IETP

India Energy Transformation Platform

Decarbonising India

# Policy recommendations for scaling up distributed systems in India

**India Energy Transformation Platform**

*Knowledge partner: cKinetics Consulting Services Pvt. Ltd. and Global Centre for Environment and Energy, Ahmedabad University*

*Secretariat: Center for study of Science, Technology & Policy*

*Supported by: Shakti Sustainable Energy Foundation and Swiss Agency for Development and Cooperation*

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## 1 About IETP

The India Energy Transformation Platform is an independent, multi-stakeholder group of experts aiming to develop an informed narrative on India's strategies for meeting its Nationally Determined Contributions (NDCs) through non-linear, transformative solutions. This unique initiative, jointly conceptualised by Center for study of Science, Technology & Policy (CSTEP) and Shakti Sustainable Energy Foundation (SSEF), hopes to ensure that India stays ahead of the curve and cements its leadership in the global transition to clean energy – even beyond 2030. Over the past year, the platform has supported research across four themes- decentralised energy systems, renewable energy dominant electricity system, industrial process heat, and urban cooling demand- exploring novel technology options to help develop low-carbon energy pathways up to 2050. The project teams (under each theme) have undertaken rigorous study and have thus put forth their results and recommendations in the form of the following policy brief.

## 2 Key Recommendations

Distributed energy systems form a significant part of India's future energy mix as they have the potential to support up to 15% of the country's energy demand by 2050. They provide more independence to energy consumers by enabling them to evolve into prosumers—producers of energy. This policy brief focuses on five (5) radical distributed systems that can help lead India's journey towards deep decarbonization in the future. These five have been prioritized from thirteen (13) technologies shortlisted as part of the study. A snapshot of the systems and their deployment scenarios along with policy interventions needed to enable their uptake is given below.

| Category | Demand sector | Deployment scenario |
|---|---|---|
| **Convergence of application and energy generation** | Buildings | **Solar rooftop** for residential, commercial and industrial buildings |
| | Agriculture | **Solar pumps** for agriculture |
| | Transportation | **Distributed hydrogen** generation for freight vehicles |
| **Distributed storage** | | High-energy-density **Li-ion batteries** for electric vehicles and vehicle–to-grid |
| **Distributed generation** | Industry | **Airborne wind energy systems** for captive power and industrial townships |

<table>
<tr><th>Deployment scenario</th><th>Near-term policy interventions to enable the technologies to achieve their potential</th></tr>
<tr><td>Solar rooftop for residential, commercial and industrial buildings</td><td>
<ul>
<li>Framing discom-owned rooftop implementation schemes for low-cost housing and peri-urban/rural areas wherein the cost of supply to the discom consumers is significantly higher than the average billing rate (Ministry of Power, State Discoms/Forum of Regulators)</li>
<li>Policy certainty and easing restrictions with regard to limit on power that can be injected back into the grid by C&I consumers (Ministry of Power/State Regulators)
<ul><li>An alternate prospective approach to address the discoms’ resistance to net metering (and consequent adverse implication on banking of excess generated power), the policy framework can provide recommendations for banking and wheeling (with no costs/surcharge, etc.) of excess power generated, which can be supplied to other consumers in the same discom area. This can pave the way for blockchain-enabled micro energy trading models.</li></ul></li>
</ul></td></tr>
<tr><td>Solar pumps for agriculture</td><td>
<ul>
<li>Modification of central financial assistance (CFA) in the existing schemes for installation of solar pumps to include relatively smaller pumps (3 HP or lower) to enable accelerated market penetration given that the size of landholdings is shrinking (MNRE)</li>
<li>Framing entrepreneur (VLE)/farmers’ collective–oriented models through joint-liability constructs (to maximize pump usage for agricultural purposes) and/or asset financing of pumps</li>
</ul></td></tr>
<tr><td>Distributed hydrogen generation for freight vehicles</td><td>
<ul>
<li>Development of a hydrogen vehicle program focused exclusively on heavy freight vehicles, co-anchored by Department of Heavy Industry (National Automotive Board) and major automobile companies
<ul><li>An initial step here could be the rollout of an R&D/technology indigenization scheme for enabling the domestic production of electrolysers—with a target of bringing the cost down to about $150/kW or less, as against the current global price of >$1,000/kW (MNRE)</li></ul></li>
<li>A segment-specific carbon-pricing mechanism (California has already adopted a similar approach) to catalyse the shift can be introduced by around 2025. Gradual pricing increase for the carbon in fossil fuels can accelerate clean hydrogen adoption.</li>
</ul></td></tr>
<tr><td>Airborne wind energy systems for captive power and industrial townships</td><td>
<ul>
<li>MNRE to commission National Institute of Wind Energy (NIWE) to develop standard wind pattern models for high altitudes</li>
<li>Department of science and technology (DST) to set up industry–academia R&D collaboration that would allow India to develop its own (or shared) intellectual property for the sector and also boost economic development through application-inspired research and innovation (undertaken with budgetary support under Mission Innovation)
<ul><li>Tie-ups with global research centers such as Delft University of Technology (Netherlands), Technical University of Munich and Indian organizations such as NIWE, Hindustan Aeronautics and IIT-KGP can be explored.</li></ul></li>
</ul></td></tr>
<tr><td>High-energy-density Li-ion batteries for electric vehicles</td><td>
<ul>
<li>Establishing domestic manufacturing facilities for lithium-ion batteries can help lower the price in the short run (FAME, DHI)</li>
<li>R&D for solid-state batteries will be key for the next phase of electric vehicles. This can be supported under the National Mission on Transformative Mobility and Battery Storage. R&D efforts can be undertaken as collaborations between different stakeholders (at domestic and global levels) such as automobile companies and research institutions.</li>
<li>Formalizing a vehicle-to-grid (V2G) mechanism that can allow consumers to leverage their unused battery cycles, and the vehicles to be treated as decentralized storage for the grid. This would require
<ul><li>Investment in bi-directional chargers and charging standards (Project Implementation and Sanctioning Committee, FAME, DHI)</li></ul></li>
</ul></td></tr>
</table>

# 3 Rationale

As per the Niti Aayog's scenario-modelling tool (IESS—India Energy Security Scenario), the annual energy demand of India in 2047 is estimated to be at least 12,656 TWh, nearly 2.5 times the current annual energy demand of 5,311 TWh. Out of this, about 5% is expected to be supplied by distributed energy systems (DES). Given the need for further decarbonizing our energy systems, the study's primary goal was to identify the opportunity to enhance the role that radical distributed energy technologies (generation, storage and smart control systems) can play in meeting the increasing energy demands and reducing the GHG emissions in India over the next 30 years.

After a comprehensive review of the current and emerging technologies and the application of key criteria influencing the uptake of technologies in the Indian context, thirteen (13) technologies that can have a significant impact in the future were identified. These thirteen were further scrutinized to identify the ones that would align with specific deployment scenarios wherein their impact can be maximized. This analysis also focused on the broader demand evolution and the carbon budget/pricing considerations that would be relevant by 2050 and would thus influence the choice and prioritization across technologies.

A comprehensive net-benefits mapping for each of the shortlisted technologies was performed to frame the economic and social rationale for their uptake.

Clearly, policy needs to lead the way for enabling the decarbonization potential that these technologies offer. Among the key ones, only solar rooftop and solar pumping have an evolved policy framework currently. However, these too need enhancement and state-level intensification, particularly solar rooftop, the business frameworks for which are still not optimized across the ecosystem. In the case of lithium-ion batteries for electric vehicles (EVs), policies have started emerging. However, R&D needs to be prioritized and given a significant push for enabling the shift to solid-state batteries. In addition, the market framework needs to be developed to allow vehicle-to-grid (V2G) mechanisms to flourish.

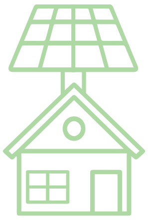
As for electric freight commercial vehicles and captive wind power plants for industries, these are newer technologies and don't figure in the current plans and/or policy mechanisms. Focused policy engagement is required to enable them to evolve comprehensively over the next decade.

# 4 Findings

The recommendations herein have the following objectives: (1) maximizing the uptake of existing technologies such as solar rooftop and solar pumps, and (2) ensuring upcoming technologies with significant India-specific opportunities can be prioritized in the country's low carbon planning in the days ahead. Further, the policy actions recommended herein are aimed at realizing the country's energy security, including access to core raw materials needed for a key technologies, market mechanisms that can help achieve the potential of these technologies, and R&D efforts to ensure requisite indigenization, among others. It is envisaged that the penetration of distributed systems would contribute to not only carbon reduction but other aspects too, as outlined on the next page.

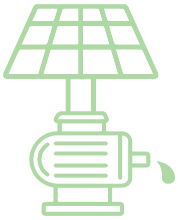
- **Grid impact:** Reduce transmission infrastructure cost and help avoid discom losses
- **Energy security:** Contribute to reduction in reliance on oil imports
- **Land needs:** Do not need additional land or can better utilize the land currently in use
- **Water systems:** Help in better utilization of natural water resources
- **User benefits:** Provide economic benefits to the end users
- **Sector development:** Enable the development of new industries, thus strengthening national economy and promoting job opportunities
- **Health benefits:** Lead to reduction in city pollution

An overview of the key features of the five prioritized technologies is given below:



SOLAR ROOFTOP

- cKinetics analysis indicates that energy in excess of 250 GW can be generated, considering the current building stock and the growth predicted over the next three decades.
    - Will fulfill 40% of the building electricity demand in 2050.



SOLAR PUMPS

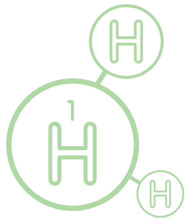
- Well-recognized segment; a flagship project launched to scale up the segment by 10–15× by 2022–23 from the current installed number of little under 250,000 solar pumps.
- cKinetics analysis indicates that more than 50 million pumps (nearly 120 GW capacity) can be installed.
    - Could power 22% of India’s agriculture pumping demand.

LI-ION BATTERIES

- Li-ion battery is a well-recognized and current default technology for EV storage. Solid-state batteries are the next generation of Li-ion batteries, which would offer safer operations. These are expected to become the default technology by 2035–40.
- cKinetics analysis indicates that personal EVs based on these storage technologies can support up to 3,941 billion passenger km by 2050.

AIRBORNE WIND ENERGY SYSTEM

- New technology—Harvests winds at higher altitudes (>500 m) in the atmosphere, where winds are stronger and more consistent than at the ground level.
    - Saves cost as it doesn’t need towers or massive blades.
- Systems have a plant load factor (PLF) potential of >65%, and for the same piece of wind-swept land, 4–6× more energy can be generated.
- cKinetics analysis indicates that these systems can be a supply source for almost 155 TWh of annual demand by 2050 and can replace ageing captive and other wind power plants set up in the 1990s.




DISTRIBUTED HYDROGEN

- New technology—Hydrogen-powered heavy commercial vehicles can play a key role in decarbonizing the freight transport sector. This will entail setting up of distributed hydrogen storage infrastructure in freight corridors.
    - Green hydrogen can be produced onsite at fuelling stations (i.e., distributed) by using electrolysers. This hydrogen can be used to power hydrogen fuel cell vehicles.
- Hydrogen used in fuel cells has an energy to weight ratio ten times that of lithium-ion batteries. Consequently, it offers much greater range while being lighter and occupying smaller volume.
- Long-haul road freight is responsible for nearly 50% of the transportation sector fuel consumption.
    - cKinetics analysis indicates that hydrogen-powered vehicles can be introduced in mid-2030s and can potentially cater to a majority of the freight demand by 2050 (initial analysis base case is at least 20% of freight demand).

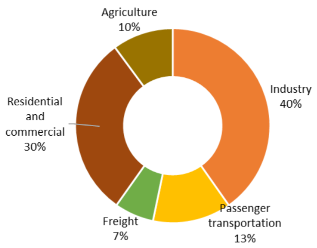
# 5 Conclusion

## ENVISIONING 2050: 1.5-DEGREE APPROACH; USD 25 TN ECONOMY BASED ON 7.2% GROWTH

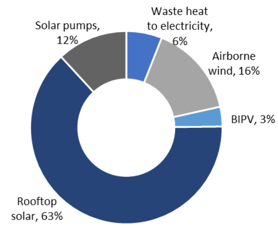
- Clean distributed energy systems considered under the business-as-usual (BAU) scenario could have a share of 5% in the total energy supply portfolio in 2050. **The prospective (recommended) radical technologies mix has the potential to drive up this share by 2–3× (10%–15%).**
- Long-range modelling indicates that a country-wise carbon budget–based approach (as compared to a global carbon price framework) for a 1.5-degree scenario is more supportive of the uptake of distributed renewables.
- Some of the key energy systems are expected to see a natural uptake owing to their attractive pricing compared with other alternatives across both scenarios. However, the associated net benefits (considering the environment, societal, economic or technical advantages associated with such systems, in addition to their decarbonization potential) provide a firm basis to prioritize the entire mix of technologies recommended. Focused programs and policies towards maximizing the uptake of these technologies in line with their true potential will pave the way for a strong distributed energy system in the country.
- Despite the best efforts at maximizing the use of renewables, heavy fossil fuels such as gas and coal would continue to be a part of the energy mix in 2050. To ensure that the objectives of deep decarbonization are met, carbon capture and sequestration technologies would be coupled with any of these deployments. An effective technology roadmap on that front would enable a standardized and competitive transition to gas–CCS and coal–CCS implementations.

CARBON BUDGET

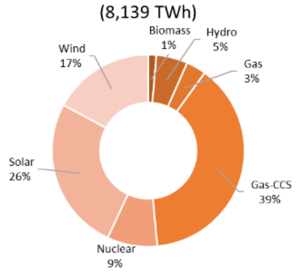
Total energy demand
(13,946 TWh)




Distributed electricity generation
(1000 TWh)

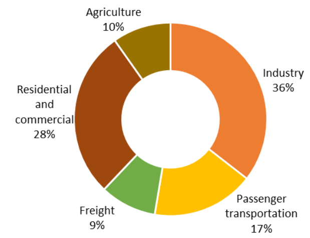



Centralized electricity generation
(8,139 TWh)

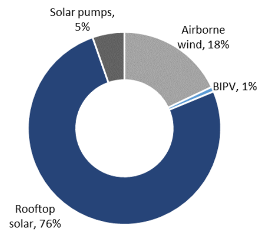



CARBON PRICING

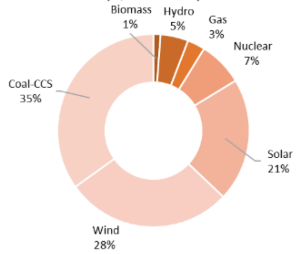
Total energy demand
(16,345 TWh)




Distributed electricity generation
(824 TWh)




Centralized electricity generation
(9,363 TWh)

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