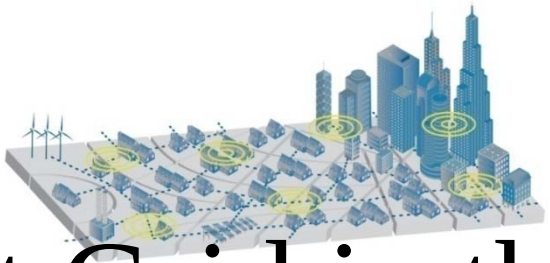


Smart Grid in the US: Status, Projects and Policies

美国智能电网：现状、项目与政策

Lisa Schwartz, 丽莎·施瓦兹, RAP

Beijing, China – May 2010

The Regulatory Assistance Project

China ♦ EU ♦ India ♦ United States

Smart Grid Key Points
智能电网要点

- Smart grid will not deliver energy efficiency, renewable energy or emissions reductions without smart policies
  - For example, smart grid can help consumers understand how to save energy in their homes and businesses. But to use that smart capability requires policies that put the grid company in the energy efficiency business.

- 没有智能政策，智能电网就不能实现能源效率、可再生能源或减排。
  - 例如，智能电网可以帮助消费者了解如何在家庭和公司中节约能源。但是，要利用这种智能性能，需要出台相关政策，使电网公司参与能源效率事业。

Smart Grid and US State Regulators
智能电网与美国各州监管机构

- Some state regulators are skeptical that smart grid technologies are worth the cost.
- Some are skeptical about the benefits of high-voltage, long-distance transmission lines.
- But *smart policies* provide benefits with, or without, smart grid/strong grid.

- 有些州的监管机构对智能电网技术是否物有所值持怀疑态度。
- 有些州的监管机构对高压远距离输电线路的效益表示怀疑。
- 但是，不管有没有智能电网/坚强电网，*智能政策*都可以产生效益。

Status in US Today
美国的现状

- 7.95 million advanced meters
- 37 gigawatts of peak demand reduction through demand response
- 161 synchrophasors
- Demonstration projects including distribution automation, micro-grids, energy storage

- 7,950,000个先进电表
- 通过需求响应减少峰荷需求37吉瓦
- 161个同步相量装置。
- 示范项目，包括配电自动化、微型电网、能源储存。

来源：联邦能源管理委员会需求响应与先进计量评估，2009年9月；北美同步相量启动项目，同步相量技术指导说明，2009年3月

Sources: FERC Assessment of Demand Response & Advanced Metering, September 2009; North American SynchroPhasor Initiative, Synchrophasor Technology Roadmap, March 2009

New Federal Smart Grid Funding
新联邦智能电网基金会

Funding (millions US$)

- Smart Grid Investment Grants - $3,400
- Smart Grid Regional Demonstrations - $615
- Standards/Interoperability Framework - $10
- Some of the funding for state regulators ($50) and state planning ($55) is for smart grid

资金（百万美元$）

- 智能电网投资拨款- $3,400
- 智能电网区域示范- $615
- 标准/互操作框架- $10
- 一些拨给州监管机构（$50）与州计划（$55）的资金是用于智能电网的。

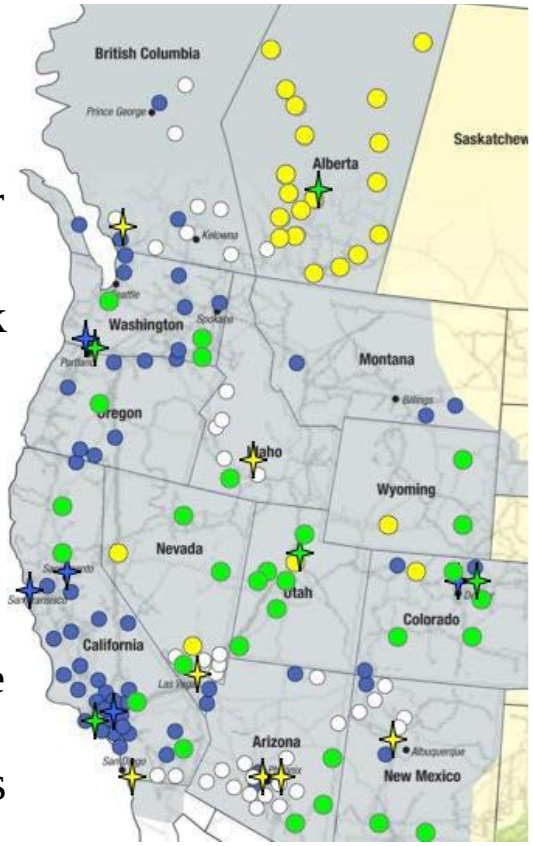
Smart Grid Investment Grants
智能电网投资拨款

Smart Grid Systems and Equipment	Number of Units
Networked Phasor Measurement Units	877
Smart Transformers	205,983
Automated Substations	671
Load Control Devices	176,814
Smart Thermostats	170,218
Smart Meters	18,179,912
In-Home Display Units	1,183, 265
Charging Stations	100

智能电网系统与设备	设施数量
联网相量测量装置	877
智能变压器	205,983
自动变电站	671
负荷控制装置	176,814
智能调温器	170,218
智能电表	18,179,912
家庭用能源显示设备	1,183, 265
充电站	100

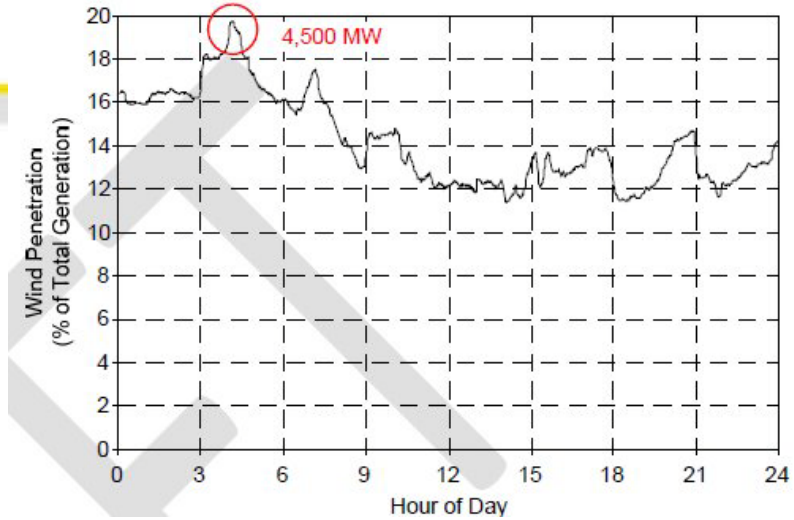
Western US Synchrophasor Project美国西部同步相量项目

- $108 million project (half from USDOE) to install 250 phasor measurement units and network
  - Sample grid 30 times per second
  - High-speed communications deliver data
  - Data processors collect, synthesize and archive data
- Real-time alerts
- Auto-response
- Predict and analyze stability problems

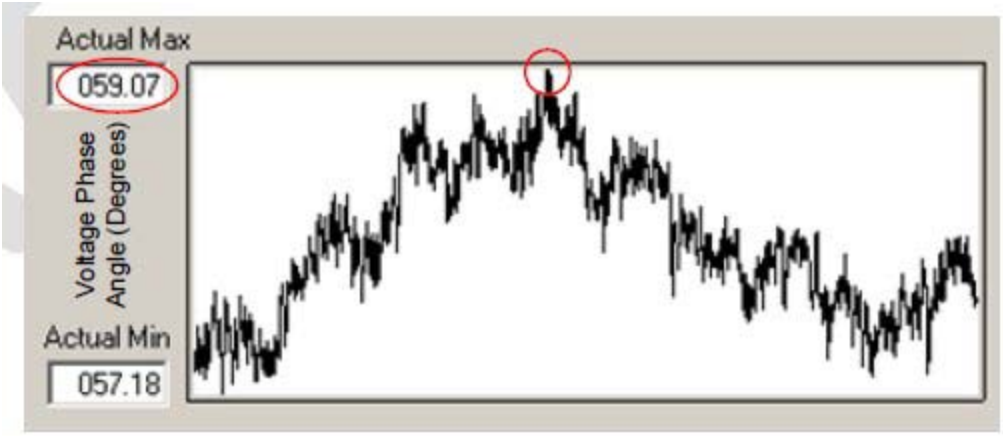


- $ 1.08亿的项目（其中一半来自美国能源部），安装250个相量测量装置与网络。
  - 电网每秒取样30次
  - 高速通讯设备传输数据
  - 数据处理机对数据进行收集、合成与存档。
- 实时报警
- 自动响应
- 预测及分析稳定性问题

Synchrophasors and Wind
同步相量与风能



- ERCOT wind event, 3/7/09
- Top graph shows wind production reached 20% of total generation in Texas
- Bottom graph shows voltage phase angle during 5-minute peak generation period reached nearly 60 degrees (typically 30 degrees)



- 德州电力可靠性委员会风能事件，2009年3月7日
- 上图显示风电产量达到德克萨斯州电力生产总量的20%
- 下图显示五分钟电力生产高峰期电压相角接近60度（通常为30度）。

Source: Dr. Mack Grady, University of Texas-Austin, and David Costello, Schweitzer Engineering
来源： 麦克▪格雷迪博士，德克萨斯大学奥斯汀分校，以及戴维▪科斯特洛,施韦策工程实验室

Smart Grid City – Boulder, Colorado
智能电网城市-科罗拉多州博尔德市

- Funding: private
- 2-way Broadband to homes
- Advanced meters, peak pricing, smart thermostats
- Customer data on Internet and advanced controls
- Automated substations, feeders, outage detection
- Dynamic voltage and reactive power optimization
- Distributed energy sources

- 资金：私人
- 连接家庭的双向宽带
- 先进电表、峰时电价、智能调温器
- 在线用户信息与先进控制技术
- 自动变电站、配电线、停电检测器
- 动态电压与无功优化
- 分布式能源

Energy Efficiency and Smart Grid
能效与智能电网

- Optimize voltage and reactive power on distribution systems
- Information-driven behavior changes
- Better evaluation
- Continuous building diagnostics

- 优化配电系统电压与无功功率
- 信息驱动行为改变
- 改进评估
- 持续的建筑物诊断

Demand Response and Smart Grid
需求响应与智能电网

Traditional Programs	传统项目
➢ Typically grid co. control ➢ Focused on a few end uses ➢ Use incentive payments	➢ 主要由电网公司控制 ➢ 关注少数终端使用 ➢ 采用奖金
With Smart Grid	**智能电网**
➢ Customer control ➢ All end uses ➢ Response motivated by pricing that varies by system, market conditions	➢ 用户控制 ➢ 所有终端 ➢ 价格根据系统和市场情况而变化，从而激励响应。

Distributed Generation and Smart Grid
分布式发电与智能电网

- Micro-grids disconnect from distribution company system during outages
  - Renewable systems at businesses and homes continue to provide power
- Example: Fort Collins, Colo.
  - Zero Energy District - Create as much energy as city uses
  - Peak reductions on feeders using distributed resources
  - Advanced meters/home control
  - Distribution automation

- 停电时，微型电网与配电公司系统断开
  - 公司与家庭可再生能源系统继续供电。
- 案例：科罗拉多州科林斯堡
  - 零能源区——尽量实现能源自给自足
  - 利用分布式资源减少馈线峰荷
  - 先进的电表/家庭控制
  - 配电自动化

Renewable Energy and Smart Grid
可再生能源与智能电网

- Dynamic integration of wind and solar
  - Awareness of grid conditions
  - Voltage support and reliability
- Better use of forecasting data
- Monitor line loading and wind curtailment
- More system flexibility
  - Demand response, PHEVs
- These benefits not needed until very high wind/solar penetrations are reached

- 风能与太阳能动态组合
  - 了解电网情况
  - 电压支撑与可靠性
- 更好地利用预测数据
- 监测线路负荷与风电输出限制
- 提高系统灵活性
  - 需求响应，电动汽车
- 在达到很高的风能/太阳能渗透率之前，不需要这些效益。

Potential Energy and Emissions Reductions
潜在节能与减排

- Consumer Information/Feedback (3%)
- Continuous Building Diagnostics (3%)
- Measurement and Verification for Efficiency Programs (1%)
- Shift Load to More Efficient Power Plants (less than 0.1%)
- Support Electric Vehicles Without Adding to Peak (3%)
- Advanced Voltage Control That Reduces Distribution System Losses and Consumer Loads (2%)
- **12% TOTAL REDUCTION**

- 用户信息/反馈（3%）
- 持续的建筑物诊断（3%）
- 效率项目测量与验证（1%）
- 向效率高的发电厂转移负荷（少于0.1%）
- 在不增加峰荷的前提下支持电动车（3%）
- 先进的电压控制，减少配电系统损失与用户负荷（2%）
- 总量减少12%

USDOE-funded study by Pacific Northwest National Laboratory, 2010. Estimates for the year 2030.
美国能源部资助的研究项目，西北太平洋国家实验室，2010。关于2030年的估计

Potential Energy and Emissions Reductions
潜在节能与减排

- Assumes 100% of necessary smart grid technologies installed
- Lower penetration of technologies yields proportionately smaller energy and emissions reductions
- Does not consider cost-effectiveness

- 假设必要的智能电网技术100%安装
- 技术的渗透率较低，获得的能源与减排收益也相应较少。
- 不考虑成本效益

Smart Grid Needs Smart Policies
智能电网需要智能政策

- Smart grid can increase energy efficiency, better integrate variable renewable resources, and support electrification of the transportation sector.
- Smart policies, regulatory support and targeted programs are needed to achieve these potential clean energy benefits.

- 智能电网可以提高能效，进一步整合各种可再生资源，支持交通运输行业的电气化。
- 要达到这些潜在的清洁能源效益，需要智能政策、监管支持与专项计划。

Smart Policies: Examples

Smart Capabilities	Smart Policies
Micro-grids provide power during grid co. outages	Support investment in clean distributed resources, simplify interconnection standards and procedures
Dynamic integration of wind and solar resources	Better planning for renewable resources, require grid company investments
Continuous building diagnostics	Require grid company to invest in energy efficiency measures
Improve evaluation of efficiency measures	Develop procedures to measure and verify energy program savings, continue improving program design
Increase demand response	Special prices or incentives, consumer access to energy usage data, support for automated controls
Improve energy efficiency for distribution systems	Performance-based regulation or incentives for grid company to optimize voltage and reactive power

智能政策：举例

智能性能	智能政策
电网公司停电时由微型电网供电。	支持对分布式清洁资源的投资，简化互连标准与程序
风能与太阳能资源的动态整合	改进对可再生资源的规划，需要电网公司投资。
持续的建筑物诊断	需要电网公司投资能效措施
改进效率措施评估	制定测量及验证能源项目节能量的程序，继续改进项目设计。
增加需求响应	特殊价格或奖励，用户可访问能源使用数据，支持自动化控制。
改进配电系统能效	通过基于绩效的监管或奖励，促进电网公司优化电压与无功功率

For More Information

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EXTRA SLIDES
附加内容

USDOE to Report Results
美国能源部报告结果

Types of US Federal Investments

- Equipment manufacturing
- Customer systems
- Advanced metering
- T&D systems
- Integrated/cross-cutting systems

Expected Results

- Jobs and innovation
- Reduced loads and consumption
- Operational efficiency
- Grid reliability and resilience
- Distributed and renewable energy
- Lower emissions

美国联邦投资类型

- 设备生产
- 用户系统
- 先进测量
- 输配电系统
- 集成/跨行业系统

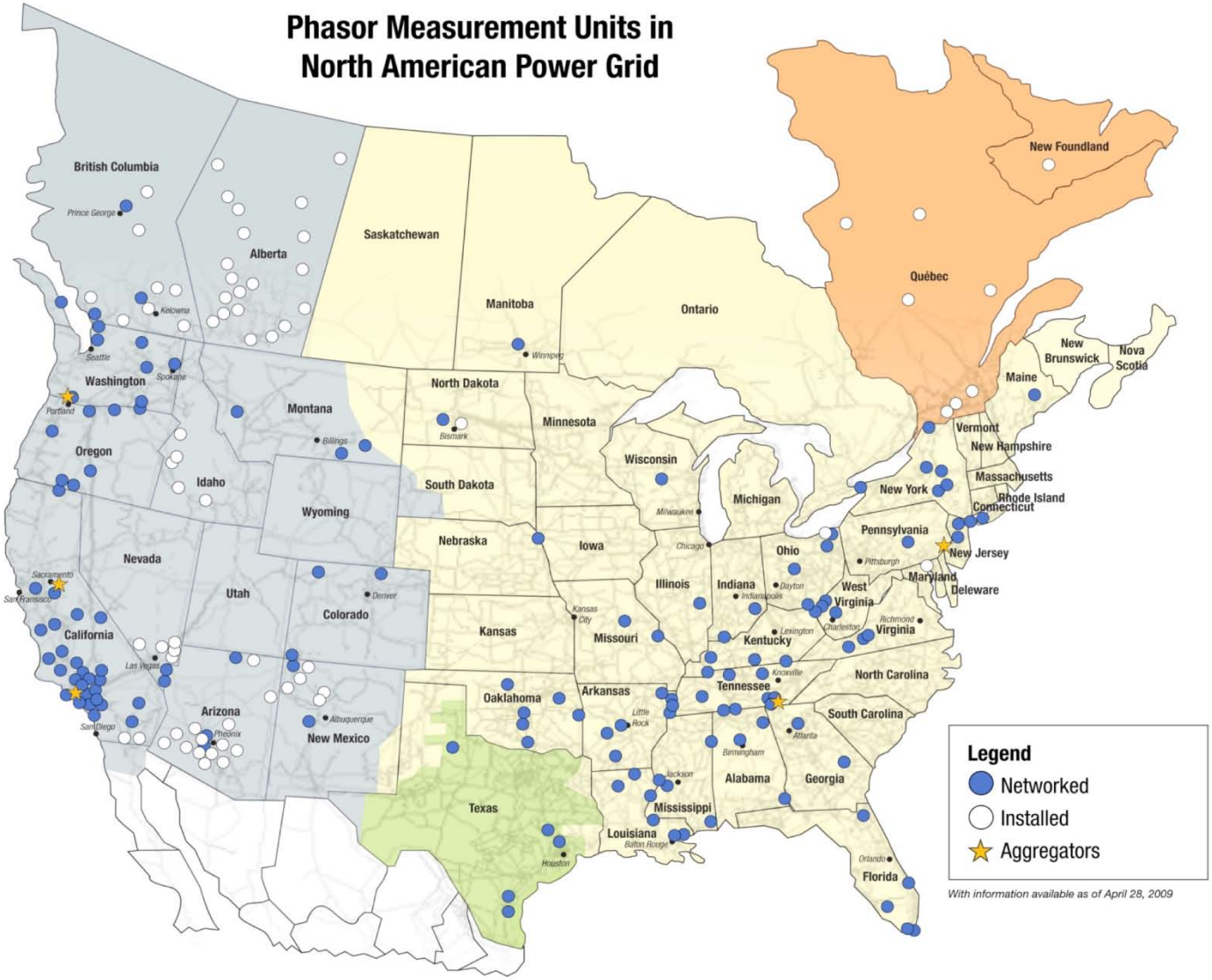
期待的结果

- 工作机会与创新
- 减少负荷与消耗
- 运行效率
- 电网可靠性与弹性
- 分布式与可再生能源
- 减少排放

Vermont Utilities' Smart Grid Project
佛蒙特公共事业公司的智能电网项目

- $138 project (half from USDOE)
- Wireless broadband from substations to devices and for data backhaul
- More than 300,000 smart meters
- Dynamic pricing, in-home energy displays, smart thermostats and appliances, energy data on Internet
- Grid automation (fiber, sensors, breakers, reclosers) integrated with metering and outage management systems, conservation voltage reduction
- Dynamic control of water heating

- $138的项目（其中一半来自美国能源部）
- 连接变电站与装置、用于数据传输的无线宽带
- 超过300，000个智能电表
- 动态定价、家庭能源显示器、智能调温器与智能家电、在线能源数据
- 整合电网自动化（光纤、感应器、断路器、自动开关）和测量与停电管理系统、降压节能。
- 水暖动态控制



Source: North American SynchroPhasor Initiative
来源：北美同步相量启动项目

Example Smart Grid Policies: California
智能电网政策举例：加州

- Determined required functions for meters
- Laid framework for review of cost-benefit analysis
- Set vision for pricing options
- Tested several types of pricing for residential and small business customers
- Developed demand response programs for customers

- 确定电表所需功能
- 制定成本收益分析评审框架
- 构想不同定价方案
- 测试数种针对居民住宅和小企业用户的价格类型
- 制定针对用户的需求响应项目

Example Smart Grid Policies: California
智能电网政策举例：加州

- Resource loading order
  1. Efficiency/demand response
  2. Renewable resources
  3. Conventional generation and transmission
- New state law requires utilities to submit smart grid plans for approval.
- New rules ensure customers and approved service providers can access energy usage data.

- 资源负载顺序
  1. 效率/需求响应
  2. 可再生资源
  3. 传统发电与输电
- 加州新的法律要求公共事业公司提交智能电网计划以求批准。
- 新的规定确保用户与经过批准的服务供应商可以访问能源使用数据。

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RAP is committed to fostering regulatory policies for the electric industry that encourage economic efficiency, protect environmental quality, assure system reliability, and allocate system benefits fairly to all customers.

RAP致力于在电力行业中发展和促进可以鼓励经济效率、保护环境质量、确保系统可靠性以及让所有用户公平地享有系统效益的监管政策。