

# 2011 FSR Annual Conference

Florence, May 25th, 2011



**Future trends in energy market design**  
***Which implications on market design?***

***Ignacio J. Pérez-Arriaga***

CEEPR, MIT

IIT, Comillas University (Madrid, Spain)

# ***Anticipated trends*** (1 of 3)



- ❑ Creating well functioning competitive wholesale & retail markets for electricity is very challenging, both technically & politically, & cannot be applied anywhere
  - Where properly implemented, wholesale markets have led to improved performance & have mobilized significant investments
  - Despite some failures & implementation difficulties, the general trend in most liberalized power sectors is to proceed with the process of reforms

# ***Anticipated trends*** (2 of 3)



- ❑ There is a serious (*& justified*) global concern about climate change & this will affect energy policy & power sector investments profoundly → intense **political oversight & interference** is anticipated
- ❑ **Security & sustainability** will have at least the same priority as **efficiency** in the regulatory design
- ❑ New & emerging **clean technologies** will be crucial in attaining a sustainable power system model, but their development & commercial deployment will typically need **regulatory support**

# ***Anticipated trends*** (3 of 3)



- ❑ It is anticipated a large penetration of renewable &/or **intermittent** &/or **distributed** generation in many power systems
- ❑ The availability of communication & control technologies plus current trends in regulation & consumer behavior signal a strong future **active demand response**
- ❑ Political developments, economic rationality & network reinforcements lead to an **integration of existing power systems & markets** into larger entities

# ***Major issues of concern***



- ◆ In the context that can be anticipated of strong sustainability & security oriented policy measures
  - 1. How to improve / redesign market regulation to facilitate that these policies reach their objectives efficiently?**
  - 2. How to make these policy measures compatible with the functioning of electricity markets?**

***Implications on market  
design  
INVESTMENT***

# ***On the future well-adapted generation technology mix***



How does a well-adapted generation mix, low in carbon emissions & with strong presence of intermittent generation, look like?

Does this mix (*the flexible generation with much cycling and low capacity factor*) need any regulatory support (*ad hoc ancillary service, capacity instrument, other*) under market conditions? (*Obviously the answer depends on the expected market prices*)

# ***On the need for additional flexible generation***



Is all the existing flexibility capability of the current power system being fully used already?

Of the conventional power plants?

Of the interconnectors?

Of the intermittent generation itself?

Are the current market rules helpful?

Perhaps many power systems can incorporate much intermittent generation with just minor adjustments in operation

# ***The regulatory challenge***



- In the event of a significant penetration of intermittent renewable production in the generation technology mix, policy and regulatory measures should be developed (*e.g. ancillary services compensation*) or adapted (*e.g. capacity mechanisms*) to facilitate adequate levels of investment in flexible & economically competitive generation capacity to ensure system reliability & efficiency

# ***Let's apply the basic principles***

- In principle just market energy prices should suffice to attract additional adequate investment
  - But they have failed with peaking units & capacity mechanisms had to be created. Why? To reduce the risk for potential investors
  - Energy prices could fail too with mid-range flexible units (*CCGTs presumably*) that will be subject to low capacity factors, much cycling, very volatile energy prices & regulatory uncertainty → *Do something to mitigate that risk*

# ***Guidelines for a sound regulatory approach***

- The objective is to reduce this new kind of risk aversion
  - but not to compensate for any errors in estimation of the demand growth or even in the regulation-driven penetration of renewable generation
- Standard capacity instruments are meant for peakers or the like & would not suffice
  - any additional remuneration scheme should be addressed to provide the new specific commodity that is needed, and should not be directly meant for investments in any specific technology

# ***First, indicative planning***

- What is intended to accomplish? (*national & supranational energy policies require long-term analysis with sustainability criteria*) → **indicative planning** (IP)
  - The IP procedure is meant to characterize meaningful energy development paths that meet any prescribed high level (*sustainability & others*) targets, in order to facilitate political decisions
  - Note that, once one path is chosen, IP
    - is more than just **prospective** analysis (*find what could happen*)
    - has **normative** character (*identify what has to be done to make sure that a future with some desirable features happens*)

# ***Any room for markets?***

- Instruments to make possible a **clean technology mix** in electricity generation
  - **Nuclear**: if politically acceptable, it might need some regulatory commitment to reduce financial risks
  - **Clean coal (CCS)**: presently only viable with regulatory support *(until sufficiently high & stable CO2 prices exist)*
  - **Renewables**: same; support scheme should depend on level of maturity of technology, cost & rules for integration in the market *(which affect the economic viability of other plants)*
  - **Flexible plants**: economic viability strongly depends on regulation of security of supply & intermittent generation
- ➔ *Reduced, but not negligible, space for the market*

## ***Other topics***



Who should pay the direct extra costs of promoting renewables? Only electricity consumers? Consumers of other forms of energy? Tax payers?

What is the influence of the regulatory mechanisms of promotion of renewables on the operation of the system & the formation of market prices?



***Implications on market  
design  
OPERATION***

# ***On potential measures to mitigate the intermittency impact***



How to reduce the impact of uncertainty & variability of wind & solar PV

- in the unit commitment function?
- in the volume & cost of operating reserves?
- when balancing supply & demand close to real time?

## **Possible measures:**

- Coordination / integration of balancing areas
  - Reduced scheduling intervals
  - Improve wind & solar output forecasting
    - Demand response / Storage
- Centralized monitoring & control of intermittent generation<sup>6</sup>

# ***On the undesirable effects of intermittent generation***



How to reduce the loss of efficiency & additional emissions due to frequent cycling of conventional plants with limited operational flexibility?

## **In the short-term**

- Origin of the problem is the lack of adaptation of the present generation mix

## **In the long-term**

- The need for a more flexible generation mix that consists of better adapted generation technologies

# ***On the impacts on electricity prices***

*(in competitive electricity markets)*



What is the actual impact of a large presence of intermittent generation on electricity market prices? How does it depend on the specific scheme of price formation & format of auctions?

Are the resulting market prices & operating conditions attractive enough for new investors?

Is there a basis to acknowledge stranded costs when a sudden & strong penetration of intermittent generation happen?

# ***On priority of dispatch, negative prices and normalcy of market rules***



Should negative spot prices be allowed? And should wind & solar PV be allowed to bid negative prices?

Do wind & solar PV require special market rules?

Could a priority of dispatch regulation be justified?



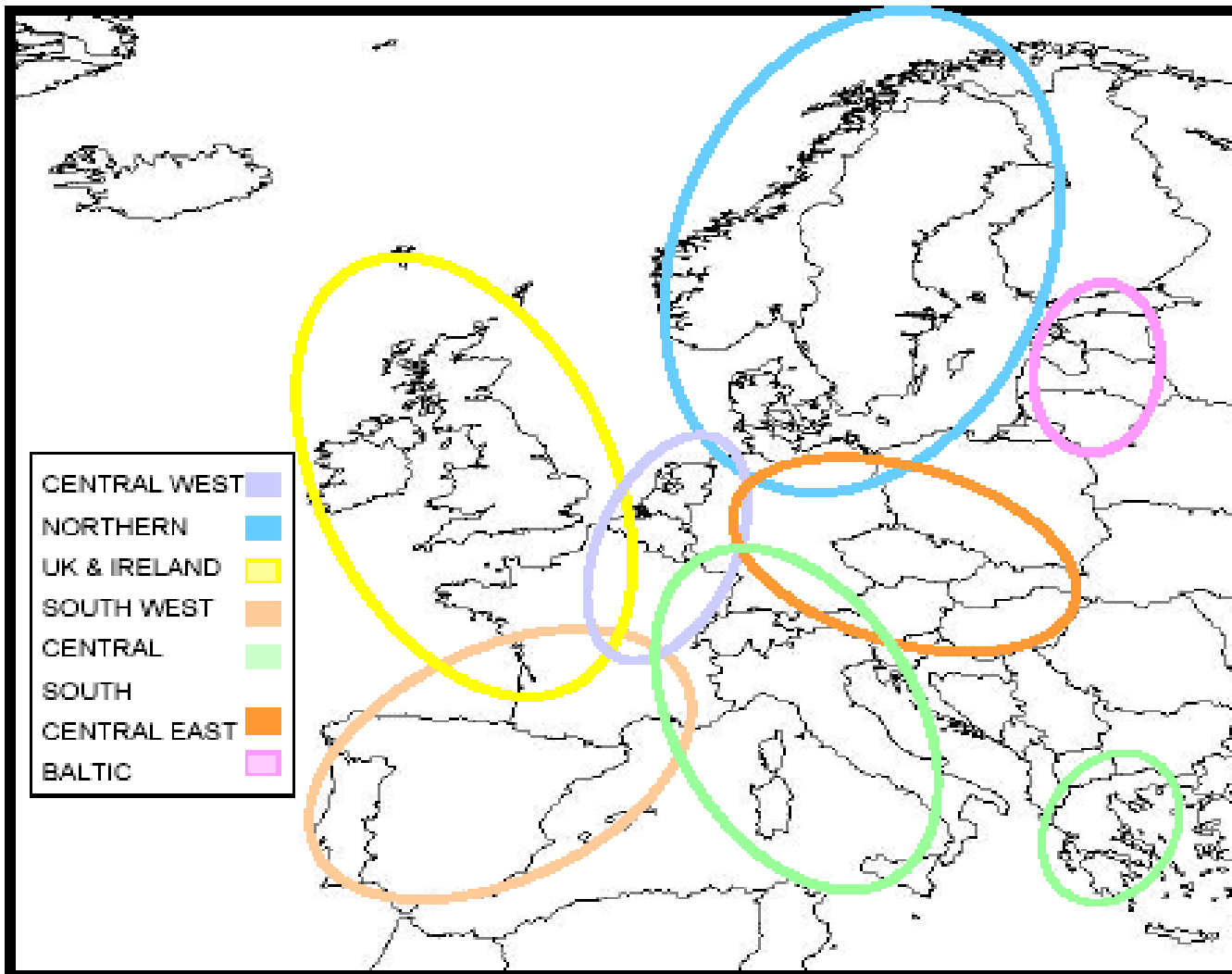
***Implications on market  
design***  
***SYSTEM INTEGRATION***

## ***At operation level...***

# ***Seamless interconnections***

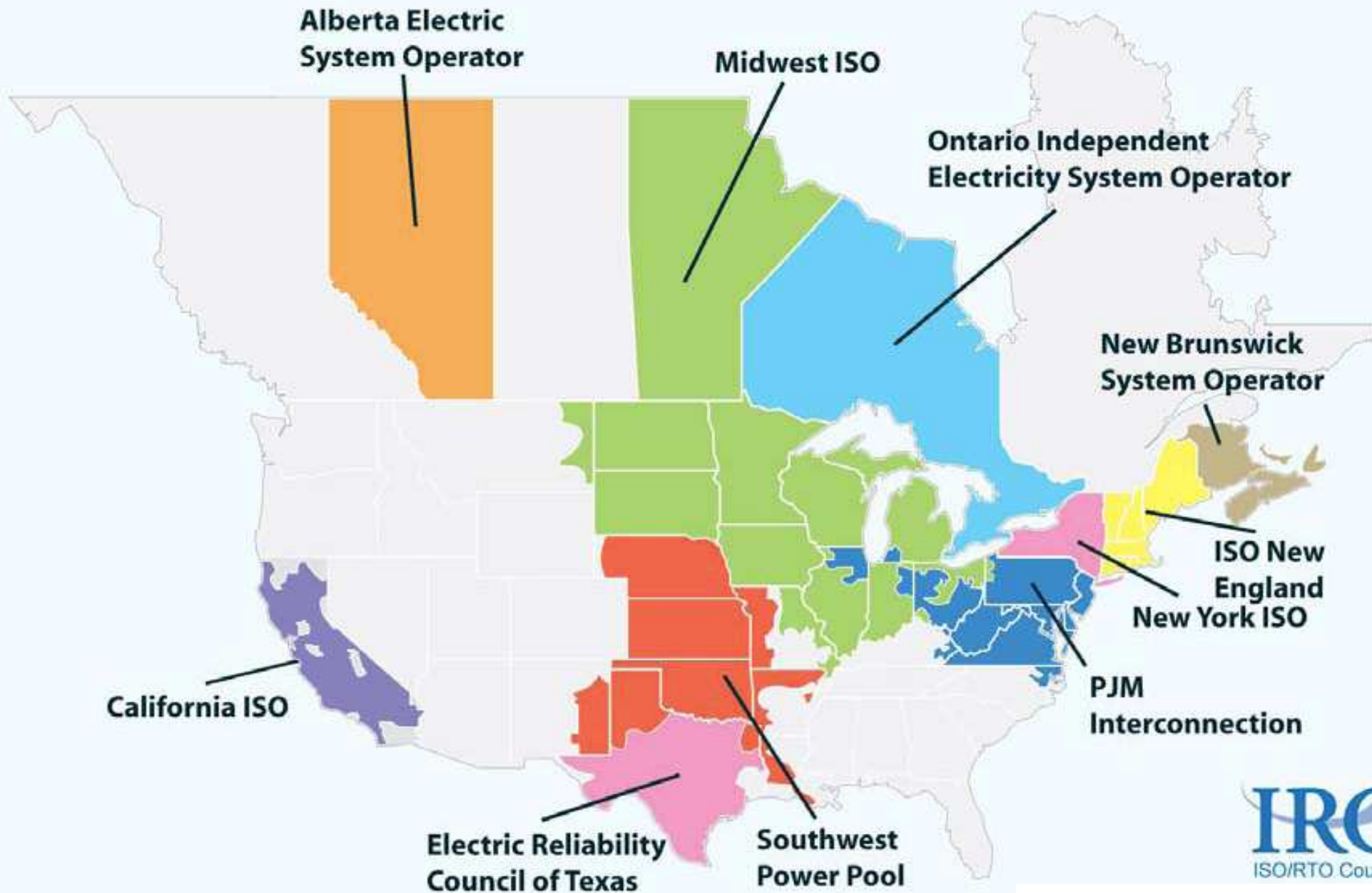
- ❑ Major challenge: coordinated congestion management at USA (Interconnection) & EU-wide levels
- ❑ In the EU
  - 7 Regional Initiatives (RIs) have been created with the expectation of integrating the RIs into a single market later
  - The EU Power Exchanges have launched an integration initiative that is proceeding fast although it continues treating the network in a very coarse way
- ❑ In the US
  - some RTOs have launched ambitious coordination processes
- ❑ Limited success so far & slow progress

# ***The Electricity Regional Initiatives***



<b>region</b>	<b>lead regulator</b>
Central-West	Belgium
Northern	Denmark
UK and Ireland	Great Britain
Central-South	Italy
South-West	Spain
Central-East	Austria
Baltic	Latvia

# Footprint of the North American ISOs and RTOs



Source: [http:// www.iso-rto.org](http://www.iso-rto.org)

# ***Seamless interconnections***

## ***Two very different approaches***



### **□ USA:**

- LMP (locational or nodal energy pricing) at RTO level
- LMP is ideal to integrate generation & network, but difficult to combine with neighboring systems & preserving identity
- Once implemented has many advantages

### **□ EU:**

- Power Exchanges with single energy prices. Their outcomes are passed to TSOs to check grid compatibility
- Easy for Power Exchanges to integrate. But underlying network compatibility only becomes worse & locational signals have to be found elsewhere



***Implications on market  
design  
NETWORK ISSUES***

# ***On the adequacy of the current transmission regulation***



Is the present regulation of transmission

- planning **criteria**
- responsible institutions for interconnection-wide **planning**
  - **cost allocation** procedures
  - **business models** for transmission developers
    - **siting** procedures

adequate to support a large deployment of the anticipated low carbon generation?

# ***The unrelenting transmission issues*** *(even without renewables)*

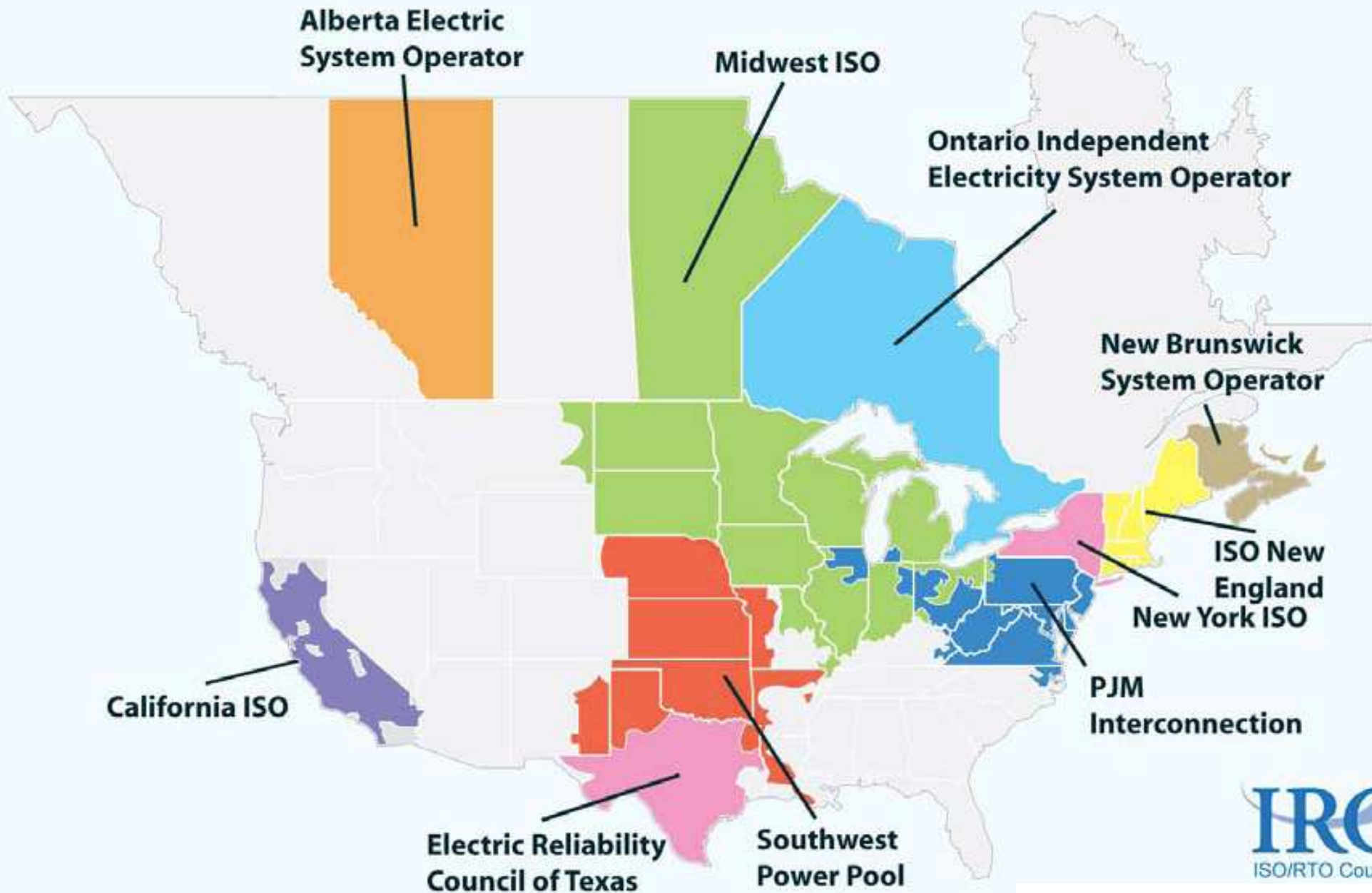


- ❑ What projects? Geographical scope? Who decides? On what basis?
- ❑ How much return on investment? From tariffs? From contracts? From LMPs?
- ❑ Who pays? On what basis?
- ❑ Whose backyard?
- ❑ How much operational coordination is desirable?
- ➔ We might learn something by comparing notes between EU & USA

## North American Electric Power Grids



# Footprint of the North American ISOs and RTOs



Source: [http:// www.iso-rto.org](http://www.iso-rto.org)

# ***US & EU: a basic comparison***

## □ EU-27 & IEM

- 4,3 Mkm<sup>2</sup>, 493 Mhab, 11600 b€ GDP
- 741 GW installed capacity
- 3309 TWh/year

## □ *(Installed capacity, annual production)*

- Germany (124 GW, 620 TWh)
- France (116 GW, 578 TWh)
- UK (81 GW, 398 TWh)
- Italy (85 GW, 304 TWh)
- Spain (70 GW, 294 TWh)

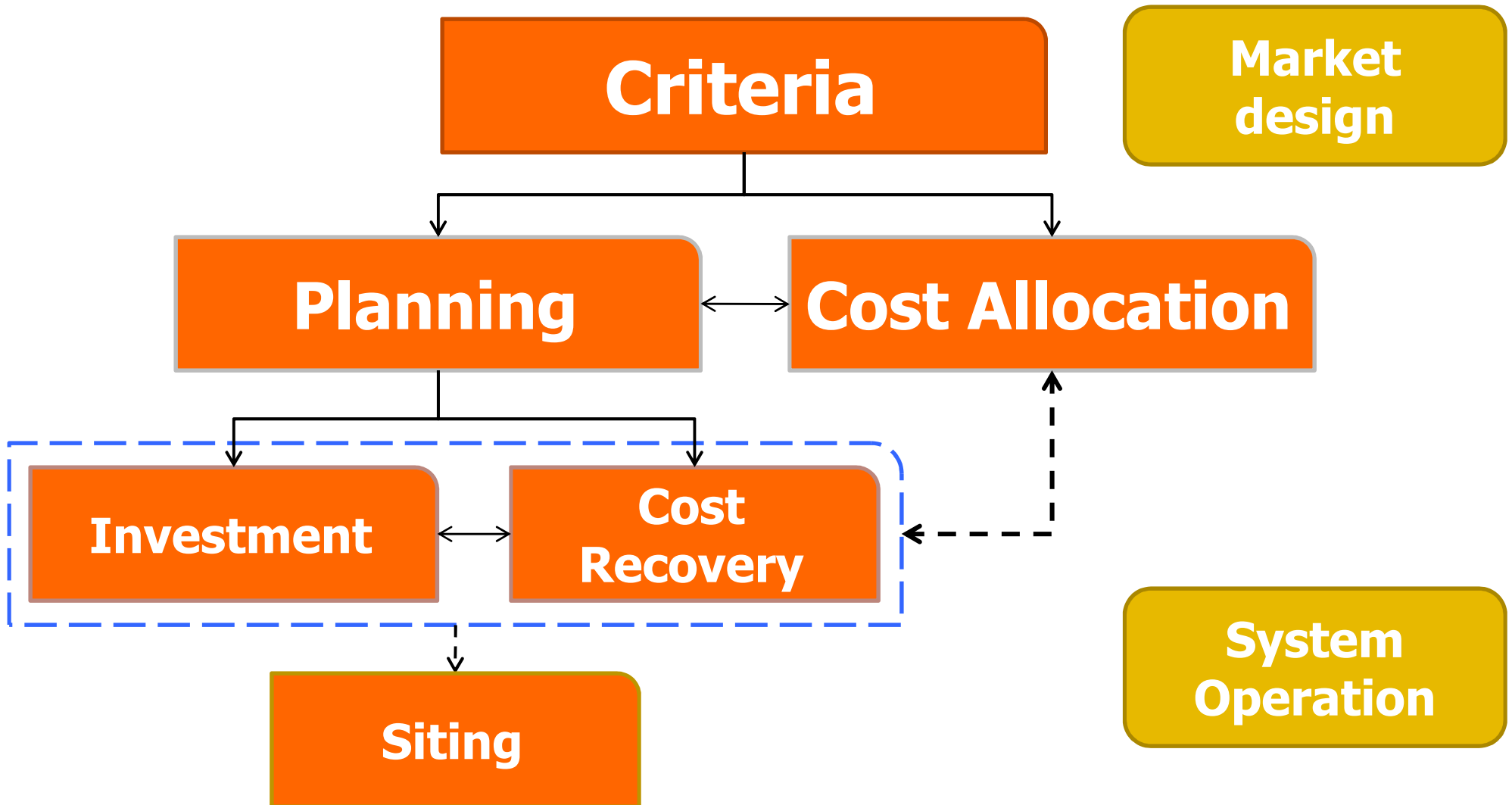
## □ USA

- 9,8 Mkm<sup>2</sup>, 300 Mhab, 13200 b\$ GDP
- 1076 GW installed capacity
- 4200 TWh/year

## □ *(Installed capacity, annual production)*

- PJM (165 GW, 763 GWh)
- MISO (160 GW, 608 GWh)
- ERCOT (80 GW, 290 TWh)
- California (55 GW, 240 TWh)
- NY-ISO (41 GW, 167 TWh)
- NE-ISO (34 GW, 134 TWh)

# ***Policy Framework***





***Implications on market  
design***

***DEMAND PARTICIPATION***

# ***Using & making possible demand response***



- ❑ Efficient deployment of advanced metering, real-time tariffs & behind-the-meter load management
- ❑ Meeting the objectives of energy efficiency & savings → Competitive & focused retail companies (energy service providers)
  - Adequate design of default tariffs, unbundling, compatibility standards, design of smart grids
- ❑ Additional challenges: electrification of mobility
- ❑ Efficient integration of active demand response can be a major component in the new paradigm for system operation



**THANK YOU  
FOR YOUR  
ATTENTION**