

A Survey on the Benefits of Application of SCED (Security Constrained Economic Dispatch) on the Indian Power System

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Abstract—This paper surveys on the detailed scheme of an Indian Electrical Power System known as Security Constrained Economic Dispatch (SCED), which has been implemented to overcome the overall cost of generating electricity of a plant and its supply cost to distribution sectors. As per concern in worldwide, the conservation of electricity is one of the vital problems that needs proper attention, but due to the high load demand of electricity, it is to be ensured that the demand is being fulfilled by a power station in an economical manner. In India, there is a gradual advancement due to the scheme, used for the purpose of the proper utilization of the electricity supplied by various generating stations to distributing companies in a cost-effective manner. The explanation of the scheme, its frameworks and benefits had been discussed in this paper.

Keywords— Security Constrained Economic Dispatch (SCED); Indian Electrical Power System; economic; advancements;

I. INTRODUCTION

One of the most vital resources for every living being on this planet is “Electricity”. The purpose of our connective living, became the backbone of our livelihood. Focusing on electricity, it is generated by utilizing and converting it from productive resources from nature. For seamless connectivity in our daily routine, a system is established by mankind, known as Power System (PS). PS is a type of study that deals with the generation, transmission and distribution of electricity from raw material to as an asset for human beings [1]. India, a nation with a population of 1.38 billion, the demand of electricity is increasing day by day and must be supplied to consumers through an economical approach [2]. In India, a total installed power capacity of 383,373 MW (in context of the year 2021), out of which the share of fossil energy is 79.8% whereas, the share of renewable energy is 17.3%. Out of the shares, coal is the major portion of resources used for the electrical generation, comprising 53.1% of the total power capacity installed in India [3].

Indian Ministry of Power (MoP), a body which regulates the infrastructure and production of PS of India, has been tremendously in search of optimal schemes such that the consumers can be benefited with the economical supply of electricity across the nation. Indian Central Electricity Regulatory Commission (CERC), a regulatory body under the MoP, which has the power to validate economical tariff

schemes, policies of the electricity in the nation, proposed a model known as “Market-based economic dispatch of electricity: Redesigning of Day Ahead in India (MBED)”. The proposed model was developed in contrast to the previous scheme known as “Ujwal Distribution Company’s (DISCOMs) Assurance Yojana (UDAY)”.

UDAY scheme had the ability in impacting the financially and operationally DISCOMs, increasing the demand for power, improvement in plant load factor of the generating plants, etc. [4]. The problem occurred in UDAY, that it does not provide the DISCOMs to declare about the cost variable or cost of their scheduled generation through self-scheduling procedure. In the MBED model, its objective is to ensure the least cost generation supply from contracted inter-state generating stations (ISGSs) with merit ordered DISCOMs, resulting in the reduction of the total cost of overall generation of electricity by the plant itself, with a note of certifying the security of the power grid [5].

In 2019, a pilot project of a scheme termed Security Constrained Economic Dispatch (SCED), appealed by the Power System Operation Corporation (POSOCO) was executed, focusing its implementation on the thermal-based ISGSs across India. As per the upcoming benefits and its optimum effects, the CERC decided to implement and expand SCED on more generators of ISGSs from the yearly feedback reports developed and surveyed by POSOCO [6]-[9]. Depending upon the feedback reports, the MBED, the proposed market model would be used for embedding it on the Indian PS.

Therefore, this paper provides a detailed survey on the SCED developments and its benefits in India. After the Introduction, Section 2 provides a detailed description of SCED and its Significance in Indian Power System. Section 3 discusses the benefits and challenges of the SCED scheme. Section 4 provides the conclusions of the work.

II. SCED AND ITS SIGNIFICANCE IN INDIAN POWER SYSTEM

A. Meaning of SCED

SCED is a power scheme of POSOCO, held under the Indian MoP, to fulfil the requirements of supplying cheaper electricity and use the un-dispatched surplus based on the

merit order of the ISGSs. This pilot project scheme safeguarded the impoverished DISCOMs to reduce its buying cost of power, optimizing the utility of the available resources for production of electricity and reducing the cost of generating system of the ISGSs [6][19].

B. Aim of SCED

The main aim of SCED over the ISGSs of India includes various aspects i.e., Optimization of Scheduling and Despatch (OSD), Strengths, Weaknesses, Opportunities, and Threat's analysis (SWOT) Analysis, Capacity Building and Skill Development and Expanding the Ambit (CBSDEA), Retaining Freedom and Choice (RFC) for reducing limitations of technical equipment and sources of power system.

OSD of thermal ISGSs of India focuses on reducing the expenditure of technical limitations of the power system followed by SWOT Analysis and CBSDEA. The motto of the SCED is to determine required action through a roadmap to take specific action to ensure human resources are strong. RFC is required to maintain requisite power based on requirements of different states with contract and power purchase agreement (PPAs) [7].

Due to the rise in production of renewable energy in PS, DISCOMs have to ensure the flexibility in retrieving the net load (power demand from ISGSs minus power demand from renewable resources), provoking the need for relevant optimization [10].

C. Features of SCED

After the feedback report of SCED 2019, it was noticed that without major structural changes in the existing system, a difficulty in optimizing and reducing the expenditure of electricity production ISGSs were detected. CERC has introduced some important features regarding SCED updated till 31st March, 2021. Some of these features from [9] are discussed in the given points:

- SCED pilot project will be open to all the eligible generating stations for participation, provided that the ISGSs and Regional Load Despatch Centers (RLDC) are allowed to exchange scheduling related information through SLDC.
- In account of SCED, the schedules of the States shall not be distorted i.e., the beneficiaries are allowed to pay the bills for the scheduled energy directly to the ISGSs.
- Due to the SCED scheme, any increments occurring in the injection schedule of a ISGSs will be paid by SCED. In case of decrement occurs in ISGSs, they have to pay the amount to the National Pool Account (NPA) for the decremental generation.
- ISGSs participating in the SCED pilot previously, will be continuing to participate in the pilot project. Other ISGSs willing to participate in the extended period shall be required to provide a one-time consent for participation in the Project itself.

D. DISCOMs Markets Analysis

By the help of DISCOMs, several approaches of markets are available for providing electricity to the end user from the

generating stations. These are Long-term Power Markets, Short-term Power Markets, Vertically Integrated Market, Liberalized Market, Real-Time Market, Centralized Market, Decentralized Market and Day Ahead Market as shown in Table 1.

TABLE I. TYPES OF MARKETS OF DISCOMS

| Serial Number | Name of the Markets | Description | References |
|---------------|------------------------------|--|------------|
| 1 | Long-term Power Markets | In this type of power market, DISCOMs have the responsibility to secure power, in favor of public distribution utilities (according to Prior to Electricity Act 2003). Approximately 89% of the power markets through power purchase agreements (PPAs) have been taken accounted by it (till 2019). | [14] |
| 2 | Short-term Power Markets | In this genre of power market, from resort to distribution of electricity is utilized through various available routes. Approximately 10% of the power markets through power purchase agreements (PPAs) have been taken accounted by it (till 2019). | [14] |
| 3 | Vertically Integrated Market | In Vertically Integrated Market, a simple owner (i.e., government) is responsible for generating, transmitting and distributing the power to the consumer. | [18] |
| 4 | Liberalized Market | Liberalized market aims at distribution of higher electricity with lower end user price by organizing commercial competition. Through the competition, different DISCOMs will be allowed to supply electricity to a certain area | [18] |
| 5 | Real-Time Market (RTM) | This is the proposed power market, introduces platform to balance power supply according to the demand as in India. It will also help to reduce address challenges to grid management. The main objective of the market is to present an alternative mechanism for DISCOMs to handle power demand on large extent. | [14], [9] |
| 6 | Centralized Market | Centralized market fulfills central unit commitment. It also replicates vertically integrated operation by inheriting some plan of | [16] |

| Serial Number | Name of the Markets | Description | References |
|---------------|------------------------|--|------------|
| | | action from national monopolies. Some examples of these types of markets are PJM, CASIO, ISO-NE. | |
| 7 | De-Centralized Market | The objective of this type of markets is to reduce monopoly influence in various domains of electricity markets. The system under the market consists of operators, manages the power system in real-time. Under the control of the market, DISCOMs are free to choose how to distribute the demanded energy to distinct location. | [16] |
| 8 | Day Ahead Market (DAM) | It is a type of physical electricity trending market, allows to exchange contracts after delivering electricity for the 24th hour to the next day. | [20] |

III. BENEFITS AND CHALLENGES

In 2016, UDAY scheme was launched in the Indian PS and most of the ISGSs have to make a power purchase agreement with the DISCOMs on the basis of long, medium or short term. Before the implementation of SCED, the DISCOMs had to acquire power specifically from their contracted generators to meet the majority of their power supply and the minority was acquired through bilateral transactions with other DISCOMs via Power Exchanges or Traders [11].

But gradually, the UDAY scheme was futile to solve the underlying issues in the Indian PS. DISCOMs, due to underpriced electricity, inadequate funding payments and long-term power purchase agreements with generation companies, continued to struggle in levitating for its profitable revenues. So, the payments from DISCOMs to ISGSs were getting delayed, producing stressed assets [12].

However, DISCOMs losses reduced from Rs 51,480 crore in the year 2016 to Rs 15,049 crore in 2018, with a sudden increase of Rs 28,369 crore in the year 2019. Thus, by not risking any further financial losses, a pilot project of SCED was initiated by POSOCO in the year 2019, with an aim of economical cost saving potential, which had the capability for DISCOMs to get relief from the financial stress that occurred due to the UDAY scheme. It was determined that POSOCO can execute the SCED project without any operational and technical glitch. As per the feedback report of SCED 2019 submitted by POSOCO, the average system marginal price mounted at 287 paise per unit [6] [13].

Initially, SCED established a savings in generation cost by increasing the schedule of low variable cost generators and reducing that of high variable cost generators, resulting in the reduction in variable cost of fuel and reduction of 1.5% was observed in the generation cost. During the stipulated period,

POSOCO has observed an ease in operation of generators as there was a 43% reduction in number of schedule changes and 34% reduction in schedule MW changes, leading to increased Plant Load Factor (PLF) in cheaper power stations [14].

During the execution of pilot project of SCED, ISGSs, especially of National Thermal Power Corporation Limited (NTPC), it helps in promoting its utilization capacity of more efficient plants which are located closer to coal mines, resulting in lower freight cost, thus reducing the generating cost of the power generating plant [15].

But, with the fruitful benefits, some issues were detected. SCED requires the ISGSs to furnish the details of cost, technical data, etc. Due to the pilot project without a market mechanism, it leads to lack of transparency in the system marginal cost as per demand. The knowledge of sharing of revenue with beneficiaries is to be decided formally before any implementation [16].

But the current task can be resolved if the CERC-MBED system is being applied with the extension of the pilot project of SCED. The benefits are economical discovery of prices, elimination of self-scheduling, etc., provided that the Bilateral Contract Settlement (BCS) will increase the rates of the trade and cause disruption if a proper procedure is not being set up [11].

IV. CONCLUSIONS

The electricity at present has been a backbone over worldwide mankind. There are various technologies developed and used to overcome the problem of electricity crisis. In this paper the current scheme i.e., SCED implemented on the Indian PS is carefully surveyed. More specifically, in the upcoming days of 2021, by the implementation of MBED model in the scheme SCED, the DISCOMs would be able to bid into the power exchange for procuring power and meeting the power demand for distribution. The generators are expected to bid based on their marginal cost of generation. The existing bilateral contract holders' fixed cost will be paid separately outside the market and fit in the proposed model based on their marginal cost. By the framework of MBED embedded in SCED scheme, it will increase the utilization of low-cost generators in ISGSs while reducing and backing down in certain cases, the expensive generators. Also, the revenue received from the market by cheaper generating stations would be shared with DISCOMs resulting in the reduction of overall procurement cost (OPC) from generation to distribution [17].

Furthermore, the challenges and disadvantages of the models are discussed accordingly. This paper not only provides a survey on SCED but also highlights the major problem of previous schemes like UDAY as well as discusses on the way to restore the optimal state of OPC for ISGSs, DISCOMs and consumers of India.

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