



Model Terms of Reference for Demand Response

Noida Smart Distribution Project

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1. Introduction and General information

1.1 Introduction

Demand Response (DR) is a widely recognized and effective method for managing electricity grids, acting as a vital tool in Demand Side Management (DSM). This approach involves consumers voluntarily adjusting their electricity usage during certain periods, motivated by incentives or penalties. These adjustments can either increase or decrease electricity demand in response to specific signals, which often involve financial implications. DR is a globally proven mechanism for grid management as a Demand Side Management tool.

The Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2023¹ defines Demand Response (DR) as “variation in electricity usage by the end consumers or by a control area manually or automatically, on standalone or aggregated basis, in response to the system requirements as identified by the concerned load dispatch center”.

The nature of Demand Response can be either automatic or based on consumer behavior, activated by various triggers like pricing signals or incentives. It plays a crucial role in stabilizing grids that heavily rely on renewable energy sources, aiding in the prevention of power outages and easing network congestion. DR is essential in creating a balance between demand flexibility and supply flexibility. It's also a key strategy used by grid operators to control peak demand.

Demand Response is a scalable solution that can be initiated with limited number of consumers and scaled up by addition of more consumers over a period of time. Depending on DISCOM's needs and priorities, different use cases and methodologies (automated and behavioral) for DR can be adopted.

1.2 Objective

In traditional sense, the main objective of DR program is to reduce the peak demand thus improving grid reliability and optimizing costs. In recent times, however, DR has transformed from a peak mitigation strategy to a multi-faceted solution that not only addresses the concerns of grid reliability but also the dynamic challenges of modern energy landscape. These challenges include high integration of RE, grid modernization, rapid growth in electricity consumption, environmental impact etc. Moreover, DR can also be seen as component of energy markets and as an ancillary service provider, aiding in maintaining grid frequency and voltage regulation.

Key benefits/ use cases of a standard Demand Response program include:

- Effective management of peak electricity demand
- Reduction in power procurement costs
- Capability to handle sudden grid fluctuations (demand and supply based)
- Avoidance of infrastructure augmentation (lines, transformation capacity etc.) to cater to peak loads for limited time periods
- DISCOM and prosumer participation in Ancillary Services market
- RE Integration

PVVNL faces a steep increase in peak demand in the evening and morning hours, which necessitates the purchase of expensive energy from short term market/ power exchange and at times augmentation of network capacity to cater to additional loads. An effective Demand Response solution could help curtail its peak load and optimize the power purchase cost. In addition, DR can

¹ [180-Regulations.pdf \(cercind.gov.in\)](https://www.cercind.gov.in/180-Regulations.pdf)

also help curtail the investment in creating additional network capacity for handling peak loads. Therefore, PVVNL proposes to demonstrate a DR program which can be scaled up in future.

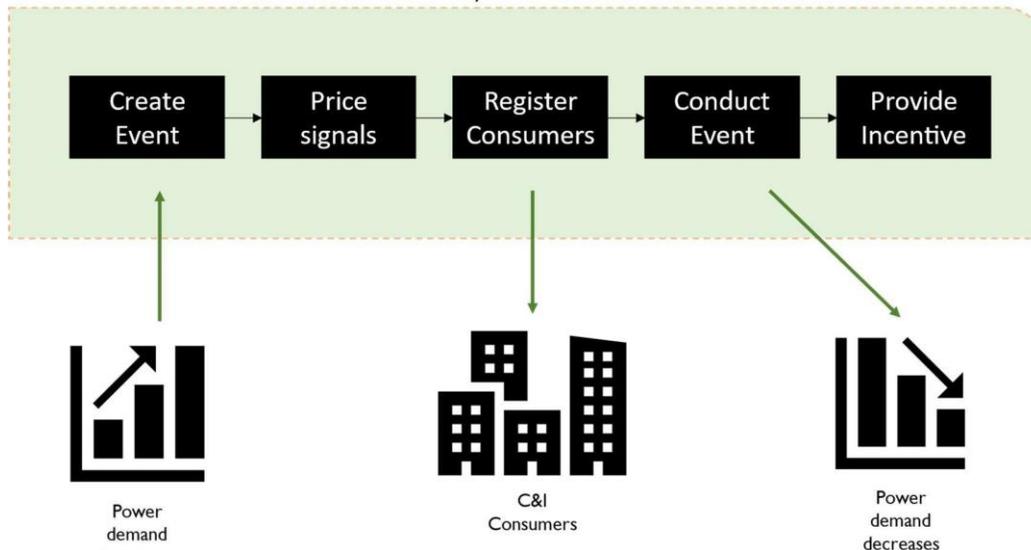
The DR pilot is envisaged to enable voluntary load reduction by consumers basis price signals (e.g., critical peak pricing) in response to grid parameters (peak load, critical peak load etc.). PVVNL aims to focus on Commercial & Industrial consumers as the response is expected to be better with high consumption consumers who are more sensitive to electricity prices.

Objectives of the DR program are -

- Reduction of network load (DTs, lines etc.) in MW
- Power procurement cost reduction (INR. Cr.)
- Peak load reduction (MW)

1.3 Schematic diagram

The high-level system architecture of the solution is highlighted as follows:



2. DRMS software requirements

The Demand Response Management System (DRMS) shall have the following key facilities:

2.1 Power demand analysis

The DRMS shall have a power demand analysis module which shall predict the power demand for a future time period of interest as desired by the user. The analysis module shall have provision for mapping the power availability - from relevant data sources such as SLDC schedule. This shall help in determining the shortfall (if any). If the shortfall is more than the pre-defined threshold level, the system shall prompt to trigger a demand response event.

2.2 DR program design

The heart of the DRMS is program design module which shall consider the several factors for each DR event design. These factors shall include but not be limited to -

- Power availability and peak power demand during the target period

- Duration of the target period for the DR event
- Number of consumers enrolled in the DR program
- Target peak shaving from the DR event
- Cost benefit analysis of DR event
- Optimum incentive offer to consumers

The DRMS shall make use of latest technologies such as Large Language Models / Generative Artificial Intelligence (AI) to assist in DR program design.

2.3 Consumer enrolment

The consumer enrolment module shall have provision to register consumers willing to enroll in PVVNL's DR program. The enrolment module shall have the ability to fetch key master data from PVVNL's billing system. Such master data may include:

- Consumer number, name, address, and contact details
- Contractual demand, voltage level and tariff category
- Maximum demand and average demand
- Month-wise energy consumption pattern (as appropriate)

2.4 Information dissemination

Once the DR event is finalized, the DRMS's information dissemination module shall assist in outreach to consumers for maximizing participation in the said event. Information dissemination may use popular methods such as SMS, email, WhatsApp, etc. for spreading awareness to consumers and sending out reminders.

Similar to program design, information dissemination module shall also make full use of latest technologies such as Large Language Models / Generative Artificial Intelligence (AI) to assist in formulating content strategies for optimizing consumer engagement and maximizing DR enrollment.

2.5 Event management facility

The DRMS shall have a dedicated module to manage and store data of each DR event and enrolled consumers. Details of events such as duration, load curtailed, consumers participated, incentives etc. shall be stored in the event instance. This shall help in cost benefit analysis of each event as well as provide inputs for planning and design of future events.

2.6 Data analytics

The DRMS solution shall conduct detailed event-wise analysis and generate actionable insights for PVVNL team. The AI / ML algorithm should support design of DR program and events, consumer registration and outreach to consumers to participate in DR events. Furthermore, AI / ML algorithms shall be developed to improve the working of PVVNL and with the objective of overall peak demand reduction, efficiency improvements and consumer service improvement.

In this context, the selected bidder / implementing agency shall research and implement novel cases for use of AI / ML algorithms. Special emphasis shall be given to latest technological advancements such as Large Language Models (LLMs) and generative AI to improve process efficiency and consumer services.

2.7 Baseline and cost benefit analysis parameters

The implementing agency shall prepare a baselining report in order to freeze the baseline numbers for determination of reduction of peak demand at the end of the project. The report shall also

outline the methodology of calculating the Cost Benefit Analysis (CBA). The parameters for cost benefit analysis as well as their baseline values shall be defined in the report. Data for these parameters shall be collected from the nodal officer of PVVNL.

2.8 Integration with other technologies

The customer enrolment module is required to capture data from consumer billing module of PVVNL. Further, the power demand analysis module may require data from load dispatch schedules. This may happen through SFTP / API route or through manual update as mutually agreed with Nodal officer of PVVNL.

2.9 Handling of data

All the data and related reports shall be shared with the nodal officer of PVVNL on a monthly basis. Sensitive data shall be encrypted and kept in a cloud storage service. Relevant formats shall be shared with the nodal officer for handover of data each month together with signoff.

2.10 Monitoring and evaluation

In order to monitor, evaluate and improve the DRMS solution, the implementing agency shall deploy a suitable team stationed at PVVNL, Noida. This team shall coordinate with nodal officer of PVVNL on a regular basis. Review methodology and frequency of review shall be defined in consultation with nodal officer of PVVNL.

3. Scope of work

The bidder is required to provide an unpriced Bill of Quantity (BoQ) for the DRMS platform and DR implementation in C&I consumers of Noida for a period of 2 years. This unpriced BoQ must state all the line items influencing the development of the solution as defined in this scope of work and the section on system requirements given above.

The scope of work shall include but will not be limited to the following:

3.1 Selection of service provider / implementing agency

The selected bidder shall empanel a qualified and experienced DR Implementing agency with requisite skillsets, teams and technology stack complementing the requirements underlined in this document.

3.2 Data baselining

The selected bidder / implementing agency shall assist PVVNL in baselining of data prior to commencement of the DR program. This shall include:

- Average Power procurement cost (INR. Cr.)
- Peak demand (in MW)
- Any other data point suggested by nodal officer of PVVNL

3.3 Customization and Installation of DRMS

The selected bidder / implementing agency shall customize their DRMS solution based on the requirements given in section 2 above. Post customization and approval on User Acceptance Test (UAT), the solution shall be installed in mutual agreement with the nodal officer of PVVNL.

3.4 Hosting Infrastructure

1. PVVNL intends to host the DRMS system, portal, and dashboard on cloud, using the latest “cloud computing” technologies. This will provide secured on-demand access to the resources with minimal management requirements. Alternatively, PVVNL may decide to host the same on local server with mutual discussion.
2. The Hosting infrastructure shall have separate Development / UAT and Production Environment. The selected bidder / implementing agency shall be responsible for keeping these environments in sync.
3. Cloud Service Providers such as Azure, AWS, Google Cloud which have high uptime and SLAs shall be used. Required services shall be purchased in the name of the PVVNL. Cloud infra should be dynamic and scalable i.e., at initial phase, lesser cloud infra may be required and later it shall be upgradeable as per the requirements of the project. (In terms of the VM, CPU, memory, Space, bandwidth, load balancers etc.)
4. The Cloud Service provider should be empaneled with MeitY and the data should reside within India only.

3.5 Security Policy

1. The selected bidder / implementing agency shall ensure that all the modules / webpages being developed are error free and hack proof. The system shall be secured from all types of unauthorized / malicious access such as hackers, malware, spyware, Trojans, backdoors etc.
2. Adequate measures shall be taken to prevent cross-site scripting, SQL injection, fishing, session hijacking, email bomb etc.
3. The system shall undergo mandatory Quality Control and QA testing.
4. The selected bidder / implementing agency shall ensure proper UAT environment for all the modules to be tested by program stakeholders. The selected bidder / implementing agency must create enabling environment on the existing infrastructure where the website has been hosted for UAT.
5. All new pages or any update / changes shall be first carried-out at UAT site and on confirmation by PVVNL the same shall be moved to production.
6. The entire system shall be free from OWASP Top 10 Vulnerabilities.
7. The system shall have Captcha function to prevent bot attacks. The system shall be protected against DoS attack targeting applications like locking of the application.
8. Audit trail shall be enabled on the website. The administrator shall be able to see the successful and unsuccessful logins, with time, IP, number of attempts, etc.
9. Audit trail at administrator level shall also be enabled. It should capture each activity done by each authorized user, IP address, Time stamp etc. to track that who, when and from where has done what changes in MIS/ Modules.

10. Administrator shall be able to generate email alerts and historical report in the security report to PVVNL, program that would contain the Time, IP address of attackers, the page under attack, and the parameter under attack with the attack values.
11. There shall be a provision of blocking any IP or Network by assigning IP Address range from accessing the pages of admin module of the website and the main websites that identified attackers can be blocked.

3.6 System Control and Audit

1. The system shall have proper security and maintenance facility with controlled access to its various functions to the users delegated with appropriate authority. The system shall restrict users from unauthorized access by allowing only the authorized users with valid profile / password to access only the allowed set of transactions mapped to the users.
2. The system shall have a capability to assign activities to roles, and map roles to users and provide role-based access to users. The date and time of critical transactions with details of creation, reading, updating, deletion or printing shall be logged by user and terminal.
3. The system shall place control on scope of activity of each user (data file, program, module, screen, data table, record, field, etc.)
4. The system shall have a capability to track changes to fields or settings and shall be able to record audit trails, audit logs and transaction logging requirements (what, when, who has changed)

3.7 Third party Certification

1. The selected bidder / implementing agency shall appoint a CERT-IN empaneled independent auditor / IT Security agency to evaluate the security IT System and shall provide certificate at its own cost.
2. PVVNL may also get the system tested for VAPT through its own vendor and the selected bidder / implementing agency shall be responsible for compliance of observations of such VAPT, if any.
3. All cost for Security audit shall be borne by the selected bidder / implementing agency. Security Audit shall be required minimum once a year.

3.8 Installation, testing & go-live

1. All levels of testing shall be conducted at Noida.
2. Testing must demonstrate that the system satisfies the operational and technical performance criteria.
3. Procurement and supply of the relevant software licenses, e-mail / SMS services, email / WhatsApp services, their installation, API integration and commissioning at all Sites and the required VPS infrastructure, space at cloud servers will have to provide by the selected bidder / implementing agency.

4. All defects found during review and acceptance testing shall be fixed by the selected bidder / implementing agency to the satisfaction of the nodal officer of PVVNL.
5. In case the whole IT System or any part thereof is found to be of inferior quality or not performing satisfactorily, the same shall be developed or modified free of charge immediately by the selected bidder / implementing agency.
6. All the expenses for UAT shall be borne by selected bidder / implementing agency.
7. It is selected bidder's / implementing agency's responsibility to evaluate test results and recommend any further changes to the infrastructure and / or system.
8. The selected bidder / implementing agency must describe how the testing methodologies will conform to requirements.

3.9 Ownership of source code / IPR

1. Ownership of the cloud instance and the entire source code shall remain with PVVNL.
2. All source code, data, documentation will be the property of the PVVNL and should be handed over to the PVVNL on day-to-day basis. Complete data transfer of application shall be done once application is Live.

3.10 System Architecture and Platform Technological Details

1. The entire system shall be developed / customized in the micro-service-based architecture.
2. The application shall be able to fetch data through APIs from different platforms / external sources etc. if required. Hence, data migration, integration and development effort may be required in order to integrate with other systems of PVVNL.
3. The application shall be built in such manner that it can share its own application data through API end points with other systems such as existing / future systems of PVVNL.
4. Development / customization of the application in open-source technology stack is preferred.
5. Technical details and all software related to the development of the DRMS system must be provided with relevant technical documents. All details related to development plan and software customization shall be mentioned on the technical proposal with unpriced BoQ as mentioned at the start of this section.

3.11 Import/ Export Facility

The system shall support upload and download of the following type of documents into from the system:

- a) Microsoft Excel files for export
- b) pdf files / documents
- c) Data files (including ASCII formats like *.csv. *.txt)
- d) Image files
- e) Any other file-formats required by PVVNL during the implementation / maintenance period.

3.12 Scalability

1. The system shall be scalable to handle an average of 100 concurrent users and 1 million consumers' data at any point of time without compromising response time or efficiency of operations.
2. The system data shall be kept on storage media with high tolerance of failure.
3. Auto-switching failover to other available server shall be supported in case of server failure of VPS. The system should support load balancing.
4. The selected bidder / implementing agency shall carryout Load Testing on the system and comply with its observations.

3.13 Data Backup / Data Archival / Restore

1. The system shall be able to archive data based on user specified parameters (for instance date range) and restore archival data for on-line use when required.
2. The system shall provide data backup and recovery facility (online and offline mode).
3. The system shall provide features to schedule backup / restore operations. The selected bidder / implementing agency shall ensure that activities such as proper data backup, data restoration, and data synchronization with DR site etc. are tested and implemented.
4. The system shall have the ability to run multiple backup tasks in parallel.
5. The system shall have the ability to manually override scheduled backup operations.
6. The system shall produce a report for each backup / restore task.
7. The system shall support direct backup of data from one machine to another / from server to storage media such as SSDs etc.
8. The system shall have provision to keep data on storage media with high tolerance of failure.
9. The system shall allow recovery of data in case of hardware / software failure, data corruption, etc. It shall be able to perform recovery to a recent historical restore point when required.
10. The selected bidder / implementing agency shall maintain a periodic duplicate database backup to minimize the chances of data loss.

3.14 On-Going Development & Iterations

1. This shall be an on-going engagement and require the selected bidder / implementing agency to have dedicated resources towards iterative development as the complexity and scale of the system grows with time.
2. Monthly meetings with PVVNL nodal officer and committee would take place for review of ongoing works and planning for the subsequent month. Each sprint would consist of one month wherein the scope would be clearly defined and agreed between all parties.

3. The selected bidder / implementing agency shall continue to provide upgrades, new features, rectify any issues, maintain and ensure 99.9% uptime at application and server layer.
4. The selected bidder / implementing agency shall be responsible for quality assurance, testing, and ongoing fixes in issues with response times mutually agreed with the nodal officer of PVVNL.
5. The selected bidder / implementing agency shall be responsible for maintaining uptime of cloud servers and shall work with PVVNL IT team to ensure security of the system remains intact throughout the operational tenure of this pilot demonstration.

3.15 Installation / Upgrade / Enhancement / New Development

1. The system shall have the facility of seamless upgradation of patches / new versions without having any adverse impact on its components.
2. Upgrades shall have minimal impact on the system and its components. Upgrades shall be implemented during non-working hours after seeking approval from PVVNL.
3. The system shall have the facility to maintain versions with documentation of changes / modifications made in each release. If required, the System shall be able to restore to the previous stable version.
4. The selected bidder / implementing agency shall be responsible for doing any kind of new development including:
 - a. Addition of new services
 - b. Third-party application integration
 - c. Modification / up-gradation / enhancement in the process or functionality to fix some complex problem requests or defect fixing to upgrade the application performance.
 - d. Update web-portal & application: design & content, layout, color schema, input forms, etc.
 - e. MIS report format

4. Training and O&M support

4.1 Training

The selected bidder shall provide comprehensive and detailed training plan describing the proposed approach & methodology, calendar / timelines, course contents, course duration, training materials, training tools, training logistics, etc.

1. Overview Training shall be provided to PVVNL Project Committee (including Nodal officer) and Project Management Unit (PMU) members at the beginning of implementation of each phase / module.
2. Technical Training shall be provided to PVVNL IT team
3. End User training shall be provided to PVVNL end users before each go-live / change. The selected bidder / implementing agency shall conduct training sessions for the users of Head Office and all regional offices and / or any other office / users suggested by PVVNL.

4. The selected bidder / implementing agency shall be responsible for preparation of the training materials, videos, handouts and update end user manuals covering “how to use” concepts for all functions/modules to be implemented. Training content and mode of delivery shall be approved by PVVNL. Training material shall be provided in both hard and soft copies. PVVNL shall be the owner of all such training materials.
5. PVVNL shall provide training halls and conference rooms (venues) at the locations where trainings are to be imparted by the selected bidder / implementing agency.
6. All incidental expenses (travel, lodging & boarding, local conveyance etc. for the selected bidder’s / implementing agency’s team) pertaining to training programs and workshops shall be borne by the selected bidder.

4.2 Operational Support and Maintenance (O & M)

The selected bidder / implementing agency shall provide onsite / offsite / hybrid support for smooth functioning of solution supplied. The Operational and Maintenance support shall remain valid for 2-years from the date of the “Final Signoff of all modules / warranty phase”.

O&M support shall have the following purpose:

1. For overall system stabilization, solution maintenance
2. System administration, security administration, database administration, network administration and end- user problem resolution (support for VPS Server, traffic, space etc.)
3. Necessary updates of software
4. Removal of the bugs from the application, modification / correction of and updates in the indicators on the dashboard / application, etc. The operational support shall ensure that the solution is functioning as intended.
5. The support shall also include supply of new versions / releases (including next generation release) upgrades, bug fixes, functionality enhancements and patches to cater to changes (including tax, legal, statutory and policy requirements) along with related documentation

5. Key Professionals (Onsite / Offsite / Hybrid Mode)

Development team should have diversified experience in their specific field of expertise in Design, Development of Web, MIS Applications, AI / ML including experience in customization, development, hosting of portal / system creation, system documentation and fully conversant with the principles and working methods of project management life cycle.

The bidder should have Back Office Support & Services, IT Technical expertise team on its own roll viz., Project Leader, Technical Lead, Subject Matter Specialist, Dev OPS, Full Stack Developer/ Programmer (specialize in financial projects/ MIS Development), Database Designer/Database Administrator, etc. of sufficiently experienced and qualified.

System Administrators / Cloud Engineer / Network/ Security DevOps/ Product manager may also be needed for this project. Domain Expert on the above-mentioned modules, financial software’s developments i.e. may also be included or software developers on these domains (Electric Vehicle/ Telematics/ MIS/ Dashboard/ Financial Loan Management/ Financial Risk Management /Guarantee product) may be preferred.

6. Deliverables

The following deliverables shall be expected from the successful bidder

No.	Deliverables
Phase I - Design Phase	
P1-A	Work plan & kick-off <ul style="list-style-type: none"> Present the Approach and Methodology outlining how the selected bidder / implementing agency will accomplish all the tasks illustrated in the scope of work within the due deadlines List of required data, data collection, development of templates to obtain inputs from PVVNL, interface requirements with other IT systems of PVVNL Team finalization from PVVNL and selected bidder / implementing agency
P1-B	
P1-C	
P1-D P1-E P1-F	Conceptualization <ul style="list-style-type: none"> Demonstration of existing solution Customization plan Approval from PVVNL nodal officer
Phase II - Development Phase	
P1I-A P1I-B P1I-C P1I-D	Team mobilization and coding <ul style="list-style-type: none"> Design finalization Customization Initial version Acceptance tests
Phase III - Installation Phase	
P1II-A P1II-B P1II-C P1II-D	Infrastructure Component <ul style="list-style-type: none"> Domain name and SSL (for 2 years) Cloud infrastructure, Virtual Machine, VPS, Space, bandwidth, Software's, and OS license etc. Annual security audits Gateways (SMS, etc.)
P1II-E P1II-F P1II-G P1II-H	Go-live <ul style="list-style-type: none"> Completion of UAT, final sign-off and approval from PVVNL Final stage release and security audit Handover of source-code to PVVNL Presentation on project experience and key highlights to PVVNL in Dissemination workshop
Phase - IV Running DR events, Support and Maintenance Phase	
P1IV - A P1IV - B	Running DR events on regular basis (as directed by Nodal officer of PVVNL) Application bugs, vulnerability fixing, bug fixing and server maintenance etc. for 2 years

Note:

The above specified scope of work is indicative and not exhaustive, and the bidder / agency is deemed and obliged to provide all necessary / incidental services and related works within their quoted cost for successful implementation / commission of the assigned work / project as per requirements of PVVNL.

7. Exit Management as per the project status

1. Agency may kindly note that contract will be continued subject to satisfactory performance of the program and availability of the funds/finance for this activity.

2. PVVNL has rights to discontinue and terminate the contract due to any unforeseen situation as mentioned above at Sr. No 1. However, all payments till that date shall be honored by PVVNL subject to acceptance of deliverables.