The First Global Stocktake

International Renewable Energy Agency (IRENA) Submission

May 2022

The International Renewable Energy Agency (IRENA) appreciates the invitation from the SBI and SBSTA Chairs to submit inputs related to the energy sector for the first Global Stocktake. IRENA is pleased to submit this contribution to the first Global Stocktake.

Mitigation guiding questions

1. **What is the collective progress in terms of the current implementation of, and ambition in, mitigation actions towards achieving the goals defined in Articles 2.1(a)[1] and 4.1[2] of the Paris Agreement?**

Despite some progress, the energy transition is far from being on track, and radical action is needed to change its current trajectory, as reflected in IRENA's *World Energy Transitions Outlook (WETO) 2022: 1.5°C Pathway*. Achieving the 2050 climate target depends on sufficient action by 2030, with the coming eight years being critical for accelerating the renewables-based transition. Any near-term shortfall in action will further reduce the chance of keeping the 1.5°C climate goal within reach.

Some important progress has been made in recent years to move the energy system away from fossil fuels, especially by adding renewables-based electricity capacity, which more than doubled over the past decade. According to IRENA's *Renewable Capacity Statistics 2022*, in 2021, the total installed capacity of renewable electricity reached 3 064 GW, generating around an estimated 8 000 terawatt-hours (TWh) of electricity. Renewable generation capacity increased by 257 GW (+9.1%) in 2021. Solar energy continued to lead capacity expansion, with an increase of 133 GW (+19%), followed by wind energy with 93 GW (+13%). Hydropower capacity increased by 19 GW (+2%) and bioenergy by 10 GW (+8%). Geothermal energy increased by 1.6 GW.

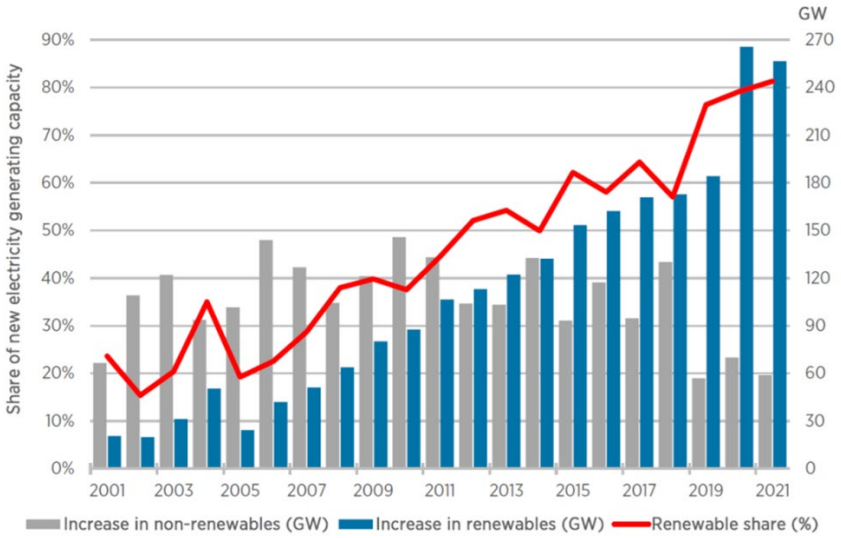
Solar and wind energy continued to dominate renewable capacity expansion, jointly accounting for 88% of all net renewable additions in 2021. Along with the higher growth of geothermal, this growth in wind and solar led to a high annual increase in renewable generating capacity.

Renewable share of annual power expansion[3]

[1] Article 2.1(a) of the Paris Agreement: "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change".

[2] Article 4.1 of the Paris Agreement: "In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty."

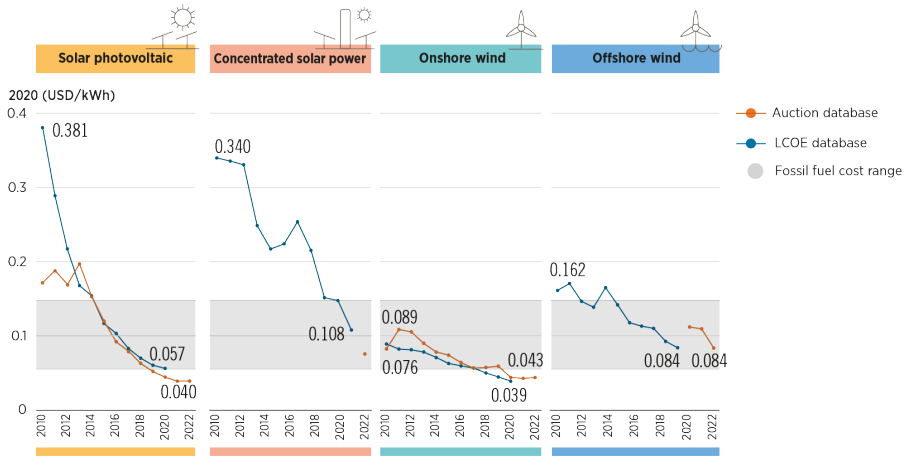
[3] IRENA (2022), *Renewable Energy Capacity Statistics 2022*, IRENA, Abu Dhabi.



According to IRENA analysis, renewable electricity capacity additions have been outpacing those of non-renewables since 2014, with solar PV and onshore wind power dominating the growth.

This trend can be attributed to, in part, the declining costs of renewable energy. According to IRENA's *Renewable Power Generation Costs in 2020* , Renewables-based electricity is now the cheapest power option in most regions. The global weighted-average levelised cost of electricity from newly commissioned utility-scale solar photovoltaic (PV) projects fell by 85% between 2010 and 2020. The corresponding cost reductions for concentrated solar power (CSP) were 68%; onshore wind, 56%; and offshore wind, 48%. As a result, renewables are already the default option for capacity additions in the power sector in almost all countries, and they dominate current investments. Solar and wind technologies have consolidated their dominance over time and, with the recent increase in fossil fuel prices, the economic outlook for renewable power is undeniably good.

Renewables-based electricity is already the cheapest power option in most regions[4]

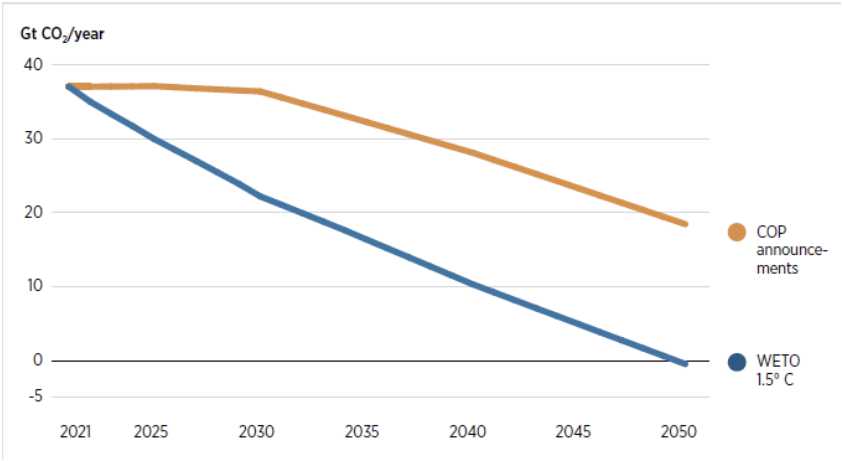


2. **Taking into account nationally determined contributions, long-term low GHG emission development strategies and relevant commitments and initiatives, what are the projected global GHG emissions, and the emission reductions still needed, in 2030 and 2050 in order to achieve the goals defined in Articles 2.1(a) and 4.1 of the Paris Agreement?**

[4] IRENA (2021), *Renewable Power Generation Costs in 2020*, IRENA, Abu Dhabi.

According to IRENA's *WETO*, to reach the 1.5°C target, CO2 emissions levels would need to fall to around 22.2 Gt in 2030, whereas the emissions levels under IRENA's COP26 announcement scenario are estimated at 37.5 Gt in 2030. The figure below shows two estimated future global CO2 emissions trajectories in gigatons based on (i) COP26 announcements[5] and (ii) the WETO 1.5°C Scenario. The area between the orange and blue lines denotes the remaining gap required to achieve the 1.5°C target.

CO2 emission trajectories based on COP announcements and the WETO 1.5° Scenario[6]



Despite the increased ambition expressed in COP26 announcements, current climate pledges are insufficient to reach net zero by mid-century, and countries must still raise their mitigation efforts significantly to be capable of decreasing emissions to around one-third of the current expected level by 2050, in order to achieve net zero emissions. If the climate commitments included in the COP26 announcements trajectory are implemented, CO2 emissions are projected to peak in 2025, due to a 0.2% increase in emissions from 2021, followed by a modest decline until 2030. Following that, a continuous declining trajectory into 2050 begins as a result of governments' announced long-term strategies and net zero targets. Although the mitigation ambition level was clearly raised at COP26, substantial additional efforts are required to bridge the gap towards the 1.5°C target, as represented by the WETO 1.5°C Scenario. The emissions gap in 2050 between the COP26 announcements trajectory and the 1.5°C Scenario is still 20 Gt.

NDCs must be translated into concrete actions, with specific targets (e.g. for renewable energy), and policies covering all end uses to attract the investment needed. Rapid acceleration is needed to achieve the Paris climate goals.

3. What efforts are being undertaken to plan, implement and accelerate mitigation action towards achieving the goals defined in Articles 2.1(a) and 4.1 of the Paris Agreement?

As of mid-November 2021, 91 parties – accounting for almost 64% of GHG emissions – had submitted NDCs that were more ambitious than the original ones. In addition, 131 countries revealed that they are considering net zero targets.

In November 2021, at COP26, countries attempted to solve a number of outstanding issues through the Glasgow Climate Pact. In the pact, countries are asked to further raise their ambition and return to the next COP with enhanced NDCs for the period to 2030. In addition, COP26 saw a number of important announcements, including a pledge by over 100 countries to reduce their methane emissions by 30% by 2030. Furthermore, more than 130 countries agreed to halt and then reverse deforestation. Other pledges

[5] The "COP26 announcements" 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), has been applied.

[6] IRENA (2022), *World Energy Transitions Outlook (WETO) 2022: 1.5°C Pathway*, IRENA, Abu Dhabi.

regarding coal phaseout and ending coal and gas exploitation by countries are welcome but as things stand, reaching the 1.5°C goal remains extremely challenging.

4. **How adequate and effective are the current mitigation efforts and support provided for mitigation action towards achieving Articles 2.1(a) and 4.1 of the Paris Agreement?**

Although COP26 announcements show increased political commitment to the energy transition, they are still not ambitious enough, as they are projected to reduce emissions by only approximately 20% by 2030 compared to business as usual before the first NDC. Moreover, for NDCs to be effective at driving investments in the various elements of the energy transition, they must be translated into concrete actions in the form of specific targets (e.g., for renewable energy) and policies covering all end uses and sectors.

Globally, the pledges made at COP26 were steps in the right direction to combat climate change, but not at the rate required to meet the 1.5°C target. Because of the gaps between present and required targets, there is a growing concern that the world is not adhering to the 1.5°C trajectory.

Policies for renewable energy are more widespread but they do not always reflect the level of ambition in NDCs, and they continue to focus on the power sector. As of 2021, almost all countries had set renewable energy targets at the national level. But mismatches still exist between renewable targets in NDCs and those in national energy plans for many countries. Moreover, 170 targets continue to focus on the power sector, with only 54 in the transport sector and 54 for renewable heating/cooling. In 2020, 145 countries had introduced policies to support renewables in the power sector, while only 70 countries had introduced national-level policies in transport and only 61 countries had introduced national renewable heating/cooling policies, mostly focused on buildings.

To meet the 1.5°C Scenario, installed renewables-based electricity generation capacity will have to more than triple by 2030 which will require annual capacity additions to ramp up significantly. However, 2021 saw an overall slow-down in the growth rate of new capacity additions, although renewables fared better than non-renewables. Policy makers need to urgently address the growing gap between current deployment and what is needed to get on the 1.5°C pathway.

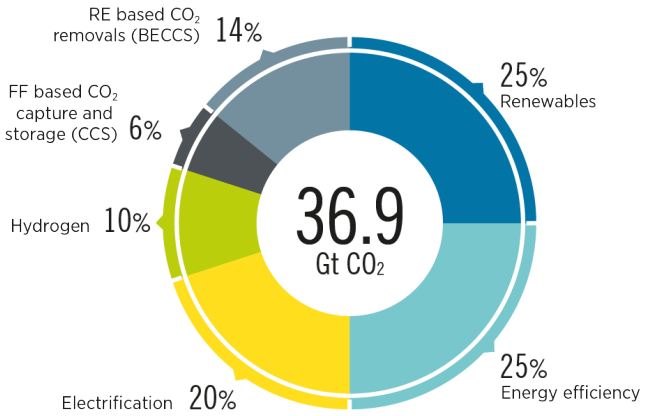
5. **In order to achieve the goals defined in Articles 2.1(a) and 4.1 of the Paris Agreement:**

a) **What further action is required?**

Overhauling the plans, policies, fiscal regimes and energy sector structures that impede progress is a political choice. With each passing day the cost of inaction pulls further ahead of the cost of action. Recent developments have demonstrated that high fossil fuel prices, in the absence of alternatives, result in energy poverty and loss of industrial competitiveness. But in the end, it is political will and resolve that will shape the transition path and determine whether it will lead to a more inclusive, equitable and stable world.

IRENA's 1.5°C pathway positions electrification and efficiency as key drivers of the energy transition, enabled by renewables, hydrogen, and sustainable biomass. This pathway, which requires a massive change in how societies produce and consume energy, would result in a cut of nearly 37 gigatonnes of annual CO2 emissions by 2050. These reductions can be achieved through 1) significant increases in generation and direct uses of renewables-based electricity; 2) substantial improvements in energy efficiency; 3) the electrification of end-use sectors (e.g. electric vehicles and heat pumps); 4) clean hydrogen and its derivatives; 5) bioenergy coupled with carbon capture and storage; and 6) last-mile use of carbon capture and storage.

Reducing emissions by 2050 through six technological avenues[7]



Phasing out fossil fuels assets should be done in tandem with measures to eliminate market distortions and incentivise energy-transition solutions. This will involve phasing out fossil fuel subsidies and ensuring that the full costs (environmental, health and social) of burning fossil fuels are reflected in their prices, thereby eliminating existing market distortions. Fiscal policies, including carbon pricing, should be implemented and adjusted to enhance the competitiveness of transition-related solutions. Such interventions should be accompanied by a careful assessment of their social and equity impact, particularly on low-income populations, to ensure that they do not exacerbate energy poverty or have other socially regressive effects.

To meet the IPCC goal, annual additions of renewable power capacity will have to be three times the current rate of deployment. Such an increase is possible if the right conditions are in place. Technology-specific targets and policies are especially needed to support less mature technologies, such as ocean energy and CSP.

Infrastructure upgrades, modernisation, and expansion are needed to increase system resilience and build flexibility for a diversified and interconnected system capable of accommodating high shares of variable renewable energy. The idea that fossil gas alone will be required to integrate higher shares of variable solar and wind is being fast overtaken by the improved economics of alternative sources of flexibility. But in addition to many technological solutions, markets will need to be adapted, both in liberalised and regulated systems. The current structure was developed during the fossil fuel era, to reduce operational costs of large, centralized power plants with differing fuel and opportunity costs. In the age of variable renewable energy, electricity should be procured considering the characteristics of decentralised generation technologies, with no fuel or opportunity cost.

Green hydrogen should move from niche to mainstream by 2030. In 2021, only 0.5 GW of electrolysers were installed; cumulative installed capacity needs to grow to some 350 GW by 2030. Hydrogen commands a great deal of policy attention, so the coming years should bring concrete actions to develop the global market and reduce costs. In this regard, the development of standards and guarantees of origin, along with support schemes to cover the cost gap for green solutions, will ensure that hydrogen offers a meaningful contribution to climate efforts in the long term. Modern bioenergy's contribution to meeting energy demand, including demand for feedstock, will have to triple by 2030. At the same time, the traditional use of biomass (such as firewood) needs to be replaced by clean cooking solutions. There is scope for biomass supply to expand, but the expansion will need to be managed carefully to ensure sustainability and minimise adverse outcomes. Policies that promote the wider use of bioenergy need to be coupled with strong, evidence-based sustainability procedures and regulations.

The majority of car sales by 2030 should be electric. Electromobility is a bright light of the energy transition progress, with EVs already at 8.3% of global car sales in 2021. This share will rise rapidly in the coming years. Annual battery manufacturing capacity is set to quadruple between 2021 and 2025, to approximately 2 500 GWh. However, EV growth ultimately depends on a massive ramp-up of recharging infrastructure in the coming decade, as well as financial and fiscal incentives to promote the uptake of EVs and charger

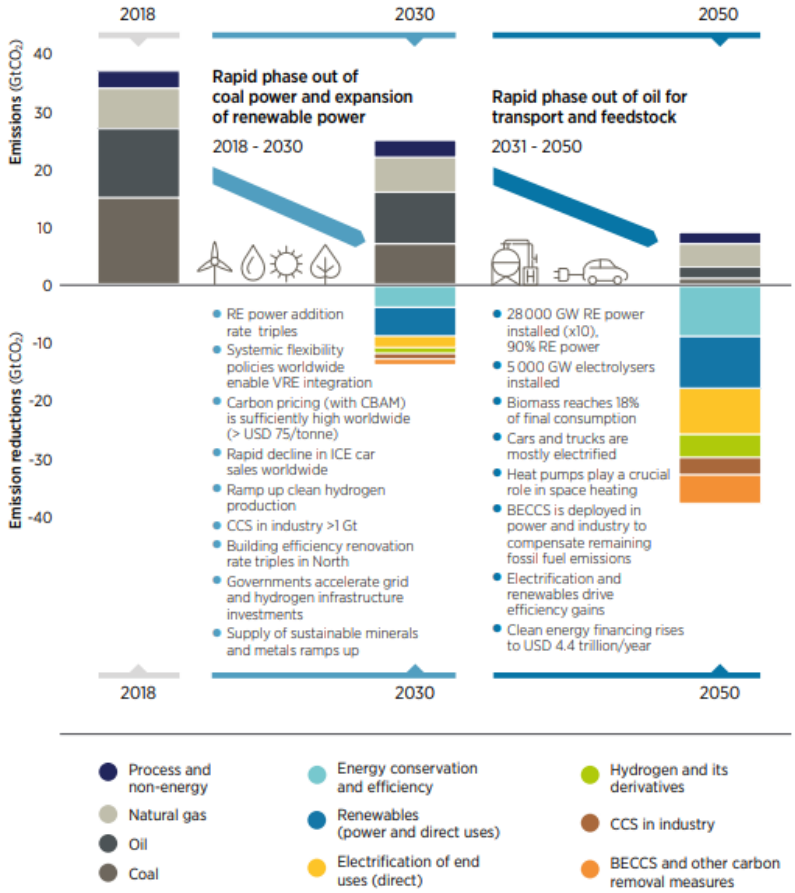
[7] IRENA (2022), *World Energy Transitions Outlook (WETO) 2022: 1.5°C Pathway*, IRENA, Abu Dhabi.

mandates, among others. In addition, greater efforts should be made to reduce travel demand and to promote a switch to public transport and cycling where possible.

All new buildings must be energy efficient, and renovation rates should be significantly increased. Improving the measures and regulations for buildings can make an immense difference in the near term. Decarbonising heating and cooling will require changes to building codes, energy performance standards for appliances, and mandates for renewables-based heating and cooling technologies, including solar water heaters, renewables-based heat pumps and geothermal heating. The effort to decarbonise heating and cooling will have to be sustained over the coming decades, but the measures just mentioned should be put in place without delay.

Increasing ambition in national energy plans and in the NDCs made under the 2015 Paris Climate Agreement must be firm enough to provide certainty of direction and guide investment strategies. The agreement on the Glasgow Climate Pact requested that parties revisit and strengthen the 2030 targets in their NDCs by the end of 2022 in line with the 1.5°C goal set out in the Paris Agreement. In addition to increasing ambition in their revised NDCs, Parties need to develop national implementation plans that include clearly defined targets, including efficiency, renewables and end uses.

Evolution of emission in accordance with the deployment of technical avenues, 2018-2050



b) **What are the barriers and challenges, and how can they be addressed at national, regional and international levels?**

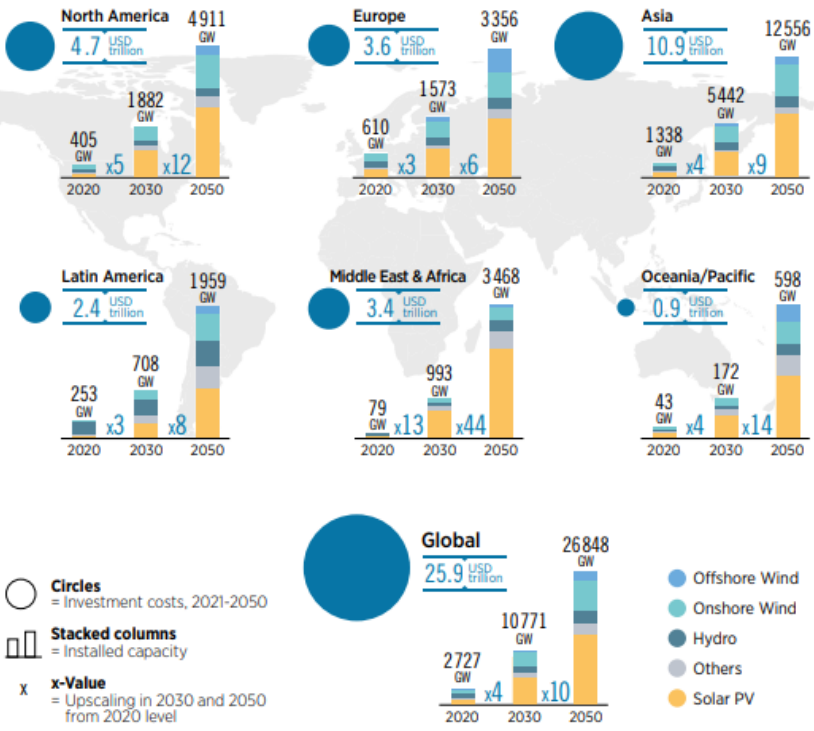
Short-term interventions to ameliorate immediate challenges must be accompanied by a steadfast focus on a successful energy transition in the medium and long term. Governments today shoulder the challenging task of tackling seemingly opposing agendas of energy security, resilience, and affordable energy for all. In the face of uncertainty, policy makers must be guided by the overarching goals of arresting climate change

and ensuring sustainable development. Any other approach, notably investing in new fossil fuel infrastructure, will only perpetuate the existing risks and raise the long-established threats of climate change

The majority of the developing world still faces great challenges in mobilising financing for critically needed energy projects ranging from electrifying health clinics to powering industry and development. These challenges were prominent even before the pandemic but subsequently, the fiscal space for recovery and sustainable development efforts became further constrained by additional obstacles to access financing, limited public and private investments and continuing debt service obligations.

All types of renewable power generation capacity must be scaled up in all regions to meet the 1.5°C target, as per the figure below. Asia, North America, and Europe will account for more than 80% of installations by 2030. Asia needs to scale up four times to reach more than 5 400 GW of renewable capacity by 2030, while North America and Europe will have to ramp up installations by around five-fold and three-fold, respectively. The scaling factors for the Middle East and Africa are even greater.

Regional distribution of total installed capacity (GW) in 2020, 2030, 2050 and cumulative investments (USD trillion) of renewables for power generation in the 1.5°C Scenario across regions, 2021-2050[8]



A net zero carbon future by 2050 is a daunting challenge, but IRENA's analysis indicates that it is feasible. Achieving it will require a massive ramp-up of efforts on seven fronts:

1. The rate of decline in energy intensity must move from the 1.2% recorded in recent years to 3%. Here, renewable power, electrification and circular economy principles have key roles to play, as do conventional energy efficiency technologies.
2. Annual growth in renewable energy's share in global primary energy production needs to accelerate eight-fold from its share in recent years.
3. Renewable power generation capacity must grow from over 2 800 GW today to 27 500 GW by 2050, or 840 GW per year and a four-fold increase in the annual capacity additions recorded in recent years.

[8] IRENA (2022), *World Energy Transitions Outlook (WETO) 2022: 1.5°C Pathway*, IRENA, Abu Dhabi.

4. Electric vehicle sales must grow from 4% of all vehicle sales today to 100%, with the stock of electric vehicles growing from 7 million in 2020 to 1.8 billion in 2050.
5. Hydrogen demand must increase from 120 Mt to 614 Mt in 2050, a five-fold increase. The share of clean hydrogen in overall demand needs to grow from 2% to 100%. Two-thirds of demand would be met by green hydrogen; one-third by blue. Meeting that goal will require the addition of 160 GW of electrolysers each year between now and 2050, from the 2020 base of 0.3 GW of installed capacity.
6. The total primary supply of biomass needed to achieve net zero emissions by 2050 would be just over 150 EJ, a near tripling of primary biomass use in 2018. Based on a detailed assessment of the potential supply of sustainable biomass, this appears feasible.
7. CCS must grow from 0.04 Gt captured in 2020 to 7-8 Gt in 2050, with bioenergy with CCS (BECCS) accounting for half for the total amount captured and stored.

All of these challenging steps must be put in place simultaneously in order to stay within the globe's carbon budget. Such a profound transition entails accelerating the scale of energy investments – starting today – and diverting investments away from fossil fuels towards energy transition technologies such as renewables, energy efficiency and electrification of end uses – plus associated infrastructure.

c) What are the opportunities, good practices, lessons learned and success stories?

IRENA works to support countries' sustainable and just energy transitions. Specific country-level activities include renewable energy roadmaps (REmaps)[9] and Renewable Resource Assessments (RRAs),[10] among others. IRENA also provides a platform for discussion and sharing of best practices among its Members, private sector, civil society, academia, and others in Collaborative Frameworks[11]. IRENA also hosts initiatives that work towards its mission to support energy transitions, such as the Global Geothermal Alliance and SIDS Lighthouses, among others.

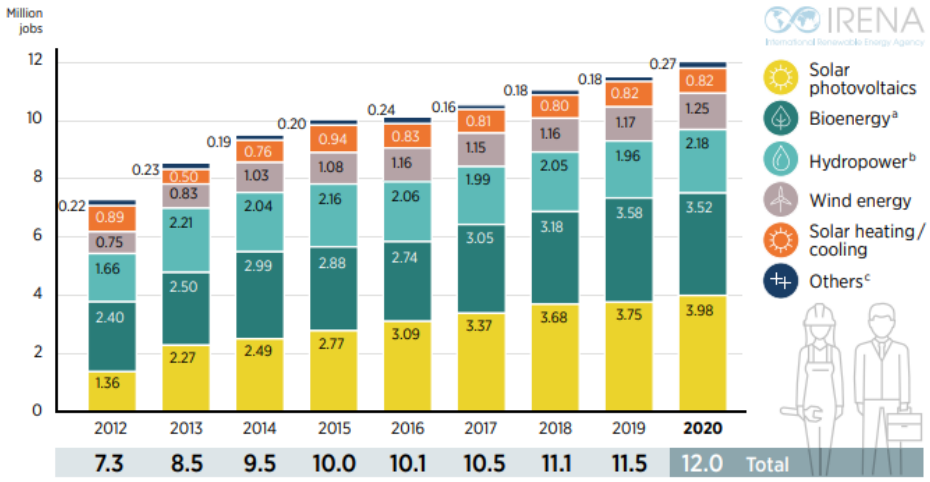
IRENA also provides data and analysis on a global scale to highlight the opportunities associated with energy transitions. IRENA has been analysing renewable energy employment worldwide since 2013, with an annual review highlighting the trends of the previous year, *Renewable Energy and Jobs*. The 2021 edition showed that renewable energy employment increased from 7.3 million in 2012, when IRENA began assessing employment trends worldwide, to 12 million in 2020. Solar PV leads the field and accounts today for some 4 million jobs, providing power from large scale installations feeding into the grid as well as from small, off-grid applications which enable much-needed access to electricity to previously remote and energy-poor communities.

[9] IRENA's REmap programme determines the potential for countries, regions and the world to scale up renewables. REmap assesses renewable energy potential assembled from the bottom-up, starting with country analyses done in collaboration with country experts, and then aggregating these results to arrive at a global picture.

[10] The Renewables Readiness Assessment is a comprehensive tool for assessing the suitability of conditions in different countries for the development and deployment of renewable energy, along with the actions required to improve those conditions. Designed and refined by IRENA since 2011, the RRA is a country-initiated process that identifies short- and medium-term actions for the rapid up-scaling of renewables.

[11] The Collaborative Frameworks will serve as multi-stakeholder platforms for co-operation and co-ordinated action, bringing public, private, intergovernmental and non-governmental actors together to support and accelerate the global energy transformation, feeding into the on-going work of the Agency. In response to the Members' request, IRENA has established Collaborative Frameworks on Hydropower, Green Hydrogen, Geopolitics, Offshore Renewables/Oceans, Enhancing Dialogue on High Shares of Renewables in Energy Systems and Just and Inclusive Energy Transitions, which are serving as effective vehicles for dialogue, peer-to-peer collaboration and exchange of knowledge.

Global renewable energy employment by technology, 2012-20[12]



Moving toward a more diverse, inclusive workforce therefore represents a tremendous opportunity for renewable energy.

Adaptation guiding questions

6. **What is the collective progress in terms of the current implementation of, and ambition in, adaptation actions towards achieving the goals defined in Articles 2.1(b)[13] and 7.1[14] of the Paris Agreement?**

One bright spot in 2020–2021 was the resilience of renewable power generation supply chains and record growth in new deployment. There was no disruption to the trend of continued cost declines for solar and wind power in 2020. Tight supply chains in 2021 were driven by a range of factors, including higher commodity prices, and led to higher solar photovoltaic (PV) module and wind turbine prices. The impact on 2021 costs has yet to be fully assessed, but it may not have been significant. This may not be the case for 2022, however, as many projects deployed in 2022 will have contracted for equipment in 2021. In view of recent fossil fuel price trends, renewable power prices have become more competitive in relative terms. Renewable power generation technologies today are typically the cheapest sources of new electricity generation. In 2020, a total of 162 GW, or 62% of the total new renewable power generation capacity added globally, had electricity costs lower than the cheapest source of new fossil fuel-fired capacity. Since 2010, globally, a cumulative total of 644 GW of renewable power generation capacity has been added with estimated costs lower than the cheapest fossil fuel-fired option.

Renewable energy can significantly contribute to climate change adaptation and create opportunities for innovative practices to address climate change. Renewables-based adaptation solutions promote mitigation and reinforce adaptation efforts synchronously across many sectors. As a versatile energy resource, renewables can serve a broad range of adaptation needs and provide benefits that other resources cannot deliver.

7. **What efforts are being undertaken to plan, implement and accelerate adaptation action towards achieving the goals defined in Articles 2.1 (b) and 7.1 of the Paris Agreement and**

[12] IRENA (2022), *Renewable Energy and Jobs - Annual Review 2021*, IRENA, Abu Dhabi.
[13] Article 2.1(b) of the Paris Agreement: "Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production". [4] Article 7.1 of the Paris Agreement: "Parties hereby establish the global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2".

with a view to recognizing the adaptation efforts of developing country Parties, what efforts have been undertaken by these Parties towards achieving these goals?

According to IRENA's *Bracing for Climate Impact: Renewables as a climate change adaptation strategy*, climate finance provided and mobilised for adaptation activities has significantly increased, rising to USD 16.8 billion in 2018 and accounting for 21% of total climate finance, up from 17% in 2016. However, a considerable amount of adaptation finance remains untapped, and renewables-based adaptation could be a prime candidate for these funding opportunities. For instance, the Green Climate Fund has been mandated since 2014 to deliver half its portfolio to adaptation projects, and in 2019 the World Bank announced it would boost its adaptation financing to USD 50 billion by 2025, ensuring that over half its climate finance will go to adaptation. Projects involving renewable energy for adaptation are gaining ground: they already compose around 42% and 60% of projects for adaptation in the financial aid of the Adaptation Fund and the Green Climate Fund, respectively.

8. **How adequate and effective are the current adaptation efforts and the support provided for adaptation towards achieving the goals defined in Articles 2.1(b) and 7.1 of the Paris Agreement?**[14]

According to IRENA's *Bracing for Climate Impact: Renewables as a climate change adaptation strategy*, many countries recognise renewable energy as a synergistic mitigation-adaptation measure and incorporate it into their NDCs and long-term development strategies under the Paris Agreement. Of the 190 countries that had submitted NDCs by the end of 2020, 64 (34%) had incorporated renewable energy into the adaptation component. Although most of those countries describe renewable energy as an adaptation measure for the energy sector (diversifying energy mix and increasing the resilience of the sector), its use for adaptation in other sectors, such as water, food and agriculture, is also frequently mentioned. Many countries, particularly small island developing states and countries in the Middle East and North Africa region, use (or plan to use) renewables in the water sector to power desalination and wastewater treatment technologies and thereby combat climate change-induced water security concerns. Some countries' long-term development strategies include newer technologies, such as renewable-powered agro-photovoltaics and vertical farming, as adaptation measures for food security. Several countries plan to preserve forest by increasing access to renewable energy and eliminating the need to use wood for heating and cooking. Enhancing the adaptation components of NDCs will become a more urgent issue for countries in their upcoming 2025/26 NDC revisions.

9. **How can the implementation of adaptation action towards achieving the goals defined in Articles 2.1(b) and 7.1 of the Paris Agreement be enhanced, taking into account the adaptation communication referred to in paragraph 10 of the Paris Agreement?**[15]

10. **In order to achieve the goals defined in Articles 2.1(b) and 7.1 of the Paris Agreement:**

    a) **What further action is required?**

A holistic approach needs to be taken to integrate renewable energy into the climate change adaptation process at all levels of upstream and downstream decision making. This integrated and holistic approach would help identify the contribution of renewable energy to adaptation, promote synergies with mitigation and sustainable development, and maximise the overall benefits of renewable energy while minimising trade-offs.

A clear framework provides a strong basis for climate adaptation; it is therefore critical that countries establish a clear climate rationale, based on the best available science, through which renewable energy technologies can be embedded in adaptation policies, programmes and projects. A cross-sector approach is essential, and a range of stakeholders should be engaged from the early stage to identify synergies, avoid conflict, decrease implementation costs, and significantly improve project success.

[14] Article 7.14 (c) of the Paris Agreement.
[15] Article 7.14 (b) of the Paris Agreement; Decision 11/CMA.1, paragraph 9.

Renewable energy options must be integrated into short- and mid- to long-term decision-making and planning processes to mainstream, structure and scale up renewable energy adaptation projects. This integration can be best realised by (i) creating an enabling environment for private investors to catalyse private financing and supplement public spending, (ii) ensuring the engagement of finance ministries in adaptation planning, and (iii) engaging international climate finance.

b) **What are the barriers and challenges, and how can they be overcome at national, regional and international levels?**

The vulnerability of renewable energy to natural disasters is a large challenge in renewable energy-based adaptation. The technology being used must be resilient to climate change effects. For instance, hydropower may not be effective in drought-prone regions, so it might be better to consider other renewable energy options. Climate change impacts can alter the expected benefits of hydro dams, so the design of water reservoirs for hydropower plants should account for climate variability. Variable renewable energy is also exposed to natural disaster risks that may aggravate supply intermittency. Disaster risk assessment must be conducted with care and then reflected in safety and land-use planning regulations.

c) **What are the opportunities, good practices, lessons learned and success stories?**

Distributed renewable energy solutions (technologies that provide power outside a central grid) can create a resilient energy system, and therefore support vital adaptation measures, for the most vulnerable communities. For instance, the residents of coastal or rural communities, who are most affected by climate change, often face the most difficulty in adapting to and recovering from its impacts. In these locations, distributed renewable energy solutions can ease exposure to climate change impacts by providing "green infrastructure" in indispensable sectors (e.g. water, food, waste treatment), allowing these services to be supplied even when faced with climate change impacts and natural disasters. Moreover, long-term access to reliable energy through distributed renewable energy solutions builds services, self-resilience and adaptive capacity in the local society and decreases its vulnerability to climate change risks – all without requiring huge upfront infrastructure investment.

Renewables can also deliver non-energy services that contribute to climate adaptation. This multifunctionality enables renewable energy technologies to provide additional forms of resilience to climate change. For instance, the multipurpose nature of hydropower and bioenergy technologies is well recognised, and their non-energy services have been used in real adaptation projects, such as solar shading (e.g. honey production under solar panels to improve food security) to reduce evaporation on agricultural land; use of byproducts from biogas facilities to make organic fertiliser; and water harvesting from hydropower dams. Well-designed and integrated climate adaptation policies should take advantage of the energy and non-energy services that renewable energy technologies provide.

Finance flows and means of implementation guiding questions

11. **What is the collective progress in terms of the current implementation of, and ambition in, making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development towards to achieving the goal defined in Article 2.1 (c) of the Paris Agreement?**[16]

Meeting international climate objectives, as set by the Paris Agreement, will require an accelerated transformation of the global energy system, encompassing not only renewable energy, but also renewable energy systems integration and enabling technologies, energy efficiency measures and the increased electrification of end-uses (e.g., heating and transport) with renewables-based power. Most importantly, it will require a phase-out of investments into fossil fuels.

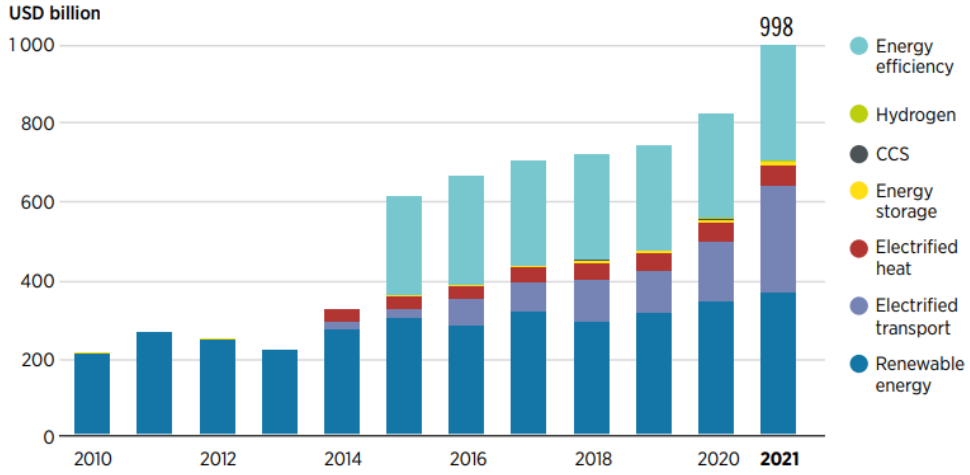
The combined efforts of a variety of stakeholders, including policy makers, capital market players, issuers and investors, are needed to shift investments away from fossil fuels and activate all available sources of capital in the renewable energy industry.

[16] Article 2.1(c) of the Paris Agreement: "Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development".

According to IRENA's *Global Landscape of Renewable Energy Finance 2020*, the landscape of renewable energy finance has evolved significantly in the past few years. In support of recent record-setting levels of capacity additions in wind and solar technologies, finance for renewable energy represented 63% of total climate mitigation finance in 2017-2018.

In 2021, energy transition-related investment was just shy of USD 1 trillion, a 21% increase from the year before. Renewable energy was still the largest sector as it attracted USD 366 billion (excluding large hydropower), up 77% from the previous year. Electrified transport saw the largest increase in 2021, with USD 273 billion invested in EVs and associated charging infrastructure, up 77% from 2020. Electrified heat investments continued to increase, albeit not at the same pace as electrified transport, attracting USD 53 billion. Hydrogen attracted USD 2 billion. In addition to these direct investments in the deployment of technologies relevant to the energy transition, another USD 165 billion was invested in climate technology companies, mostly focused on the energy and transport sectors, and is likely to be used in the coming years to scale up operations related to the energy transition.

Global investment in energy transition technologies, 2010-2021[17]



These trends clearly show ongoing disparities in countries' ability to attract investments. About 84% of global investments were focused in China, Europe, the United States, Japan and India, whereas many countries with reduced public spending struggled to attract investments. These trends have become more pronounced as COVID-19 recovery packages were introduced in advanced economies best positioned to mobilise public financing, attracting record-high investments.

12. **What is the collective progress in terms of the implementation of, and ambition in, the provision and mobilization of scaled-up financial resources from a wide variety of sources, instruments and channels towards achieving the goals defined in Article 9 of the Paris Agreement, noting the significant role of public funds, and aiming to achieve a balance between finance for adaptation and mitigation?**[18]

International co-operation and the international flow of public financing will be more critical than ever to achieve a global energy transition that is just and inclusive. In 2019, international public financial flows to developing countries in support of renewable energy, for example, amounted to less than USD 11 billion, which is equivalent to less than 3.5% of global investments in renewables. Top funding countries include China, France, Germany and the United States, together with the EU institutions, multilateral development banks, and climate funds such as the Climate Investment Funds and Green Climate Fund. The majority of this funding went to Sub-Saharan Africa (about 37%, or USD 4 billion), Central and Southern Asia (19%, USD 2.1 billion), Western Asia and Northern Africa (17%, USD 1.8 billion), and Latin America and the Caribbean (14%, or USD 1.5 billion). The Oceania region attracted the smallest share of investment – USD

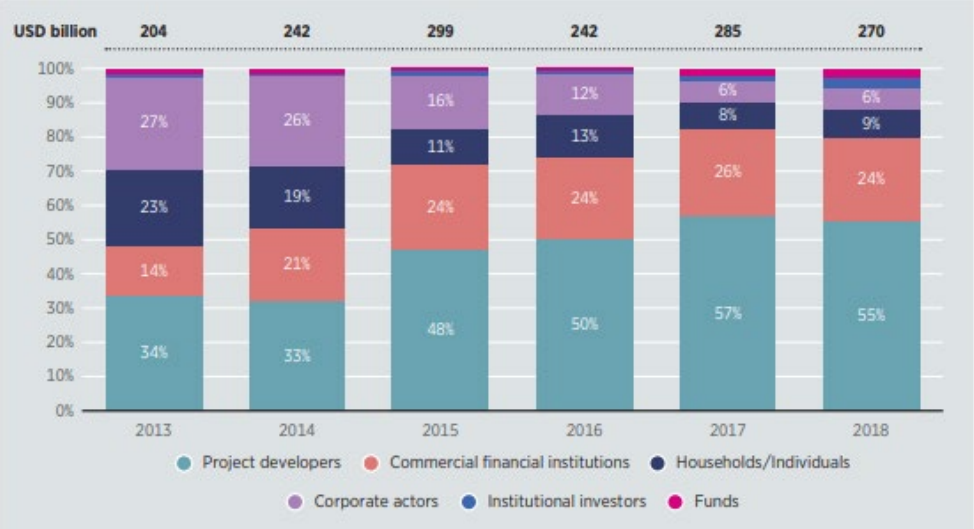
[17] IRENA (2021), *World Energy Transitions Outlook (WETO) 2021: 1.5°C Pathway*, IRENA, Abu Dhabi.
[18] Article 9.3 and 9.4 of the Paris Agreement; Decision 19/CMA.1, paragraph 36(d).

132 million. In emerging markets, international financial flows will continue to play an important role, as direct investments in energy transition assets and in attracting private capital through policies and measures.

IRENA's 1.5°C Scenario will require investment of USD 5.7 trillion per year until 2030, including a redirection of investments of USD 0.7 trillion per year from fossil fuels to energy transition technologies. While most of the additional capital is expected to come from the private sector (debt and equity raised from capital markets and private investors), public financing will still play a crucial role in facilitating the transition, as markets alone are not likely to move rapidly enough. Public funding will have to almost double to catalyse private finance and ensure that the energy transition unfolds in a just and inclusive way. Public funds are also needed to create an enabling environment for the transition and to ensure 1) that it occurs fast enough to meet climate goals and 2) that it has the best possible socio-economic outcomes.

Private finance provided, on average, 86% of total investment for renewable energy projects between 2013 and 2018, equivalent to annual commitments of USD 257 billion. Public finance reached an average of USD 44 billion annually in the same period. Throughout 2013-2018, project developers continued to be the main actors within private finance, providing an average of 56% of total private finance in 2017-2018, mainly through balance sheet finance, either through debt or equity Commercial banks and investment banks represented, on average, 25% of total private finance in 2017-2018, often providing nonconcessional debt to mature technologies such as solar PV and onshore wind, as well as offshore wind. Institutional investors (including pension plans, insurance companies, sovereign wealth funds, endowments and foundations), provided, on average, only 2% of private direct investment in new renewable energy projects in 2017-2018.

Annual financial commitments in renewable energy by technology, 2013-2018[19]



13. **What is the collective progress in terms of the state of current implementation of, and ambition in, technology development and transfer towards achieving the vision defined in Article 10.1 of the Paris Agreement?[20] What is the state of cooperative action on technology development and transfer?**

Renewable energy technologies are developing globally at an unprecedented rate, with their costs, performance and potential changing year by year. The same applies to renewable energy enabling technologies, such as electric and thermal storage or grid systems. Technological innovation plays a key role in reducing costs, improving reliability, and making renewable energy available and accessible for various end-use applications. The innovation process encompasses generation technologies (e.g. solar modules,

[19] IRENA (2020), *Global Landscape of Renewable Energy Finance 2020*, IRENA, Abu Dhabi.

[20] Article 10.1 of the Paris Agreement: "Parties share a long-term vision on the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions." [10] Article 11.3 of the Paris Agreement.

micro-hydro turbines), balance-of-system components (e.g. inverters, electronic load controllers, smart meters), control systems, appliances (e.g. energy-efficient pumps, televisions, processing equipment) and enabling infrastructure (e.g. digital payments). Beyond technology, innovations in business models and market design play a critical role.

Systemic innovation must be promoted, not only in technology but also in market design, system planning and operation, and business models. One-size-fits-all solutions do not exist. The optimal strategy for each power system and the implementation of various innovations depends on the country context and system-specific variables. Across settings, smart electrification is the only way to move forward. Systemic innovation is the key to achieving the energy transformation.

According to IRENA's *Innovation landscape for a renewable-powered future*, priorities include making the needed technology available, defining the regulatory framework for sending the right signals to market players, accounting for innovations in the planning stage of the systems and enabling innovative business models emerge to capture the value added from smart electrification strategies.

14. **What is the collective progress in terms of the state of current implementation of, and ambition in, enhancing the capacity of developing country Parties to implement the Paris Agreement?[10] How effective has been the implementation of capacity-building efforts?**

Developing countries see the energy transition as a catalyst for alleviating poverty and spurring human development. Because it is widely acknowledged that fair emissions often surpass necessary global emission reductions, developing countries require special attention and support to leapfrog to climate consistent energy systems and reap the transition benefits. The beneficiaries of this pillar are selected based on climate equity and are those for which fair emissions are higher than mitigation emission requirements in 2030. This is consistent with literature regarding principles of carbon egalitarianism, which advocates for emissions reductions being stricter in developed countries and justifies monetary transfers from developed to developing countries as ODA flows.

IRENA provides capacity building and policy advice to countries to support the acceleration of their energy transitions. Specifically, IRENA supports developing countries in topics such as long-term energy planning, climate investment and financial flows in the energy sector, renewable energy targets and auctions, NDCs[21], power system flexibility, and ensuring all actors are participants in their respective energy transitions.

15. **In order to achieve the goal defined in Article 2.1(c) of the Paris Agreement as well as scale up the provision and mobilization of means of implementation (including finance, technology development and transfer and capacity-building), including in the short term, both from public and private sources, at the national and international levels to achieve the Paris Agreement goals:**

    a) **What further action is required?**

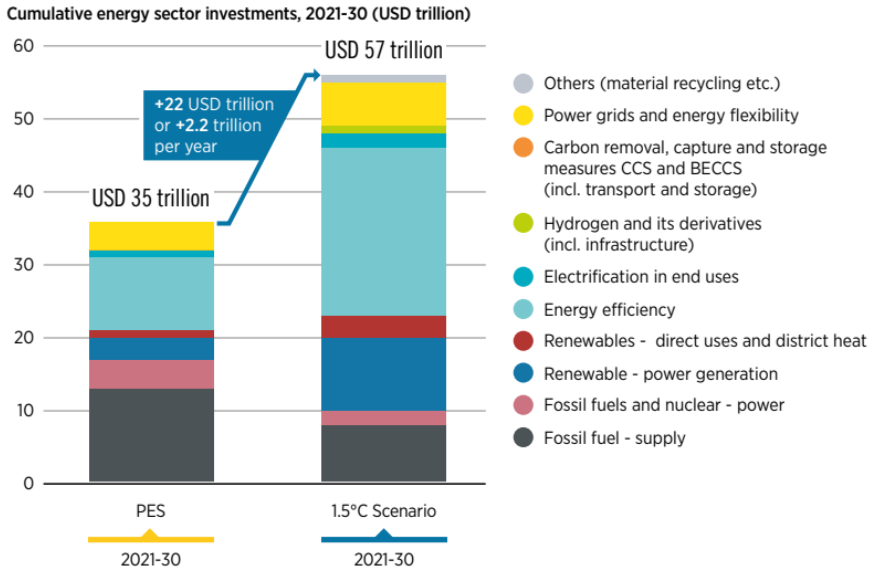
The 1.5°C Scenario requires additional investments of almost USD 2.2 trillion per year over IRENA's "Planned Energy Scenario" until 2030, plus the redirection of investments from fossil fuels towards energy transition technologies amounting to USD 0.7 trillion per year. As mentioned in IRENA's *WETO 2021*, energy transition-related investments amount to around 80% of total energy sector investments, namely, USD 47 trillion in cumulative terms between 2021 and 2030. In annual terms this translates to USD 4.7 trillion per year up till 2030 and USD 3.5 trillion per year from 2031 to 2050, figures that are six-fold and four-fold higher than the historical average of USD 0.824 trillion per year between 2017 to 2019. In 2021, global energy transformation investment fell short of the required USD 4.7 trillion. As a result, the 1.5°C Scenario demands spreading out the remaining required investment for 2021 across the decade.

A comprehensive set of policies will be needed to achieve the necessary deployment of climate friendly renewable technologies by 2030. Deployment policies must include structured procurement mechanisms (e.g. auctions, FITs) and financial and fiscal incentives to build markets, thus facilitating scale-up, reducing technology costs and increasing investment levels in line with the needs of the energy transition. Enabling

[21] https://www.irena.org/publications/2021/Nov/IRENA-Energy-Transition-Support-to-Strengthen-Climate-Action

policies include instruments to support access to finance, policies to phase out fossil fuels, and measures to eliminate market distortions that currently favour fossil fuel use. This will involve phasing out fossil fuel subsidies and changing fiscal systems to factor in the negative environmental, health and social costs of the fossil fuel-based energy system. Monetary and fiscal policies, including carbon pricing policies, will enhance the competitiveness of solutions that advance the transition. Such interventions should be accompanied by a careful assessment of the social and equity dimensions to ensure that the situation of low-income populations is not worsened but improved. Structural and just transition policies, along with the creation of strong institutions to ensure policy co-ordination and cohesion, are required to manage potential misalignments. A holistic global policy framework is needed to bring countries together to commit to a just transition and strengthen the international flow of finance, capacity and technologies.

Total investments by technology avenue: PES[22] and 1.5°C Scenario, 2021-2030[23]



b) What are the barriers and challenges and how can they be overcome at national, regional and international levels?

To realise investment and technology development potential, several market barriers need to be lowered. These include lack of awareness of the benefits of green bonds (and hence lack of investor demand); lack of regulatory clarity and mandates surrounding the green taxonomy and green certification, bond issuance and reporting on use of proceeds; and relatively high transaction costs. To lower these barriers, regulators can adopt issuance and certification standards aligned with climate targets such as those offered by the Climate Bonds Initiative. They can also provide economic incentives in co-operation with DFIs to fund demonstration issuances and offer grants to offset transaction costs. Policy makers can co-operate with green bond leaders in the financial industry to build financial skills needed to issue green bonds and other new instruments. Finally, policy makers can create green mandates for crucially important capital holders such as institutional investors, thereby ensuring steady demand for green financial instruments.

Public financing resources, although limited, can be crucial to reduce risks, overcome initial barriers, attract private investors and bring new markets to maturity. Annual investment of USD 45 billion in modern energy is required to achieve universal access by 2030. Lack of access to affordable finance remains one of the biggest challenges for off-grid renewable energy projects, both upstream for project developers and downstream for energy users. New financing approaches (e.g., results-based financing) and tools

[22] "Planned Energy Scenario (PES)" is the primary reference case for this study, providing a perspective on energy system developments based on.
[23] IRENA (2022), *World Energy Transitions Outlook (WETO) 2022: 1.5°C Pathway*, IRENA, Abu Dhabi.

(standardisation of project documentation and aggregation) are therefore needed to ensure improved access to capital and to reach the scale of investment needed to achieve universal energy access by 2030.

c) What are the opportunities, good practices, lessons learned and success stories?

IRENA supports the deployment of renewable energy projects by helping project developers secure financing more efficiently and supporting investors and lenders to build stronger project portfolios. The benefits of project facilitation include increasing financing flows towards renewable energy projects, strengthening the renewable energy project development base, enhancing the quality of renewable energy project proposals, linking renewable energy project stakeholders via hubs and networks and disseminating knowledge and information on bankable renewable energy projects.

Specifically, IRENA offers support through activities such as the Climate Investment Platform (CIP) and Energy Transition Accelerator Financing (ETAF) Platform to support renewable energy projects come to fruition. The CIP is a joint initiative of the International Renewable Energy Agency (IRENA), United Nations Development Programme (UNDP), and the Sustainable Energy for All (SEforALL), in collaboration with the Green Climate Fund (GCF). CIP's mandate is to increase capital mobilisation and RE impact investing in developing countries.

The ETAF Platform is an inclusive, multi-stakeholder climate finance solution managed by the International Renewable Energy Agency to advance the energy transition across the Agency's 166-strong membership. With anchor funding of USD400 million from the United Arab Emirates via the Abu Dhabi Fund for Development (ADFD), the Platform serves as the first global climate finance partnership from the Middle East to the world. ETAF aims to mobilise approximately USD 1 billion of capital by 2030 from various funding partners, investors, private sector, and donors.

Guiding questions related to efforts referred to in Decision 19/CMA.1, paragraph 6(b), that may be taken into account as appropriate, that:

Address the social and economic consequences and impacts of response measures:

16. **What is the collective progress in terms of the current implementation of, and ambition in, efforts made that address the social and economic consequences and impacts of response measures while implementing mitigation policies and actions towards the achievement of the Paris Agreement goals?**[24]

IRENA's socio-economic analysis shows that progressive policy and regulatory measures generate greater benefits from the energy transition. Globally and in most countries, higher socio-economic benefits are obtained under the pathway to 1.5°C than with current plans and policies. To support these positive outcomes, however, progressive policies and programmes will be essential. Their key impact is the significant improvement in the distribution of the socio-economic benefits of the transition across societies and geographies.

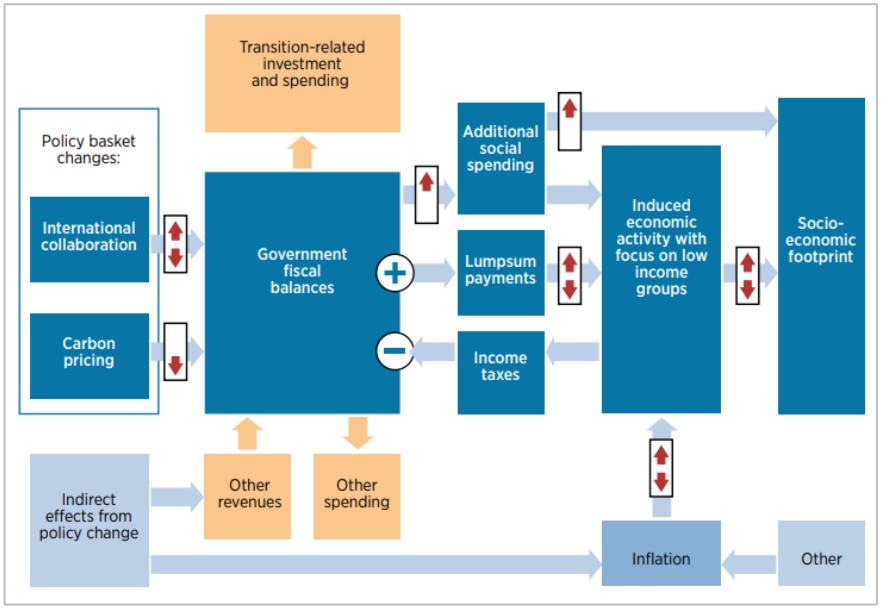
IRENA's Energy Transition Welfare Index shows that the 1.5°C pathway improves global welfare significantly. The Index, with its five dimensions, provides a holistic vision of the transition's socioeconomic impacts. The following insights deserve particular attention:

- Assessing the impact of policies on the socio-economic footprints of transition roadmaps conveys a better understanding of the lived experience of the transition. Policy makers should explore these impacts and adjust their plans to ensure maximum shared benefits of climate policies.
- Implementing more progressive fiscal and regulatory measures and programmes, both domestically and internationally, will temper the regressive impacts of carbon taxes while improving the distribution of transition benefits and burdens.
- Enabling a rapid transition that complies with climate goals requires political commitment to support higher levels of international co-operation. By 2030, international climate collaboration

[24] Article 4.15 of the Paris Agreement and Decision 19/CMA.1, paragraph 6(b)(i).

should dramatically increase from current levels. Introducing these higher levels of international co-operation and more progressive distributional policies will ensure a fair and just transition.

The socio-economic footprint: Policy baskets and government fiscal balances[25]



According to IRENA's *WETO*, by 2030, the 1.5°C-aligned energy transition promises the creation of close to 85 million additional energy transition-related jobs compared to 2019 and support a boost in global gross domestic product (GDP). The additional 26.5 million jobs in renewables and 58.3 million extra jobs in energy efficiency, power grids and flexibility, and hydrogen more than offset losses of 12 million jobs in the fossil fuel and nuclear industries. Meeting the human resource capacity necessary to fill these newly created jobs requires a scaling up of education and training programmes as well as measures aimed at building an inclusive and gender-balanced transition workforce. While global GDP is boosted under IRENA's 1.5°C pathway, the Agency's analysis reveals that regional and country-level variances will depend highly on policy and regulatory measures and international co-operative flows of financial assistance and knowledge.

Avert, minimize and address loss and damage associated with the adverse effects of climate change:

17. **What is the collective progress in terms of the current implementation of, and ambition in, efforts made to enhance understanding, action and support towards averting, minimizing and addressing loss and damage associated with the adverse effects of climate change?[26] What further action is required to strengthen these efforts? [27]**

According to IRENA's *NDCs and Renewable Energy Targets in 2021*, Least developed countries (LDCs) and small island developing states (SIDS) bear a disproportionate cost of climate change-related impacts, despite being home to a fraction of the world's population and contributing only around 7% of global GHG emissions. Over the last 50 years, about 69% of deaths due to climate-related disasters globally were in these two groups of countries, which also experienced the displacement of millions of people, loss and damage of physical and natural resources, and worsening inequality.

In light of these setbacks, these countries are increasingly capitalising on renewable energy sources to mitigate and adapt against their climate-induced vulnerabilities while ensuring energy security and sustainable socio-economic growth. Around 32 LDCs and 27 SIDS, representing a total of 55 parties,6

[25] IRENA (2022), *World Energy Transitions Outlook (WETO) 2022: 1.5°C Pathway*, IRENA, Abu Dhabi.
[26] Article 8 of the Paris Agreement and Decision 19/CMA.1, paragraph 6(b)(ii).
[27] Decision 19/CMA.1, paragraph 36(e).
Decision 19/CMA.1, paragraph 36(h).

have submitted new, updated or second NDCs since September 2020, more than 35 Parties submitted stronger pledges. About 44 Parties also included renewable energy targets.

Several mechanisms are in place to provide countries with the requisite financial and technical support to enhance NDC implementation. For example, the NDC Partnership – a coalition of over 100 countries and institutions including IRENA, several UN bodies and multilateral development banks (MDBs) – is supporting countries in NDC formulation, implementation, monitoring and/ or reporting. In collaboration with the NDC Partnership, UNDP's Climate Promise and through direct country support, IRENA is providing similar support to countries, placing renewable energy at the forefront.

Cross-cutting guiding questions

18. **How are fairness considerations, including equity, being reflected in Parties' NDCs?**[14]

A comprehensive set of cross-cutting, structural policies covering all technological avenues and just transition objectives is needed to achieve the necessary deployment levels by 2030. Increasing ambition in the NDCs and national energy plans under the Glasgow Climate Pact must provide certainty and guide investment strategies in line with 1.5°C.

In this context, IRENA supports countries in enhancing their NDCs through direct support and with partners, such as NDC Partnership and UNDP. Among other aspects, IRENA helps countries embed just transition aspects into their NDCs to ensure no one is left behind in energy transitions.

Recognising the need to embed equity and justice into the energy transition, IRENA established the Just and Inclusive Energy Transitions' collaborative framework to promote multi-stakeholder dialogue and foster international collaboration directed towards just and inclusive energy transitions.

19. **How is climate action respecting, promoting and considering Parties' respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity?**[28]

The global energy transition offers an unprecedented opportunity to transform the energy sector in all aspects. The transition towards a renewable, distributed, decarbonized energy system is creating an array of social and economic benefits, including growing employment. In the report, *Renewable Energy: A Gender Perspective*, IRENA estimates that the number of jobs in the sector could increase from 10.3 million in 2017 to nearly 29 million in 2050. The sector offers diverse opportunities along the value chain, requiring different skill sets and talents. A key pillar of the energy should be to ensure that the opportunities it creates are equally accessible, and the benefits it bestows, equitably distributed.

Adopting a gender perspective to renewable energy development is critically important to ensure that women's contributions – their skills and views – represent an integral part of the growing industry. Increased women's engagement expands the talent pool for the renewables sector. Meanwhile, greater gender diversity also brings substantial co-benefits. Studies suggest that women bring new perspectives to the workplace and improve collaboration, while increasing the number of qualified women in an organisation's leadership yields better performance overall. In the context of energy access, engaging women as active agents in deploying off-grid renewable energy solutions is known to improve sustainability and gender outcomes.

Renewable energy offers a range of unprecedented opportunities. With public policy support, women can garner a growing share of expanding employment in this young and dynamic sector. Because of its multi-disciplinary dimension, the renewable energy field exerts an appeal on women that the fossil fuel industry has lacked. This report found that women represent 32% of the fulltime employees of responding organisations – substantially higher than the 22% average in the global oil and gas industry. Still, in renewables, women's participation is much lower in science, technology, engineering and mathematics (STEM) jobs than in administrative jobs.

[28] Preamble of the Paris Agreement.

Gender balances in the energy sector workforce[29]

IRENA is continuing this work on gender and expanding to analyse gender balance in renewable energy technology sectors, such as *Wind energy: A gender perspective*. This report found that women represent only 21% of the wind energy workforce (based on survey responses), compared to 32% in renewables overall and 22% in traditional energy industries like oil and gas. As wind energy is one of the fastest-growing renewable energy industries, it is estimated that these trends will continue. Appropriate policies can ensure that women are able to garner their fair share of those jobs. Policy areas include better access to education and training, mainstreaming efforts, networking and mentoring opportunities, workplace policies and regulations, and work-life balance.

20. **How are Parties recognizing the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity,[30] in order to achieve the purpose and long-term goals of the Paris Agreement?**

As per IRENA's *Innovation Outlook: Ocean Energy Technologies* report, relatively little is known about the impact of ocean energy technologies on marine life due to the early stage of technology deployment. Negative impacts could arise in the form of habitat loss, animal-turbine interactions, noise and electromagnetic fields produced by sea cables, which may have effects on aquatic species. While key lessons can be learned from other offshore activities, such as conventional oil and gas as well as offshore wind operation, this is yet to be studied in-depth for ocean energy technologies.

An additional issue is that studies are very location specific, and findings cannot be easily transferred to other sites. Also, the increased vessel traffic due to deployment and maintenance can further intensify environmental effects. It has been indicated that learning-by-doing, which is often practiced when developing other technologies, cannot be applied as simply for ocean energy because risk mitigation needs to be demonstrated before a project can be performed. Nevertheless, major deployment sites have numerous monitoring devices attached to their turbine to continue researching the impacts on the environment. The main objectives that are analysed are collision risk, mainly of marine mammals, fish and birds; acoustic impacts; and impact on currents, erosion and sediment transport. Hydrophones, sensors, cameras, acoustic Doppler current profilers (ADCPs) and land-based observation are common tools to do such analyses, and developers often collaborate with universities for data analytics and to develop appropriate tools and software

With the Earth's average temperature continuing to rise, efforts to lower global carbon emissions have become progressively more intense. Increased use of renewable energy resources, which are much lower in carbon emissions than fossil fuels, is key to winning the race, and bioenergy will play a key role. IRENA's *Sustainable pastureland intensification: Making room for energy crops without harming biodiversity* sees bioenergy accounting for about a third of total cost-effective renewable energy potential in 2050.

Achieving this goal requires intensively increasing the production of bioenergy resources. Intuitively, this may appear to require an increase in area of land used to grow such resources. However, substantial amounts of bioenergy can be obtained from crop and wood residues on farms and forestlands that are already cultivated. Additionally, bioenergy crops could also be grown on land freed up by reducing waste

[29] IRENA (2019), *Renewable Energy: A Gender Perspective*, IRENA, Abu Dhabi.
[30] Preamble of the Paris Agreement.

and losses in the food chain, restoring degraded lands to productive use, and raising yields on farmland used for growing crops or raising livestock.

21. **In what way are non-Party stakeholders (including subnational governments, indigenous peoples and local communities, youth, non-governmental organizations, international organizations, the private sector, financial institutions and multi-stakeholder initiatives) contributing to the progress made to achieve the purpose and long-term goals of the Paris Agreement?**

Non-Party Stakeholders (NPS) are essential to implementation and improvement of the entire UNFCCC framework, including the Paris Agreement. Not only do NPS implement policies and strategies in cities, countries, and regions, but they also inform the policies and strategies of what needs to happen, what is possible, and how they can support each other. NPS are therefore vital to energy transitions in the fight against climate change. By coming together on areas of common interest in the form of partnerships or initiatives, NPS raise awareness and enhance ambition around the world. This is extremely important, as climate change will not be resolved on one level, but requires all levels of society across all sectors of the global economy.

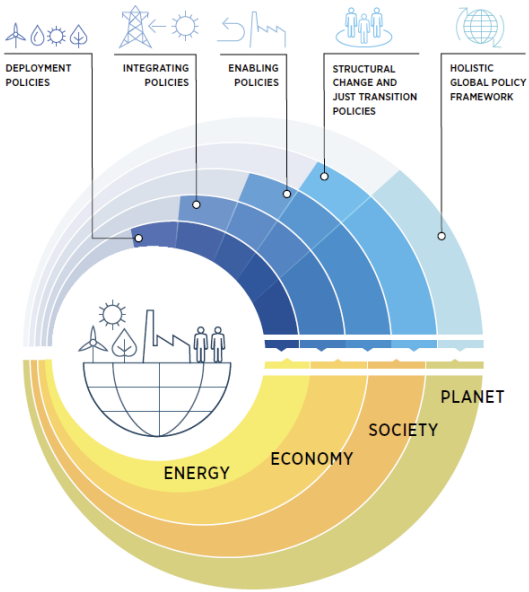
IRENA has created its own initiatives and partnerships and also supports initiatives an partnerships of others, providing expert advice and technical assistance. Most notably, IRENA leads the energy thematic area of the Marrakech Partnership for Global Climate Action, where IRENA coordinates the Climate Action Pathway for Energy and the Energy Action Event at COPs, as well as organise the thematic group's inputs to UNFCCC events, projects, and documents, when helpful.

22. **In order to achieve the purpose and long-term goals of the Paris Agreement:**

a) **What integrated and holistic approaches are available?**

A holistic global policy framework can guide climate action under IRENA's 1.5°C Pathway and reinforce the energy transition at a national level. Climate policies, including fiscal policy aligned with climate objectives, represent an important component of such a framework. A diverse portfolio of measures and instruments focused on enabling and supporting the transition must be integrated into a wider and transparent policy strategy that accounts for the fact that policies introduce strong links and feedback between energy, economic and social systems.

A holistic policy framework for the energy transition[31]



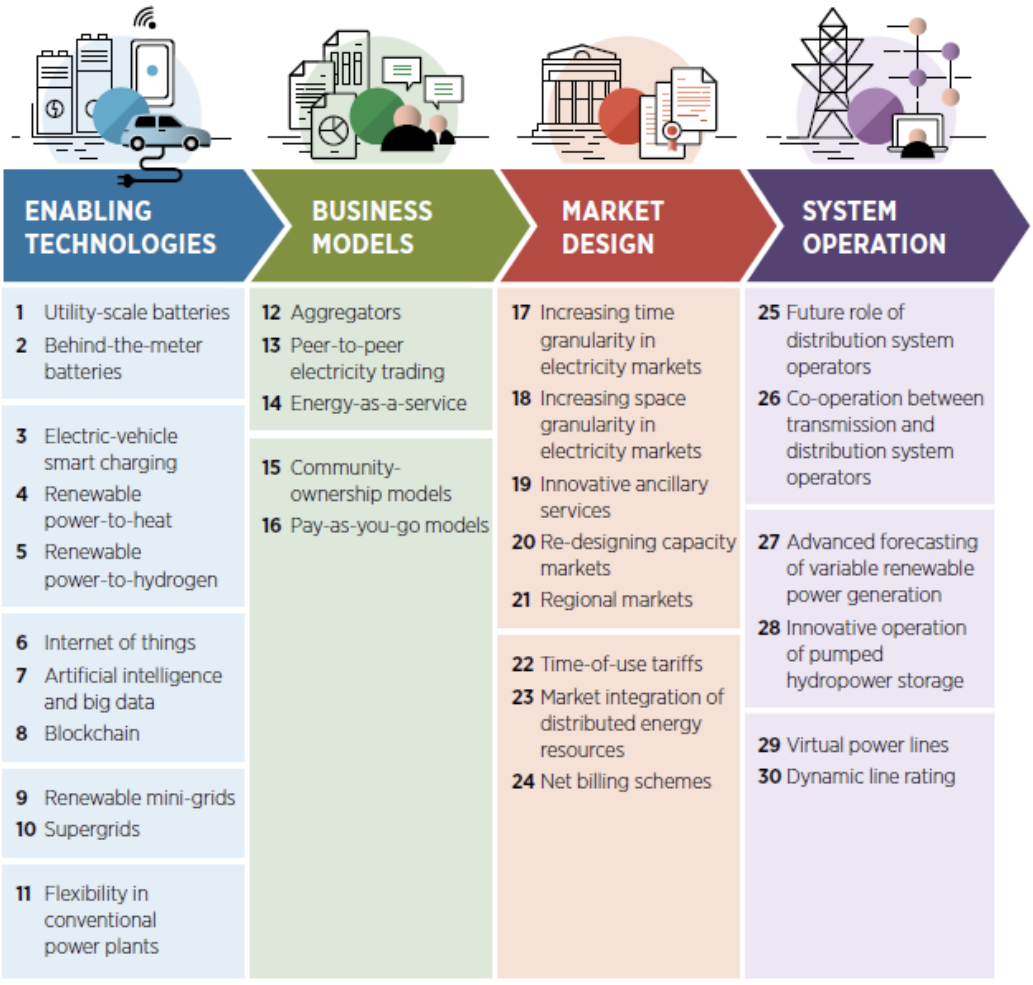
[31] IRENA (2022), *World Energy Transitions Outlook (WETO) 2022: 1.5°C Pathway*, IRENA, Abu Dhabi.

The policies needed to advance the energy transition reinforce one another and have implications for the energy system, economy, society and planet. An integrated policy approach is necessary to account for feedback among policies and across systems to ensure a timely, just and inclusive energy transition.

b) How can science and innovation be accelerated, encouraged and enabled?

Three main innovation trends – digitalisation, decentralisation and electrification – are accelerating the transformation of the power sector, with variable renewable energy at its core: They are changing paradigms and unlocking power system flexibility for integrating larger shares of variable renewables. Innovations are not only technological; they also include innovations in market designs, system operation and business models. Innovative solutions emerge from systemic innovation, the matching and leveraging of synergies between various innovations across multiple components of the power system. *In* *Innovation Landscape for a Renewable-Powered Future,* IRENA identified 30 innovations that facilitate the integration of large shares of variable renewables, following the systemic innovation approach. One-size-fits-all solutions do not exist: The design of an optimal strategy for each power system and the implementation of different innovations depend on the country context and system-specific variables, such as the technical and economic aspects of a given power system. IRENA provides a toolbox of innovations that countries can use to create their own tailored solutions for flexible power systems.

IRENA's innovation landscape for integrating variable renewable energy[32]



[32] IRENA (2019), *Innovation landscape for a renewable-powered future*, IRENA, Abu Dhabi.

a) How can international cooperation for climate action be enhanced?

Aiming to minimise current inequalities, international cooperation can support countries in making the necessary transitions to build capacity in key areas such as institutions, economic structures, risk management, social cohesion, research and innovation to achieve effective sustainable development. While ambitious climate and energy targets continue to be set, many are yet to be translated into effective policy and regulatory frameworks. Renewable technologies have yet to make sufficient inroads into the end-use sectors, such as direct heat, buildings and transport. And countries are grappling with multiple priorities, many of which cannot be solved in isolation. The need for international cooperation is evident as the world looks for solutions to meet energy and economic demands, rectify systemic inequalities, and reverse the climate change trends.

As a global platform for inclusive co-operation, IRENA is uniquely positioned to bring together different constituencies with a common goal of accelerating the energy transition. It serves as the convening platform to advance the widespread adoption and use of renewable energy, with the ultimate goal of safeguarding a sustainable future.

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 cooperation, 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.

With a mandate from countries around the world, IRENA encourages governments to adopt enabling policies for renewable energy investments, provides practical tools and policy advice to accelerate renewable energy deployment, and facilitates knowledge sharing and technology transfer to provide clean, sustainable energy for the world's growing population.

In line with these aims, IRENA provides a wide range of products and services, including:

- Annual reviews of renewable energy employment;
- Renewable energy capacity statistics;
- Renewable energy cost studies;
- Renewables Readiness Assessments, conducted in partnership with governments and regional organisations, to help boost renewable energy development on a country by country basis;
- The Global Atlas, which maps resource potential by source and by location;
- Renewable energy benefits studies;
- REmap, a roadmap to double renewable energy use worldwide by 2030;
- Renewable energy technology briefs;
- Facilitation of regional renewable energy planning.

With more than 180 countries actively engaged, IRENA promotes renewable resources and technologies as the key to a sustainable future and helps countries achieve their renewable energy potential.