

# Regulatory Challenges for Smart Grid

## 智能电网发展对监管的要求

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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

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- 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

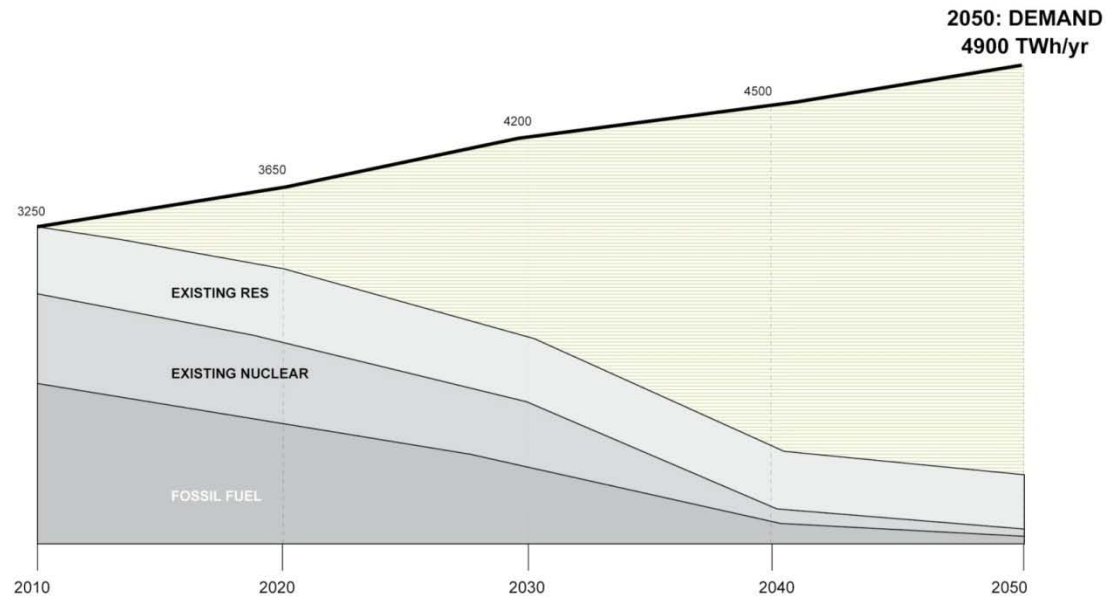
## 将可再生能源并入到电力系统操作中

- 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 CO<sub>2</sub>-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)

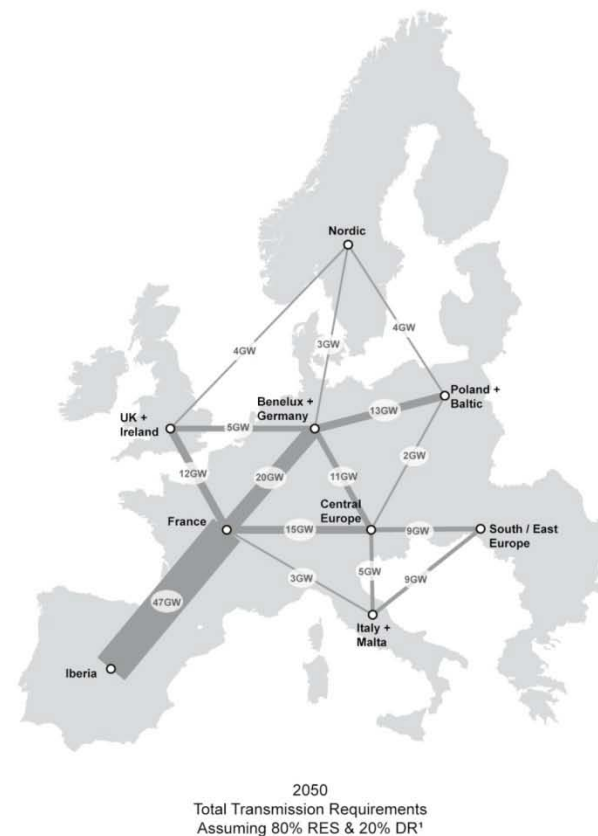
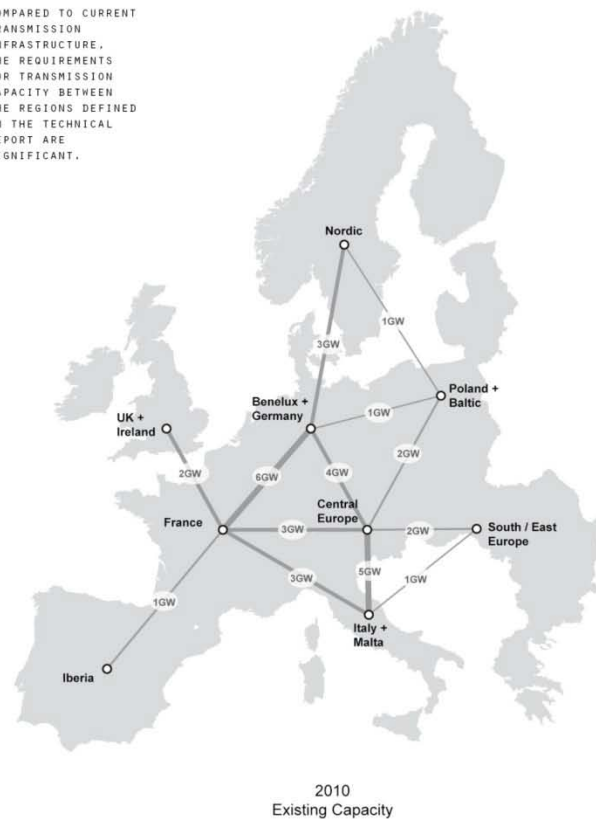


# Integration through Transfer Capability

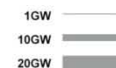
## 通过输电容量进行并网

### INTER-REGIONAL TRANSMISSION REQUIREMENTS

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



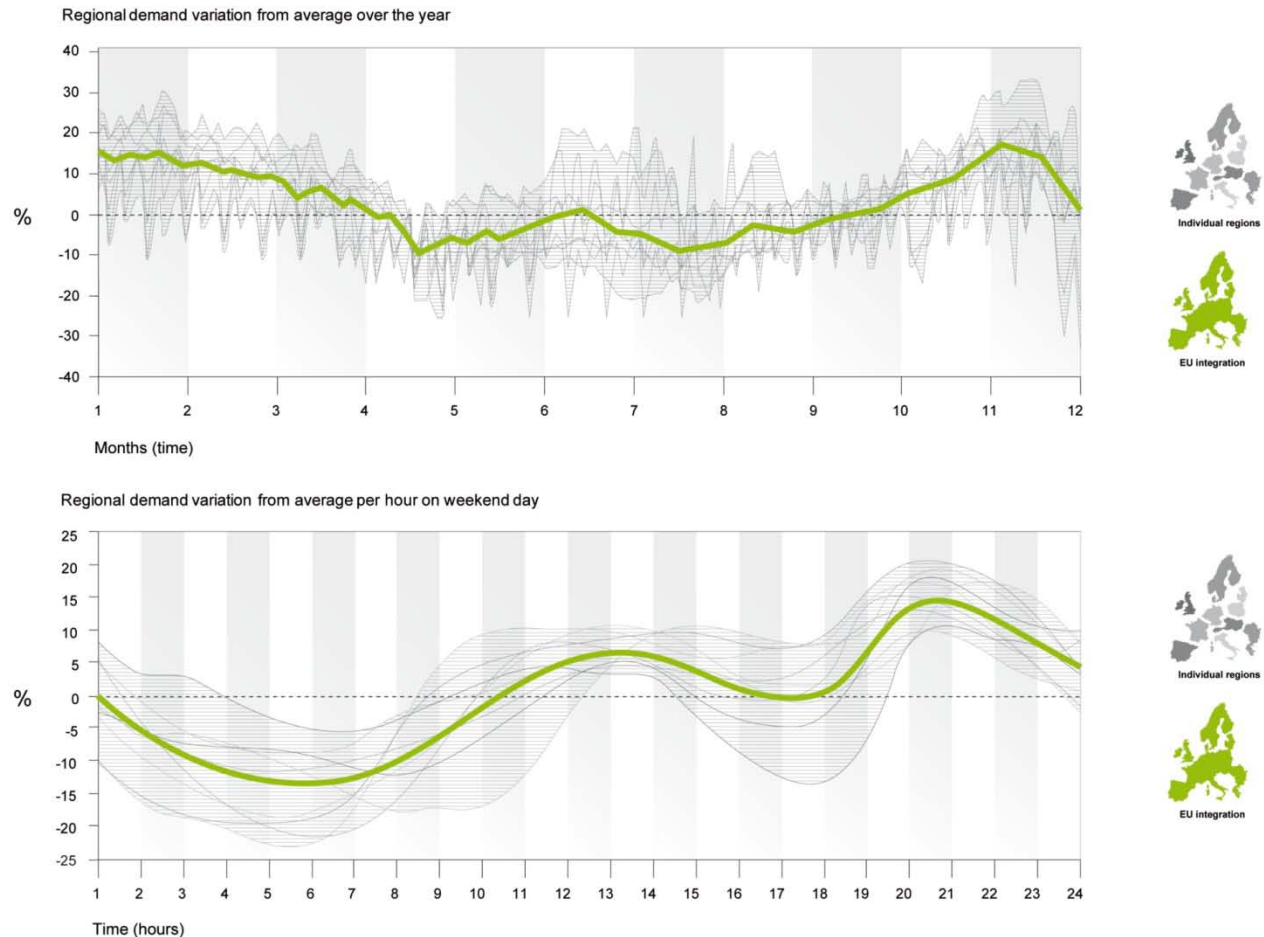
<sup>1</sup> Demand response as used in this paper refers to changing a customer's electricity demand in response to dispatch instructions or price signals through communications technologies. In the Volume 1 analysis, it is assumed that any such changes retained the total energy consumed within the 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

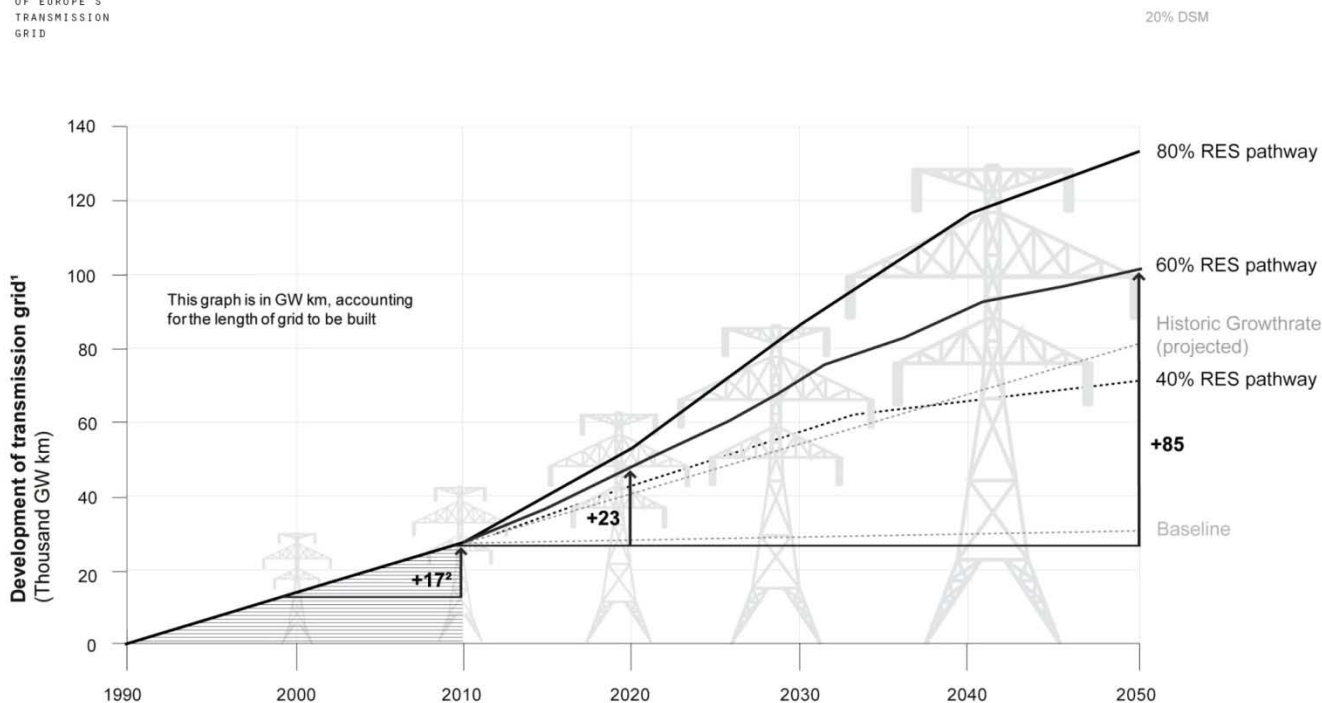


# EU Roadmap Calls for Increases in Grid Capacity

## 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



<sup>1</sup> Development of grid is assumed to be driven by the penetration of intermittent power sources (solar PV, wind onshore and wind offshore)  
<sup>2</sup> 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

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- 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

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- 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

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- 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

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- What does smart grid suggest for power sector regulation and structure
  - Part of a bigger question: what do energy efficiency and environmental goals suggest?
- 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？
- How to determine what's cost-effective?
- 如何确定什么是成本效益？



# Smart Grid and Policy

## 智能电网与政策

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- 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

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➤ Questions?

➤ 问题?