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 off-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 inefficiencies 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 off-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.

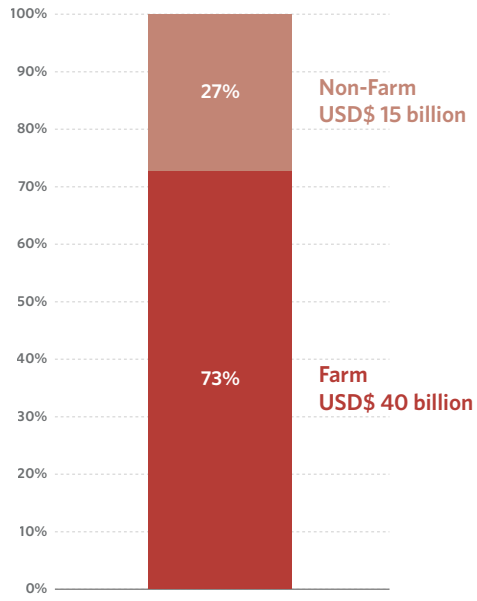
The cold chain & warehousing industry has one of the highest electricity costs per unit of production among all industries. Here, distributed solar and energy storage can play a critical role.

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)



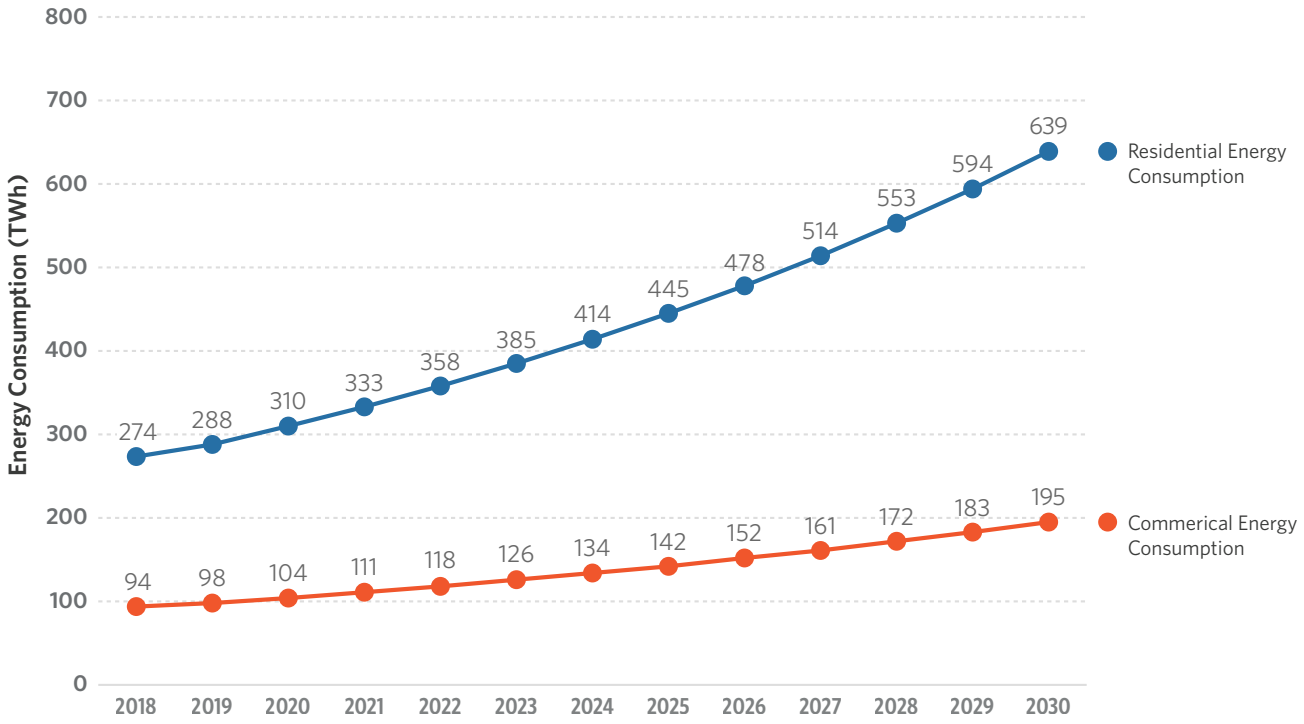
Source: CEEW report

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 efficiency codes. Efficiency 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 Efficiency 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 Efficiency 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 affordable electricity remains a challenge. DISCOMs continue to suffer 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.