National Online Roof-top Solar Data Monitoring Centre

National Institute of Solar Energy (NISE)
## Contents

<table>
<thead>
<tr>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>About NISE Pilot DMC initiative</td>
</tr>
<tr>
<td>Frameworks assessed through the pilot</td>
</tr>
<tr>
<td>Achieving scalability through AMI framework</td>
</tr>
<tr>
<td>Solutions for Greenfield projects</td>
</tr>
<tr>
<td>Solutions for Brownfield projects</td>
</tr>
<tr>
<td>Value addition for stakeholders and interactions</td>
</tr>
<tr>
<td>Implementation Modalities</td>
</tr>
</tbody>
</table>
NISE to support India’s solar initiatives and facilitate stakeholder needs with the emerging energy ecosystem, launched a pilot solar data monitoring initiative

**Policy and Regulatory**
Need to visualize the project status, subsidy flows and environmental impacts of projects

**Distribution companies**
Require improved demand forecasting and planning

**Manufacturer**
Require real-time performance data utilized for enhancing product/service offerings

**End users**
Participate in energy markets, future electricity requirement planning

**Financial Institutions**
Need high quality real-time generation data to validate performance of proposed projects

---

**India Renewable Energy Targets (GW) by 2022**

- **Total: 175 GW**
  - 60 GW Solar
  - 10 GW Wind
  - 5 GW Biomass
  - 40 GW Ground mounted/utility scale
  - 60 GW Small Hydro
  - 10 GW Solar PV rooftop

**Source:** EY Analysis
NISE implemented the pilot project for installation of Data Acquisition Systems for Performance Monitoring of Solar PV Systems capturing 40 sites with 9.4 Mwp capacity.

**Site Distribution**

- Total: 40
- Academic institute: 1
- Water works site: 1
- Police station: 1
- IT Park: 1
- District Court: 1
- Hospital: 1
- Sports complex: 1
- Transport facility: 1
- Local Datalogger Storage

**Plant capacity (Kwp)**

- Total: 9.4 MWP
  - 100
  - 50
  - 155
  - 300
  - 535
  - 2840

**Weather Sensors**

- Pyranometer: 22
- Thermo-coupler: 22
- Anemometer: 40
- Total: 84

**Data Access through both**

- Inverter and Meter

**38**

- Meter-Datalogger Connections
- Inverter-Datalogger

**Ongoing Inverter API integration**

- 7 sites
- Successfully integrated

**38**

- DLMS to MODBUS conversion meters

**Inbuilt**

- GSM/GPRS modem for data upload with Dataloggers

**IP65**

- Rating for Datalogger

**16 GB**

- Local Datalogger Storage

---

Page 4
NISE pilot implementation incorporates “data logger” based acquisition through generation meter and captures inverter data through API access*

*API access is yet to be facilitated
Towards achieving a national scalability of the pilot adoption of AMI methodology is considered

Technology components of AMI

Smart Meters
- Advanced meter devices with two-way communication capabilities
- Capacity to collect information about energy generation at various time intervals
- Transmits data through fixed communication networks
- Receive information like pricing signals from utility and convey it to the consumer

Communication Network
- Advanced communication networks supporting two-way communication
- Networks such as:
  - Broadband over PowerLine (BPL)
  - Power Line Communication
  - Fiber Optic Communication
  - Fixed Radio Frequency or public networks (e.g., landline, cellular, paging)

Meter Data Acquisition System (MDAS)
- Software applications on the Control Centre hardware used to acquire data from meters

Meter Data Management System (MDMS)
- Host system which receives, stores and analyzes the metering information. In this case, NISE Data Monitoring Center
The greenfield projects are expected to be commissioned with the required AMI guidelines and smart meter installations.
For Brownfield a plugin communication device can be installed to the existing solar generation meter that can send the real-time generation parameters.

Upcoming initiatives and regulations are focusing on replacing conventional meters with the AMI framework based smart meters resolving functional level challenges with the components.
The Data Monitoring centre at NISE will be a value add for various stakeholders, including policy makers, developers, DISCOMs and consumers.

1. Visibility on generation achieved and plant performance
   - Visibility on environmental benefits achieved

2. Subsidy Allocation

3. Performance rating for developers
   - Certified and validated generation data can facilitate bankers in project yield assessment
   - Reliable information about O&M, track record and plant performance

4. Competitive performance benchmarking
   - Access to solar performance ratings
   - Access to solar component performance ratings
   - Reduced transaction costs for the generation of climate assets
   - Aggregation, processing and storing of plant level data at NISE

5. Improved demand forecasting, planning and scheduling
   - Monitoring and meeting RPO requirements
   - Generation based incentives to the project developers

6. Neighbourhood performance benchmark
   - Participation in Energy markets
   - Information on demand trends

MNRE

State Nodal Agency

Developer/Vendor performance

Subsidy Disbursement

Financier/Bank

Developer/EPC

NISE Data Monitoring Platform

DISCOM

Plant owner/Prosumer

Net Import

Net Export

Plant Installation

Tariff

Loan disbursement based on commercial due diligence

Financial flow

Services

NORS-DMC value additions
Assumptions:
1. This is a High-Level architecture view
2. Data Center Infra, monitoring, NMS etc. are assumed to be pre-existing.
3. Only required infrastructure for the HES, MDM and ReportPlus systems are defined
4. Storage is defined for data volume for 50000+ meters only
5. All network bandwidths from DNS onwards are assumed to be Gigabit network
6. DR Site is assumed to perform without High Availability (HA)
7. RPO/RTO need to be defined
8. HES from multiple vendors may be integrated to the MDM
Network Architectural topology
NORS-DMC: Visualization Dashboard for pilot sites

National Online Rooftop Solar Data Monitoring Centre

<table>
<thead>
<tr>
<th>No of Sites</th>
<th>Total Capacity (in mWp)</th>
<th>Total No of Active Sites</th>
<th>Cumulative Total Generation (in mW)</th>
<th>Total Generation today (in kWh)</th>
<th>CUF (in%)</th>
<th>Specific Yield (kWh/kWp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>9.4</td>
<td>16</td>
<td>0.1</td>
<td>70.46</td>
<td>0.00</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Energy Generation by Hour Trends

Status of Site

Select
- Custom
- Live (Last 24 hr)

Year
2019

Month
(All)

Week
(All)

Map View

Page 12
Component architecture and list

<table>
<thead>
<tr>
<th>Component List</th>
<th>Quantities for High Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application server</td>
<td>2</td>
</tr>
<tr>
<td>Application container</td>
<td>2</td>
</tr>
<tr>
<td>Archive Servers</td>
<td>1</td>
</tr>
<tr>
<td>Mass Data Storage</td>
<td>2</td>
</tr>
<tr>
<td>Hard Disk Arrays</td>
<td>2</td>
</tr>
<tr>
<td>Development server</td>
<td>1</td>
</tr>
<tr>
<td>NMS server</td>
<td>2</td>
</tr>
<tr>
<td>Identity server</td>
<td>2</td>
</tr>
<tr>
<td>Data replica server</td>
<td>2</td>
</tr>
<tr>
<td>Web server</td>
<td>2</td>
</tr>
<tr>
<td>Process LAN HUB/Switch</td>
<td>10</td>
</tr>
<tr>
<td>Firewall</td>
<td>2</td>
</tr>
<tr>
<td>Operator Consoles (2 Monitors per console)</td>
<td>2</td>
</tr>
<tr>
<td>Engineering Consoles (Monitors per console)</td>
<td>2</td>
</tr>
</tbody>
</table>
### Approach for Procurement

<table>
<thead>
<tr>
<th>Procurement Strategy</th>
<th>Package type</th>
<th>Server location</th>
<th>DMC Sizing</th>
<th>Ancillary infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1</td>
<td>All systems in one contract</td>
<td>NISE</td>
<td>Maximum capacity</td>
<td>Required</td>
</tr>
<tr>
<td>Alternative 2</td>
<td>Phased system implementation</td>
<td>NISE</td>
<td>Phase wise capacity addition based on utilization</td>
<td>Required</td>
</tr>
<tr>
<td>Alternative 3</td>
<td>Modular implementation</td>
<td>Cloud</td>
<td>Phase wise capacity addition based on utilization</td>
<td>Required</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vendor Strategy</th>
<th>Benefits</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Package Vendor Strategy for entire NORS-DMC including hardware &amp; software</td>
<td>Project Management would be smoother. Solution provider can be a single point contact.</td>
<td>• NORS-DMC systems tied to a single technology solution. Dependency on single contractor for all systems and accountability of the desired output lays on the lead vendor. • Contractor execution capabilities can lead to stretching of the project duration as parallel integration of multiple sites may not be achievable.</td>
</tr>
<tr>
<td>Multiple Package Vendor Strategy for entire NORS-DMC including hardware &amp; software</td>
<td>Multiple procurement packages can be built for HES, MDMS, Monitoring platform and analytic tools</td>
<td>• Project management will be tedious. • Packages can be built in multiple combinations hence identifying best possible combinations deriving most economical value could be a challenge. • Integration aspects between various vendors could be a challenge and have to be well-defined before initiating the process.</td>
</tr>
</tbody>
</table>
Implementation strategy

**Conceptualization Stage**
- The As-is assessment of the NISE’s pilot online monitoring platform development for the 40 sites and record its findings.
- Development of the concept note highlighting the site and DMC implementation aspects covering components, communication networks, visualization platform and server hosting aspects.
- Stakeholder engagement workshop to disseminate NORS-DMC concept and identify possible data integration methodologies through stakeholders.

**Pre-Development Stage/Field Test**
- Preparation of tender document and Request for Proposal
- Pre-Bid meeting with the bidders
- Evaluation of proposal submitted by the bidders
- Selection of CMC system developer and signing a contract with them

**Development Stage**
- Preparation of IT system requirement specifications and approval from NISE.
- Development of NORS-DMC hosting system (NISE IT infrastructure)
- Site/stakeholder integration testing
- Development of online monitoring, user accounts and other front-end packages
- Deployment of final NORS DMC system

**Post Development Stage**
- In this stage, the NORS-DMC system will be in the functioning stage. The activities involved in this stage are as follows –
  - System developers would prepare the user manual for the NORS-DMC system
  - Training to NISE staff on the functioning of NORS-DMC system
MRV methodology for GRPV systems
Potential for climate asset monetisation - ITMO generation under Art 6 regime

- MRV essential for ensuring transparency, good governance, accountability, and credibility of results, and for building confidence that resources are being utilized effectively to track and meet NDC progress.
- Since GRPV projects are clean source of energy, these will help reduce the carbon intensity of the national power grid of India which is currently dominated by thermal power plants.

OUTCOME
creation of a platform for developing climate assets in terms of emission reductions.

- Focusing on the projects that will be commissioned under the WB-SBI TA program as a CDM PDD (CPDD)
- Overall installed solar rooftop projects as Program of Activities (POADD) for large inclusion across India
- Need for aligned MRV framework of NORS DMC and PDDs
### Monitoring and Recording Procedure

1. **GRPV Project Site (Level I)** – monitoring at field level using energy meters, calibration record kept for future verifications.
2. **Program (Level II)** – Data monitoring and verification through data and documents stored at National Centralized Data Monitoring Centre (NCDMC). This will be used for the preparation of the Monitoring Report (MR) for emission reduction verification purpose.

### QA/QC procedure

1. **Calibration of meters** – Energy Meters will be calibrated at a frequency prescribed by local regulations or national regulation but at least once in three years.
2. **Event of failure of meters** – Meters to be replaced in event of (i) meter found faulty or not working; (ii) meter fails to communicate with NCDMC; (iii) energy bills of DISCOM to be used to cross verify net generation of electricity.

### Data Archiving Period

1. The monitored data will be kept for two years after the verification of last emission reductions for each GRPV project.
MRV Arrangement: Parameters to be monitored for the purpose of estimating emission reductions

<table>
<thead>
<tr>
<th>Data/Parameter</th>
<th>Description</th>
<th>Source of data</th>
<th>Value(s) applied</th>
<th>Measurement methods and procedures</th>
<th>Monitoring frequency</th>
<th>QA/QC procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data/Parameter</strong></td>
<td><strong>Data unit</strong></td>
<td><strong>Description</strong></td>
<td><strong>Source of data</strong></td>
<td><strong>Value(s) applied</strong></td>
<td><strong>Monitoring frequency</strong></td>
<td><strong>QA/QC procedures</strong></td>
</tr>
</tbody>
</table>
| **EG BL, i, y**        | kWh                                                                                           | Quantity of electricity generated by the solar PV system at site ‘i’ displacing the grid electricity during the year y. | Direct measurement or calculated based on measurements from more than one electricity meters installed at the site ‘i’. | Electricity generated by the solar PV displacing grid electricity                                                   | Data will be monitored continuously and recorded monthly.                                              | *Calibration of meters:* The electricity meter(s) will be subject to regular maintenance and testing in accordance with the stipulation of the meter supplier or national requirements. The calibration of meters, including the frequency of calibration, should be done in accordance with national standards or requirements set by the meter supplier. The accuracy class of the meters should be in accordance with the stipulation of the meter supplier or national requirements. If these standards are not available, calibrate the meters every 3 years and use the meters with at least 0.5 accuracy class (e.g. meter with 0.2 accuracy class is more accurate and thus it is accepted). In the event, meters are found faulty they will be replaced with immediate effect with new calibrated meters.  
*Cross-check:* The electricity generation would be cross-checked with joint meter reading (JMR) records and invoices [in case of RESCO model]; inverter data, trend analysis and with irradiation data for plausibility check. |
## MRV Arrangement: Parameters to be monitored for the purpose of estimating emission reductions

<table>
<thead>
<tr>
<th>Data/Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EF&lt;sub&gt;grid,CM,y&lt;/sub&gt;</td>
<td>Combined Margin CO&lt;sub&gt;2&lt;/sub&gt; emission factor for the Indian electricity system in year (Grid emission factor)</td>
</tr>
<tr>
<td>Data unit</td>
<td>tCO2/kWh</td>
</tr>
<tr>
<td>Source of data</td>
<td>CO&lt;sub&gt;2&lt;/sub&gt; Baseline database for the Indian Power Sector published by Central Electricity Authority (CEA)</td>
</tr>
<tr>
<td>Value(s) applied</td>
<td>Latest published value</td>
</tr>
<tr>
<td>Measurement methods and procedures</td>
<td>Combined Margin (CM), consisting of the combination of Operating Margin (OM) and Build Margin (BM) according to the procedures prescribed in “Tool to calculate the emission factor for an electricity system”</td>
</tr>
<tr>
<td>Monitoring frequency</td>
<td>To be updated annually</td>
</tr>
</tbody>
</table>
Nithyanandam Yuvaraj Dinesh Babu
Team Leader, EY Consortium/ Executive Director
Ernst & Young LLP
Contact: 9560719349
Email: Yuvaraj.Dinesh@in.ey.com

Ashish Kulkarni
Associate Partner | Advisory Services
Ernst & Young LLP
Mobile: +91 9958222583
Email: Ashish1.kulkarni@in.ey.com