The Federal Role in Smart Grids

Presented May, 2010
2010年5月
Beijing, China
中国北京

Jon Wellinghoff
Chairman
Federal Energy Regulatory Commission

乔恩·威灵霍夫
主席
联邦能源管理委员会

Transmission 输电

- Integrating new generation is not only an issue for wind resources. Large coal and nuclear generation have integration costs, too
- Proactive transmission planning on large-scale clearly necessary
  - The wind resource is distant from load in China and U.S.
  - 1/3 of wind capacity installed in China is reportedly not grid-connected, but this is temporary condition
  - 10+ GW/yr additions require planning
- Transmission expansion may support other generation, but dispatch and curtailment policies are needed to deliver emissions reductions
- The US has much to learn from China about how to plan and build transmission for wind

- 并网问题不仅仅是风电面临的问题，大规模煤电和核电也同样存在并网成本问题
- 现阶段明显需要积极主动的大规模输电规划
  - 中国和美国的风能资源都远离负荷中心
  - 报告显示，中国三分之一的风电装机容量没有并网发电，但这只是暂时的情况
  - 每年超过千万千瓦的新增风电装机需要输电规划
- 输电网扩展可以支持不同类型的发电，但是需要制定合理的调度和限发政策，以减少排放
- 中国在规划和建设风电输电网络方面有很多经验值得美国借鉴

Wind Forecasting Critical
风功率预测很重要

- Consider establishing a central wind forecasting system that would cover the entire country (or, at least multiple provinces)
- Will need multiple time levels of wind forecasts (e.g., hourly, day-ahead, week-ahead and month-ahead)
- Will likely need ramp forecasts as well (more difficult to do and should be in addition to regular wind forecast)
- Consider using an ensemble of multiple wind forecasts
  - Some wind forecasts more tuned to certain wind patterns than others
  - Increase in accuracy may offset higher costs

- 考虑建立一个覆盖全国（至少覆盖多个省份）的中央风功率预测系统
- 需要多个不同时间层次的风功率预测（如每小时、提前一天、提前一周和提前一个月）
- 很可能也需要爬坡预测（难度更大，应在常规风功率预测基础上，增加爬坡预测）
- 考虑采用多种风功率预测的组合办法：
  - 某些风功率预测更侧重某种风力类型
  - 预测准确性的提高可以抵消额外成本

Grid Codes and Other Items
并网标准和其它事项

- Strong and continually updated grid code will encourage advanced wind turbines
  - Can provide reactive power or frequency reserves
  - Can ride through low-voltage faults or other grid events
  - Newer wind turbines can also contribute to system inertia
- None of this is free and will not be part of standard wind turbine installations unless required, through grid code, or encouraged through extra payments

- 加强并不断修订并网标准，促进风机技术进步
  - 可提供无功或频率备用
  - 可以在低电压或其它电网故障下维持运行
  - 新一代的风机也有助于系统惯性
- 上述技术需要资金投入，开发商不会主动增加这些技术，除非并网标准有所规定或有额外的补偿机制

Grid Codes and Other Items
并网标准和其它事项

- Larger regional operations will smooth wind output and make accessing needed balancing flexibility resources easier
- Encourage geographic diversification of wind power
  - Will make operational issues easier
  - Smooth wind output

- 在更大区域范围内运行，可以平滑风电出力的不稳定性，也可以获得更多的灵活发电资源来平衡风电
- 鼓励风电场在地理分布上更加分散
  - 易于系统运行
  - 可以平滑风电出力

Flexible Generation / Ancillary Services 灵活的发电资源 / 辅助服务

- High levels of wind generation will require more flexible generation / ancillary services, primarily load following
- Revise existing payment mechanisms for conventional generation to encourage flexible generation
- Consider providing incentives (such as higher payment) for generators that can operate at lower levels, start up quickly, or respond quickly to operator signals
- Consider increasing non-spinning reserves to track wind ramps
- FERC has a pending investigation on these issues

- 大规模风电发展需要更多的灵活发电资源/辅助服务，尤其是负荷跟踪
- 修改对常规发电的支付方式，鼓励灵活发电
- 考虑对低水平运行、启动快或对系统运营商信号反应迅速的发电机组提供奖励（如支付更高电价）
- 考虑增加非旋转备用，追踪风速变化
- 联邦能源监管委员会即将对上述问题进行调查

Consider a Wind Integration Study
考虑开展风电并网研究

- International studies show integration is not difficult or costly
- Grid companies have data to perform study
- International expertise is available
- Data needs are immense
  - Time-synchronized hourly generation and load data
  - Meso-scale wind data for high penetration wind scenarios
  - Wind energy forecasts
  - Periods of sub-hourly generation and load data to analyze “interesting periods” (i.e., high wind/low load, low wind/high load, etc.)

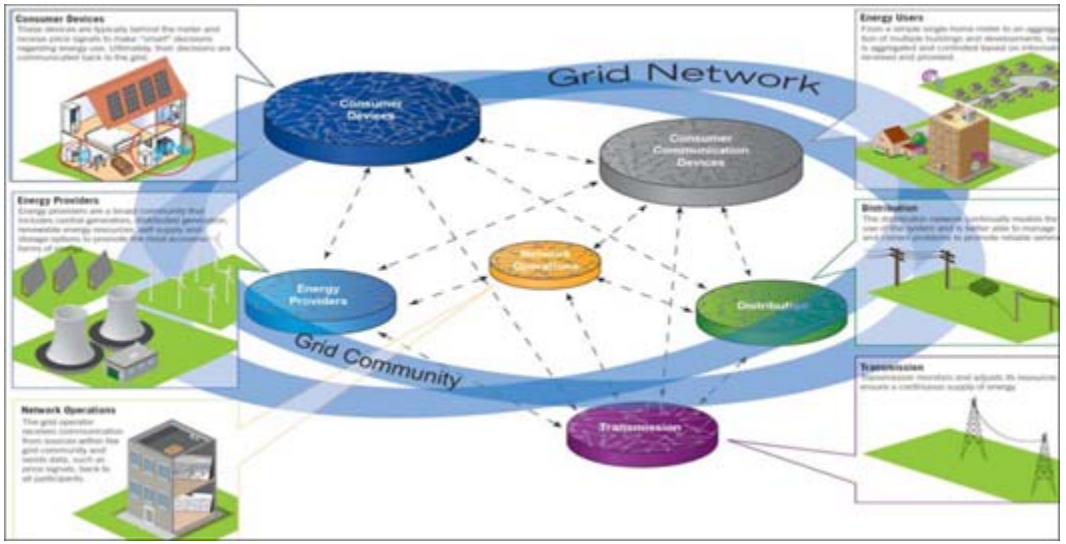
- 国际研究显示，风电并网并不困难，成本也不高
- 电网公司拥有开展研究需要的数据
- 国际上有现成的专业知识
- 巨大的数据需求
  - 时间同步的每小时发电量和负荷数据
  - 对于高风电情景，需要中尺度风资源数据
  - 每小时发电周期和负荷数据，分析“有趣的周期”，如疾风/低负荷或低风/高负荷

Demand Response and PHEVs
需求响应和插电式混合动力车

- Demand response could help integrate higher levels of wind generation at a lower cost than adding new generation or ancillary services
  - Particularly true for extreme wind events that may happen for only a few hours per year
- Introduction of Plug-In Electric Vehicles can also help with high levels of wind power
  - PHEV charging at night coincides with timing of higher levels of wind production

- 需求响应有助于吸纳更多风电，且较增加发电容量或辅助服务成本更低
  - 对解决极端风况下的并网问题更为成本有效，这种情况一年可能仅发生几个小时
- 引进插电式电动车也有助于吸纳更多风电
  - 插电式混合动力车在晚间充电，刚好与风电产量高的时段吻合

Smart Grid/
Strong Grid
智能电网/
坚强电网



Wind
and Solar
风能和太阳能

Smart
Response
智能响应

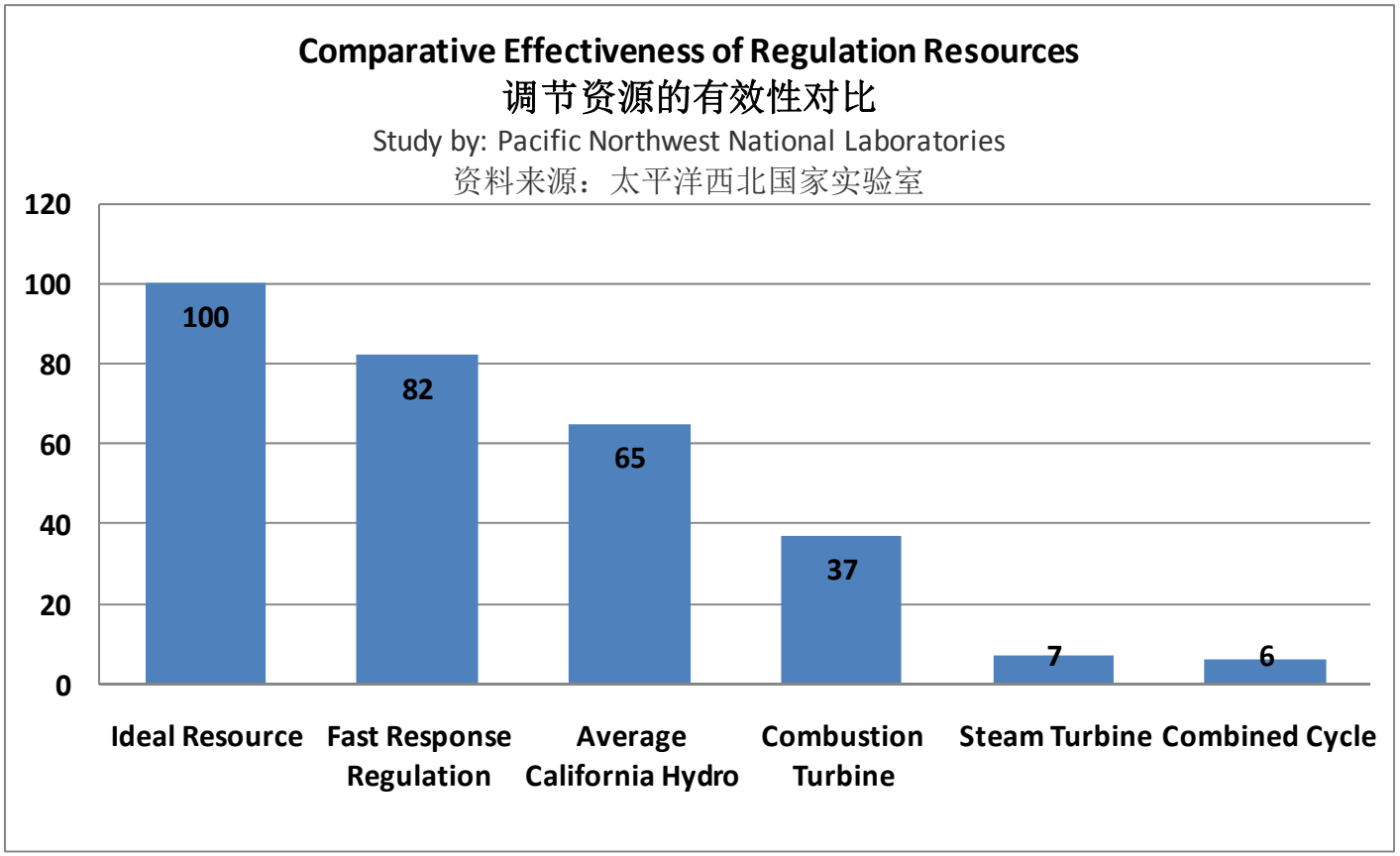
Energy
Efficiency
能源效率

Demand
Response
需求响应

System Benefits of Fast Regulation
快速调节的系统效益

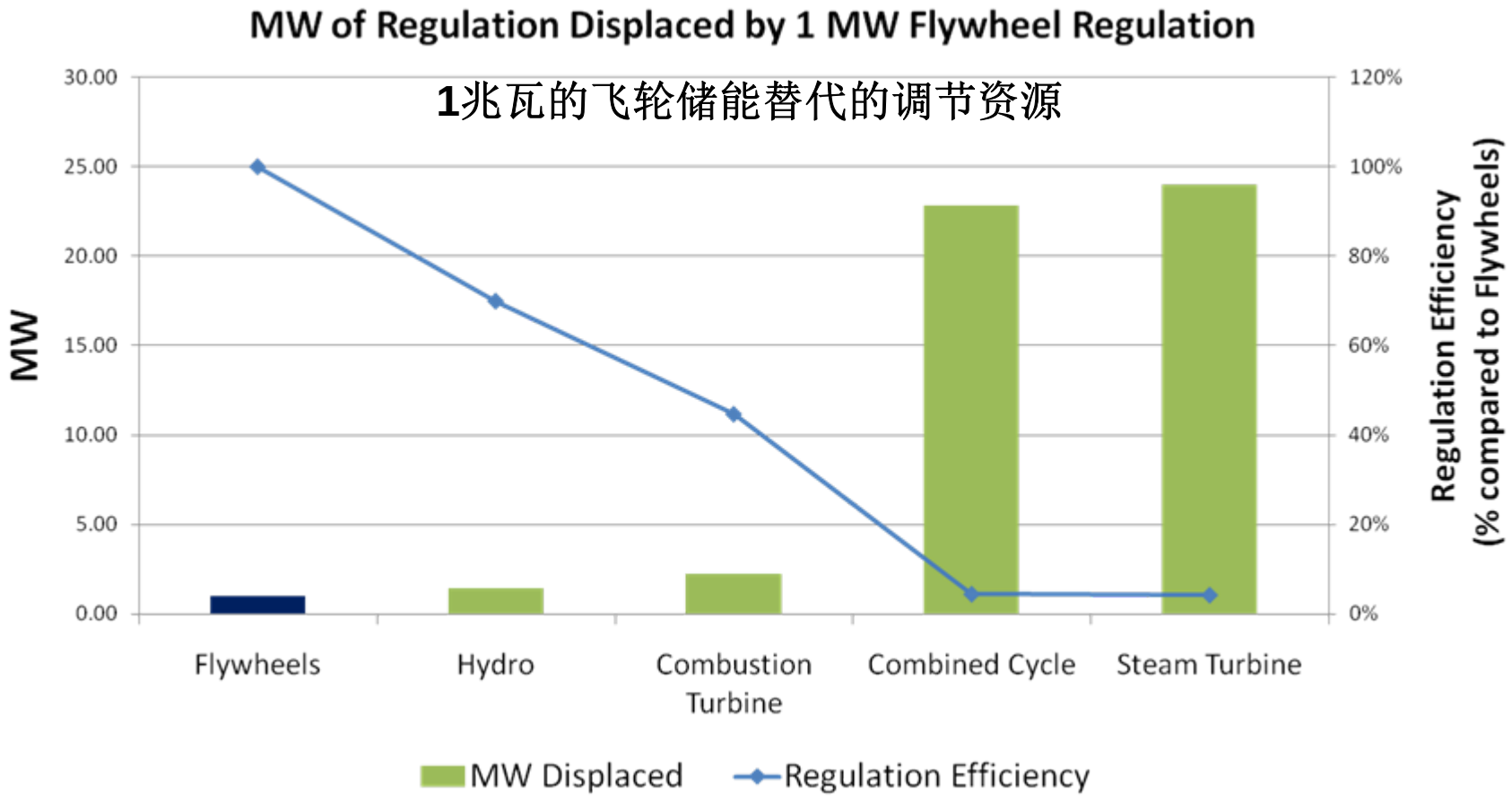
MW of Regulation Displaced by 1 MW Fast Response Resource

1兆瓦的快速响应资源替代的调节资源



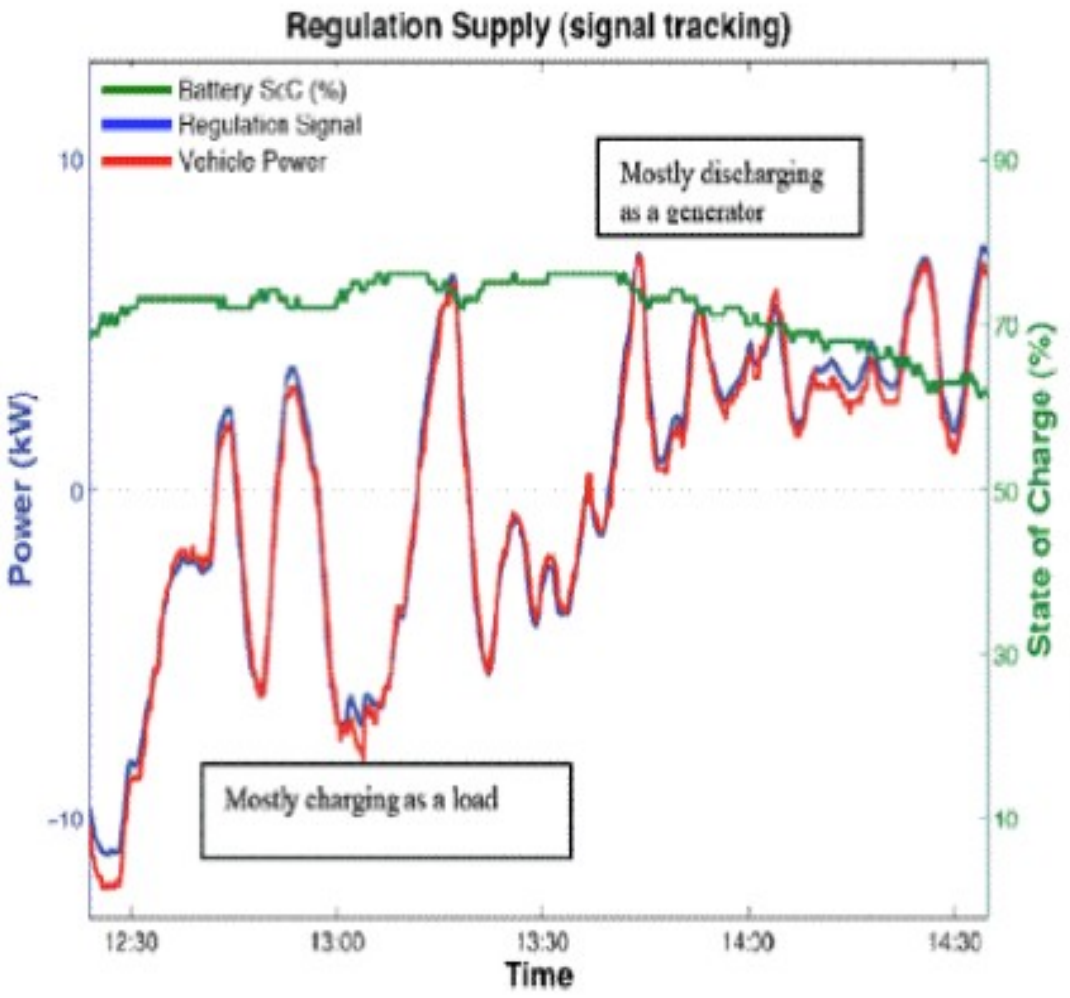
Fast Response resources reduce the amount of necessary Regulation
快速响应资源减少了必要的调节资源

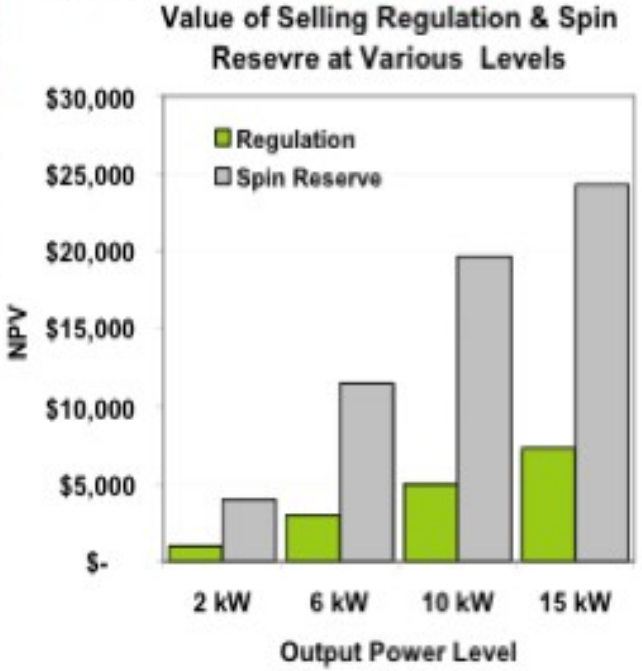
System Benefits of Fast Regulation
快速调节的系统效益



E-vehicle Regulation
电动车调节

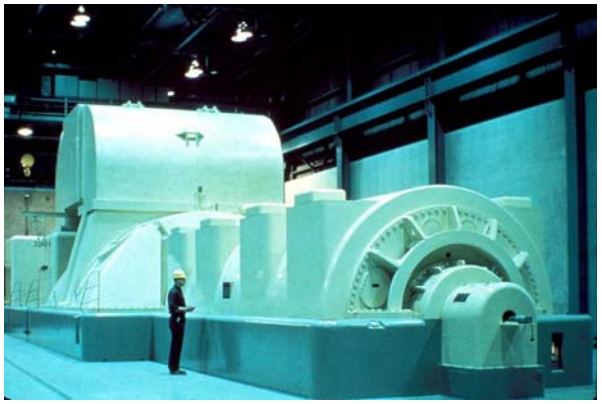
Regulation Services
管制服务



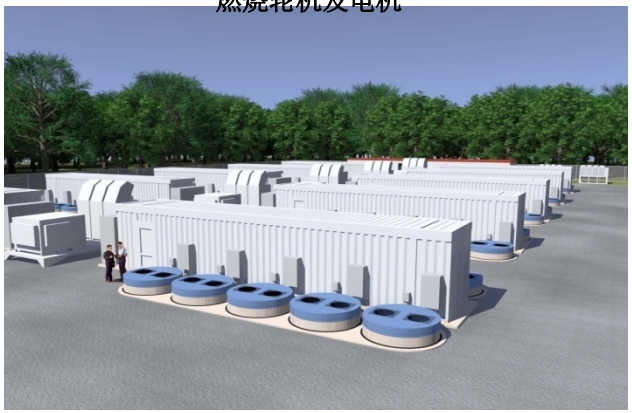


Source: W. Kempton, Victor Udo, Ken Huber, Kevin Komara, Steve Letendre, Scott Baker, Doug Brunner & Nat Pearre – A Test of V2G for energy storage & Frequency Regulation in the PJM System - August 2008

Wind Integration/Frequency Control
风电并网/频率控制



Combustion Turbine Generator
燃烧轮机发电机



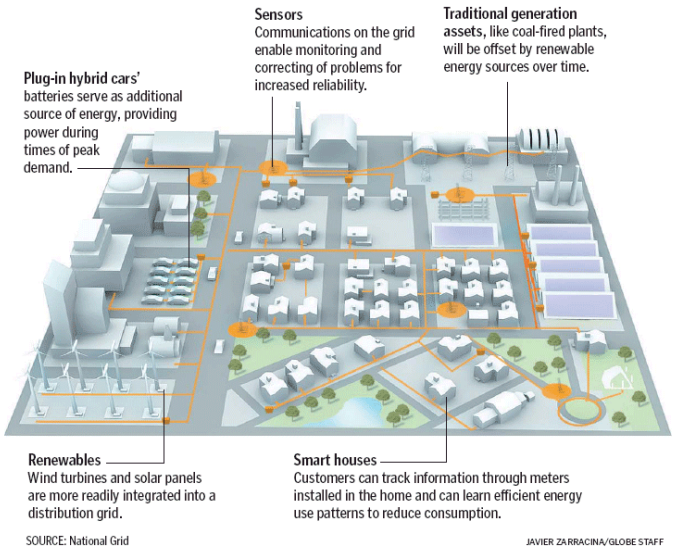
Flywheels
飞轮

E-vehicle电动车

Ice Bear Unit冰熊储存设备

Regulatory Policy 监管政策

Smart Grid/Strong Grid
智能电网/坚强电网



Regulatory Structure
监管结构

Smart Response
智能响应

Energy Efficiency
能源效率

- Build end-use energy efficiency into power sector
- FERC has limited authority to do this, but we have pressed hard to build energy efficiency into markets (e.g., FCM)
- China is investing more in energy efficiency than the US
  - But very little energy efficiency investment in China is made by grid companies
  - This is a huge opportunity for China
  - Design markets to acquire EEPs and impose the obligation to buy EPPs on grid companies

- 在电力产业提高终端能源效率
- 联邦能源管理委员会的权威有限，但是我们努力在市场设计中融入能源效率（如FCM）
- 中国在能效投资超过美国
  - 但中国能效投资中来自电网企业的很少
  - 中国面临着巨大的机会
  - 设计市场，建设能效电厂，规定电网企业承担收购能效电厂的义务。

Illustrative Comparison – CPP & EPP
案例比较 —— CPP 和 EPP

CHARACTERISTICS特性	CONVENTIONAL POWER PLANT常规电厂	ENERGY EFFICIENCY POWER PLANT能效电厂
SIZE规模	500 MW	500 MW
ANNUAL PRODUCTION/SAVINGS年产量/年节能量	2500 GWH	2500 GWH
CAPITAL COST资金成本	$ 500 Million 5亿美元	$ 250 Million 2.5亿美元
OPERATING COST运营成本	$0.020/ KwH	$0.005/ KwH
TOTAL ANNUAL COST年度总成本	$0.052/kWh	$0.021/kWh
FUEL USE (COAL)燃料使用（煤）	500-800 g/kWh	0 g/kWh
GHG EMISSIONS温室气体排放	0.5-0.8 kg/kWh	0 kg/kWh
ANNUAL GHG EMISSIONS 全年温室气体排放	1.25-2.00 Million Tons 125-200万吨	0 Tons 0吨

Alternative EPP Models
可供选择的能效电厂模式

- Model 1 – Utility delivery cost recovery (“California” Model)
- Model 2 – Public Benefit Fund administered by Independent Agency (“New York” Model)
- Model 3 – Government Funding (“Korea” Model)
- Model 4 – Direct Consumer Funding, including Energy Savings Fee, or ESF (“Guangdong” Model)
- Model 5 – Public-Private Partnership (“Hebei” Model)
- Model 6 – Procurement of DSM resources (“DSM Resource Acquisition” Model)

- 模式一——输电成本回收（加州模式）
- 模式二——由独立机构管理公共效益基金（纽约模式）
- 模式三——政府出资（韩国模式）
- 模式四——直接消费者基金，包括节能费或ESF（广东模式）
- 模式五——公私合作（河北模式）
- 模式六——需求侧管理资源采购（需求侧管理资源并购模式）

Regulatory and Policy Initiatives

监管和政策方案

MODEL 模式	REGULATORY INITIATIVES 监管方案	GOVERNMENT ACTIONS 政府行动
Utility Implementation 电力公司实施	Establish utility responsibilities and targets, define funding levels 规定电力公司的责任、目标和出资程度	None无
Public Benefit Charge 公共效益收费	Establish levy and procedures to transfer funds to implementing agency 建立征税和采购机制，注资实施机构	Establish implementing agency 设立实施机构
Government Funding 政府出资	Cooperate with government agency 与政府机构合作	Establish government fund and implementing organization 建立政府基金和实施机构
Energy Savings Fee 节能费	Establish fee mechanism and utility collection procedure 建立收费体制和电费征收程序	Establish project management organization (PMO) 建立项目管理机构（PMO）
Public-Private Partnership 公私合作	Define incentives for the PPP 为公私合作制定激励机制	Establish public agency partner 设立公共机构合作伙伴
DSM Resource Acquisition 需求侧管理资源获取	Define payment level and criteria for resource acquisition 界定支付水平和资源获取标准	None无

Examples of Energy Efficiency Funds – U.S.
美国能源效率资金案例

- State-level initiatives
- Examples of funding sources
  - Regulators using electricity tariff mechanism
  - State energy agencies using taxes or general revenues
  - State bonds
  - Petroleum taxes
- Funding levels historically have been in the range of 1% to 3% of electricity sales revenues

- 各州的节能计划
- 资金来源
  - 监管机构利用电价机制
  - 州能源机构利用税收或一般收入
  - 州债券
  - 汽油税
- 历年来资金比例占电力销售收入的1%到3%。

Total EE Funding by U.S. State
美国各州的能源效率资金总额

STATE 州	EE Spending as % of Annual Utility Revenues能效支出占年度占事业收入的比例 （%）
Vermont佛蒙特州	3.0%
Massachusetts马萨诸塞州	2.4%
Washington华盛顿州	2.0%
Rhode Island罗德岛州	1.9%
New Hampshire新罕布什尔州	1.8%
Oregon俄勒冈州	1.7%
Wisconsin威斯康新州	1.4%
New Jersey 新泽西州	1.4%
Montana 蒙大拿州	1.3%
California 加州	1.2%
New York 纽约州	1.0%

Clean First 清洁为先

- Meeting climate and environmental challenges requires integrating energy and environmental regulation
- China and US both have Clean First studies underway
- China’s new State Council Rule on Regional Air Quality is a great step forward

- 应对气候和环境的挑战需要节能监管与环境监管相结合
- 中美两国都在进行清洁能源研究
- 中国国务院新颁发的关于改善区域空气质量指导意见使节能工作迈进了一大步。


Thank you
谢谢大家！