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Challenges of Payment Security Mechanism in Power Sector and it's solution through Smart Contracts

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SUMMARY

Electricity infrastructure in India has been developed in India through four types of ownership models viz. Government, Public Sector enterprise, Public Private Partnership (PPP) and Private sector. During this transition it has matured from deficit power to surplus power scenario as well. Payment security for transacted energy is ensured through Power Purchase Agreements (PPAs). Initially under Government ownership model, funding and realization was not an issue as the Government was solely responsible. As the working model shifted towards private sector stage, the issues regarding payment security surfaced and the outstanding dues of GENCOs (Generator Companies) surmounted to more than Rs. 1 lac Cr. Settlement as per PPAs which were envisaged for payment security started getting dishonored/delayed due to various reasons viz. subsidized power supply, theft of power, lack of competition for DISCOMs (Distribution Companies), etc. The major reasons behind these large outstanding dues are physical PPAs, PPA non-compliances, inadequate penalty & dues recovery mechanism, and absence of real time settlement practices. This paper discusses the challenges of PSM and proposes auto executable smart contracts in place of legacy PPAs. These smart contracts will enable real time settlements for transacted power, help in minimizing the outstanding dues, enable the GENCOs to sell the share of defaulting parties in open electricity market, etc. thus strengthening the entire supply chain of Power sector.

KEYWORDS

Payment Security Mechanism PSM - Power Purchase Agreement PPA - Smart Contracts

Introduction

Sustainability of business, economy, and infrastructure solely depends on the returns generated by its use. Electricity also comes under the same ambit. The energy sector is highly capital intensive and it requires a period of minimum 10-15 years to recover its principal amount. After this period only, the effective R.O.I. (Return on Investment) starts and it further narrows due to the aging effect

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on the plants and connected infra. Due to the typical cycle of such investments, funding houses need a long-term guarantee of returns and hence, the prior agreement, i.e., PPAs which are pre-requisite for any investment in the Power Sector. This mechanism on one side assures funding houses, and on the other side makes both parties complacent and heavily interdependent. Electricity is dependent on its carrier which is fixed and limited and hence, unlike other commodities, sellers and buyers have very limited or no choice. If the GENCOs, Transmission licensees and DISCOMs (Distribution Companies) are not able to recover their revenues, they are bound to fail in a very short period. Failure of an entity is mostly due to socialization principles or non-levying of bare minimum utilization charges. PPAs, if not followed religiously may turn into hurdle for growth of electricity infrastructure. In Indian power sector almost all PPAs are in physical form that requires to be referred in case of legal disputes. Since these PPAs are neither online nor in the form of auto executable smart contracts, the dispute resolution takes longer time to settle and, in some cases, remains unresolved for many years.

Procedure of Billing and payment settlement mechanism of Energy charges:

In India, Special Energy Meters (SEMs) are installed at generating and evacuating substations for recording of transacted power. The readings of SEMs are recorded in a DCD (Data Collecting Device) through optical port at respective substation on weekly basis. These readings are sent to respective Regional Load dispatch centers (RLDCs) in an encrypted form which is then decrypted at RLDC. This whole procedure takes place in a period of approx. 20 to 30 days. The billing cycle itself is approx. 01 month and then approx. 15 days is granted for clearing the dues. Energy bill is issued by Regional Protection Committee (RPC) based on the readings furnished by respective RLDC. Upon receipt of these bills, stakeholders settle their dues within the stipulated timelines.

Challenges of Payment Security Mechanism (PSM):

DISCOMs draw power in advance and generators has to manage working capital for this period. Even after receiving the energy bill approx. 30 days after the supply of power, some DISCOMs do not pay the dues in stipulated time citing their poor financial conditions. LC (Letter of Credit) clause is integral part of all PPAs which can be exercised in case of delayed payments, but GENCOs are unable to encash these LCs due to various socio-political and legal reasons. Socio- political reasons covers the government subsidies and legal reasons covers company disputes, mergers and acquisitions, name changes, etc. Due to heavy outstanding dues, generators struggle even for managing fuel cost and new investors get demotivated. Economic viability of Generation, Transmission and distribution is key to sustainability & future of Power sector.

PPAs when executed considers the cost prevalent at that time and based on inflationary, depreciation and certain assumptions, it calculates cost for upcoming 20 to 25 years. However, it is difficult to ascertain the cost of power 20- 25 years ahead as lot of uncertainties and dynamism of future exists which are beyond calculation algorithm. In these calculations, state or country specific factors were envisaged, but with the onset of globalization, factors pertaining to all parts of world are affecting the future price determination matrix. Due to this transition, a product which was competitive in it's inception time due to either monopoly or less number of players is certain to become cheaper due to global competition. Older generating plants which were once dispatched round the clock couldn't get schedule due to newer and cheaper plants. Discoms also prefer to procure power from cheaper plants to improve their profitability and competitive requirements. In view of these scenarios, DISCOMs either delay/deny payments to these generators and also are in process of cancelling the long term PPAs.

As of now, in India, there are outstanding dues of approx. Rs. 117000 cr. (≈ 155 Billion USD) (Source: www.praapti.in). Government is continuously striving hard and insisting the utilities to follow PPAs strictly and strengthen their PSM to take away the woes of the power sector. In this quest, the Government has also issued a notification vide which defaulting Discoms are barred from buying power from open access. In compliance with this order, Discoms have started paying the advance payment for power purchase w.e.f notification date, but the pending dues still remains unsettled.

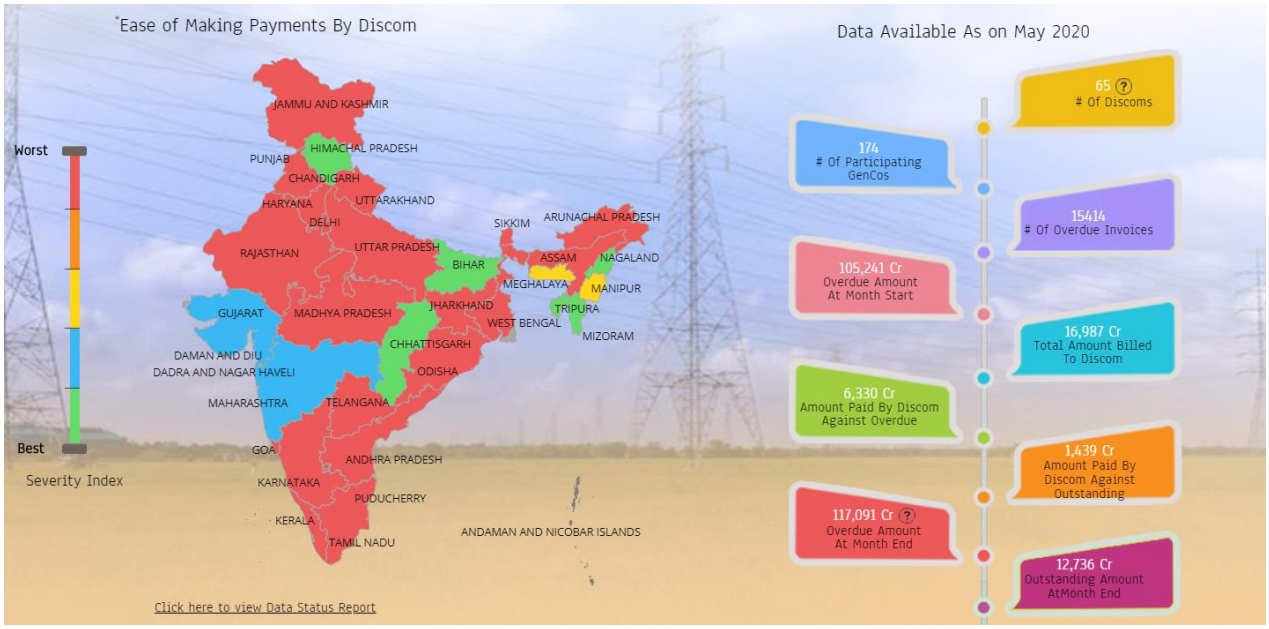

Fig 1 Outstanding Dues of Discom

Solutions for PSM through Smart Contracts:

There are many reasons for huge outstanding dues, however, the main reason being the legacy PPAs in physical form or in Offline mode. If any agreement is in physical form, interpretation and implementation depends upon respective parties and in case of disputes, legal route is followed which further delays consensus. Due to this, a lot of settlement gets stuck thus endangering PSM. This paper proposes to convert physical PPAs in Smart Contracts (SC) for resolving challenges of PSM.

Smart contracts, i.e. user-defined programs that determine the rules of writing in the ledger. SC is user-defined business logics for business transactions that are automatically executed across inter-authorized organizations based on distributed consensus protocol. Smart contracts are executable programs that make changes in the ledger and can be triggered automatically if a certain condition is met, such as if an agreement between the transacting parties is honored. Smart contracts are self-enforceable and tamper-evident bringing about significant benefits such as removing the intermediaries and reducing transacting, contracting, enforcement and compliance costs. The transactions carried out are recorded in the electronic ledger whose copy is with both the parties. Any change carried out in ledger of one's party is validated by other party. This ledger in blockchain world is termed as Distributed Ledger.

Blockchain (BC) has been widely recognized as an epoch-making technology. BC in general is conceptually characterized with "decentralization, i.e., direct peer-to-peer transactions (e.g., financial transfer) without relying on any central third party. BC is characterized with "consensus protocol, "distributed ledger," and "hash chain," to enable the decentralization nature. The

permissioned BC has been attracting significant attention in enterprise domains as an emerging technology for efficient cross-organizational business transactions. Permissioned BC allows only inter-authorized organizations (forming consortium) to construct a limited transaction scope in order to achieve high transaction performance. In addition to the fundamental BC features (i.e., consensus protocol, distributed ledger, and hash chain), a key characteristic in permissioned BC is "Smart-Contract (SC)," where business transactions across different organizations can automatically be executed based on the consensus protocol over user-defined business logics pre-built with program codes.

By combining several conditions as mentioned in PPA, a smart contract could, for example, automate the settlements of a transaction, if a certain set of conditions are met. The following steps are to be followed for proposed Smart Contract model:

- Contract terms of physical PPA are recorded in computer language encoding legal constraints and terms of agreement i.e. conversion of PPAs in SC.
- Allocation of logics for validation and execution in case of trusted transaction thus incorporation of DLT (Distributed Ledger Technology) mechanism.
- Putting the Smart Contracts on Blockchain network

The process of converting physical PPA in Smart contract is shown in Fig 2.

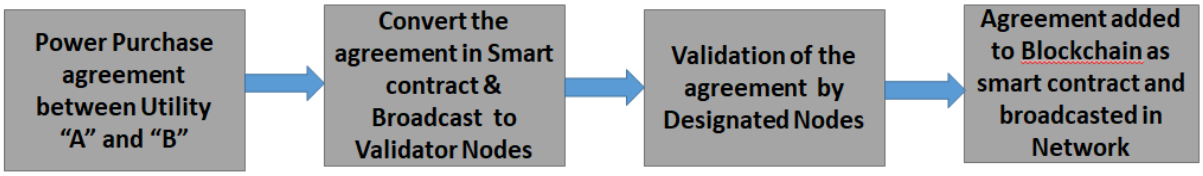

Fig 2 : Block diagram for Converting Physical PPA in SC

The proposed online approach keeps consistency of operations by the operational agent executing the operations according to operational instructions (embedded in operational event) defined inside the SC. This model requires to convert legacy PPAs into SC. The SC can be written in object-oriented programming language viz. Solidity, Java script, Go, etc. The encoding is based on the natural language of legal contracts & agreement. However, if a standard format is followed initially, then in future uniformity could be maintained and inter accessibility on blockchain network will be hassle free. The enforcement of the agreements that are reached between parties involved, are further translated into SC programming code. The most prevalent SC-enabled technology is Ethereum [2], and another blockchain platform such as Hyperledger Fabric [3] is providing high-level programmable SC. This platform introduces a special SC called "System Chain code (SCC)," which enables to run SC in process and is used for internal processing and configuration value sharing of the BC platform currently. By design, SC has some technological features. SC remains immutable once it is deployed on the blockchain, by contract transaction. Validation rights for every eligible transaction needs to be assigned to respective parties. SC is then linked to financial platform to enable the payment to GENCOs by DISCOMs based on the validated transaction of energy on daily/hourly/real time basis as per the agreement. Upon successful execution of SC between respective parties, this SC is added on blockchain network. All nodes (parties) on the blockchain network act as independent nodes whose ledger is distributed/shared across the network [Fig 3]. A node(party) can have transactions with one or more nodes based on the permissions accorded through encryption technology. All nodes can mutually carry out energy transactions subject to availability of transmission line connectivity. The agreed energy transactions are broadcasted in the blockchain network near to real time and the same schedules are dispatched by the grid operator

within grid security limits. Each & every transaction is validated by respective parties after actual transfer of energy and is uploaded in distributed ledger [Fig 4]. This provides greater visibility to all participating nodes for balancing their demand and supply portfolio. Hence, with the use of SC, DLT and blockchain technology, energy transactions take place in a more transparent manner, decentralized way, and dues settlements take place faster thus minimizing the huge outstanding dues.

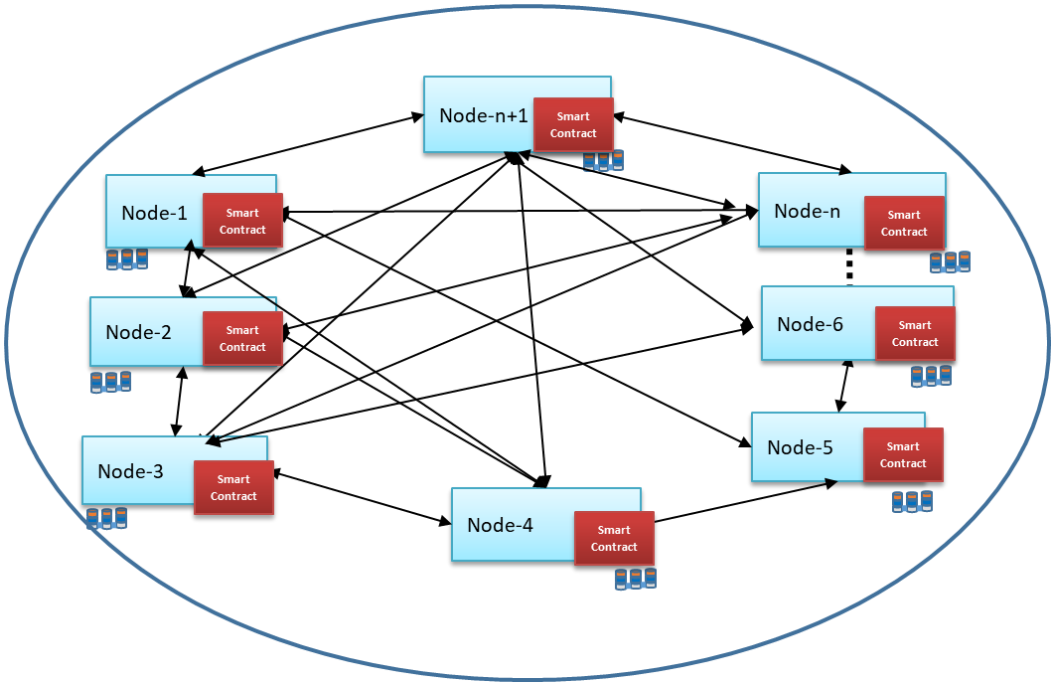

Fig 3 Distributed Network

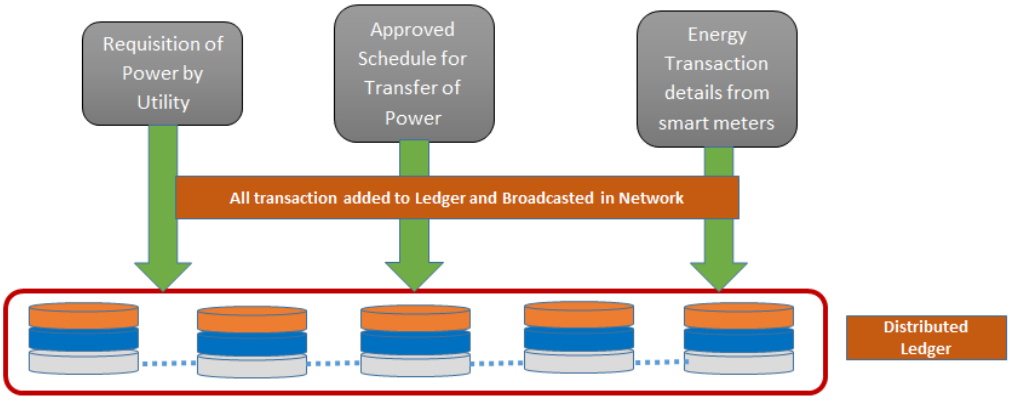

Fig 4 Adding Transactions in Ledger

Conclusion and Way Forward

In traditional energy transaction system, it normally involves steps viz. demand forecast, scheduling, dispatch, grid balancing, billing & settlement, etc. This system involves mostly offline exercise and the conditions are entirely different in real time due to several unknown factors like demand variation, weather changes, grid variances, etc. With introduction of Smart PPAs, Smart contracts, DLT & blockchain technology most of these operations can be managed in real times with minimal human intervention & decentralized manner. Due to this, Grid can be balanced more smoothly, safely & economically with optimum resources. Latest technologies namely Blockchain,

Artificial Intelligence, Machine Learning & Internet of Things (IOT) can help the electrical grid to transform from Dumb (non- communicative) to Communicative Grid. Regulators and policy makers are also coming up with regulations that will ensure adequate payment security mechanism for dispatch of electricity so as to minimize the outstanding dues so as to ensure sustainability of grid infrastructure.

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