U.S. SMART GRID

Situation and Perspectives

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Outline and Key Points on Smart Grid in the U.S.

Drivers towards Smart Grid

Proactive Federal Policies as a Key Components of Smart Grid Deployment

Data Analytics are new Possible Ways for Utilities to Improve Electric System’s Operations and Bring New Services to Customers

ICT Expansion Brings New Players in the Energy Sector and Allows New Energy Services

U.S. as a Leading Nation in Smart Grid Cyber Security

Standardization and Interoperability: an Obvious Need, Significant Progress, but Still not Fully Achieved

Microgrids: Expected Resilience, Reliability and Cost Effectiveness
### U.S. Smart Grid: Drivers, Goals, Means and Enablers

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Drivers toward Smart Grid

#1 - Ageing Grid. Lack of Investment

#2 - Economic Crisis

#3 - Climate Risks

#4 - ICT Expansion

#5 - ICT Vendor Lobbying, Marketing and Strategies
Driver #1: Ageing Grid. Lack of Investment

"Smart grid investment of $338 bn to $476 bn could yield $2 trillion in benefits by 2030"

"Electricity infrastructure gap estimated to be $107 bn by 2020 ($11 bn per year)"

U.S. Administration: “Power outages cost consumers about $150 bn annually”

SAIDI: 140 min. SAIFI: 1.2 (excl. major events)
Large dispersion between areas

Huge investment gap to fill in Smart Grid leverage effect expected

Source: Berkeley Nat. Lab.
“Each of us has a part to play in a new future that will benefit all of us. As we recover from this recession, the transition to clean energy has the potential to grow our economy and create millions of jobs—but only if we accelerate that transition. Only if we seize the moment. And only if we rally together and act as one nation—workers and entrepreneurs; scientists and citizens; the public and private sectors.”

—President Obama, June 15, 2010
**Driver #3: Climate Risks**

**Integrating Renewable Energies**
- 29 states have Renewable Portfolio Standards
- 21 states have incentives towards EV or PHEV
- Cap and Trade Mechanisms (CA, MA, NH, NY...)

**Storm Sandy as a Catastrophic Reminder**
- N.Y.: a **$5.7B** plan to make the state's electric system stronger, smarter and greener by 2020

**Sandy raises urgent needs:** resilience of the electric grid, and resilience of U.S. cities

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**Most States Have Renewable Portfolio Standards, Mandates, or Goals, 2010**

**Non-Hydro Renewable Energies (GW)**

Source: Reuters

Source: Bloomberg
Driver #4: ICT Expansion

2 bn internet users in 2013
Internet traffic 2013: 667 exaoctets, $10^{18}$ octets
149 trillions of Instagram pics
137 M Americans have a Smart Phone

New areas (education, finance, health, etc.) => less frontiers between activities and emergence of common techniques for data processing (ex. Hadoop), visualization tools...

Source: Semanticweb.com
Driver #5: ICT Vendor Lobbying, Marketing and Strategies

Major ICT players influence the deployment of the smart grid

Some ICT Vendors propose services in the core of utilities’ businesses

Distributech 2013 Sponsors

Duke Energy
Revenue: $20bn
Market Size: IN, KY, OH, SC, NC, FL

IBM
Revenue: $105bn
Market Size: 150 Countries

Distributech Conference, San Diego, CA, January 2013
Proactive Federal Policies as a Key Components of the U.S. Smart Grid Deployment (Smart Metering, DA, Storage, etc.)
Obama’s Fundamental Acts and Policies in Energy

Energy Independence and Security Act

2007 Clean renewable fuels, protection of consumers, products efficiency, buildings, and vehicles, CCS, modernization of the electric grid...

American Recovery and Reinvestment Act (ARRA)

2009 Jobs creation, economy stimulation, energy conservation, long term growth...
Total ARRA funding: $840 bn
Funds allowed to U.S. DOE: $35 bn

Source: U.S. DOE
Distribution of ARRA Funds for Grid Modernization

$4.5 bn allowed by the DOE’s Office of ‘Electricity Delivery and Energy Reliability’, in charge of the grid modernization

Smart Grid Investment Grant – SGIG - $3.4 bn
Helping deployment of mature technologies

Smart Grid Demonstration Program
SGDP - $620 M
Helping development of new technologies

- Workforce Training and Development Program ($100M)
- Interconnection Transmission Planning ($80M)
- State Assistance for Recovery Act related Electricity Policies ($49M)
- Enhancing State Energy Assurance ($44M)
- Interoperability Standards and framework ($12M)
- Enhancing Local Government Energy Assurance ($8M)
Smart Grid Investment Grant (SGIG)

Total value of 99 Smart Grid pilot projects: $7.8bn
(DoE funds: $3.4bn + private funds: $5.4bn)

SGIG: “Reduced uncertainty for decision makers resulting from analysis of costs and benefits”

SGIG Expenditures by Type of Project
(federal + recipient expenditures through March 2012)

Source: U.S. DOE

SGIG Projects by Type of Recipient

Source: U.S. DOE

SGIG funds have boosted U.S. smart metering and distribution grid automation
Smart Meters Deployment

Current figure: **40M+** AMI smart meters

Shipping of smart meters is declining: some states are saturated (CA), while some others lag behind

Smart meter penetration show large differences among U.S. States and Utilities

Some developments have been postponed

U.S. statistics show less than 1% opt-out
Smart Grid Demonstration Program (SGDP)

32 projects selected by the DOE

Total value of pilot projects: **$1.6 bn** (DoE funds: $0.6 bn + private funds: $ 1bn)

U.S. DOE website: SGIG and SGDP projects and budgets

Example: SCE got $40M for Irvine SG demo (SGDP)

SGDP funds have boosted new technologies (energy storage...)

Source: U.S. DOE

At-A-Glance

- **Recipient**: Southern California Edison Company (Irvine Smart Grid Demonstration)
- **HQ State**: California
- **States Benefitted**: California
- **NERC Region**:
- **Total Budget**: $79,242,416
- **Federal Share**: $39,621,206
Energy Storage Development

Numerous demonstration projects, favorable regulations, active innovation and manufacturing

Pay-for-Performance (FERC Order #755) to favor energy storage for ancillary services

Recent and strong regulations in California

CPUC’s: 1,300 MW by 2020 with energy storage volumes by Utility and type of application (transmission, distribution, residential)

Hawai’i: 12+ batteries, 30+ MW of installed capacity

California Sets Energy Storage Target of 1.3GW by 2020

After years of wrangling, California’s energy storage future starts to take shape.

Source: GreenTechMedia

Source: Sempra Generation
Demand Response

Potential peak reduction through DR: 53 GW
Different kinds of DR programs (dispatchable vs. non-dispatchable)
Different ways to monetize it
U.S. DOE puts emphasis on Dynamic Pricing through SGDP

Residential has a large but mostly untapped potential for DR

Enrolled load by type of DR program and Customer Class

Source: FERC and Brattle Group

EDF Inc. R&D Center – 2013
Federal Goals and Criteria

Smart Grids: opportunity to become the world’s leader and to boost U.S. exports

Macro-economic indicators matter for U.S. DOE

Two ways to measure Smart Grid development: “build metrics”: project status “impact metrics”: costs/benefits analysis

DOE’s six criteria:
1. Job Creation and Marketplace Innovation
2. Peak Demand and Electricity Consumption
3. Operational Efficiency
4. Grid Reliability and Resilience
5. DER and Renewable Energy
6. Carbon Dioxide Emissions

Federal level needs to get outcomes from public spending U.S. utilities currently evaluating benefits and defining their strategies

System (Program, Project, Sub-Project)

Device 1  Device 2

Device 3  Device 4

Function 1

Function 2

Function 3

Application

System Configuration & Operation
- Location
- Connection
- Direction of Influence
- Point of Impact
- Intended Use

Market Environment
- Market versus Integrated Utility
- Regulatory conditions

Application: Use of System in its Environment

Impacts: Measurable Physical Changes

Metrics: Calculated from Impacts

Costs/Benefits: Monetized Impacts

Measure  Calculate (algorithms)  Monetize

Impacts  Metrics  Costs/Benefits

Source: EPRI

Buy American!

Public Guidance on Implementation, Documentation, Non-compliance and Enforcement
March 2011

Fed Govt.

2013

EDF Inc. R&D Center – 2013
Data Analytics are new Possible Ways for Utilities to Improve Electric System’s Operations and Bring New Services to Customers
Data Analytics for Utilities

**Data Analytics:** technologies, services and processes that enable utilities to transform data into actionable insights

“...the big question is what to do with all of this data. How do you use this data, and how do you present this data to someone that could actually use this data? Those are really, really tough questions that most utilities are facing right now if they’re deploying smart meters.” - Mary Rich, smart grid Systems Manager, CenterPoint Energy

Only the half of the utilities which have installed smart meters analyze the data collected from the meter (GTM Research)

The idea is not that new but there are significant improvements in underlying technologies: Moore’s law, GIS, high perf. computing, connectivity, mobility, data mining, visualization...

Source: EPRI

EDF Inc. R&D Center – 2013
Data Analytics for Utilities

Rapid development of customer applications based on data analytics

Identification of numerous use cases for power system optimization

South Calif. Edison’s Budget Assistant

A way to make customers understand and confirm the benefits of the smart grid?

Some low hanging fruits, but various conditions for full value assessment: technical, management, security requirements, privacy, regulations…

Outage Detection
Customer Information
Post Outage Recovery
Field Crew Data Access
Cond. Based Maintenance
PQ Monitoring

Load Profiling
Revenue Protection
Automatic Modeling
Situational Awareness

EDF Inc. R&D Center – 2013

* with credit to Ron Parsons, Southern Company
ICT Expansion Brings New Players in the Energy Sector and Allows New Energy Services
New Market Players and New Services

Smart meters, utilities’ APIs, Green Button: new enablers to develop energy services market

U.S. DOE is very active: Apps for Energy challenge, Green Button...

- Standardization
- Easy access
- Easy to manipulate
- Low Cost

Foster creativity to develop new customer services

People Power has mobile applications that allow users to view energy consumption data from their phones

Plotwatt develops computer algorithms that can detect changes in energy consumption patterns and can make an assumption on what device was turned on at any moment

EDF Inc. R&D Center – 2013
New Market Players and New Services

New services of consumption visualization managed by Distribution Companies

New market players exploit IT development in Smart Grids to penetrate the energy sector

For Utilities: data analytics, visualization...
For End-users: energy use, ways to reduce it...


Green Button and HAN (Zigbee...) present opportunities for new players to develop products for end-users independently. SaaS, B2C
U.S. as a Leading Nation in Smart Grid Cyber Security
Cyber Security and Privacy – Situation in the U.S.

15 years of U.S. Critical Infrastructures Cyber Security (1998) NISTIR 7628 starting point of Smart Grid Security & Privacy

Enforced regulation in the U.S.:
- NERC CIP for Generation, Transmission (in place)
- States Utility Councils for Distribution (in progress)

Electric Utilities can get significant fines if not compliant

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International Initiatives: ISO/IEC 27019
Towards an international standard for energy industry?

ISO/IEC DTR 27019
Information security management guidelines based on ISO/IEC 27002 for process control systems specific to the energy industry

U.S. regulation is already in place. Towards a unified international standard?
Government involvement (White House)
Certification and compliance
Privacy is a real concern and a possible obstacle to adoption

Collaboration and convergence: EPRI Smart Grid Cyber Security and Privacy collaboration has 30+ members

U.S. DOE, National Labs, R&D Centers, and Academics deeply involved (mostly specific projects and lab. Activities)

Cyber security of critical infrastructures is a top priority for U.S. Government
Cyber Security and Privacy - Market

Smart Grid Cyber Security Market to Reach $3.7Bn by 2015 (Pike Research), $1.5Bn in North-America

Compound Annual Growth Rate 2011-2018: ~ 10%

EPRI: $3.7M budget in 2013 (estimate)

Emerging startups:
• Cylance announced $15M funding
• Morta Security raises seed funding

Growing market attracting now major investors (Koshla Ventures, etc.)
Standardization and Interoperability: an Obvious Need, Significant Progress, but Still not Fully Achieved
Standards Supporting Smart Grids

A clear trend towards more interoperability and standardization. EPRI representing utilities in standardization groups

Utilities have learned that architectures and standards are not always sufficient to implement the desired plug-and-play integration

Emerging standards like OpenADR2.0 (a, b...), CEA-2045, EUI (Green Button)... with expansion at international level

U.S. utilities realize that they have to get more involved in standardization working groups, through EPRI or directly

Source: http://www.gridwiseac.org
Microgrids: Expected Resilience, Reliability and Cost Effectiveness
Microgrids: Expected Resilience, Reliability and Cost Effectiveness

Lots of experiments and developments: universities, utilities, military bases...

Universities / campus
- UC San Diego
- Cornell University
- Illinois Institute of Technology
- Howard University

Utilities
- SMUD
- SDGE
- AEP American Electric Power

Military bases + field operations
- Los Angeles Air Force Base
- Fort Bragg
- Camp Pendleton, CA
- Fort Bliss, Texas
- ExFOB

Over 40 military bases either have operating microgrids or are planning and demonstrating microgrids
Microgrids: Expected Resilience, Reliability and Cost Effectiveness

Main Drivers (civil + military)
• Security / independence
• Resilience toward climate events
• Reliability of legacy electric grid
• Cost of in-house generation vs. grid
• Market opportunities: DR markets

Specific Military Drivers
• Resilience toward cyber attacks
• Renewable: achieving DOD's goals
• Reducing weight in field operations
• Saving human losses (fuel convoys)

U.S. DOE and DOD in favor of Microgrids

Market Development (world, Navigant)
$40Bn in 2020 / CAGR: 17%

Many questions remain
• Cost effectiveness?
• Efficient local optimization?
• Security assessment?
• Who gets the benefits?
• Utilities’ grid costs allocation?
• Quality of service?
• How to ensure competition in supply?

Active Vendors
Thank You for Your Attention!

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