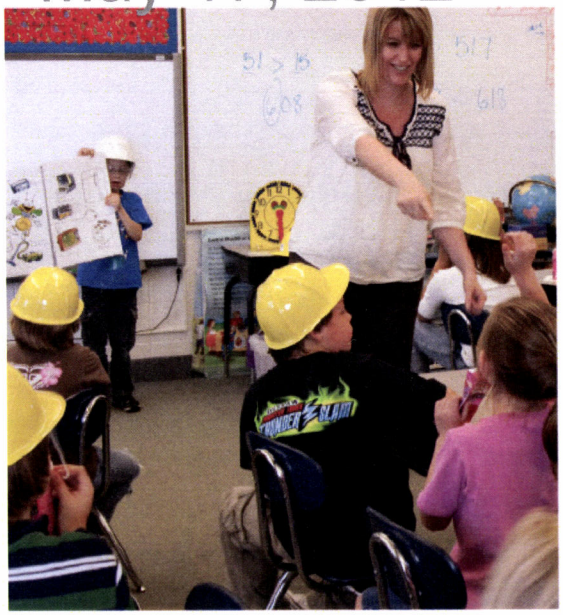
Energy & Telecommunications Interim Committee
Smart Grid Project Update
May 17, 2012



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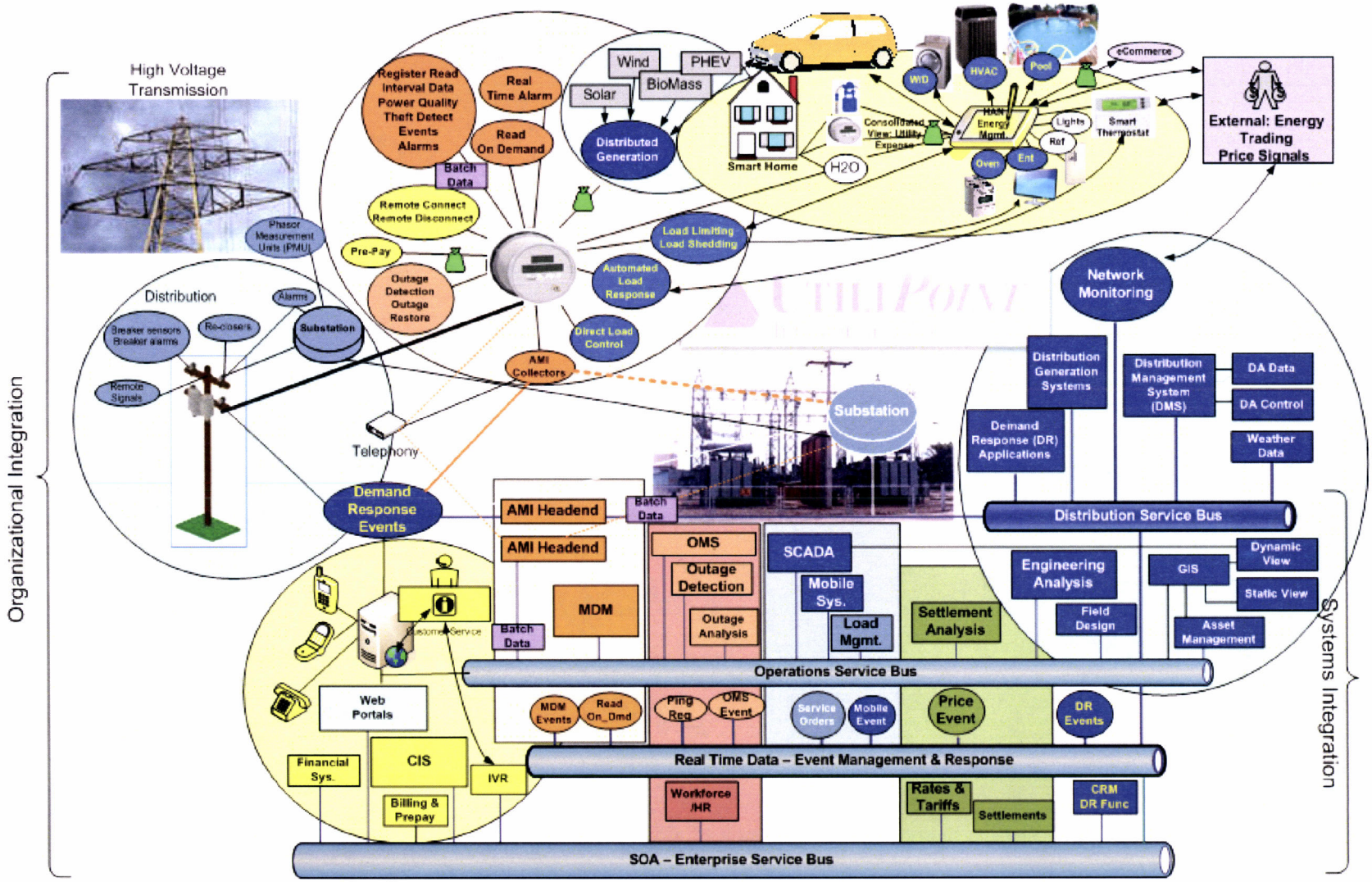
SMART GRID



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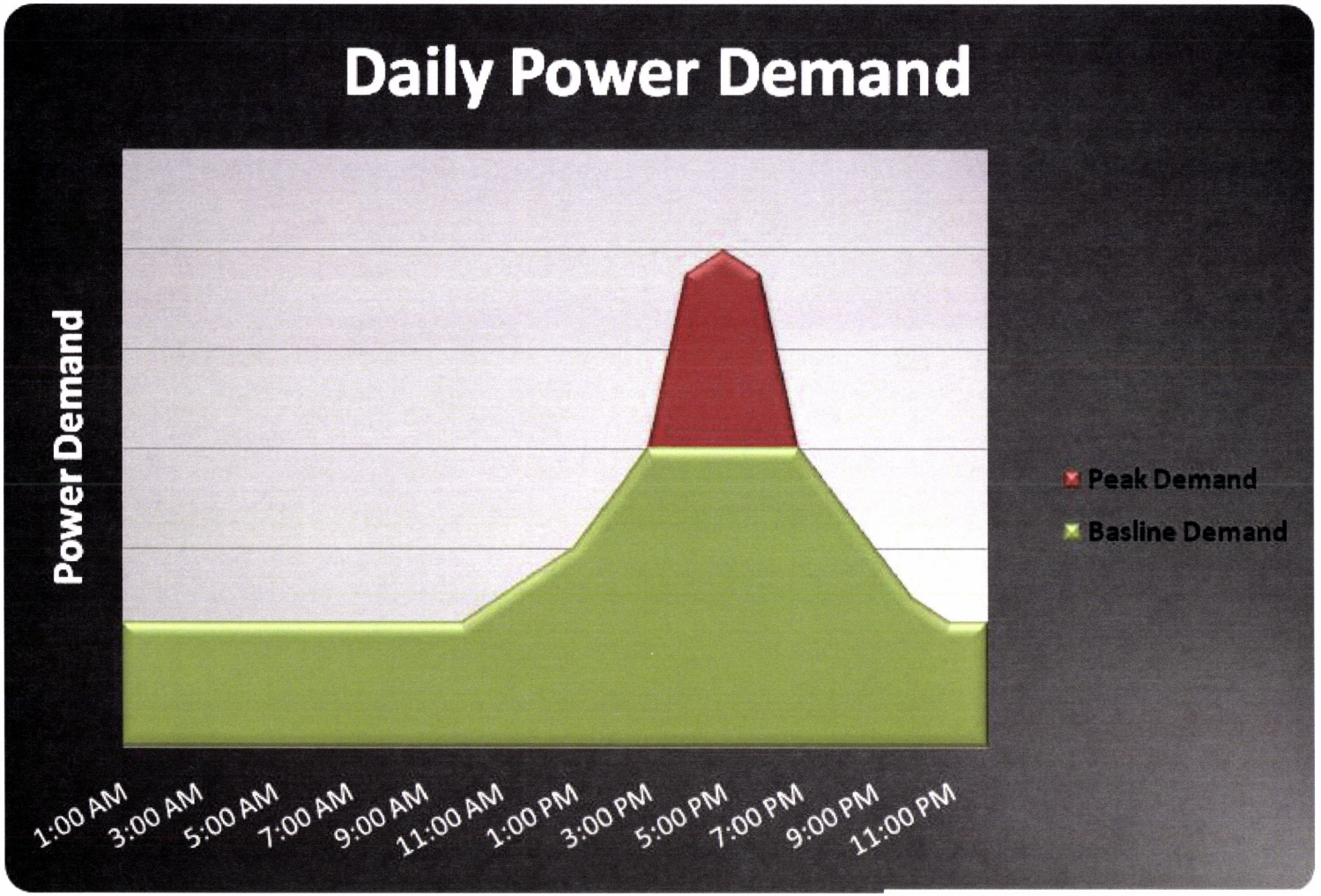
SMART GRID DEMONSTRATION PROJECT

THE ROOT OF THE PROBLEM – UNEVEN DEMAND OVER TIME



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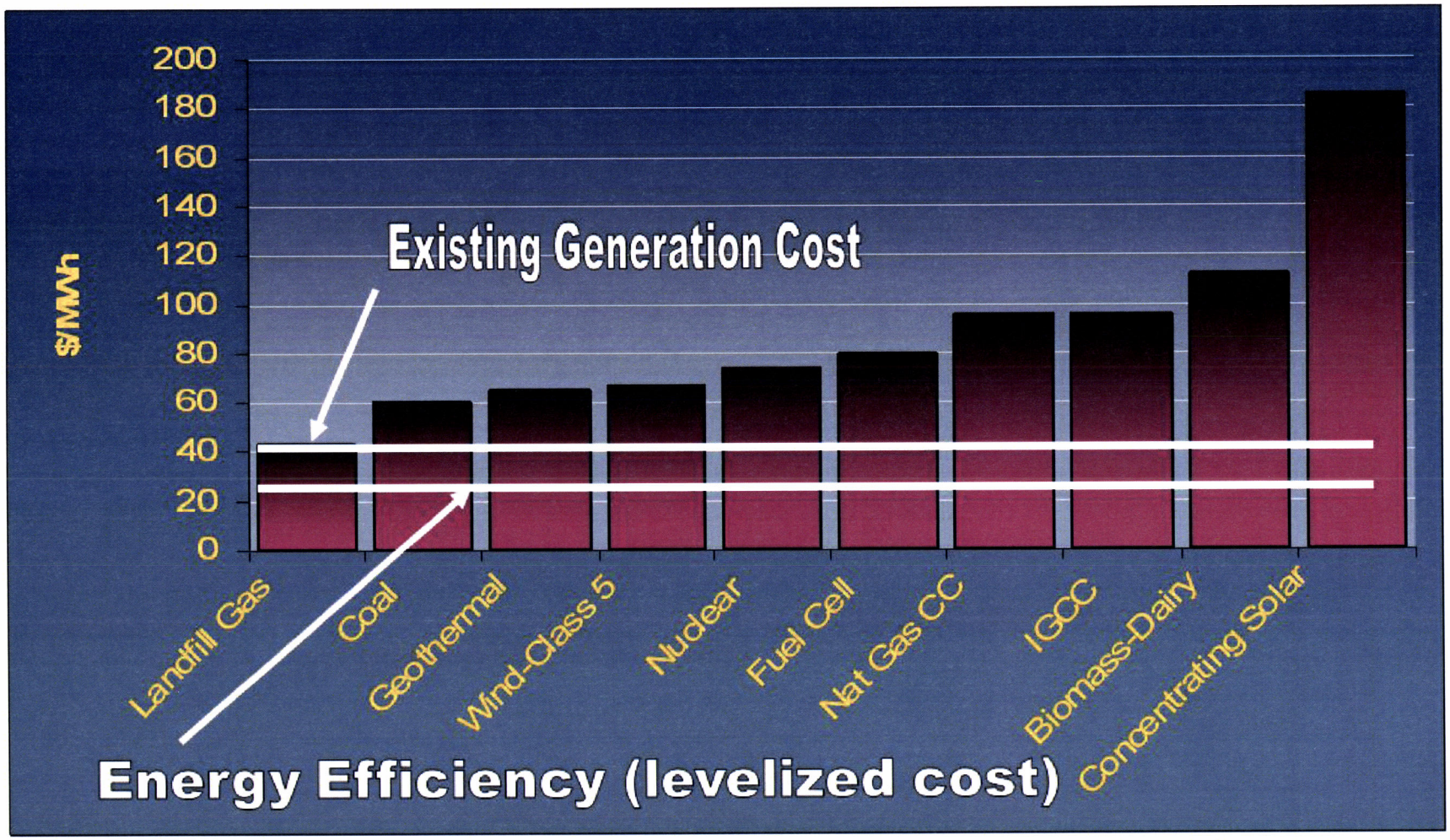
DEMONSTRATION PROJECT

COST FOLLOWS LOAD



Source: California Energy Commission, June 2007

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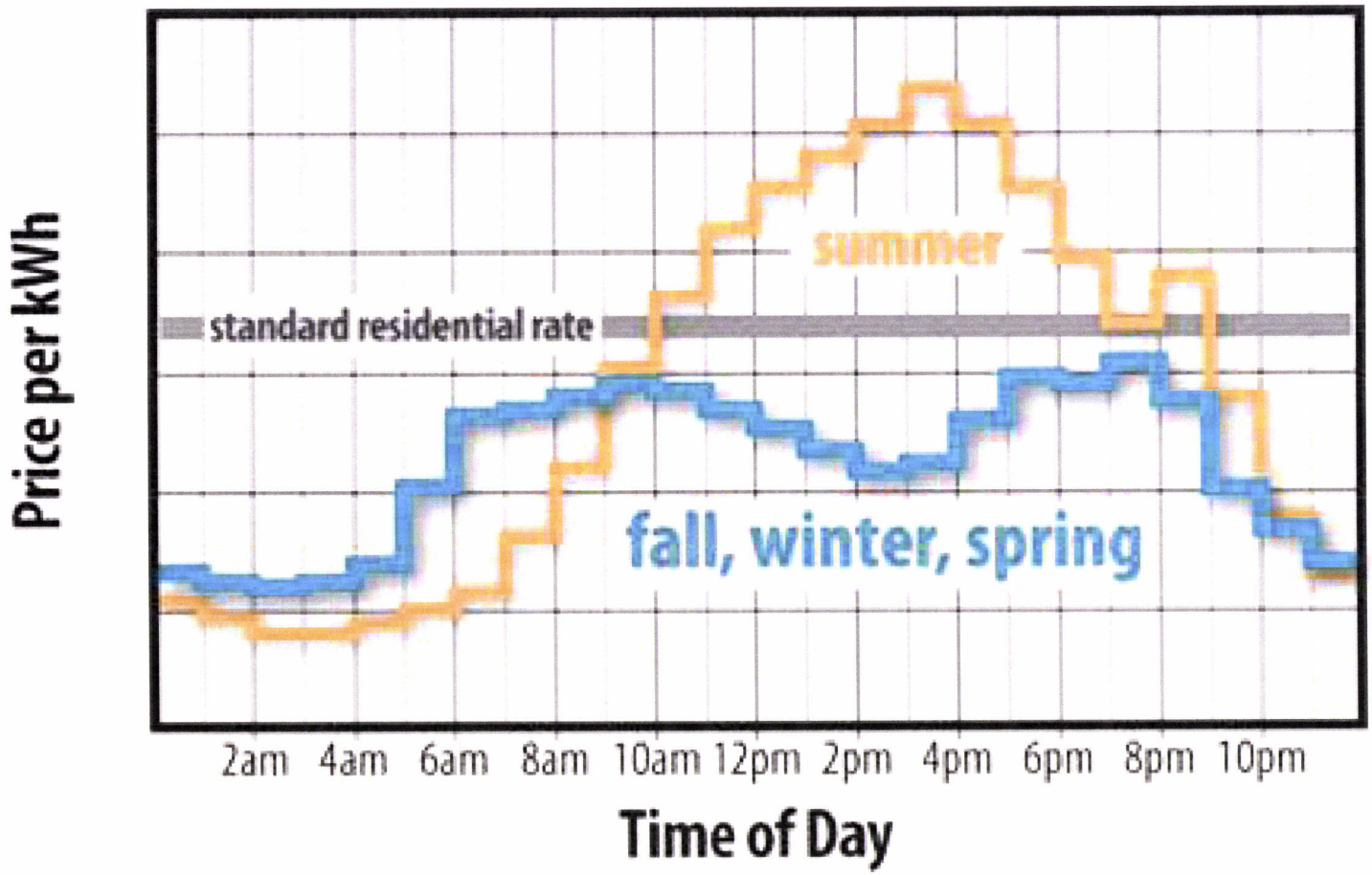
DEMONSTRATION PROJECT

PRICING (RATES) DOESN'T USUALLY REFLECT COST



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SMART GRID
DEMONSTRATION PROJECT

KEEP BUILDING OR EXTRACT MORE FROM WHAT IS NOW IN PLACE – OR SOME OF BOTH?

- Definitions (there are many)
  - A smart grid is a digitally enabled electrical grid that gathers, distributes, and acts on information about the behavior of all participants (suppliers and consumers) in order to improve the efficiency, importance, reliability, economics, and sustainability of electricity services
  - As defined by the Department of Energy, a smart grid is an electricity delivery network modernized using latest digital/information technologies to meet key defining functions:
    - Enable active participation by consumers
    - Optimizing assets and operating efficiently
    - Enabling new products, services, and markets
    - Accommodating all generation and storage options
    - Anticipating and responding to system disturbances in a self-healing manner
    - Operating resiliently against physical and cyber attack and natural disasters
    - Providing the power quality for the range of needs in a digital economy
- Implications
  - The smart grid implies a fundamental re-engineering of the electricity services industry, but focuses on the technical infrastructure.
  - Extensive communications are needed:
    - Build more? Or use what we now have?
    - Is the existing backbone communications system sufficient?
    - Is it secure?

WALK BEFORE WE RUN – LOOK BEFORE WE LEAP

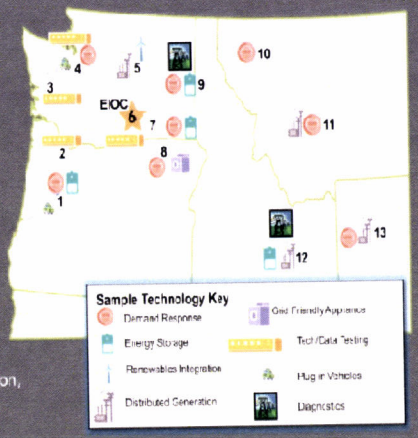
- Install, test, demonstrate, inquire & evaluate
  - Does the technology work?
  - What does it cost?
  - Is it reliable?
  - Will consumers accept and use the technology?
  - Will they be willing to pay for it?
  - Will price signals work to change/improve the current pattern of demand?
  - Time-of-Use energy pricing
    - More closely match time & cost of energy production with energy consumption
    - Cost causer pays

SMART GRID

Pacific Northwest SMART GRID
DEMONSTRATION PROJECT

About the Project

- Battelle-led ARRA project in collaboration with Bonneville Power Administration, 11 utilities, 2 universities and 5 vendors
- $178M, five-year cost-shared demonstration
- 60,000 metered customers in five states
- Foundation for the future of the nation's power grid.



Project Objectives

The team will implement a unique distributed communication, control and incentive system designed to bring the electric transmission system into the information age. The project:

- Validates new smart grid technologies and business models
- Demonstrates the value of the distributed transactive control technique for two-way communication between distributed generation, storage and demand assets
- Quantifies smart grid costs and benefits
- Advances standards for interoperability—the smooth, seamless integration of all elements of the electric system—and cyber security approaches.

Benefits to the Region and Nation

- New assets and infrastructure in place
- Peak electricity demand managed
- Renewable resources integrated
- Improved system reliability and efficiency
- Overall system optimization

AVISTA · Flathead Electric · IBM · PGE · 3TIER · Idaho Falls Power · NorthWestern Energy · ALSTOM · Quality Logic · Ellensburg · Battelle The Business of Innovation · LOWER VALLEY ENERGY · NETEZZA · UNIVERSITY OF WASHINGTON · WASHINGTON STATE UNIVERSITY

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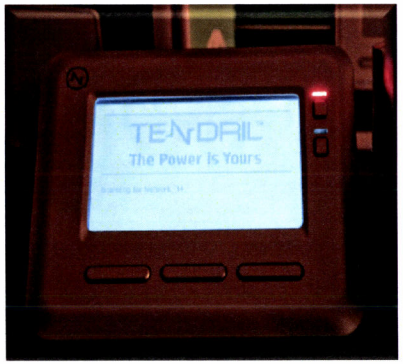
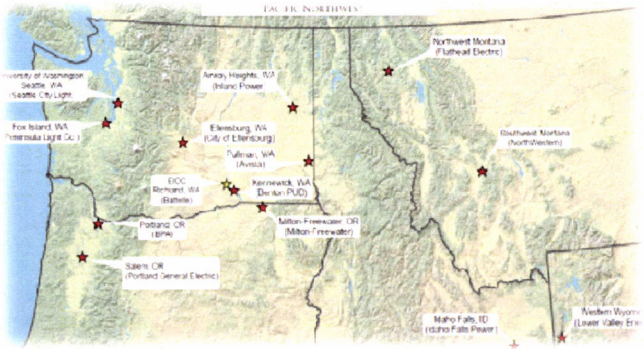
SMART GRID
DEMONSTRATION PROJECT



Pacific Northwest
SMART GRID
DEMONSTRATION PROJECT



NorthWestern Energy Smart Grid Demonstration Project

A Test Bed for the Future

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SMART GRID
DEMONSTRATION PROJECT

NORTHWESTERN'S ROLE & OBJECTIVES

- Contributing member/participant in larger Regional experiment
- Test & demonstrate Smart Grid technologies
- Evaluate costs, benefits and impacts on system reliability
- Inform NorthWestern about possible future deployment

- Utility "side" of the project:
  - Volt/VAR Optimization [VVO] – energy savings
  - Distribution Automation – improve reliability

- Customer "side" of the project:
  - Provide customers with new & innovative ways to control usage
  - Time of Use Pricing – energy savings
  - Demand Response & Load Control – energy savings

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SMART GRID
DEMONSTRATION PROJECT

NWE'S COMMITMENT & PROJECT LOCATIONS

- Budget = $4.2 million
  - 50/50 cost sharing with DOE funds
- Scope: A Distribution Project in two locations
  - City of Helena (urban area)
    - 3 – Substation (out of 7)
    - 8 – Distribution Circuits
    - Approximately 200 homes, and 2 state government facilities
  - Philipsburg (rural area)
    - 1 – Substation
    - 1 – Distribution Circuit (240 miles, 1200 Customers)

SMART GRID PROJECT: TIMELINE & STATUS

	2010	2011	2012	2013	2014
Phase 1 - Design	6 months				
Phase 2 - Build Out		24 months			
Phase 3 - Data Collection			24 months		
Phase 4 - Cost Benefit Analysis & Reporting					6 months

Phase 2 - Build Out	2011				2012	
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter
Utility Side - Energy Efficiency (Volt/VAR)	Software Installation			Test/Train		
			Helena - Field			
				Philipsburg - Field Equip		
Utility Side - Reliability (DA or FLISR)		Software			Test/Train	
				Helena - Field Equip		
				Pburg - Field Equip		
Customer Side - Energy Efficiency	Lockheed Martin / Tendril / Itron			Test/Train		
			Home Area Networks			

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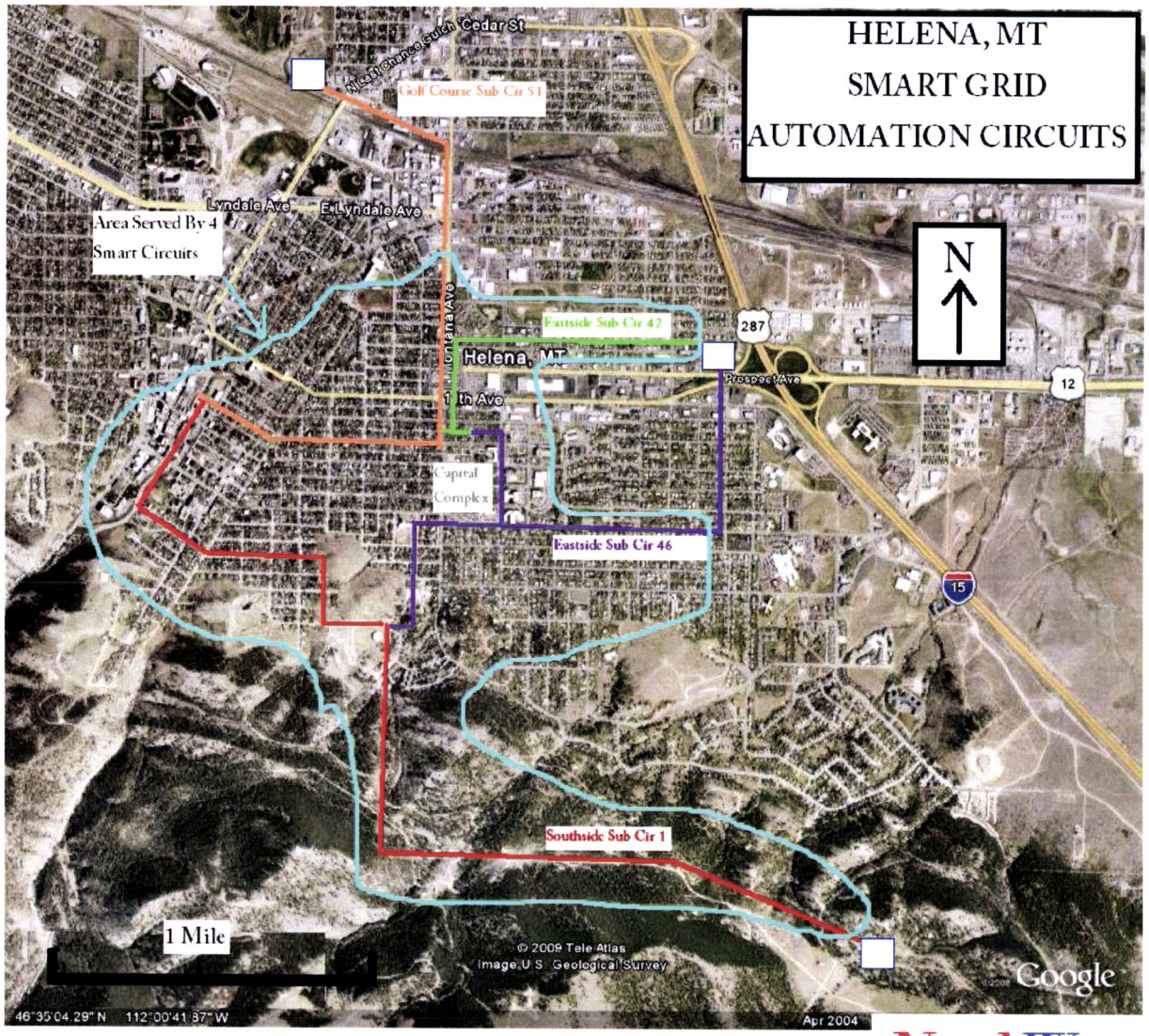
SMART GRID
DEMONSTRATION PROJECT

HELENA CIRCUIT MAP



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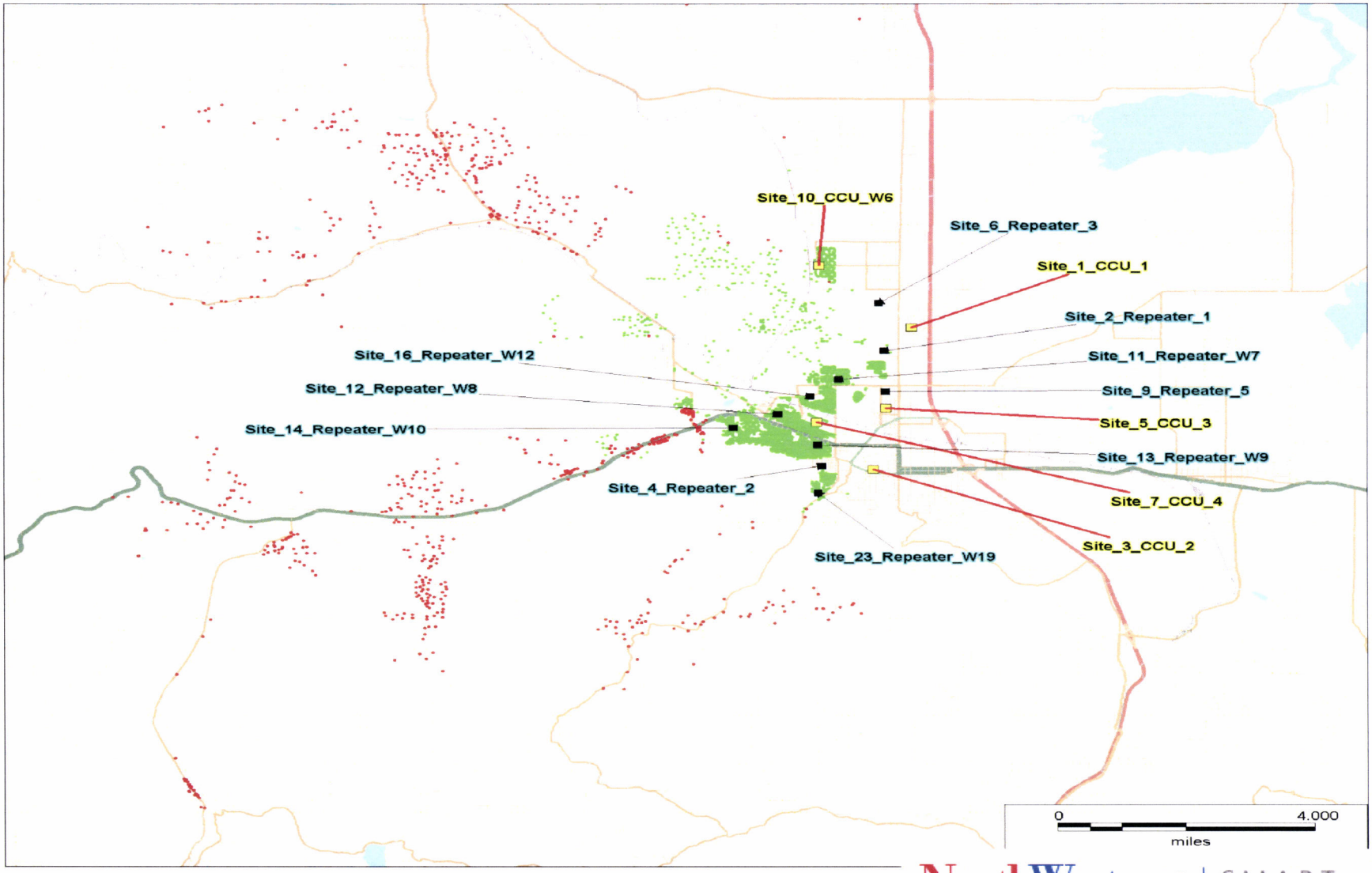
SMART GRID
DEMONSTRATION PROJECT

HELENA WIRELESS COVERAGE



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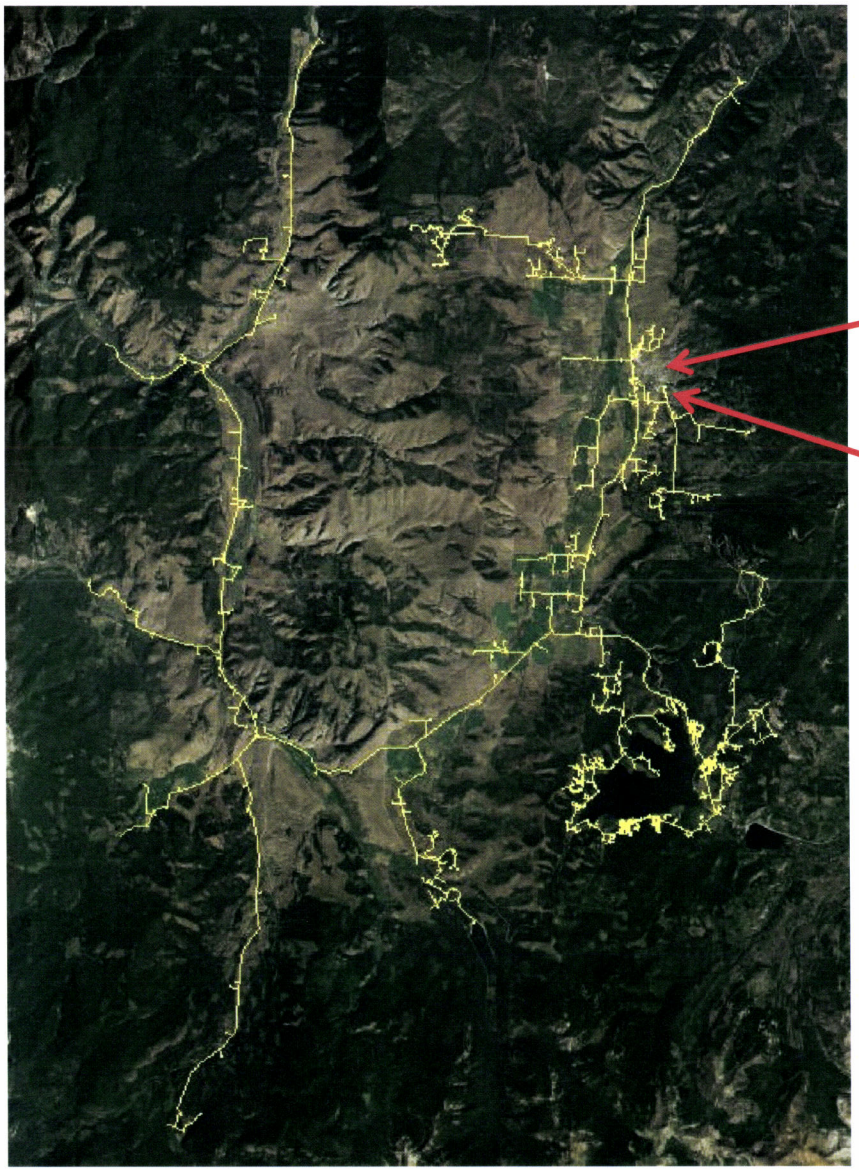
DEMONSTRATION PROJECT

PHILIPSBURG CIRCUIT MAP



Philipsburg Circuit 25-3

Town of Philipsburg

Philipsburg Substation

Scale:

2 Miles
Approx.

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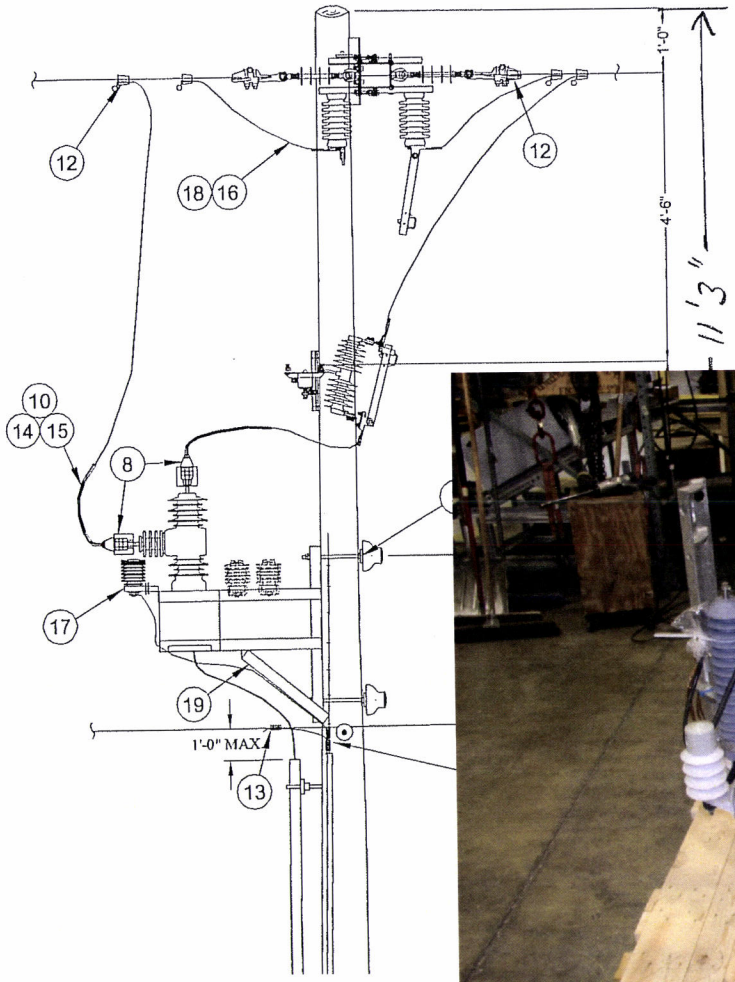
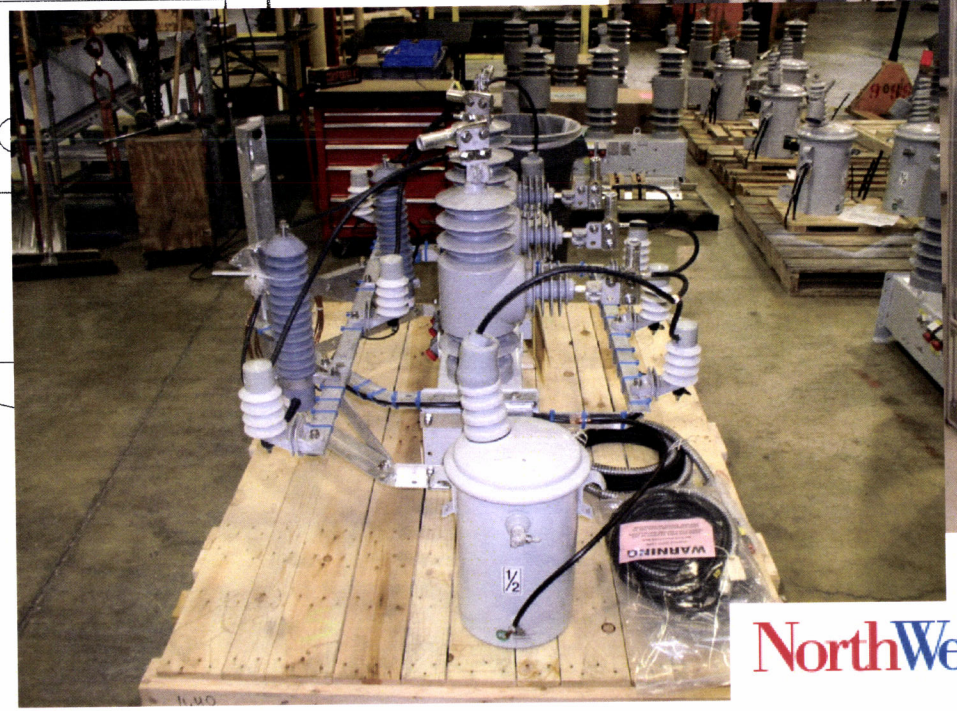
SMART GRID
DEMONSTRATION PROJECT

PROJECT OBJECTIVES: TEST DISTRIBUTION AUTOMATION





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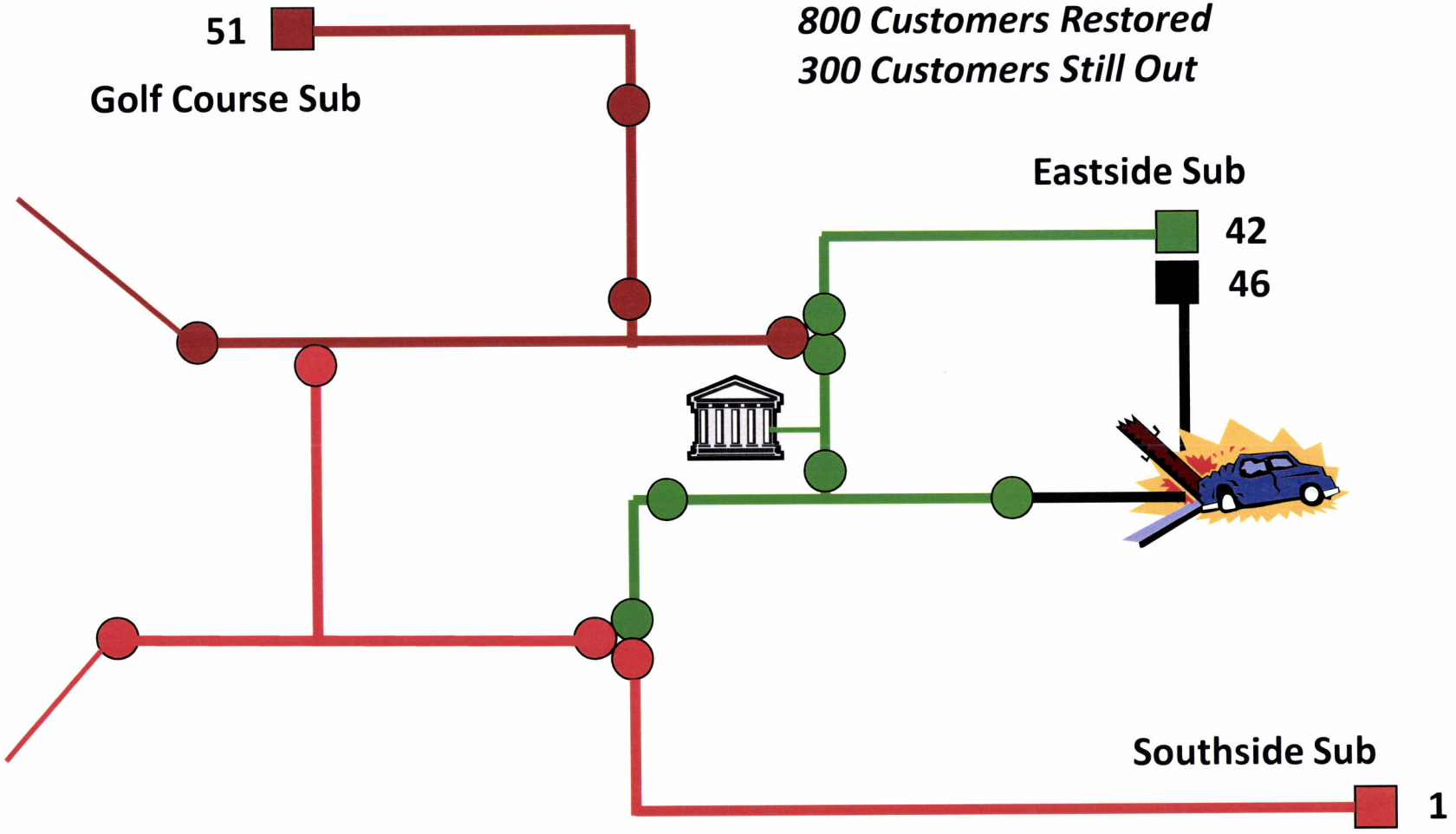
DEMONSTRATION PROJECT

EXAMPLE: "INTELLIGENT AUTO-RESTORATION"



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PROJECT OBJECTIVES: TEST VOLT/VAR OPTIMIZATION

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DEMONSTRATION PROJECT

VVO A.K.A. CVR – (ENERGY SAVING)

- VVO = Volt/VAR Optimization &
- CVR = Conservation Voltage Reduction
  - Where do the energy savings come from?
    - First, from additional equipment and measures applied to system
    - Second, use of control system to gain additional energy savings
    - Third, use of control system to lower system voltage
  - How does voltage reduction result in savings?
    - % Voltage Change – is proportional to – % Energy Change
    - Therefore if system voltage is lowered, then energy is saved
  - Where do the overall savings come from?
    - Approximately 15% from the Distribution System
    - Approximately 85% from the Customer Side of the Meter
  - What is the potential?
    - Potential Exists to shave 1 – 3% of circuit load:
      - kW Demand
      - Kwh Energy Consumption
      - Also KVAR demand reductions

MILESTONES & NEXT STEPS FOR DA & VVO

- Distribution Automation [DA] – Reliability
  - Substation & Line Equipment
    - Helena – Installations are ongoing
    - Philipsburg – Installations set to begin soon
  - Control Software & System
    - Software RFP in process
    - Purchased & install by year end
    - Acceptance testing is complete
- Volt/VAR Optimization [VVO]
  - Substation & Line Equipment
    - Helena – Installations are ongoing
    - Philipsburg – Installations set to begin soon
  - Control Software & System
    - Software installation and set up is under way
    - Acceptance testing is complete

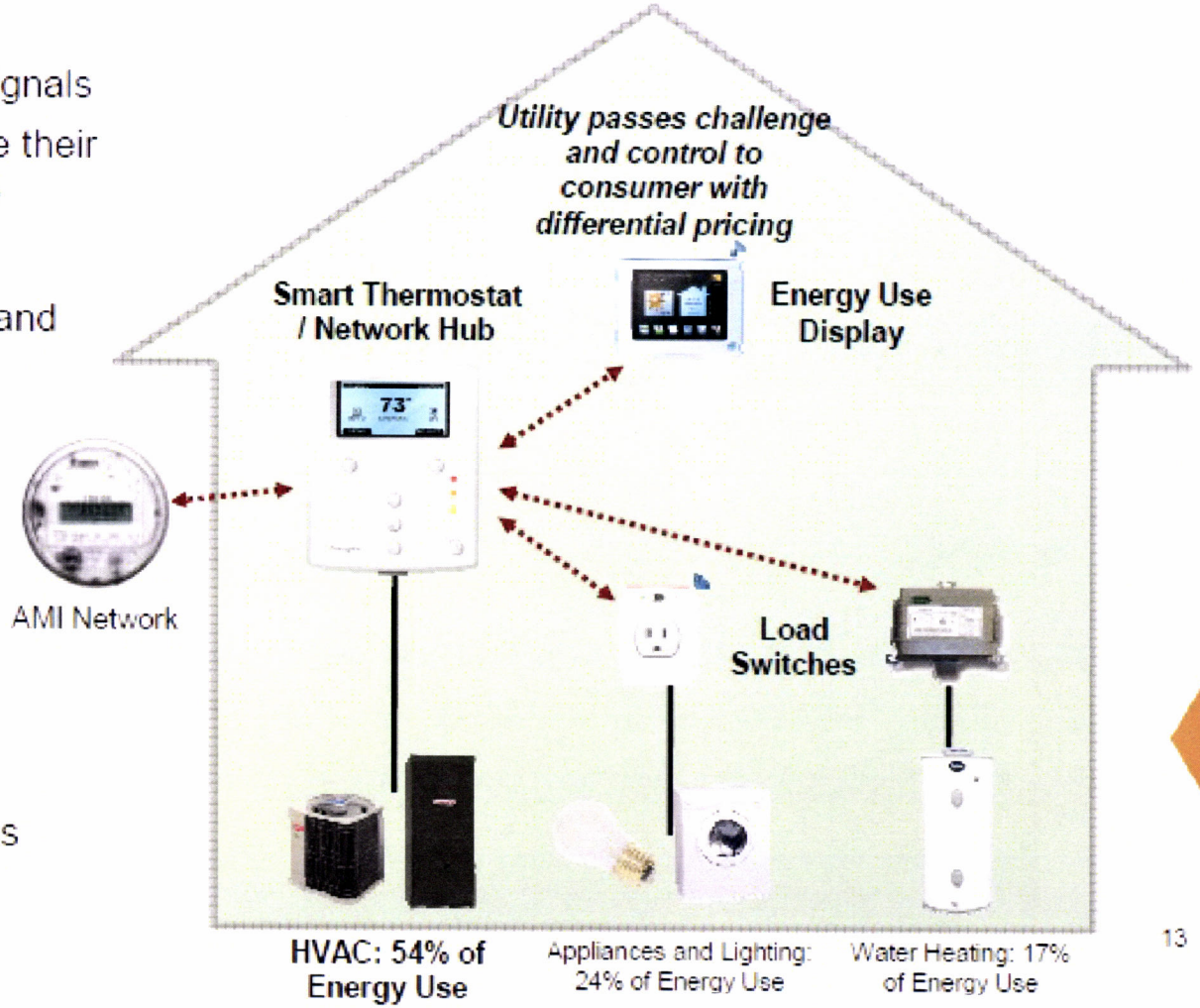
CUSTOMER SIDE OF METER – TEST DEMAND RESPONSE & LOAD CONTROL

Consumers

- Utilities provide price signals
- Consumers can choose their settings based on price
- Consumers can save
- Consumer can control and automate preferences

Utility

- 2-Way Communications



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SMART GRID DEMONSTRATION PROJECT

PROVIDE CUSTOMERS MORE INFO & WAYS TO CONTROL USAGE

- Install Home Area Networks
- Web-based services
  - Energy Use Profiles
  - (via in-home displays)
- Offer time variable pricing
- Observe customer response to pricing signals
- Evaluate performance of metering, communications & HAN technology

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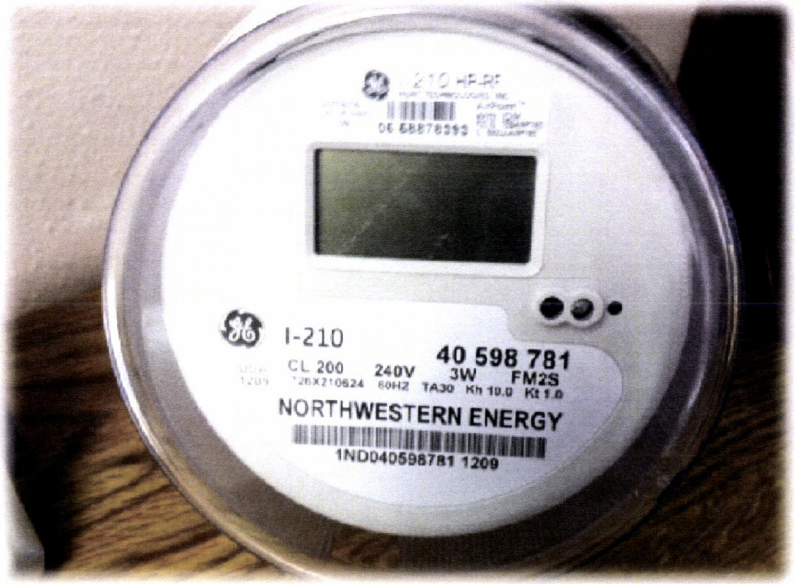
SMART GRID
DEMONSTRATION PROJECT

INTERVAL METERING & DATA HOSTING STATUS

- ITRON, Inc.
  - 200 Centron meters to be installed
  - Radio coverage study is complete
  - 4 Cell Control Units purchased & received
  - Additional Repeaters as needed
  - Install, test & maintain wireless network
  - Collect 15-minute electric interval data
  - Perform hosting and MDM services
  - Export meter data to NorthWestern's MV-90 system
  - Field installation happening now



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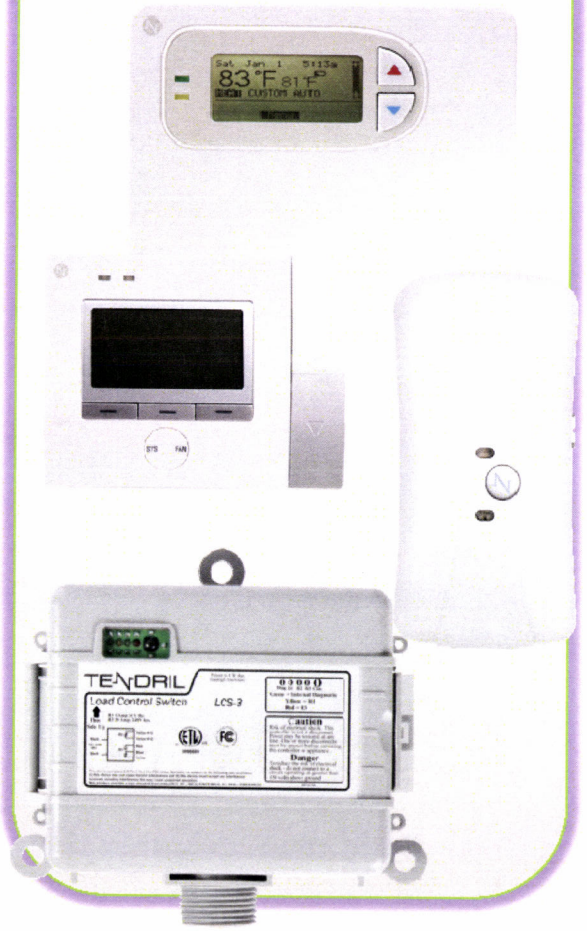
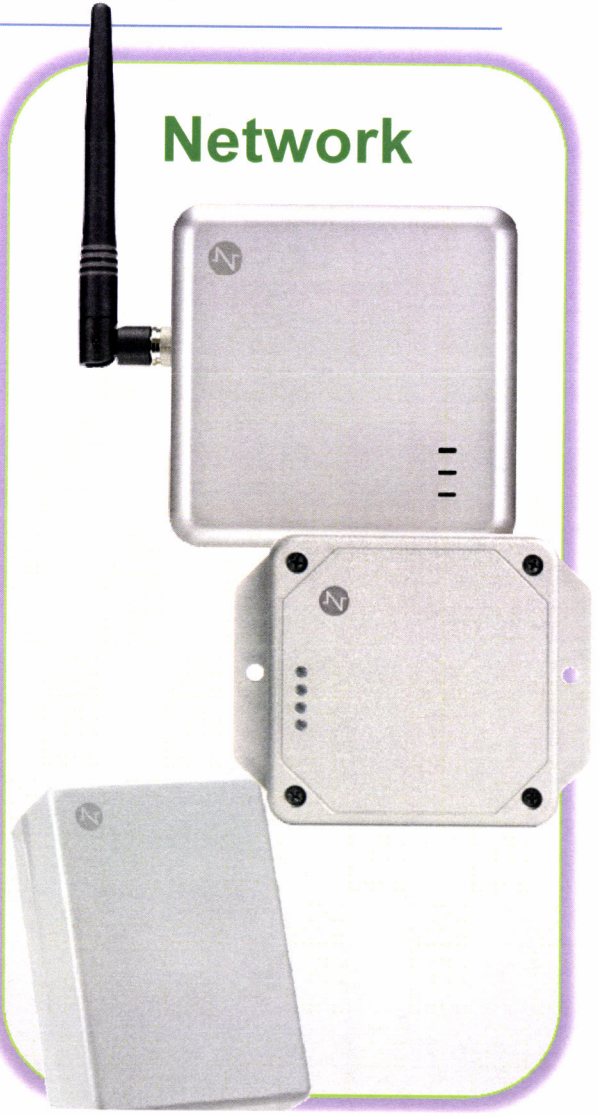
HOME AREA NETWORK COMPONENTS

Display

Monitor & Control



Network



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HOME AREA NETWORK "DASHBOARD"

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DASHBOARD | EXPLORE | HOME NETWORK | EVENTS | USER PROFILE

ACCOUNT STATUS

Amy's Home

in Helena

75° F

Mostly Cloudy

Program:

Montana Energy Smart

Rate: Energy Supply Flat Rate

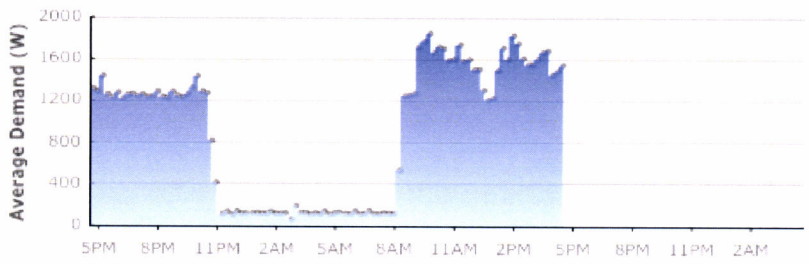
6.13¢ / kWh

MESSAGES

Friday, September 09, 2011 3:33 PM Importance: NORMAL

This message is to alert you to an upcoming Peak Energy Event. This event will occur Friday, September 9th from 3 p.m. until 5 p.m.
Thank you for participating in the Montana Energy Smart program.
If you have any questions please call: 877-220-2839.

TODAY'S USAGE



ESTIMATED BILL

Bill Cycle: September 01 to October 01, 2011

Estimated Total Bill:	$38.44
Estimated Bill to Date:	$27.77
Today's Cost:	86.00¢

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TIME OF USE PRICING

- TOU tariff has been approved by MPSC
- Testing data pathways:
  - Interval meters (Helena) – fixed network – ITRON hosting (Spokane) – MV 90 (Butte) – TOU calculator – NWE billing system
- Automated extraction of monthly kWh from MV-90 15-minute interval data
  - Complete build of TOU energy cost calculator using MV-90 output and Master TOU pricing table
- Automated export of monthly TOU energy cost to utility billing system
- Automated calculation of delta between TOU energy cost and normal non-TOU energy cost
  - Posting of TOU "credit" to Smart Grid participants' monthly bill. Send appropriate message via HAN system (and possibly billing statement)
  - No "debit" will be charged to customer if usage increases; Send appropriate message via HAN system (and possibly billing statement)
- Automated "How am I doing" messages to residential participants based on results of their participation, operation of HAN, and TOU-induced energy usage changes

TIME OF USE PRICING (CONT.)

- 3-level Time of Use **Energy** Pricing (traffic signal color scheme)
  - On peak ($0.08/kwh)
  - Mid ($0.05/kwh)
  - Off Peak ($0.03/kwh)

Mountain Time - Hour Ending

	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	NOON	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM	12 AM
Jan	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.05	0.03
Feb	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.05	0.03
Mar	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.05	0.03
Apr	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.03
May	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.03
Jun	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.03
Jul	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.03
Aug	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.03
Sep	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.03
Oct	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.05	0.03
Nov	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.05	0.03
Dec	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.08	0.08	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.08	0.08	0.08	0.08	0.05	0.03

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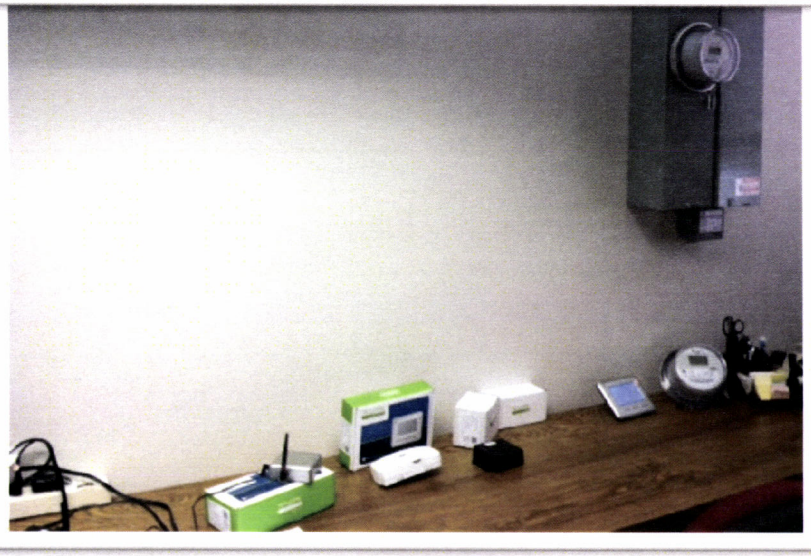
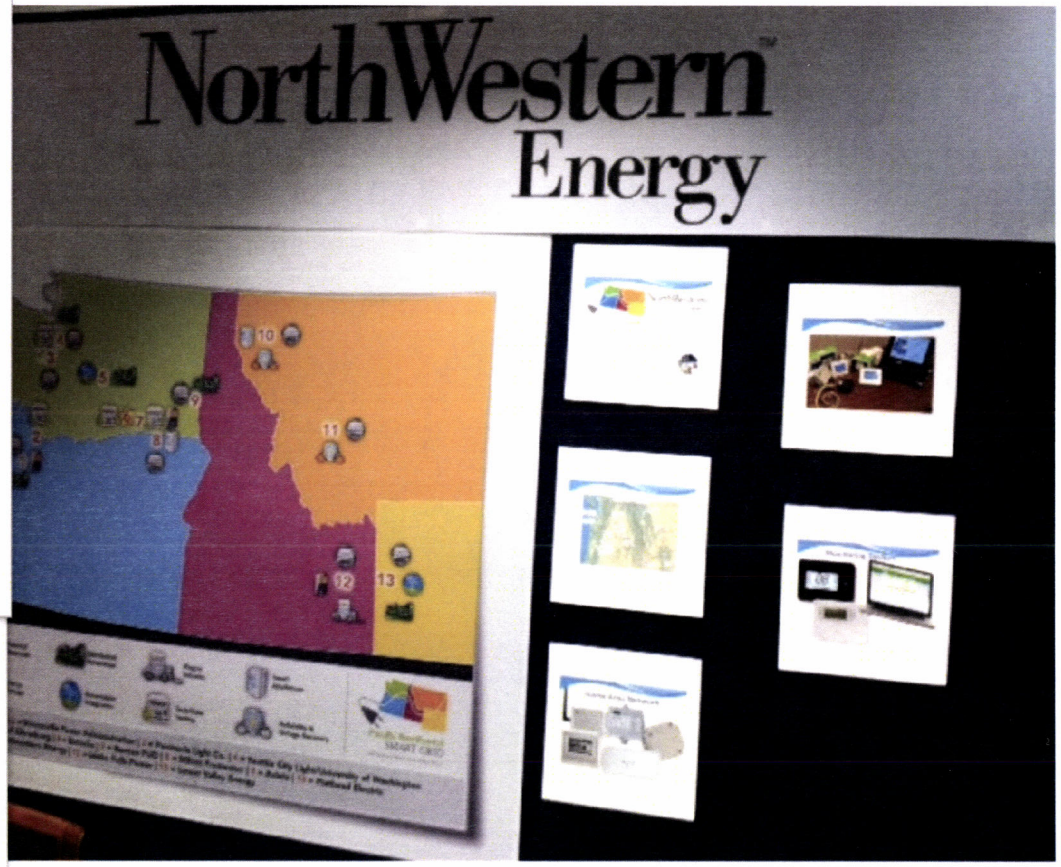
DEMONSTRATION LAB





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HOME PAGE DESIGN

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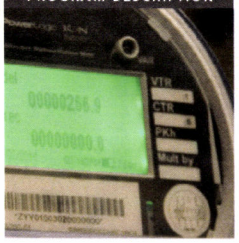
PROGRAM DESCRIPTION | ENROLLMENT | PRODUCT INFO | RESOURCES

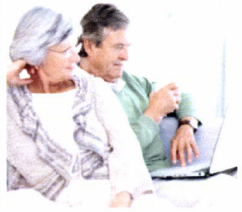
PROGRAM DESCRIPTION



NorthWestern Energy has joined with regional partners to develop a Smart Grid Demonstration Project.

Learn More >>

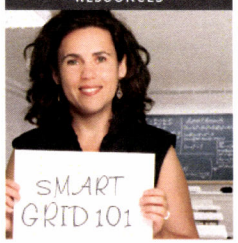
ENROLLMENT



NorthWestern Energy has selected a sample group of customers to participate in the project.

Learn More >>

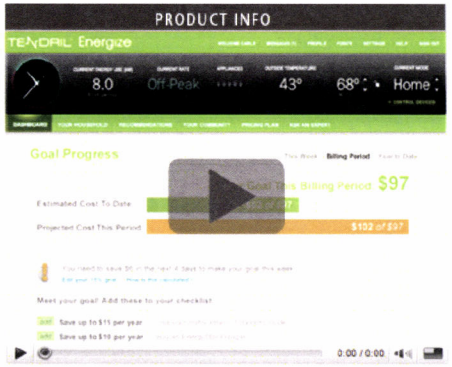
RESOURCES



This extensive library will provide you with tons of information and valuable facts.

Learn More >>

PRODUCT INFO



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INSTALLATION PROCESS

- KEMA performs installation and follow up (KEMA/Tendril Contract)
- Enrollment Website produces customer list for NorthWestern/KEMA
- KEMA contacts customer to schedule installation
- Installation consists of:
  - Equipment Install
  - Customer Education
    - Equipment Operation Video
  - Welcome Kit
    - Getting Started Guide
    - Technical support phone number
    - NorthWestern help email address
      - smartgrid@northwestern.com

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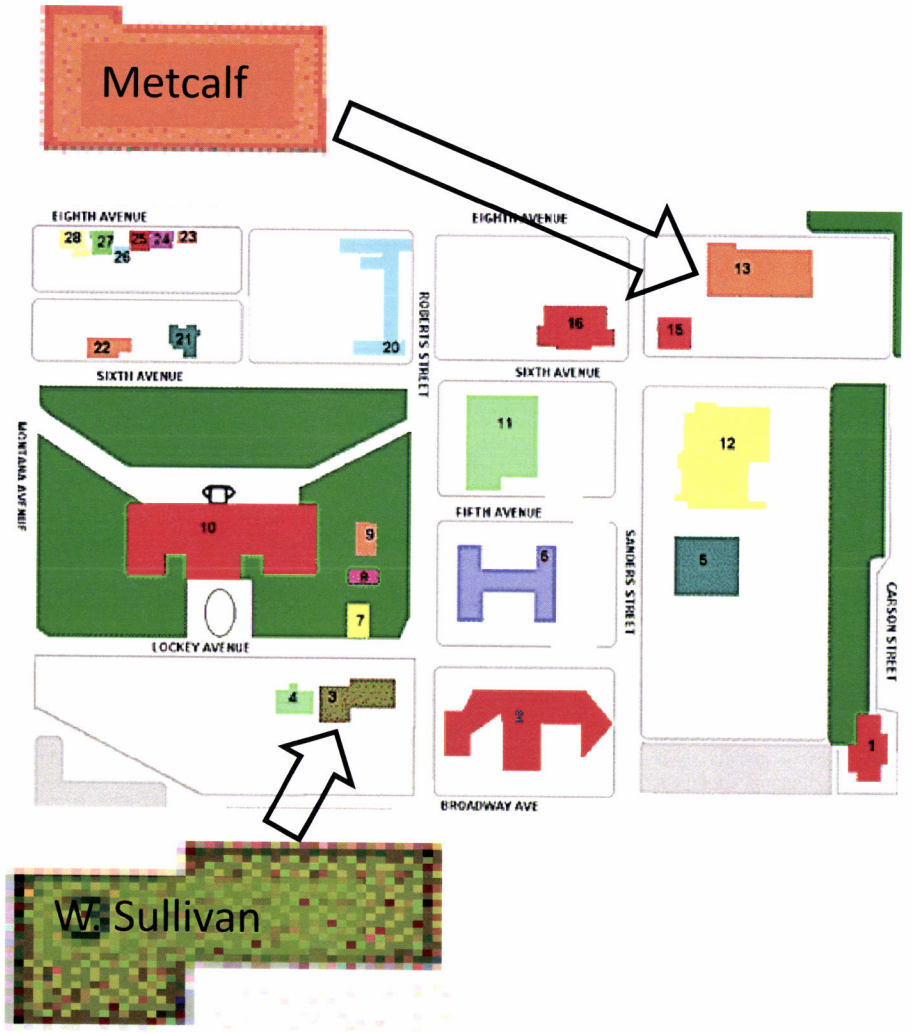
SMART GRID
DEMONSTRATION PROJECT

STATE OF MONTANA BUILDINGS

- Metcalf Building Tasks
  - Review existing lighting plan
  - Upgrade lighting
    - Install control areas along outside windows – both overhead lights and possibly automatic window shades
    - Install occupancy sensors
    - Install diming control in other areas
  - Integrate Lockheed Martin (LM) See Load/See Grid demand response application
  - Survey results of smart grid influence on business practices at periodic intervals throughout the study
- Walt Sullivan Building Tasks
  - Review existing air conditioning automation
  - Upgrade load usage measurements and possibly AC controls
  - Integrate LM SeeLoad/SeeGrid demand response application
  - Survey occupants



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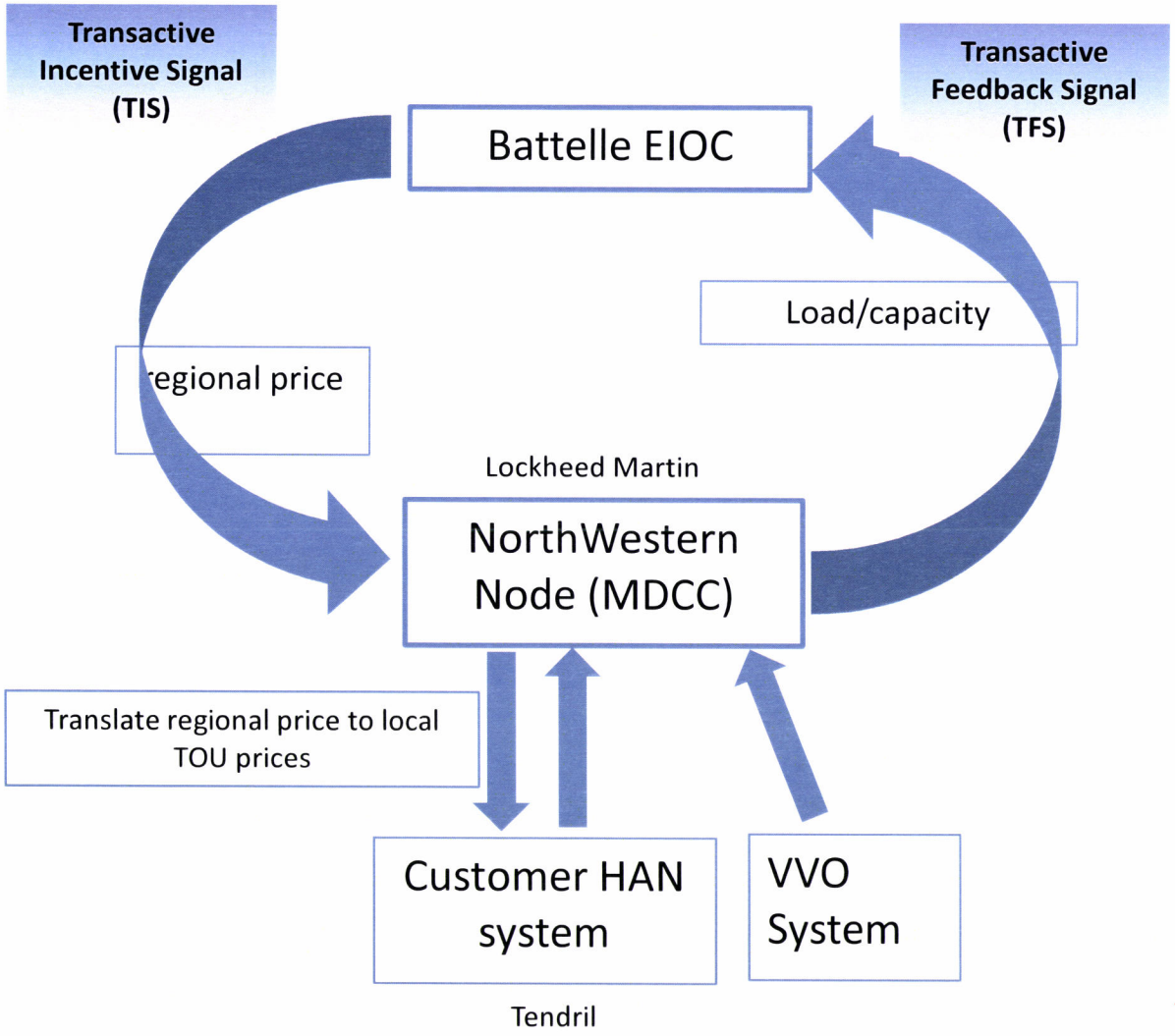
STATE OF MONTANA BUILDINGS (CONT.)

- Test Demand Response/Peak Pricing Application
  - Peak Pricing/Demand Response
    - Send pricing signal to existing building automation control system
    - Buildings respond according to predetermined load curtailment schedules to reduce load based on price
    - Building energy measurements fed back to Lockheed Martin SeeLoad/SeeGrid demand response application
    - In near-real-time, communication sent to building occupants through graphical display on computer screens
    - Informs occupants of building control changes so they can correlate environmental changes with Smart Grid operation
      - Example - when lighting levels reduced, computer screen will communicate light levels reduced through Smart Grid control
- Control Energy Use
  - Lighting Loads
  - Air Conditioning Loads
- Proposed Buildings
  - Metcalf Building (Lighting Control)
  - Walt Sullivan Building (AC Control)

TRANSACTIVE CONTROL



- Technical issues:
  - Cyber security
  - Standards
- NorthWestern's status:
  - Node installed & tested
  - VPN tunnel installed & tested
  - Security in place
  - Proxy Node
  - Lockheed Martin contributions
  - NorthWestern's I/T staff

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SMART GRID PROJECT: ACTION ITEMS

- Volt/VAR Optimization [VVO] application is making good progress. In Helena - application should run by year end, and in Philipsburg – by summer of 2012
- Distribution Automation [DA] application is also making good progress. In Helena – application should run by Q1 of 2012, and in Philipsburg – by summer of 2012
- Completing recruitment of 200 residential participants
- Scheduling and installing HAN equipment and training participants on use
- Complete installation & testing of fixed meter reading network in Helena
- Complete testing of MDM system, internal/external data pathways, production of billing determinants, routing of customer inquiries, other internal business processes
- Begin regular monthly communication with 200 HAN participants
- Complete preliminary Metcalf lighting Design (done)
- Continue regional Transactive Control signal development (continuing)

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WHAT HAVE WE LEARNED?

- Do we try to make consumers smarter about energy, or devices and systems that automate the decisions that result in energy consumption?
  - Some of both … build awareness among consumers, and automation (in homes and on electrical system) that is intuitive, economic, flexible, standardized
- Consumers want control, options and choices
  - But, the want Cruise Control … "Set it and forget it"
    - Consumers set the parameters they want … system does monitoring and decision-making per consumer's instructions
    - Consumers can check periodically (monthly?) to see if the system is giving them the results they want. If not, they can tweak the parameters
    - Consumers want the option to cancel, temporarily override, or opt out completely
- Diversity + Complexity = Stability?

May 2012 Update

- Battelle, DOE, and Regional Project
  - We continue to have a weekly conference call with Battelle, the other utilities, and the project level partners. Major meeting topics of late are
    - The continued development of the "Transactive Control" signal and integration with the 11 utilities and the project technical partners. This aspect of the project continues to technically challenging for all participants.
    - The project schedule, and also the meeting of the go-live date of September 1, 2012 remains a firm target.
  - At this time all the utilities on this project seem to be in a similar mode as we are. They are each working hard to be on line and ready by the end of August. A few have indicated that portions of their projects, may not be ready by the go-live date.

- NWE System Side of Project
  - **Helena**
    - Field Equipment - 100% deployment of communications, voltage sensors, and capacitors. Automated switches should be 100% deployed within a week or two.
    - Substation Equipment – 100% deployment at Eastside Substation. Southside and Golf Course Substations will follow soon.
  - **Philipsburg** – Some field and substation work is completed. Construction for final portion is scheduled for May and June.
  - **S&C Electric Company** – IntelliTeam Volt/VAR control software (energy savings and efficiency)
    - We are acceptance testing the software on the Helena system.
    - Final GIS upload should occur by June, and final training in June and July.
  - **Cooper Power Systems** – Yukon Feeder Automation software (reliability)
    - Contracting completed in early March, and project kick-off meeting occurred on March 16th.
    - We are scheduled to be trained on the system, and fully up and running by the

May 2012 Update (continued)

- NWE Customer Side of Project
  - **Helena**
    - Residential Customers – Our goal is 200 participants, 208 have signed up to date.
    - State of Montana - Walt Sullivan and Lee Metcalf Buildings: lighting and air handling equipment retrofits have been identified and preliminary design work has been completed.
  - **ITRON** – Interval meter reading, meter data management, and HAN equipment.
    - Meter collection system will be deployed in Helena in the next few weeks.
    - Testing of interval data pathways from Helena to ITRON hosting and then to NorthWestern energy Load Research have been successfully completed.
  - **Tendril Networks** – Home Hosting, TOU, Demand Response, and Customer Service Center.
    - 150 HAN equipment installations are complete.
    - The HAN system will go live August 1, 2012.
  - **Lockheed Martin** – Node Software, systems integration, Battelle EIOC interface, Demand Response, diagnostics, and reporting.
    - Node software is in place, has been tested and is functioning as intended.
    - Services agreement in place to work with Battelle on developing interface for the Transactive Control
    - Additional work to integrate the LM Node Software with IBM/Battelle systems is in process.
    - Additional systems integration work is needed and in process between LM and Tendril Networks.

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