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# Open Automated Demand Response: Industry Value to Indian Utilities and Knowledge from the Deployment

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# Disclaimer

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***Abstract* – India suffers from severe electricity shortages, particularly during peak demand hours, and often experiences shutdowns from several hours to days in certain locations. India faced an unprecedented blackout for two days in July 2012 that affected an estimated 680 million people, which is twice the population of the United States. This blackout highlights the increasing pressure on India's power system for infrastructure and market investments for peak load management and customer engagement. Certified Smart Grid products and technology solutions from the industry provide a robust Automated Demand Response (AutoDR) system to automatically manage demand when the grid is under stress. Using the AutoDR solutions by Honeywell, a key utility vendor in India, is testing the deployments of a cost effective AutoDR solution with its customers. The DR communications technology, developed by a U.S. national laboratory, is an open specification with a compliance-testing program for interoperable deployments.**

**Tata Power Delhi Distribution Limited (TPDDL) is the first Indian utility to launch the AutoDR project with smart meters in the nation's capital. The project is implemented in partnership with Honeywell, IBM, and third-party MDMS (Meter data Management system) vendor, with participation from industrial and commercial electricity customers. A total of 173 consumers participated in this project. Utility customers having load greater than 100 kilowatts (kW) and a consolidated connected load of over 400 MW are included in the project. The project includes about one hundred 11-kilovolt feeders, fed from 40 substations spread across the utility's distribution territory. This paper reports the deployment lessons and technical challenges relevant to the Indian context.**

***Keywords*—** *Smart Grid Technologies; Automated Demand Response; Interoperability Standards; Peak Load Management;*

## I. INTRODUCTION AND BACKGROUND

Certified Smart Grid products and technology solutions from the industry provide an Automated Demand Response (AutoDR) system to manage demand when the grid is under stress. AutoDR enables the utilities to send grid reliability and price signals to customers' controls and equipment, enabling the customer-chosen pre-programmed strategies to be activated with no human in the loop. .The DR communications technology, developed by the Lawrence Berkeley National Laboratory (LBNL), is an open specification with a compliance testing program for interoperable deployments.

Honeywell Smart Grid solutions provide the very reliable commercial and industrial AutoDR system, which is certified for interoperability. This solution includes the demand response automation server (DRAS) and automated demand response (AutoDR) Gateway. For the AutoDR, the facility controls are pre-programmed by the customers, and responses are fully automated to a receipt of an external signal from a utility. Customers are always notified of the DR event and have the option to opt out if they choose to. Honeywell's DRAS is a tool proven to achieve the goals of customer engagement and provide cost-effective and fully automated DR. The Honeywell DRAS was developed working with LBNL using an interoperable and standardized specification, supported by a testing and certification platform. It is the central point that manages utility DR programs, from participant registration through event management and monitoring. The AutoDR Gateway has been reused from the existing ComfortPoint™ hardware platform deployed at the customer site. It can integrate with site energy meters, collect energy data, and send the data to the DRAS.

Interoperability for DR communications was achieved through Open AutoDR specifications (OpenADR). OpenADR is U.S. national standard for standardized DR Price and reliability information. These standards were developed using the OpenADR 1.0 communications specifications, with the standards development organization, Organization for Advancement of Structured Information Standards (OASIS), developed the OpenADR 2.0 profiles under the Energy Interoperation committee [1]. These profile specifications, supported by the industry, were part of the OpenADR Alliance's testing and certification for the building controls and devices to receive and respond automatically to DR and price signals [2]. This specification helps the vendors to standardize, automate, and simplify the solution so that it provides the interoperability across the multivendor products. The International Electrotechnical Committee (IEC), under

Project Committee 118, is considering OpenADR 2.0 for international standardization, which would allow vendors to harmonize interoperable products globally [3].

TPDDL one of the most progressive utilities in India's capital became the first utility to launch the AutoDR project with smart meters. The project is implemented in partnership with Honeywell, IBM, the AMI for the project was from a US vendor, with participation from industrial and commercial electricity customers. A total of approximately 173 consumers participated in this project, with an aggregated peak demand of over 67 megawatts (MW). Utility customers having load greater than 100 kilowatts (kW) and consolidated connected load of over 400 MW are included in the project. The project includes about one hundred 11 kilovolt feeders, fed from 40 substations spread across the utility's distribution territory.

This paper reports the deployment lessons and technical challenges relevant to the Indian context. It is organized in two sections: the applications of technology solutions, and the major deployment challenges.

### A. *Background*

At present, utilities and consumers in India are not very aware of DR technologies and their benefits. The current DR demonstration project provides an opportunity to instill confidence and trust of DR technologies on the part of government and private utilities, and also enable consumers to participate in demand response programs. Demand response programs enable consumers to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods, in response to time-based rates or other forms of financial incentives. Electric system planners and operators are using them as a demand-side resource options for balancing supply and demand. Such programs can lower the cost of electricity in wholesale markets, and in turn, lead to lower retail rates apart from providing opportunities to improve energy efficiency in their equipment and processes.

The aforementioned technology solutions have the potential to address the electric grid reliability and also alleviate the pressure on the power system by making the demand flexible through DR programs. The applications of such technologies can enable utilities and customers to leverage the existing infrastructure to address the shortage of peak power and improve reliability in the system.

## II. Applications of Technology Solutions

The DRAS is managed by the utility to send AutoDR signals. The signals are based on programs defined by the utility. The OpenADR Gateway receives load shed events and communicates the shed events to the shed strategies configured in the site for reducing the current demand from that site. The commissioning tool allows users to quickly deploy the gateway in the site and reduces the commissioning time with an enhanced user interface.

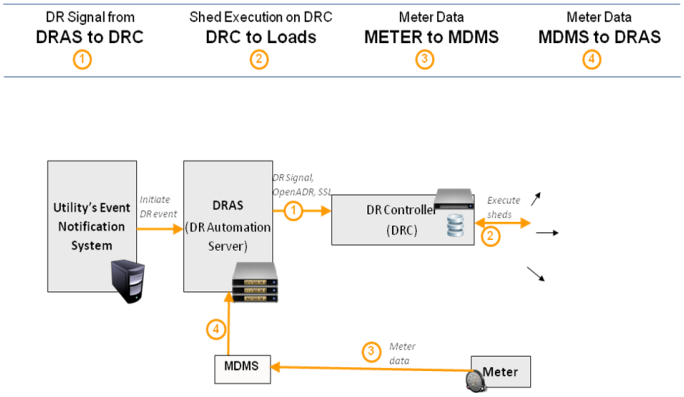



Fig. 1. AutoDR deployment topology between a utiltiy and a customer.

DRAS is integrated with the utility's event notification system, either by manual event notification by the operator or through an automated process. These events are converted in DR signals, and those are transmitted to the demand response controller/gateways in the site. The DR controller then shuts down or modulates the loads based on the shed strategies configured or commissioned in the site for each load. The meter data is integrated via the Meter Data Management System (MDMS) interface, where all the consumer's meter data are integrated with each site. The meter ID of each customer is used to associate the gateway with the meter data to calculate the telemetry, baseline, and calculated demand.

### A. *Honeywell Demand Response Automation Server*

The Honeywell DRAS[4] is the central communication network used by the utility to efficiently manage DR program participants, understand device communication status, and initiate and manage AutoDR curtailment events. Upon the event initiation, OpenADR signals are communicated to each facility's Energy Management System (EMS) or control system, automatically initiating shed strategies predefined and implemented in collaboration with the customer.

With the Honeywell DRAS, the utility will be able to:

- Generate load shed via an end-to-end solution that allows a variety of flexible, automated load control events;
- Predict, monitor, and verify load shed;
- Adhere to standards and open protocols, thus lengthening asset lifecycles, allowing system interoperability and facilitating development of compatible software and hardware by a broad network of participating vendors; and
- Access the data and analytics required to quantify the benefits of demand response in real time, and initiate and monitor the effect of demand response events via a user-friendly utility dashboard.

### B. *Low-Cost Demand Response Gateway Solution*

A low-cost demand rresponse gateway [5] is used to address key issues, such as:

- Complexity in deployment and configuration,

- Needed well-trained engineers for deployment, and
- High cost of hardware.

The AutoDR Gateway has been reused from the existing Building Solutions hardware platform deployed at the customer site. It has the capability to integrate with site energy meters, collect energy data, and send the data to the DRAS server, which is managed by the utility. Also, based on the programs defined by the utility, the Open AutoDR Gateway receives shed events and communicates them to the shed strategies configured in the site for reducing the current demand from that site. A commissioning tool allows the user to quickly deploy the gateway in the site and reduces the commissioning time with an enhanced user interface.

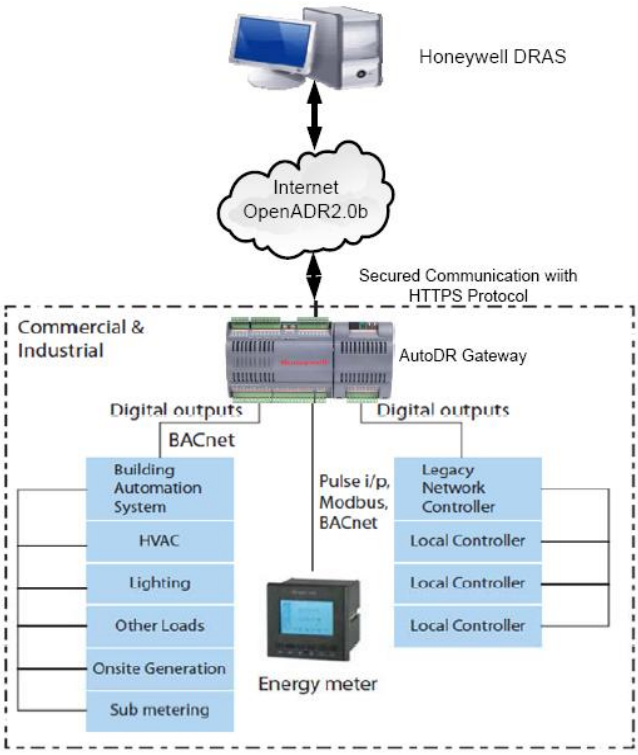



Fig. 2. AutoDR Gateway features and connectivity of the sub-systems.

The major features of this DR Controller are as follows:

1. Certified OpenADR 2.0b profile.
2. Meter Integration via industry standard protocols such as Modbus RS485, BACnet IP, BACnet MSTP, and Pulse interface.
3. Data storage up to five days, and the data can be recovered if communication failed between DRAS and AutoDR Gateway.
4. Configurable meter data push intervals.
5. Network Time Protocol (NTP) server communication to enable time synchronization.
6. Standard network configuration support, to secure the gateway communications.
7. Integration to building management system though a BACnet interface.
8. DR events triggered through onboard digital output terminals.

The DR and pricing standards used by the utility's DRAS and customer's DR controller provide the following benefits, in addition to interoperability:

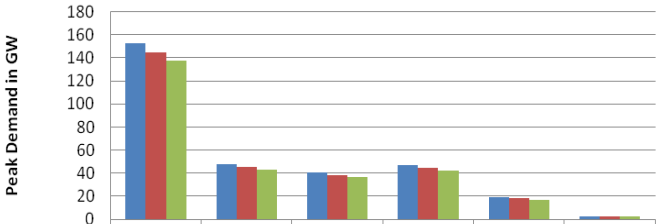
***Low-Cost Deployments:*** This does not refer to hardware costs, which depend on the installation, commissioning, meter integration and integration of the AutoDR Gateway with the loads. Most of the older AutoDR Gateway solutions are using an OBIX(Open Building Information Exchange) interface to communicate meter data to the DRAS servers. Even though the protocol is interoperable and the configuration necessary to commission the system is time consuming and based on field inputs, it used to take an average of two days per site to deploy and commission the solution. Also if a user wants to integrate the system with third-party DRAS providers (or vice versa), then the systems will require much testing, modification, and customization.

With the new OpenADR 2.0 reporting service, it very easy to integrate the meter data from the field to the Gateway and then provide the data to the utility servers or DR management systems. Field technicians for the Honeywell new AutoDR Gateway with OpenADR 2.0 need very minimal training, and with minimum configurations the system can be deployed and commissioned in four to eight hours. Due to the above-mentioned savings, this will reduce the cost to serve to the customer, improve productivity, and quicken deployments.

***Cyber Security:*** Security issues arose with previous AutoDR systems on the market. With OpenADR 2.0b, security considerations are embedded in the specifications; they are mandatory for OpenADR 2.0 compliance. This instills confidence in customers that the system is secure. As utilities and customers use the OpenADR2.0b solutions, the team has identified enhancements on the security considerations.

### *C. India Auto DR Market Potential (Region-wise)*

Figure 3 shows the region wise AutoDR market potential in India. These assessments were done by smart grid operations team at Honeywell after conducting multiple workshops with the regional utilities and assuming the factors such as type of DR programs perused, market acceptance of the programs and overall cost effectiveness of the programs.




| | All India | North | South | West | East | North East |
|---|---|---|---|---|---|---|
| BAU | 152.746 | 48.136 | 40.367 | 47.108 | 19.088 | 2.536 |
| Achievable | 145.1087 | 45.7292 | 38.34865 | 44.7526 | 18.1336 | 2.4092 |
| Maximum | 137.4714 | 43.3224 | 36.3303 | 42.3972 | 17.1792 | 2.2824 |

Fig. 3. AutoDR market potential in India

The assessments indicate the following:

- Northern, Western, and Southern regions contribute for about 90% of India's peak demand.
- Assuming that the commercial and industrial (C&I) sector contributes 50% to peak demand, with the other 50% attributable to the residential and rural sectors.
- The C&I demand response market size throughout India is 3.81~7.63 gigawatts (GW).
- The C&I demand response market size in the Northern, Western, and Southern Region is 3.39~6.78 GW.

## III. TECHNOLOGY DEPLOYMENT CHALLENGES

As this is one of the first AutoDR deployments for both Honeywell and the utility, the technical and management team has faced the following major challenges. These challenges lead to increase in deployment cost by 15% to 20%. That includes procurement of new devices such as modems and uninterruptible power supply (UPS) systems, integration of manually controlled loads, and other factors.

### *A. Interoperability challenges – Integrating the MDMS with DRAS Server.*

The major challenges involve getting the meter data of all consumers from the MDMS system, mapping them to ggateways connected to the customer, and mapping them in a customer portal. Using the support of OpenADR 2.0b services, using Ei Report service, we achieved this interoperability and used the customers' meter IDs to map them to the gateway and in the customer portal. The MDMS acted as another OepnADR 2.0 client for the utility's OpenADR 2.0 server.

### *B. Handling Bulk data between DRAS and Gateways*

To reduce the modem cost and the tariff rates, the system is designed to support GSM modems. Due to the lower network bandwidth, there were issues transferring the large amount of data from multiple sites to and fro from the DRAS to the gateway. And many of the gateways showed offline even though the gateways are online. The team configured the varying polling frequency in the gateways so that the gateways can poll the DRAS in different intervals to reduce the load on DRAS server.

### *C. Load Segregation Challenges*

The segregation of critical and non-critical loads under the single site is always a challenge because of the inconsistent consumption patterns of the most of the consumer sites. Also in many cases customer did not have supporting technologies or equipment, which could support the integration into the controller.

### *D. Consumer Level Holiday, Customized Calendars*

The DRAS server was supporting the common system-level calendar and holiday schedules. It was difficult to configure some of the customers' DR with this calendar who had different schedules. But most of the production industry consumer's operating calendars are different, and are not common. This new feature to standardize this information will be a new enhancement for upcoming releases.

The consumers' energy consumption patterns are not consistent and because of this representing the shed in the telemetry view is very difficult and even if we display the shed window it doesn't look like actual shed due varying consumption patterns. The technology team is currently working on this issue to find a solution.

### *E. Customer's Internet availability*

Most of the customers did not have Internet access at the facility and because of that the team had to identify the low-cost Global System for Mobile communication (GSM) modems to enable the communication of AutoDR gateways with the DRAS server. Ensuring a secure installation of these modems at the sites was the major challenge.

### *F. Power Backup for the Gateways*

The AutoDR controller is expected operate 24/7, so that it is receiving DR events from the DRAS server and sending the meter data to the DRAS server. Any interruption in the DR controller operating power supply may lead to improper operation of the DR system deployed in the consumer site. So a UPS power backup is necessary for a DR deployment if it does not have power backup facilities. In the current deployment, almost all the consumer sites do not have the power backup, so the deployment team needs to maintain a local power backup using UPS within the DR controller panel. This addition of the UPS led to the increase in deployment costs.

### *G. Integration of Manually Controlled Loads*

In most consumer sites, such as flour mills and other production industries, the loads, such as pumps and motors, are not monitored through the automation system. These loads were controlled manually using electrical panels. When DR controller receives the shed events, it was not possible to detect the loads which are in ON status and for such loads trigger the appropriate shutdown commands. To overcome this integration issue, the team developed a small relay assembly, which can monitor the status of the load and drive the events received from the DR controller to respective loads which are in the ON state.

### *H. Regulatory Policies*

The present project was done without offering any incentives to the customers. To encourage a larger participation, a incentive scheme for the customers to be introduced and regulator policies should encourage DR and energy efficiencies with specifics to support the technologies and solutions.

## IV. CONCLUSIONS AND FUTURE WORK

This paper reviewed the technology solutions for addressing grid reliability and peak power in India. The findings from the application of these technologies were derived from an AutoDR project within a large utility in India's capital, New Delhi. Through the project's deployment,

the team learned many lessons on the contextual applications of technologies with Indian customers and electricity markets.

The technologies successfully enabled an interoperable DR signaling infrastructure to the utilities. The controllers in the facilities used these signals to automate their responses. The results of these responses, conducted in another study, was over 10% of the peak load [6]. The technologies in each customer sector had its challenges. For example, the dust in the flour mills required an enclosure and heat dissipation methods. Even under these circumstances, the flour mill and industrial customer sector provided the most significant DR peak reduction, in the range of 10% to 20% [6].

The project has proved that AutoDR technologies provide value to both customers and utilities to leverage the load flexibility as a cost-effective and carbon-friendly solution to the increase in the generation capacity. Some specific technical findings from the deployments are as follows:

### *A. Automated Demand Response – Values Delivered*

*1) Scalable and Flexible Platform*

With a single platform, DRAS allows customers to participate in multiple programs, depending on their business rules and the response nature of participating loads. As noted in Indian utility demonstration project requirements, flexibility and scalability is critical to successfully serving many different types of customer facilities, from office buildings and multi-use commercial buildings to college campuses and smaller factories.

*2) Single Unified Head End*

As a singular unified Auto DR head end platform, the DRAS can be deployed not only for these commercial sites, but also in future this can also be integrated to Non Honeywell commercial and industrial facilities, and residential buildings.

*3) Customer Benefit, Relationships and Trust*

The utility retains the customer relationship. It owns the curtailment portfolio and initiates the event from its command center. The utility is offering value to the customer, and therefore the program offers a great opportunity for it to provide a higher level of customer service. This is going to be of paramount importance in future, as the regulator approves retail supply of electricity in Delhi. The program will initially be implemented at 250 commercial customer sites, and will scale to thousands over time. The curtailed portfolio will be very reliable, as the solution is "co-authored" with the customer, taking into account the "business rules" applicable for the particular facility. The opportunity the solution provided for the customer to have detailed information of his consumption and load will help them to manage their load effectively and use the same to reduce their bill looking at their Time of the Day (ToD) tariff. The detailed audit also informs the customer how he can save electricity by becoming more efficient and using energy saving equipment and processes. The solution also gives customer a portal which provides his details of his consumption data including load profile which would help them in identify opportunity to improve energy efficiency and productivity, thus the solution also empowers the customer.

*4) Event Management - Enhanced Analytics*

The redesigned user interface includes features such as data/resource visualization, grouping of assets, and aggregation, which enable the utility to get the most out of every demand response event. More analytics continue to be implemented, and they will be available to the utility as they become available.

*5) Customization Flexibility*

Honeywell's DRAS is customizable based on the needs and requirements of utility. The DRAS is used to place pending call notices, calls, and post-call follow-up notices on the web, while other system components—such as the AutoADR Gateway poll the web interface, receive these notices, and act upon them. This polling process produces rapid responses to event calls. Commands can be delivered to the gateways in less than 10 seconds.

*6) Dashboards and Baselines*

DRAS generates baselines for the participating facilities, leveraging the meter data received from the site. DRAS follows the n/m baseline to calculate the baselines. The n/m baseline model is the average hourly load shape of the "n" highest consumption days within "m" selected like-days. DRAS adopts three common n/m weekday models: 3/10, 5/10, and 10/10[8]. In addition to using historical data from previous days, DRAS offers the capability to adjust baselines, based on measurements made in the morning of the same day, called *morning adjustments.*

*7) Ease of Integration and the Software as a Service (SaaS) Deployment Model*

DRAS offers application programming interfaces that can be used to integrate with any enterprise software used by the utility. In the current scenario, DRAS will integrate with the MDMS of utility's choice, thus reducing extra costs involved in installation of additional meters at the site, for baselining and reporting purposes. In a similar way DRAS can integrate with the Customer Relationship Management (CRM) system, payment systems, etc.

*8) Open Standards-based Solution*

The Honeywell AutoDR solution is based on open standards. The DRAS is OpenADR 2.0b certified. Utilities receive the following benefits from adopting the open standards-based solution:

- It ensures that utilities are not tied in to a singular or proprietary technology.
- There are no post-pilot stranded assets for the utility.
- OpenADR has already been adopted by 100+ vendors.
- It is scalable for generation-side activities

*9) Cyber Security*

Security is a central concern and an important element that must be addressed by any utility seeking to take advantage of the Smart Grid. Any "smart grid" system must be able to detect, prevent, and communicate and recover from system security threats, up to and including cyber security threats and terrorism. The Honeywell AutoDR solution was thoroughly evaluated to ensure that critical infrastructure cyber security standards were followed for all the elements in this project.

Honeywell addressed the functional requirements of cyber security at three levels: physical security, server security, and client security.

*10) Easy Opt Out*

Another feature DRAS provides to customers is an option to opt out of DR events and notify the utility. Cellular Short Message Service (SMS) functionality was used to opt-out of the DR events when customers chose. This opt-out functionality using SMS was unique, and the customers were using it without any additional documentation or training.

*11) Better Asset Management*

A good backing of DR potential from a network would give opportunity for utilities to optimize their assets and network. The changing customer behavior which is bringing in increased use of air conditioners and other electrical appliances would result into stress in the network, DR could be a better potential product to address to this need rather than increasing power procurement.

## *B. Future Work*

The AutoDR technologies have a significant potential for deployments in the Indian markets. With the U.S. vendors such as Honeywell, IBM, and others that have competitive technology solutions for residential and commercial AutoDR services, additional field applications by the utilities are necessary to gain knowledge and support the scaling of technology transfer in new emerging markets in India. Technology vendors must work on the technology innovations to reduce the cost of the overall solution for the high-growth regions and demonstrate the solution to utilities across India. The bilateral collaborations between the U.S. and India must support the initiatives to promote AutoDR in the Indian market, as well in other high-growth regions. Both the public and private sector must work to develop the advanced shed strategies that are supported by the building management system for the standard loads. Such actions will provide the flexibility in integration of the AutoDR system with larger commercial and industrial buildings though their integrated building management system and a resource to the electric grid. The Smart Grid solutions team in Honeywell must provide any new feedback from deployment lessons to the standards organizations and policy makers with respect to interoperability and security for India-specific markets.

To make concept of Smart Grid succeed it is important for the government to come with policies, which essentially encourage energy efficiencies, reduce cost of power, and reduce our energy intensity.

## ACKNOWLEDGMENT

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## BIOGRAPHY

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**Ganesh Das** heads the Strategy and Business Relations at TPDDL. His experiences are in the areas of strategy planning, business development, customer relationship management, process improvement, consulting and technology. His key interest areas are consumer behavior and effect of Technology on Consumers. He was the part of the global team involved in conceptualizing, development and enablement of "Smart Grid Maturity Model"(SGMM) whose rights now rests with Software Engineering Institute (SEI), Carnegie Mellon University (U.S). Dr. Das is holds a MBA, LLB and PhD in the area of Strategic Marketing and Consumer Behavior from Indian Institute of Technology, Delhi, India.

**Sujoy Kumar Saha** is an Electrical Engineer with specialization in Power Distribution. He has more than 24 years of rich experience in various organizations like HM, West Bengal State Electricity Board and Tata Power Delhi Distribution Limited. he is Deputy General Manager with Tata Power Delhi Distribution Limited (TPDDL, a Tata group company, he is responsible for major technology interventions including Smart Grid Initiatives.