U.S. DEPARTMENT OF ENERGY

SOLAR DECATHLON 2009

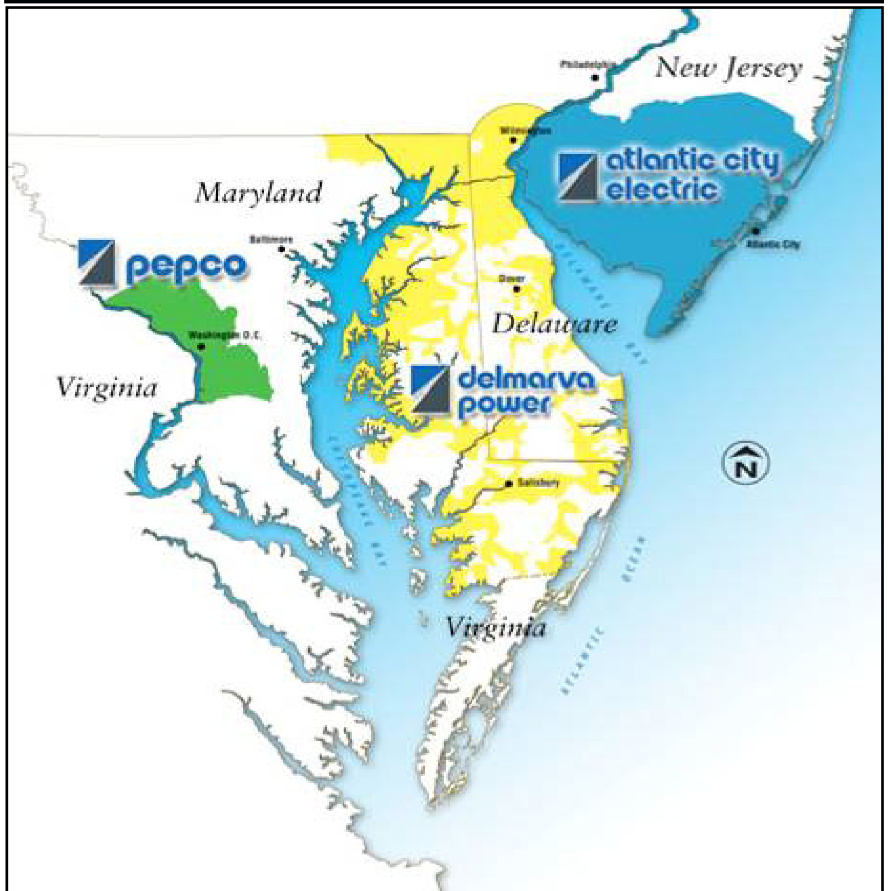
Smart Grid Discussion

Robert Stewart
Manager, Technology Evaluation and Implementation

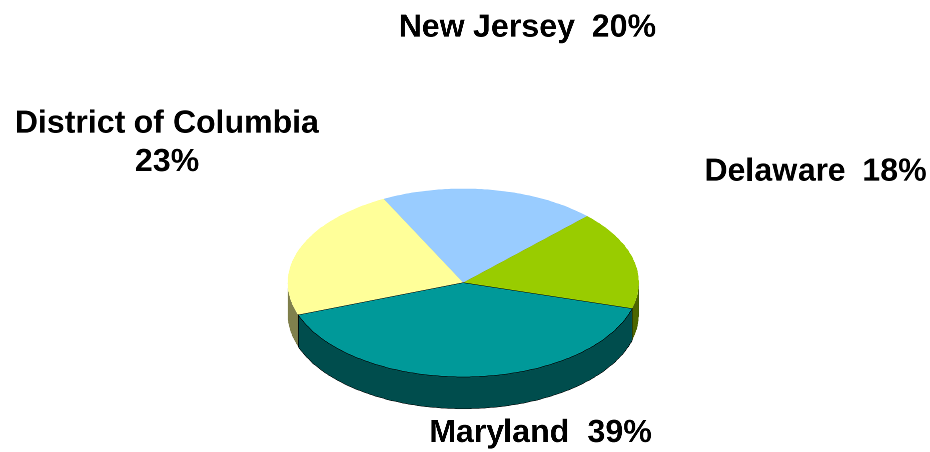
Pepco Holdings, Inc

PHI Overview

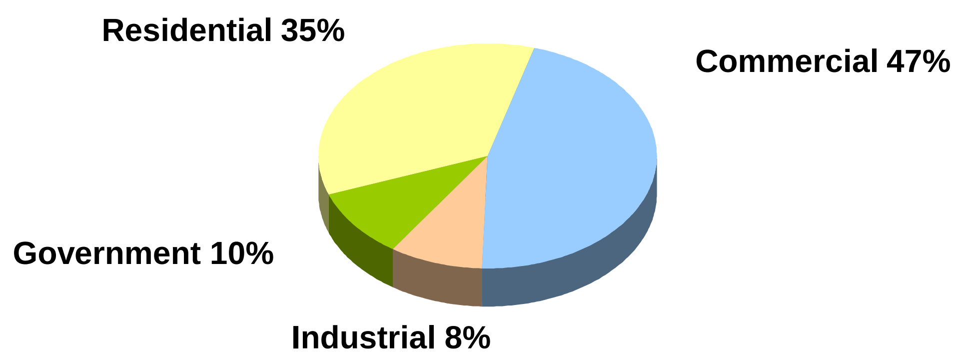
Combined Service Territory



Regulatory Diversity*



Diversified Customer Mix*



Business Overview

Power Delivery

	pepco (A PHI Company)	delmarva power (A PHI Company)		atlantic city electric (A PHI Company)
	Electric	*Electric*	*Gas*	*Electric*
Customers	767,000	498,000	122,000	547,000
GWh	26,863	13,015	N/A	10,089
Mcf (000's)	N/A	N/A	20,300	N/A
Service Area *(square miles)*	640	5,000	275	2,700
	District of Columbia, major portions of Prince George's and Montgomery Counties	Major portions of Delmarva Peninsula	Northern Delaware	Southern New Jersey
Population	2.1 million	1.3 million	.5 million	1.1 million

Note: Based on 2008 annual data

PHI's Smart Grid Vision…

*Through the '**Smart Grid**', customers will become empowered to make choices regarding their use and cost of energy.*

*It will open opportunities for **innovation**.*

*It will provide the ability for a utility and its customers to take advantage of energy alternatives and **efficiencies** regarding both the **production** and **consumption of energy**.*

*It includes a solid foundation of **intelligent grid sensors**, components and operational design to improve control, **quality, reliability, and security**.*

*Adding, operating and maintaining grid assets will be based upon **more up-to-date, fact-based data**. This will enable the evolution from **preventative and reactive** to **predictive and self adjusting** for more efficient use of resources.*

PHI believes there are 5 evolutionary steps to achieving the Smart Grid…

Maturity

Step 1

Intelligent devices infrastructure:
- AMI, or 'Smart Meters'
- Distribution Automation Devices
- Demand Response Devices
- Substation IED Controllers

Step 2

Communications infrastructure:
- Enterprise communication system for rapid and accurate transmission of data
- Integration of fiber and mesh broadband networks

Step 3

Integration:
- Corporate IT systems integrated to allow rapid processing of data
- Open architecture based design to facilitate sharing of information

Step 4

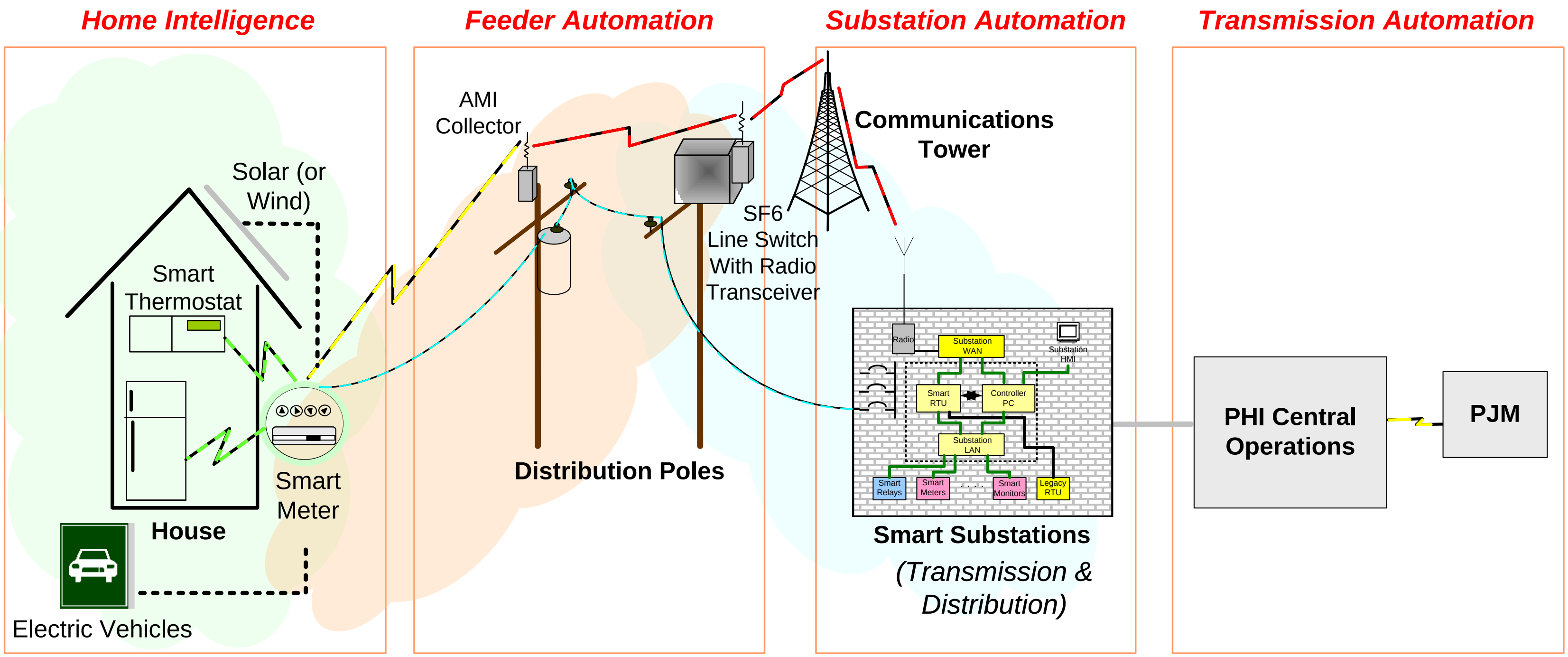
Analytical infrastructure:
- Development of new data analysis capabilities
- Increased ability to display information (in form of dashboards, etc.)

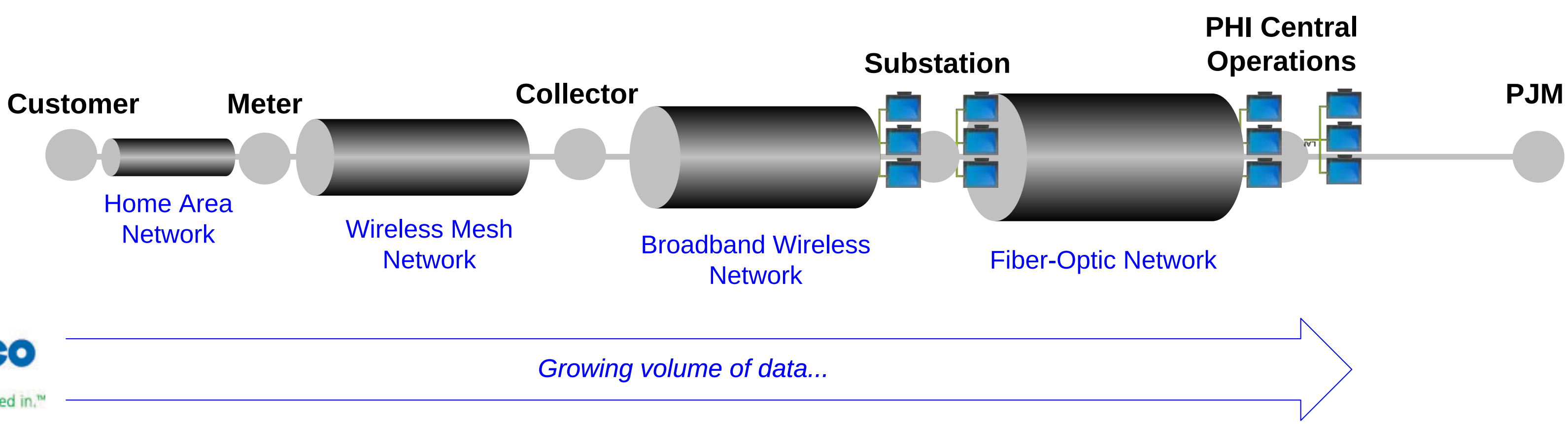
Step 5

Optimization:
- Capability of real-time optimization of distribution network performance
- Decisions based on near real-time information, no longer only historical data

Capability

PHI's Smart Grid Domains and Integrated Communications Infrastructure





Smart Grid Devices and Technologies

Customer — Meter — Collector — Substation — Central Operations — PJM

	Home Intelligence	Feeder Automation	Substation Automation	Transmission Automation
Advanced Metering Infrastructure	• Smart Meter			
Distribution Automation		• Automatic Circuit Reclosers (ACRs) • Automatic Sectionalizing and Tie Switches • Advanced Voltage Control • VAR Control / Capacitors • Network Protector Monitoring & Control • Network Cable / Vault Monitoring • Smart Remote Terminal Units (RTUs) • Fault Detectors	• Automatic Sectionalizing & Restoration (ASR) scheme • Substation Local Area Network • Microprocessor, or 'Smart' Relays • Application Servers • Smart Monitoring & Controls • Distributed Smart Remote Terminal Units (RTUs) • Voltage Control, Substation-Level by Smart Relays or EMS	
Transmission Automation				• Synchrophasor • Motor Operated Disconnect (MOD) • Dynamic Ratings • State Estimation • High Voltage Direct Current (HVDC) • Static VAR Compensator (SVC)
Demand Response (DLC & Dynamic Rates)	• Smart Thermostat • In-Home Display • Plug-In Hybrids			
Distributed Generation	• Micro-generation (solar, wind) • Electric Vehicles/Vehicle-to-Grid	• Upgrades to monitor DG	• Upgrades to monitor DG	
Energy Efficiency	• Smart Appliances • Weatherization			

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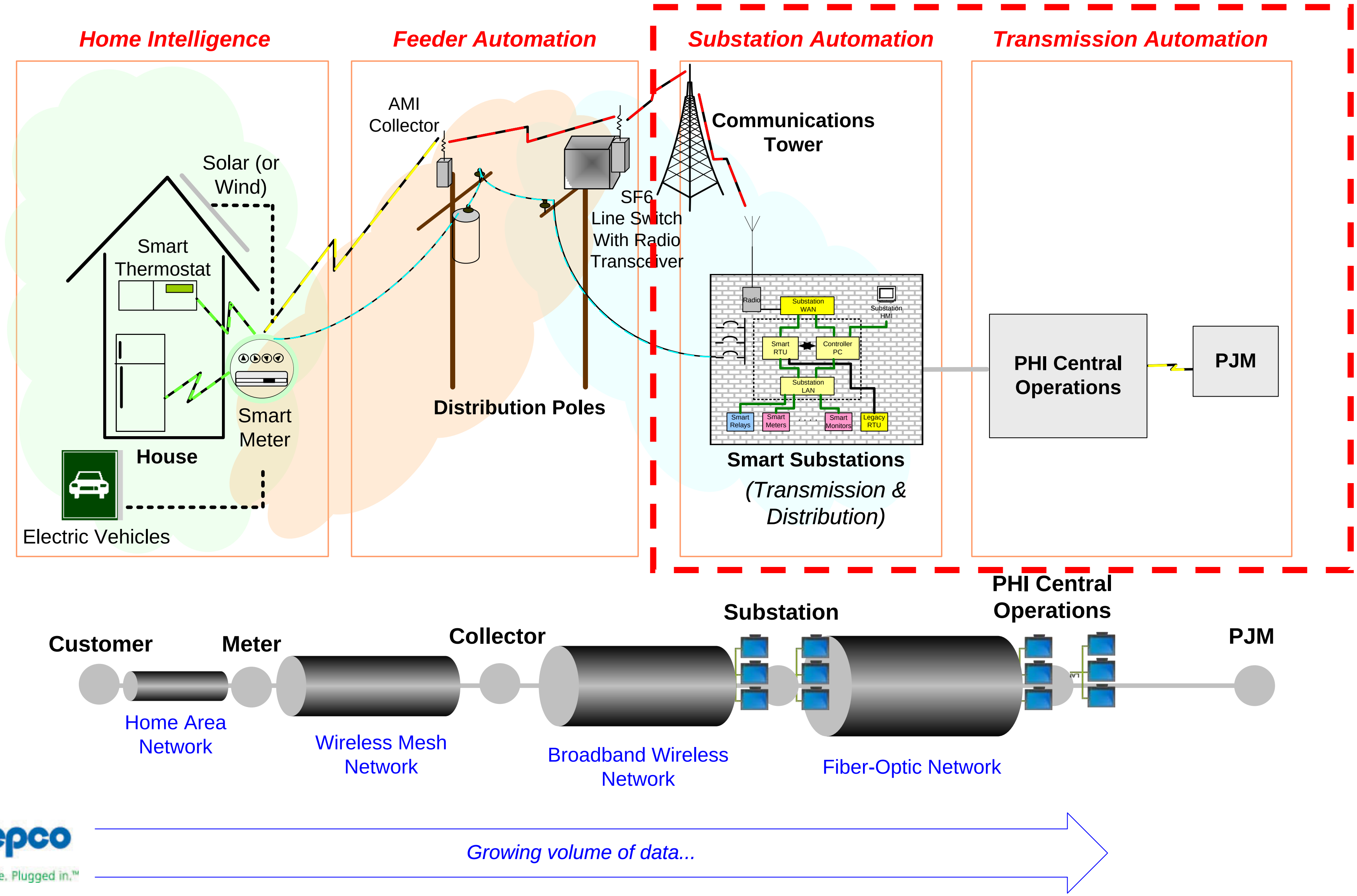
Substation Automation



Transition to Smart Substations

Analog Substations

- Separate relays for each target
- Limited Situational awareness
- Visual confirmation of trip flag

Digital Substations

- Multiple Targets managed by Smart Relays
- Increased Situational Awareness
- Status Communication to Control Center

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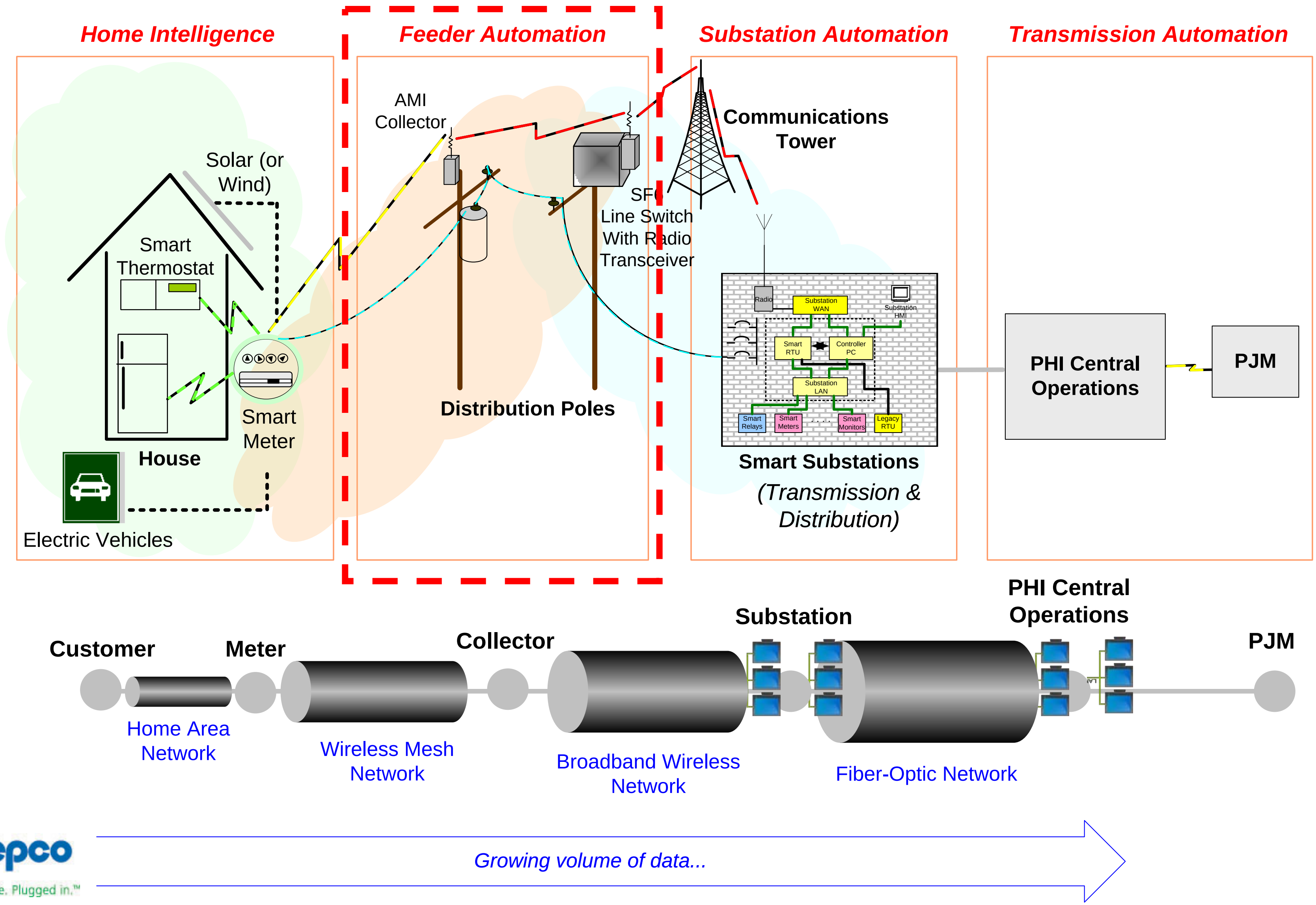
Feeder Automation



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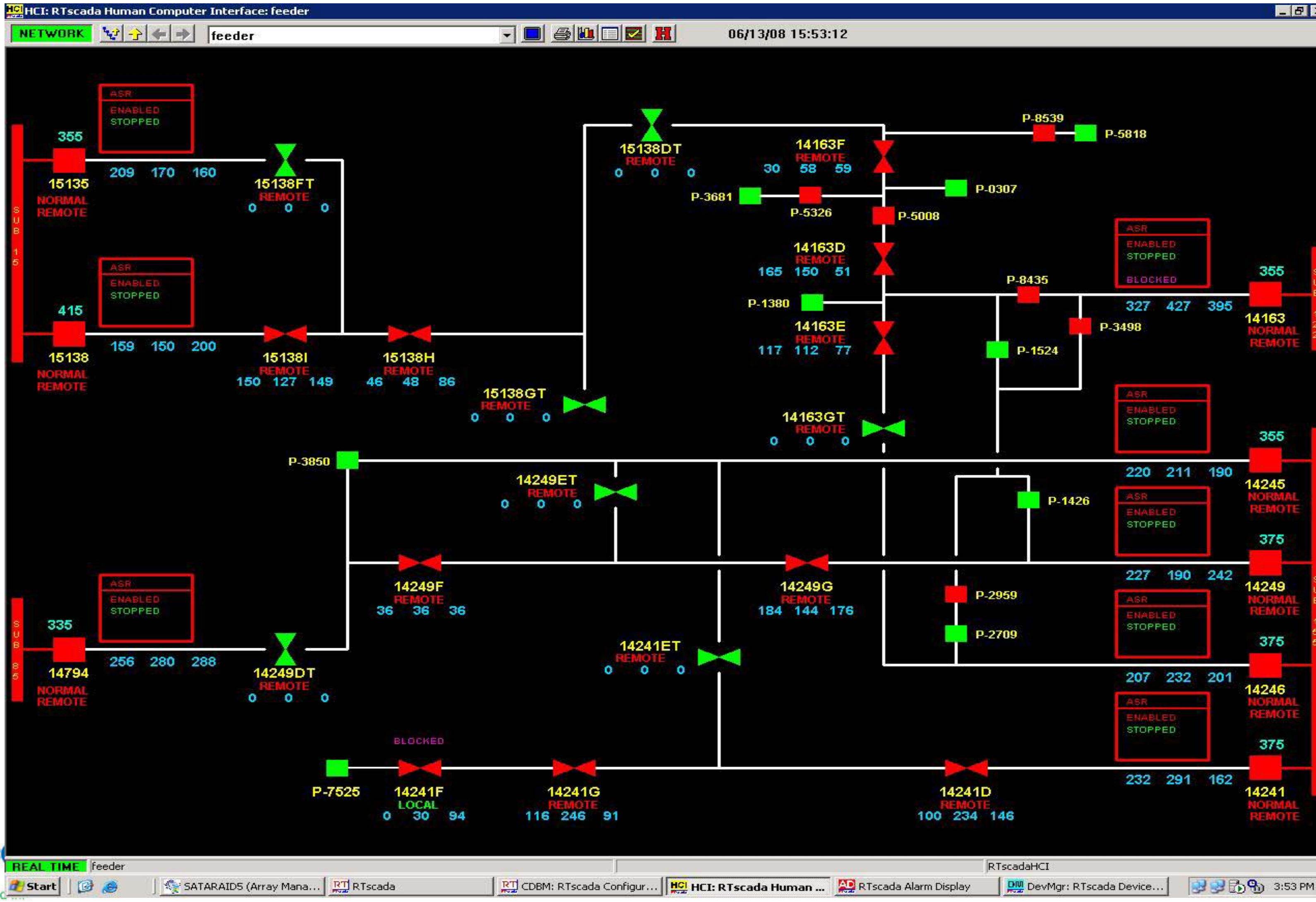
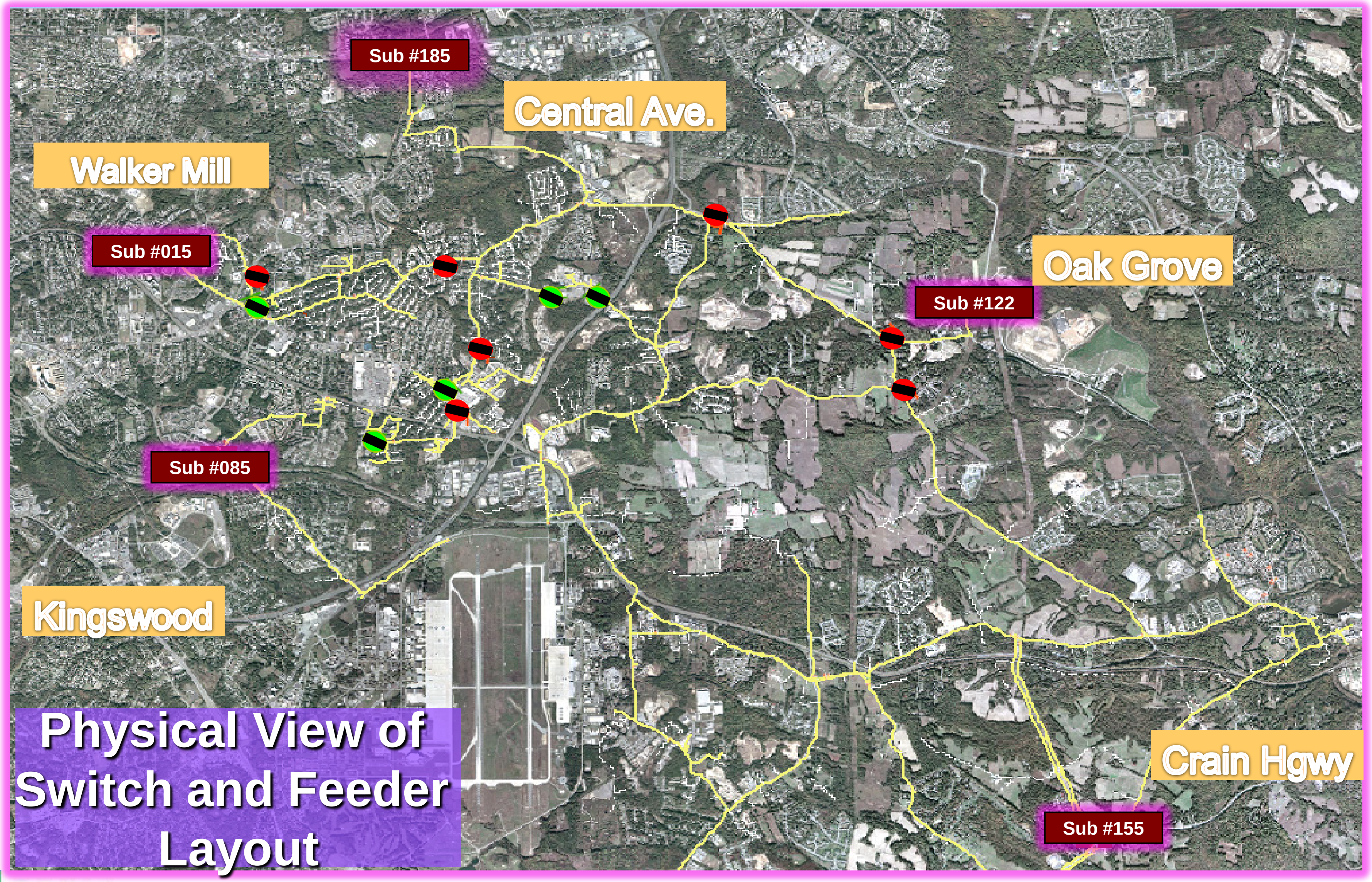
Automatic Sectionalizing and Restoration (ASR) System

Operational Events Overview

One-Line Representation of ASR Scheme





Physical View of Switch and Feeder Layout

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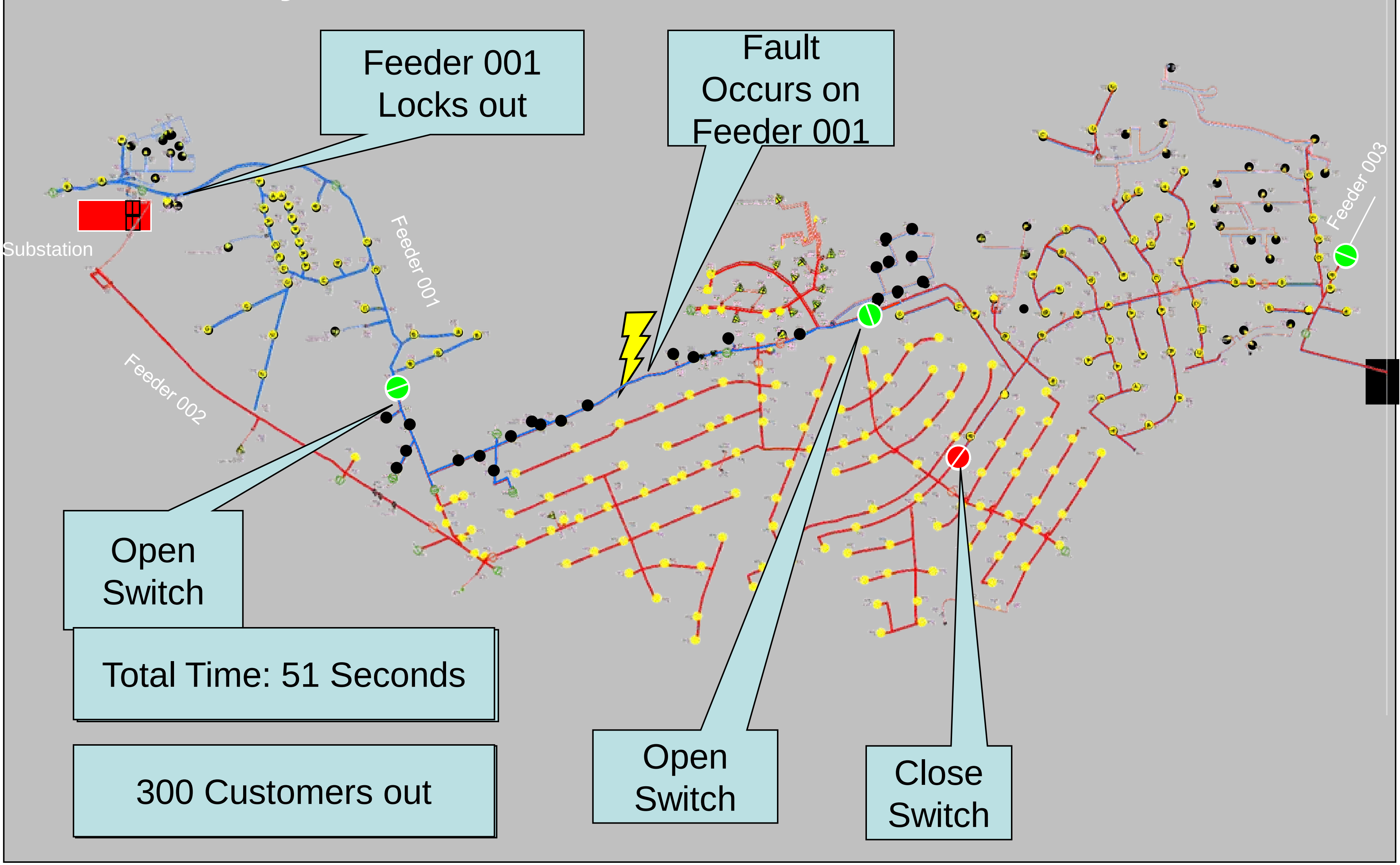
PHI's ASR System – Demonstration



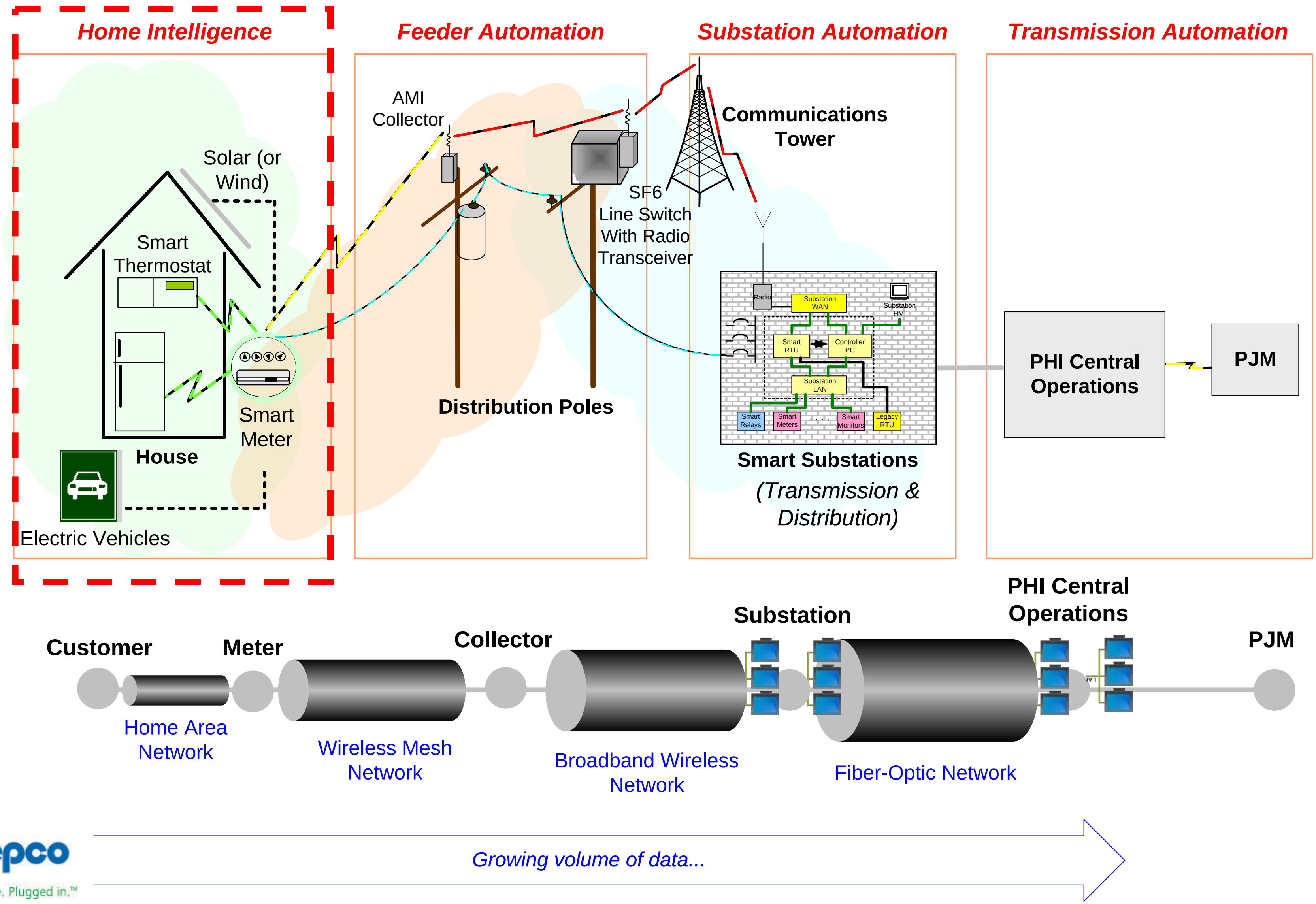
PHI's ASR System – District Heights – Upper Marlboro Scheme

- Number of feeders protected by the ASR Scheme: 4
- Total Events: 7
- Number of Times that the Scheme Operated: 5
- Total Customers on the Four Feeders: 3773

Reliability Indices

	without ASR Scheme	With ASR Scheme	Improvement
SAIFI	1.73	0.81	53%
SAIDI	258.58	110.22	57%

Home Intelligence



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AMI Progress to Date

Vendor Selection

- Comverge – Direct Load Control
- Silver Spring Networks – AMI communication network
- IBM – system integrator
- GE and Landis + Gyr – meter manufacturers
- Scope Services – Meter Installation Contractor

Delaware Deployment

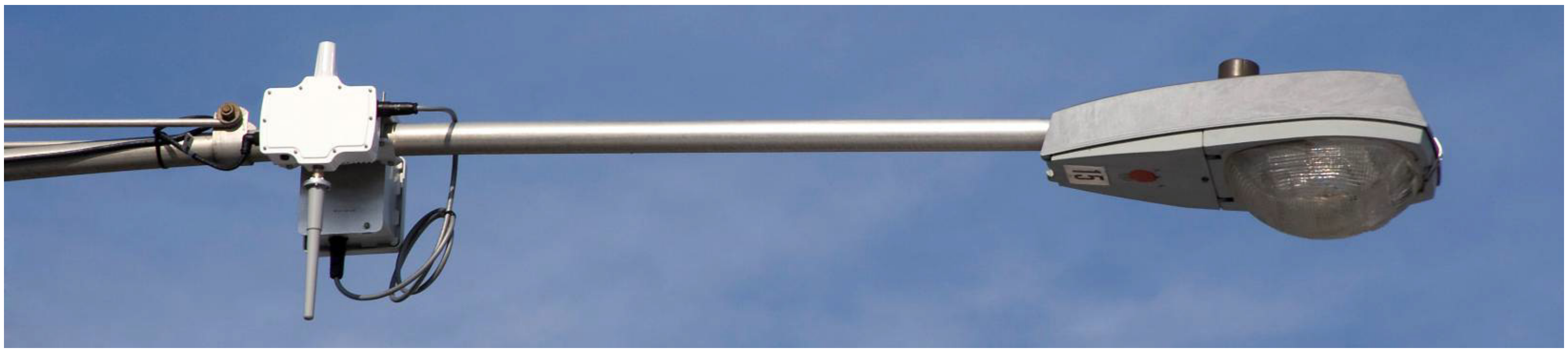
- Field Acceptance Test in progress
- System development and integration in progress
- 4Q 2009 - Commence AMI deployment in Delaware
- 1Q 2010 - Initial customer functionality

AMI Meter Capability

- Two-way communication to the meter/IMU (Gas has battery)
- HAN using ZigBee protocols (Electric only)
- Power quality reporting (Electric only)
- Hourly or 15 minute interval data recording for electric customers, depending on their rate
- Daily consumption for gas customers (hourly reads for gas once a day)
- Diagnostic Alarms, Tamper Flags, and Outage/Switch Counters (E&G)
- Time stamped outage and restoration reporting (Electric only)
- Remote programming and software upgrade capabilities (E&G)
- Backup memory in the meter/IMU (E&G)
- Net energy metering capability (Electric only)
- Capable of supporting remote turn on/off under glass (Electric only)

AMI Network Equipment

Access Point

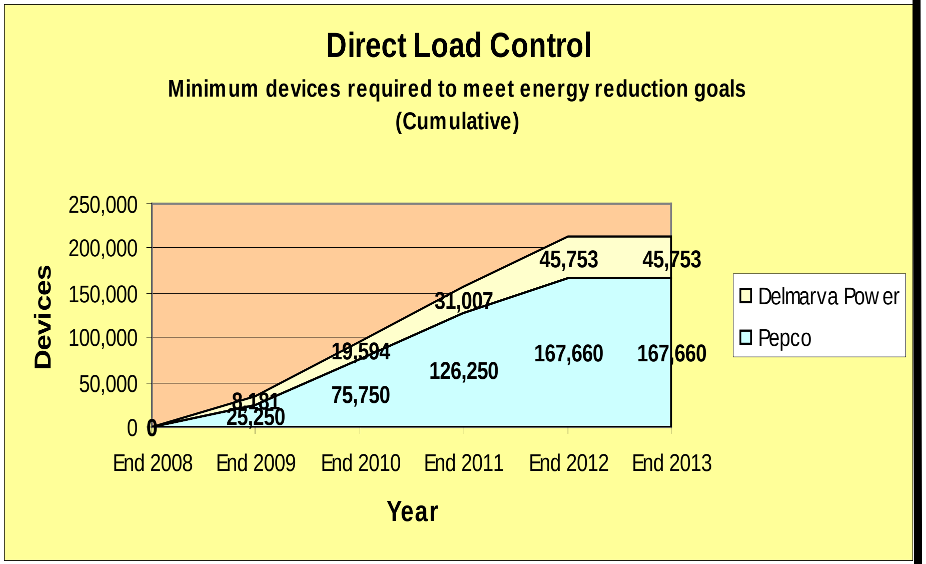


Landis+Gyr and GE Electric Meters

SSN Gas IMU

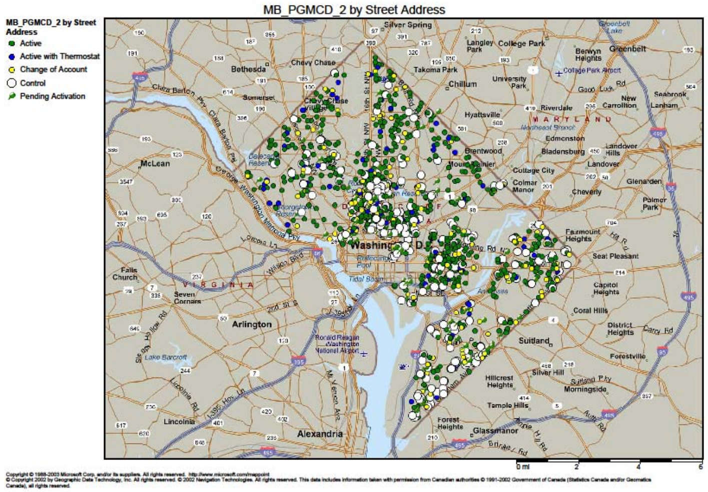
Direct Load Control / Demand Response

MD DLC



- Smart Thermostats and Outdoor switches
- Program Currently Underway
- 33,000 Devices by 2009
- 222,000 by Devices by 2013
- Compatible with AMI

PowerCents DC



- 780 Participants
- Pilot Designed to Test Market Receptivity to

  Three Pricing Alternatives (Supply Portion Only)

  1. Hourly Pricing
  2. Critical Peak Pricing
  3. Critical Peak Rebate

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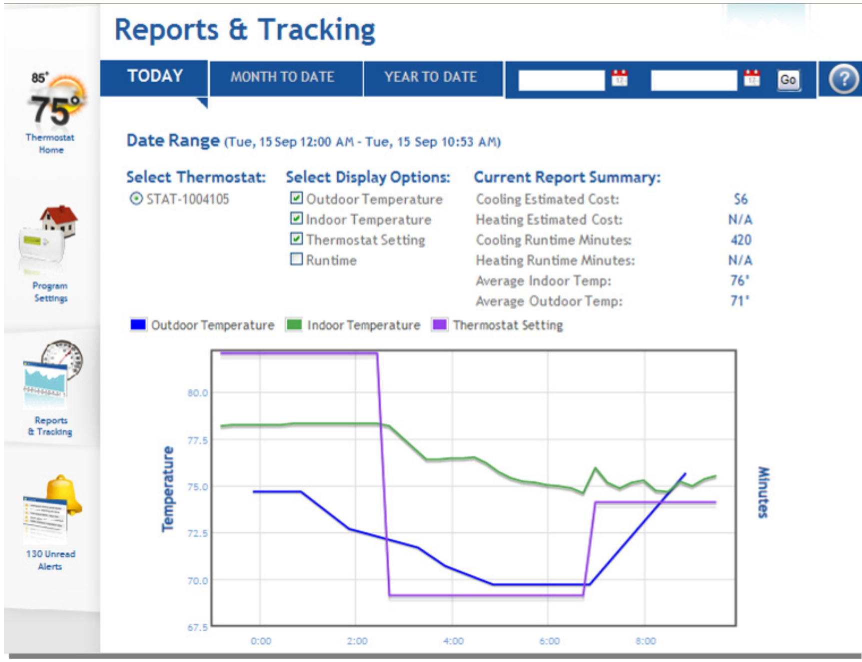
Smart Thermostats

- Will reduce central air conditioner compressor use in response to receipt of a radio-controlled signal; and when programmed, automatically reduces electricity use of air conditioners or central heating systems during high priced hours.
- Contains a wireless receiver inside.
- Can be remotely programmed on behalf of the customer. Customer can override.
- During high priced hours or critical peak rebate periods, signals will be sent to the thermostat to reduce compressor load.
- Alpha-numeric display shows the current price of electricity and the estimated bill to date.



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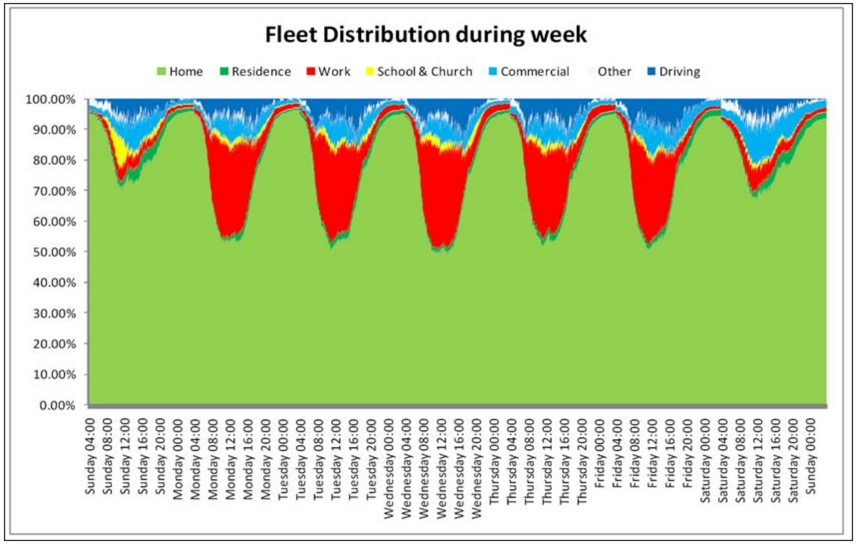
Smart In-Home Display

- Studies have shown that Customers who get frequent information on their energy use may additionally conserve up to 15%.

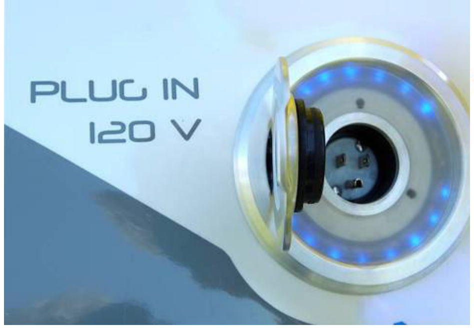
- Typical smart in-home display shows:
  - Power consumed since last bill
  - Estimated bill since last bill
  - Current price of power
  - Price Signal Information
  - Other Messaging

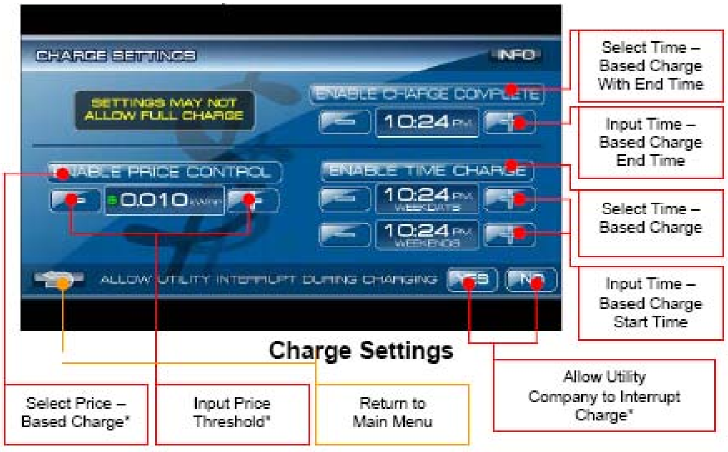
Plug-In Vehicles

- PHI is currently working with EPRI to evaluate the Ford Escape PHEV
- Smart Grid technology will allow for full integration of PEVs into grid
- Infrastructure readiness needs to be considered
- Charger control will reduce risk



Source: Tate and Savagian (GM) SAE 2009-01-1311





*- Denotes that option is only available if Utility Zigbee interface is present. If option is selected

The Link: Smart Grid ⬄ Solar

The Solar Decathlon

- Pepco has installed ‘Smart’ Meters for net metering for the solar homes in the Decathlon
- Net metering is most heavily weighted scoring category in the competition this year
- Demonstrates, in a village setting, how net metering can integrate solar energy into the energy mix

Smart Grid Benefits for Renewable Energy

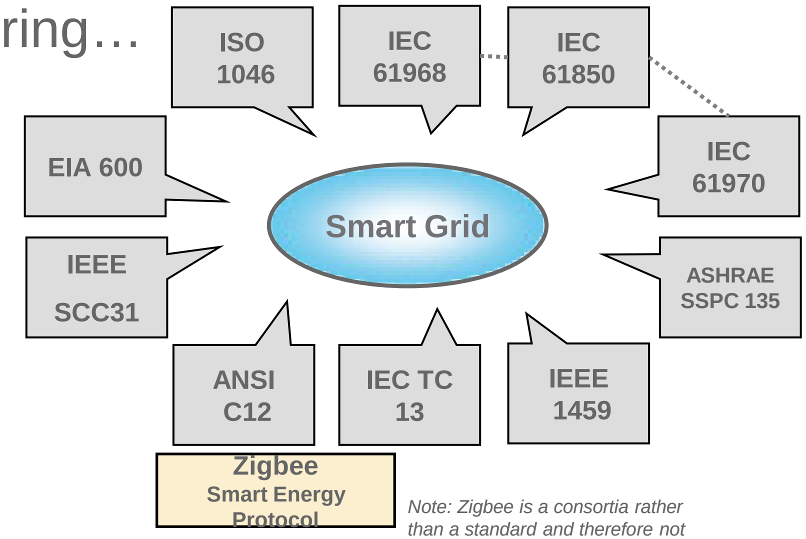
- Net Metering and Net Billing, which support and encourage solar installations, become easier to implement because AMI smart meters can separately record flows of energy in each direction
- AMI enables the increased use of solar by making it easier to integrate them into the grid
- With AMI enabled dynamic pricing customers with solar can lower energy costs by monitoring prices and choosing to use more of their solar resources during peak pricing
- Customers with solar will not have to compromise by reducing electrical usage during peak pricing periods

Solar Electricity - Interconnection

- Green Power Connection™
  - Pepco makes the process of green power interconnection easy
  - Our Green Power Connection™ website provides useful information including:
    - Scenarios
    - Application Process
    - Incentives
    - Pepco Tariffs
    - Important links
  - www.pepco.com/energy/renewable/connection/

Smart Grid Key Maturing Standards…

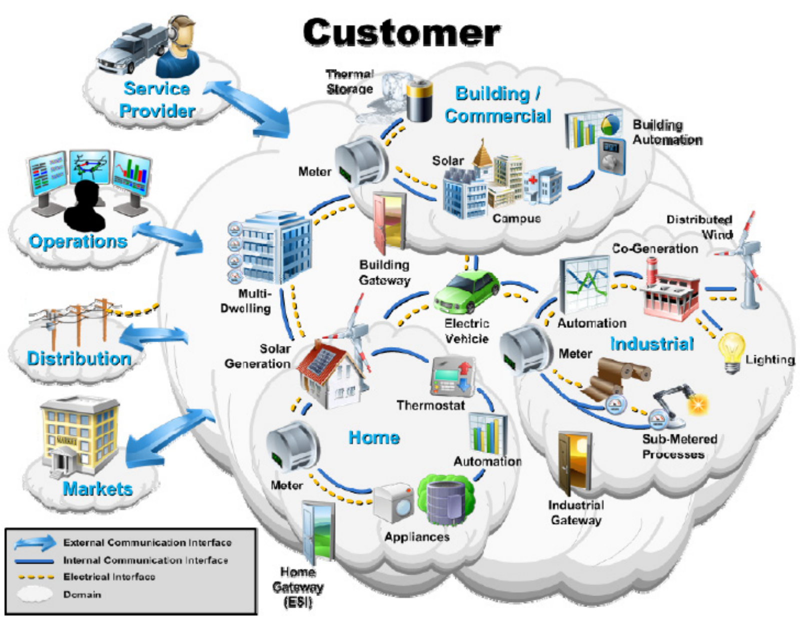
There are a number of standards that are emerging from the Smart Grid and are in the process of maturing…



Note: Zigbee is a consortia rather than a standard and therefore not included above

The 2007 EISA States that NIST:

"….shall have primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems…."



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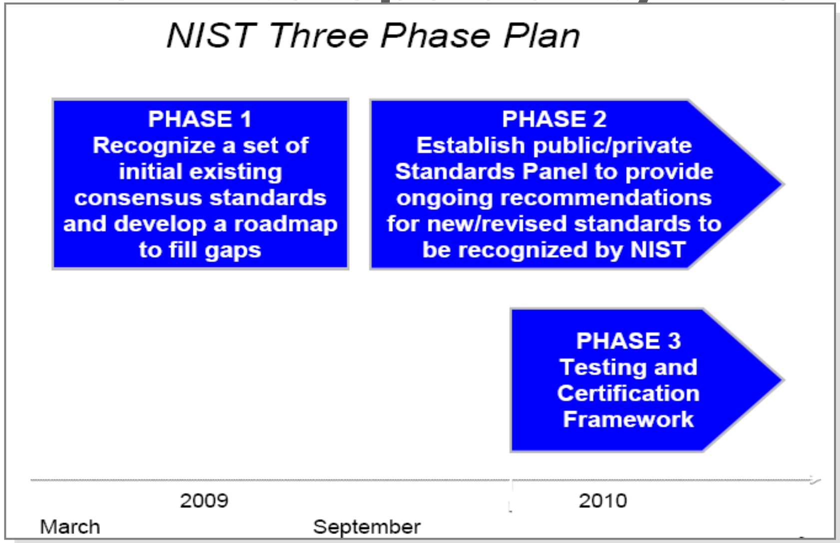
The goal of the Interoperability Effort is to:

- Respond to the NIST Charter as defined in EISA 2007
- Provide the status of key elements of Smart Grid related Standards, recommended Practices and infrastructure Development
- Provide a proposed pathway to the development of a robust, open, well managed and secure infrastructure for smart grid development, deployment and life-cycle management

NIST Interoperability Efforts



14 Priority Action Plans			
1.	IP for the Smart Grid	8.	CIM for Distribution Grid Management
2.	Wireless Communications for the Smart Grid	9.	Standard DR Signals
3.	Common Pricing Model	10.	Standard Energy Usage Information
4.	Common Scheduling Mechanism	11.	Common Object Models for Electric Transportation
5.	Standard Meter Data Profiles	12.	IEC 61850 Objects / DNP3 Mapping
6.	Common Semantic Model for Meter Data Tables	13.	Time Synchronization, IEC 61850 Objects / IEEE 37.118 Harmonization
7.	Electric Storage Interconnection Guidelines	14.	Transmission and Distribution Power Systems Model Mapping

- Held a series of cross-industry workshops
- Focus on identifying “low hanging” standards for Smart Grid and developing Priority Action Plans (PAPs)
- Initial 16 Standards extended to 31 (with 46 additional under review)
- NIST identified 14 PAPs key to the development of the Smart Grid
- Includes Cyber Security
- Announced last month the formation of a Smart Grid Interoperability Panel

PHI's security framework has a holistic approach…

We are using a security framework that:

- Takes a **holistic** approach to security, providing protection at all levels with the intent of minimizing the impact/exposure to our systems and customer data
- Evaluates the appropriate level of security at each point in the network

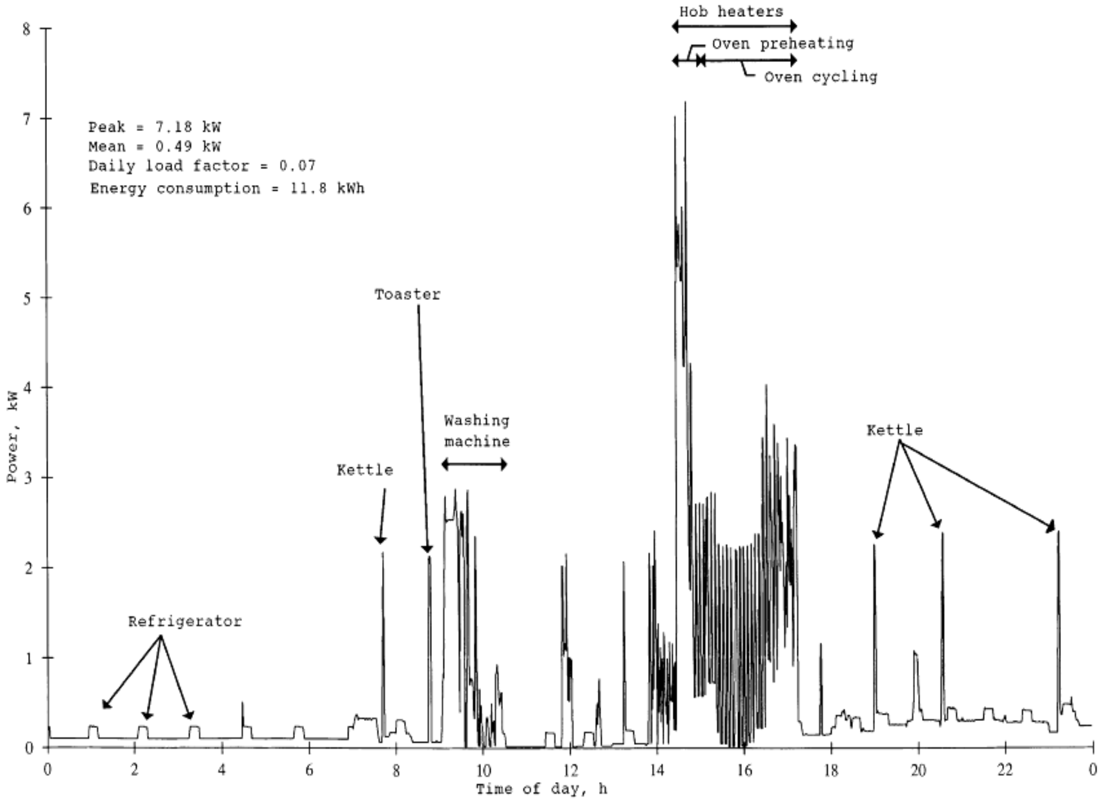
  ie, the security level at a substation will be greater than that at a meter
- **Regularly** assesses risks and **dynamically monitors** for any malicious attacks to our networks which may adversely impact our business, our customers and the public at large
- Provides the capability to **dynamically change** security rules, policies and procedures to ensure that we remain agile against a changing risk environment
- Leverages security experts from other industries that have already been through these issues
- Uses design standards that include, for example, the Advanced Encryption Standard (AES) and Control & Limit Access (Radius Authentication Standard)
- Extends the use of Firewalls to distribution substations and out to the feeder level as well, both minimizing and isolating the impact of external threats. Traditionally, Firewalls were placed only in centralized IT systems

Customer Privacy Concerns – A Key Issue

"All consumers are entitled to protection of their privacy and must be protected from use of their customer records or payment history without their expressed, informed consent." Source: From the NASUCA Consumer Bill of Rights resolution (from 1998) at http://www.nasuca.org/res/conpro/conpro9802.php

- **Data can be very useful for helping customers understand their energy use and modify their behavior.**
- **Third parties can also use this data to provide additional services to customers.**
- **Customers need to be educated on the importance of this data and exercise judgment before releasing it.**
- **NARUC is currently evaluating privacy protections and regulations in various States.**
  - Will likely propose legislation

How power use can reveal personal activities[1]



[1]Elias Leake Quinn, *A Report for the Colorado Public Utilities Commission, Spring 2009*, pg. 3. (citing M. Newborough & P. 3Augood, *Demand-side Management Opportunities for the UK Domestic Sector*, IEEE Proceedings of GenerationTransmission and Distribution 146 (3) (1999) 283–293).

Key Takeaways

"The smart grid will only work to the extent that customers win,"
Joseph Rigby, CEO of Pepco Holdings, Inc

- Customer Adoption and Participation is a key enabler

- Smart Grid will move at the *Speed of Value*
  - Utilities will still need Regulatory approval for large projects related to Smart Grid
  - Standards and Interoperability are key to preventing stranded assets

- Interoperability and Standardization are not spectator activities.
  - Utilities need to get involved and make their voices heard

- Through the Smart Grid, Utilities will become "Technology" Companies
  - No longer the "best solutions" but rather iterations of "Better Solutions"
  - Similar to Electric System Operations, Communication Network Operations and enhanced Cyber Security will become part of our future DNA

- Legislation should be applied judiciously
  - Standards are hard to change, laws are nearly impossible.