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IEEE-PES Smart Grid Super Session

Drivers for Change

Internal Drivers	External Drivers
Workforce aging	Merger Failures
Cost of assets	Market expectation for higher dividends
Drive to control costs (Capital and O&M)	Distributed generation
Assets stranded by movement of industry and population to green fields	Push by service companies to move up the food chain
Separation of P&Ls (generation, distribution, transmission, etc)	Increase in services delivered to customers
Cost containment	Private Equity
Aging Assets	Growth in energy consumption
Regulatory Drivers	**Environmental Drivers**
Focus on service levels	911 Security concerns
Performance Based Rates	Movement outward of cities (3rd generation suburbs)
Demand for fewer and shorter outages	Increased drive from renewable energy
Demand for more buried wires, less overhead	Aging of the US population
Re-regulation of the markets	Improvement in renewable technology
Emissions (Carbon, NOx, etc)	

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Smart Grid of the Future

20th Century Grid	21st Century Grid
Electromechanical	Digital
One-way communications (if any)	Two-way communications
Built for centralized generation	Accommodates distributed generation
Radial topology	Network topology
Few sensors	Monitors and sensors throughout
"Blind"	Self-monitoring
Manual restoration	Semi-automated restoration and, eventually, self-healing
Prone to failures and blackouts	Adaptive protection and islanding
Check equipment manually	Monitor equipment remotely
Emergency decisions by committee and phone	Decision support systems, predictive reliability
Limited control over power flows	Pervasive control systems
Limited price information	Full price information
Few customer choices	Many customer choices

Source: Wikipedia

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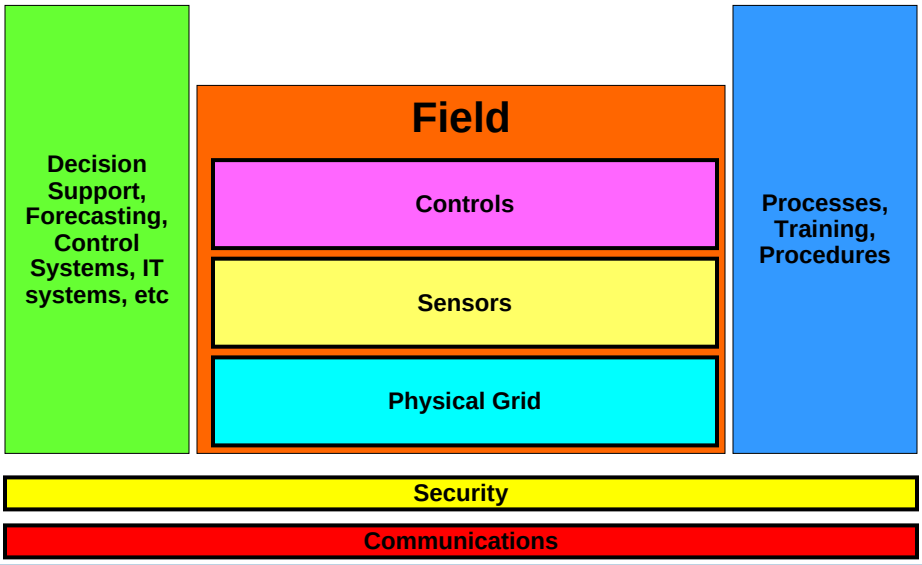
Smart Grid - Conceptually



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Over 200 technologies will impact T&D by 2025

Optimize Assets

Improve asset utilization and performance.

Extend life cycles to maximize usefulness.

Achieve cost efficiencies and revenue enhancements from existing assets.

Improve Processes

Benchmark leading practices and change current work processes to catch up or leapfrog.

Increase effectiveness along the value chain.

Proactively test and implement new technologies.

Capture New Revenue

Develop new products and service offerings in response to customer needs.

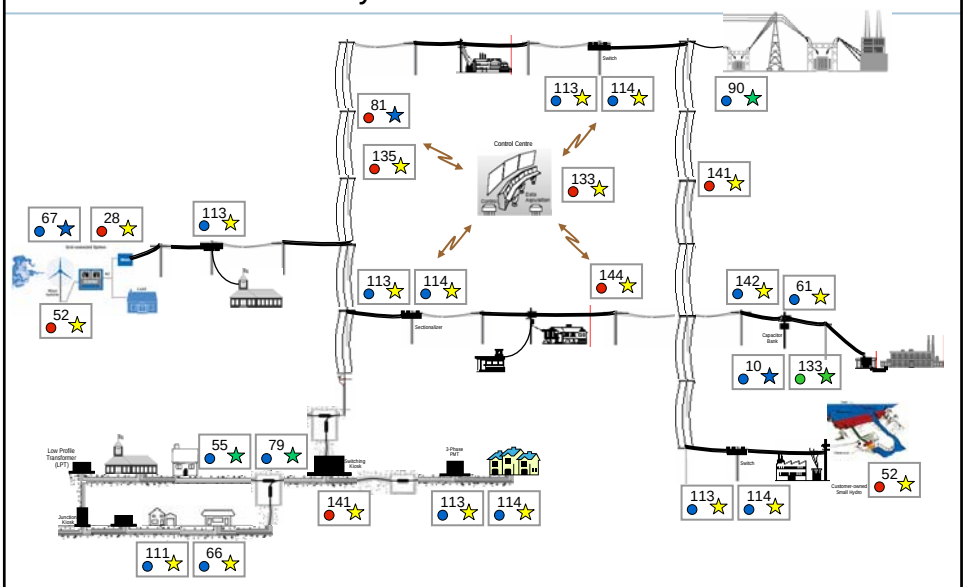
Seek "non-wires" business opportunities and establish revenue streams.

	Technology	Value Chain: Deliver: Planning	Deliver: Supply	Deliver: Design	Deliver: Construction	Deliver: Maintenance	Deliver: Operation	Deliver: End User	Asset Management Strategy: Asset Optimization	Asset Management Strategy: Process Improvement	Asset Management Strategy: New Revenue Capture
1	Agent based modeling					x	x		x	x	
2	Air conditioning, super high efficiency							x	x		
3	Automated Meter Reading (AMR), fixed read						x			x	
4	AMR; mobile read						x			x	
5	AMR; using Broadband over Power Line (BPL) or Power Line Carrier (PLC)						x			x	
6	Appliance reporting					x		x	x	x	x
7	Artificial Intelligence - Fuzzy logic					x	x			x	
8	Artificial Intelligence - True artificial intelligence						x			x	
9	Artificial Intelligence - Expert systems						x			x	
10	Artificial Intelligence - Neural nets						x			x	
11	Artificial Intelligence - Machine intelligence					x	x				
12	Asset effectiveness monitoring					x	x		x	x	
13	Asset Management IT Systems						x		x	x	
14	Asset modeling	x				x			x	x	
15	Automated workflow and sign-offs			x	x	x	x			x	
16	Batteries, Liquid		x								
17	Bio fuels		x								
18	Boring machines				x					x	
19	Broadband Over Power Line (BPL)					x	x	x		x	x
20	Buying agent, intelligent							x			x
21	Cameras, wearable				x	x	x			x	
22	Camouflage, asset	x		x	x						
23	Capacitors, electrochemical		x				x		x		
24	Capacitor, protection of						x		x		
25	Circuit breakers for feeders					x	x		x		
26	Computing, pervasive					x	x			x	
27	Conductor materials (Al vs. Cu)	x		x	x	x	x		x		
28	Corrosion prevention materials				x	x			x		
29	DC transmission to AC distribution		x	x			x		x		
30	DC distribution		x	x			x	x	x		x
31	DC in the consumer location						x	x			x
32	Demand management agent						x	x		x	
33	Demand side management on the consumer site						x	x		x	x
34	Device control via remote						x	x		x	x
35	Devices; remote control of to manage load shapes							x	x		
36	Device self-reporting					x	x		x	x	
37	Distributed workforce				x	x				x	
38	Fault anticipators						x			x	
39	Fault detection and reporting, automated						x		x	x	

Ten technology megatrends and their impact on Utilities

Technology	Distribution	Transmission	Generation	Gas
Pervasive Sensors	AMR	Line Noise	Emissions	Pipe Noise and Stress
Pervasive Communications	Truck of the Future/AMR	Enhanced SCADA		Load Management
Dist. Generation	Solar Cells	Wind Generation	Voltage Support	Gas A/C – Residential B/U
Visualization	System Loading	Incipient failure	Plant tuning	Pipeline
Massive Real-time processing	Forecasting	Load Analysis	Fuel/Emissions tuning	Forecasting
Demand Management	consumption based system design	Blackout management	Economic tuning	Pressure management
Home Automation	Appliance level demand response	Voltage control	Economic tuning	Demand time shifting – burner management
Improved Materials	Composite poles and "slippery" conduits	Carbon fiber cored lines	High temperature turbines	Liquid thin wall pipeline liners
Asset Modeling	Planning and design	Just in time replacement	Maintenance management	Pipe life expectancy
Super Capacitors	Voltage Support	Switching transient management	Base load curve management	

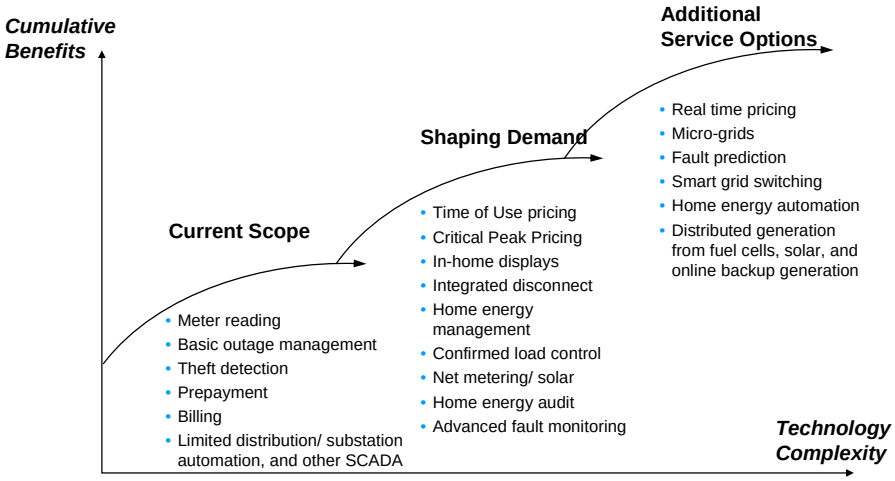
Suburban Customer Density



Sensors

Smart Grid Enabling Hardware Technologies - Sensors	Location	Communication Frequency	Permissible Latency
Smart Metering - Fixed Read System	Meter	As &When	Non-issue
Circuit Breakers for Feeders with Automatic Sensing & Re-closing	Line	As & When	Specified Window
Metering - Two Way	Meter	Constantly	Near real-time
Metering - Pre-Paid	Meter	As & When	Specified Window
Distributed Resource Interconnection	Resource	Constantly	Near real-time
Smart Metering - Fixed Network	Meter	As & When	Near real-time
Second Generation Remote Load Control Devices	End User	As & When	Near real-time
Management of Supply Remote	Resource	Constantly	Near real-time
Smart Metering - using Broadband	Meter	As & When	Near real-time
Appliance Reporting	End user	As & When	Specified Window
Fault Anticipators	Line	As & When	Near real-time
Device Control via Remote	End user	As & When	Near real-time
Device to Manage Load Shapes - Remote Control	End user	As & When	Near real-time
Device - Self Reporting	End user	As & When	Near real-time
Fault Detecting and Reporting - Automated	Line	As & When	Near real-time
Intelligent Building	End user	As & When	Near real-time
SCADA Network Penetration	Line	Constantly	Near real-time
Sensors - Wireless	Line	As & When	Near real-time
Wireline Sensors	Line	As & When	Near real-time
Auto Sensing Grid Segmentation Devices	Line	As & When	Near real-time
Smart Metering – Networked	Meter	As & When	Near real-time
Matrix Fault Current Limiter	Line	As & When	Near real-time

Smart Grid



Utility Challenge → **Integrate** existing services to new platform → **Transform** existing services using advanced communications capability → **Enable** future services and innovation

Logical IT Systems for Smart Grid

- ***Distribution Monitoring and Control System (DMCS)***
- ***Distribution Substation Monitoring System (DSMS)***
- ***Automated Feeder Switch System (AFSS)***
- ***Distributed Generation Monitoring System (DGMS)***
- ***Automated Meter Operations System (AMOS)***
- ***Meter Data Management System (MDMS)***
- ***Distribution Forecasting System (DFS)***
- ***Smart Grid Work Management System (SGWMS)***
- ***Communications Network Monitoring System (CNMS)***
- ***Minor Equipment Monitoring System (MEMS)***
- ***Smart Grid Planning System (SGPS)***
- ***Smart Grid Operational Data Store (SGODS)***

Driving to a smart grid – first steps

Determine scope of the long range effort
- Get everyone involved
- What do you want to measure
- Where is this equipment
- What information do you want
- Do not worry about technology

Use the table to determine data rates
- Do each location type separately
- Determine the number of similar points

Determine overall communications strategy
- What do you already own – is it suitable for what you need
- What regulatory requirements are you facing
- What other parts of the company can use what you are doing

Determine one or more communications technologies

Introduction to the Rest of the Session

Erich Gunther - Enernex.com
-Developers of the Smart Grid

Reza Ghafurian – Consolidated Edison
-Third Generation System of the Future

Tommy Childress - Cellnet+Hunt
-Key People

Open Discussion