Smart Metering
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Advanced Metering Infrastructure, Smart Grid, Smart Metering

- How it is defined today?
- Benefit Identification
- Requirements Process
- Implementation Technology
- Integrating the home
  - Programmable Communicating Thermostats
  - Distributed Generation
- Lessons Learned
- Questions

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Smart Grid Definition

A. an enhanced electric transmission or distribution network that extensively utilizes internet-like communications network technology, distributed computing and associated sensors and software (including equipment installed on the premises of an electric customer) to provide

i. smart metering;
ii. demand response;
iii. distributed generation management;
iv. electrical storage management;
v. thermal storage management;
vi. transmission management;
vii. power outage and restoration detection;
viii. power quality management;
ix. preventive maintenance improves the reliability, security and efficiency of the distribution grid;
x. distribution automation; or

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Smart Grid Definition

B. other facilities, equipment, or systems that operate in conjunction with such communications network, or that directly interface with the electric utility transmission or distribution network, to provide the capabilities described in clauses (i) through (x) in paragraph (A).

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The Smart Grid

Smart Grid

AMI Capability+

Remote detection

Central and distributed analysis

Correction of disturbances on the grid

Optimizes grid assets

AMI

AMR Capability+

Load Profiling

Remote TFTN

New Rate Design

Price Signals sent to Customer

Demand Response

Customer Voltage Measurement

Customer Outage Detection

Load Control

Theft ID

Hourly Remote Meter Reads

Remote Meter Programming

AMR

Automated Meter Reads

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AMI Definition

- The UtilityAMI organization has created a multi-part definition of AMI
- Part 1
  - An advanced metering infrastructure is a comprehensive, **integrated collection of devices**, networks, computer systems, protocols and organizational processes dedicated to distributing highly accurate information about customer electricity and / or gas usage **throughout the utility and back to the customers** themselves.
- Part 2
  - Such an infrastructure is considered “advanced” because it not only gathers customer data automatically but does so securely, reliably, and in a timely fashion while **adhering to published, open standards** and permitting simple, automated upgrading and expansion.

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AMI Definition

- Part 3
  - A well-deployed advanced metering **infrastructure enables a variety of utility applications** to be performed more accurately and efficiently including time-differentiated tariffs, demand response, outage detection, theft detection, network optimization, and market operations.
- Part 3 is the key – recognizing that an AMI is an enabler for a wide variety of utility applications
- Focus should be on the I in AMI

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Benefit Identification

- Every utility is different
  - Geography, system design, regulatory environment, business practices, existing optimizations, etc.
- There are examples from other utilities of numerous benefit opportunities – e.g. California Framework
- A well designed process should be used to identify benefits
  - EPRI IntelliGrid Application Guide
  - Applied at SCE, Consumers Energy, Alliant Energy

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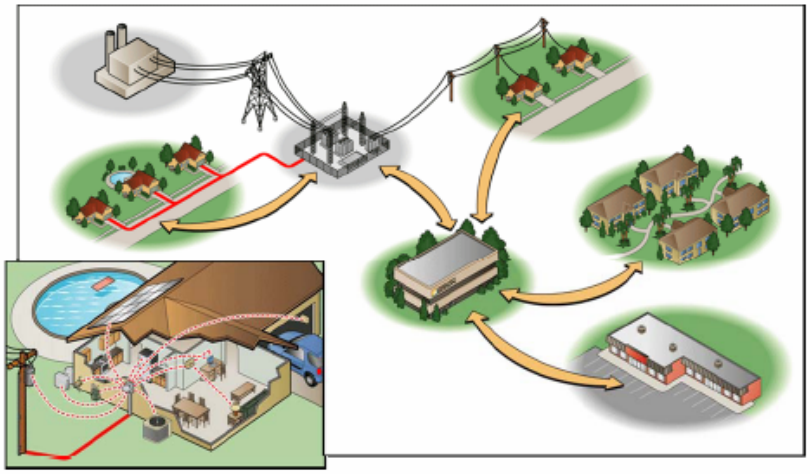
Leveraging the Infrastructure

SCE seeks to leverage a 2-way communications infrastructure with 5 million intelligent metering devices on our distribution network to create lasting value for our customers and our operations

- Enable Energy Smart Customers
  - *Integrated information from utility*
  - *Payment options (e.g., pre-payment)*
  - *Outage & service condition information*
  - *Support rate option innovations*
- Manage Distributed Resources
  - *Economic dispatch of load resources*
  - *Dispatch of load for grid management*
  - *Intelligent net metering*
  - *Management of distributed energy resources*
- Operational Efficiencies
  - *Field communication links to distribution*
  - *Revenue cycle improvements*
  - *Situational data in near real-time*
  - *Wholesale - retail markets integration*
- Built with the future in mind
  - *Upgradeable WAN/**HAN** communications*
  - *Leverage open architecture principles in system design*
  - *Future customer service offerings*



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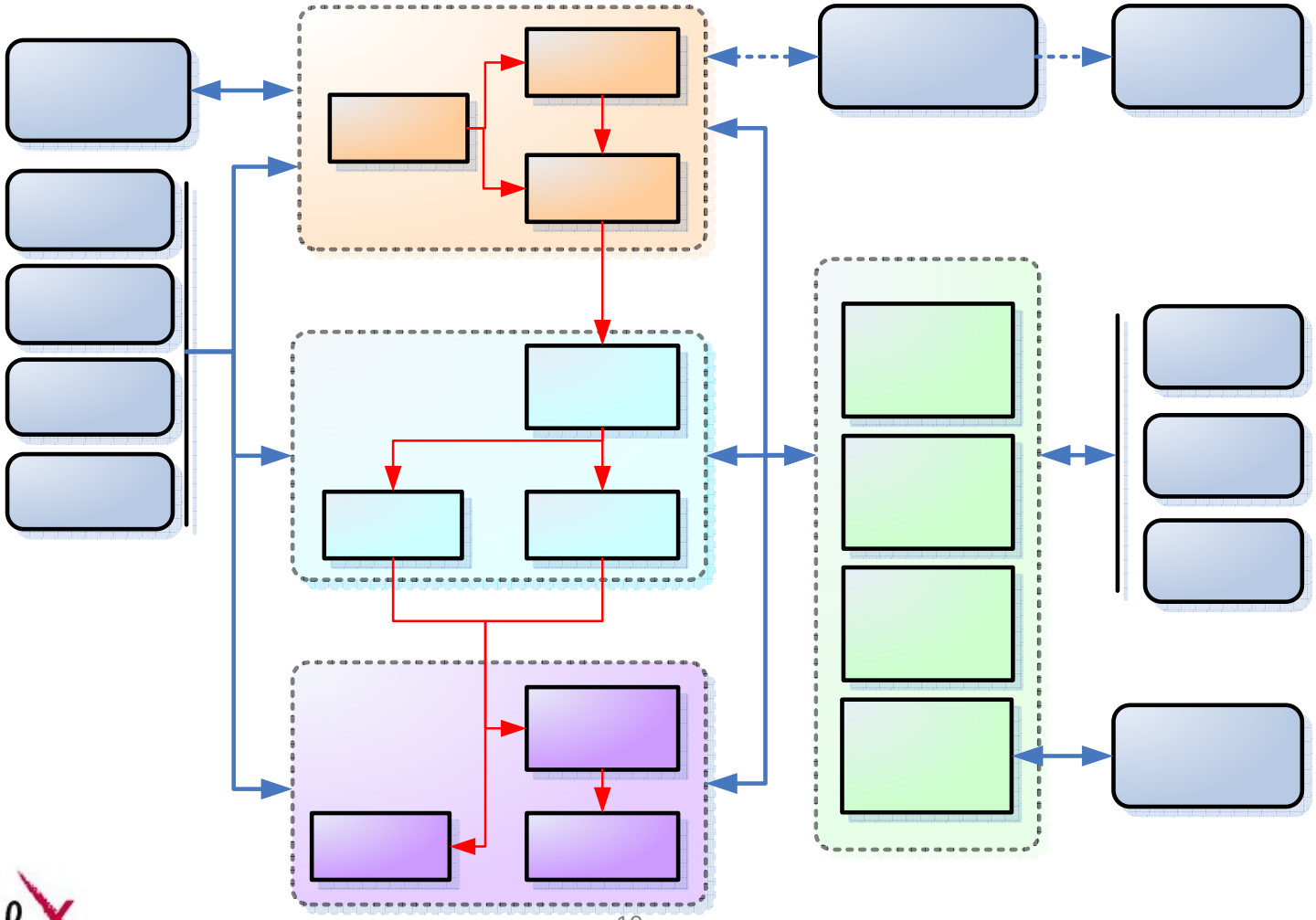
Requirements Process is Critical



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Systems Architecture

Metering Technologies

System Element/Feature	Manual	Automatic Meter Reading (AMR)	Advanced Metering Infrastructure
Meters	Electromechanical	Hybrid 	Hybrid or solid-state
Data collection	Manual, monthly	Drive-by, monthly	Remote via communications network, daily or more often
Data recording	Total consumption	Total consumption	Time-based (usage each hour or more often)
Primary applications	Total consumption billing	Total consumption billing	Pricing options Customer options Utility operations Emergency demand response
Key software interfaces	Billing and customer information system	Billing and customer information system	Billing and customer information system Customer data display Outage management Emergency demand response
Additional devices enabled (but not included in base infrastructure)	None	None	Smart thermostats In-home displays Appliance controllers

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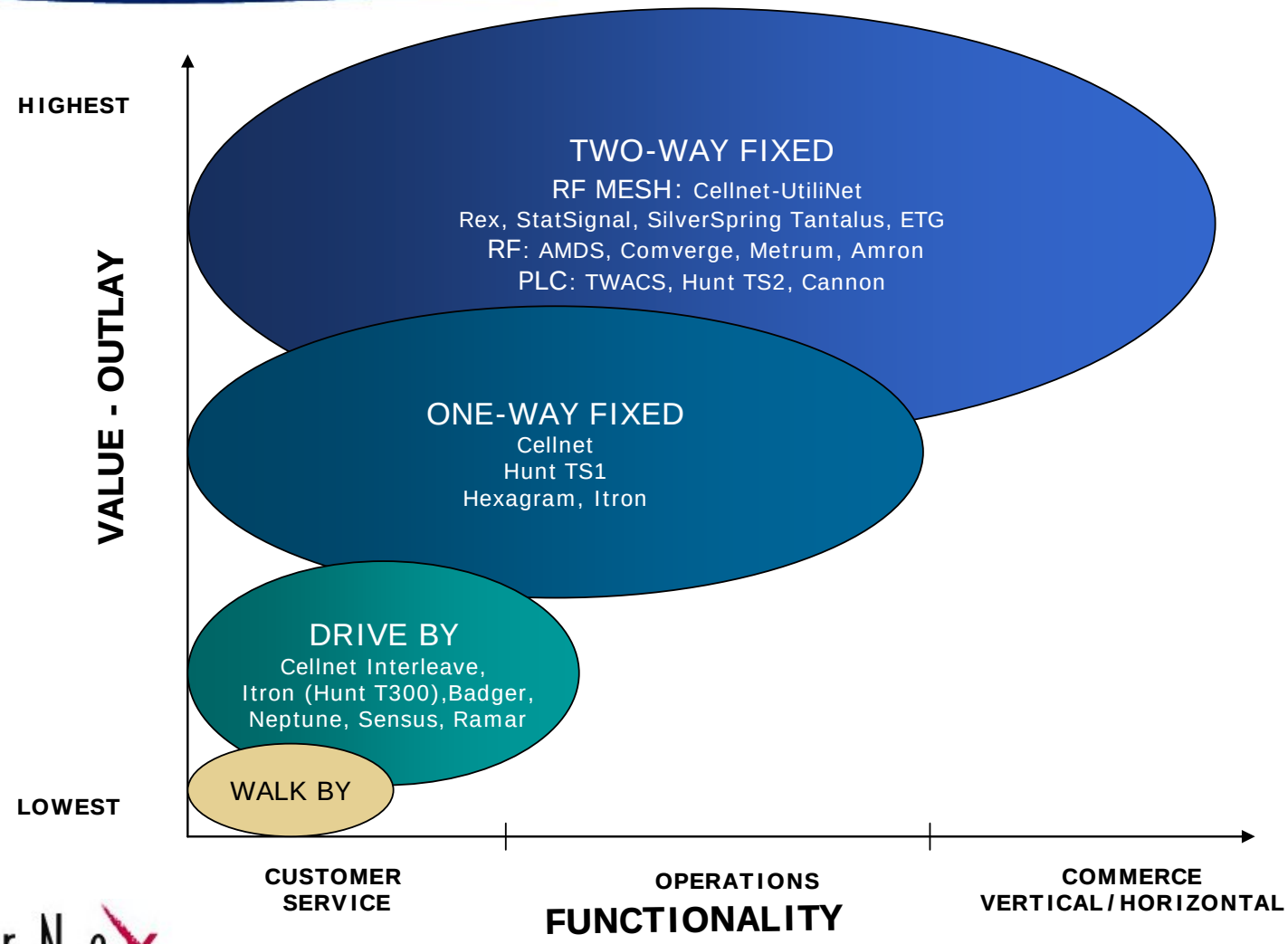
Communication Technologies



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Cost Trends

- 2000
  - Residential Meter $50 to $70 each
  - AMR transponder $60 to $120 each
  - Load Control Device (5 relays) -$200 to $300 each
  - Average installed cost $600
- 2004
  - Residential Meter $20 to 35 each
  - AMR transponder $25 to 50 each
  - Load Control Device (5 relays) $100 to 150 each
  - Average installed cost $300
- Expected volumes in 2005 to 2007 should reduce the hardware costs by 30 to 40%
  - E.g. Vendor stating $20 for integrated disconnect in large volume

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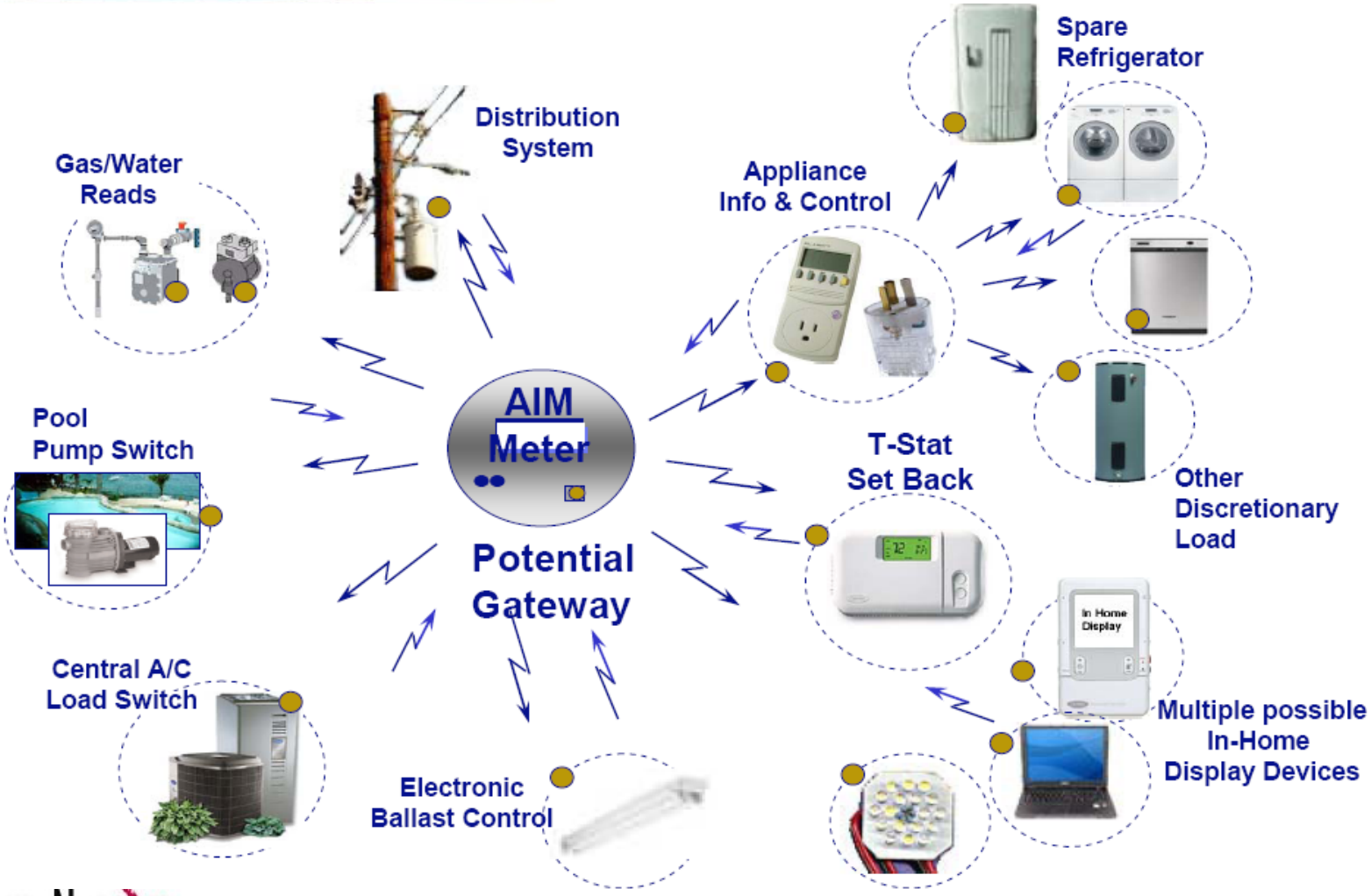
Integrating the Home



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Smart Metering Lessons learned

- Fear of picking the wrong technology
- Trusting a single vendor to provide the whole solution –"one throat to choke" – but vendor lock in can choke the system owner - interoperability
- Impact on the rest of the infrastructure
- Not effectively integrating the AMI solution into the rest of the infrastructure
- Underestimating the process changes that AMI creates in the business
- Using it only as a meter reading system – not as a data collection system to provide the data to everyone – or as the basis for the smart grid
- Determining the right order for the deployment
- Data management – synchronization, alignment, quantity and quality
- Data is retained in silos and not available to everyone who needs it
- Cannot be implemented in traditional silos
- Systems are partially deployed for years and "sampled" so that the system is constantly treated as "unreliable" – pilot-itis
- Regulations are not updated to allow full use and value of the system

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Summary

- Focus on the I in AMI – laying a smart grid foundation
- It is important to create a good business case model and update it often
- Value often comes in places you don't expect
- There are many communications technologies that can be used with AMI
- Costs are coming down dramatically due to large deployments (disconnect now $20 – was > $70 last year)
- Not being first can be a good thing
- Incremental deployment is a good way to implement the infrastructure while leveraging falling costs of equipment at the end points
- Huge body of knowledge to draw from – information sharing is the norm in this arena – pioneered by SCE, continued by UtilityAMI

Questions?

- Relevant Organizations and Resources
  - DOE GridWise Architecture Council – http://www.gridwiseac.org/
    - ✓ *Interoperability Checklist for Regulators and Decision Makers*
    - ✓ *Interoperability Framework*
    - ✓ *GridWise Constitutional Principles*
  - EPRI IntelliGrid – http://www.epri.com/intelligrid/
  - UtilityAMI – http://www.utilityami.org/
  - DOE NETL Modern Grid Initiative – http://www.themoderngrid.org/
  - GridWeek Conference Proceedings – http://www.gridweek.com/
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AMR/AMI Deployments

Utility	Type	Technology	Quantity	Install Completed
U.S.				
Kansas City Power & Light (MO)	Electric	Wireless	400,000	1996
Duquesne Light (PA)	Electric	Wireless	580,000	1998
Ameren (MO)	Electric & Gas	Wireless	1,400,000	1999
Xcel Energy (MN)	Electric & Gas	Wireless	1,400,000	1999
Puget Sound Energy (WA)	Electric & Gas	Wireless	1,500,000	2000
United Illuminating (CT)	Electric	Wireless	320,000	2000
Indianapolis Power & Light (IN)	Electric	Wireless	470,000	2000
Exelon (PA)	Electric & Gas	Wireless	2,100,000	2002
Wisconsin Public Service (WI)	Gas	Wireless	200,000	2003
Wisconsin Public Service (WI)	Electric	Distribution line carrier	650,000	2004
PPL (PA)	Electric	Distribution line carrier	1,300,000	2004
JEA (FL)	Electric & Water	Wireless	600,000	2005
WE Energies (WI)	Electric & Gas	Wireless	1,000,000	2005
Hundreds of Small Utilities	Electric & Gas	Various	5,000,000	2004
International				
ENEL (Italy)	Electric	Power line carrier	30,000,000	2005
PREPA (Puerto Rico)	Electric	Distribution line carrier	1,400,000	2006
Sweden	Electric	Wireless & power line carrier	5,200,000	2009
Ontario (Canada)	Electric	To be determined	[5,000,000]	2010
Victoria (Australia)	Electric	To be determined	[2,500,000]	2013

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Deployment Drivers

Operational Efficiency	Ameren	KCPL	NSP	PSE	IPL	Exelon	UI	JEA	IPC	PPL	WE Energies
Operating Costs	●	●	●	●	●	●	●	●	●	●	●
Improved Accuracy		●	●	●		●		●	●	●	●
Theft Detection	●	●		●	●	●	●	●	●	●	
Distribution Service	●	●	●			●				●	●
Demand Response							●				
Customer Service											
Rate Options				●			●				
Billing Options		●		●	●		●	●			●
Internet Access		●		●							
Outage Response	●		●	●	●		●	●			
Service Quality	●	●	●	●	●	●	●	●		●	●

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