ELECTRICITY MARKET DESIGN: HIDDEN VALUES

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A Sandia report on potential values of electricity storage illustrates the range of potential values that might be identified for consideration in economic analysis. (Eyer & Corey, 2010) **Are these values hidden or revealed in markets? How should they be recognized and compensated?**

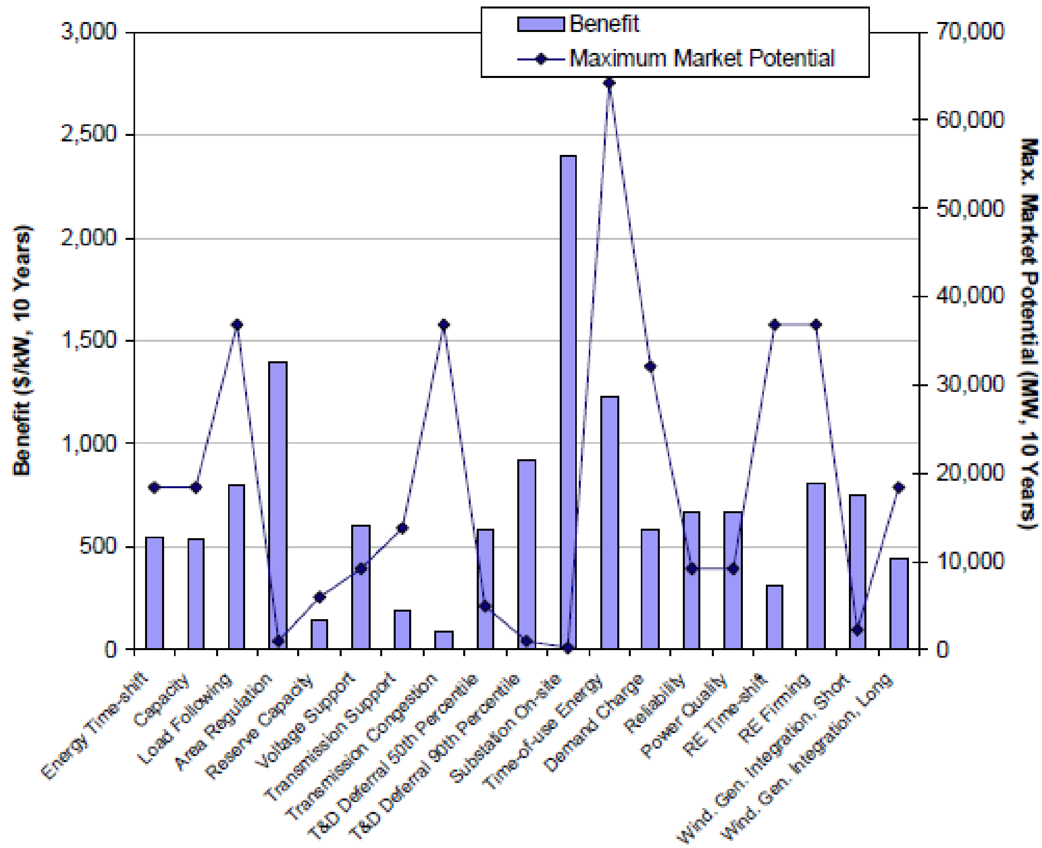
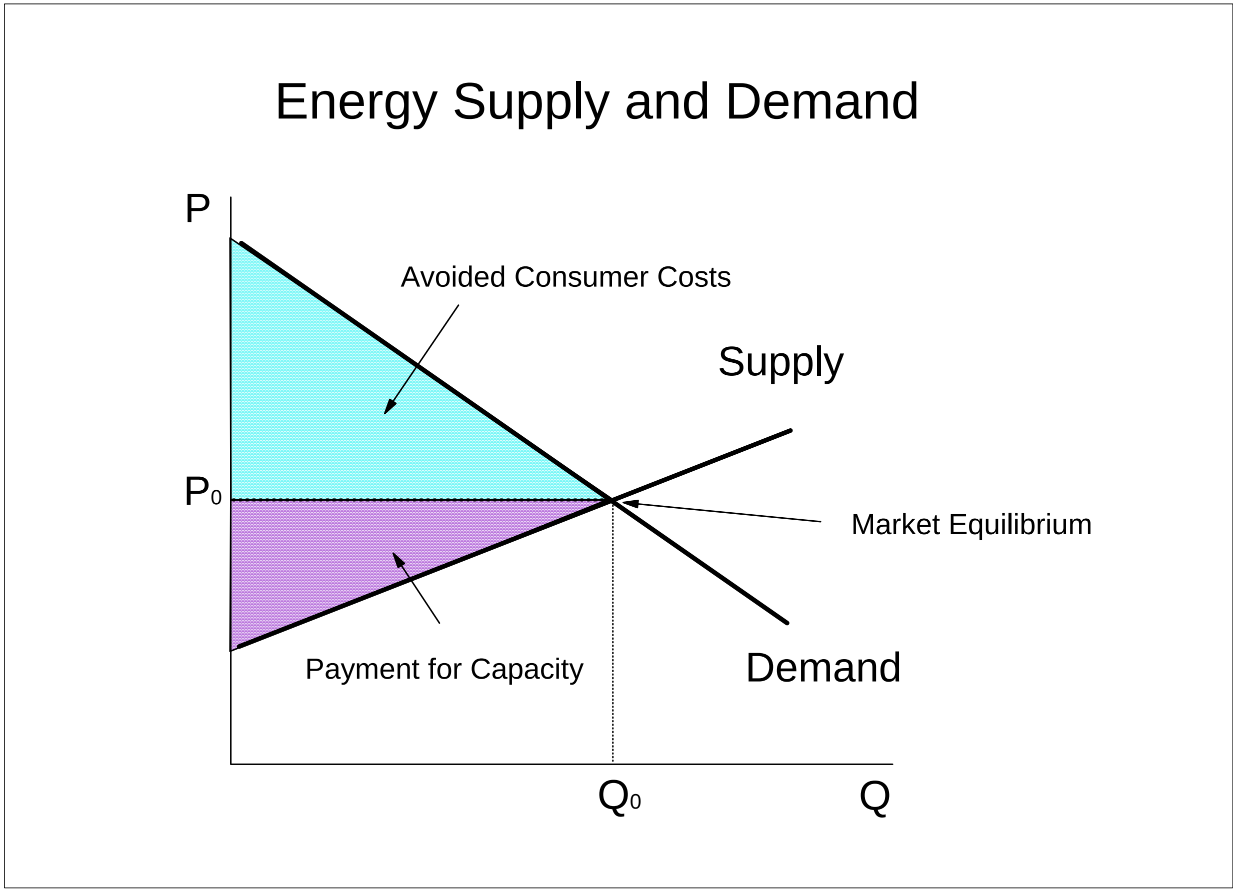
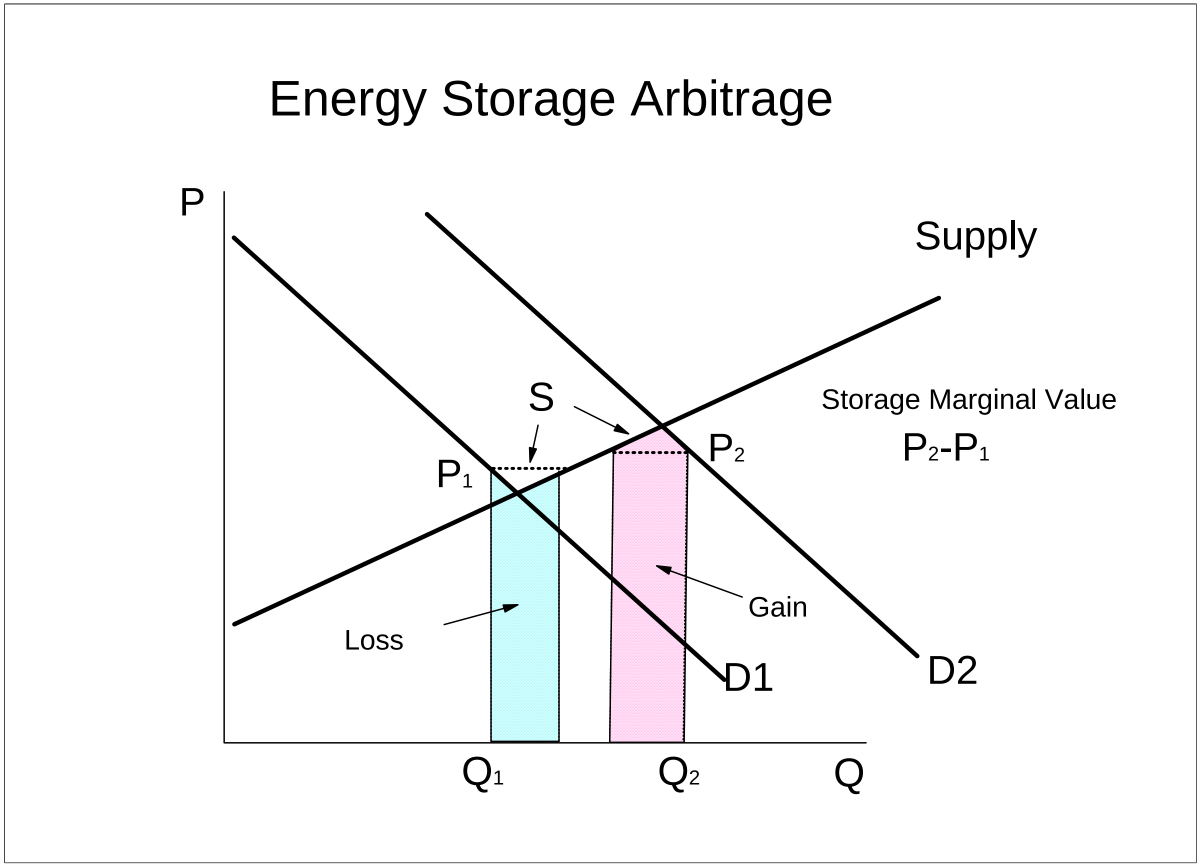


Figure ES-1. Application-specific 10-year benefit and maximum market potential estimates for the U.S.

The textbook example of a complete market includes total consumer and producer costs. Market-clearing prices support the efficient outcome that maximizes the net social welfare. There are no hidden values that need to be included in out-of-market payments.

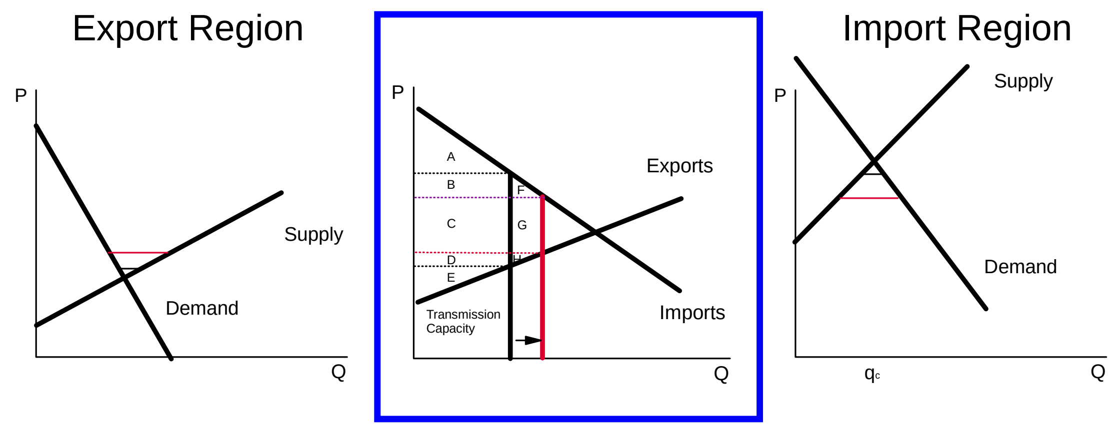


The textbook example extends to storage and energy arbitrage. The gains exceed the losses, to maximize social welfare. The marginal value of storage is defined by the difference in the energy prices. Market-clearing prices support the efficient outcome, without hidden value compensation.



The complete market model also applies to the case of transmission with small changes in capacity and continuous costs.

Unpacking Transmission Benefits

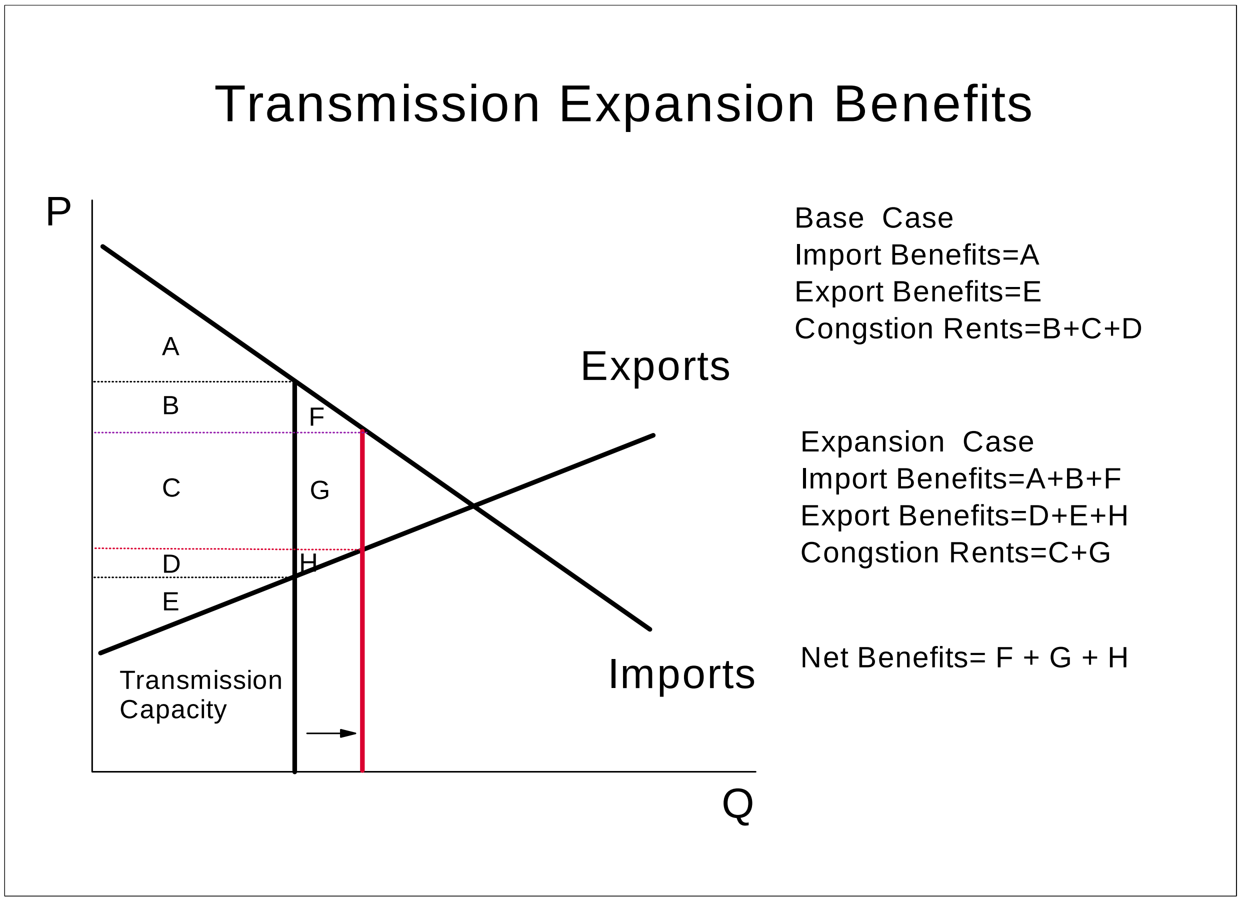


Export Region
Generator gains
Load losses

Import Region
Generator losses
Load gains

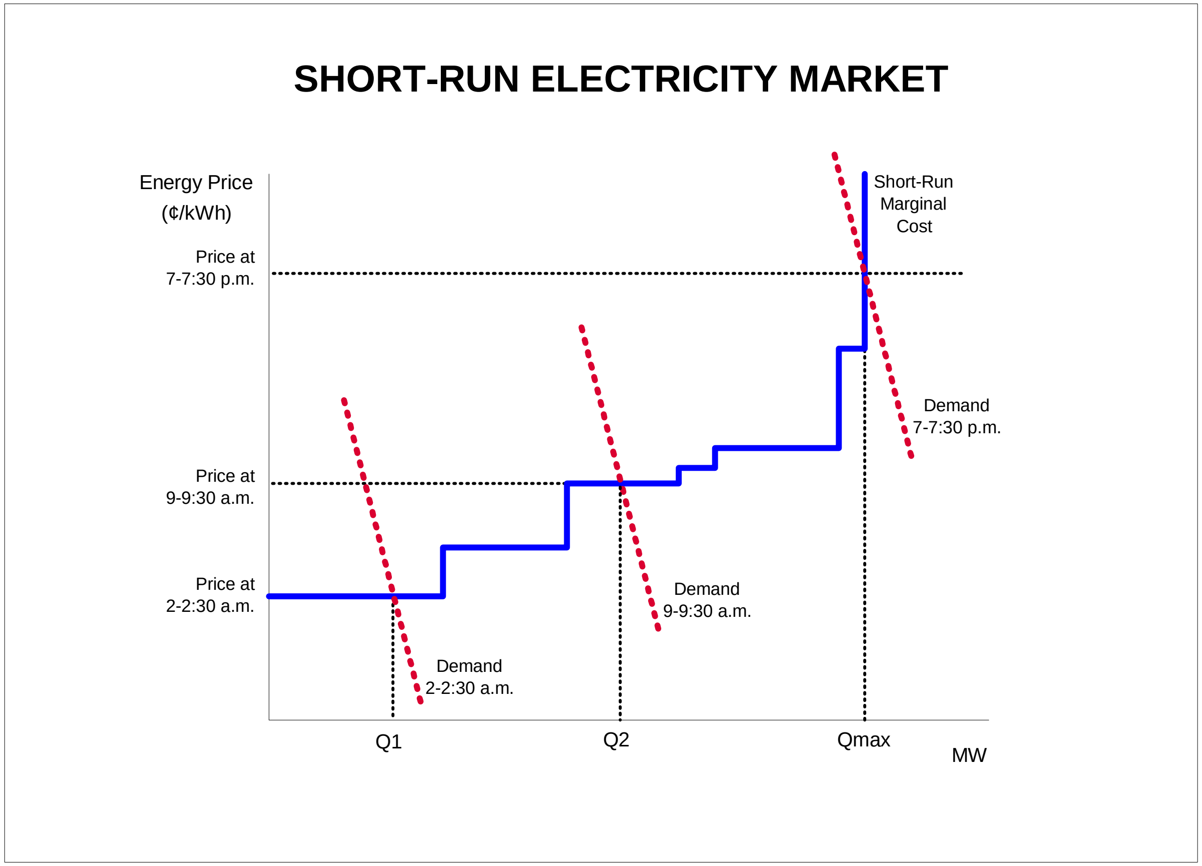
Gains - Losses = Net Benefits
Gains ~ Net Benefits implies merchant case.
Gains >> Net Benefits implies core coalition.

For marginal expansions of transmission, the incremental benefits are equal to the marginal congestion impact that can be capture in financial transmission rights. Market-clearing prices support the efficient outcome without hidden values.



ELECTRICITY MARKET Pool Dispatch

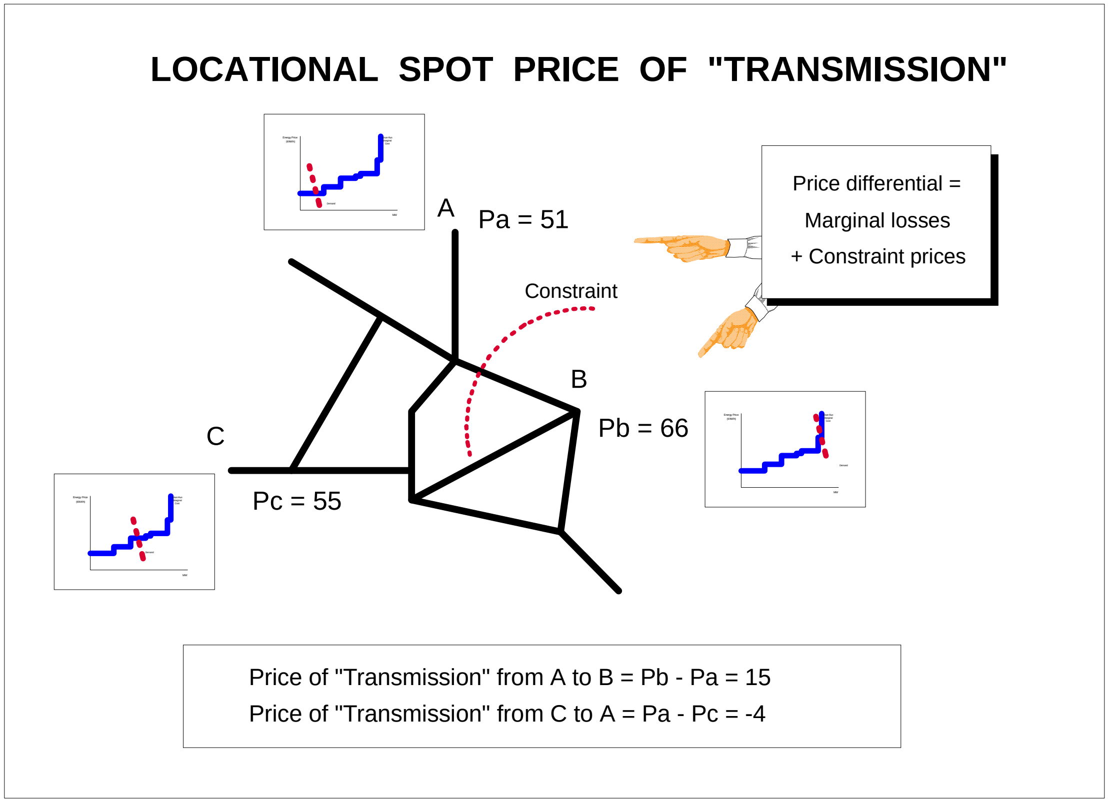
An efficient short-run electricity market determines a market clearing price based on conditions of supply and demand balanced in an economic dispatch. Everyone pays or is paid the same price.



The natural extension of a single price electricity market is to operate a market with locational spot prices. The market-clearing prices support an efficient outcome under the textbook conditions of complete markets. (Schweppe, Caramanis, Tabors, & Bohn, 1988)

- It is a straightforward matter to compute "Schweppe" spot prices based on marginal costs at each location.

- Transmission spot prices arise as the difference in the locational prices.



An argument for "Hidden Values" in electricity markets could be framed as an analysis about incomplete or missing markets.

- **Diagnosis: Incomplete markets can arise for different reasons.**
    - **A Policy Not to Have a Market**
    - **Avoidable Market Design Flaws**
    - **Imperfect Market Implementation**
    - **Market Failures**
        - **Fundamental characteristics of technology**
        - **Correctable market externalities**

- **Prescription: The policy response should reflect the diagnosis.**
    - **Market Reform**
    - **Hybrid Market Design**
    - **Monetization of Hidden Values**

Market design in RTOs/ISOs is well advanced but still incomplete.

- **Regional Markets Not Fully Deployed**
- **Reforms of Reforms**
  California MRTU, ERCOT Texas Nodal, SPP, Western EIM are reformed or expanded markets. Now cover over 70% United States electricity consumers.
- **Market Defects: Scarcity Pricing, Extended LMP, Retail Rate Design**
  Smarter pricing to support operations, infrastructure investment and resource adequacy.
- **Market Failure: Transmission Investment**
  - Regulatory mandates for lumpy transmission mixed with market-based investments.
  - Design principles for cost allocation to support a mixed market (i.e., beneficiary pays).

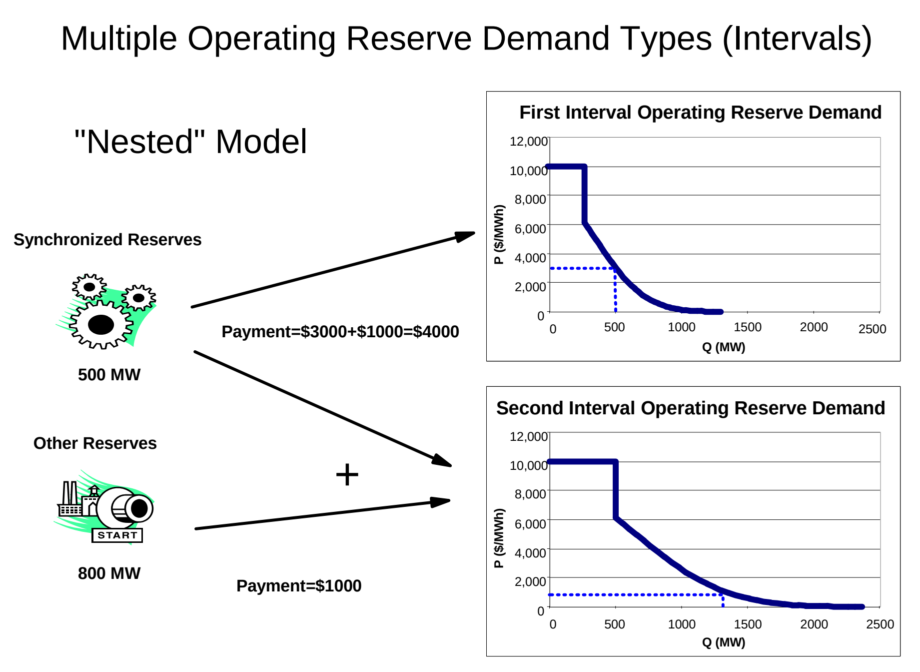
- **Market Challenges: Address Requirements for Climate Change Policy**

Ancillary electricity products and services are another source of value and may give rise to missing markets. The hidden values can be revealed in some cases through improved market design. In other cases the hidden values may be relevant but small in total value.

- **Operating Reserves.**
- **Voltage Support.**
- **Frequency Regulation.**
- **Black Start.**
- **Other.**

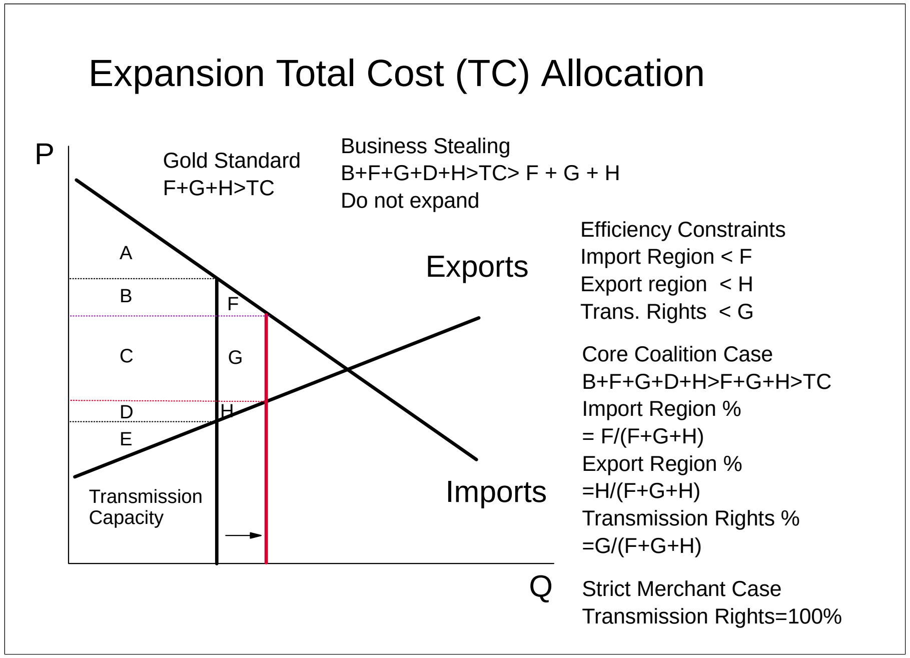
The first step in policy reform should be to get the prices right. (Hogan, 2014) **The second step should be to recognize the hidden values and allocate the uplift costs to minimize the impact on the markets.**

Multiple types of operating reserves exist according to response time. ERCOT implemented a nested model divides the period into consecutive intervals. Reserve schedules set before the period. Uncertainty revealed after the start of the period. Faster responding reserves modeled as available for subsequent intervals. The operating reserve demand curves apply to intervals and the payments to generators include the sum of the prices for the available intervals. (Hogan, 2013)



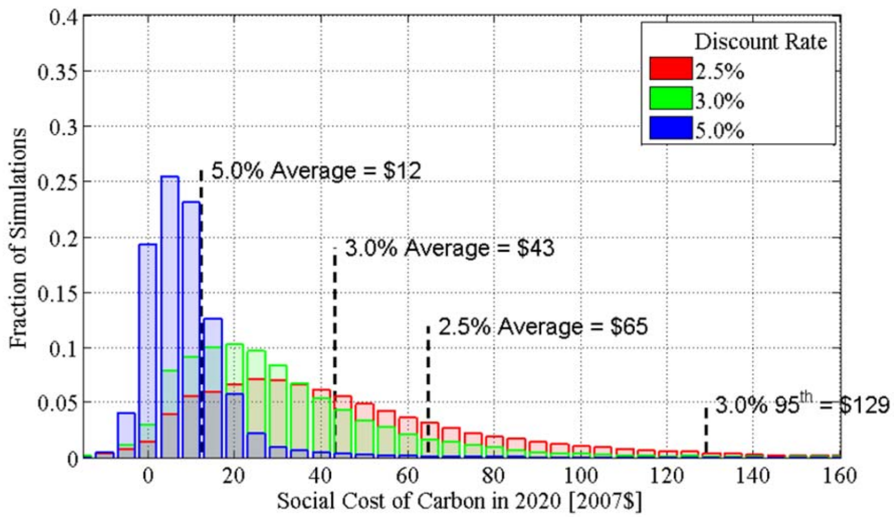
Nested model with two intervals, decisions made before uncertainty revealed.

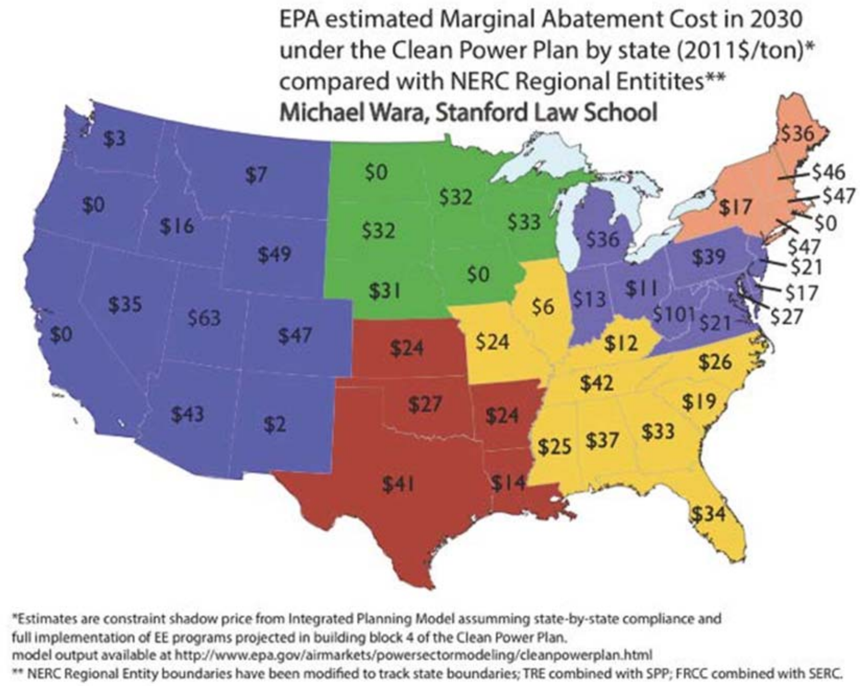
For large investments, a transmission infrastructure mandatory cost allocation framework requires a hybrid system that is regional in scope and compatible with the larger market design. "The cost of transmission facilities must be allocated to those within the transmission planning region that benefit from those facilities in a manner that is at least roughly commensurate with estimated benefits." (FERC Order 1000, ¶ 622, 637) Cost benefit analysis of transmission expansion inherently provides information about the distribution of benefits for use in cost allocation.



Importantly, the required estimation of total benefits and associated cost allocation applies to the large lumpy transmission expansion, but not to the resources that compete with transmission. (Hogan, 2011) **There are no hidden values to compensate other services.**

The challenge of climate change and the impact of carbon dioxide and other greenhouse gas emissions is a textbook example of a market failure. The policy implication is to internalize the cost of carbon. The benchmark for the best policy is a carbon tax. The uncertainty about the social cost of carbon is important, but it does not affect the form of the best policy. (U. S. Government Interagency Working Group on Social Cost of Carbon, 2013) **We are a long way away from the simple ideal of a common price for carbon.** (Wara, 2015)





The initial electricity market reform emphasized the high voltage grid and wholesale markets. Even retail market open access rules left distribution systems largely untouched.

- **Demand Bidding**
    - **Demand Participation: Charge demand the market price for load taken. A natural fit with good market design.**
    - **Demand Response: Pay demand for the load not taken. An unnatural fit spawned by flat retail rate design.** (Cicchetti & Hogan, 1989)
- **Distribution Pricing**
    - **Fixed and Variable Cost**
    - **Distribution Operations**
        - **DLMP**
        - **Voltage Support**
        - **Congestion and Reliability**
- **Technology Innovation**
    - **Distributed Energy Resources and Net Metering**
    - **Smart Grids and Dumb Prices**
- **Reforming the Energy Vision** (NYS Department of Public Service, 2014)

The integrated grid and distribution reform will change electricity markets. A hybrid system would emphasize good market design and smart pricing. The goal should be to move as much of the value chain into the market, and not leave values hidden behind regulatory mandates.

The most prominent examples of "Hidden Values" in electricity markets arise from market design failures rather than inherent market failures. Often the values would be implicit in market clearing prices and separate identification as hidden values is double counting.

- **Get the Prices Right. Fix the Market Design Failures.**
  - **Better scarcity pricing**
  - **Carbon pricing**
  - **Distribution pricing and DLMP**
- **Design Market Hybrids Compatible with Good Pricing Policy.**
  - **Lumpy transmission expansion and beneficiary pays**
  - **Extended Locational Market Pricing and startup costs**
  - **Uplift allocation rules to minimize market distortions**

The hidden values that elicit calls for subsidies create their own inefficiencies. Much of the motivation for electricity restructuring sprang from dissatisfaction with "avoided cost" mandates and energy subsidy programs. (Hogan, 2002) **The hidden part of the green agenda is often hidden costs not values.**

> "Subsidies pose a more general problem in this context. They attempt to discourage carbon-intensive activities by making other activities more attractive. One difficulty with subsidies is identifying the eligible low-carbon activities. Why subsidize hybrid cars (which we do) and not biking (which we do not)? Is the answer to subsidize all low carbon activities? Of course, that is impossible because there are just too many low-carbon activities, and it would prove astronomically expensive. Another problem is that subsidies are so uneven in their impact. A recent study by the National Academy of Sciences looked at the impact of several subsidies on GHG emissions. It found a vast difference in their effectiveness in terms of CO_2 removed per dollar of subsidy. None of the subsidies were efficient; some were horribly inefficient; and others such as the ethanol subsidy were perverse and actually increased GHG emissions. The net effect of all the subsidies taken together was effectively zero!
>
> So in the end, it is much more effective to penalize carbon emissions than to subsidize everything else." (Nordhaus, 2013) (p. 266)

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