Using GIS, PCS, ADMS, & Weather Forecasting to Manage Renewables & DER

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Key Learning Objectives

- Learn how renewables, microgrids and distributed energy resources can impact an electric distribution system.
- Discover ways to manage and optimize renewables, microgrids, and distributed energy resources using ADMS.
- Maximize benefits from renewables by leveraging integration of accurate renewable power forecasts within ADMS.
Burbank Water and Power

- Services 45,000 households and 7,000 businesses in Burbank, California with water, electricity, and communications
- 20 Substations, 120 feeders, 320MW peak load
Burbank Water and Power

- Miner & Miner customer #10 of ~600
- Started in production with ArcFM v8.0 in 1999
- Long-time user of Esri and Schneider Electric products, now running version 10.0.2

- ArcGIS
- ArcGIS Server
- ArcFM
- Responder OMS
- Conduit Manager/UFM
- Fiber Manager
- OASyS SCADA
- SAGE RTU’s

Working to implement:

- Schneider Electric’s Power Control System (PCS) with integration to OASyS SCADA, DTN WeatherSentry, and OATI WebDistribute (completed)
- Demand Response and Load Management (ongoing)
- Schneider Electric’s Advanced Distribution Management System (proposed)
BWP Smart Grid Program Overview

$60 million – 4 year Capital Program

Command and Control
- Schneider Electric OASyS SCADA and PCS
- Integrated Automated Dispatch System (IADS)
- New Power Operations Center

Security Suite
- Physical security
- Cyber security
- Policy, procedures, standards

Distribution/Station Automation
- Station Automation projects
- Feeder Automation projects
- Digital Relays / Auto-Reclousers
- Static Power Flow Model

Improved Business Systems
- ArcFM GIS
- Responder OMS
- TIBCO Enterprise Service Bus
- Customer Information System (CIS)
- Virtualized Server Environment

Customer Smart Choice
- Demand Response and Load Management Analysis
- Home Energy Reports
- Customer Web Portal
- Time of Use Rates
- Smart Appliance Demonstration

AMI/MDM Systems:
- Cisco powered fiber optic network
- Tropos City-wide wireless mesh network
- Trilliant AMI meter system
- eMeter Meter Data Management System (MDMS)

Demonstration Projects
- Electric Vehicle Chargers
- Black Start Project (Microgrid)
- Energy Storage
A global company

$34 billion revenue in 2013

43% of sales in new economies

160,000+ people in 100+ countries

committed to innovation

4-5% of sales devoted to R&D

~$1.5 billion devoted to R&D

Some of the world class brands that we have built or acquired in our 175 year history

Delivering Solutions for End Users

 Utilities & Infrastructure  25%

 Industrial & machines  22%

 Data Centers  15%

 Non-residential buildings  29%

 Residential  9%
ADMS/PCS Projects Worldwide

Over 180 control centers and 88M meters
Only ADMS to be awarded Gartner’s highest rating in 2012, 2013, 2014
The Advanced DMS

DMS
Network automation, FLISR, VVO, Energy Losses, Relay Protection

SCADA
Alarming, Tagging, Trending, Switching Validation

OMS
Incident, Fault, Customer Call, Switching, and Crew Mgmt and Reporting

EMS
State Estimation, AGC, Economic Dispatch, Unit Commitment

DSM
Load Forecast, Distributed Energy Mgmt, Demand Response

Common Platform, Database, Infrastructure, Security, History, and User Interface

Applications

DMS SCADA OMS EMS DSM

Network Model Management

Realtime Infrastructure

Common User Experience, Integrated Components

Data, Performance, Calculation

Security, Scalability, Integration, Availability
ADMS Functionality

- Train
  - Real-time Simulation
  - Off-line Simulation
  - What-if Analysis
  - Historical Playback

- Plan
  - Load Flow
  - State Estimation
  - Energy Losses
  - Fault Calculation
  - Reliability Analysis
  - Relay Protection
  - Device Capability
  - Contingency Analysis

- Optimize
  - Telemetry
  - Alarming
  - Tagging
  - Trending
  - Reporting

- Operate
  - Volt/VAR Optimization
  - Network Reconfiguration
  - Near and Short-term Load Forecasting
  - Demand Response
  - Distributed Energy Mgmt.

- Analyze
  - Medium and Long-term Load Forecasting
  - Network Automation
  - Network Reinforcement
  - Optimal Device Placement

- Monitor
  - Outage Management
  - Fault Management
  - Switch Management
  - Crew Management
  - Under-load Switching
  - Large Area Restoration
  - Load Shedding

ADMS Benefits
- Safety
- Reliability
- Efficiency
- Standardized Training
- Unified Interface
- Advanced Analytics
Utility Transformation

How do you expect utility business models to be in 2030 compared to today?

<table>
<thead>
<tr>
<th>Region</th>
<th>More or less the same</th>
<th>Similar but with important changes</th>
<th>Transformed*</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>10%</td>
<td>50%</td>
<td>40%</td>
</tr>
<tr>
<td>South America</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Europe</td>
<td>8%</td>
<td>46%</td>
<td>46%</td>
</tr>
<tr>
<td>Asia</td>
<td>31%</td>
<td>69%</td>
<td></td>
</tr>
<tr>
<td>Middle East &amp; Africa</td>
<td>10%</td>
<td>70%</td>
<td>20%</td>
</tr>
<tr>
<td>Global</td>
<td>6%</td>
<td>53%</td>
<td>41%</td>
</tr>
</tbody>
</table>

* of which 'unrecognisable transformation' – North America 0%, Europe 8%, Asia 8% and Global 4%.
Source: 13th PwC Annual Global Power & Utilities Survey
Utility Transformation

Which energy market transformation vision most closely matches your expectations of your market?

Source: 13th PwC Annual Global Power & Utilities Survey
Renewable Resource Commitment

- In June 2007, the Burbank City Council adopted BWP's recommendation that 33% of electricity be procured from renewable resources by 2020.
- Burbank was the first city in the United States to step up to this ambitious goal.
- Burbank now is considering obtaining 50% of electricity from renewable resources by 2025.
- Renewables will be a combination of primarily wind, solar, and compressed air storage systems.
Renewable Resource Variability
Impacts of Renewable Generation on Electricity Demand

Growing need for flexibility starting 2015

Net load

Significant change starting in 2015

Increased ramp

Potential over-generation

California ISO
Definitions

- **Distributed Generation (DG)**
  - Dispersed generation, typically less than 10 MW, in the distribution network
  - Controllable DG: Combined Heat and Power, Generators, ~Hydro
  - Non-controllable DG: Wind and Solar

- **Energy Storage Systems (ES)**
  - Battery Banks, Compressed Air Systems, Thermal Storage Systems

- **Distributed Energy Resources (DERs)**
  - Combination of DG and ES, located throughout the distribution network

- **Microgrid**
  - DERs + loads, can optionally be islanded

<table>
<thead>
<tr>
<th>Power Resource</th>
<th>Type*</th>
<th>Controllable?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generators</td>
<td>Supply</td>
<td>Yes</td>
</tr>
<tr>
<td>Wind</td>
<td>Supply</td>
<td>No</td>
</tr>
<tr>
<td>Solar</td>
<td>Supply</td>
<td>No</td>
</tr>
<tr>
<td>Interties</td>
<td>Supply/Demand</td>
<td>Yes</td>
</tr>
<tr>
<td>Battery Banks</td>
<td>Supply/Demand</td>
<td>Yes</td>
</tr>
<tr>
<td>Electric Vehicles</td>
<td>Supply/Demand</td>
<td>Yes</td>
</tr>
<tr>
<td>Compressed Air Systems</td>
<td>Supply/Demand</td>
<td>Yes</td>
</tr>
<tr>
<td>Thermal Storage Systems</td>
<td>Demand</td>
<td>Yes</td>
</tr>
<tr>
<td>Demand Response</td>
<td>Demand</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* Supply-side provides power, demand-side consumes power or affects consumption
The DER Challenge

● Integration of renewables, storage, and microgrids is a challenge for networks designed to operate in the “classical” way (one way: transmission -> distribution -> consumer)

● DER’s in the distribution system completely change the philosophy of network operation:
  ● reverse power flow
  ● impact on voltage profile
  ● protection schemes

● Distribution network starts to look more like the transmission network
Problems Created By DER in the Network

- Without ADMS, DG/DER’s in the network introduce several dilemmas for engineering and operations:
  - No visibility of network state with DG/DER’s
  - Not clear if operating problems like high/low voltages are caused by DG/DER’s or normal loading conditions
  - Not clear how to select the optimal location for connecting large DG/DER resources to the network
  - No clear direction on how to maximize the operation and value of “green” energy provided by renewables
- Result is operating problems such as high/low feeder voltage and reverse power flows may go unseen until customers are affected
Emerging Challenges

Distribution utilities face significant new challenges

Wind Generation
Microgrids
Weather Stations
Building Management Systems
Smart Field Devices
CHP Plants
Houses + Electrical Vehicles
Solar Panels
Smart Devices
Energy Storage
DER Visualization, Monitoring, Analysis, and Forecasting with ADMS

- Visualization - Geographic, schematic, substation views
- Monitoring - DG/DER activity and active/reactive over/under generation
- Harmonic analysis and remediation
- Historical trending and reporting - violations
- Near-term and short-term forecasting - load and solar/wind generation
WeatherSentry

- Weather imposes the largest external impact on your Smart Grid
- Demand, renewable energy supply, and outages are heavily influenced by weather
- Intelligent weather integration is the key factor in efficient Smart Grid management

Load Forecasting
90% of demand variation due to weather

Wind Power
Highly variable, difficult to predict. Causes increases in spinning reserve generation and risk of grid instability

Transmission
Temperature, humidity and wind impact line capacity

Distribution
Weather is largest cause of outages (lightning, high winds, ice, transformer failures due to high load, etc.)

Trading
Improved prediction of load and renewable energy contribution improves trading decisions

Distributed Generation
Home solar contributions can cause system instability due to rapid cloud cover changes

WindPower Forecasts

Solar Power Forecasts
Distributed Generation and Renewable Power Forecasting

Forecasts:
- Generation Planning
- Grid Stability

- Schneider Electric provides
  - solar irradiance and wind forecasts
  - temperature and humidity for load forecasting
- Highest accuracy forecasting in North America
ADMS Operation & Optimization of DER

- Dispatch (reliability, economic)
  - Dispatch entire network or localized areas
  - Increase or decrease generation (automatically/manually)
- Operation Validation
  - What-if analysis in simulation mode
  - Prevent operation on adjacent feeders
- Volt/VAR Optimization
  - Manage VVO in the presence of DERs
  - Utilize DERs as VVO resource
- Relay Protection Coordination
  - Adaptive relay protection and transfer trip settings
- Microgrid Islanding
  - Maintaining reliable service with islanded networks
Full Network State Visibility
Short Circuit Current
Near Term Operation Planning supported by Weather Forecast Inputs
**Microgrid Optimization with ADMS**

- Provide monitoring of microgrid level resources
- Identify capabilities of generators; especially renewables
- Determine historical behavior of renewables (vs. weather input)
- Provide monitoring of interchange through supply transformer or tie line
- Provide forecast of load and renewable production (weather monitoring plus weather forecast)
- Calculate costs/benefits of microgrid operation, including forecasting
- Optimize operation of utility resources ("regional islanding")
Microgrid Island Operation

- Real islanding (no connection with main grid) is typically forbidden due to inadequate control and management systems.
- Islanding requires much more investment and tuning:
  - Load shedding to balance island production and consumption at the moment of islanding.
  - Is stable frequency required? If yes, effective and efficient under frequency protection is required to align imbalance at any moment.
  - Regulating unit capable of keeping stable frequency:
    - e.g. CHP of 10 MW has ramp up about 50 kW/sec; economic threshold for e.g. CHP is above 4000h/year.
    - Hydro unit can have even greater ramp up, but ramp down can be a problem.
Application Support for Microgrids

- Applications:
  - Automatic Generation Control – AGC
  - Economic Dispatching – ED
  - Unit Commitment – UC
  - Load Forecasts – LF
  - Renewable Production Forecast – RPF
  - Load Shedding – LS
  - Interchange Transaction Scheduler – ITS

- Additionally, ADMS applications can be added for monitoring/control when the full network model is used.

- Product Focus
  - ADMS for Distribution
  - EMS for Transmission
  - PCS for Generation
  - Convergence of Systems
Summary and Questions

- Schneider Electric has a long history of applying technology to solve complex problems for utilities.
- Advanced systems like those provided by Schneider Electric can balance and optimize supply and demand and provide reliable, safe, and efficient power in the presence of highly variable renewable resources.
- Integrations including weather forecasts for load and renewable forecasting are a critical component of renewable, DER, and microgrid optimization.
- For more information on ADMS: http://www.schneider-electric-dms.com/ or contact me at john.dirkman@schneider-electric.com
- Questions?
Thank You!

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