



# What will drive India's four energy transitions?

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NTPC Business School

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# CEEW – Among Asia's leading policy research institutions



Energy Access



Renewables



Power Sector



Industrial Sustainability & Competitiveness



Low-Carbon Pathways



Risks & Adaptation



Technology, Finance & Trade



CEEW Centre for Energy Finance

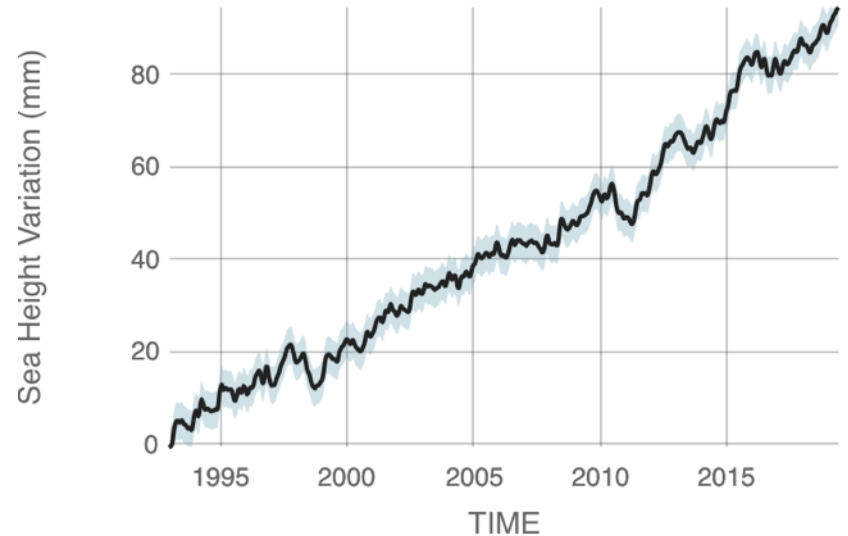
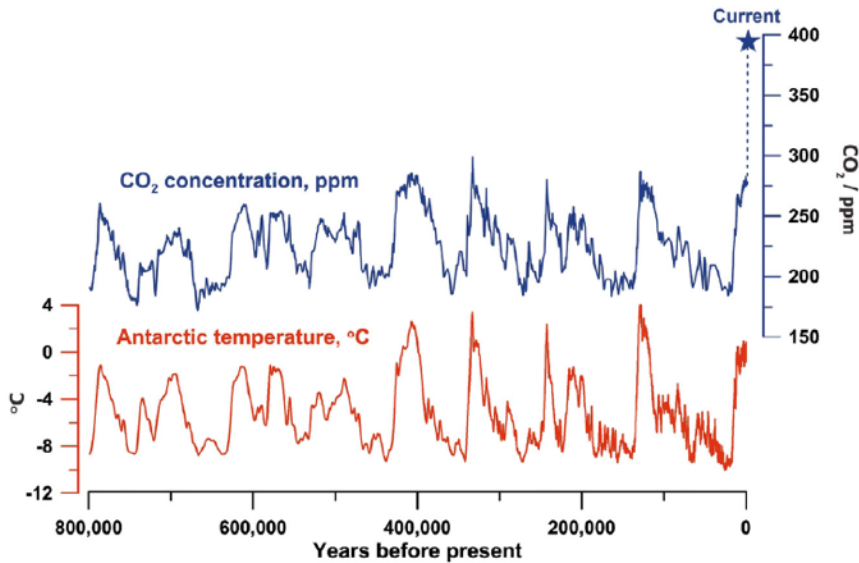
# Nearly 100-member team believing in leadership by initiative





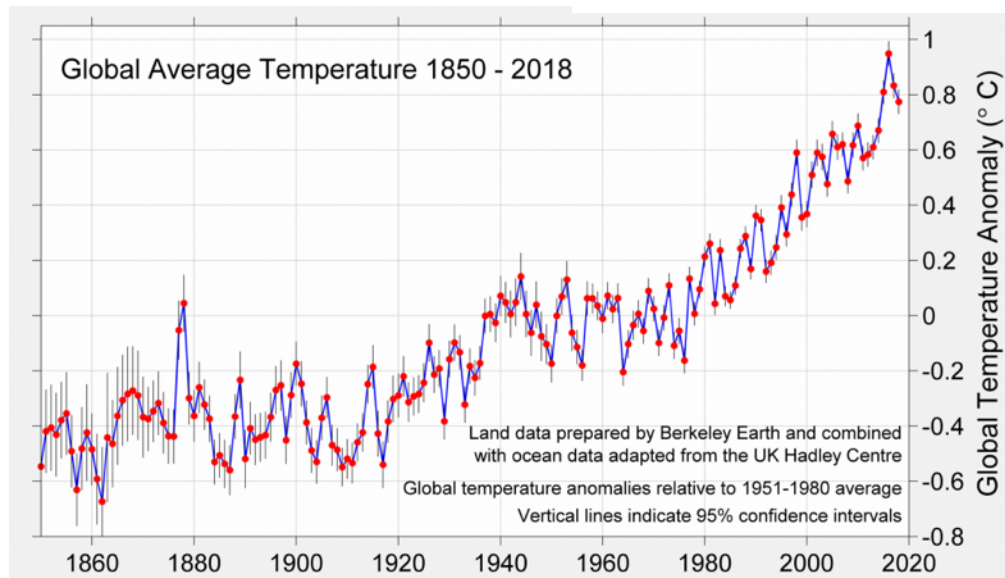
# RISK: WHAT WILL THE PLANET DO TO US?

# A tale in three charts



Last 800,000 years changes in Antarctic air temperatures and atmospheric CO<sub>2</sub> concentrations

Source: climate.nasa.gov

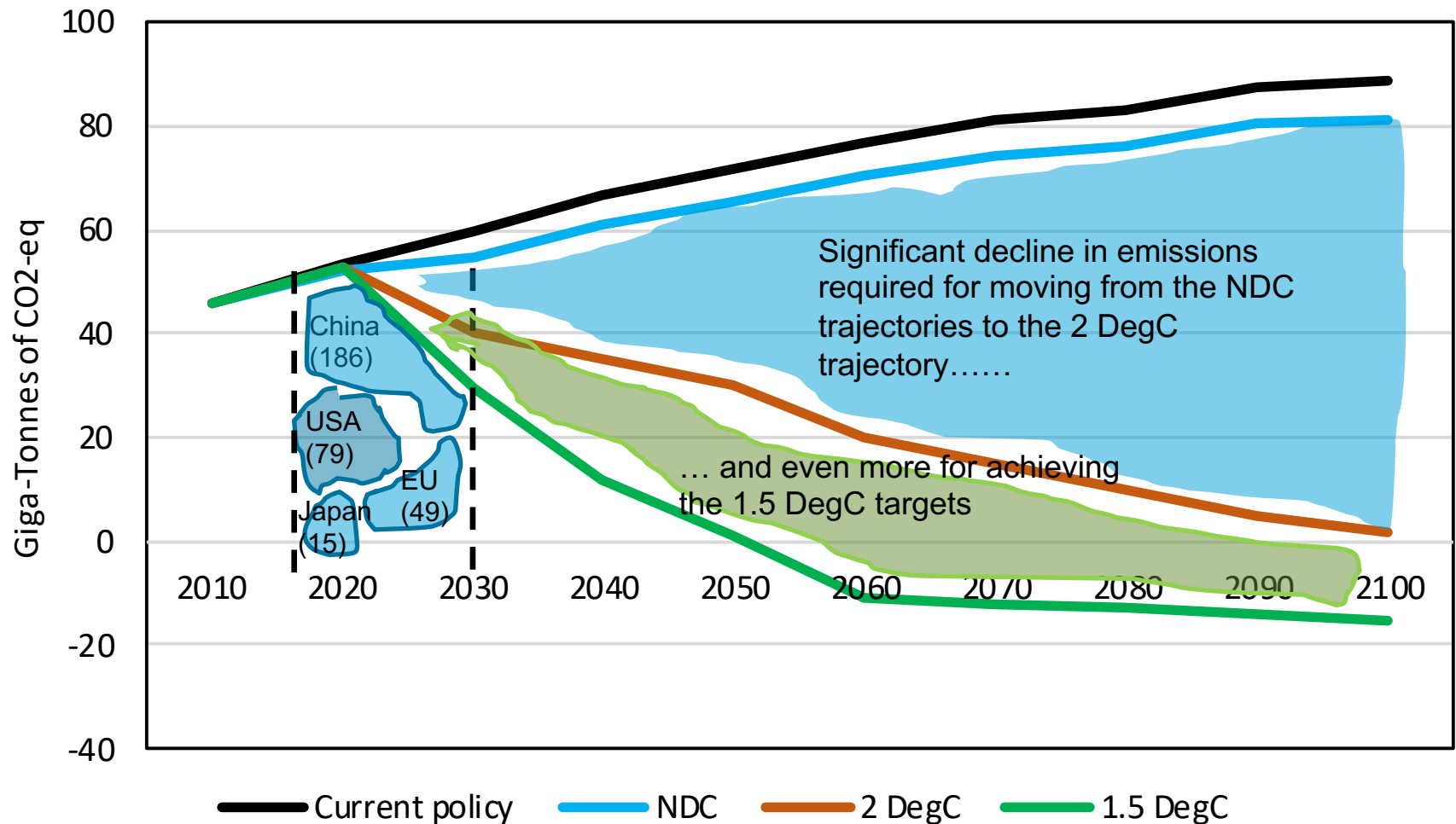


Mean sea levels have risen **3.7 inches in 25 years**; 8 inches since 1880

Average temperatures are **1 degree Celsius** above pre-industrial era

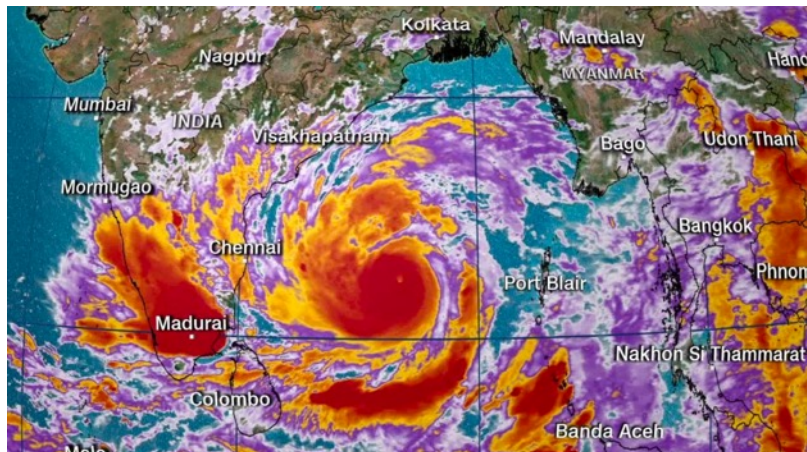
# Carbon budget gets consumed by the biggest polluters

Global GHG emission trajectories across scenarios



Based on their NDC trajectories, China, USA, EU and Japan will appropriate 49% of global carbon space between 2018 and 2030

# Cyclones Amphan and Nisarga among the strongest ever



- India experienced 478 extreme weather events since 1972, most occurring after 2005
- The frequency of cyclones is rising, jumping from 33 in the 1980s to 58 in the 2010s

## India is particularly vulnerable

- Average temperature in India increased 0.7C during 1901-2018
- If emissions continue at the high end of the predicted range by 2100 the temperature could rise 4.4C relative to the 1976-2005 average
- Frequency of heat waves could increase three to four times, with average duration doubling
- From 1998 to 2017 climate-related disasters caused \$80 billion of damage
- The Hindu Kush Himalaya region, source of 10 major rivers, could endure a temperature rise of 5.2C by 2100
- In the worst case, CEEW analysis finds that food crop losses could be \$1.4 trillion-\$2.7 trillion at 2015 prices during 2050-2100



# Four energy transitions

Traditional to modern

Rural to urban

Deeper integration into global energy markets

Growth to sustainable growth

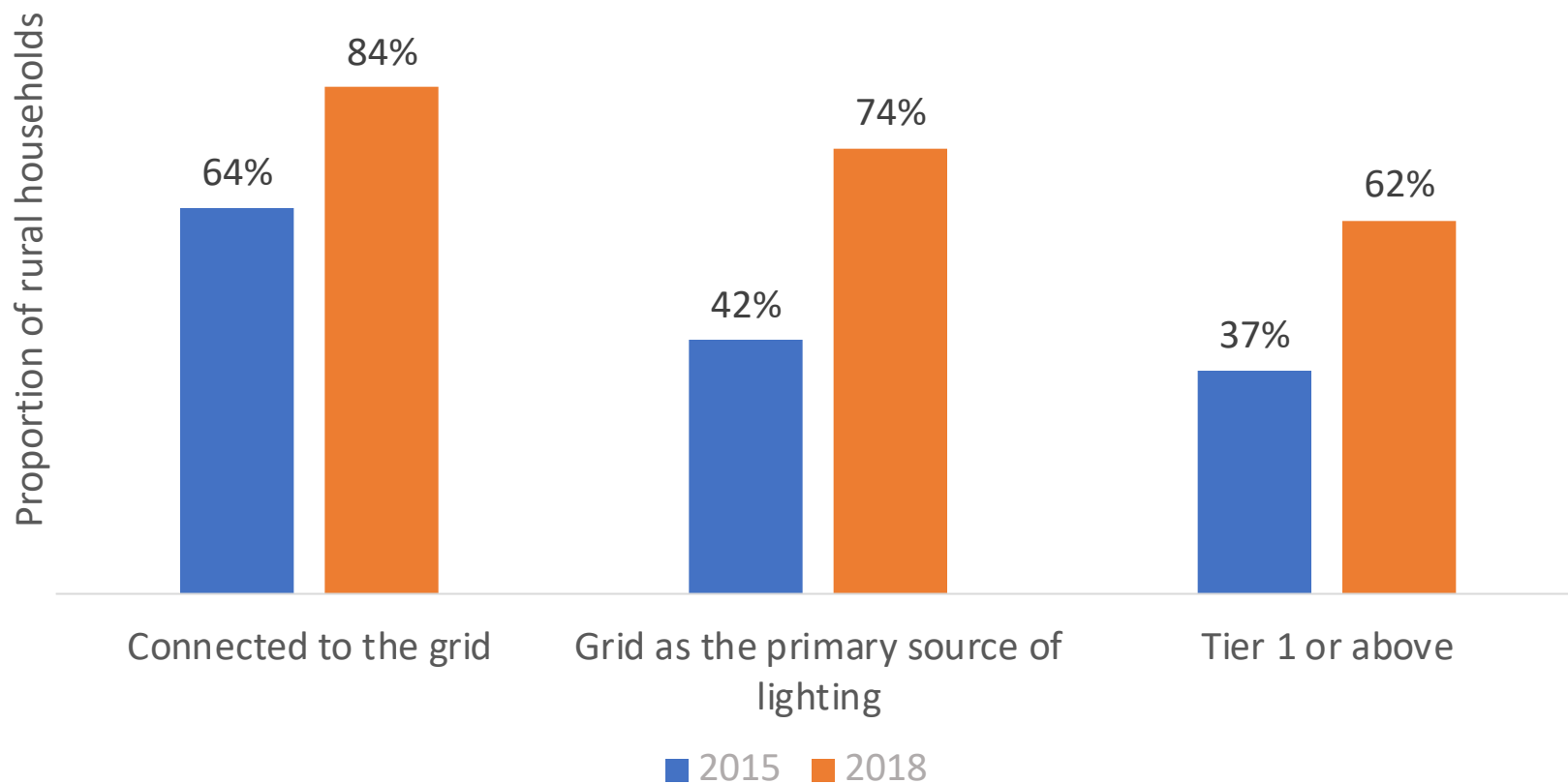


# ENDING ENERGY POVERTY?



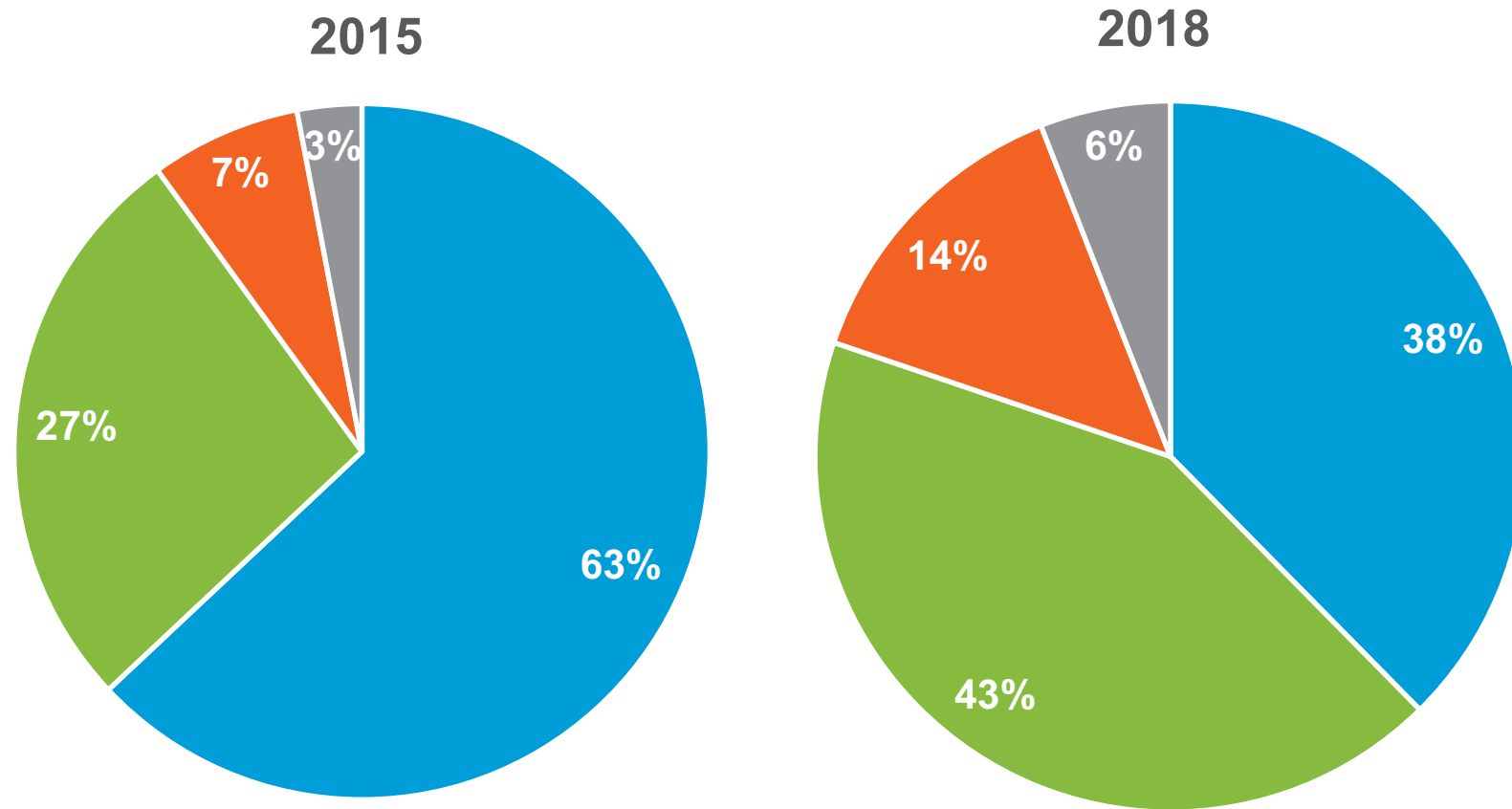
# 118 million have moved out of absolute electricity poverty in 3 years (Past decade 350 million)

## Access to electricity in six states



# But long way to go, as only 20% of rural households are in top-two tiers

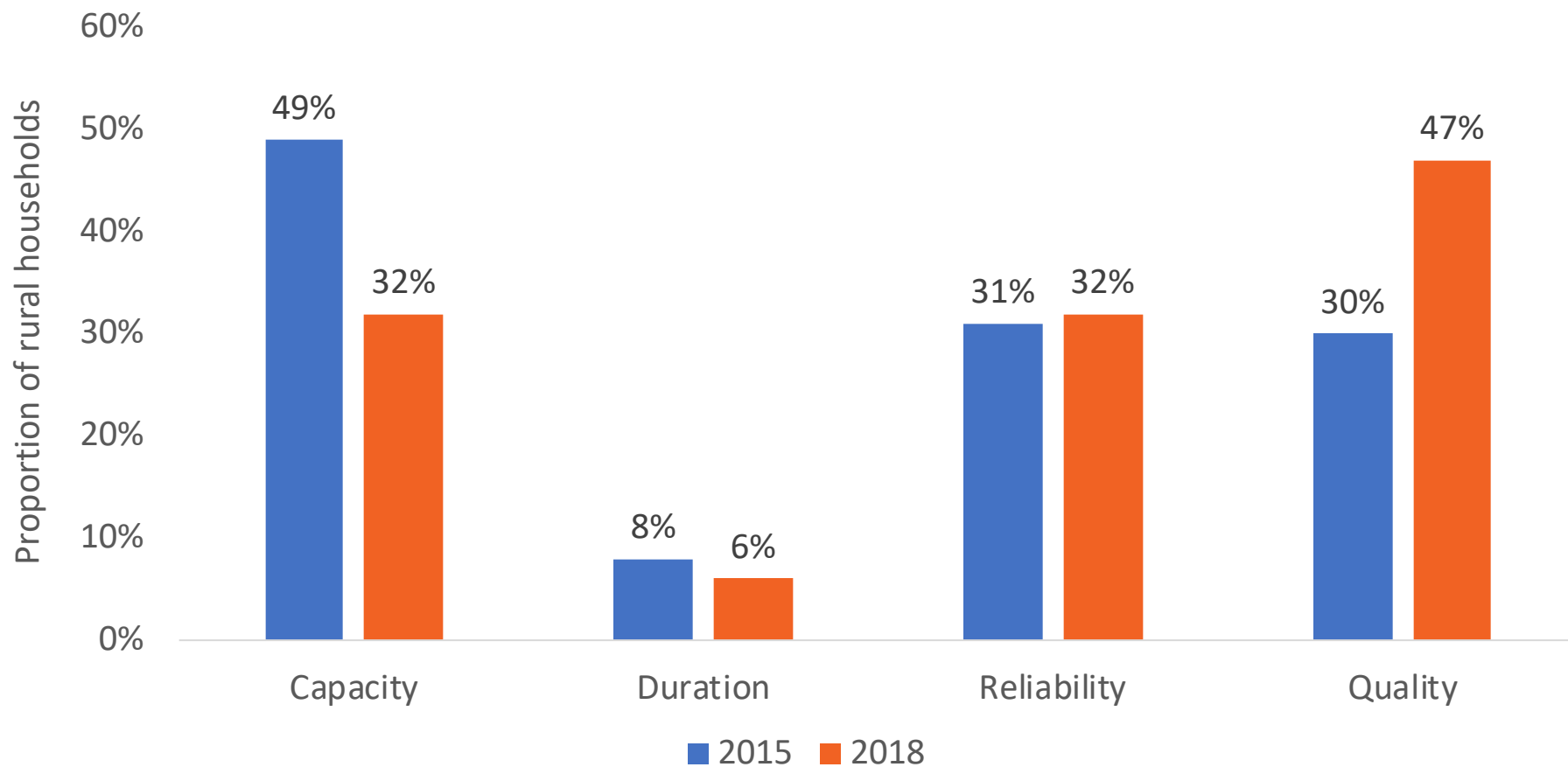
## Electricity Access Evolution



■ Tier 0 ■ Tier 1 ■ Tier 2 ■ Tier 3

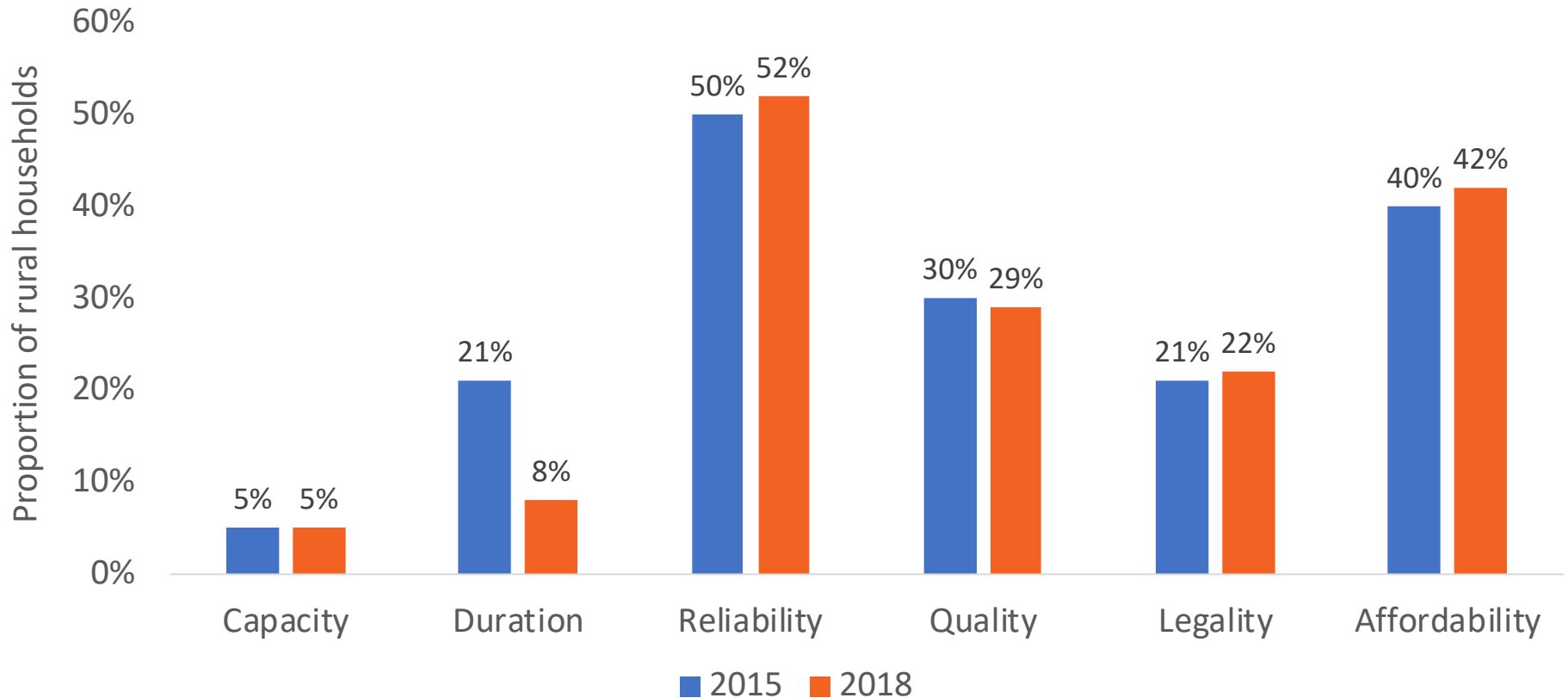
# Quality and reliability of supply remain main issues for Tier 0 HHs

## Bottlenecks in electricity access faced by Tier 0 households



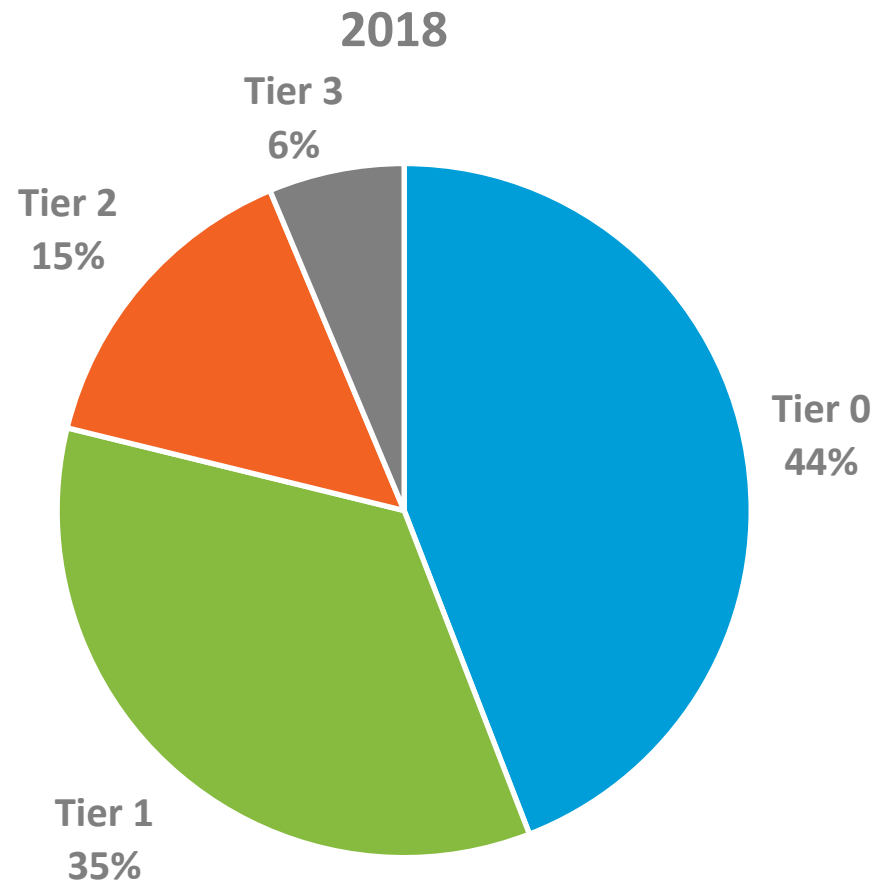
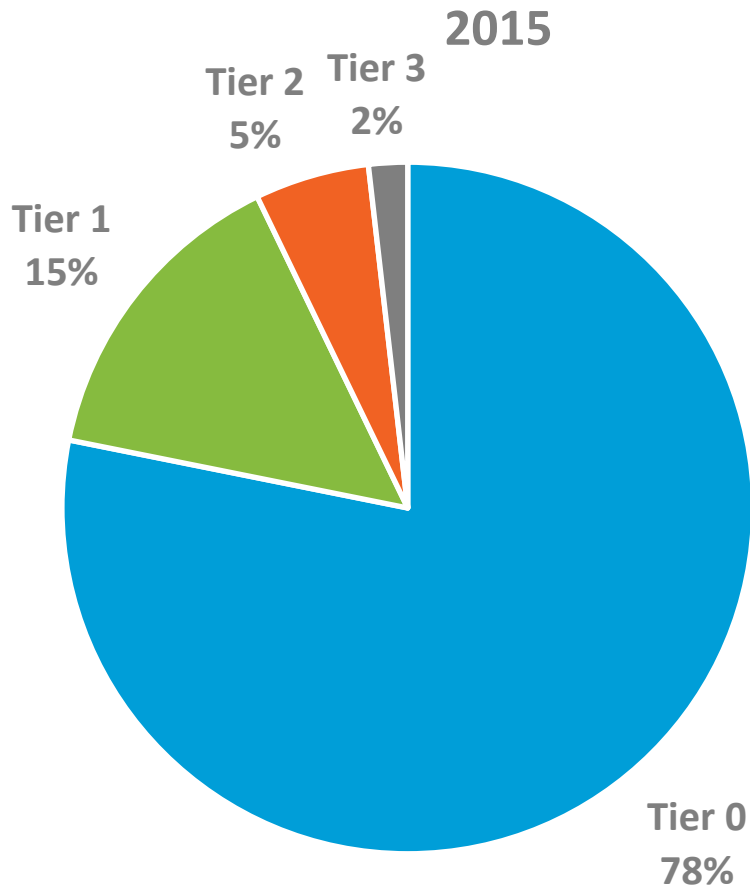
# Duration of supply has improved, but reliability remains a concern

## Bottlenecks in electricity access faced by Tier 1 households



# 160 million have gained access to clean cooking energy in 3 years

(Past decade, 700 million)

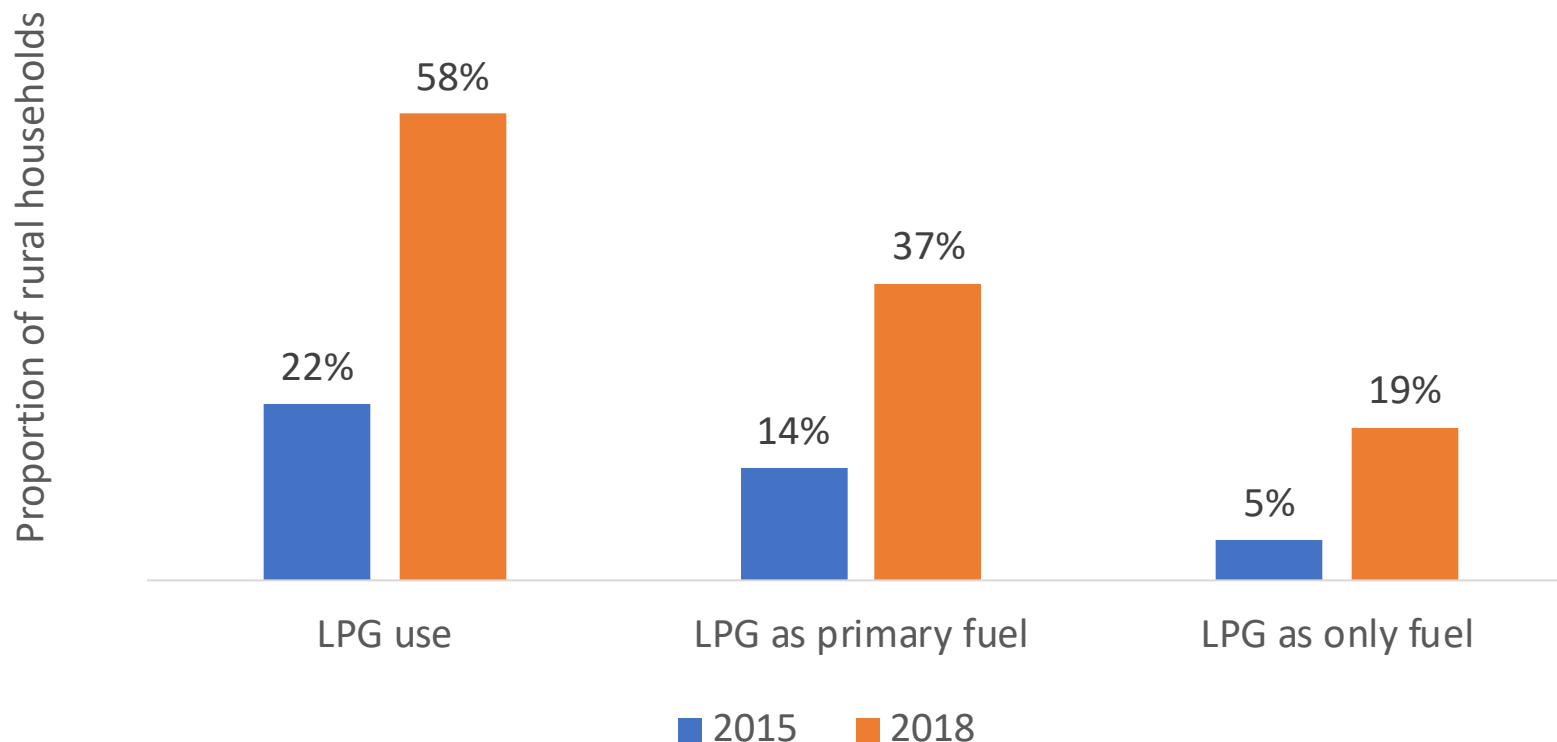


■ Tier 0 ■ Tier 1 ■ Tier 2 ■ Tier 3

# LPG is the driver for all the change, but a long way to go

LPG connection and its use as a primary fuel has increased two-fold

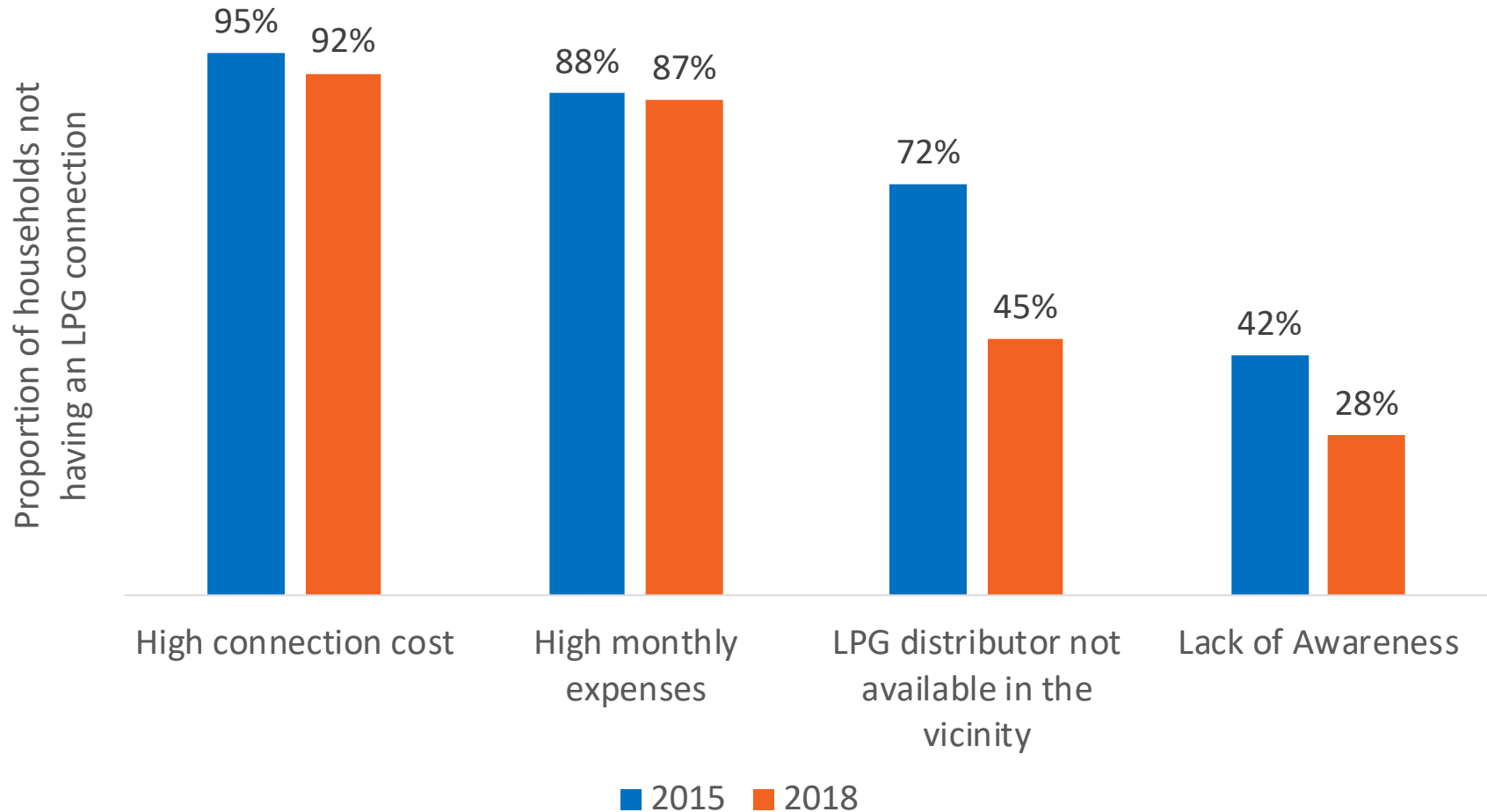
LPG adoption and use in rural areas of six major states

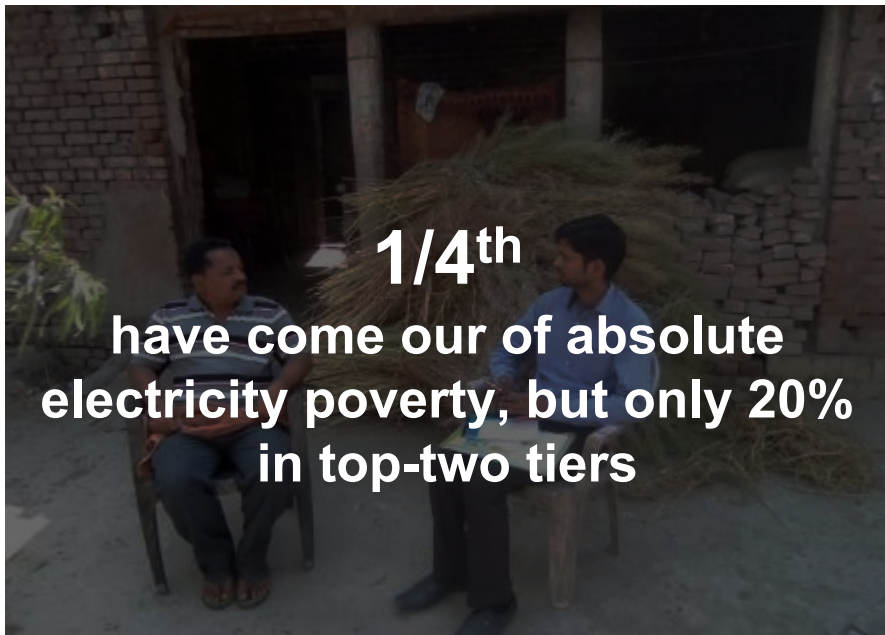




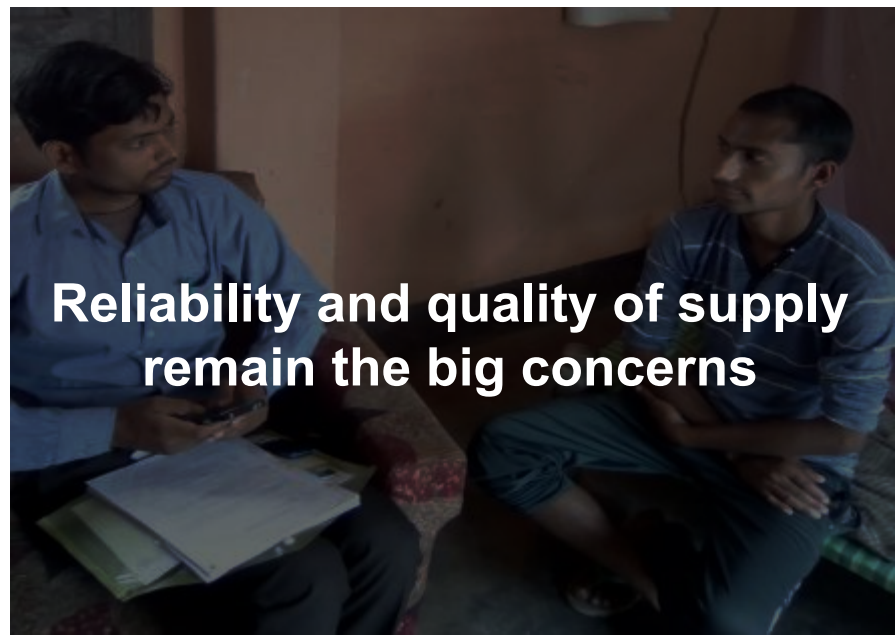
# Affordability remains the biggest challenge to adopt and use LPG

Reasons for not having an LPG connection in 2015 and 2018

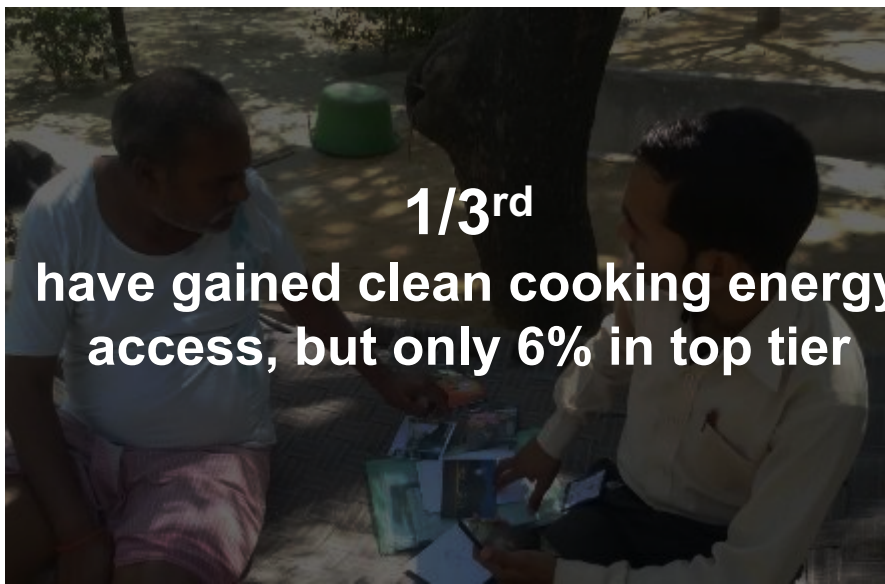




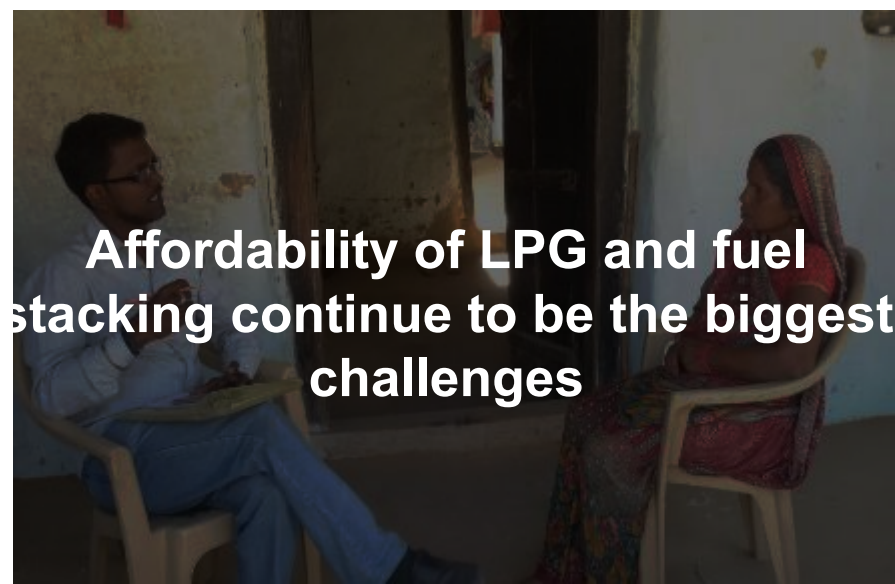
**1/4<sup>th</sup>**  
 have come out of absolute  
 electricity poverty, but only 20%  
 in top-two tiers



**Reliability and quality of supply  
 remain the big concerns**



**1/3<sup>rd</sup>**  
 have gained clean cooking energy  
 access, but only 6% in top tier

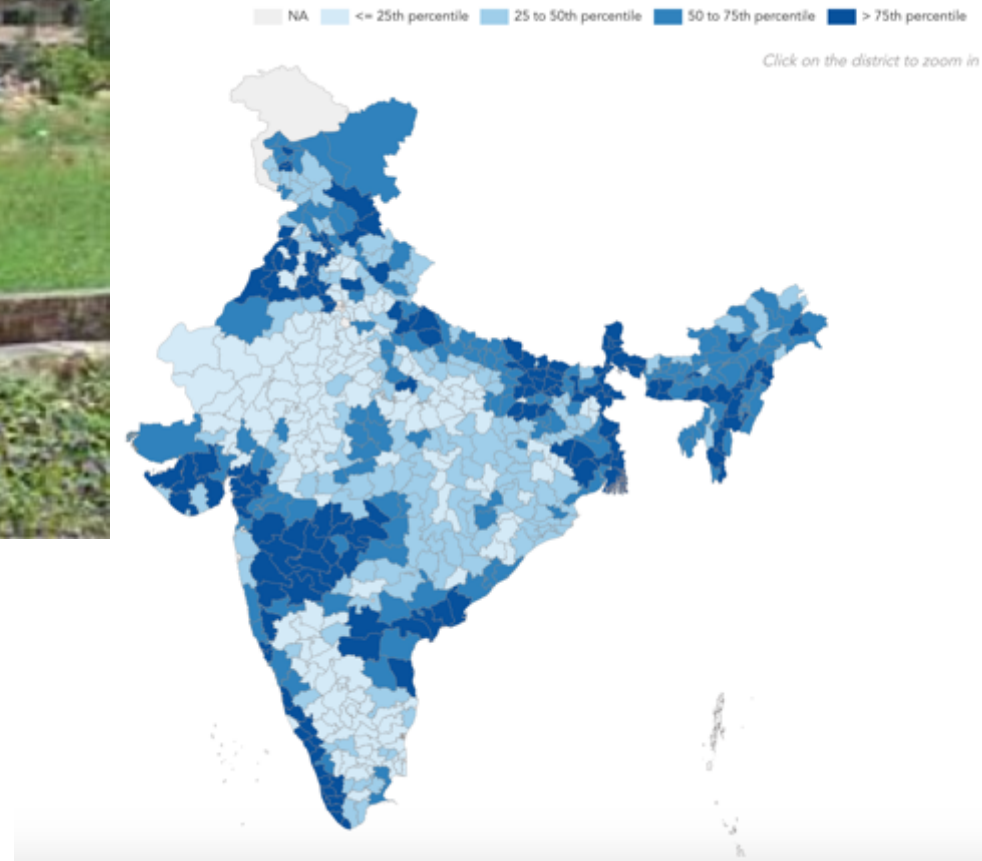


**Affordability of LPG and fuel  
 stacking continue to be the biggest  
 challenges**

# RURAL TO URBAN ENERGY DEMAND?



# Can we make solar irrigation sustainable?



# Powering Livelihoods: A \$50 billion opportunity



Solar-powered paddle loom, Gondal, Gujarat



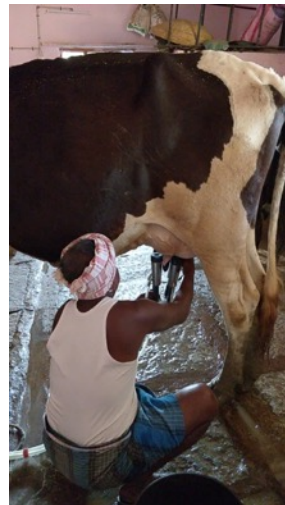
Solar-powered amber charkha, Gondal, Gujarat



Solar-powered sewing machine, Chitradurga, Karnataka



Solar-powered refrigerator, Chitradurga, Karnataka



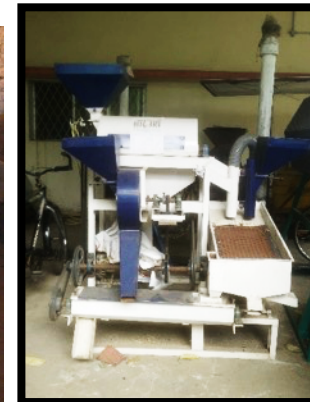
Solar-powered milking machine, Chitradurga, Karnataka



Energy-efficient sugarcane juicer, Rajkot, Gujarat

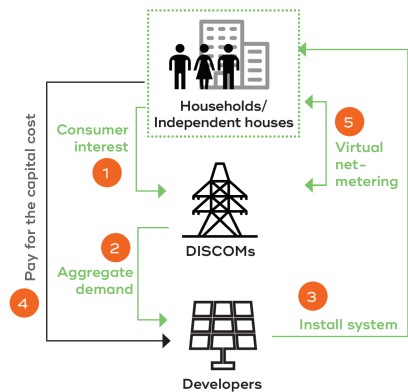


Solar-powered flour mill, Jawhar, Maharashtra

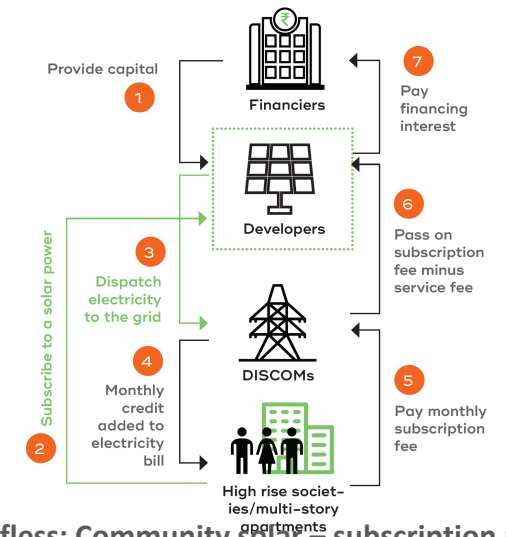


Energy-efficient dal mill, Wardha, Maharashtra

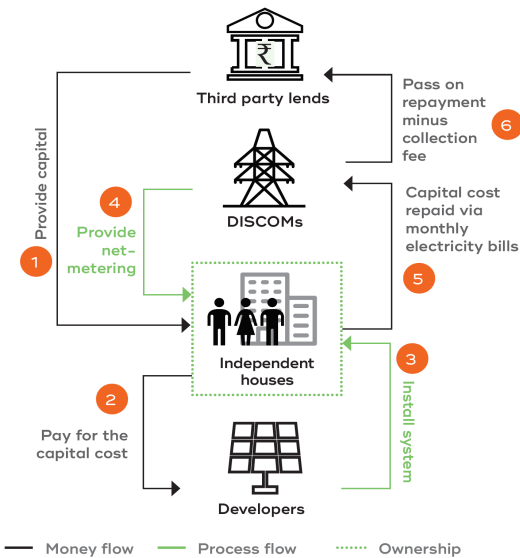
# Using our roofs? DISCOM-led business models



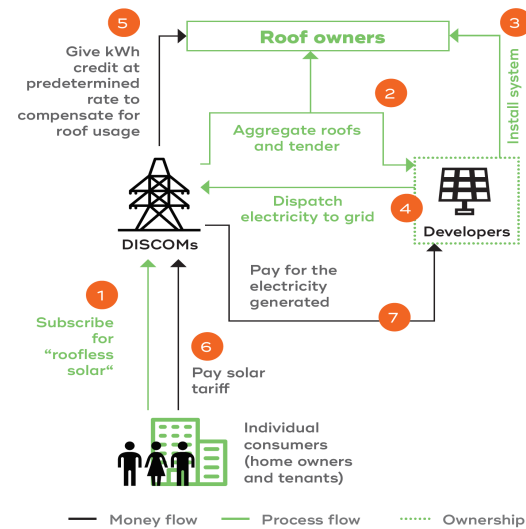
1.a For the roofless: Community solar – upfront payment



1.b For the roofless: Community solar – subscription mode



2. For the creditless: On-bill financing model



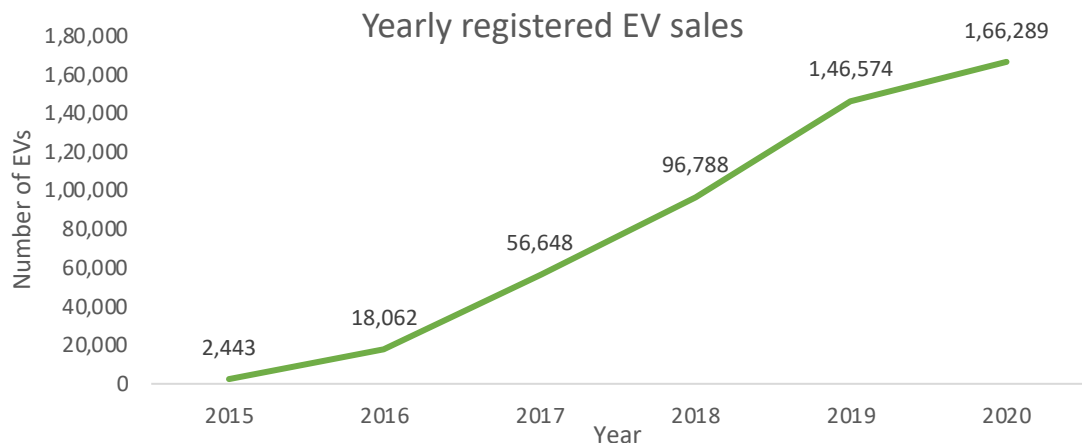
3. For all: Solar partners model

# Sustainable mobility for a country on the move?

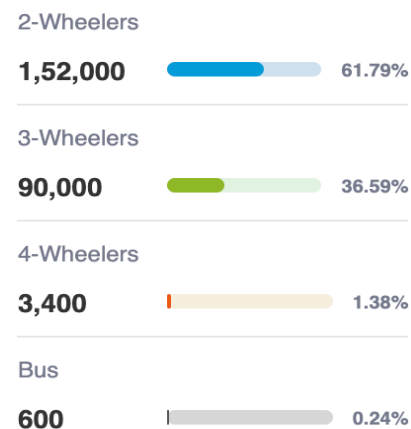


# Electric vehicles (EVs) on the rise, but fast enough?

- Total registered EV stock for FY20: 530,560 vehicles, with 166,289 registered EVs sales
- Registered EV sales increased by 13.45% from 2018-19 to 2019-20;
- Projections for EV stock rise to 23.8 million by FY30
- In the unregistered EV market (2-wheelers & 3-wheelers), stock of e-rickshaws is 1.5 million as of FY20; (industry estimates stating that 246,000 registered and unregistered EVs were sold in 2019-20)

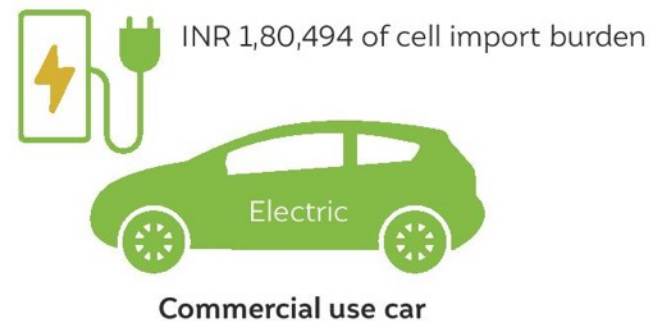
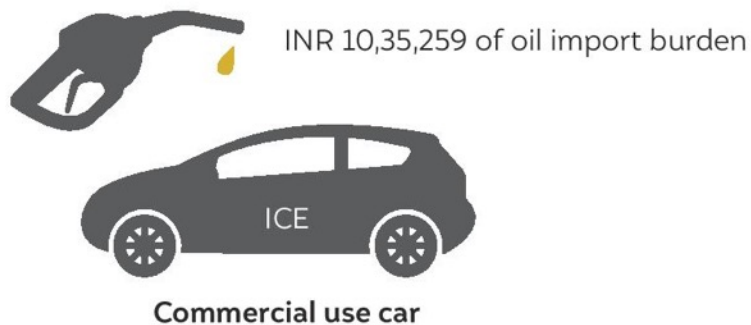
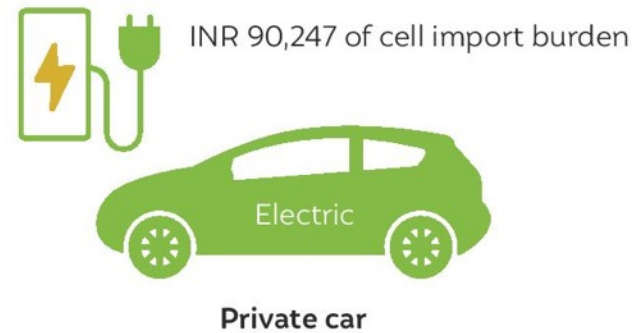
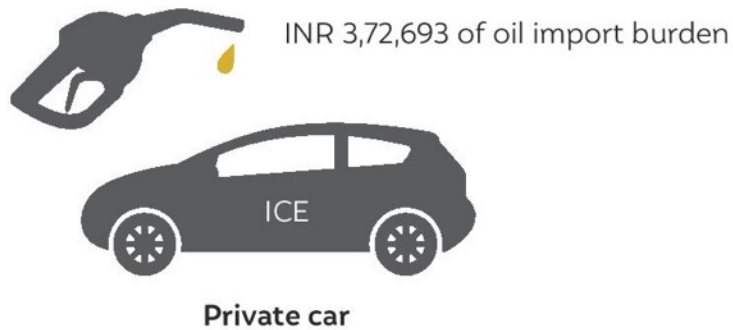


EVs sales by vehicle type for 2019-20

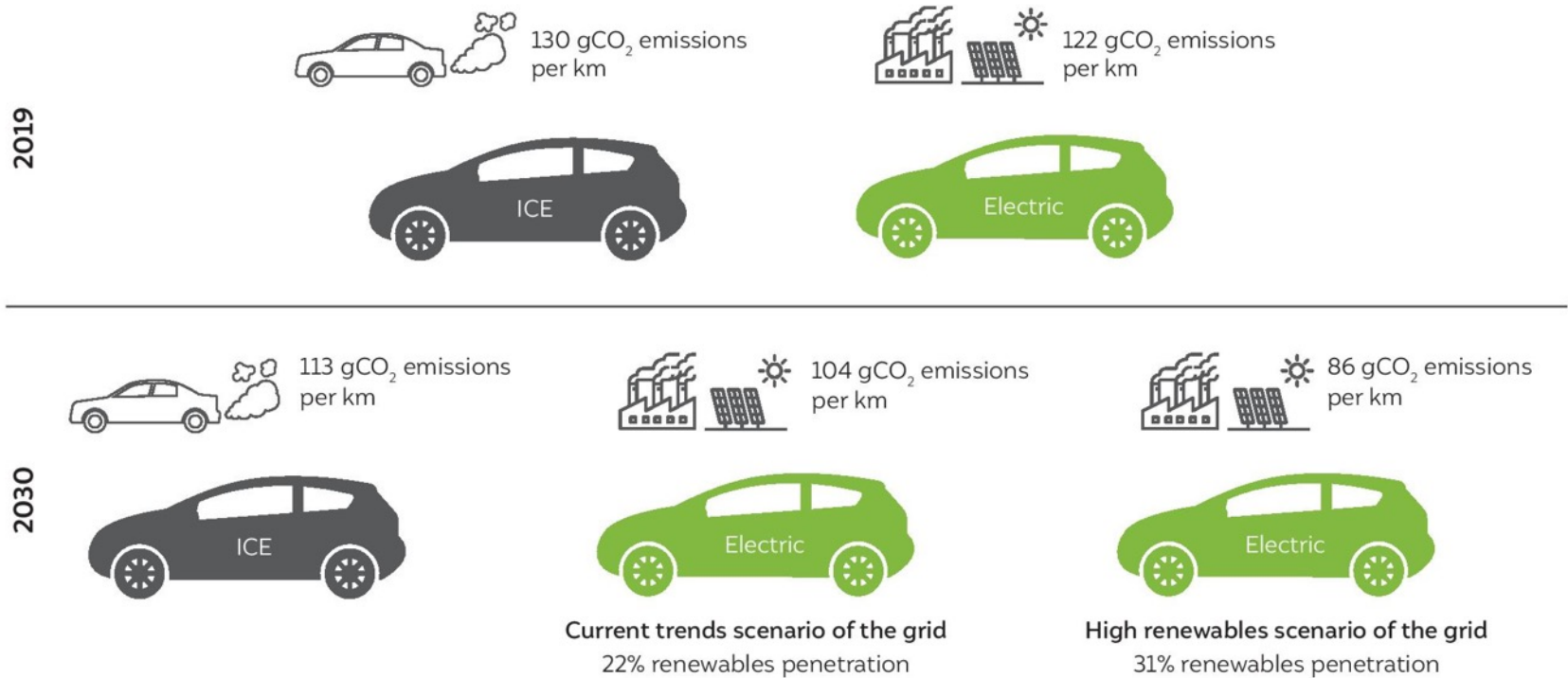




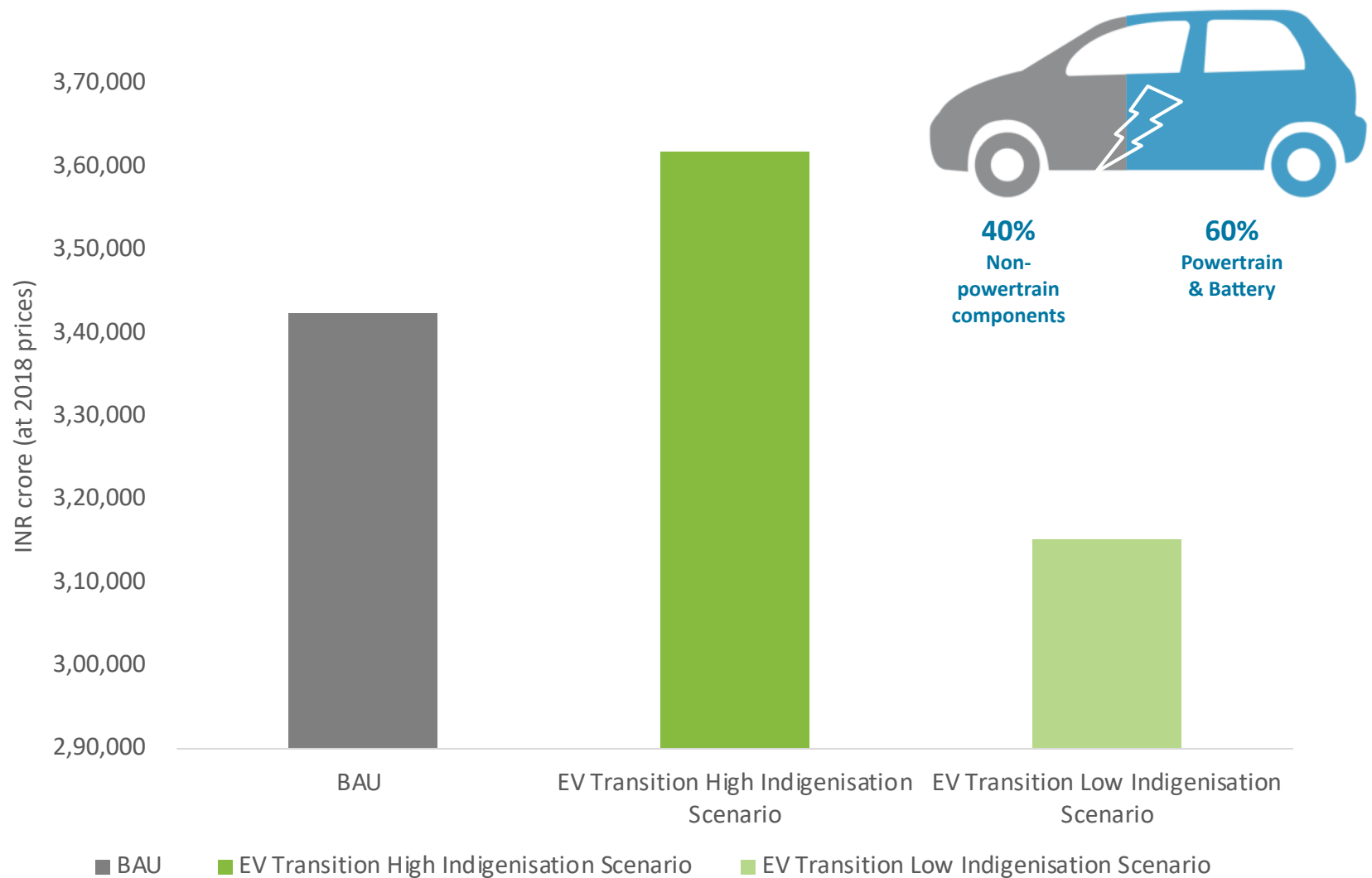
# Import burden of an electric car would be 4-6 times lesser for EVs in 2030



# CO<sub>2</sub> emissions per electric car will be 8%-24% lower compared to an ICE car in 2030



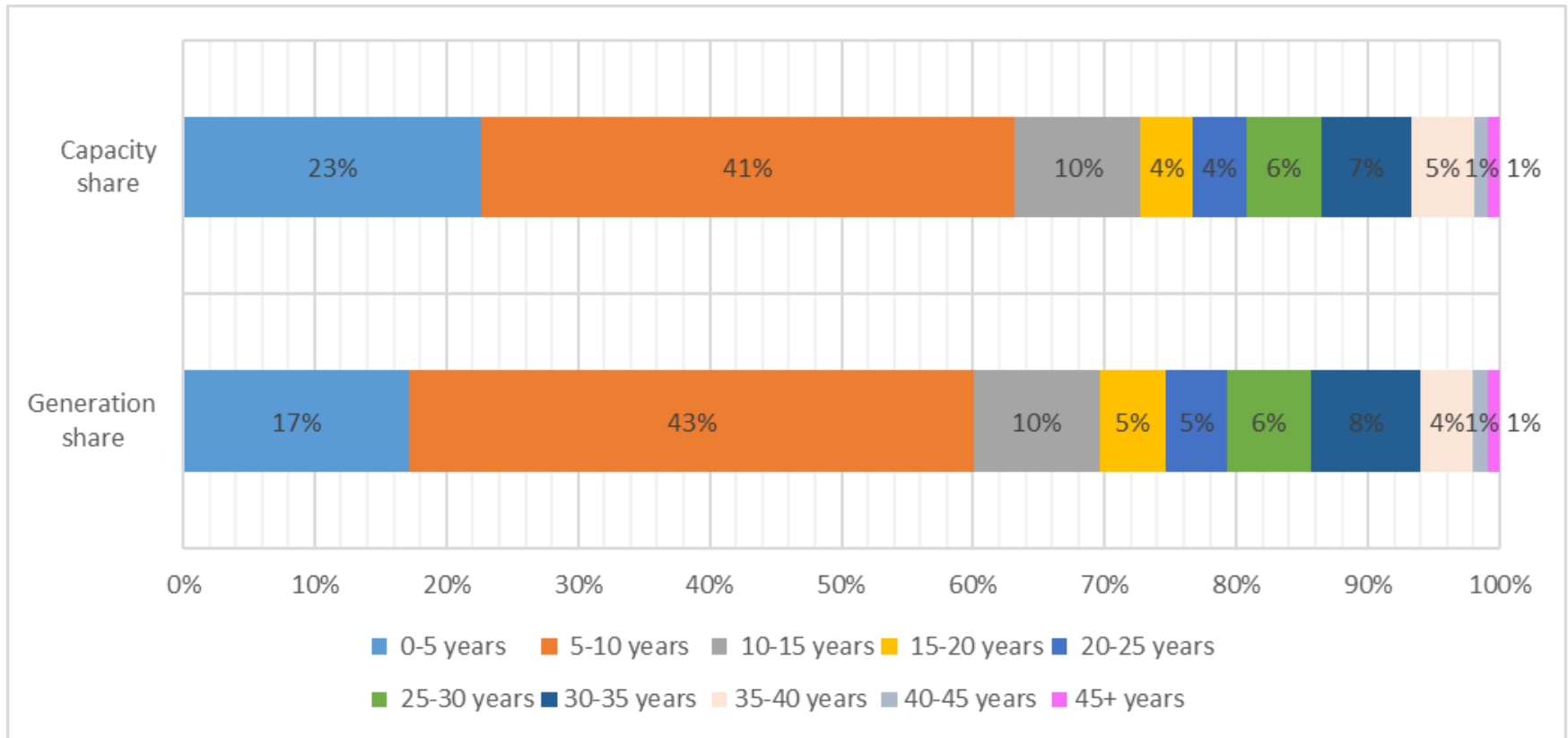
# 5.7% higher value add (USD 2.7 billion) from high indigenisation



# TAPPING EVERY RAY OF THE SUN?

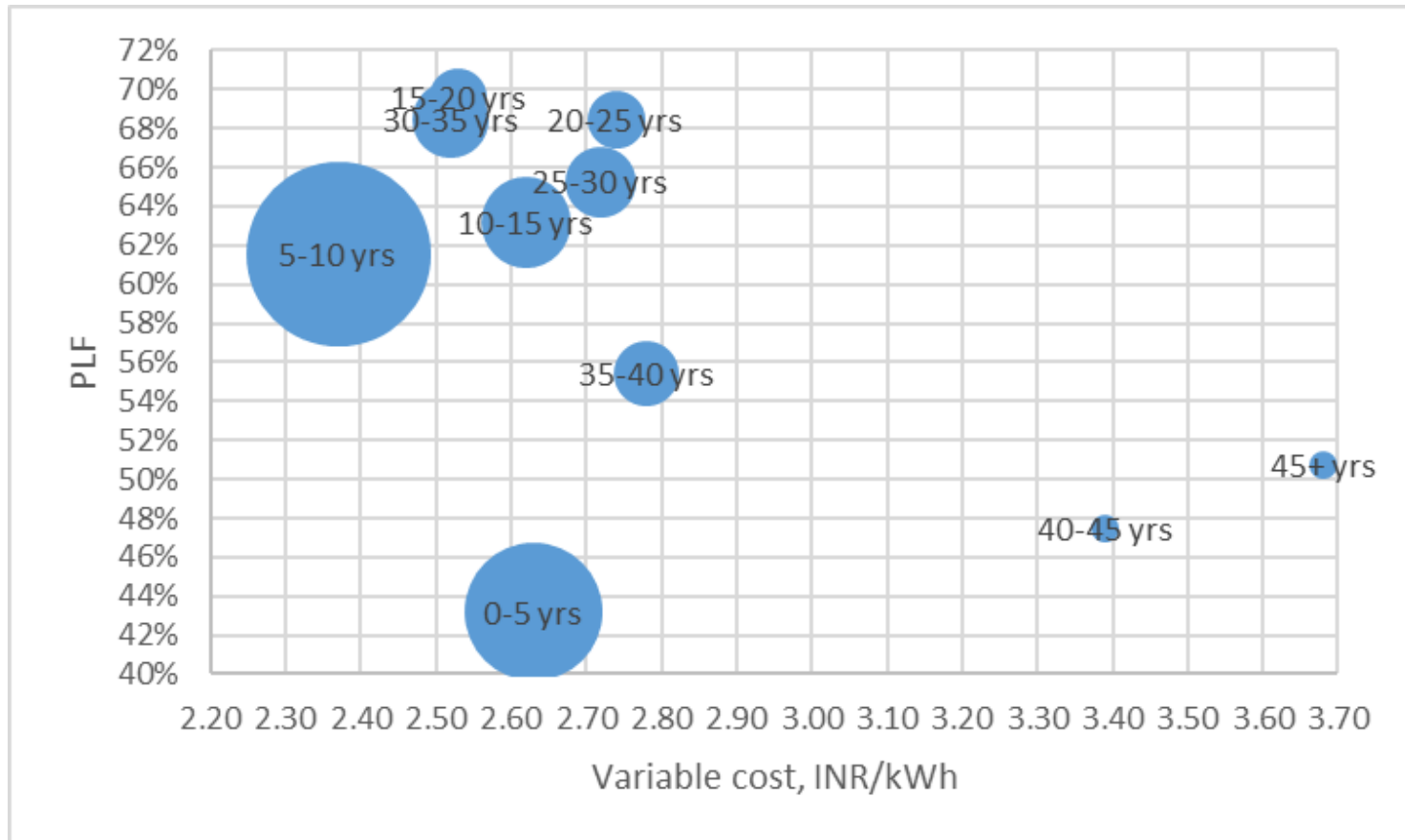


# Newer thermal power plants punching well below their weight



SOURCE: CEEW analysis from CEA daily generation reports 2019

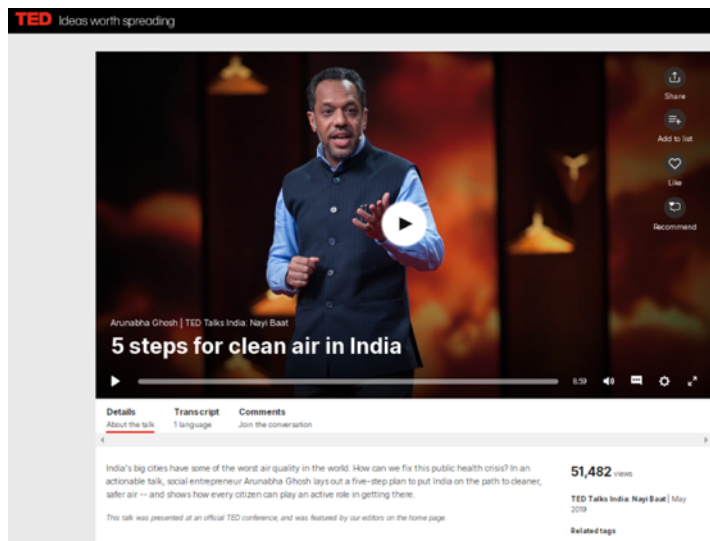
# Despite having low variable cost, the PLF of 5-10 year group is low



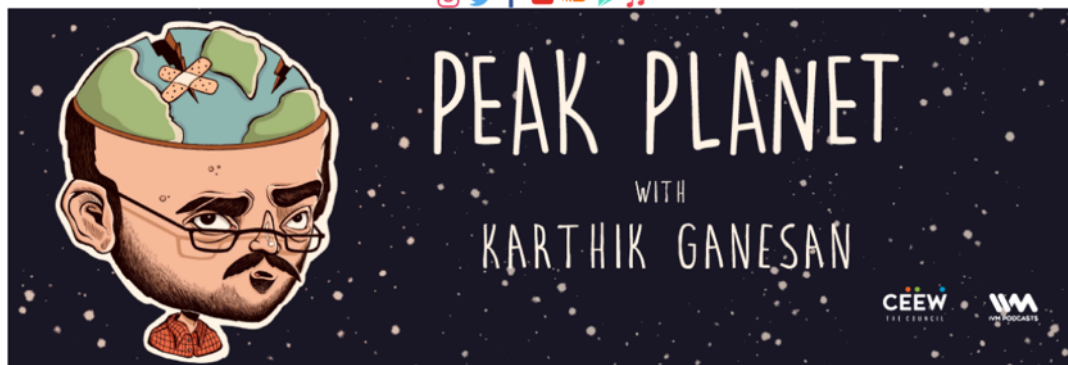
SOURCE: CEEW adaptation from CEA daily generation reports and MERIT state-wise daily summary data

NOTE: The bubble size represents the capacity share

# Creating a democratic demand for clean air



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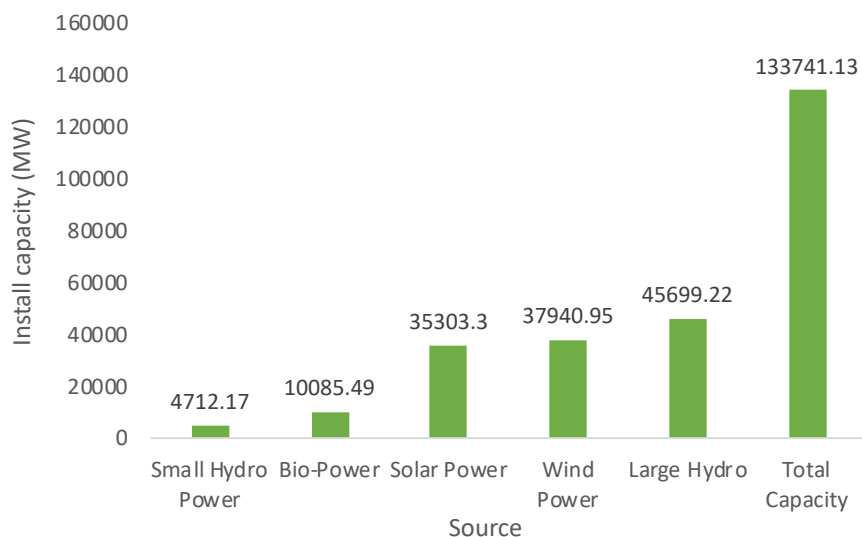
**Sahba Chauhan** @SahbaChauhan · Nov 7

Best podcast! Fast overtaking my first love @TheEnergyGang

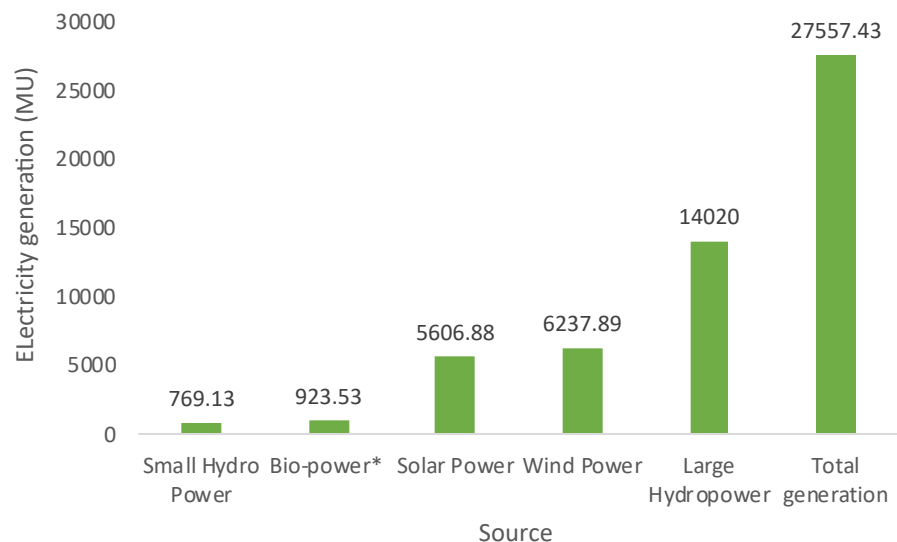
# Meanwhile, a big leap forward on renewables

- Ranked 3<sup>rd</sup> globally in installed RE capacity in 2019-20
- 29% of India's total electricity was generated from RES and hydropower, with solar and wind generating 5.82% and 6.48% respectively in May 2020
- Total daily generation as of 24 August 2020 stood at 436.64 MU

Installed RE capacity (July 2020)



Total electricity generation (May 2020)



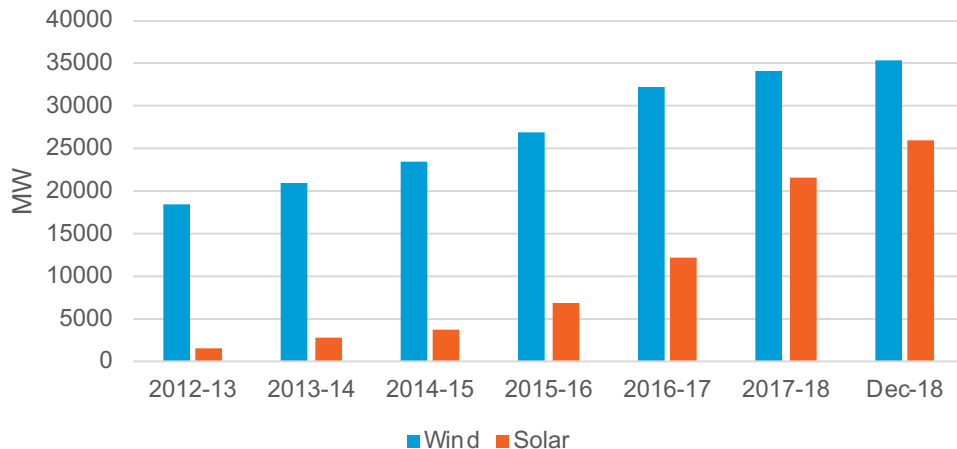
\*Bagasse and biomass

SOURCE: CEA (2020), CEEF-CEF (2020), National Power Portal (2020)

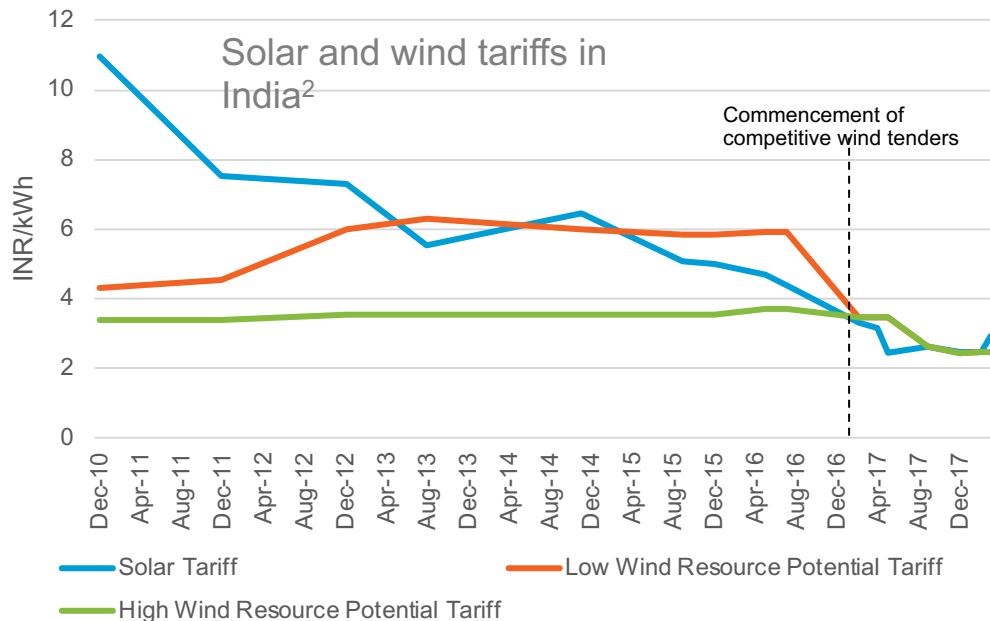


# India's renewable energy journey

India's solar and wind installed capacity<sup>1</sup>



- Policy push on solar since 2014-15 has driven sharp increase in solar installed capacity



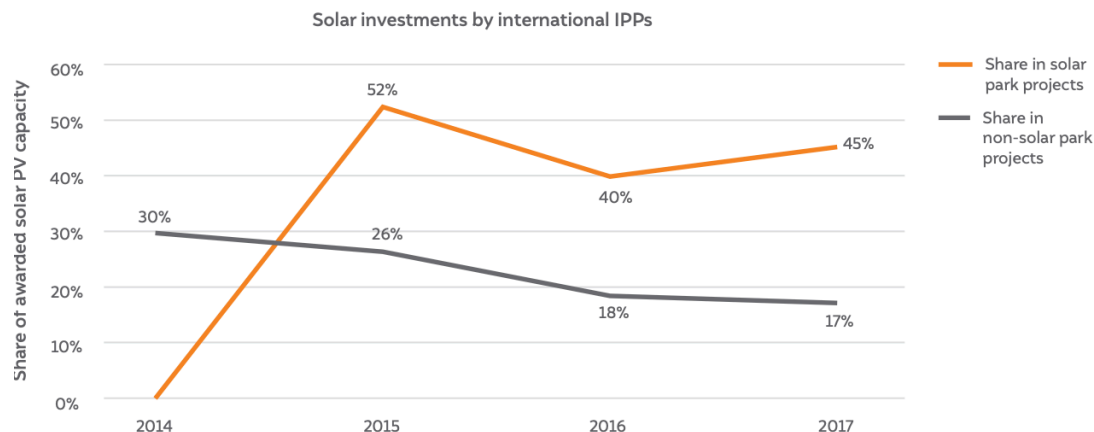
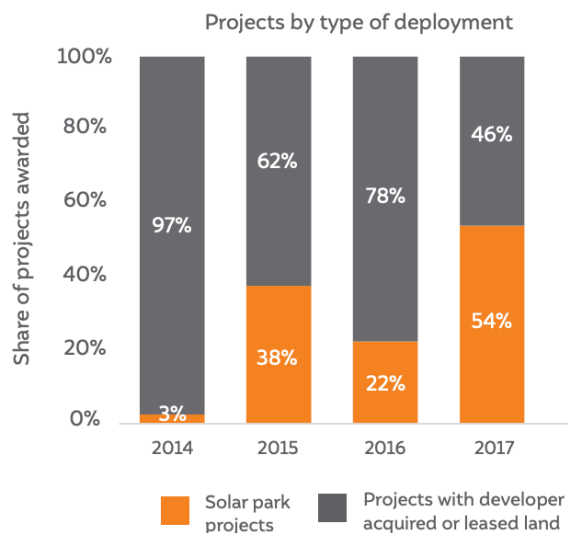
- Solar and wind tariffs have stabilised below USD c 4/kWh

1 Source: Central Electricity Authority & Ministry of New & Renewable Energy

2 Source: CEEW Analysis

# India's RE drive is a big investment opportunity

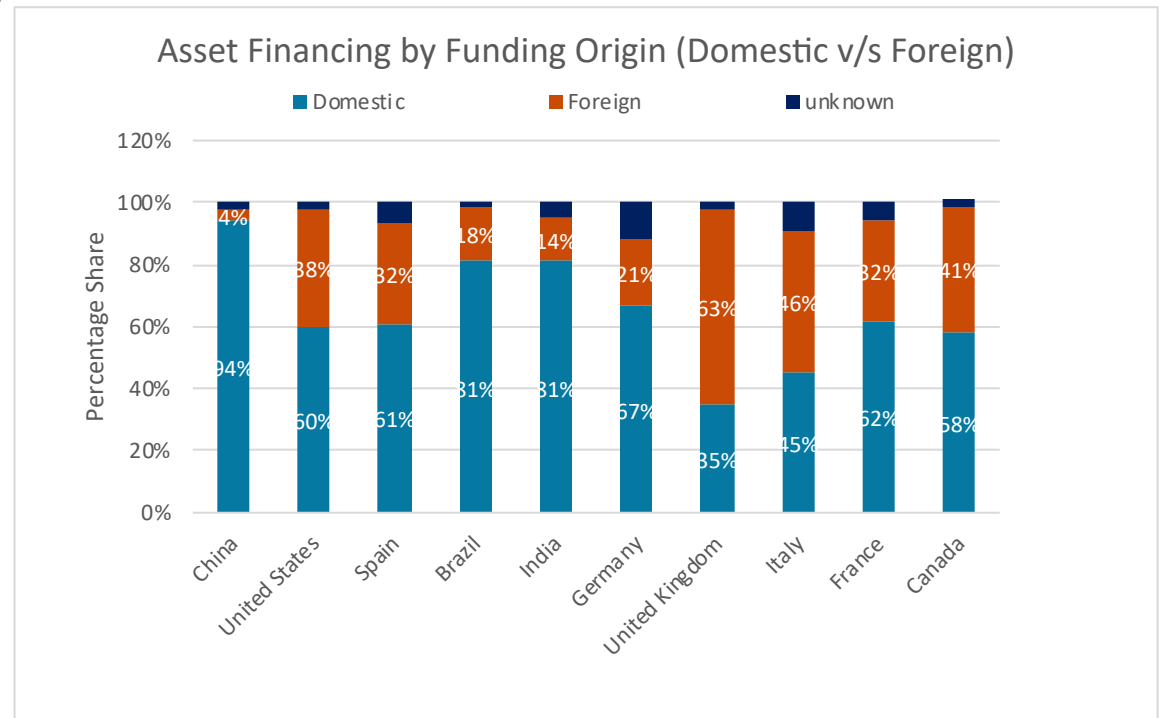
- RE installations are a investment opportunity of USD 199 billion
- Solar parks have been instrumental for driving solar capacity addition in India by presenting a 'plug-and-play' model



- Despite this, India will require a 16% CAGR in capacity addition on the 88.091 GW and debt capital of USD 160 billion to achieve its 450 GW by 2030

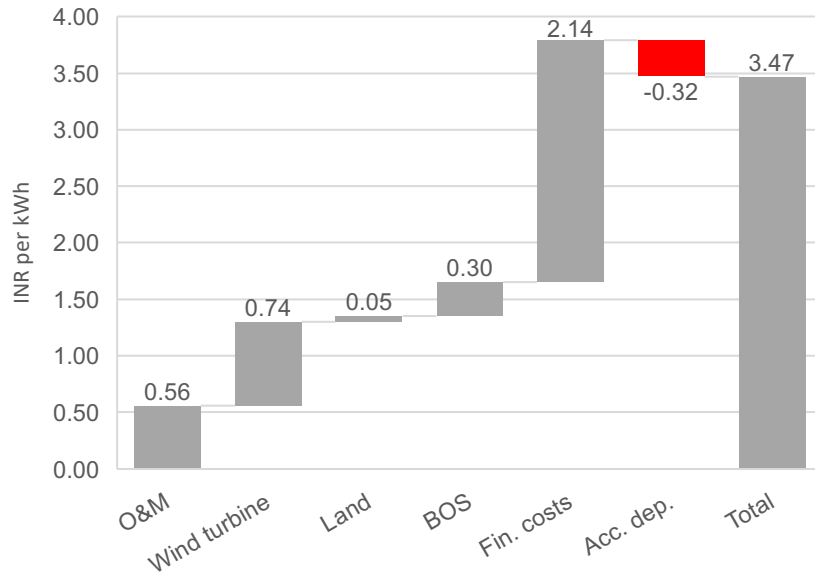
# There's a mismatch: Capital circulating in capital-rich regions

- In 2018, global energy investment stood at more than USD 1.8 trillion
- Only a third of that, USD 620 billion, was invested in low carbon energy
- 15% of the world's population, got 40% of the world's energy investment in 2018 – in high-income countries
- Energy consumption in developing countries has doubled in the last 15 years, and will grow another 30% in the next fifteen years

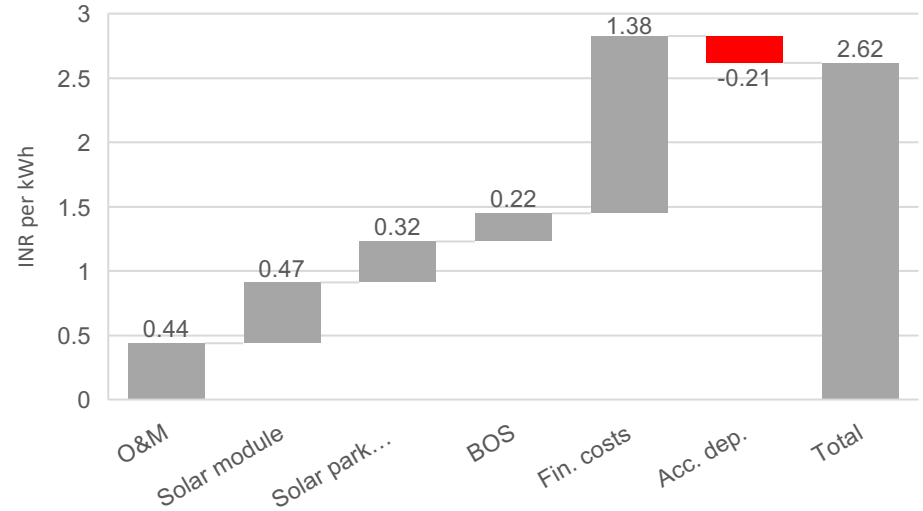


# Understanding the mismatch: evidence from India

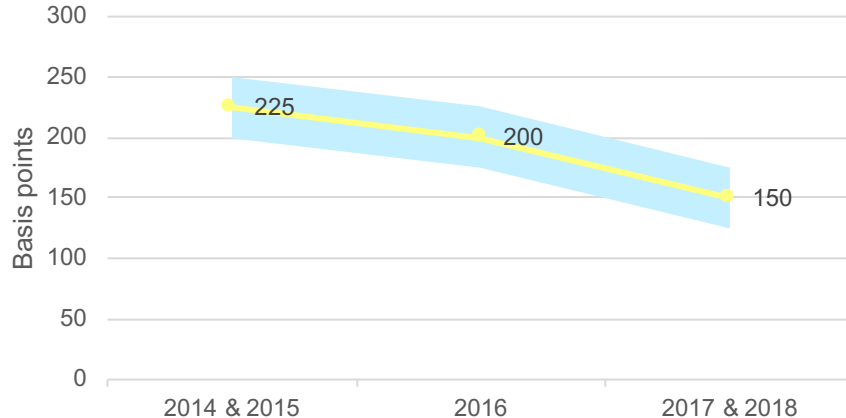
Feb 2017 Wind Tariff



May 2017 Solar Tariff



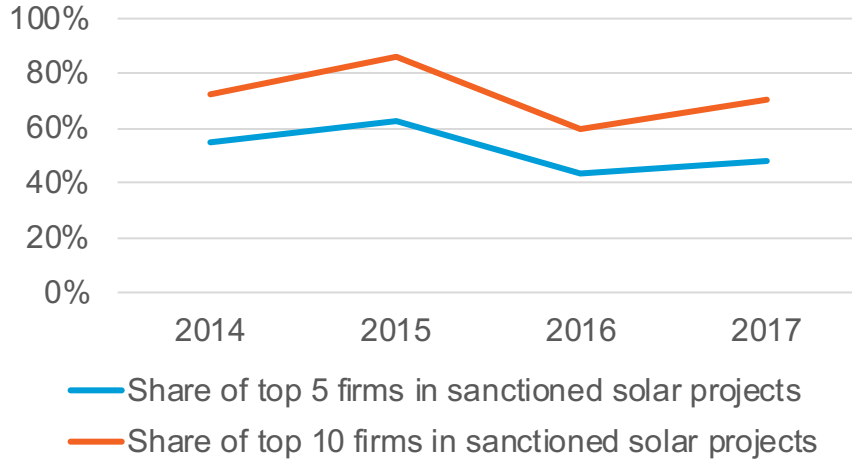
Interest rate spreads - solar PV and wind



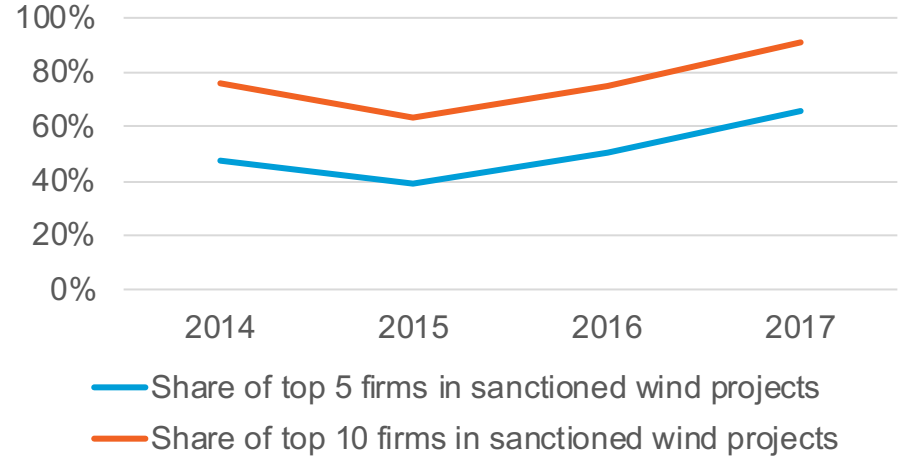
- Financing costs constitute 50-65% of Indian RE tariffs
- PV module/wind turbine costs account for only around 20% of RE tariffs
- Interest rate spreads for lending to RE projects have declined by 75-125 bps from 2014-2018, tariffs from USD 9 cents to 4 cents/kWh

# Greater market concentration; solar parks become attractive

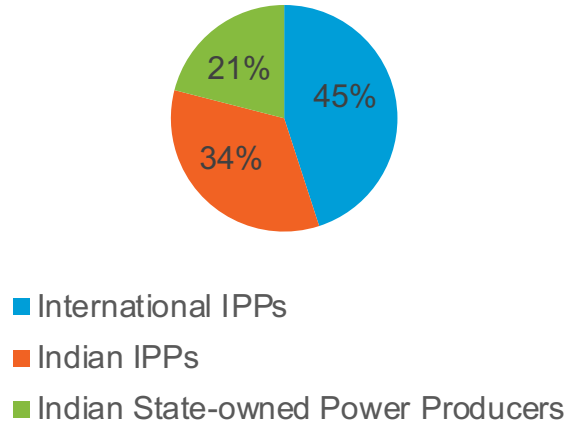
Market concentration in solar energy generation



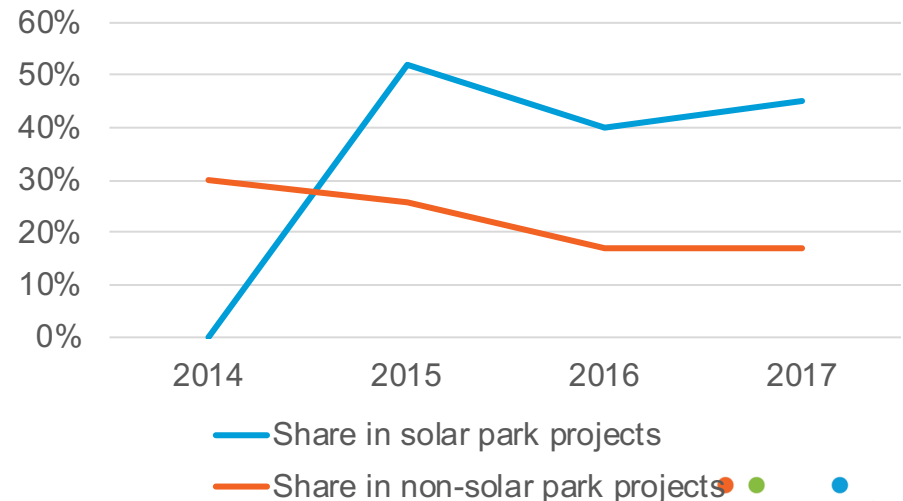
Market concentration in wind energy generation



Share of projects at solar parks (2014-2017)

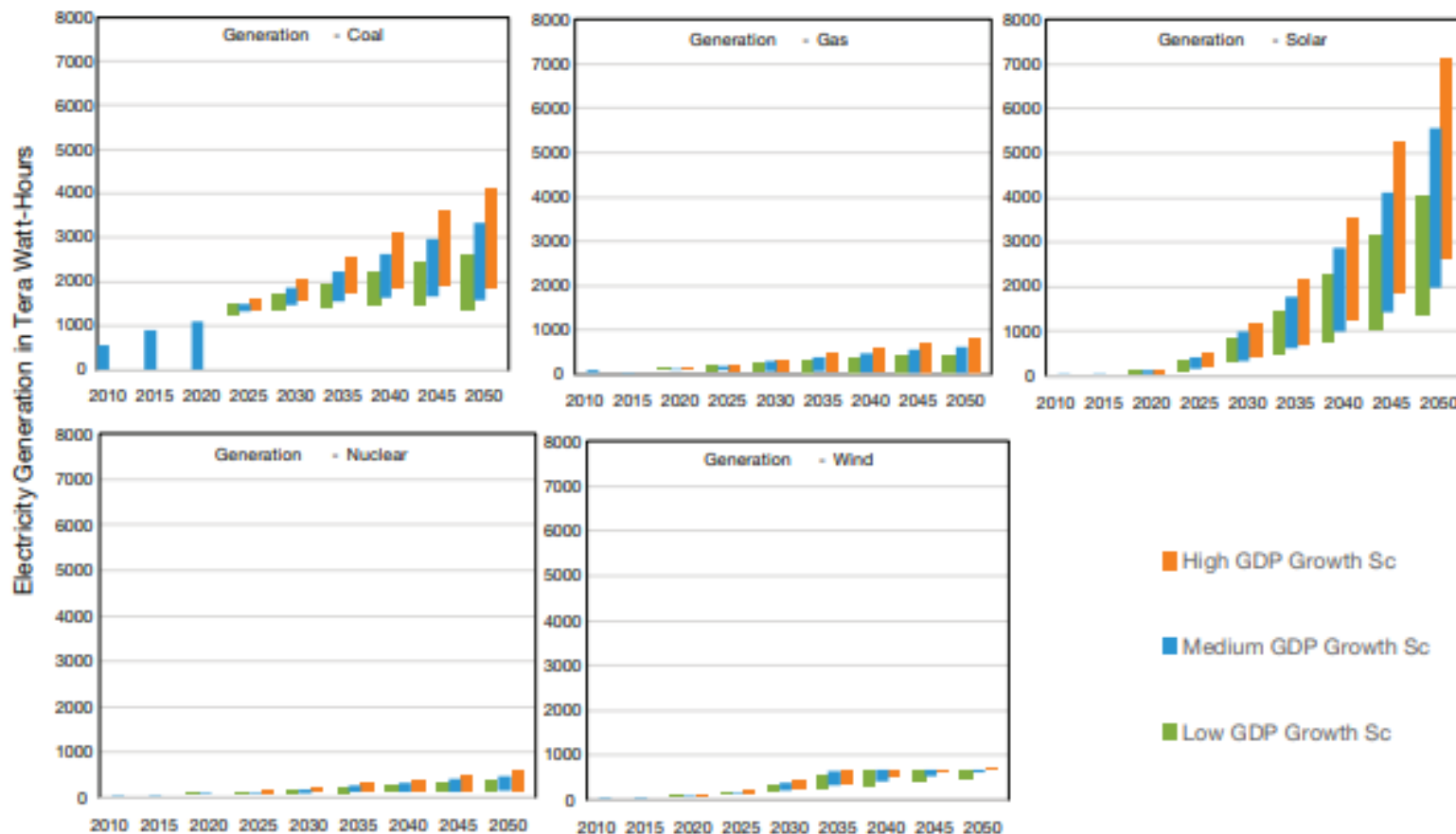


Solar investments by international IPPs



# What gets built and used: who bears integration costs?

a) Electricity generation range by technology WITHOUT grid integration cost levied on VRE producers




# What gets built and used: who bears integration costs?

b) Electricity generation range by technology WITH grid integration cost levied on VRE producers



# Correcting the mismatch: Information and innovation


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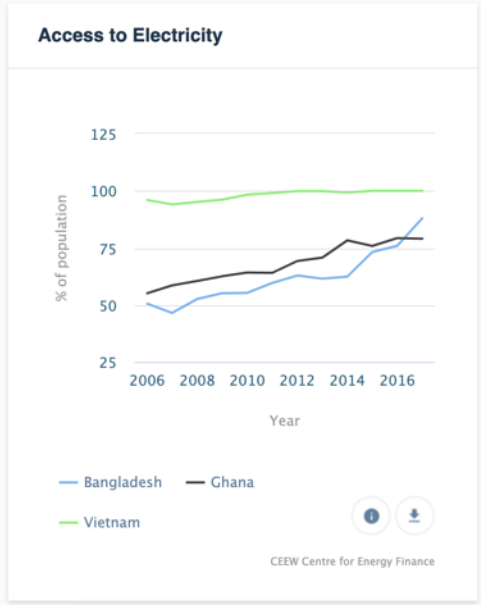
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COUNTRY

## India

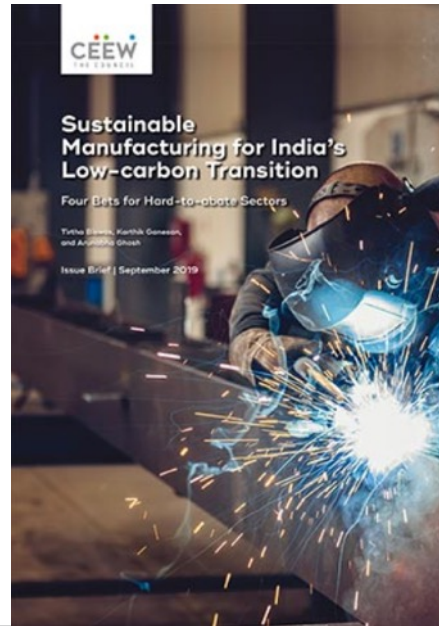
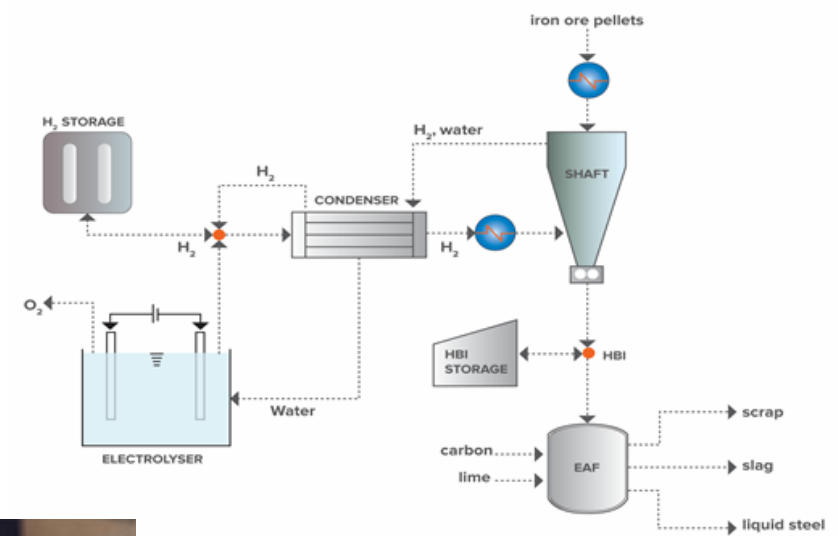
India is the second most populous and seventh largest country by land area in the world. The power sector, with over 350 GW of installed capacity, ranks third globally in terms of size. With a target of 175 GW of installed renewable energy capacity by the year 2022, India offers one of the world's largest renewable energy markets.

Comparison On **Bangladesh** **Ghana** **Vietnam**





# Can green industrialisation become a growth mantra?



# A SWING PLAYER IN GLOBAL ENERGY MARKETS?



# Energy security is not the same as energy independence

A complex quest for **adequate quantities** of energy resources, at prices that are **affordable and predictable**, while minimising the risk of overseas **supply disruptions** and ensuring **sustainability** of the environment and of the energy system for future generations.

## Focus areas for India

### ASSURED SUPPLY

Developing capacity for energy diplomacy  
Critically evaluate overseas investments

### SAFE PASSAGE

Invest in building fleet capacity  
Strengthen security partnerships in IOR

### SECURE STORAGE

Build domestic storage capacity  
Cooperative arrangements for storage  
Institutional capacity to manage reserves

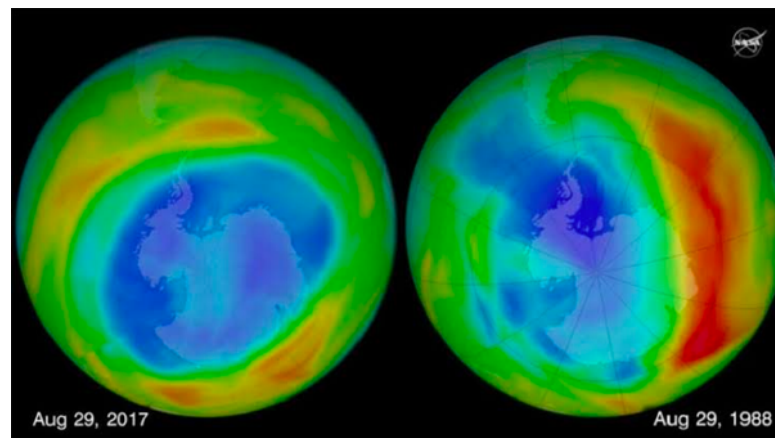
### FUNCTIONAL INSTITUTIONS

Transparency; dealing with supply shocks;  
collective security; arbitrate disputes;  
pooling resources; sharing best practices

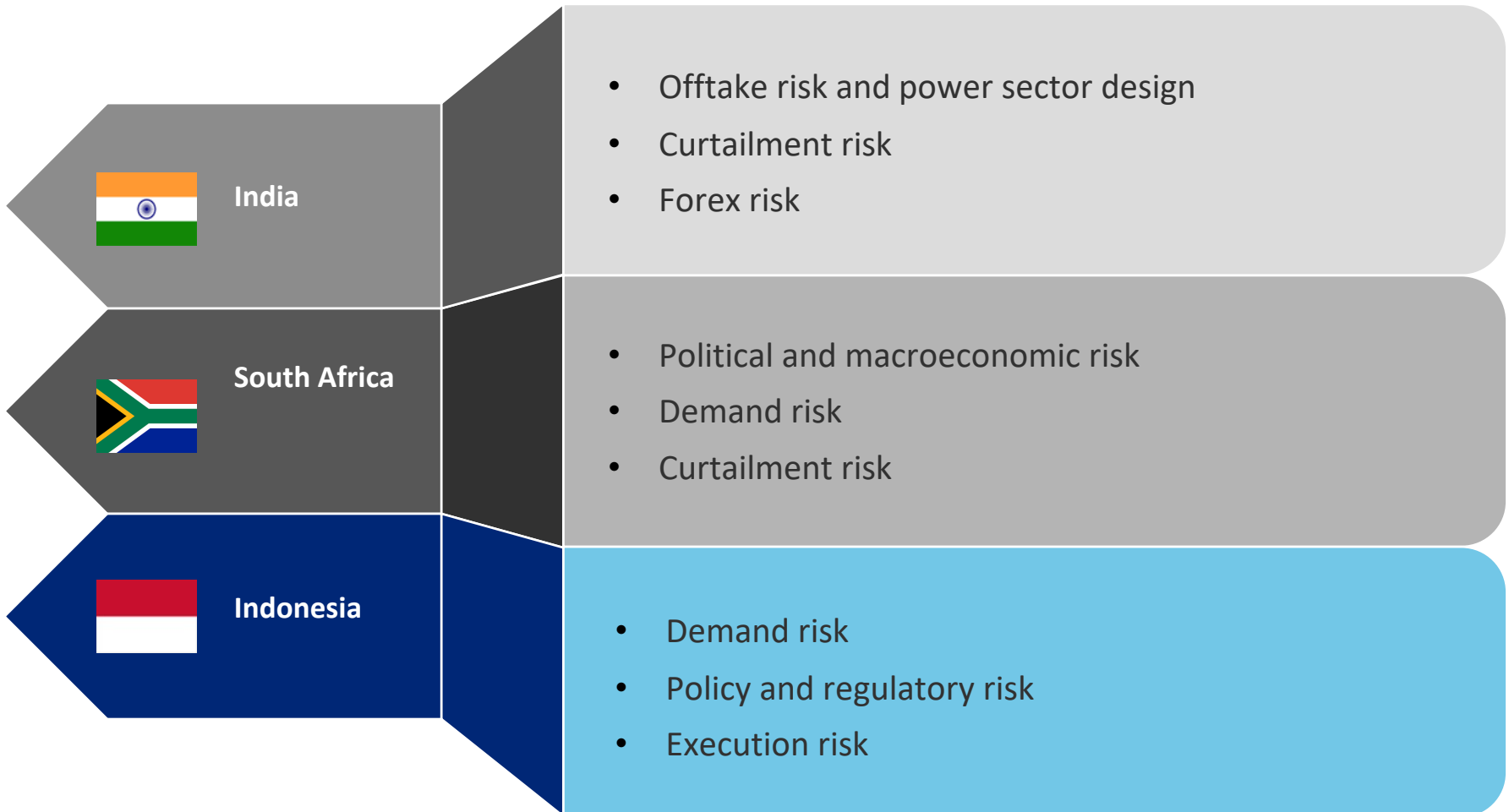
### EXPLOITING MARKET POWER

Moving from a price taker to price influencer.

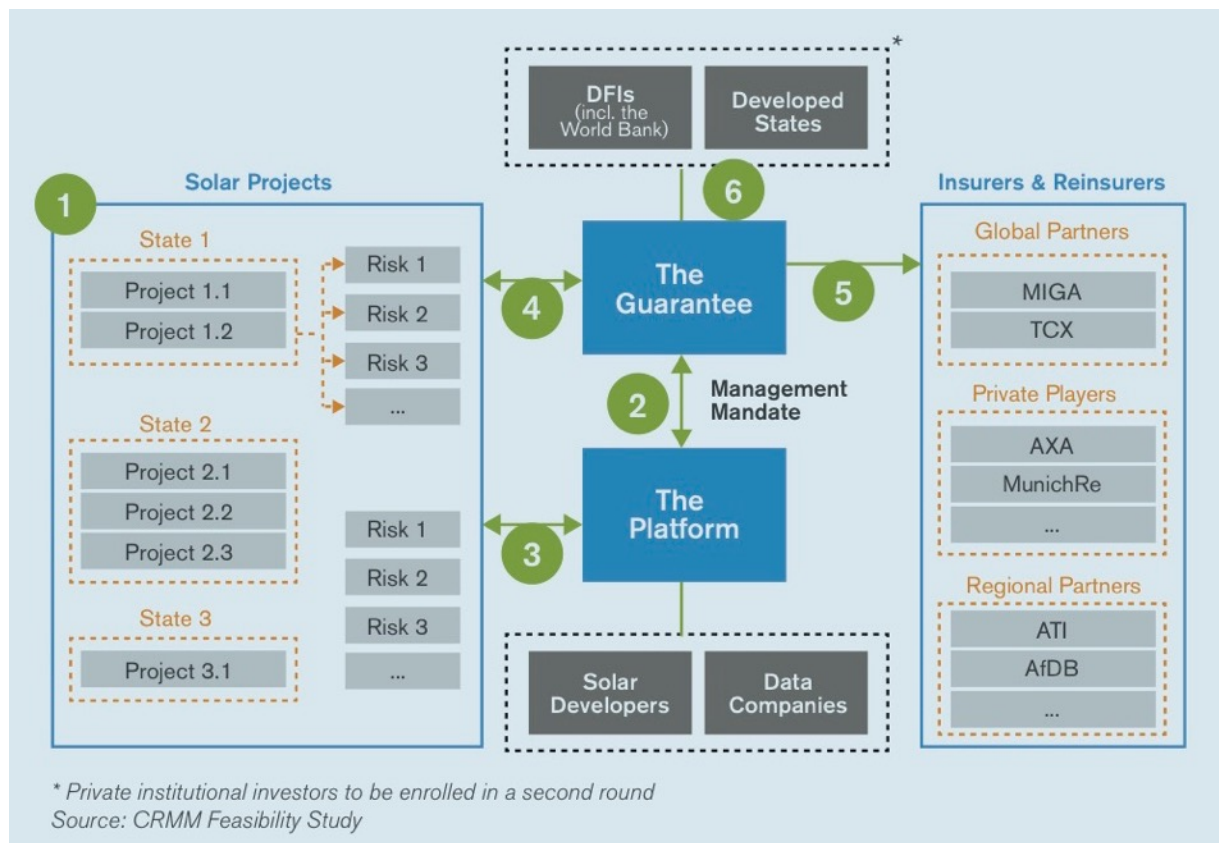
# India is no longer a naysayer; India is a climate leader



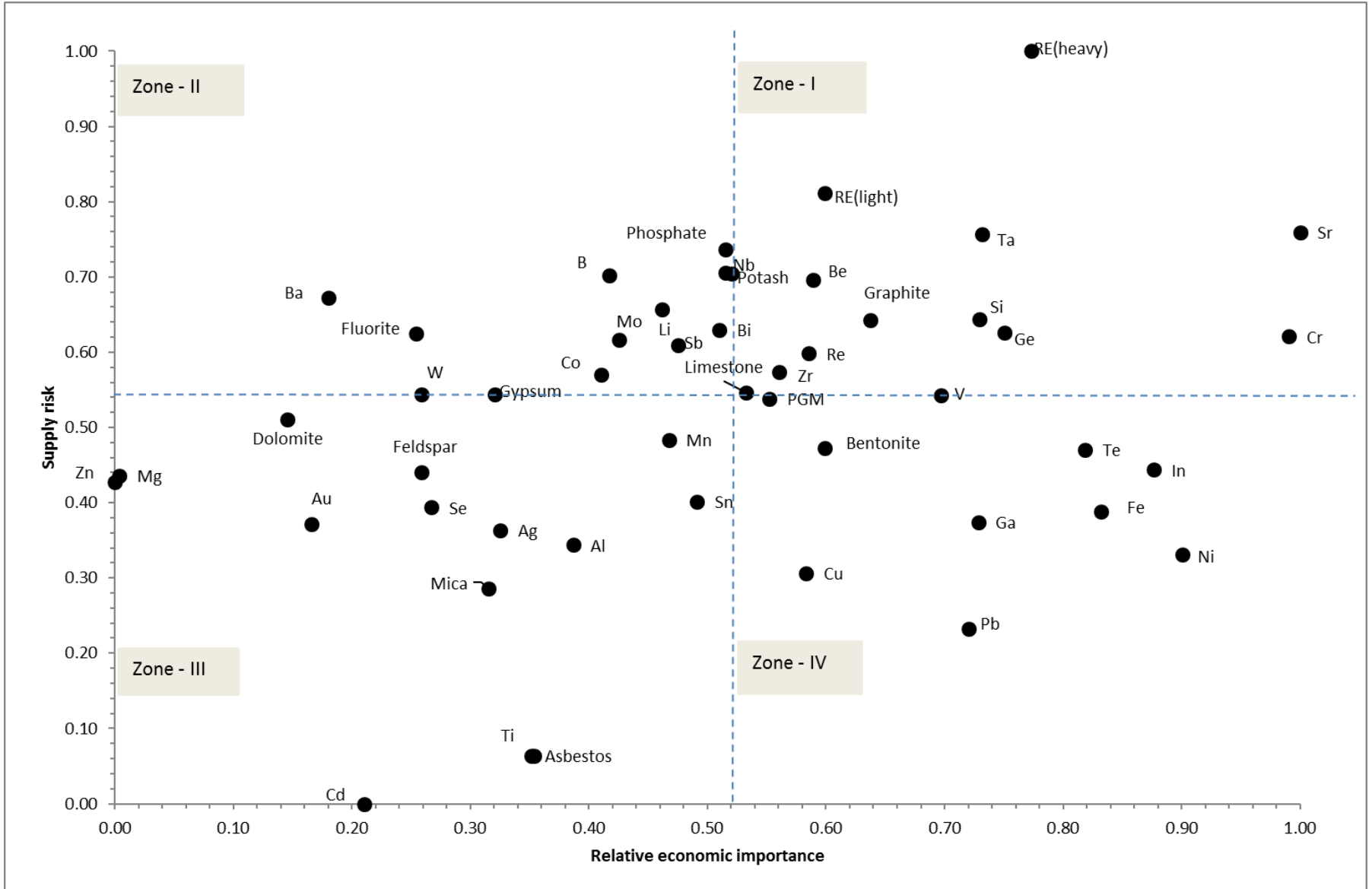
# India's energy transition has lessons for other emerging markets



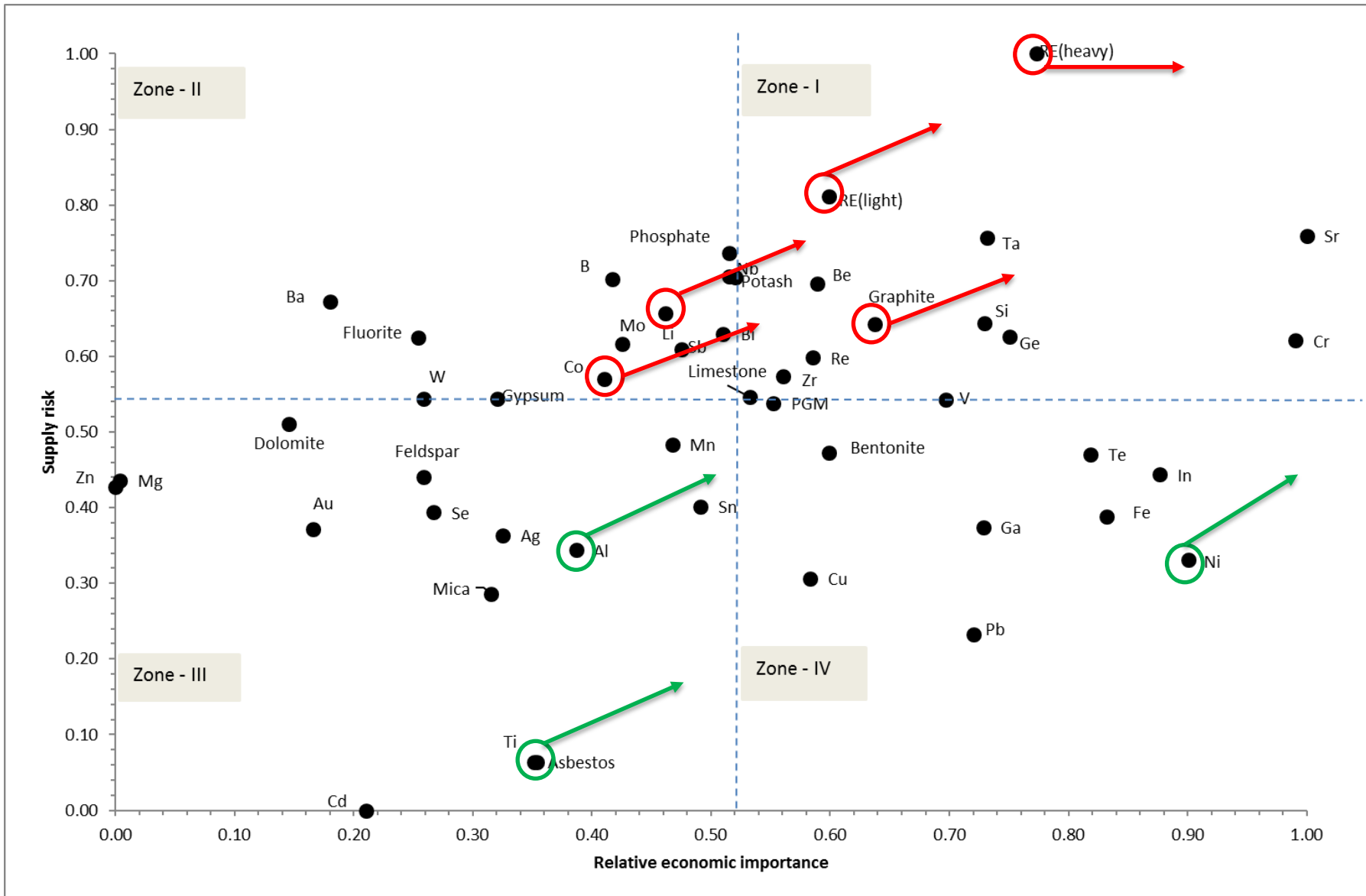
# Innovation: Common Risk Mitigation Mechanism



# Critical minerals: CEEW scenario\_2030



# Critical minerals: Potential impact of recent ambitious EV targets





# Effective tech partnerships: Global Green Hydrogen Alliance?

## Guiding principles

- Objectives matter
- Prices matter
- Pooling resources
- Innovative finance
- Risk and responsibility
- Voice in governance

## Modalities

- Emerging economies as the test-beds
- Joint development — unlike Mission Innovation — would mitigate concerns around IP monopoly or IP theft
- Funding from public and private sources, in cash and in kind
- Consider high mitigation potential
- Also assess risks against inaction or insufficient action on climate mitigation



# Disruptions create winners and losers



**Thank you**

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