The Future of Distributed Renewable Energy in India

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CLIMATE POLICY INITIATIVE

USICEF

US-India Clean Energy Finance

AUTHORS

Kushagra Gautam

Dhruba Purkayastha

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CPI is an analysis and advisory organization with deep expertise in finance and policy. Our mission is to help governments, businesses, and financial institutions drive economic growth while addressing climate change. CPI has six offices around the world in Brazil, India, Indonesia, Kenya, the United Kingdom, and the United States.

ABOUT USICEF

US-India Clean Energy Finance (USICEF) is India's first project preparation and pipeline development facility to help promising distributed solar projects develop into viable investment opportunities. A partnership between the Indian Ministry of New and Renewable Energy, the Overseas Private Investment Corporation (OPIC), and a consortium of foundations, USICEF provides project preparation support that will catalyze longterm debt financing for distributed solar power from OPIC and other international financial institutions.

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CONTACT

Dhruba Purkayastha
dhruba.purkayastha@cpiglobal.org

MEDIA CONTACT

Angel Jacob
angel.jacob@cpiglobal.org

EXECUTIVE SUMMARY

India has set ambitious targets to increase the share of renewable energy (RE) in its energy mix. The Government of India (GoI) plans to install 175 GW of renewable energy projects by 2022 and 450 GW by 2030. To put that in perspective, total installed energy capacity in India at the end of 2020 was 379 GW, or which 93 GW (25%) was RE.

To date, the government's primary focus of RE expansion has been on large grid-scale solar. However, achieving India's ambitious RE targets will also require an increase in distributed renewable energy (DRE) projects. If a more favorable regulatory and policy environment is created, such DRE projects, though smaller in size, have greater scalability potential. They also avoid the long lead times and execution bottlenecks associated with public-sector o□take procurement projects.

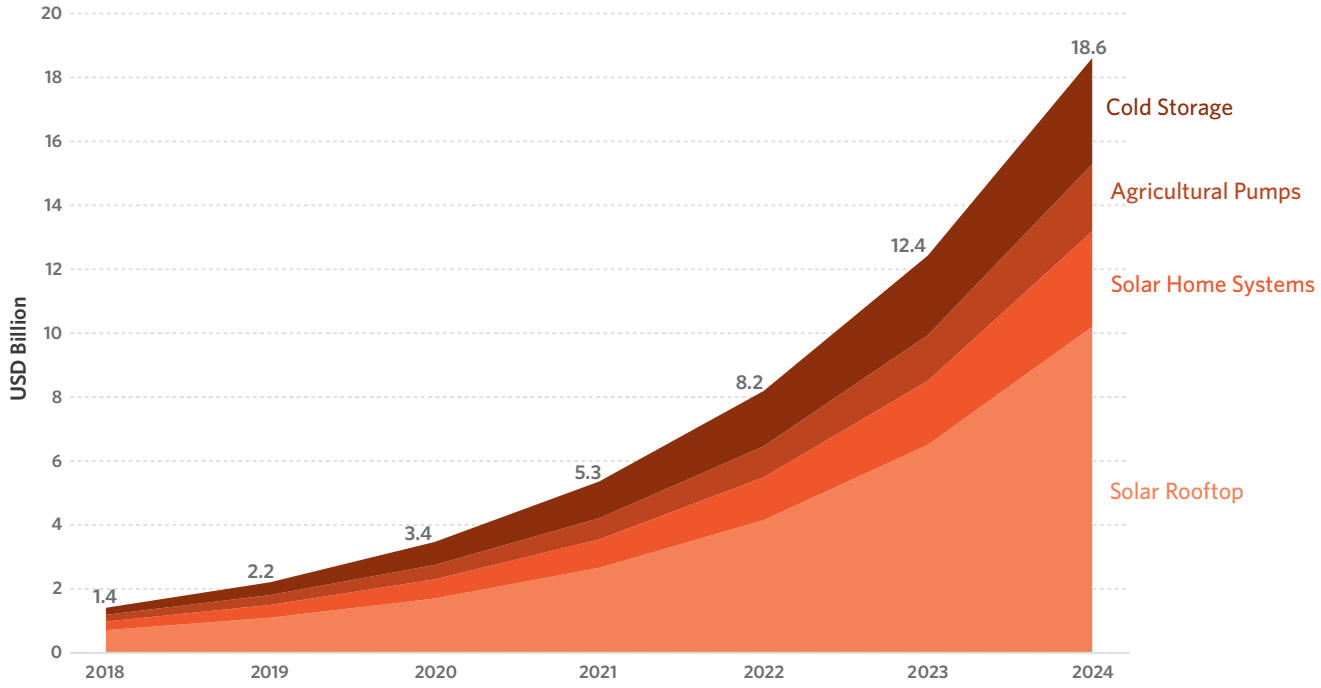
In this CPI report, we outline the benefits and market potential of India's DRE sector, examine the current policy and institutional landscape, and provide tailored recommendations for the different stakeholders.

To meet its sustainable energy targets, India will require annual DRE investment of USD 18 billion by 2024, a 10x increase from current levels.

The 2022 target of 175 GW of RE includes 100 GW of solar capacity, out of which 40 GW is earmarked for rooftop solar (RTS) and o□-grid solar (OGS). There are multiple market opportunities for RTS and OGS. The government previously introduced policy frameworks for multiple downstream o□-grid solar (OGS) applications, such as agricultural pumps, cold storage, and home systems, and multiple other DRE downstream applications are emerging, such as energy storage, EV charging, and rural non-farm productive use appliances.

All of these opportunities mean that DRE can, and should, play a vital role in achieving India's sustainable energy targets in the coming decade. However, to achieve these targets we estimate that India will require a significant increase in annual investments, from USD 2 billion in 2019 to USD 18 billion by 2024. That level of investment increase will not be possible without significant changes to India's existing DRE policy framework.

Figure ES1: DRE annual financing market



Source: CPI Research

Backed by central government incentives, states had initially created a favorable policy environment for DRE. However, in recent years, a number of these incentives have been rolled back. For example, due to RTS subsidy rollbacks, state electricity distribution companies (DISCOMs) are turning hostile towards RTS as they foresee a loss in revenue, an increase in costs, and the longer-term threat of disintermediation. In addition, the COVID-19 outbreak has had a severe financial impact on all stakeholders, leading to a conservative outlook on demand, profitability, and cash flows.

In these circumstances, it is imperative that the GoI re-evaluates its approach towards DRE and considers a rejuvenated policy framework that would both develop the private market for multiple downstream applications and maintain a meaningful role and revenue stream for DISCOMs.

POLICY GAPS AND OPPORTUNITIES

In addition to its current focus on large grid-scale projects, to meet its sustainable energy goals India needs a shift in policy focus towards creating a robust private market for the DRE sector.

A stable policy environment with incentives for all stakeholders is required to accelerate growth and would help direct more public and private financing, from domestic and international sources, into the DRE sector. Specific examples developed further in this report include:

- **Rooftop Solar:** A more holistic demand aggregation model integrated into the GoI's Phase II grid-connected RTS scheme would allow DISCOMs to get both a transaction fee for

facilitating the installation as well as monthly fee for Operation & Maintenance (O&M), such that billing/collection would better allow them to stay relevant and eliminate the threat of disintermediation.

- **Distributed Storage:** Distributed energy-storage policy should be integrated with the Phase II RTS scheme. Instead of promoting a capital-subsidy based model, the government should create a more favorable environment for operational models with the involvement of DISCOMs.
- **Smart Energy Management:** Creating incentives for Internet of Things (IoT) based energy e□ciency retrofits, that can attach to existing home circuits, will accelerate energy consumption optimization in households and small commercial establishments. This would not only help reduce energy bills and carbon footprint, but could strengthen overall grid resilience. For example, DISCOMs could move more quickly towards Time-of-Day billing as a part of their demand-side management.
- **Electric Vehicle Charging Infrastructure:** India's EV-charging infrastructure should be treated as a public good. Policy should support a decentralized approach, with DISCOMs being the implementing agency for a franchise-based model. Allowing commercial establishments that produce excess solar power from RTS to set up retail charging points would be another step in the right direction.
- **Solar Agricultural Pumps:** The GoI's KUSUM scheme currently has a centralized tendering process. Allowing state DISCOMs to partner with private installers at a local level should be considered. DISCOMs could facilitate commercial partnerships with solar pump installers and local farmer co-operatives. The DISCOM, through the installer, could pool the excess power generated from solar pumps into a single point of injection into the grid and pay power purchase costs, net of service fees, to farmer co-operatives.
- **Solar Cold Storage:** The GoI currently o□ers a 30% subsidy on solar cold storage installation under its broader rural livelihood subsidy scheme. However, considering the importance of cold storage in the agriculture supply chain, it is vital to create a separate solar cold storage program to bring down capital costs.
- **Productive Use Appliances:** It is imperative to shift the focus of grants from subsidizing product purchases to providing project development support to entrepreneurs developing the products. Equipment subsidies limit grant usage to the number of assets that it can fund, whereas project development support allows entrepreneurs to both defray technical assessment costs associated with commercial capital raising as well as develop commercially scalable business models that reduce the cost of products for end-users.

FINANCING GAPS AND OPPORTUNITIES

The RTS and OGS markets are small and fragmented, largely reliant on philanthropy or subsidized private funding. There is currently limited interest from private commercial capital. Supported by stronger financial-sector policy and strategic public investment, the public, private, development and philanthropic sectors have a tremendous opportunity to work in coordination to open significant new DRE market opportunities for India.

DRE and its downstream applications offer an opportunity to not only meet India's climate and renewable energy targets but also provide attractive returns to financial investors.

Over the last few years an increasing number of smaller RTS and OGS companies have been able to better develop their business models and are now in need of growth-stage funding. However, many smaller RTS and OGS developers still lack the required capabilities to navigate the entire credit appraisal process of lenders. This lack of expertise also reduces their probability of reaching financial close. For such developers, there is increasing demand and need for additional rounds of early-stage capital, technical assistance, and strategic advice to move towards commercialization and to attract growth equity.

Information asymmetry, due to lack of project preparation and targeted transaction advisory, is also a significant cause of lack of access to capital for smaller DRE developers. Government and philanthropic support should be channeled to quickly address these gaps, allowing the DRE sector to scale more rapidly.

On the private capital side, though impact investors have scaled up their DRE operations over the last decade, participation among private capital owners such as family o□ces, high net-worth individuals, and corporates remains limited. With competing demands for capital from mainstream business models, such investors view DRE as less financially attractive. Blended finance instruments can potentially help to bridge this gap.

Even with the positive intent of impact investors, currently impact investors, along with commercial financial investors active in the space, tend to favor mature-stage companies and projects. An opportunity exists to create incentives and expand investment focus to finance smaller and emerging companies in niche segments that have the potential to scale over the next few years.

DRE and its downstream applications o□er an opportunity to not only meet India's climate and renewable energy targets, but also provide attractive returns to financial investors. DRE also paves the way for India to reduce import-dependence on crude oil, in turn accelerating economic growth and jobs in the long run. Addressing the existing policy and financing gaps identified in this report through a combination of policy advocacy, knowledge dissemination, and catalytic finance would not only allow for better targeting and risk-hedging of government spending programs, but would also allow capital to be recycled e□ciently, thereby enhancing both the duration and magnitude of the impact.

CONTENTS

1. CONTEXT

India is the world's third largest carbon emitter, with emissions expected to rise as the economy grows. While this economic growth is important for advancing development objectives, especially in the wake of a likely recession due to the COVID-19 pandemic, it also poses a challenge as around 600 million people in India are at risk from the impacts of climate change such as floods, wildfires, and heat waves. Additionally, inaction on this threat could shave USD 1.12 trillion o the country's GDP by 2050,[2] eroding progress on sustainable development and poverty alleviation in a country that already struggles with meeting basic needs.

Recognizing these various needs and challenges, India has rightly targeted its energy sector for transformation, with an ambitious target of 175 GW of renewable energy by 2022. Solar energy comprises 100 GW of this target, of which 40 GW will be rooftop solar (including small-scale grid connected solar projects).

Between 2015-17, there was significant uptake in renewable energy capacity addition, which could be attributed to the falling costs of renewable energy technology and favorable policy measures by the government. Since 2017, the capacity additions have been somewhat slower given the slowing economy as well as the introduction of tari caps for large scale renewable energy. As of March 31, 2020, with installations of 32 GW, the utility-scale solar installations are well behind their target of 60 GW. In addition, with installations of 5.25 GW, the RTS installations are only at ~13% of their 40 GW target.[3]

The retail electricity market in India is structured in a way that the rural and agricultural customers pay the lowest price for power, but they also su er the most from the intermittent and low-quality supply of power. This leads them to incur indirect e ects such as low quality of life for households and low quality of output for farmers. This segment would benefit the most from downstream applications of o -grid solar. Targeted schemes, such as Kisan Suraksha Abhiyan Utthan Mahabhiyan (KUSUM) subsidy for installation of agricultural solar pumps, and Direct Benefit Transfer (DBT) of power subsidies directly to the people through their bank accounts, are designed to help alleviate losses for state electricity distribution companies (DISCOMs) as well as improve the competitiveness of the agricultural sector and the quality of life of rural households.

Due to this cross-subsidized model of power pricing, Commercial and Industrial (C&I) customers demonstrate the highest tendency to shift towards rooftop solar and would benefit the most from future downstream applications such as behind-the-meter energy storage.

Commercial and Industrial (C&I) customers consume only 51% of the power in India but pay the highest tari□s, are a major share of DISCOM income, and cross-subsidize rural and agricultural customers.

This report studies the market potential of DRE and its multiple downstream applications, their role in addressing government energy security goals, identifies policy and institutional challenges, and provides recommendations to fill the identified gaps.

2. MARKET POTENTIAL

The potential of distributed renewable energy in India is huge. In this section, we outline the sub-segments that have the highest growth potential for meeting government targets for sustainable energy security in the coming years but have fallen short so far on this front.

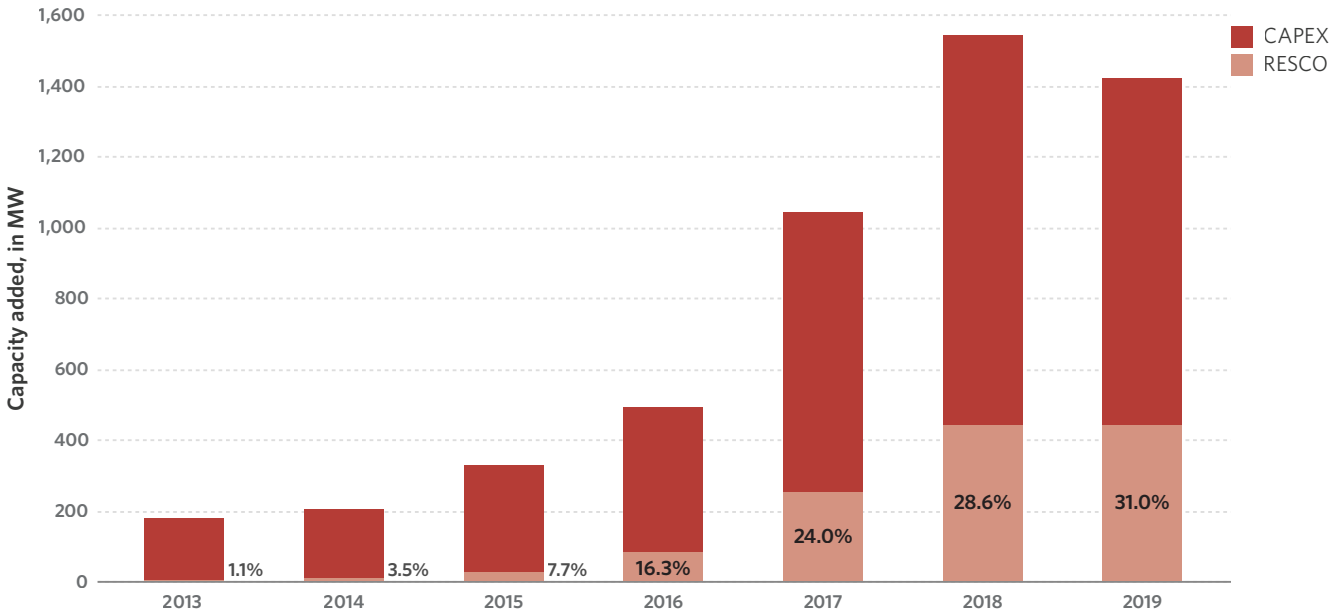
2.1 ROOFTOP SOLAR

Adoption of rooftop solar by several small and medium industries can play a key role in decarbonizing India's manufacturing supply chain.

In addition, given the high cost of electricity and deteriorating air quality in cities, rooftop solar is increasingly being considered as a replacement for diesel generator sets in residential and commercial segments.

Despite the potential for capacity installation, mitigation, and developmental impact, and the potential investment opportunities in emerging business models, the growth of rooftop solar in India is constrained due to lack of access to institutional finance - both debt and equity. An estimated total investment of USD 25-30 billion is required to achieve the 40 GW rooftop solar target.[4] **Moreover, as the current installed capacity of rooftop solar is only 5.25 GW, India will require a compound annual growth rate of over ~100% (or more than double the addition to capacity every year) to reach this target.**[5]

Figure 1: Annual capacity addition

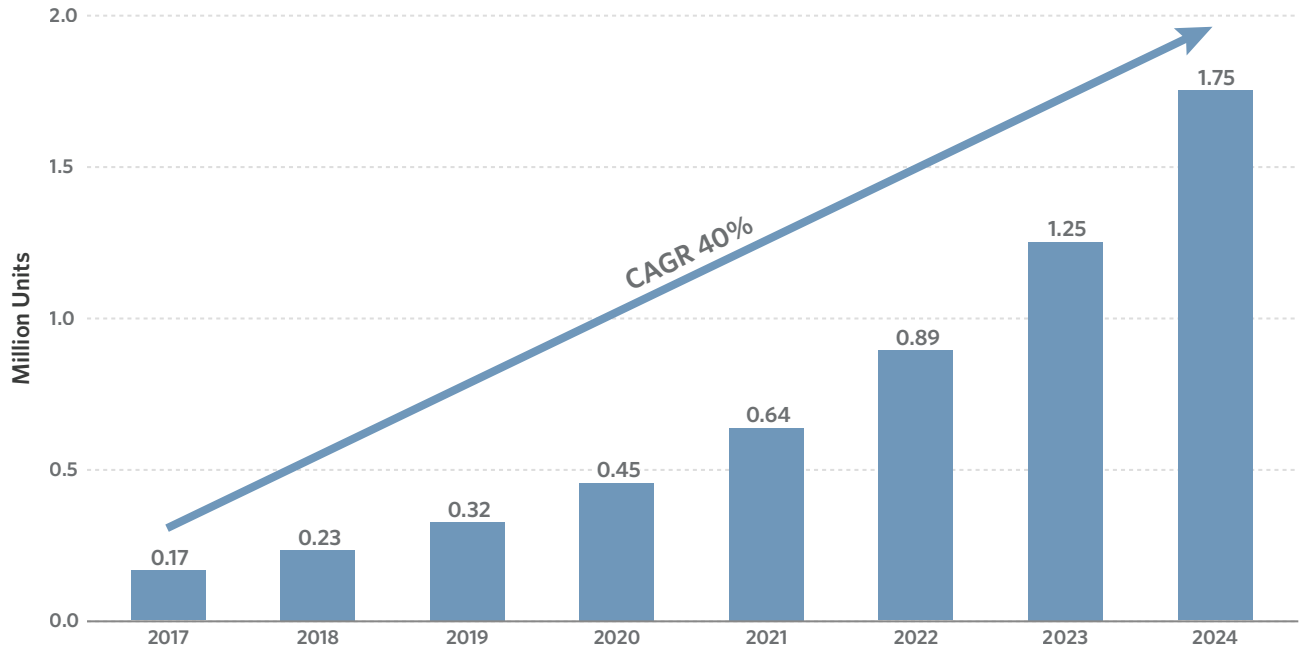


Source: Bridge to India

2.2 SOLAR AGRI-PUMPS

India has traditionally been an agricultural economy with over 160 million households dependent on agriculture for livelihood.[6] Access to reliable water remains a challenge as only ~50% of the agricultural land in India is currently under irrigation.[7] This presents a unique market opportunity to provide solar-based irrigation solutions to around 80 million households in India. The Government of India (GoI), under its KUSUM scheme, has targeted a cumulative installed capacity of 1.75 million solar water pumps (around 6% of the total agricultural pumps in the country) by 2024.[8] At the current average price of agricultural pumps of around INR 200,000 (USD 2,700), the estimated annual market size would be INR 10,000 crores (USD 1.5 Billion).

Figure 2: Solar water pump installed capacity



Source: GoI KUSUM Proposal and CPI research

2.3 SOLAR COLD STORAGE

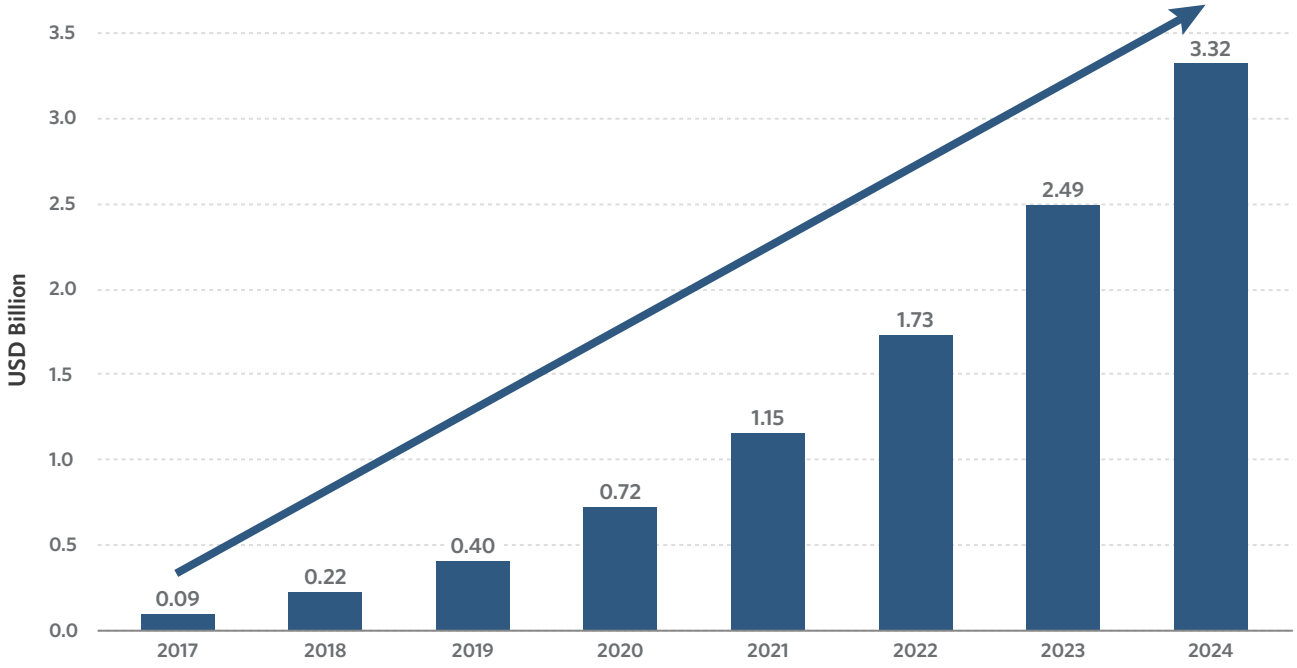
India's weak agriculture supply chain results in significant loss in agricultural produce, leading to loss in income for farmers. The government has set itself a target of doubling farm income by 2024, for which having a robust supply cold storage infrastructure is essential.

The cold chain industry in India was worth around USD 3.5 billion in 2017 and is expected to reach USD 9.5 billion by 2024.[9] Access to grid-based electricity has been a challenge for the rural population in India. This presents an opportunity for solar-based cold-storage solutions to penetrate the market. The GoI launched a nodal agency called National Center for Cold Chain Development (NCCD), which promotes a number of subsidy schemes for setting up

cold chain elements in India.[10] With an average connected load of 20-25 kW, cold storage o□ers a significant unaddressed potential for use of decentralized solar energy.

On a conservative basis, we estimate that over the next 7 years, the contribution of solar cold storage to the overall cold storage market will increase in a linear fashion from 1% to10%. This would translate into a market opportunity of USD 3.3 billion.

Figure 3: Solar cold storage market size

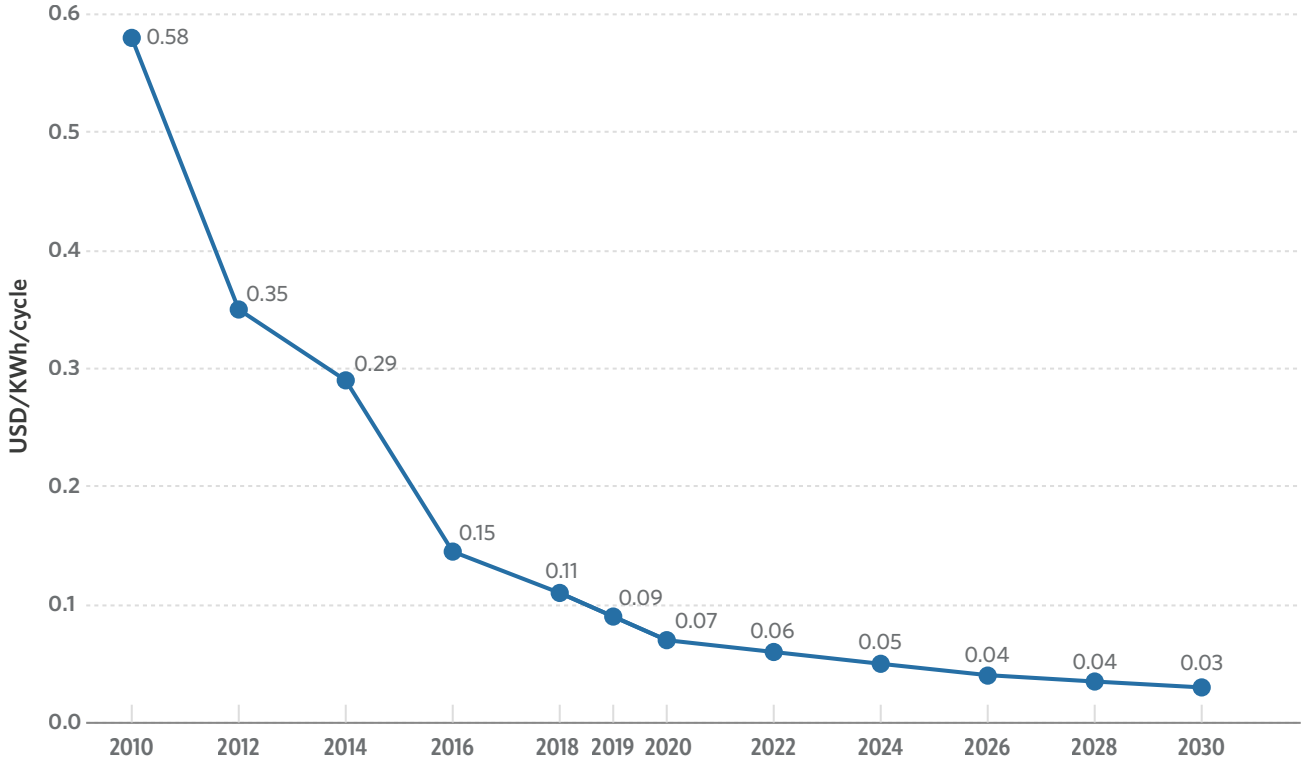


Source: CPI Research

2.4 DISTRIBUTED ENERGY STORAGE

Energy storage is a crucial tool for enabling the e□ective integration of renewable energy and unlocking the benefits of local generation and a clean, resilient energy supply. The technology is valuable to grid operators around the world who must manage the variable generation of solar and wind energy. However, the development of advanced energy storage systems (ESS) has been highly concentrated in select markets, primarily in developed economies.

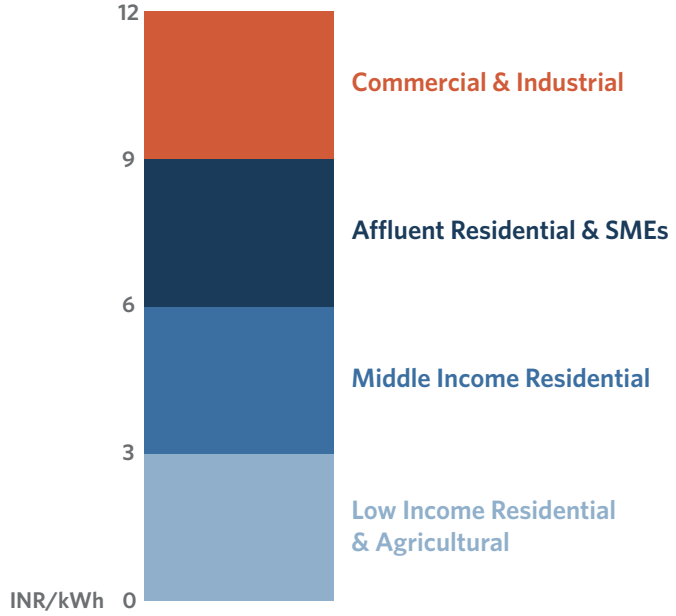
Figure 4: Lithium-ion battery costs



Source: Bloomberg New Energy Finance (BNEF)

In India, factors like operational inefficiencies in the state distribution system, cross-subsidization of agricultural and residential customers, and infrastructure development costs to support government schemes (such as rural electrification) have created a huge revenue gap for DISCOMs, leading to an increase in tariffs for commercial and industrial customers.

Figure 5: Tariff structure in India



Source: CPI Research

With energy storage costs continuing to fall, a combination of solar rooftop with energy storage is expected to become cost competitive to grid tariffs for C&I consumers in the near future, resulting in an increasing trend of grid disintermediation (going "behind-the-meter").

This would also reduce the need for net metering from the distribution utilities and allow for decentralized renewable energy to operate unconstrained in the market without the need for subsidies.

Research shows that the energy storage market for o□-grid renewable energy in India is expected to be worth INR 16,500 crores (USD 2.36 billion) by 2024, with rooftop solar accounting for 80% of the total (CEEW, 2016).[11]

2.5 ELECTRIC VEHICLE CHARGING INFRASTRUCTURE

India has over 200 million registered vehicles - with the number of vehicles increasing by over 20% in just the last five years. This number is expected to go up significantly in the coming years as private motor vehicle penetration in India is only 4% as compared to about 80% in the United States and about 55% in the EU. By 2030, it is estimated that India will have 600 million vehicles. In 2017, electric vehicles (EVs) accounted for less than 0.1% of the total automotive sales in India. With technology development and favorable government policies leading to a fall in total cost of ownership, it is estimated that EVs have the potential to account for up to 30% of the total automotive sales in India by 2030.[12]

The GoI is developing several incentives and policies for increasing the adoption of EVs.

The National Electric Mobility Mission Plan (NEMMP) 2020 was launched by the Central Government in 2013 to boost the manufacturing of hybrid and EVs in India. It aims to achieve the production of seven million EVs by 2020. In addition, with the Government deciding to fund up to 60% of Research & Development (R&D) costs for the development of indigenous low-cost electric technology, global automobile players are investing heavily in R&D of EV technologies in India. These initiatives have been complemented by the Government providing demand-side incentives through its Faster Adoption & Manufacturing of Hybrid and EVs in India (FAME) scheme.[13]

These factors are expected to present multiple opportunities in the EV value chain: charging infrastructure, design and engineering, manufacturing, fleet management, last mile connectivity, mobility service providers, and software/digital technologies.

3. STRUCTURAL CHALLENGES TO ACHIEVING MARKET POTENTIAL

DRE also has excellent potential to help the government meet its sustainable energy goals. Favorable rooftop solar policy incentives would allow the private market to function better and in turn, accelerate the RTS capacity additions. It is estimated that with favorable policy, the realizable potential for RTS in India is 125 GW, with a total gross potential of 350 GW.[14] In this section we evaluate some of the broader market failures in the energy sector and the role that DRE can play in addressing them.

3.1. AGGREGATE TECHNICAL & COMMERCIAL (AT&C) LOSSES OF DISCOMS

Transmission and distribution infrastructure in India has not kept pace with its power generating capacity growth. It is estimated that transmission and commercial losses average 15-25% across different states in India.

Many of the state DISCOMs are under significant financial stress due to private sector participation, high AT&C losses, and artificially low prices for low-income residential and agricultural consumers leading to large financial losses. These ine□ciencies in the state distribution system have created a huge revenue gap for state DISCOMs, which are partly being recovered from C&I customers.

Since the launch of the UDAY scheme, from an overall AT&C loss of 26% (2015-16), the government targeted reduction of AT&C losses to 22% by March 2019. However, the numbers for March 2020 and onwards are expected to further weaken, especially with the onset of COVID-19 and the subsequent lockdowns. In the same manner, the gap, as calculated in the table below, in the average cost of supplying electricity (ACS) and the average revenue realized (ARR) has only reduced from INR 0.65/unit in FY2016 to 0.54/unit in FY19.[15]

Table 1: Average and Incremental Cost of Power for the DISCOM

Average and Incremental Cost of Power for the DISCOMS	
Cost of power purchase (INR/kWh) (A)	3.82
Other Costs (INR/kwh) (B)	1.05
Average Cost of Supply (ACS) (INR/kWh) (A+B)	4.87
Average Revenue Realized (ARR) Including Subsidy (INR/kWh) (C)	4.33
Gap (A+B-C)	0.54
Accumulated Losses (USD Billion)	5,276

Source: CPI Research

Creating a commercially meaningful role for DISCOMs in promoting RTS for C&I and residential customers with smart net-metering systems could help them reduce their AT&C losses.

3.2. RESIDENTIAL/COMMERCIAL LOAD SHEDDING DURING PEAK HOURS

With increasing financial losses and liquidity challenges over the last many years, DISCOMs have had limited ability to invest in system upgradation, resulting in frequent bouts of load shedding during peak hours in high power-consuming residential/commercial areas. The resulting complications of low reserve margins (excess available capacity over expected peak demand) and transmission congestion can be addressed through the use of distributed storage in the transmission & distribution value chain.

With a rapidly falling cost of energy storage systems, a combination of rooftop solar and storage has emerged as a feasible o□-grid option, which could also help to increase energy access in under-served regions in the future. In addition, storage solutions can help in regulating the frequency of the distributed solar power injected into the grid under a metered system, thereby reducing the need for capital expenditure in system upgrades.

3.3. INCREASING POLLUTION AND FUEL IMPORT COSTS

India's daily consumption of crude oil is the third highest in the world after the US and China. However, only 20% of India's demand is produced domestically, leaving the country highly dependent on imports of crude oil.

A shift towards EVs would allow consumers to benefit from reduced fuel costs over the long term as well as help to reduce India's energy import bill and current account deficit.

The second phase of the Faster Adoption & Manufacturing of Hybrid and EVs (FAME) scheme commenced in April 2019, with an ambitious outlay of USD 1.5 billion over three years to support the electrification of public and shared transport through subsidies to 7,000 e-buses, 500,000 electric three-wheelers, 55,000 electric four-wheeler passenger cars, and one million electric two-wheelers. Additionally, the scheme would support the creation of charging infrastructure in select cities and along the major highways including 2,700 charging stations in metros, smart cities, and cities of hilly states across the country. This is to ensure that at least one charging station will be available in an area of 3 km x 3 km.[16]

3.4. LOW AGRICULTURAL FARM INCOMES FROM UNSUSTAINABLE FARMING PRACTICES

Rural farm incomes in India have traditionally lagged non-farm urban incomes by a considerable portion. This has been a major factor in the recurring cases of agrarian distress in India leading to multiple bouts of farmer suicides. With agriculture becoming increasingly difficult to sustain livelihoods, an increasing number of farmers of newer generations are migrating towards low-paid informal jobs in urban and semi-urban areas. This trend is likely to have an adverse impact on the long-term quality of agriculture in India. With this in mind, the government has created a policy target to double farm incomes by 2022.

Farm incomes have remained depressed over the last many decades due to low productivity per unit of land holding, which is a result of small size of land holdings and low irrigation coverage over large parts of India. Among the more prosperous agricultural regions, where irrigation infrastructure is present, lack of reliable grid electricity has resulted in farmers using diesel gen-sets to irrigate the land. This not only increases the overall cost of farming but also results in increased pollution and contributes to climate change.

The union budget of 2018 introduced the Kisan Urja Suraksha Evam Utthaan Mahaabhiyan (KUSUM) scheme with a proposed outlay of USD 20 billion over 10 years to replace diesel pumps and grid-connected electric tube wells with solar irrigation pumps. The program has largely missed its target so far. The program's centralized procurement process has helped to reduce unit costs but has also led to an increase in execution costs and implementation delays. For example, the first tender was launched by Energy Efficiency Services Limited (EESL) in December 2019, nearly two years after the program launch.[17]

The benefits of solar pumps are evident for DISCOMs – making the farmer independent of the grid can help to lower the subsidy burden as well as reduce the cost of supply to rural areas.

3.5. WEAK AGRICULTURAL SUPPLY CHAIN

India's weak agriculture supply chain results in a significant loss in agricultural produce, leading to a loss in income for farmers. The government has set itself a target of doubling farm income by 2022, for which having a robust cold storage infrastructure in the supply chain is essential.

Cold storage infrastructure is an integral part of any food supply chain, especially in a growing country like India. Though India has a sizable agricultural output, a lot of wastage occurs in logistics, reducing the total contribution to GDP. In addition, the lack of reliable grid electricity is an area of concern in rural regions where the government envisages setting up cold storage facilities.

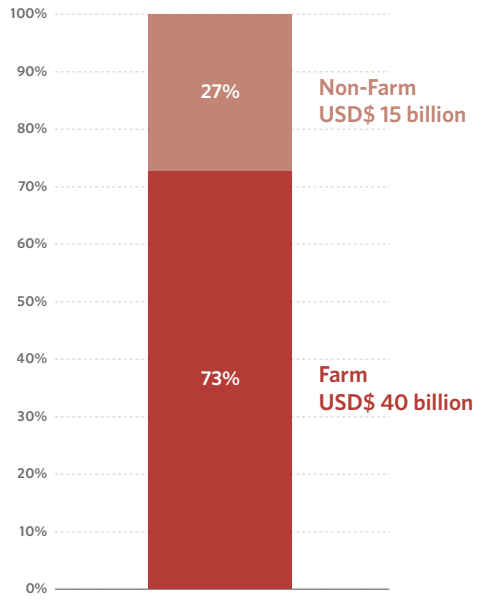
The cold chain & warehousing industry has one of the highest electricity costs per unit of production among all industries. Here, distributed solar and energy storage can play a critical role.

Currently, the cold storage subsidy program is housed under the National Horticulture Policy which includes multiple other segments unrelated to energy. A dedicated solar cold storage policy within Ministry of New and Renewable Energy (MNRE) is essential. The aim should be to encourage solar cold storage installers to work on an operational model with local farmer co-operatives. This would not only provide scale in the purchase of power, but also allow better control over the quality of installation and subsequent Operation & Maintenance (O&M). As in the case of solar pumps, an option should be available to solar cold storage installers to export surplus solar power produced to the grid through either a net or gross metered system.

3.6. DEVELOPING THE RURAL SERVICES ECONOMY

Access to a reliable grid-based electricity source remains a challenge for agriculture in India. As a result, mechanization in the farm and non-farm sectors remains low. The total addressable market for equipment such as reaper binders, knapsack sprayers, and rice transplanters has been estimated at around USD 40 billion. A multitude of activities exist in the ancillary (non-farm) agricultural sector that can benefit from reliable clean electricity: milk cooling, flour milling, sewing, weaving, tailoring, pottery, jewelry, poultry, vehicle repair, furniture manufacture, restaurants, retail, etc. The total addressable market for such activities has been estimated at around USD 15 billion.[18]

Figure 6: Total addressable rural services market (USD Billion)



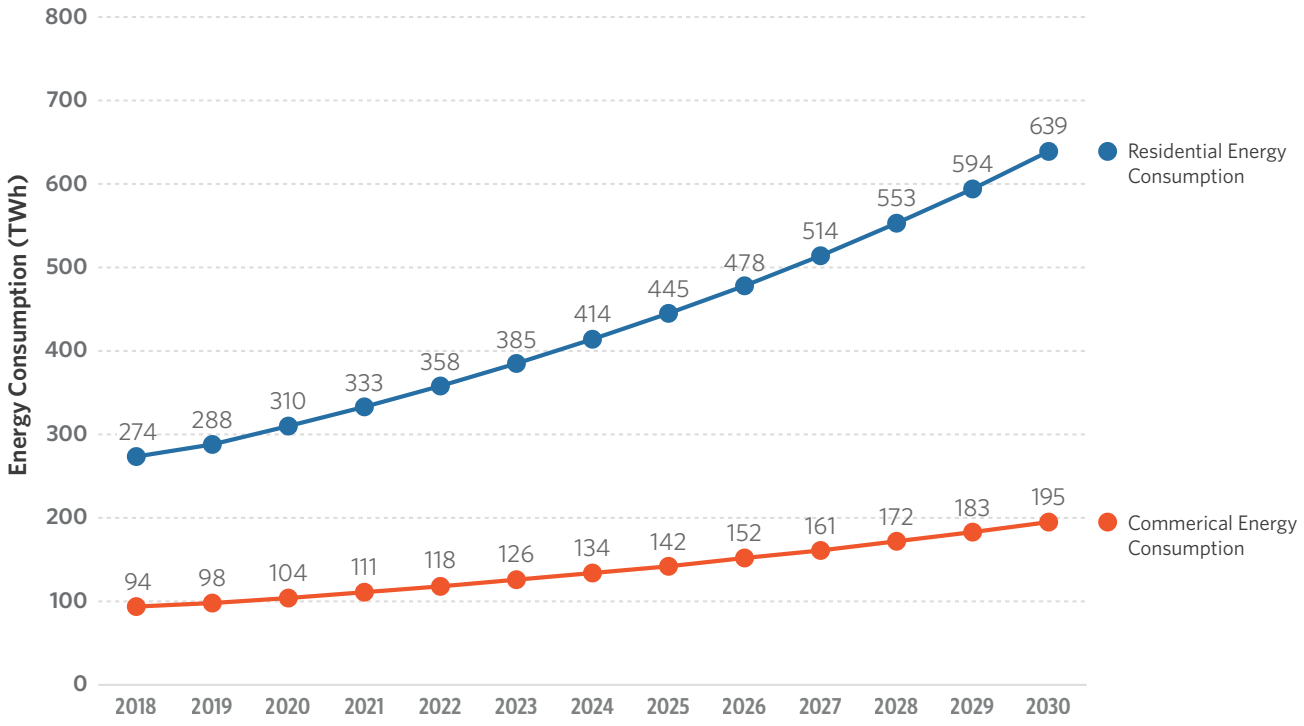
Source: CEEW report

While India has reached 100% village electrification per government statistics, villages suffer from intermittent power. In addition, several village economic activities are located away from village electrified areas, increasing demand for solar-powered productive use appliances.

3.7. MANAGING PEAK DEMAND AND SUPPLY DEFICITS

The total household energy consumption was 275 TWh in 2018 and is expected to reach 640 TWh by 2030, a CAGR of 7.5%, due to increasing household electrical appliance use. In addition, commercial energy consumption is expected to increase from 95 TWh in 2018 to 200 TWh by 2022, a CAGR of 6.5%, due to increasing commercial building heating, ventilation, and air conditioning (HVAC) demand.[19]

Figure 7: Energy consumption in India



Source: Central Energy Authority (CEA), India Report

The GoI has already put in place building energy e□ciency codes. E□ciency measures can help save 30-40% energy in new buildings and about 20% in existing buildings through the application of suitable retrofit measures.20 Through Energy E□ciency Services Limited (EESL), GoI has signed a USD 220 million Loan Agreement and USD 80 million Guarantee Agreement with the World Bank for the India Energy E□ciency Scale-Up Program.21

Going forward, energy services companies (ESCOs) have the potential to provide holistic solutions – from HVAC airflow management to building sensors and controls and automation to big data analytics. Increasing use of data analytics, smart meters, and home energy management devices can help DISCOMs flatten peak demand curves with time-of-day billing, thereby enabling better demand/supply side management.

3.8. DFI INVOLVEMENT IN DRE APPLICATIONS

With the GoI creating a favorable environment for growth, the RTS sector in India is receiving strong support from bilateral and multilateral institutions.

- **World Bank** has committed USD 625 million in loans for solar rooftop projects that is being on-lent by State Bank of India (SBI).
- **Asian Development Bank** (ADB) has announced a USD 500 million for financing rooftop solar systems through Punjab National Bank (PNB).
- **KfW** has tied up with the Bank of Baroda (BoB) to extend funding of USD 110 million to re-finance solar projects under the over-arching Indo-German Solar Energy Partnership.
- **KfW** also has a parallel agreement with the Indian Renewable Energy Development Agency (IREDA) to finance up to USD 220 million of renewable energy projects.
- **European Investment Bank** (EIB) has signed a loan agreement with IREDA for financing up to USD 200 million of renewable energy projects.

While some of these lines remain under-utilized due to a lack of investment-ready high-impact projects, other lines of credit have been disbursed mostly to larger players with strong corporate backing.

Government policy initiatives such as credit guarantee mechanisms could help to catalyze more financing for smaller and mid-sized companies in this segment.

Better grid management through DRE

While India has reached 100% electrification, access to uninterrupted and a□ordable electricity remains a challenge. DISCOMs continue to su□er from AT&C losses. Here distributed energy can feed into the grid at the distribution transformer level and contribute to the reduction in losses on transmission and power procurement. In addition, the use of energy storage at the distribution transformer level can allow for meeting the instantaneous peak demand (peak shaving) and thereby reduce system upgradation costs. Simultaneously, moving towards a time-of-day billing can allow for better demand-side management. Since the agricultural and rural consumer revenue does not cover the cost of supply, self-sustainable and sub-licensee based mini-grids could be a possible alternative. In addition, the government move towards Direct Benefit Transfer (DBT) for agricultural power subsidy is a welcome move.

4. POLICY CHALLENGES TO ACHIEVING MARKET POTENTIAL

Though DRE has the potential to make good on government goals, a range of policy and institutional challenges hold it back, exacerbated by the COVID-19 pandemic.

4.1. POLICY APPROACH

The Government's clean energy objectives are not only driven by a need to cut emissions, improve living standards, and prevent climate- related calamities, but also generate social and economic benefits to the community by way of employment generation and access to reliable electricity supply.

For example, achieving the 40 GW distributed solar target can create more than 500,000 short-term jobs and over 100,000 full-time jobs.[22]

With these factors in mind, and with backing from the central government, a number of states initially created favorable targeted policies for DRE. The key features are detailed below:

Table 2: State-level policies for the distributed renewable energy sector

Name of State	Key Features
Delhi[23]	• An incentive of Rs. 2/unit for an annual generation of power beyond 1,100 units of RTS installed -- valid for first three years from the date of installation. • DISCOMs are responsible for the evacuation of generated power. • There would be a monthly billing cycle and annual compensation for any surplus power produced
Maharashtra[24]	• Starting from 4.5% in 2020, Renewable Purchase Obligation (RPO) target of 13.5 per-cent aimed over the next five years. • DISCOMs will be penalized for the shortfall in RE procurement yearly.
Karnataka[25]	• Average cost of supply (ACOS) paid for power exported to grid as opposed to average power purchase cost (APPC) / Feed-in-tari (FiT) followed by many other states. • Compensation is made on a monthly basis.
Telangana	• Subsidy of 30 percent is o ered on the benchmark or invoice price of the RTS system installed.[26] • Compensation for surplus power generated will be paid on a half-yearly basis.[27]
Uttar Pradesh[28]	• Allowed range of installation for developers - 1 kW to 2 MW. • Currently permits only gross metering systems. • Compensation is calculated based on FiT decided by the SERC. • Grant of Rs. 30,000 is o ered to residential customers. • No incentives are o ered for RTS installations in group housing societies.

Name of State	Key Features
Rajasthan[29]	• Average generation from RTS system is capped at 4.8 units per kW of approved installed capacity per day. • Erstwhile provision of carrying forward net surplus electricity available at the end of billing period stands lifted for all segments except domestic.
Gujarat[30]	• APPC decided through auctions held by the state's umbrella entity for electricity services, Gujarat Urja Vikas Nigam Ltd. with an additional 20 paise/unit. • RESCO models are not permitted in the 2019 state policy.
Tamil Nadu[31]	• Maximum capacity of RTS system installation is not allowed to exceed producer's contracted demand with their distribution licensee. • Under the solar net feed-in program, producers are required to install separate meters to track solar power generation and import/export.
Punjab[32]	• Direction to vendors to charge buyers up to 3 kW RTS systems only above the 40 percent subsidy o□ered by the centre. • State subsidies announced for grid-connected RTS between 1 and 10 kW capacities in the residential sector. • Non-residential sectors are removed from availing subsidies.
Madhya Pradesh	• Limitation in the capacity of RTS system is revised to 30 percent of transformer capacity. • In a bid to ensure timely execution of projects, percentage refund of performance guarantee is o□ered to developers as per set benchmarks and timelines[33]. • Installation of RTS systems is allowed up to 1 MW capacity[34]
Haryana	• Limitation in the capacity of RTS system - up to 30 percent of transformer capacity for low tension lines and 15 percent for high tension lines.[35]

4.2. KEY ISSUES

However, over the last few years, a number of issues have cropped up in the state government policy towards distributed solar. These are highlighted below:

- **Net Metering:** Although this mechanism was rolled out in a bid to improve the accessibility and a□ordability of the DRE systems, the scheme is now facing resistance from DISCOMs, since they lose vital revenues from their highest paying and most profitable customers (C&I and a□uent residential segments) Most states have capped their solar plant sizes to 1 MW, restricting developers from achieving scale.
- **Reduced Distributed Transformer level share:** More than a dozen states in India have been restricting RTS system size to less than 50 percent of transformer capacity.[6] This acts as a critical deterrent for potential large-size RTS system installers. It is important that the states start analyzing grid areas to assess the permissible share of RE instead of capping distribution transformer (DT) level share across their jurisdiction.
- **RTS additional charges:** State governments have proposed imposing additional charges as a means to recover the costs of the established network and maintenance done by the DISCOMs. Maharashtra has recently proposed levying grid support charges from consumers having a sanctioned load above 10 kW.[7] However, the Maharashtra Electricity Regulatory Commission (MERC) has decided not to levy the grid support charges until the cumulative rooftop solar capacity reaches 2 GW in the state.
- **Renewable Energy (RE) curtailment:** Curtailment of generated power is done by the grid operators for maintaining grid stability in the event of any congestion in the

system. However, RE generating stations have been granted the privilege of must-run status.8 This puts additional load on the DISCOM's already over-burdened distribution infrastructure and entails DISCOM's to carry out significant capital expenditures for system upgradation, a huge ask given their current financial health.

Among the above, net metering has become the most contentious issue as it leads to a loss in revenue from the highest paying customers, i.e., Commercial & Industrial (C&I). For example, in recent times, several states have issued amendments to their distributed-solar policies, which indicate a degree of hostility towards net-metering.

Table 3: State-level amendments to distributed solar policies

State	Date of Amendment	Key Features
Uttar Pradesh[36]	January 2019	Removed net metering for C&I consumers in favor of gross metering, where compensation for power export would be at the weighted average tari of large-scale solar projects discovered through competitive bidding.
Tamil Nadu[37]	March 2019	Removed net metering for all consumers and only allowed gross metering for residential and Low-Tension (LT) C&I and residential consumers.
Himachal Pradesh[38]	April 2019	Those who have a letter of approval for installation of net-metered solar rooftop after Nov 15, 2018, will be paid a quasi-gross metered rate - 30 percent of the weighted average per kWh rate at which the DISCOM has purchased power from the ground-mounted solar PV projects up to 5 MW capacity located in the state during the calendar year ending December 31.
Karnataka[39]	December 2019	Has removed net metering for C&I consumers as well as HT residential consumers in favor of gross metering. LT residential consumers can avail of either net or gross metering.
Andhra Pradesh[40]	March 2020	The proposed draft amendment to Solar Rooftop Policy 2018 - projects under net/gross metering to not exceed the di erence of pooled variable cost and balancing cost or the applicable tari at the time of commercial operation date (CoD), whichever is less.

All these factors point to the need for a policy environment that both encourages the private market as well as standardizes a meaningful role for DISCOMs to maintain their relevance and alleviate the threat of disintermediation.

4.3. IMPACT OF COVID-19 PANDEMIC

The slowdown in renewable capacity addition could get amplified post the COVID-19 outbreak, with the government's spending capabilities getting limited even further. In such a scenario, it becomes imperative for the government to move towards a more favorable policy environment for DRE.

4.3.1. EXECUTION AND SUPPLY CHAIN DISRUPTIONS

In May 2020, we conducted a survey of rooftop solar developers who are beneficiaries of the US-India Clean Energy Finance Program (USICEF), for which CPI serves as the Program Manager. This was done to assess the fallout from the COVID-19 lockdown and the possible repercussions over the coming year. The survey consisted of 20 questions – 18 objective/multiple choice and two subjective questions. The objective questions were designed to allow participants to report their qualitative opinions on a quantitative scale.

The COVID-19 outbreak had a negative impact on the balance sheets and liquidity status of respondents with the majority reporting an increase in receivables amounting to 20% and above.

During the lockdown, delays in government approvals, such as for net metering, created the biggest execution bottleneck, followed by labor shortages for construction.

At that time, the prospect of further partial lockdowns and/or reduced economic activity was a cause of significant concern for the respondents. A significant number of respondents felt this could reduce their sales pipeline/order book by 30% or more.

4.3.2. FINANCING CHALLENGES IN TERMS OF LENDER RISK AVERSION

In the above-mentioned survey, the lack of availability of working capital was a concern for those respondents that required capital. Respondents were also concerned that an increase in due diligence timelines of lenders due to fallouts from the pandemic could become a significant bottleneck to access loans. Respondents indicated that positive lender actions such as faster due-diligence and reduced interest rates would have a maximum positive benefit in mitigating financing challenges from COVID-19.

Getting markets to work in DRE.

DISCOMs have become wary of losing revenue from their highest paying residential and C&I customers and thereby have created strong resistance to RTS systems. The role of government policies should be to find a meaningful role of DISCOMs in existing net metering models – as a demand aggregator, as well as value added service provider for billing & collection.

The productive use appliance segment can be made more attractive for participants with the onset of Voluntary Emissions Reductions (VERs). With the phasing out of the Certified Emissions Reduction (CER) regime by 2020, buyers are emerging who want to mitigate their climate impact on a voluntary basis in order to meet their CSR initiatives, sustainable production targets, or for consumer branding. The qualitative aspects of a project, and the resulting depth, rather than just the scale, of the impact created, play a vital role in determining the price of these VERs. The extent to which buyers are willing to pay for attributes such as social impact, health, poverty reduction, climate conservation, play an important role in the realization of the price of these credits. The pricing in this market varies from USD 1 (for a large-scale sustainable energy project) to up to USD 20 (for a small scale clean cookstoves project), with the average price around USD 3-6/tCO2e, which is over 10-20x the average market price of CERs.[41]

5. RECOMMENDATIONS

In this section, we identify some key areas for policy action that could have a significant catalyzing e□ect on India's distributed energy sector.

5.1. ROOFTOP SOLAR

The GoI's Phase II grid-connected RTS scheme, which provides a central role to DISCOMs for disbursement of central government subsidy, is a step in the right direction. However, the program only covers the residential segment and links the fiscal incentives for DISCOMs to annual installed capacity, which would be di□cult to achieve unless the C&I segment is also considered. A more holistic demand aggregation model, which allows DISCOMs to get both a transaction fee for facilitating the installation as well as monthly fee for Operation & Maintenance (O&M) and billing /collection would better allow them to stay relevant and eliminate the threat of dis-intermediation.

5.2. ENERGY STORAGE

It is imperative for the government to promote a distributed energy-storage policy that can be integrated with the Phase II RTS scheme mentioned in the above section. The role of DISCOMs on the following matters needs to be detailed:

- Channel subsidy incentives for pilot projects with customers.
- Partnerships with private sector ESCOs to install storage at the distribution sub-station level.
- Gross/Net-metering benefits and/or other incentives to end-user (residential/commercial/industrial) for the integration of storage with RTS at the point of consumption.

Instead of promoting a capital-subsidy based model, it is imperative for the government to create a more favorable environment for operational models with the involvement of DISCOMs.

5.3. EV CHARGING INFRASTRUCTURE

While the aim to install charging infrastructure would be an important step towards further implementation of EVs, as well as incentivize private individuals to purchase EVs, the government policy needs to be directed towards creating the necessary charging infrastructure as a public good. Here, it is important to evolve a decentralized approach – with DISCOMs being the implementing agency for a franchise-based model. This would allow for faster execution in states that are in the more advanced adoption stage. In addition, allowing

commercial establishments that produce excess solar power from their rooftop installations to set up retail charging points would be a step in the right direction. This would also solve the DISCOM problem of receiving excess solar power export from such establishments that have resulted in a trend of curtailment.

5.4. SOLAR AGRI PUMPS

The GoI's KUSUM scheme currently has a centralized tendering process. Alternatively, allowing state DISCOM to partner with private installers at a local level could be considered. While the proposal for putting agricultural power subsidy under Direct Benefit Transfer (DBT) would be a positive step, convincing farmers to give up subsidized grid electricity as well as pay for the installation of the solar pump could be tough. To alleviate this, the government could think in terms of an operational model where DISCOMs could facilitate commercial partnerships with solar pump installers and local farmer co-operatives. The DISCOM, through the installer, could pool the excess power generated from solar pumps into a single point of injection into the grid and pay power purchase costs, net of service fees to the farmer co-operatives.

5.5. SOLAR COLD STORAGE

The GoI currently offers a 30% subsidy on solar cold storage installation under its broader rural livelihood subsidy scheme.[42] However, considering the importance of cold storage in the agriculture supply chain, it is vital to create a separate solar cold storage program.

India is the second-largest producer of fruits and vegetables in the world. However over 30% of this is wasted in the supply chain. Lack of reliable electricity in rural producer locations is one of the chief reasons for this wastage. Given the high capital costs (INR 200,000-400,000/unit or USD 2,500-5,500/unit),[43] and the fact that there are only a handful of solar cold storage manufacturers in India, a targeted policy could help to bring down these costs. In addition to the subsidy model, a tax-break model could be used to utilize reserves of cash-rich high net-worth individuals (HNIs). Providing additional tax breaks through accelerated depreciation could enable HNIs to make investments into solar cold storage installations.

5.6. PRODUCTIVE USE APPLIANCES

The government, along with United Nations Development Program (UNDP) and Global Environment Facility (GEF) has launched a scheme for "Scale Up of Access to Clean Energy for Rural Productive Uses" in three states: Assam, Madhya Pradesh, and Odisha. The project aims to demonstrate and develop the market for o□-grid renewable energy systems that have rural livelihood applications. Though this program is completely funded on a grant basis, its success would indicate if it can be scaled up commercially. In addition, the project is driven by state nodal agencies of MNRE. If this scheme is to be operationalized in a commercial manner, it becomes imperative for the government to involve DISCOMs and shift the focus of the grants from subsidizing product purchases to providing project development support

to entrepreneurs developing the products. Capital subsidy limits grant usage to the number of equipment /assets that it can fund, whereas project development support to entrepreneurs allows them to both defray technical assessment costs associated with commercial capital raising as well as develop commercially scalable business models that reduce cost of products for end-users. Involvement of local microfinance institutions (MFIs) as project lenders to private participants for the capital deployment could also be beneficial. DISCOMs would be incentivized to participate in such programs as rural customers have the highest cost-to-serve, and hence require direct Government subsidies and cross-subsidization through C&I customers, which severely impact DISCOMs' profitability.

5.7. SMART ENERGY MANAGEMENT

As a result of the COVID-19 outbreak, we expect to witness an increasing trend of social distancing and people working from home. This would entail a substantial increase in home energy consumption and higher electricity bills, which such people would not be accustomed to. Therefore, it is imperative to increase the use of home energy management devices to create a smart and energy-e□cient home. It would also be imperative for the government to create a policy to allow DISCOMs to shift to a time-of-day billing model to reduce their power procurement costs as well as defer capital expenditure on system upgradation.

Internet of things (IoT) based energy efficiency retrofits can attach to existing home circuits for monitoring and optimizing energy consumption. It has the potential to help households and small commercial establishments to reduce their energy bill and carbon footprint. It would also help DISCOMs to move towards a Time-of-Day billing as a part of their demand-side management.

6. CONCLUDING REMARKS

India has set a high and ambitious target of achieving 175 GW of renewable energy by 2022 and plans to scale it further to 450 GW by 2030.1 The interim target of 175 GW includes 100 GW of solar capacity addition out of which 40 GW is earmarked for RTS and OGS – which can play a key role in decarbonizing India's energy supply and increasing the reliability of energy in its underserved regions.[43] In addition, multiple other downstream applications are emerging – energy storage, EV charging, and rural non-farm productive use appliances – that will play a vital role in achieving India's sustainable energy targets in the coming decade

POLICY GAPS

While government policies have had a positive impact on greenhouse gas mitigation and job creation, over the last few years, DISCOMs , fueled in part by policy shifts,are increasingly resistant towards DRE. On top of this, the recent COVID-19 outbreak has created multiple execution and supply chain disruptions as well as financing challenges for DRE developers.

However, the market potential for DRE segments such as RTS and OGS and their multiple downstream applications – energy storage, EV charging, solar pumps, solar cold storage, and rural non-farm productive use appliances - remains large.

Government policy going forward should foster private market growth while providing a meaningful role for DISCOMs so that they stay relevant and do not feel the threat of disintermediation.

The commercial and industrial (C&I) segment in India consumes 51 percent of power in India, adding a large share to the DISCOM income. Due to the cross-subsidy model of power pricing, this segment bears the burden of the highest per-unit cost of power.

As a result, this segment has the highest tendency to adopt RTS and would benefit the most from favorable policy around future downstream applications such as behind-the-meter energy storage. A□uent residential consumers are the next most inelastic to power prices and would similarly benefit from falling prices and favorable policy around energy storage in the future.

Rural and agricultural segments pay the lowest power price but su□er the most from intermittent and low-quality supply of power. This leads them to incur indirect e□ects such as low quality of life for households and low quality of output for farmers. This segment would benefit the most from downstream applications of o□-grid solar (OGS). Targeted schemes, such as KUSUM for agricultural pumps, and conversion of power subsidy into DBT would help to alleviate losses for DISCOMs as well as improve the competitiveness of the agricultural/ rural sector and the quality of life of rural households.

FINANCING GAPS

The RTS industry is largely fragmented, with only a few players reaching a pan-India scale – these are mostly early entrants that were either backed by Indian corporate or foreign private capital. The remaining players are largely local installers, executing work orders for the larger players. The OGS market also remains small and fragmented, with limited interest from private capital and largely reliant on philanthropy or subsidized private funding.

However, over the last few years, the smaller RTS and OGS companies have been able to better develop their business models and are now in need of growth-stage funding. Information asymmetry, due to lack of project preparation and targeted transaction advisory, has been the primary cause of lack of access to capital.

Though impact investors have scaled up their operations over the last decade, participation among private capital owners such as family o□ces, high net-worth individuals, and corporates remains limited. With competing demands for capital from mainstream business models, such investors view DRE as less financially attractive. Blended finance instruments can potentially help to bridge this gap.

The nature of impact investors in India is quite close to that of commercial financial investors, with a focus on generating both market returns and development impact through investing in mature stage companies/projects. An opportunity exists to finance smaller and emerging companies in niche segments that have the potential to scale over the next few years.

Companies, after the startup and technology development stage, require further support in the form of seed capital and technical assistance/strategic advisory to move towards commercialization and to attract growth equity. Smaller RTS and OGS developers lack the required capabilities to navigate the entire credit appraisal process of lenders. This lack of expertise also reduces the probability of reaching financial close for small-sized firms.

In these circumstances, philanthropies have an important role in stimulating the DRE sector. The sector needs a combination of policy advocacy, knowledge dissemination, and catalytic finance.

DRE and its downstream applications o□er an opportunity to not only meet India's climate and energy access targets, but also provide attractive returns to financial investors. It also providers pathways for India to reduce import-dependence on crude oil as well as create economic growth and jobs in the long run. In addition, addressing existing policy and financing gaps would not only allow for better targeting and risk-hedging of government spending programs, but would also allow capital to be recycled e□ciently, thereby enhancing both the duration and magnitude of the impact.

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