Global Climate and Energy Project
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Visions for the Utility of the Future

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Utility of the Future Is the Integration of “Intelligence” Infrastructure with Our Electric Delivery System
Utility of the Future will combine power delivery hardware with sensing and monitoring technology, a communications network, and information technology to enhance grid performance, create operational efficiencies, extend energy efficiency to the fullest extent possible, and support additional services to customers.

Ultimately, we see a future of networked, end-use devices interacting with the marketplace for electricity and other consumer-based services including sending “prices to devices” to enable customers to “set it and forget it” to optimize their energy consumption.

As it is fully deployed, Utility of the Future can have dramatic impacts on system reliability and customer satisfaction, as well as energy savings and CO2 reductions.
Societal Benefits Enabled by a Smart Grid

- **Initial estimated impact (US, 2010):** 35 – 187 billion kWh annual energy savings

- Equivalent to reducing 23 – 120 million metric tons of CO$_2$

- Equivalent to taking 4 to 20 million cars off the road

Source: EPRI
“North Carolina-based Duke Energy has been quietly turning itself into one of North America's Smart Grid leaders -- if not in the quantity of its short-term deployments, then certainly in the quality of its long-term thinking.

**SGN Prediction:** The approach Duke is taking (to planning) and the demands it is making (to vendors) will set the tone for hundreds of utilities to follow.”
Utility of the Future
Will Deliver Operational Benefits

<table>
<thead>
<tr>
<th>Metering</th>
<th>Distribution Mgmt</th>
<th>Outage Mgmt</th>
<th>Grid Modernization</th>
<th>Contact Center</th>
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</thead>
<tbody>
<tr>
<td>Automatic, remote reading</td>
<td>VAR mgmt – ensuring Capacitor Banks are working as expected</td>
<td>Outage Detection &amp; Verification</td>
<td>Digital communications &amp; operational control</td>
<td>An increase in billing calls due to remote disconnects may be offset by:</td>
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<tr>
<td>Read-in/read-out for customer turnover</td>
<td>Capacitor Bank Inspection</td>
<td>Reduced downtime</td>
<td>Comprehensive system information available in near real time</td>
<td>Decrease in billing calls due to minimizing estimates, cancel bills, etc</td>
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<td>Off cycle reads</td>
<td>System Voltage Control</td>
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<td>Self healing capabilities are enabled</td>
<td>Reduction in outage related calls and metering related calls</td>
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<td>Remote disconnect/reconnect (non-pay, move-out)</td>
<td>Continuous Voltage Monitoring</td>
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<td>Innovation from outside the utility industry can be applied to current operations</td>
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<td>Improved accuracy of billing process (billing exceptions and efficiencies)</td>
<td>Reduction of technical losses in system due to better modeling</td>
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<td>Revenue recovery and protection through improved read accuracy, less theft</td>
<td>Asset mgmt – better data should help investment planning</td>
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<td>Load research</td>
<td>Transformer Load Mgmt – monitor loads across transformers will enable longer life</td>
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<td>Accident avoidance/Workers Compensation</td>
<td>Conservative voltage reduction – better control over the grid</td>
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Will Enable More Energy Efficiency

- Utility of the Future creates the infrastructure that enables the utility to communicate inside the customers’ home and therefore could provide new energy efficiency programs and services for customers.

- Additional customer devices would be required and would be considered as part of the save-a-watt initiative.
  - A home monitoring dashboard to indicate time differentiated pricing plus current or planned consumption activity.
  - The next generation of in home load control. Examples include:
    - Air Conditioning that can be intelligently cycled based on energy signals and comfort specifications.
    - Smart refrigerators with intelligent defrost cycling.
    - Dishwashers that will automatically delay operation - unless over-ridden - based on preferences.
    - Clothes dryers that can tumble without heat if energy pricing are above certain parameters.
And Will Deliver Benefits to Customers

- Remote initiation, transfer, and termination of service
- Automatic disconnection and reconnection
- Prepaid metering
- Individualized pricing and additional payment conveniences
- Energy efficiency programs and energy savings for residential and nonresidential customers
- Load control initiatives
- Elimination of Meter Access Plan and estimated meter reads
- Increased power quality

Increased reliability, fewer outages and reduced outage durations
How Benefits Will Be Delivered

Utility Enterprise

Operations
EMS/WAM, OMS/DMS/DA

Business Applications
GIS/Apps, CIS, ERP, Asset Mgmt.

Integrated Network Manager

Communications Infrastructure

Smart grid devices
LTC
Voltage Regulator
Cap Bank
RTU
M&D Sensors
Relays & PMUs

Home area network
• Zigbee/ Homeplug

AMI, smart home & demand response

WiMax / BPL /RF
We Are Building for Future Needs

Deployments are designed in part to solve existing operational problems, but with an emphasis on preparing Duke for future technology development and customer requirements.

Utility of the Future
- Energy Management Services
  - Residential, Commercial
- Home area network gateway
  - PLC (i.e. LonWorks)
  - RF (Bluetooth)
- Web-based applications
  - Demand response
  - Prepayment
  - Load control
  - Revenue protection
  - Web move in/out
- Distribution
  - Load profiling/engineering
  - Phase balancing
  - Transformer optimization
  - Energy forecasting
  - Outage and GIS
  - Work force management
  - Asset management

Advanced Metering Infrastructure (AMI)
- On-demand reads
- Programmable load intervals
- Bi-directional and net metering
- TOU, RTP, CPP pricing options
- Demand response
- Power quality data
- Voltage readings
- Current readings
- Power Factor
- Frequency
- Detailed power outage data
- Remote programmable
- Remotely upgradeable
- Internal expansion port
- Future functionality

Smart Meters
- Solid-state platform
- Integrated communications
- Integrated disconnect switch
  - Remotely disconnect
  - Remotely connect
- Power quality data
- Voltage readings
- Current readings
- Power Factor
- Frequency
- Detailed power outage data
- Remote programmable
- Remotely upgradeable
- Internal expansion port
- Future functionality

Automatic Meter Reading (AMR)
- One-way or two-way
- Monthly kWh reads
- Interval data
- Basic theft detection
- Outage/Restoration Detection

Manual meter reading
- Monthly kWh reads
- Basic theft detection
- Outage/Restoration Detection
Demonstration Labs Will Bring Utility of the Future To Life

- Provides a “hands on” experience of how the assets work
- Energy efficiency concepts as well as utility operations are part of the design
- Integration of distributed generation and energy storage to show leading edge concepts
- Partnership opportunities with Universities, other non-profits and vendors are being explored
North Carolina

Charlotte, NC
The deployment in Charlotte will utilize a combination of meters, Echelon and GE, and other distribution devices connected with an RF mesh wireless network and digital cellular technology.

Line sensors, substation equipment and capacitors will be connected to the network.

A select number of customers, less than a dozen will also be asked to participate in communication to the home trials.

Cost of initial deployments: $3 to $5 million

Number of endpoints: 6,000 to 8,000

Timeline: Deployment of communication technology to commence in October with endpoints connected in November/December

Project Manager: David Staggs
### Overview

- **Cost of initial deployments:** $1 to $2.5 million
- **Number of endpoints:** 2,500 to 4,000
- **Timeline:** Communication technology will be deployed in October, connecting existing distribution assets. New line sensors will be deployed in the October/November. Meters and other endpoints will be installed, as available, in December and the first quarter of 2008.
- **Project manager:** Ron Burkhalter

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**Upstate SC**

The deployment will test the communication architecture in a rural environment as well as connectivity to the endpoints, including meters, capacitors, transformers and line sensors.

In home communication will also be tested with a small number of customers. In home battery backup and renewable generation facilitation will also be part of the deployment.
Ohio

**Overview**

- Cost of initial deployments: up to $34 million
- Number of endpoints: ≥75,000
- Timeline: Deployment will be coordinated with electric rate case
- Project Manager: Avery Adams

**Cincinnati, OH**

The Cincinnati deployment will configure GE and Echelon meters along with communication systems from Silverspring Networks and digital cellular.

Distribution assets will also be connected to the network and back office integration systems. Customers will be connected to an online portal where energy information gathered from the system can be delivered to shape energy usage.