

# Evolution and Institutional Building of Load Despatch Centres in India

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**Abstract**—This paper attempts to document the evolution of Load Despatch as an institution in India. It describes initiatives taken in India for institutional restructuring of Load Despatch Centres. The paper traces the history of the establishment of an Independent System Operator for the integrated operation of the Indian national grid. The technical, financial, organizational and human resource-related challenges have been discussed. The various strategies adopted for managing the transition in different phases have been outlined. The paper also highlights the key learnings which may be relevant for the organizational restructuring initiatives in other public infrastructure institutions as a part of the reforms process.

**Keywords**—Independent System Operator, Institution, India, Load Despatch, Reform, Restructuring

## I. INTRODUCTION

The classical functions of load dispatch depicted in Fig.1, involves the activities related to operational planning, protection coordination, defense plans, reliability assessment, transmission network capability assessment, power system elements outage management, load frequency control through reserves despatch, reactive power management, switching instructions, real-time supervision, resource scheduling, economic dispatch, optimization, ancillary services, congestion management, toggling of HVDC set-points, design and operation of System Protection Schemes, optimization, revival and restoration post grid events and post-facto event analysis for ensuring the reliability of the power system.

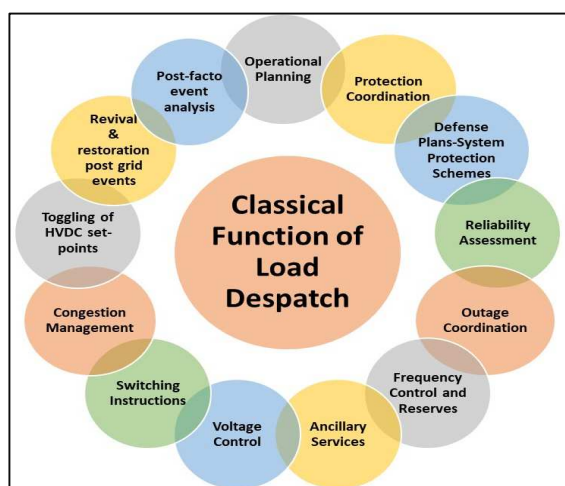


Fig. 1. Activities in classical functions of Load Despatch

Indian grid is amongst the world's largest power systems with dynamic wholesale electricity market. It is also unique due to diverse and federated governance in load despatch activity pan-India.

## II. FIRST STEPS

In the pre-independence era, the maiden Electricity Act was legislated in 1910 in India. Post-independence in 1947,

the power sector in India began taking shape with the Electricity Supply Act of 1948 [1].

The demarcation of the Indian geography into five 'electrical' regions viz. Northern, Western, Southern, Eastern and North-eastern was done during the third five-year plan (1961-66) [2]. During the formative years, the concept of regional planning in power sector was promoted to achieve regional self-sufficiency. It was followed with constitution of Regional Electricity Boards in each of the five regions in 1964. The mandate of REBs was to ensure integrated grid operations in respective region and coordination between the constituent State Electricity Boards (SEBs).

The Rajadhyaksha Committee recommended extensive power sector reforms to the GoI in 1980 [3]. Subsequently, in 1981, the integrated operation of the inter-state and intra-state transmission systems was taken as policy decision by GoI, paving the way forward for a national electricity grid.

The amendment in the year 1991 [1] to the Electricity Supply Act 1948 recognized statutorily, for the first time, the distinct activity of load despatch as part of the power system. The Regional Load Despatch Centers (RLDCs) were designated to coordinate the operations of each of the regional electricity grids constituting the country's power system. RLDCs, till 1994, were part of REBs under the overall umbrella of Central Electricity Authority (CEA).

RLDCs and State Load Despatch Centres (SLDCs), through the amendments to the Electricity Supply Act 1948 [1] in the year 1998, were mandated for secure operation of the power system in respective region/state. Further, RLDCs and SLDCs were made responsible for the coordination of the integration of regional level (within the territory of India or outside) and state level power system with other power systems respectively.

The planning philosophy evolved from achieving regional self-sufficiency to optimization of national resources through transfer of large quantum of power from surplus to deficit areas across the State/regional boundaries. Thus, the establishment of a robust inter-state transmission system assumed importance. In this direction, in 1989, Power Grid Corporation of India Ltd. (POWERGRID) was set up for development of the required inter-state and inter-regional transmission systems.

With the increasing complexities in the power system operations and restructuring of power systems to facilitate competition, RLDCs were progressively transferred from CEA to POWERGRID during 1994-1996 period. Later, statutory function of Central Transmission Utility (CTU) was assigned to POWERGRID by the Ministry of Power (MoP), GoI in December, 1998 and subsequently, in November, 2003.

### III. INSTITUTIONAL EMPOWERMENT OF LDCs

The thrust on institutional empowerment of the load despatch centres in India was given by Electricity Act, 2003 [4]. National Load Despatch Centre (NLDC) has been mandated for optimum scheduling and despatch of electricity amongst the regions. The SLDCs and RLDCs have been mandated as the apex bodies to ensure integrated operation of the respective state and regional power system. The functions of the RLDCs and SLDCs have been laid down in terms of:

- secure and economic grid operations & monitoring
- optimum scheduling and despatch of electricity
- keeping accounts of electricity
- supervision and control over transmission system
- compliance with Grid Standards and Grid Code

The levy and collection of fees and charges has been provided by the Electricity Act, 2003 as the basis for the sustainable revenue stream in accordance with the regulatory framework at the central and state level. The compliance of the directions of the load despatch centres has been emphasized by the legislation with penal provisions in case of non-compliance.

The Electricity Act 2003 stipulated that the LDCs shall be operated by a Government company, or any authority or corporation as may be notified by the Central/State government. Till such time, the respective LDCs would be operated by the CTU at the central level and respective State Transmission Utility (STU) at the state level.

National Electricity Policy (NEP), 2005[5] emphasized independent system operation through LDCs at the National, Regional and State levels.

### IV. MOTIVATION FOR INSTITUTIONAL REFORMS IN LDCs

The motivation for reforms in the LDCs as major institution in electricity sector ecosystem are as follows:

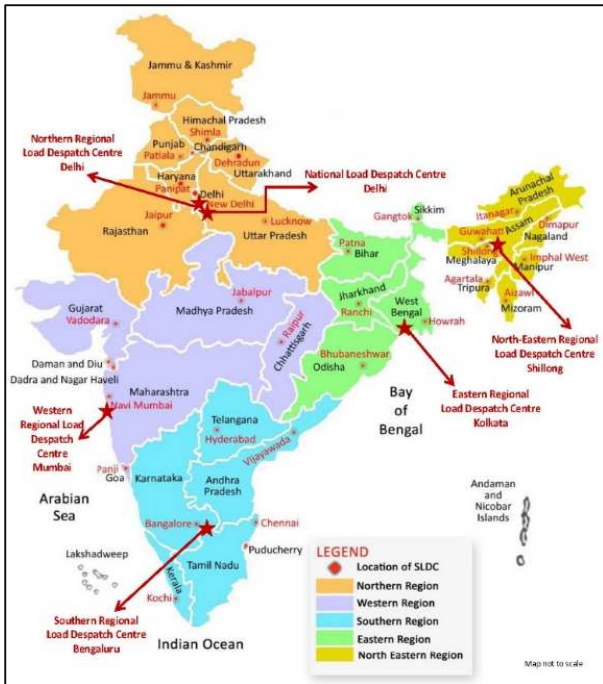


Fig. 2. Load Despatch Centres in India

### A. Investment in technology and infrastructure upgradation

The integration of the state grids and thereafter regional grids called for upgradation of the communication and the Supervisory Control and Data Acquisition (SCADA) - Energy Management Systems (EMS) infrastructure in the LDCs. In the 1980s and the 1990s, the majority of the RLDCs and SLDC infrastructure came up along with the first state-of-the-art SCADA/EMS control centres. The location of LDCs pan-India is depicted in Fig. 2 [6].

The implementation of the Unified Load Despatch and Communication (ULDC) scheme was envisaged to establish dedicated and redundant high-speed microwave and fiber-optic communication links and SCADA/EMS for real-time monitoring, supervision and coordination [7].

Considering the financing requirements to the tune of 22 billion Indian rupees for pan-India ULDC scheme from the government equity and the challenges in implementing the project under the prevailing bureaucratic institutional set-up, it was decided by the GoI to transfer the RLDCs to CTU-POWERGRID which was a commercial entity and could execute the project with funding from multilateral institutions.

### B. Competition in Power Transmission Sector

The competitive paradigm shift introduced by Electricity Act 2003 attracted private sector participation both in generation (about 47% of all India generation capacity) and transmission (presently more than 30 transmission licensees).

In order to instill confidence in the private transmission licensees and ensure a level playing field in the bidding, implementation and operation of transmission projects, separation of system operation function from the CTU i.e., POWERGRID (which is also a transmission licensee and participates in competitive bidding process for transmission projects) was envisaged by the GoI.

### C. Non-discriminatory open access in transmission

The de-licensing of generation and open access in transmission are the foundations for electricity market laid down by Electricity Act, 2003. It was soon realized that the neutral and independent operation of the LDCs was critical for effective implementation of non-discriminatory open access, robust electricity markets and dispute-free settlement systems.

### V. MILESTONES IN THE FORMATION OF POSOCO

The major milestones in the formation of an Independent System Operator (ISO) in India namely Power System Operation Corporation (POSOCO), encompassing RLDCs and NLDC, are as follows:

#### A. Statutory Mandate of ISO as per Electricity Act, 2003

As per Sections 26 of the Act, it has been envisaged that NLDC and RLDCs would be operated under governmental setup in form of a Government Company or Authority or Corporation as may be notified by the Central Government.

#### B. National Electricity Policy, 2005

In addition to enshrining independent system operation of LDCs, NEP also stipulated the review of the then

prevailing arrangement of CTU-POWERGRID operating the RLDCs by Central Government.

*C. Committee of Secretaries (CoS) review in August, 2006*

It was observed by CoS that the performance of the grid had improved with RLDCs under POWERGRID/CTU. However, with the introduction of multiple private transmission licensees, it may create a situation wherein operation of the RLDCs by POWERGRID (which is also a transmission licensee) would be perceived as a conflict of interest. Therefore, to separate the function of load despatcher and transmitter of electricity, it was decided by CoS to set up an organization for system operation as a subsidiary of POWERGRID, to begin with, which would gradually be made independent at an appropriate time.

*D. Stakeholder consultations in November, 2007*

An interactive session was convened by MoP, GoI with all state governments and electricity regulatory commissions (ERCs) on the institutional capacity building of LDCs.

*E. MoP, GoI directions to POWERGRID in July, 2008*

MoP, GoI directed POWERGRID to set up POSOCO as a wholly owned subsidiary of POWERGRID. POSOCO's functions included, inter-alia, supervision and control of all aspects including manpower requirement alongwith planning and implementation of infrastructure concerning operations of NLDC and RLDCs. An additional function was to handhold the SLDCs including for specialized training.

*F. MoP committee report on LDCs in August, 2008*

A high level MoP, GoI committee (MoP Committee) was formed in February 2008 on LDC system operators manpower, certification and incentives aspects. MoP Committee also examined and recommended ring-fencing of the LDCs towards functional and financial autonomy. In August, 2008, MoP Committee submitted the report [8]. The recommendations of the report were endorsed by the Central and State Governments as well as respective ERCs.

Subsequently, in order to monitor and implementation of the recommendations of the MoP Committee, four task forces were formed by the MoP and CEA. The details of the task forces are tabulated in Table-I as follows:

TABLE 1: TASK FORCES FOR IMPLEMENTATION OF MoP COMMITTEE RECOMMENDATIONS ON LDCS

S. No.	Terms of reference of Task Force	Report
1.	Oversee implementation of the recommendations of MoP Committee [9]	-
2.	Financial augmentation and up gradation of SLDCs and issues related to emoluments for the LDCs personnel [10]	March 2009
3.	Selection/recruitment procedures and tenures for the personnel in LDCs [11]	June 2009
4.	Training and certification of System Operators [12]	March 2010

*G. Forum of Load Despatchers (FOLD) in November, 2008*

Forum of Regulators (FOR) consisting of central and state ERCs approved the formation of FOLD in November, 2008 [13] and the FOLD charter in January, 2009.

*H. POSOCO as subsidiary of POWERGRID - March, 2009*

In accordance with MoP, GoI directives, the incorporation of POSOCO as a wholly owned subsidiary of POWERGRID was done and registered on 20<sup>th</sup> March, 2009. An independent revenue stream through RLDC Fees and Charges regulations was put in place by Central Electricity Regulatory Commission (CERC). POSOCO was entrusted with the responsibility of operating NLDC and RLDCs w.e.f. 1st October, 2010.

*I. Grid Disturbance Enquiry Committee, 2012*

The Enquiry Committee set up following the July 2012 twin grid disturbances, stressed on autonomy to LDCs with setting up of independent system operator [14]. Further, Central Regulator in its order in February, 2014, mentioned the need to expedite establishment of POSOCO as an independent company.

*J. National synchronous grid in December, 2013*

On 31st December 2013, the Southern Regional Grid was synchronized with the North-East-West-North East synchronous regional grids, making the Indian Power System a single synchronous grid with associated complexities. With the manifold expansion of Indian transmission network, security and reliability in operation of the power system by an independent system operator has taken paramount importance.

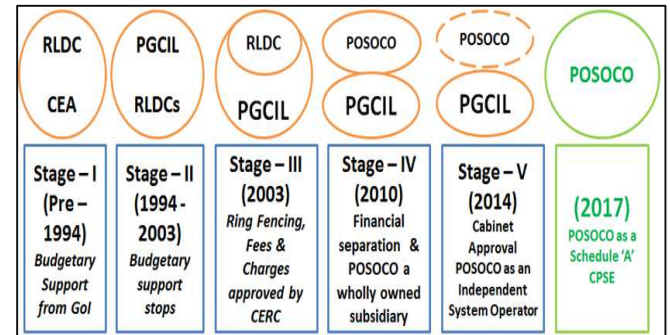


Fig. 3. Evolution of Independent System Operator in India

*K. GoI order on setting up of POSOCO in March, 2015*

MoP, GoI vide communication dated 25<sup>th</sup> March 2015, communicated the need for independent system operation at the interstate/national level with POSOCO as a wholly owned Government of India Company.

*L. POSOCO as Independent System Operator w.e.f 03<sup>rd</sup> January, 2017*

POSOCO started operating the NLDC and RLDCs, as an independent government company, since 3<sup>rd</sup> January 2017 in accordance with MoP, GoI gazette notification dated 19<sup>th</sup> December 2016 [15].

VI. FUNCTIONAL AUTONOMY OF LDCS

Prior to the 1990s, in addition to the other functions, CEA performed the role of transmission system planner, transmission system operator as well as electricity tariff regulator. As the Indian power system evolved, separate institutions in the form of CTU and CERC were established



for Transmission System Operation and tariff regulation, respectively [16]. With this in view, authority-based model and company-based models were examined for developing a national level system operator.

Internationally, the organization models for system operations are dependent on historical context and market development (depicted in Table-II). There is no single dominant model with various merits and limitations.

TABLE II: INTERNATIONAL ORGANIZATION MODELS FOR SYSTEM OPERATION

Name of System Operator	Legal Structure	Degree of separation from transmission asset owner
AESO	Statutory	Full - ISO
California	Public benefit	Full - ISO
Eir Grid (Ireland)	State-owned public limited company	Limited separation
New York	Public corporation	Full - ISO
PJM (USA)	Privately held, limited liability	Full - ISO
Transpower	Statutory	ITSO
Energinet	State-owned	Limited -ITSO
National Grid ESO (GB)	Private company limited by shares	Limited separation

It was felt that the company model would provide the requisite flexibility and autonomy to POSOCO for operations as well as for attracting and retaining high quality skilled personnel for long-term organizational sustainability. Besides, any dynamic changes that may be required in the role and structure of POSOCO would be possible in a company model.

The restructuring and unbundling of most of the state level utilities have been completed. Almost all SLDCs are under umbrella of the respective transmission utilities in a TSO arrangement. The adaptation of the POSOCO model at the state-level is being encouraged. Various steps are being taken up gradually for ring-fencing of the SLDCs.

## VII. FINANCIAL AUTONOMY OF LDCs

Financial autonomy plays an important role in the sustainable functioning of the LDC. The LDCs are considered to be Capital Expenditure (CAPEX)-lite and profit would not be primary objective. Thus, the financial model for the LDCs sustainability would have to be distinct from other historically capital-intensive entities [6].

In the initial years, RLDCs were funded for capital and operational expenditure through the budgetary support by GoI to CEA. Subsequently, when CTU-POWERGRID operated the RLDCs, the revenue stream of RLDCs was part of the tariff of the SCADA/EMS in ULDC scheme. RLDC charges were booked as a percentage of O&M charges. The situation at the SLDCs was also similar.

The financial dependence of LDC either on the grants by Central/State government or on the bundled utility constrained the independent operations. This institutional design deficiency was identified by the ERCs and hence, provision of operating charges was put in the respective regulatory frameworks for implementing open access.

In May 2003, for the first time, CERC approved the revenue stream as part of RLDC fees and charges from 2000-2001 onwards (215 million Indian rupees in the starting year). Subsequently, from 2005 onwards, ULDC

scheme charges were merged with RLDC fees & charges. It was decided to notify the RLDC fees and charges regulations separate from transmission tariff regulations. The notification of maiden 'Fees and Charges of RLDCs' regulations was done by CERC on 18<sup>th</sup> September 2009.

The revenue stream for RLDCs & NLDC primarily comprises of two components namely registration fees & monthly charges. There are other sources of income, inter-alia, open access application fees & operating charges, registration fees and charges for renewable energy and energy efficiency certificate mechanism. The income, after meeting the running expenses, is transferred to LDC Development (LDCD) fund. LDCD fund can be utilized as reserve fund by the RLDCs and NLDC only under the regulatory oversight of the CERC.

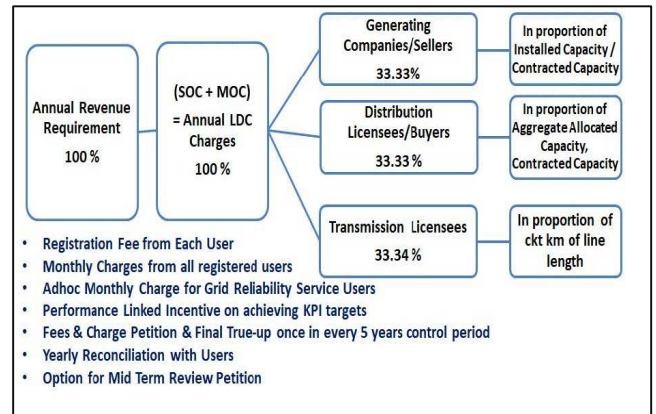


Fig 4. Revenue Model of POSOCO

The Fees and Charges regulations, for last three five-year control periods, have ensured financial autonomy for POSOCO through independent revenue stream of regulated fees and charges. The users are Generating stations/Sellers, Distribution Licensees / Buyers and the Transmission Licensees towards the services provided to them as depicted in Fig. 4.

There are seven components of Fees & Charges. The Human Resource (HR) expenses have been segregated from other operational charges recognizing the intellectual capital of POSOCO being a knowledge-based organization [17]. The HR expenses form a major portion of the total expenses of POSOCO. In the initial control period, it was in the range of 40-50% and gradually rose to around 70% in the latest one.

Incentives for achieving the CERC Key Performance Indicators (twelve nos.) targets replaced the transmission incentive for RLDCs and NLDC personnel. The spirit of the Act was to ensure the altruistic, ethical and frugal character of LDCs. Therefore, it has been recognized that the performance metrics and incentives of the RLDCs/NLDC have to be de-linked from the commercial profits of any kind.

## VIII. SEGREGATION AND TRANSFER OF ASSETS AND LIABILITIES OF LDCs

The separation of RLDC accounts from POWERGRID was done since 2009.

MoP, GoI Task Force [10] recommended the segregation of assets/liabilities between CTU & RLDCs/NLDC as well as between SEBs/STUs & SLDC.

The task force laid down the methodology of segregation of assets and liabilities with the separate detailing of assets, outstanding equity and loan for central and state entities.

POSOCO was carved as Independent Government Company as per GoI directive and hence, the equity of POWERGRID in POSOCO was bought out by the GoI. The liability of POWERGRID towards loan drawn for POSOCO assets were met from LDCD fund.

#### IX. HUMAN CAPITAL TRANSITION MANAGEMENT

During system operators transition from one type of organization to another, there are parallel responsibilities of maintaining reliable grid operations and conducting the smooth transfer of human capital assets.

When RLDCs as part of CEA were being transferred to CTU/POWERGRID during 1994-96 period, it was optional for personnel to join POWERGRID. The appropriate fitment of pay-scale and designation was provided to take care of the changes in the organization set-up (government department to public corporation), hierarchy, growth opportunities, incentives and retirement benefits.

The mode of transfer of personnel from POWERGRID to POSOCO was done on secondment basis in June 2010 when POSOCO was incorporated as a subsidiary of POWERGRID. The same terms and conditions including employee benefits and compensation were applicable for the personnel in POSOCO as applicable to the personnel in CTU/POWERGRID.

A high-level MoP, GoI committee formulated a transfer scheme in December, 2015 at the time of creation of POSOCO as an independent government company. The committee formulated transfer scheme to facilitate smooth personnel movement between POSOCO and POWERGRID and vice-versa. The employees posted in POSOCO and POWERGRID were given choice, in April, 2016, for their willingness to join POSOCO or continue with POWERGRID. The modus-operandi was developed stable yet flexible personnel movement to ensure continuity in the critical functions of grid operations. The transfer of the employees was done in a hassle-free manner staying focused on secure grid operations with formation of separate company.

There was a personnel positioning exercise undertaken with employee landscaping and skill mapping. This exercise was required to fill the skill gaps in the new setup. It helped in assembling and rightsizing the team in newly formed POSOCO. Interactions with potential candidates through various mediums at various levels of management were set up to gauge their areas of interest and the reason for joining POSOCO.

Open discussions with senior management were held to allay the concerns of the personnel regarding pay-scale and benefits protection. One of the important points was continuity of the 'Schedule-A' categorization of POSOCO as public sector company, granted as special dispensation by GoI, which has impact on performance related pay and career progression paths [18].

The absorption of personnel in newly formed POSOCO with continuity of service and inter-se seniority was maintained. A joint committee of POSOCO and POWERGRID was formed to oversee the transition on day-

to-day basis. Parallely, the recruitment activity for induction of fresh employees was initiated by POWERGRID before separation so as to ensure adequacy of manpower. A back-up plan included inviting applications from POWERGRID and other public utilities under the MoP in case of shortfall of manpower. The movement of manpower between POSOCO and POWERGRID was done in phase-wise manner.

#### X. COMPETENCE OF SYSTEM OPERATORS

It is the responsibility of LDCs to operate interconnected grid comprising of assets owned by other agencies. There are implications for safety of human life, power system reliability, operation under defined rules and codes with economy. The relevant extracts from Section 5.1 (h) of the Indian Electricity Grid Code 2010 is quoted as follows:

*“...the control rooms of the RLDCs, SLDCs and power plants, substation of 132 kV and above, and any other control centres of all regional entities shall be manned round the clock by qualified and adequately trained personnel....”*

The power system operator certification program through the National Power Training Institute has been a major initiative for capacity building of power system operators in India. The certifications in the disciplines of system reliability, electricity market, regulatory affairs, renewable integration and SCADA/EMS are done at various levels viz. basic, specialist and management levels. The provision of operator certificate retainership to the certified system operators has been made in the CERC Fees and Charges Regulations to encourage the certification of system operators.

#### XI. VALUE ADDITION IN THE SECTOR THROUGH ISO

Recognition of power system operation as a distinct faculty in power sector and creation of an Independent System Operator at the regional/national level has brought encouraging results. It has given a major boost to the various reform initiatives in the power sector. System visualization, reliability coordination, monitoring of regulatory compliance and disaster resilience in power sector has strengthened. Data intensive reports on topics such as demand analysis, load factor, scheduling and settlement system, flexibility, renewable integration, market analysis, hydro optimization, reserves and ancillary services, ramping capability, security constrained economic dispatch, gate closure, system inertia etc. that are being compiled through diverse stakeholder collaborations are providing inputs for policy making and long-term planning. These reports have enhanced data sharing and transparency.

Pilot projects on ancillary services, security constrained economic dispatch and automatic generation control have provided rich insights, facilitated capacity building across board and thus paved way for pan-India roll out of new instruments for deepening markets (Gate-Closure, RTM) and reliability enhancement (RRAS, FRAS, AGC). Post creation of the ISO in India, the efforts for harmonization of procedures across all SLDCs and their institutional capacity building by sharing of best practices have intensified. Mobilization of resources and inter utility coordination to respond to high impact low frequency events like the pandemic, tropical cyclones, solar eclipse, lights off events etc. could be effectively achieved under the ISO set-up.

Industry-academia collaboration has improved through initiatives like power system awards, LDC excellence awards, increased number of publications in the national/international conferences and joint research. Substantial improvement in contribution from India in the international platforms like GO15, IEEE and CIGRE is being recognized and appreciated globally.

## XII. KEY LEARNINGS

It has been recognized that the value proposition in the institutional capacity building of the LDCs would be immense in terms of grid security, reliability and economy. The data intensive studies and feedback from LDCs helps in optimization of the future CAPEX in the power sector. There is mostly intangible nature of services rendered by the LDCs. The LDCs role is system-wide and resource-agnostic.

Institutional capacity building of LDCs has been an evolutionary process with objectives and priorities adapted as per the context. The long-term vision transparency, clarity in responsibility and accountability have been essential for transition of LDCs under various organizational arrangements. Open dialogue and consultative approach have been the key for general buy-in by internal stakeholders.

Robust institutions are built from the inside. Successful reform requires the synergy of elements of engineering, economics and institutions. The institution of LDC is part of the ever-increasing complex and dynamic power system and hence, the steps have to be treaded cautiously. The process has given learnings for institutional building as starting with simple steps and oversights corrected at every stage. The institutional reforms process has to be seen as a continuum of small steps rather than a binary state of “on” or “off.”

## XIII. FUTURE OUTLOOK

The functional responsibilities of the LDCs would continue to evolve with the evolution of the energy sector. The coordination between CTU/STUs, LDCs and Distribution System Operators (DSO) would be vital for integration of renewable / distributed energy resources and the envisaged inter-sectoral coupling for sustainable energy transition. The transition from shallow to deep ISO would call for continuous investment in institutional capacity building. In future, the actions and performance of LDCs would have significant consumer impact and hence their accountability to consumers would further increase. The benchmarking of LDCs is needed to be based on factors like frugality in approach, performance to resource ratios etc.

The LDCs would require a stable revenue stream to perform its roles and functions effectively with right organizational incentives. The dilemma of revenue model (not-for profit, profit neutral, for profit) needs to be resolved in order to be able to raise capital to manage short-term cashflows and finance capital expenditure. Innovative ways for performance assessment and incentivization of personnel working in LDCs would have to be devised.

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