# Wireless Communications for Smart Grid

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September 25, 2010

# Smart Grid

- Delivers electricity from suppliers to consumers using two-way digital technology to control appliances at consumers' homes to save energy, reduce cost and increase reliability
- Overlays the electricity distribution grid with the information technology and communication system
- Combines sensing and measurement with two-way communications to monitor and control the power grid
- Integrates renewable electricity such as solar and wind power

# Smart Grid Benefits – Business Case

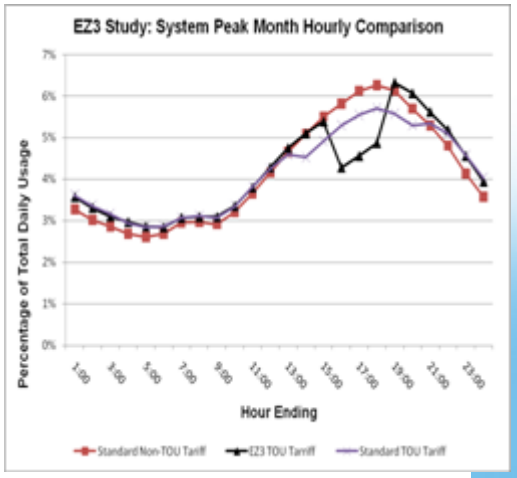
- Lower customer bills
  - Bill credits through Smart Energy Pricing
  - Empowered consumers managing energy use
- Improved reliability
- Automated outage reporting / faster restoration
- On-demand meter reads
- Eliminates manual meter reading
- Reduces truck rolls for turn on/off of service
- Lower energy  consumption-Reduced carbon emissions
- Infrastructure that can support renewable energy generation
- Infrastructure than can support smart charging of Plug-in Hybrid Electric Vehicles
- Remote fault indication
- Voltage optimization and efficiency gains
- Peak load reductions

# Smart Grid – Today: **Efficiency Benefits**

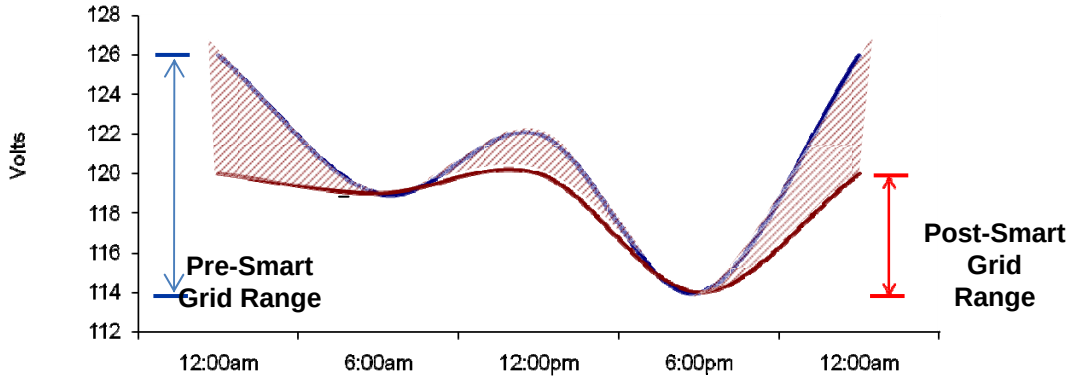
Peak reduction is being obtained and improved

- Expanded use of traditional Time-of-Use (TOU)
- Monitoring and Improvement in TOU rates
- Critical-Tier-Pricing




Voltage monitoring and control are showing…

- 6-8% reduction in voltage yields…
- 4-6% reduction in energy consumed
- Conservation / bill reduction with zero consumer involvement



# Smart Grid – Today: **Cost & Societal Benefits**

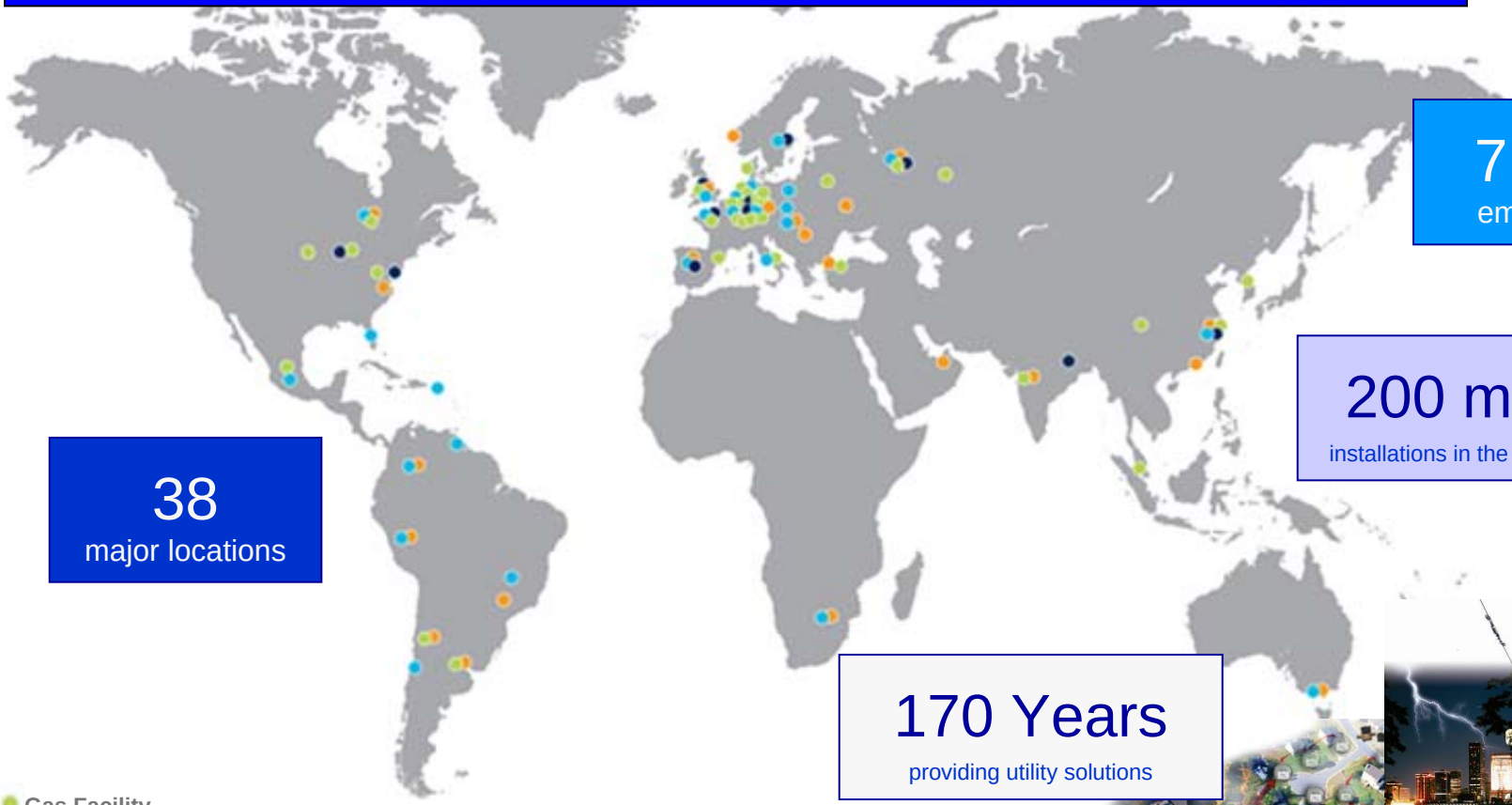
2009 Data Example: One utility with 500k installed points to date (half their consumers)

- Eliminated: 246k field visits (in addition to billing cycle reads)
  - Saved 82k labor hours
  - Saved 443k miles
  - Saved 44k gallons of fuel
- Improved safety across the workforce
  - Reduced personal injury 39%
  - Reduced vehicular accidents 10%
- Improved response to service reconnection
  - From: 4 days after payment
  - To: 1 day, 24 hours a day, 7 days per week

# Elster - The world leader

Elster sells products and services in more than 130 countries across electricity, gas, water and multi-utility applications for residential, commercial and industrial customers



**7,500**
employees

**200 million**
installations in the last ten years

**38**
major locations

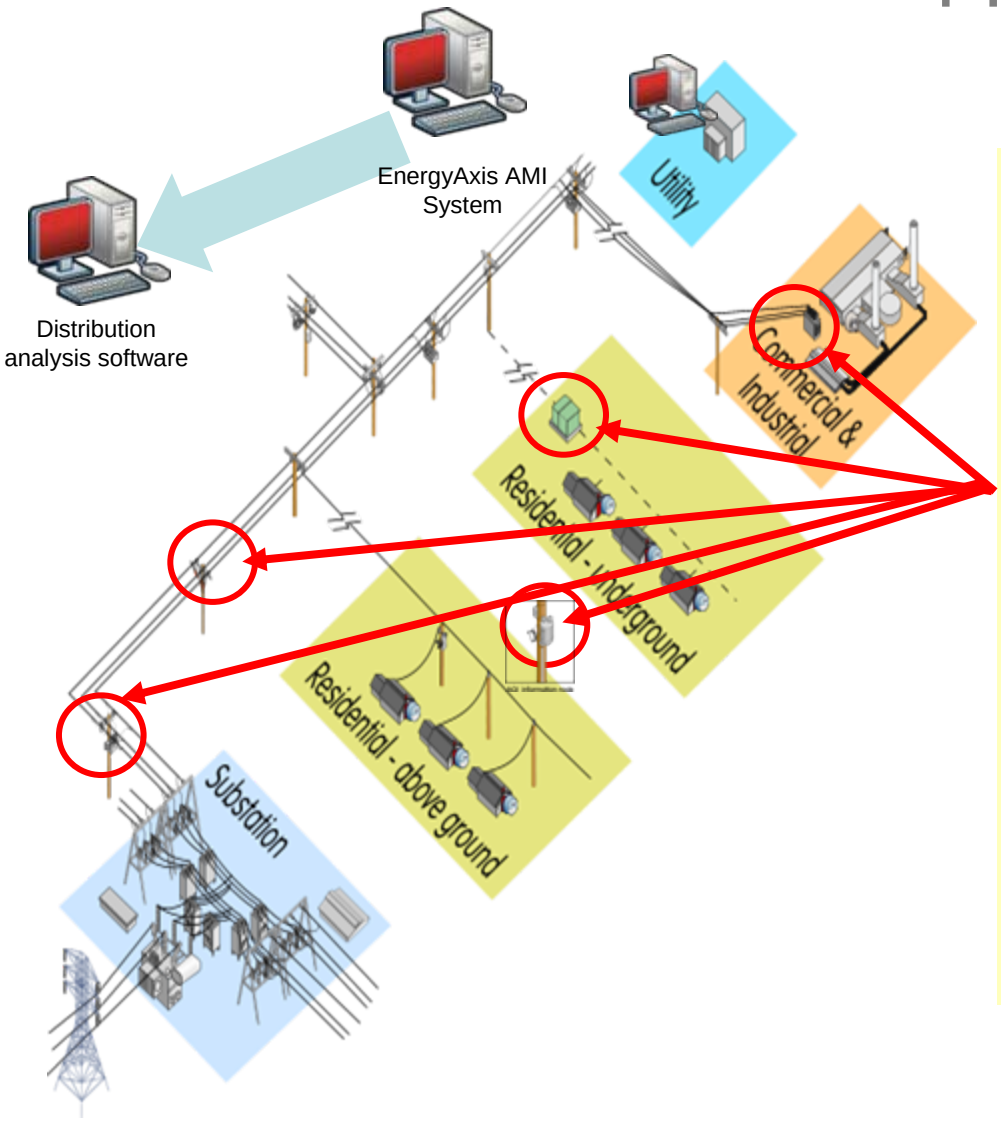
**170 Years**
providing utility solutions

- Gas Facility
- Electricity Facility
- Water Facility
- Industrial Furnace Facility

**Elster/Kromschroeder/Instromet** (Gas)
**American Meter** (NA Gas)
**Westinghouse/GEC/ABB** (Electricity)
**Kent** (Water)
**Coronis** (RF) / **PowerOneData** (GPRS)

# Utilizing Elster Communication Infrastructure for Grid Applications




## Applications:

- Voltage and VAR Control
- Transformer Voltage Regulation
- Non-technical Loss Discovery
- Fault Location, Isolation and Service Restoration
- Feeder/Substation Planning
- Feeder Balancing
- Condition Assessment
- Feeder Reconfiguration
- Contingency Analysis
- Transformer Sizing

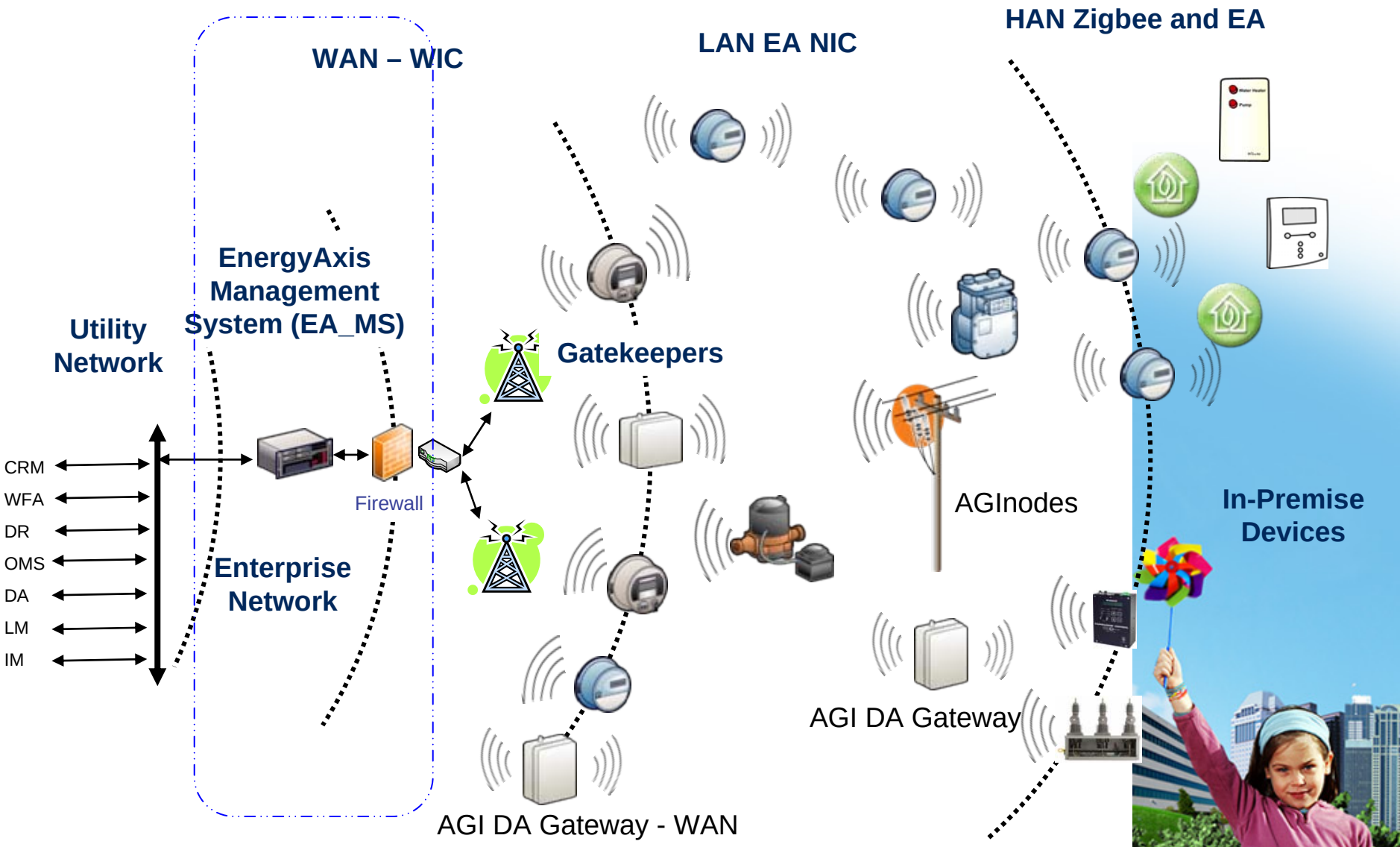
 

# Smart Grid Communications and Smart Metering

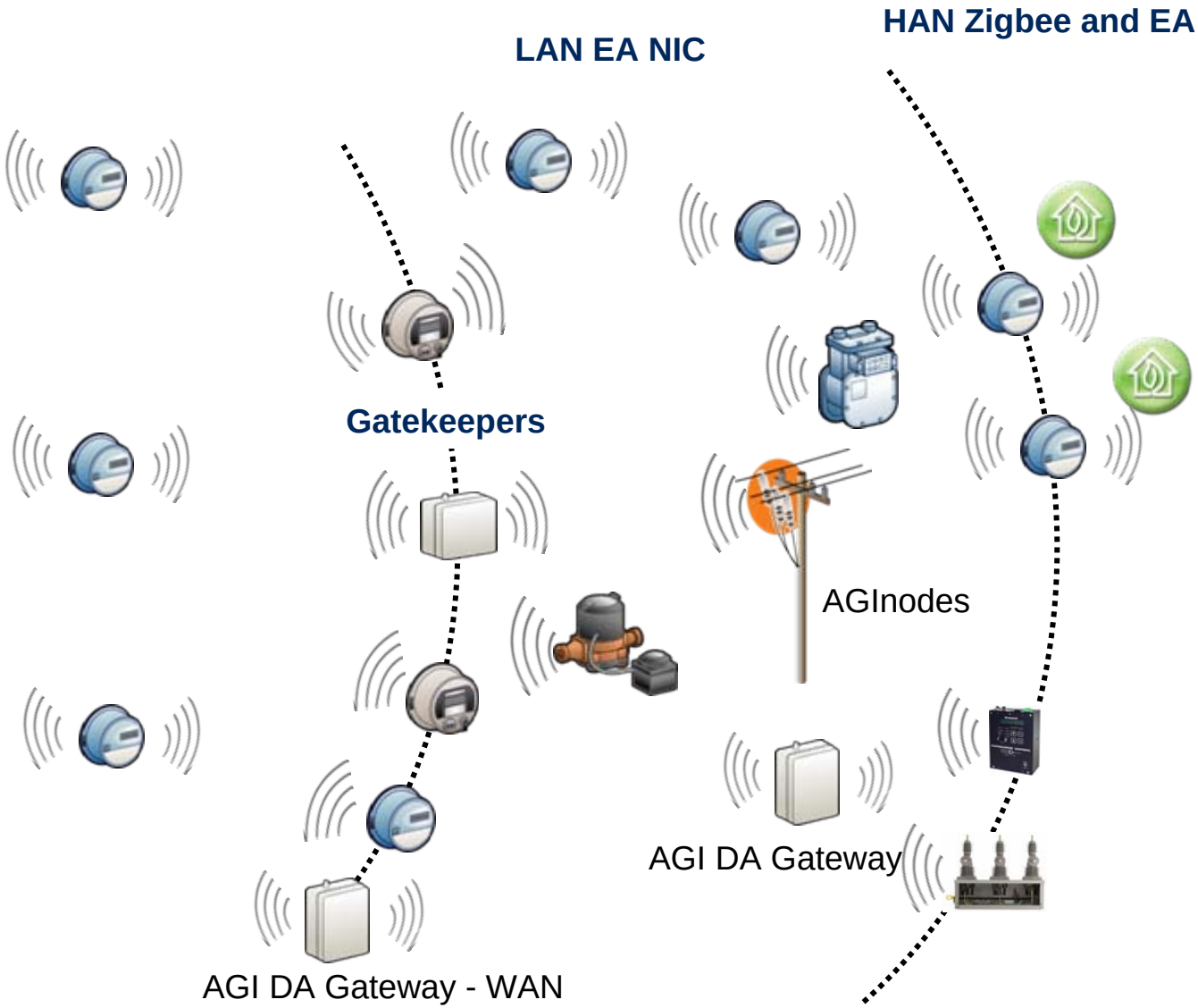
- EnergyAxis is Elster's communication system for Smart Grid applications
- Over 4 Million endpoints in 80 systems in 8 countries
- Production EnergyAxis systems are reading over 4M meters daily
  - Daily reads for Time of Use (TOU) data
  - Daily reads for interval (i.e. energy usage in each interval of the day)
  - >1,000 service connect/disconnects each week
  - Electricity, gas, and water metering
- It's more than metering
  - Grid infrastructure control and monitoring

# EnergyAxis® Component View



# Neighborhood Area Network (NAN) (Smart Utility Network-SUN)



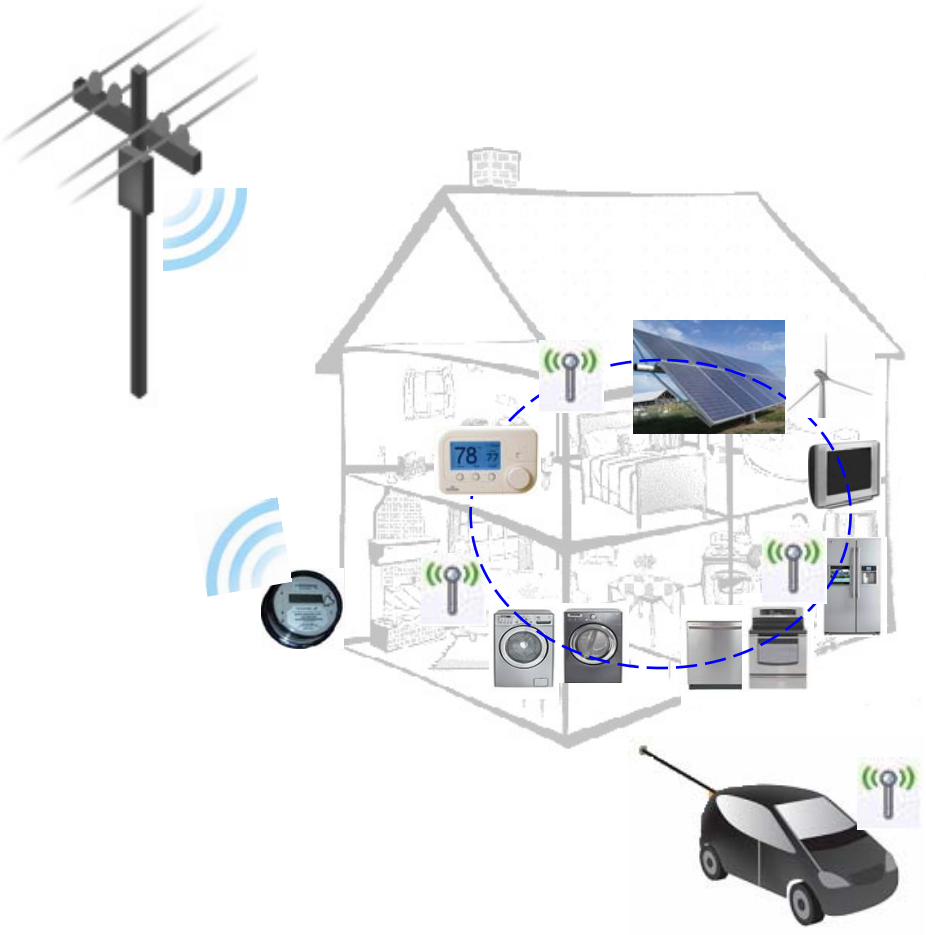
# Communication Technologies for NAN (SUN)

- Wireless based Mesh Network
  - FSK operating in 900 MHz
  - DSSS-O-QPSK based technology operating in 2.4 GHz (IEEE 802.15.4/ZigBee)
- Powerline communications
- Private licensed frequencies bands
- Standardization effort in IEEE 802.15.4g

# Home Area Network (HAN)

- A communication network consists of smart appliances and renewable energy generators (solar, wind and PHEV (plug-in hybrid electric vehicle))
- Communicates Meter Data into home to enable home automation and energy management
- Energy management systems/Home automation includes policy-based control of HVAC and smart appliances



# Communication Technologies for HAN

- Wireless technologies:
  - IEEE 802.15.4/ZigBee (DSSS-O-QPSK based technology operating in 2.4 GHz)
  - IEEE 802.11/WiFi
- Powerline communications
- Application protocol-Smart Energy Profile 2.0
  - Support physical standards such as 802.15.4, 802.11, P1901

# Residential Demand Management

## *Smart Energy Profile – ZigBee and TOU*

- ***Challenge:***
  - Provide real time consumer usage/consumption and peak load management
  - Implement residential TOU program
  - Implement Smart Appliance control
- ***Solution:***
  - Leverage SEP ZigBee Demand Response to display and control in-home use
- ***Benefits:***
  - Accurate data enables consumer to determine the **optimal usage and reduce peak demand**
  - Information, knowledge and ability to better manage demand
    - Better understanding of the cost of using appliances, AC, heating, etc.
      - In general
      - At different times of the day under a TOU rate
  - Ability to manage / reduce overall energy consumption
    - Manage peaks, shift load
    - Additional benefits during Critical Peak periods
  - Control (direct/indirect) of energy use
- ***Enabling Solutions/Partnerships*:**
  - Displays, Thermostats, other ZigBee enabled devices

# WiFi Alliance/IEEE 802.11

- Created Smart Grid Task Group in 2009
  - Promote Wi-Fi for Smart Grid
  - Extend Wi-Fi certified testing program for Smart Grid devices and applications
- IEEE 802.11 for sub GHz:
  - Study Group was formed in January 2010 Meeting in LA
  - Task Group starts functioning in the coming September meeting

# IEEE 802.15.4g

- IEEE802.15.4g Task Group defines a PHY amendment to IEEE 802.15.4 to address outdoor Smart Utility Network
- AMI/Smart Meter applications
- Started as Study Group on September, 2008
- Call for preliminary proposal on March 2009
- Preliminary and final proposals presented on May 16-22, 2009
- Issued 1st Letter Ballot on April 2010
- 2nd Letter Ballot will be out early October

# IEEE 802.15.4g (cont'd)

- This Standard defines a PHY amendment (and only those MAC modifications needed to support its PHY change) to IEEE 802.15.4 to address outdoor Low Data Rate Wireless Smart Metering Utility Network (SUN).
- The amendment supports the following:
  - Operation in available license exempt frequency bands, such as 700MHz to 1GHz, and the 2.4 GHz band.
  - Data rate of at least 40 kbits/sec but not more than 1000 kbits/sec
  - Achieve optimal energy efficient link margin under SUN deployments.
  - PHY frame sizes up to a minimum of 1500 octets.
  - Simultaneous operation for at least 3 co-located orthogonal networks
  - Connectivity to at least one thousand direct neighbors in dense urban deployment
  - Provides mechanisms to coexist with other systems in the same band(s) including IEEE 802.11, 802.15 and 802.16 systems.

# IEEE 802.15.4g (cont'd)

- Three different PHY proposals:
  - FSK
    - Narrow band frequency hopping using FSK (GFSK)
  - MR-OQPSK
    - Based on existing 802.15.4 DSSS PHY
  - OFDM

# 4g (SUN) Frequency Bands and Data Rates for FSK

- 915 MHz/2.4 GHz unlicensed band
  - 50 kbps (mandatory), 150/200 kbps (optional)
- 950 MHz Japanese band
  - 50, 100, 200, 400 kbps
- 863 MHz European band
  - 50, 100, 200 kbps
- 470 MHz Chinese band
  - 50, 100, 200 kbps
- Licensed bands
  - Data rates 40 kbps or lower

# 4g (SUN) Frequency Bands and Data Rates for OFDM

- 915 MHz/2.4 GHz unlicensed band
- 950 MHz Japanese band
- 922 MHz Korean band
- 863 MHz European band
- 470, 780 MHz Chinese band
- Data rates from 50 kbps to 800 kbps

# 4g (SUN) Frequency Bands and Data Rates for O-QPSK

- 915 MHz/2.4 GHz unlicensed band
- 950 MHz Japanese band
- 868 MHz European band
- 470, 780 MHz Chinese band
- Data rates from 12.5 kbps to 500 kbps

# Thank You!

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