Energy Efficiency in the Distribution System

March 9, 2010

USEA/USAID

Global Energy Efficiency Workshop

current®

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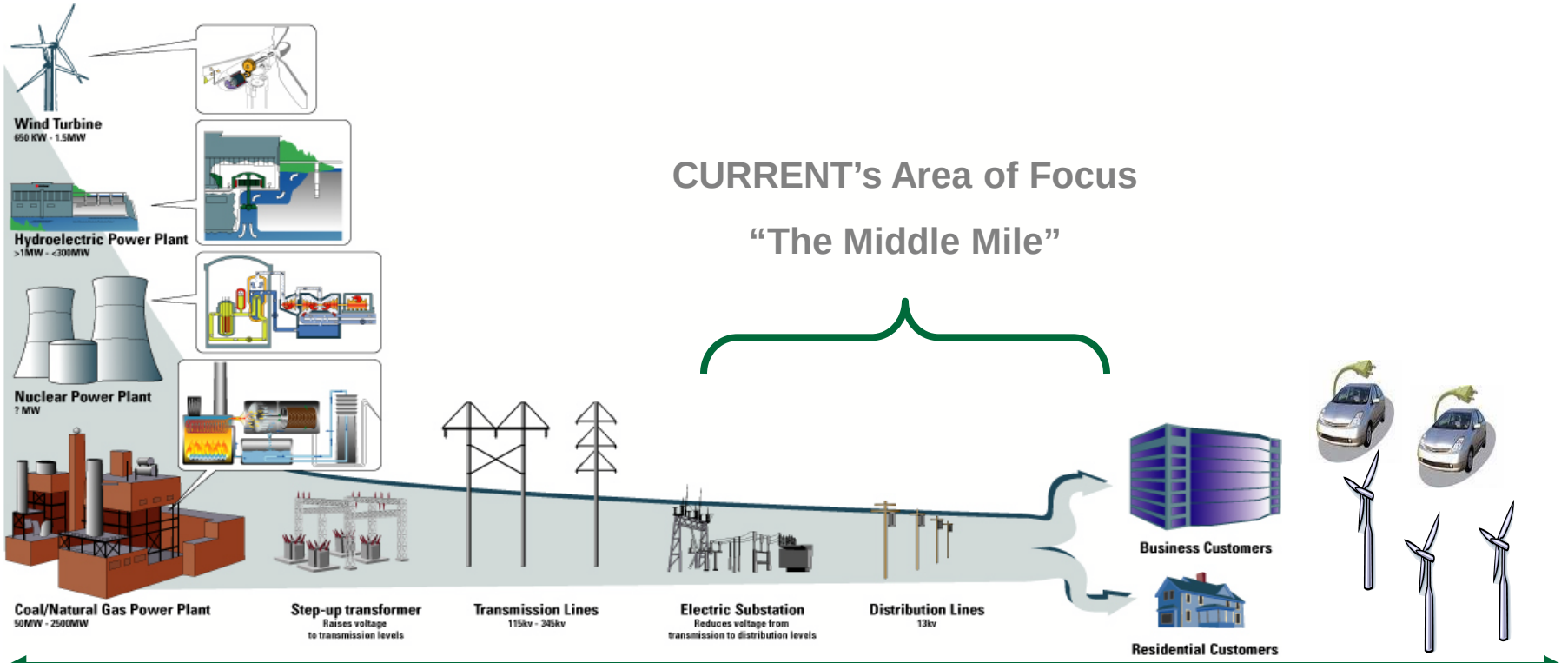
About CURRENT

- ***Offices in Washington, DC, Zurich, Switzerland and Rochester, NY***
- ***Enabler of Smart Grid communications, sensing and analytics platform for SmartGridCity™ with Xcel Energy***
- ***Collaborating with Iberdrola and EDF in EU-funded program to develop European Smart Grid platform that enables an open standard for metering, integrated communication technologies, and advanced distribution management capabilities***
- ***More than 35,000 sensors deployed***
- ***Holds over 70 patents with as many pending***
- ***Member of:***
  GridWise Alliance, Smart Grid Australia, IEEE, and the Joint US-China Cooperation on Clean Energy
- ***Winner of:***
  - *One of the world's Top Ten Smart Grid Innovators at GreenBeat 2009 by VentureBeat*
  - *2009 World Economic Forum Technology Pioneer*
  - *Go Green East 2009*
  - *Dow Jones 2008 Ten Most Innovative Clean Tech Companies in Europe*

Investors

Smart Grid Vision

". . . a power system that can incorporate millions of sensors all connected through an advanced communication and data acquisition system. This system will provide real-time analysis by a distributed computing system that will enable predictive rather than reactive responses to blink-of-the-eye disruptions." (EPRI, emphasis added)



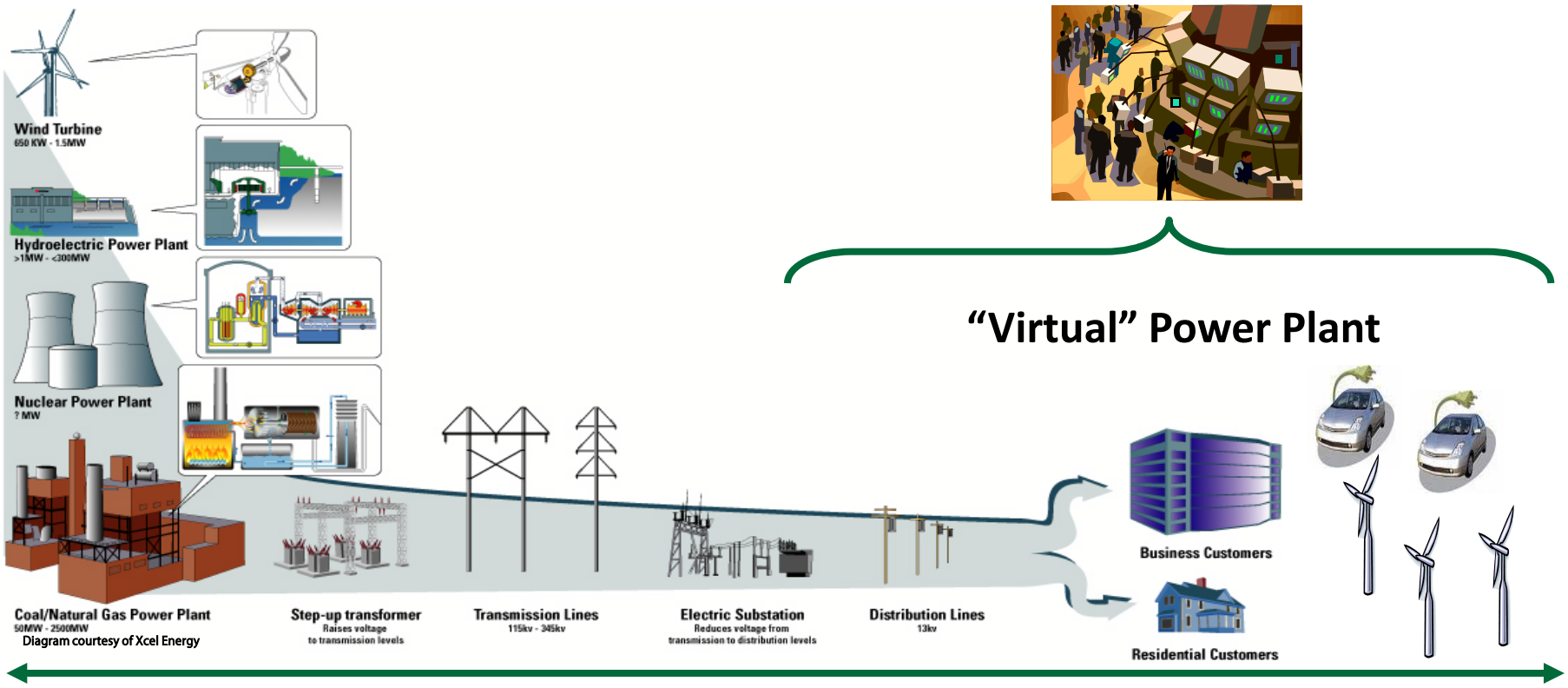
Today: High degree of automation, optimization and control

Limited automation, optimization and control

(picture courtesy of Xcel Energy)

Middle Mile can provide a Virtual Power Plant

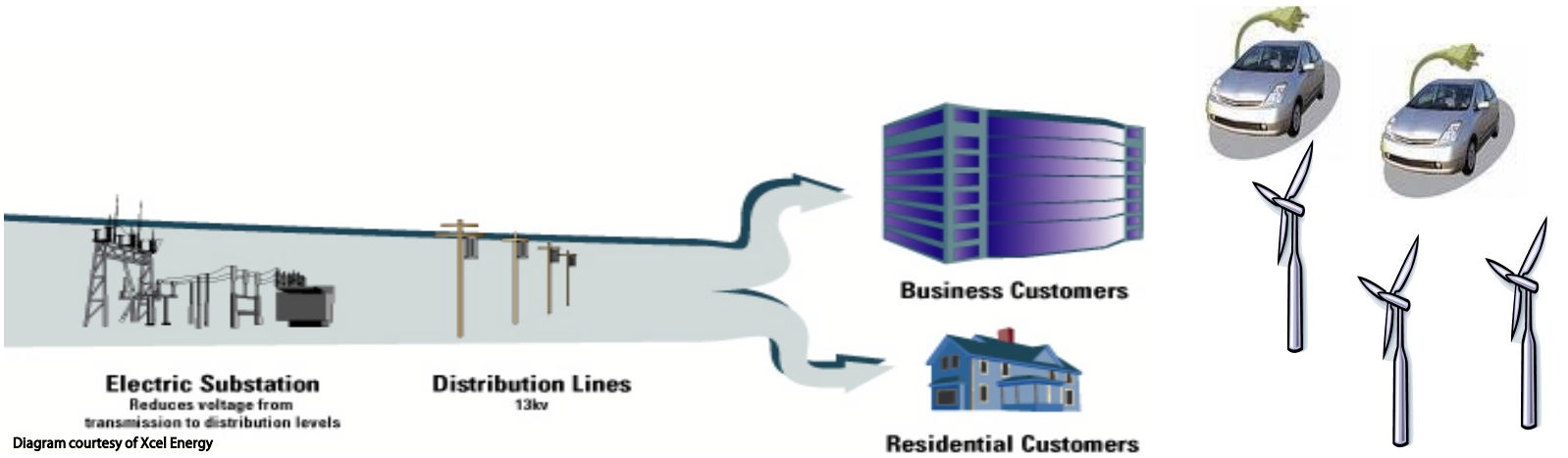
Optimizing neglected areas of the value chain to create
“virtual generation”,
which can help handle volatility by fusing supply and demand



High degree of automation, optimization and control

Limited automation, optimization and control

Two Distinct Value Creation Opportunities



Real-Time, Concrete Measurement and Verification is REQUIRED across the value chain

System Optimization

- Dynamically control voltage 24X7 to optimize power needed and/or carbon produced
- Reduce energy lost in distribution ("line losses")
- Result is savings of up to 3-5% of energy generated or purchased at any time, without impact on customers
- **Dynamic adjustment can occur in minutes providing alternative to spinning reserves and solution to intermittent renewables**
- **Use of distribution as a 'shock absorber' for volatility, rather than generation spooling…**

Edge Energy Management

- Adjust and aggregate customer load through demand response, typically in peak periods (~ 80 hours a year), creating high value capacity and energy
- Manage emerging forms of distributed generation, renewables and PHEV's
- Enable new and innovative residential and business energy management products

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Analytics and Control Systems - System Optimization

Company Drivers

- Challenge of adding clean generation capacity
- Integration of distributed renewables
- Load and customer growth
- State renewable and efficiency incentives and standard

Organizational Priorities

- Real-time visibility to grid conditions
- Proactive management of the distribution system
- Stream lined operations in the control room requiring minimal intervention
- Real-time measurement and verification of system optimization operations

The CURRENT Solution

Grid Optimization Will:

- Free up system capacity through grid based demand response
- Reduce technical losses
- Better utilize aging network assets
- Verifiable results to meet efficiency and renewable standards

Volt/VAR Control Solution

Issue

- Continual system losses occur from reactive load, or “VAR”
- Voltage and VAR controls are not coordinated - resulting in suboptimal operational performance in the feeder network

Solution

- Real-time readings of selected distribution line voltage and/or current sensors
- Real-time monitoring and control of distribution line capacitors and voltage regulators
- Real-time monitoring and control of substation LTCs and substation capacitor banks
- Real-time monitoring of substation feeder metrology through integration with SCADA systems.
- Advanced analytic and control software

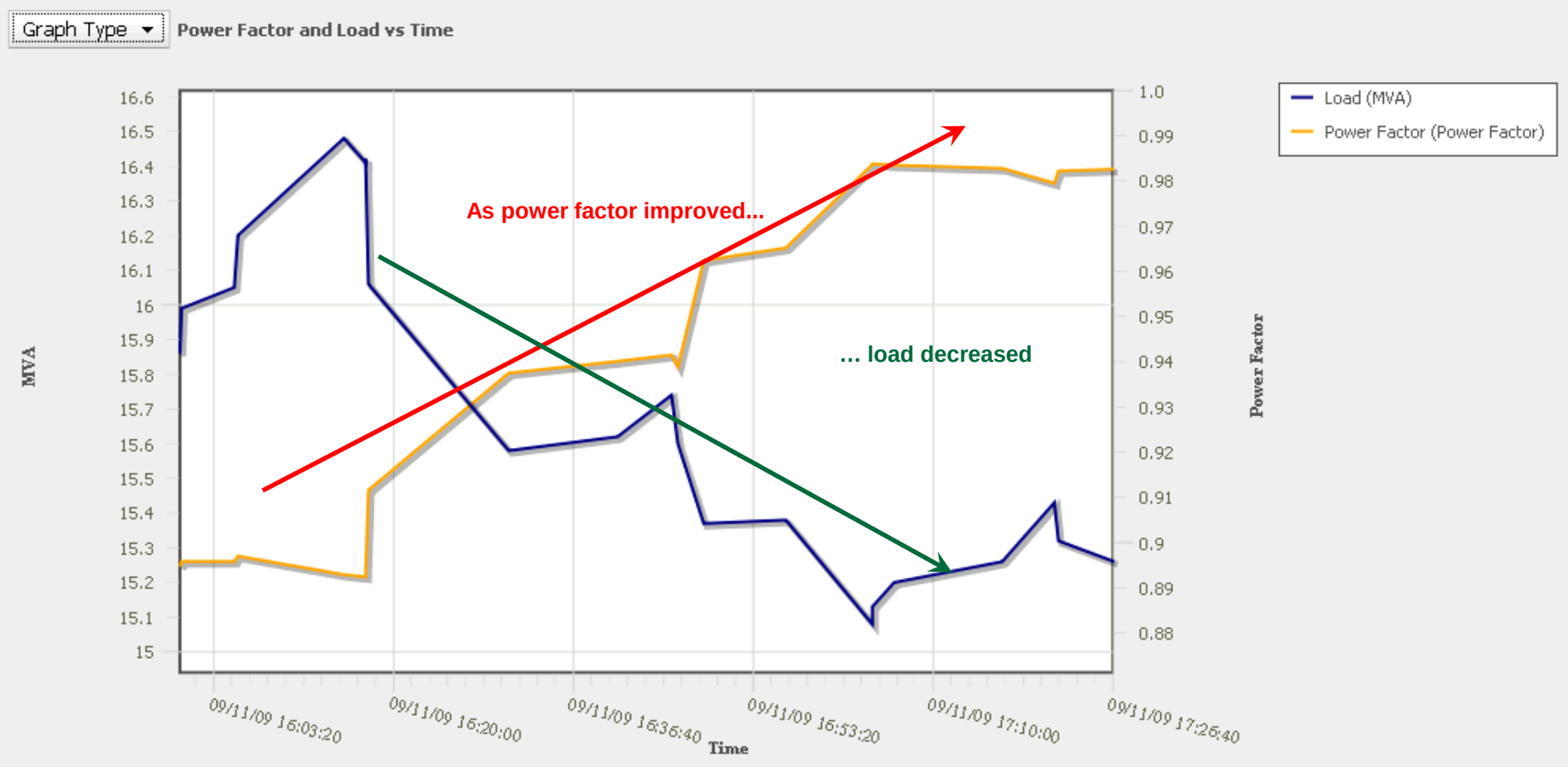
Results

- **Integration Flexibility:**
  CURRENT Volt/VAR Control monitors and controls LTCs, Substation Capacitor Banks, Distribution Capacitors, and Distribution Line Regulators.
- **Carbon Savings:**
  Save energy generation and the associated carbon emissions.
- **Loss Reduction:**
  Optimization of the system power factor and the corresponding minimization of current and reduction of distribution I^2R losses.

Volt/VAR Control - Results

Actionable Intelligence®
CURRENT OpenGrid Volt/VAR Control

Improve Power Factor → Reduce VARs → Reduce Losses → Reduce Load → Reduce Emissions



Dynamic Voltage Optimization

Issue

- Voltage is set at higher levels of the regulatory standard to ensure tariff compliance
- Capacity and carbon emissions constraints

Solution

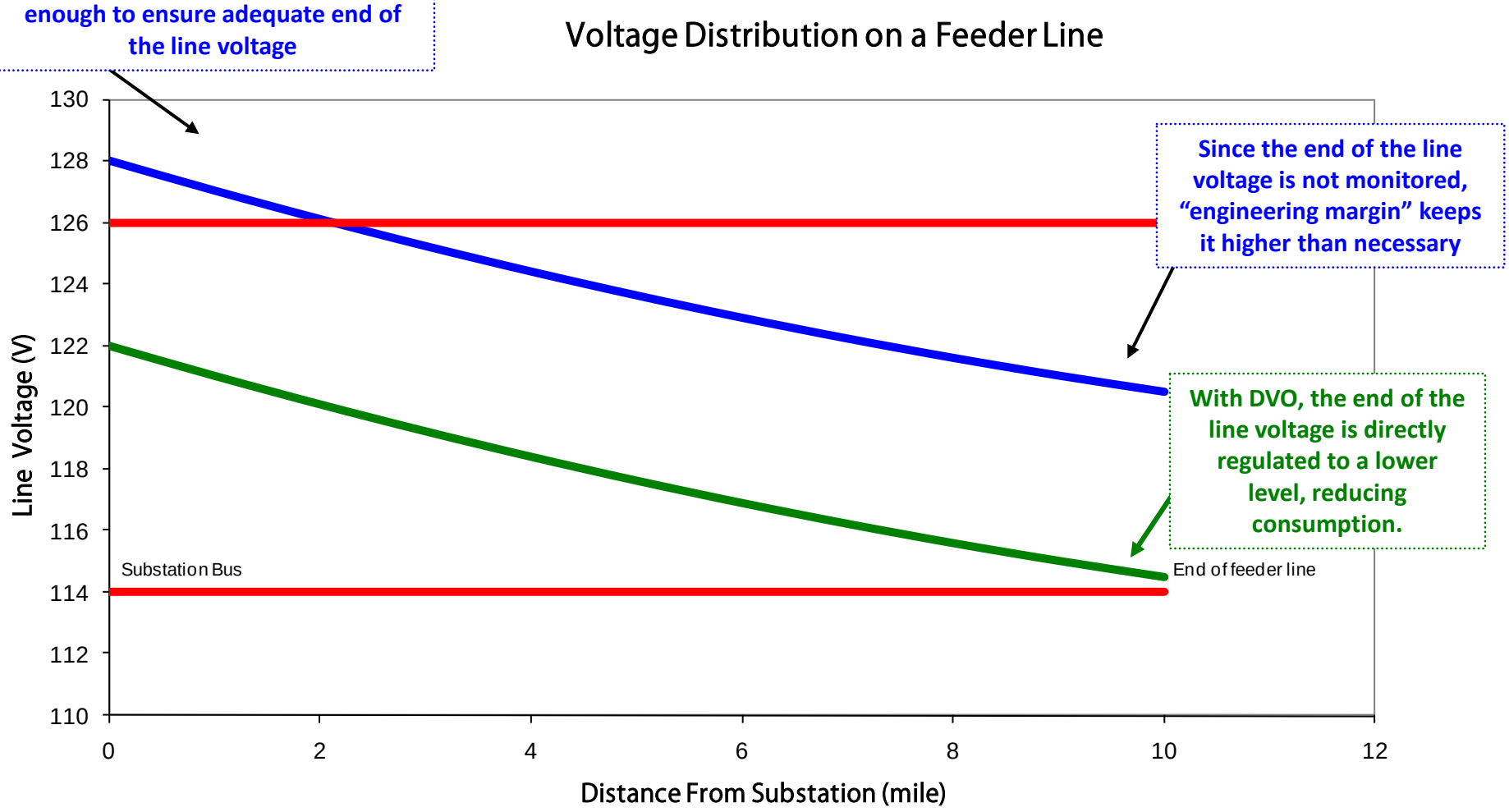
- Centralized control of voltage regulation across the distribution system.
- Integration with **Substation SCADA Measurement Data**, **Line Capacitor Banks**, and **Substation Load Tap Changer Controls**.

Results

- **Operational Savings:**
  Reduce delivery inefficiency from running the system "hot".
- **Capacity Savings:**
  Reduce the need for additional base load and peak generation by reducing delivery inefficiencies.
- **Carbon Savings:**
  Reduce total energy consumed by end customers and related generation emissions.
- **Integrate Renewable Energy Sources:**
  Reduce the risk of integrating renewable generation sources with greater control of demand.

Dynamic Voltage Optimization

Without DVO, utilities regulate the substation bus voltage to a level high enough to ensure adequate end of the line voltage



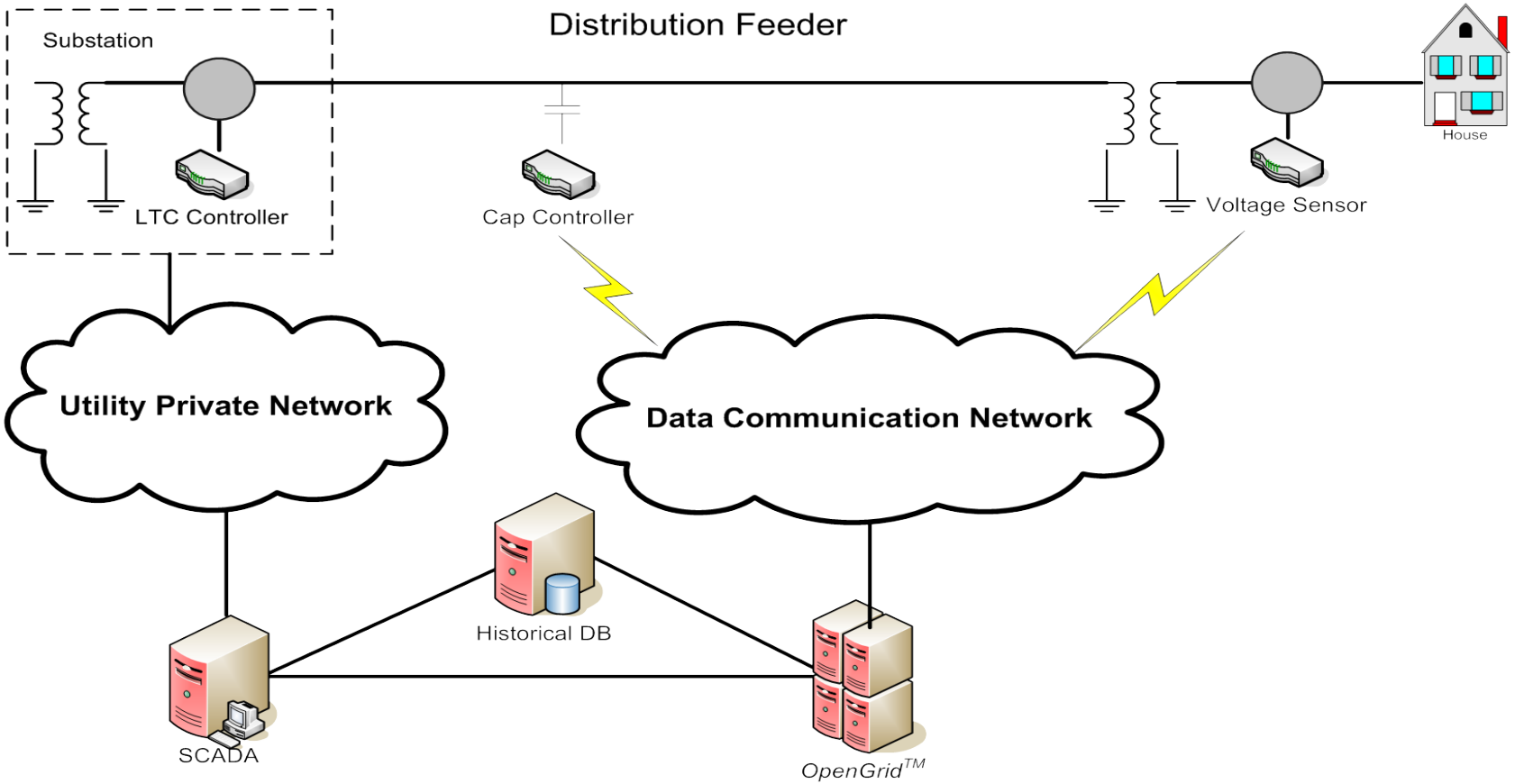
Since the end of the line voltage is not monitored, "engineering margin" keeps it higher than necessary

With DVO, the end of the line voltage is directly regulated to a lower level, reducing consumption.

System Optimization Solution Components

CURRENT's system integrates with
only a few key components within the distribution system.

The following diagram provides a high level view
of what is typically involved with the integration effort.



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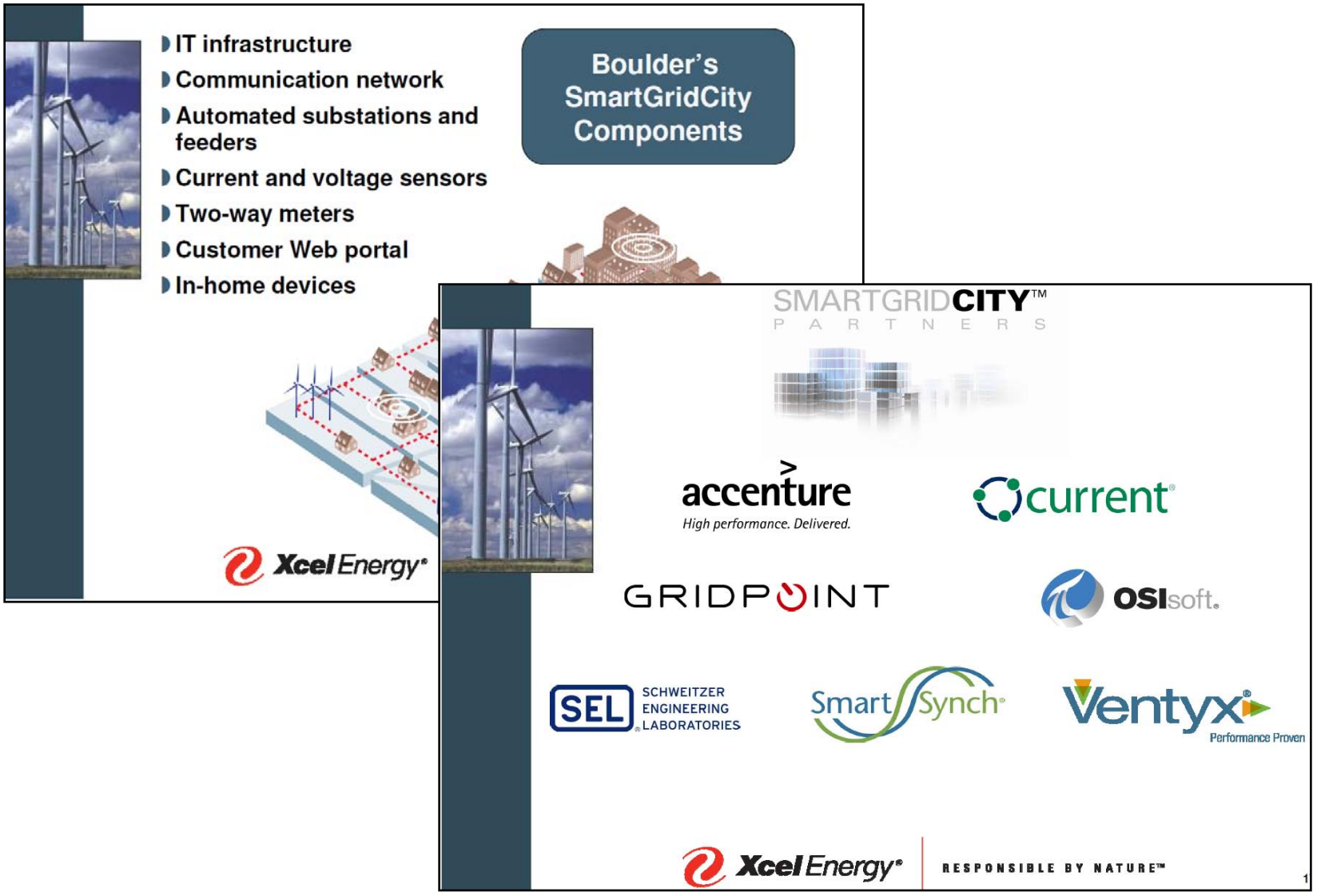

IT infrastructure
Communication network
Automated substations and feeders
Current and voltage sensors
Two-way meters
Customer Web portal
In-home devices
Boulder's SmartGridCity Components
Xcel Energy®
SMARTGRIDCITY™
PARTNERS
accenture
High performance. Delivered.
current®
GRIDPOINT
OSIsoft.
SEL
SCHWEITZER ENGINEERING LABORATORIES
SmartSynch®
Ventyx®
Performance Proven
Xcel Energy®
RESPONSIBLE BY NATURE™
1

SmartGridCity™ Implementation Strategy and Results

Operations and Reliability Enhancement

- Xcel Energy moved from **reactive** to **preventive** maintenance program.
- Voltage problems have been reduced by over 90%; there have been no customer **voltage complaints** this year.
- Unpredicted **transformer failures have been significantly reduced**. 7 detected and addressed prior to failure through July 2009.

Optimize Power Delivery

- **System Optimization** Solution successfully implemented.
- Preliminary Results are exceeding expectations **with 4 to 7% efficiency impact**

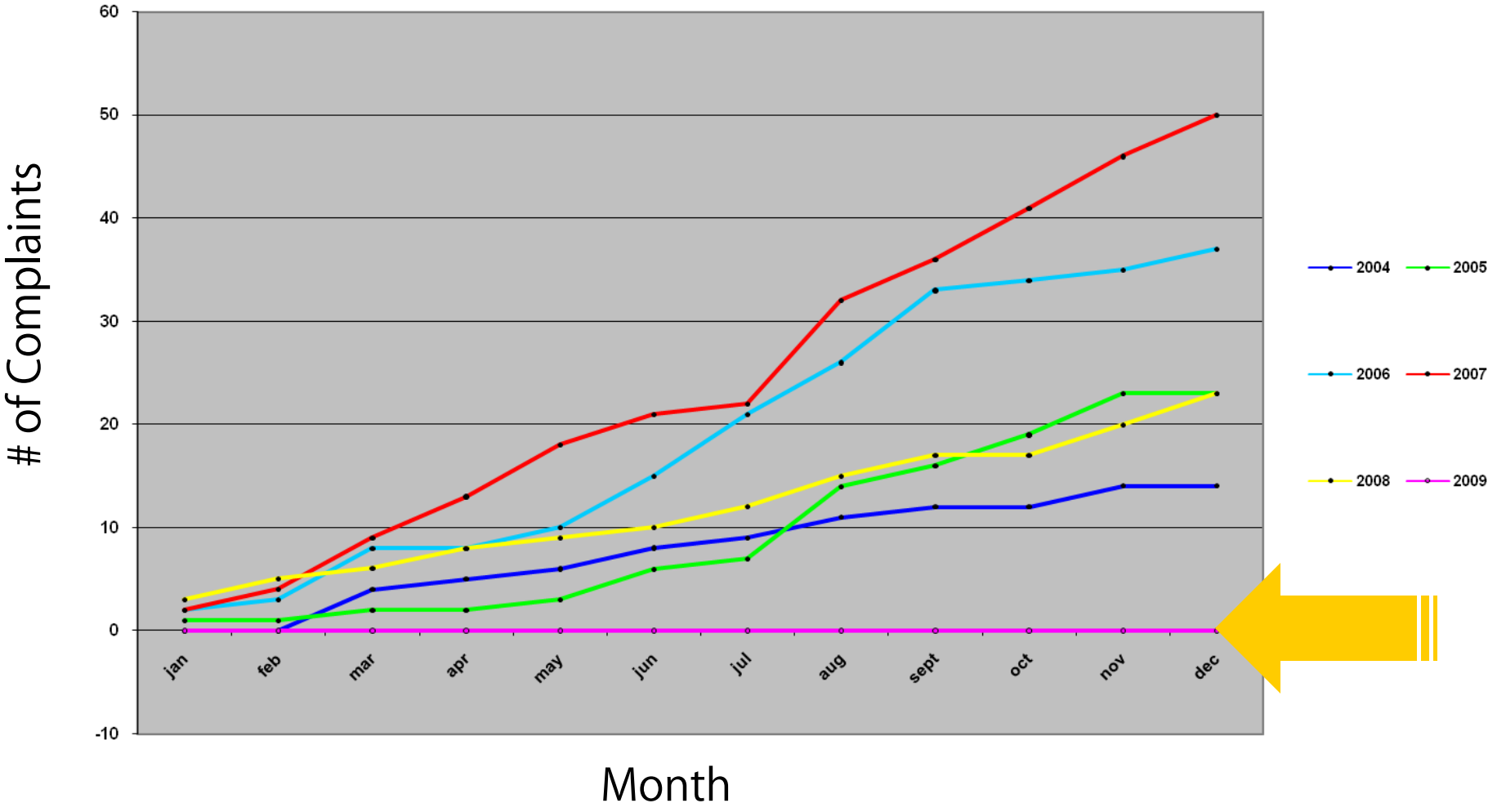
Renewables and Distributed Generation

- Monitoring impact of distributed renewables on grid assets and performance
- Detected unknown distributed renewables feeding onto grid.
- Just the beginning….

End User Energy Management

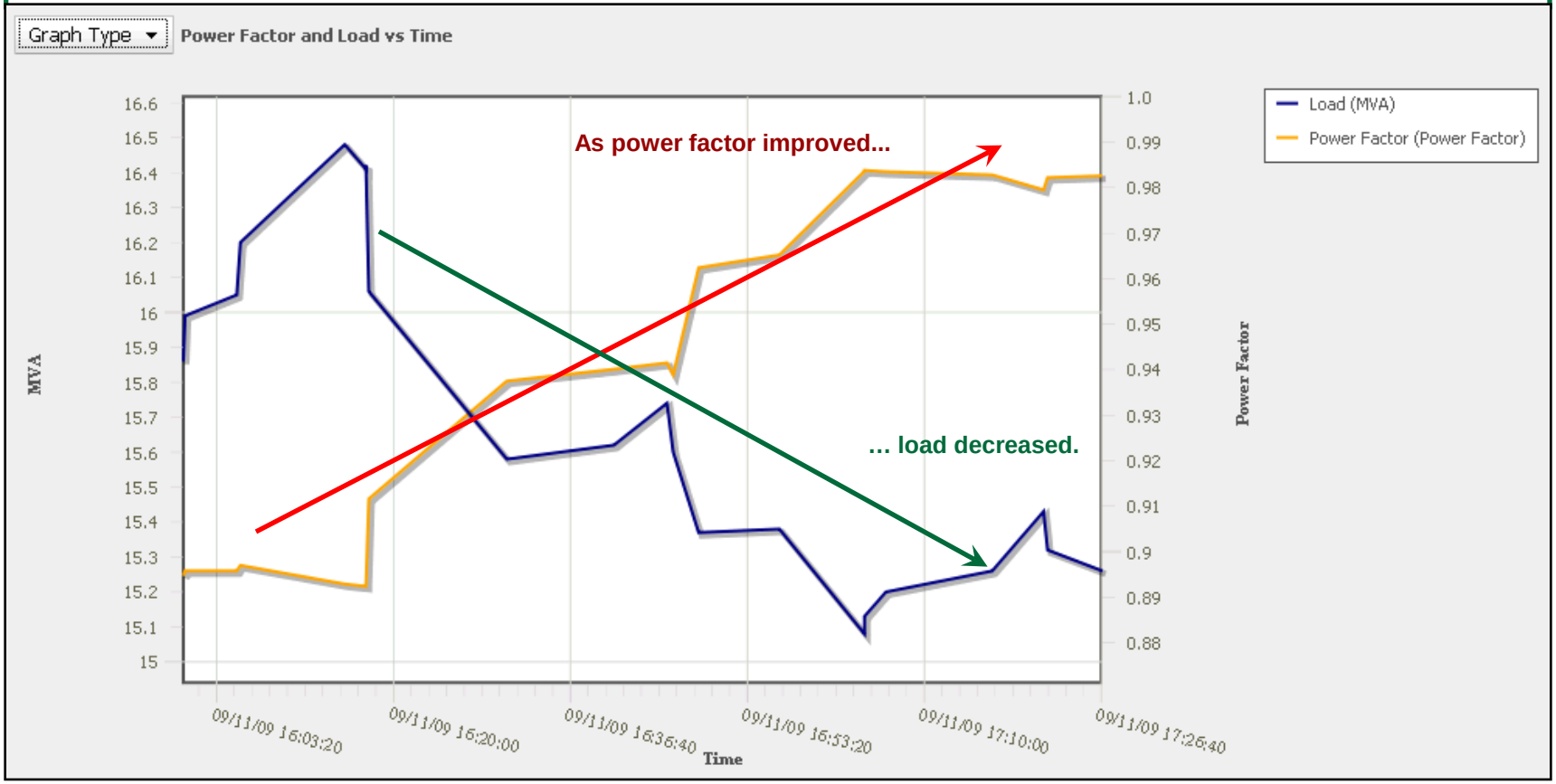
- Last to start
- Enabled several in-home energy management systems
- Integrated Meters with Xcel Billing System
- Roll-out of broader program in 2010

Voltage Complaints by Year in City of Boulder



Grid Optimization – Initial Results

Reduce VA Losses → Reduce Load → Reduce Emissions



- Actual substation load reduction achieved in this example was between 4% to 7% over the course of about an hour by optimizing the system
- Expected nationwide target is 3% to 5% of load
  - *On national basis, 3% would save over $10 billion annually*
  - *Reduce carbon equivalent to taking 15% of all cars in the U.S. off of the road*

System Optimization Benefits

System Optimization provides three primary high value benefits:

- Reduces power delivery technical losses
  - Volt/VAR control – Makes power delivery more efficient by compensating for reactive loads from motors and air conditioners that cause increased losses
  - Can reduce total system load by up to 0.3 to 0.5%
- Enables demand to be managed more dynamically on the grid to increase grid efficiency and capacity without impacting consumer behavior
  - Dynamic Voltage Optimization - Load can be reduced between 1-3% in a peak demand scenario to increase system capacity, or on a persistent basis to reduce customer bills and power purchases
- Enables the integration of distributed energy resources into the distribution grid

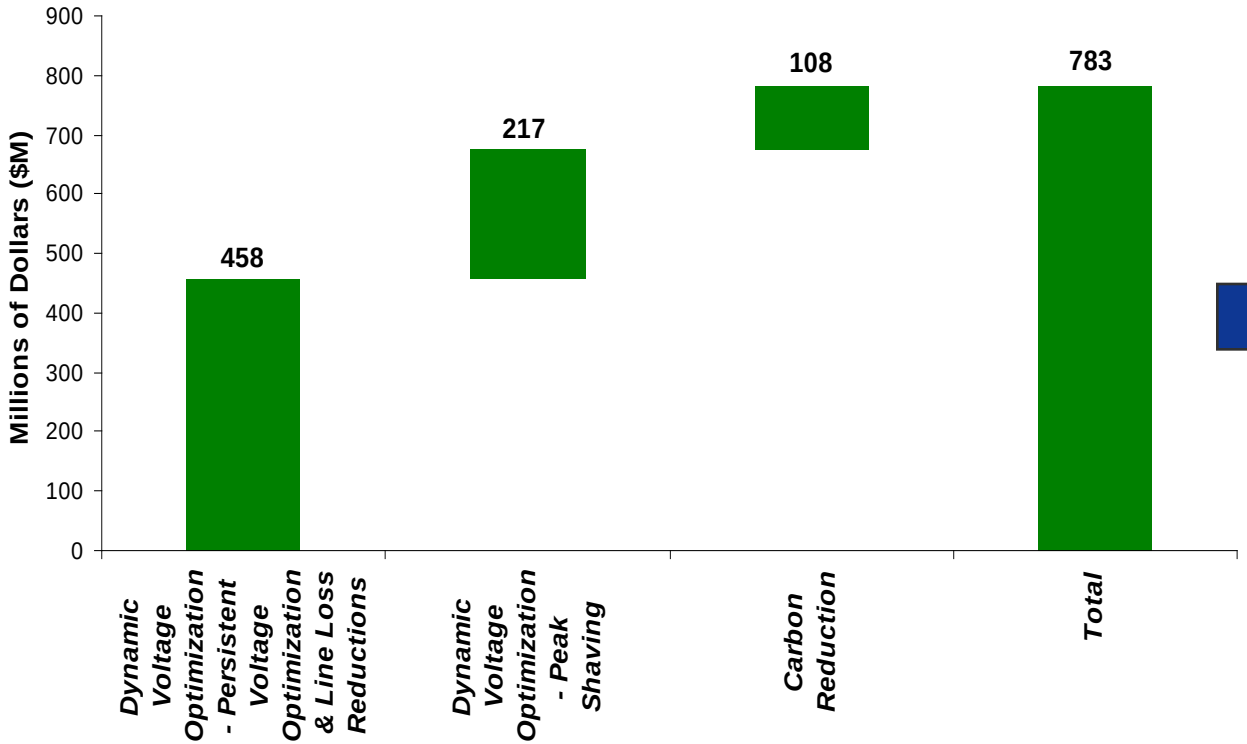
Extremely positive business case / ROI (2 to 4 year payback)

Includes software platform for communications and integration management

System Optimization Benefits

10-Year Cumulative Gross Benefits by Category

Generic 1M Meter US Utility



Category Description

- Optimization of power flow characteristics of the distribution grid to reduce technical line losses
- Optimization of voltage levels to maintain lower average voltage across feeders while remaining within tariff voltage ranges
- Estimated carbon savings associated with reduction in total consumption resulting from Smart Grid applications
- Does not include carbon impacts of peak load shifting / shedding applications such as DR

Key Assumptions

- Assumes $20 per metric ton of carbon emissions - based on pending Legislation
- System Optimization Voltage Reduction of 3.3 Volts
- Dynamic Voltage Optimization load reduction of 2.5%
- Smart Grid Power factor reduction is 0.25% of load

PV = $488M

Note: PV assumes 8.5% per year discount rate

Why Grid Efficiency / Optimization?

- *Highest value applications with lowest level of investment*
- *Real-time data based on real-time status of the distribution grid*
- *Proven technology – **DEPLOYED TODAY***
- *Delivered results*
- *Scalable, open platform to manage future challenges or other immediate needs*
  - *Theft Detection*
  - *Intermittent renewables integration impact*
- *Modularity in design to fit scope and budget*

Questions ?