

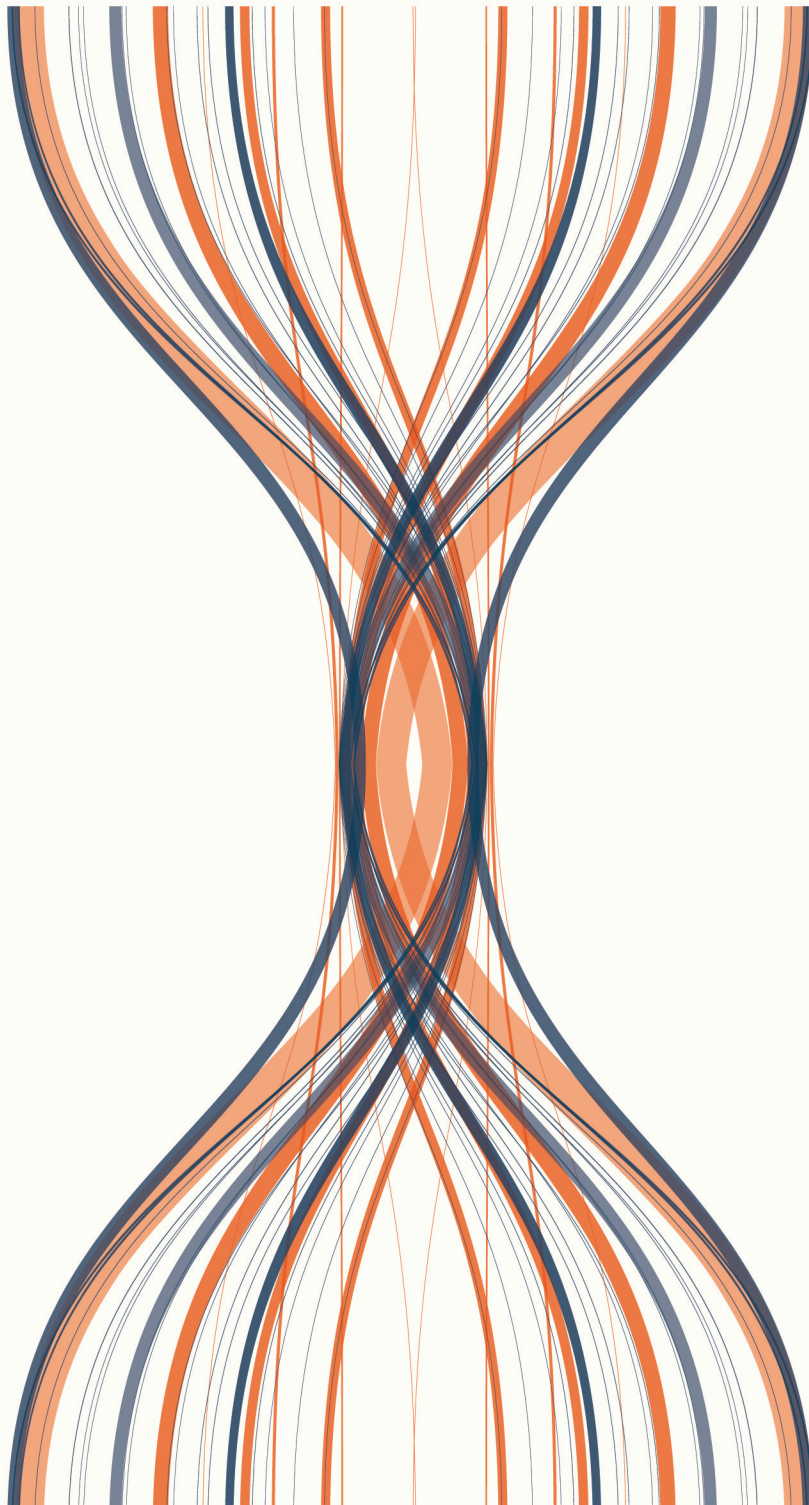
LOCAL GRIDS TO GLOBAL POWER

INDIA'S ENERGY TRANSITION

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Local Grids to Global Power India's Energy Transition

The first-of-its-kind data book on the world's largest clean energy transformation.

India's energy transition is rewriting the global growth story. With 1.45 billion people, it's the fastest-growing major economy and a nation aiming for net-zero emissions by 2070. This data-driven chronicle captures how India is electrifying every home, scaling renewables from megawatts to gigawatts, and pioneering fuels of the future like green hydrogen.

From solar villages to smart grids, digital subsidies to global alliances, India is showing that decarbonisation and development can go hand in hand. Local Grids to Global Power reveals the numbers, the networks, and the new geopolitics of clean energy — and how a country's choices could determine the planet's climate future and give a blueprint for the Global South.

Authors: Poojil Tiwari, Neera Majumdar, and Arunabha Ghosh.

Organisation: The Council on Energy, Environment and Water (CEEW)—a **homegrown institution** with headquarters in New Delhi—is among the **world's leading climate think tanks**. The Council uses **data, integrated analysis, and strategic outreach** to support public policy, transform markets, shape technology, and nudge behaviour. CEEW seeks to explain—and change—the use, reuse, and misuse of resources. It addresses pressing global challenges through an **integrated and internationally focused** approach. The Council prides itself on the **independence** of its high-quality research and strives to **impact sustainable development at scale**. In over 15 years of operation, CEEW has impacted over 400 million lives and engaged with over 20 state governments. Follow us on LinkedIn and X (formerly Twitter) for the latest updates.

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INTRODUCTION

The energy transition underway in India is not just a sustainability or resilience imperative, but a growth strategy.

With 1.45 billion people, it is the world's most populous country¹, the fastest-growing major economy², and the current third-largest emitter³. At the 26th Conference of Parties in Glasgow in 2021, India committed to achieving net-zero emissions by 2070. This is a transition that could move over a billion people into a sustainable, low-emissions future and give the planet a fighting chance to stay warming within 2°C above preindustrial levels.

In 2015, when the Sustainable Development Goals were adopted, India had the world's largest population without access to electricity.⁴ Today, its household electrification programme has reached 28 million people in just 18 months since 2017.⁵ Cleaner cooking fuels now reach almost all households, reducing both carbon emissions and indoor air pollution.⁶ India's digital revolution—one of the cornerstones of its development strategy—is also cutting emissions. As hundreds of millions gained access to mobile phones and data, government services went online, including those delivering green energy subsidies directly to citizens. Smart meters now enable utilities to deliver electricity more efficiently and bill them correctly, while green appliances such as super-efficient ceiling fans are helping households reduce consumption.⁷ As a result, India has cut the emissions intensity of its GDP by 36 per cent between 2005 and 2020.⁸ All this, while becoming the world's fourth-largest installer of renewable energy capacity.⁹

The scale of India's clean energy build-out has been remarkable. In 2010, the country had less than 20 megawatts (MW) of solar power capacity; today it has over 127,000 MW.¹⁰ Wind capacity has risen from 9,400 MW in 2008 to more than 53,000 MW.¹¹ Nuclear power contributes another 8,700 MW¹², with the country ramping

up its ambitions with the announcement of a National Nuclear Mission in 2025, which aims to scale this up to 100,000 MW by 2047.¹³ Collectively, non-fossil sources now account for more than 50 per cent of India's installed capacity.¹⁴

India is attempting what few countries have done: provide affordable clean energy to hundreds of millions, clean up one of the world's largest energy systems, and become an economic and industrial powerhouse — all at once. Yet, industries today receive less than 20 per cent¹⁵ of their energy from electricity. Heavy industries still require fuels for high-intensity operations, which cannot be met by electricity alone.¹⁶ For this, the country is placing a strategic bet on fuels of the future such as green hydrogen. Approved in 2023 with an outlay of nearly USD 2.4 billion, the National Green Hydrogen Mission targets five million tonnes of green hydrogen production per year by 2030.¹⁷

India's ambitions extend beyond its borders. It helped found the International Solar Alliance, the Coalition for Disaster Resilient Infrastructure, and the Global Biofuels Alliance — global partnerships for clean energy and climate adaptation. Through the One Sun, One World, One Grid initiative, India envisions linking renewable-rich regions across Asia, the Middle East, and Africa through high-voltage transmission networks.¹⁸ By 2040, 85 per cent of global energy demand will come from emerging economies in these regions.¹⁹ However, we are hard-pressed to find in 2025, the world that signed the Paris Agreement a decade ago in 2015. Developed countries are projected to collectively emit around 3.7 GtCO₂e more in 2030 than their stated reduction goals.²⁰ Even if they achieve net zero by 2050, they will consume 40–50 per cent of the carbon budget left to keep the increase in warming within 1.5°C of pre-industrial levels.²¹

The clean energy transition can also expand energy access. Decarbonisation does not mean compromising economic growth. And much of the developing world will not gradually transition its energy systems, but leap into a sustainable future. New Delhi is providing a blueprint for how this can happen.

1. INDIA NEEDS TO TRANSITION FOR THE WORLD TO TRANSITION

BIG TRANSITIONS ARE COMING IN EMERGING ECONOMIES

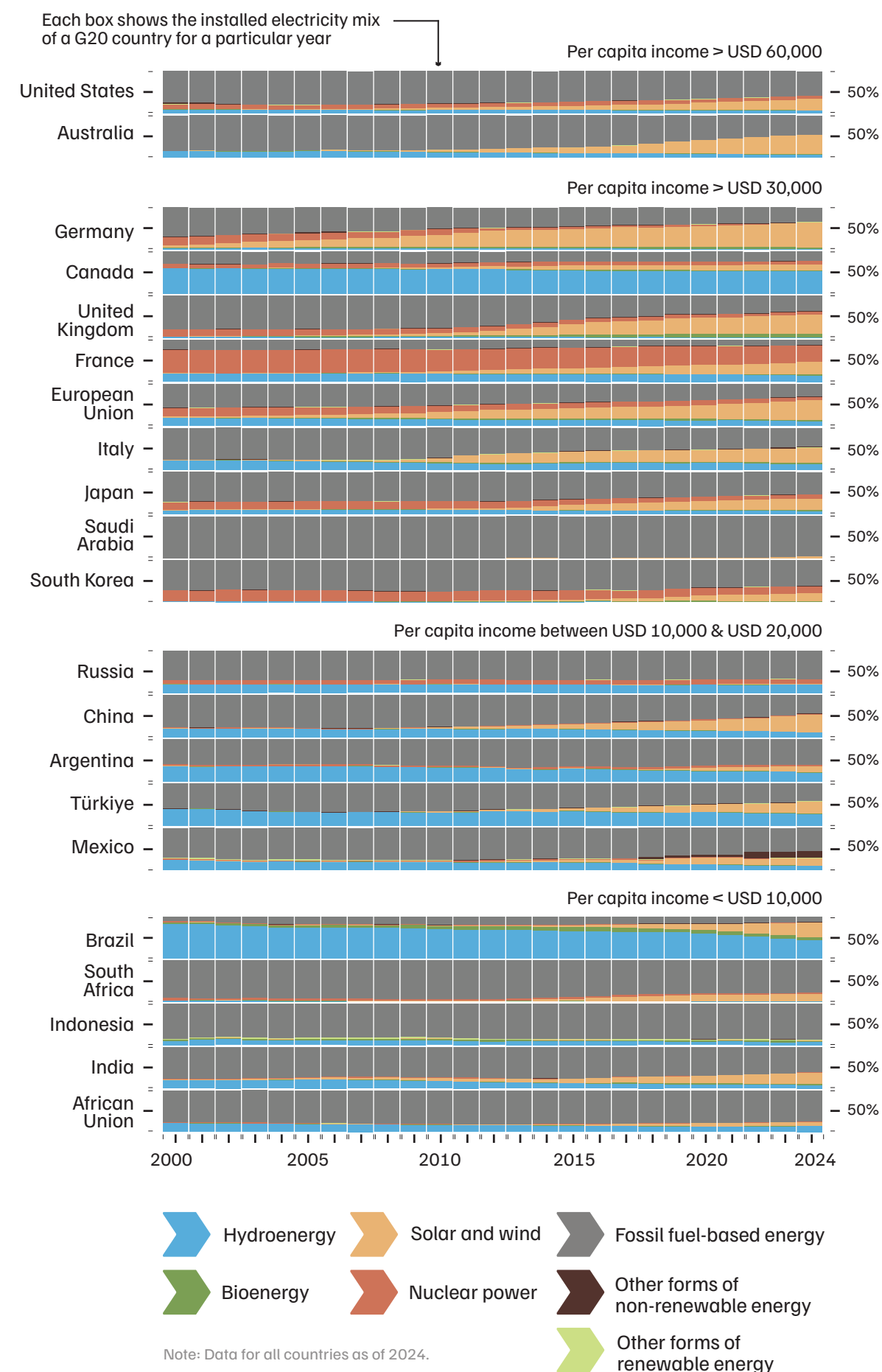
Developed countries have usually seen economic prosperity before undergoing a transition to cleaner sources of energy.¹ Today, that story is being rewritten—from New Delhi to Ankara, São Paulo to Jakarta.

For instance, non-fossil-fuels now make up 50 per cent of India's installed power capacity.² This is in tandem with near-universal household electrification³ and LPG becoming the primary cooking fuel in nearly three in four households⁴. All this at a per capita GDP of ~USD 2,800⁵, far below where countries like the United States or the United Kingdom began dedicated clean energy efforts.

South Africa, at ~USD 6,000, is replacing coal with wind and solar as a solution to its

energy crisis. In 2023, the country's solar PV installations grew by 33 per cent.⁶ Brazil, with ~USD 10,000 per capita, has already achieved more than 80 per cent clean energy in its power system.⁷

Looking at data from the G20 countries, it is evident that the energy transition is being driven not only by advanced economies but also by emerging ones.



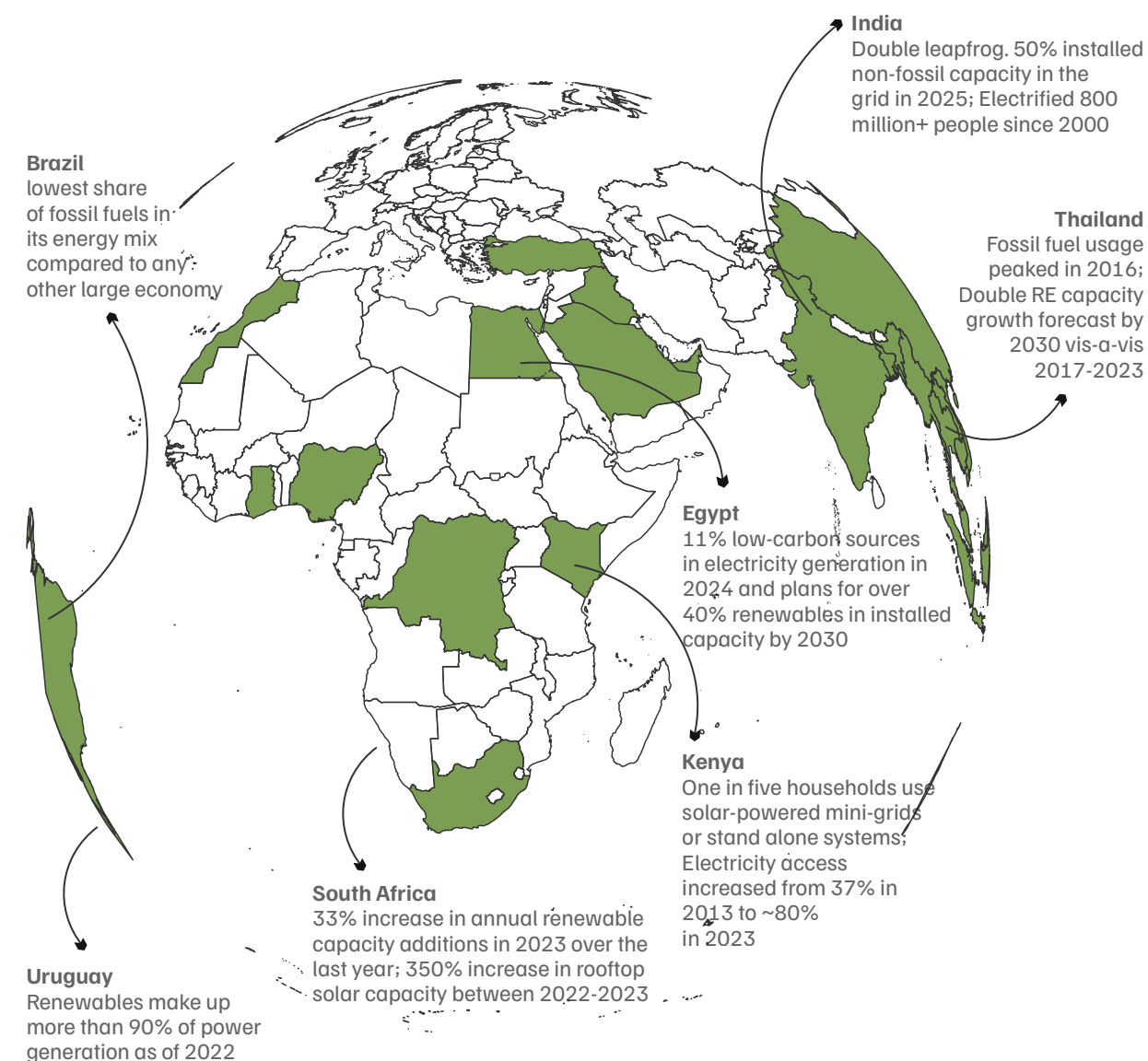
EMERGING ECONOMIES ARE LEAPFROGGING INTO A CLEAN ENERGY PARADIGM

Over 80 per cent of the growth in global electricity demand in the next decade will come from emerging economies.⁸ Unlike developed countries, they are not gradually transitioning toward clean energy. They are leapfrogging to clean energy to meet the rising demand from fast-growing economies.

In Asia Pacific (excluding China), renewable capacity is expected to grow more than 680 GW between 2024-2030, double than what was added in the preceding six years.⁹ In the Middle East and North Africa (MENA), renewable energy (RE) expansion is expected to triple from 53 GW in 2023 to almost 150 GW in 2030. This is spurred by growing domestic demand, coupled with population and economic growth.¹⁰ Latin America, long dominated by hydropower, is pivoting decisively to solar and wind. Brazil

leads with over half of the region's planned capacity additions, followed by Chile, Mexico, and Colombia.¹¹

In countries such as South Africa, Chile, Thailand, and Turkey, fossil fuel demand for electricity generation has already peaked¹², while others, such as India, are undergoing a double leapfrog, advancing clean energy deployment while simultaneously bringing electricity access to its citizens.¹³



Source: Bond, Kingsmill, Arunabha Ghosh, Ed Vaughan, and Harry Benham. 2021. *Reach for the sun: The emerging market electricity leapfrog*. A Carbon Tracker-CEEW report. London: Carbon Tracker, Ferris, Nick; IRENA. *Renewable Capacity Statistics 2025*. International Renewable Energy Agency, 2025; "Weekly Data: South Africa's Unprecedented Rooftop Solar Boom." *Energy Monitor*, 14 August 2023; "Uruguay." International Energy Agency (IEA); "Kenya's energy sector is making strides toward universal electricity access, clean cooking solutions and renewable energy development." *IEA News*, 14 April 2025; "Egypt." *Ember*, 11 April 2025.

Selected emerging markets

CLEAN ENERGY NOW POWERS HALF OF INDIA'S INSTALLED POWER CAPACITY

In 2010, India had about 20 megawatts (MW) of solar capacity.¹⁴ Today, the country has added more solar in just the last four years than in all the years prior.¹⁵

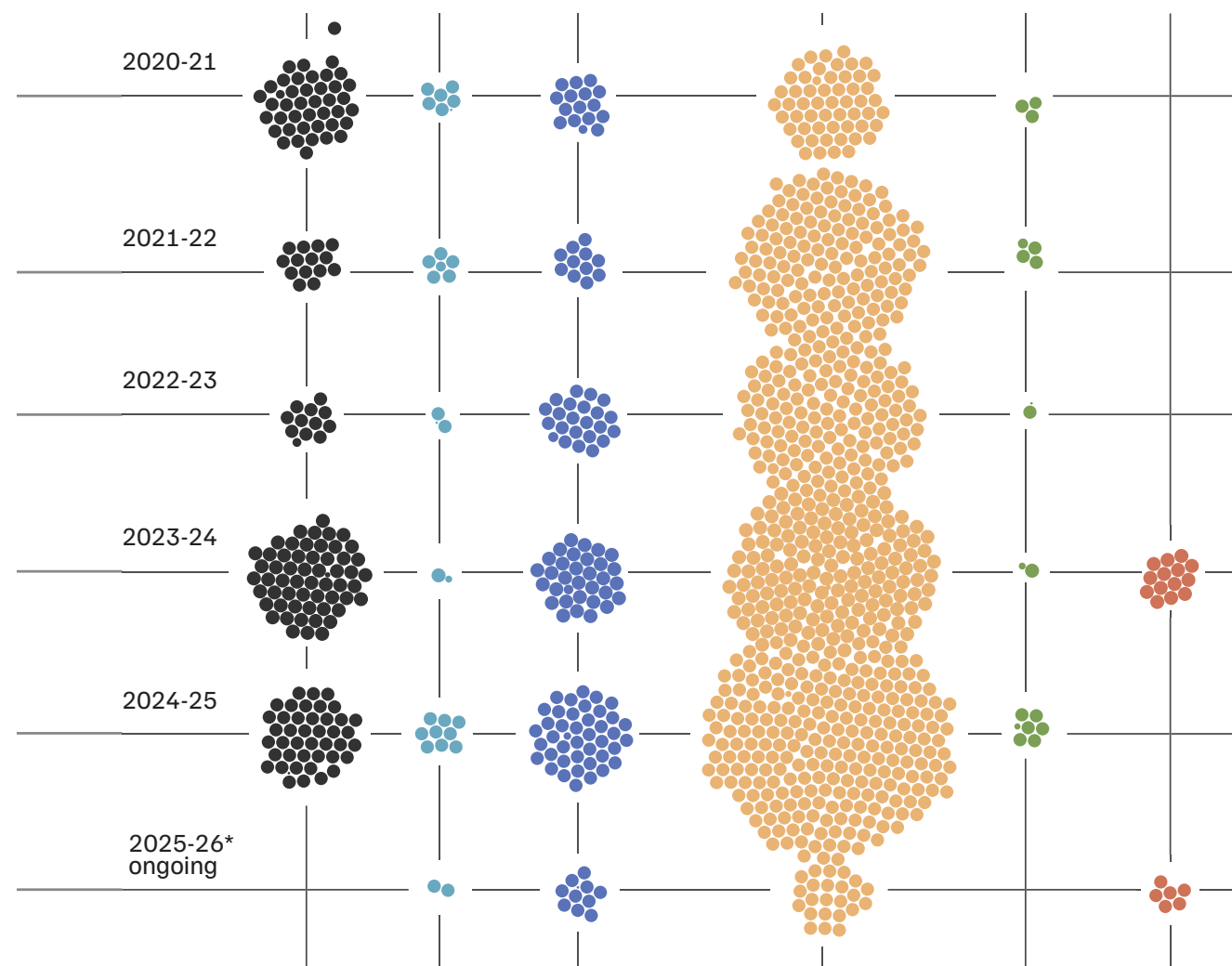
India's wind and hydropower sectors have matured. Its grid is nationally integrated, and for the first time, annual renewable energy additions are outpacing those from fossil fuels.¹⁶ New Delhi is already in the middle of one of the most ambitious clean energy transitions the world has seen. In capacity terms, it is exceeded only by China and the United States in renewable energy installations between 2020 and 2024. In percentage terms, its grid already has more installed renewable capacity than the US.¹⁷ Further, the International Energy Agency (IEA) reports that while China is the largest builder of renewable capacity in net volume, India is installing renewables at the fastest rate among major economies.¹⁸

India has already met its 2030 Nationally Determined Contribution (NDC) of non-fossils making up 50 per cent of its installed power capacity, five years ahead of schedule¹⁹. While the drive ahead may not be so linear, New Delhi is well on its way.

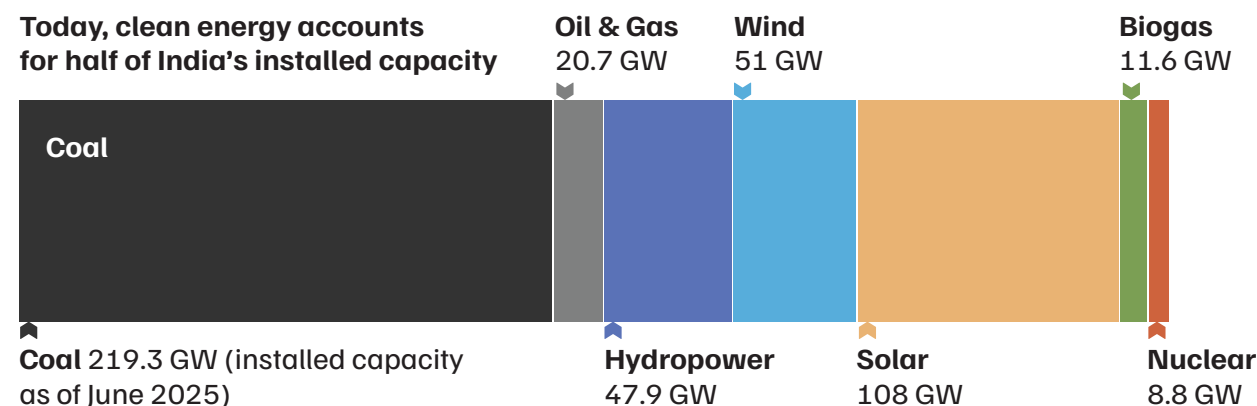
- 2021 | Panchamrit announced India sets a 500 GW non-fossil target for 2030 at COP26
- 2022 | 100 GW RE milestone. Solar hits ~67 GW, wind ~40 GW
-
-
- 2024 | Solar hits record pace India adds 24.5 GW, its biggest-ever annual solar installation
- 2025 | Renewed impetus for Nuclear Capacity doubled over the last decade; Budget 2025 sets a 100 GW target by 2047
-

In 2020, coal made up 55% of India's total installed capacity. Since then, India has dramatically scaled up its clean energy deployment

Each circle represents approx. 100 MW of additional installed capacity



Today, clean energy accounts for half of India's installed capacity



Source: Authors' analysis of data from NITI Aayog and Vasudha Foundation. India Climate & Energy Dashboard (ICED)

Note: India has not added new oil and gas capacity since 2020. Hydro includes small-hydro. Data for 2025-26 is as of June 2025.

INDIA SHOULD AIM FOR 600 GW OF CLEAN ENERGY BY 2030

New Delhi's commitment to install 500 GW of non-fossil-fuel energy capacity by 2030 will be enough to meet India's future power demand in 2030.

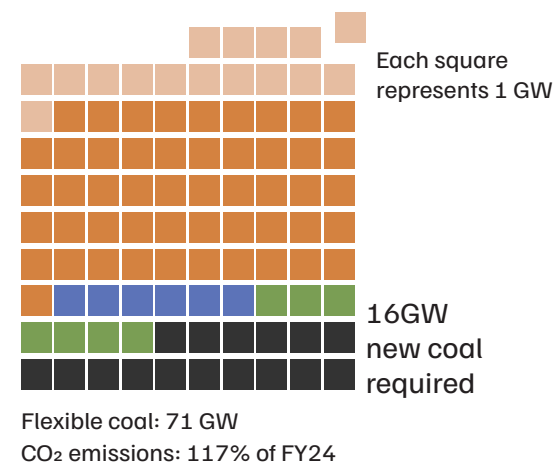
This is in a moderate demand scenario, where electricity demand grows by 5.8 per cent annually from 2022, as projected by the country's Central Electricity Authority.²⁰ Analysis by CEEW shows that existing, under-construction, and planned projects can meet demand without adding new coal to the grid.²¹

A more compelling and ambitious case is for going further. India's energy demand is estimated to grow by more than any other country in the coming decades.²² If demand outpaces economic growth—driven by the need for cooling or even data centres—India would need an extra 100 GW of clean power by 2030 to avoid new coal on the grid.²³

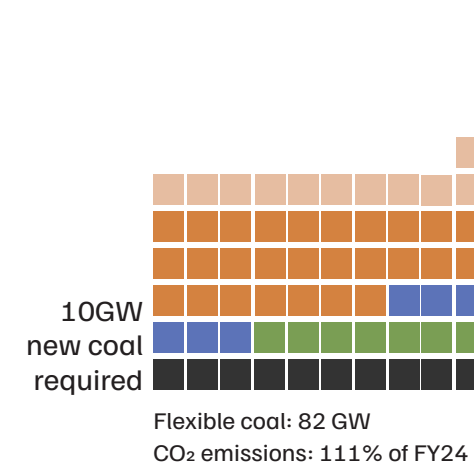
Each square in the chart represents one GW of additional resources—storage, hydro, new coal—needed over and above the installed renewable energy capacity across scenarios.

Deploying 600 GW of clean energy across states by 2030 offers a more reliable and cost-effective path to energy security. We estimate this could save up to INR 42,400 crore in power procurement costs, while creating as many as 240,000 additional full-time equivalent jobs and cutting carbon emissions by ~16 per cent from FY24 levels.²⁴

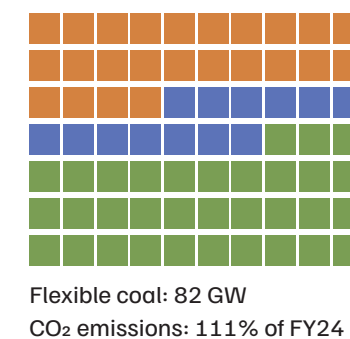
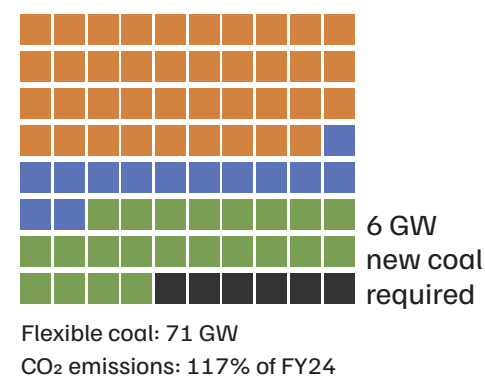
High power demand in 2030
(2,473 billion units)



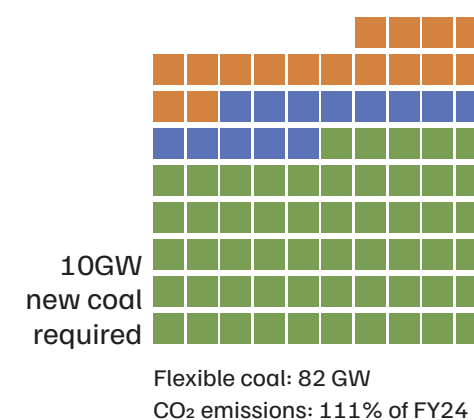
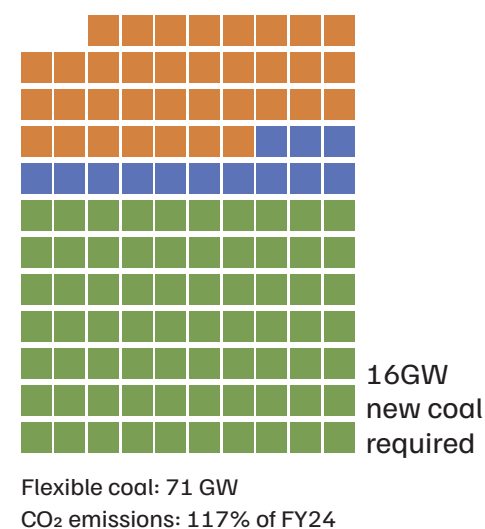
Moderate power demand in 2030
(2,377 billion units)



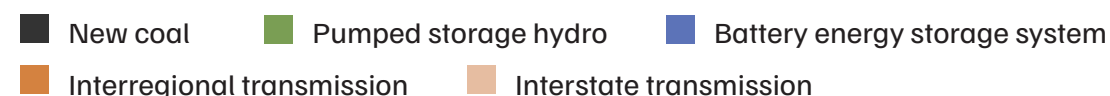
India meets 80% of its target with 400 GW non-fossil capacity



India meets its non-fossil target of 500 GW by 2030



India exceeds its target with 600 GW non-fossil capacity spread across states



A 2070 NET-ZERO WILL COME WITH PEOPLE, LAND, AND CLIMATE CHALLENGES

On the very first day of COP26 in Glasgow, in 2021, India's Prime Minister announced the country's aim to reach net zero emissions by 2070.²⁵

By one estimate, India's achievement of this target could alone reduce warming globally by 0.2°C.²⁶ To meet it, the country could need 7,000 GW of renewable energy—wind and solar—capacity²⁷. Currently, it has an installed capacity of ~180 GW.²⁸

On the ground, deploying RE beyond 300 GW will require making realistic tradeoffs. For instance, between deploying on highly-priced land and highly-populated land.²⁹ Beyond 750 GW, RE will need to be deployed in areas that are either prone to earthquakes or areas with higher seasonality, which impacts solar availability.³⁰ Beyond 1,500 GW, India would also need to tap into areas with higher population density—up to 750 people per square kilometre. Finally, unlocking potential beyond 3,000 GW will require exploring areas with high climate risks and land-related social conflicts.³¹

Policy reforms, infrastructure investment, and real-time data that enables smarter site selection and faster project approvals will be critical. Every gigawatt added here helps keep the 1.5°C target within reach. The next phase of India's energy transition will be shaped not just by how much the country builds—but where and how it chooses to build it.

➤ 7,000 GW
Renewable energy required to meet India's net-zero target

➤ Beyond 5,000 GW
Deployment goes into high seismic and climate-risk zones

➤ 3,000–5,000 GW
All constraints intensify— land availability, population density, conflict, climate

➤ 1,500–3,000 GW
Population density constraints of 400–750 people/km² and land conflict exposure

➤ 1,500 GW

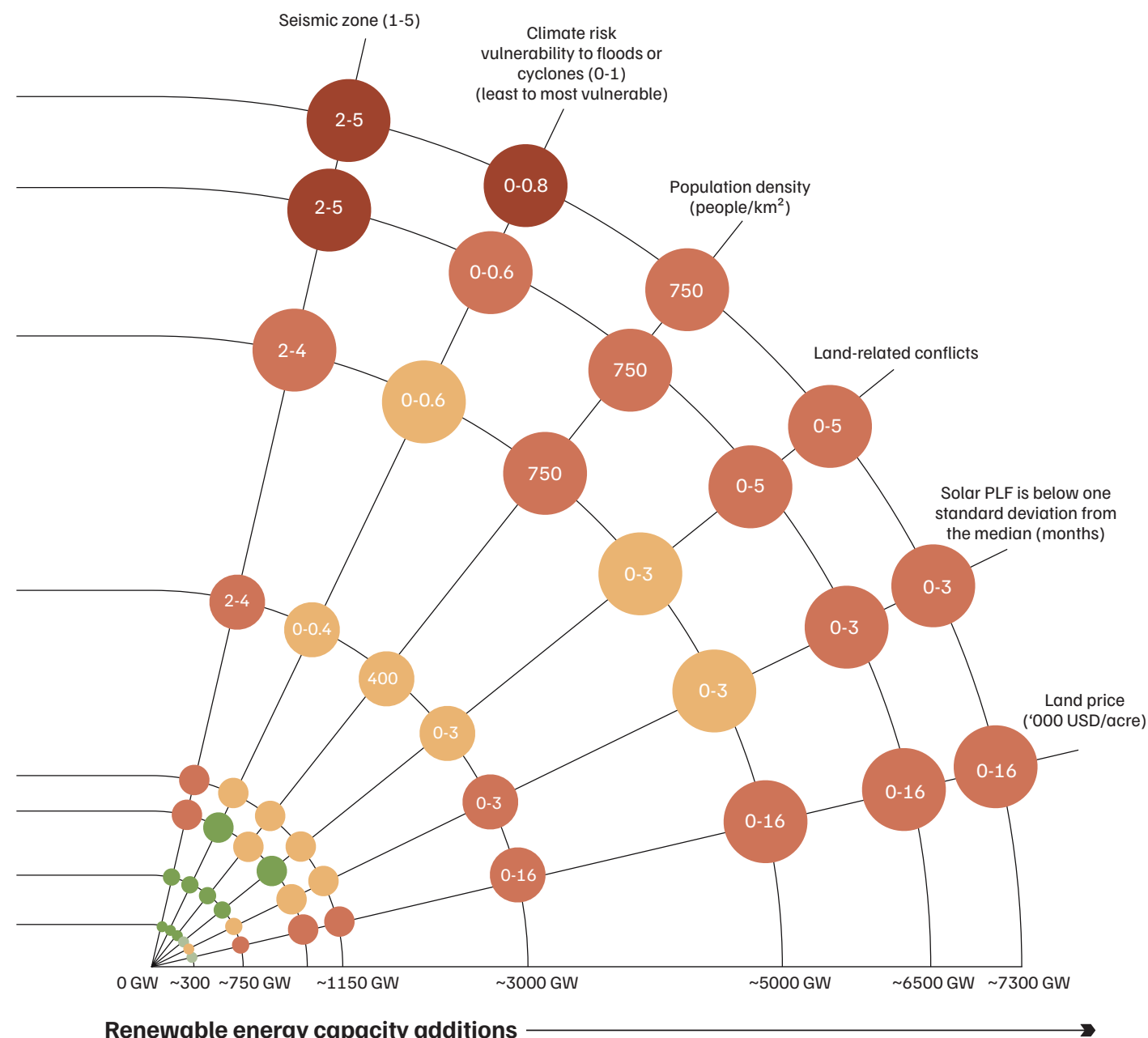
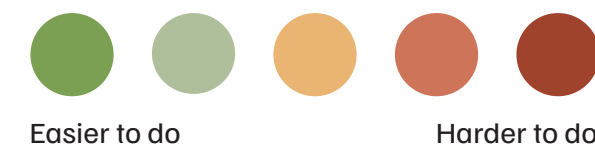
➤ 60–300 GW
India's current RE capacity is ~220 GW

Source: Mallya, Hemant, Deepak Yadav, Anushka Maheshwari, Nitin Bassi, and Prerna Prabhakar *Unlocking India's RE and Green Hydrogen Potential: An Assessment of Land, Water, and Climate Nexus*. Council on Energy, Environment and Water.

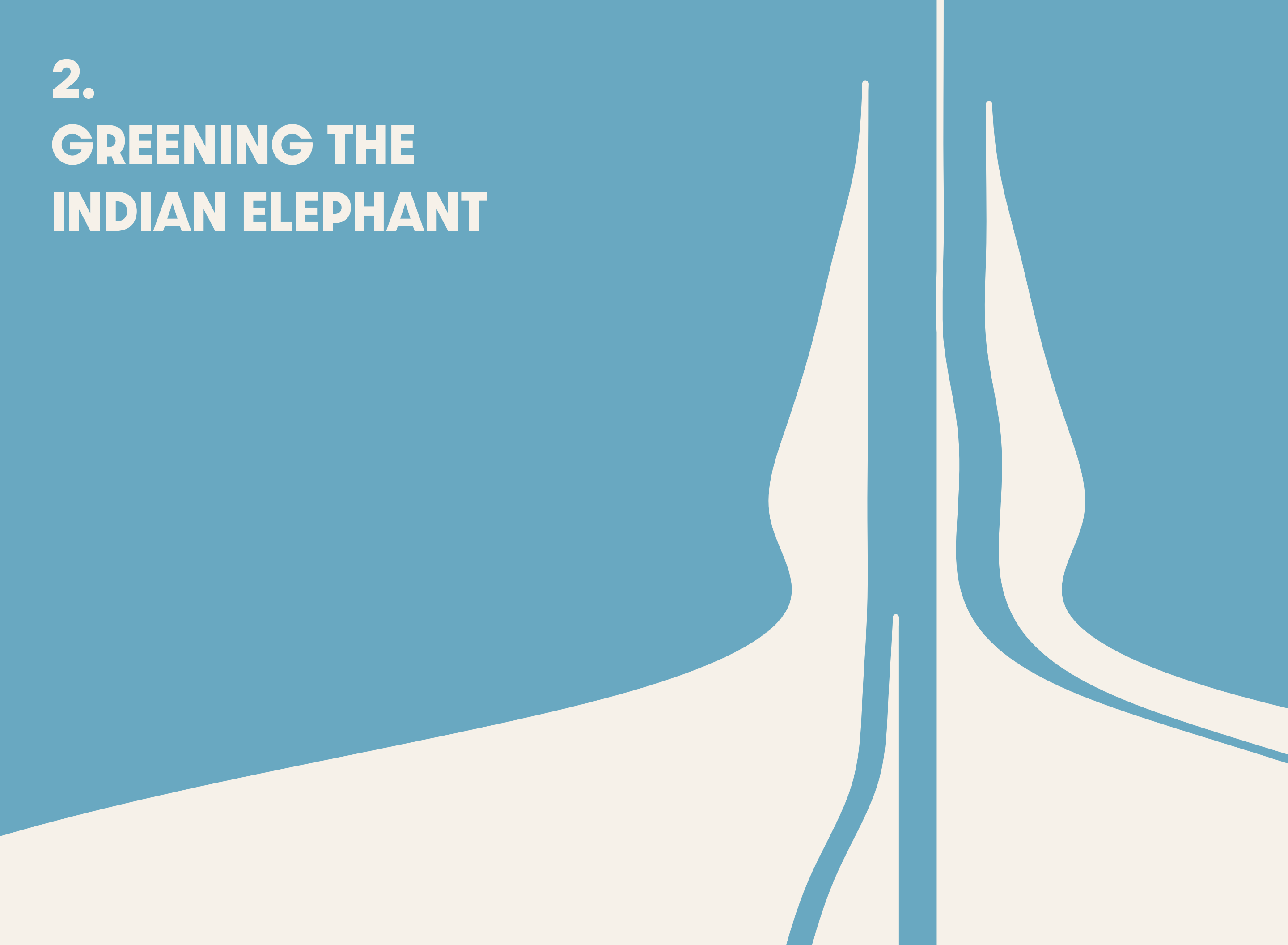
To meet its net-zero goal by 2070, India could need up to 7,000 GW of renewable energy.

But each additional GW comes with greater constraints on land, population density, climate risk, and availability of sunlight.

Each circle represents the levels of difficulty to building more RE in India



2. GREENING THE INDIAN ELEPHANT



INDIA'S CLIMATE POLICIES ARE ALREADY PAYING OFF

Between 2015 and 2020, India's climate policies helped avoid 440 million tonnes of CO₂ emissions.¹

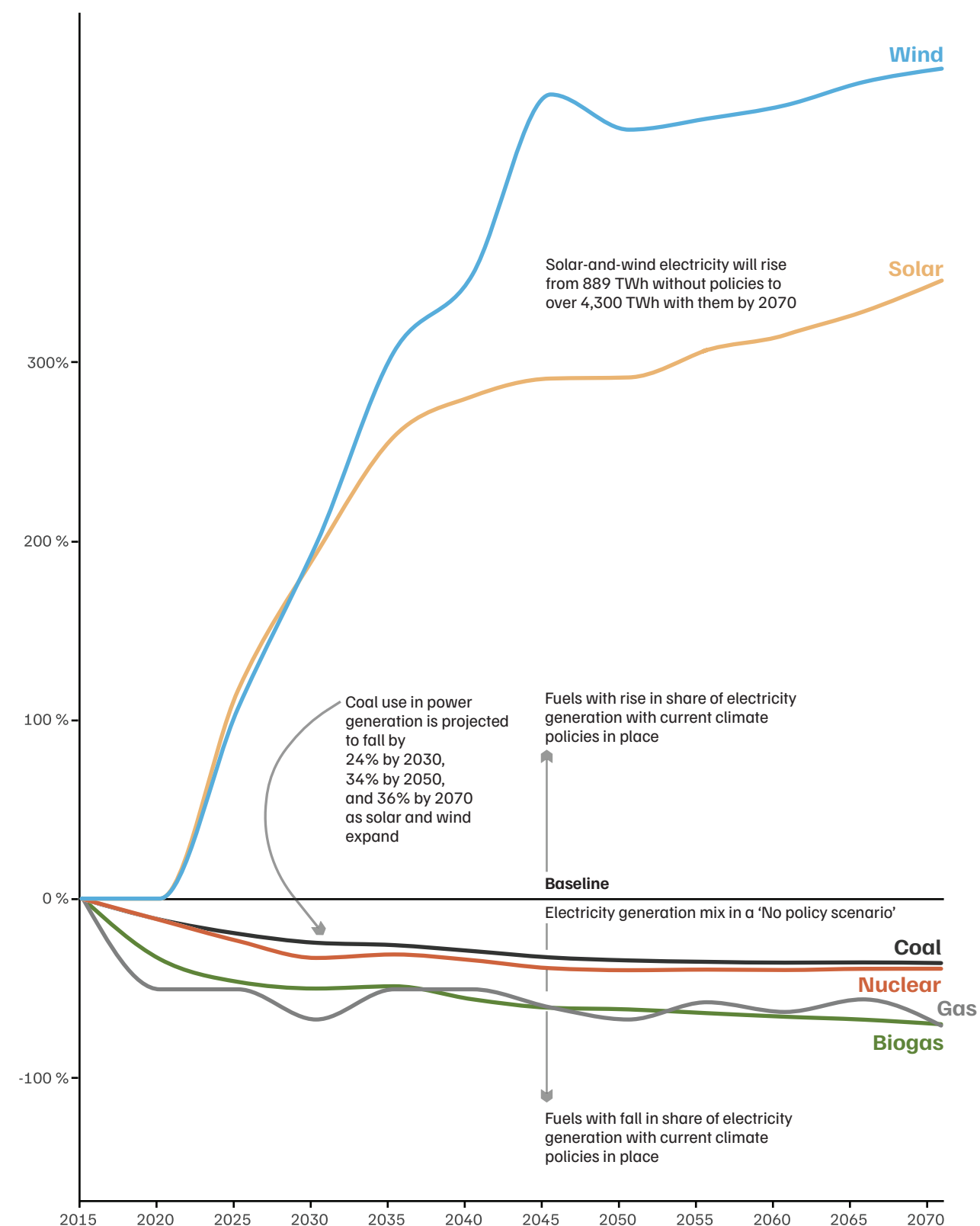
Policies across power, transport, and residential sectors are further projected to reduce emissions by four billion tonnes between 2020 and 2030, well beyond the one billion tonne reduction India promised at COP26 in Glasgow.²

CEEW modelled India's energy mix up till 2070 under two scenarios: a 'current policy scenario'—reflecting interventions such as the National Solar Mission, renewable energy auctions, LED adoption, FAME and FAME II for incentivising electric vehicle sales—and a No Policy Scenario. Stronger

policies for solar and wind have helped avoid the addition of 80 GW of new coal-based power plants, otherwise needed to meet the country's growing demand.³

Without these policies—and even with the current climate policies—coal would remain important for India's energy security and affordability, especially in the near-term. And while the current policies are bending the long-term emissions curve, they would fall short of achieving net-zero by 2070, making the case for an even more ambitious long-term energy transition plan.⁴

With climate policies, electricity generation from renewables surges as that from fossil fuels declines



Note: The percentage increase in wind is higher due to a relatively lower base.

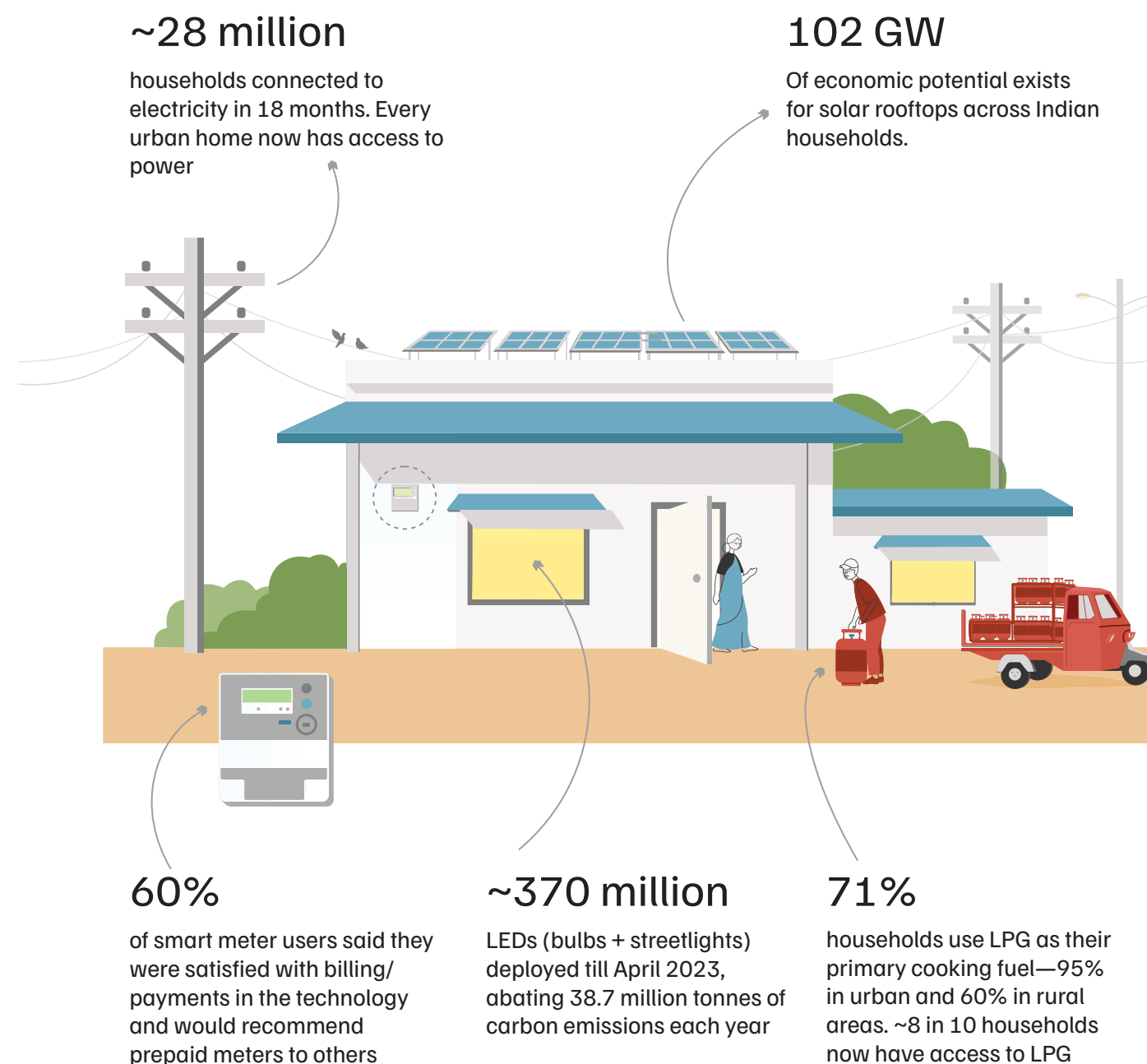
INDIA IS CHAMPIONING DOORSTEP DELIVERY OF SUSTAINABILITY

The energy transition is increasingly becoming visible in India's economy, policies, and homes.

Between 2005 and 2020, the emissions intensity of India's GDP—the amount of emissions generated per dollar added to national income—fell by 31.5 per cent.⁵ This reduction has happened with increased energy efficiency and green energy deployment, driving economic growth. Since 2017, the *Saubhagya* (or “good fortune”) scheme connected ~28 million homes to electricity, bringing household electrification rates to at least 98 per cent.⁶ India is also the largest procurer of LED light bulbs under the *Unnat Jyoti by Affordable LEDs for All (UJALA)* scheme. New Delhi's large-scale purchases brought down the price of a single light bulb by 85 per cent between 2015 and 2019, further lowering the cost of energy-efficient lighting for ordinary households.⁷ Another priority has been providing

Indian homes with cleaner cooking fuels, reducing reliance on firewood and other plant materials that release large amounts of carbon dioxide. The 2016 *Ujjawala* (or “bright”) scheme brought LPG cylinders to four-fifths of the country's households by 2020, up from half just a few years earlier.⁸ And more recently, the country has made a big push for decentralised energy with the *PM Surya Ghar: Muft Bijli Yojana* (or “solar-powered homes”) scheme, promising to deploy rooftop solar systems in 10 million homes by 2026-27.⁹

When citizens experience the benefits of growing through greening—fairer and cheaper billing, cleaner cooking and indoor air quality, and energy-efficient homes—sustainability gains public momentum.



Source: Press Information Bureau, Government of India. “SAUBHAGYA Electrification Scheme – A Total 2.86 crore Households Have Been Electrified” March 16, 2023; Zachariah, Sachin, Bhawna Tyagi, and Neeraj Kuldeep. 2023. *Mapping India's Residential Rooftop Solar Potential: A Bottom Up Assessment Using Primary Data*. Council on Energy, Environment and Water (CEEW); Mani, Sunil, Shalu Agrawal, Abhishek Jain and Karthik Ganesan. 2021. *State of Clean Cooking Energy Access in India: Insights from the India Residential Energy Survey (IRES) 2020*. CEEW; Shalu Agrawal, Sunil Mani, Simran Kalra, Bharat Sharma, and Kanika Balani. 2023. *Enabling A Consumer-Centric Smart Metering Transition in India: Insights from A Survey of Six States*. CEEW, and Press Information Bureau, Government of India. “PM Surya Ghar: India's Solar Revolution—Muft Bijli Yojana Crosses Milestone of 10 Lakh Installations.” Press Release, March 13, 2025

THE ENERGY TRANSITION IS POWERING NEW RURAL ENTERPRISES IN INDIA

India's clean energy transition is not just about increasing access; it is also about powering livelihoods.

Neither is it just an urban India story. With the near-universal electrification of villages and households, energy demand patterns will shift. Electricity use will rise in homes and across rural enterprises seeking higher productivity. Decentralised renewable energy technologies (DRE) could sustainably meet this rising demand and steer growth in rural economies.¹⁰

In 2022, India adopted a first-of-its-kind national policy for DRE technologies supporting livelihoods¹¹. These clean energy technologies draw power from the sun—and other renewables such as biomass—to supply electricity locally. DRE can run appliances, and power small enterprises, reducing reliance on the central power grid. For instance, a portable solar dryer can extend the shelf

life of farm produce (think dry flowers, mangoes and tomatoes), reducing food loss and increasing farmers' incomes.¹² A CEEW survey of DRE users found that six in 10 are engaged in farming,¹³ underscoring DRE's importance for agriculture, India's largest employer. Notably, the sector accounts for three-fourths of rural women's jobs¹⁴, and 62 per cent of DRE users are women.¹⁵

Distributed clean tech also represents a massive economic opportunity. CEEW further estimates that mature technologies could support 37 million livelihoods and create a USD ~50 billion market for deploying enterprises.¹⁶ Unlocking this will require financing across the value chain—from innovators designing solutions, to rural enterprises scaling production, and to end-users adopting DRE for livelihoods.

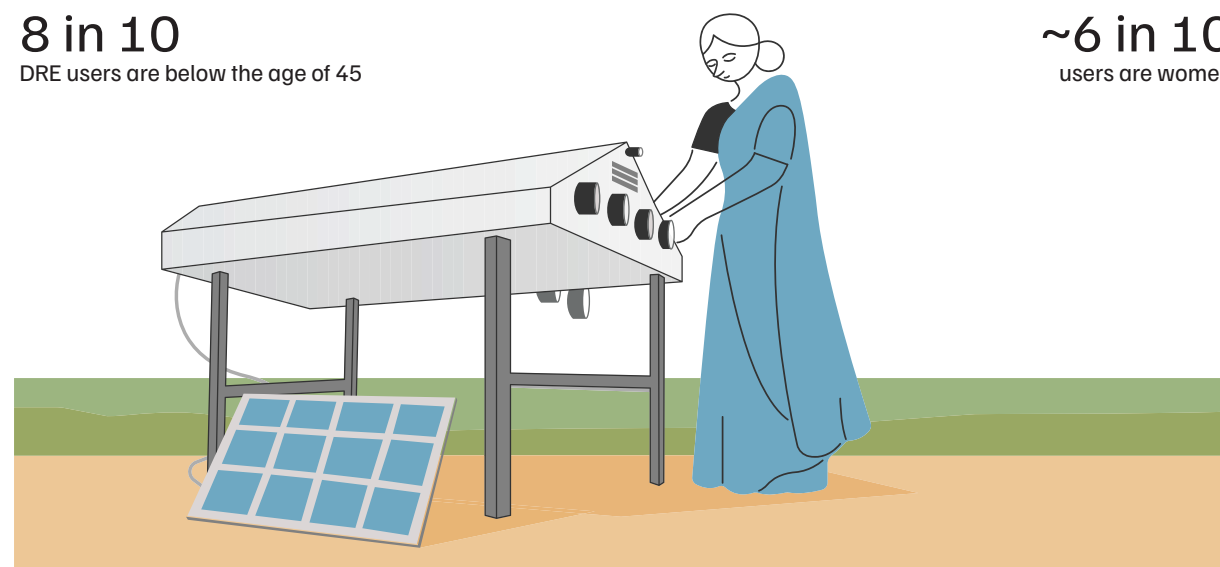
Who is using distributed clean tech in India?

8 in 10

DRE users are below the age of 45

~6 in 10

users are women



4 in 10

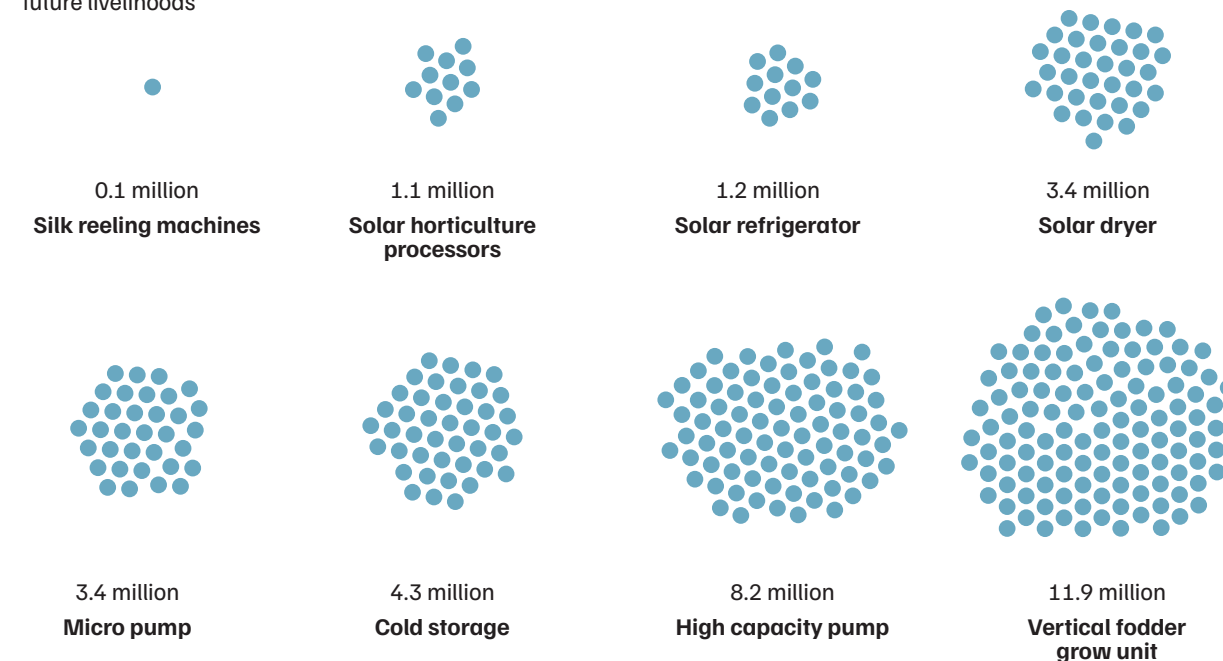
DRE users belong to Scheduled Castes and Scheduled Tribes: historically marginalised communities that have faced social exclusion and limited economic mobility

~6 in 10

users have a household income below 1,800 USD per year

DRE clean tech has the potential to support 37 million livelihoods, further catalysing a ~USD 50 billion market

Every dot corresponds to 100,000 future livelihoods



Note: Selected technologies shown have deployment scales between 100 and 100,000+ users.

Source: Yasaswi, Priyatam, Divya Gaur, and Abhishek Jain. 2025. *How Decentralised Renewable Energy-powered Technologies Impact Sustainable Livelihoods: Findings from the Ground*. Council on Energy, Environment and Water and Jain, Abhishek, Wase Khalid, and Shruti Jindal. 2023. *Decentralised Renewable Energy Technologies for Sustainable Livelihoods: Market, Viability, and Impact Potential in India*. Council on Energy, Environment and Water.

POLICIES ARE BUILDING MOMENTUM FOR THE EV STORY

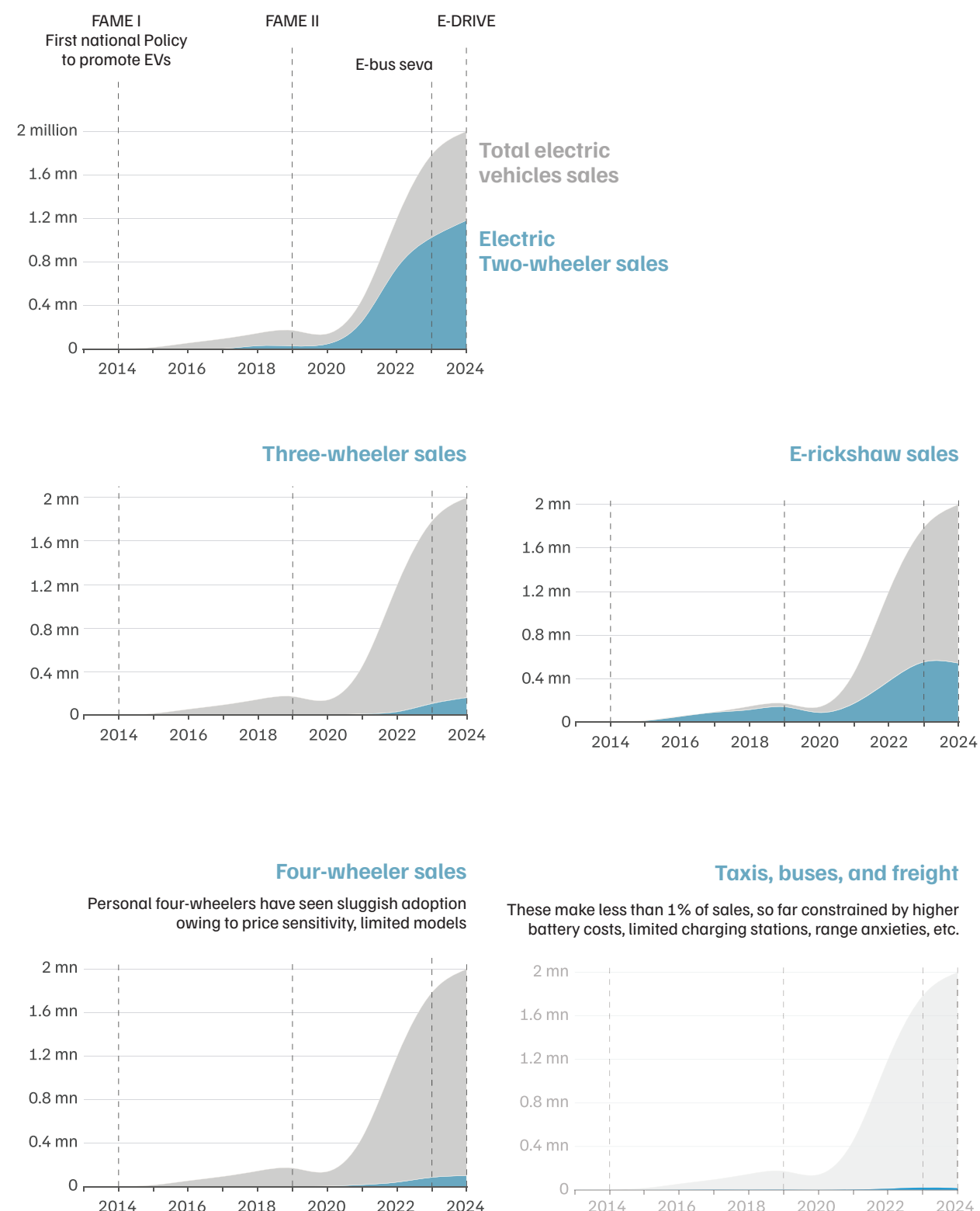
Much like clean cooking and household electrification, India's approach to transport must balance two goals—expanding public transport access and ensuring clean mobility.

On the latter, India is on the road. In 2024–25, electric vehicle (EV) sales neared 2 million¹⁷ and are projected to rise to about 6 million combined by 2026, incentivised by supportive policies and subsidies.¹⁸ The inflexion point came in 2019 with FAME II, a USD 1.4 billion (2019 prices) scheme offering subsidies for electric two-, three-, and four-wheelers and public buses.¹⁹ This was followed by the PM e-Bus Sewa initiative in 2023 to deploy 10,000 electric buses²⁰, and PM e-Drive in 2024, which extended incentives for 2.9 million EVs,

with two-fifths of its financial outlay dedicated to e-buses.²¹

The push for public transport is relevant because 94 per cent of electric vehicles sold in 2024-25 were two- and three-wheelers.²² Both remain cheaper to own and operate—at a total cost of ownership of less than INR 1.5/km—across their entire life cycle.²³ Yet, while these lighter EVs meet rising income aspirations and last-mile mobility needs, their rapid growth risks adding to congestion and pressure on urban roads.²⁴

India's EV sales near 2 million in 2024-25



INDIA IS BETTING BIG ON GREEN HYDROGEN

New Delhi has set one of the world's most ambitious production target for a single economy—five million metric tonnes per annum (MTPA) by 2030.²⁵

Further, over 10 times this production potential exists in areas without major water availability issues.²⁶ Producing hydrogen requires splitting water into hydrogen and oxygen, a process that requires significant energy. When that energy comes from renewable or non-fossil sources, the result is green hydrogen.

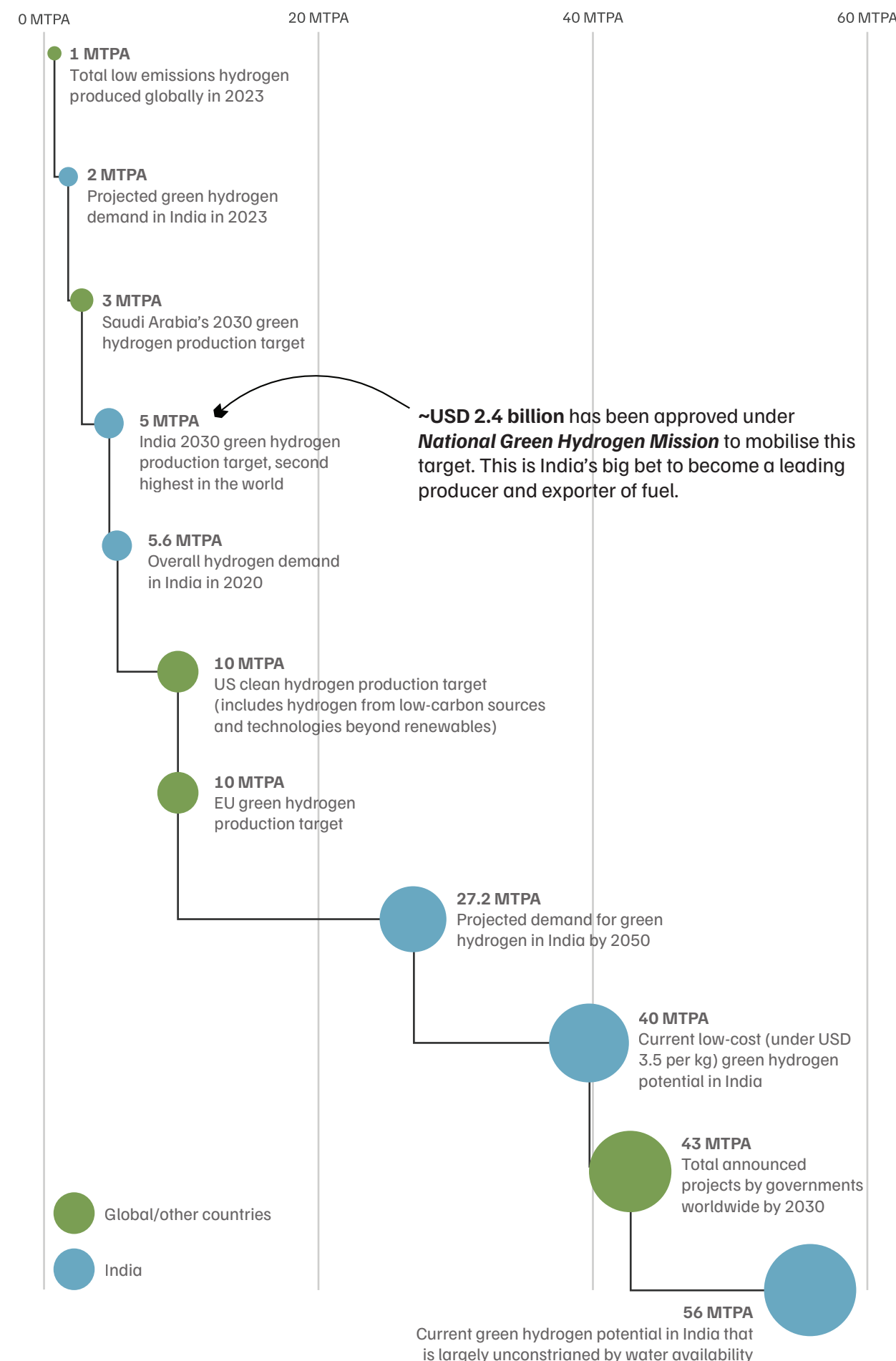
India will need to add about 135 GW of new RE capacity to meet the 310 billion units of electricity required to meet its 2030 target.²⁷ This is nearly 13 per cent of the current projected electricity demand in 2030²⁸, an example of how deeply the fuel could reshape the way India consumes power. For hard-to-abate sectors such as steel, freight transport, and petrochemicals, this fuel-of-the-future could be a game-

changer, advancing industrial growth while simultaneously reducing industrial emissions.

Early signs show that India's green hydrogen push will be state-led. Six states—Gujarat, Maharashtra, Tamil Nadu, Andhra Pradesh, Odisha, and Uttar Pradesh—could deliver nearly 90 per cent of the 2030 target. Gujarat alone may produce 2 MTPA, driven by its ports, industries, and strong wind-solar base.²⁹

India is showing leadership in production targets. It must also lead in promoting a global, rules-based framework to avoid protectionist barriers in green hydrogen trade and technology.

Source: International Energy Agency (IEA). Global Hydrogen Review 2024. International Energy Agency, 2024; Mallya, Hemant, Deepak Yadav, Anushka Maheshwari, Nitin Bassi, and Prerna Prabhakar Unlocking India's RE and Green Hydrogen Potential: An Assessment of Land, Water, and Climate Nexus. Council on Energy, Environment and Water (CEEW); CFLI India and CEEW. 2024. Financing Green Hydrogen in India: Private Sector Considerations to Strengthen India's Enabling Environment for a Competitive Green Hydrogen Economy. CEEW, and Ghosh, Arunabha, Tulika Gupta, Shuva Raha, Hemant Mallya, Deepak Yadav, and Nandini Harihar. 2022. Rules for an Energy-Secure Global Green Hydrogen Economy. CEEW.



3. THE ENERGY TRANSITION IS STILL AN UPHILL TASK



MONEY DOESN'T FLOW WHERE THE SUN SHINES THE MOST – THE GLOBAL SOUTH

No conversation on exponential climate action can happen without one on exponential climate finance.¹

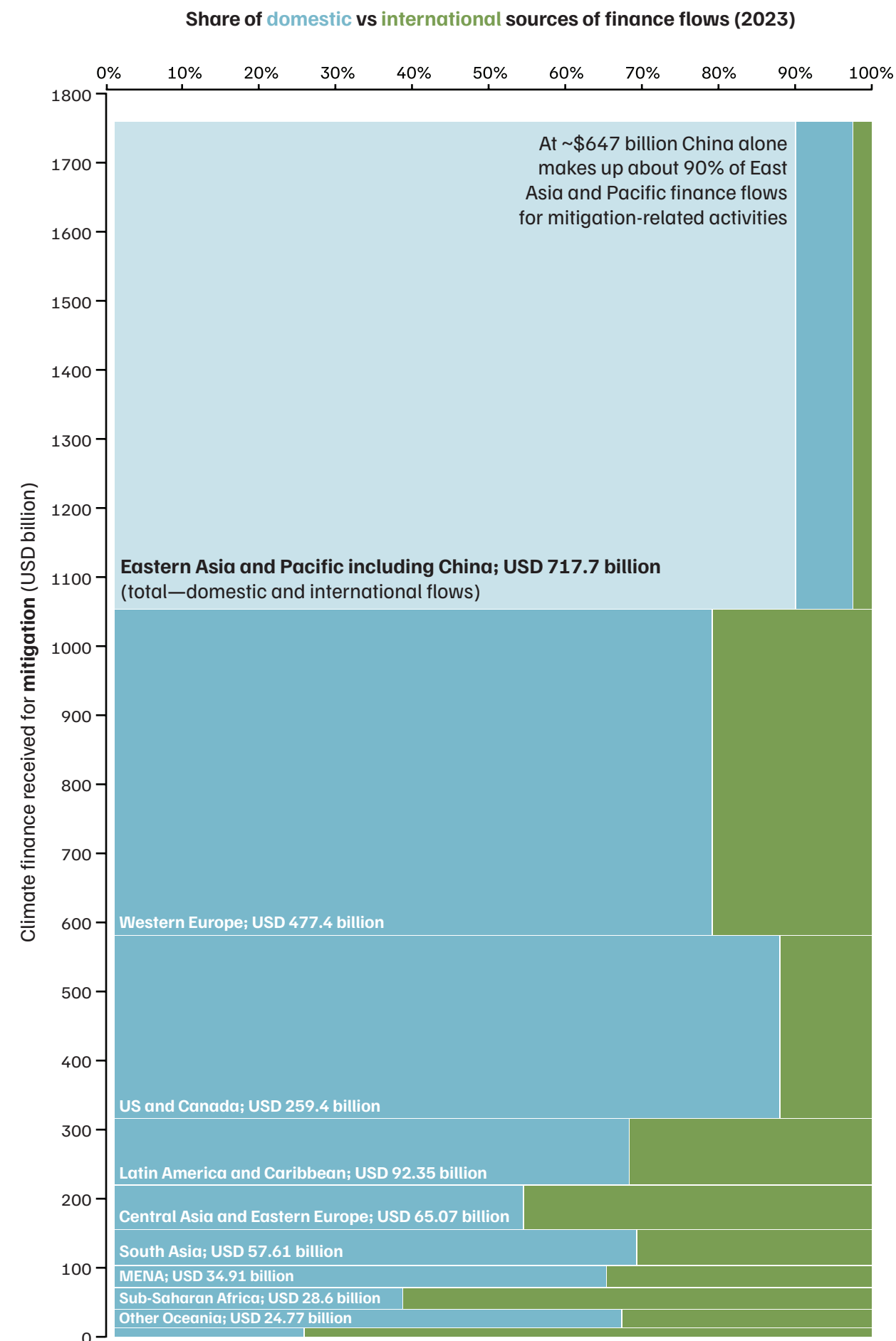
Global climate finance reached USD 1.9 trillion in 2023²—less than two per cent of global GDP. Over 90 per cent of this went to mitigation,³ financing clean energy, transport, and industrial efforts to reduce or prevent emissions. For context, the Independent High Level Expert Group on Climate Finance estimates that developing countries (excluding China) will need USD 3.2 trillion annually by 2035 for climate and nature investments. USD 1.3 trillion of this must come from international sources.⁴

International investors may often overestimate risks in emerging markets, partly due to information gaps. As a result, they either avoid clean energy projects or demand such high returns that capital becomes prohibitively expensive.⁵ In parallel, developing countries have to

balance climate ambition with economic growth. Around 3.4 billion people live in countries that currently spend more on interest payments than on health or education.⁶

At the 29th Conference of the Parties in Baku, developed countries committed to “taking the lead” in mobilising USD 300 billion annually by 2035—far below what is needed. CEEW estimates that India alone will require about USD 202 billion each year till 2070 to meet its net-zero target.⁷ Mitigation finance in the Global South must therefore be de-risked. One proposal by CEEW—Global Clean Investment Risk Mitigation Mechanism—seeks to do this by pooling risk across projects and countries, and safeguarding investors against political, currency, or utility-related risks.⁸

Source: Climate Policy Initiative. Global Landscape of Climate Finance: Data Dashboard.



THE MINERALS CRITICAL TO THE CLEAN ENERGY TRANSITION ARE HELD BY A FEW COUNTRIES

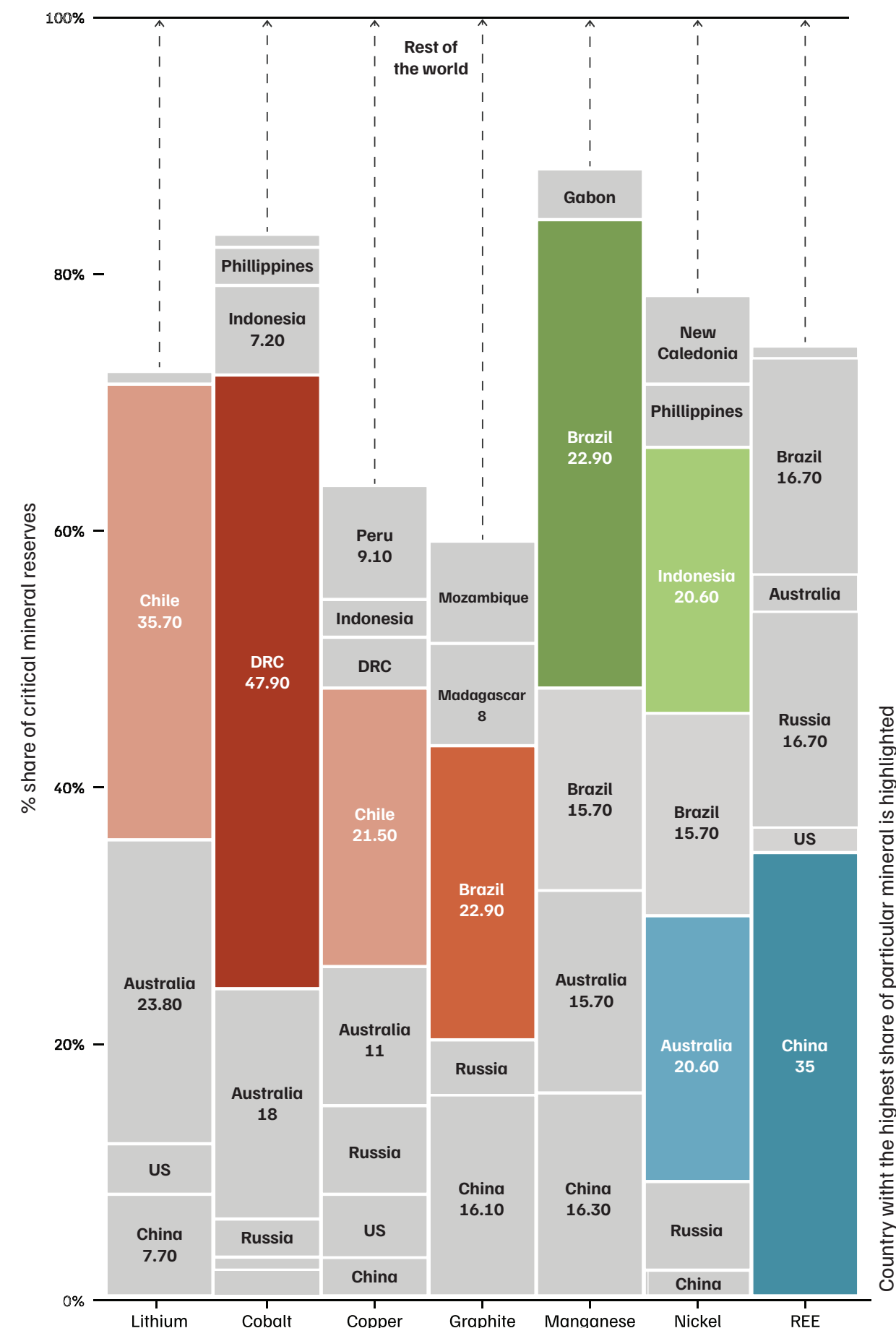
In 2023, India discovered 5.9 million tonnes of lithium reserves in the northern-most region of Jammu and Kashmir.⁹ This discovery made it the seventh-largest holder of global reserves at the time.¹⁰ But reserves alone don't make a battery industry.

Building capacity to extract lithium from reserves can take 12 years, and manufacturing batteries from it four years more.¹¹ The fastest route will need diversified supply chains and rules-based global collaboration.

Fifteen countries are home to 55 to 90 per cent of critical minerals—such as copper, lithium, nickel, cobalt, and rare earth—needed for the clean tech transition.¹² These minerals find applications in solar panels, wind turbines, electric vehicles, standalone batteries, and semiconductors. Further, the same countries produced 75 to 90 per cent of these critical minerals in 2022.¹³

India possesses commercial-scale reserves of seven critical minerals. Further, it has decades of experience processing base metals such as iron and aluminum, which can be extended to critical minerals through scaling research, workforce upskilling, and building processing hubs.¹⁴

Oil shaped the geopolitics of energy security in the past decades. The emerging energy transition paradigm should leave no one behind. We need global guardrails on mining and the use of critical minerals while recognising national sovereignty and environmental and social imperatives.¹⁵



Note: DRC is Democratic Republic of Congo

Source: CEEW, IEA, UC-DAVIS and WRII. 2023. Addressing Vulnerabilities in the Supply Chain of Critical Minerals. Council on Energy, Environment and Water.

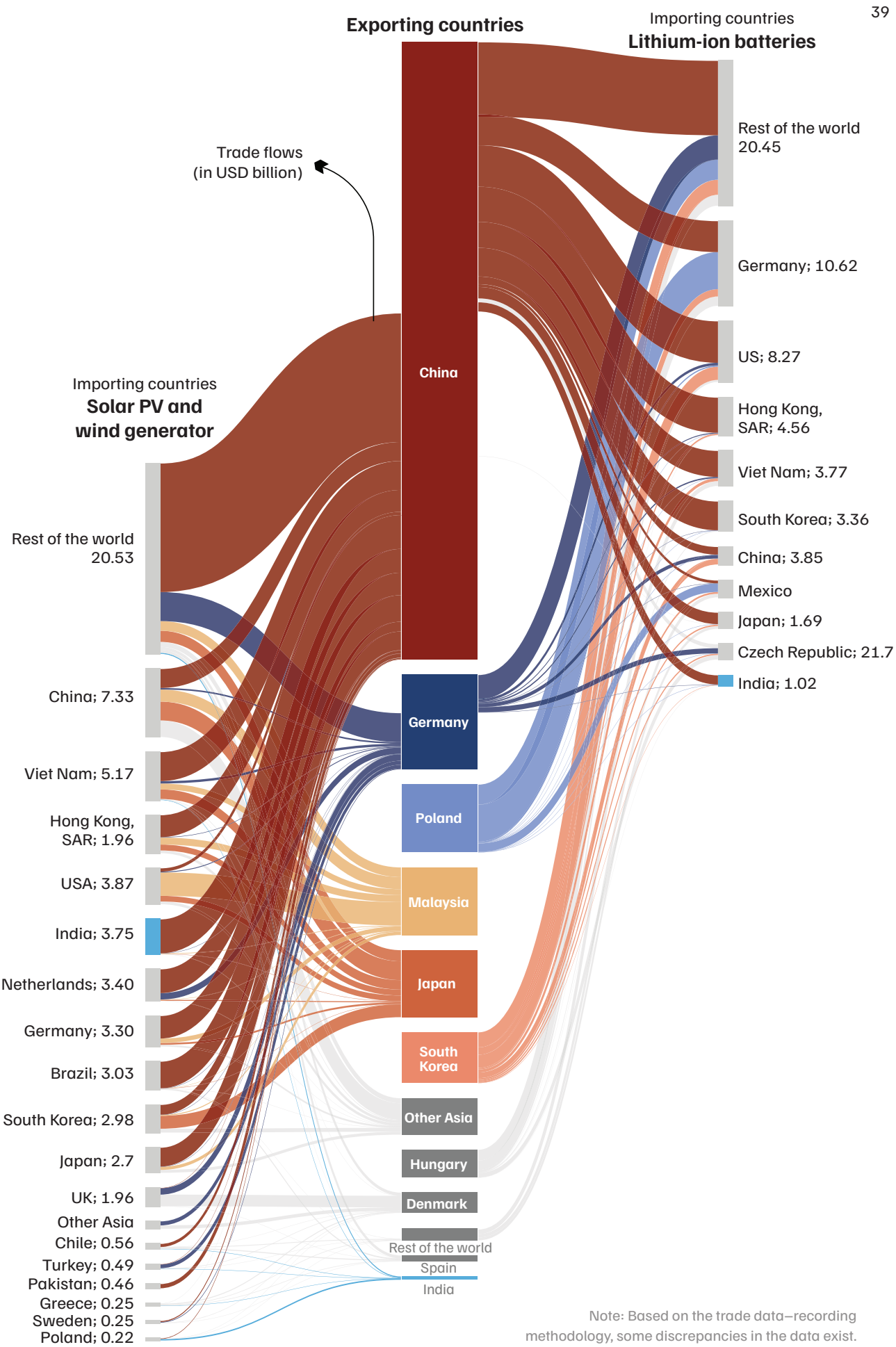
THE CLEAN TECHNOLOGY BOOM IS CURRENTLY RUNNING ON CONCENTRATED IMPORTS

Concentration in clean energy isn't just about minerals. It extends down the value chain to the very technologies built on them.

Four countries—China, Malaysia, Japan, and Germany—made up 70 per cent of global solar photovoltaic exports between 2012 and 2021.¹⁶ Similarly, China, Germany, Denmark, and Spain made up more than 80 per cent of global wind generator exports in the same time period.¹⁷ Lithium-ion batteries are even more skewed. China now accounts for nearly half of global trade in batteries, even as the shares of other major exporters such as South Korea and Japan have declined over the decade.¹⁸

This is happening alongside falling technology costs and a sharp rise in global trade of these technologies since 2017. For instance, global trade of solar cells and modules has grown to around USD 70 billion in 2021, even as per-unit prices fell sharply.¹⁹ The number of countries importing more than USD 10 million worth of these products rose by nearly 30 per cent over the past decade. Yet a G20 report finds that nearly 70 per cent of importers have a concentrated import mix, a trend that has only intensified with time.²⁰

Source: CEEW. 2023. *Developing Resilient Renewable Energy Supply Chains for Global Clean Energy Transition*. Council on Energy, Environment and Water.



THE FINAL FRONTIER OF THE ENERGY TRANSITION—CLEANING UP HEAVY INDUSTRIES

India is the second-largest producer of steel and cement in the world, together responsible for over 500 million tonnes of CO₂ emissions each year.^{21,22}

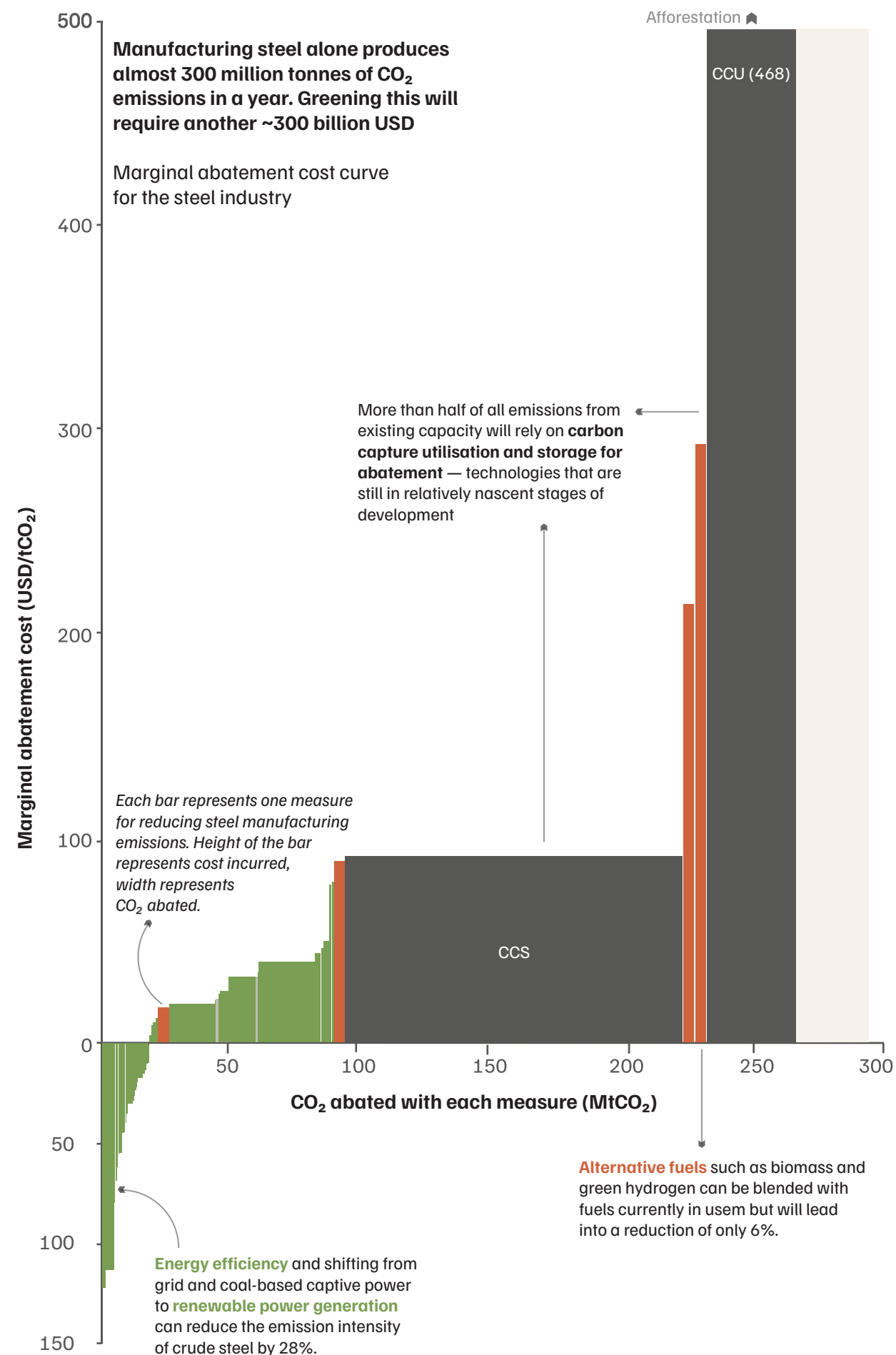
Rising incomes, rapid urbanisation, and expanding infrastructure mean that much of India is still being built. Steel and cement remain critical to this story. But for net-zero, they must be made far more sustainably. The steel industry alone emitted nearly 300 million tonnes in 2021-22, largely from coal-based reduction—complex processes that the industry is locked into.²³ CEEW estimates that decarbonising existing steel plants will need USD 283 billion in capital investment (CAPEX) and USD 8.8 billion in operating costs (OPEX) every year.²⁴

Cement is no easier—USD 334 billion will be required in CAPEX and USD 3 billion more in OPEX annually.²⁵ Over half of these

emissions cuts depend on technologies that are not mature, such as carbon capture, utilisation, and storage (CCUS), making near-net-zero steel up to 70 per cent²⁶ and cement up to 107 per cent²⁷ costlier than today's prices.

Cleaning up heavy industries also demands international concessional finance, round-the-clock renewable power^{28 29}, and affordable factory-floor logistics. Without this, India risks being locked into carbon-intensive growth. With it, the country can prove that even the hardest-to-abate sectors could be the green backbone of India's industrial future.

Source: Elango, Sabarish, Kartheek Nitturu, Deepak Yadav, Pratheek Sripathy, Rishabh Patidar, and Hemant Malliya. 2023. Evaluating Net-zero for the Indian Steel Industry: Marginal Abatement Cost Curves of Carbon Mitigation Technologies. Council on Energy, Environment and Water.



BETWEEN HEAT AND RAIN, CLIMATE RISKS ARE COMPOUNDING THE DECARBONISATION CHALLENGE

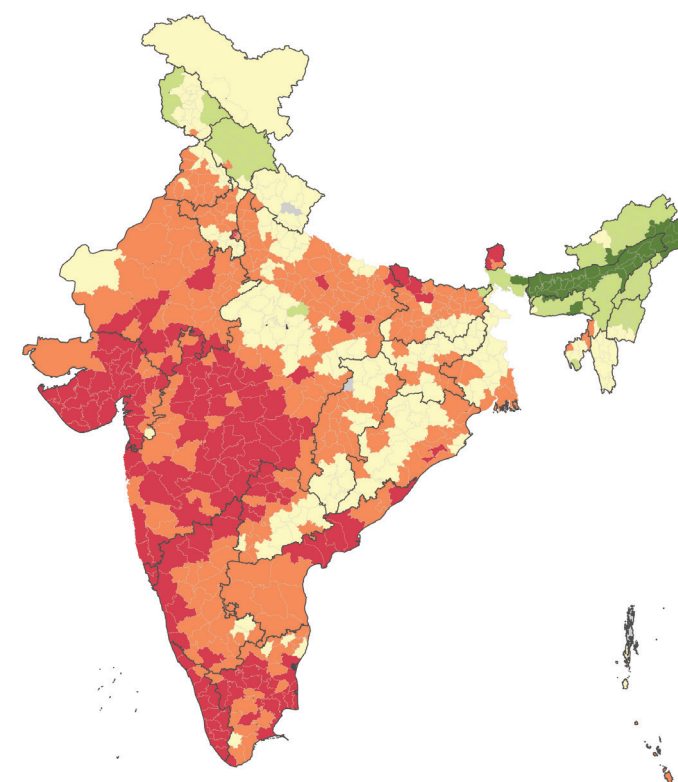
Three-fourths of India's districts are vulnerable to extreme climate events such as floods, cyclones, or droughts. More than 80 per cent of the country's population lives in these districts.³⁰

CEEW's heat-risk index, based on four decades of data, across 734 districts, and 35+ indicators, shows that 57 per cent of the country's districts—home to ~1.1 billion people—face high to very high heat risk.³¹ This is the context in which India's energy transition is unfolding. Dense urban districts such as Mumbai, Delhi, and those across the agriculturally important Indo-Gangetic Plains face the greatest exposure.³²

For outdoor workers—especially those in agriculture, construction, and the gig economy—rising heat and humidity impair the body's natural cooling mechanism, compounding health risks.³³ The International Labour Organization estimates that by 2030, India could lose the equivalent

of 35 million full-time jobs to heat stress,³⁴ turning it into a productivity crisis. Rainfall patterns are also shifting. Nearly a quarter of districts—including Bengaluru, Jaipur, and Indore—saw both deficient and excessive rainfall between 2012 and 2022, compared to the previous four decades.³⁵ When this is happening matters even more. Almost all sub-districts that saw a decline in rainfall, experienced it during June and July—the start of the summer sowing season.³⁶

As climate risks rise, India's path to growth must also build resilience—through data-driven, locally grounded plans that make cities ready for heat, floods, and the future.³⁷

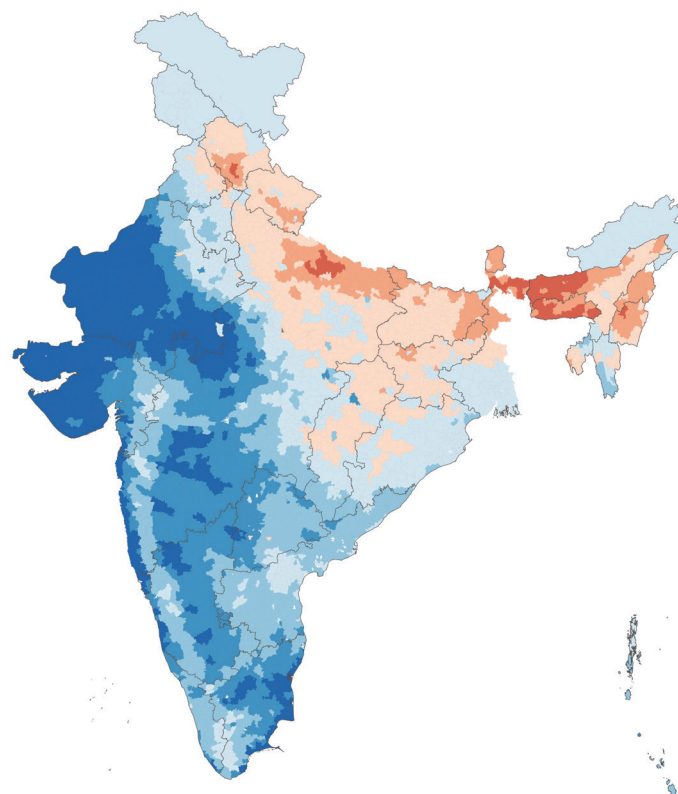
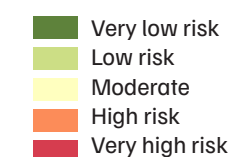


57% of Indian districts, home to three-fourths of the population, now face high to very high heat risk

Many districts in the agriculturally important Indo-Gangetic plains of Uttar Pradesh and Bihar face high to very high risk

On the western coast, Gujarat, Maharashtra, Goa and Kerala are facing the heat with more than 75% of their districts under very high risk

Heat risk index

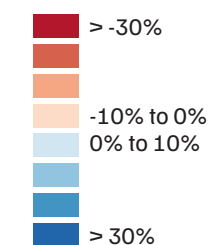


55% of sub-districts, recorded more than a 10% rise in southwest monsoon rainfall between 2012 and 2022

Heavy rainfall days have become more frequent in 64% of sub-districts, especially in Maharashtra, Gujarat, Tamil Nadu, and Karnataka

11% of sub-districts saw a >10% decline in rainfall, mainly in the Indo-Gangetic Plains, Northeast, and Himalayas

Changes in southwest monsoon rainfall (%)



4. WHERE DO WE GO FROM HERE?



WHERE WILL 500 GW OF NON-FOSSILS BY 2030 COME FROM?

At COP26 in Glasgow, India announced the Panchamrit—five commitments to decouple growth from emissions—which included a pledge to go net zero by 2070.¹

By 2025, it had achieved half of its installed power capacity from non-fossil sources², reduced emissions intensity of its GDP³, and launched Mission LiFE (Lifestyle for Environment) for pro-planet lifestyles⁴.

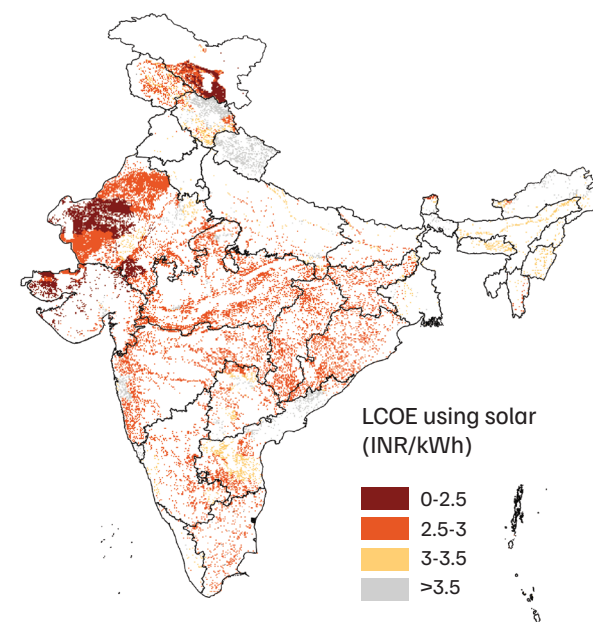
The next milestone is 500 GW of non-fossil capacity by 2030.⁵ Achieving this will hinge on economics as much as ambition. Analysis of levelised cost of electricity (LCOE)—the yearly cost of building and running a power plant for each unit of electricity generated—shows where renewables can be deployed most cost-effectively. Rajasthan, Madhya Pradesh, and Maharashtra together hold over 11,000 GW of solar potential below INR 2.8 per kWh.⁶ Tamil Nadu has the cheapest wind

power at less than INR 2.65 per kWh, with Karnataka, Gujarat, and Maharashtra offering another 700 GW of low-cost potential.⁷

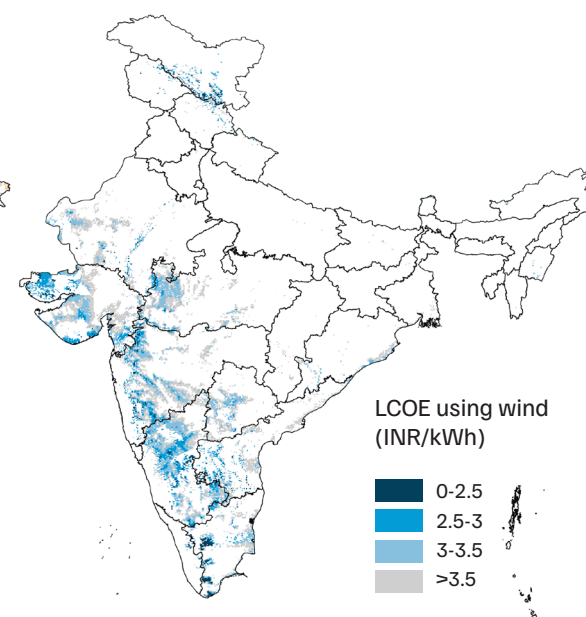
Nuclear power will also play a larger role, with plans to nearly triple capacity to 22.5 GW by 2032. Expansions of existing and new projects have been approved in Andhra Pradesh, Gujarat, Rajasthan, Tamil Nadu, Haryana, Karnataka, and Madhya Pradesh.⁸

To meet its 2030 target, India will need to find space for renewables in deserts and croplands, on rooftops, and in policies, in just five years.

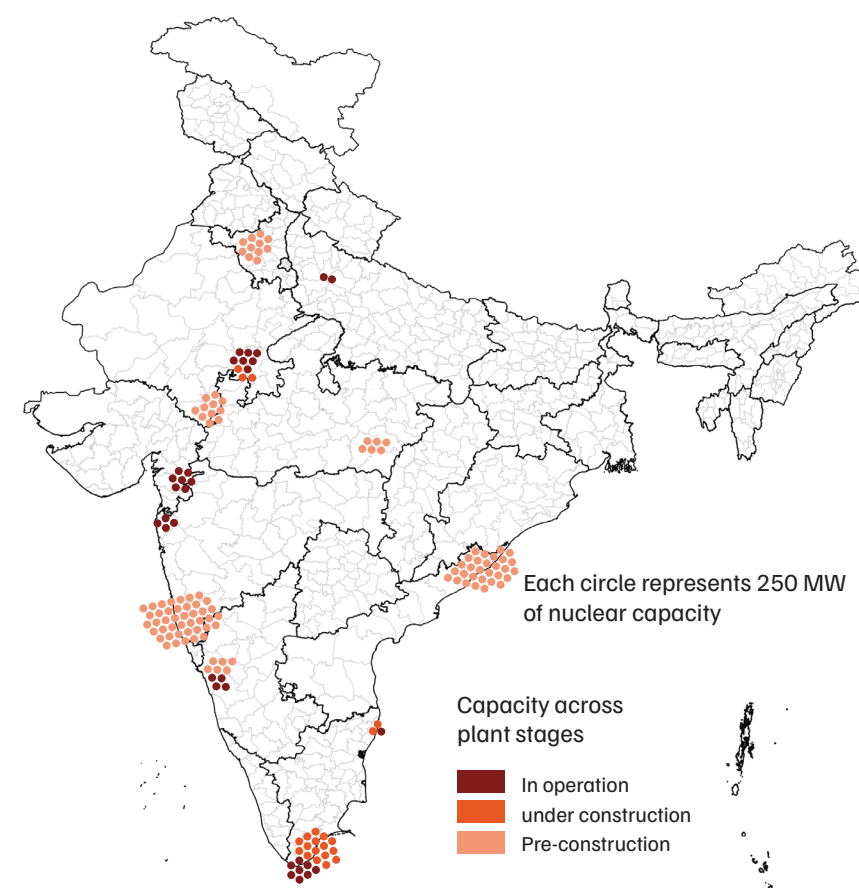
Optimal solar sites
based on levelised
cost of electricity (LCOE)



Optimal wind sites
based on levelised
cost of electricity



Nuclear capacity
Proposed and operating



AFTER 2030, WHAT COULD GIVE INDIA THE BIGGEST CUTS IN EMISSIONS?

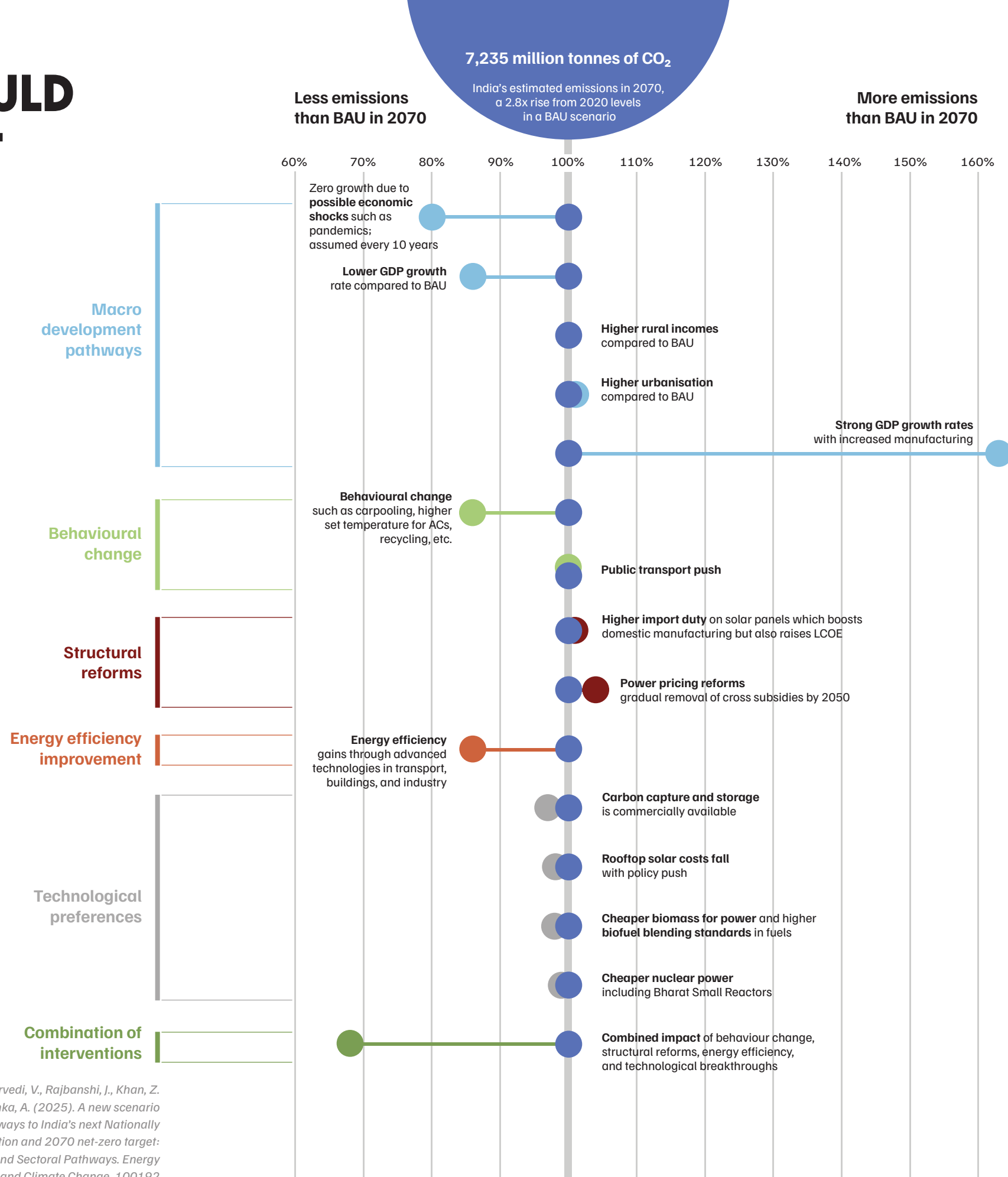
India is on track to meet its NDC of reducing the emissions intensity of its GDP by 45 per cent by 2030.⁹

By 2019, it had already cut its emissions intensity by a third¹⁰, and further climate emissions modelling suggests a 48–57 per cent decline from 2005 levels by 2030.¹¹ This reaffirms what India has shown since the Paris Agreement, that growth and emissions reductions can go hand in hand. It also poses the question: What comes after 2030? Researchers modelled 18 scenarios for India's net-zero target, identifying actions delivering the largest emission cuts. This includes a business-as-usual scenario (BAU) that reflects the country's trajectory with current policies.

Behavioural and lifestyle changes—such as using fewer private vehicles and adopting energy-efficient appliances—under the Mission LiFE framework could deliver up to 10 per cent emissions reductions by 2050 compared to BAU, while easing pressure on land resources.¹² Similarly, rationalised tariffs—lower for industrial and commercial users—could accelerate electrification and clean energy uptake, while higher tariffs for households coupled with targeted support could make rooftop solar more attractive. Even a high growth scenario would see India's emissions intensity of GDP fall by 3 per cent compared to BAU.¹³

India's current climate policies are expected to cut nearly four billion tonnes of CO₂ emissions in this decade.¹⁴ The story after 2030 is not just whether India can reduce emissions, but which pathways it could take to net zero.

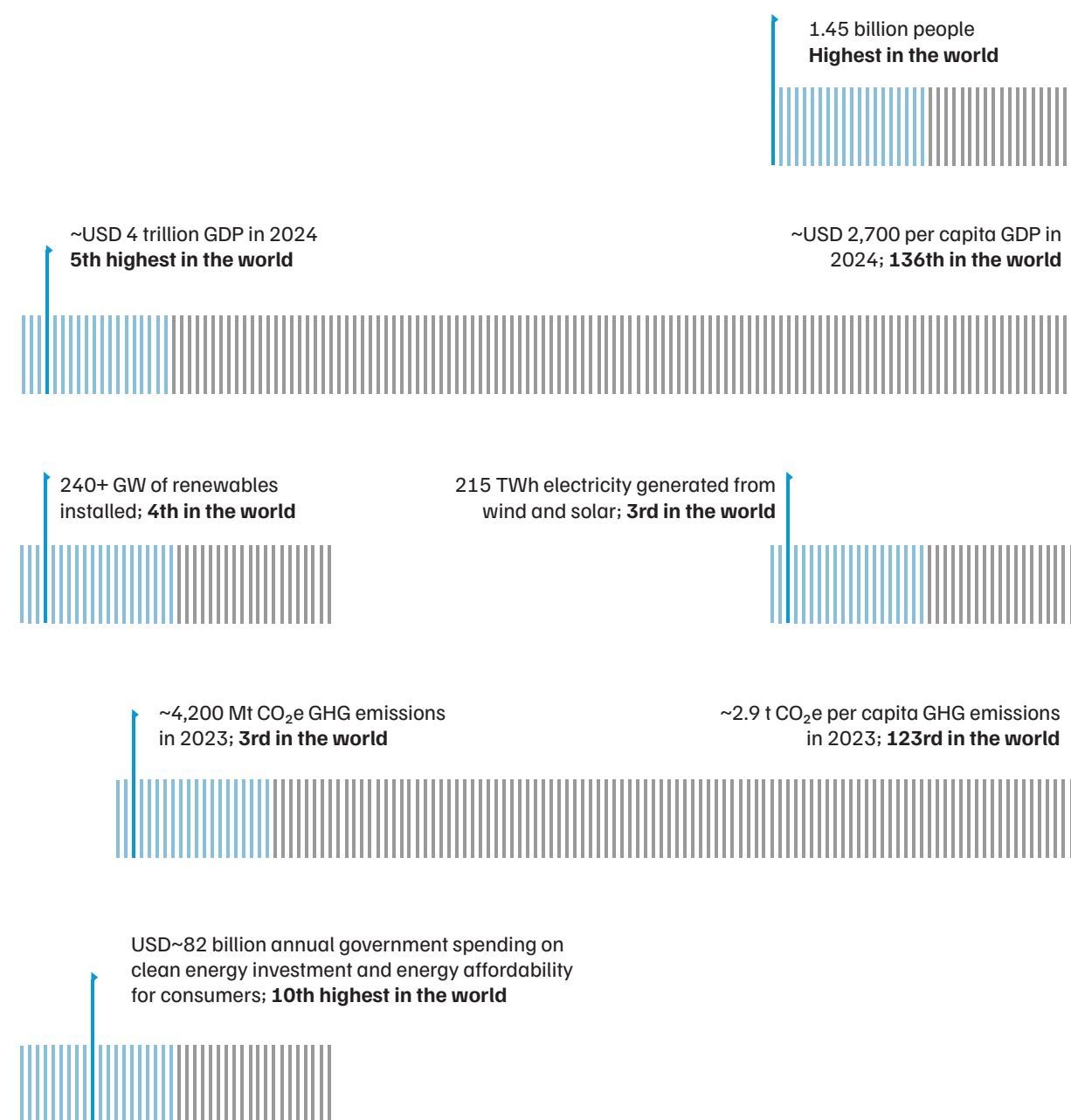
Source: Das, P., Chaturvedi, V., Rajbanshi, J., Khan, Z. A., Kumar, S., & Goenka, A. (2025). A new scenario set for informing pathways to India's next Nationally Determined Contribution and 2070 net-zero target: Structural reforms, LiFE, and Sectoral Pathways. *Energy and Climate Change*, 100192



5. INDIA AND THE WORLD NEED EACH OTHER



WHY INDIA'S TRANSITION MATTERS FOR THE WORLD



There are many parallel realities in India.

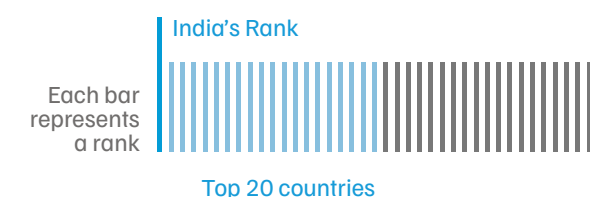
Home to 1.45 billion people, it is the world's largest country¹—and its third-largest emitter—yet ranks around 123rd in per capita greenhouse gas emissions². For context, the United States ranks 17th and China 26th. By the end of this decade, India is projected to become the world's third-largest economy.³ This is the backdrop for its energy transition. But India is not undergoing just one transition.

Multiple transitions are unfolding at once. From rural to urban, traditional to modern

sources of energy, growth to sustainable growth, and a deeper integration into the energy markets.⁴ Achieving net zero by 2070 will require average investments of USD 202 billion every year for the next five decades.⁵

This is the energy transition that can shift 1.4 billion people into a sustainable, low-emissions future. The world has an interest in making sure India succeeds.

How to read



Source: Authors' compilation of data from World Bank. World Bank Open Data and International Energy Agency. Government Energy Spending Tracker: Policy Database. International Energy Agency, 2024.

IT'S A PLURILATERAL WORLD AND INDIA COULD LEAD IN IT

Ten years on, the multilateral world that signed the Paris Agreement is under threat. Economic protectionism, rising debt burdens, and political and geopolitical upheavals have contributed to diluting climate ambitions. Strategic bilateralism and smart plurilateralism could show us the way out of it.⁶

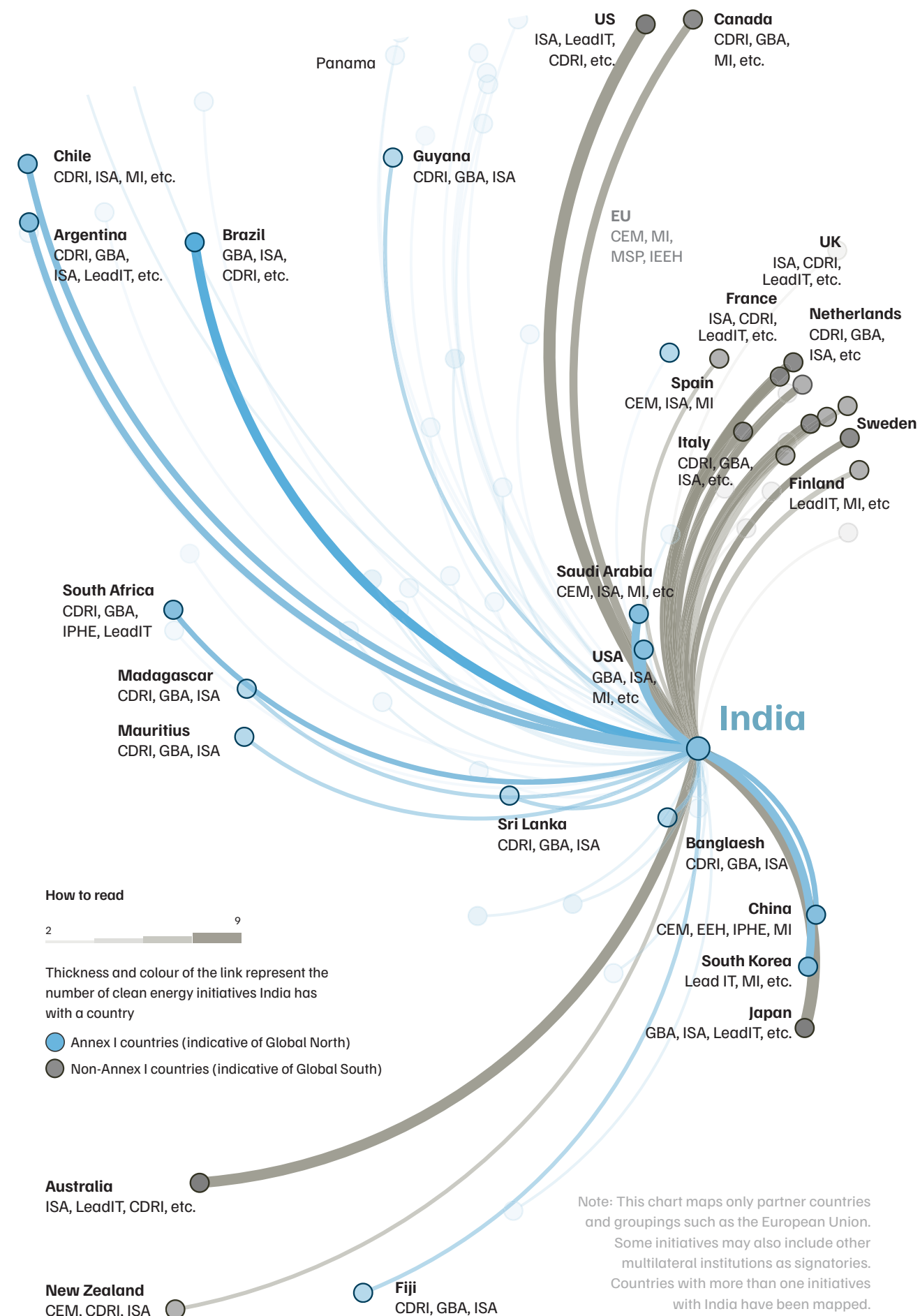
New Delhi has already proven that it is up to the task. From the International Solar Alliance—with 120+ signatories⁷—launched at the Paris COP in 2015 to the Global Biofuels Alliance announced during India's G20 presidency⁸, the country is providing a litmus test for how durable plurilateral platforms can be born in the Global South and scaled worldwide.

Selected clean energy initiatives

Clean Energy Ministerial (CEM)
 Coalition for Disaster Resilient Infrastructure (CDRI)
 Global Biofuel Alliance (GBA)
 International Energy Efficiency Hub (IEEH)
 International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)
 International Solar Alliance (ISA)
 Leadership Group for Industry Transition (LeadIT)
 Minerals Security Partnership (MSP)
 Mission Innovation (MI)

Initiatives co-launched by India

Source: Authors' compilation based on information from the official websites of clean energy initiatives mentioned in the visualisation



ENDNOTES

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India needs to transition for the world to transition

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- Sustainable livelihoods & green economy
- Quality of life of citizens
- India’s story to the world

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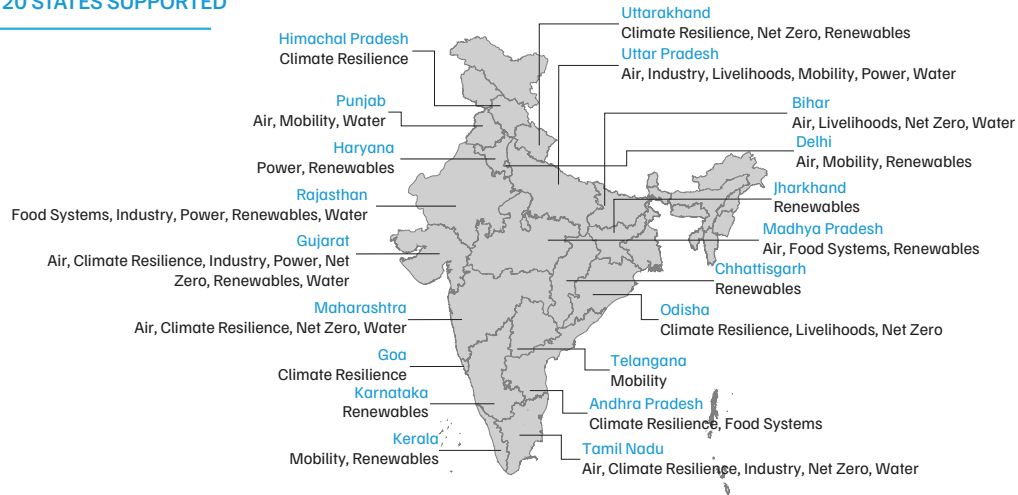
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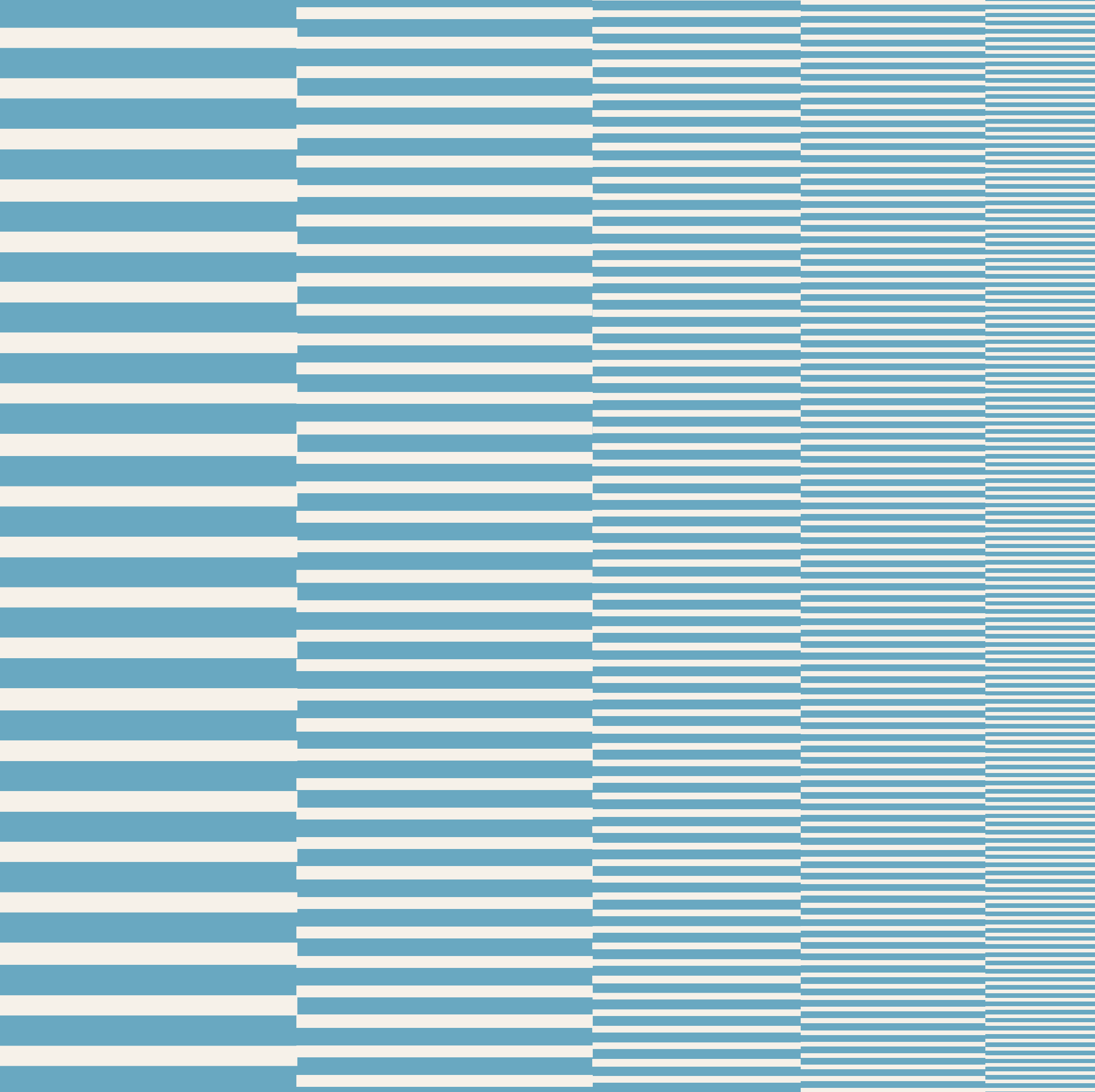
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- 2014 | 175 GW renewables target
- 2015 | International Solar Alliance
- 2016 | PM *Ujjwala Yojana*
- 2017 | *Saubhagya* Schemes
- 2019 | Climate Vulnerability Index
- 2021 | Net Zero by 2070
- 2022 | Mission LiFE
- 2022 | National Bioenergy Programme
- 2022 | E-waste (Management) Rules
- 2023 | G20 Green Development Pact
- 2023 | National Green Hydrogen Mission
- 2024 | Green Steel Taxonomy
- 2024 | PM *Surya Ghar Yojana*
- 2025 | National Critical Mineral Mission
- 2025 | Rajya Sabha guidelines on crop residue burning
- 2025 | National Adaptation Plan

STATE

- 2022 | Rajasthan Organic Farming Mission
- 2022 | Jharkhand Solar Policy
- 2022 | Uttar Pradesh *Vidyut Sakhi* programme
- 2023 | Rajasthan Green Hydrogen Policy
- 2023 | Uttarakhand Solar Policy
- 2024 | Net-zero roadmaps for Bihar & Tamil Nadu
- 2025 | Green Odisha Initiative
- 2025 | Maharashtra Climate Action Plan 2.0
- 2025 | 50 Heat Action Plans (GJ, OD, MH, TN)
- 2025 | Delhi Clean Air Action Plan
- 2025 | Delhi EV Policy 2.0

20 STATES SUPPORTED





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