The smart grid at work

REAL. SMART. SOLUTIONS

Geopolitical drivers …

100%

Amount global energy demand is expected to grow by 2030

Source: Army Corp of Engineers

40%

Amount of greenhouse gas emissions for which electricity generation accounts
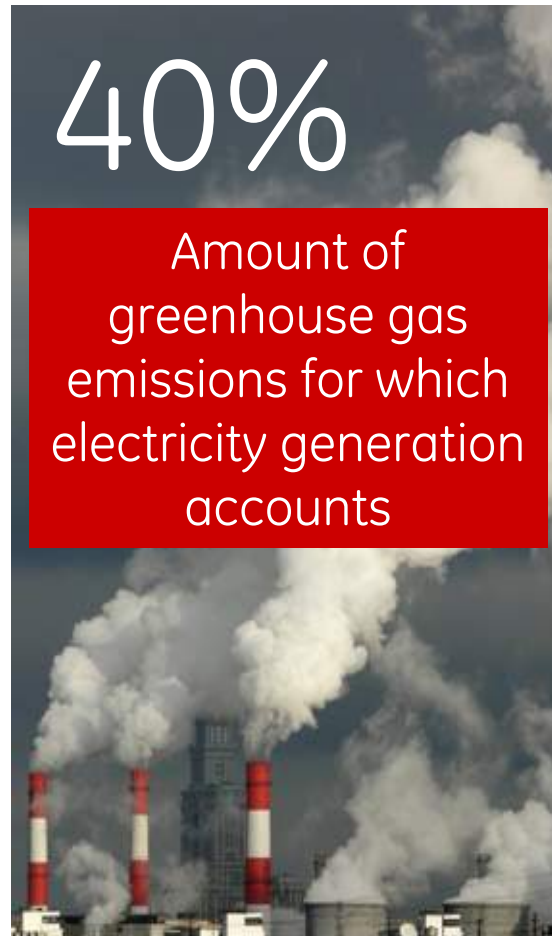
Source: U.S. Conference of Mayors resolution for Congress

170 times

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

Source: Energy Information Administration

Growth drivers …

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

4 "E's"

Smart Grid Dependencies

| Federal	State	Technological	Socio-economic
• Cap and trade	• Rate recovery	• Standards	• "Green Jobs" creation
• Transmission siting	• Decoupling	• Interoperability	• Requires "Green Investment"
• Renewable portfolio standard	• Dynamic pricing	• "Common interface model"	• Consumer engagement … awareness, incentives
• Tax incentives	• Net metering	• Cyber-security	
		• Smart loads	

Smart Grid Overview

Smart grid maximizes the potential of our existing infrastructure …

The integration of <u>two</u> infrastructures

… to provide
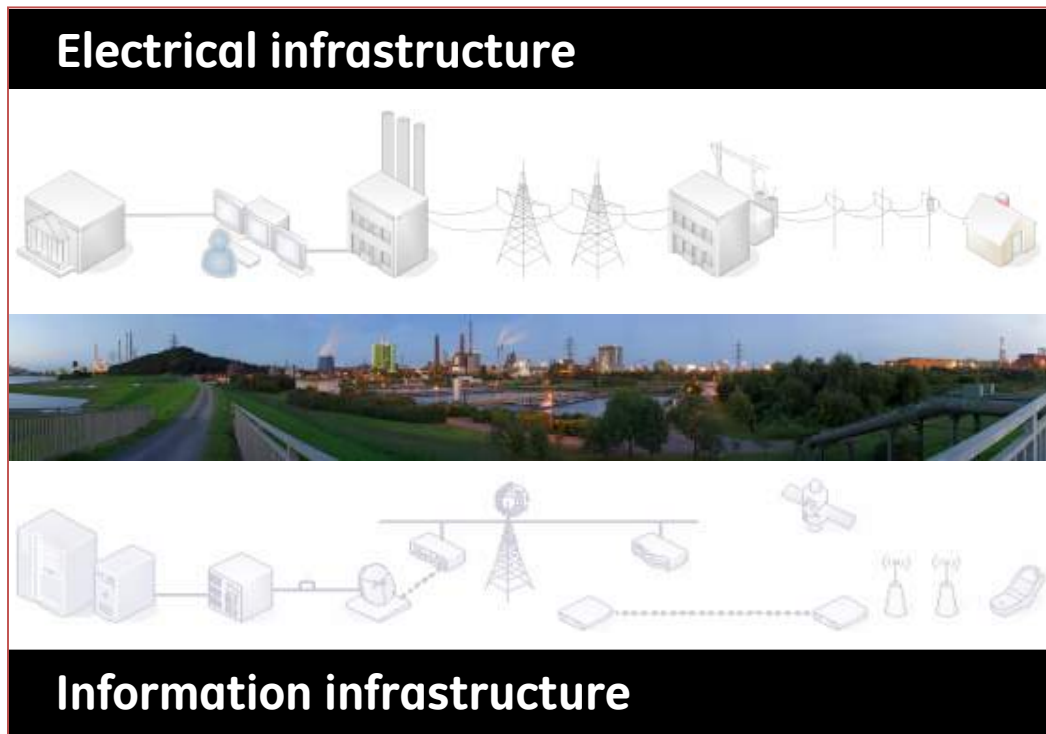
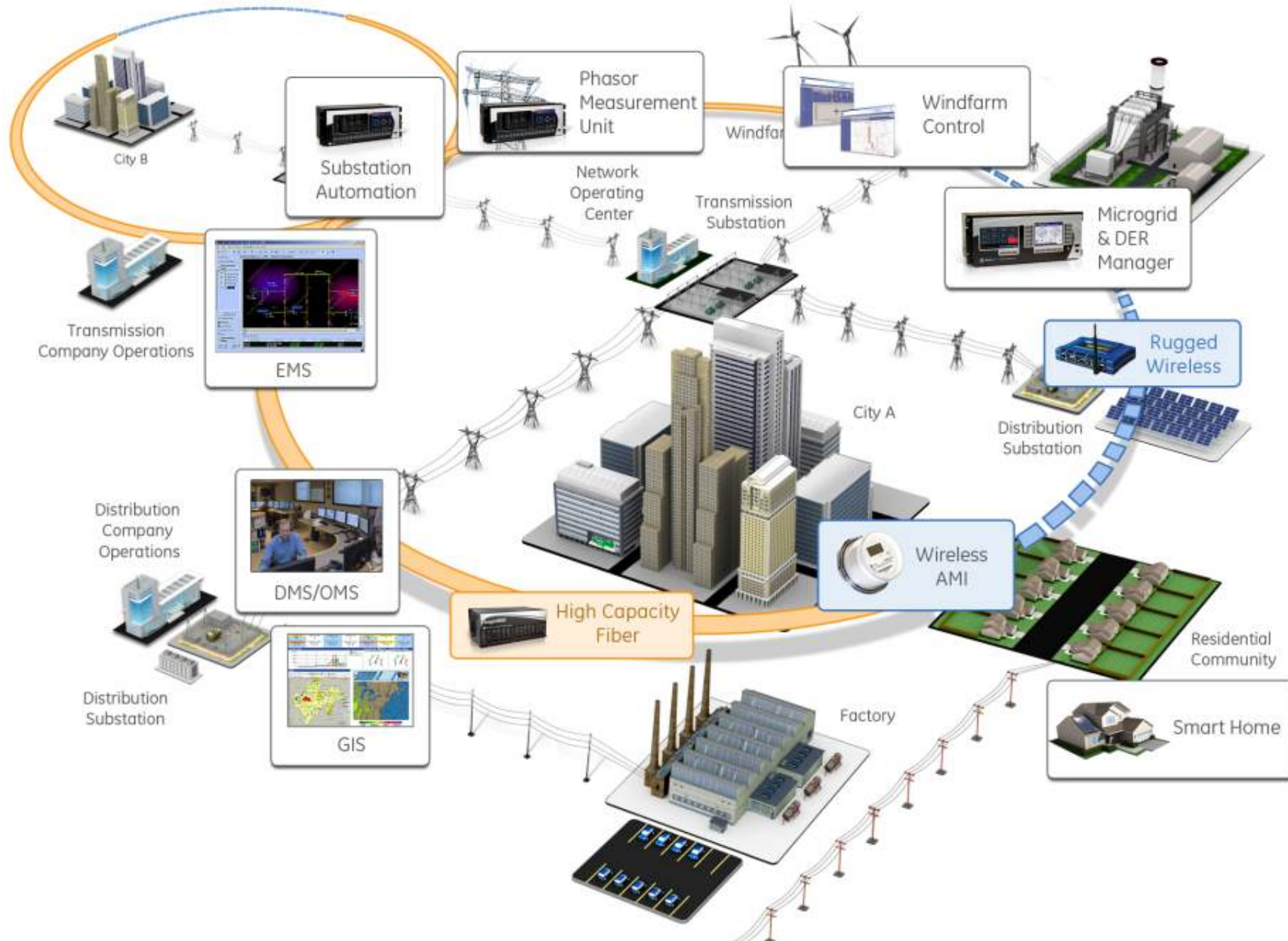Deliver a sustainable energy future through increased efficiency

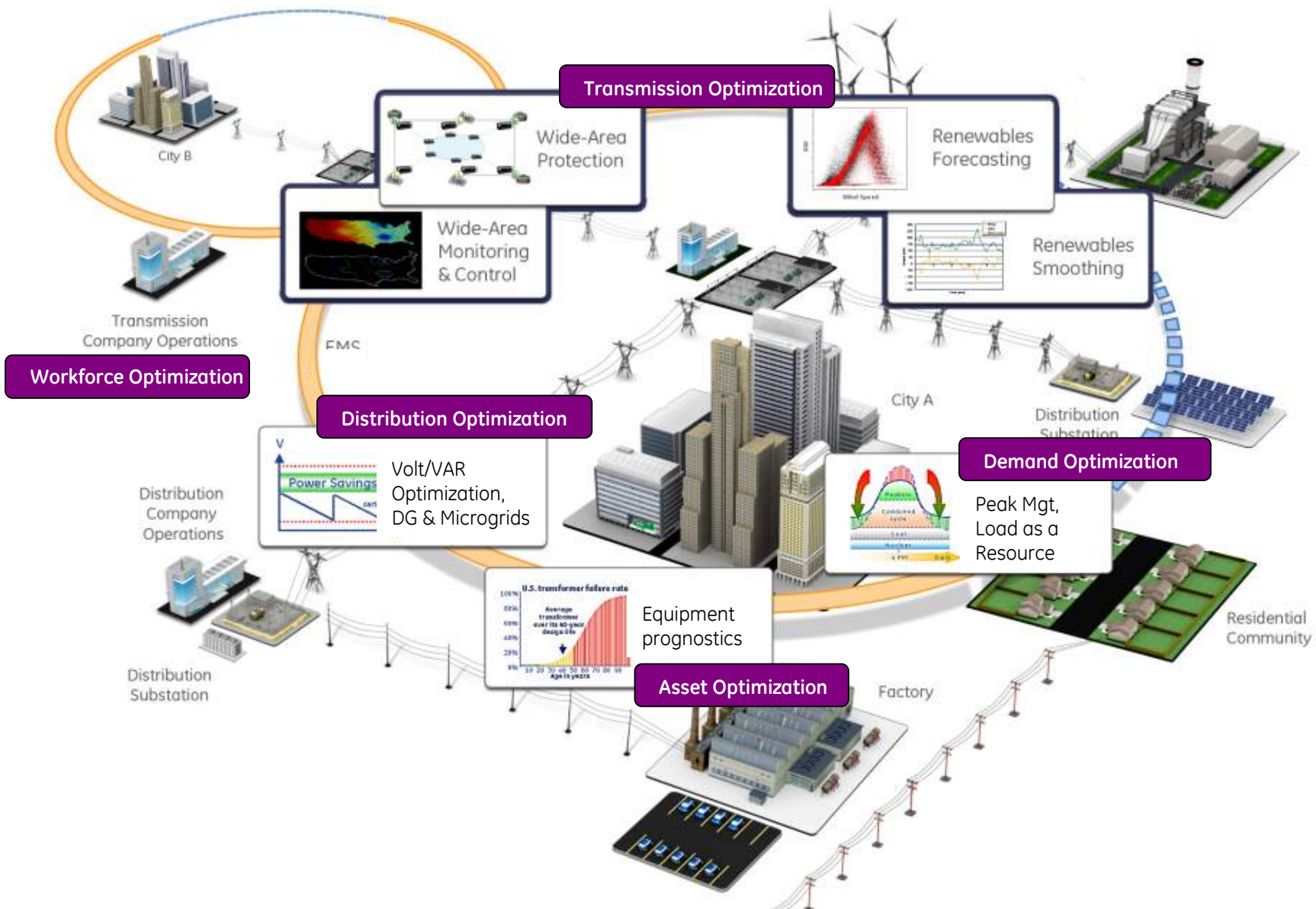Embrace more renewables & PHEVs

Informing consumers

Improve reliability

Increase operational productivity

Plan: Build Capability for Today

Goal: Flexibility for Emerging Capabilities . . .

Energy smart cities – FP&L

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

gridSMART^SM *Program*

AEP is one of the largest electric utilities in the US, delivering electricity to more than 5 million customers in 11 states

➤ gridSMART^SM - a **$150m deployment program in NE Columbus, Ohio**

- Columbus ~110k customers
- Deployment over 18 mo (2010-11)
- Benefit Analysis over 24 mo (2011-13)

- AMI / Smart Meters
- In-home Energy Mgmt / Customer Programs
- Distribution Automation
- Coordinated Volt VAR (CVVC)
- Monitoring & Diagnostics
- Transformer Asset Management
- DOE Project Enhancements
- Enterprise System Integration

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

Working together to provide customer solutions

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
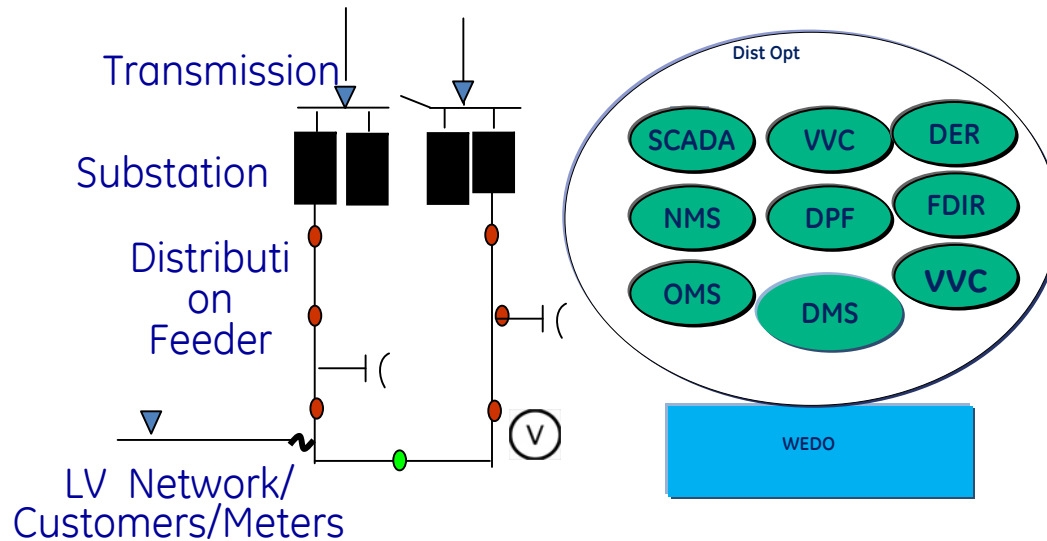
Value*

- -$7MM/yr***+
- -45K tons of CO_2 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

Distribution Optimization - Tomorrow

Operations Processes

Transmission

Substation

Distribution Feeder

LV Network/ Customers/Meters

Dist Opt

SCADA VVC DER

NMS DPF FDIR

OMS DMS VVC

WEDO

DMSOMS

Dispatch/Network Operations/ Power Quality/Crew Mgt

Integrated Solution

Tomorrow's Grid

Engineering Processes

Increased grid automation

ENABLES

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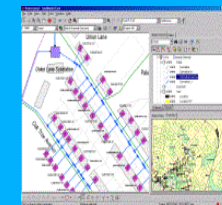- Streamlined business processes
- Optimization tools

GIS Design WMS

Design/Plan/Schedule/Crew Mgt

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 CO_2 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

What it is

Wide area protection, control and integration of centralized renewables

Why

Less energy waste and higher profit margins

Utility value/MM customers*

$5MM/year
Deferral of the capacity upgrade

+ $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

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
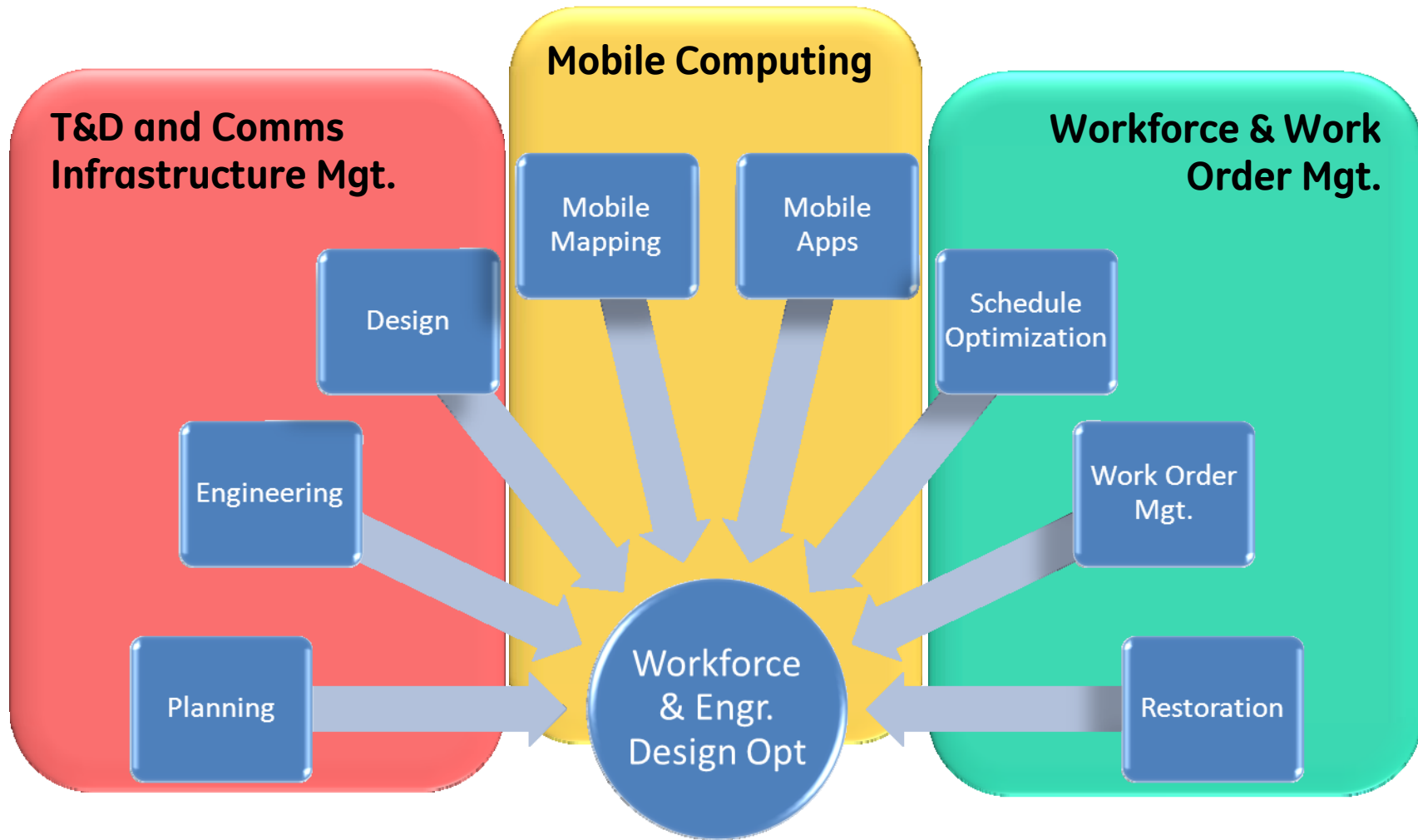
Smart Grid – a complete view

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

CO_2 Capture

BP H2 Joint Venture
Synfuels Technology

T&D

Back Office

Geospatial Asset Mgmnt
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
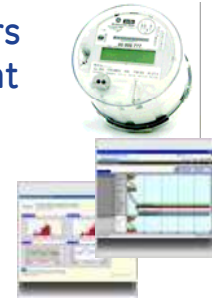Engr Procure Const Projects

Infrastructure

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

Customer

Comm & Indust

C&I Smart Meters
Water Treatment
Automation
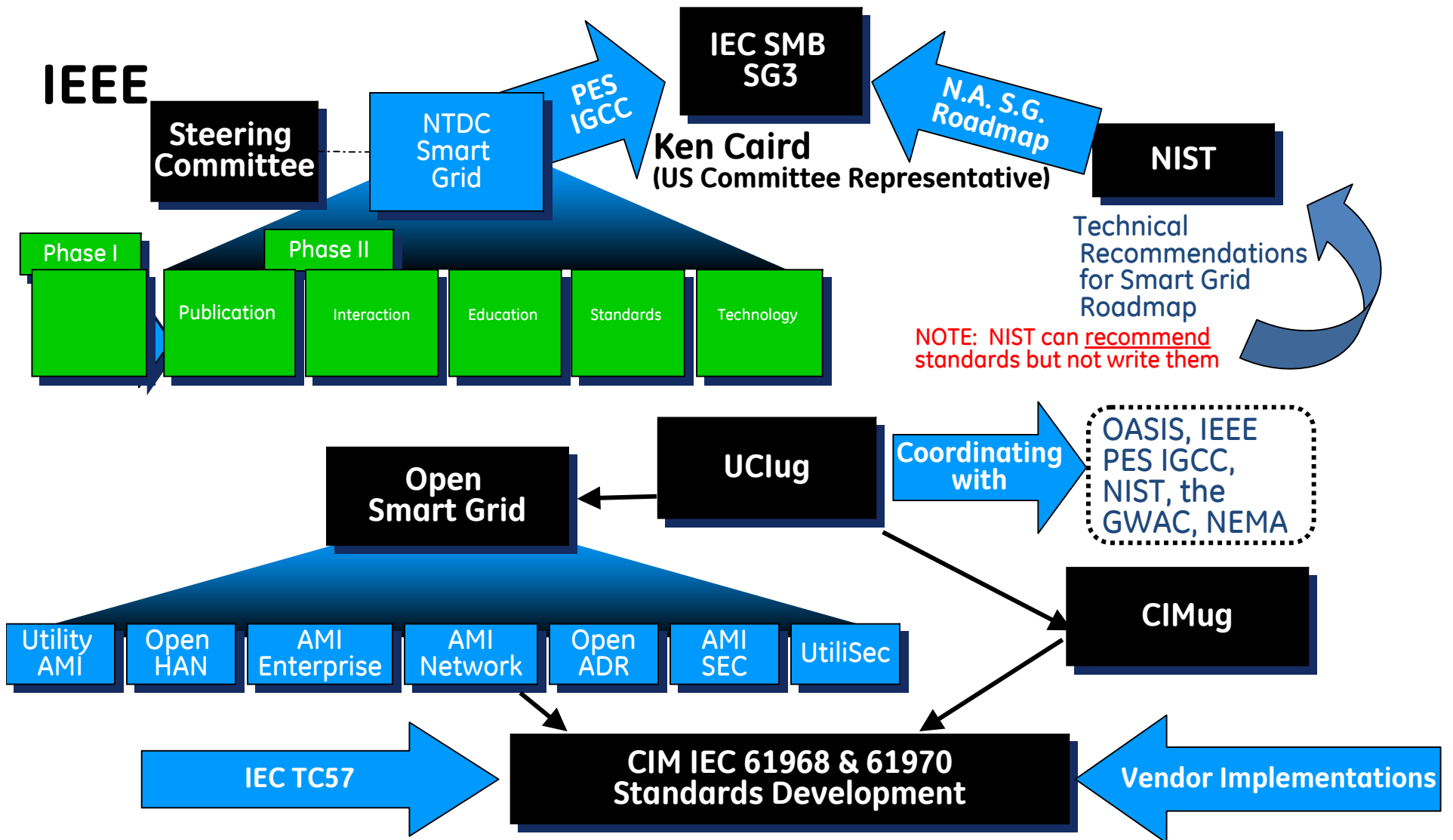Energy Finance

Residential

Smart Meters
Home Area Nets
EcoPanel
Security
Healthcare
Entertainment
Consumer Services
Water Systems
Load Control
DSM Sensors
Smart Appliances

Standards

Smart Grid Standards

IEEE

Steering Committee ---- NTDC Smart Grid

PES IGCC → **IEC SMB SG3**

Ken Caird (US Committee Representative)

← **N.A. S.G. Roadmap** ← **NIST**

Phase I | Phase II

Publication | Interaction | Education | Standards | Technology

Technical Recommendations for Smart Grid Roadmap

NOTE: NIST can recommend standards but not write them

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

IEC TC57 → **CIM IEC 61968 & 61970 Standards Development** ← **Vendor Implementations**

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
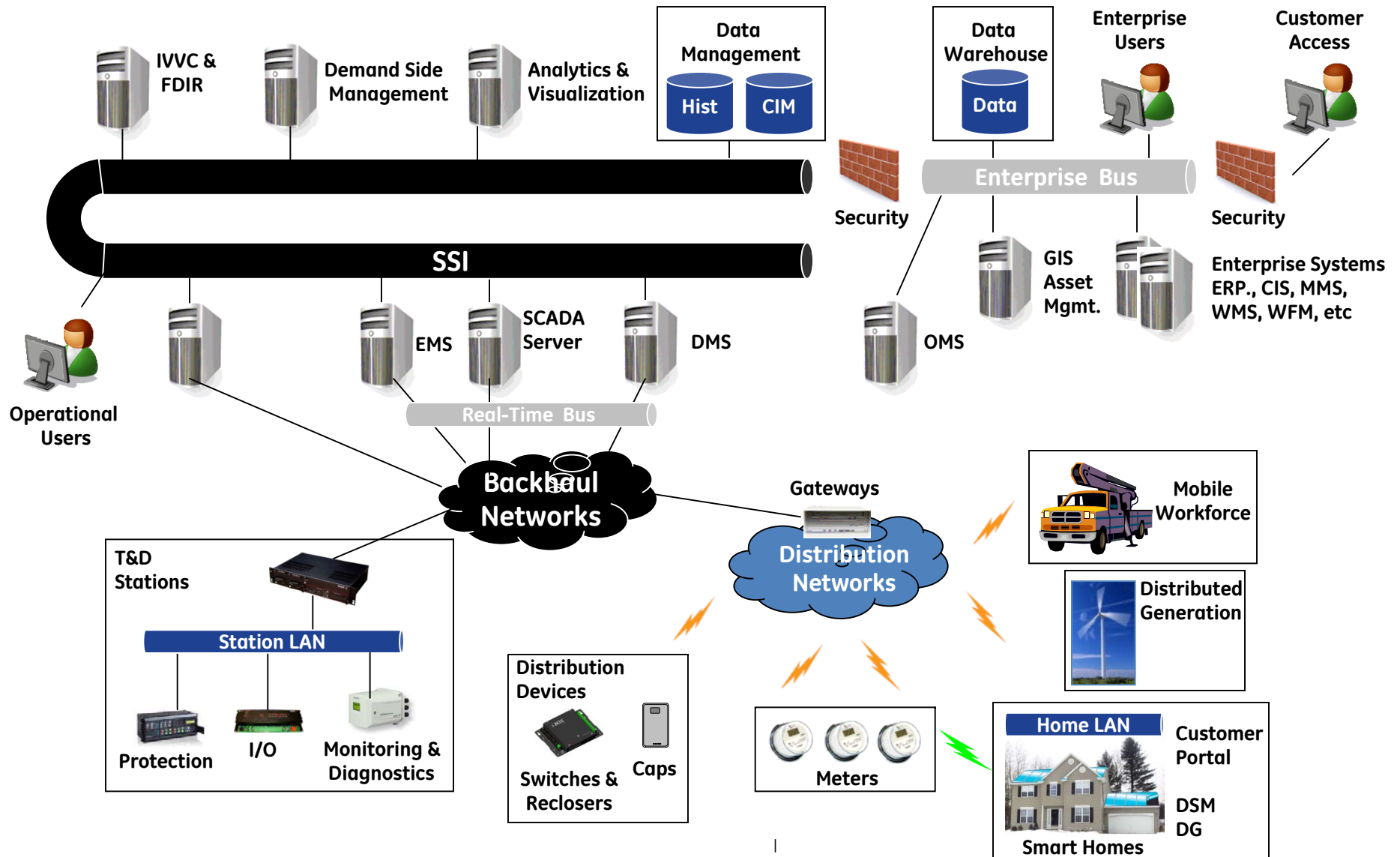
Security

Interoperability Architecture

Smart Grid Architecture

SG Architecture

The Smart Grid at Work

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