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Master Class on Energy Transition Strategies and Pathways to Net Zero Power Systems

Presented By

Glenn Pritchard, Sr. Manager, Advanced Grid, PECO

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Glenn Pritchard

Glenn Pritchard is currently the Manager of Advanced Grid Operations and Technology for PECO's Smart Grid/Smart Meter system. PECO's Smart Grid consists of 2.3M electric and gas meters and over 4,000 Distribution Automation devices. Pritchard graduated from Clemson University in 1990 with a B.S. Degree in Electrical Engineering. He is a registered professional engineer in Pennsylvania. He has been with Exelon/PECO in Philadelphia for over thirty-two years where he is responsible for developing new applications that leverage the Smart Grid, AMI Systems and metering data.

Other areas of experience include distribution & transmission engineering, substation automation and communications. Pritchard specializes in finding new applications of existing and emerging technologies.

Beyond his work at PECO, Pritchard has taught numerous classes and frequently presents at the key industry venues, including DistribuTECH, EEI and IEEE. He has authored numerous papers on Smart Grids, AMI systems and the use of the data generated by such platforms.

Pritchard has been recently recognized as PECO's Innovation Champion of the Year for 2021. Other notable awards include EPRI's Technology Transfer Award in 2017 and 2014, the 2010 IEC Grid Vision and the 2008 Utilimetrics' Utility Best Practices Awards for his work in the Smart Grid and AMI fields.

AMI Update – What's New?

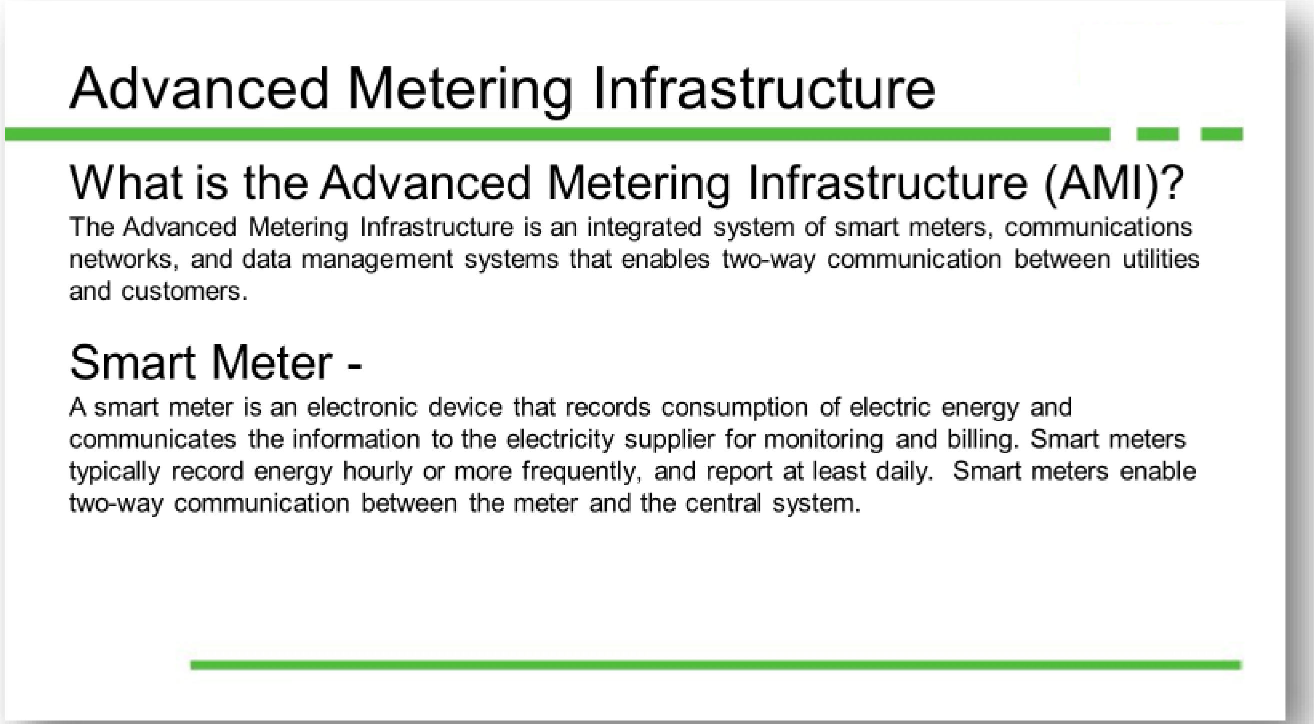
- AMI 2.0
- Meter Architecture Evolution
- Data Opportunities and Analytics
- Distributed Intelligence & Grid Edge Solutions
- System Obsolescence Challenges

AMI 2.0

- AMI 2.0 is a system upgrade that results in increased network reliability and more reliable exchanges of data

- The functions build upon AMI 1.0, which set the foundation for the future

“Many of the end user/customer advantages promised by AMI 1.0 did not materialize.”



Advanced Metering Infrastructure

What is the Advanced Metering Infrastructure (AMI)?

The Advanced Metering Infrastructure is an integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers.

Smart Meter -

A smart meter is an electronic device that records consumption of electric energy and communicates the information to the electricity supplier for monitoring and billing. Smart meters typically record energy hourly or more frequently, and report at least daily. Smart meters enable two-way communication between the meter and the central system.

More Data & New Functions

- Increased Sample Rates
  - 60-, 15-, 5- & 1-minute samples are possible
- Multiple Recording Channels
  - Some vendors are claiming up to 32 <u>independent</u> channels are available
- Distributed Intelligence and Decision Making local to the meter

Question – *Has the network and head-end kept pace with the new meter capabilities?*

New Data Opportunities

Going Beyond Energy Consumption and Usage

Voltage

- True RMS data to give accurate profiles throughout a feeder
- Key for managing the distribution grid that is rich with DER inputs
- Creates the foundation for voltage management programs

Power Quality & Harmonics

- Ability to track and manage power factor and flow across a feeder
- Helps ensure low noise is maintained
- Helps identify sources/locations of emerging trouble on the grid

New Functions

- On-Board Decision Making
  - EV Charging Management
  - Voltage Regulation
- Analytics
  - Non-intrusive load monitoring & Load Disaggregation
- New Communications Methods for FAN and HAN
  - WiFi Enabled Meters

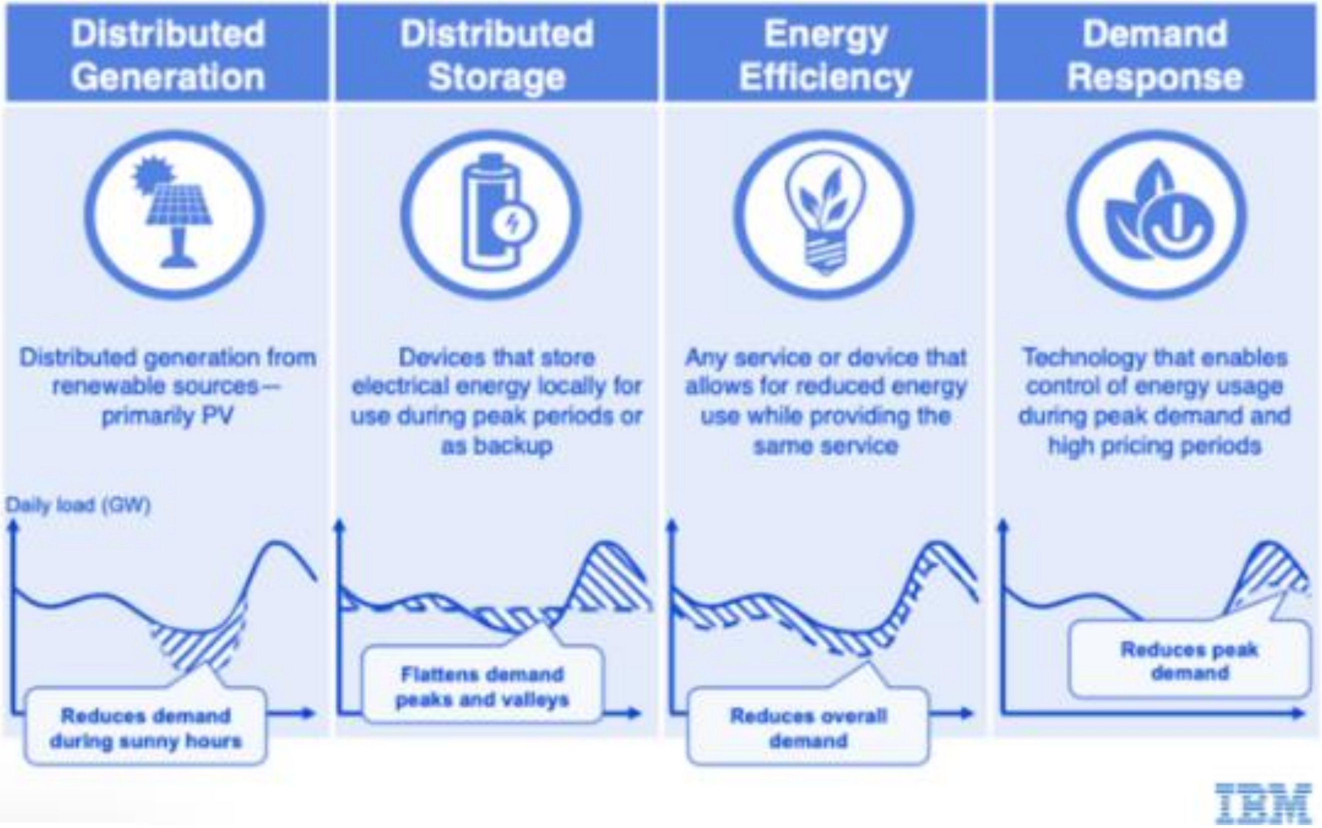
AMI 2.0 Use Cases

Grid optimization use cases

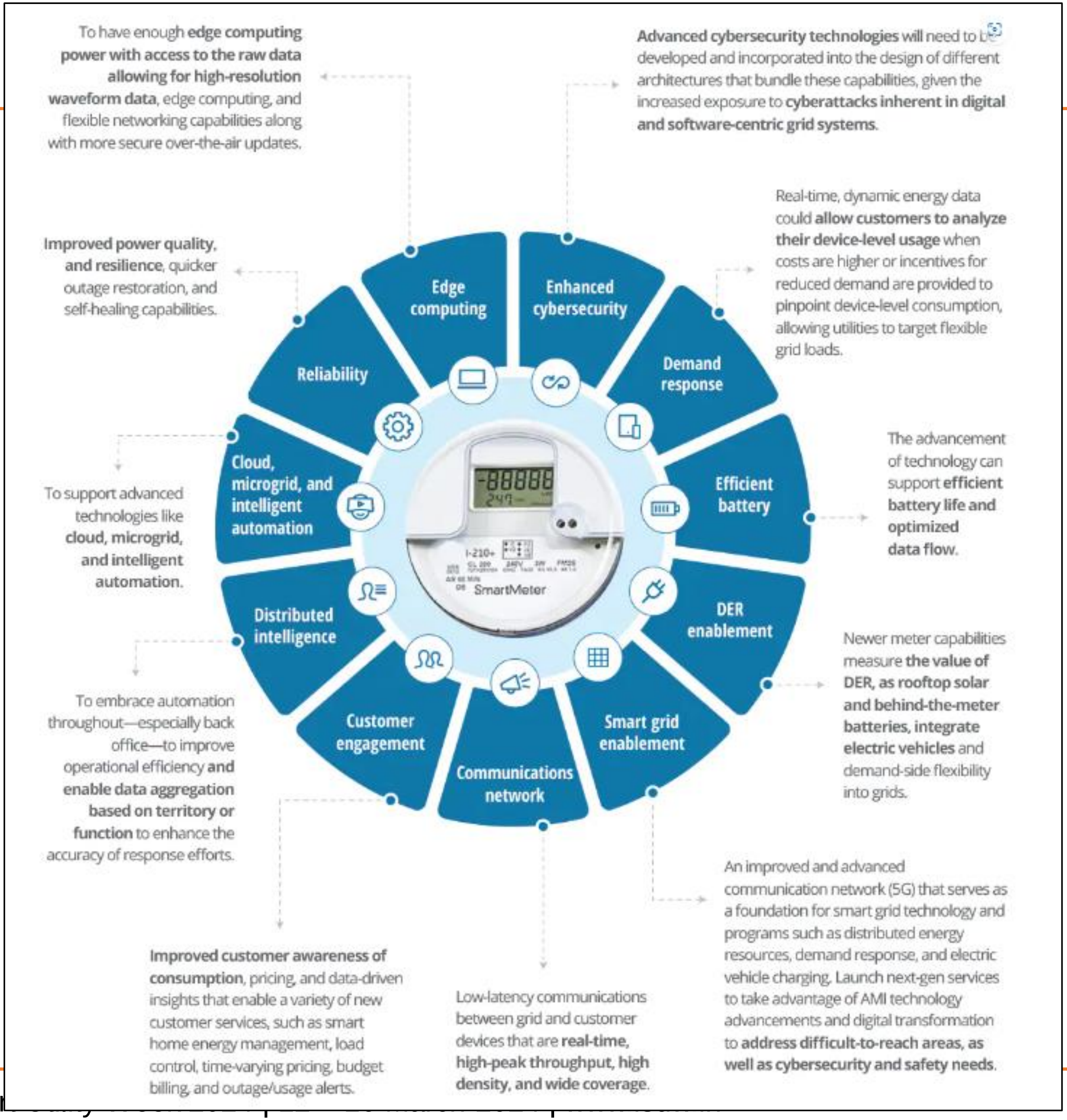
- Supply/Demand security on all voltage levels
- Manage Congestion management (dispatching)
- Keep Grid stable (frequency, voltage) despite renewable
- Optimize utilization of grid capacity

Distributed Energy Resources use cases

- Distributed generation
- Distributed storage
- Energy Efficiency
- Demand Response
- Load and Feed-in Management
- Micrograds & VPP (Virtual Power Plant) Mgmt.
- Ripple Control (heating, heat pumps)



[AMI – Advanced Analytics Opportunities - Utility Analytics Institute]



From Deloitte’s AMI 2.0 Study

https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/next-gen-advanced-metering-infrastructure.html

Meter Hardware Evolution

- Key Changes
  - New Microprocessors
    - Faster
    - Greater Functionality
  - Access to more internal Memory
  - Modern Interfaces
  - Expansion Slots
  - Improved Security

Meter Architecture Evolution

Core Functionality

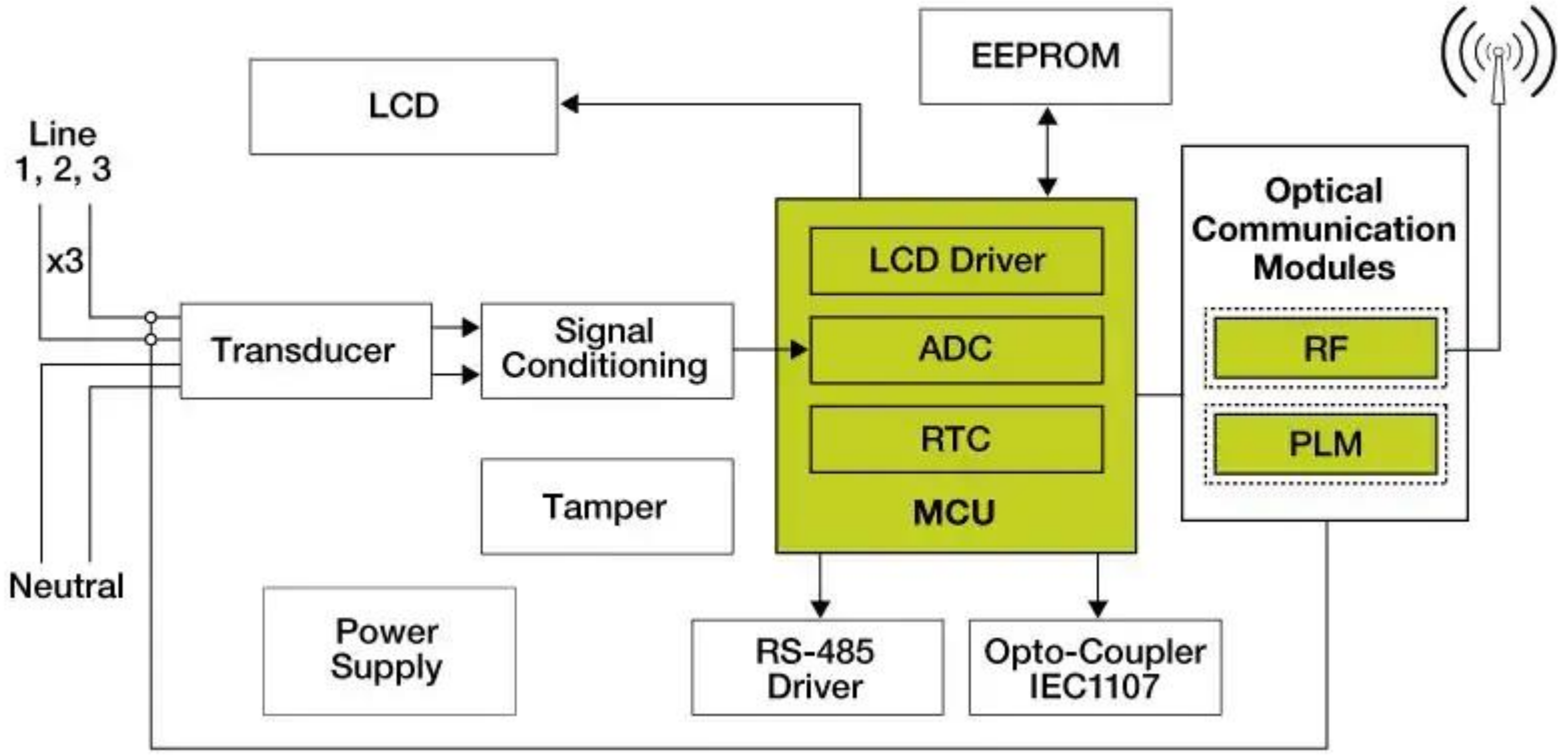
- Energy Measurement
  - Register Reads
  - Interval Reads
- Real & Reactive Power
- Net Metering
- Alarms
  - Tamper/Non-Technical Losses
  - Outage
  - Meter Health

New Functionality

- Independent channels (up to 32) that have unique sample rates and transmit frequencies
  - DER, Electric Vehicles, Storage
- Advanced Alarms
  - Sag/Swell
  - Power Quality
- Distributed Intelligence

Meters are now able to record multiple data streams independently to delivery new benefit. Each channel may be configured to deliver data at unique intervals as require

Meter Block Diagram



Key Components

- Metrology
- CTs/Coils
- CPU/Memory
- Battery
- Display
- Interfaces
- Communications
- RCD Switch
- Surge Suppression

Analytics Use Cases

Grid

Distribution Operations

- Outage Management
- TLM/Overload Prevention
- CVR
- Phase Balancing
- Non-tech Loss Localization
- Event Correlations
- Deployment Health

System Planning

- Device Capacity Planning
- Device lifecycle management
- EV Planning
- Connectivity Model Audit
- Stressed Asset ID
- Data Quality

Energy Procurement

- Demand Forecasting
- Inventory Monitoring

Meter

Meter Services

- Defective Meter ID
- Defective Socket ID
- New Meter Health
- Contract Validation
- Data Quality Assurance
- Geospatial Outlier Monitoring
- Net Meter
- Geospatial Reporting
- Meter Inventory Tracking

AMI Deployment

- New meter health
- Deployment Tracking
- Network Tracking
- Customer Refusal Tracking
- Deployment Data Quality
- Geospatial Reporting

Customer

Billing

- High Bill Prioritization
- Low Bill Prioritization
- Stopped Meter
- Slow Consumption
- Diagnostic Prioritization
- Account Billing Prioritization
- Rates Analysis
- Bill Cycle Monitoring
- Consumption reporting
- Settlements Reporting

Call Center

- High Bill Customer Benchmarking
- High Bill Account Reporting

Safety

- Gas Leaks
- Water Leaks
- Meter Overheating

Demand Response & Energy Efficiency

- Program Customer Targeting
- Load Disaggregation
- Behavioral Program Analytics
- Geospatial Reporting
- Customer Usage Reporting
- Program Efficacy
- Auditing Support
- Regulatory Compliance/M&V
- Whole Building Reporting
- Predictive load

Operations

- Resource Planning Prioritization
- Account Transition Monitoring

Finance

Revenue Protection

- Identifying bypass
- Diversions
- Identifying meter swaps
- Identifying meter tampering
- Smart meter deployment theft
- Identifying Behavioral Trends

Operations

- Unbilled Sales Reporting
- Forecasting
- Rate Development

Evolution of Analytics

- Centralized
  - Analytics developed on a centralized platform and data lake
  - Easy to integrate data from multiple sources to gain insight
  - Analytics take place at many locations throughout the meter to cash process flow
- Decentralized
  - Computing power is now available deep into the grid and specifically at the meter
- Hybrid
  - Maximizing the benefits of both Centralize and Decentralized applications and analysis

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Grid Edge Applications and Functionality

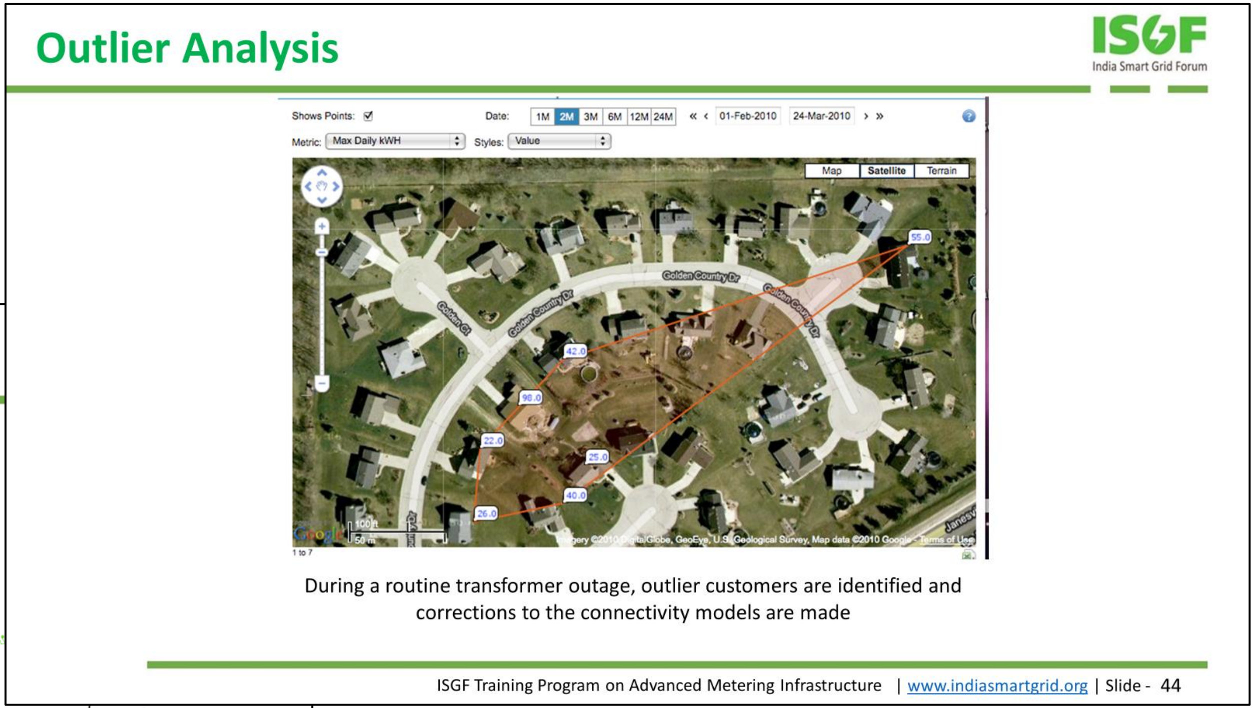
- Downloadable Applications
  - Meter and Socket Health
  - Location Awareness
  - Tamper & Non-Technical Losses
  - Load Disaggregation
  - Transformer Load Analysis
  - DER Management
  - Load Shedding
  - IoT/Smart Device Management
- Concerns
  - Validating Applications
  - Managing Application functions
  - Version Control
  - Meter Maintenance actions
    - Meter changes
    - Functional Changes
    - Updates in firmware

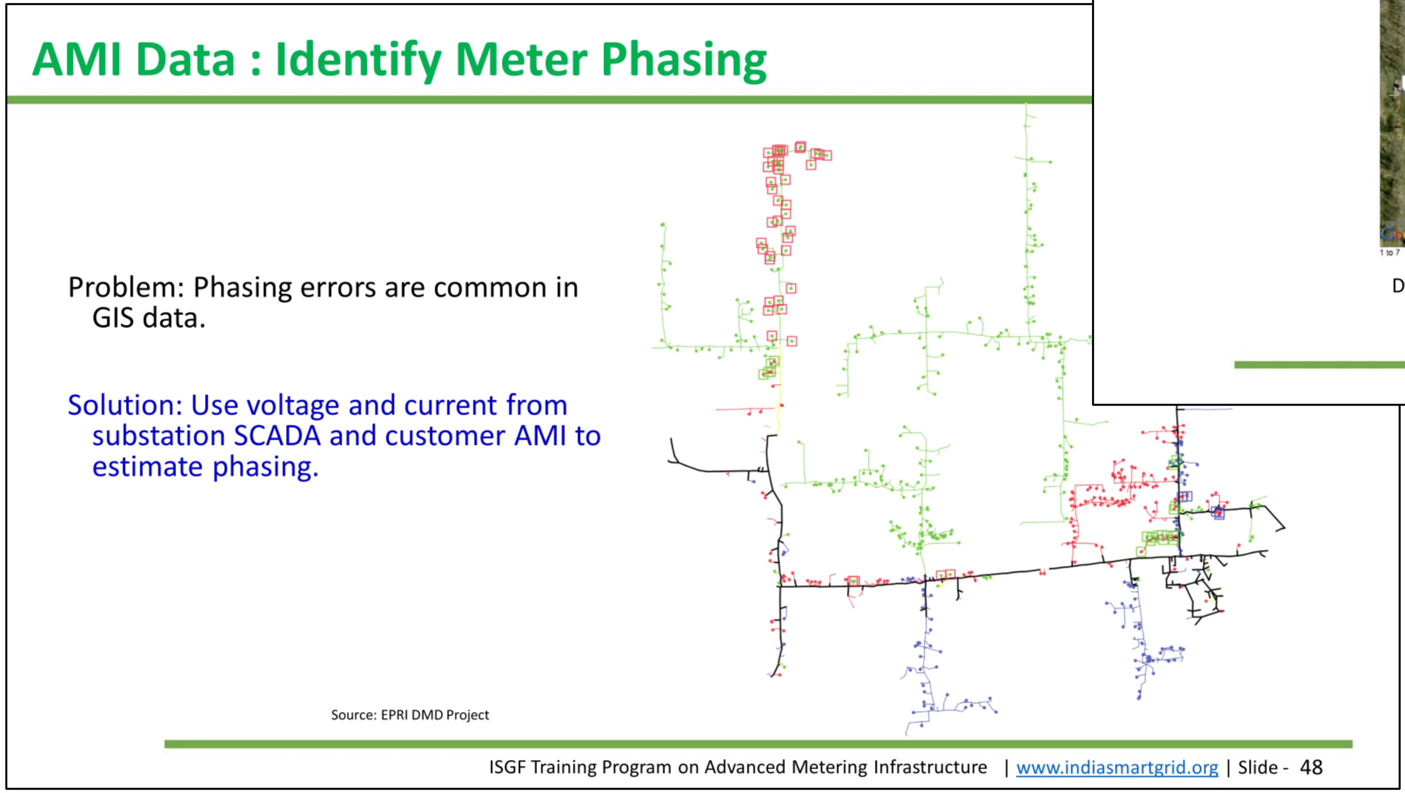
Use Case : Meter and Socket Health

- Remotely identifying meter irregularities and emerging problems
- Excess temperature detection and alarming
  - Auto Make Safe by disconnecting load
- Battery monitoring, if equipped

Use Case: Location Awareness

- Identifying neighbouring meters to connectivity model accuracy
- Reduces unnecessary dispatch and truck rolls





Use Case: Tamper & Non-Technical Losses

- Alarming on expected conditions
- Identifying changes in service impedance, sending alarms for further investigation

Use Case: Load Disaggregation

- Ability to sense various types of loads
  - Electric Vehicles
  - Heat Pumps/Air Conditioning
  - Machinery
- Potentially able to coordinate and schedule loads according to current grid conditions

Use Case: Transformer Load Analysis

- Using metering data to construct actual models of transformer performance
- Monitoring transformer loading and alarming when overloads are identified

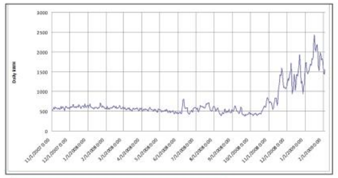
Transformer Performance, Loading etc.,

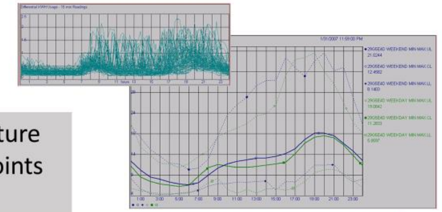
Compare transformer vs meters
Identify transformer loading (for planning and operational purposes)
Load profile at transformer level
Identify transformer to premise mapping in accuracies
Distribution transformer loading
Transformer Asset Monitoring

- Capture time-series kVA data from meter and compare to that at transformer
- Track transformers with loading levels
- Track and trend load profiles at transformer level
- Identify transformer to premise mapping
- Use meter data to determine transformer loading
- Identify risk of failure and corresponding costs (transformer asset monitoring)

Transformer Monitoring

- Utilities use analytics to determine transformer overloads and predict failures based on metering data from the AMR / AMI data
- A program was initiated to investigate daily transformer consumption data (aggregated from meter data) for failures that occurred during winter peak load days
- Transformers with yr-to-yr load increase of more than 25% (3,764 winter, 1,233 summer) were flagged for investigation





The ultimate goal is incorporating a day-of-week and temperature estimation for all distribution transformer or primary meter points into the outage, and planning systems

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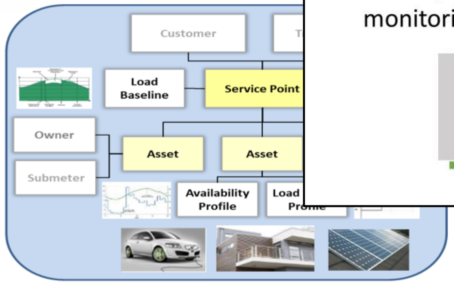
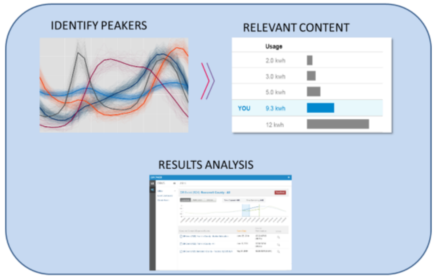
Load Monitoring and Analytics

Develop weather normalized capacity peak load contribution
Predict system load by customer class
Correlate usage to weather especially abnormal usage profiles.
Customer Analytics

- Calculate feeder losses to capture meter theft
- Determine voltage profile on feeders
- Determine feeder abnormalities and phase detection
- Provide feeder monitoring
- Trending and Analysis of feeder historical data
- Customer Analytics
  - Usage patters at and correlations with system load
  - Unbilled energy
  - Recoverable revenue
  - Social media value
  - Load profile by customers and groups
  - Abnormal load patters (EV usage for example)
  - Determine optimized aggregation.
  - Load patterns with Net-Metering
  - System enhancements determination
  - Electric/ gas/ water correlation





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Use Case: Load Shedding

- Traditionally emergency load sheds are managed at the feeder/circuit level
  - Results in greater impact to customers
- Smart Meters allow you to tactically choose which meters and which load is temporarily turned off and for how long
  - This allows for a safer and more equitable sharing of the impact

Use Case: IoT/Smart Device Management

- The meter continues to be a viable node or gateway into the consumers Smart Home.
- The meter can send load and price information to the house
- It can help make decisions as to which load is modified or turned off
  - Minimal consumer action is needed one the system is set up
  - Different modes can be created for Home, Away, Eco & Comfort

Meter and System Obsolescence

Systems and Hardware get ***OLD*** . . .

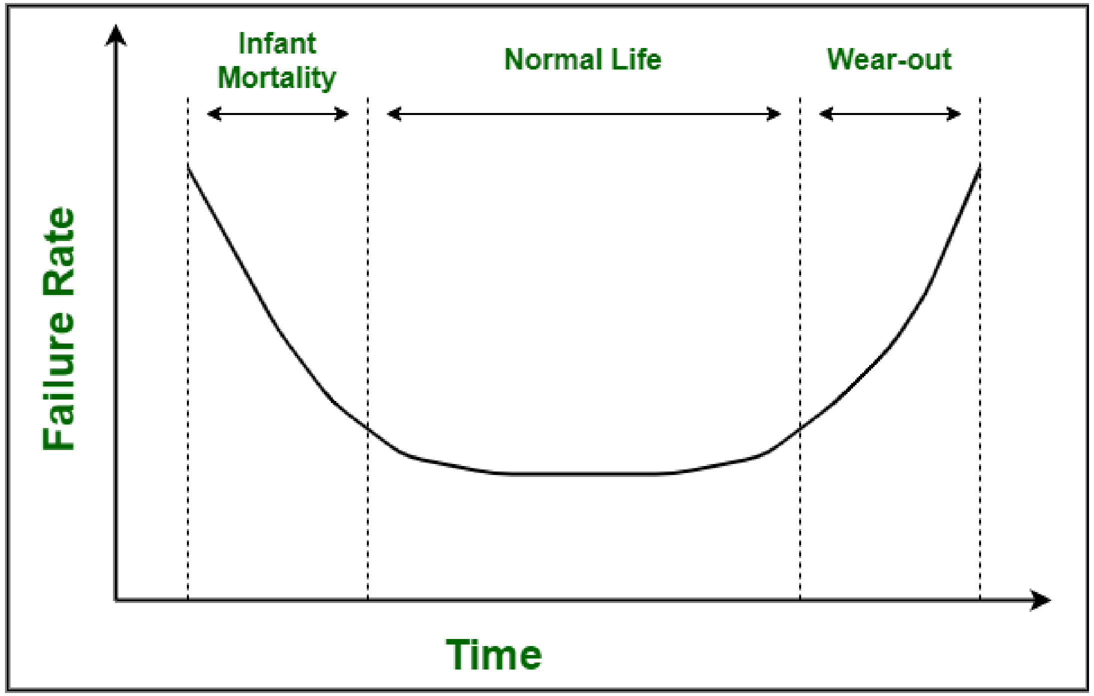
- Bathtub Curve
- Impact from the COVID Pandemic
- Obsolescence Planning
- Financial Concerns

Bathtub Curve

- **Infant Mortality Section :** Infant mortality section is simply referred to as early failure period. By seeing curve, one can easily understand that in this section, asset is beginning with its usage for first time. Initially, failure rate i.e. probability of failure occurrence is very high and with increasing time, there is a gradual decrease in failure rate. In this section, failures are usually occurred due to manufacturing defects, installation issues, design issues, material defects, or improper start-up procedures, etc.

- **Normal Life Section :** Normal life section is simply referred to as usual life period or steady-state operation. It can also be said that this section represents normal operating life of assets. By seeing curve, one can easily understand that in this section, asset is still experiencing failure but at normal and low rate. In this section, failures are usually occurred due to overloading, hidden defects, collision with other objects, mistakes of personnel, etc. Failure occurrence generally depends upon function and condition of particular asset. Therefore, for different assets, failure rate can be different. In this period or section, an asset can be remaining unchecked for some time as chances of failure occurrence is low during this period and therefore resources can be used wherever required. Failure rate is almost constant in this phase. One can say that failures generally occur due to random events.

- **Wear-out Section :** Wear-out section is simply referred to as aging period. By seeing curve, one can easily understand that in this section, there is gradual increase in failure rate of assets with increasing time. Number of failures occurrence experienced by assets generally increases with time. In this section, failures are usually occurred due to fatigue, wear, gradual deterioration, corrosion, etc. This period simply represents end of life cycle of assets.

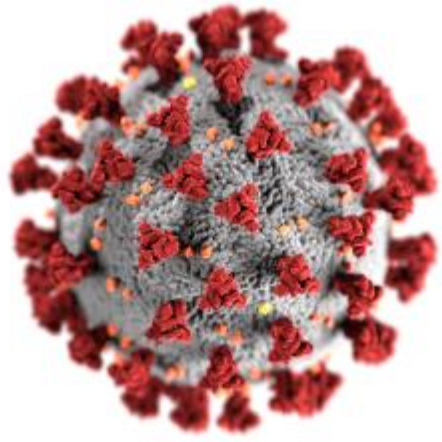


Bathtub Curve

Meter and System Obsolescence

Impact from the COVID Pandemic:

- COVID has changed everything
- Manufacturing plants shut down, some permanently leading to shortages in material supplies
- Manufacturers change their focus on the most profitable product lines, niche lines were closed down
- Meter vendors needed to switch to products that were available and being mass produced
- New meter lines emerged



Obsolescence Planning

- New Smart Meters have a finite useful life (15-20yrs)
- As you prepare to start your initial rollouts, it is important to recognize that there will be a future need to replace both the meters and the networks
- Is a future full redeployment an option?
- Do you have a lifecycle plan?
- What about a future annual replacement plan?

- *It pays to plan for this now, account for it in your Long-Range Financial Plans*
- *It is also advisable to include your regulators and stakeholders*

Meter and System Obsolescence

Financial Concerns

- How will obsolescence impact your initial deployment?
- Will the funding models change?
- When do you begin to prepare for a future redeployment?
  - Will you do a system wide refresh, in one large project?
  - Or, will you consider changing ~10% of your meter population every year to keep the system fresh?

It best to have a plan now for these questions while you still have options

Meter and System Obsolescence

- AMI 2.0
- Meter Architecture Evolution
- Data Opportunities and Analytics
- Distributed Intelligence & Grid Edge Solutions
- System Obsolescence Challenges

Questions?

Thank You!

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THANK YOU

For discussions/suggestions/queries email: ***isuw@isuw.in***

visit: www.isuw.in

Links/References (If any)

DER – Monitoring and Control

- AMI Meters can directly interact with all forms of DER
  - Solar
  - Storage
  - Electric Vehicles
- Provides telemetry and control to best take advantage of these solutions
- Multiple communication options
  - Direct Connections
  - Fan Radio and Networks