Smart Grid - DA: Use Cases for Metering at the Transformer Level

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Use Cases for Transformer Metering

- **Power Diversion**
  - Tamper/unauthorized Meter Seals
  - Meter tampering, tilting, interference and bypassing
  - Changing connection
  - Direct tapping from line

- **Conditioned Based Maintenance/Monitoring**
  - Voltage/Overload monitoring/Load balancing
  - Insulation deterioration / pre-fail condition assessment / real-time neutrals
  - Improved outage notification/Work Force Management
Distribution Automation and Technology

“...at its most basic, DA works at the distribution circuit level. It involves outfitting the electrical system with remote control switches, monitoring points, regulation controls, and any number of downstream devices to optimize performance and improve reliability.”

-CRN’s Tech Surveillance Magazine  8/1/2010
Smart Grid recognizes Sensing as Enabling technology

Needed leadership in the electricity delivery vision and operating model; industry too fractured to form a consensus in this area; Federal / States must take the lead – industry expects/needs this

Integration – gap in today's science and technology development
Distribution Transformer Metering (DTM)

**Dynamic Connectivity**
- Revenue Assurance
- Asset Management
- Renewable / DG
- Dist Loading / Configuration
- Outage Detection
- Voltage Monitoring
- PEV Smart Charging
**Distribution Automation: Dynamic Connectivity**

- Dynamic Connectivity is a term used for end-to-end communication which supports distribution automation solutions by providing continuous monitoring and reporting of information based on dynamic changes in the electric grid.

- An example of Dynamic Connectivity is the association of AMI meter consumption data used to compared transformer loads to detect power theft from a consumer.

- When the consumption data does not match the transformer secondary loading, the differential may be theft or a power quality issue which could be investigated by utility operations.
Distribution Automation: Dynamic Connectivity

- Leverage AMI solutions to support multi-service applications
- Increase Grid Situational Awareness
- Develop high-value propositions for Advanced Smart Grid Analytics
- Support OpenWay AMI/distribution automation solutions

- Acquire interval data from Distribution Transformer Meters along with the interval data from associated downstream Customer Meters. The AMI MDM will use transformer meter-to-customer meter connectivity and feeder meter-to-customer meter connectivity
Utility Case Study: Power Diversion

Canadian utility profile:
- Provides electric service to 1.8 million residential, commercial, and industrial customers
- 18,000 kilometers transmission
- 57,278 kilometers distribution

- Recognized problem of marihuana grow operations impact on energy delivery and public safety
- Leveraging grid monitoring to help detect power quality and diversion conditions

Utility Case Study: Power Diversion

Canadian utility estimates the electric value stolen is **$110 million** in lost revenue
- 13,500 estimated grow operations
- Grow operation consumption model is Qty=36, 1000w lamps with an annual grow usage of 181,440 kwh/yr
- Half operations “steal” power through diversion; all considered “wasted consumption” of an illegal enterprise
- Societal impact – higher kwh electric costs; $100 million/yr could supply power to 77,000 residential homes

**Challenge:** total grow operation revenue is a $3.6 Billion to $4.5 Billion annual tax free “business” impacting utility energy consumption
Utility Case Study: Power Diversion

Public and Operation Safety Concerns:
- Illegal connections divert power
- Unsafe design lacks protection and improper install exceeds ratings of connections and electric equipment
- Risk to both general public and utility line crews

Threat to sustainability of electric supply:
- Due to clean power contracts, additional demand charges passed to consumers is a higher rate that could be avoided.
- If theft from grow operations were eliminated, the savings to electric consumers would be estimated at $154.5 million/year

Challenge: Electrical Hazards are 5 times more likely to occur from a grow house – typically diverting power beyond the rated design for equipment and taxing excess consumption
Utility Case Study: Power Diversion

“To Catch a Thief”

- Solution may leverage AMI meter data with upstream energy delivery monitoring for time synchronized consumption data capture
- Application of feeder meters and distribution transformer meters may monitor and report abnormal conditions (i.e. meter tilt, tamper, excess consumption, diverse loading)
- Phasing and centralized analytics may be able to provide a “grow light” signature provided there is “correct customer alignment” between the residential meter and upstream monitor

Challenge: Power diversion routing transformer service drop away from meter for direct connection to grow operation
LV Transformer Monitoring for Theft/Revenue Protection

Transformer secondary load compared to AMI consumption at enterprise application w/smart sensor

Substation

Distribution Transformer w/smart sensor

Residential AMI (energy consumption data)
Additional Transformer Monitoring Use Cases

- Transformer loading and Conditioned Based Monitoring
- Support End-of-Line (EOL) voltage sensing
- Remote voltage control from LTC to EOL
- Collect Real-Time Measurement Data from multiple sources – supports alarms, theft algorithms, loading, and transformer capacity management
Transformer Loading and Conditioned-Based Monitoring

- Transformers have a long projected life span and most are installed before Smart Grid technology became available.
- Smart Grid Replacement Pattern – changing mindset:
  - If a transformer lifespan is 25 years, then only 1/25 of the install base may be upgrade eligible.
  - 4% of transformer installed base per year over the next 25 years
  - Is monitoring only for a new transformer feature or is there value in legacy retrofit?
Transformer losses and loading

- Increasing consumer energy consumption:
  - Drives higher load profiles which increase winding losses
  - Higher loading effects both transformer efficiency and life span

Source: DOE Distribution Transformers - Chapter 3 - Market and Technology Assessment (July, 2004)
Aging Infrastructure: Transformer failure rates

Source: GE Energy Lunch and Learn Series
Why Monitor? Can this scene be prevented?

BOOM!!!.flv
Types of communication-enabled sensors

- Line Sensor (FCI, condition monitor)
- External Transformer Monitor
- Line Post Sensor
- External Voltage Sensor
- Feeder Meter
Distribution Automation-Enabled Information

DA allows more refined monitoring and switching of the system.

- Two-Way communication with near real-time information for remote condition monitoring
- AMI and transformer monitoring enables voltage reduction to reduce load without power quality issues.
- AMI Outage identification and recovery can enhance customer notification.
- Feeder and transformer load optimization is supported through device monitoring and control.
- Sensor information supports Fault detection, Isolation, Service Restoration beyond recloser operations.
Questions?

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