



Empowering India

The Clean Energy Growth Opportunity

Will Atkinson

Laurens Speelman

Chiara Gulli

Jagabanta Ningthoujam

Marshall Abramczyk

with Galvanize Climate Solutions

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Executive Summary

India is growing fast — and with much of its infrastructure still to be built, India can bypass legacy systems to build a clean energy future at remarkable speed, scale, and savings.

In this report, we go beyond legacy narratives to highlight India's rapid progress and its opportunity to show the way toward a resilient, modern, and clean energy system for all.

India's energy demand is growing fast. Electricity demand could triple by 2050, led by the increasing need for space cooling in a warming world. Peak demand is outpacing supply, even if all planned thermal and hydro capacity is built on time.

India imports fossil fuels but is self-sufficient in renewable energy. The country is a net importer of coal, gas, and oil, costing 5% of the nation's GDP. But renewable energy is a reliable resource — with enough domestic resources and manufacturing to fully supply its solar, wind, and batteries.

Increased investment is bringing record renewables deployment. Some 93% of investment for power generation is now in clean sources, and solar-plus-storage is already cheaper than coal on a life-cycle basis. Renewables are expected to supply most of India's new generation.

From homes to vehicles, electrification is growing fast. Electricity access has improved 3x faster than many other regions, while electric vehicles (EVs) are taking off — led by two- and three-wheelers, which have already reduced costly oil imports.

India has prioritized stable policy for clean energy and efficiency. India has been a leader for recent efficiency improvements, thanks to a suite of policies and market incentives across sectors. As the Union Budget prioritizes cleantech growth, these conditions will continue.

Cities are leveraging incentives to scale up quickly. From rooftop solar in Varanasi to EV policy in Delhi and efficient design in Palava City, several cities across India are showing what is possible.

Growing cleanly has many payoffs — from cutting costs to raising revenue, and from millions of jobs gained to millions of lives saved.

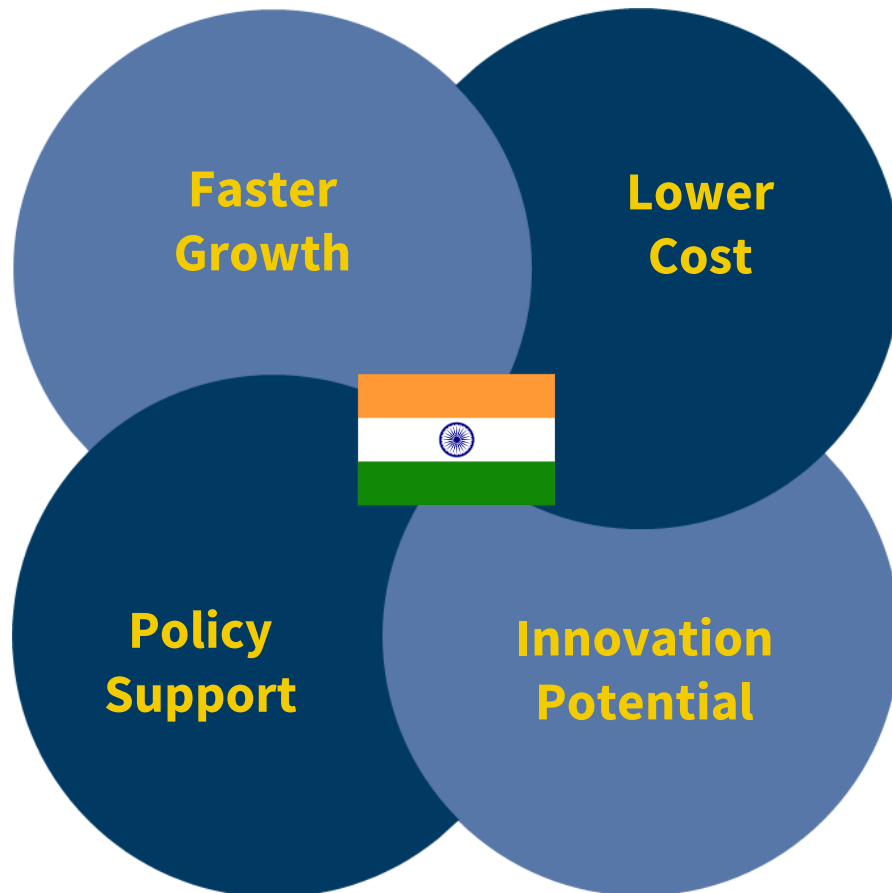
With more investment, India can go even faster. All sectors have room for more, from grid reform to revenue-raising methane action.

India's immense growth is an extraordinary opportunity. From steel production to home construction, India will see more growth than any other region. If that share of growth is met by a similar share of clean energy investment, there will be broader benefits for all.

A different mindset for India

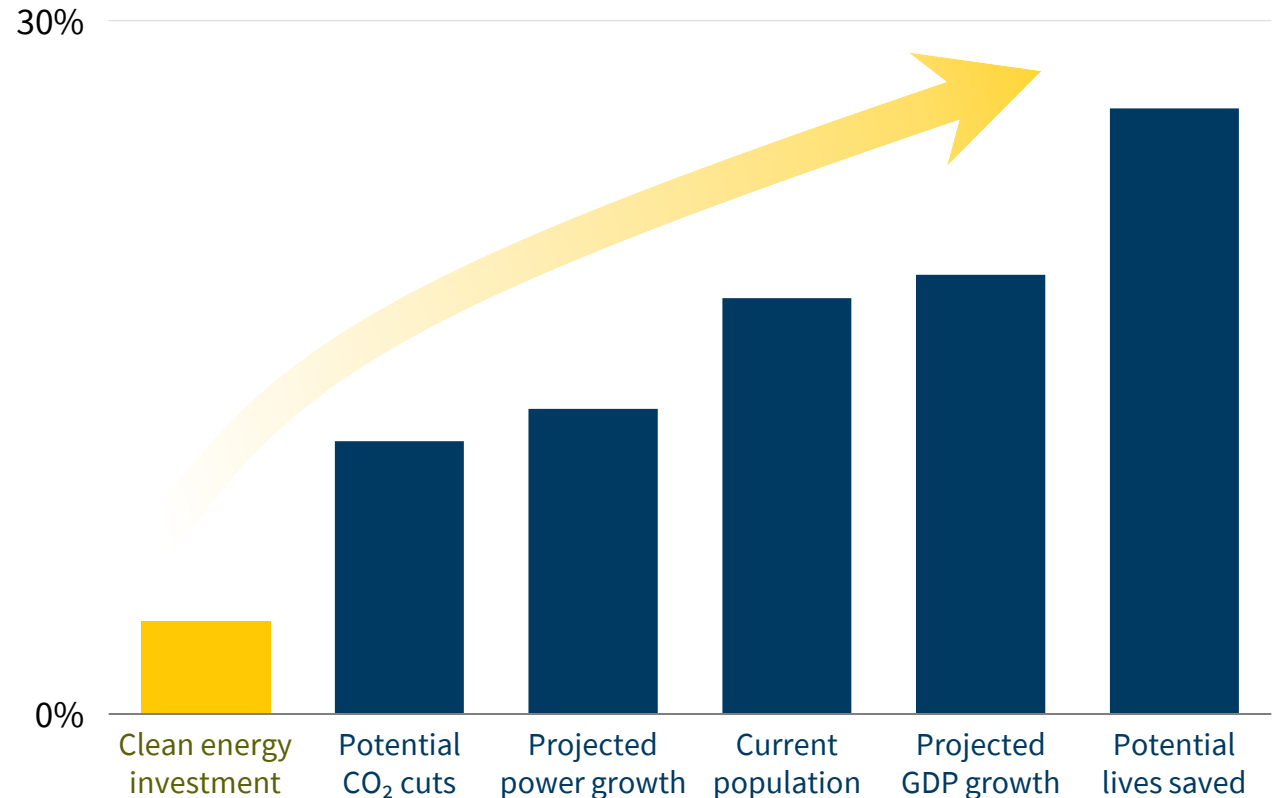
India can be a test ground for progress at scale, from lower-cost green hydrogen to innovative energy efficiency

India's unique strengths...



...are an untapped opportunity for investment and impact

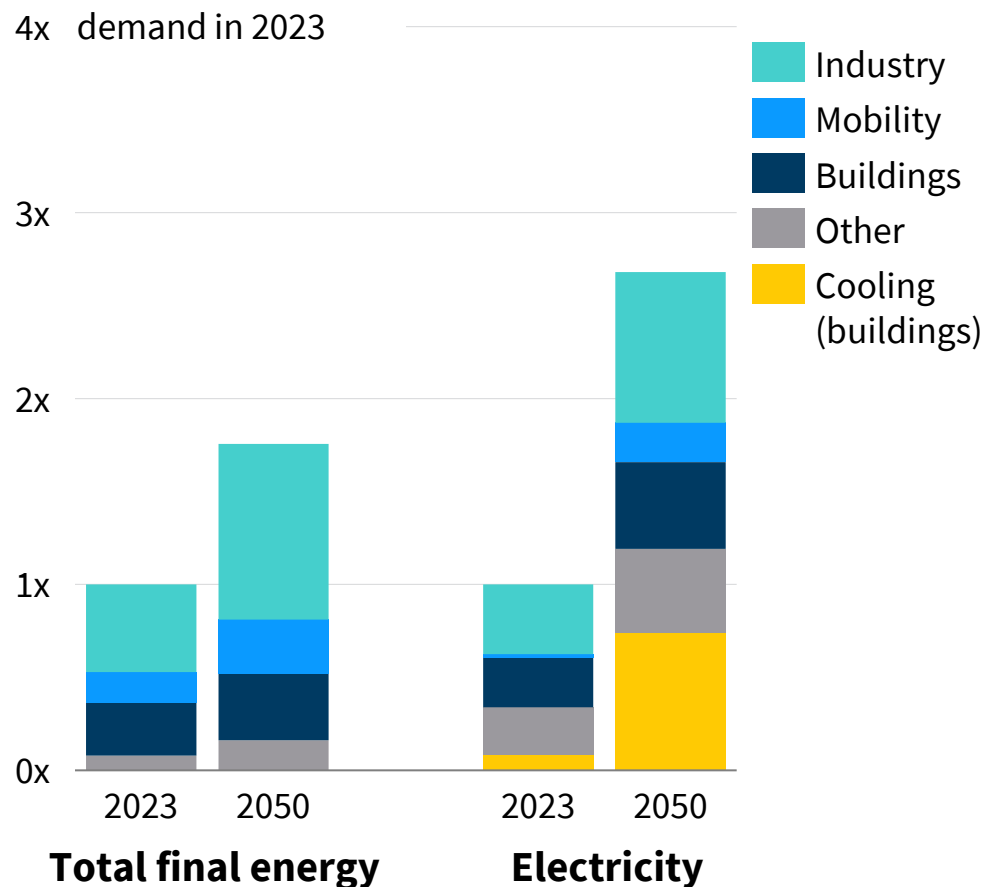
Global share from India



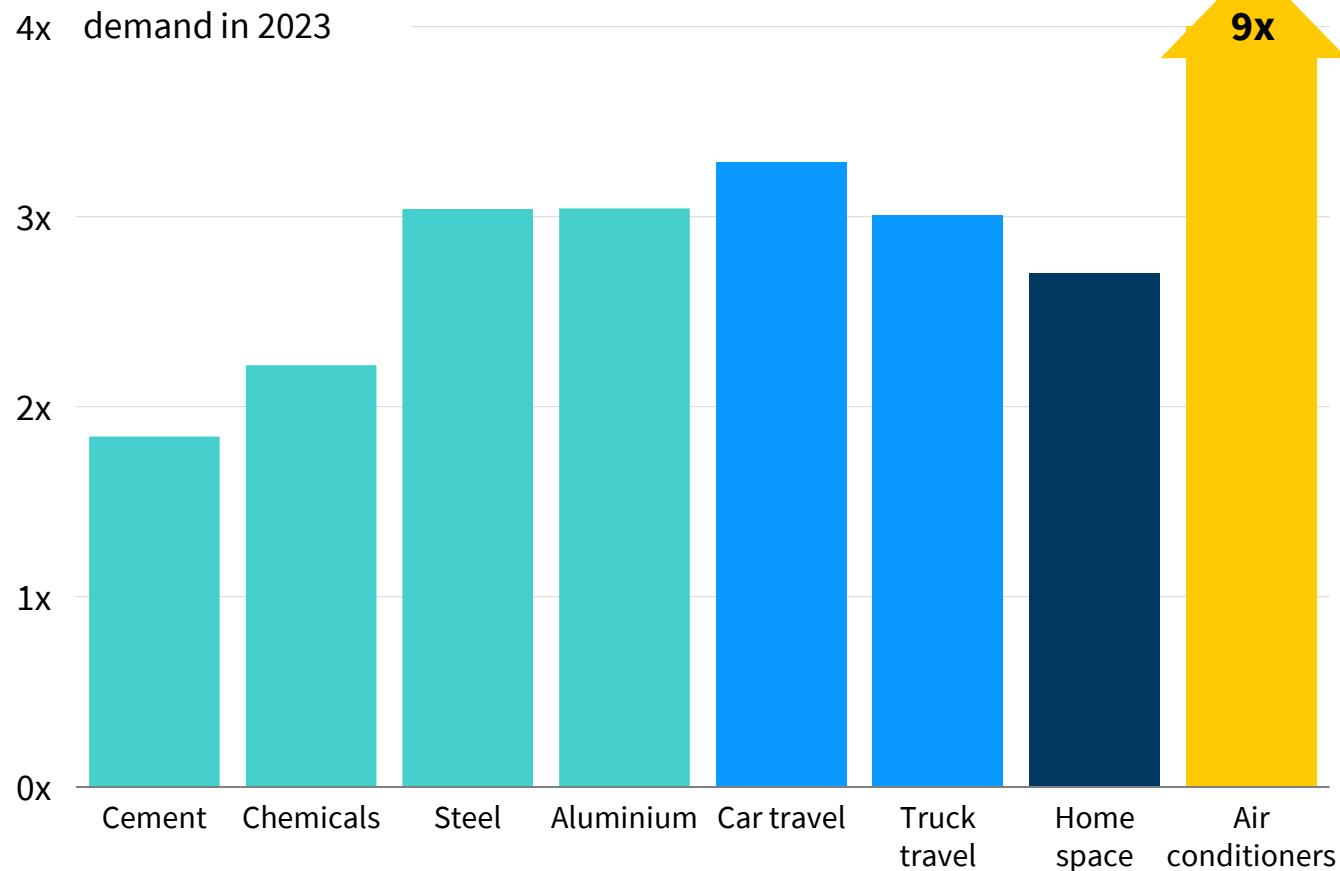
India's energy demand sources are set to double, triple, or more

There will be rapid growth across sectors, led by the need for space cooling in a warming world

Growth in India's energy demand...



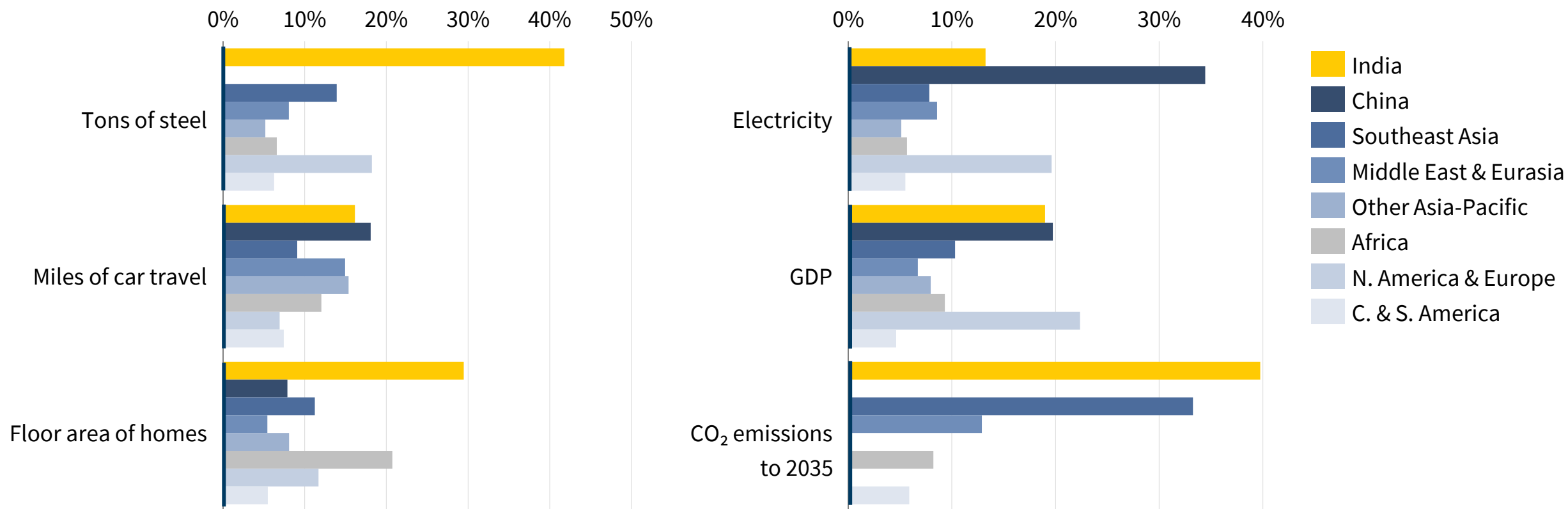
...due to growth across sectors by 2050



With the world's largest growth, India has an opportunity to build right the first time

From steel production to building space, India's potential for solutions is far above other regions

Fraction of projected global growth from 2023 to 2050



Which means India's projects are a different scale

Across clean energy, industry, and cities

**Largest renewable energy project
under construction**



India:

**Khavda
Renewable
Energy
Park**

Largest green ammonia auction



India:

**Solar
Energy
Corp.
of India**

Fastest-growing city



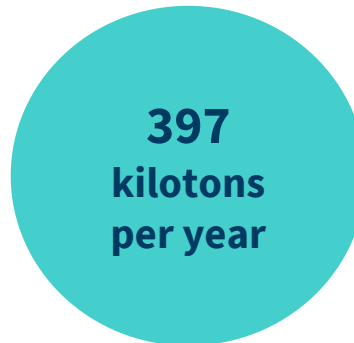
India:

Delhi



US & Europe:

Dogger Bank



US & Europe:

H2Global



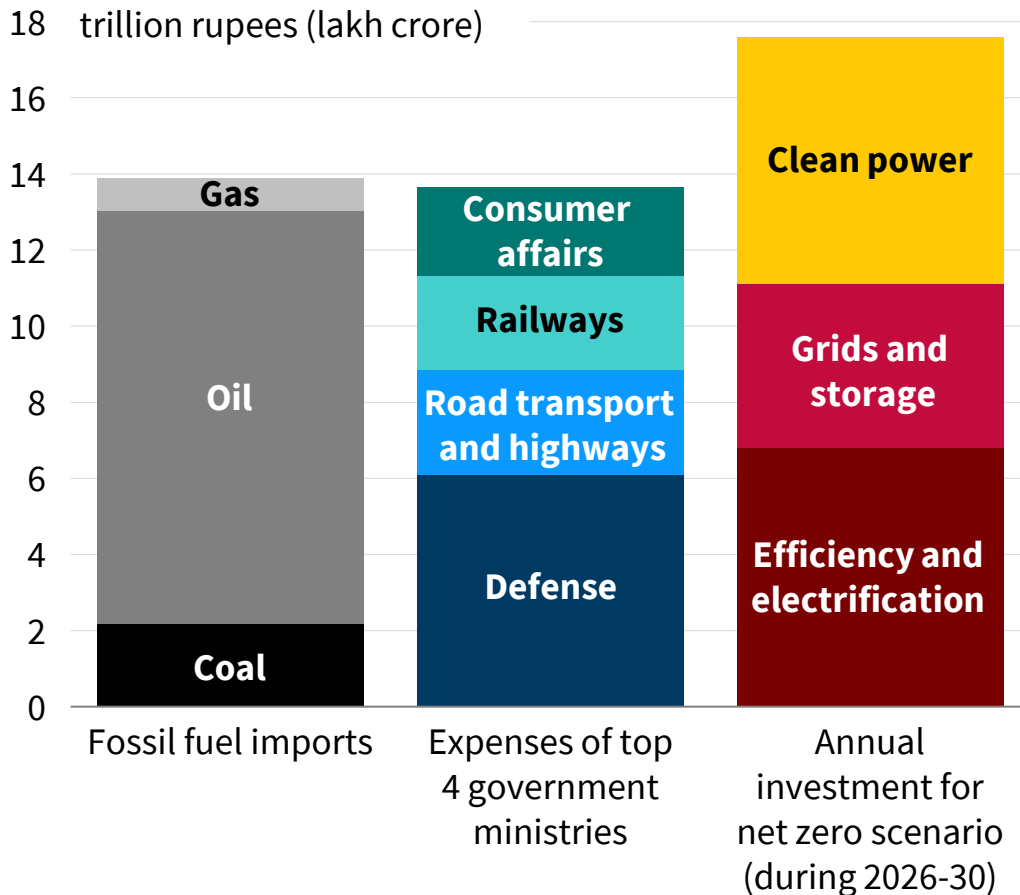
US & Europe:

Several

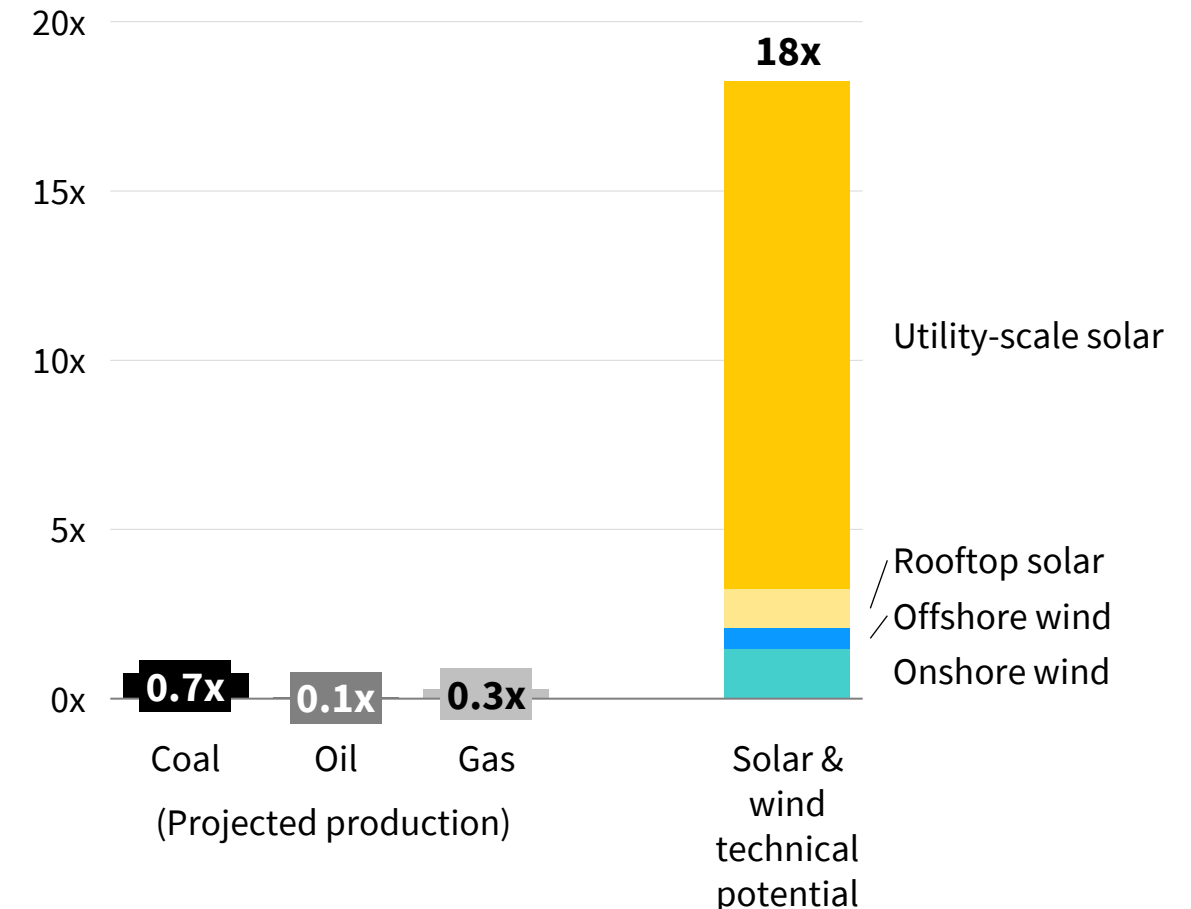
India imports fossil fuels but is rich in renewables

Though India imports all three fuels at a growing cost, renewable energy is a reliable resource

Annual import costs (vs. other totals for perspective)

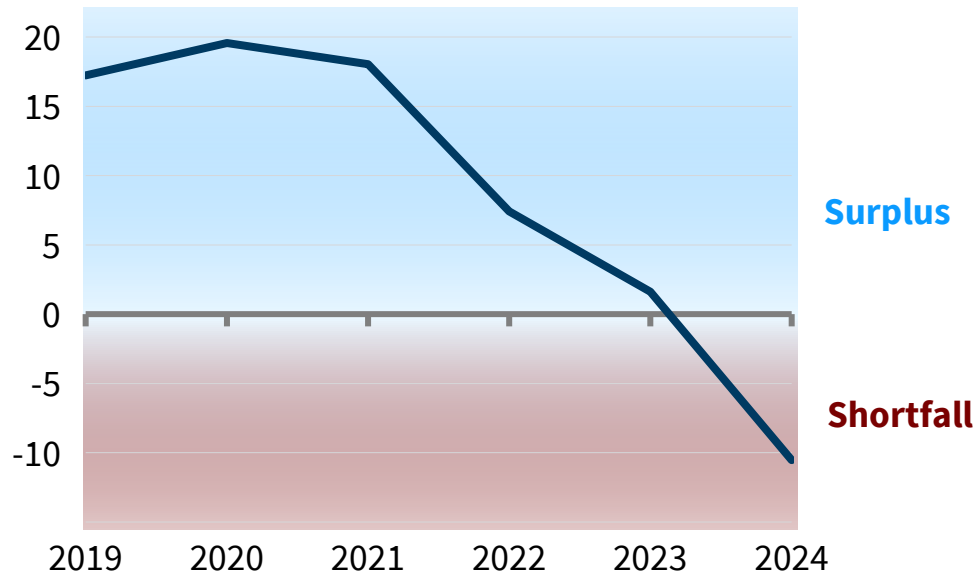


Multiple of 2050 demand met by domestic resources



But barriers must be overcome to meet near-term demand growth

Margin of peak load forecast, GW



India could see evening power shortages of **20–40 GW by 2027**, even with all planned thermal and hydro capacity built on time

Key barriers



Local constraints from underestimated load growth, due to cooling demand and new loads including EVs



Insufficient storage and transmission, leading to stranded renewable energy that cannot reach the grid



Delayed power purchase agreements for renewables, due to slow processes and anticipation of lower tariffs



Fuel and generation shortages, including issues of coal supply, high-cost gas, and drought for hydropower

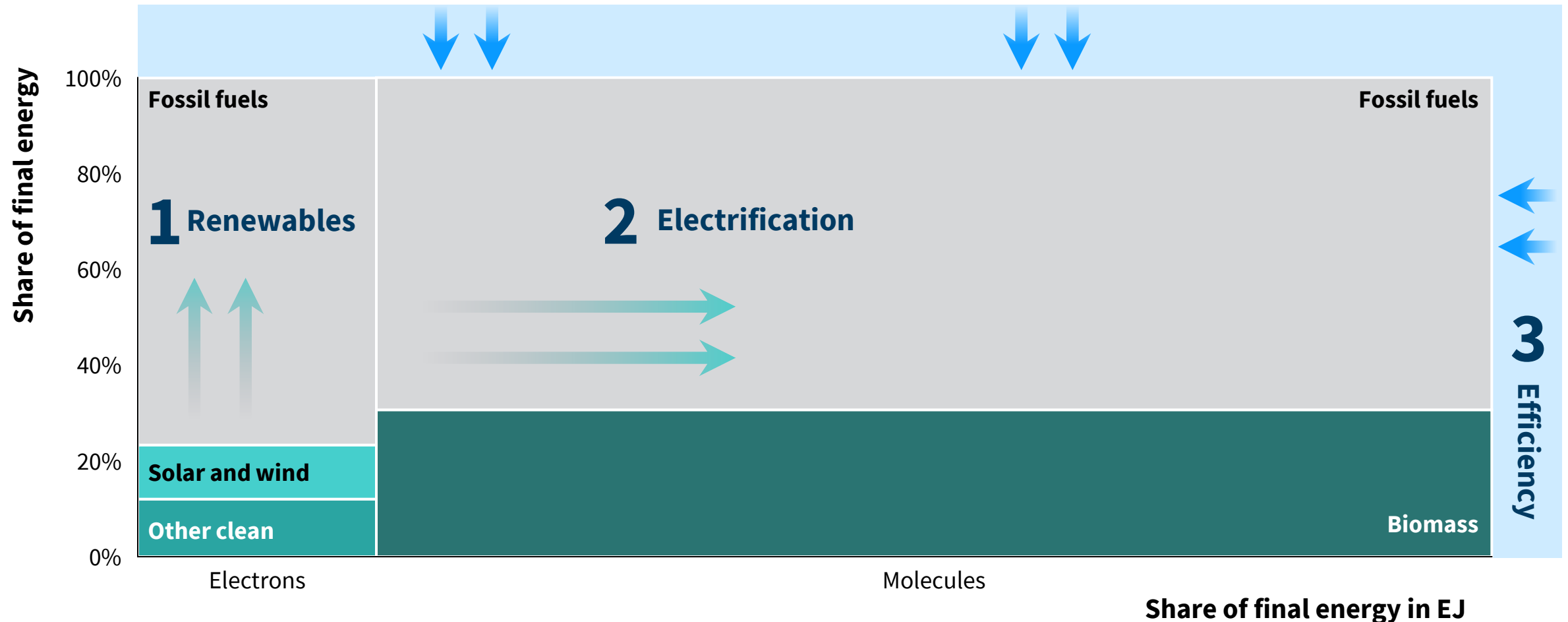


Utility finance challenges (despite improvement), particularly for local Discoms

Past progress has been led by three factors

Renewables, electrification, and efficiency are on track to rapidly transform the energy system

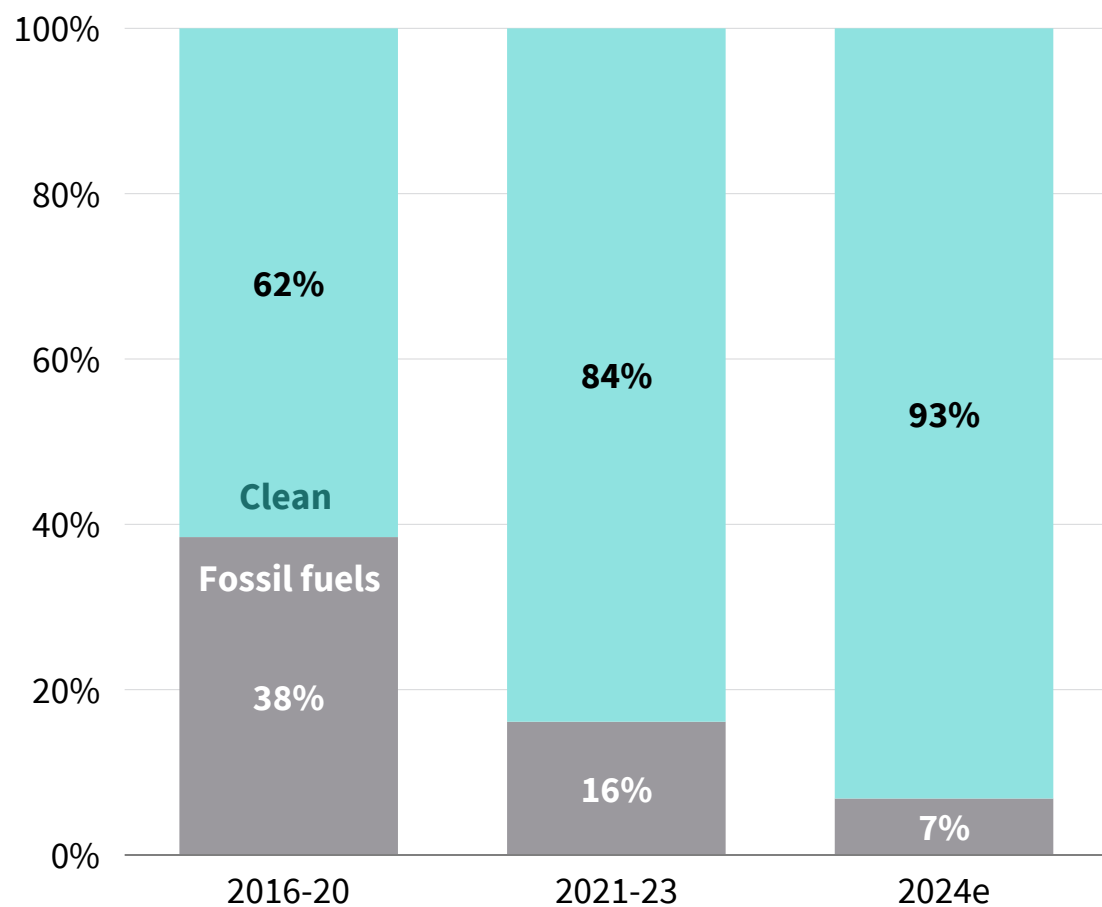
India's energy demand in 2023



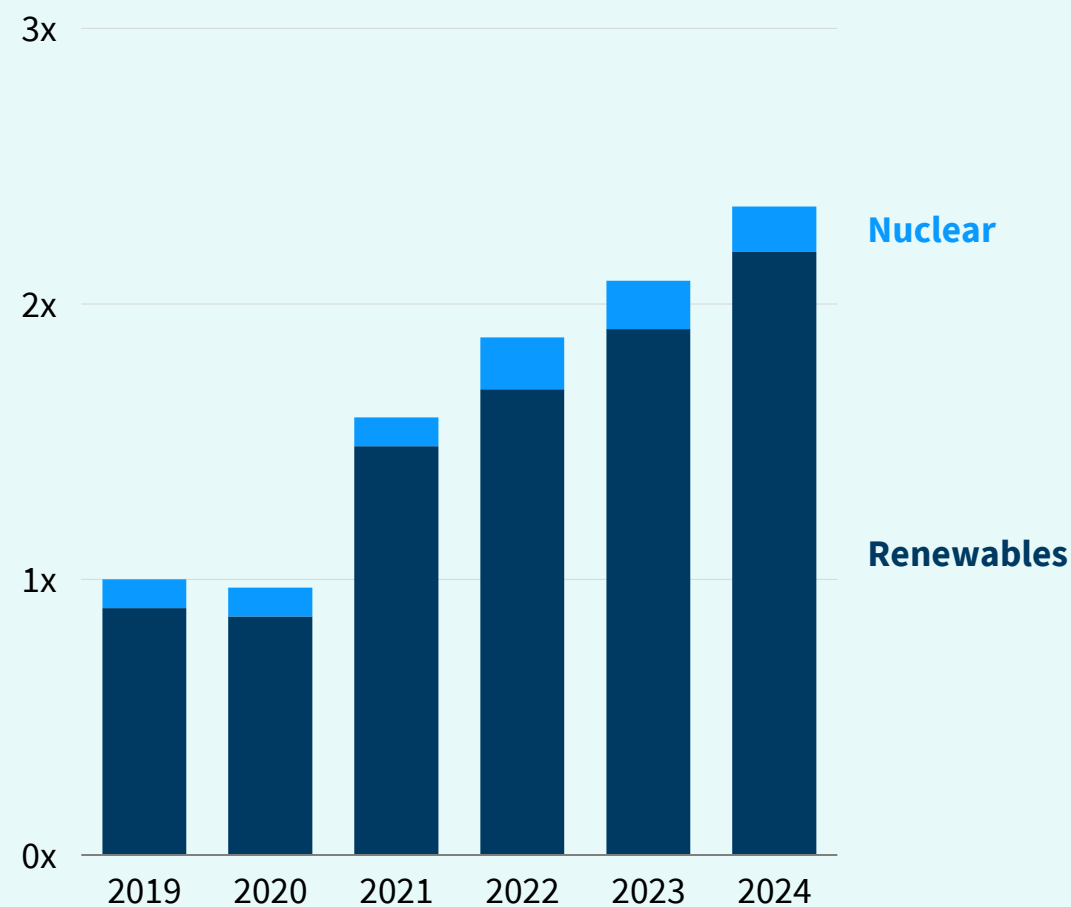
India's electricity investment is moving from fossil to clean as it grows

93% of capital is now in clean sources, with 2x as much investment as five years ago

Fraction of electricity capital



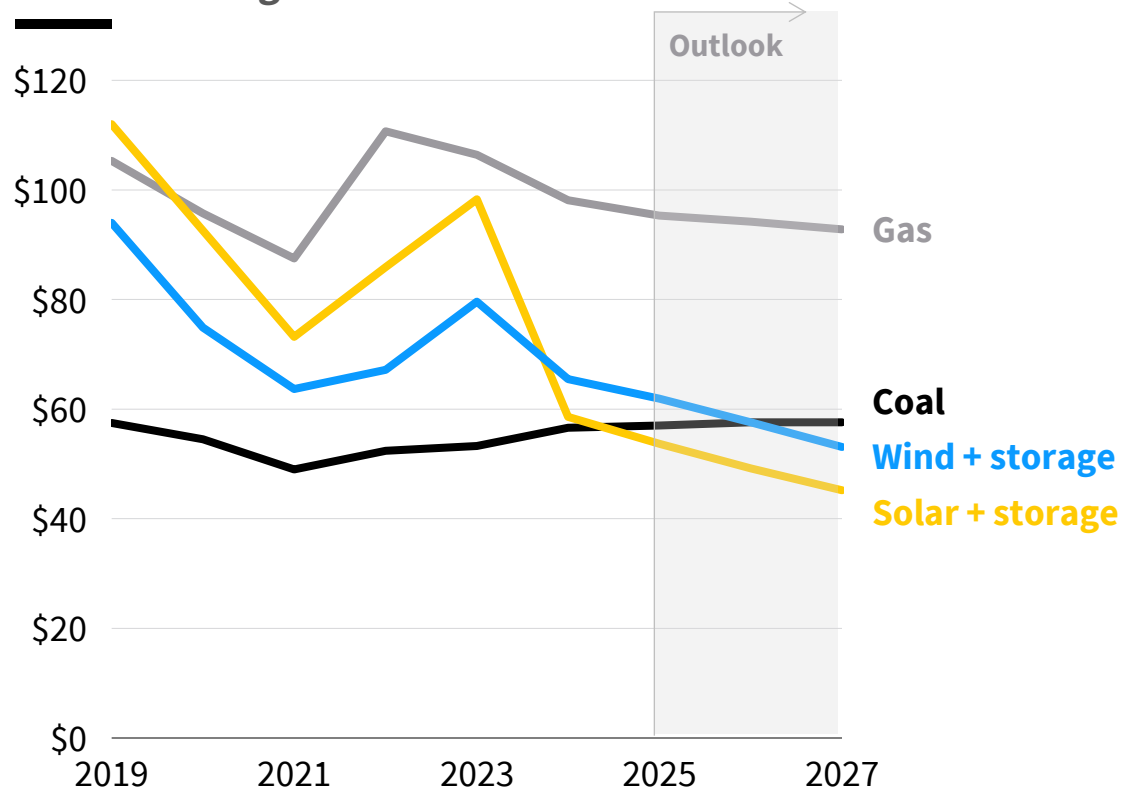
Total clean electricity capital, relative to 2019



Clean portfolios are quickly becoming India's least-cost option

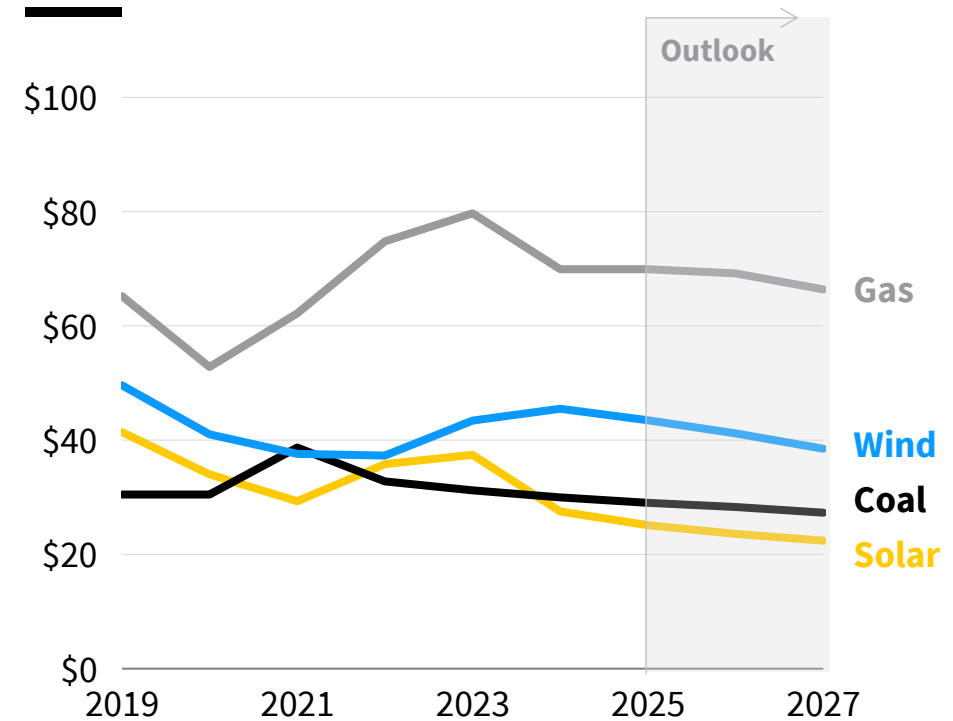
New solar + storage is cheaper than new coal

LCOE of new generation



New solar is cheaper than existing coal

LCOE of renewables vs. coal and gas short-run marginal cost

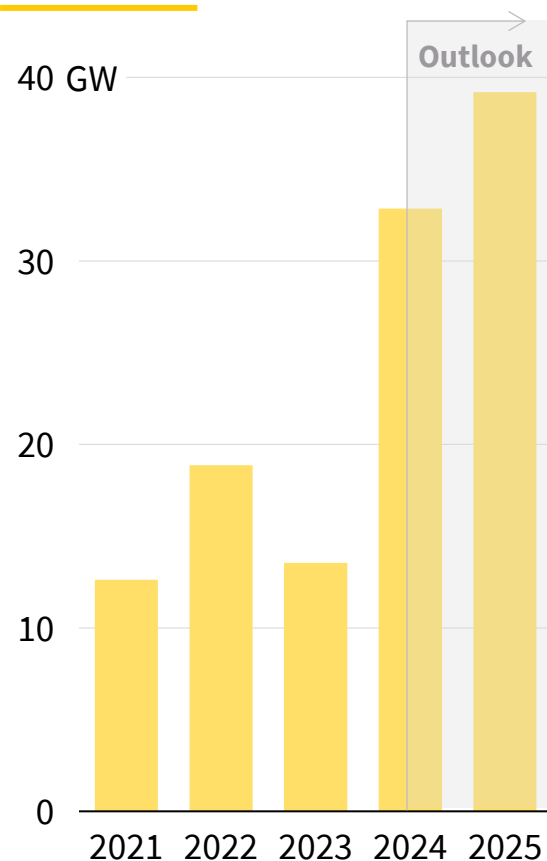


Clean energy deployment rose higher than ever in 2024

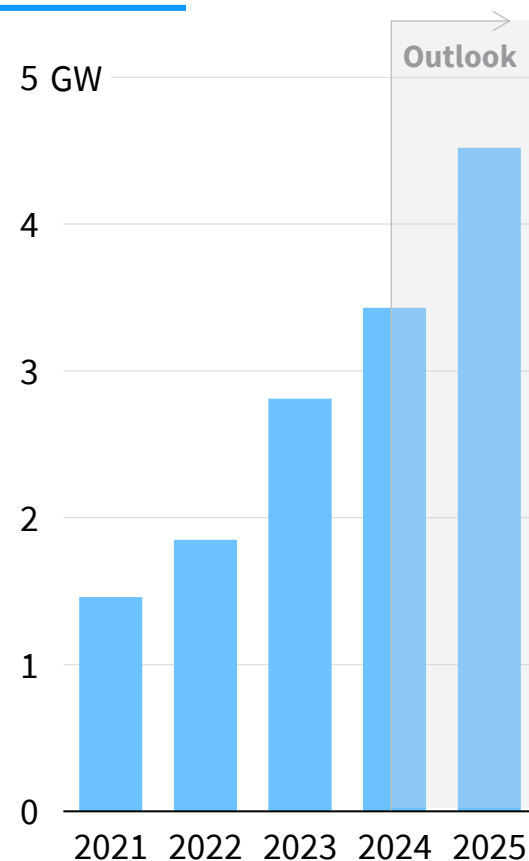
With further growth expected across solar, wind, and batteries

Annual capacity additions

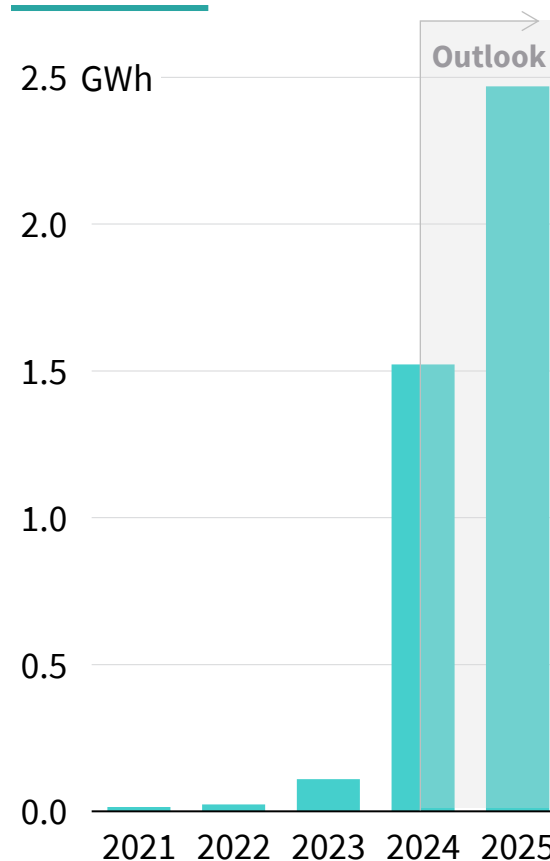
Solar



Wind



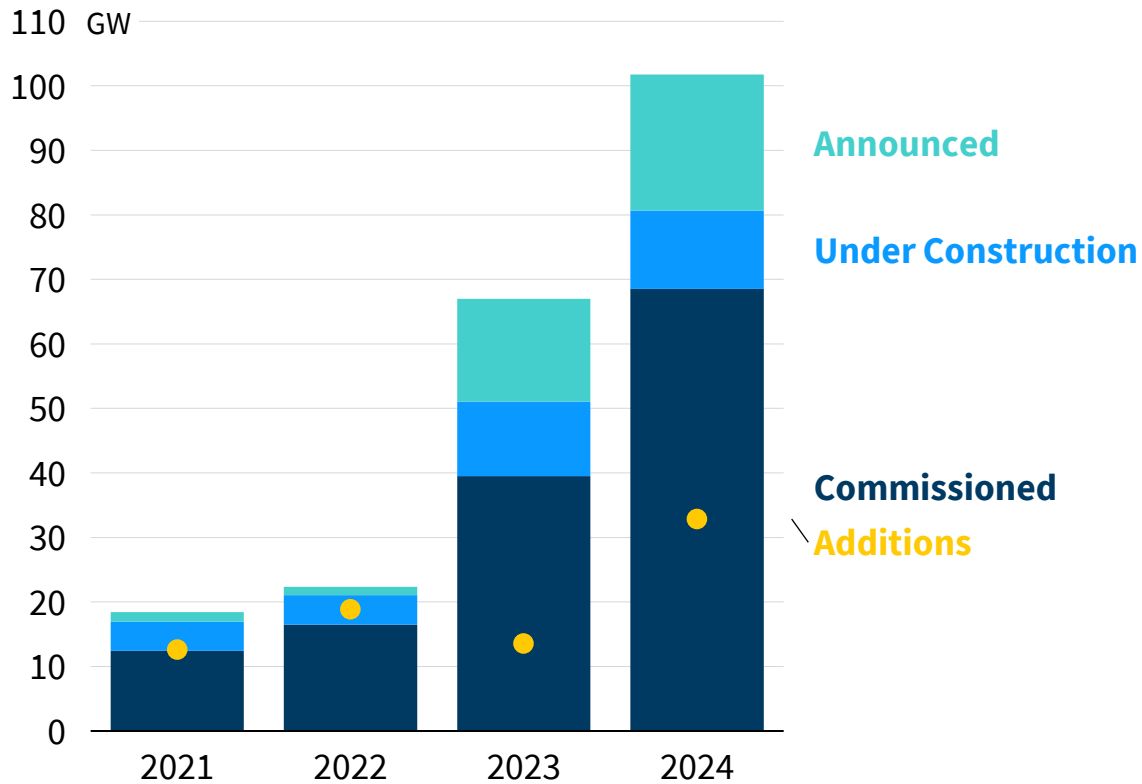
Battery grid storage



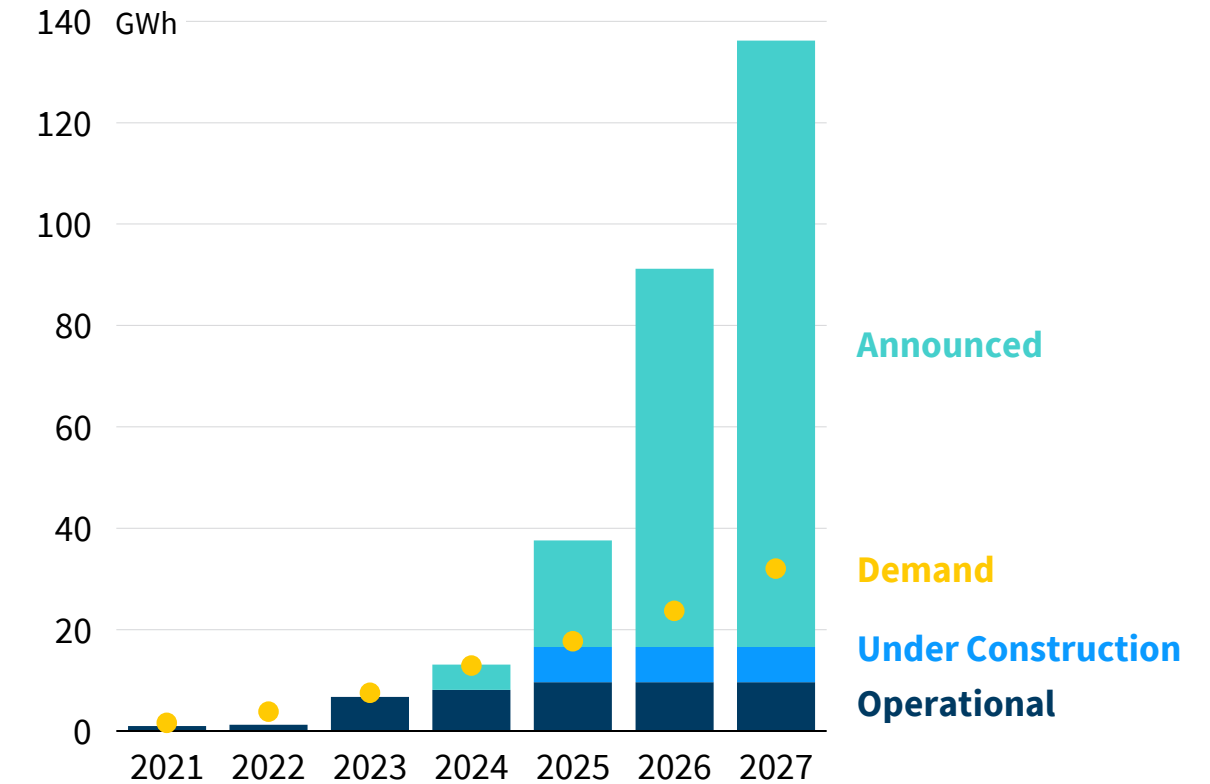
Cleantech manufacturing will help ensure India's progress

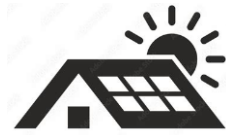
India is a net exporter of wind generators; incentives and investment are enabling the same for solar and batteries

Solar module manufacturing capacity vs. annual additions



Battery cell manufacturing capacity vs. annual demand

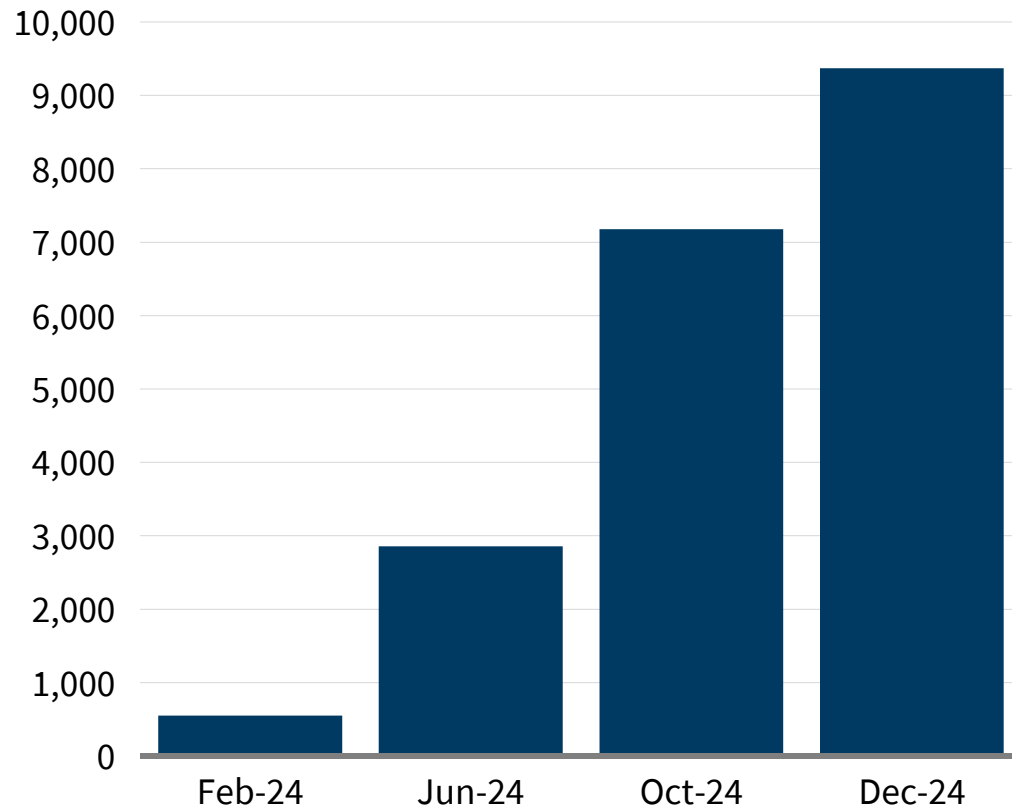




Case study: rooftop solar in Varanasi

India has nearly doubled the total home rooftop capacity in 10 months, including 15x growth in Varanasi

Rooftop solar installations in Varanasi



Actions that contributed



PM Surya Ghar Program from the national government, aimed at solarizing 10 million homes by 2027



Clear local targets and tracking, roughly doubling the national average in solarized households per capita



Doubling the number of market vendors, with banking institutions engaged to ensure access to finance



Enhanced consumer outreach, including large-group registrations and awareness efforts on the ground

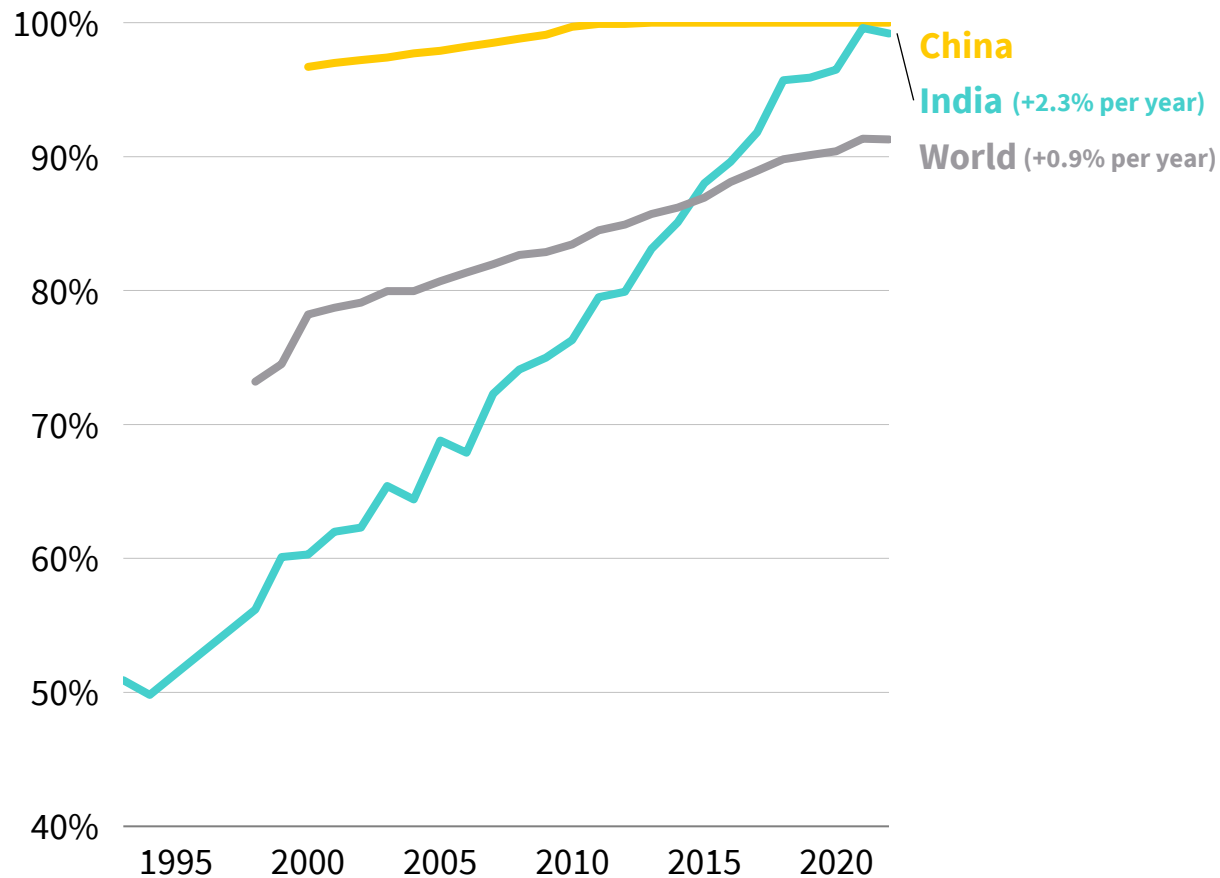


Streamlined digital processes for registration, with portals for low-interest loans and grievance redressal

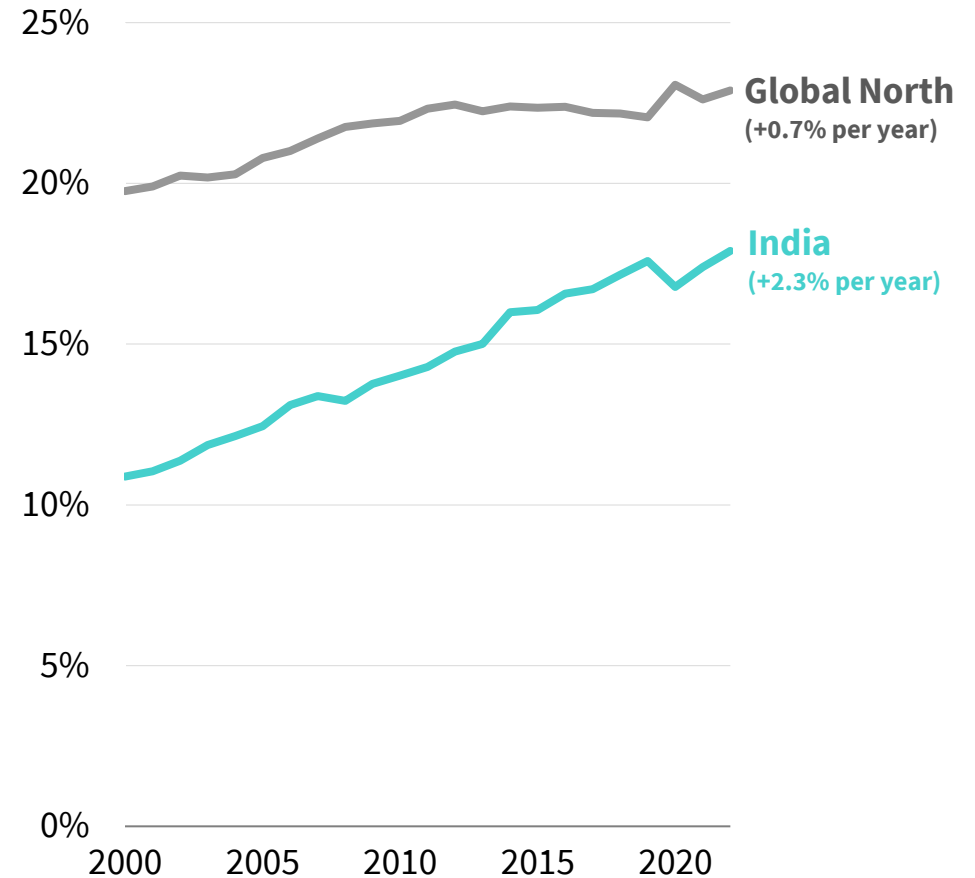
Electrification is growing fast, providing more secure energy access

Progress has been 3x faster than many other regions, both for access and for electricity's share of final energy

Share of the population with access to electricity



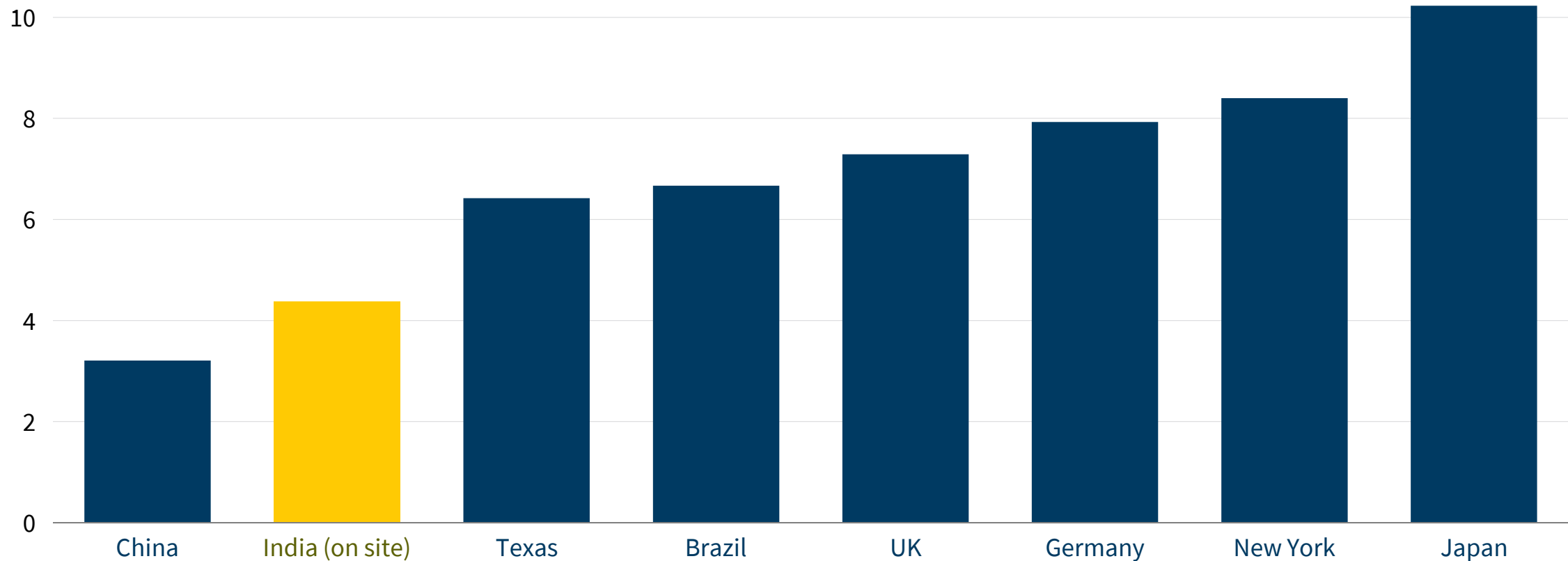
Electricity as a share of final energy consumption



Electrification progress is also enabling lower-cost green hydrogen

And with higher-cost gray hydrogen in India, green sources are set to be cost-competitive before other areas

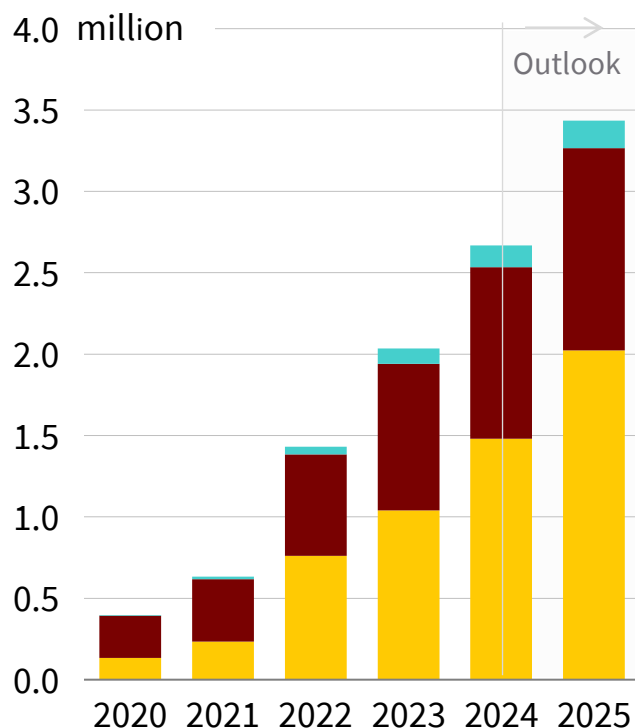
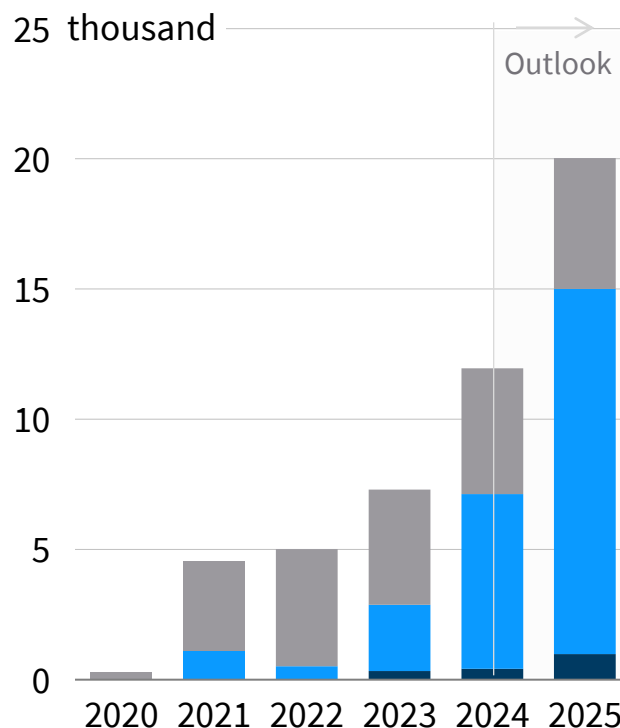
Production cost of green hydrogen in 2025



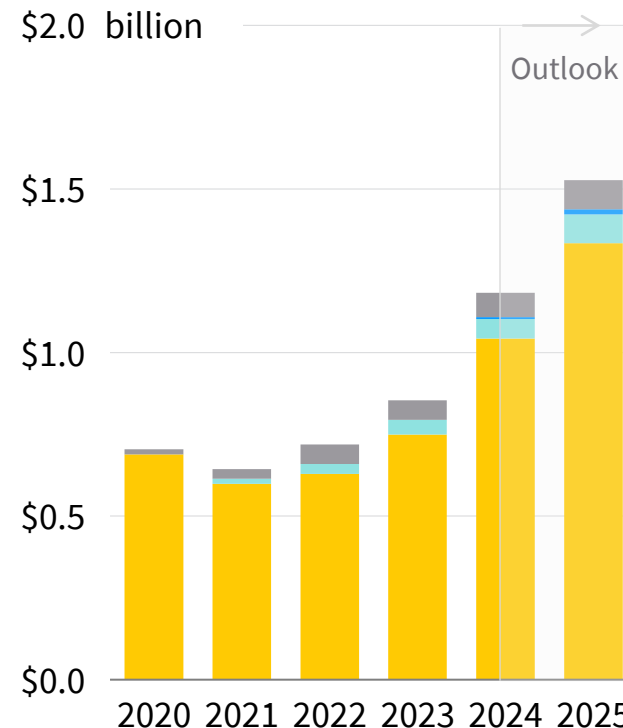
Electric vehicles are rising rapidly, avoiding costly oil imports

Two- and three-wheelers lead the way, with all sectors on track to accelerate

Sales of electric vehicles



Oil imports saved



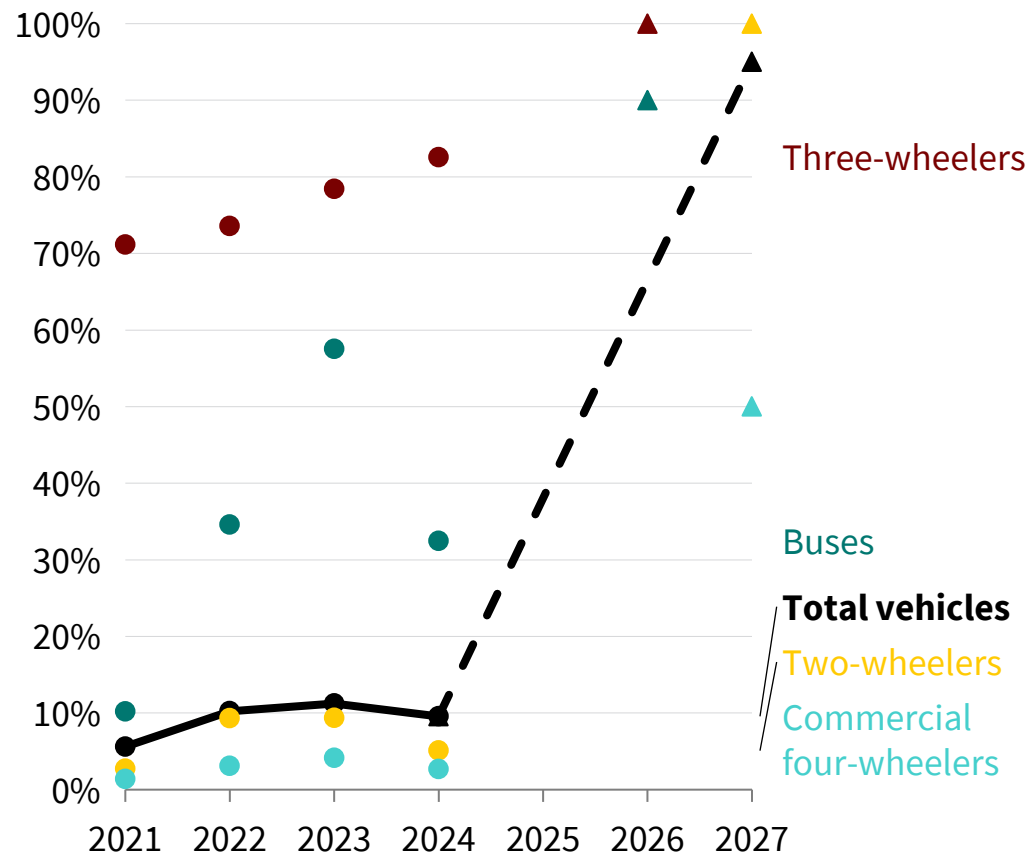
Two-wheelers Three-wheelers Passenger vehicles Medium- & heavy-duty trucks Light-duty trucks Buses



Case study: EV Policy 2.0 in Delhi (under review)

Potential target of a 95% EV sales share by 2027, with purchase and replacement incentives across vehicle types

Recent and target sales shares of electric vehicles



Policy steps to get there



Policy mandates of a 100% electric sales share for two- and three-wheelers by April 2027 and 2026



Purchase, scrappage and retrofitting incentives across vehicle types for faster progress



Quadrupling the number of charging stations from March 2025 to 2026, including fast-charging corridors and mandatory stations for new buildings



Workforce training efforts through the Delhi Skill & Entrepreneurship University

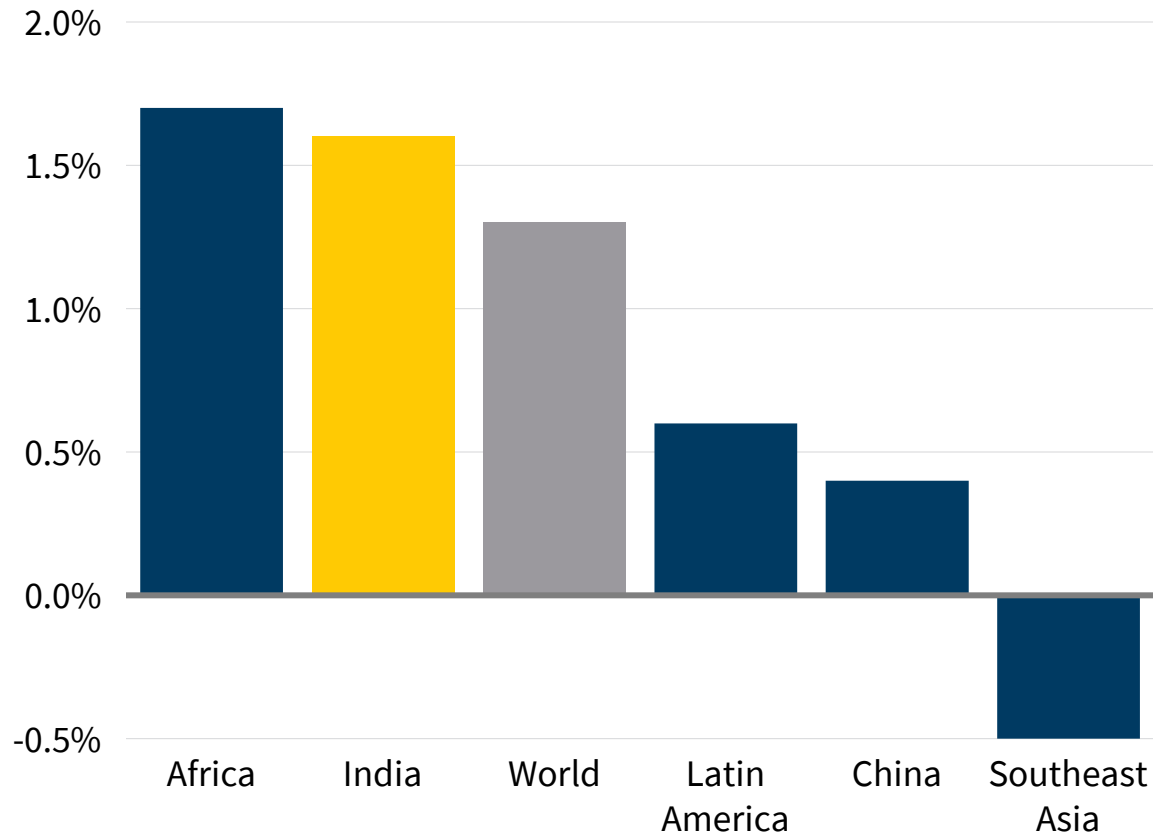


State EV Fund to finance these incentives, supported by pollution levies and license fees

India is also outpacing many regions in energy efficiency progress

Due to market incentives and policies across buildings, industry, and transportation

Estimated annual energy efficiency improvement, 2021–2024



Example efficiency actions in India



UJALA program, the world's largest zero-subsidy initiative for LED light bulb production and finance



Energy Efficiency Services Limited initiatives, which use demand aggregation for efficient appliances



Energy Conservation Building Codes, which can save 25%–35% of energy demand if fully implemented



Perform, Achieve, and Trade scheme, a successful market mechanism for saving energy in industry



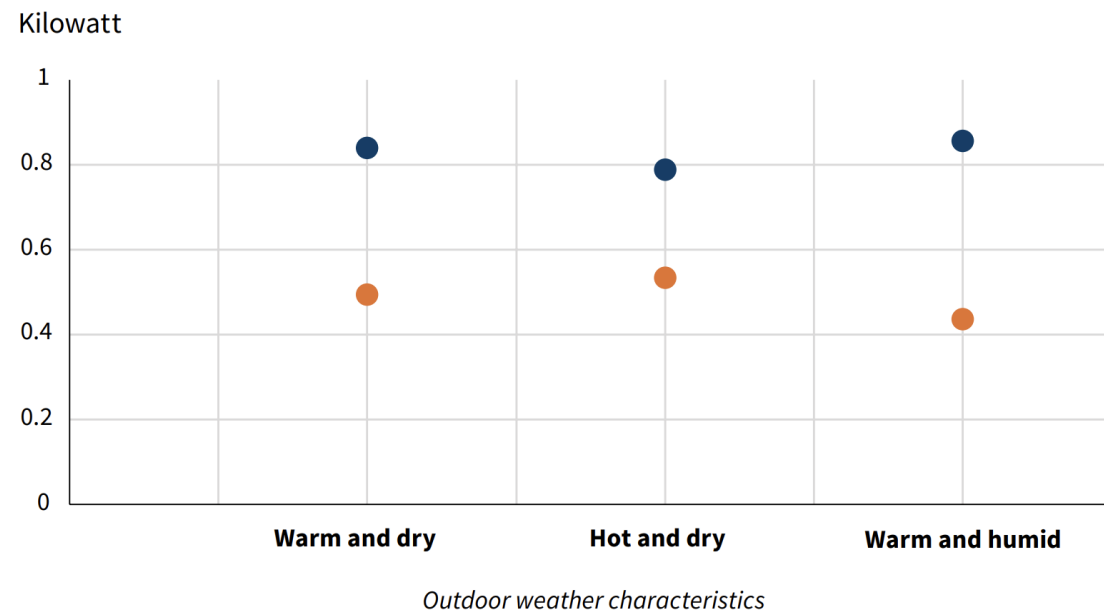
Fuel economy standards and EV incentives, for improving efficiency in the transportation sector

Innovations are progressing, like super-efficient air conditioners (ACs)

Nine-month field testing shows how scaling adoption can benefit the grid, climate, and consumers

Peak power draw of a super-efficient AC versus a typical AC for the field-testing period

● Typical AC (3-star, inverter) ● Super-efficient AC prototype



The value of super-efficient ACs



60% less energy than a typical AC, while meeting the target temperature and relative humidity more consistently



4.9x lower climate impact than the Global Cooling Prize baseline AC, due to efficiency and low-warming refrigerants



50% savings (or more) on energy bills, leading to a much lower total cost of ownership than a typical AC



50% lower peak electricity demand if adoption is scaled, helping avoid power outages and costly infrastructure

*But barriers remain. The current testing standard undervalues efficiency by ignoring how **humidity requires typical ACs to use extra energy (up to 25%)**.*

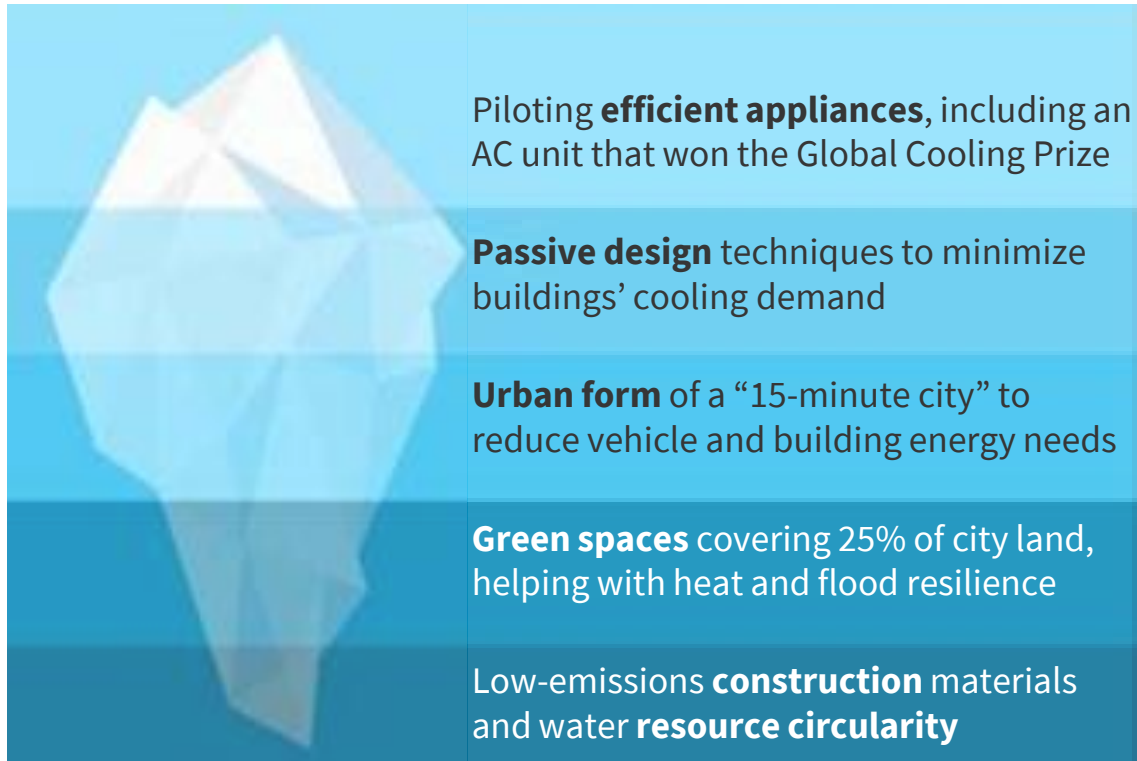
If typical ACs were adopted worldwide, by 2050 they could account for 2x today's total global emissions.



Case study: energy efficiency in Palava City

Flagship net-zero energy city uses system-wide measures to exemplify sustainable urban living

With system efficiency, appliances are just the tip of the iceberg...



...helping the city thrive in sustainability and prosperity



30% more efficient home energy use
vs. industry benchmarks



100% of equivalent energy needs from solar
as a goal, via solar panels and water heaters



Only 4% of days with unhealthy air
(vs. 42% in nearby Mumbai)



2°C cooler than Mumbai, saving energy
and lives during deadly heat waves



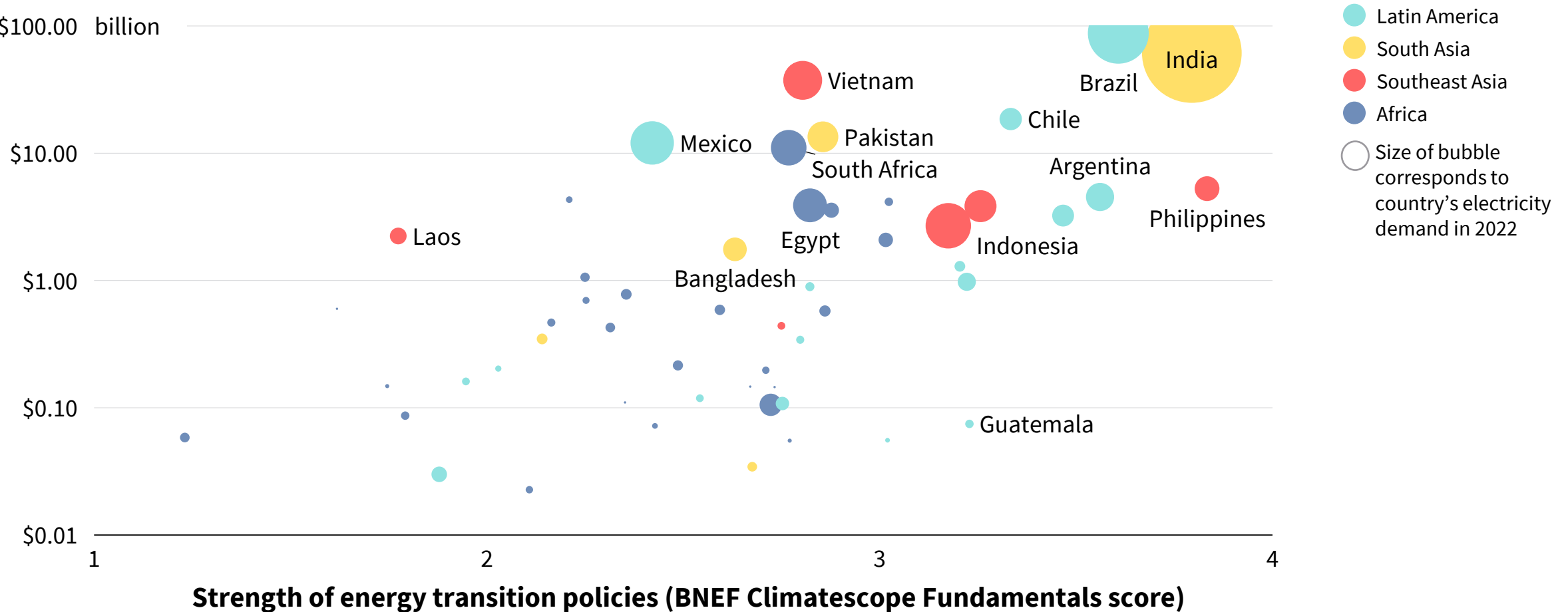
\$1 billion in annual buildings revenue
expected after scale-up by the Lodha Group

As we look ahead, India's policies make it attractive for investment

Good policy attracts investment — and India is leading on both across emerging economies

Investment in renewable energy (2019–23)

\$100.00 billion



As policy support continues, cleantech investment will surge

Reasons for growth: long-term goals



500 GW (50%) of **power capacity from non-fossil sources** by 2031–32, with the percentage target met in 2025



208 GWh of **battery storage** by 2030, from 2 GWh in 2024



EV sales share of 80% for two- and three-wheelers by 2030, and 30% for private cars



Doubling energy efficiency improvements, with savings by 2030 that are equivalent to 10% of current energy use



45% **lower emissions intensity** in 2030 vs. 2005 levels

Reasons for growth: near-term Union Budget



80% increase in solar project funding



Double the investment for green hydrogen, in line with India's National Mission



National Manufacturing Mission and tax measures to strengthen domestic EV production



Incentives for regulatory reform to encourage renewable energy

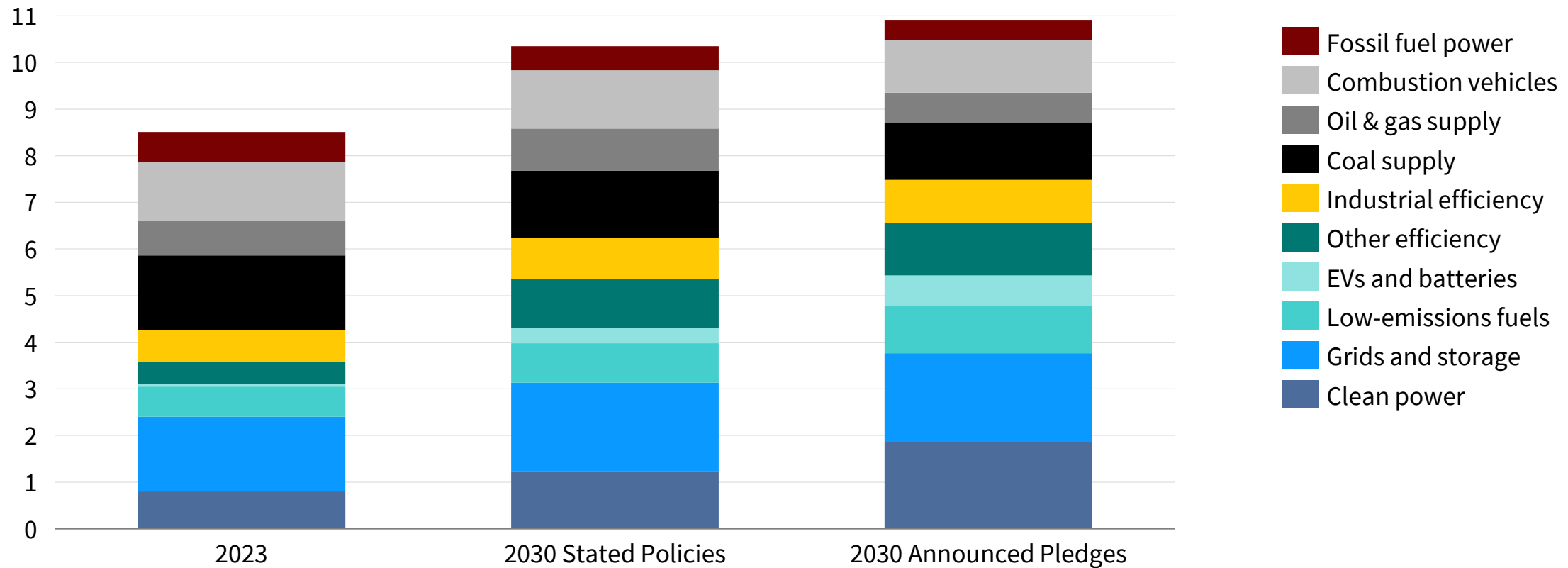


R&D funding for further innovation

The energy transition provides millions more jobs for India

Clean sources will add at least 4x more jobs than fossil fuels might lose

Millions of energy jobs in India



With the cost of heat, solutions are an economic opportunity

More than half of heat's global labor effects are in India, but actions can drastically reduce future impacts

Past annual costs of extreme heat (2001–2020 average)



259 billion labor hours

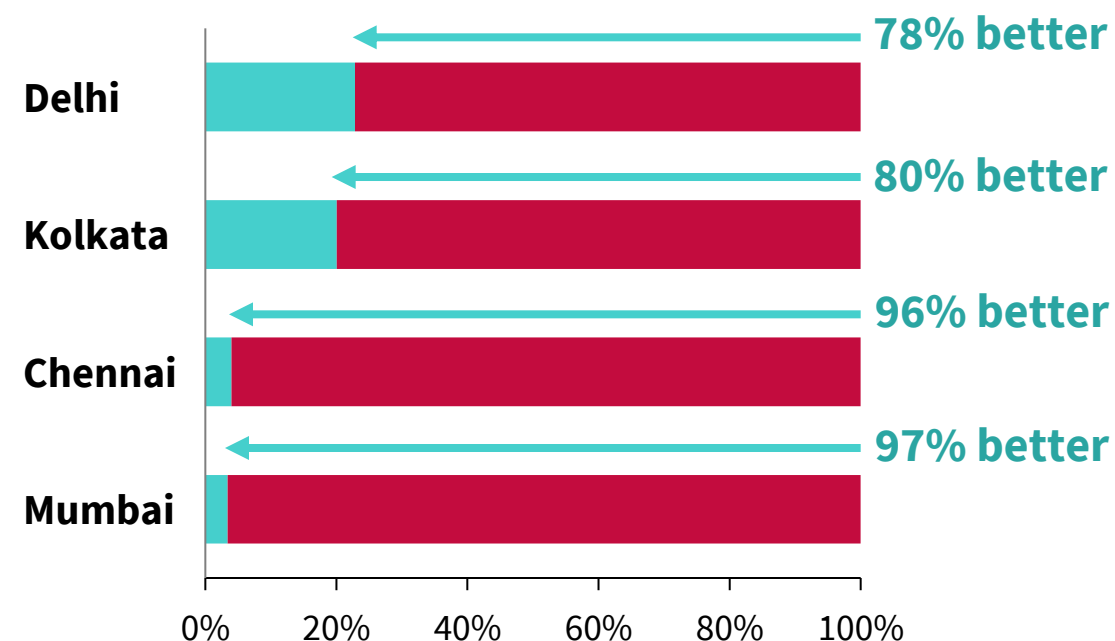


Thousands of deaths



\$624 billion (₹54 trillion)

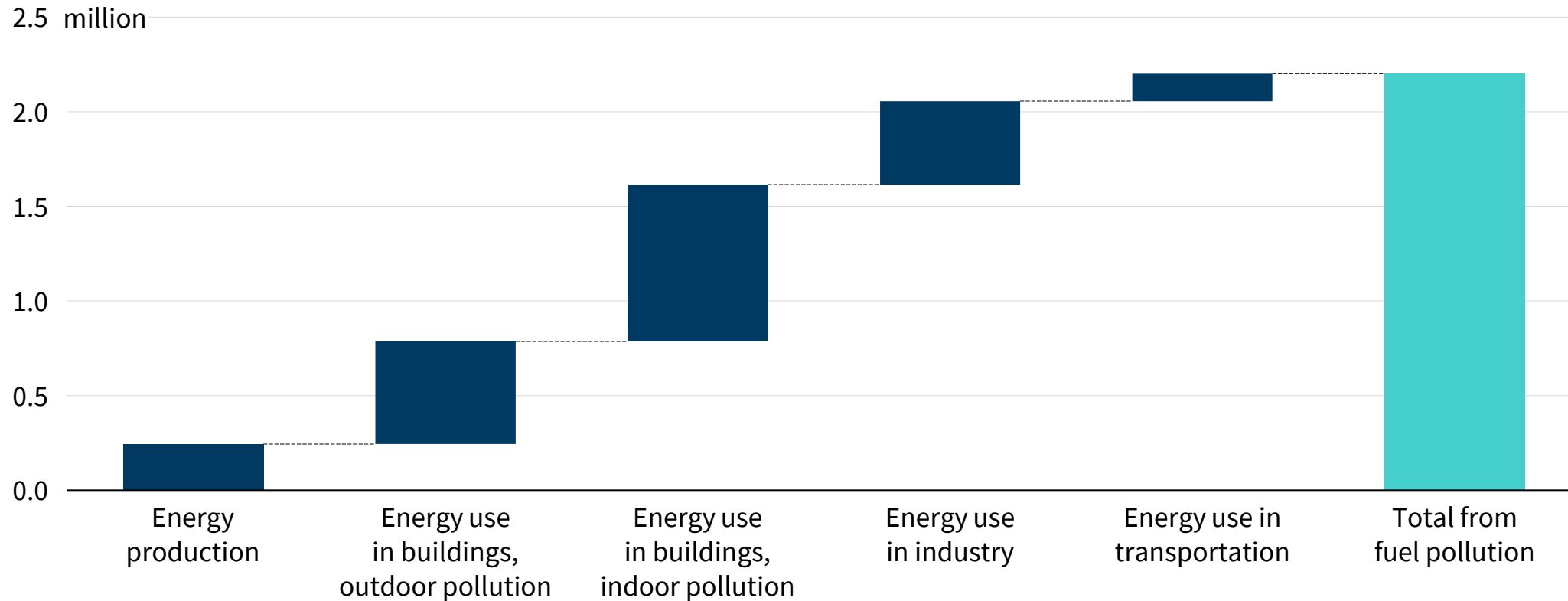
Fraction of hot-hours at 2°C vs. 3°C of warming



Solutions can curb air pollution, which causes 1 in 4 deaths in India

With the potential to save 2.2 million lives every year, more than the deaths from any other risk factor

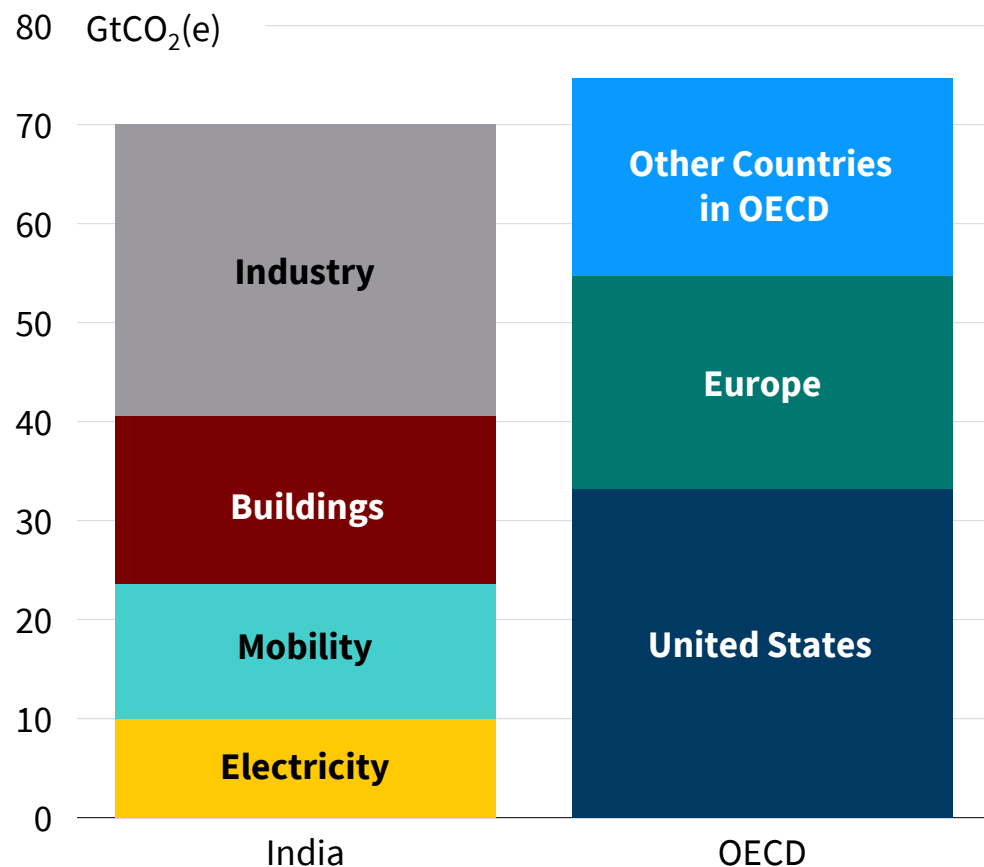
Human lives we can save every year with clean energy



Most of all, the transition can cut costs and raise revenue

While saving more emissions than the US and Europe combined

Potential cumulative CO₂ reductions through midcentury



Example economic benefits, annually

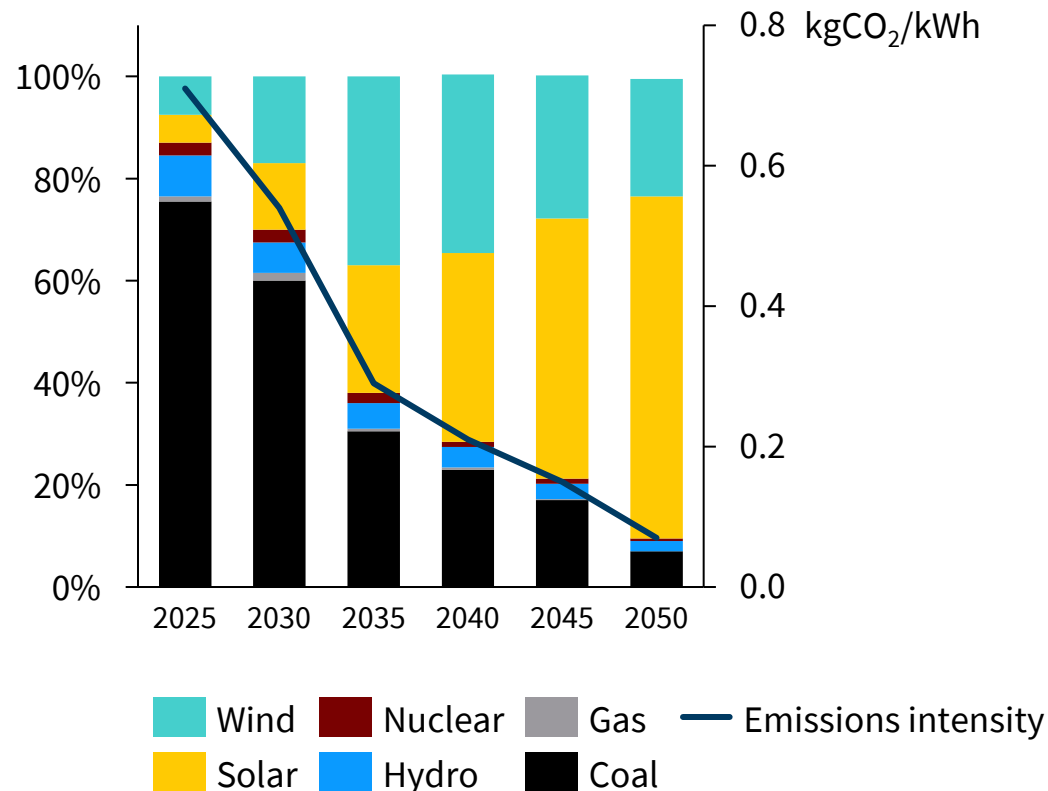
-  **₹7 lakh crore (\$81 billion)** in midcentury savings from electricity system costs with a cleaner grid
-  **₹13 lakh crore (\$147 billion)** in midcentury savings by avoiding oil imports for road transportation
-  **₹54 hundred crore (\$620 million)** in revenue from feasible methane reductions in energy production

Electricity: renewable energy can power 90% of the grid by 2050

Saving ₹7 lakh crore (\$81 billion) in 2050, equivalent to 30%–40% lower electricity system costs

Results of least-cost scenario

Generation share



Via five key actions across technologies



Reform market design and operations for a cleaner grid



Streamline market and policies for grid storage and demand flexibility



Bridge green premium gaps for clean energy technologies



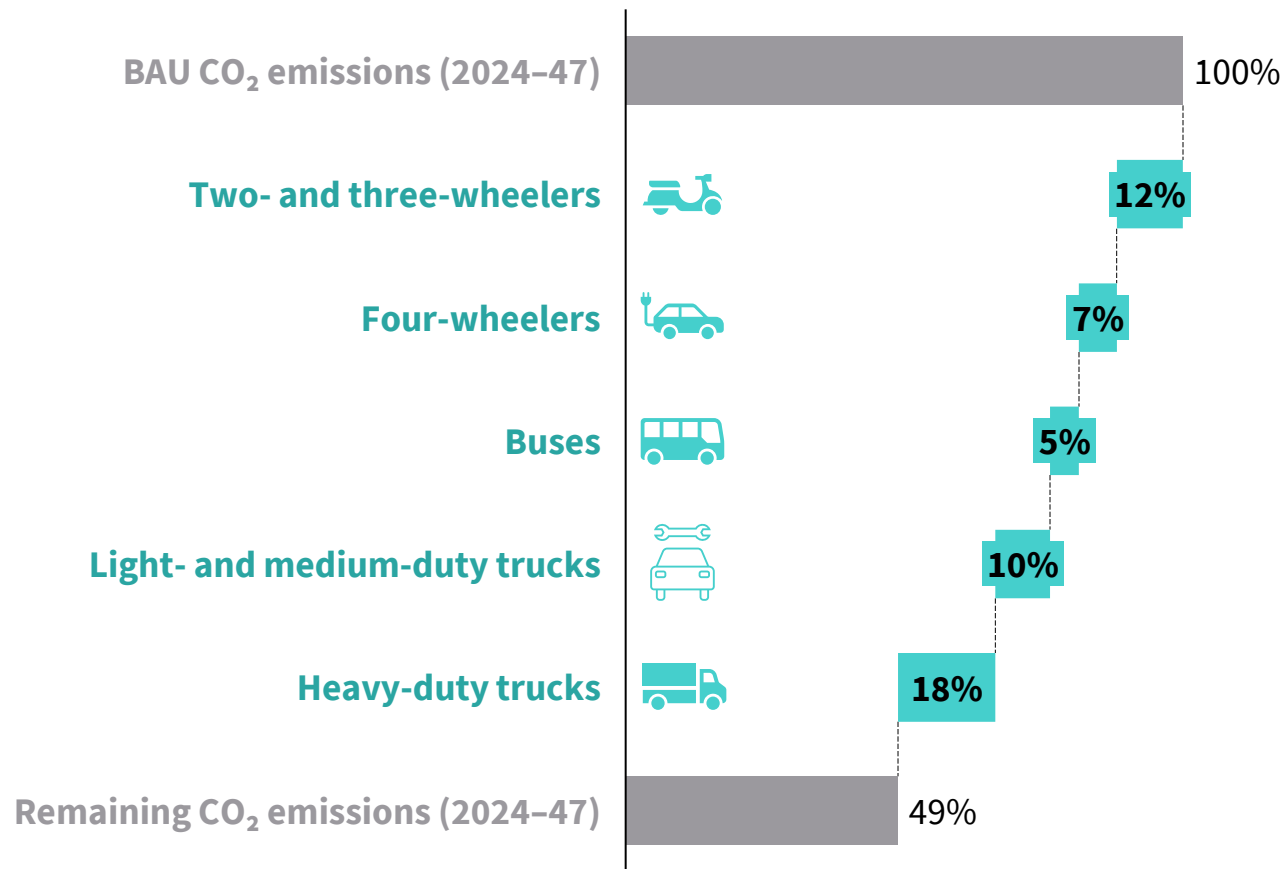
Mainstream reliability and resilience in planning and investment



Invest in optimized grid infrastructure and asset management

Mobility: accelerated action can save a cumulative \$2 trillion in oil imports

With 90% lower sectoral imports and emissions in the year 2050, led by electric trucks and two-wheelers*



Via five key actions across vehicle types



Comprehensive supply- and demand-side **policies**



Accessible, affordable, and safe EV **infrastructure**



Innovative **financing** mechanisms to de-risk adoption



Clean electricity by 2045 to power EV charging

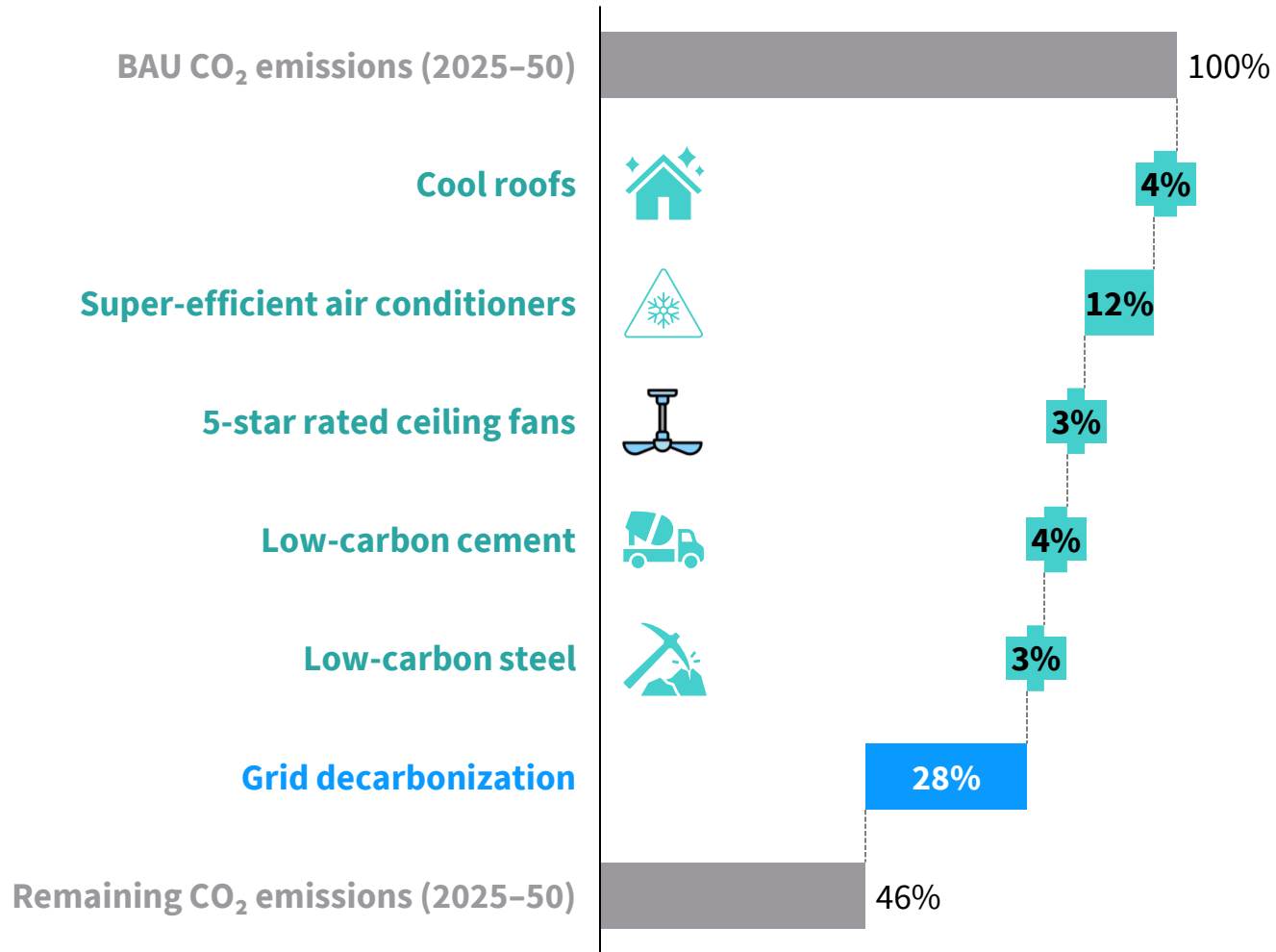


Domestic EV **production** and a battery **circular economy**

*Not including urban planning, which can cut 2050 mobility emissions by one-third or more

Buildings: existing solutions can cut cumulative emissions in half

With rapid adoption possible because 98% of India's building stock in 2050 is yet to be built



Via five key actions across solutions



Launch **public awareness** campaigns on efficient solutions



Standardize **policy** for energy performance and appliance ratings



Pilot innovations with financial incentives for adoption



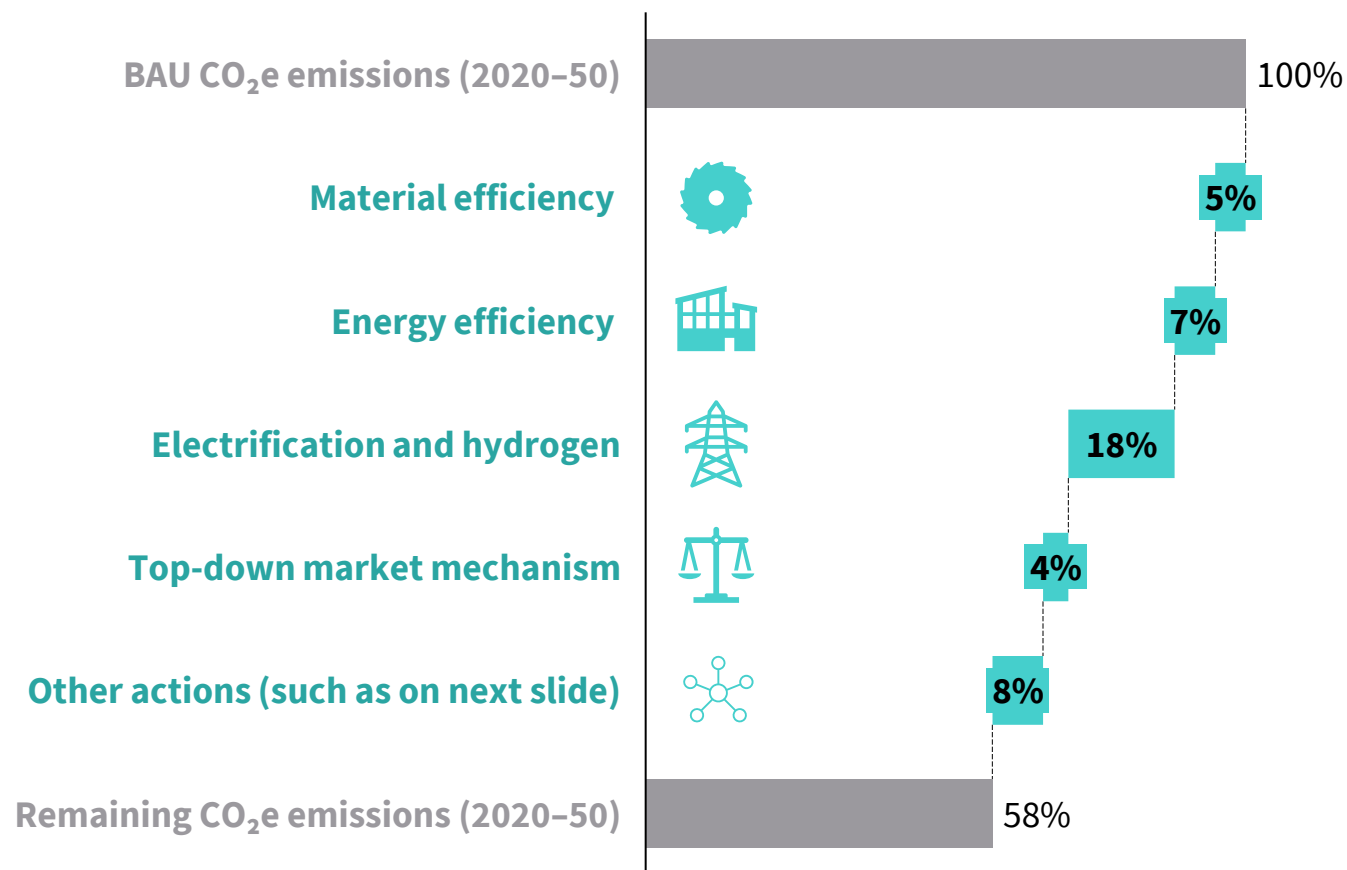
Integrate low-carbon materials into standards and **procurement**



Build **workforce capacity** for prioritizing sustainable practices

Industry: efficiency and electrification lead a full system of solutions

Major progress is possible across steel, cement, chemicals, mining, and more



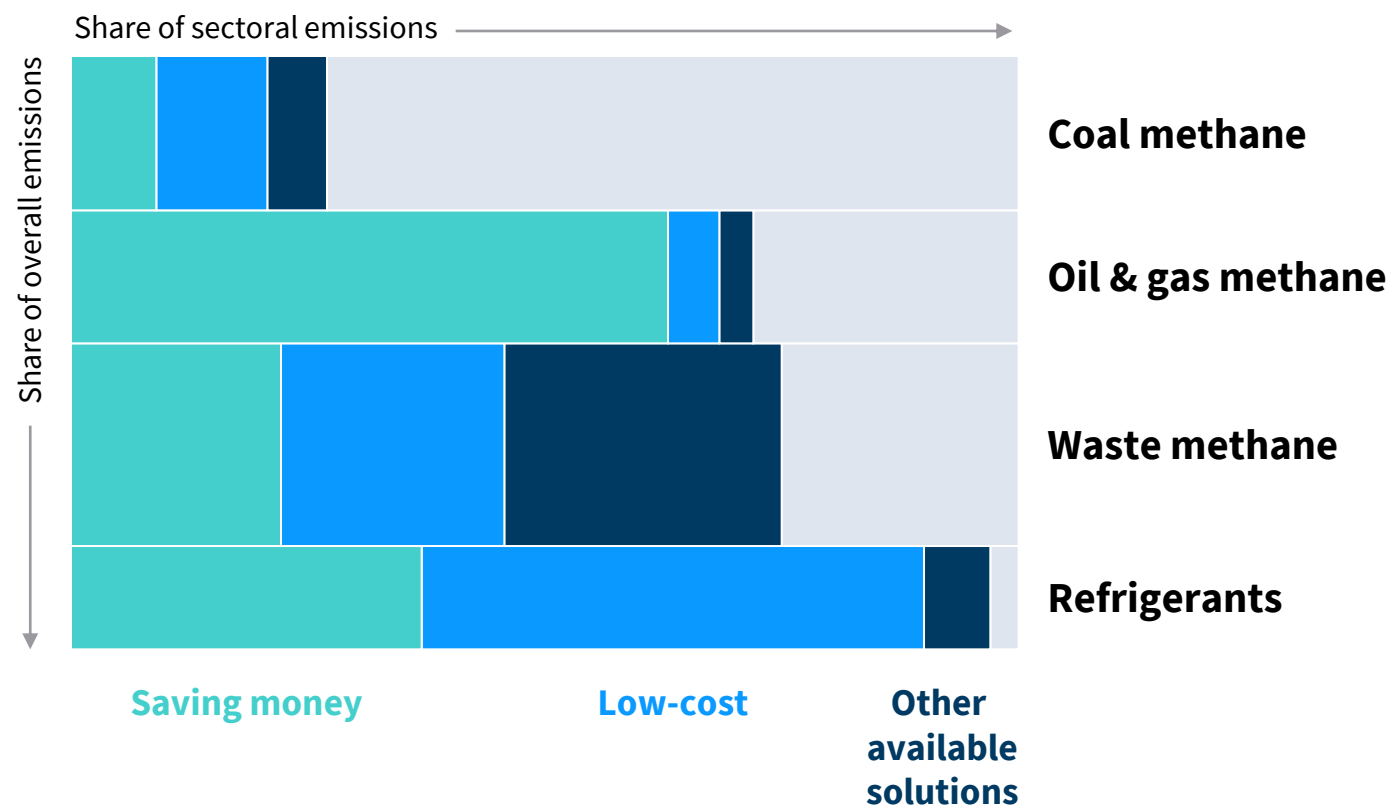
Via five key actions across sectors

-  **Invest in finance**, especially for smaller enterprises
-  **Elevate demand-side policies**, such as on circularity
-  **Build domestic manufacturing** for cleantech products
-  **Support R&D to innovate**, such as on green steel
-  **Provide workforce training** to implement solutions

Beyond CO₂ emissions, curbing pollution brings savings and revenue

Saving millions of lives and earning ₹54 billion (\$620 million) annually from fossil fuel methane action alone

Energy-related non-CO₂ emissions that can be avoided...



...via cross-sector actions such as:

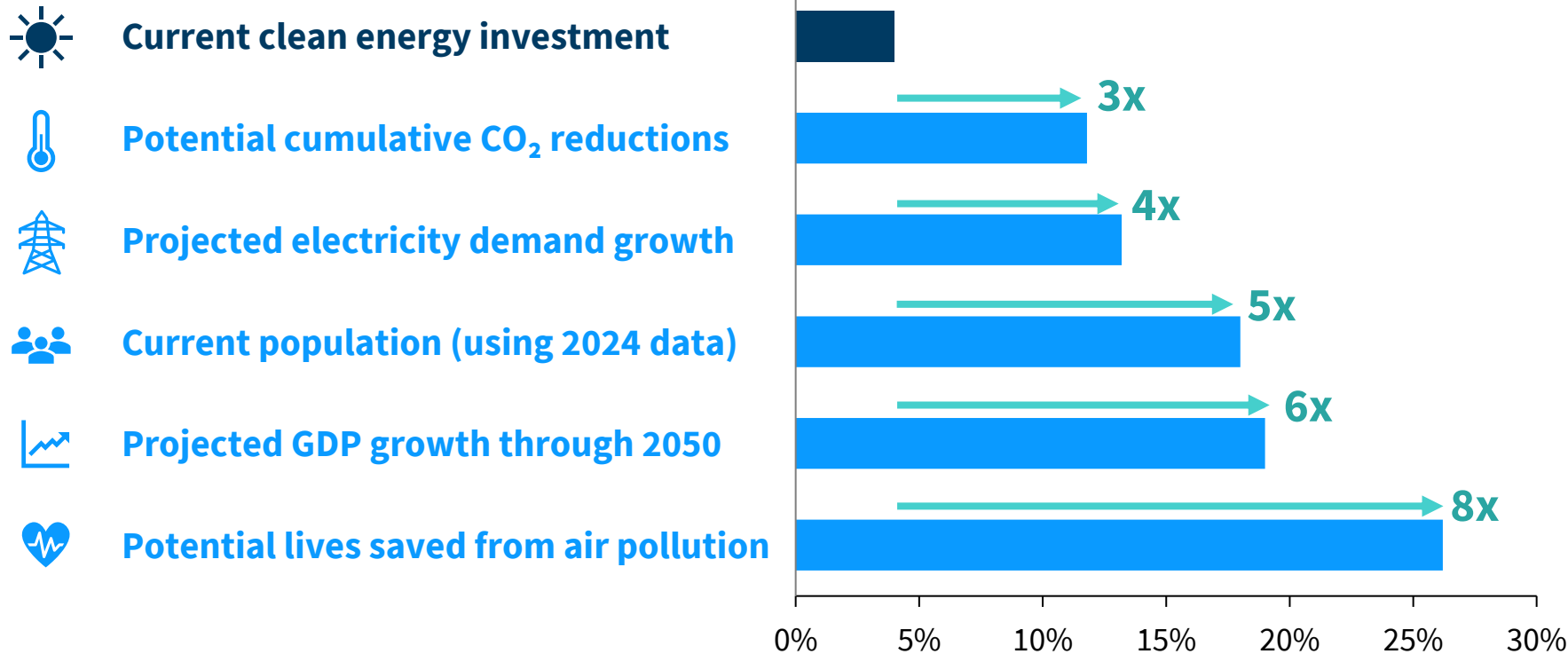
-  **Data transparency**, via comprehensive monitoring and inventory work
-  **Holistic inclusion in policy initiatives**, such as the future Indian Carbon Market
-  **Using the waste management hierarchy** to prioritize full-system solutions
-  **Revised metrics to remove bottlenecks**, including for air conditioner ratings
-  **Innovation and finance to scale solutions**, from cooling to coal mines

India's investment gap is a massive opportunity, locally and globally

If India's share of clean energy investment grows to its share of global impact, there will be broader benefits for all

India's share of...

Growth opportunity to match the rest of the world



About RMI

Rocky Mountain Institute (RMI) is an independent, nonpartisan nonprofit founded in 1982 that transforms global energy systems through market-driven solutions to secure a prosperous, resilient, clean energy future for all. In collaboration with businesses, policymakers, funders, communities, and other partners, RMI drives investment to scale clean energy solutions, reduce energy waste, and boost access to affordable clean energy in ways that enhance security, strengthen the economy, and improve people's livelihoods. RMI is active in over 60 countries.

Contacts

Will Atkinson, watkinson@rmi.org

Laurens Speelman, lspeelman@rmi.org

Chiara Gulli, chiara.gulli@rmi.org

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Title image: Palava City.

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