Metering Road Map

An Essential Imperative for Utility

Rajesh Bansal, Head (EMG), BSES Delhi
Reliance Energy: Leader in Private Sector Distribution

- Serving over 7 million customers in Mumbai, Delhi, and Orissa
- Powering 2 out of 3 homes in Mumbai & Delhi, and 3 out of 4 homes in Orissa
- Distributing over 5,000 MW – the largest in India
- Employs more than 30,000 personnel
- Industrial, commercial, and residential urban consumers

Largest customer base for a Private Sector Utility in India
Reliance Infrastructure Ltd. acquired 51% stake in July 2002 in two out of three Discoms.

<table>
<thead>
<tr>
<th>SN</th>
<th>Particulars</th>
<th>Unit</th>
<th>BSES Delhi Discoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Area</td>
<td>sq. km</td>
<td>950</td>
</tr>
<tr>
<td>2</td>
<td>Total Registered Customers</td>
<td>Million</td>
<td>2.8</td>
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<tr>
<td>3</td>
<td>Peak Demand</td>
<td>MW</td>
<td>3350</td>
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<tr>
<td>4</td>
<td>Consumption per year</td>
<td>MU</td>
<td>17,500</td>
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<tr>
<td>5</td>
<td>Employees</td>
<td>Nos.</td>
<td>7,218</td>
</tr>
<tr>
<td>6</td>
<td>Customer Density</td>
<td>Cons/sq km</td>
<td>2,964</td>
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<tr>
<td>7</td>
<td>Revenue (as per ARR 2011-12)</td>
<td>Billion USD</td>
<td>1.44</td>
</tr>
</tbody>
</table>
Life starts with a breath and ends with a breath.

Power Distribution
Starts with Meter and
Ends at Meter
Innovation is the nature of man

Last two decades have seen two major technical revolution

TELECOMMUNICATION & IT
Is Metering development in sync with these evolution (say telephone)....?

**before 1990....**
- Dial Up Phone
- Dial Type Meters

**In sync in late 1990....**
- Digital Phone
- Digital Energy Meter

**Also when Mobile was introduced...**
- Mobile Telephone
- Meter With Modem

**Status as on date....**
- Smart Phone – 4G

Remote reading is Possible using AMR

**Smart Meter**

**AMI**

Meter technology is changing so fast. Like mobile meters cannot be replaced. What Utility should do ??
Utility has many metering options.....

Mechanical Meter
Static Meter
AMR
Pole Mounted Meter
Prepaid Meter
AMI
CMRI

Advanced Metering Infrastructure Systems (AMI)

BSES
Role of meter is changing .... Moving towards Smart future

Meter is no longer a product.
Utility success depends on meter data usage.
Meter – The most critical component

Meter is also called as cash box of Utility. Has to be planned properly.

Energy meter is final interface with consumer.

Although Basic purpose of meter is for Tariff implementation, but it can generate lot of information.

The revenue loss due to faulty meter can be more than meter cost.

Meter Replacement is a massive exercise – ensure long useful life.
Energy Meter Affects All Stakeholders

- Tariff compliance
- SLA compliance
- Information to customer
- Supply quality
- Billing dispute
- Street lights

- Network health
- Network Planning
- Outage management
- Fault prediction
- Supply quality
- Field team efficiency

- Cash box
- Theft control
- Prepayment system
- Non payment – disconnect
- Revenue cycle
- Other business

- Service level norms
- Renewable integration
- Electric vehicles
- Load growth forecasting
- DSM & EE
- Other services

Customer And Regulator
Utility Operations
Utility Balance Sheet
Govt. Future Policy
Factors affecting metering road map

1. Tariff compliance
   - Tariff compliance
   - Future tariff
   - Tariff directive & SLA

2. Role of meter
   - Apart from tariff
   - O&M
   - Network health

3. Change in Technology
   - Very fast change
   - IT and communication
   - New features

4. Cost factor
   - Cost of meter
   - justification
   - Return of investment

5. Consumer interface
   - Consumer profile
   - Consumer requirement
   - Future expectation

6. Process
   - Installation process
   - Theft level
   - Meter reading

USEFUL life is the main key factor
Tariff compliance

- Fixed charges based on MD
- TOD Tariff Accuracy class
- Basic tariff is based on KWh
- KVAh billing or PF penalty
- SLA parameters

Meter should not only comply with present Tariff directive but also future tariff.
Tariff Parameters

- KWh and its accuracy
- Fundamental or total energy
- KVAh – method of computation
- Power factor penalty
- Maximum Demand and Integration period
- Voltage level

Measuring Parameters

- May not be applicable today
- RTC reliability
- Time zone – nos and programming
- Tariff slab – Nos and Programming
- RTC programming
- Data on display

TOD
Service level Agreement - SLA

- Power Availability
- Voltage quality
- Outage details

- Nos of Hrs/ month
- Total interruptions
- Voltage range +/- 6%
- Unbalance voltage
- Harmonics
- Outage details

- Plan meter as not possible at later stage
- Voltage curve
- Phasor diagram
- Outage history

SLA
Tariff Directive Compliance Factor

- DESCOM has to comply with Regulator tariff directive
- Foresee future possible tariff plan. It is critical for Prepaid meters also.
- Regarding measurement plan – parameters, accuracy and method of measurement.
- Consumer are getting aware – they are demanding. Ready for SLA
- Incase meter cannot comply with Tariff Regulation its useful life is over.
Apart from Above, one major application is to identify Energy Theft
Supply Quality - **Voltage Profile**

*Meter at Grid, DT or consumer level provides data*

- **Key meter parameters**
  - Voltage - Inst voltage, Load survey voltage curve, Voltage at any event

- **Analysis for**
  - Voltage range v/s permissible limits
  - Unbalance voltage – Vector sum of three phase not zero
    - Phase voltage magnitude mismatch
    - Phase angle – other than 120 deg

Voltage unbalance can severely affect appliance efficiency
Outage Management Flow – DT/Tail end

Complaint to call centre

Based on phone / KNO tagging, Consumer plotted on GIS

GIS

OMS Software

Helps in operational decisions

DT Automation Software

Field Operational level

Local fault

LT feeder level

ACB level

11 KV feeder level

Outage Team

More calls from area

No load change at DT

More load change at DT

Load has become Zero

DT voltage is zero

Based on phone / KNO tagging, Consumer plotted on GIS

OMS Software

Helps in operational decisions

DT Automation Software

Field Operational level

Local fault

LT feeder level

ACB level

11 KV feeder level

Outage Team

More calls from area
Network Stress – comparing Tail end voltage

Voltage drop in network

- Key parameters
  - Voltage at Grid/DT end
  - Voltage at Tail end consumer
  - DT & consumer location on feeder

- Analysis
  - Voltage drop represent the technical loss in network.
  - Higher voltage drop means network under stress
  - Variation of Vdrop with load change – input for Vregulation

Voltage drop is the easiest way to estimate technical loss & voltage regulations
Network Stress

Network Health – 11 KV feeders, Power/distribution Transformers

Importance of network health
- Network technical loss
- Break down
- Load growth plan
- Capital investment optimization
- Effect on electricity quality

Key parameters
- Phase-wise Current & voltage
- Peak KVA
- Power On/Off
- Power factor
- KVAR generation

Analysis- Asset wise
- Overloading/underloading
- Load Unbalancing
- Unbalance voltage
- Power availability
- Low power factor

Monitoring can be extended to ACB level for LT feeders
Network Stress

Power Factor Planning

- Key parameters
  - Power factor at Grid/DT/consumer end with lag & lead
  - Location of DT/consumer on feeder
  - KVAr drawl- maximum & minimum values
  - Distance between assets

- Analysis
  - KVAr requirement
  - Location of capacitors
  - Working status- already installed APFC

APFC installation requires comprehensive analysis
Role of meter - Factor

1. Meter has multiple role. Planning is must
2. Incorporating features at later stage is difficult
3. Asking for features but not using same is also a crime
4. Involve IT, O&M & Business while planning meters
5. Imagine typical meter has 100 months life. It should not block your ideas.
Consumer profile.

- Education & awareness level
- Consumption and load pattern
- Future Expectations
- Socio-economic factor

Since Meter is at consumer premises, ensure it helps consumer
Consumer Profile

- Can consumer use information ??
- Energy conservation – scope ??
- Demand side management - scope
- Is quality means availability ??
- Data on website – what about internet ??

- All single phase consumer are identical ??
- Should shop, house, slum, village house, agriculture, office, industry have same meter??
- Data on display – do they need ??
- Power outage criticalness.

Consumer profile
Consumer Load Quality

- Key parameters
  - Power Factor of load
  - Phase wise load – unbalance
  - Harmonics
  - Load curve- pattern

- Analysis
  - Discipline level in consumer load
  - Load contributing during peak - DR
  - Load pattern study - forecasting

Evolution of Tariff Structure
- EBT- Energy based tariff
- ABT- Availability based tariff
- DBT- Discipline based tariff (Incentive/penalty based on discipline factors)

Harmonic level measurement in meter - yet to be initiated

Any near future plan ??
Future Expectations

- Renewable integration
- DSM
- Vehicle charging

- Bi-direction energy
- Grid connectivity
- Load for DR
- EE plan
- Storage at consumer end
- Any plan
- Involve in DSM

- On line data
- Connect disconnec.t
- Charging planning
- complex meter

Plan meter as not possible at later stage
Theft is a social problem – it is an individual nature.

Electricity is essential like air, water, road. Rest may be free but not electricity.

Those who cannot pay and those who won’t pay – both are dangerous.

For few theft is necessity for survival.

Metering and billing should in line with consumer economic conditions.

Is theft a Taboo ??

This is one of the most important factor. A successful Technology can fail, if socio-economic factor changes

Money is attached with meters. Revenue leakage can be dangerous
Consumer Profile Factor

Consumer are getting aware – can they be involved

Adopt metering technology suitable for all profile consumer
Versatile, flexible but cheaper

Expecting new expectation in future – plan it.

Since money is attached to meter – do not ignore socio-economic factor

It is difficult to predict change in consumer behaviors. Proper meter can help you to tackle all profile consumers.
**Meter cost factor**

- Avg Consumer consumption (Average monthly bill)
- Technology cost including Associated system cost
- Operating cost of Technology
- Additional gains

**Very important**
Meter Performance With Age

1. Acceptable Pattern
2. Acceptable - Long Life - Preferred
3. Intermittency – Not Acceptable
4. Long Intermittency - Dangerous

Meter should have no/ smallest possible intermittency period to avoid revenue loss.
Ensuring no adverse effect of fault

**Self Diagnostic:**

- **Causes** – Determine causes of problems
- **Identify parameters** – Need to be monitored
- **Built in Intelligence** – To check health Parameters and monitor fitness

Can meters will tell own health??
Energy meter cost analysis

**Basic Concept**

Cost of metering (per consumer) and Average monthly bill have a relation.

- Meter life is typically 100 months (8.33 years)
- If Cost of meter = One month Average bill means out of total income, 1% will be spent on meter.
- If meter (say AMI) cost is equivalent to say 20 month bill, means 20% company revenue goes in it.
- High cost is justified if reduce other OPEX or T&D loss.
- Ensure proper ROI.
- Do not copy technology as your consumer profile can be different

**Total cost**

- Direct meter cost
- Opex + cost due to Faulty meter

As a thumb rule – meter cost should be one month Avg bill unless huge gain are expected
Cost Factor

- Compare meter cost with average monthly bill
- The above factor should be 1, but not more than 2.
- High cost is justified if you expect loss or OPEX reduction
- Incase technology has to be adopted due to directive – contact Regulator
- Be Practical. See your country strength. IN some country Utility is just not only business but have more responsibility.
Installation Process

- **Premises**
  - At consumer premises
  - At utility premises – say pole

- **Installation practices.**
  - Separate cable v/s busbar
  - Non accessible V/s accessible
  - Individual meter V/s group meter
  - Sealing process

- **Data down load**
  - Manual
  - AMR
  - HHU / CMRI
  - No reading – prepaid/ community billing.

- **Protection**
  - Protection before meter
  - Periodical meter testing.
Installation Quality

- **Key Meter Parameters**
  - Phasor diagram
  - Instantaneous parameters
  - Tamper events

- **Analysis**
  - Abnormal voltage – 400V, zero V
  - Current without voltage
  - Abnormal phase association
  - Abnormal pf with substantial load

**Observation:** B-phase voltage is missing and current available in that phase

**Observation:** Common input to R & Y phase. Phase currents available.

Tracking of installation quality is very important
Analytics is a continuous development process.

**Continual Development**
- New Logics
- New Parameters
- New application

**New Parameters**
- Example – Temperature

**Application**
- Installation quality – loose wiring
- Sparking, over loading
- Intentional burning.
Role of Meter
Energy Theft Analytics

Rajesh Bansal, Head (Meters), BSES Delhi
What is Theft?
A deliberate attempt to steal “Considerable amount of energy” by ensuring no / low energy recording in the measuring device.

What thief will try ...........

- Without damaging the meter
- Without Detection
- Theft can be done on “will”
- Theft for a considerable Quantity
- Theft which can not be proved

Theft is both ART and Science
**Theft Theory ..........**
Any Abnormal condition resulting to
- Slowing of meter
- Switching OFF of meter
- Can lead to data change

Are potential methods of theft

**How to control?**
Study impact of theft rather than method of theft.
All theft leave evidence.
Co-relate method with symptoms.

**Kick Start ..........**

As Abnormal conditions can result to meter tampering,
It can also damage the meters.
Analysis of damaged / field removed meters can give vital clues.
Theft policing

- Philosophy –
  - Meter provides Lot Of information.
  - All theft leaves some symptoms
  - Develop Logics to identify abnormalities.
  - Ensure timely and correct data transfer.
  - keep updating knowledge about new theft techniques

Looks for evidence acceptable to court
Theft Control Plan

- Meter Technical Team
- Meter Specifications
- Theft plotting
- Meter Lab - Analysis for failure causes
- Energy Audit - High Gap areas
- Enforcement Cell
- Designing anti-theft features
- Bi-directional communication
- Data download
- Cause & symptoms
- Analytics
- Theft leads
Anti Theft feature in meter

Effect of theft method

- Immunity
  - No effect

Anti Theft method

- Event logging
  - Detection of event

- Direct Symptoms
  - Used Analytics Cell
    - Helps to analytics

- Indirect symptoms – AddIn parameters
  - Helps to analytics

Use deterrent mode – check legality
Few Anti theft feature

- To prevent tampering in meter–
  - Ultra sonic welding of body
  - Top cover sensing
- Wiring related theft.
  - Both wire current sensing in Sph
  - Single wire – current operated supply
  - Uni-direction energy
  - Voltage manipulation detector
- Data tampering
  - No provision to write in meter
  - Compromise with flexibility
- External theft
  - Sensing for abnormal power off
  - Magnet, temperature, abnormal field sensing.
Installation process and theft level

- Theft level – meter has to protect revenue leakage
- If utility is facing theft problem – all cost to protect theft is justified
- Ensure meter is really theft proof. Better buy solution then technology
- Installation and meter reading process also affect metering plan.
- Metering road map also include meter accessories planning.
Define - Role of meter
Define install/ MR process
Define parameters/ features
Metering road map
Cost factor and ROI
Accessories
Theft control team
Consumer awareness
Consumer profile
Theft level
Future tariff
Inputs from

BSES
Meter – key Parameters

**Meter – measurement**
- To measure parameter for Billing
  - Plan for future need
  - TOD, MD, KVAH, PF, calendar month billing

**Other Electrical parameters**

**Meter intelligence**
- Computation
- Logics
- Local analysis of parameters – events/alarm
  - Initiate communication in case of alarm
- Intelligence to identify data corruption
  - Ensure no data loss.
Meter – key Parameters

Memory

- Vast memory
  - Load survey, billing history etc
  - Ensure multiple read write
- Display units
- Data management – no data loss

Communication & interface

- Communication through Port/ MODEM
  - Protocol/ data transfer speed
  - No data corruption
- Interface with
  - MODEM, I/O
  - Connect disconnect system
Meter – key Parameters

- Theft protection
- Immunity
- Detection and Logging of event
- Detection and penalty
- Messages from utility
  - Consumption pattern / Consumption history
  - Bill related information
  - Bad load
  - Prepaid/ post paid options
- Interfacing home appliances on/ off (HAN).
Meter – key Parameters

Life of meter

- Reliable life-
  - Meter should be intelligent to detect mistakes
- Useful life - should be futuristic
- Expected failure pattern – loss revenue can be more than meter cost

Knowledge about – how meter is going to fail is most important
Meter – key Parameters

• Meter is no longer a product
  • No longer Deliver and forget
• Need vendor support
• Maintain relation
• Do not change for small money gain.
• Ensure Pilots can be repeated en-mass.

Lot of utility faces problem when vendor with draw support.
Company Metering Philosophy:

- Metering specification is just a guidelines - it is minimum requirement what meter should comply.

- There are many features/ specifications which are not mentioned but must. Example during use meter data should not get corrupted.

- Any feature/ specification affecting basic working and useful life, even if not mentioned, should not be treated an excuse for non compliance.

- The Good meter is not just which pass all the test as per standard and specification but the one which does not fail in any test affecting basic working and useful life and if fail it should not affect consumer and utility.

- Meter supply is not just supply of product - it includes service and technical support. One has to ensure continuous interaction between technical team both sides.

- Meter life should not judged by whether the meter is working or not - but by its useful ness in field.
Metering Philosophy:

- The cost of meter is not what you pay (at time of procurement) but it should include what utility loss when it malfunctions in field.

- The vision of meter technical, both of utility and vendor, to offer technology and product which serve best to field.

- It is important to know, how meter will behave in field, but more important is to know how meter will behave when its life will over or when it will fail.

Always plan and have next 5 years Metering road map.
Thank You

Contact detail

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Think what you need V/s correct technology

For KWh Ferries Type meter are perfect
Brain storm what you want in future

Anti Theft

Immunity

Logging of Cause

All Tampers finally result to

Change in Accuracy

Meter Non Functional

Change in Data

Need is to detect /immune above changes
FUTURE NEEDS – COMMUNICATION

So far Communication:
Once in a month
• CMRI
• AMR

New need of communication

Online
Less operation Cost
Two way Communication
Alarm
FUTURE NEEDS – CONSUMER INTERFACE

Important for consumer

- Bill on Display Unit
- Meter not accessible
  Only Display Accessible
- Load on/off Choice
- Message to Consumer
  display unit
FUTURE NEEDS – LOSS REDUCTION

Definition: \( \% \text{ Loss} = \frac{\text{Energy supply} - \text{recorded}}{\text{Energy Supply}} \times 100 \)

Need

- Online supply Energy recording
- Online consumer Energy recording
- If gap is high ----- Alarm / Disconnection
- Ensuring No Loss
- Energy Audit
FUTURE NEEDS – Demand Side Management

Why DSM

- Generation Limitation
- Load Curve – List of Dips & peaks
- ABT : Tariff
- Consumer role in DSM

Tariff
- TOD
- MD during peak
- Legislation

Meter Functionality
- Peak load control
- Switch On/Off load
- Prohibited load
FUTURE NEEDS - Outage Management

No Supply

Bad Supply

Alarm

Auto Information to Call Centre
FUTURE NEEDS – As Per User Profile

Old Classification Style

- Single Phase Meter
- Three Phase Meter
- LT-CT Meter
- HT Meter

New Classification Style (Depending on user Profile)

- JJ Consumers
- Kothi
- Apartment
- Shops
- Un-manned site
- Temporary
- Weekly market
Energy Meter affects All stakeholders

Customer & Regulator
- Tariff compliance
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Utility Operations
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Energy Meter

BSES
Thank You

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