The smart grid at work
Geopolitical drivers...

100% Amount global energy demand is expected to grow by 2030

40% Amount of greenhouse gas emissions for which electricity generation accounts

170 times Cost of generating a KWh versus the cost of saving a KWh through efficiency

Source: Army Corp of Engineers
Source: U.S. Conference of Mayors resolution for Congress
Source: Energy Information Administration
Growth drivers ...

Economic competitiveness | Energy security | Empowerment-Consumer | Environmental sustainability

4 “E’s”
## Smart Grid Dependencies

<table>
<thead>
<tr>
<th>Federal</th>
<th>State</th>
<th>Technological</th>
<th>Socio-economic</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cap and trade</td>
<td>• Rate recovery</td>
<td>• Standards</td>
<td>• “Green Jobs” creation</td>
</tr>
<tr>
<td>• Transmission siting</td>
<td>• Decoupling</td>
<td>• Interoperability</td>
<td>• Requires “Green Investment”</td>
</tr>
<tr>
<td>• Renewable portfolio standard</td>
<td>• Dynamic pricing</td>
<td>• “Common interface model”</td>
<td>• Consumer engagement ... incentives</td>
</tr>
<tr>
<td>• Tax incentives</td>
<td>• Net metering</td>
<td>• Cyber-security</td>
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<tr>
<td></td>
<td></td>
<td>• Smart loads</td>
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</tbody>
</table>
Smart grid maximizes the potential of our existing infrastructure ... 

The integration of two infrastructures ... to provide

**Electrical infrastructure**
- Deliver a sustainable energy future through increased efficiency
- Embrace more renewables & PHEVs
- Informing consumers
- Improve reliability
- Increase operational productivity

**Information infrastructure**
Plan: Build Capability for Today
Goal: Flexibility for Emerging Capabilities . . .
**Miami** proposes to lead the nation in energy efficiency with $200 million smart grid initiative

**Scope**

- ~1MM customers involved
- Public/private alliance
  - City of Miami
  - Florida Power & Light
  - Software companies
- Creates “green collar” jobs
- Implementation over 2-3 yrs

- Smart Meters
- In-home Energy Mgmt
- Distribution Automation
- Substation Automation
- Enterprise Systems
- Solar / Small Wind Integration
- Advanced Monitoring & Diagnostics

City-scale deployment ... smart grid at work
AEP is one of the largest electric utilities in the US, delivering electricity to more than 5 million customers in 11 states.

- gridSMART™ - a $150m deployment program in NE Columbus, Ohio
  - Columbus ~110k customers
  - Deployment over 18 mo (2010-11)
  - Benefit Analysis over 24 mo (2011-13)

Transforming the way AEP does business to better serve our customers, improve reliability, reduce costs and lower emissions.
Advanced holistic solutions

**Demand optimization**
*Reducing peak demand, empowering consumers, deferring infrastructure investment*

**Distribution optimization**
*Improving reliability and efficiency, integrating renewables*

**Asset optimization**
*Reducing outages and unexpected transformer failure, maximizing life of aging assets*

**Transmission optimization**
*Improving reliability and efficiency, integrating centralized renewables, wide area protection*

**Workforce & engineering optimization**
*Increasing productivity, cost-effective grid design*
Advanced, holistic solutions ... for a smarter grid

Distribution optimization

What it is
Distribution automation, enabling advanced applications

Why
Improved reliability and efficiency & integration of distributed energy resources and plug-in cars

Value*
-$7MM/yr***+
-45K tons of CO2 reduction
-Reduce line losses up to 10%
-Decrease power purchase up to 3%
-Reduce outages by 33% + restore power 30% faster

*Based on 1 million customers
***IVVC with 0.5% CVR peak (only) load reduction
+ $85/kW-yr peak generation capacity value
RPS: Renewable Portfolio Standard
Increased grid automation

**ENABLES**

- Full visibility and control
- Proactive maintenance
- Shared operational data
- Streamlined business processes
- Optimization tools

**Operations Processes**

- Dispatch/Network Operations/Power Quality/Crew Mgt

**Integrated Solution**

**Engineering Processes**

- GIS
- Design
- WMS

**Design/Plan/Schedule/Crew Mgt**

**Tomorrow's Grid**
Advanced, holistic solutions ...

for a smarter grid

Asset optimization

What it is  
Prognostics for proactive equipment maintenance

Why  
Reduced outages, reduced asset failure, focused maintenance dollars, maximum asset performance

Value*  
-$11MM/yr  
--~4.5 year ROI  
-Reduced unexpected transformer failure and unplanned outages up to 80%

*Based on 1 million customers
Advanced, holistic solutions ... for a smarter grid

**Demand optimization**

**What it is**
Reduce peak and consumption via demand response and management

**Why**
Avoid additional P&E invest; increase utilization; consumer empowerment

**Utility value/MM customers**

$18MM/yr***
43K tons of CO2 reduction
Res consumer savings up to 10%

+ $85/kW-yr peak generation capacity value
RPS: Renewable Portfolio Standard
*Utility savings are approximate annual savings/M customers
***1.5% peak load reduction using CPP
****IVVC with 0.5% CVR peak (only) load reduction
**Advanced, holistic solutions ... for a smarter grid**

**Transmission optimization**

<table>
<thead>
<tr>
<th>What it is</th>
<th>Why</th>
</tr>
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<tbody>
<tr>
<td>Wide area protection, control and integration of centralized renewables</td>
<td>Less energy waste and higher profit margins</td>
</tr>
</tbody>
</table>

**Utility value/MM customers***

$5MM/year

Deferral of the capacity upgrade

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+ $85/kW-yr peak generation capacity value
RPS: Renewable Portfolio Standard
*Utility savings are approximate annual savings/MM customers
**1.5% peak load reduction using CPP
***IVVC with 0.5% CVR peak (only) load reduction
Advanced, holistic solutions ... for a smarter grid

Workforce and engineering optimization

What it is
Workforce enabling technologies & system design/modeling

Why
Increased workforce productivity & cost effective grid design

Utility value
Up to 30% reduction in engineering costs

+ $85/kW-yr peak generation capacity value
RPS: Renewable Portfolio Standard
*Utility savings are approximate annual savings/M customers
**1.5% peak load reduction using CPP
***IVVC with 0.5% CVR peak (only) load reduction
It is more than just GIS. It is the integration of the Office, Crew & Customer
Smart Grid – a complete view

**Generation**

- **Renewables**
  - Wind Turbines
  - Solar Power
  - Biogas Engines
  - Hydro Power
  - Energy Finance

- **Natural Gas**
  - Large-Frame Turbines
  - LM Turbines
  - Energy Finance

- **Base Load**
  - Steam Turbines
  - IGCC Cleaner Coal
  - ESBWR Nuclear

- **CO₂ Capture**
  - BP H₂ Joint Venture
  - Synfuels Technology

**T&D**

- **Back Office**
  - Geospatial Asset Mgmt
  - SCADA/EMS/DMS Software
  - Optimization & Diagnostics
  - Metering Comm Systems
  - Communications Security
  - Work Force Management

- **Substations**
  - Communications from Office to Sub to Meter
  - Automation
  - Protection
  - Network Equipment
  - Physical and Cyber Security
  - Asset Condition Monitoring
  - Engr Procure Const Projects

- **Infrastructure**
  - Transformers - Pwr, Dist, Net
  - Capacitors
  - Voltage Regulators
  - Surge Arrestors
  - Busway

**Customer**

- **Comm & Indust**
  - C&I Smart Meters
  - Water Treatment
  - Automation
  - Energy Finance

- **Residential**
  - Smart Meters
  - Home Area Nets
  - EcoPanel
  - Security
  - Healthcare
  - Entertainment
  - Consumer Services
  - Water Systems
  - Load Control
  - DSM Sensors
  - Smart Appliances
Standards
Smart Grid Standards

IEEEx
Steering Committee
NTDC Smart Grid

PES IGCC

IEC SMB SG3

Ken Caird (US Committee Representative)

N.A. S.G. Roadmap

NIST
Technical Recommendations for Smart Grid Roadmap

NOTE: NIST can recommend standards but not write them

IEEE

Open Smart Grid

UClug

Coordinating with

OASIS, IEEE PES IGCC, NIST, the GWAC, NEMA

CIMug

Utility AMI
Open HAN
AMI Enterprise
AMI Network
Open ADR
AMI SEC
UtiliSec

ICM IEC 61968 & 61970 Standards Development

Vendor Implementations

IEC TC57
Smart Grid Architecture...Security

- **Authentication** – Identity user and system accessing any resource
- **Authorization** – Ensure only authorized users, systems or services can perform actions
- **Availability** – Protect systems from any known security attacks such as DoS
- **Confidentiality** – Encrypt confidential information when exchanged or stored
- **Integrity and Non-Repudiation** – Digitally sign any data that is exchanged within and outside of SG systems
- **Auditing and Compliance** – Create audit logs and monitor for various compliance requirements
Interoperability Architecture
The Smart Grid at Work

Vision, experience, investments and resources powering the brain of the 21st century grid