Lessons Learned on Forward Markets

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Contributing Experts:

Markus Benjamin Janitzek, Special advisor**,** Danish Energy Agency

Khem Raj Gautam, Sector expert, Danish Energy Agency

Caroline Sejr Damgaard, Special advisor, Danish Energy Agency

Andreas Sejr Andersen, Advisor, Danish Energy Agency

Ravi Chandra Kadam, Senior advisor, CERC

Pardeep Jindal, Chief Engineer, CEA

S.S Brapanda, Director - Market Operation, Grid-India

Samir Chandra Saxena, Executive Director – Grid-India

K.V.N Pawan Kumar, Chief Manager, Grid-India

Jim Vilsson, Senior Economist, Energinet

Morten Pindstrup, International Chief Engineer, Energinet

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This Forward market report is a product of the India-Denmark Energy Partnership (INDEP) cooperation. The publication summarises experience and potential learnings from Denmark and EU, and the discussions from the INDEP – Joint market working sessions with staff from Central Electricity Authority (CEA), Central Electricity Regulatory Commission (CERC), Grid Controller India, Danish Energy Agency, and Energinet. The learnings and takeaways presented here are not necessarily the views of the respective organisation.

Executive summary

In the wake of the findings from the Intergovernmental Panel on Climate Change (IPCC), countries around the world are joining efforts to plan and develop future power systems, where renewable energy sources (RES) will be the paramount players. Denmark is a global leader in the integration of RES in the power system. In 2020, the equivalent of 50% of electricity consumption was produced by variable RES, such as wind and solar. India has similar levels of ambitious, at a far larger scale; by 2040 India is projected to generate two and a half times as much electricity as today, while having ambitious targets to supply substantial amounts of this demand with RES: in 2019 the Indian government announced ambitions to reach 450 GW of installed RES by 2030.

Integration of increasing levels of RES on the grid poses challenges to the efficient and stable operation of the system, to ensure that production and demand for electricity is balanced in the most efficient way. This will require the development of more flexible energy systems. To this end, well-functioning and future-proof electricity markets are key for unlocking investments and facilitating efficient balancing of supply and demand. Short-term electricity markets provide a mechanism for electricity generators and consumers to buy and sell electricity near-real-time, and provide a means for grid operators and market participants to manage supply and demand imbalances. By allowing suppliers to quickly adjust their output based on changes in demand, these markets allow cost efficient balancing. Promoting competition among generators ensures cheaper prices to consumers. Most importantly, short-term electricity markets help facilitate the integration of intermittent renewable energy sources into the grid by allowing renewable energy generators to sell their electricity when it is available, which improves efficiency of the system as a whole and can help to reduce curtailment and increase the overall amount of renewable energy on the grid.

However, short-term electricity markets are volatile, and expose all market participants to price risks, which must be managed to encourage participation and long term stability. Here, forward markets have a key role to play, providing hedging opportunities for market participants, and thereby supporting efficient operation of short-term markets for electricity. The forward market creates benefits both for market participants and system operators (e.g., transmission system operators (TSOs)). Benefits include financial risk management and steady cash flow for market participants, which in turn provides a foundation for investment decisions and long-term security of supply.

In the Danish and European context, well-established Day-Ahead markets with high levels of participation, robust transparency regulation, and high levels of market trust, has been the back-bone of the European zonal electricity market since the liberalisation of the electricity market during the mid-1990s. The Day-Ahead markets have been able to provide a robust reference price for the forward markets, enabling market participants to manage price risk from volatile short term markets.

While electricity markets have been developing and emerging in India since 2001, forward markets have not yet been developed, partly due to ambiguities between SEBI and CERC. Currently, electricity market participants thus lack financial products for hedging, in a power sector characterised by a dominance of longer duration PPAs in power procurement and limited representation of power exchange in overall electricity transactions[1]. However, having reached agreement in 2021 on the division of responsibilities between CERC and SEBI, the way has been paved for the introduction of forward instruments.

Based on the review of market arrangements and developments in the Danish, European and Indian contexts, presented in this report, potential learnings are highlighted and relevant considerations for the development of forward markets in contexts such as the Indian.

[1] Short-term markets have evolved over the years, with introduction of a variety of products and growing volumes of electricity transacted in short term markets, but the majority of electricity generated in India remains transacted in long-term power purchase agreements.

- **Policy push**: In Denmark, policy push helped increase the liquidity of the day-ahead market by exposing the power generators to the prices of the wholesale markets, as their long-term physical contracts were bought by the state, via careful structuring. There are several ways of ensuring such a push, where the most important factor is to link the settlement of the long-term physical contract to the short-term markets.
- **Clarity in regulatory jurisdiction:** Clear frameworks for the regulatory setup, roles and responsibilities are of utmost importance for effective oversight and regulation of electricity markets. Notably, having already defined separate roles for the financial and physical regulator in the electricity market, India has a strong regulatory basis for the development of financial electricity markets. This division of roles anticipates problems with overlapping roles of regulators, as has been seen in the European context, where the role of ACER, in some cases, overlaps with that of the financial regulator, one of the problematic features of the current European setup.
- **Market surveillance and transparency:** Market monitoring, transparency and market surveillance are all important measures to minimise risk of market abuse, and allow market participants to understand and trust the market setup, incentivising participation in the market.
- **Forward markets & resource adequacy:** In a well-functioning market place, forward prices will reflect expected future resource adequacy levels; if future capacity shortage is expected, forward prices increase, creating a strong price signal incentivising investment in new capacity. In Denmark market participants use 10- to 15-year financial contracts to secure financing from banks for development projects.
- **Forward markets enable flexibility:** As generators are not bound to their physical delivery via the contract, forward markets allow for greater flexibility compared to a system based on long-term physical PPAs, with regards to cost-efficient balancing of the power grid.
- **Dynamic contracts for RES:** More RES penetration in the markets creates a need for more dynamic products, in addition to the more traditional base load or peak load contracts, to cover the stochastic nature of the production profiles.

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List of abbreviations

Abbreviations	Definition
ACER	Agency for the Cooperation of Energy Regulators
AMMR	Annual market monitoring reports
BRP	Balance responsible party
BSE	Bombay Stock Exchange
CEA	Central Electricity Authority
CEER	Council of European Regulators
CERC	Central Electricity Regulatory Commission
CfDs	Contracts for difference
DA	Day-Ahead
DISCOM	Distribution companies
DSM	Deviation Settlement Mechanism
EPAD	Electricity Price Area Differentials
ER	Renewable energy
FRA	Forward rate agreement
FTRs	Financial transmission rights
GDAC	Green Day-Ahead Contract
GTAM	Green Term Ahead Market
HPX	Hindustan Power Exchange Limited
IEX	Indian Energy Exchange
IIP	Inside information platform
INDEP	India-Denmark Energy Partnership
IPCC	Intergovernmental Panel on Climate Change
ISGS	Inter-state generating stations
JWG	Joint working group
LTTRs	Long-term transmission rights
MARS	Market abuse regulation
MBED	Market based electricity dispatch
MCX	Multi Commodity Exchange
MMC	The Market Monitoring Cell
MMMR	Monthly market monitoring reports
NEP	National Electricity Policy
NRA	National Regulatory Agency
NSE	National Stock Exchange

NUCS	Nordic Unavailability Collection System
Ofgem	Office of Gas and Electricity Market
OTC	Over the counter
PPA	Power purchase agreements
PGRID-INDIA	Power System Operation Corporation
PTRs	Physical transmission rights
PXIL	Power Exchange India Ltd.
RES	Renewable energy sources
RPO	Renewable Purchase Obligation
RTM	Real-Time Market
SDAC	Single Day-Ahead Coupling
SEBI	Securities and Exchange Board of India
SERCs	State Electricity Regulatory Commissions
TAM	Term Ahead Market
TR	Transparency regulation
TSO	Transmission system operator

Regulations

CACM Capacity Allocation and Congestion Management Guideline, 2015/1222

FCA GL Forward Capacity Allocation Guideline, 2016/1719

MiFID Markets in Financial Instruments Directive, 2004/39 and 2014/65

REMIT Regulation on Wholesale Energy Market Integrity and Transparency, 1227/2011

Transparency Regulation Submission and publication of data in electricity markets, 543/2013

SCRA Securities Contracts (Regulation) Act, 1956

Definitions

Derivatives: Financial instruments that derive their value from an underlying asset, such as stocks, bonds, or commodities (specifically, electricity in this report).

EPAD contracts: Futures traded on the Nordic exchange whose value is determined by the discrepancy between the System Price and each zone's anticipated true bidding zone price within the Nordic region.

Financial contracts: Contracts whose underlying asset is derived from commodity prices, and can either be traded on a formal exchange or over the counter. Provides flexibility in contract specifications, including quantity, delivery period, and settlement terms. Financial contracts may be either physically or financially settled. Physically settled financial contracts comes with an obligation to deliver the underlying asset, whereas financially settled contracts is an arrangement whereby the seller transfers the net financial position instead of delivering the actual asset.

Financial markets: Term used for organized markets where financial contracts are traded.

Forward markets: The market where contracts are priced and traded. These types of contracts can be either standardized exchange-traded futures, bilateral forwards or options. The contacts are traded from a few days ahead up to 3 years ahead of delivery.

Forwards: Customised bilateral contracts that are financially settled at the end of the contract period.

Futures: Standardised contracts traded on an exchange, where prices are settled daily (margin call) until the end of the contract.

Long-term markets: A broad definition for exchange-traded products such as futures and bilateral contracts such as forwards and PPA. These products refer to contracts longer than the day before delivery and have a fixed price for power attached to them. In a European context, PPA can also be used for a long-term contract only, including balancing services.

Options: A futures contract under which the buyer has the right to buy (for 'call' options) or to sell (for 'put' options) futures at a predetermined price (the 'strike price'), at a predetermined date before the futures' delivery period (the 'expiry date' of the option).

Physical contracts: Contracts that involve the physical delivery and focus on the quantity, quality, delivery period, and other terms related to the actual delivery.

Short-term markets: A broad definition for markets where products are exchanged within a Day-Ahead or a shorter timeframe. In Indian context, all contracts less than 1 years are sometimes referred to as short-term contracts, which should not be confused with the "**Short-term markets"** referred in this report

System price: An unconstrained market clearing reference price for the Nordic region. It is an artificial price only used for financial contracts as it is calculated as the "perfect" price without any grid restriction in the Nordics.

The clean dark spread: A metric that accounts not only for the cost of coal but also for the carbon emissions that needs to be offset in the EU (due to the carbon pollution generated by producing electricity from coal-fired generators).

The dark spread: A commonly used metric that factors in coal's power price and fuel cost to measure the profitability of coal-fired electricity generators. This measure has historically been used in many parts of the world to estimate the base price level of electricity, as coal-fired plants provide reliable baseload power production with high flexibility.

1. Introduction

This report is a product of the India-Denmark Energy Partnership (INDEP) cooperation. The publication summarises experience, potential learnings, and ongoing developments across the Danish, EU and Indian context. The paper is based on discussions from the "INDEP – Joint market working sessions", between Central Electricity Authority (CEA), Central Electricity Regulatory Commission (CERC), Grid Controller India, the Danish Energy Agency, and Energinet.

As CERC and the Securities and Exchange Board of India (SEBI) are currently developing forward markets in India, this report is a timely contribution to the ongoing debates and considerations amongst policymakers and regulators in India, particularly in relation to financial markets and products, which could support increased share of power traded on power exchanges and increased efficiency of short term electricity markets in India.

There are many similarities in the energy sector development in India and Denmark. Both countries have unbundled the sector throughout this century and have introduced competition in the power sector by allowing private capital to increase efficiency.

In the EU, the electricity market design is supported by the forward market, which allows trading to occur several years ahead of delivery and up to two days ahead of delivery. This means that market participants can hedge themselves against the volatile prices of the physical and electrical spot markets and secure future cash flow well in advance. The increase of renewable energy sources (RES) in Europe and recent shocks to fuel prices (leading to highly volatile spot markets) have only stressed the importance of forward markets for managing volatility and unforeseen events.

There are various types of forward market instruments, including long-term transmission rights (LTTR), futures, and forwards; this report focuses mainly on futures and forwards, as the most relevant topics for Danish-Indian knowledge sharing at present. The potential learnings from the development of Danish and EU forward markets for the Indian context are discussed, including key structures surrounding the markets in the EU and the critical role of market transparency and regulation.

While electricity markets have been developing and emerging in India since 2001, forward markets have not yet been developed, due to ambiguities between SEBI and CERC. However, having reached agreement in 2021 on the division of responsibilities between the two institutions, the way has been paved for the introduction of forward instruments.

The following chapter sets out some of the key benefits of forward markets, particularly their role in supporting efficient operation of short term markets, their function as hedging tool against price volatility, and their role providing investment signals and ensuring future security of supply. This is followed by an introduction to the European/Nordic and Indian market setups (Chapter 3) and existing regulatory landscapes (Chapter 4). Chapter 5 then discusses the transition from long-term physical products to a market based system, outlining European experiences and considerations for the transition in India. Finally, Chapter 6 summarises key learnings.

2. Benefits of forward markets

One of the key benefits of forward markets is to facilitate the efficient operation of short-term markets for electricity.

Short-term electricity markets, in turn, provide a mechanism for electricity generators and consumers to buy and sell electricity near-real-time. Short-term electricity markets provide a means for grid operators and market participants to manage supply and demand imbalances. By allowing suppliers to quickly adjust their output based on changes in demand, these markets allow cost efficient balancing. They also promote competition among generators. In a competitive market, generators must offer competitive prices to ensure they are dispatched, which ensures cheaper prices to consumers. Most importantly, short-term electricity markets help facilitate the integration of intermittent renewable energy sources into the grid by allowing renewable energy generators to sell their electricity when it is available, which improves efficiency of the system as a whole and can help to reduce curtailment and increase the overall amount of renewable energy on the grid.

However, short-term electricity markets are volatile, even more so with the increase of RES. Factors including transmission congestion and other physical attributes of electricity production and distribution contribute to volatility of short-term markets, creating price risk exposures for all market participants.

The forward market provides a necessary tool for market participants to hedge themselves against the volatile prices of short-term markets, by hedging the risk of uncertain future cash flows well in advance of delivery. The forward market creates benefits both for market participants and system operators (e.g., transmission system operators (TSOs)). Benefits include financial risk management and steady cash flow for market participants, which in turn provides a foundation for investment decisions and long-term security of supply. The forward market is the first market where market participants enter to manage their current and future risks.

2.1. Securing financing

In the EU, before physical projects are in place almost all generation units secure long-term financial contracts in order to secure financing using the forward hedge as security for the investors and banks. In the Nordics over the last decade the norm has become 10-15 years financial contracts (often in the form of financial power purchase agreements (PPAs) and contracts for difference (CfDs)), in order to secure financing from the bank.

2.2. Cash flow & risk management

The forward market creates a foundation for a steady cash flow for both consumer and production units because they can establish the future terms and prices at which they will transact. This provides stability and allows for better financial planning and certainty regarding future cash flow.

Market participants with physical assets that are active in the forward market buy and sell the hedging instruments available, both through exchanges and over-the-counter (OTC), to protect against future price changes.

Suppliers use the long-term financial instruments to price the contracts given to their consumers when contracts are signed. The forward markets are then used to hedge the residual volumes of these long-term financial contracts. The forward market is thus used by market participants both on the demand side and supply side, which is necessary for good liquidity. Generation units often outlive PPA periods; for these units, forward markets offer long term, steady cash flow.

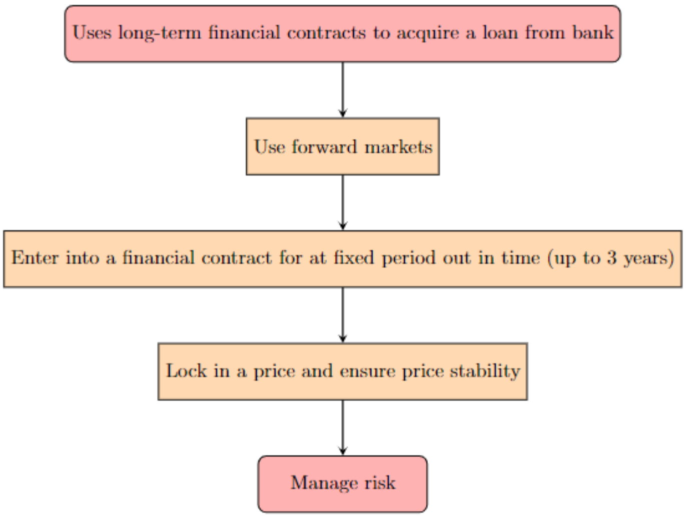

Figure 1 Flow chart of risk management typically used by generators and consumers

2.3. Certainty for the grid operator

Forward markets provide important investment signals for market participants, encouraging investment in capacity, and thereby contributing to future security of supply. In a well-functioning market place, forward prices reflect expectations around future resource adequacy; when future capacity shortage is anticipated, forward prices increase, incentivising investment in new capacity. This works along with price formation in short term markets to inform investment decisions on both demand and supply side, including for flexible generation and demand. Thus, well-functioning markets contribute to resource adequacy by affecting decisions on both the supply and demand side.

When market participants have entered into long-term hedges, their existence in the market is secured for the presence of the long-term contract. This creates certainty for the grid operator for long-term availability across both supply and consumption in the grid.

2.4. Forward markets vs long-term physical contracts

From a resource adequacy perspective, long-term physical contracts are a good tool to ensure adequacy. However, in the context of increasing RE and a move to greater use of short term markets, long-term physical contracts have their limitations, posing a hindrance to flexibility as generators are bound to their physical delivery via the agreed physical contracts. Forward markets provide greater flexibility and more liquidity into short-term markets, and secure the lowest costs of generation. And importantly, European/Danish experience shows that forward markets can deliver the same levels of resource adequacy.

3. Overview of market contexts in Europe/Denmark and India

This section outlines existing market structures and developments, particularly related to forward and financial markets, in the EU/Denmark and India. The section concludes with considerations for establishment of forward and financial markets in India, drawing on lessons learnt in in the Danish/European context.

3.1. Europe/Denmark – Market overview

Figure 2 below provides a visual representation of the European electricity market structure. For the purposes of this paper, this section focuses on the Forward Markets in the European and Danish context, as well Day-Ahead (DA) markets, which form the backbone of the European electricity market.

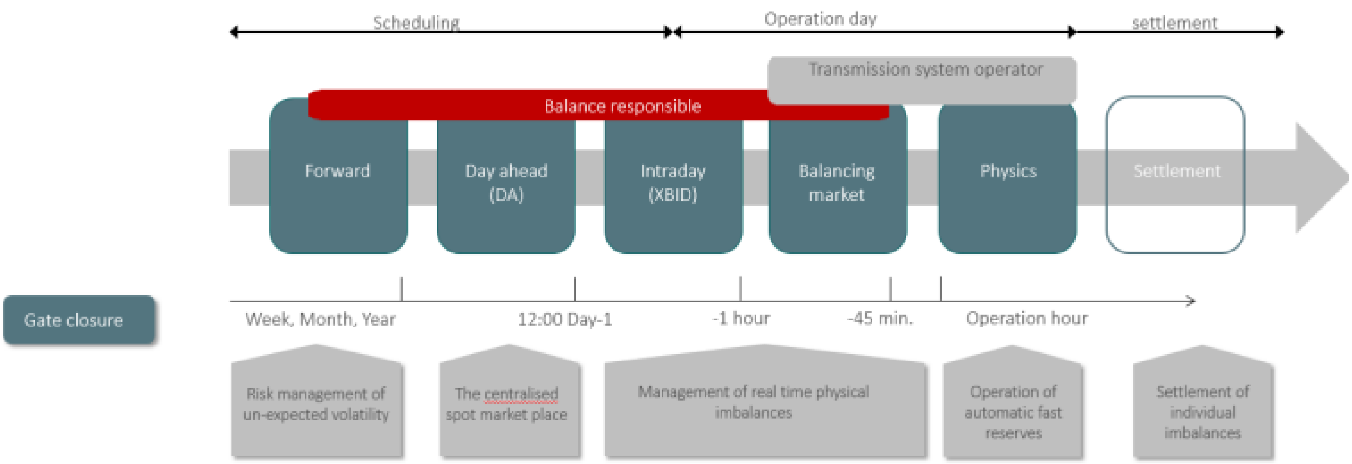

Figure 2 European electricity market structure. Source: Danish Energy Agency 2020

EU Day-Ahead markets

The DA market is the backbone of the European zonal electricity market and has been so since the liberalisation of the electricity market during the mid-90s. The DA market is organised in an auction that closes at D-1 12:00 and sets the prices for each bidding zone in the EU and the expected supply and demand for the same bidding zones. The DA auction is carried out under the Single Day-Ahead Coupling (SDAC) mechanism, which has been in place since 2014. Before 2014 there were regional market coupling areas but, in 2014 a large part of European countries were able to join and achieve prices and dispatch schedules through SDAC. Since 2014 almost all EU countries have been able to join SDAC or will, in the future, join this successful DA project (Figure 3).

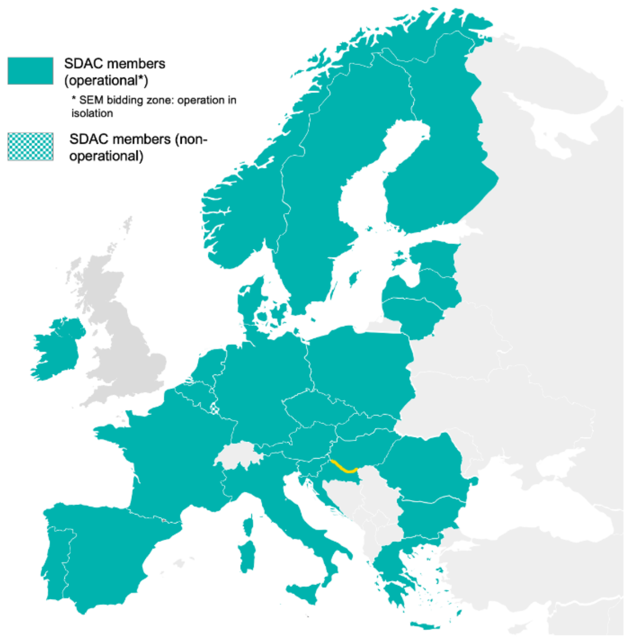

Figure 3 Single Day-Ahead Market Coupling Map of members. Source: ENTSO-E

Price and dispatching curves in each bidding zone of the electricity market are determined using the algorithm Euphemia. The primary goal of this algorithm is to match the demand and supply curves of market participants, while also taking into account transferable capacity between bidding zones and various other constraints. Since there are several DA power exchanges in the EU, they are all obligated to share their order books (demand and supply) with the algorithm, so the best price can be established, and supply and demand can meet in each bidding zone. The marginal cost pricing principle is used to determine the price for each bidding zone in the electricity market. This price is set at the point where the demand and supply curves intersect; the marginal price is reflects the marginal cost of the most expensive generator that is needed to meet the demand at any given moment. The marginal cost is the price each producer receives, and each consumer pays in each bidding zone. In the example illustrated in Figure 4, the marginal generation unit is coal-fired, and the Day-Ahead price is set accordingly.

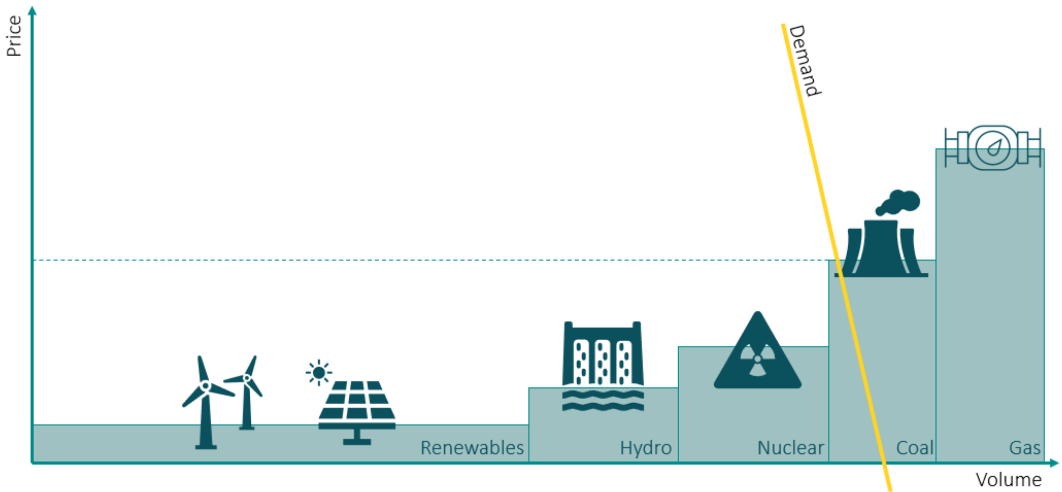

Figure 4 Merit order and marginal pricing methodology. Source: Energinet

EU/Nordic forward market

In the face of the volatility of DA prices, financial contracts traded on the forward market create stability and increase investor security for both consumers and generators.

A crucial factor for effective hedging in forward markets is the participation of enough buyers and sellers (sufficient liquidity) in the forward market. In Europe, regulators are responsible for assessing hedging opportunities and market liquidity, and if found inadequate, TSOs may have to take action to enhance liquidity (often through the use of LTTRs to improve liquidity in specific areas of the electricity market).

The European forward market provides several types of electricity derivative products, where the underlying reference price is typically given by the DA price. This includes Contracts for Difference (CfDs), LLTRs and, in the Nordics, Electricity Price Area Differentials (EPADs), each briefly explained below.

Contracts for Difference

The most common and widespread derivative product in the EU is the future product, base-load CfD. A baseload CfD provides the seller and buyer a hedge at a particular agreed price (market price at the exchange) for each of the hours during the contract period. A CfD contract has a fixed agreed hedging price; for hours, when the price in the DA market is above the agreed price, the seller of the CfD contract is bound to compensate the buyer of the CfD contract for the price difference, and vice versa.

Figure 5 illustrates a baseload CfD relative to the variable DA price. Here, the seller of the CfD would receive money for the first 6 hours of the day, when the actual price is below the agreed hedge price of 30 EUR/MWh. The buyer would receive money for the rest of the hours for this particular day until 23:00, as the DA price is above the agreed price. The seller would again receive money for the last hour of the day in this example.

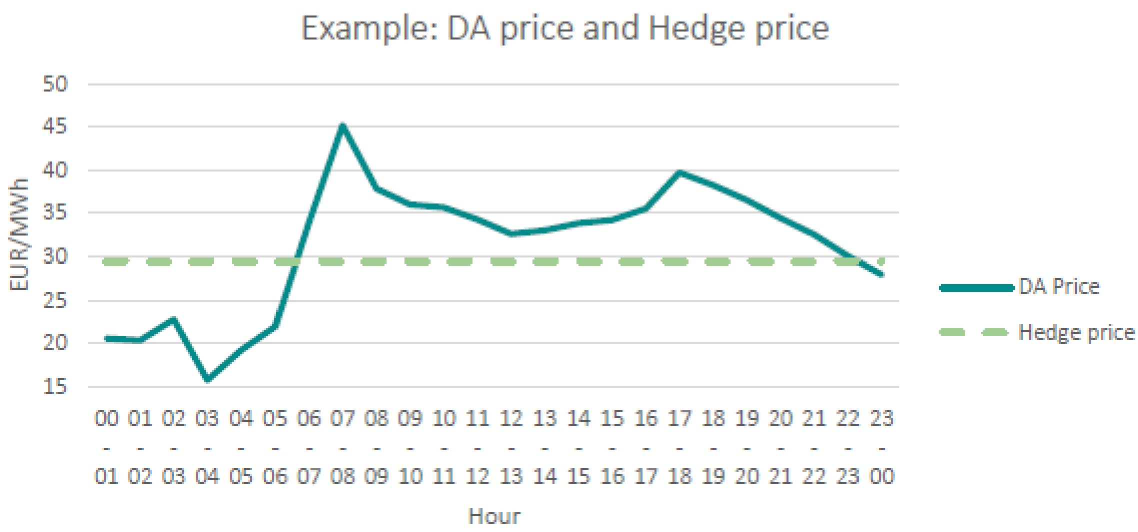

Figure 5 Example of DA price and the hedging price (base-load contract). Source: Energinet

Another common contract is the peak CfD contract, which provides a seller and buyer a hedge just during the peak hours (weekdays 08:00-20:00) for the length of the contract. Both baseload and peak contracts are used in countries with only one bidding zone and no internal congestion (note: these are not used in the Nordics). Typical CfD contracts are week ahead, month ahead, quarter ahead, and year ahead. Most markets are transitioning into financially settled contracts, but some still require physical delivery.

Notably, with more RES penetration in the markets, the need for more dynamic contracts has increased, to cover the stochastic nature of RES production profiles. Base-load contracts are not ideal for variable generation, as they set out a single expected volume for each hour, while generation can vary significantly from this expected volume (see for example Figure 6, showing an example of actual wind production compared to an example fixed contractual expected volume).

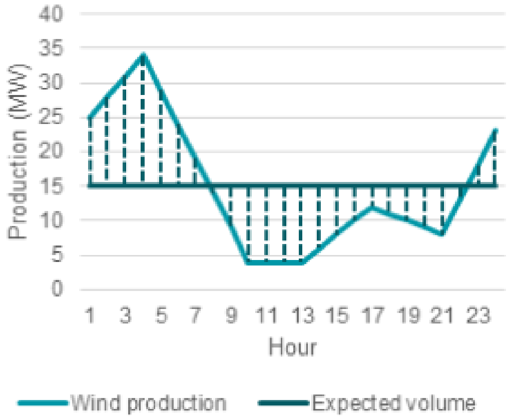

Figure 6 Expected vs. actual wind energy generation. Source: Energinet

Long Term Transmission Rights

LTTRs are hedging contracts between a TSO (or Single Allocation Platform (SAP)) and a market participant for the right to transmit electricity between two network locations based on cross-zonal capacity allocation. They provide market participants with hedging solutions against bidding area price difference risks that are created by interconnector congestion and day-ahead congestion pricing. An LTTR is a financial right to the congestion income created on a particular border; when using an LTTR, the market participants are able to hedge their position (physical or financial) in other electricity markets across the bidding zones, where the liquidity might be higher. Recent proposals for changes to the EU electricity forward markets include a focus on LTTRs and the use of cross-zonal capacity allocation to further integrate the European forward markets (ACER 2023).

The Nordics: System price & EPADs

The Nordic model differs somewhat, due to having numerous bidding zones in each country. In the Nordics, multiple bidding zones are aggregated into a virtual 'hub' with a single reference 'system price'. The Nordic forward market then includes system price contracts, complemented by Electricity Price Area Differential (EPAD) contracts.

The system price is an index price of the Nordic market, an unconstrained market clearing reference price for the Nordic region, calculated without any congestion restrictions by setting capacities to infinity between bidding zones. This aims to increase liquidity by combining several smaller bidding zones to a larger, more liquid aggregated trading hub.

The Electricity Price Area Differential (EPAD) is used to hedge the price risk in individual bidding zones. EPAD is the difference between the system price and the price in a particular Nordic bidding zone. The EPAD is calculated with the real physical constraints and represents the difference between the bidding zone price and the system price. EPADs are typically traded in areas with large volatility compared to the system price, such as in the bidding zone of Western Denmark (DK1).

System price contracts and EPAD contracts are used to hedge against price volatility, whether it is spatial or temporal. It is necessary for a market participant to have access to both contracts to fully hedge the price risk in the particular bidding zone. An EPAD without a system price contract would not give a fully firm hedge towards the area price risk.

Derivative types

Across these products, different types of electricity derivatives are traded in Europe, including:

Financially-settled futures: These contracts involve exchanging the difference between the futures and spot price of electricity over a set future period. They are standardised, traded on exchanges, and marked-to-market. Parties post an initial margin to cover future price changes, and at maturity, the futures price converges to the spot price. The exchange settles the difference between the spot and futures prices during the delivery period. (Example: CfD, EPAD).

Physically-settled forwards: These contracts involve delivering a set amount of electricity at a predetermined price during a specific delivery period. Physically-settled forwards are similar in economic value to futures, but they are not market-to-market, with the forward price paid by the buyer to the seller at maturity. Forwards require higher guarantee requirements compared to financially-settled futures. Forwards are not standardised like futures and are traded over the counter. **(**Example**:** OTC contracts)

Financially-settled options: Electricity options are contracts that give the buyer the right to buy (for call options) or sell (for put options) an electricity futures contract at a predetermined price (the strike price) before the expiry date of the option. These options are financially settled, meaning the holder is not required to trade electricity. Instead, they provide a hedge against high or low electricity prices during the futures' delivery period. (Example: Unidirectional CfD contract that specifies minimum buying price but not the maximum, LLTRs)

Hedging strategy in Europe/Nordics

The European DA market is becoming increasingly volatile because of increasingly large shares of RES. Market participants strive for hedging opportunities in forward markets to reduce the exposure to fluctuations in the DA market.

Market participants hedge themselves in the investment-driven timeframe covering 10–15 years and the ‘trading-driven’ timeframe covering up to 3 years. In this report, the primary focus is on the trading-driven timeframe, i.e., entering into forward transactions to secure the revenues for a certain future delivery period.

Figure 7 illustrates an example of a hedging strategy that is typically utilised by market participants. A basic but well-used hedging strategy in the European electricity market is to have a T-4 plan for determining when a specific ratio of the portfolio needs to be hedged. Large portfolios usually work with T = years, while smaller portfolios can work with T = quarter or T = months.

The T-4 hedging strategy assures both flexibilities in terms of when to hedge (What T) but also creates an opportunity for the market participant to act when there are possibilities for extra profit margin in the market. The T-4 hedging strategy is also called the “Stair” hedge strategy (by how it looks). The T-4 or Stair hedging plan also provides a necessary risk framework for an organisation active in the electricity market.

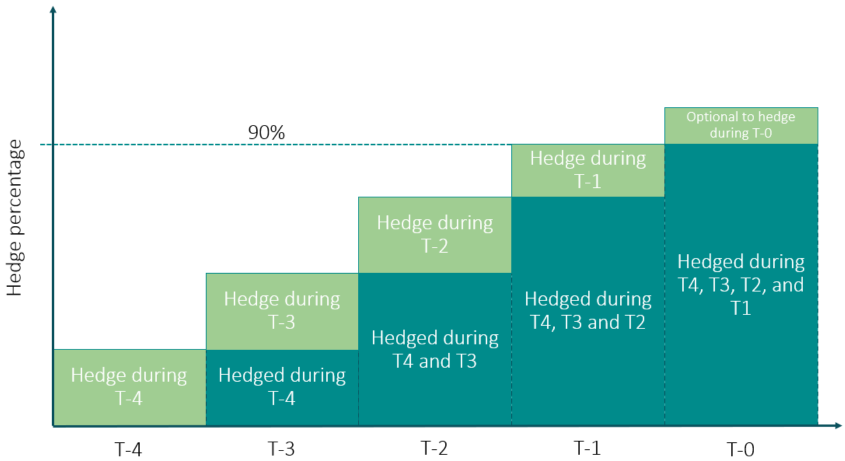

Figure 7 Example of a possible hedging strategy. Source: Energinet

Pricing

The expectation of prices in the EU electricity market is normally based on in-house simulation as well as power curves received by vendors. Every EU electricity market bidding zone has vendors that sell their expected power curves. These power curves are then used for modelling expected profit and risk with the current positions in the portfolio.

As an example, a market participant covers their spread for production with measures like the dark spread (Power price = Coal*efficiency) and would then cover their income side in the forward market.[2]

The dark spread is a commonly used metric that factors in coal's power price and fuel cost to measure the profitability of coal-fired electricity generators. This measure has historically been used in many parts of the world to estimate the base price level of electricity, as coal-fired plants provide reliable baseload power production with high flexibility. As a result, the average price are usually set near the dark spread.

To analyse price trends in the electricity market, market participants need up-to-date information about production, consumption, and transmission. As this information is published on a common website, such as Nordic Unavailability Collection System (NUCS)[3] and ENTSO-E Transparency Platform[4], as discussed further in chapter 4 on transparency and market surveillance.

Since prices in the electricity market can be influenced by various factors, having access to publicly available information is crucial for making informed decisions with minimal uncertainty. The explanation in context of the Nordic bidding zones is that the bidding zones are highly sensitive to weather forecasts and even minor changes in interconnector capacities. For instance, in West Denmark, where the base-load consumption is 3500 MW and the wind capacity is nearly 6000 MW, wind energy generation can meet the entire demand in some scenarios, causing a significant reduction in prices. Additionally, the available interconnector capacity is a critical factor that affects EPAD (the forward financial contracts traded in the Nordics). Therefore, market participants rely on timely information regarding the go-live date and potential delays in introducing new interconnectors and their capacity to react promptly to price impacts. Political decisions, such as the construction of energy islands or new interconnectors, put increased risk premiums into the pricing of contracts in the forward market, due to the uncertainty of e.g., timing and the effect of these projects on the electricity markets and price developments.

Low liquidity in the current European forward market

Low liquidity is amongst the key challenges in the European forward market, identified by ACER and CEER in a recent publication (ACER, 2022)[5].

[2] Note that in e.g., countries where a CO_2 quota is implemented, the Clean dark spread is used, (Power price = Coal*efficiency-CO2 quota price). The clean dark spread is a metric that accounts not only for the cost of coal but also for the carbon emissions that is need to be offset in the EU (due to the carbon pollution generated by producing electricity from coal-fired generators).

[3] Available at: https://www.nucs.net/

[4] Available at: https://transparency.entsoe.eu/

[5] In June 2022, the Agency for the Cooperation of Energy Regulators (ACER), together with the Council of European Regulators (CEER) started a consultation on improvements to the forward electricity market in Europe. They identified a number of issues experienced in the European forward market, and provide suggestions for policymakers based on a qualitative assessment (ACER, 2022). Identified issues include low liquidity, inadequate maturities, and unsuitable products.

Proposed solutions include (i) allocation of zone-to-hub financial transmission rights (FTRs) by TSOs (ii) market coupling with contracts for CfDs and (iii) market coupling with energy futures. All three options involve allocation of long-term cross-zonal capacities by TSOs (either explicit or implicit) in timeframes up to three years ahead of delivery. Further, it is argued that FTRs should come as obligations and not as options, as this would lead to more capacity offered to in for Transmission Rights and a closer correlation to existing forward instruments in Europe. Therefore, it is expected that the guidelines of LTTR’s and forward capacity allocations (FCA) will be revisited in the future.

During the last 10 years the liquidity in the Nordic forward market has decreased making it harder for market participants to hedge their physical position and also increasing cost to consumers. Contributing factors include, but are not limited to, the following market developments:

- **Credit**: Increased need of credit lines due to one market participant's failure (Reuters, 2018) to cover the losses made in the market, which has posted extra cost on all market participants going forward.
- **Market development**: Increased share of Renewable Energy (RE) has rapidly increased the sell side without new buyers coming into the market. The products do not match the need from new power sources.
- **Price development:** Increased power and fundamental fuel prices also increase the collateral that traders must deposit with their broker to maintain their open positions in the market. The collateral requirement is closely tied to the spot price development, with daily requirements changing directly with spot prices.

The decreased liquidity over the last 10 years raises the question of how much liquidity is enough for the forward market. The concept of liquidity is complex and hard to grasp without a clear definition or measure of 'Good liquidity'. The EU grid code on Forward Capacity Allocation guidelines (FCA GL) (European Union, 2016), Section 2, article 30 (3), refers the liquidity as follows:

> *"…market provides sufficient hedging opportunities in the concerned bidding zones".*

While the UK National Regulatory Agency (Ofgem) set out their definition in their paper, Liquidity in the GB wholesale energy markets (Ofgem, 2009):

> *"Liquidity is an important feature of a well-functioning market. We can define liquidity as the ability to quickly buy or sell a desired commodity or financial instrument without causing a significant change in its price and without incurring significant transaction costs. A key feature of a liquid market is that it has a large number of buyers and sellers willing to transact at all times".*

There has been and is still ongoing discussion amongst TSOs, market participants, National Regulatory Authorities (NRAs), ACER and the European Commission – both in the context of the European electricity market, and within national electricity markets, including in Denmark – on how liquidity should be measured and whether each market, and the forward market in particular, provide efficient hedging opportunities. Three potential measures of liquidity considered are the Bid/Ask spread, churn rate and open interest. All three of these measures come with benefits and drawbacks:

- **Bid/Ask spread:** the difference between the best buy price and best sell price. This is also known as societal cost, as there could be a risk of market participants wanting to hedge without the possibility of doing so due to the spread between best Bid and the best Ask. One can argue that a liquid market with enough buyers and sellers should have a low or close to none Bid/Ask spread. However, Bid/Ask spreads can also widen if the underlying commodity (DA price in this case) is volatile or the political landscape is uncertain in the particular country/bidding zone.
- **Churn rate:** a measure of the turnover or activity in a market, calculated by dividing the total volume of trades by the total number of outstanding contracts.
- **Open interest:** a measure of the total number of outstanding contracts that have not been closed or settled. Large trades can have a significant impact on both churn rate and open interest. For example, a single large trade can cause a spike in volume, which would inflate the churn rate. Similarly, a large trade that involves the creation or closure of a large number of contracts or shares can cause a sudden increase or decrease in open interest.

Since the European electricity market does not have a single standard for liquidity, it is up to each NRA to decide on the measure to be used and the level of good liquidity. All participants in the EU electricity market (TSOs, NRAs, and market participants) do, however, agree that a well-functioning forward market consists of and allow for the following:

- Provide good opportunities for buyers and sellers to agree on terms and prices that are acceptable for both sides
- Gather a sufficiently high number of participants
- Low transaction costs (described previously as low Bid/Ask spread)
- Allow all market participant, from producer to end-consumer optimize their portfolio in order to provide the cheapest possible power price to customers.

3.2. India – Market overview

While the majority of electricity generated in India is transacted in long-term power purchase agreements, short-term markets have evolved over the years, with introduction of a variety of products and growing volumes of electricity transacted in short term markets. An overview of the Indian physical and financial electricity markets (as of 2021) is provided in Figure 8 (IEEFA, 2021), with further temporal and spatial distribution of the markets presented in Figure 9.

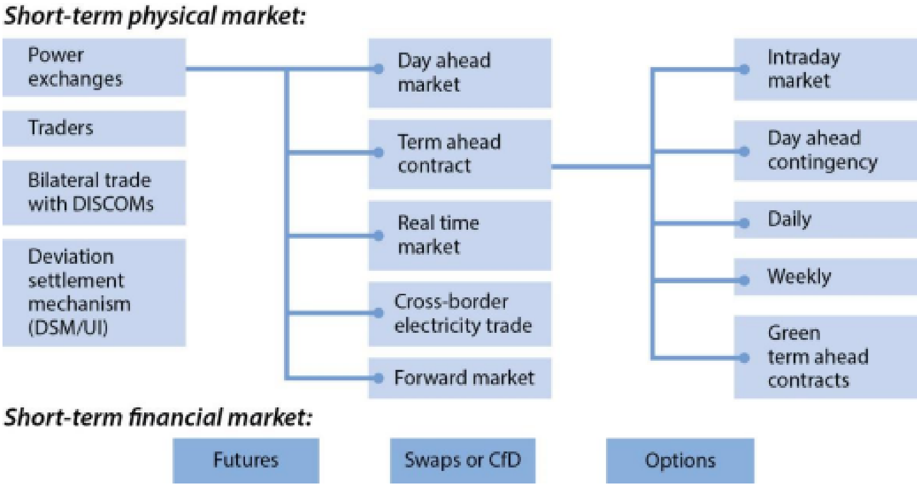

Figure 8 Overview of the Indian Physical and Financial Electricity Markets. Source: IEEFA 2021

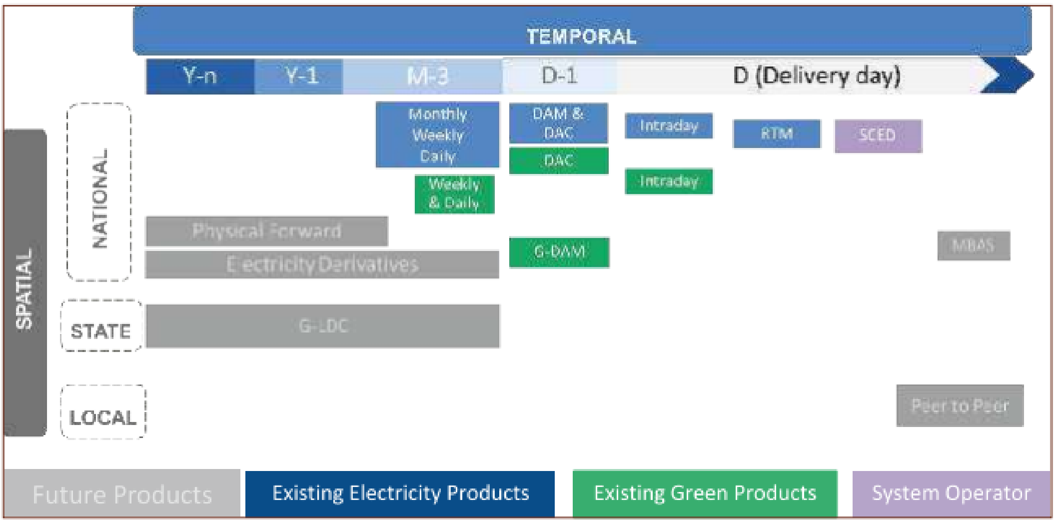

Figure 9 Temporal and spatial distribution of market setup in India. Source: NiSM 2022

As shown in Figure 10, the major volume of electricity in India is transacted in the long-term segment (contracts longer than one year period), representing roughly 84.1% of total electricity generation in March 2023. Electricity contracts of less than a one-year period make up 15.9% of total generation, transacted through the following segments (each discussed further below):

- **Power exchange segment** comprising 37.26% of contracts under 1 year, with transactions across the following short term markets:
    - Day-Ahead Market (DAM),
    - Green Day-Ahead Market (GDAM),
    - Term Ahead Market (TAM),
    - Green Term Ahead Market (G-TAM), and
    - Real Time Market (RTM);
- **Bilateral transactions** comprise of 51.63% of all short-term contracts under 1year. Bilateral transaction are combination of **Trading licensees** (inter-state part only) under bilateral transactions or the “bilateral trader” segment (34.97%) and **Direct transactions** of electricity between distribution companies (DISCOMs) (16.66%)
- **Deviation Settlement Mechanism (DSM)** segment (comprising 11.11% of contracts under 1 year)

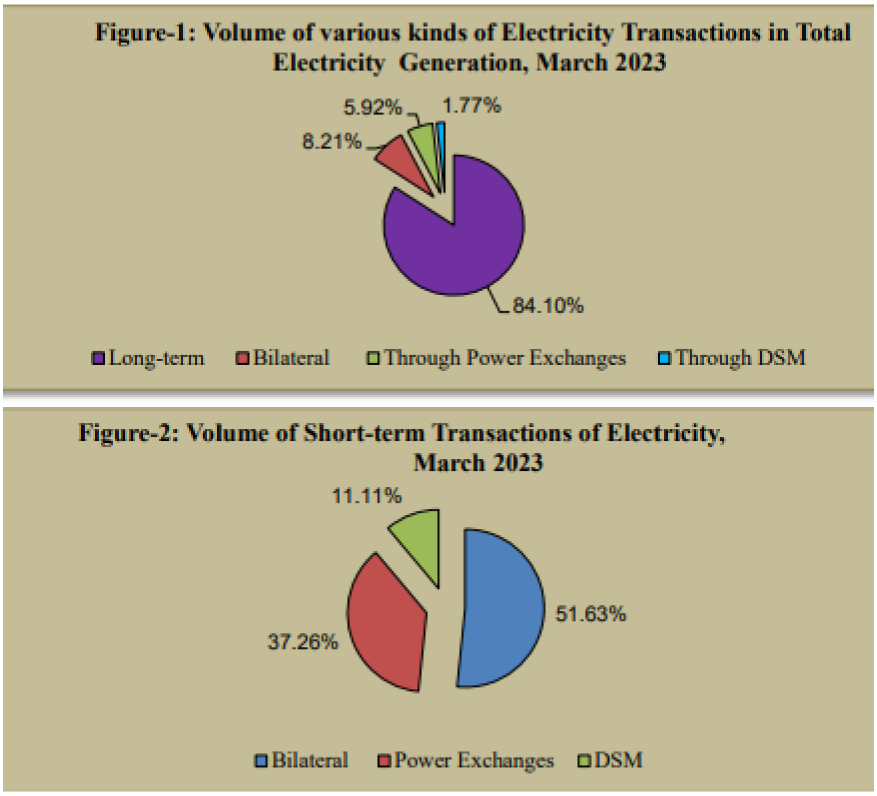

Figure 10: Share of market segments in total electricity generation, March 2023, India. Source: CEA 2023

Interstate trading licensees (traders) have been undertaking trading in electricity since 2004, and the power exchanges started operating in 2008. As of 31st March 2022, there was a total of 43 inter-state trading licensees and two power exchanges (Indian Energy Exchange (IEX) and Power Exchange India Ltd. (PXIL)) operating in India, with a third power exchange, Hindustan Power Exchange Limited (HPX) operating since July 2022.

In recent years, several new short term market segments have been introduced in addition to the DAM, with the Real-Time Market (RTM) and Green Term Ahead Market (G-TAM) introduced by CERC in 2020-21.

The RTM allows better portfolio management for utilities and closer-to-real-time trading. The G-TAM comprises a variety of contracts, as set out in Figure 11. It incentivizes RE resource-rich states to develop capacity beyond their obligation and allows for balance in renewable purchase obligation (RPO) targets.

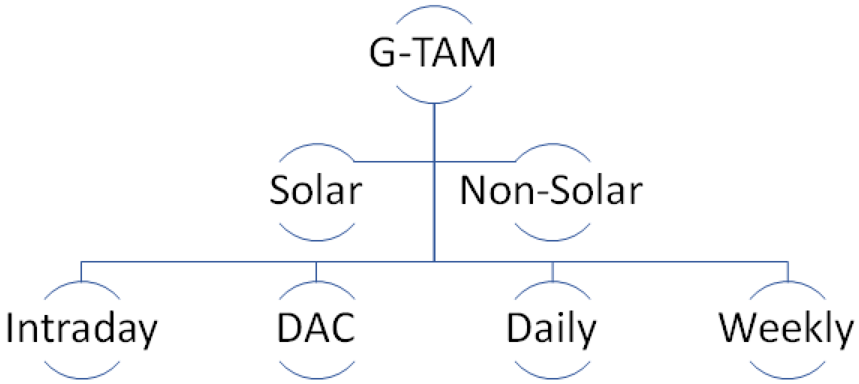

Figure 11 Overview of G-TAM segment. The G-TAM includes a variety of contracts, including Green Intraday, Green Day-ahead Contingecy (DAC), Green Daily and Green Weekly, each availabe for solar and non-solar attribute. Source: IEX (n.d.)

In 2021-22, the Commission also approved the introduction of green day-ahead contracts on the exchanges, to allow trade of day-ahead contracts for renewable generation, leading to the launch of the green day-ahead market (GDAM) in 2021, providing additional avenues for RE and hydropower generators to sell power and obligated entities to meet their requirements. A new market segment for expansive generators, the High Price Day Ahead Market segment, was introduced in early 2023, and the ancillary service market, Tertiary Reserve Ancillary Services market, is planned to be introduced in May 2023.

Indian Day-Ahead markets

The introduction of the GDAM in 2021 made India the only large electricity market in the world to implement a day ahead market exclusively for renewable energy (NiSM 2022). The GDAM introduced separate clearing mechanism and price discovery for renewable and conventional energy sources. Both are cleared by the same exchange, one after the other, with priority given to renewables, which has mandatory execution status considering the availability of transmission corridor.

Data of all trades in power exchanges from March 2023 shows that about 50% of all electricity generation traded in power exchanges are traded in the DAM, making this the market with the highest trading volume in India (about 20% each are traded in the TAM and RTM and the rest is traded in the GDAM and G-TAM). Meanwhile, this remains a small fraction of total national electricity generation, as only 6.8% of generated electricity is traded on power exchanges, meaning the DA market accounts for about 3.4% of the country’s total generation.

In contrast, around 50-70% of electricity generated in Europe is traded in DA markets, as of 2021 (the percentage varies by country and region, with some areas having a higher reliance on the DA market for electricity trading than others).

For short term markets to play a bigger role in the Indian power system, there is a need to increase liquidity in these markets. Here, forward markets can have a role to play.

History of Derivatives Markets in India

India has a long history of derivatives markets, first introduced in India with Bombay Cotton Trade Association started futures trading way back in 1875. On 14th December 1995, National Stock Exchange (NSE) requested SEBI for permission to trade index futures. Derivatives trading commenced in India in June 2000 after SEBI granted the final approval to this effect in May 2000 on the recommendation of L. C Gupta committee.

SEBI permitted the derivative segments of two stock exchanges, NSE and Bombay Stock Exchange (BSE), and their clearing house/corporation to commence trading and settlement in approved derivatives contracts. The trading in BSE Sensex options commenced on June 4, 2001, and the trading in options on individual securities commenced in July 2001. Futures contracts on individual stocks were launched in November 2001. In June 2003, NSE introduced Interest Rate Futures which were subsequently banned due to pricing issue.

Date	Progress
14 Dec. 1995	NSE asked SEBI for permission to trade index futures.
7 Jul. 1999	Reserve Bank of India gave permission for OTC forward rate agreements and interest rate swaps
24 May 2000	SIMEX chose Nifty for trading futures and options on an Indian index.
25 May 2000	SEBI gave permission to NSE and BSE to do index futures trading.
9 Jun. 2000	Trading of BSE futures commenced at BSE.
12 Jun. 2000	Trading of Nifty futures commenced at NSE.
31 Aug. 2000	Trading of futures and options on Nifty to commence at SIMEX.
Jun. 2001	Trading of Equity Index Options at NSE.
Jul. 2001	Trading of Stock Options at NSE
Nov. 9, 2002	Trading of Single Stock futures at BSE
Jun. 2003	Trading of Interest Rate Futures at NSE
Sept. 13, 2004	Weekly Options at BSE
Jan. 1, 2008	Trading of Chhota (Mini) Sensex at BSE
Jan. 1, 2008	Trading of Mini Index Futures & Options at NSE
Aug. 29,2008	Trading of Currency Futures at NSE
Oct. 2,2008	Trading of Currency Futures at BSE

The commodity market ecosystem consists of 2 segments:

- **Physical Markets:** comprising 1) spot markets or cash markets and 2) markets for physical forwards[6]
- **Forward Markets[7]:** Derivatives (Risk Mgmt. tools for products), including futures and options.

SEBI has notified 91 commodities, where exchanges may launch derivative contracts. Among these Crude oil and Natural gas have also been notified as Energy commodities. For example, MCX iCOMDEX Energy Index is based on the liquid Crude oil and natural gas futures contracts traded on the Multi Commodity Exchange (MCX) (MCX ENRGDEX, n.d.).

Status and plans for financial products and forward market for electricity

While electricity markets have been developing and emerging in India since 2001, forward markets have not yet been developed, partly due to ambiguities between SEBI and CERC. Currently, electricity market participants thus lack financial products for hedging, in a power sector characterised by a dominance of

[6] These physical forwards are physical contracts, as opposed to physically *settled* financial contracts.
[7] Forward markets are for financial contracts, which may be physically settled or financially settled.

longer duration PPAs in power procurement and limited representation of power exchange in overall electricity transactions.

However, having reached agreement in 2021 on the division of responsibilities between CERC and SEBI, the way has been paved for the introduction of forward instruments.

Division of responsibilities between CERC & SEBI

CERC operates under the Electricity Act, which is an exhaustive legislation that covers all aspects of electricity such as Generation, Licensing, Transmission, Distribution, setting up Tariffs, Investigation and Enforcement, etc. The Securities and Exchange Board of India operates under the Securities and Exchange Board of India Act, 1992, and covers all aspects related to the Securities Market such as shares, scrips, stocks, bonds, debentures, debenture stock, derivatives, etc.

Under section 18A of the Securities Contracts (Regulation) Act, 1956 (SCRA), forward contracts can be entered into only in respect of goods notified by the Central Government in the Official Gazette and the contracts in respect of the goods so notified are mandatorily required to be entered into only by and between the members of a stock exchange or with any such member, failing which, a forward contract even in respect of notified goods would be illegal. In a notification issued by the Department of Economic Affairs, Ministry of Finance on 27th September 2016, the Central Government in consultation with SEBI notified the goods specified in the Schedule under Section 2(bc) of SCRA, where electricity was mentioned as a commodity that could be traded as derivatives.

The issue of regulatory jurisdiction between CERC (the electricity regulator) and SEBI (the financial market regulator) over the financial contracts in electricity has been sub-judice since 2011. A Committee was constituted by the Ministry of Power, Government of India, to examine the technical, operational, and legal framework for futures/forward and derivative contracts in electricity and to give recommendations. Based on the recommendations of the Committee, both SEBI and CERC agreed that CERC would regulate all the physical delivery-based forward contracts, whereas SEBI would regulate the financial derivatives.

In November 2021, in line with the recommendations of the Committee's Report, a Joint Working Group (JWG) was constituted to regulate electricity derivatives with representations from CERC and SEBI efficiently. The JWG has met several times, and discussions on financial derivatives are in progress. The Power system operator and various subject experts have also been engaged in these discussions.

Introduction of Longer Duration Contracts in Indian Power Sector

Subsequent to the agreement between the two regulators, CERC approved the power exchanges to introduce additional contracts in TAM and GTAM beyond T+11 days. These contracts are physical delivery-based forward contracts and/or NTSD Contracts. The power exchanges have launched/ are in the process of launching the below contracts (for clarity on delivery options refer to Table 1):

- Daily Contracts with Delivery T+2 to T+90 days
- Weekly Contracts with Delivery TW+1 to TW+12 weeks
- Monthly Contracts with Delivery TM+1 to TM+3 months
- Any day Single side reverse auction Contract with Delivery T+2 to T+90 days.

This has opened the gates for introduction of longer duration delivery-based contracts in the Power Exchanges which has otherwise been restricted to only 11 days due to the pendency of the case. This will enable the DISCOMs and other large consumers to plan their short-term power procurement more efficiently. Similarly, the commodity exchanges viz. MCX etc. can now introduce financial products viz. Electricity futures etc. which will enable the DISCOMs and other large consumers to effectively hedge their risks of power procurement. This is a significant development and has the potential to change the landscape of the electricity market in the country. This will bring newer products in the power/commodity exchanges and attract increased participation from power generation companies, DISCOMs, large consumers etc. which will eventually deepen the electricity market. In order to work out the modalities of implementation a JWG of SEBI and CERC has been constituted and work is ongoing in this regard.

The two power exchanges, Indian IEX and PXIL, filed their petitions before the commission for seeking approval on term-ahead contracts beyond 11 days. In accordance with Electricity market Regulations, 2021, CERC examined proposals of the IEX and PXIL for longer-duration contracts and, accordingly, permitted to introduce monthly contracts and any-day single-sided contracts. CERC also allowed modification in the existing daily contracts and weekly contracts to make them available beyond 11 days. Recently Hindustan Power Exchange has also been granted permission to introduce these contracts through CERC order on petition number 206/MP/2022 dated 30th December 2022. CERC approved these contracts for a maximum duration of three months, considering the month in which the transaction is made as the zero-month. Any day single-sided contracts were approved with reverse auction, while other contracts, such as daily contracts, weekly contracts and monthly contracts were approved with a uniform price step open auction.

Contract specifications of approved forward contracts to be introduced at power exchanges

Name of the contract	Commencement of bidding	Last day of bidding	Delivery duration	Price discovery
Daily contracts	On daily basis	Two days before delivery day	T+2 to T +90 days	Uniform price step open auction
Weekly contract	Monday of the week prior to delivery	Friday of one week prior to delivery	TW+1 to TW +12 weeks	Uniform price step open auction
Monthly contract	First day of zero-month	For the first month (M1) contract – 10 days prior to the close of zero-month (M0); for the second month (M2) contract – 5 days prior to the close of zero-month (M0); for the third month (M3) contract – last day of zero-month (M0)	TM+1 to TM+ 3 months	Uniform price step open auction
Any-day single-sided contract	On daily basis	Two days before delivery day	T+2 to T+90 days	Reverse auction

Source: CERC orders dated June 7, 2022 with respect to applications of IEX and PXIL

Table 1 Contract specification of approved forward contracts in India

Hence, daily contracts, weekly contracts and any-day single-sided contracts for the third month can be traded on a rolling basis in zero-month (M0), first month (M1), second month (M2) and third month (M3), subject to the timelines specified in the accompanying table. With regard to the monthly contract, the first month (M1) contract can be traded up to 10 days prior to the close of the zero-month (M0); the second month (M2) contract can be traded up to five days prior to the close of the zero-month (M0); and the third month (M3) contract can be traded up to the last day of the zero-month (M0). Daily weekly and monthly contracts would be available for pre-specified time blocks, while any-day single-sided contract would be available as per user-defined days and time blocks. Also, the capacity offered under these contracts from a resource in the same time block would be separate and non-overlapping, which effectively means that the source of power with respect to the energy transacted under these contracts will not be able to participate in other available market avenues.

Long-duration contracts are already actively segmented in Indian PXs. For the duration of 1st September 2022 to 30th April 2023, the total scheduled volume in PXs for Term Ahead and Green Term Ahead long-duration contracts (greater than T+11 days) was about 2800 million units. Whereas for the same period, the total approved volume for less than T+11 days was about 9000 million units.

Need for Electricity Derivatives in India

Electricity spot prices in the emerging electricity markets, such as in India, are generally volatile (for example, Volatility in the DA market for 2022 was around 16%), due to smaller market size (6% of total electricity generation), various dynamic factors such as weather conditions, change in fuel supply positions, variation in RE generation, transmission congestion and other physical attributes of electricity production and distribution. There is a need for hedging instruments that reduce price risk exposure for market participants, including generators, buyers and load serving entities.

In the Indian power sector, there is a need to develop price risk management tools to help electricity market players manage price risk arising from the volatility of prices. This would necessitate development of derivatives market as derivatives are used for purpose of price risk management, hedging and risk transfer between participants with different risk profiles.

However, a large, liquid and efficient spot market is essential for the healthy development of derivative markets. For derivative markets to function optimally, it is essential that the price discovery process in the spot market is robust, to provide the benchmark for the derivative market. Once supply/demand deficit reduces, liquidity gathers in spot markets, markets mature and deepen, derivatives may be introduced.

The role of power exchanges is expected to transform over time. From the present main purpose of acting as price signal for investments, to increasingly also act as risk transfer platform. The present trend, globally, is to promote exchange traded contracts (in all types of markets), due to the robust risk management of exchanges/clearing corporation, reducing issues of systemic risk. However, OTC traders are expected to continue to play an important role, providing structured and financing solution to power players and play the role of buyer/supplier aggregator.

Notably, derivative markets cannot be viewed in isolation as the larger purpose of derivatives is to provide participants in other electricity markets with services like price risk management and hedging, the forward price curve to show the demand supply situation in the long term, and as a platform for risk transfer between participants of different risk profiles. There is strong theoretical and empirical basis that activities in the derivative markets impact the spot/delivery market and therefore regulation of derivative market is essential for successful development of electricity markets.

3.3. Key insights on forward market development

The need for well-functioning Day-Ahead market

In Europe, historically, DA markets have received the most attention, developing first as national markets. Integration of national DA markets across Europe occurred over time, and were the first electricity markets to be fully coupled into a single European Day-Ahead market. In Europe, the DA market has enjoyed a high level of participation, stricter transparency regulation, and greater market trust encouraging both smaller and larger players to compete. DA markets, in turn, have been able to provide a reference price for the derivative markets, trading decisions, and execution of governmental subsidy policies. The DA market and the establishment of SDAC have made it easier for the power forward exchanges to establish and channel new products into the market, as all market participants know the underlying price formation and what price to be used for settlement.

Market liquidity

Liquidity in the market(s) delivering the reference price is essential for a well-functioning forward market but is very hard to evaluate. This is particularly the case in Europe, with the constantly developing European electricity markets. Different financial exchanges have been established in each country, and measures to increase liquidity have been put in place at a very uneven rate. Therefore, it is close to impossible to agree to an EU-wide common understanding of good liquidity, although standard definitions have been explored ((FCA GL), Section 2, article 30 (3)). In a new context, it would be ideal to set common standards and measurements before establishing a forward electricity market.

Dynamic products for RES integration

Base-load contracts (using an average spot price over a contract period) are well-functioning hedging tools in a stable market and have worked well to start a liquid forward electricity market, as it covers the requirements for most (conventional) generators' and consumers' profiles, resulting in most market participants having a benefit in utilizing these types of base-load contracts. However, with the increase of RES, more dynamic products suitable for stochastic production profiles will be required, as RES production profiles do not follow the standard base-load profile. In countries with strong ambitions for integration of a large share of RES, dynamic products should be considered from the beginning, when establishing forward markets.

The establishment of a forward market for power has increased investment security. Since most contracts are financial, market participants are encouraged to still participate in the DA market. Forward markets can provide an opportunity for cost-efficient balancing and the same level of system security as the long-term physical contracts, providing steady cash flow solutions for market participants, a robust foundation for investment decisions, and long-term security of supply.

4. Regulation of forward markets

This section outlines regulations and legal frameworks relevant to the forward and financial markets in the EU/Denmark and India.

4.1. Regulations in Europe/Denmark

Markets in Financial Instruments Directives (MiFID) I and II

The framework governing the financial contracts is the MiFID, the Markets in Financial Instruments Directive (2004/39/EC). It is a framework that is applicable to all financial markets, not merely the markets dealing with electricity as a commodity. Active since 2007, it is an important act that secures harmonised rules and protection for market participants, and improves competitiveness in the forward markets. MiFID includes organisation requirements for market participants and conduct of business, but also the regulatory reporting to avoid market abuse, rules on admission of instruments to trading. MiFID I was revised and updated with MiFID II (2014/65/EU) in October 2011. The main improvements of MiFID II over MiFID I were within transparency (introduced additional reporting requirements and increased the amount of information that is available to market participants). Further, additional improvements of non-discriminatory access to central counterparties and stricter requirements to high-frequency trading, trading venues and benchmarks were set in MiFID II to increase competition. The MiFID II also improves the protection of investors, with requirements that cover structured deposits, responsibilities of management bodies, staff remunerations and best executions, amongst others. As directives impose to be transposed into national law to enter into force, MiFID II was transposed into Danish law in 2017, and it has been active since 2018.

Market Abuse Regulation

The Market Abuse Regulation (MAR) No 596/2014 of 16 April 2014 provides a common regulatory framework for financial instruments (not merely related to electricity) on insider dealing, the unlawful disclosure of inside information and market manipulation, all three constituting market abuse, as well as measures to prevent such market abuse to ensure the integrity of forward markets in the EU and enhance investor protection and confidence in those markets.

According to Annex I Section C(6) of MiFID II, the financial legislation, including MAR applies to all financial instruments except for wholesale energy products traded on an organised trading facility that must be physically settled. In this case, the EU REMIT is applicable.

Transparency Regulation and Regulation on Wholesale Energy Market Integrity and Transparency

Market monitoring and transparency regulations are among the other aspects that are theoretically subject to regulation in forward markets. In Europe there are two overarching regulations that govern market monitoring and transparency for wholesale energy products, those two being the transparency regulation (TR) and the REMIT. These are in place to ensure a fair and well-functioning electricity market, maintaining markets' integrity.

The TR, (EU) No 543/2013 of 14 June 2013 requires TSOs to publish information provided by market participants regarding the planned or unplanned unavailability of consumption, transmission capacity, and generation and production units of 100 MW or more. The information must be published as soon as possible, but latest one hour after the decision regarding planned unavailability, and in case of unplanned change one hour after the change occurred. This information is published on ENTSO-E's own transparency platform (Entsoe, n.d.). However, the responsibility for ensuring the accuracy and completeness of published information lies with market participants, not the platform, except for instances where data errors occur after the market participant has submitted the information

REMIT ((EU) No. 1227/2011 of 25 October 2011) was specifically designed to accommodate the operational complexity of physical energy markets and specificities of the energy sector (electricity and natural gas) and to complement the market abuse legislation covering the financial sector, which today includes MAR as described above. REMIT applies to wholesale energy markets and contains provisions against market manipulation and insider trading for wholesale energy products. REMIT defines wholesale energy markets to encompass both commodity markets and derivative markets, including inter alia, regulated markets, multilateral trading facilities, and OTC transactions and bilateral contracts, direct or through brokers.

REMIT is addressed mostly to market participants, who must register with the European register of market participants. REMIT, like the TR, requires the publication of certain information (ACER, 2014). However, unlike the TR, which has a clear threshold of 100 MW, REMIT covers any information that is considered "inside information." For details on REMIT Reporting Guidance and requirements please refer to ACER's page on the topic (ACER, 2021). Inside information and insider trading is explained in more detail later.

Guideline on Forward Capacity Allocation

Forward markets and OCT are currently not part of the European network codes, however, the Commission Regulation (EU) 2016/1719 of 26 September 2016 establishes a guideline on forward capacity allocation (FCA), which introduces LTTRs on TSO's bidding zone borders. The regulation states that the competent regulatory authorities (often the National Regulatory Authorities, e.g. Danish Utility Regulator in Denmark) may adopt the decision to not issue LTTRs on a bidding zone border, if they assess that the available forward market provides sufficient opportunity for hedging on the respective bidding zone border.

The FCA sets out that TSOs offer LTTR through auctions, based on the marginal price methodology, either as physical transmission rights (PTRs) or FTRs (not in parallel on one border). Further, the FCA requires harmonised allocation rules to be proposed by TSOs, and once approved by all regulatory authorities, the auctions are to be operated by a single entity, which since 2017 is the Joint Allocation office (owned by 20 TSOs in 17 countries). As of 2022, most TSOs in Europe have converted or are in the process of converting PTRs to FTRs. In FTR auctions, "Use-it-or-sell-it" condition of PTRs becomes "Sell-it-without-the-possibility-of-using-it". As discussed earlier, ACER and CEER have identified several shortfalls on the current FCA, therefore it is likely to be updated in the future.

Market surveillance

Efficient market monitoring at the EU level is key to detecting and deterring market abuse in energy markets. Monitoring markets allow to detection of suspicious patterns or abnormalities in prices and can trigger regulatory and criminal investigations. In general, strong cross-border market monitoring is essential for the completion of a fully functioning, interconnected and integrated internal energy market. Markets are not limited by national borders; market participants can be active in different countries and there are many instances where cross-border transactions can be suspicious. The underlying purpose is to protect consumers and guarantee affordable energy prices. It is important to ensure that market participants can have confidence in the integrity of electricity and gas markets. When markets are being monitored, market participants expect that they are working as they should. Prices should reflect supply and demand, which are impacted by many factors (e.g., unavailability, unplanned outages), and should not be influenced by misleading signals on supply or demand.

Market surveillance is a requirement for the exchanges, based on the Capacity Allocation and Congestion Management Guideline (CACM) ((EU) 2015/1222) article 6. Further, REMIT article 15 states that any person professional arranging transactions for wholesale energy products shall establish and maintain effective arrangements and procedures to identify breaches of the prohibition of insider trading or market manipulation. In addition, national law also requires that the market is observed. Therefore, Power Exchanges and financial exchanges have implemented market surveillance instances in their organisations to secure that the markets are fair. These market surveillance teams must have appropriate governance models and internal procedures and policies, based on the assessment of the potential sources of risk, including communication and human resources procedures aiming at avoiding any conflict of interests that could otherwise be experienced. These procedures require for example all market surveillance work to be recorded and traceable for a period of at least five years.

For rules on the financial products exchanged on the market in the Nordics, NASDAQ has published all their rules and setup, available online (NASDAQ, 2023).

ACER has published a general Guidance on how the application of REMIT that includes a more detailed interpretation of market manipulation and insider trading and information on how exchanges fulfil their market surveillance responsibilities (ACER, 2023) as well as several guidance notes on specific forms of market manipulation: wash trades, capacity hoarding, layering, and spoofing.

Inside information and insider trading

Article 4 of REMIT mandates market participants to publish information, which can also serve as the basis for a case of insider trading under Article 3, potentially resulting in criminal proceedings. Market participants must publicly disclose inside information that they possess in an effective and timely manner. It shall include information relevant to the capacity and use of facilities for the production, storage, consumption or transmission of electricity or natural gas, including planned or unplanned unavailability of these facilities. 'Inside information' means information of a precise nature that has not been made public, which relates directly or indirectly to one or more wholesale energy products and which, if made public, would likely affect the prices of those wholesale energy products significantly. It is a subjective assessment from market participants to decide whether the information they possess constitutes inside information or not.

The information must be published as soon as possible but, in any case, before trading in wholesale energy products to which that information relates. Few exceptions apply, mainly to protect critical interests.

The information shall be published on a so-called inside information platform (IIP), in the form of an urgent market message. These IPPs must be approved by ACER, the European energy agency, and fulfil a series of requirements, including publicity and technical standards. An example of such IPP is NUCS, the platform created by the Nordic TSOs (NUCS, 2023).

If information is deemed to be inside information, a person who possesses it must not use it to acquire or dispose of, directly or indirectly, the products that the information relates to, nor disclose this information to any other person, nor recommend or induce anyone based on that information to acquire or dispose of a product to which the information relates to. If a person possessing inside information has traded or attempted to trade related products, there is a presumption of insider trading unless proven otherwise. The burden of proof lies, therefore, on the presumed insider trader to show that the existence and possession of inside information were not linked to their decision on a respective transaction.

The prohibition of insider trading aims to reduce information asymmetry between market participants, allowing for fair market participation. It fosters market confidence and helps ensure that prices on energy markets reflect a fair balance between supply and demand, untainted by illicit gains from such abusive practices.

Market manipulation Enforcement of the prohibition rules of insider trading and market manipulation

There are different parties involved in the surveillance of the markets, as illustrated in Figure 12. ACER, as an overarching entity and the one responsible for collecting all the data under REMIT, analyses the markets continuously and, in case of potential breach reports this to the responsible NRA of the country where the Balance responsible party (BRP) is registered. The organised marketplaces also have implemented arrangements to identify potential breaches and report these to the relevant NRA.

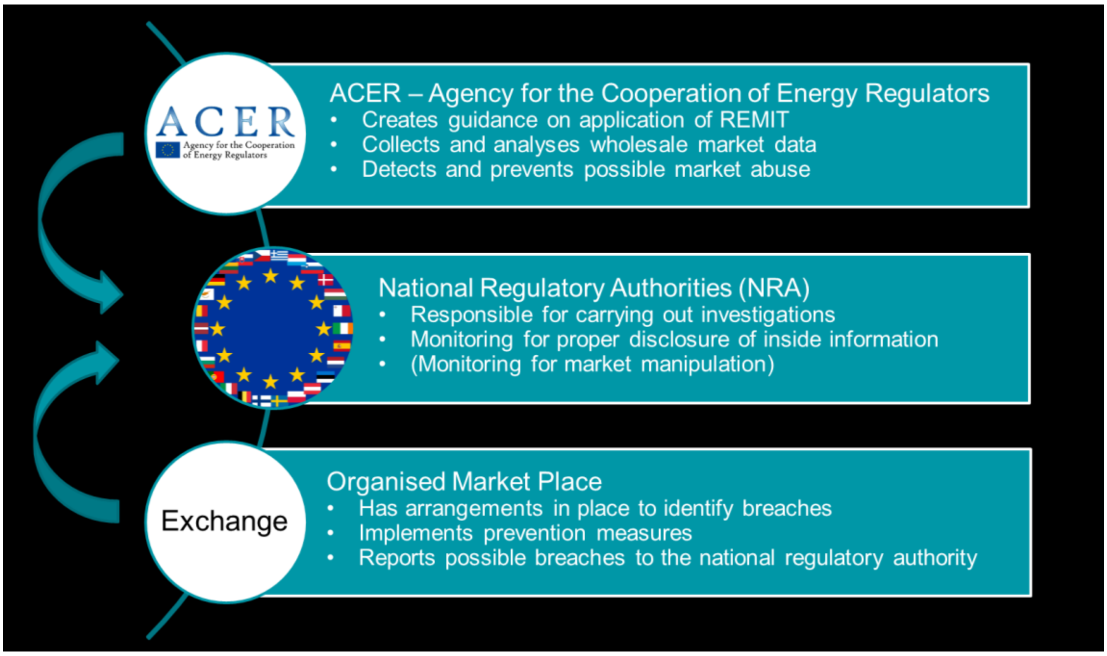

Figure 12 Roles between parties in EU for market surveillance. Source: NordPool

The national authorities are responsible for further investigations nationally and following through with procedures for prosecuting. National authorities look at cases related to market manipulation and insider trading based on REMIT and TR.

In Denmark, the process of identifying and combating market abuse, as well as promoting fair competition and preventing antitrust violations, involves multiple authorities and regulatory bodies. Figure 13 provides an overview of the authorities and their responsibility.

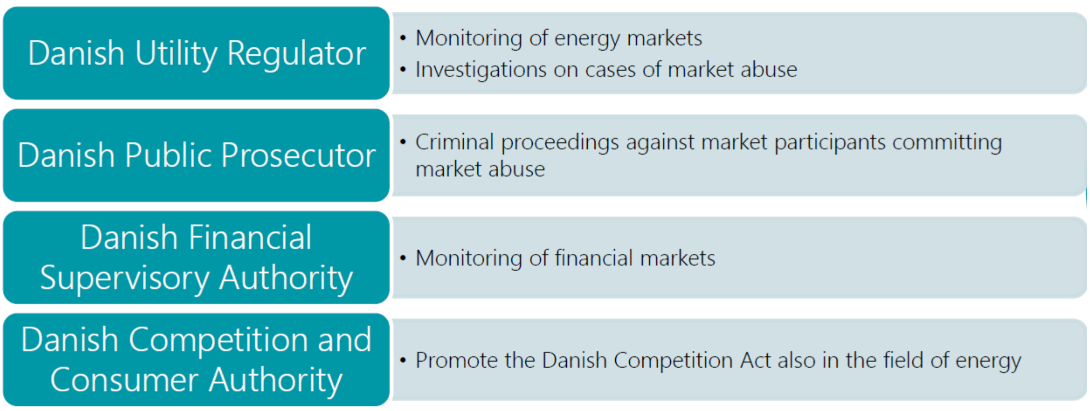

Figure 13 Danish authorities involved in market abuse investigations and prosecutions. Source: DEA

The Danish Financial Supervisory Authority also looks over the stock exchange, and it is the party responsible for monitoring the forward markets. Prosecution etc., is performed by the Danish Public Prosecutor, who receives the case from the other authorities. Danish Utility Regulator mostly focuses on the physical energy markets, and the Danish Competition and Consumer Authority are overarching and generally involved in securing fair competition in markets. Potential overlaps between these authorities are usually solved through internal coordination and mutual agreement on who is the most relevant to investigate specific cases.

Although market abuse through market manipulation or insider trading is prohibited EU-wide according to EU rules, each EU country retains its national sovereignty over how the investigations and subsequent prosecution are conducted. They also have a large leeway when it comes to their sanctioning powers. In some EU countries, the national regulatory authority can impose direct administrative fines on market participants in case of proven market abuse, while in others, such as in Denmark, only the prosecutor or a judge may do so after criminal procedures. According to REMIT, the penalties for market abuse should be proportionate, effective, and dissuasive and reflect the gravity of the infringements, the damage caused to consumers, and the potential gains from abusive trading. As these are the only requirements set in REMIT, there are large disparities throughout the EU between how much the fines can be in each country, as illustrated in Table 2 below (ACER, n.d.).

Decision date	NRA, Member State	Market Participant	Type of REMIT breach	Fine	Status
30 September 2021	BNetzA (DE)	Energi Danmark A/S	Article 5	EUR 200,000	Final
30 September 2021	BNetzA (DE)	Optimax Energy GmgH	Article 5	EUR 175,000	Under appeal
24 August 2021	OFGEM (UK)	ESB Independent Generation Trading Limited and Carrington Power Limited	Article 5	~ EUR 7 million	Final
25 February 2021	CNMC (ES)	Rock Trading World S.A.	Article 5	EUR 60,000	Appeal possible
16 December 2020	OFGEM (UK)	EDF Energy (Thermal Generation) Limited	Article 5	~ EUR 6.7 million	Final
25 March 2020	OFGEM (UK)	InterGen (UK) Ltd, Coryton Energy Company Ltd, Rocksavage Power Company Ltd, Spalding Energy Company Ltd	Article 5	~ EUR 42.5 million	Final
03 January 2020	NERC (LT)	UAB Geros dujos	Article 5	EUR 28,583	Final
19 December 2019	CRE (FR)	BP Gas Marketing Limited	Article 5	EUR 1,000,000	Appeal possible
December 2019	MEKH (HU)	Valahia Gaz S.R.L.	Article 5	~ EUR 90,000)	Final
September 2019	MEKH (HU)	MAVIR Magyar Villamosenergia-ipari Átviteli Rendszerirányító Zártkörűen Működő Részvénytársaság	Article 5	~ EUR 3,000	Final
05 September 2019	OFGEM (UK)	Engie Global Markets	Article 5	~ EUR 2,393,427.80	Final
20 February 2019	BNetzA (DE)	Uniper Global Commodities SE + Two traders	Article 5	EUR 150,000 and fines of EUR 1,500 and EUR 2,000 for each trader respectively.	Final
21 December 2018	Prosecutor/DUR (DK)	Neas Energy A/S	Article 5	~ EUR 20,400	Final
28 November 2018	CNMC (ES)	Multienergía Verde, S.L.U.	Article 5	EUR 120,000	Under appeal
28 November 2018	CNMC (ES)	Galp Gas Natural, S.A.	Article 5	EUR 80,000	Final
30 October 2018	Prosecutor/DUR (DK)	Energi Danmark A/S	Article 5	~ EUR 147,000	Final
05 October 2018	CRE (FR)	VITOL S.A.	Article 5	EUR 5,000,000	Final
24 November 2015	CNMC (ES)	Iberdrola Generación S.A.U.	Article 5	EUR 25,000,000	Under appeal

Table 2 Example of conclusions on breach of REMIT article 5. Source: ACER (n.d.)

4.2. Regulation in the Indian power sector

Financial markets for electricity production are still under development in India. However, as financial products emerge, it is agreed that CERC will regulate all the physical delivery-based forward contracts, and SEBI will regulate the financial derivatives in future. In this chapter, the regulations applicable for existing physical delivery-based forward contracts in India are discussed. Note: several of these acts and policies were under amendment during the writing of this report, but the main points discussed below remain applicable.

Electricity Act, 2003

The promotion of competition in the Electricity Supply Ecosystem in India is one of the key objectives of the Indian Electricity Act, 2003 (the Act). The Preamble to the Act states as follows:

*"An Act to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity and generally for taking measures conducive to **development of electricity industry, promoting competition** therein, protecting interest of consumers and supply of electricity to all areas, rationalization of electricity tariff, ensuring transparent policies regarding subsidies, **promotion of efficient and environmentally benign policies**, constitution of Central Electricity Authority, Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto."*

The Act opened up the hitherto largely regulated industry characterized by long term PPAs. The Act empowers the appropriate commissions to specify, by regulations, the provisions for open access. The structure of the Indian electricity sector is depicted in Figure 14.

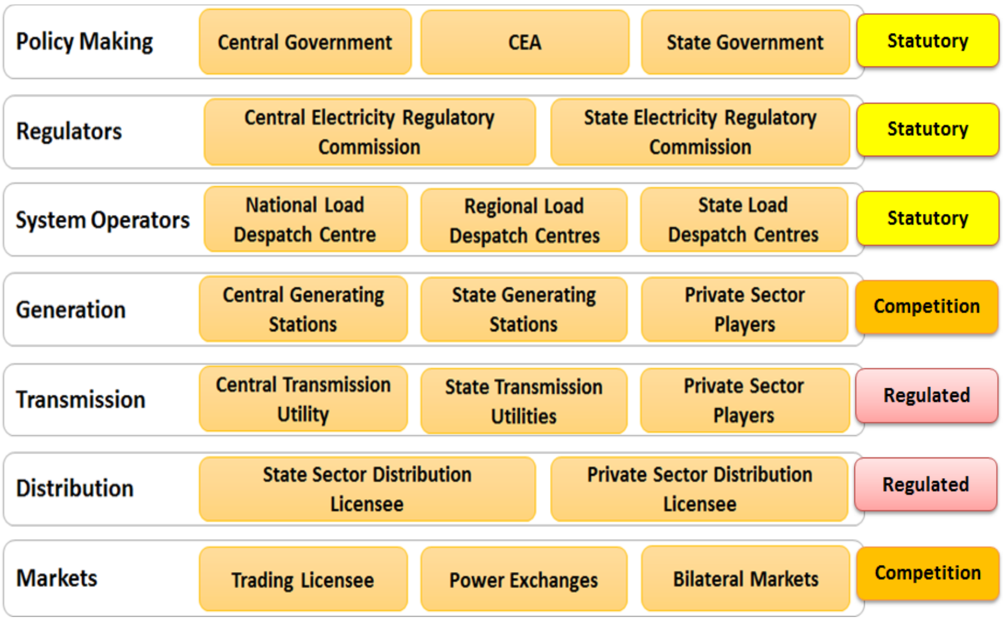

Figure 14 Structure of Indian Electricity Sector.

As per of the Act Open Access is defined in *Section 2(47)*, as:

"…… Open Access means the non-discriminatory provision for use of transmission line or distribution system or associated facilities with such line or system by any licensee or consumer or a person engaged in the generation in accordance with the regulations specified by the Appropriate Commission…"

Section 66 of the Act mandates Appropriate Commission to promote the development of a market (including trading) in power in such manner as may be specified and guided by the National Electricity Policy (NEP). The Act recognises trading as a separate licenced activity. The CERC issues licence for inter-state trading in electricity. The trading licensees undertake electricity transactions through bilateral and power exchanges arrangements. There were 48 trading licensees as of February 2023. (*Source: CERC Monthly MMC Report February, 2023*)

The regulatory framework governing the markets framework includes Indian Electricity Grid Code, 2010, CERC (Connectivity and General Network Access to the inter-State Transmission System) Regulations, 2022, CERC (Open Access in inter-State Transmission) Regulations, 2008, CERC (Electricity market) Regulations, 2021, CERC (Procedure, Terms and Conditions for grant of trading licence and other related matters) Regulations, 2020, Guidelines for Registration and Filing Application for Establishing and Operating Over the Counter (OTC) Platform, 2022, CERC (Terms and Conditions for Renewable Energy Certificates for Renewable Energy Generation) Regulations, 2022, CERC (Deviation Settlement Mechanism and Related Matters) Regulations, 2022, CERC (Ancillary Services) Regulations, 2022 and CERC (Sharing of Inter-State Transmission Charges and Losses) Regulations, 2020.

National Electricity Policy, 2005

The NEP aims at laying guidelines for accelerated development of the power sector, providing supply of electricity to all areas and protecting interests of consumers and other stakeholders keeping in view availability of energy resources, technology available to exploit these resources, economics of generation using different resources, and energy security issues. The policy emphasizes that the State Electricity Regulatory Commissions (SERCs) need to provide facilitative framework for non-discriminatory open access including open access to distribution networks, initially for bulk consumers, to increase the availability of power. The relevant extracts from the NEP are quoted as below:

- *"5.7 COMPETITION AIMED AT CONSUMER BENEFITS*
    - *"5.7.1 ...d. Development of electricity market would need to be undertaken by the Appropriate Commission in consultation with all concerned.*
        - *e. The Central Commission and the State Commissions are empowered to make regulations under section 178 and section 181 of the Act respectively. These regulations will ensure implementation of various provisions of the Act regarding encouragement to competition and also consumer protection....."*

Tariff Policy, 2016

Some of the major objectives of the Tariff Policy, 2016 are to promote competition, efficiency in operations and improvement in quality of supply, transparency, consistency and predictability in regulatory approaches across jurisdictions, minimise perceptions of regulatory risks and encouragement of renewable generation. Tariff Policy, 2016 recognizes that competition will lead to significant benefits to consumers through reduction in capital costs and also efficiency of operations. The relevant extracts from the Tariff Policy, 2016 are quoted as below:

> *"...5.9 The real benefits of competition would be available only with the emergence of appropriate market conditions. Shortages of power supply will need to be overcome. Multiple players will enhance the quality of service through competition. All efforts will need to be made to bring power industry to this situation as early as possible in the overall interests of consumers...."*

Guidelines on Cross Border Trade of Electricity, 2018

In order to facilitate and promote cross border trade of electricity, the Guidelines for Import / Export (Cross Border) of Electricity- 2018 (the Guidelines) have been issued by Ministry of Power, Government of India on 18th December 2018. The objectives of the Guidelines are to:

> *a. Facilitate import/ export of electricity between India and neighbouring countries;*
>
> *b. Evolve a dynamic and robust electricity infrastructure for import/ export of electricity;*
>
> *c. Promote transparency, consistency and predictability in regulatory mechanism pertaining to import/ export of electricity in the country;*
>
> *d. Reliable grid operation and transmission of electricity for import/ export ..."*

Central Electricity Regulatory Commission (Cross Border Trade of Electricity) Regulations, 2019 were notified on 08th March, 2019. As a designated authority under the guidelines, CEA has issued its procedure for facilitating the import and export of electricity on 26th Feb 2021.

The role of the regulators

CERC and SEBI are two regulatory bodies in India that operate under different acts of legislation. CERC operates under the Electricity Act, which covers all aspects of electricity including generation, licensing, transmission, distribution, setting up tariffs, and investigation and enforcement. SEBI operates under the Securities and Exchange Board of India Act, 1992, which covers all aspects related to the securities market such as shares, stocks, bonds, and derivatives.

However, there has been a longstanding issue of regulatory jurisdiction between CERC and SEBI over financial contracts in the electricity sector since 2011. To address this, the Ministry of Power, Government of India, constituted a committee to examine the technical, operational, and legal framework for futures/forward and derivative contracts in electricity and to provide recommendations.

Based on the Committee's recommendations, both CERC and SEBI agreed that CERC would regulate all physical delivery-based forward contracts, while SEBI would regulate financial derivatives. This agreement helped to resolve the issue of regulatory jurisdiction between the two regulatory bodies and provided clarity on the regulatory framework for financial contracts in the electricity sector in India.

Electricity Market Monitoring in India

Ministry of Power in March 2019 had entrusted CEA with the task of monitoring the volume and price of electricity transacted on the power exchanges of India, (i.e., IEX, PXIL, and HPX). Subsequently, the Regulatory Affairs Division of CEA started preparing monthly market monitoring reports (MMMR) and annual market monitoring Reports (AMMR) with the objective of an analysis of the movement of prices discovered for the electricity transacted on the power exchanges in India in the short term markets (DAM, GDAM, TAM, GTAM, and RTM), suggest modalities for deepening the electricity market, facilitate the introduction of new products in the power exchanges, etc. CEA is not responsible for market surveillance.

The Market Monitoring Cell (MMC), a part of the Economics Division of the CERC, is responsible for monitoring electricity markets from a regulatory perspective. Its main functions include monitoring compliance with Electricity market Regulations and Trading Licence Regulations, collecting data from traders, power exchanges, and Power System Operation Corporation (GRID-INDIA), and preparing monthly and annual reports on short-term electricity transactions. The MMC is also responsible for market surveillance and oversight, reviewing the functioning of power exchanges, highlighting market abnormalities to CERC for necessary action, and disseminating market information.

The scope of the Monitoring Mechanism is limited to short-term transactions of electricity (contracts of less than one year) for electricity transacted through traders and directly between DISCOMs, power exchanges, and DSM.

MMC monitors compliance with Electricity Market Regulations 2010 and Trading Licence Regulations 2020. Power exchanges submit quarterly Market Surveillance Reports, Half-Yearly Risk Management Committee Reports, Annual IT Audit Reports, and audited annual reports to ensure compliance with net worth and shareholding pattern requirements.

Traders and power exchanges submit data, including the volume and price of each transaction, trading margin charged, bidding patterns, and congestion details, per the formats prescribed by MMC/Electricity Market Regulations.

MMC disseminates the reports on the website of CERC and requires traders and power exchanges to post the data on their websites as directed by the Commission occasionally. CERC publishes an annual report on short-term electricity market and circulates it to stakeholders, including MOP, CEA, GRID-INDIA, traders, power exchanges, SERCs, etc.

Currently, there is no mechanism for real-time surveillance on behaviour of market participants. Nether CEA or CERC have access to historical & real-time bidding data required to automatically detect foul play in the market

In the near future, MMC, CERC envisions strengthening coordination between MMC, GRID-INDIA, traders, and power exchanges. The Power Market Regulations 2021 emphasized the importance of preventing market manipulation, insider trading, cartelization, and abuse of dominant position by any market participant. Additionally, MMC sees a need to improve the quality of reports submitted by power exchanges, extend market monitoring to long-term contracts, adopt new methods, and monitor indices for further data analysis to enhance market efficiency. Adopting international best practices on market monitoring and utilizing technology to monitor electricity transactions in real-time is also in the pipeline.

4.3. Insights from the European/Danish experience

A clear framework for regulatory setup, roles, and responsibilities is important, especially when designing markets across states and jurisdictions' boundaries. E.g., the interaction between ACER and national regulators has been very important for the regulatory setup and its compliance in Europe. This setup has helped also part in increasing trust in the markets.

Efficient markets rely heavily on market monitoring and transparency. These practices provide the necessary framework for data availability, which enables market participants to better understand market trends and price themselves accordingly. This is especially important when it comes to planning for the future.

Market surveillance plays a vital role in minimizing the risk of market abuse. This is accomplished through the use of established regulatory systems, both at the national and central level in Europe. These systems work to identify potential breaches of market rules and take appropriate action to sanction such breaches.

In Europe, LLTRs, which are financial products, are not regulated as a market product by the financial regulations but rather by ACER. Thus, the role of ACER overlaps with that of the financial regulator, which is being seen as one of the problematic features of the current European setup.

India has already set a separate role for the financial and physical regulator in the electricity market, anticipating problems with overlapping roles of regulators, and designing a regulatory solution, which overcomes this. In this regard, India already has a more favourable regulatory basis for the development of financial electricity markets

5. Transition from long-term physical products to forward markets

This chapter discusses some of the challenges and considerations in the transition from long-term physical products to forward markets, including on the choice of reference price and the design of the market(s) that generates the reference price. The approach across the Danish and European experience as well as considerations in the Indian context are discussed.

The following section discusses measures taken in Denmark and considerations in the Indian context in the process of transitioning from long-term physical PPAs to a market based system. This is followed by specific considerations around reference price generation for forward markets in the Indian context and overview of the Danish/European approach.

5.1. Insights from the transition in Denmark & Europe

The basis for a well-functioning forward market is a trustworthy and transparent short-term electricity market that provides reference prices. Establishing a regulatory framework and governing bodies is crucial to ensure reliable and transparent price discovery (see also section 4). In addition, the underlying electricity market needs to have a relatively large participation. During the transition from long-term physical PPAs, in order to increase market participation, it may be necessary to create incentives or even make market participation mandatory. This was the case in Denmark during the liberalization of the EU and Danish energy markets.

In Denmark, during the liberalization of the EU and Danish energy markets, many large generators and consumers had long-term physical PPAs, which did not incentivize participation in the DA market. To encourage greater market participation, long-term physical contracts were converted into financial contracts with the bidding zone price from the DA market serving as the reference price. This enabled market participants to maintain their hedged position established by the long-term physical contract while also actively participating in the electricity market and taking advantage of price signals generated by the DA market. The Danish government provided a financial boost of over 1 billion Euro for power plants to make the transition. See Box 1 for further detail.

By transferring existing physical PPAs to long-term financial contracts against the system price, this allows a transition, where generators do not lose revenue, and without increasing costs for consumers (e.g. DISCOMs).

Prior to this, contracts for consumption, production, and transmission based on physical delivery and reservation of transmission capacity meant that generators would schedule power through the same transmission grid towards consumers. This resulted in self-scheduling in silos, where production capacity was unresponsive to external events and would always generate power. Additionally, transmission capacity was always scheduled in the same direction. This meant that, depending on location, consumers may only be able to purchase power from local generators, and were not exposed to impacts in the wider system, e.g. cheaper power generation from another state.

Transitioning physical PPAs into long-term financial contracts in a market based system can lead to more responsiveness to external factors and improved socio-economic welfare, by exposing generating units to competition and enabling more efficient use of transmission capacity. In a system based on physical PPAs and no central market, there are limited external factors that can improve the overall welfare because generators don't face competition from more cost-efficient units, transmission capacity is not used to its full potential, and consumers have limited options for purchasing electricity.

Box 1 From the report "Liberalisation of the Danish Power Sector 1995-2020; capital injection to power generators." (Source: DEA, 2021).

Extract from the report; *Liberalisation of the Danish power sector, 1995-2020* (DEA 2021).

It was agreed that generation plants should be compensated for extra costs for environmentally friendly electricity generation and gas purchase agreements by:

- Existing RE plants owned by generation companies should be given green certificates for their electricity generation.
- Existing RE and small-scale natural gas-fired combined heat and power (CHP) plants owned by generation companies would also receive a regulated subsidy (a supplement to the sales price) for a four year transition period.
- The generator companies would be compensated for stranded costs of gas purchase commitments.

In addition, the generation companies would have the opportunity to strengthen the capital base by:

- The generation companies were allowed to keep unused deposits, whereas before the liberalization the vertically integrated entities were obliged to return unused deposits to the consumers.
- Revaluation of transmission networks (in the opening balances for transmission networks, etc. when transitioning from the non-profit price regulation to the new price regulation) could be capitalized,
- The generation companies should receive payment for ancillary services from the TSOs in connection with the TSOs taking over responsibility for the security of supply.

The TSOs and the transmission network companies were to finance this capital injection by raising loans. Generation companies received in total €1.2 billion to ensure that they would be able to operate in the future market. The costs were collected by the TSOs during a ten-year period to reduce the short-term impact on consumers. In accordance with EU regulation, the funds were allocated for the purposes stated above, such as subsidies to wind turbines and small natural gas-based CHPs, and an obligation of future pension costs.

Based on a Danish initiative, the EU Directive from 1996 stated that Service of General Interest also included environmental concerns - later transferred to the current Public Service Obligation (PSO). This has since driven the Danish green transition, e.g. subsidies to wind turbines (see section 1.4 below). In return for the capital transfer (and as part of the agreement), generator companies accepted to merge into two companies, one on each side of the Great Belt (West and East Denmark). Due to the economic situation at the time it was considered essential that possible efficiency gains were realized as quickly as possible.

In addition to this, some of the obligations imposed during monopoly times were put on the two groups of generator companies (ELSAM and Elkraft respectively) and by merging the companies within these groups it was not necessary to go through a complicated split of the obligations between individual companies.

Active participation in the forward markets and hedging markets for coal, gas, and carbon emissions offers significant advantage. In a continuous market setting, generators can hedge the dark spread (power and production fuel) simultaneously to minimize risks. Conversely, in a long-term physical contract, producers may only be able to sign contracts for one part of the transaction, i.e., either sell power or buy fuel, which exposes them to risk. Additionally, the financial market offers the benefit of not having any obligation to feed power into the grid. This means that when prices are favourable, producers can choose not to produce, and rather purchase power from the markets to reduce fuel usage and other short-term marginal costs.

An important change when moving from long term physical contracts to a market based system is the change of cash flow for all involved parties. Producers will, in a market set up where the short-term market is used for dispatching, receive the prime source of income from the market and the power exchanges/market operator. Consumers, buying power from the market, will buy from the power exchange, instead of paying a specific producer for the power. The function of the power exchanges thus includes clearing and settlement as well as the buying and selling of power. Since bilateral contacts are usually tied to large counterparty risk, such agreements come with a large collateral and credit cost. In a market-based setup, where the power exchanges/market operator handles the payment stream in anonymised manner from all parties, the transaction cost for each individual market participant should in the long run be reduced compared to a system based on bilateral contracts. The role of the power exchanges/market operator is therefore of social economic value since transaction cost are reduced. In addition, short-term markets offer faster settlement times, providing increased cash liquidity compared to long-term contracts that settle monthly.

The cash flow is also changed when market participants use the forward market instead of bilateral contracts to hedge the prices and reduce exposure to volatile short-term market prices. The initial cash flow from the short-term market is still existing but an extra layer of cash flow is added. As above, introduction of forward market reduces transaction costs compared to bilateral contracts, by eliminating the need for participants to evaluate and cover the risk of default of the other counterparty, as payments are cleared and anonymized via the power exchange.

5.2. Considerations for a transition in India

As emphasised, a functional reference market/price is necessary for a forward market (further discussed in the following section). Since electricity markets already exist in India, the current focus should be to boost trading volumes in these markets, to ensure sufficient volume for robust reference-price generation. There are several options to achieve this, and a few of them are discussed below. These options are not definitive recommendations but a basis for further discussion. Implementing any of these options in the Indian context requires thorough research and consideration.

CERC's (2018) Market Based Electricity Dispatch (MBED) (CERC, 2018) discussion paper highlights one option. The MBED discussion paper offers a solution to transform bilateral physical contracts to financial contracts through a Bilateral Contract Settlement (BCS) mechanism as hedging arrangement, whereby the parties are exposed to Day Ahead Market prices, but the difference between market clearing price and contracted price is subsequently settled between the parties (as shown in Figure 15). Such solution could provide a boost for the overall introduction of financial contracts and the potential to further deepen the liquidity of the short-term markets. The economic dispatch model would be explored for increased participation from states, based on the learning from the 2019 pilot, to optimize the dispatch of power plants and reduce carbon emissions. The process of introducing economic dispatch model could be carefully linked to the extension and establishment of forward markets.

In addition, there could be a discussion on the length of contracts e.g., not having >12-year contracts in place, and ensuring that new contracts are of a financial nature without physical settlement.

Academics have suggested allowing DISCOMs to partially exchange portions of their power PPAs through short-term trading in the electricity market. Currently, PPAs in India are quite rigid, making it challenging for DISCOMs to manage price fluctuations in the electricity market. By permitting DISCOMs to engage in bilateral financial trades to exchange parts of their PPAs, it may create hedging opportunities that could enable DISCOMs to better manage their risks without the need for centralized market intervention (although this could be an option in the future if required).

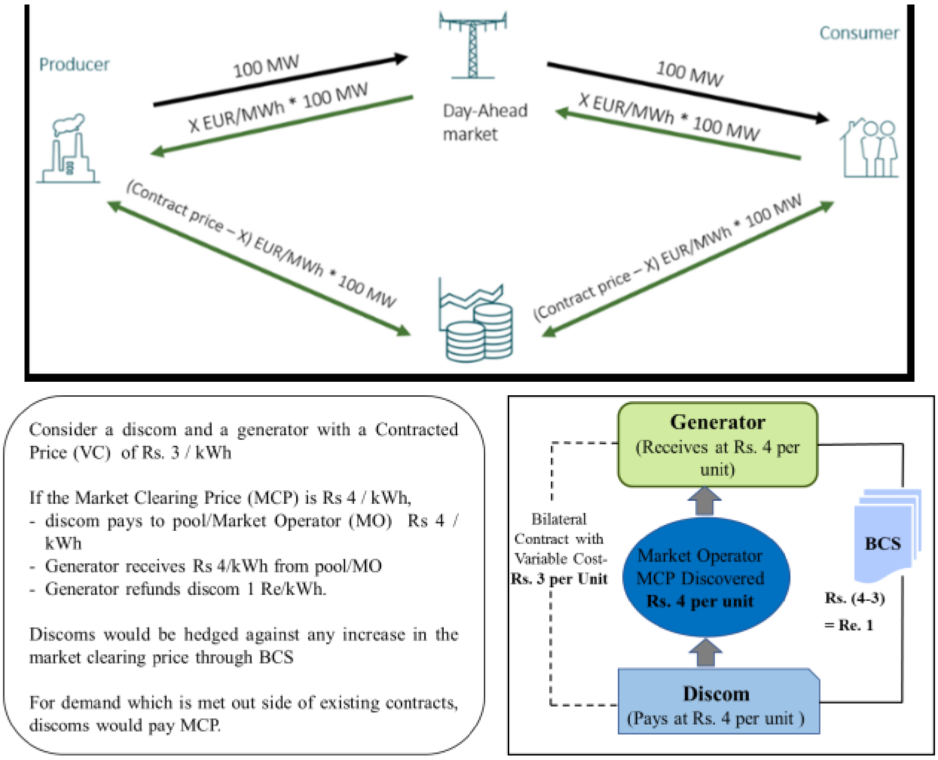

Figure 15: Transitioning from long term physical PPA to financial contract with DA market exposure. Top: Settlement of financial contracts towards DA market price (Source: Energinet). Bottom: Illustration of proposed Bilateral Contract Settlement Mechanism (Source: CERC 2018)

An expert Group for the Development of the Electricity Market in India constituted by the Ministry of Power submitted its report on 15th of May 2023. The report acknowledges the need for more depth in short-term liquidity in power exchanges and recommends long-term contracts to be at most 10-15 years, (similar to the practice in the Nordics), and setting up a system where DISCOMs would competitively contract a good mix of long-term, medium-term, and short-term capacities. The report also envisions a scenario where DISCOMs can procure and re-trade capacities in the market.

Another alternative to increase liquidity in DA markets could be to legally mandate generators, whose contracts have run out or are about to run out, to participate in DA markets.

Scheduling and dispatching measures are also important to consider. In India, most power generation is tied to contracts longer than one year with DISCOMs (87% of all generation). DISCOMs use self-scheduling to meet most of their power needs and procure the rest from bilateral transactions with other DISCOMs, through power exchanges or traders. DISCOMs are not required to inform the system operator of the variable cost of contracted generators. Self-scheduling can lead to problems such as underutilization of cheaper generation options because DISCOMs are not aware of them or allowed to schedule power from stations without contracts. This highlights the need for transition from long-term physical contracts to short term market-based contracts that are not restricted by the physical nature of delivery.

The Electricity Act 2003 mandates regional and state load dispatch centres to optimize the scheduling and dispatch of electricity within their regions based on contracts with licensees or generating companies. The complex allocation system, involving multiple beneficiaries and inter-state generating stations (ISGS), has resulted in un-requisitioned generation and the potential for optimizing dispatch by utilizing cheaper stations. During the scheduling and dispatch process, each state already optimizes locally by following a merit order dispatch approach. However, due to variations in state requirements, there is an un-requisitioned generation in certain ISGS. As a result, some beneficiaries draw more expensive power from ISGS, while cheaper stations have excess capacity that remains un-dispatched.

Ministry of Power has, recently floated a proposal for enlarging the scope of Security Constrained Economic Dispatch (SCED) to include more power plants and to run the National Merit Order Dispatch through SCED on a day-ahead basis for providing a look ahead schedule. The proposed SCED does not necessarily deepen the electricity market but provides necessary steps toward optimum market-based scheduling.

Finally, it should be noted that many aspects need to be considered when transitioning from long-term PPAs to a market-based system, such as the consequence of introducing a large share of generators to the power exchange, change of cash flow for market participants, financial settlement going from monthly to daily, procedures of IT, infrastructure, operational matters and many more.

5.3. Reference market(s) and price

As previously mentioned, one challenge when transitioning from long term PPAs to forward financial markets coupled with short term markets is that of establishing the reference price, and ensuring that the formed reference price is deemed valid and trustworthy by market participants. Below, considerations in the Indian context are presented, followed by an overview of the approach in Europe.

Considerations in India

In the Indian context, one consideration in this regard is around the appropriate volume of traded electricity for the reference price to be based on. In 2020-21, around 6% of the total generated electrical power was traded on power exchanges in India. While this appears to be a low share of generation, in terms of absolute volume, this corresponds to 79.59 TWh (or Billion Units/BU) in 2020-21, nearly double the power consumption in Denmark. Arguably, this volume is sufficient to base a reference price on.

Another consideration is around the choice of reference market(s). As described in section 3, the Indian Day-Ahead electricity market consists of multiple segments, making it challenging to select a single market to generate the reference price, as is the case in Europe. An alternative approach could be to derive a reference price using an index based on the prices in various market segments. Additional research is necessary to develop frameworks for reference-price generation, including choice of reference price-generating market(s) and sufficiency of traded volumes in such market(s).

The European example

In Europe, the day-ahead price is the reference price for all traded physical and financial forward contracts in the European electricity market, as the DA market has been the backbone for dispatching and prices for consumers and generators in the EU. Prices in the EU DA markets are determined through a uniform pricing mechanism, which means a single clearing price applies to all market participants. The DA market is also more liquid than other electricity markets. This, combined with strict regulations on transparency, reporting, and data publication, help ensure that prices discovered in DA markets are fair and reflect the true supply and demand conditions in the market.

In contrast, other markets in the EU, for example, intraday markets, use a pay-as-bid pricing mechanism, similar to those used in stock or currency markets. The pay-as-bid can lead to a lack of uniformity in prices and result in prices that do not reflect the true value of electricity. In the past, before the introduction of regulations like the Single Intraday Market Coupling, REMIT, and TP regulation, the intraday market was not as strictly regulated in terms of transparency and publication of prices. This made it difficult to determine a clear and reliable reference price for financial products based on the intraday market.

It is essential that the reference price signal is robust and trustworthy. In Europe, the robustness and trustworthiness of market prices and the signal they send to market participants are defined by ACER in “ACER Decision on the methodology and assumptions that are to be used in the bidding zone review process and for the alternative bidding zone configurations to be considered: Annex I” (ACER, 2020).

Article 15.10 of this methodology states that "*Prices are accurate and robust when a majority of market participants, i.e. participating to day-ahead markets and/or using the day-ahead price as the main price reference, perceive the benefits of reacting to the actual needs of the system at the precise location and point in time".*

This is a good explanation of the price robustness, and the definition sets out the important outcome of ensuring accurate and robust prices. However, difficulties remain with regards to estimating and evaluating how market participants use and rely on the market prices.

5.4. Insights from Europe/Danish experience

Policy push: In Denmark, policy push helped increase the liquidity of the day-ahead market by exposing the power generators to the prices of the wholesale markets, as their long-term physical contracts were bought by the state. There are several ways of ensuring such a push, where the most important factor is to link the settlement of the long-term physical contract to the short-term markets.

Remove barriers for electricity risk and asset management companies (DEA, 2018)**:** Policies and Regulations should make it easy to trade for all participants. In Europe, the establishment of the new market and a clear definition of the role of a BRP facilitated trade. For smaller generators and consumers, the relative costs to participate in the markets can be high, but with the establishment of BRP, the costs can be reduced. BRP is a powerful asset management company, aggregator, or other intermediate company that trades for buyers and sellers in a given market. Further, it is important that the power exchanges have the incentive to develop hedging products that reflect the demand, as it may vary with the types of production and consumption in a given electricity system.

Power exchange fee structure: High fees may reduce the advantage of using a power exchange or financial exchange compared to long-term agreements. Therefore, considering the consequences of the fee structure and competition therein between power exchanges when implementing policy changes is also important in order to secure those incentives for small parties joining the short-term market.

In addition to a financial exchange, decentralised OTC platforms play a significant role in the financial market set up in Europe, especially in Germany. OTC offers flexibility to market participants in terms of the terms and conditions of the trade. Participants can negotiate customized contracts that suit their specific needs and risk profiles and can be more cost-effective and efficient means of managing price risk compared to exchange-traded markets.

Regulatory balance: High regulatory requirements on, e.g., collateral has caused higher entry barriers for market participants; therefore, the balance between market regulation and its effects on market participation should be carefully considered when designing the forward markets.

Size of bidding zones: The larger the bidding zones, the more potential volume and liquidity in the electricity market. If the bidding zones are too large, they will not reflect the internal congestion and potential benefits from grid investments. The Nordic area is divided into 12 bidding zones s compared to Germany, with only one bidding zone with larger production and consumption. Transparency: Publicly available price information and reporting/monitoring makes it easier for market participants to conduct analyses for their own risk management strategies and future planning and investment decisions based on the electricity price. The European power exchanges all have prices and volumes made publicly available in real-time. For operational reasons, prices on the Nordic balancing market are delayed by 1 hour to avoid changes in the production and consumption plans in the operational hour of the market.

6. Key Takeaways

This report has discussed considerations around forward markets in EU/DK and India, including learnings from the Danish and EU contexts and possible approaches to development of forward market in India. This chapter briefly summarises key points and learnings, discussed throughout the report.

Regulatory framework for market surveillance and transparency

It is of utmost importance to establish clear frameworks both for the regulatory setup and roles and responsibilities when designing markets that go across boundaries of states and jurisdictions. Market monitoring, transparency and market surveillance are all important measures to minimise risk of market abuse, and allow market participants to understand and trust the market setup, incentivising participation in the market.

Clarity in regulatory jurisdiction is important for effective oversight and regulation of electricity markets. Here, the Indian setup is already favourable, following recent decisions on the roles of and division of responsibilities between CERC and SEBI.

Financial contracts can contribute to resource adequacy

Over the last decade in Denmark, market participants have requested 10- to 15-year financial contracts in order to secure financing from banks for development projects.

Here, market participants with large consumer portfolios use the forward market to price the contracts given to their consumers, and when contracts are signed, the forward market is also used to hedge possible residuals of volumes of these long-term contracts. The forward market is thus used by market participants on both demand- and supply side, which is necessary for liquidity to exist. Generation units often outlive PPA periods; for these units, forward markets offer steady cash flow.

Forward market additionally creates certainty for the grid operator for long term availability of both supply and consumption in the grid. Forward markets support resource adequacy and long term security of supply. Moreover, as generators are not bound to their physical delivery via the contract, forward markets allow for greater flexibility compared to a system based on long-term physical PPAs, with regards to cost-efficient balancing of the power grid.

Ensuring dynamic contracts for RES

Typical contracts in forward markets are Week ahead, Month ahead, Quarter ahead, and Year ahead for either base or peak hours, where most markets are transitioning into financially settled contracts, but some remain physically settled, requiring physical delivery. With more RES penetration in the markets, the need for more dynamic contracts, in addition to base load or peak load contracts, has increased, to cover the stochastic nature of the production profiles. This could see contracts with shorter pricing windows over the contract period and recognition of the variability of generated volumes, as opposed to the single average price and volume used in base- and peak load contracts.

Policy push is important.

In Denmark, policy push helped increase the liquidity of the day-ahead market by exposing the power generators to the prices of the wholesale markets, as their long-term physical contracts were bought by the state, via careful structuring. There are several ways of ensuring such a push, where the most important factor is to link the settlement of the long-term physical contract to the short-term markets.

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Annex I – Perspective on other international experiences.

ERCOT Texas

Similar to both Europe and India, Texas was unbundled from 1999, where the TSO was assigned 4 main responsibilities, in the market legislation:

- **System reliability**
- **Competitive wholesale market**
- **Open access to transmission**
- **Competitive retail market**

Texas market is setup as a nodal system, which makes it difficult to directly compare to the forward markets in Europe, and also India, where especially the latter does not at the current moment in time have grid constraints between the bidding zones.

That being said, in Texas there are two types of forward energy markets, one being the DA market and the other bilateral trades.

In the DA market in Texas, there can both be a minimum-energy offer, an energy offer curve, or an energy-only offer. The first is an indication of willingness to offer energy, whilst considering, startup costs, keep at minimum and cost to dispatch at that level. The Energy offer curve is indicating willingness to offer energy without considering the starting cost. Now, the energy-only offer is not specific to the resource, as it is a proposal to sell energy at any settlement point (delivery hour). This in principle is a financial product and sold in the DA market. When awarded such a contract the energy paid is based on that settlement point. This allows both generators and consumers to either satisfy their demand and supply in the DA market, or use the price to speculate towards the cost in the real time operations. The Qualified scheduling entity (form of BRP), could for example by energy in DA market for a given operational hour, then it will pay for that based on the DA market price for that operational hour. This is a financial cred for purchased energy, which is based on the real time price for that specific settlement point the DA market product was referring too. If the Qualified scheduling entity does not make use of the product bought, it will be paid based on the Real Time settlement point price, which is the reason for it being a financial transaction.

The bilateral trades are more specific or similar to the way it is handled in Europe, they are financial transactions between two entities, where potential schedules are sent to ERCOT for settlement purposes.

Thus, the DA market is very different from Europe, however, the bilateral trades can be compared to those of Europe.

As is visible in the above there are close dependencies between the short-term markets and hedging products available. Therefore, in developing financial products the DA market structure needs to be considered carefully.

JAPAN

In 2016 the electricity market was fully liberalised in Japan, which, as is the case in many countries, came on the offset of several regulatory reforms.

In Japan only retailers and generators with physical assets can enter the markets. There are different types of markets in Japan. The DA market, a single price auction for each market time unit of 30 minutes, which is the main market to balance supply and demand. Real time market, that allows for adjustments during the day. And the forward market, for hedging opportunities.

The calculation for the day-ahead market is performed within the regions, where the right to transmit between regions is accrued in the auction for transmission rights.

The forward market started in 2019 on the Tokyo Commodity Exchange in September 2019, where both base-load and daytime load power can be traded for the regions of Tokyo and Kansai. In 2020, EEX (European Power Exchange) Japan launched their market in May 2020 and quickly became the largest exchange in terms of volume traded.

The forward market, in contrast to the day-ahead and real time market do not require physical assets.

For the products the underlying/reference price is the average price of Japan Electric Power Exchange (JEPX) spot market for the respective area in the timeframe of the contract (base-load 00:01-24:00 and peak 08:00-20:00). Thus, the setup is quite similar to the European forward markets.

The forward market in Japan, provide opportunity for hedging of future price volatilities, in addition it has its reference towards the day-ahead price of the respective regions and trading on the financial exchange provides (contra bilateral transactions) hedging function against the credit risk.