

Solar World Congress 2025

POLICY RECOMMENDATIONS FOR ACHIEVING NATIONAL AND GLOBAL 100% RENEWABLE ENERGY TARGETS**Summary**

The Towards 100% Renewable Energy Working Group, one of three Working Groups supported under the International Renewable Energy Agency's Coalition for Action, has been developing white papers and policy briefs that aim toward informing decision makers on best practices and case studies for achieving 100% renewable energy systems, regionally and globally, ideally by mid-century or sooner. Recent products of the Working Group include a Policy Brief as well as a broader Policy Paper providing key recommendations. The recommendations are based in part on analysis of energy development scenario studies, generally out to the year 2050, that focus on achieving either net-zero or 100% renewable energy targets. This paper summarizes the analysis that was conducted on the scenarios by the Working Group in the context of providing a series of policy recommendations specifically designed to encourage and support governments to set fully 100% renewable energy targets.

Keywords: Energy supply targets, 100% renewables, net-zero, scenarios, policies,

1. Introduction

This paper highlights the results of the Towards 100% Working Group of the International Renewable Energy Agency's (IRENA's) Coalition for Action (CfA) analysis of five renewable energy development scenarios recently undertaken by key intergovernmental organizations and research institutions. The primary goal of these studies was to configure an energy system that reduces greenhouse gas (GHG) emissions from current levels to zero, or net-zero, by 2050. Such an energy system would put the world on track to limiting global warming to a maximum of 1.5 °C above pre-industrial levels by the end of the century, a key outcome of the declaration signed at the 21st United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP 21) in Paris in 2015. The objective of the Working Group was to identify key policy recommendations, backed by the findings of these studies, that should place the world on a pathway to meeting our climate goals. Two Coalition for Action publications have come out of this work: a Policy Brief (IRENA, 2024) and a more comprehensive policy analysis (IRENA 2025).

The scenarios are all based on the premise that the three key aspects of a successful renewable energy transformation involve successful technologies supported by adequate financing and an enabling policy environment. Two of the scenario analyses studied by the working group were focused on achieving a net-zero energy system by 2050 in order to limit global warming to no more than 1.5°C by 2050: the IRENA 1.5°C Scenario (IRENA, 2021) and the International Energy Agency (IEA) Net-Zero Emissions (NZE) Scenario (IEA, 2021). Three studies undertaken by universities and research institutions focused on scenarios that achieved fully 100% renewable energy: The Lappeenranta-Lahti University of Technology (LUT) Global 100% RE Scenario (Bogdanov et al., 2021); The University of Technology Sydney (UTS) 1.5°C Scenario included in their "Achieving the Paris Climate Goals" Report (Teske, 2019); and Stanford University's 100% Wind-Water-Solar (WWS) Scenario that specifically covers 145 countries (Jacobson et al., 2022). A 100% renewable system goes beyond a net-zero carbon emission system in that all energy sources are renewables-based, with no fossil-or nuclear-based energy sources whatsoever. The net-zero studies can allow for some energy-related fossil fuel emissions well into the future, as long as the resulting GHG concentrations in the atmosphere are removed through Carbon Capture, Utilization and Storage (CCUS) schemes.

Recognizing that the scenario studies represent ongoing work at many of the organizations, updates that have been made to the original studies were factored into the more comprehensive policy analysis (IRENA, 2025).

2. Scenario Analysis

Table 1, extracted from the Policy Brief (IRENA, 2024), highlights a few key features of each of the five scenario studies. Most of these studies have been updated since their original publication, and key events of the past decade, such as the COVID-19 pandemic and resulting energy crisis are not fully captured in the original work. In some cases, the approaches and assumptions vary among the studies, making it challenging to directly compare some of the outcomes. Still, the Table provides a generic overview of the five scenarios where commonalities could be highlighted. The total energy mixes for each scenario will be provided in the full paper.

Table 1. Highlights of each of the five scenarios studied

Scenario Name	Global 100%RE	1.5°C Scenario	100% Wind-Water-Solar (WWS)	1.5 °C Scenario	Net-Zero Emissions (NZE)
Institution	LUT (2021)	UTS (2019)	Stanford (2022)	IRENA (2021)	IEA (2021)
Target(s)	100% renewable energy system by 2050	Achieve 1.5 °C by 2050; primary energy supply = 100% RE	80% WWS by 2030 100% WWS by 2050 for 145 countries	Energy transition pathway aligned with the 1.5 °C target (net-zero by 2050)	Net-Zero by 2050
RE Share in Total Energy Supply by 2050	100%	Primary energy supply in 2050 based on 100% RE	100%	74% in total energy supply; 90% in electricity generation	67% in total energy supply; 88% in electricity generation
Energy Sources Included in Total Energy Supply (UTS is Total Primary Energy Demand)	Solar photovoltaics (Solar PV), Concentrated Solar Power (CSP), wind, hydro, geothermal and bioenergy	Solar, wind, hydro, geothermal, biomass, ocean energy (tidal and wave)	Power: wind, solar PV, CSP, geothermal, hydro, ocean energy. Heat: solar thermal, geothermal heat	Solar, wind, biogas, biomass, hydro, geothermal, ocean, natural gas, oil, coal and nuclear	Solar, wind, bioenergy, hydro, geothermal, other renewables, natural gas, oil, coal and nuclear
2050 Electrification Share	89% (Total Primary Energy Demand)	92.3% (Total Final Energy Demand)	99.1% Total Energy Demand	51% (Total Final Energy Consumption)	49% (Total Final Energy Consumption)
Estimated Cumulative Investment Needed to 2050 (USD)	72 trillion,	51 trillion across the power sector 12.4 trillion for the heating sector	~61.5 trillion	131 trillion (annual average ~4.4 trillion),	Annual investments of 4-5 trillion by 2030 - 5 trillion by 2040 -4.5 trillion by 2050

3. Policy Recommendations

The policy recommendations presented in the most recent CfA publication (IRENA, 2025) add to and expand upon those presented in the earlier Policy Brief (IRENA, 2024) and are explicitly mentioned as pathways for 100% renewables. These policy recommendations are further motivated by the agreement signed by over 130 countries at COP28 in Dubai in 2023 calling for a tripling of renewable power capacity from 2022 levels by 2030 in order to keep the world on track towards the 1.5 °C global warming limit.

Two key factors are addressed in IRENA 2025 that will be fundamental towards a transformation to 100% renewable energy systems. One is on the important topic of financing. The 100% scenarios argue that the cost of financing a 100% renewable energy future would be roughly half of the cost of a future that relies on a net-zero target, meaning that there are significant cost advantages to phasing out all non-renewable energy sources. The second topic is about an effective fossil fuels exit strategy which could be developed so that subsidies and competitive advantages of carbon-emitting technologies are phased out in favor of clean renewable sources. Carbon pricing and other policies must be structured to internalize the costs of negative health and environmental impacts that are currently treated as external costs. The strategy also requires a shift to a far more decentralized energy system where renewable energy sources are more co-located with demand centers, and where renewables plus storage, rather than large, centralized fossil fuel stations, provide the necessary flexibility to the grid of the future.

The policy recommendations are based on four tenets: 1) Establishing targets, incentives, and regulatory frameworks favorable to renewables; 2) Facilitating fossil (and nuclear) phaseout strategies in ways that ensure a just transformation of the work force and minimize societal impacts; 3) Supporting R&D programs that enable infrastructure and technology enhancements and innovations; and 4) Stimulating project investments through public and private financing and capacity building.

The final paper will go into further detail on these recommendations as well as the technological and financial factors that are already in place now to support them, and others expected to occur in the future. The combination of reliable and cost effective technologies supported by robust R&D, access to low-cost public and private financing, and an enabling policy environment, are the three pillars that will transform the world's future energy systems to 100% renewables.

4. References

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