesel with 40% palm oil", Reuters, https://www.reuters.com/business/sustainable-business/indonesia-runs-road-test-biodiesel-with-40-palm-oil-2022-07-27/ (accessed 23 August 2022).

Climate Watch (2021), "NDC Enhancement Tracker", https://www.climatewatchdata.org/2020-ndc-tracker (accessed 10 August 2022).

Commonwealth of Massachusetts (2022), "Clean Peak Energy Standard", Mass.gov, https://www.mass.gov/clean-peak-energy-standard (accessed 1 September 2022).

COP26 (2022), "Six-Month Update on Progress in Advancing the Just Energy Transition Partnership (JETP)", UN Climate Change Conference (COP26) at the SEC – Glasgow 2021, https://ukcop26.org/six-month-update-on-progress-in-advancing-the-just-energy-transition-partnership-jetp/ (accessed 1 September 2022).

Daily News Egypt (2022), "European countries turn back to coal as sanctions on Russian energy backfire", https://dailynewsegypt.com/2022/06/23/european-countries-turn-back-to-coal-as-sanctions-on-russian-energy-backfire/ (accessed 20 September 2022).

ECREEE (2017), Plano De Ação Nacional No Sector Das Energias Renováveis (Paner) Da Guiné-Bissau, www.ecowrex.org/system/files/web_plano_de_acao_nacional_optimized.pdf.

Energy Monitor (2022), "What does including plug-in hybrids mean for Germany's EV target?", Energy Monitor, https://www.energymonitor.ai/tech/electrification/what-does-including-plug-in-hybrids-mean-for-germanys-electric-vehicle-target (accessed 11 August 2022).

Energy Tracker Asia (2022a), "Net-Zero Companies: Vague Pledges Lead to Greenwashing", https://energytracker.asia/net-zero-companies-vague-pledges-lead-to-greenwashing/ (accessed 20 September 2022).

Energy Tracker Asia (2022b), "Vietnam Coal Pledge at COP26 - A New PDP8 and Net-Zero by 2050", https://energytracker.asia/vietnam-coal-cop26/ (accessed 20 September 2022).

ESMAP (2020), The State of Access to Modern Energy Cooking Services, World Bank Group, Washington, D.C., https://www.esmap.org/the-state-of-access-to-modern-energy-cooking-services (accessed 30 January 2022).

EURACTIV Press Release Site (n.d.), "Fine Member States that fail to meet national emission reduction targets, says Environment Committee", EURACTIV PR, https://pr.euractiv.com/pr/fine-member-states-fail-meet-national-emission-reduction-targets-says-environment-committee-88351 (accessed 2 September 2022).

Europe Beyond Coal (2022), "Coal Exit Timeline", Europe Beyond Coal, https://beyond-coal.eu/coal-exit-timeline/ (accessed 11 August 2022).

European Commission (2022a), "High volatility and geopolitical tensions impact electricity and gas market developments in Q1 2022", https://ec.europa.eu/info/news/high-volatility-and-geopolitical-tensions-impact-electricity-and-gas-market-developments-q1-2022-2022-jul-08_en (accessed 19 August 2022).

European Commission (2022b), "REPowerEU", European Commission – European Commission, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131 (accessed 18 August 2022).

European Commission (2022c), "Renewable energy targets", https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-targets_en (accessed 3 September 2022).

Fisher, J. (2022), "EU reveals its plans to stop using Russian gas", BBC News, www.bbc.com/news/science-environment-61497315.

Fitch Solutions (2022), "EU Energy Policy Reform To Shake Up The Continental Renewable Sector And Its Supply Chains", http://www.fitchsolutions.com/power/eu-energy-policy-reform-shake-continental-renewable-sector-and-its-supply-chains-11-07-2022 (accessed 20 August 2022).

France24 (2022), "Europe's electricity prices hit record high as Russian supply cuts begin to bite", France24, www.france24.com/en/economy/20220826-europe-s-electricity-prices-hit-record-high-as-supply-cuts-begin-to-bite.

G7 (2022), G7 Leaders' Communiqué, www.g7germany.de/resource/blob/974430/2062292/9c213e6b4b36ed1bd687e82480040399/2022-07-14-leaders-communique-data.pdf.

Government of Canada (2021), "Canada and the world move closer to powering past coal with more climate ambition at COP26", news release, , https://www.canada.ca/en/environment-climate-change/news/2021/11/canada-and-the-world-move-closer-to-powering-past-coal-with-more-climate-ambition-at-cop26.html (accessed 22 August 2022).

Government of the United Kingdom (2020a), Powering our Net Zero Future: Energy White Paper, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945899/201216_BEIS_EWP_Command_Paper_Accessible.pdf.

Government of the United Kingdom (2020b), The Ten Point Plan for a Green Industrial Revolution, www.assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf.

Government of Zimbabwe (2020), Biofuels Policy of Zimbabwe, p. 32.

howindialives.com (2022), "The rooftop eclipse on India's solar ambitions", mint, https://www.livemint.com/industry/the-rooftop-burn-in-india-s-100-gw-solar-target-11650365117161.html (accessed 1 September 2022).

Hu Min (2022), "Can China's 14th 5-year-plan for Renewable Energy deliver an early emissions peak before 2030?", Energy Post, https://energypost.eu/can-chinas-14th-5-year-plan-for-renewable-energy-deliver-an-early-emissions-peak-before-2030/ (accessed 2 September 2022).

IEA (International Energy Agency) (2022), Renewable Energy Market Update – May 2022 – Analysis, https://www.iea.org/reports/renewable-energy-market-update-may-2022 (accessed 15 August 2022).

IEA (2021), "COP26 climate pledges could help limit global warming to 1.8 °C, but implementing them will be the key – Analysis", https://www.iea.org/commentaries/cop26-climate-pledges-could-help-limit-global-warming-to-1-8-c-but-implementing-them-will-be-the-key (accessed 23 August 2022).

IHS Markit (2022), "UK takes a couple of steps toward 50 GW of offshore wind by 2030 goal", https://cleanenergynews.ihsmarkit.com/research-analysis/uk-takes-a-couple-of-steps-toward-50-gw-of-offshore-wind-by-20.html (accessed 1 September 2022).

International Civil Aviation Organisation (2017), Renewable Energy for Aviation: Practical Applications to Achieve Carbon Reeuctions and Cost Savings, https://www.icao.int/environmental-protection/Documents/ICAO_UNDP_GEF_RenewableEnergyGuidance.pdf.

International Maritime Organisation (n.d.), "Initial IMO GHG Strategy", https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx (accessed 23 August 2022).

International Railway Journal (2019), "SNCF aims for zero emissions by 2035 - International Railway Journal", https://www.railjournal.com/news/sncf-aims-for-zero-emissions-by-2035/ (accessed 23 August 2022).

IRENA (forthcoming), Accelerating Hydrogen Deployment in G7: Recommendations for the Hydrogen Action Pact, International Renewable Energy Agency, Abu Dhabi.

IRENA (2022a), World Energy Transitions Outlook: 1.5°C Pathway, International Renewable Energy Agency, Abu Dhabi.

IRENA (2022b), "IRENA Renewable Energy Targets Database", International Renewable Energy Agency, Abu Dhabi.

IRENA (2022c), Bioenergy for the Transition: Ensuring Sustainability and Overcoming Barriers, International Renewable Energy Agency, Abu Dhabi.

IRENA (2022d), "Ecuador Energy Profile", International Renewable Energy Agency, Abu Dhabi, www.irena.org/IRENADocuments/Statistical_Profiles/South%20America/Ecuador_South%20America_RE_SP.pdf.

IRENA (2022e), Geopolitics of the Energy Transformation: The hydrogen factor, International Renewable Energy Agency, Abu Dhabi.

IRENA (2022f), Green Hydrogen for Industry: A Guide to Policy Making, International Renewable Energy Agency, Abu Dhabi.

IRENA (2022g), Renewable Power Generation Costs in 2021, International Renewable Energy Agency, Abu Dhabi.

IRENA (2022h), Renewable Capacity Statistics 2022, International Renewable Energy Agency, Abu Dhabi.

IRENA (2021), Green Hydrogen Supply: A Guide to Policy Making, International Renewable Energy Agency, Abu Dhabi.

IRENA (2019a), Renewable Energy Auctions: Status and trends beyond price, International Renewable Energy Agency, Abu Dhabi.

IRENA (2019b), Renewable Energy Market Analysis: Southeast Europe, International Renewable Energy Agency, Abu Dhabi.

IRENA (2016), Capacity Needs Assessment for Renewable Energy Statistics, International Renewable Energy Agency, Abu Dhabi.

IRENA (2015), Renewable Energy Target Setting, International Renewable Energy Agency, Abu Dhabi.

IRENA and AfDB (2022), Renewable Energy Market Analysis: Africa and its Regions, https://www.irena.org/publications/2022/Jan/Renewable-Energy-Market-Analysis-Africa (accessed 18 August 2022).

IRENA, IEA and REN21 (2020), "Renewable Energy Policies in a Time of Transition: Heating and Cooling", /publications/2020/Nov/Renewable-Energy-Policies-in-a-Time-of-Transition-Heating-and-Cooling, https://www.irena.org/publications/2020/Nov/Renewable-Energy-Policies-in-a-Time-of-Transition-Heating-and-Cooling (accessed 3 September 2022).

IRENA *et al.* (2022), Tracking SDG 7: The Energy Progress Report 2022,, https://www.irena.org/publications/2022/Jun/Tracking-SDG-7-2022 (accessed 10 August 2022).

Jacobs, D. (2014), "Policy invention as evolutionary tinkering and codification: the emergence of feed-in tariffs for renewable electricity", Environmental Politics, Vol. 23/5, pp. 755–73, Routledge, https://doi.org/10.1080/09644016.2014.923627

Moreno, A. (n.d.), "The United States' Clean Energy Goals", www.renewable-ei.org/pdfdownload/activities/01_Key_AlejandroMoreno.pdf.

National Centers for Environmental Information (2022), July 2022 Global Climate Report, https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202207#:~:text=The%20July%202022%20global%20surface,have%20all%20occurred%20since%202016.

Net Zero Tracker (2022), Net Zero Tracker, https://www.zerotracker.net/.

New Zealand *et al.* (2022), "Te hau marohi ki anamata: Towards a productive, sustainable and inclusive economy: Aotearoa New Zealand's first emissions reduction plan", https://environment.govt.nz/assets/publications/Aotearoa-New-Zealands-first-emissions-reduction-plan.pdf (accessed 22 August 2022).

Our World in Data (2022), "Share of electricity production from coal", https://ourworldindata.org/grapher/share-electricity-coal (accessed 20 September 2022).

Owusu-Mante, S. (2020), "South Africa's 2019 IRP Renewable Energy Targets", Climate Policy Lab, https://www.climatepolicylab.org/communityvoices/2020/5/13/south-africas-2019-irp-renewable-energy-targets (accessed 1 September 2022).

Philippine Electricity Market Corporation (n.d.), Renewable Portfolio Standards, https://www.wesm.ph/market-development/re-market/renewable-portfolio-standards (accessed 2 September 2022).

RE100 (n.d.), "RE100 Members", RE100, https://www.there100.org/re100-members (accessed 17 August 2022).

REN21 (2022), "Renewables 2022: Global Status Report", https://www.ren21.net/wp-content/uploads/2019/05/GSR2022_Full_Report.pdf.

REN21 (2021a), Renewables 2021 Global Status Report, Renewable Energy Policy Network for the 21st Century Secretariat, Paris, https://www.ren21.net/wp-content/uploads/2019/05/GSR2021_Full_Report.pdf.

REN21 (2021b), Renewables in Cities: 2021 Global Status Report, Renewable Energy Policy Network for the 21st Century Secretariat, Paris, https://www.ren21.net/wp-content/uploads/2019/05/REC_2021_full-report_en.pdf.

Salesforce (2021), "Salesforce Achieves Net Zero Across Its Value Chain and 100% Renewable Energy", Salesforce News, https://www.salesforce.com/news/press-releases/2021/09/21/salesforce-achieves-net-zero-across-its-full-value-chain/ (accessed 17 August 2022).

Sarkaritel (2015), "PM sets targets for reducing oil imports for 2022 and 2030", Sarkaritel.com, https://www.sarkaritel.com/pm-sets-targets-for-reducing-oil-imports-for-2022-and-2030/ (accessed 31 August 2022).

SEforAll (2018), "Rwanda looks to market solutions to close clean cooking access gap", Sustainable Energy for All (SEforALL), https://www.seforall.org/news/rwanda-looks-to-market-solutions-to-close-clean-cooking-access-gap (accessed 11 August 2022).

Science X (2019), "China's Hainan province to end fossil fuel car sales in 2030", https://phys.org/news/2019-03-china-hainan-province-fossil-fuel.html (accessed 23 August 2022).

The Times of India (2022), "India to launch 20% ethanol-mixed gasoline: Why it's important and what are the challenges", https://timesofindia.indiatimes.com/business/india-business/india-to-launch-20-ethanol-mixed-gasoline-why-its-important-and-what-are-the-challenges/articleshow/91662300.cms (accessed 1 September 2022).

The White House (2021), "Fact Sheet: President Biden Announces Steps to Drive American Leadership Forward on Clean Cars and Trucks", The White House, https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/05/fact-sheet-president-biden-announces-steps-to-drive-american-leadership-forward-on-clean-cars-and-trucks/ (accessed 11 August 2022).

UK Government (2021), Net Zero Strategy: Build Back Greener, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf.

UNEP (2021), Addendum to the Emission Gap Report 2021, United Nations Environment Programme, https://wedocs.unep.org/bitstream/handle/20.500.11822/37350/AddEGR21.pdf.

UNFCCC (2021), "Global Coal to Clean Power Transition Statement", UN Climate Change Conference (COP26) at the SEC – Glasgow 2021, https://ukcop26.org/global-coal-to-clean-power-transition-statement/ (accessed 22 August 2022).

USDA and GAIN (2022), Vietnam Issues the National Strategy on Climate Change by 2050 and the Action Plan on Methane Emissions Reduction by 2030, https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Vietnam%20Issues%20the%20National%20Strategy%20on%20Climate%20Change%20by%202050%20and%20the%20Action%20Plan%20on%20Methane%20Emissions%20Reduction%20by%202030_Hanoi_Vietnam_VM2022-0059.pdf.

USDA (2018), "Indonesia Biofuels Annual 2018", USDA Foreign Agricultural Service, https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=biofuels%20annual_jakarta_indonesia_8-13-2018.pdf.

WBCSD and WRI, J. (n.d.), "The Greenhouse Gas Protocol", p. 116.

Wood, T. (2013), "Shock to the system: dealing with falling electricity demand", Grattan Institute, https://grattan.edu.au/report/shock-to-the-system-dealing-with-falling-electricity-demand/ (accessed 3 September 2022).

World Economic Forum (2022), "The Horn of Africa is facing an unprecedented drought. What is the world doing to help solve it?", https://www.weforum.org/agenda/2022/07/africa-drought-food-starvation/ (accessed 5 September 2022).

World Energy Council (2021), Hydrogen on the Horizon: Hydrogen demand and cost dynamics, https://www.worldenergy.org/publications/entry/working-paper-hydrogen-demand-and-cost-dynamics.

Renewable energy targets in 2022

A guide to design

IRENA
International Renewable Energy Agency