Poolco: *What's the trick?*

Coordination for Competition, Transmission Pricing and Open Access in the Restructured Electricity Market

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Support of competition must be recast within the context of the future of a very different electricity market. A competitive wholesale electricity market is coming as the law of the land (EPAct 92) and the clear policy objective of the Federal Energy Regulatory Commission (FERC).

- **Open Access.** Virtually anyone will be able to obtain access to essential facilities and participate in the market.
- **Comparability of Service.** The non-discrimination rules will require comparability of terms and conditions for monopoly provision of services in essential facilities.

We are likely today to underestimate just how different some things may be, and in the transition to the new era there will be many opportunities to revisit and revise the conventional wisdom.

- **Reliability Will Be Maintained.** When you flip the switch, the lights will come on.
- **Everything Else Will Change.** For example, by now everyone knows that the old truth of the contract path for transmission was only a workable fiction with no relation to reality and which is now collapsing under the pressures of the competitive market. This is only the tip of the iceberg.

Many old assumptions and convenient fictions will need to be revisited. A partial list includes:

- **Energy and Capacity**: The need for separate energy and capacity planning and pricing arises in part from the incentives of cost-of-service regulation. The new incentives of the market may eliminate the practical need for maintaining any distinction.

- **Generation and Transmission**: Control over flexible generation is required to manage the flow of power and the interactions in the network. In the short run, with economic dispatch in an integrated network, generation and transmission are parts of the same function. Separate pricing of generation dispatch and transmission usage may be as unnecessary as it would be difficult. The pool-based market proposals define an alternative approach that consolidates dispatch and transmission.

- **Cost-Effective Conservation**: Criteria for evaluating cost-effective conservation investments must change with a move to marginal cost pricing that should be inherent in a more competitive electricity market. The important market failure created by average-cost pricing will be eliminated and incentives recast.

- **Portfolio Planning**: Under the closed cost-of-service system, the franchise utility was the only source of diversification and portfolio planning for the long-run. With competition and open access to the essential facilities, the portfolio management function for commodity electricity can move to private markets.

- **Environmental Protection**: Programs to improve environmental performance can be compatible with customer choice. Regulation would shift from restricting customer options to expanding environmental opportunities. Explicit subsidies to environmentally preferred technologies can replace command-and-control procurement directives.

- **Obligation to Serve**: Cost-based regulation of a monopoly creates the need for a broad "obligation to serve." Redrawing the boundaries of the monopoly creates both the opportunity and the necessity to recast the obligation to serve to apply only to the monopoly elements. With the residual monopoly of transmission and distribution, the new world calls only for an obligation to deliver the commodity energy that can be purchased in the competitive market.

- **Market Power**: Market power issues must be addressed in regional generation markets. No simple design can overcome a fundamental concentration of market power. The new market model for generation needs to recognize concentrations of ownership and provide mechanisms to prevent monopoly pricing through market dominance. However, the new institutions of the competitive market will create alternatives for regulating generation that can prevent monopoly pricing while preserving competitive pricing, both of which will differ from cost-of-service pricing.

We could add to the list, but the point would be the same. We all must go back to basics in reconsidering many of the assumptions about the most obvious facts of the electricity industry which may not be facts at all.

An efficient design for an open access electricity market must balance a number of competing objectives.

- **Reliability, Safety and Environmental Excellence.** Engineering limitations on operations must be respected to preserve the stability and security of the electric power grid. Environmental stewardship must be respected.

- **Open Access.** Commercial functions must facilitate non-discriminatory, comparable open access and support market operations in the competitive sectors. The EPAct requirements and the FERC implementation emphasize the need to obtain market access under terms and conditions that support competition. Everyone should have equal access to and use of essential facilities, particularly transmission, with the rights of ownership limited to compensation consistent with opportunity costs in a competitive market. The "golden rule" of comparability is a common thread.

- **Least-Cost Dispatch.** The benefits of least-cost dispatch in achieving efficient use of existing resources should be preserved with appropriate pricing for the various services needed to support the associated power transmission.

- **Efficient Trading and Investment.** Short-run trading in the market should be economically efficient and compatible with long-run efficient investments and associated contracts.

- **Shared Benefits.** Market structure should facilitate extending the benefits of competition to everyone, not just to larger players able to operate easily in the wholesale market.

- **Distinct Physical and Financial Transactions.** Market institutions and operations should allow for financial transactions that implement flexible bilateral commercial arrangements while separately coordinating the spot market interactions of physical delivery of electricity in the transmission network. This will provide automatic sources of backup power and easier resolution of contract disputes.

- **Compatibility with Other Public Policy Goals.** Objectives that are not met through the operation of the market--such as protecting the environment, low income assistance, industrial development--should to the extent possible be supported through rules that are neutral towards other market choices.

- **Revenue Adequacy.** The pricing framework should accommodate recovery of legitimate costs incurred in providing the electricity system and supporting public policy goals.

- **Consistent Federal and State Regulation.** Pricing and access rules for the regulated monopoly essential facilities should be consistent between federal and state jurisdictions.

- **Practicality.** Transition steps should reflect and respect the jurisdictional responsibilities for the regulated elements of the system. Workable approximations should be available and robust.

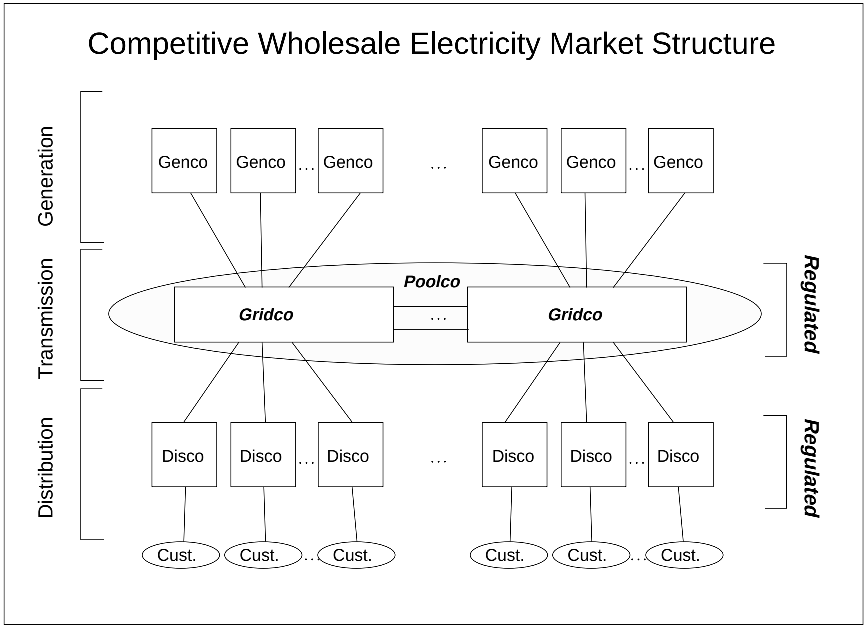
Two elements stand at the core of a new market structure that can be fashioned consistent with this set of objectives.

- **Pool-Based Market:** Operation of the short-term market through a closely coordinated or pool-based dispatch. System security and network congestion problems handled as part of the dispatch. Transmission capacity rights allocated along with grid costs but implemented through short-term pool pricing and rental payments for use of allocated capacity. Long-run investment and contracts for energy handled in bilateral markets.

- **Customer Choice:** Under *Efficient Direct Access* customers remain with the local utility which buys from the wholesale market and resells at a time-of-use rate based on the spot price. There are no necessary changes in cost-of-service principles. All customers remain under the utility tariff but have effective access to the market. Decisions on cost recovery can proceed as before. Whatever can be done under traditional cost-of-service regulation can be continued. Universal service support, investments in energy efficiency, and subsidies for renewable and other environmentally preferred alternatives could be made when justified, and included in the cost of service applied to all customers separate from the time-of-use energy charges.

The pool-based, short-term electricity market addresses the few necessary constraints and technical issues by coordinating system operations and power plant dispatch. Customers, brokers and aggregators enjoy free choice to make long-term arrangements with any supplier or rely solely on access to the short-term market.

The usual separation into generation, transmission, and distribution is insufficient. In an electricity market, the transmission wires and the pool dispatch are distinct essential facilities.



The special conditions in the electricity system stand as barriers to an efficient, large-scale bilateral market in electricity. A pool based market model helps overcome these barriers. The immediate need is to define further the problems and craft workable solutions.

Poolco. ***What's the trick?*** **Criticisms of the Poolco approach have several strands:**

- **The technical details of transmission are both unimportant and separate from generation dispatch. Central coordination through a Poolco is unnecessary.** -- The coordination function is found everywhere and is not a small detail to be brushed aside. "This problem makes my head hurt." Control of transmission operates primarily through control of dispatch at the margin. A system operator is necessary. To be efficient, something like a Poolco for coordination of the short-term market is desirable.

- **The old monopoly utilities will dominate and control the new monopoly Poolco. Truly independent system operation is impossible.** -- A system operator is necessary; in the interest of competition it must be made independent. Analogies are the NYSE, FAA, or the way existing power pools deal fairly with individual members.

- **The Poolco will create or enhance the market power of large generating companies.** -- Market power is an important issue. Functional separation of the Poolco-Gridco from Genco-Disco provides open access to eliminate vertical market power. Remaining horizontal market power of large generating companies would need to be addressed, but would not derive from the Poolco structure. Compared to other approaches, the Poolco model enhances transparency as it both reduces the scope of and expands the mitigation options for any residual market power.

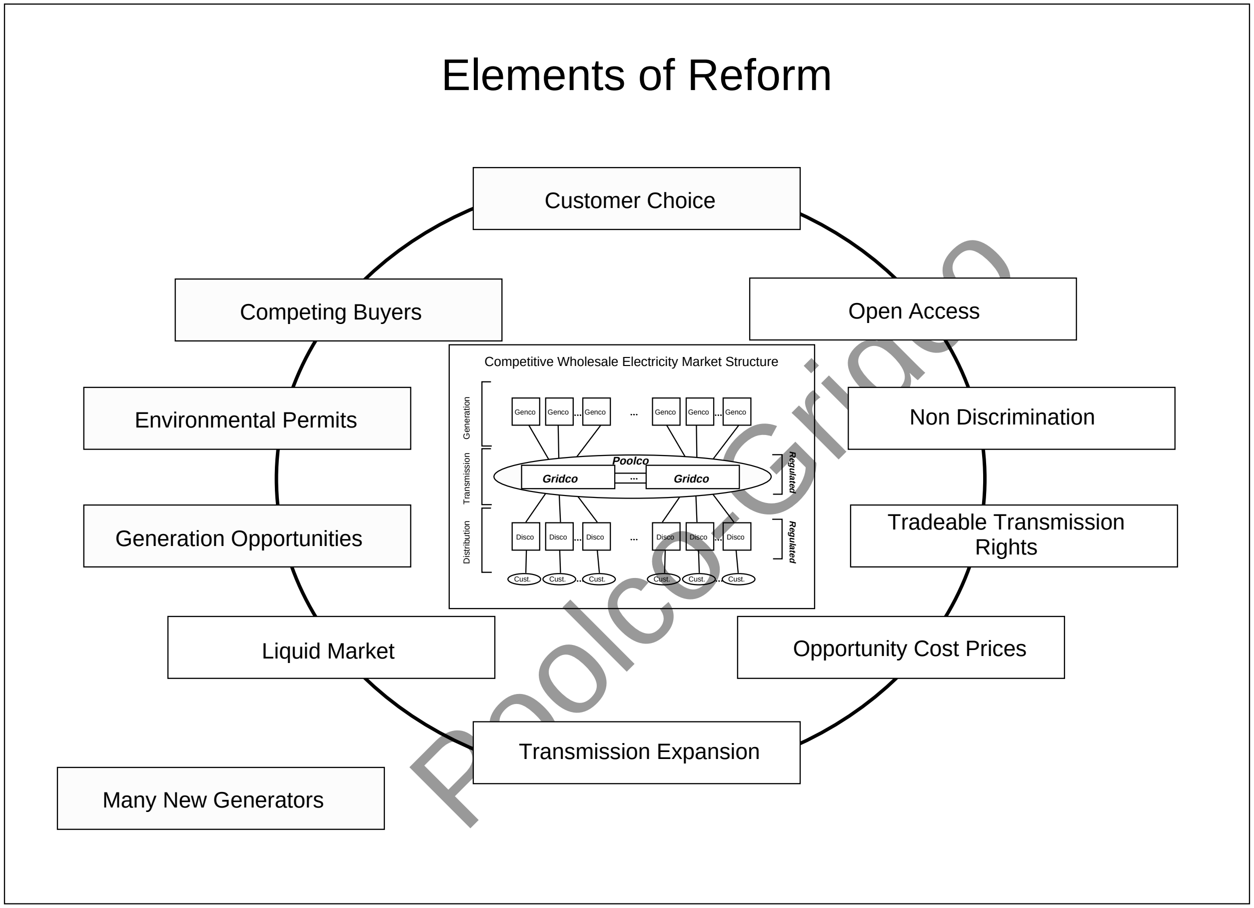
Poolco. ***What's the trick?*** **Criticisms of the Poolco approach have several strands (cont.):**

- **The technical complexity of the transmission grid exceeds the regulators' ability to provide effective oversight of Poolco.** -- Regulatory oversight of transmission and the attendant system operations is unavoidable. The Poolco model with its focus on short-term dispatch (greatly) simplifies the audit function. Poolco dispatch, pricing and settlements systems should be easier to review than the systems of the existing power pools.

- **Regulators will have oversight of Poolco and could interfere with the market.** -- True, but unavoidable. Regulators will have oversight of the residual monopoly functions and could use this to interfere with the competitive market, no matter how the system is organized. An efficient open-access Poolco would reduce the need for regulatory intervention.

- **Poolco is a tactic designed to delay open access and real competition.** -- Perhaps this is or was the motivation of some proponents. However, an efficient open-access market will eventually lead to a Poolco model and it is better to get on with the details of implementation. The real delay so far has been caused by the opponents who are coming wrenchingly to the realization that something very much like a Poolco is needed, but insist on choosing a better name.

Poolco. ***What's the trick?*** **There is no trick. Poolco provides a large part of the solution.**



Is economic dispatch a natural monopoly?

- **Natural monopoly is an economic concept.** Although there are minor differences between textbooks in their respective definitions of natural monopoly, the common theme is that a single firm can provide the lowest total cost in serving a particular market. The economics--the costs--are essential, and without specifying the cost structure there would be no foundation for asserting a natural monopoly condition. There is no theory of "natural physical monopoly," and with appropriate restrictions virtually any market could be served in a number of ways that would involve more than one firm. The distinctive characteristic of a natural monopoly is not that there is no alternative to a monopoly, but rather that provision through a monopoly is the lowest cost solution.

- **Least-cost dispatch is the competitive market equilibrium.** The least-cost dispatch satisfies the "law of one price" and the "no arbitrage" condition of the competitive equilibrium.

- **The characteristics of electricity coupled with poorly defined property rights create a natural monopoly in dispatch.** Convergence of a fully decentralized market to a competitive equilibrium depends on ease of trading and well-defined property rights. Neither condition holds in the electricity system.

The emphasis is on characteristics of the electricity system with important engineering and commercial implications.

- **Cost Diversity.** The short-term cost of operating existing power plants exhibits great heterogeneity across plant types and locations. There are always substantial gains from trade by using low cost plants that are available to substitute for higher cost plants.

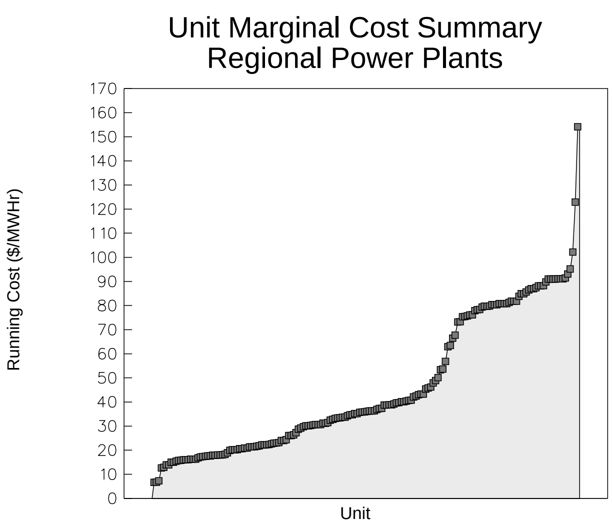
- **Load Uncertainty.** Load conditions change substantially over the day and season. Variations in load are difficult to predict and change differently at different locations.

- **Complex Control Requirements.** Operating conditions require close monitoring and control on very short time horizons. For many important decisions, operating conditions must anticipate emergency contingencies. These constraints can and often do limit the flexibility to select the running levels of individual power plants.

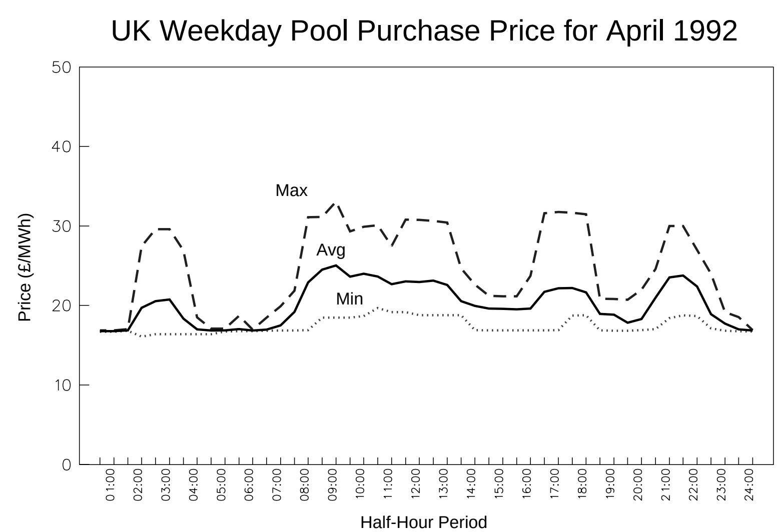
- **Network Interactions.** The interconnected network under current technology creates strong interactions across locations. Every power plant and load affects all others. The interactions with system constraints can be large and differ substantially by location.

The combination of factors greatly complicates operation of a short-run bilateral market. It is difficult to specify and use decentralized information that would allow decentralized trades to approach the efficient short-run solution. These problems historically motivated the development of electricity power pools.

The variation in unit marginal costs can span an order of magnitude. The incremental cost of the marginal unit for a given hour can easily differ by 100% across utilities meeting own load demand. Hence, short term coordination, though trading or central dispatch, is important for the commercial efficiency of the electricity market.

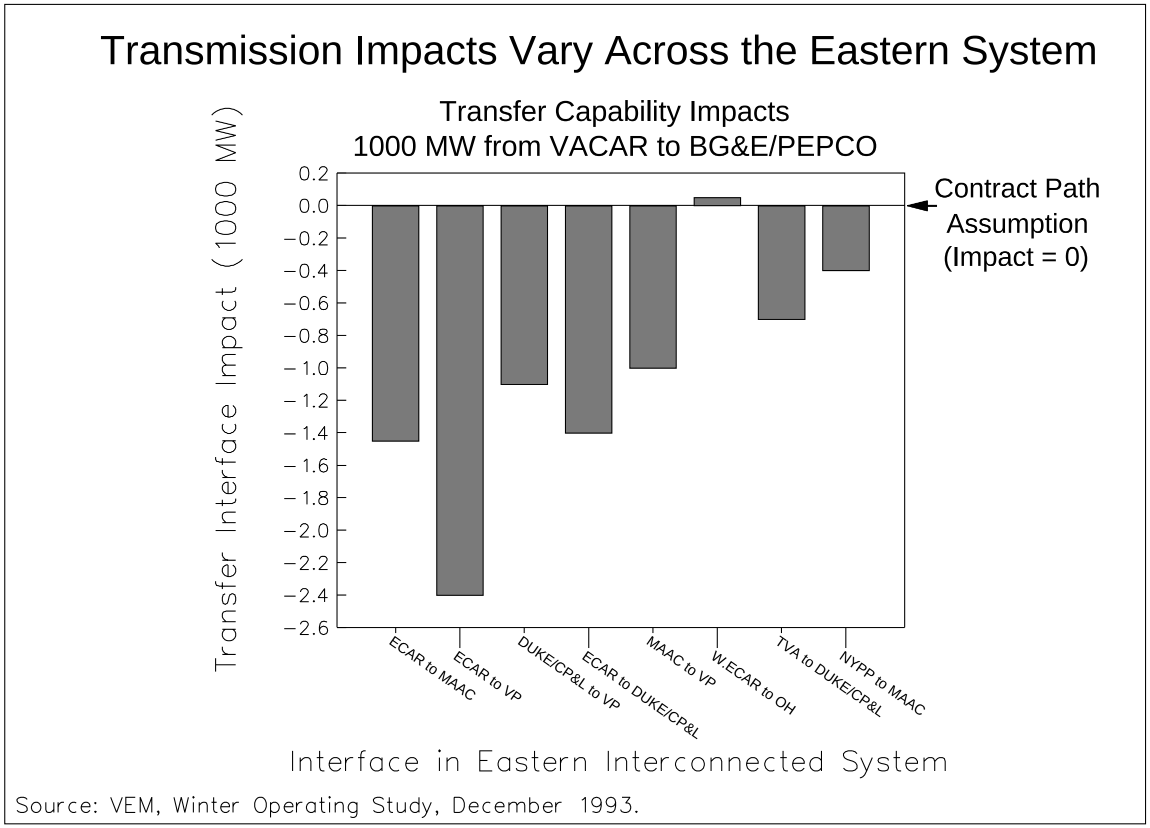


Note: Unit Running Rates for 1200 Bus Case.

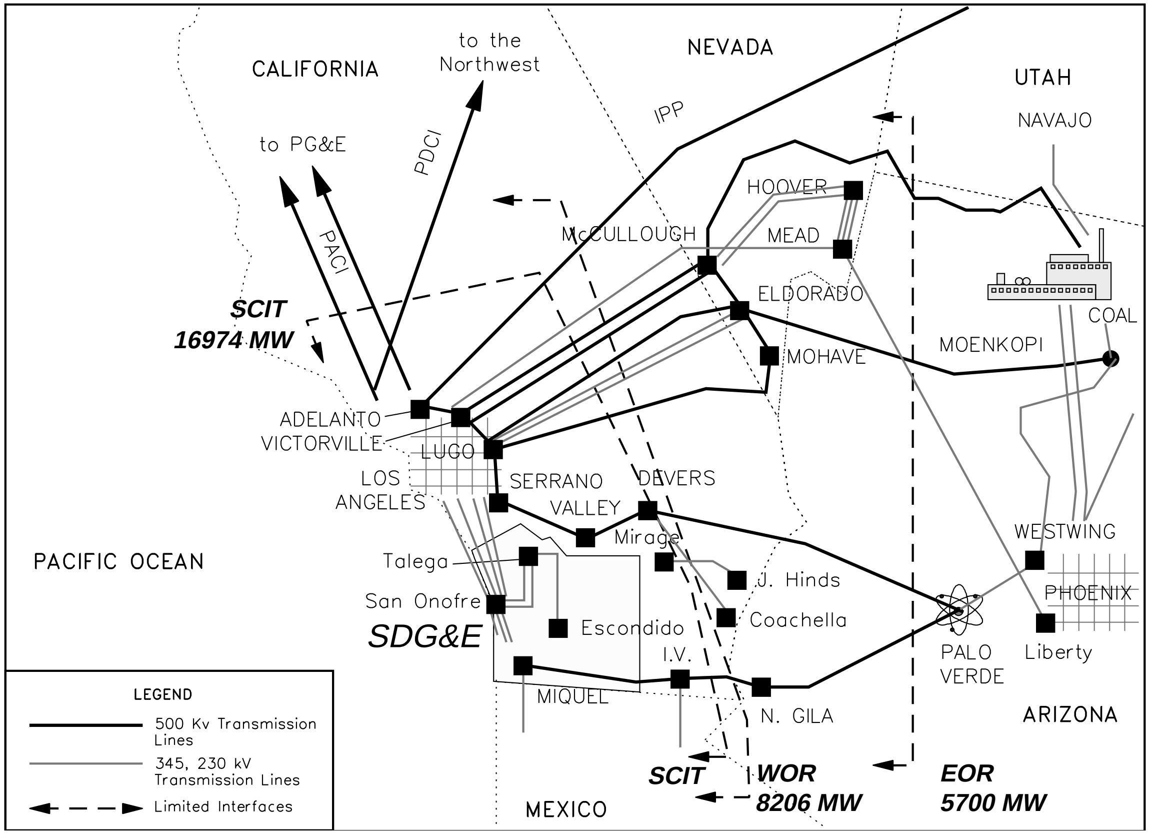


Source: NGC, Pool Settlement Data, COMAPR92.FIN.

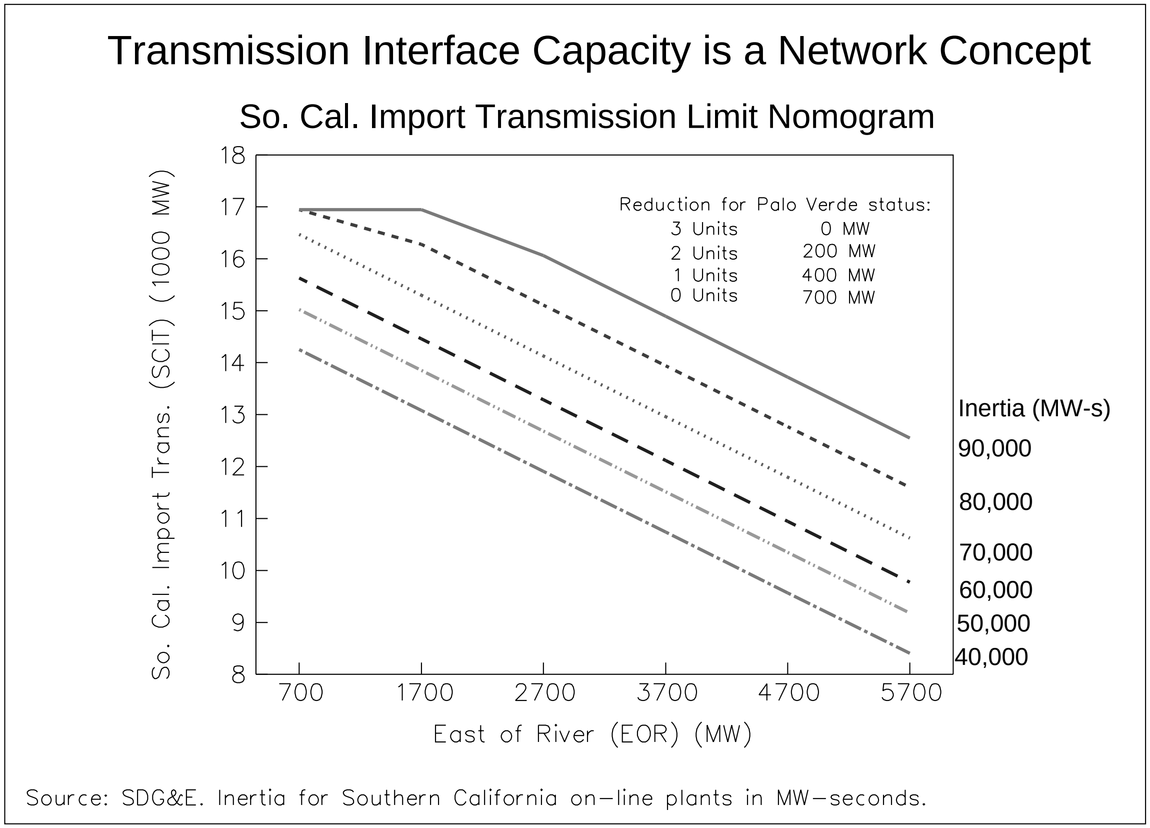
There is a fatal flaw in the old "contract path" model of power moving between locations along a designated path. The network effects are strong. Power flows across one "interface" can have a dramatic effect on the capacity of other, distant interfaces.



The strong network effects apply in most, or all interconnected grids. In southern California, for example, there are important interfaces with maximum limits that cannot be achieved simultaneously. Complex "nomograms" summarize the simultaneous constraints. (see next page)



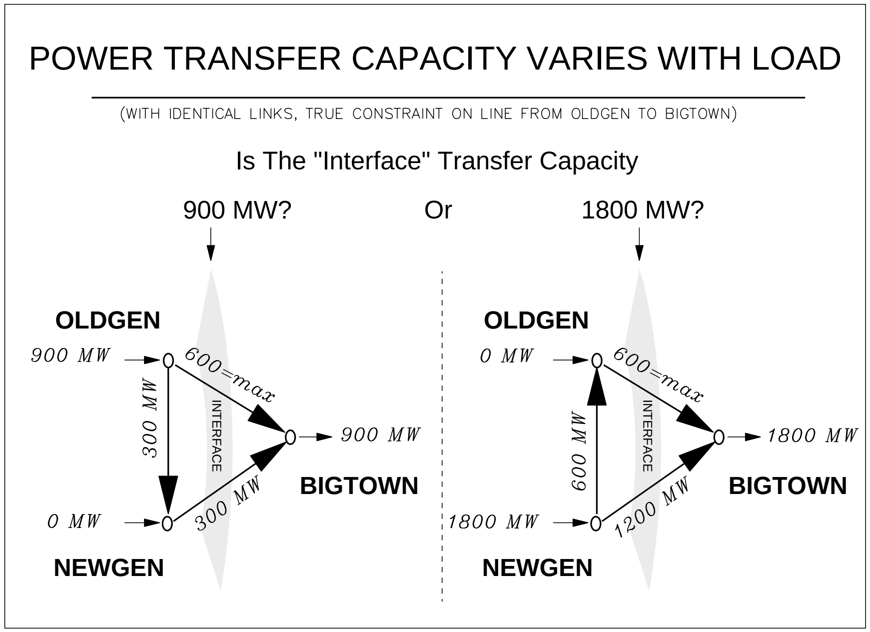
The SCIT "nomogram" for southern California illustrates the strong interdependencies of network flows and the breakdown of the contract path model. Management of this system requires a network perspective and a network coordinator, here Southern California Edison.



Electric transmission network interactions can be large and important.

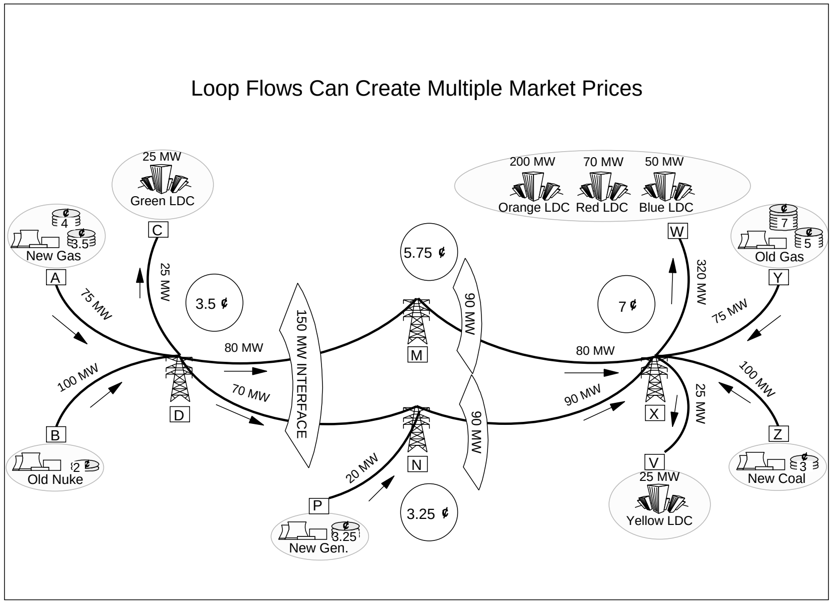
- Conventional definitions of network "Interface" transfer capacity depend on the assumed load conditions.

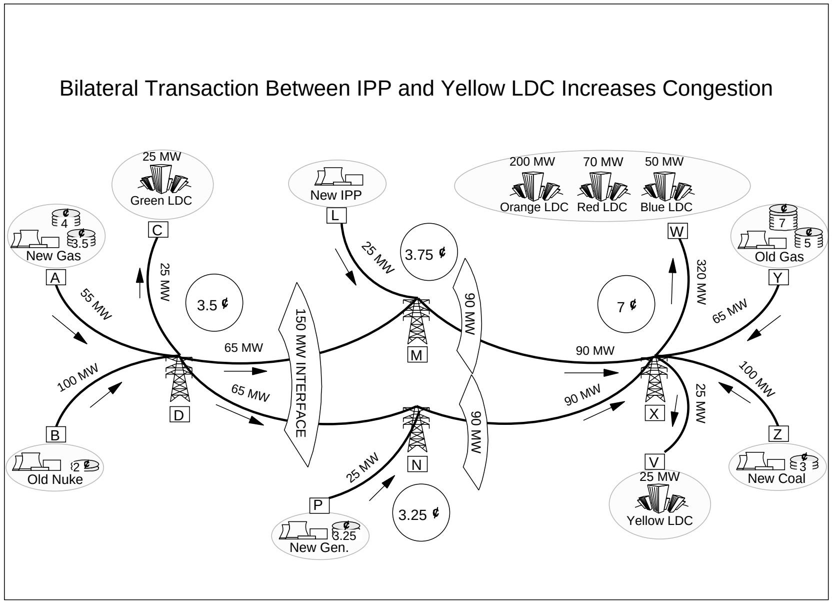
- Transfer capacity cannot be defined or guaranteed over any reasonable horizon.



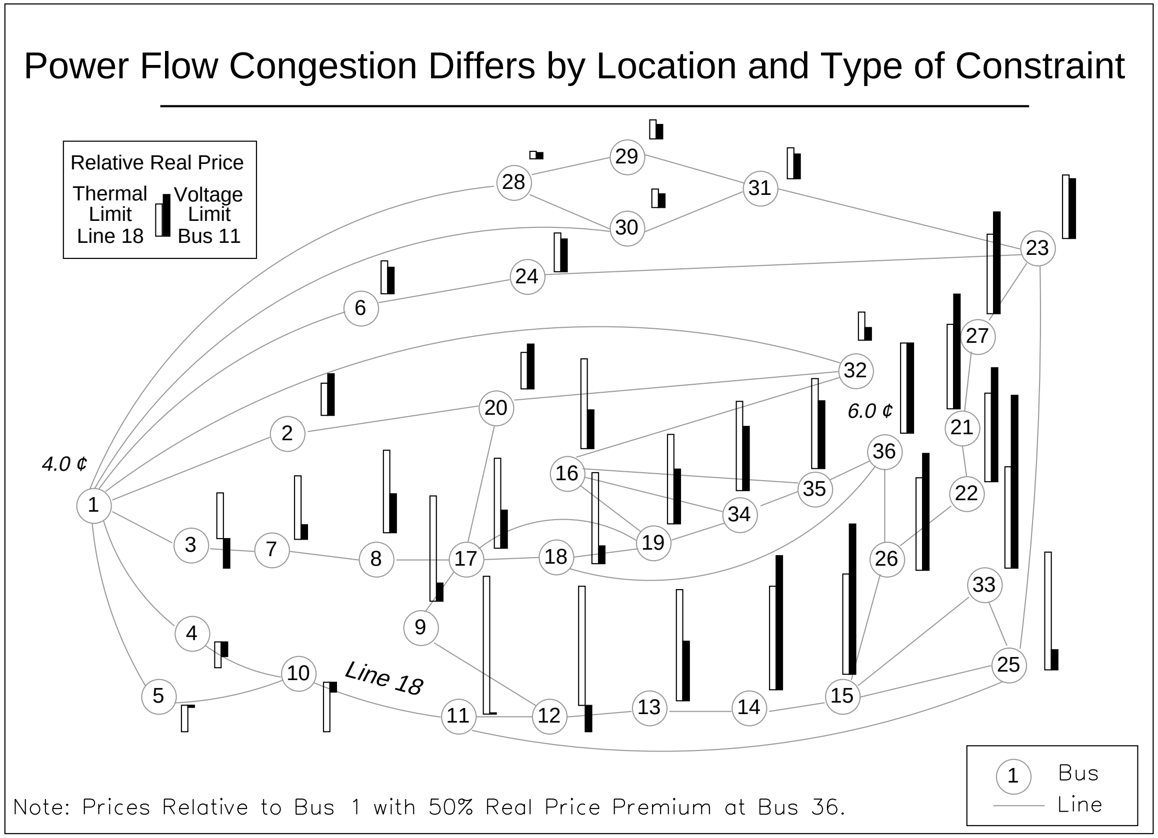
Market equilibrium for an economic dispatch can require changes in distant generation to respect the system constraints.

- Introduction of a new IPP plant at node M is the only change in conditions between the left and right panels.
- All generation and prices change due to the 90 MWs individual lines limits; the interface constraint "limit" cannot be approached, foreclosing "rights" to move 150 MWs of power from the west.





Power flows throughout the network confront voltage and line limits. Congestion impacts summarize the differential effects on transmission capacity that would affect the value of transmission rights. Efficient exchanges would be in proportion to congestion impacts.



The "physical market:"

Beginning of story.

There is a single integrated grid.

All power flows into and out of a commingled whole.

The inputs and outputs must be rebalanced continuously to respect system constraints.

End of story.

THERE IS A POOL!

Is a system operations coordinator required in support of a market? Always.

- **In England and Wales it is the "Pool."**
- **In New Zealand it is "Trans Power."**
- **In Norway it is "Statnett Marked."**
- **In the California Energy Commission proposal it is "Symcord."**
- **In the Pacific Gas & Electric proposal it the "Independent Grid Operator."**
- **In the San Diego Gas&Electric/Southern California Edison proposal it is "Poolco."**

Pool-based systems exist in Chile, Argentina, and have been endorsed by the Alberta regulators, the California Public Utilities Ccommission, utilities in Australia, ... New names keep cropping up: Opco, ISO, PSO, Netcoor, EMEX, WEPEX ...; but the basic coordination functions will always be there, somewhere.

The independent system operator provides a dispatch function. Three questions remain. Just say yes, and the market can decide on the split between bilateral and coordinated exchange.

- **Should the system operator be allowed to offer an economic dispatch service for some plants?**

The alternative would be to define a set of administrative procedures and rules for system balancing that purposely ignore the information about the costs of running particular plants. It seems more natural that the operator consider customer bids and provide economic dispatch for some plants.

- **Should the system operator apply marginal cost prices for power provided through the dispatch?**

Under an economic dispatch for the flexible plants and loads, it is a straightforward matter to determine the locational marginal costs of additional power. These marginal costs are also the prices that would apply in the case of a perfect competitive market at equilibrium. In addition, these locational marginal cost prices provide the consistent foundation for the design of a comparable transmission tariff.

- **Should generators and customers be allowed to participate in the economic dispatch offered by the system operator?**

The natural extension of open access and the principles of choice would suggest that participation should be voluntary. Market participants can evaluate their own economic situation and make their own choice about participating in the operator's economic dispatch or finding similar services elsewhere.

A system coordinator or pool is required in support of a competitive market. The basic pool functions will always be there, somewhere:

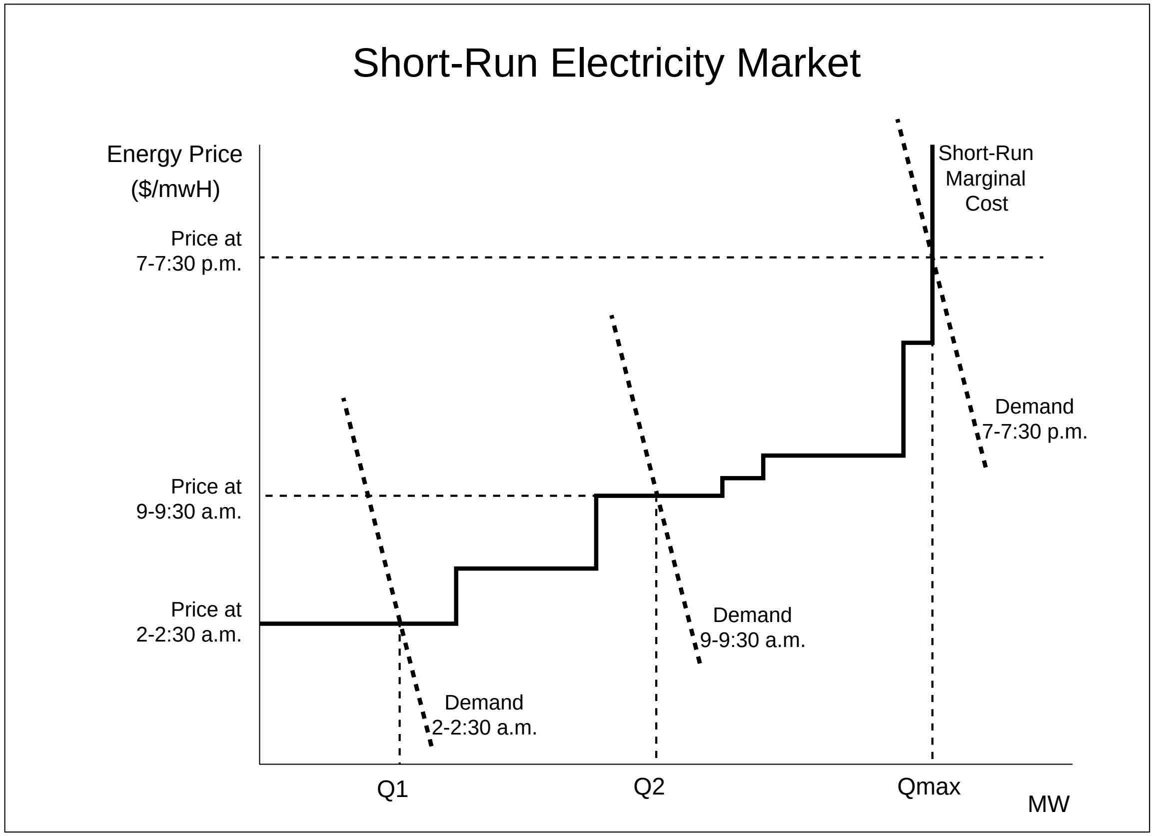
"The importance of effective Pooling arrangements in a competitive [Electric Supply Industry] cannot be overstated. The Pool provides:

- a source of firm back-up and top-up power to support either generators or suppliers offering long-term contracts to final customers; without access to a Pool firm power could only be offered by generators owning a portfolio of plant and to the extent that firm power is a necessary requirement of consumers the competitiveness of both the generation market and the final supply would be limited;
- a ready market for generators unable to sell their power under contract or wanting a market for spill or excess production;
- a reference price for long or short-term contracts struck outside the Pool which provide participants with price stability not immediately available inside the Pool;
- a reference price to be used in signalling the optimal development of generation and transmission capacity on the system.

In addition, of course, the Pool provides the traditional means by which generation costs can be minimized through merit order operation and the aggregation of reserve requirements."

(J. Moen, "Electric Utility Regulation, Structure and Competition. Experiences from the Norwegian Electric Supply Industry (ESI)," Norwegian Water Resources and Energy Administration, NVE, Oslo, April 1994, p. II-5.)

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



The new electricity market will follow new principles. Examples of basic principles that have emerged with special importance in the case of electricity include:

- **Separate Ownership from Use of Essential Facilities:** Everyone should have equal access to and use of essential facilities, particularly transmission, with the rights of ownership limited to compensation consistent with opportunity costs in a competitive market;

- **Separate Physical Delivery from Financial Transactions:** Market institutions and operations should allow for financial transactions that implement bilateral commercial arrangements while separately coordinating the spot market interactions of physical delivery of electricity in the transmission network;

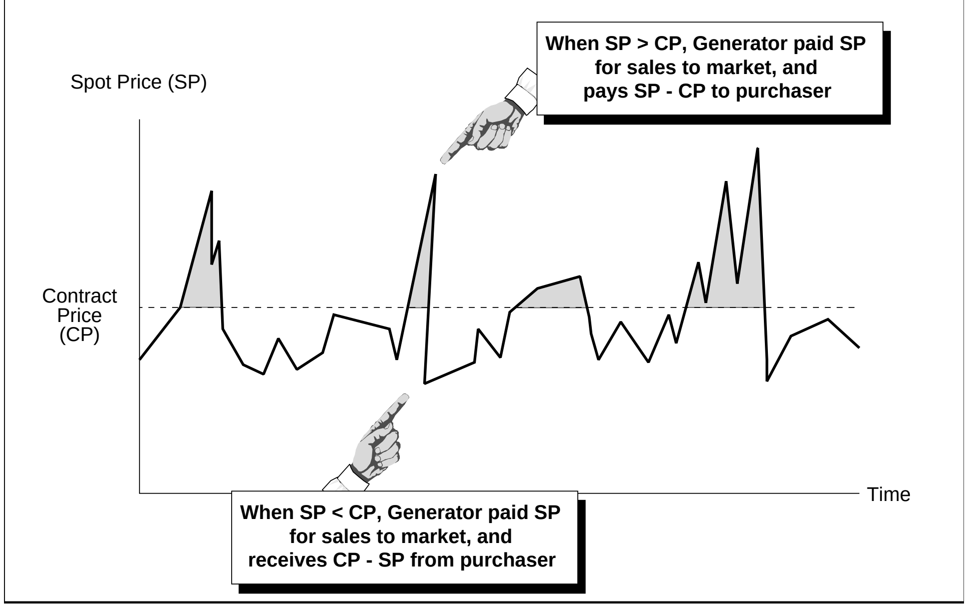
With a competitive spot market, separation of physical delivery from financial transactions allows contracts to evolve that reference the spot market. These "Contracts for Differences" recognize that delivery takes place in the spot market, and price agreements can be honored through a simple settlements process:

- **Spot Price Below Contract:** Customer uses savings to pay difference to the generator.

- **Spot Price Above Contract:** Generator uses profits to pay difference to customer.

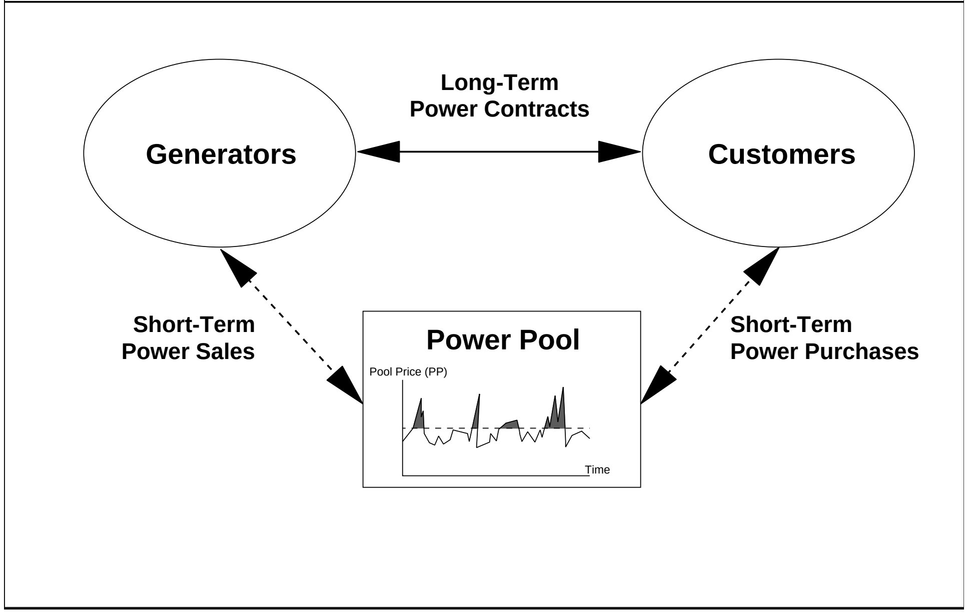
With an efficient wholesale market available, a "Contract for Differences" can provide generators and purchasers the ability to execute bilateral contracts without requiring physical control. Contract imbalances in production or use settle automatically at the market price.

"CONTRACTS FOR DIFFERENCES" Allow Bilateral Transactions



An efficient short-run electricity market with a transparent spot price allows bilateral contracts to share or shift the risks of price uncertainty, provide long-term power purchases, and create a variety of new products and services. An extensive market with "contracts for differences" has developed in the United Kingdom, completely outside the regulatory framework.

CONTRACTS CAN HEDGE SPOT PRICES



A limitation of a single price electricity market, such as that utilized in the United Kingdom, is that it ignores network interactions and transmission constraints:

- The market assumes that all generation and consumption occur at the same point, with no transmission constraints.
- True transmission constraints create "out-of-merit" generation and a growing cost problem that, in the U.K., is currently spread across all system users.
- With large congestion costs ignored, system users do not face efficient incentives for generation and consumption.
- Grid operators have no market method to signal efficient grid expansion and, as in the U.K., no method of compensation for grid upgrades.
- Fundamentally, the single price or U.K. model ignores grid interactions that are central to any analysis of the transmission system.
- The Norwegian pricing structure includes congestion costs, but these are minor and have not required a system of tradeable transmission rights.

Postage stamp rates or one-part transmission prices based on actual usage are simple and familiar, but may not be adequate in supporting a more competitive electricity market.

- For the vertically integrated electricity industry, least-cost system usage did not depend on pricing incentives. Historical focus of transmission pricing has been on revenue recovery without concern for economic incentives affecting use of the grid.

- Open access and competition require and reinforce a focus on economic incentives and equivalent pricing for equivalent unbundled services.

- Economies of scale and network interactions in transmission loom large, and economic efficiency may require two-part tariff structures:

  - -- Fixed charges to cover revenue requirements and pay for long-term transmission rights;

  - -- Short-term opportunity cost pricing for actual system use.

- Open-access on an equivalent basis is defined as the right to connect to the grid and pay short-term usage prices for actual power flows.

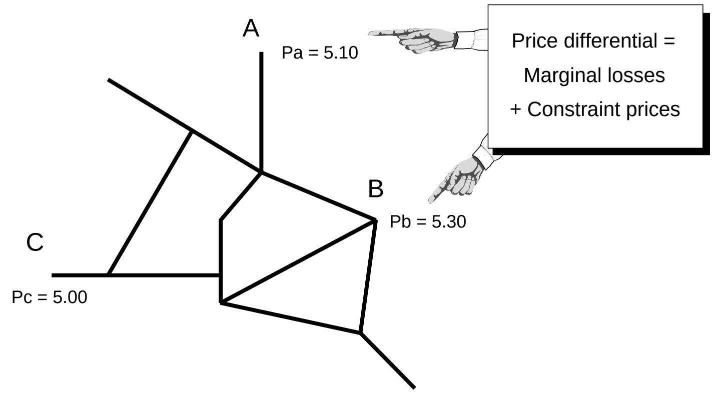
- Consistent with a two-part tariff structure, the long-term transmission right is to collect congestion rentals to hedge the changes in usage prices.

The natural extension of a single price electricity market is to operate a market with locational spot prices.

- 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.

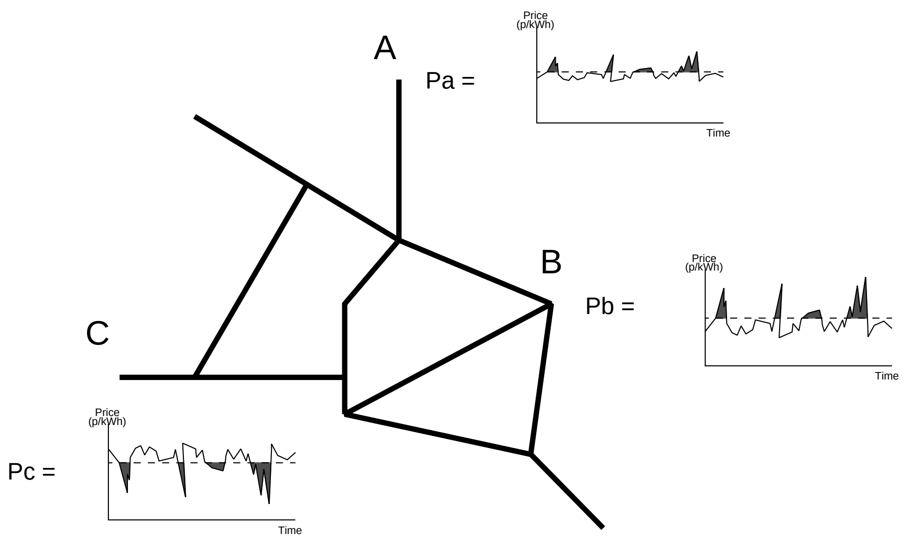
LOCATIONAL SPOT PRICE OF "TRANSMISSION"



Price of "Transmission" from A to B = Pb - Pa = 0.20
Price of "Transmission" from A to C = Pc - Pa = -0.10

The volatility of locational spot prices implies volatile transmission prices between locations. This requires some mechanism to provide long-run price certainty.

NEED "Hedges" FOR LOCATIONAL PRICING



Price of "Transmission" from C to B = Pb - Pc = Volatile Price

The design of a system of transmission rights stands at the center of the policy debate. Analysis of common objectives reveals the importance of network interactions.

- **Contract Implementation.** Transmission rights should provide the owner with the economic equivalent of a long-term transmission contract. In effect, transmission rights should provide the owner with the right to deliver power to the grid at the origin bus and to receive power from the grid at the destination bus. The transmission rights should be based on compensation consistent with economic dispatch and efficient prices. This avoids the need to guarantee specific performance.

- **Bankable Charges.** A generator should be able to contract with a customer and be certain of the cost of power delivery over the life of the contract, supporting financing of long-term contract.

- **Maximal Allocations.** The combined set of transmission rights should be such that if the actual use of the system is according to the rights, no other rights that users value could be allocated.

- **Revenue Adequacy.** The transmission rights should not create any economic risk exposure for the system operator. The compensation system should be revenue adequate such that the operator will always collect enough revenue to cover obligations related to the transmission rights.

- **Efficient Operations.** There should be no incentives for the system operator to deviate from the least-cost dispatch or create congestion. All congestion revenues should be distributed to the right-holders, with no residual congestion payments.

- **Incremental Expansion.** The rights should allow for incremental expansion of the transmission grid without affecting the allocation of existing rights.

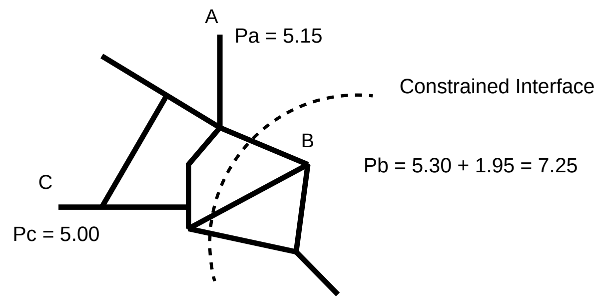
- **Market Determined.** Transmission grid expansion should be market driven with users paying fixed charges for expansion and receiving transmission rights.

- **Bidirectional Application?** In the case of a single line, it is natural to think of transmission rights as bidirectional. For instance, a simple sharing rule is both bankable and bidirectional. However, in a network, the sharing rule is not bankable. Bankable network rights may be inherently directional: the flow is defined "from i to j," not "between i and j." This is gives rise to negative congestion obligations under certain circumstances.

A mechanism for hedging volatile transmission prices can be established by defining transmission congestion contracts to collect the congestion rents inherent in efficient, short-run spot prices.

NETWORK TRANSMISSION CONGESTION CONTRACTS

Bus Price = Generation Cost + Marginal Losses + Congestion Costs



Pcb = Pb - Pc = Marginal Losses + Congestion Costs = 0.3 + 1.95 = 2.25

- DEFINE TRANSMISSION CONGESTION CONTRACTS BETWEEN LOCATIONS.
- FOR SIMPLICITY, TREAT LOSSES AS OPERATING COSTS.
- RECEIVE CONGESTION PAYMENTS FROM ACTUAL USERS; MAKE CONGESTION PAYMENTS TO HOLDERS OF CONGESTION CONTRACTS.
- TRANSMISSION CONGESTION CONTRACTS PROVIDE PROTECTION AGAINST CHANGING LOCATIONAL DIFFERENCES.

There are alternative interpretations of contract network rights defined as transmission congestion contracts, with various advantages for implementation and interpretation. For example:

- **Difference in Congestion Costs**. Receive the difference in congestion costs between two buses for a fixed quantity of power.

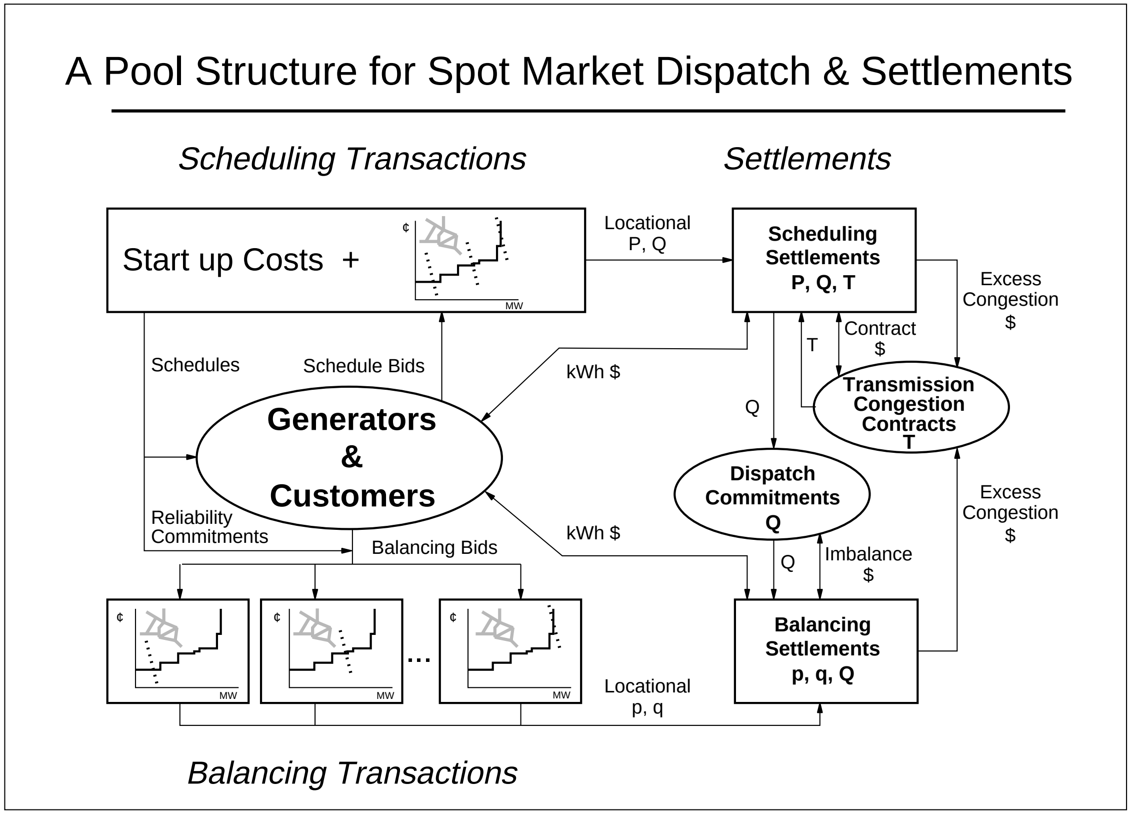
- **Purchase at a Distant Location**. Purchase a fixed quantity of power at one location but pay the price applicable at a distant location.

- **Dispatch with No Congestion Payment**. Inject and remove a fixed quantity of power without any congestion payment.

Excess congestion rents may remain after paying all obligations under the transmission congestion contracts. These excess rentals should not remain with the pool operator or grid owner, but could be distributed according to some sharing formula to those paying the fixed costs of the existing grid or along with the payments under transmission congestion contracts.

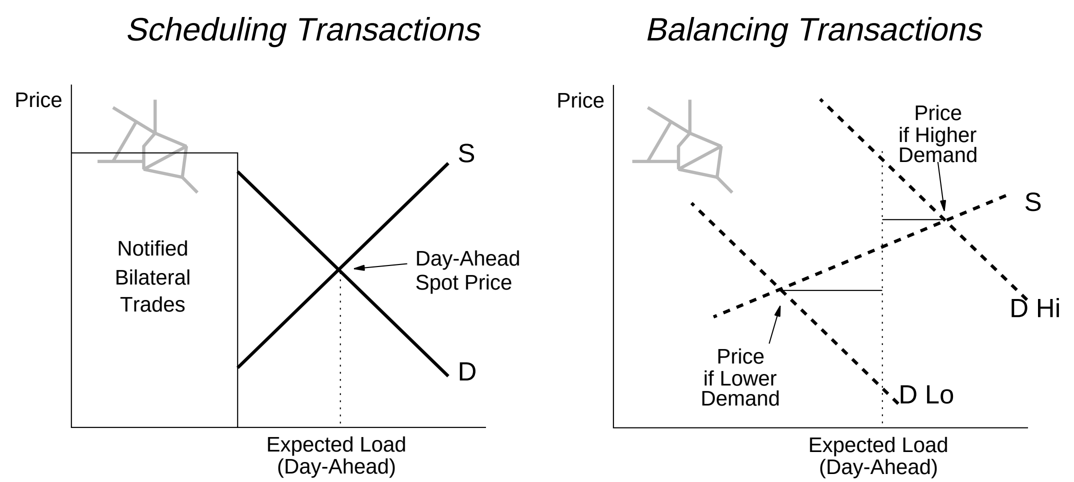
Many variants are possible, allowing great flexibility in developing and trading contracts. The contract network can allow great commercial flexibility while respecting the reality of the actual network in determining the locational prices.

The pool-based market structure could include scheduling transactions to deal with unit commitment issues and balancing transactions for the final dispatch. Contract-network transmission congestion contracts would be valued for the scheduling transactions. Bidding for the scheduling transactions would determine final dispatch commitments.



The scheduled loads from the day-ahead bids establish the dispatch commitments for the spot market. Scheduling settlements are at the day-ahead price and final balancing settlements apply the imbalance price to deviations from the scheduled quantities.

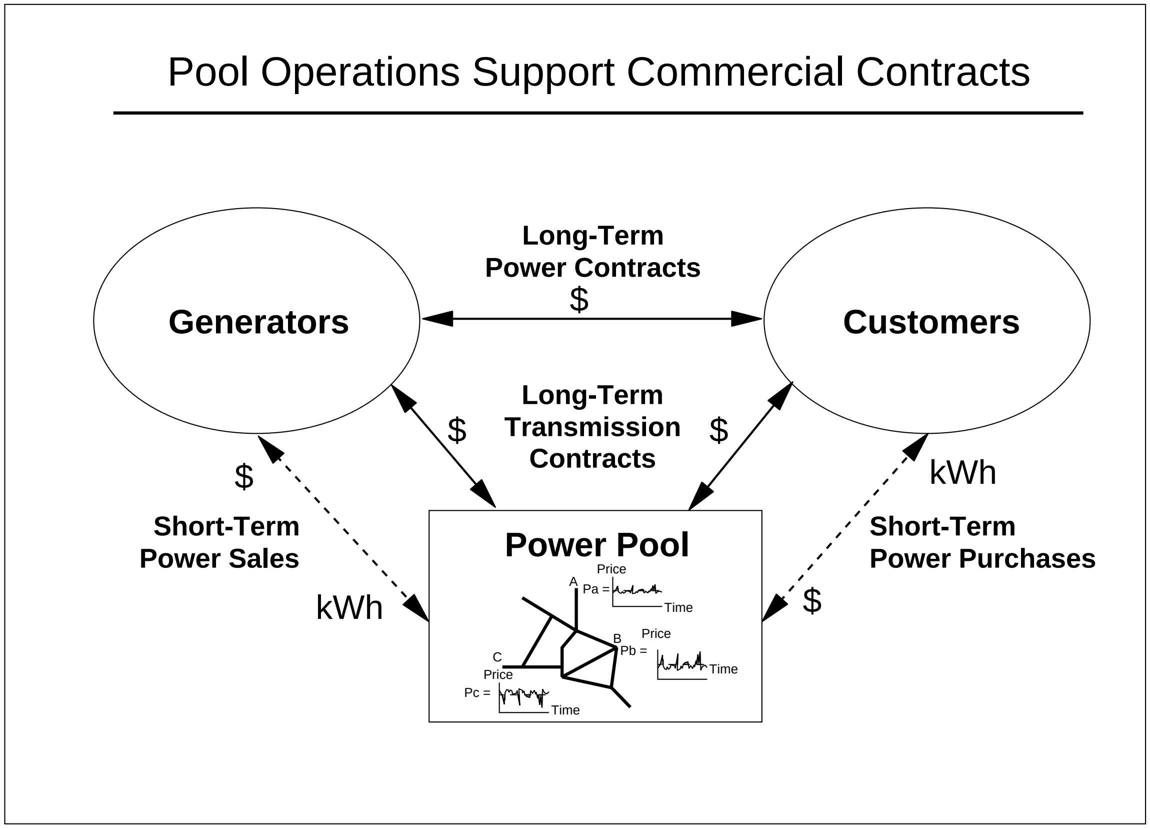
Balancing Price for Deviations from Scheduled Commitments



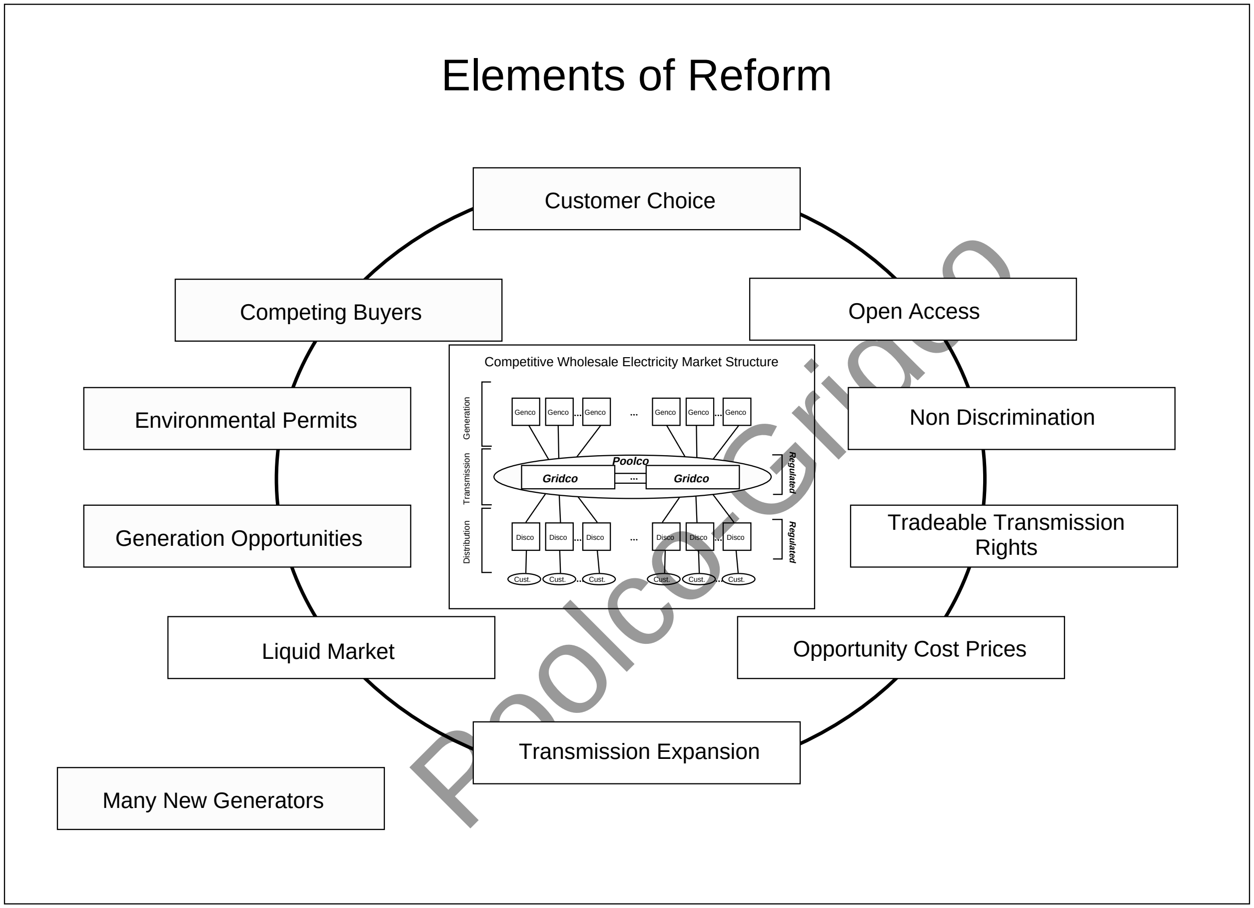
- Notified bilateral trades pay locational transmission charge but are settled outside pool
- Other trades settle at day-ahead price
- Locational congestion rents paid under transmission congestion contracts along with excess congestion costs

- Payments for deviations from day-ahead trades at balancing price for all transactions
- Uplift covers ancillary services and other costs
- Excess congestion costs paid to holders of transmission congestion contracts

Market participants can achieve price stability through contracts. Bilateral contracts can share risks for electricity prices at a location. Transmission contracts can protect buyers and sellers against system congestion.



Poolco support of transmission open access and coordination *for* competition provides a large part of the solution.



Customer choice through *Efficient Direct Access* builds on the reality of a competitive market with open access and comparability of service. It provides real customer choice through access to the wholesale market consistent with jurisdictional boundaries and incentives for efficient decisions.

- **Arm's Length Spot Price.** The wholesale market will develop a transparent arm's length spot price. It may be through hubs--such as in natural gas--or a pool, or some mixture of a bilateral and a pool-based market. The more efficient the wholesale market, the better, but some price will appear against which buyers and sellers can trade.

- **Time-of-Use Tariff**. All customers remain with the distribution utility under traditional cost-of-service rate principles. However, customers have a time-of-use tariff with the energy component set to the observed arm's length spot price. This approach is related to "net back" pricing principles familiar from other regulatory settings and as advanced by many others (Moskovitz).

With such time-of-use rates, customers have real access to the wholesale market. They can enter into contracts for differences with generators, to provide whatever security or flexibility that they are prepared to pay for in the market. This moves the obligation to invest in commodity energy from regulated monopoly to a competitive market.

- **Commodity Energy Investments Left to Market**. Regulated utilities stop making investments in new long-term energy or generation capacity commitments under cost-of-service regulation.

Efficient Direct Access **requires only a competitive wholesale market and a modest rate innovation. This approach to direct access is functionally equivalent to "physical direct access" but easier to implement. Efficient Direct Access (aka "virtual direct access" by the CPUC):**

- **Changes No Jurisdiction.** Customers never leave the local utility. Formally the utility buys from the wholesale market and resells at the spot price. There are no changes in cost-of-service principles or formal entry into the FERC regulated wholesale market.

- **Requires No New Legislation**. State regulatory authorities have long set the time-of-use tariffs. The extension to using the arm's length spot price is important, but it is a difference only in a small detail that should raise no controversy.

- **Strands No Assets**. All customers remain under the cost-of-service tariff. Decisions on rates and cost recovery can proceed as before, independent of the existence of Efficient Direct Access and customer choice.

- **Abandons No Worthy Programs**. Whatever can be done under traditional cost-of-service regulation--limited by the inevitable pressures of a more open wholesale market--can be continued under Efficient Direct Access. Universal service support, investments in energy efficiency, and subsidies for renewable and other environmentally preferred alternatives could be made when justified, and included in the cost of service applied to all customers separate from the time-of-use energy charges.

Efficient Direct Access **provides real benefits consistent with the many other goals of the partially competitive and partially regulated electricity market. Efficient Direct Access:**

- **Provides Customer Choice.** Customers who wish to make long-term arrangements for contracts with generators have full freedom through the mechanism of contracts for differences, which conform to the reality of the electricity market.

- **Reduces Regulatory Demands**. Central planning for all commodity resource procurement can move to the decentralized decisions of the competitive market.

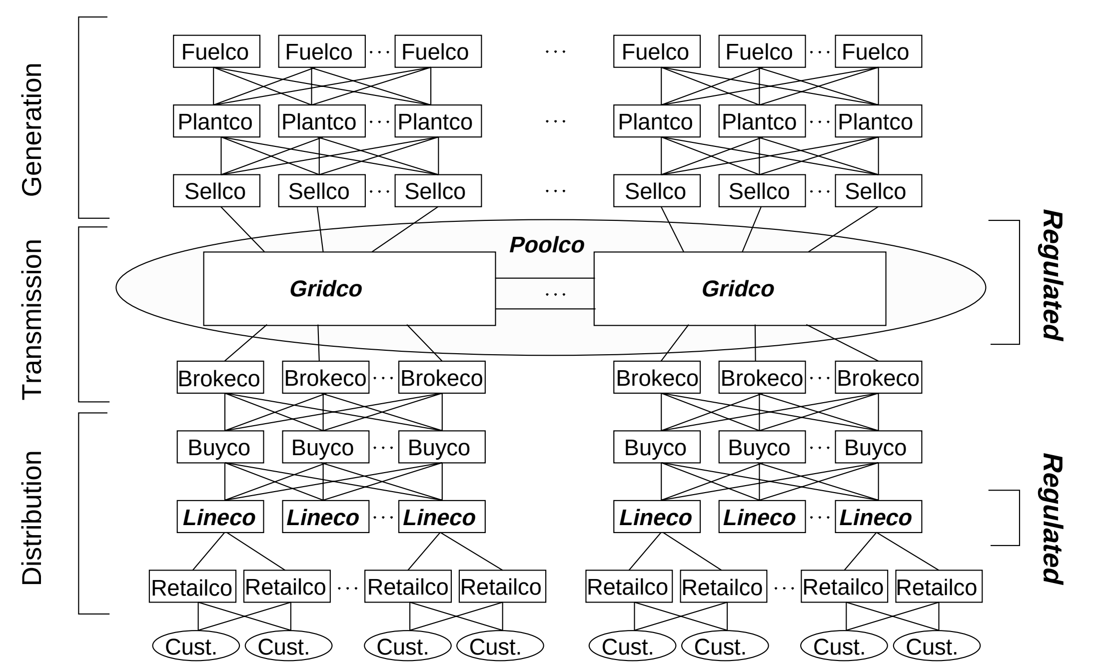
- **Supports Efficient Investment**. Since payment for sunk costs or other mandated programs is independent of the source of power or the arrangements under long-term contracts, the incentives support efficient investment in new facilities and services for commodity electricity.

- **Gives Utilities an Exit Strategy**. Since there is no need to delay Efficient Direct Access to allow for recovery of sunk costs, regulated utilities can immediately stop investment in new regulated generation commitments, redefining the obligation to serve as the obligation to deliver.

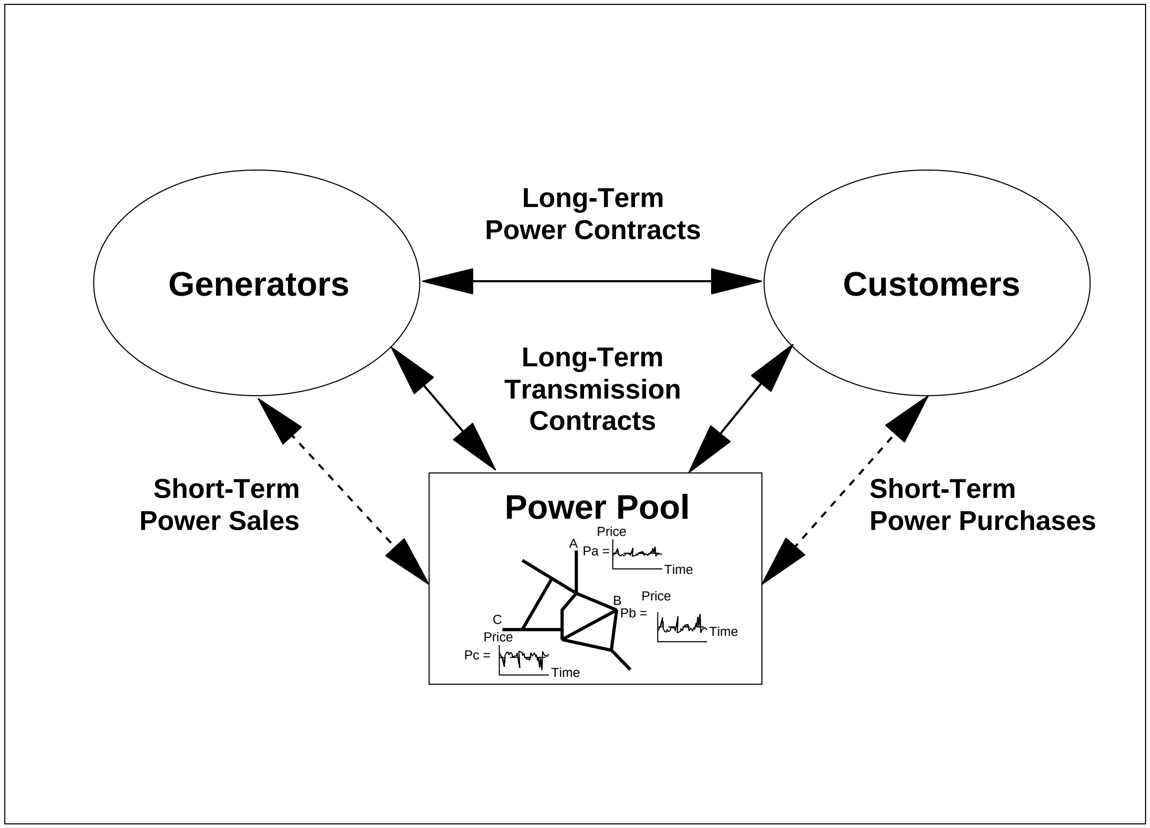
Efficient Direct Access need not disrupt the market, and retail wheeling can be abandoned as a fiction from the past, like the contract path for transmission. Attention should return to the development of the wholesale market and regulation of the remaining monopoly elements.

The degree of unbundling and competition, whether wholesale or retail, is a policy choice. In designing a competitive market, a focus should remain on providing nondiscriminatory, equal access to the essential facilities.

Fully Unbundled Competitive Electricity Market



Market participants can achieve price stability through contracts. Bilateral contracts can share risks for electricity prices at a location. Transmission contracts can protect buyers and sellers against system congestion.



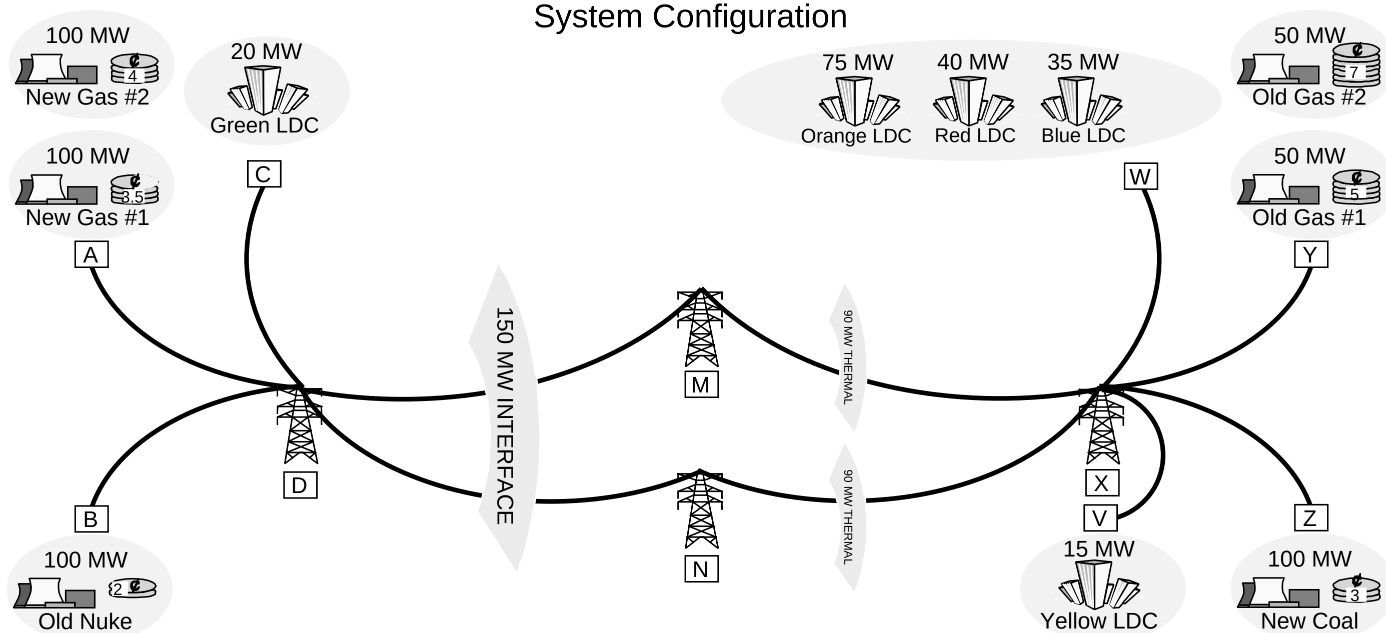
Appendix

Pool Structure and Network Pricing Illustrations

The examples assume a transmission system with the following characteristics:

- Generation available at four locations in the East (Y, Z) and West (A, B).
- Load in the East, consisting of the Yellow LDC at V and the Orange, Red and Blue LDCs at W.
- Load in the West, consisting of a Green LDC at C.
- Interface constraint of 150 MW between bus D and buses M and N.
- Thermal constraints of 90 MW between M and X and between N and X.
- The New Gas and Old Gas generating facilities each consist of two generating units whose marginal costs of production differ.

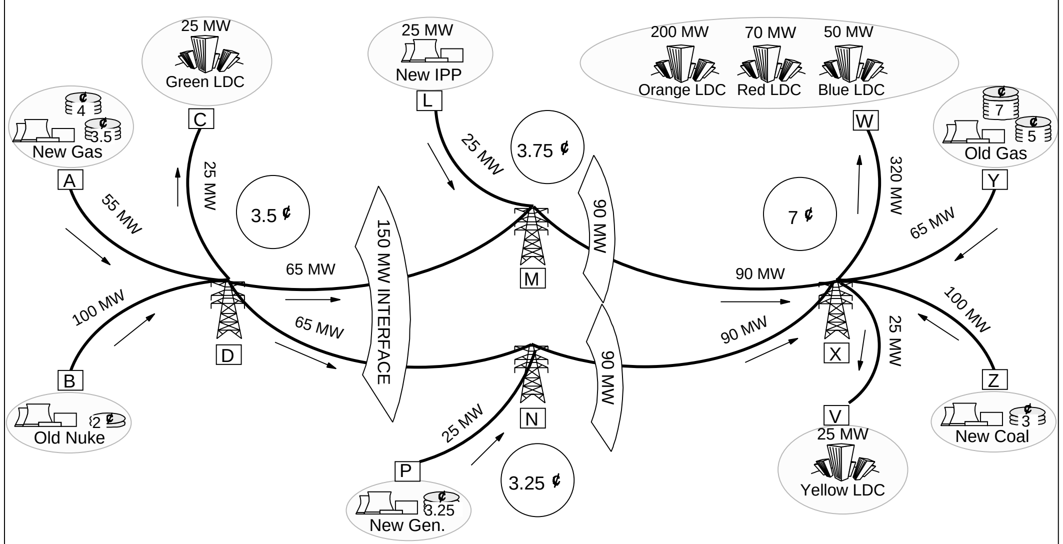
System Configuration



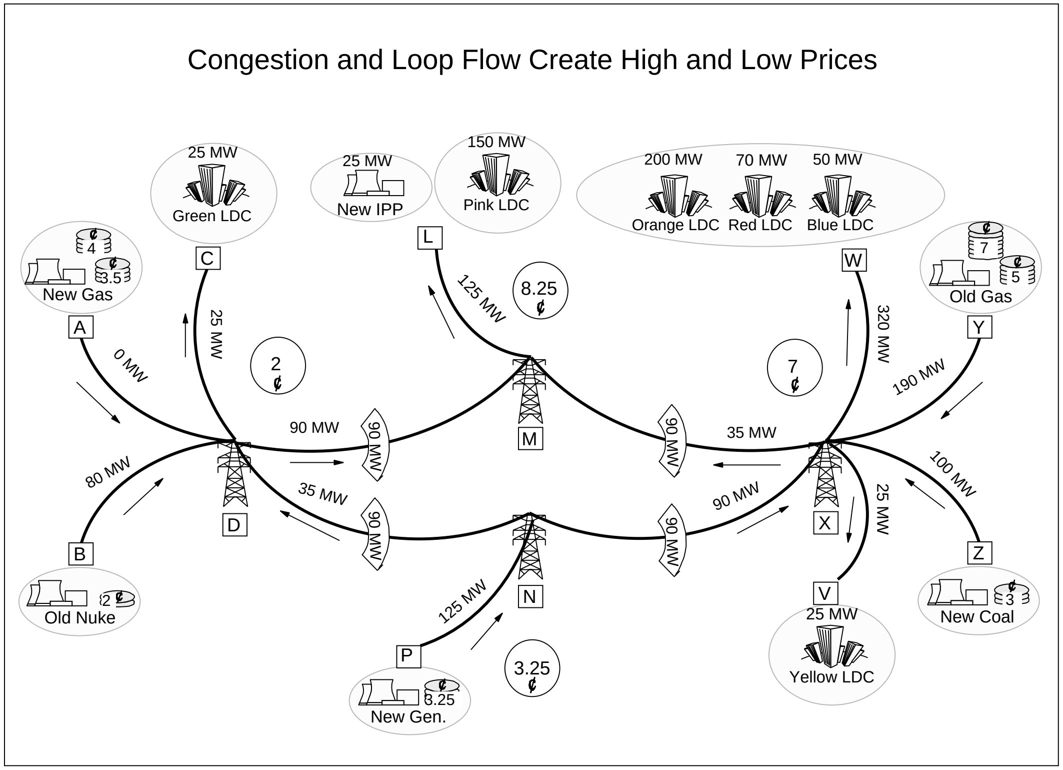
Loads in this figure are illustrative and will vary systematically in each example. For convenience, losses are ignored in all examples.

A low cost, large capacity generator becomes available at bus "P." The IPP at bus "L" has bid in a must run plant at 25 MW, having arranged a corresponding sale to the Yellow distribution company at bus "V". Were it not for the IPP sale, more power could be taken from the inexpensive generators at bus "P" and at bus "A". However, because of the effects of loop flow, these plants are constrained in output, and there are different prices applicable at buses "D", "M", "N", and "X".

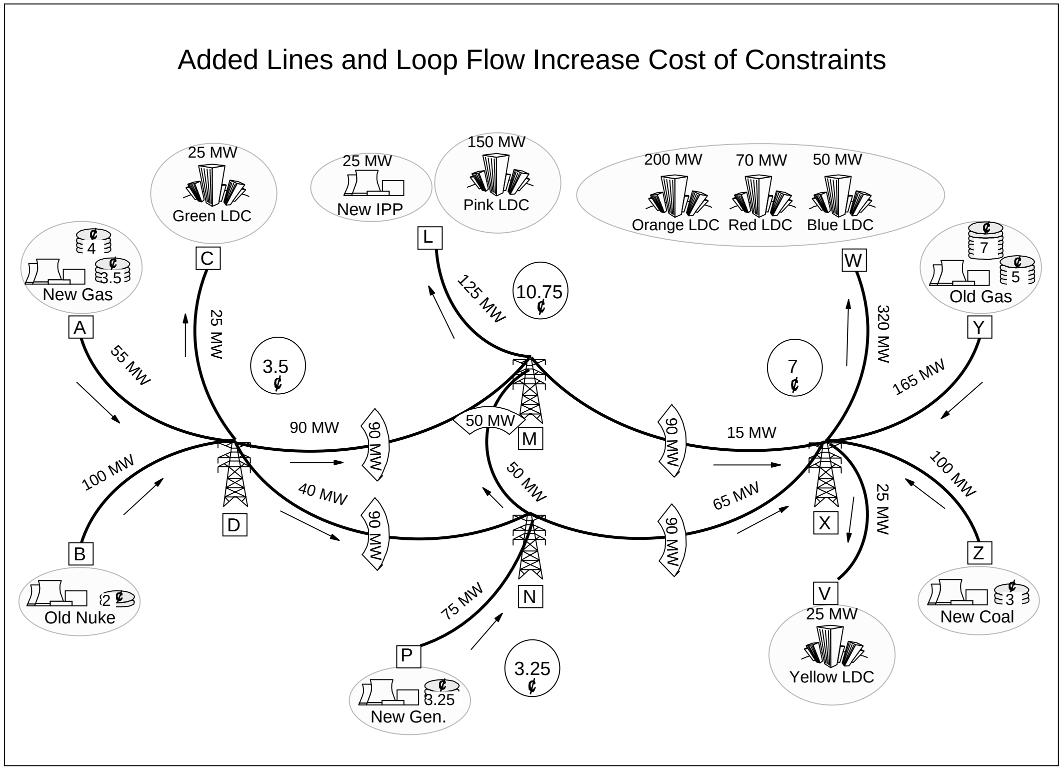
Bilateral Transaction Between IPP and Yellow LDC Increases Congestion



Here every line in the main loop is constrained by a thermal limit of 90 MW, replacing the interface limit. With these constraints, an added load of 150 MW at bus "L" alters the flows for the market equilibrium. In this case, the combined effect of the increased load and the constraints leads to a price of 8.25¢ per kWh at bus "L". This price is higher than the 7¢ marginal running cost of the old gas plant at bus "Y", the most expensive plant in the system.

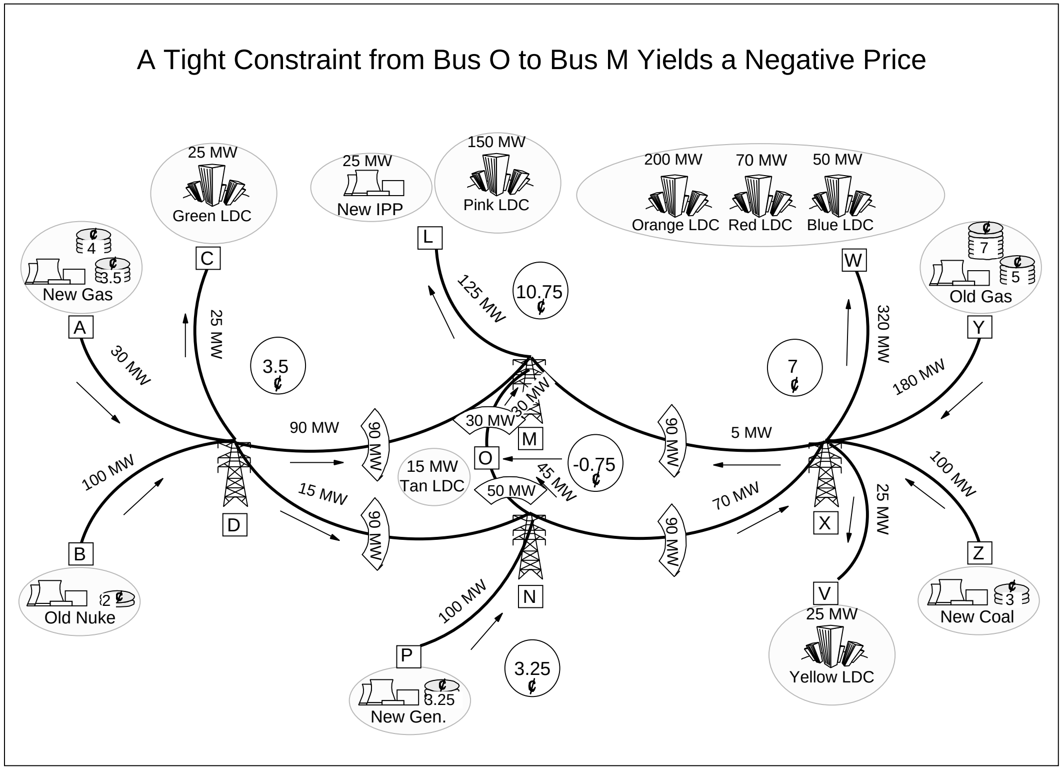


Next a new line has been added to the network, connecting bus "N" to bus "M". This line is assumed to have a thermal limit of 50 MW. The new line adds to the capability of the network in that the new pattern of generation lowers the overall cost of satisfying the same load. The total cost reduces from $20,962.50 to $19,912.50. Although the average cost of power generation fell, the marginal cost of power increased at bus "L", where the price is now 10.75¢ per kWh.

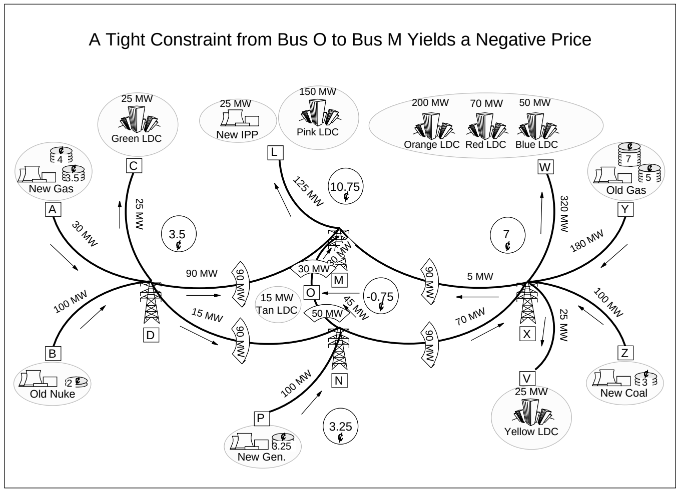


Added Lines and Loop Flow Increase Cost of Constraints

Add a new bus "O" between bus "M" and bus "N", and lower the limit to 30 MW between bus "O" and bus "M". Bus "O" has a small load of 15 MW. The increased load of 15 MW at bus "O" actually lowers the total cost of the dispatch, as reflected in the negative price. Each additional MW of load at bus "O" changes the flows to allow a dispatch that lowers the overall cost of meeting the total load. With the 30 MW limit and no load at bus "O", there is no feasible dispatch.



The congestion costs collected will always be sufficient to meet obligations under transmission congestion contracts. Consider the example network with two feasible sets of transmission congestion contracts (TCC) for hub at "O".



From-To	TCC 1 (MW)	TCC 2 (MW)
"D-O"	180	160
"O-X"	180	160
"M-O"	30	10
"N-O"	30	70

Load at "L"	Bus Prices ¢/kWh					Total Rents $	TCC 1	TCC 2
MW	"D"	"M"	"N"	"O"	"X"			
0	3.50	3.75	3.25	3.50	7.00	6300	6300	5750
50	3.50	5.58	3.25	4.15	7.00	6300	6138	6084
150	3.50	10.75	3.25	-0.75	7.00	10950	1650	1650

Supporting papers and additional detail can be obtained from the author. William W. Hogan is the Thornton Bradshaw Professor of Public Policy and Management, John F. Kennedy School of Government, Harvard University, and Director, Putnam, Hayes & Bartlett, Inc., Cambridge MA. This presentation draws on work for the Harvard Electricity Policy Group and the Harvard-Japan Project on Energy and the Environment. Many individuals have provided helpful comments, especially Robert Arnold, John Ballance, Jeff Bastian, Ashley Brown, John Chandley, Doug Foy, Don Garber, Scott Harvey, Jere Jacobi, Paul Joskow, Jim Kritikson, Dale Landgren, Amory Lovins, Richard Pierce, Howard Pifer, Susan Pope, Larry Ruff, Michael Schnitzer, Irwin Stelzer, Jan Strack, Julie Voeck and Carter Wall. The author is or has been a consultant on electric market reform and transmission issues for British National Grid Company, General Public Utilities Corporation, Duquesne Light Company, Electricity Corporation of New Zealand, National Independent Energy Producers, New York Power Pool, New York Utilities Collaborative, San Diego Gas & Electric Corp., Trans Power of New Zealand, and Wisconsin Electric Power Company. The views presented here are not necessarily attributable to any of those mentioned, and the remaining errors are solely the responsibility of the author.