Smart Grid and its implementation challenges: An Overview of Puducherry Pilot Project
• What is Smart Grid and it’s objectives?
• Basic architecture of AMI
• Functionalities of AMI, MDAS, MDMS and PLM
• Benefits to utilities and consumers
• Challenges in field implementations
• Conclusion
SMART GRID
“A technology that deploys various technological advancements to bring in efficiency, reliability & affordability

“A system where Megawatts of Power controlled by Megabytes of Data”
The main objectives of the project include:

- Demonstrating the usefulness of smart meters to the stakeholders
- Demonstrating time-of-use (TOU) and peak-power pricing (PPP) and how it helps the utility in managing load
- Providing the ability for a utility to curtail loads as against load shed
- Providing the ability for a consumer to manage energy use
- Improving grid reliability and availability
- Providing proactive maintenance to avoid failures
- Managing distribution of load throughout the day
- Improving billing efficiency through elimination of manual intervention in billing
- Reducing AT&C losses
- Reducing failures in customer equipment
- Reducing failures in grid equipment (e.g., DT's)
- Improving load balancing
- Increasing revenues through premium services
- Determining the capabilities needed to integrate intermittent renewable energy into the grid
- Determining appropriate training for utility employees to manage the Smart Grid
- Determining the benefits of the Smart Grid, including qualitative benefits
Overview of Puducherry Smart grid Project

- Puducherry Smart grid project is one of the 13 smart grid pilot projects of Govt. of India covered under IPDS (Erstwhile R-APDRP Part-C)
- Consumers covered – 33,499 consumers including 1640 LT CT operated meters
- Functionalities: **AMI and PLM**
- Project Cost – 33.83 Crores + 2.74 Crores for 5 yr maintenance
- MoP share – 50% of project cost
- Utility share – to be met by Investor and to be repaid by the State Government in 60 equated instalments after completion of the Project.
SM - Smart Meter
DCU - Data collector unit
Communication layer
MDMS - Meter Data Management System
MDAS - Meter Data Acquisition System
GPRS

Puducherry Advance Metering Infrastructure System

LT CT Consumers
Functionalities in Smart Meters

- V, I, KW, KVAR, Power factor and other Energy parameters read for every 15 minutes. Except Energy, all will be average of values in the 15 minute interval.
- Instantaneous values of above parameters can be read through manual polling.
- Connect / Disconnect feature
- PLM feature (If load restriction set from MDAS for particular period, Smart Meter tracks the consumption and disconnects two times temporarily for 3 min and if still load is not curtailed, load is completely disconnected for balance load restriction period)
- Pre-paid functionality achieved.
  (MDAS keeps track on balance amount and if turns nil, disconnect command sent from MDAS)
- Net metering
- Tamper alerts
- Time of Use

Standards:
- Smart meters: IS 16444
- Communication: IS 15959/ DLMS

Smart meters and DCU installed in field
Communication Systems Used

- Two way communication system backbone for Smart Grids
- Cellular (GPRS) is used for CT operated meters direct communication with MDAS
- RF is used for Smart meter and DCU (a gateway). DCU to MDAS uses GPRS

Radio Frequency:
- ISM band 865-867MHz,
- Short distance, Low power, Low data speed & Low cost
- Factors affecting RF
  - Orientation of meters installed
  - Require repeaters for long corridors or basement
  - Metal enclosures
  - Line of sight

Data availability of RF
<table>
<thead>
<tr>
<th>No</th>
<th>Date</th>
<th>DCU Type</th>
<th>DCU Name</th>
<th>Online Counts</th>
<th>Online Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000290(NSS-IV)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>57</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000272(VEERAMAMUNI)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>58</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000273(NETHAJI NAGAP)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>59</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000316(PIDIC SS-XVIII)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>60</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000275(CEST CLINIC S)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>61</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000276(LAPORTE SS-I)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>62</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000277(CEST CLINIC S)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>63</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000278(VEERAMAMUNI)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>64</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000294(NSS-XLVIII)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>65</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000285(RAMAN SS)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>66</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000318(PIDIC SS-XVIII)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>67</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000304(PIDIC SS-III)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>68</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000296(SURCOUFF SS-II)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>69</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000303(THIRUVANAI P)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>70</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000297(S/THANANDHA</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>71</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000292(NSS-I)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>72</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000293(NSS-XLVIII)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>73</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000298(DRIANGE SS)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>74</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000299(VEERAMAMUNI)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>75</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000301(THIRUVANAI P)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>76</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000300(THIRUVANAI P)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>77</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000302(THIRUVANAI P)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>78</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000230(V/AMAMUNIV)</td>
<td>95</td>
<td>98.96</td>
</tr>
<tr>
<td>79</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000265(PSS - XIV)</td>
<td>95</td>
<td>98.96</td>
</tr>
<tr>
<td>80</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000204(SEDARAPET SS-)</td>
<td>95</td>
<td>98.96</td>
</tr>
<tr>
<td>81</td>
<td>2018-12-21</td>
<td>CT AP</td>
<td>CT-37000202(SEDARAPET SS-)</td>
<td>95</td>
<td>98.96</td>
</tr>
</tbody>
</table>

Legend: Unknown, Online, Offline
## Smart meter Online rates

### Meter Status Summary:

<table>
<thead>
<tr>
<th>Organization</th>
<th>Total number</th>
<th>Onlines</th>
<th>Offline number</th>
<th>Online rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>total</td>
<td>206</td>
<td>192</td>
<td>14</td>
<td>93.20</td>
</tr>
<tr>
<td>PED</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0.00</td>
</tr>
<tr>
<td>Urban O&amp;M Division</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Town-1 Sub.division</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Town North</td>
<td>30</td>
<td>28</td>
<td>2</td>
<td>93.33</td>
</tr>
<tr>
<td>Town South Central</td>
<td>78</td>
<td>69</td>
<td>9</td>
<td>98.46</td>
</tr>
<tr>
<td>Town Central</td>
<td>76</td>
<td>74</td>
<td>2</td>
<td>97.37</td>
</tr>
<tr>
<td>Town South</td>
<td>21</td>
<td>21</td>
<td>0</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Legend: less than 90%
MDAS (Meter Data Acquisition System)

- Meter Data Acquisition system collects instantaneous, load survey data from the Smart Meters / DCU on timely basis
- It collects all tamper, alarms and events from meters and push to MDMS
- All the control commands from MDMS shall be executed through MDAS
- All the events like power outage /down time, peak loads, system disturbances etc. can be monitored through MDAS
- MDAS is like gateway between MDMS and Smart meters

Consumer data base configured in MDAS
MDAS (Meter Data Acquisition System)

Consumer load survey data in MDAS
MDMS (Meter Data Management System)

- Meter Data Management System is a data analytical system that collects raw data from MDAS and processes it for different applications.
- MDMS provides billing data, alarms, events, analytics, viz., load forecasting, power outages, etc.
- MDMS generates service orders based on maintenance activities.
- VEE is the main core analytical tool for MDMS.
- All the functions shall be performed through MDMS only.

Consumer data analytics

Alarms and events
Peak Load Management allows utilities to reduce demand for electricity during peak usage times, which can, in turn, reduce costs by eliminating the need for peaking power plants.

**Demand Response (DR):**

"Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized. Demand response allows energy users of all kinds to act as “virtual power plants,” adding stability to the grid by voluntarily lowering their demand for electricity."
Demand side management shall be done at utility side by taking prior consent with the consumers / group of consumers.

Loads can be prioritised based on requirement:
- Critical loads
- Medium-Critical loads
- Non-Critical loads

Part of load shall be supplied during peak hours which is called brown out instead of block out. Incentives shall be paid to consumers, who registered for DSM during PLM.

Key results: DR integrated with Smart Meters Peak Shave minimum 10-15%
A web portal has been provided to all consumers covered in the project, where individual can log-in to web portal and monitor live & historical consumption data. This also will help the consumers for proper planning of their energy utilisation and bills. Consumers shall also be well informed in regard to various messages such as power shutdowns, ToU tariffs, billing etc.
Benefits to Utility

- Reduction of AT&C losses
  - Improved billing & collection efficiency
  - Increase in revenue

- Online energy accounting & auditing, tamper detection and system load analysis
  - Theft detection & revenue protection
  - Better understanding of system load to design DR programs

- Improved Load Management
  - Optimal utilization of assets – avoidance of capacity addition
  - Avoidance of blackouts & purchase of expensive peak power

- Improved Power Quality of supply
  - Reduction of overloading of devices
Benefits to Utility…

- **Reduced outage time**
  - Increased revenue
  - Improved quality and reliability of supply

- **Crew and asset management**
  - Faster Identification of fault
  - Speedy power supply restoration
  - Improved asset quality & life by remote monitoring of health & undertaking preventive maintenance

- **Renewable Integration & Net Metering**
  - Facilitate penetration of renewable energy in the grid as the meters provided are bidirectional.
Benefits to Consumers

- Consumers can log in to the portal and can view their consumption patterns.
- Consumer Engagement & empowerment with greater control over their energy use and bill
- Improved quality & reliability of power supply
- Increased life of appliances and gadgets due to improved power quality
- Rooftop renewable generation with facility to feed excess power into the grid
- Prompt and Correct billing improving overall consumer satisfaction
Challenges Encountered

- Choice of Communication systems. Initially PLC communication planned between DCU and SM. But as it could not deliver the required data speed, RF was chosen.
- Scalability: Even-though protocol is defined as DLMS, Interoperability of MDAS with other manufacturer meters need to be tested at field.
- Integration with billing and collection system: As PED use generic computer billing system, integration of data flow between AMI and billing system has been achieved manually through Excel files. However, new software is being developed to achieve automatic data flow.
- Cyber security: Additional overheads towards ensuring Cyber security
- Consumer apprehension on high bills had to be addressed.
The smart grid system deployment in Puducherry Electricity Department provides some insight in issues on AMI implementation.

The above project will facilitate detailed techno economic study for such deployments in rest of the country. With the growing maturity in technologies, such smart grid projects may serve in better and efficient energy delivery system benefitting the utility as well as the consumers.

The real challenge is on how the data collected is utilized for various data analytics and the utility can plan the quantum of data required from smart meters as per the requirements based on the data collection experience in the presented AMI project.
Thank You