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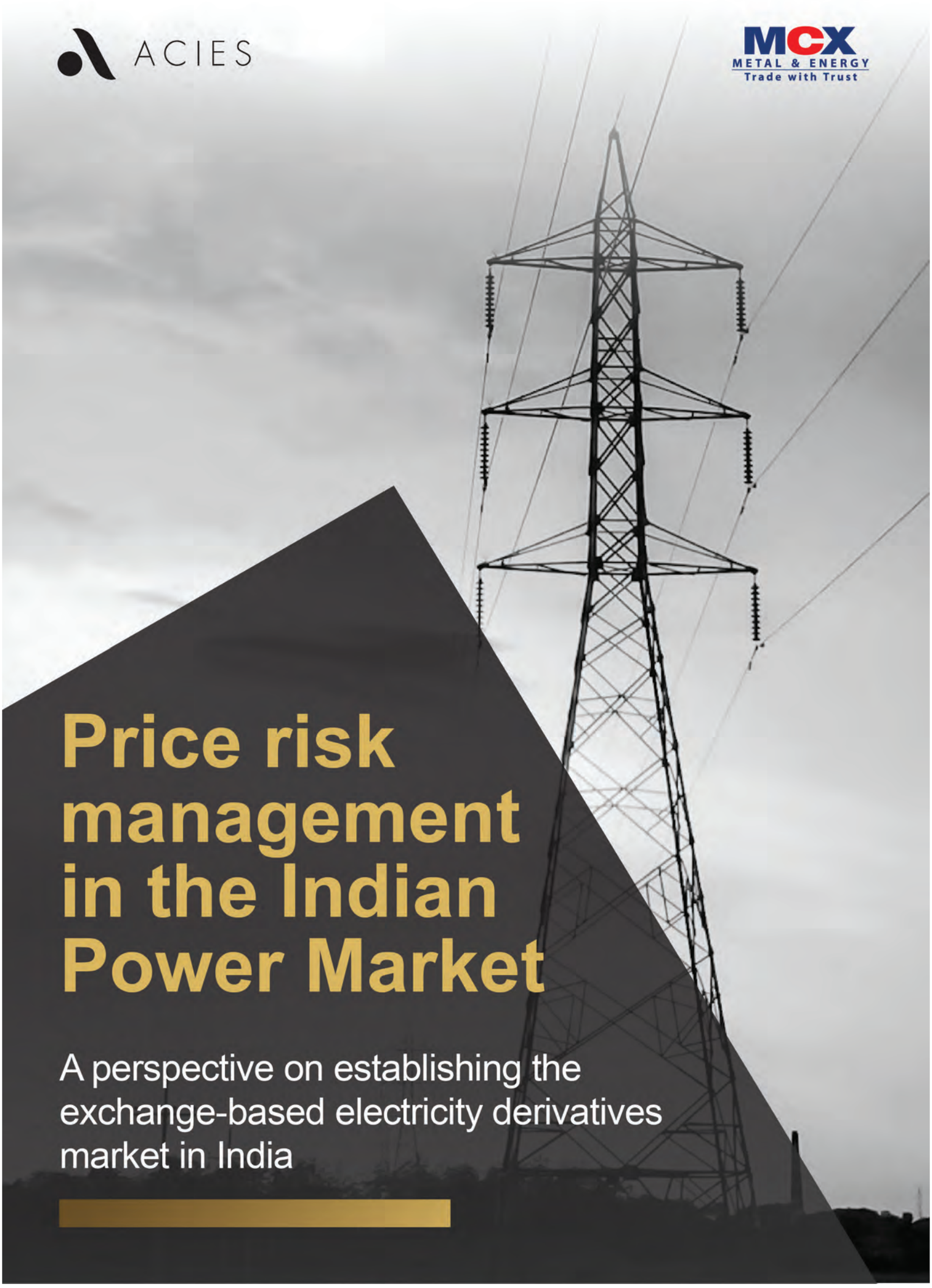

Price risk management in the Indian Power Market

A perspective on establishing the exchange-based electricity derivatives market in India



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01 Executive summary

India is today widely considered as the third largest power market in the world – having generated electricity of approximately 1,382 million Megawatt hours (or 1,382 Terawatt hours (TWh) or billion units (BU)) of electricity during the financial year 2020-21. While India was also primarily known to be a net-importer of electricity from neighboring countries, with the significant increase in installed generation capacity to meet most of the peak demand of the country, since 2016-17, India has moved from being a net-importer to a net-exporter of electricity.

There continues to be a growing demand for electricity in India, and the broad objective to address this growing demand has been to increase the installed capacity of power plants for generating electricity through different sources of energy, as well as move towards generating electricity less from thermal sources and more from renewable sources of energy over the next few decades - and the country has since been steadily increasing the installed capacity.

Over the last decade, approximately 89-90% of the total electricity generation has been procured from electricity generation companies (GENCOs) through long-term contracting arrangements – primarily in the form of long-term power purchase agreements (PPAs). The pricing under PPAs has been largely kept as fixed quantities with almost fixed prices with a less significant variable component portion of purchases. While on one side prices have been relatively fixed to a certain degree, on the other side, for distribution companies (DISCOMs), selling prices to retail, industrial and other end-consumers has been on a competitive basis. Therefore leading to several large DISCOMs having their revenues lesser than their cost of supply.

Since 2008, a steady and gradual shift is being observed in the Indian electricity market as more and more short-term transactions are being enabled through power exchanges. As on May 2021, approximately 85% of the short term transactions in the electricity market were undertaken through power exchanges and bilateral transactions with traders. DISCOMs today use the option of forgoing the variable component of their PPA by procuring electricity in the form of short-term exchange based transactions, primarily when the exchange traded price of electricity is lower than the variable component of their PPAs – to reduce their cost of supply.

In most large global power markets, there is a well-developed liquid and competitive power market comprising physical contracts and financial derivatives for electricity to help the various physical value chain market participants as well as traders to sell and buy power at competitive rates. In India today, approximately 5% of the Indian electricity transactions are traded on power exchanges, while in most large and organized global markets in Europe and other countries, trading of electricity on exchanges contributes to a higher amount of the total volume of electricity transactions.

Having a derivatives market for electricity often tends to help in lowering price volatility over time and having a strong and liquid derivatives market for electricity allows for better price discovery and transparency.

While power exchanges in India have provided some reprieve to certain large electricity buyers/ sellers to buy/ sell comparatively cheaper electricity, there is an absence of any financial instrument today that can be used as a risk management tool for protecting themselves against price fluctuations. As a result, they are forced to bear the impact of adverse price movements of electricity in their financial performance.

Having a derivatives market for electricity often tends to help in lowering price volatility over time and having a strong and liquid derivatives market for electricity allows for better price discovery and transparency. This in turn makes it attractive for physical value chain participants to engage in derivative instruments as part of their price risk management program to help both in mitigating the impact of price volatility on their profitability and serve as an avenue to optimize the cost of long term PPA contracts. The long-pending matter between SEBI and CERC regarding regulatory jurisdiction of Electricity Derivatives has finally got resolved with the Supreme Court favorably disposing of the matter in terms of the agreement reached upon by SEBI and CERC. A Joint Working Group between SEBI and CERC shall be constituted with Terms of Reference as agreed in the Report of the Committee. Based on the recommendations of the Committee both SEBI and CERC have come to an agreement that CERC will regulate all the physical delivery based forward contracts whereas the financial derivatives will be regulated by SEBI.

The success for any commodity derivatives market is based on continuously addressing and enhancing key drivers such as the availability of different financial instruments to suit the

risk profile and risk appetite of the market participants, ensuring simplicity in contract specifications, and enabling transparency in price discovery and settlement mechanisms. This also applies to the electricity derivatives market in India.

In certain global power markets, there are models of commodity exchanges providing a single platform for spot transactions with physical fulfilment of electricity as well as a marketplace for derivative transactions that can be financially/ cash settled – most notably, undertaken by the European Energy Exchange (EEX), one of the largest commodity exchanges for electricity. While on other hand, there are models for having a separate spot power exchange offering delivery of electricity and a separate commodity derivatives exchange offering electricity derivative instruments that are cash settled, such as the Intercontinental Exchange (ICE) and the Singapore Exchange (SGX).

In the Indian context, the second model shall operate upon the outcome of the Supreme Court settling the long drawn regulatory jurisdiction overlap. Henceforth, the Central Electricity Regulatory Commission ('CERC') shall regulate all physical delivery based spot and forward contracts whereas financial derivatives will be regulated by SEBI. IEX and PXIL are the two power exchanges currently handling physical delivery based contracts. Electricity derivatives (based on regulatory approvals) can be made available for trading on commodity derivative exchanges like the MCX.

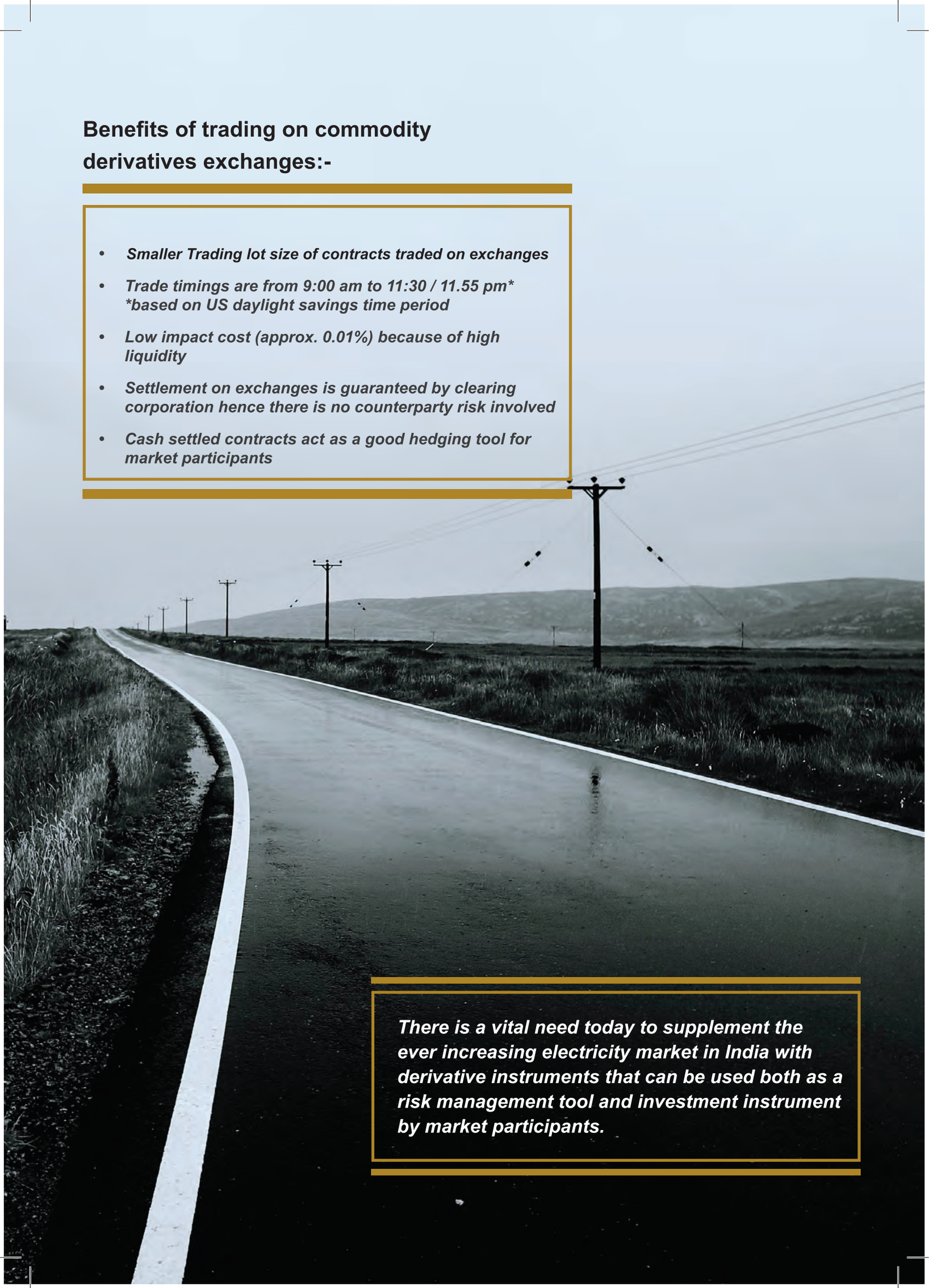
Most global commodity derivatives exchanges offer futures and options as the derivative instruments for electricity, that are linked to an underlying physical marketplace or exchange. Similarly in India, electricity derivatives shall have spot prices quoted in the physical exchanges as the underlying. As electricity derivative markets are an important avenue for companies seeking to hedge their underlying electricity exposures, enabling sufficient liquidity in the marketplace through market making and providing financing for undertaking derivative transactions, is equally important for the success of an electricity derivative market.

In conclusion, there is a vital need today to supplement the ever increasing electricity market in India with derivative instruments that can be used both as a risk management tool and investment instrument by market participants. The introduction of a derivatives market in India for electricity will further pave the way for India being perceived as an emerging power market to being an established global power marketplace.



Benefits of trading on commodity derivatives exchanges:-

- *Smaller Trading lot size of contracts traded on exchanges*
- *Trade timings are from 9:00 am to 11:30 / 11.55 pm* *based on US daylight savings time period*
- *Low impact cost (approx. 0.01%) because of high liquidity*
- *Settlement on exchanges is guaranteed by clearing corporation hence there is no counterparty risk involved*
- *Cash settled contracts act as a good hedging tool for market participants*



There is a vital need today to supplement the ever increasing electricity market in India with derivative instruments that can be used both as a risk management tool and investment instrument by market participants.

02 Introduction

India is the third largest power market in the world today

With over 388,134 Megawatts (MW)[1] (or 388 GW) (as on August 2021) of installed electricity generation capacity available through thermal, hydro, nuclear and renewable energy sources across the country, India's electricity generation in the financial year-ended March 31, 2021 amounted to 1,382 million Megawatt hours (or 1,382 Terawatt hours (TWh) or billion units (BU)) of electricity[2] - moreover less than 0.5% of total electricity generation was in the form of import.

As a result, India is the third largest power market (comprising electricity generation and consumption) in the world – attributing to approximately 5.5% of the global power market.

Only China and the United States of America (USA) have a larger power market than India – where along with Russia and Japan, the five countries contribute to approximately 58% of the global power market.

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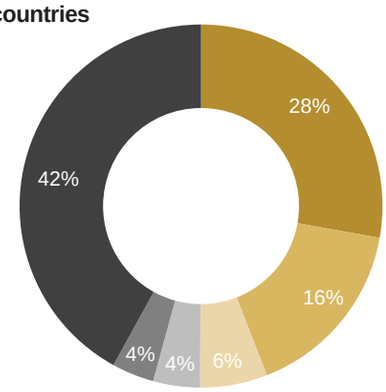
Figure 1 – Largest electricity generating countries

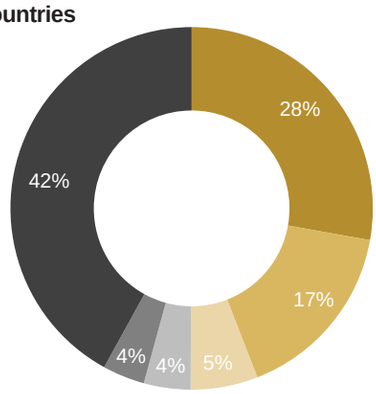


Global electricity production ~ 27,000 TwH

China USA India Russia
Japan Rest of world

Source: Enerdata Statistical Yearbook 2020/ BP Statistical Review of World Energy, 2019

Figure 2 – Largest electricity consuming countries



Global electricity production ~ 23,100 TwH

China USA India Russia
Japan Rest of world

Source: Enerdata Statistical Yearbook 2020/ BP Statistical Review of World Energy, 2019

The objective for the next decade is aimed at substantially increasing installed capacity through an optimal mix of energy sources

Power generation in India is obtained from conventional energy sources such as thermal (coal, lignite, natural gas, and oil), hydro and nuclear power plants and renewable energy sources (wind and solar).

To meet the growing demand for electricity in India, increasing the installed capacity of power plants for generating electricity through different sources of energy is vital for India - and the country has been steadily increasing the installed capacity. Since the last decade the capacity has increased from approximately 174 GW in 2010-11 to slightly over 388 GW as on August 2021. The continued increase in capacity has been supported by way of private sector involvement where, as on August 2021, private sector contribution to the installed capacity mix amounted to approximately 48% of India's total installed capacity.

Over the past decade, over 60% of India's installed electricity generation capacity mix has been driven by thermal power plants, providing over 75% of India's gross electricity generation.

[1] Source: CEA Growth of Electricity Sector in India from 1947 to 2020, October 2020
[2] Source: CERC Report on Short term Power Market in India: 2019-2020

Over the next decade, the Indian Government aims to increase its installed capacity from over 370 GW to over 840 GW with over 50% of the total installed capacity from renewable energy sources.

Additionally, the institution of energy storage systems like pump and battery storage will be essential technologies for preserving and distributing excess electricity over different time horizons[3].

Growth in electricity requirement expected to nearly double in the next decade

Over the past 12 years, the growth in electricity demand grew by over 50% from 831 million MWh (or 831 TWh) in 2009-10 to 1,276 million MWh (or 1,276 TWh) in 2020-21.

During this period, India has been able to successfully increase the supply of electricity through the increased installed capacity, to reduce the shortage of supply of electricity to meet overall and peak electricity demand from approximately 10% in 2010-11 to under 0.5% in 2020-21.

In 2020, the Indian power sector and demand for electricity was significantly impacted by the global CoVID-19 pandemic. Upon the introduction of the national lockdown in March 2020, as reported by the International Energy Agency (IEA), electricity demand relative to the same period in 2019 fell by 28%.

From May 2020, the demand recovered and were reaching the 2019 levels in August 2020 and then showed year-on-year growth by October 2020. A rebound on increased electricity demand is being witnessed in 2021 already as shown in Figure 4 above.

[3] Source: CEA Report on Optimal Generation Mix for 2029-30, January 2020

Figure 3 – Projected installed capacity mix (in GW) by source

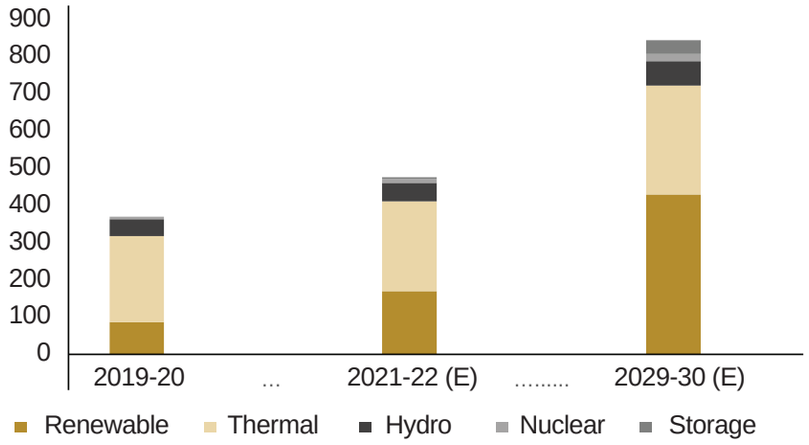
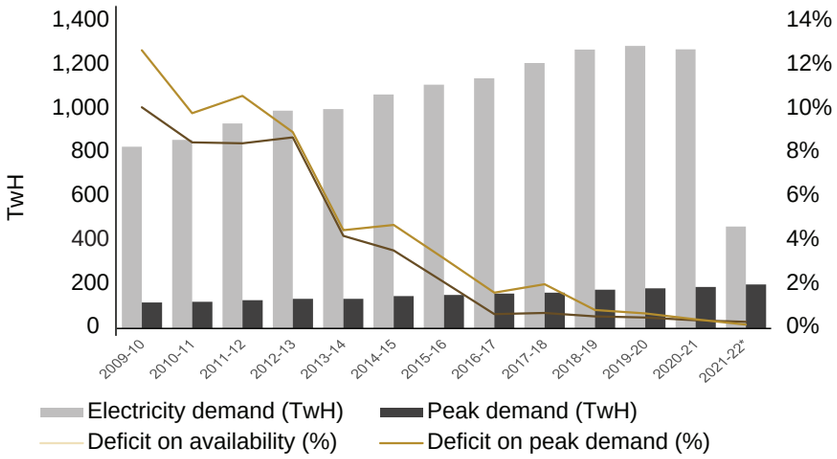
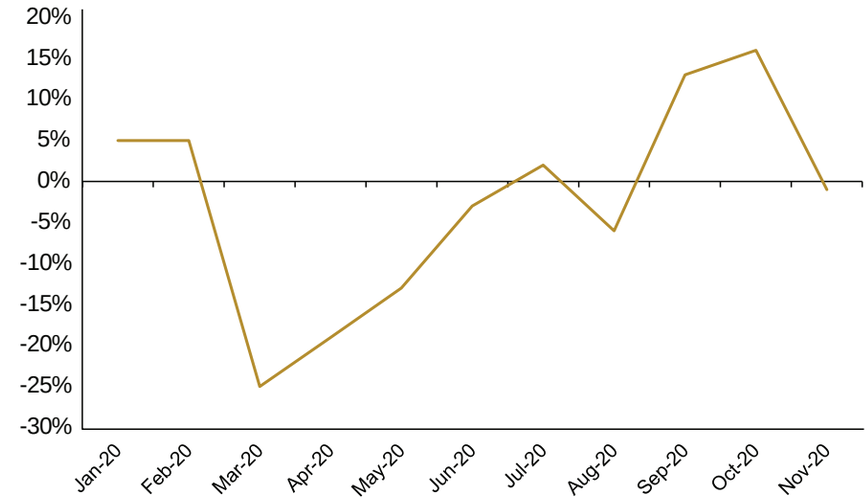


Figure 4 – Electricity demand and deficit (including peak)



Source: CEA Report (refer Footnote 3)

Figure 5 – 2020 year- on-year change in electricity demand



Source: IEA – Electricity Market Report 2020

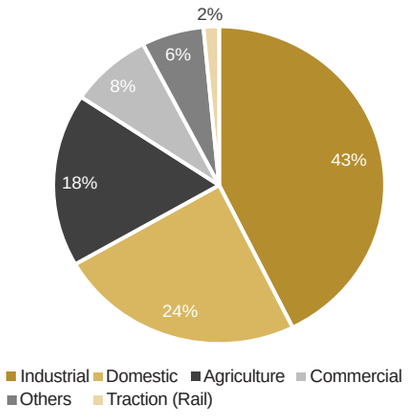
As the rebound in demand for electricity since late 2020 affirms the increasing dependency of electricity as a source of power by different consumer groups, over the next decade, as per the 19th Electric Power Supply (EPS) report published by the CEA, electricity requirement is forecasted to almost double from 1,291 million MWh in 2019-20 to 2,325 million MWh by 2029-30 with peak demand increasing from 183.80 million MWh to approximately 340 million MWh for the same period.

Industrial businesses are the largest consumers of electricity in India

In 2019-20, approximately 1,291.10 million MWh of electricity was consumed in India, primarily by the industrial (manufacturing companies), domestic (rural, semi-urban and urban households) and agricultural sectors.

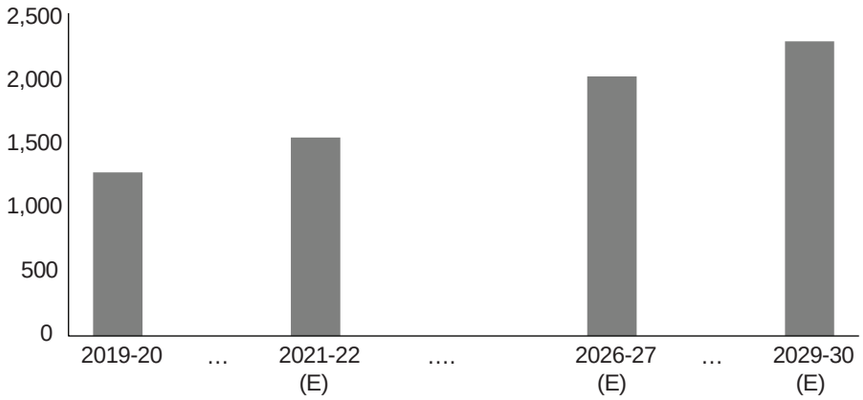
Approximately 43% of the above total electricity consumed in India is from the industrial sector – comprising manufacturing and service companies. The primary purpose for electricity is to act as a source of power and fuel for purposes ranging from powering their production process for manufacturing companies to ensuring network and server up-times for services companies, respectively.

Figure 7 – Consumption of electricity by consumer type (2019-20)



Source: CEA Report (refer Footnote 3)

Figure 6 – Electricity demand projections for the next decade (in TWh)



Source: CERC Annual Report: 2019-20 and CEA Optimal Generation Mix for 2029-30

Other large consumer sectors include the domestic household sector (including rural, semi-urban and urban households) and the agricultural sector (primarily for farming and irrigation purposes), respectively.

Power and fuel costs play a significant impact to the profitability of the businesses in certain industries within the industrial sector.

Many large producer and processor companies that are consumers of electricity have a high electricity demand of 1MW and higher and tend to manage and optimize their power and fuel costs through captive power plants which typically use steam or diesel as the source of energy.

Figure 8 – Power and fuel cost significance to select sectors

Select industry sectors	Power & fuel as a % of revenue
Communication services	38%
Materials	17%
Industrials	14%
Consumer discretionary	11%

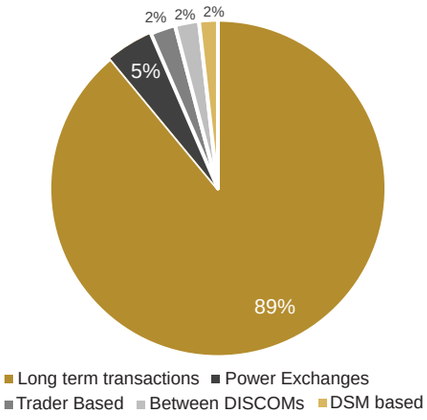
Source: IEX – Investor Presentation, Q3 FY-20

Industrial consumers often pay higher tariffs on account of rising cost of supply for DISCOMs and subsidized tariffs paid by other consumers

Supply of electricity to consumers is undertaken by distribution companies (DISCOMs) where state DISCOMs and State Electricity Boards (SEBs) own and manage most of the distribution in the electricity supply chain.

Over the last decade, approximately 89-90% of the total electricity generation has been procured by DISCOMs through long-term contracting arrangements – primarily in the form of long-term power purchase agreements (PPAs). PPAs are usually undertaken by the central and state electricity generating companies with distribution companies (DISCOMs), often for a tenor greater than 7-10 years.

Figure 9 – Share of different electricity transactions (2019-20)



Source: CERC Annual Report 2019-20

Typically, for DISCOMs, the PPAs with thermal power generators bear a two-part tariff arrangement which comprises a fixed component of the tariff which has to be paid regardless of actual procurement of power and a variable component which has to be paid upon only upon procuring certain quantity of power under the PPA

As on 2019-20, the tariff on procurement from central power plants for example ranged from INR 2,010/ MWh to INR 8,460/ MWh, which is based on the type of power plant from where the power is supplied (hydro stations are the most expensive while coal-based stations are the lowest) and the terms agreed as per the PPA. The cost of supply from state power utilities for DISCOMs has been steadily increasing where, as on 2018-19, the average cost of supply for DISCOMs was approximately INR 6,090 per MWh.

The cost of supply borne by the DISCOMs are typically not passed through to agriculture and domestic consumers where its sold below cost or at subsidized rates - which is then further managed by over-charging industrial and commercial consumers to manage the revenue and earnings of the DISCOM. As of today, the average MCP day-ahead market clearing price quoted in the physical exchanges is approximately INR 3,760/ MWh.

Power exchanges today have paved the way for enhancing the market infrastructure for electricity transactions

Since 2008, a steady and gradual shift is being observed in the Indian electricity market as more and more short-term transactions are being enabled through power exchanges. As of May 2021, approximately 85% of the short term transactions in the electricity market are undertaken through power exchanges and bilateral transactions with traders.

Power exchanges have so far improved the price discovery in spot and day and time ahead basis and have enabled a more efficient marketplace powered by technology. In 2020, the real time power market was launched, which enabled providing corrections an hour ahead for intermittent and variable generation such as solar and wind. As reported in the CERC Monthly Report on Short Term Transactions of Electricity in India, May 2021, the weighted average price of transactions effected through bilateral arrangements with traders was approximately INR 3.27/kWH (approximately INR 3,270/ MWh) and for transactions effected through power exchanges in the day-ahead market was approximately INR 2.90/ kWH (approximately INR 2,900/ MWh).

Subsequently, the IEX launched the ‘Green Term Ahead Market’ where, as per current market rates, green electricity is traded at a premium (compared to the regular day-ahead market) at INR 4,900/ MWh for clients looking to fulfil their Renewables Purchase Obligations (RPO) through market purchases.

Having a derivatives market for electricity enables a better organization of the Indian power market as maintained in large global power markets

In most large global power markets, there is a well-developed liquid and competitive power market comprising physical contracts and financial derivatives for electricity to help the various physical value chain market participants and traders to sell and buy power at competitive rates. As indicated in Figure 9, approximately 5% of the Indian electricity transactions are currently traded on IEX and PXIL respectively, while in most large and organized global markets in Europe and other countries, trading of electricity on exchanges contributes to around 50% of the electricity transactions.

Presently, the Indian spot electricity market, while trading at lower prices than long-term PPA contracts, continues to show high volatility in price movements. Having a derivatives market for electricity often tends to help in lowering price volatility over time and having a strong and liquid derivatives market for electricity allows for better price discovery and transparency. This in turns makes it attractive for physical value chain participants to engage in derivative instruments as part of their price risk management program to help both in mitigating the impact of price volatility on their profitability and serve as an avenue to optimize the cost of long term PPA contracts.

In July 2020, the Ministry of Power (MoP) permitted the introduction of the electricity derivatives market so as to allow electricity to be traded as other energy commodities like oil and natural gas with financial derivatives on commodity exchanges – along with an expected separation between the physical and financial markets for electricity on different exchanges. Subsequently, in the month of October 2021, the Supreme Court of India affirmed the role of the Securities and Exchange Board of India (‘SEBI’) as the regulator for financial derivatives for electricity.

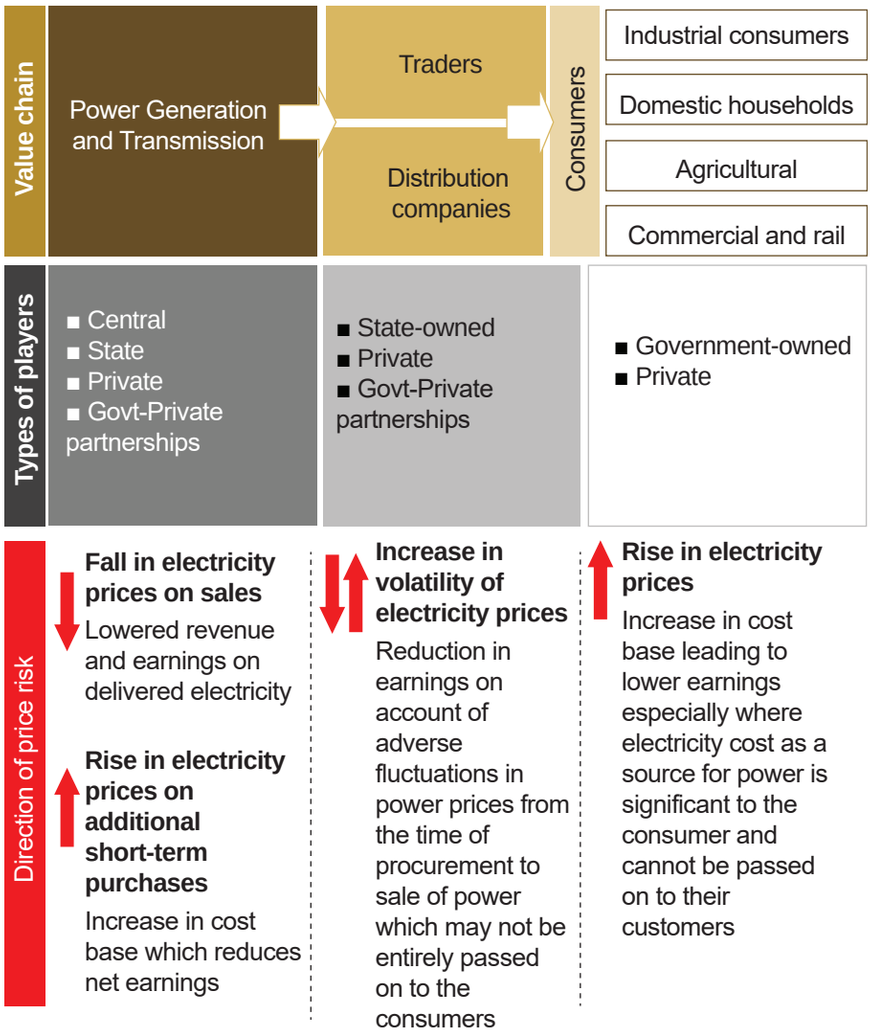
As a result, with the afore-mentioned Supreme Court verdict, the long-awaited introduction of a derivatives market in India for electricity will help in paving the way for India from being perceived as an emerging power market to being an established global power marketplace.

03 Financial instruments for managing electricity price risk

The impact of adverse price movements in electricity on physical value chain players

Price volatility and adverse price movements in electricity impacts any company's profitability either on its revenue stream or cost base based on where they are based in the physical value chain as given below:

Figure 10 – Typical physical value chain for electricity



The importance of financial instruments for electricity to manage price risk

Financial instruments in an electricity derivatives market provide several advantages across the physical value chain such as the following:

For a GENCO

- Where sale of electricity occurs in the spot power exchanges, financial instruments can be used to protect against a fall in electricity prices at the time of delivery of electricity to DISCOMs and traders.
- Alternatively, where a GENCO seeks to purchase additional power from the spot power exchanges, financial instruments can be used to protect against a rise in electricity prices at the time of obtaining delivery of the secondary market electricity.

For a DISCOM

- Where electricity is purchased through a PPA contract or buying short term from spot power exchanges, financial instruments can be used to protect the rise or fall of electricity prices based on the stage of delivery from the GENCO or distribution to the end consumers.
- Financial instruments also may help in minimizing the difference between the cost of supply from GENCOs and the average billing rate charged to the customers.

For End Consumers

- Financial instruments can be used to optimize the cost of purchase of electricity from a DISCOM, especially at times in rising electricity prices – which in turn helps in stabilizing the cost of operations and its impact on the profitability of the consumer company.

As electricity derivative markets are an important avenue for companies seeking to hedge their underlying electricity exposures, enabling sufficient liquidity in the marketplace, sometimes through market making and providing financing for undertaking derivative transactions is equally important for the success of an electricity derivative market.

Hence, the involvement of financial institutions is essential given the various methods for accessing the derivatives market such as:

- Broker-dealer services on the derivatives exchange for retail and corporate clients where approved by regulations.
- Advisory services to corporate and retail clients for considering electricity derivative contracts for risk management or investment purposes, and
- Providing financing for market participants to participate in the electricity derivatives market

Similarly, such derivative instruments also serve as a trading and investment portfolio diversification opportunity for high net-worth retail individuals and professional investors – which also aid in improving the liquidity of the electricity derivatives market.

Typical electricity derivative instruments offered by commodity exchanges

Most commodity derivatives exchanges offer futures, options and in some cases commodity swaps for the particular commodity, based on the assessment of the need, liquidity, transparency in price discovery and settlement mechanisms.

In India, typically futures and options are offered by commodity derivatives exchanges. For example, for crude oil, the MCX offers futures and options contracts, which are highly efficient and liquid contracts.

Most global commodity derivatives exchanges offer futures and options for electricity, that are linked to an underlying physical marketplace which may bear additional pricing-specifications relating to the base load, peak load, spread between physical markets and other parameters.

The following explains how each derivative instrument works in terms of pay-off structures with relevant examples on how it is used as a hedging instrument:

1. Electricity futures

A future is a standardized contract where all terms associated with the transaction have been defined in advance, leaving price as the only remaining point of negotiation or determination in the marketplace.

The major difference between a forward and a future is that in case of a forward, these become bilateral contracts that can be customized in a way agreeable between the buyer and seller of the contract, which is undertaken in the OTC market. However, there continues to be credit risk exposure in the transaction between the two parties. Futures contracts help in eliminating credit risk exposure between the two parties as the commodity exchange effectively ensures settlement of the transaction. Moreover, as futures contracts are standardized even with respect to quantity of electricity per contract, this helps make price discovery and settlement transparent because no correction for quality is needed to compare different contracts.

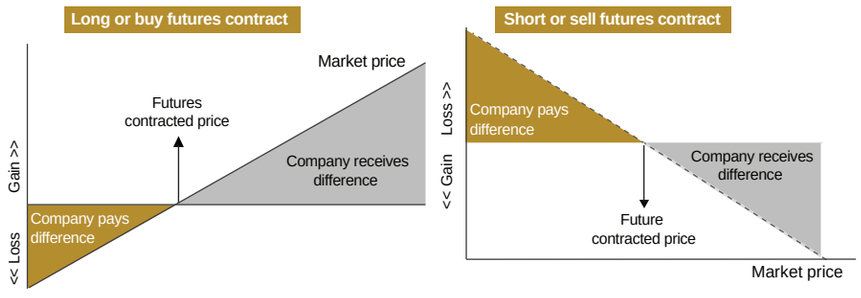
The settlement methodology specified in the contract specifications showcases transparency in the approach for arriving at the settlement rate covering both the commodity price reference and the currency rate reference (if the benchmark commodity price is quoted in a currency that is not in the functional currency of the country of the commodity exchange).

Electricity futures can be financially or physically settled based on the offerings of the commodity exchange. Typically, where physical exchanges are separated from commodity derivative exchanges for electricity, such futures contracts are cash or financially settled.

A typical pay-off structure for a futures contract is as follows:

A typical pay-off structure for a futures contract is as follows:

Figure 11 – Pay-off structure of a typical futures contract





An example of how electricity futures can be used in the price risk management framework:

Illustration 1

A consumer has entered into contract with a DISCOM for procurement of electricity where billing occurs on a monthly basis based on fixed charges and slab rates that are based on the amount of electricity consumption for the month. Let's assume that the estimated billing rate is INR 5,000/ MWh for 10 MW consumed for the month. It implies that the consumer is required to pay INR 50,000 for the month.

- Price per MWh to be paid to the DISCOM = INR 5,000/ MWh
- Settlement gain of futures contract = INR 4,500/ MWh – INR 3,000/ MWh = INR 1,500/ MWh
- Payment to DISCOM for the month (1) = INR 5,000/ MWh * 10 MWh = INR 50,000
- Gain earned from futures contract (2) = INR 1,500/ MWh * 10 MWh = INR 15,000
- Net payment for consumption of 10 MWh of electricity (1 – 2) = INR 35,000

In summary,

Illustration 2

Another example of how electricity futures can be used in the price risk management framework:

A DISCOM plans in January 2021 to purchase 50MWh of electricity from the physical exchange in the day-ahead market (DAM) for delivery in March 2021. The spot price at the time of planning in January 2021 is INR 2,000/ MWh and the future price for delivery in March 2021 is at INR 3,500/ MWh

Illustration 1: In summary		
S. no	**Particulars**	**Calculations**
	Physical exposure	
1	Quantity consumed (in MW) for the month	10 MW
2	Billing rate charged by DISCOM (in INR/ MWh) for the month	5,000/ MWh
3	Total amount due (in INR) at month-end = 1 x 2	INR 50,000
	Hedging approach	
3	Spot price at market at start of the month (in INR/ MWh)	2,500/ MWh
4	One-month futures price quoted in the market (in INR/ MWh)	3,000/ MWh
5	Contract size typically offered by commodity exchange (in MW)	1 MW
6	Contracts undertaken to hedge price risk (in numbers)	10
7	Total hedge position (in MW)	10 MW
8	Hedge ratio (7/1) (in %)	100%
	Settlement of physical exposure and hedges	
9	Amount to be paid to DISCOM (from 3) (in INR)	INR 50,000
10	Spot price at month-end (in INR/ MWh)	4,500/ MWh
11	Settlement gain/ (loss) = (Settlement rate (10) – Hedge rate (4)) x total hedge position (7) = (4,500-3,000) x 10 (in INR)	INR 15,000
12	Net position after settlement of hedges = (9) – (11)	INR 35,000

During the period, let's assume that the spot-price at the start of the month is INR 2,500/ MWh and the future price at the start of the month for a one-month futures contract is trading at INR 3,000/ MWh. Therefore, the consumer can buy futures contract amounting to 10 MW at INR 3/ MWh at the start of the month for settlement at the end of the month. Let's assume that the spot price at the end of the month is INR 4,500/ MWh. As a result, the futures contract is 'sold' or 'squared off' at INR 4,500/ MWh and the pay-off considering no transaction cost will be as follows for the consumer:

As a result, the consumer is able to reduce its month's electricity consumption cost by 30% by entering into a futures contract, which further benefits its profitability for the month.

However, if the spot price at the end of the month is lower than INR 3,000/ MWh, the consumer will face a loss in their futures contract and end up bearing more than just INR 50,000 of payment.

The DISCOM buys a future contract in January 2021 for expiry March 2021 at INR 3,500 MWh. In the month of March 2021, the DISCOM buys from 50 MW from the spot market (DAM) from the physical exchange at INR 4,000/ MWh and sells 50 MW to consumers at an average billing rate charged at INR 3,500/MWh. The futures contract undertaken in January 2021 is 'settled' at INR 4,000/ KWh. As a result, the following will be the cash flows experienced by the DISCOM in the month of March 2021.

- Purchase of electricity from the spot (DAM) market (1) = INR 4,000/ MWh

- Average billing rate sold to customers (2) = INR 3,500/ MWh
- Expected loss on earnings in an unhedged scenario (3) = INR (500)/ MWh
- Gain earned from futures contract (4) = INR (4,000 (spot price) – 3,500 (futures contract) = INR 500/MWh
- Net gain/ loss on earnings in a hedging scenario (3 + 4) = INR 0/ MWh

As a result, the DISCOM was able to lower its loss of INR 500/ MWh on selling electricity to consumers to becoming a no-profit-no-loss result on its earnings for the month of March 2021.

However, if the spot price at the end of the month is lower than INR 3,500/ MWh with no change in the average billing rate, any earnings obtained from an unhedged scenario would have been further reduced or may lead to the DISCOM bearing a net-loss for the month on settlement of the futures contracts.

Illustration 2: In summary

S.no.	Particulars	Calculations
	Physical exposure	
1	Quantity to purchase (in MW)	50 MW
2	Spot price in day-ahead market in March 2021 (in INR/ MWh)	4,000/ MWh
3	Average billing rate to customers in March 2021 (in INR/ MWh)	3,500/ MWh
4	Revenue loss experienced = (3 – 2) (in INR/ MWh)	(500)/ MWh
	Hedging approach	
5	Spot price at market in January (in INR/ MWh)	2,000/ MWh
6	Two-month futures price quoted in the market (in INR/ MWh)	3,500/ MWh
7	Contract size typically offered by commodity exchange (in MWh)	1 MW
8	Contracts undertaken to hedge price risk (in numbers)	50
9	Total hedge position (in MW)	50 MW
10	Hedge ratio (9/1) (in %)	100%
	Settlement of physical exposure and hedges	
11	Spot price at month-end (in INR/ MWh)	4,000/ MWh
12	Settlement gain/ (loss) = (Settlement rate (11) – Hedge rate (6)) (in INR/ MWh)	500/ MWh
13	Net position after settlement of hedges = (10) + (4) (in INR/ MWh)	0/ MWh

2. Electricity options

An option is a derivative contract which gives the buyer (the owner or holder of the option) the right, but not the obligation, to buy or sell an underlying. For owning this right, the option holder pays a cost (called 'option premium') to the seller of this right. The seller (writer) of option, on the other hand, bears the obligation to honor the contract should the buyer choose to exercise the option. Typically exercising of options may be based on the option being either an American option, where the right to exercise can be undertaken anytime during the life of the contract or a European option, where the right to exercise can only be undertaken upon the expiry of the option contract.

There are two types of options: a put option and a call option.

- **Call options:** It gives buyer the right to buy the underlying but not the obligation. Typically, buyers of call options expect prices to rise from the current price levels at a future date (or expiry date).
- **Put options:** It gives buyer the right to sell the underlying but not the obligation. Typically, buyers of put options expect prices to fall from the current price levels at a future date (or expiry date).

The buyer of an option goes 'long' on an option while the seller of an option goes 'short'. If the buyer chooses to exercise the right to buy, then on the date of expiry, the options contract converts into the futures contract. A buyer of an option will only execute the right when there is intrinsic value; that is, the strike price is lower or higher than the prevailing price of the commodity futures contract based on the type of option (i.e., call or put) entered by the buyer.

Option contracts may be undertaken through the over-the-counter market or where standardized, can be undertaken through a commodity exchange.

A typical pay-off structure for a buyer of a call or put option is follows on next page:

Here the break-even price is the sum of the strike price, the option premium cost and any other transactional charges applicable for entering into the option. Therefore, the movement from the strike price to the break-even price indicates a diminishing loss borne by the buyer of the option.

The seller of a call or a put option provides a reverse of the pay-off structure as depicted above.

Illustration 3

An example of how electricity options can used in the price risk management framework is provided below:

In January 2021, a GENCO plans to sell 100 MW of electricity in the physical exchange day-ahead (spot) market for delivery period June 2021. The spot price at the time of planning is INR 5/ KWh with indications in the forward market that the price is forecasted to decrease to INR 3/ KWh in June 2021, however showing varying price volatility.

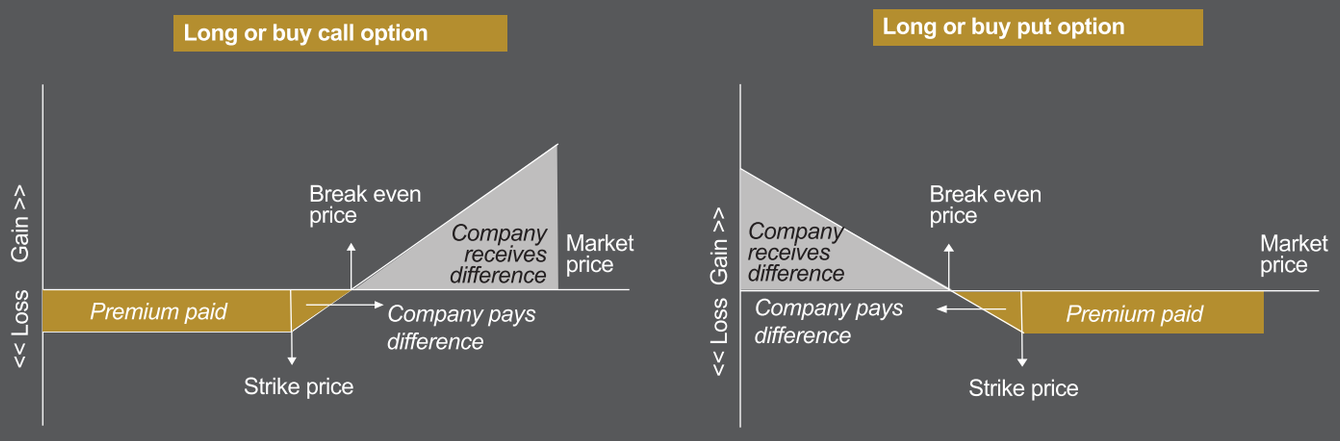
The GENCO decides to buy a put option for strike price INR 3.5 KWh and bears a premium of INR 0.25/KWh – with no other transactional costs on the option contract, it implies that the break-even price for the GENCO to realize a gain on the put option is for the spot price to be lower than INR 3.75 KWh. In the month of June 2021, the GENCO sells 100 MW of electricity in the day-ahead market for INR 4/KWh indicating a decrease by only INR 1/ KWh from January 2021 to June 2021. With the spot price being higher than the strike price, the loss borne by the GENCO is limited to only the premium of INR 0.25/ KWh paid at the time of entering into option contract.

Had the GENCO taken a short position on the futures contract for the same price, the loss borne by the GENCO would have been INR 0.5/KWh (INR 3.5/ KWh futures price – INR 4/ KWh spot price). As a result, while obtaining a relatively higher realization of sales compared to estimated, the GENCO's net earnings was only impacted by the premium paid on the option contract.

Option contracts are therefore considered to be a cheaper derivative instrument compared to futures contract. However, as options do not have a linear pay-off structure compared to futures contract, where the underlying exposure's impact on price movement is also linear, futures contract are typically considered to be the preferred derivative instrument.

An electricity spread future is a standardized contract where all terms associated with the transaction have been defined in advance, leaving the difference in prices quoted between two location points or two physical markets as the only remaining point of negotiation. These contracts are suitable for participants either for trading purposes or only where there are business operations occurring in those specific locations having different price discovery mechanisms.

Figure 12 – Pay-off structure of a typical long-call and long-put option contract



04 Key aspects to be considered while undertaking electricity price risk management

In India, electricity futures are expected to link to the spot prices quoted in the physical exchanges and be cash settled. Electricity options meanwhile are expected to be linked to an electricity futures offered by the commodity derivatives exchange. While both futures and options are preferred risk management instruments, it is essential that when a company is planning as part of the price risk management framework to enter into derivative contracts for hedging purposes, the following are evaluated prior to undertaking such transactions:

- Recognition of firm forecasted/ actual purchases/ sales that are exposed to electricity price movements to be considered as ‘exposures’
- Direction of price risk emanating from the underlying exposure/s (i.e., buyers of electricity face price risk on the rise of electricity prices and vice-versa for sellers of electricity)
- Monitoring of spot price movements and price influencing signals (supply/ demand, macro-economic factors, environmental factors, and other event-based triggers that may impact the price of electricity)
- Selection of the appropriate derivative instrument based on the cost of hedging and fitment as a hedging instrument to the underlying exposure
- Evaluation of future prices to assess contango (future price > spot price) or backwardation (future price < spot price) at the time of assessment
- Target ‘hedge ratio’ (i.e., total value of hedged amount / total value of underlying exposure) acceptable based on ‘risk appetite’ (i.e., the extent of unhedged amount of exposure that is acceptable by the company to be exposed to adverse price movements that the bottom-line of the company can withstand



05 Understanding global electricity derivative markets

Derivative markets for electricity are typically separated from the physical market – where price discovery of the derivative instruments are typically linked to the physical marketplaces.

Most physical power markets can be classified as one of the below:

- Power pool or centralized market
- Bilateral contract or exchange based model

Power pool or centralized market

In a power pool or centralized market, electricity generation companies offer price and quantity pairs for the supply of electricity to the distribution companies. Bids and offers are matched in the market clearing process and result in a commitment to procure and deliver the matched volumes.

Bilateral contract or exchange based model

Alternative to the power pool market, physical bilateral contracts act as a market mechanism based model i.e., where the buyers and sellers of electricity can enter into bilateral contracts for power supply. Typically, sellers will be electricity generating companies and buyers will be distribution companies or DISCOMs. Electricity generating companies may also be buyers at times where there is a shortage of generation from their plants.

Bilateral contracts may also include brokers that act as an intermediary between the buyer and seller dealing in standardized contracts. Typically, these types of contracts are executed on an over-the-counter (OTC) basis. As an alternative to bilateral contracts, a power exchange acts as the standard market operator for undertaking buying and selling of power through a single platform. When compared to bilateral contracts, typically there may not be differences between contracted and actual volumes and as a result settlement of imbalances is relatively limited.

Contract-for-Difference (CfD)

A contract for differences (CfD) is an agreement, like a swap, to exchange the opening and closing prices of some tradable asset.

In power markets, a CfD is a bilateral agreement in which one party gets a fixed price for electric energy (the strike price) plus an adjustment to cover the difference between the strike price and the spot price. This adjustment may be a positive or negative number.

Operating the physical and derivative markets for electricity may either be done by separate commodity or power exchanges, government-appointed power agencies/ departments or by the same commodity exchange, as explained in this section.

US Spot Market and CME Group – NYMEX Division

Nymex offers hundreds of financially-settled U.S. electric power futures contracts as well as UK and continental European power contracts, which bring all the benefits of exchange transparency and clearing. The electricity futures provides an important advantage in speed, price dissemination and margin collateral offsets for customers to navigate power markets. There are multiple regional transmission organization (RTOs) in US markets. Leading ones being Pennsylvania, Jersey, Maryland Power Pool PJM, New York Independent System Operator (NYISO), California Independent System Operator (CASIO). PJM, NYISO Peak and Off peak contracts are some of their types.

The Nord Pool Market in Europe

The Nordic countries deregulated their power markets in the early 1990s and brought their individual markets together into a common Nordic market – called the ‘Nord Pool’. Estonia, Latvia, and Lithuania deregulated their power markets, and joined the Nord Pool market in 2010-2013. As a result, this introduced a concept of a free competitive market without the involvement of the state.

Today the Nord Pool covers large parts of Europe and the market is relatively liquid having large volumes traded daily with a secure mode of supply of power to the consumer.

The Nord Pool also offers financial derivative contracts that are used for price hedging and risk management. The contracts have a time horizon up to ten years, covering daily, weekly, monthly, quarterly, and annual contracts. There is no physical delivery for these financial contracts. Cash settlement takes place throughout trading – and/ or the delivery period, starting at the due date of each contract, depending on the derivative contract being a futures contract. Clearing and settlement operations are undertaken by a wholly-owned subsidiary – the Nordic Electricity Clearing House ASA.



As a result, the Nord Pool has evolved from a power pool market to an integrated power exchange market by being the primary marketplace between the buyers and sellers for supply of power. Approximately 85% of the total Nordic electricity consumption is undertaken through the Nord Pool spot market[4]. Their derivatives are listed and traded on ICE Exchange and European Energy Exchange (EEX).

European Energy Exchange (EEX)[5]

EEX is a leading exchange platform in the European power market offers trading in power derivatives for Euro (€) denominated cash-settled futures contracts for 20 European power markets across Europe. The EEX also maintains a Spot Market and also offers a Physical Fulfilment Service to allow participants to enter bids in the corresponding EPEX SPOT day-ahead auction according to the participants' respective position in an EEX power futures product.

In 2017, the EEX Group acquired the USA-based Nodal Exchange, a derivatives exchange providing price, credit, and liquidity risk management to participants in the North American commodities markets to also extend their access for providing power futures and other derivative products to the North American region.

The EEX offers power futures which are cash settled futures contract that derive value from the underlying day-ahead market of a specific European power market. For example: the EEX German Power Future, one of the most liquid contract for European power, has the pricing linked to the underlying day-ahead price for the market area, which contains the AMPRION control zone, which is equivalent to standard terms in bilateral agreements. The standard delivery rate for a typical EEX German Power Future is 1MW with a tick size of € 0.01 per MWh – with maturities ranging from 34 days to 6 months to 6 years.

The EEX also offers Power Future Spread products, which are essentially location spread products for trading price differences between different EEX markets. Like above, these future contracts are also financially settled.

In 2020, the EEX launched its trade registration services for Japanese power futures on the EEX European platform which also will comprise clearing of trades for weekly, monthly, quarterly, seasonal, and annual delivery periods up to six years in advance.

2020 witnessed a 10% growth in the overall volume of power trading in the EEX platform to approximately 7,078 TWh across the spot and derivatives market of the exchange – primarily driven by the rise in trading volumes in the European power market. The following table6 provides a snapshot of the volume of power traded in the EEX in the past year.

EEX Power Market	Unit	Volume – 2020	Volume – 2019
Power Spot Market – Europe	TWh	622	598
Power Derivatives Market – Europe	TWh	4,736	3,973
Power Derivatives Market – USA	TWh	1,719	1,857
Power Derivatives Market – Japan	TWh	0.59	-
Total	**TWh**	**7,078**	**6,428**

[4] Source: The Nord Pool (www.nordpoolgroup.com)
[5] Source: EEX Group
[6] Source: EEX Group Annual Volume Report - 2020

Intercontinental Exchange (ICE)[7]

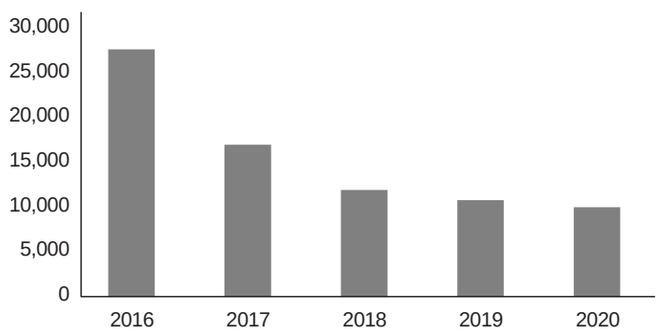
ICE, a leading commodity exchange also offers electricity derivatives for the European and North American power markets. The exchange offers over 160 futures and options contracts in the USA and North American power market and over 10 futures and options contracts in the European power market, respectively.

All of the ICE power derivative contracts are financially settled contracts which are linked to the underlying prices published by the physical markets. For example, in the USA, the PJM Western Hub Real-Time Peak (1MW) fixed price futures contract is a monthly cash settled futures contract that is based upon a mathematical methodology of daily prices calculations by averaging the peak hourly electricity prices published by PJM for the location of the USA Western Hub power market.

A typical ICE electricity/ power futures contract has a trading/ delivery unit of 1 MW per hour for each day which becomes approximately 720 MWh per calendar month. Maturities are typically on a monthly basis. Options for the same trading unit are offered by ICE that are either average price options or a calendar one time option.

Over the past five years, the volume of power contracts (futures and options) traded on ICE has reduced from approximately 28,000 GW to approximately 10,000 GW.

Figure 13 – Volume of power contracts traded on ICE (2016-20)



Source: ICE

Singapore Exchange (SGX)[8]

SGX is considered as the first fully developed energy market in Asia and one of the primary Asian energy hubs. With the liberalization of Singapore's retail electricity market in 2019, participants to the electricity market are able to use the SGX futures market to fix prices for their consumers or capacity generation.

The Singapore electricity market is thermal, with more than 90% based on natural gas. Most of the natural gas is typically imported through pipelines from Malaysia and Indonesia respectively, which is typically linked to the market price of High Sulfur Fuel Oil ('HSFO'). The natural gas is primarily used by the power generation companies to generate Singapore's electricity, which is subsequently bought and sold through the National Electricity Market of Singapore ('NEMS') - the wholesale electricity market (i.e., spot market) operated by the Singapore Energy Market Company ('EMC').

SGX's electricity futures are primarily used by electricity consumers who purchase electricity directly from the spot market are therefore exposed to spot price fluctuations. To help mitigate the adverse exposure spot price fluctuations, the electricity futures contracts are undertaken by them. These futures contracts are cash settled only.

SGX offers two types of futures contracts – the SGX USEP Quarterly Base Load Electricity Futures and the SGX USEP Monthly Base Load Electricity Futures. USEP or the Uniform Singapore Energy Price is published by the Singapore Energy Market Company ('EMC'). Typical contract size is 0.50 MW over each half hour per day over the contract length for both these futures contract subject to the contract period (Quarterly futures contract period is 9 consecutive quarters while monthly futures are 4-6 consecutive contract months respectively). Final settlement pricing is based on the arithmetic average of all half-hourly USEP in the expiring contract quarter or month (based on the type of futures contract executed).

[7] Source: ICE
[8] Source: SGX



06 Key enablers for a well-established Indian electricity derivatives market

Structuring and offering electricity derivative instruments that are aligned to physical market dynamics

To enable suitable attraction for participation by various participants across the physical value chain and the financial investors, derivative instruments structured by commodity derivative exchanges must be aligned with the need and dynamics in the physical market with respect to:

- **Contract size** – Globally, a typical contract offered by a power exchange is 1 MWh. To enable suitable participation across the physical value chain, a commodity derivative exchange may consider structuring contracts that are 1MWh based and lower.
- **Contract period** – In line with the types of derivative contracts offered by global commodity derivative exchanges, providing contracts that are monthly and quarterly based may be considered to cater to short-term and mid-term requirements for a market participant in a year.
- **Price discovery** - Most global commodity derivative exchanges offering power/ electricity futures and options contracts have their price discovery linked to the actual spot market where physical purchase and sale of power is being undertaken. These prices are typically market-driven thereby having less dependency on using complex or theoretical calculation methodologies for deriving the final settlement prices of the derivatives contract.



- **Settlement methodology** - The primary purpose of offering power/ electricity derivatives by a commodity derivatives exchange is to offer a risk management tool for market participants ranging from producers to consumers for mitigating the exposure to adverse physical power/ electricity prices. As there already exists a well-established spot and time-ahead market for physical purchase and sale of electricity in India by power exchanges, a commodity derivatives exchange in India may provide such derivative contracts to complement the power market landscape.

Regulatory guidance for physical market participants

Encouraging physical value chain participants like GENCOs and DISCOMs by the regulators to hedge their price risk by participating in electricity derivatives offered by commodity exchanges – in a similar approach as witnessed in the precious metals space, will also vastly help in increasing the liquidity of the electricity derivatives market and better price discovery.

Enhancing the electricity derivatives market in line with the changing regulatory and market landscape

With a significant goal in India to increase the supply of electricity through additional investments in capacity as well as optimizing cost of consumption of electricity from renewable sources, it is essential for the commodity derivatives exchange to monitor the requirements of the marketplace upon changing energy sources and offering derivative contracts such a futures spread contracts where electricity pricing range is significant for different energy sources and more - that may be aligned to the consequent changes in the physical market dynamics.



07 Strategic role of financial participants

Liquidity in the electricity derivatives market supported by power traders and financial institutions

To enable sufficient liquidity in the electricity derivatives market, it is essential that power trading companies in the physical market use such derivative contracts as a risk management tool for their trading activities given that they are present both on the purchase and sale of electricity in the marketplace.

Additionally assuming the risk and generating liquidity to provide a smooth and seamless platform for hedgers to mitigate the risk, is the strategic and most important role that is undertaken by the financial participants. They enable the contract to become successful and set the standards and the barometer for a contract to become useful to market participants by increasing liquidity and information efficiency. Hedgers and Financial investors are the two key participants in derivatives markets. Hedgers enter the derivatives contract for protecting them against adverse price changes. By contrast, financial investors attempt to utilize the price opportunities for making profit by anticipating changes in market prices or fundamental events. As such involvement of financial participants and strategic role of a broker-trading members on the derivatives exchange on behalf of retail and corporate clients is highly important given the various methods for accessing the derivatives market for market making and trading purposes.

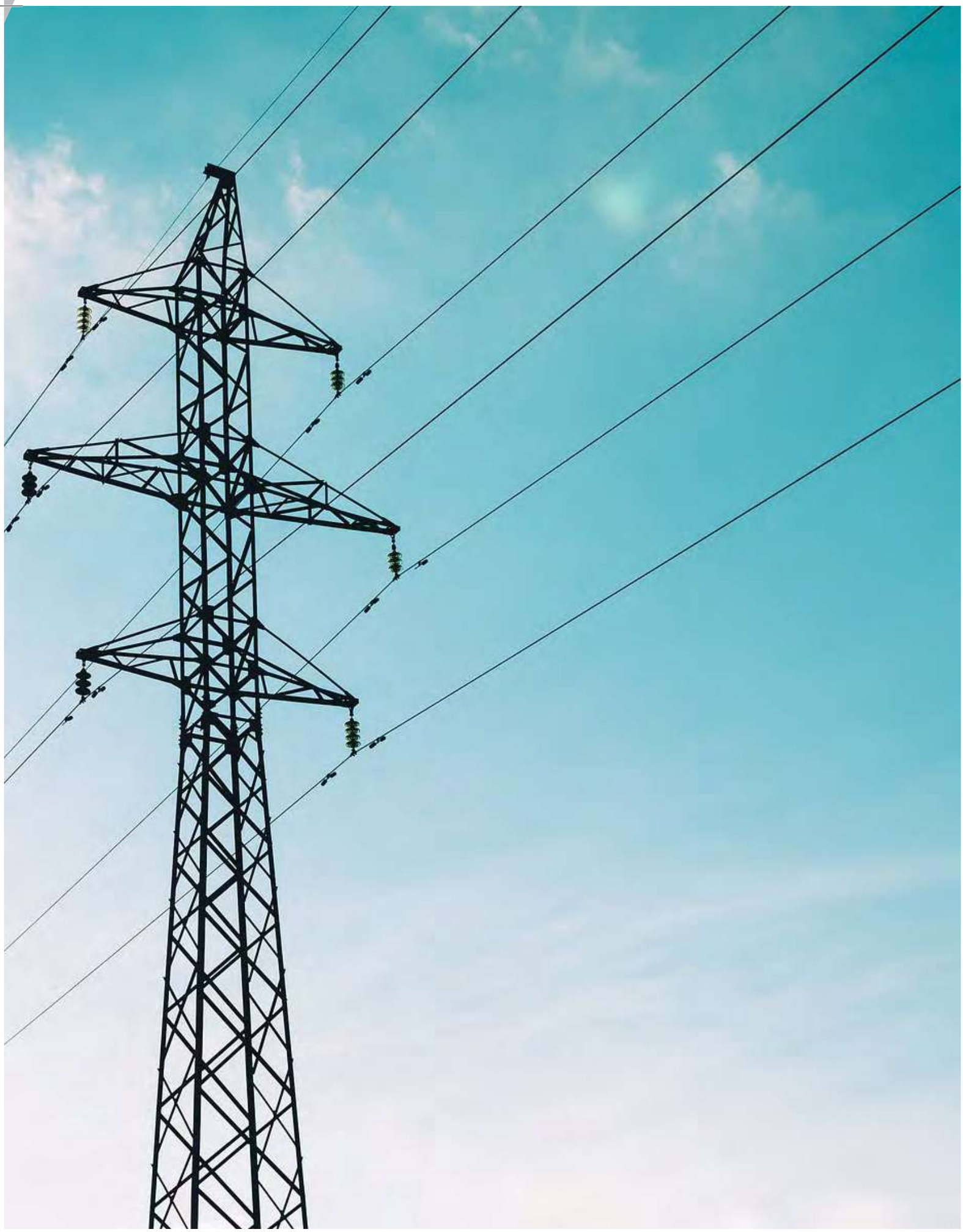
Further even the financial institutions or fund managers can utilize the electricity derivatives to achieve Portfolio diversification & optimisation of asset allocation. Such derivative instruments serve as a trading and investment portfolio diversification opportunity for high net-worth retail individuals and professional investors – which also aids in improving the liquidity of the electricity derivatives market. Even offering advisory services to corporate and retail clients for considering electricity derivative contracts for risk management and other purposes is the need of the hour.

Electricity is considered a flow commodity especially due to its very limited storability and unique transportability. As such the fundamentals effecting the electricity markets are quite dynamic in nature and financial participants can utilize multiple trading strategies for participating in these markets.



08 List of abbreviations

BU	Billion Units of Energy	KWh	Kilowatt hours
CEA	Central Electricity Authority	MCX	Multi Commodity Exchange of India
CERC	Central Electricity Regulatory Commission	MoP	Ministry of Power
CfD	Contract-for-difference	MOSPI	Ministry of Statistics and Program Implementation
DISCOM	Distribution Company	MW	Megawatt
EEX	European Energy Exchange	MWh	Megawatt hours
EMC	Singapore Energy Market Company	NEMS	National Electricity Market of Singapore
EPS	Electric Power Supply	OTC	Over-the-counter
GENCO	Electricity Generation Company	PPA	Power Purchase Agreement
GW	Gigawatt	PXIL	Power Exchange of India Limited
GWh	Gigawatt hours	SEB	State Electricity Board
HSFO	High Sulfur Fuel Oil	SEBI	Securities and Exchange Board of India
ICE	Intercontinental Exchange	SGX	Singapore Exchange
IEA	International Energy Agency	TWh	Terawatt hours
IEX	Indian Energy Exchange	USD	United States Dollar
INR	Indian Rupee	USEP	Uniform Singapore Energy Price



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The Multi Commodity Exchange of India Limited (MCX), India's first listed exchange, is a state-of-the-art, commodity derivatives exchange that facilitates online trading of commodity derivatives transactions, thereby providing a platform for price discovery and risk management. The Exchange, which started operations in November 2003, operates under the regulatory framework of Securities and Exchange Board of India (SEBI).

MCX offers trading in commodity derivative contracts across varied segments including bullion, industrial metals, energy and agricultural commodities, as also on indices constituted from these contracts. It is India's first Exchange to offer commodity options contracts, bullion index futures and base metals index futures contracts. The Exchange focuses on providing commodity value chain participants with neutral, secure and transparent trade mechanisms, and formulates quality parameters and trade regulations, in conformity with the regulatory framework. The Exchange has an extensive national reach, with 636 registered members and 52,777 Authorised Persons with its presence in around 1016 cities and towns across India as on 31 March 2021. MCX is India's leading commodity derivatives exchange with a market share of 96.04 per cent in terms of the value of commodity futures contracts traded in the financial year 2020-21.

The Exchange's flagship index series, MCX iCOMDEX, is a series of real-time commodity futures price indices, which give information on market movements in key commodities/ segments traded on MCX. The MCX iCOMDEX series consists of a Composite index, apart from three sectoral indices: the Base Metal index, the Bullion index and the Energy index, and also nine single-commodity indices: Gold, Silver, Aluminium, Copper, Lead, Nickel, Zinc, Crude Oil and Natural Gas indices.

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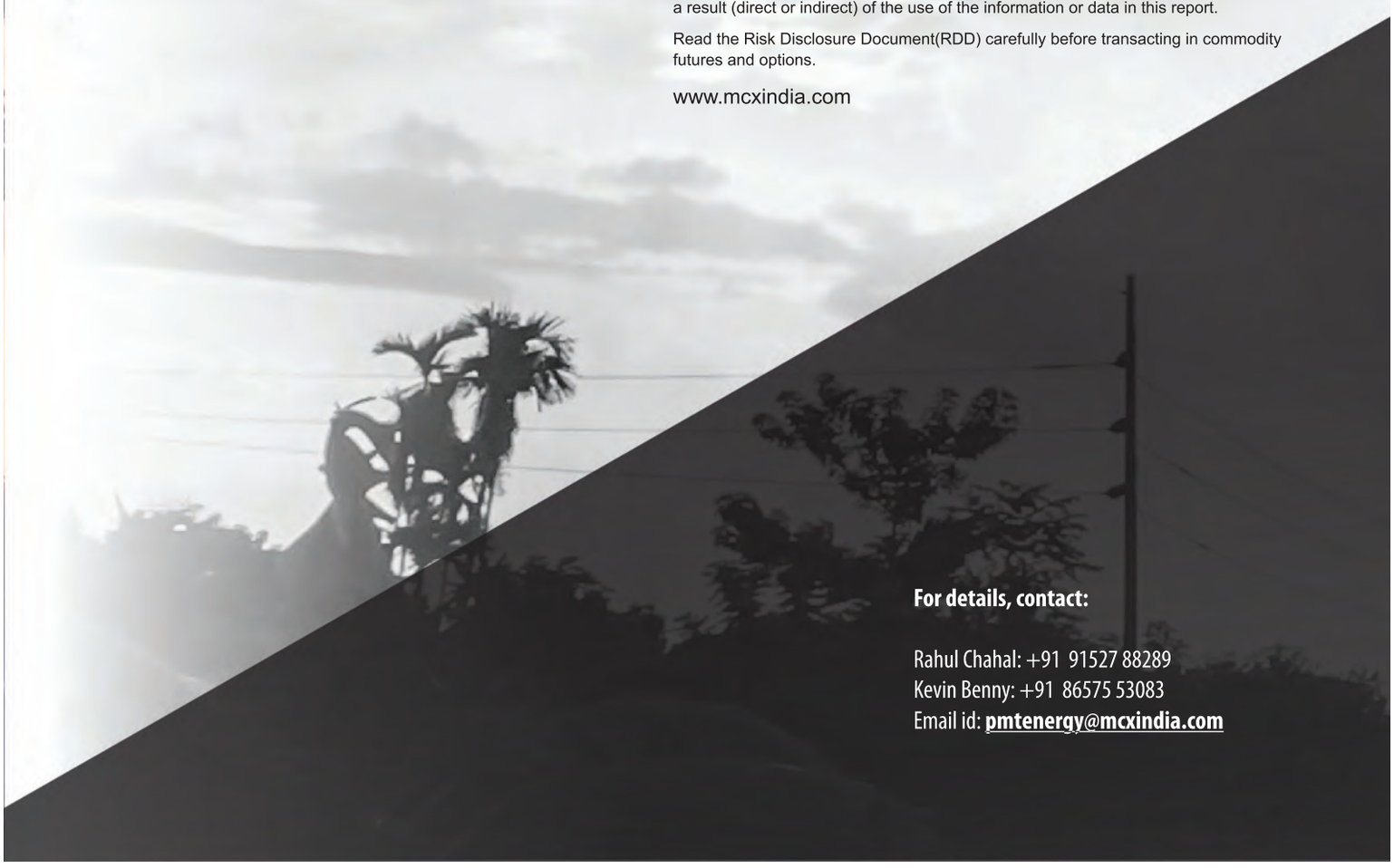

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