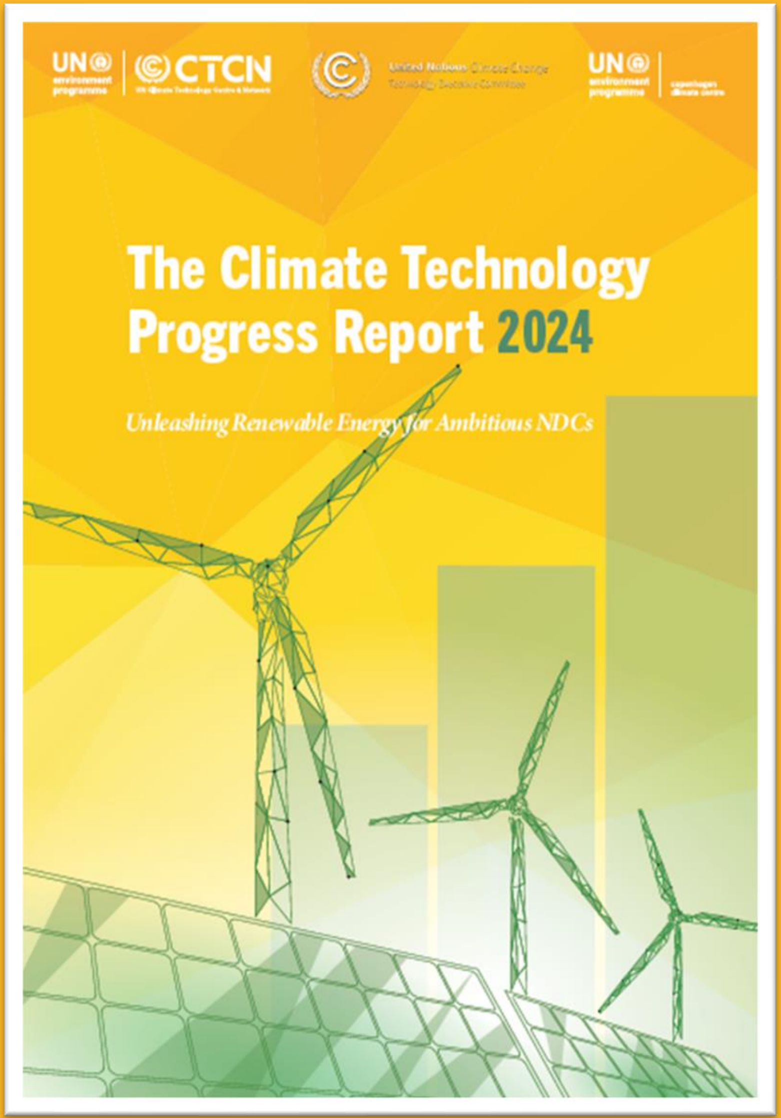
Launch of the
Climate Technology Progress Report

Unleashing Renewable Energy for Ambitious NDCs



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Speakers

Dechen Tsering
Director a.i., Climate Change Division and Director, Regional Office of Asia Pacific, UNEP

Thibyan Ibrahim
Chair of UN Technology Executive Committee

Stephen Minas
Vice Chair of UN Climate Technology Centre & Network (CTCN) Advisory Board

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Debora Ley
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Elisabeth Gilmore
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Agenda

1. Introductory remarks

- Dechen Tsering, Director a.i., Climate Change Division, and Director, Regional Office of Asia Pacific, UNEP
- Stephen Minas, Vice-Chair of the UN Climate Technology Centre & Network Advisory Board
- Thibyan Ibrahim, Chair of the UNFCCC Technology Executive Committee

2. Introduction to the report - Sara Traerup

3. Chapters key highlights

Chapter 2: Technology Adoption - Marie-Blanche Ting

Chapter 3: Feasibility Assessment - Debora Ley

Chapter 4: Investment and Finance - Elisabeth Gilmore

Chapter 5: Digital Innovation & Governance - Lucas Somavilla, Karsten Schulz

Q&A/Discussion

1. Introduction

Lead author: Sara Traerup (UNEP-CCC), Heleen de Coninck (Eindhoven University of Technology) and Ambuj Sagar (Indian Institute of Technology)

The Climate Technology Progress Report 2024

Special focus on

- Where are we at in tripling renewable energy capacity globally by 2030 and what are the opportunities to reach this target?
- How can this transition be done in a just, orderly and equitable manner?
- What is required to stimulate ambition in the next round of NDCs in 2025 to keep 1.5 °C within reach.

Continues to explore

- What progress is being made on technology transfer?
- What has enabled it?
- Where are the gaps?
- Building on this understanding, how do we better enhance climate technology development and transfer?

Structure

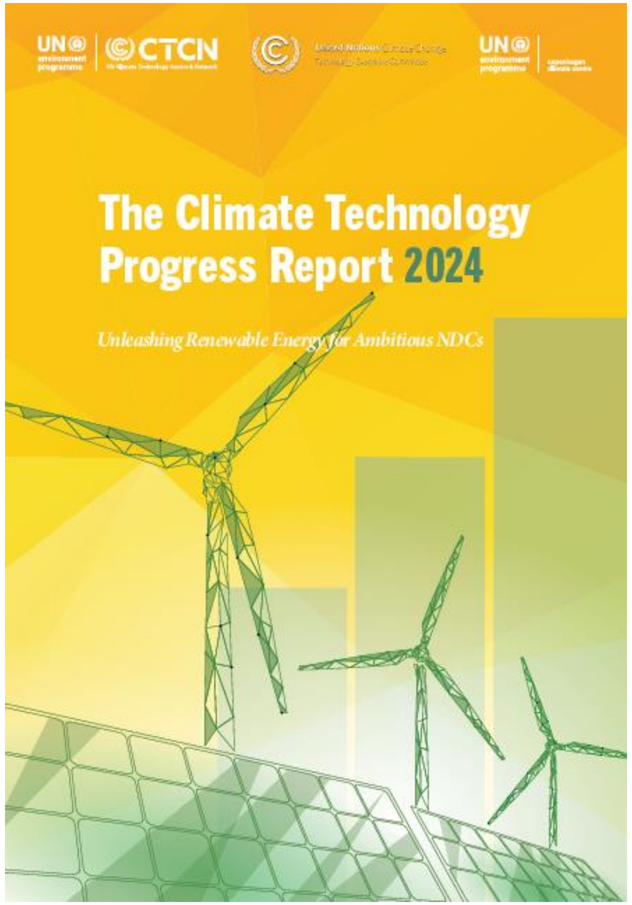
Overall focus on
Renewable energy technologies
Systems approach

Part A: Technology adoption – where are we at?

Part B: How do we enable progress? We focus on

- Feasibility
- Investment and finance
- Digital innovation and governance

Global focus with regional break downs of the assessment.
Case studies and more insights into specific contexts.



2. Technology Adoption Rates

Lead authors: Marie Blanche Ting (UNEP-CCC)

Contributing authors: Dmitrii Bogdanov (LUT University)

The pace of RE progress

- At present, the total installed capacity of renewables on a global scale is around 3,800 GW, led by solar PV and wind power.

- The pathways assessed by IPCC indicate that the goal of tripling renewable capacity involves increasing it 3.2 to 3.4 times compared with 2022 levels to reach 11 TW by 2030.

- Accordingly, global solar PV and wind energy capacities grew 170% and 70%, respectively, between 2015 and 2019.

- Relatedly the cost of electricity from solar PV and wind sources decreased by 56% and 45%, respectively, while battery prices fell by 64%.

- To meet tripling RE target, the annual pace of capacity additions needs to rise from 336 GW in 2022 to over 1,250 GW by 2030 – an annual average increase of 18%.

The current pace of RE installation needs to be accelerated!

Figure 2.2 Solar PV global capacity and annual additions from 2012 to 2022

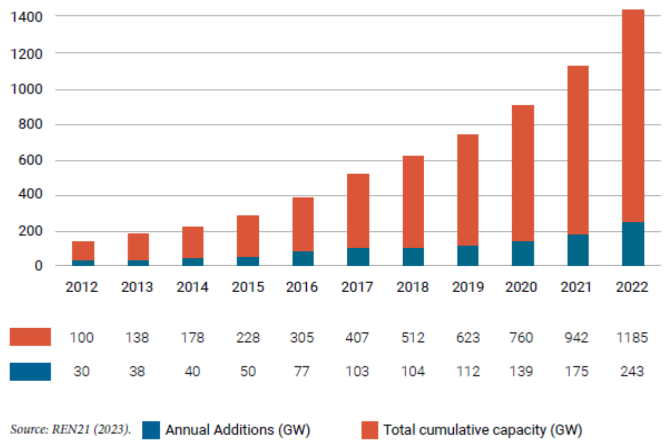
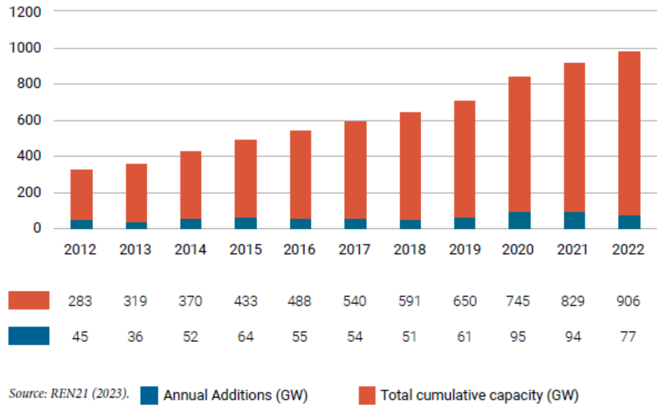


Figure 2.3 Wind capacity and annual additions from 2012–2022



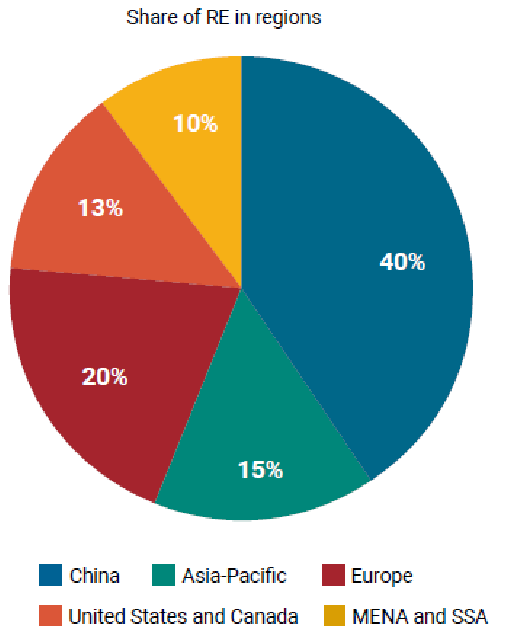
Regional share of RE tripling

- Different regions are scaling their renewable energy capacity at different rates, influenced by each country's existing capacity and the urgency with which they aim to achieve tripling renewable energy capacity by 2030.

- MENA region exhibits the highest growth factor, given its relatively modest base at present and ambitious 2030 targets. With a goal of installing 200 GW of renewable energy capacity by 2030 – 4.5 times its current installed base – the region is led by Saudi Arabia, Egypt and Algeria.

- African countries have set a goal of reaching 300 GW of clean power by 2030, up from just 56 GW. The aim is both to address energy poverty and bolster the global supply of cost-effective clean energy for industry.

Figure 2.4 The share of tripling renewable energy by region according to collective national energy plans



Source: Adopted from IEA (2024).

Systems operation

- As RE implementation progresses, so does the need for systems integration. These include
  - Supportive infrastructure for grid integration (grid bottleneck, grid stability)
  - sector coupling
  - energy storage to balance supply and demand of VRE
  - Advance control systems
  - demand-side management

- An imperative for low-carbon energy system transitions is the enhanced integration across energy system sectors and scales (spatial scale district, regional, national and international domains).

- The deployment of integration options hinges on various factors, such as their relative costs and benefits, regulatory frameworks and the design of electricity markets.

Key messages

- Traditional biomass continues to be utilized. This underscores the persistent challenge of inadequate access to clean, reliable and safe energy in regions such as sub-Saharan Africa and parts of Asia. Tripling renewable energy requires more than technological advances—it demands equitable access to clean, reliable, and safe energy as emphasized in SDG 7.

- Access to and benefits from technological advancements are not neutral; they depend on user access to financial, social, physical and informational capital.

- There is a strong correlation between increased adoption rates and a reduction in technology costs. This refers specifically to technologies that are smaller and with more modular features, and low design complexity.

- With the integration of energy storage solutions, electricity systems powered predominantly by renewables are rapidly becoming not only viable, but also increasingly cost-competitive when compared with fossil-fuel-based systems. Significant progress can be achieved by prioritizing grid modernization and storage technologies.

3. Feasibility assessment

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Contributing authors: Adedoyin Adeleke (Green Growth), Anas Alhusban (Carleton University), Hope Corsair (Oak Ridge National Laboratory), Scott DeNeale (Oak Ridge National Laboratory), Lucas Duffy Rodriguez (California Public Utilities Commission), Carly Hansen (Oak Ridge National Laboratory), Bavisha Kalyan (University of California, Berkeley), Aaditee Kudrimoti (University of California, Berkeley), Jasmine Hiroko McAdams (University of California, Berkeley), Daniel Alejandro Pacheco-Rojas (National Autonomous University of Mexico)

Chapter Fellow: Anas Alhusban (Carleton University)

Key messages

- Countries need to set more ambitious renewable energy targets in their updated Nationally Determined Contributions. This involves aligning national policies to achieve the goal of tripling renewable energy capacity by 2030. Hence, institutional capacity, along with supportive policies, regulations and standards, needs to be strengthened to improve the overall feasibility of those technologies that scored the least.

- Globally, solar and wind power are highly feasible considering institutional, economic, technological, geophysical, and socio-cultural dimensions. However, data gaps may still be limiting regional expansion.

- Several renewable energy technologies meet both mitigation and adaptation goals, while also being of benefit to the Sustainable Development Goals. This relates to electricity generation and energy storage, and to the resilience and reliability of these systems.

Feasibility Assessment for Adaptation

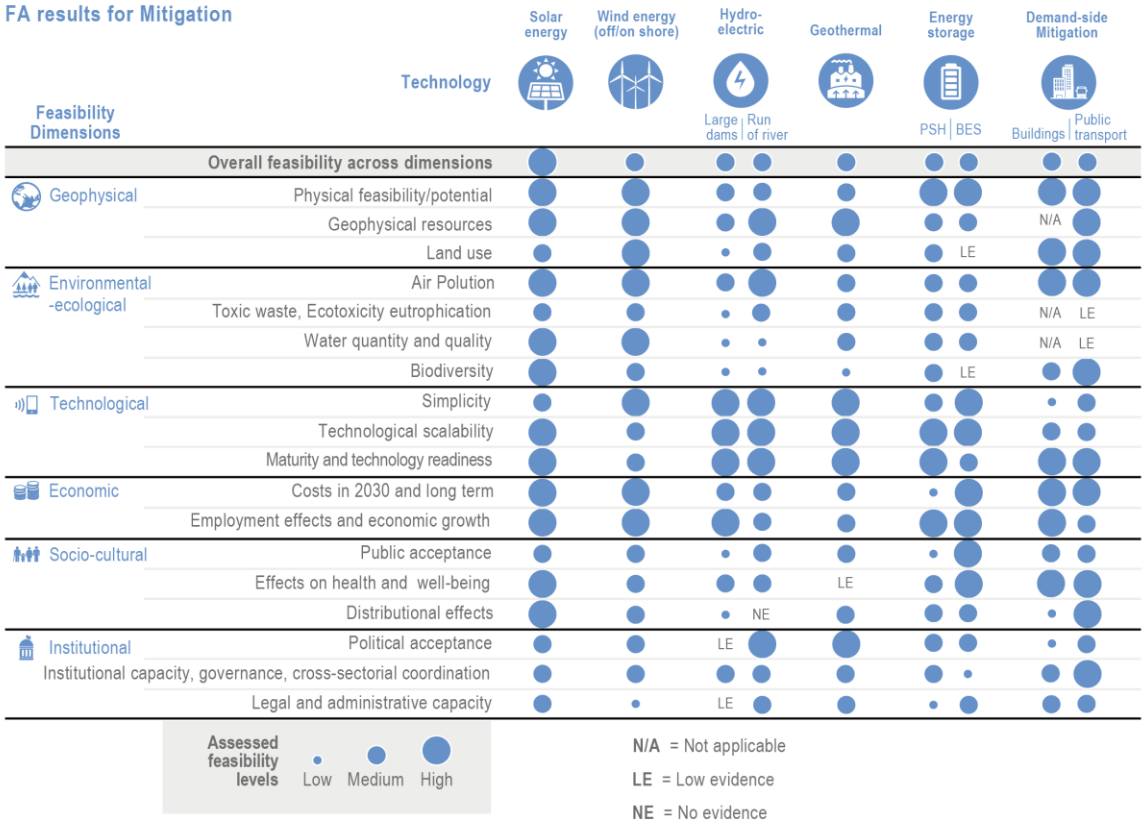
FA results for Adaptation

Feasibility Dimensions	Technology	Resilient power system	Energy reliability	Water use efficiency	Smart grid digitalization
	Overall feasibility across dimensions	High	High	High	LE
Geophysical	Physical feasibility/potential	N/A	N/A	Medium	N/A
	Hazard risk reduction potential	N/A	N/A	High	N/A
	Land use	High	N/A	High	N/A
Environmental-ecological	Ecological impacts	Medium	NE	High	LE
	Adaptive capacity / resilience	High	High	High	LE
Technological	Technical potential	High	High	High	High
	Risks mitigation potential	High	High	High	Medium
Economic	Socioeconomic vulnerability reduction potential	High	High	High	NE
	Employment, economic growth and productivity enhacement potential	Medium	Medium	NE	LE
	Microeconomic viability	High	High	High	LE
	Macroeconomic viability	High	Medium	High	NE
Socio-cultural	Socio-cultural / Public acceptability	High	High	LE	LE
	Social co-benefits	High	High	LE	LE
	Social and regional inclusiveness	High	High	NE	LE
	Gender equity	Medium	LE	NE	NE
	Intergenerational equity	Medium	LE	NE	NE
Institutional	Political acceptance	High	High	Medium	NE
	Legal and regulatory acceptability	Medium	Medium	LE	LE
	Institutional capacity and administrative feasibility	Medium	Medium	Medium	LE
	Transparency and accountability potential	Medium	NE	NE	NE

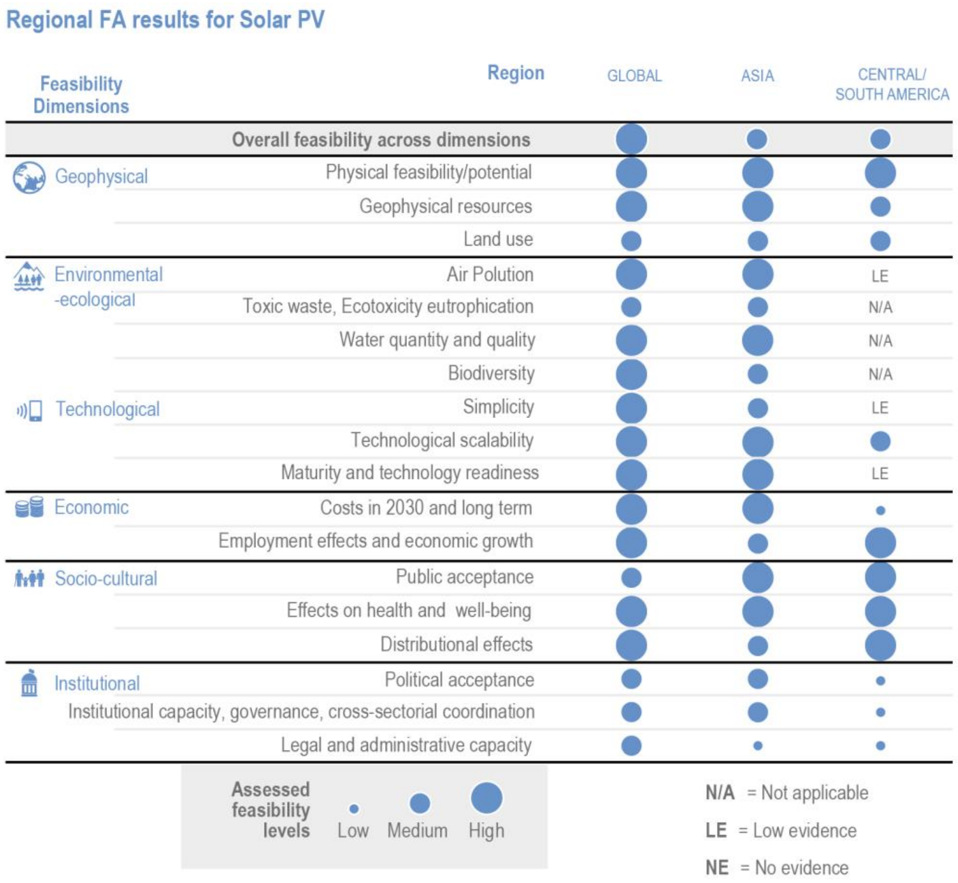
Assessed feasibility levels: Low, Medium, High

N/A = Not applicable
LE = Low evidence
NE = No evidence

Feasibility Assessment for Mitigation



Regional Feasibility Assessment for Solar PV



Regional Feasibility Assessment for Hydroelectric power

Regional FA results for Hydroelectric power (Large dams)

Feasibility Dimensions	Region	GLOBAL	AFRICA	ASIA	AUSTRALIA	CENTRAL/ SOUTH AMERICA	EUROPE	NORTH AMERICA	SMALL ISLANDS
	Overall feasibility across dimensions	Medium	-	-	-	-	-	-	-
Geophysical	Physical feasibility/potential	Medium	High	High	High	High	Low	Low	NE
	Geophysical resources	Medium	Medium	Medium	Medium	Medium	Medium	Medium	NE
	Land use	Low	Low	Low	LE	Low	Low	Low	NE
Environmental-ecological	Air Polution	Medium	Medium	Medium	NE	Medium	Medium	Medium	NE
	Toxic waste, Ecotoxicity eutrophication	Low	NE	NE	NE	NE	LE	LE	NE
	Water quantity and quality	Low	Low	NE	NE	NE	NE	Low	NE
	Biodiversity	Low	LE	LE	NE	LE	LE	LE	NE
Technological	Simplicity	High	NE	NE	NE	NE	NE	NE	NE
	Technological scalability	High	NE	NE	NE	NE	NE	NE	NE
	Maturity and technology readiness	High	NE	NE	NE	NE	NE	NE	NE
Economic	Costs in 2030 and long term	Medium	NE	NE	NE	NE	NE	NE	NE
	Employment effects and economic growth	High	LE	LE	NE	LE	LE	LE	NE
Socio-cultural	Public acceptance	Low	LE	LE	NE	Low	Low	Low	NE
	Effects on health and well-being	Medium	LE	NE	NE	NE	NE	NE	NE
	Distributional effects	Low	Low	Low	NE	LE	NE	NE	NE
Institutional	Political acceptance	LE	NE	LE	NE	NE	NE	Medium	NE
	Institutional capacity, governance, cross-sectorial coordination	Medium	LE	LE	NE	NE	NE	Medium	NE
	Legal and administrative capacity	LE	LE	LE	NE	NE	NE	Medium	NE

Assessed feasibility levels: Low, Medium, High

N/A = Not applicable

LE = Low evidence

NE = No evidence

Enabling Conditions

- **Governance** structures can determine the speed of implementation and whether the benefits and costs are equitably distributed.
- The capacity of **institutions** to support these transitions with supportive legislation and policies is especially important. establishing clear regulatory frameworks.
- **Finance and investment** for the renewable energy sector has been one of the more positive aspects of the energy transition with costs falling rapidly. However, in many developing countries, financial barriers are persistent, including perceptions of risk, challenges for access to capital, and gaps and mismatches in financial flows
- **Innovation** plays a critical role in enabling climate technology progress, such as through machine learning and artificial intelligence.

Conclusions

- There are some **highly feasible** renewable energy technologies with **significant synergies** between mitigation, adaptation, and sustainable development, highlighting that implementing these technologies can be **consistent with expanding justice and equity by understanding and prioritizing the local context and the needs of the most vulnerable groups**.
- The system transitions approach helps ensure that **mitigation and adaptation are considered together** and **reduces the risk of maladaptation and inequality.**
- Supportive technologies and enablers are also needed for renewable energy expansion. For example, **national transmission, and distribution and storage systems**
- **Equity and justice** are at the heart of a just energy transition, and together with a system transitions approach, leads us on a path towards **climate resilient development**.

4. Investment and finance

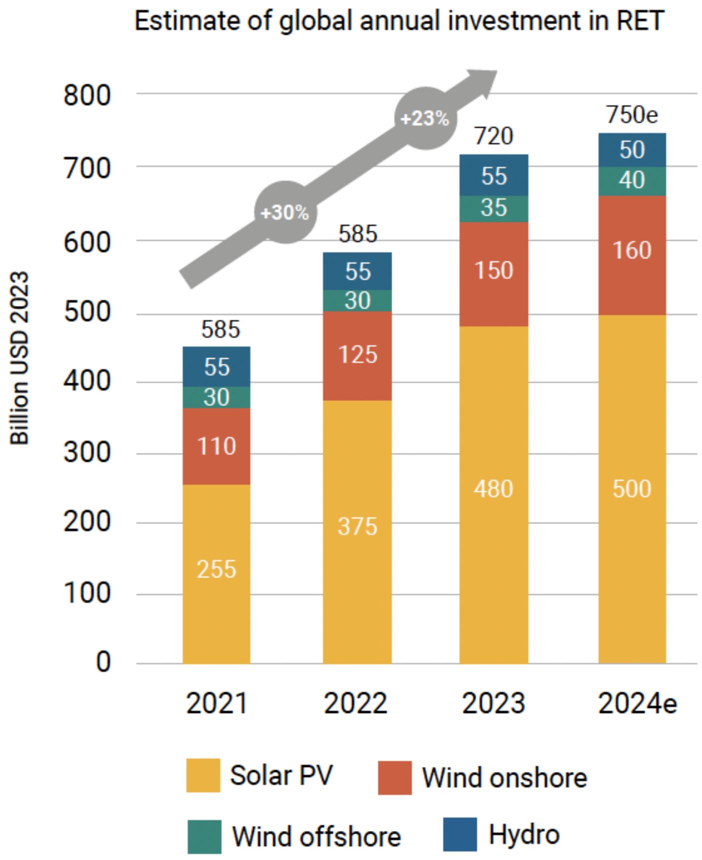
Lead authors: Elisabeth Gilmore (Carleton University), Bjarne Steffen (ETH Zurich)

Contributing authors: Anurag Gumber (Hong Kong University of Science and Technology), Lena Klaassen (ETH Zurich, Switzerland), Churchill Agutu (UNDP)

Key messages

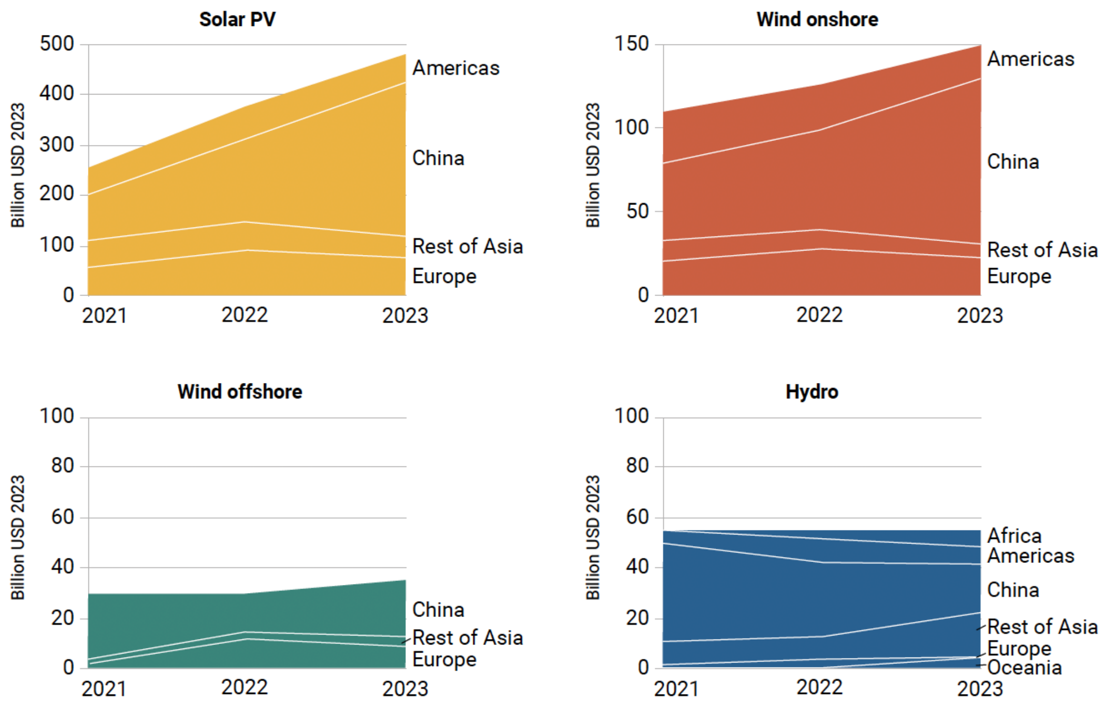
- Renewable energy technologies, especially solar and wind technologies, have seen rapid cost reductions.
- Each year, globally renewables perform better than expected on key metrics of investment and cost of capital.

Figure 4.2. Estimates of global annual investments by renewable energy technology



- China, OECD countries and some emerging markets lead in financial commitments and renewable energy investments.
- Investment remains very limited in many developing countries and is not growing in other emerging economies.
- Removing fossil fuel subsidies, setting up effective carbon pricing, and adjusting market structures can facilitate the deployment of renewable energy.

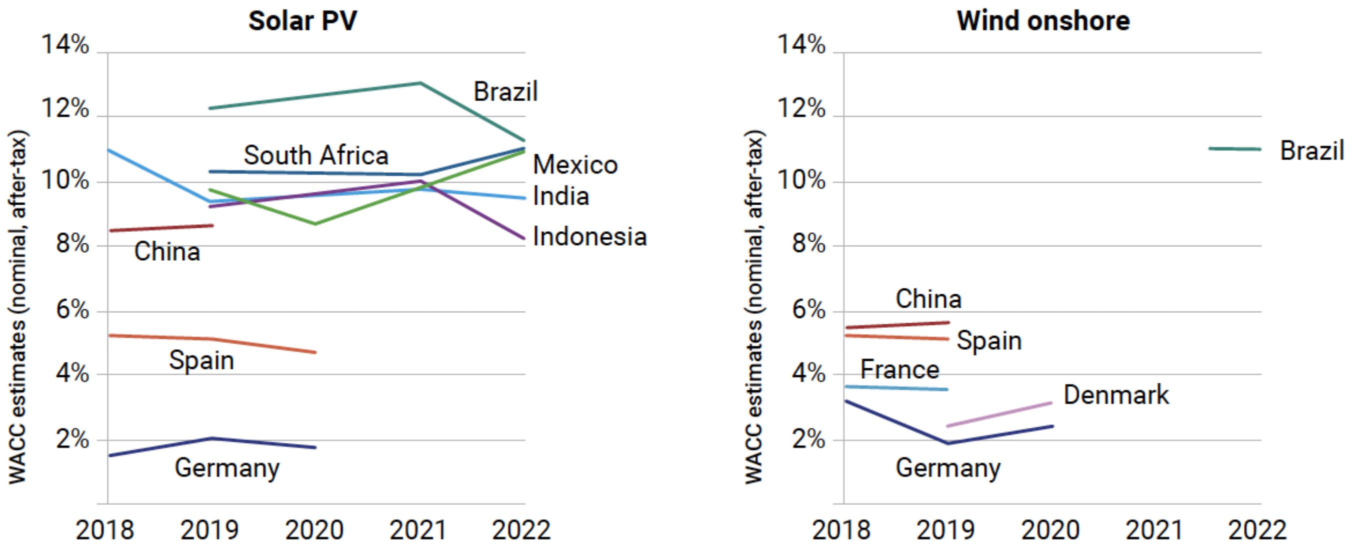
Figure 4.3. Estimates of region- and technology-specific annual investments in renewable energy technologies



- The persistently high cost of capital in many developing countries is an important investment barrier.

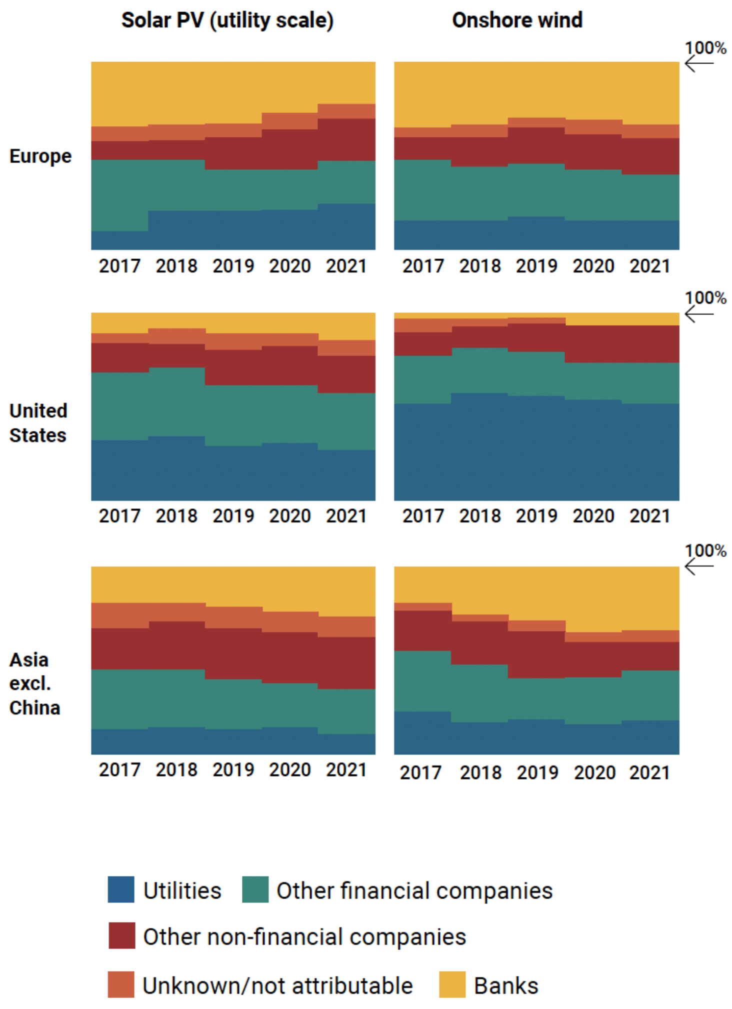
- Holistic policy mixes that address the energy sector, the financial sector and the economy more broadly are needed to reduce these costs.

Figure 4.4. Weighted average cost of capital (in large economies by renewable energy technology)[4]



- Investment support – including through derisking instruments – by multilateral development banks and climate finance institutions remains crucial for upscaling deployment of renewable energy technologies in most developing countries.
- The current investor landscape is dominated by large private investors, revealing opportunities for alternative ownership structures that can support communities in generating broad societal benefits and fostering just transitions

Figure 4.5. Investor landscape for renewable energy technologies for selected regions



5. Digital innovation and governance

Lead authors: Lucas Somavilla Croxatto (University College London and University of Oxford); Karsten Schulz (University of Groningen).

Contributing authors: Samira Barzin (University of Oxford); Henrik Larsen (EEA); Anastasiia Tiurmenko and Nadege Trocellier (CTCN)

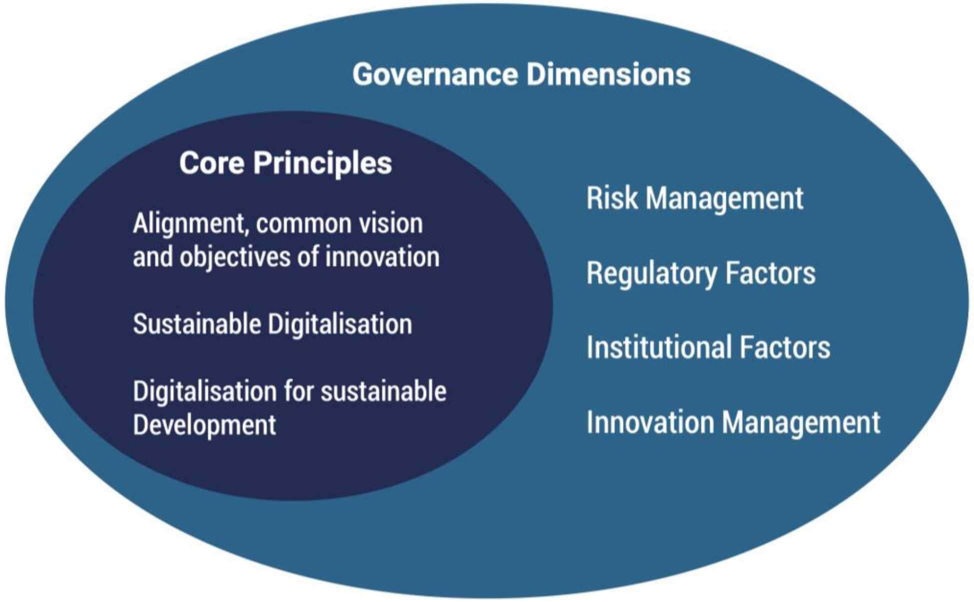
Introduction

- Examines the role of digitalization in the global energy transition through a responsible innovation governance lens, highlighting its transformative potential.
- Digital technologies, with unique, disruptive features, are essential for accelerating energy transitions. The chapter focuses on the rationale and governance of digital innovations, emphasizing their applications in energy systems and cross-sector benefits.
- Digital innovations include hardware (ICT, data centres, robotics, IoT) and software (applications, cloud computing, AI), with diverse applications across energy.
- Although digitalization rates vary globally, it's pivotal for climate change mitigation, requiring responsible governance to manage its risks and harness its potential.
- Recognizes the need for varied approaches to assess the benefits and risks of digital tech in the energy transition.
- Presents two case studies: (1) AI and GIS tools to map global rooftop solar potential, illustrating digitalization’s global scope; and (2) the implementation of pay-as-you-go (PAYG) solar technology in Burkina Faso, showcasing its impact on energy access in developing regions.

Learning from Opportunities and Challenges in Governing Digital Innovation for the Energy Transition

- **Digitalization as a Key Driver**: Reshapes energy transitions by transforming energy assessment, production, distribution, and consumption, especially in renewables.
- **High-Income Countries Leading**: Digitalization progress is concentrated in high-income nations, highlighting a need for more investment in digital infrastructure in low- and middle-income regions.
- **Challenges and Risks**: Increases energy demands (e.g., data centres), impacts the environment, and widens the global digital divide, particularly in energy-scarce regions like sub-Saharan Africa.
- **Biases and Information Asymmetry**: AI/ML can have biases from poor data quality, and contextual mismatches creating information asymmetry that affects trust and collaboration.
- **Contextual Innovation Governance**: Responsible governance tailored to specific contexts is essential to harness digitalization's benefits in energy transitions while managing risks.

Responsible digital innovation in the context of the energy transition



Source: Authors own elaboration.

Table 5.1 Guiding questions for assessing opportunities/risks and improving governance

Problem area	Guiding questions for assessing opportunities/risks and improving governance
Digitalization and sustainable development	Which aspects of the technology in question promote sustainable digitalization? If sustainability considerations are missing, how can they be integrated to drive digital innovation towards sustainable development objectives?
Regulatory factors and governance	What are the context-specific requirements, including policy, for the effective governance of this technology? What key regulatory factors and capacities are needed for proper regulation?
Risk management	What are the main social (diversity, equity and inclusion) and environmental risks associated with the technology in question? Are adequate risk management strategies in place to address these issues?
Institutional factors and innovation management	Which institutional factors can act as barriers or enablers for the mobilization, deployment and implementation of the technology? What processes and resources are needed for effective short- and long-term technology management? Who are the key stakeholders and how are they informed, involved or affected by these innovations?

Case Studies

Case study 1: Using artificial intelligence for rooftop solar capacity expansion

Predicted rooftop solar potential over buildings of São Paulo.

Source: https://developers.google.com/maps/documentation/solar/overview

Source: authors using Google Solar API

Case study 2: Developing last-mile pay-as- you- go energy access innovations in Burkina Faso

Representative image

Key messages

- **Integrating Renewables**: Smart grids and advanced energy management systems help stabilize grids with renewables, accelerating their adoption with responsible governance.
- **National Governance and Circular Economy**: Strong national governance and circular economy practices are essential to manage increased ICT demand, avoiding potential offsets to sustainability gains.
- **Context-Specific Decarbonization**: Further research is needed to understand digitalization’s role in regional decarbonization pathways, for example across Sub-Saharan African countries.
- **Digital Tech for Efficiency and Interconnections**: Digital tools are valuable for mapping renewable potential, boosting efficiency, and linking with sectors like water and agriculture but cannot replace the need for physical infrastructure or effective governance systems.
- **Responsible AI Use**: Governance frameworks must ensure responsible AI in renewables, with standards for data privacy and equitable access. **Inclusive AI Access**: Subsidies and a global AI fund can support digital literacy and provide marginalized communities access to AI-enabled platforms.
- **Building Digital Skills**: National policies should enhance digital literacy, promote evidence generation on energy digitalization, and mobilize global funding for digital education in low- and middle-income countries.

Thank you

On behalf of the

28 Authors,
10 Steering committee members, and
the production team of the report

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