

Regulatory Challenges for Smart Grid

智能电网发展对监管的要求

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The Regulatory Assistance Project

China ♦ India ♦ European Union ♦ Latin America ♦ United States



Smart Grid, Strong Grid

智能电网、坚强电网

- What are China's goals?
 - Reliable, reasonably priced electricity
 - More energy efficiency, emissions reductions, more renewable resources, reduced carbon intensity
 - How should the grid be designed to help meet those goals?
 - Strong and smart
 - Strength is in the grid's backbone—the transmission system and its ability to move bulk power long distances
 - Intelligence is in the distribution system—better means of matching supply and demand
 - Strong solutions may be much more cost-effective than smart ones—at least to start.
- 中国的目标是什么？
 - 可靠、价格合理的电力
 - 提高能效，减少排放，增加可再生资源，减少碳强度
 - 为了达到这些目标，应如何设计电网？
 - 坚强与智能
 - 实力在于电网的后盾——输电系统及其远距离大容量输电的能力
 - 智能在于配电系统——更好地平衡供应与需求的方法
 - 坚强解决方案可能比智能解决方案更具成本效益——至少在起步阶段



Smart Grid, Strong Grid

智能电网、坚强电网

- In the US, new large-scale transmission will be needed to deliver and integrate remote large-scale renewables into the system
- Smart distribution (demand response, flexible resources) can help, but mostly when higher penetrations of renewables are achieved
- 在美国，需要新型大规模输电系统将远距离大规模可再生能源输送和并网。
- 智能配电（需求响应、弹性资源）会有利于更多的可再生能源并网。

Integrating Renewables into Electric System Operations

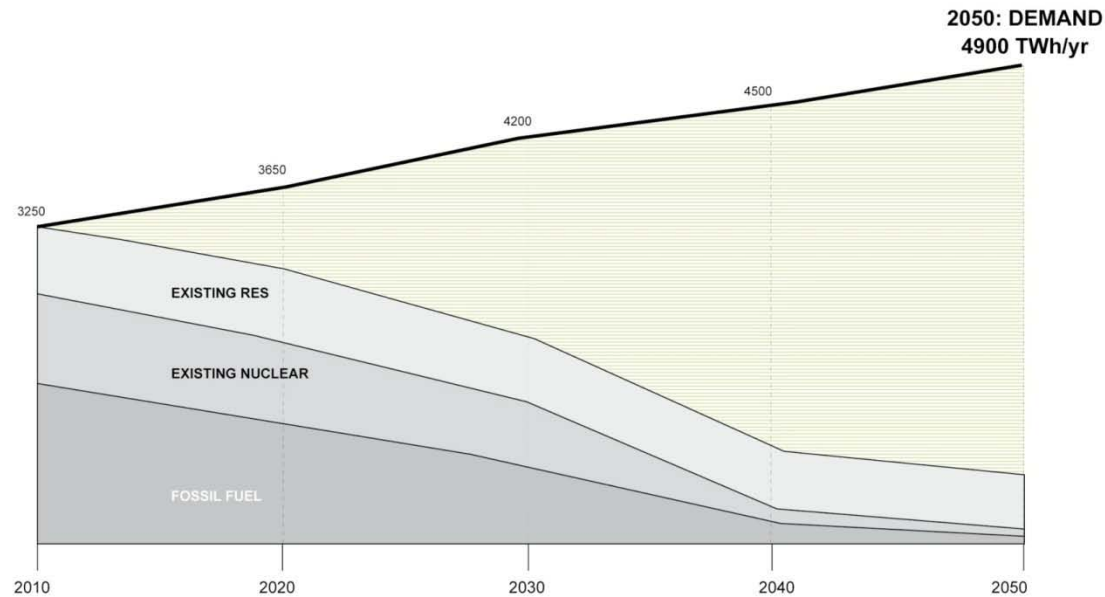
将可再生能源并入到电力系统操作中

- International studies show integration is not particularly difficult or costly
 - EU 2050 Roadmap
 - US DOE Renewable Energy Futures Study
 - Eastern Wind Integration and Transmission Study
 - Western Wind and Solar Integration Study
- Integration of significant amounts of renewables does not depend on smart grid technologies
- But smart grid will offer new integration opportunities
 - Demand response
 - Electric vehicles
 - Thermal storage
- 国际研究表明并网并不会特别困难或昂贵
 - 欧盟2050路线图
 - 美国能源部可再生能源前景研究
 - 东部风电并网与输电研究
 - 西部风能与太阳能整合研究
- 大容量可再生能源并网不依赖智能电网技术
- 但智能电网可以提供新的并网机会
 - 需求响应
 - 电动车辆
 - 蓄热

EU Roadmap: No CO₂-Emitting Resources by 2050

欧盟路线图：2050年无二氧化碳排放的资源

ELECTRICITY DEMAND 2050
(EU27 PLUS NORWAY & SWITZERLAND)

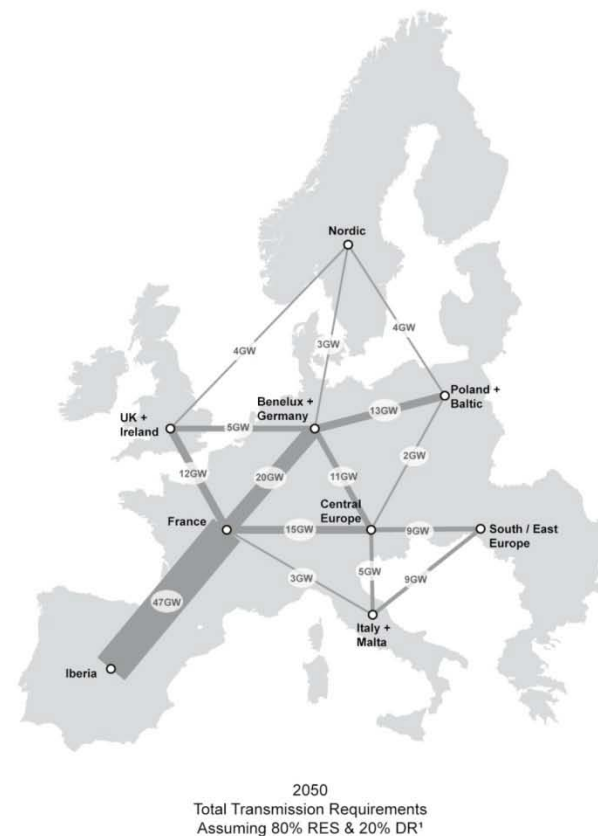
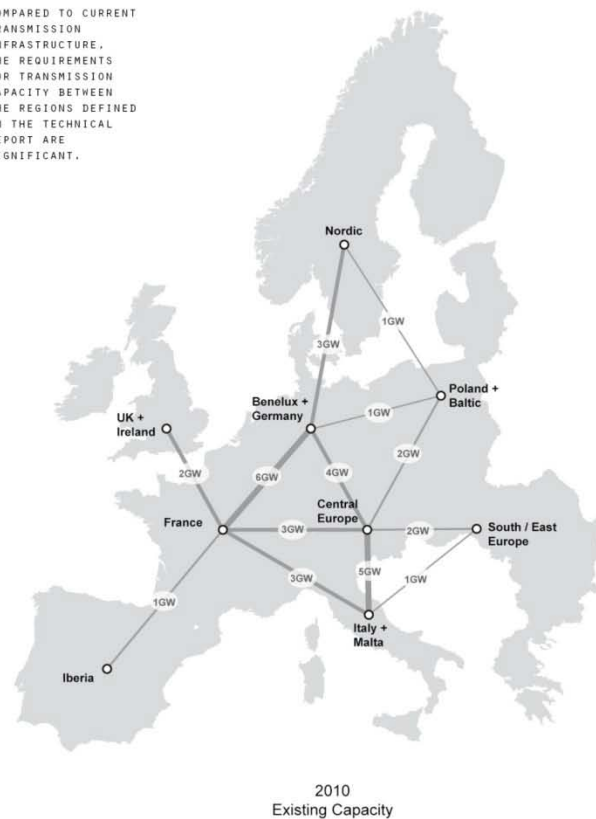


Integration through Transfer Capability

通过输电容量进行并网

INTER-REGIONAL TRANSMISSION REQUIREMENTS

COMPARED TO CURRENT TRANSMISSION INFRASTRUCTURE, THE REQUIREMENTS FOR TRANSMISSION CAPACITY BETWEEN THE REGIONS DEFINED IN THE TECHNICAL REPORT ARE SIGNIFICANT.



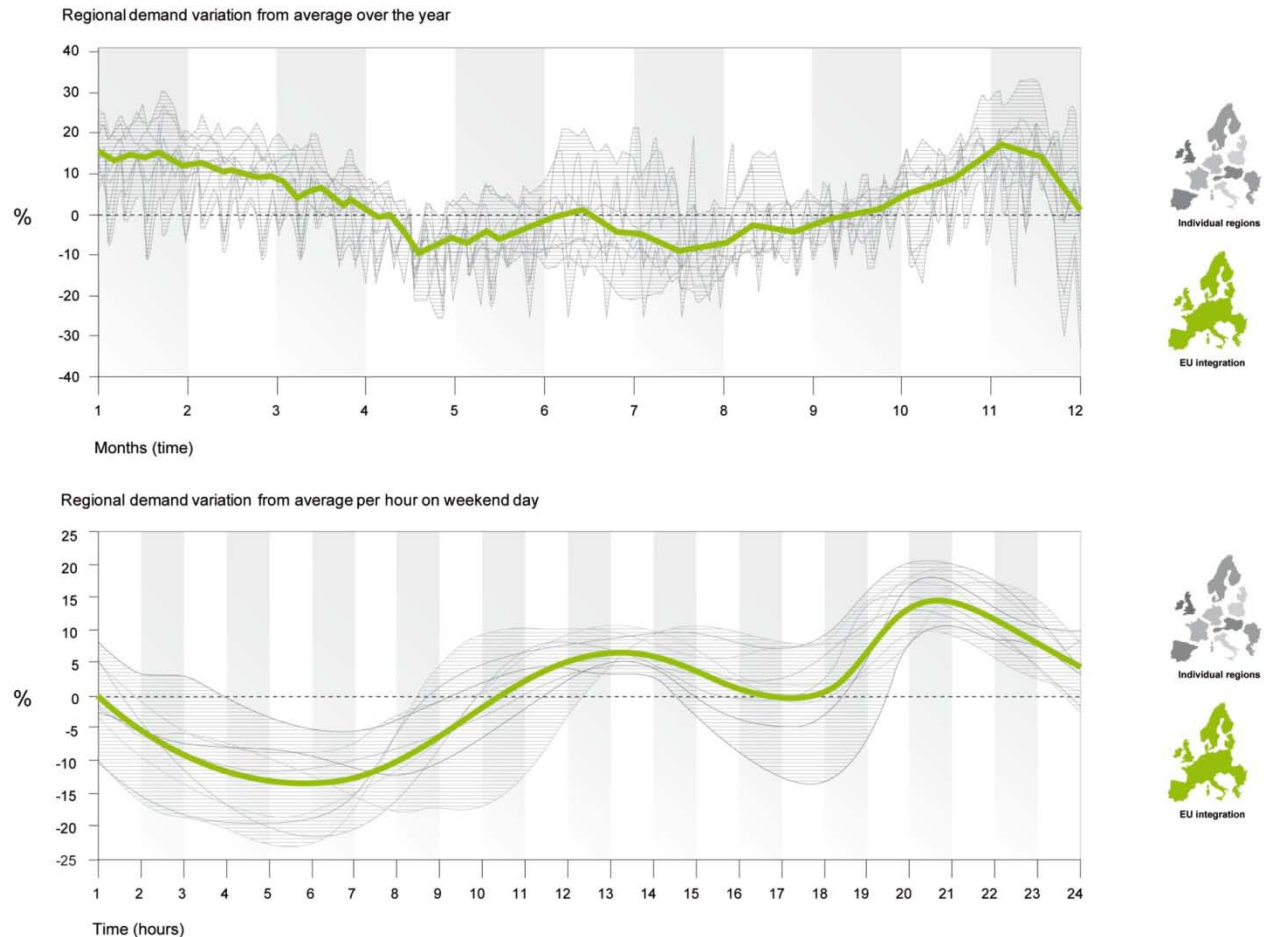
¹ Demand response as used in this paper refers to changing a customer's electricity demand in response to dispatch instructions or price signals through communications technologies. In the Volume 1 analysis, it is assumed that any such changes retained the total energy consumed within the day; that is, moved or shifted demand rather than reduced total daily consumption. NOTE: Iberia-France link is challenging and maybe reduced by different solar/wind mix. SOURCE: Roadmap 2050 Technical Analysis



Diversity of Demand can be Captured through Transmission

通过输电捕获需求多样性

COMBINING REGIONAL DEMAND CURVES REDUCES VOLATILITY

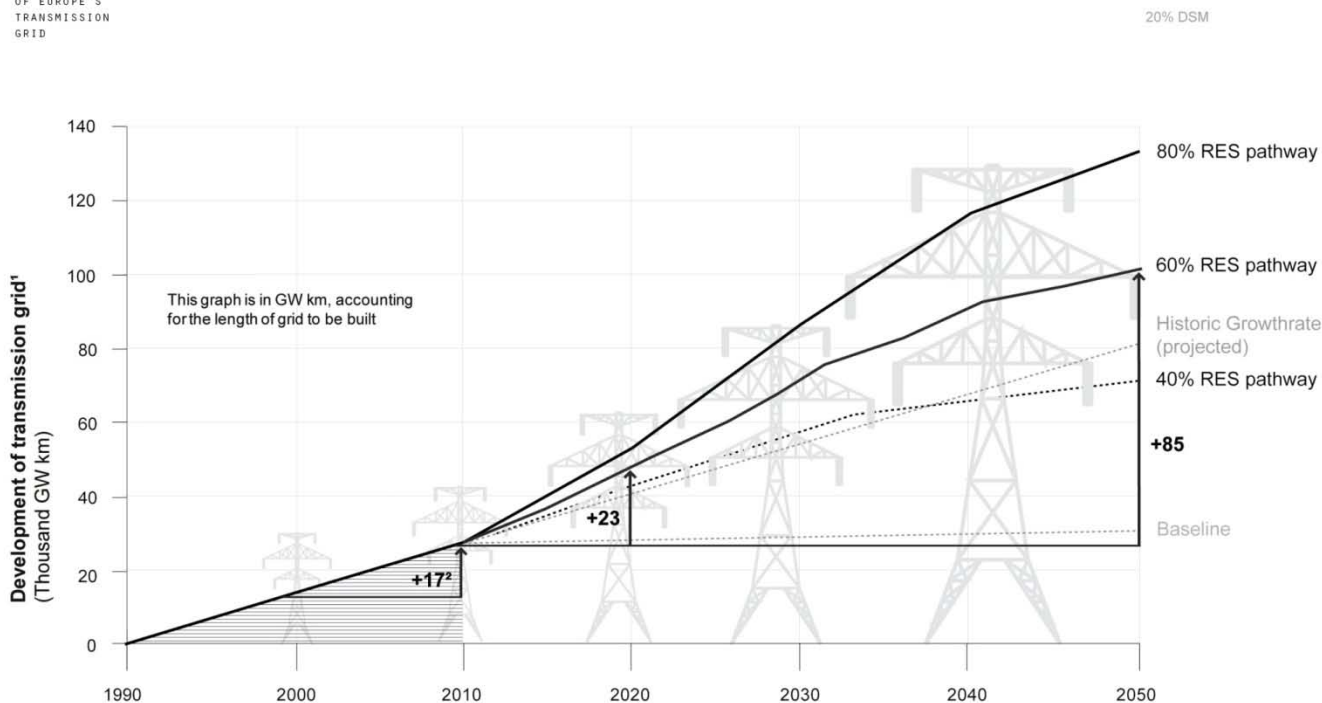


EU Roadmap Calls for Increases in Grid Capacity

欧盟路线图要求增加电网容量

INCREASE IN GRID CAPACITY

THE ROADMAP
REQUIRES
SIGNIFICANT
DEVELOPMENT
OF EUROPE'S
TRANSMISSION
GRID



¹ Development of grid is assumed to be driven by the penetration of intermittent power sources (solar PV, wind onshore and wind offshore)
² This assumes a linear build up of grid capacity in thousand GW km between 1990 and 2010, starting at zero, although some grid has been built even before 1990, i.e. UK-France and much of the Central European interconnectors



Energy and the Environment

能源与环境

- China has serious environmental challenges
- Energy use and environmental damage are connected
- Climate Friendly AQM
- New RAQM Rule, substantial focus on energy issues
- Power sector structure must be designed to serve not only economic and energy goals, but environmental policy too
- 中国面临严峻的环境挑战
- 能源利用与环境破坏联系在一起
- 气候友好型空气质量管理
- 新的区域空气质量管理规则，重点关注能源问题
- 电力部门结构调整不仅要考虑经济与能源目标，也要考虑环境政策。



End-Use Energy Efficiency

终端能效

- China is investing heavily in end-use efficiency
 - Mostly government-funded
- The greatest missed opportunity is the failure to make energy efficiency a responsibility of the grid company
- The US has many models for (1) determining energy efficiency objectives and (2) meeting those objectives (i.e., acquiring savings)
 - And more are coming. . . .
- 中国对终端能效进行了大量投资
 - 主要由政府资助
 - 错过的最大的机会是让电网公司能效投资承担负责。
 - 关于（1）确定能效目标与（2）达到这些目标（即：获得节能量），美国有很多模型
 - 未来还有更多模型.....



Defining Energy Efficiency Goals

确定能效目标

- Integrated resource planning
 - All cost-effective EE
 - Cost-effective means less costly than supply-side alternatives
- Energy Efficiency Resource (Portfolio) Standards (EERS)
 - Energy and capacity savings targets specified by law or rule
 - Similar to a requirement that grid companies buy EPPs
- 综合资源规划
 - 所有具有成本效益的能源效率
 - 成本效益意即比供应侧方案更廉价
- 能效资源（配额）标准（EERS）
 - 通过法律和规定明确能源与容量节省目标
 - 与电网公司购买能效电厂的要求类似

Delivering Energy Efficiency:

Approaches Vary

实现能源效率：方法各异

➤ At least five approaches in the US, employed alone or in combination:

- Distribution company delivery
 - Most states, including CA
- State agency delivery
 - New York
- Independent efficiency administrator
 - Vermont, Oregon
- Performance contracts with 3rd parties
 - Texas
- Bidding into regional capacity markets
 - ISO-NE Forward Capacity Market
 - PJM Reliability Pricing Model

➤ 美国至少采用了五种方法，单独或综合使用：

- 通过配电公司实现
 - 大多数州，包括加州
- 通过州机构实现
 - 纽约
- 通过独立能效机构实现
 - 佛蒙特、俄勒冈
- 通过第三方进行合同管理
 - 德克萨斯
- 区域容量市场投标
 - 新英格兰独立系统运营商远期容量市场
 - PJM（宾夕法尼亚、新泽西、马里兰）可靠性定价模型

Delivering Energy Efficiency:

Approaches Vary

实现能源效率：方法各异

- Federal legislation for national EE resources standards has been proposed
- In China:
 - Direct spending by government
 - Energy Efficiency Power Plants (EPPs): EE programs bundled to produce savings that resemble the output of a conventional power plant
- 提议通过联邦立法确定国家能效资源标准
- 在中国：
 - 政府直接开支
 - 能效电厂：打包能效项目产生节能，节能量与常规电厂的输出量类似。



Smart Grid and Policy

智能电网与政策

- What does smart grid suggest for power sector regulation and structure
 - Part of a bigger question: what do energy efficiency and environmental goals suggest?
- How to determine what's cost-effective?
- 智能电网对电力部门监管和结构意味着什么
 - 更大问题的一部分：能源效率与环境目标意味着什么？
- 如何确定什么是成本效益？



Smart Grid and Policy

智能电网与政策

- Who pays for smart grid?
- Grid company business model
 - Not merely electricity delivery
 - Other services: energy management, entertainment, communications
 - Where are the profit opportunities and how should they be regulated?
 - Who owns the information that smart grid collects?
- Price structures
 - Retail prices more accurately reflecting the true economic costs of generation and delivery
- 谁为智能电网买单?
- 电网公司商业模式
 - 不仅仅是供电商
 - 其他服务：如能源管理，能源服务等
 - 最大的盈利机会在哪里？如何监管？
 - 谁享有智能电网收集到的数据？
- 价格结构
 - 零售价格更准确地反应发电和书店的经济成本

Policies to Advance Clean Energy Outcomes

推动清洁能源成果的政策

- Grid company business model
 - Revenue regulation to remove the grid company's incentive to deliver more kWhs (decoupling)
 - Energy efficiency as a grid company obligation
 - Rewards for meeting EE goals
- Reduced energy intensity and carbon intensity of electricity production
- Clean First:
 - Efficiency (or environmental) dispatch
 - Grid access based on environmental performance
- 电网公司商业模式
 - 通过收入监管来消除电网公司售电越多盈利越多的机制（脱钩）
 - 使能效成为电网公司的义务
 - 达到能效目标后予以奖励
- 减少电力生产的能源强度和碳强度
- 清洁第一
 - 效率（或环境）调度
 - 根据环境绩效评价确定并网

Policies to Advance Clean Energy Outcomes

推动清洁能源结果的政策

- Build EPPs into power sector structure, planning, markets
- Increased investment in renewable energy
 - Integration through larger regional operations
 - Improved wind forecasting
 - Strong grid code requiring state-of-the-art turbine technology
- Flexible Resources/Ancillary Services
 - Financial rewards for generators that can operate at lower levels, start up quickly, or respond quickly to operator signals
 - Demand management
 - Charging plug-in electric vehicles
- 将能效电厂引入电力部门结构、规划、市场
- 增加对可再生能源的投资
 - 通过更大型区域系统实现并网
 - 改进风能预测
 - 坚强电网技术规范要求最新的涡轮技术
- 弹性资源/辅助服务
 - 对能在较低发电水平操作、快速启动或对操作员信号反应迅速的发电商提供财务奖励
 - 需求管理
 - 给充电式电动汽车充电



Thanks 谢谢

➤ Questions?

➤ 问题?