Colombia’s Forward Energy Market[1]

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1 Summary

This paper presents a market design for Colombia’s forward energy market, which is scheduled to began in 2008. The forward energy market is an organized market to procure energy for electricity customers on a forward basis. It includes both the regulated market (residential and other small customers) and the nonregulated market (large customers). Currently, regulated customers represent 68% of the total electricity demand and nonregulated customers represent the remaining 32%. The proposed design is novel in that it integrates both the regulated and nonregulated customers into a single organized market. Although the regulated and nonregulated energy products remain distinct, their integration into a single market facilitates arbitrage between the products, improves liquidity, and reduces transaction costs. Both regulated and nonregulated customers benefit from this unified approach. This paper presents all elements of the market design: the product design (see also Cramton 2007), the auction design, and the transition to the new market.

Figure 1. Two products, one market

- Regulated customers (68% of load)
  - – *Small* customers *without* hourly meters
  - – *Passive* buyers in auction
- Nonregulated customers (32% of load)
  - – *Large* customers *with* hourly meters
  - – *Active* buyers in auction

As shown in Figure 1, the two customer groups, regulated and nonregulated, are integrated into a single market. Regulated customers are small customers without hourly meters;

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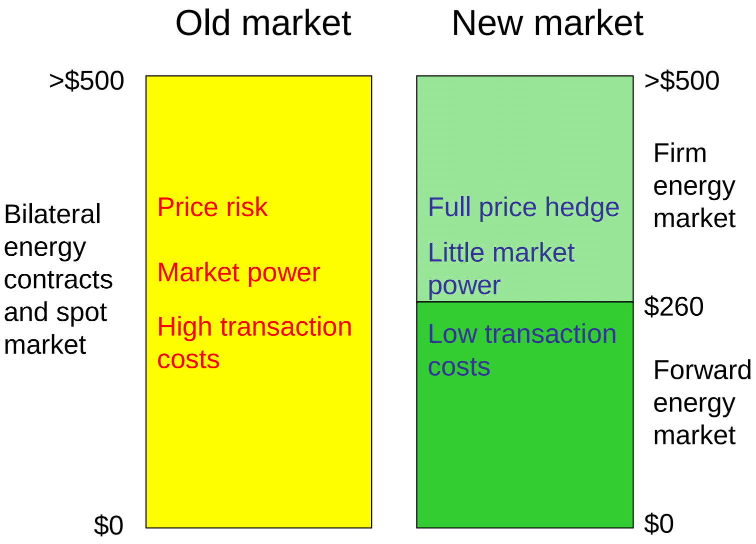
nonregulated customers are large customers with hourly meters. The nonregulated product will make use of the hourly meters to encourage demand response. In addition due to their large size, nonregulated customers will be active buyers in the forward energy market, submitting demand bids. In contrast, the regulated customers will have a more limited demand response capability and will not be active buyers in the forward energy auction—their demands will be set administratively.

I propose a market based on two load-following products, a regulated product and a nonregulated product. For the regulated product, each supplier bids to serve its desired share of Colombia's regulated load. A supplier that wins a 10% share at auction has an obligation to serve 10% of the actual regulated load in every hour of the commitment period. The supplier is paid the clearing price for every MWh of energy supplied. Deviations between the supplier's hourly supply and obligation are settled at the spot energy price or the scarcity price, whichever is lower. The spot settlement price is capped at the scarcity price, since the firm energy market provides price coverage for prices above the scarcity price (about $260/kWh in January 2007 Colombian pesos; or US$120/MWh); see Cramton and Stoft (2007). The nonregulated product is essentially the same, except each supplier bids to serve its desired share of the nonregulated load.

Figure 2. Price coverage of regulated customer

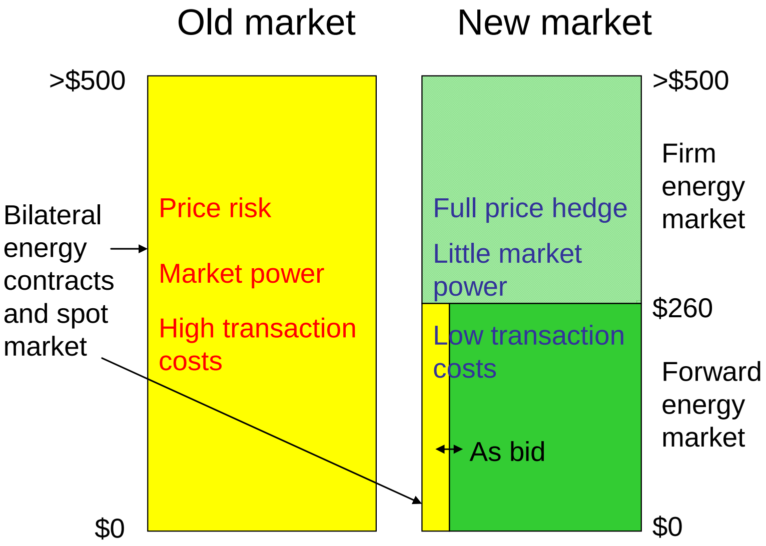


One-hundred percent of regulated load is purchased on behalf of the regulated customers in a sequence of auctions. Thus, the forward energy market together with the firm energy market provides 100% price coverage for all regulated customers, as shown in Figure 2. The forward energy market provides price coverage from zero to the scarcity price, and the firm energy market provides price coverage above the scarcity price. This accomplishes two things: 1) it provides rate stability for regulated customers, and 2) it provides revenue stability for suppliers. The result is reduced risk for both sides of the market.

The prior approach of bilateral contracts and the spot market suffers from three problems. Price risk is greater since the contract cover is incomplete. Market power in both the spot market and the bilateral market is more of a concern, since supplier positions are more apt to be out of balance entering the spot market and competition for bilaterals is weaker with specialized local products. The absence of a standard contract also results in high transaction costs in addition to weaker competition. In contrast, the new market provides full price coverage, suppliers enter the spot market with nearly balanced positions, and the single product minimizes transaction costs. In addition, the problem of self-dealing between the LSE and its supplier affiliate is eliminated.

The market is mandatory for regulated customers, but voluntary for suppliers. Mandatory participation on the demand side motivates robust participation on the supply side.

Figure 3. Price coverage of nonregulated customer



As shown in Figure 3, the nonregulated customers enjoy similar benefits from the forward energy market as the regulated customers. The main difference is that the nonregulated customers actively bid in the forward energy market, and thus decide how much contract cover to purchase and in which auction. Although nonregulated customers participate voluntarily, I believe most will decide to participate fully and will adopt procurement strategies that do not differ too much from those of the regulated customers.

Although only a single product is proposed for each customer group, the approach readily accommodates multiple customer classes, as needed. Such an extension is desirable if there are significant cost differences in serving different customer classes, say because of different load shapes. However, I find that the cost differences across regulated customers are small, and therefore a single product is best for regulated customers. This will simplify the market, while enhancing liquidity and competition. For nonregulated customers, cost differences are larger, but it is a simple matter to adjust payments based on a quality factor. This enormously simplifies the market and yet allows payments to reflect cost differences.

The energy-share product enables load to be fully covered with a single product. For a supplier, the load-following product is natural, since in aggregate suppliers *must* follow load. A supplier is able to manage its exposure to the spot energy price through its portfolio of resources and its portfolio of nonregulated energy contracts. Even for a small supplier without a portfolio of resources or energy contracts, the risk from spot-price exposure is modest.

The proposed product does an excellent job of rate stability. Regulated load is fully hedged from the spot price. This makes sense for customers without hourly meters and demand management systems. However, for large nonregulated customers hourly meters are required and demand response is encouraged. The proposal accommodates participation of such customers by basing the nonregulated product on expected load, rather than actual load. The actual load contract (pay as demand) is based on the customer's actual load in each and every hour of the commitment period. In contrast, the expected load contract is based on the customer's expected (forecasted) load in each and every hour of the commitment period as specified by the nonregulated customer or, if not specified, as estimated from its historical load shape and estimated growth over the period.

The expected-load contract hedges price risk, yet still exposes the customer to the spot price on the margin, motivating demand response. In this way, the proposal is extended to handle nonregulated demand, and in the future, regulated customers capable of demand response.

There are a number of possible choices for the timing and frequency of auctions, and the duration of contracts. These three elements can be adjusted to manage price and credit risk, while minimizing transaction costs. I present several alternatives. I recommend quarterly auctions of 2-year contracts, which are rolling on an annual basis. The use of 2-year contracts is consistent with the most common contract in the bilateral market. More importantly, the approach is simple and yet provides broad time diversification, shielding customers from transient events. One-eighth of regulated load is purchased in each auction. At any one time, two products are active and the customer rate reflects the average of eight auctions equally spaced over a two-year period. Even the auction with the shortest planning period occurs five months before the start of the contract. This means that the auction price will be set before there is much resolution of how severe conditions will be in the following dry season. I believe that this structure strikes the right balance between risk reduction and the cost of guarantees to assure performance.

The proposed firm energy market complements the other key elements of the Colombian market: the spot energy market and the firm energy market. Combined, the forward energy market and the firm energy market fully cover load. Not only does this reduce risk for both sides of the market, it puts suppliers in a nearly balanced position in the spot energy market. As a result, incentives to exercise market power are greatly mitigated in the spot market. This improves the price signal in the spot market, since a supplier in a balanced position has an incentive to offer its true marginal cost.

Efficient price formation is one of the most important objectives of the forward energy market. The simultaneous descending clock auction is ideally suited to promote efficient price formation. The descending clock auction provides excellent price discovery and enables suppliers to freely arbitrage across the regulated and nonregulated products. This assures that any price difference between the two products is a reflection of cost differences.

The integration of the regulated and nonregulated markets will lead to greater liquidity, improved price formation, and lower transaction costs. My view is that the forward energy market as proposed here will dramatically improve the energy contract market for both regulated and nonregulated customers, and improve the spot market as well, since suppliers typically will enter the spot market with a nearly balanced position, eliminating incentives to exercise market power.

2 Introduction

As in most electricity markets, the vast majority of Colombia's energy is settled according to energy contracts with terms that are much longer than the hourly spot market. Energy contracts often have durations of one or two years, and sometimes more. These energy contracts benefit both supply and demand. Both sides of the market are able to lock in a price, and thereby reduce price risk from the more volatile spot market.

Unfortunately, the existing energy contracting market has high transaction costs, as a result of non-standard contracts, poor price formation, localized contracting, lack of transparency, and other factors. Evidence of a problem is seen in the frequent occurrence of higher contract prices for regulated customers compared with nonregulated customers, which is unexplained by load shapes, credit risks, and other factors.

CREG has proposed an organized regulated market (MOR) to address these problems. The goal of MOR is to promote efficient price formation in an energy contract market for regulated customers, both residential and small commercial. Here I simplify and extend MOR to an integrated forward energy market for both regulated and nonregulated customers. The proposed market should dramatically lower transaction costs as a result of standard contracts and robust price formation in a transparent, national market.

This paper presents a market design for each of the key elements of the market: product design, auction design, and transition. Product design is the critical first step in the design of any market. It defines what is being traded. Good product design can play an important role in reducing complexity and increasing liquidity in the market. The second step is auction design—how the product is traded. Finally, markets typically require a transition period to move effectively from the status quo to the new market.

The paper is organized as follows. First, I discuss the purpose of the market. Then I consider elements of the Colombia electricity market that are relevant to product and auction design. Next, I argue for an especially simple product design. I then examine other features of the product, such as the timing and frequency of purchase, and the duration of commitment. Then I turn to the auction design. Finally, I address how best to transition from the current market to the new market. Each major section (product design, auction design, and transition) ends with a discussion of common questions from industry.

Many important issues are beyond the scope of this study. Critical issues of qualification and credit requirements, as well as other contractual arrangements will be addressed elsewhere.

3 Purpose of the market

Many objectives must be considered in the design of the forward energy market. These can be grouped into seven interrelated categories: efficient price formation, transparency, neutrality, risk management, liquidity, simplicity, and consistency.

- *Efficient price formation.* The market should produce reliable price signals based on market fundamentals. It should enhance competition and mitigate market structure problems. It should produce market-based rates for regulated customers, such that any price difference from nonregulated rates is consistent with cost of service differences.

- *Transparency*. The market should be highly transparent. Offers should be comparable. It should be clear why one supplier offer is accepted and another rejected. It should result in prompt regulatory review and approval, and encourage regulatory certainty.
- *Neutrality*. All suppliers should be treated equally, and all demanders should be treated equally.
- *Risk management*. It should reduce risks for both supply and demand by providing rate stability, yet be responsive to long-run market fundamentals. The market should shield participants from short-term transient events, and address counterparty risk.
- *Liquidity*. The market should promote a secondary market, including a liquid market for the primary product, as well as derivative products of both longer and shorter term.
- *Simplicity*. The market should be simple for participants, for the system operator, and for the regulator.
- *Consistency*. The market should be consistent with the other key elements of the Colombia setting. The most important of these are the spot energy market and the firm energy market. It also should be consistent with, or improve upon, the best-practice in other electricity markets.

Fortunately, these objectives are largely complementary with one another. Hence, it is possible to design the market to satisfy all of these objectives.

4 The Colombia setting

Colombia has a hydro-dominated electricity market. Roughly 80% of its energy comes from hydro resources, 67% of its capacity, and 50% of its firm energy—energy in an exceptionally dry period.

The cornerstones of the wholesale electricity market in Colombia are the spot energy market and the firm energy market. The spot energy market is a single-zone hourly market that determines the spot energy price in every hour as well as the efficient dispatch of resources. Supplier offers are submitted one day ahead of dispatch. The firm energy market is a long-term market to assure that there will be sufficient energy resources, even in an exceptionally dry period. The firm energy market pays suppliers a reliability charge per MWh of firm energy provided. Suppliers have an obligation to supply energy at prices above a scarcity price. Hence, the firm energy market provides price coverage for all prices above the scarcity price.[3] The forward energy market is intended to provide the residual price coverage for prices from $0 up to the scarcity price, which currently is about $260/kWh in January 2007 Colombian pesos (US$120/MWh).

As is true of all electricity markets, the wholesale market in Colombia is not perfectly competitive. The largest-four companies provide about two-thirds of both the capacity and firm energy. Market shares of firm energy are shown in Figure 4.

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[3] The scarcity price is established by CREG and updated monthly based on the variation of the Fuel Price Index (the New York Harbor Residual Fuel Oil 1% Sulfur LP Spot Price). It has a double purpose. On the one hand, it indicates the time when the different generation units or plants will be required to fulfill their firm energy obligations, which happens when the spot price exceeds the scarcity price, and on the other hand, it is the price at which this energy will be paid.

Figure 4. Company firm energy shares and market concentration

Company	ENFICC Declared (GWh)			Market share	HHI
	Hydro	Thermal	Total		
Emgesa	10,419	2,373	12,792	21%	455
Epm	8,523	3,295	11,818	20%	388
Corelca		9,873	9,873	16%	271
Isagen	5,099	2,327	7,426	12%	153
Epsa	1,487	1,655	3,142	5%	27
AES Chivor	2,925		2,925	5%	24
Gensa	57	2,594	2,651	4%	20
Termoflores		2,189	2,189	4%	13
Termoemcali		1,533	1,533	3%	7
Merielectrica		1,404	1,404	2%	5
Termotasajero		1,349	1,349	2%	5
Termocandelaria		1,062	1,062	2%	3
Proelectrica		708	708	1%	1
Menores	689		689	1%	1
Urra S.A	438		438	1%	1
Total	29,637	30,363	60,000	100%	1,374

I calculate the Herfindahl-Hirschman Index, HHI, for firm energy. HHI is a commonly accepted measure of market concentration. The firm energy HHI is 1,374. Thus, the Colombian electricity market is moderately concentrated.[4]

These numbers are consistent with most electricity markets in the U.S. and elsewhere. Moderate concentration means that the market design should recognize the potential for market power and attempt to mitigate its abuse.

The market concentration picture would be much worse if transmission was inadequate to support a single-zone system. To maintain consistency with the spot market and firm energy market, I only consider a single-zone energy contract market. However, this does not preclude the possibility of multiple customer classes. The essential element is that all suppliers can compete for any of the customer classes, regardless of the supplier's location.

5 Product definition: energy share of regulated load

I propose a market based on a single load-following product in which each supplier bids to serve its desired share of the Colombia regulated load. Thus, a supplier that wins a 10% share at auction has an obligation to serve 10% of the actual regulated load in every hour of the commitment period. The supplier is paid the clearing price for every MWh of energy supplied. Deviations between its hourly obligation and its supply are settled at the spot energy price or the

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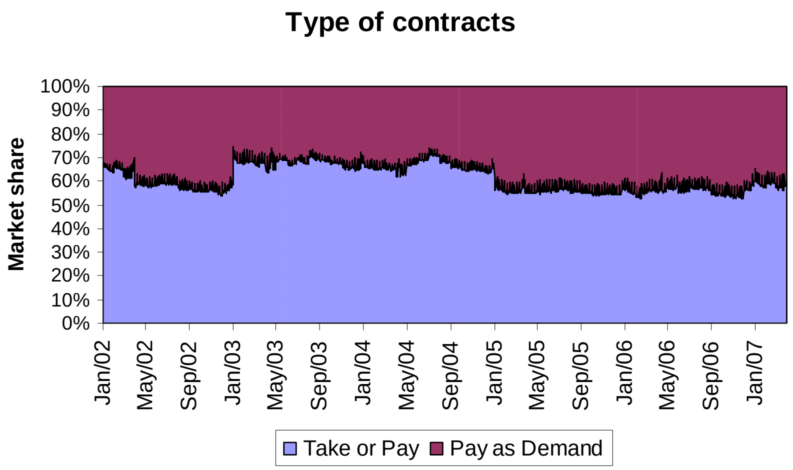
[4] The U.S. Department of Justice and the FERC, for example, use the HHI for evaluating mergers. A market with an HHI less than 1,000 is considered to be competitive, one with an HHI between 1,000 and 1,800 is considered to be moderately concentrated, and one with an HHI of 1,800 or greater is considered to be highly concentrated. To compute the HHI, one sums the squares of the sellers' market shares. The HHI can range from a minimum of close to 0 to a maximum of 10,000. An HHI approaching zero would indicate near-perfect competition, with many thousands of sellers with negligible market shares. An HHI of 10,000 indicates the existence of a single firm with 100% market share.

scarcity price, whichever is lower. The spot settlement price is capped at the scarcity price, since the firm energy market provides price coverage for prices above the scarcity price.

Thus, the product is a version of the familiar pay-as-demand contract. Figure 5 below show that pay-as-demand is a significant contract form in Colombia with roughly 40% of energy contracts, volume weighted, taking this form.

Figure 5. Pay-as-demand is a common contract form



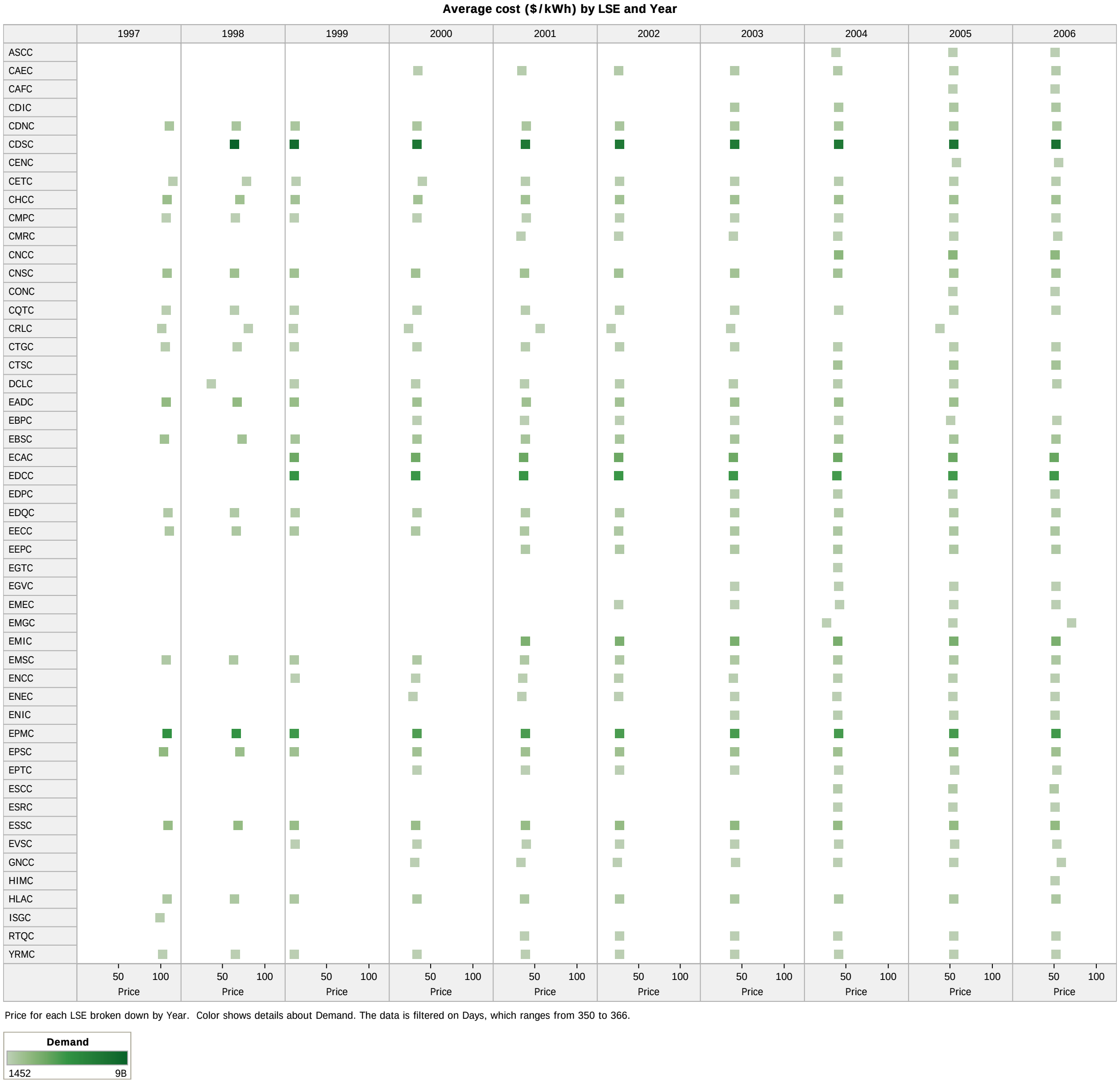
The regulated load is the aggregate load in the regulated market, including all 44 Load Serving Entities (LSEs) in Colombia. There are three alternative ways to handle contractual arrangements. In the first, a clearinghouse is established to manage the contracting. The clearinghouse would be the supplier's counterparty in the contract signed after the auction. In the second, as in the spot market, there is a master agreement, and a special scheme of guaranties, thus avoiding the need for a clearing house. In the third, the bundled product is purchased at auction, but the individual LSEs would be the supplier's counterparty. Thus, at the conclusion of the auction, each winning supplier would sign 44 contracts, one with each LSE for the share of load won in the auction. Which approach is better depends on legal matters that are beyond the scope of this study. In all cases, there is a single standard contract form and the auction mechanics are identical.

One-hundred percent of regulated load is purchased on behalf of the regulated customers in a sequence of auctions. Thus, the forward energy market together with the firm energy market provides 100% price coverage for all regulated customers. The forward energy market provides price coverage from zero to the scarcity price, and the firm energy market provides price coverage above the scarcity price.

The market is mandatory for the LSEs, but voluntary for the suppliers. The reason for this distinction is simple. Mandatory participation by the LSEs provides regulatory certainty that benefits rate payers. Suppliers know that a large quantity of energy will be purchased and this motivates their participation. Some suppliers, especially small niche companies, may prefer to specialize in servicing the nonregulated market. Hence, participation on the supply-side is voluntary.

The approach readily accommodates multiple customer classes. This would be appropriate if different customer classes have substantially different costs. However, there is little variation in costs across the LSEs. This is seen in Figure 6 below which shows average cost for each LSE for each of the last 10 years. Therefore, I recommend a single customer class for all regulated load.

Figure 6. One customer class is sufficient



Price for each LSE broken down by Year. Color shows details about Demand. The data is filtered on Days, which ranges from 350 to 366.

The approach also eliminates all the problems of LSE purchase from its affiliate. The LSE cannot favor its affiliate, since all suppliers compete on the same basis for all regulated load. The procurement process is transparent, nondiscriminatory, and clearly defined. It is administered by an independent third-party.

5.1 Comparison with CREG’s initial proposal

The “energy share” product definition is a major simplification from CREG’s initial proposal, which involved two time-of-day products that did not fully cover load and therefore required a second market to cover the residual. There are numerous advantages to the simpler approach.

- *Improved liquidity*. A single standard product for regulated load improves liquidity. This in turn promotes a stronger secondary market, both for the product and for derivatives of the product, such as monthly slices or long-term strips. Similarly, nonregulated load benefits from the use of a single standard product.
- *Enhanced competition*. Competition is enhanced, since all suppliers are competing for the same liquid products.
- *Reduced risk*. By providing 100% price coverage in combination with the firm energy market, regulated customers are fully hedged from spot price volatility. Suppliers too are able to sell forward, thus avoiding spot price volatility. Both sides of the market can further reduce exposure to transient events through the timing of purchase and sale, as discussed below. Finally, the aggregate regulated load is better understood and less volatile than less aggregated products. Nonregulated customers enjoy similar risk reduction as a result of being nearly fully hedged from spot price volatility. In addition, nonregulated customers can take advantage of demand response to further reduce energy costs.

One other area where I amend CREG’s initial proposal is in the timing and frequency of auctions. As I discuss below, I recommend a greater frequency of auctions and a long-term commitment. The motivation for these changes is to further reduce supplier and customer risk from transient events.

Finally, my proposal fully integrates regulated and nonregulated customers into the same organized market, yet accommodates the important differences of the two customer groups.

In many other respects the proposal here is the same as CREG’s initial proposal. Most importantly, there is a single centralized market with a standard contract. The product is bundled across all LSEs, rather than LSE specific. These features are essential to reducing transaction costs, improving liquidity, and enhancing competition.

5.2 Further issues

I now discuss a number of further issues of the product design.

5.2.1 Cross-subsidies

Different customers have different load shapes, both over the day and over the year. To the extent that these differences result in large cost differences, then it may be inappropriate to bundle the customers together into a single class. Fortunately, the cost differences across LSEs are small, as seen in Figure 6 above showing the average cost of each LSE. Thus, it is appropriate to have a single customer class.

I estimated the cost differences from historical data over the last ten years. This likely overstates the cost differences. The reason is that recent market improvements, such as the firm energy market and the proposed forward energy market, will likely flatten prices over the day. Hence, the cost difference from different load shapes will be reduced. The recent market innovations are likely to flatten prices over the day, because 1) prices will be capped at the scarcity price, and 2) incentives for spot market manipulation will be greatly reduced. This should tend to flatten prices over the day, consistent with a competitive hydro system with ample capacity.

5.2.2 Load-following obligation is not ideal for all generators

In aggregate, generators must follow load, so load-following contracts are natural. They also allow full coverage of load with a single, simple product. However, some suppliers may not wish to follow load. For example, a low-marginal-cost baseload plant may prefer horizontal energy blocks (24-7 take-or-pay energy). The forward energy market's use of load-following contracts would not prevent such a supplier from adopting such a contract—it would simply require the supplier to look for such a contract among the nonregulated customers or among other suppliers. In addition, the supplier with the baseload plant likely has other plants, such as hydro or peakers, which enables the supplier to follow load with its portfolio of resources. Indeed, a supplier typically invests in a portfolio of resources that allows it to follow load, again for the simple reason that that is what suppliers *must* do in aggregate. For such a supplier, the load-following contract is not a problem.

For a supplier without a balanced portfolio of plants capable of following load, the energy share product is still not much of a problem. It just means that in some hours the generator will over-perform and in some hours it will under-perform. As a result, it will receive a net reward or penalty, based on its aggregate performance. Aside from issues of market power, the load-following obligation does not distort at all the supplier's bidding incentives in the spot energy market or its dispatch. For example, a hydro resource with limited water will want to bid to supply in the highest priced hours, irrespective of the load-following obligation; a low-cost baseload resource will want to supply 24-7, irrespective of its obligation.

The consequence of a poorly balanced portfolio for a supplier is simply slightly greater risk, because its hourly obligation will not match its hourly output. There will be greater exposure to the spot price and greater risk. Importantly, there is no distortion to the bids or the dispatch, aside from issues of market power.

An example will help clarify the implications of an obligation/resource mismatch. I keep the example especially simple to convey the idea—it readily generalizes to realistic cases.

Assume there is no risk in the market as everyone knows future load precisely, generators never break down, and both the spot market and the forward energy market are competitive. Assume load is 90 MW for 80% of the time, and 140 MW for the remaining 20%, so the average load is 100 MW. Assume the baseload marginal cost is $20 and peaker marginal cost is $100.

With competitive entry there is 90 MW of baseload and 50 MW of peaker. The spot market prices equal the marginal cost of the marginal resource: $20 80% of the time and $100 20% of the time. Thus, the time-average spot price is .8 (20) + .2 (100) = $36. The load-weighted average spot price is [.8 (90)(20) + .2 (140)(100)]/100 = $42.40. Hence, the competitive auction price is $42.40, the expectation of the spot price (load weighted).

The 90-MW baseload plant sells 90% of load, which is 81 MW off peak and 126 MW on peak. It will overproduce by 9 MW 80% of the time and under-produce by 36 MW 20% of the time. Its net deviation payment is

.8 (9)($20) – 0.2 (36)($100) = – $576, or – $6.40/MWh.

Thus, the plant's payment is $42.40 – $6.40 = $36/MWh, which is exactly what the baseload unit would earn in a competitive spot market, generating 90 MW in every hour. The baseload plant is indifferent between selling in the forward energy market or supplying in the spot market. It makes a profit of $16/MWh, which contributes to its fixed cost. The residual fixed cost is covered in the firm energy market.

Now consider the 50-MW peaker plant, which sells the remaining 10% of the load, which is 9 MW off peak and 14 MW on peak. It will under-produce by 9 MW 80% of the time and overproduce by 36 MW 20% of the time. Its net deviation payment is:

– .8 (9)($20) + 0.2 (36)($100) = + $576, or + $57.60/MWh.

Thus, the peaker's payment is $42.40 + $57.60 = $100/MWh, exactly what it would earn if it instead sold its output in the spot market. The peaker is also indifferent between selling in the forward energy market or supplying in the spot market. Either way its payment just covers its variable cost. Its fixed cost is recovered in the firm energy market.

This example demonstrates that the load-following obligation does not distort the mix of plants, aside from issues of risk and market power.

Based on my analysis of risk in the firm energy market (Cramton et al. 2006), I conclude that the risk issue should not be a concern here. Companies can manage risk through 1) a portfolio of resources, and 2) a portfolio of nonregulated contracts, and even when the company lacks a portfolio, the spot price risk is modest. Moreover, the risk from obligation/resource mismatch should be less important in the future, as prices over the day will tend to flatten, as a result of the recent and proposed market innovations.

5.2.3 Is a daily obligation preferable to an hourly obligation?

One variation to the product definition is to have a daily obligation, rather than an hourly obligation. In this variation, the obligation of each supplier is still a load-following product, but the settlement for the supplier is done using the daily energy, not the hourly energy, that has been delivered. Then if the agent does not deliver the daily obligation the imbalance is settled according to an hourly obligation at the hourly price (load following).

The benefit of the daily obligation is that the supplier obligation is consistent with its hourly dispatch. This makes the product less risky for the supplier. It also reduces market power issues in the spot market, since absent deviation each supplier is in a balanced position in each hour.

The downside of this approach is that it may distort investment incentives. In particular it may favor baseload units, since the baseload unit is getting the same forward energy price, but supplying more energy in off peak (lower priced hours) than a peaking unit or a reservoir-constrained hydro unit.

Given that the hourly obligation does not distort the generator mix and does not involve substantial risk, I recommend the use of the hourly obligation, rather than a daily obligation.

5.2.4 Is the price signal to the customer strong enough?

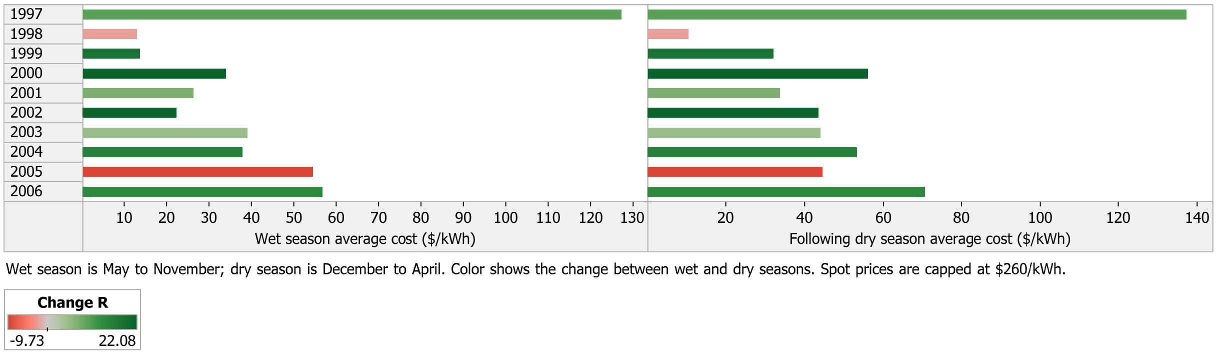
The proposal earns high marks for rate stability. The customer sees a flat price. The rate reflects long-term fundamentals and possibly differences in customer classes as discussed above. In addition, the rate can reflect seasonal factors. If costs, as reflected in expected spot prices, differ on a regular basis by season, then it may make sense to introduce a seasonal factor, which scales prices up in the dry season and down in the wet season. Such an extension is easily introduced.

Seasonal factors often are used in the U.S. to scale customer rates to better reflect long-run costs. Rates are scaled up in the three summer months (peak season), and down in the nine winter months (off-peak season). For example, in New Jersey, the summer factor is about 1.15 and the winter factor is about 0.95. Hence, customers pay 15% extra in the summer time and 5% less in the nine summer months. These factors are determined from long-run cost differences in the two seasons. Such a rate design is more efficient than a single flat rate throughout the year. Even with monthly meter reading, customer demand is able to respond to the higher rates in the high-cost season (summer).

I have studied expected cost in Colombia, based on the spot energy price, during the wet and dry seasons over the last ten years. For regulated customers, I find that there is a 19% difference in expected cost between the dry season (December to April) and the wet season (May to November). This implies seasonal factors of .92 in the wet season and 1.11 in the dry season. Figure 7 shows the average cost in the wet and dry seasons in each of the last ten years for the regulated and nonregulated markets. Color shows the change from wet to dry season: dark green indicates a large increase in cost from wet to dry; orange indicates a large decrease in cost.

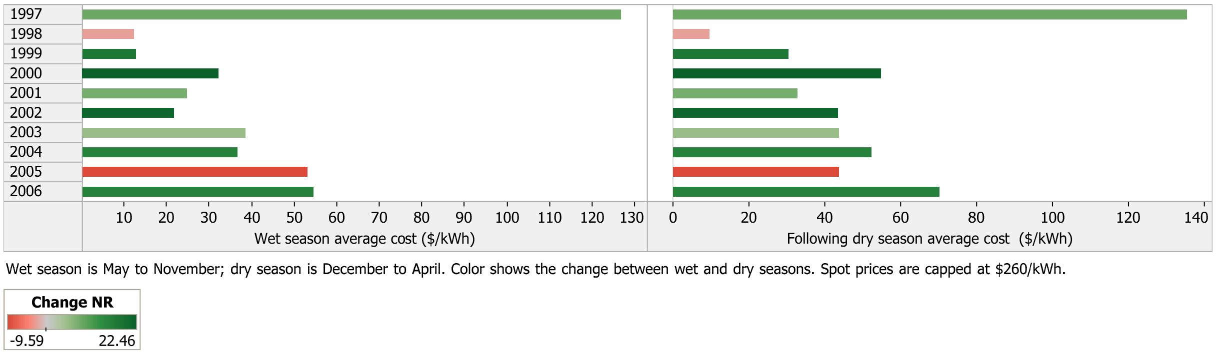
Figure 7. Seasonal factor is not necessary

Average cost in wet and dry seasons, regulated market



Wet season is May to November; dry season is December to April. Color shows the change between wet and dry seasons. Spot prices are capped at $260/kWh.

Average cost in wet and dry seasons, non-regulated market



Wet season is May to November; dry season is December to April. Color shows the change between wet and dry seasons. Spot prices are capped at $260/kWh.

The justification for seasonal factors is much weaker in Colombia than in the U.S. In the U.S., the actual cost in the summer is nearly always higher than in the winter; hence, charging a price that better reflects expected costs will also better reflect actual costs. In Colombia, high prices in the dry season are rare, since it is only in exceptional dry seasons that water is scarce. Thus, charging a higher price in all dry seasons may in fact elicit the wrong demand response. A further issue with seasonal factors is that they adversely impact a customer's cash flow—many customers prefer to pay a roughly constant amount in each month. Cash flow especially is important in Colombia where the vast majority of residential customers are poor. For these reasons, I recommend against the use of seasonal factors.

The problem with a flat rate is that it eliminates any incentive for demand response during periods with a high spot price. Short-term transient spikes are neither seen nor felt by the customer. This is appropriate for small customers today. Since these customers do not have an hourly meter, it makes little sense to expose them to the spot price: the customer's short-term demand response cannot be measured, and therefore cannot be rewarded.

However, the world is changing. It is inevitable that over the next twenty years low-cost hourly meters will be available at the residential level in Colombia (California already has these meters in place). In addition, customers will have demand management systems that can make effective use of the hourly price signals. It would be nice if today's forward energy market is able to handle such future innovations. Fortunately, the answer is that it can. All that is required is a simple change in the standard contract. Rather than have the contract follow *actual* load, it follows *expected* load as specified by the nonregulated customer or, if not specified, as estimated from the customers historical load shape and growth factors. In this way, load is still fully hedged with respect to its expected purchase, but deviations from the expected purchase are settled at the spot price. The customer sees and feels the spot price *on the margin*, motivating demand response, but its exposure to the spot price is limited to the difference between its actual and expected load.

Once hourly meters are installed and demand management systems are available at the residential level, it will make sense to switch to expected-load energy contracts. Until that time, the actual-load energy contracts are best for regulated customers.

5.2.5 Regulated demand participation

Under the proposal the LSEs must purchase 100% of regulated load in the forward energy auction. That is, on the demand side, the auction is mandatory for regulated customers.

Related markets in the U.S. typically allow regulated customers to switch out of the regulated market. This option is called "retail choice." Retail choice has been a failure in many parts of the U.S. It has led to complex rules and gaming behavior by both customers and retail providers. Some programs are simply irrelevant, such as in Illinois, where retail choice has been available for five years and yet there has not even been a single company to apply to offer the retail service in competition with the utility. The exception is Texas, where retail choice has been a resounding success with many retail energy providers serving over 50% of the load.

Given the U.S. experience, I recommend against a retail choice program at this time. If one is introduced, the rules for switching out of and into the regulated market will need to be developed with care to avoid the gaming problems seen in the U.S. markets. Choice, to the extent it is exercised, should be exercised directly by the customer, rather than the LSE.

I recommend a one-way switch from the regulated market to the nonregulated market. This allows regulated customers to install hourly meters and then participate in the nonregulated market. The one-way feature prevents the obvious gaming strategy of taking the regulated price during periods of relative scarcity and the spot price in periods of surplus.

Another issue is the boundary between the regulated and nonregulated customers. It will make sense to examine both how the boundary is defined and how it evolves over time. My view is that regulated customers should be identified primarily by the presence of an hourly meter. Customers without hourly meters should be regulated and hedge actual load; customers with hourly meters should be nonregulated and hedge expected load. Thus, customers can switch from regulated to nonregulated status by installing hourly meters. In this way, the customer can take advantage of hourly demand response.

Over time, I anticipate that additional regulated customers will shift to the nonregulated product, as the economics of demand response systems become more attractive.

Even the smallest customer can benefit from the demand response of the nonregulated market as soon as it has an hourly meter. Participation of these small customers in the nonregulated market can be made trivial. The small customer simply designates itself as a "noncompetitive" bidder, whereupon the administrative demand curve is submitted on its behalf in each primary auction. This distinction is common between "competitive" bidders—large bidders that bid directly and likely impact the clearing price—and "noncompetitive" bidders—small bidders that bid in a simpler way and are unlikely to impact the clearing price. For example, the distinction is made in most treasury auctions. The primary dealers participate as competitive bidders submitting carefully constructed individual demand curves; whereas, the small bidders simply request a particular quantity of the issue and are price takers.

5.2.6 Nonregulated demand participation

My initial thinking was that large customers should be excluded from the forward energy market. These customers can take care of themselves, just as they have in the past. This simple approach avoids cross-subsidies to large customers with undesirable load shapes and/or poor credit. Such customers would readily enter the forward energy market, and increase rates for regulated customers.

However, a better alternative is to expand the centralized market to include both regulated and unregulated customers. The regulated customers participate as described above, and the nonregulated participate as a separate customer class. Nonregulated customers would be grouped into one or more standard customer classes, based on load shape. Credit issues would be addressed with guarantees. Each customer class would be a separate product in the auction. Alternatively and preferably, a single product may be used that is properly indexed for load shape.

The auction for nonregulated load would occur simultaneously with the auction for regulated load, and indeed promote supplier substitution across the two products.

The standard contract for nonregulated customers would differ in two important respects from the regulated customer contract. First, credit and guarantee issues would be dealt with differently. Second, the contract would be an expected-load energy contract, rather than a actual-load energy contract, and hourly meters would be required. Nonregulated customers, then, would be hedged for their expected load, but would be exposed to the spot price on the margin. This motivates demand response and the acquisition of demand management systems.

Participation by nonregulated customers would be voluntary. These customers would apply two months before the auction. One week before the auction, each qualified customer would specify a demand curve—the quantity it desires to buy at various prices. Before the auction, the aggregate demand for each customer class would be revealed together with the aggregate load shape for the customer class.

Allowing the nonregulated demand to participate in this way has many advantages. First, it lets the nonregulated demand take advantage of the centralized market and standard contracts without harming the regulated customers. Second, it motivates demand response and demand management by the large customers. This will provide immediate benefits, and in addition, establish a path for subsequent innovation by residential customers over the next decades.

As I describe in the next section, the auction design can also be adapted to accommodate the nonregulated customers. Regulated customers benefit from the voluntary participation of nonregulated demand. In particular, the nonregulated demand response helps mitigate supplier market power in the centralized market.

5.2.7 Qualification and credit

Qualification and credit issues are beyond the scope of this study. They are, however, crucial to the success of the market. They also are interrelated with the product design. For example, contracts of longer duration would require larger guarantees. Thus, the choice of a longer-term contract needs to reflect the tradeoff between reduced price risk and the cost of a larger guarantee.

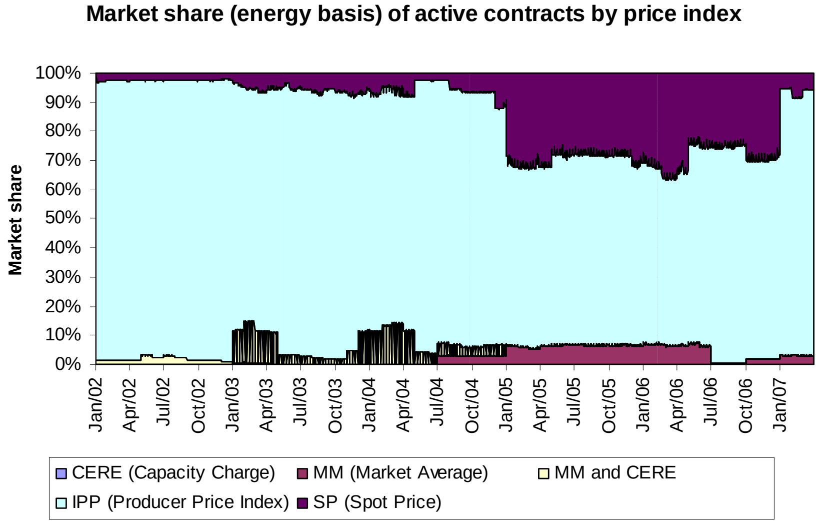
Guarantees should be kept as small as possible and still satisfy a high level of security. For suppliers, it is possible to reduce the size of the guarantee to the extent the energy contract is backed with physical resources and firm fuel. It is important to take advantage of these factors in setting guarantee levels. Otherwise, guarantees might be so high so as to discourage participation from new entrants. These new entrants are important in promoting both competition and innovation.

To minimize transaction costs, supplier qualification and credit should be as close to identical as possible for regulated and nonregulated products.

5.2.8 Price index

To limit inflation risk, I recommend that for multi-year commitments that the price be indexed for inflation. I recommend the Colombian Producers’ Price Index (IPP). This is consistent with the majority of existing contracts, as shown in Figure 8.

Figure 8. Index multi-year contracts with IPP



5.2.9 Lot size

I recommend a small lot size, say 0.1% of regulated load—about 6 MW. This gives suppliers great flexibility in expressing quantity. In France, the lot size is 1 MW. New Jersey has a large lot size, about 100 MW. I see no advantage to this large lot size.

5.3 Planning, commitment, and frequency

The final elements I address in this section are the timing and frequency of the auctions, as well as the duration of the contracts. As will become clear, these elements are best discussed together, since they are closely intertwined. First some definitions:

- *Planning period* is the time between the auction and the beginning of the commitment period. It gives the supplier the opportunity to make adjustments to its resources and other contract positions in order to be ready for its obligation. It also impacts how much uncertainty is resolved before the commitment begins, and thus has implications for risk. Longer planning periods increase price stability by removing more transient events from the price. However, guarantees must be held longer to manage credit risk.
- *Commitment period* is the contract duration—the time between the beginning and end of the commitment. The commitment period also impacts risk. As with longer planning periods, longer commitment periods increase price stability by removing more transient events from the price. Longer commitment periods also allow suppliers to secure financing and make longer term fuel commitments. However, guarantees must be larger to manage credit risk.
- *Frequency* is how often auctions are conducted. Frequency also impacts risk. More frequent auctions tends to reduce risk, since less volume is purchased at any one time. However, transaction costs increase with the frequency of auctions.

An important goal of the design is to use these three instruments to manage price risk and credit risk, while minimizing transaction costs. This is as much art as science. There are many possibilities that will work well. I now consider six reasonable options, and discuss the advantages and disadvantages of each. The six options are grouped into four broad categories:

1. Single auction for a single commitment period
2. Multiple auctions for a single commitment period with multiple planning lengths
3. Rolling auctions with a single commitment length and a single planning length
4. Rolling auctions with multiple commitment lengths

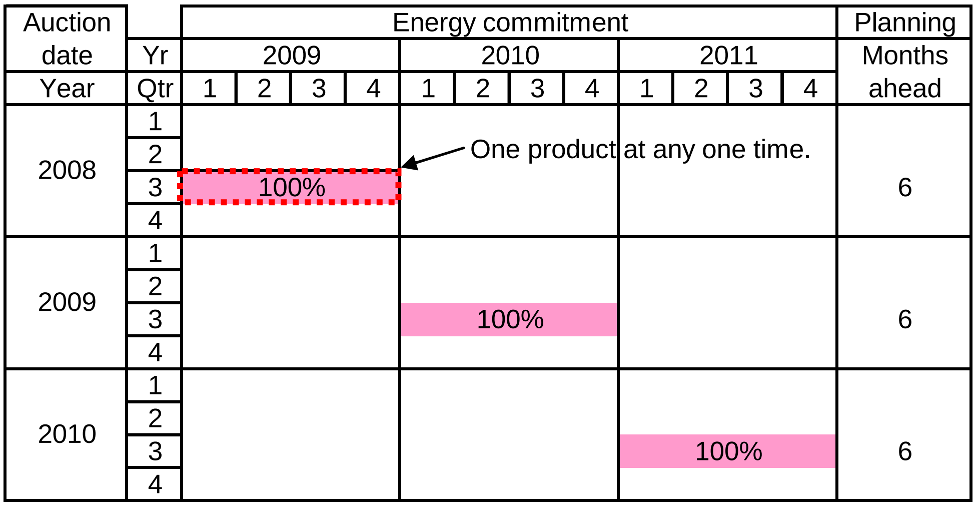
Each option is presented in its steady-state form, assuming the approach has been used for a long time. Typically, there needs to be a transition period of one or more years in which the schedule of auctions and the volumes are adjusted to reflect the situation at the start. This is addressed later in this paper.

The six options are presented assuming contracts follow the calendar year, but this may be some alternative "power year." It makes little difference in the discussion below.

5.3.1 Single auction for a single commitment period

The simplest option is a single auction for a single commitment period. An annual version is shown below.

Option 1. Annual auction for 1-year commitment (6-month planning period)



Auction date	Yr	Energy commitment												Planning
		2009				2010				2011				Months ahead
Year	Qtr	1	2	3	4	1	2	3	4	1	2	3	4	
2008	1													6
	2													
	3	100%												
	4													
2009	1													6
	2													
	3					100%								
	4													
2010	1													6
	2													
	3									100%				
	4													

One product at any one time.

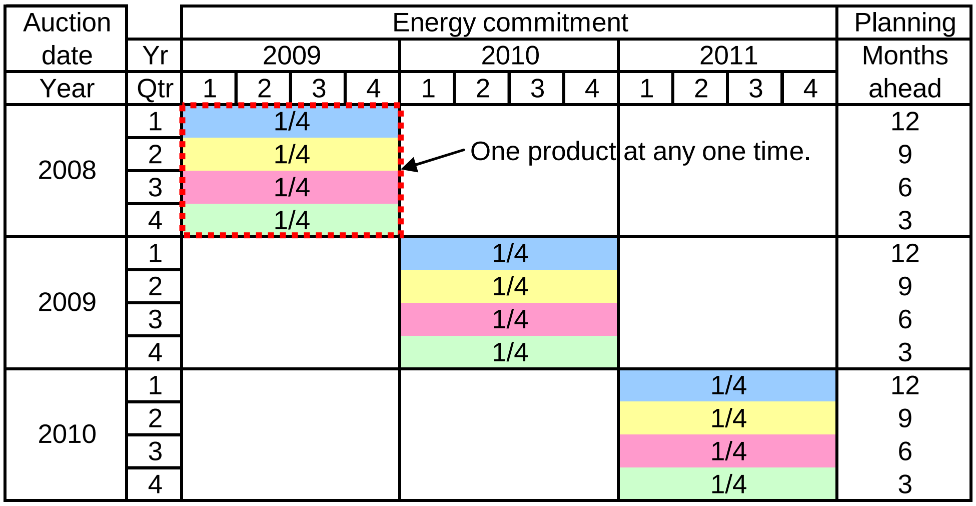
With this option there is a single product at any one time. The advantage is simplicity. Suppliers do not need to decide when to sell—there is only one opportunity. The disadvantage is that 100% of regulated load for an entire year is purchased at one time. This increases risk, since the rate will reflect the market fundamentals at a particular instant, rather than an average of market fundamentals over time.

Many market participants voiced concern with such an approach. I agree—there are too many eggs in one basket.

5.3.2 Multiple auctions for a single commitment period with multiple planning lengths

The second option addresses the difficulty of the first. Multiple auctions are held for the single commitment period. An example with quarterly auctions is shown in Option 2.

Option 2. Quarterly auction for 1-year commitment with variable planning lengths



Auction		Energy commitment												Planning
date	Yr	2009				2010				2011				Months
Year	Qtr	1	2	3	4	1	2	3	4	1	2	3	4	ahead
2008	1	1/4												12
	2	1/4												9
	3	1/4												6
	4	1/4												3
2009	1					1/4								12
	2					1/4								9
	3					1/4								6
	4					1/4								3
2010	1									1/4				12
	2									1/4				9
	3									1/4				6
	4									1/4				3

One product at any one time.

In this option, the annual load is purchased over four quarterly auctions. Each auction procures one-quarter (25%) of the load. There is still only a single product at any one time, but the customer rate reflects the average of four prices from four different auctions taking place over the entire year. This provides the time diversification absent in the first approach.

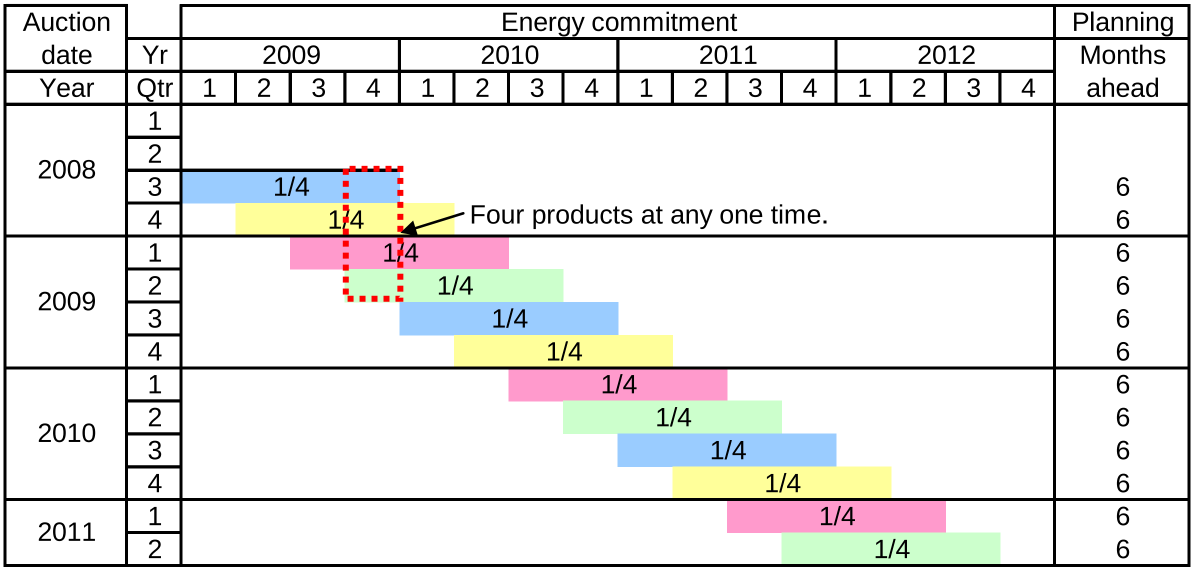
To accommodate this option, the planning period must differ with each auction, starting for example with 12 months for the first and down to 3 months for the last. I view this as an advantage, since it will accommodate the different planning needs of different suppliers. Also the conditional distribution of spot prices likely varies in important ways, depending on the length of the planning period, so different planning lengths provides further diversification.

The only difficulty with multiple auctions for the same commitment period is that the supplier must decide when to sell. The same product is sold at four different times. This may make the supplier's problem more difficult, but it does give the supplier greater flexibility in contracting throughout the year, which should improve the supplier's ability to manage risk. One simple strategy, which would work well for many suppliers, would be to sell one-quarter of its intended annual total in each of the four auctions.

5.3.3 Rolling auctions with a single commitment and planning length

A variation of the second option is to have rolling auctions. This allows a fixed planning period, but expands the number of products. Option 3 has rolling quarterly auctions with a one-year commitment. Like in Option 2, one-quarter of the load is purchased in each auction, and each auction is for just a single product.

Option 3. Rolling quarterly auction for 1-year commitment with 6-month planning length

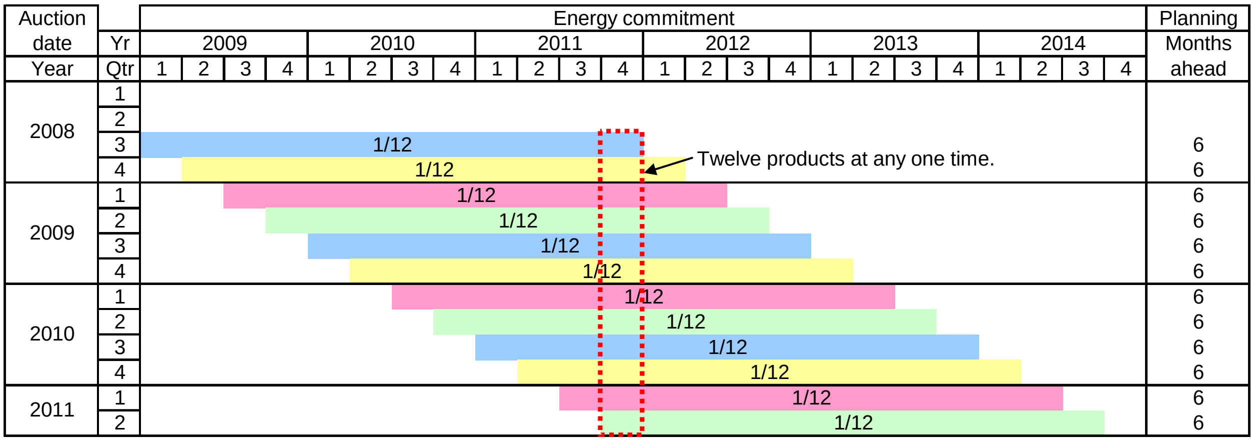


Option 3 provides time diversification—the customer rate at any time is based on the average of four distinct auction prices. The difference is that the year's load is covered with four products, rather than one. This may reduce liquidity, since there are many more products. However, the products are closely related, so I do not believe that liquidity is a major issue. Indeed, the rolling product structure gives suppliers an easy way to manage quantity variation over the year by adjusting its quantities for the quarterly products. Thus, there may be less need to rely on derivative products.

Both option 2 and 3 are sensible.

Option 4 is another variation: rolling quarterly auctions with a 3-year commitment. With the longer duration and the same frequency, there is now even greater time diversification. The customer rate is the average of twelve prices over a three-year period. The downside is that there now are 12 products covering load at any one time. Also the 3-year commitment may be well-suited for some, but may not be best for everyone.

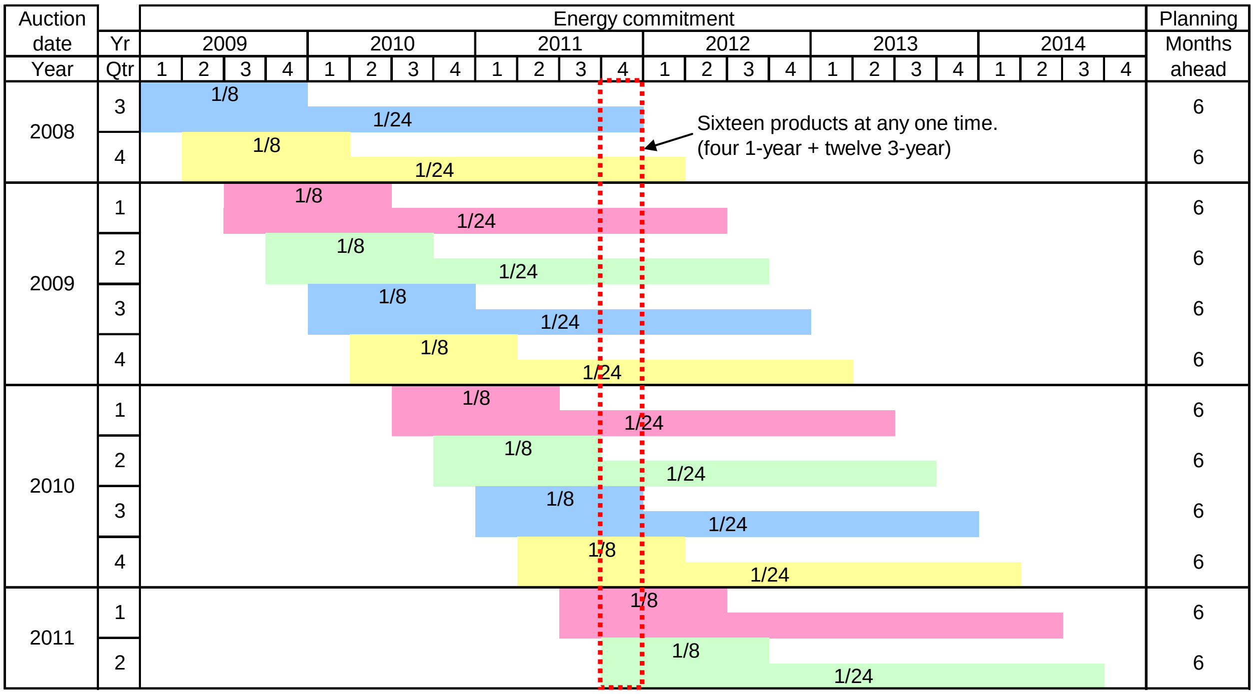
Option 4. Rolling quarterly auction for 3-year commitment with 6-month planning length



5.3.4 Rolling auctions with multiple commitment lengths

Option 5 introduces the flexibility of multiple commitment lengths.

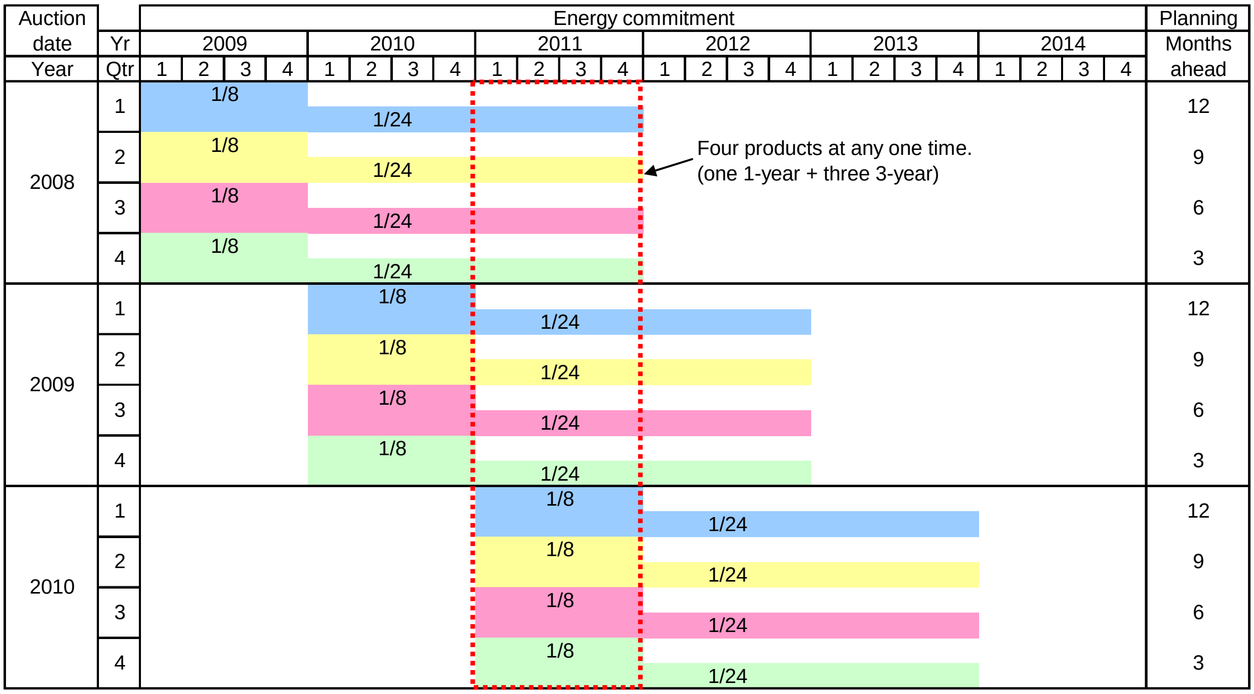
Option 5. Rolling quarterly auction for 1-year and 3-year commitments (6-month planning length)



Each quarterly auction now procures two products: a 1-year product (1/8th of load) and a 3-year product (1/24th of load over three years). The customer rate is the average of sixteen prices. This example splits the purchase 50-50 between 1-year and 3-year. Of course, any other split is possible. The best choice is the split that enables the market participants to best manage price and credit risk, and minimize transaction costs.

Finally, Option 6 reduces the number of products by having each quarterly auction sell the same two products. Thus there are four products at any one time, a 1-year product and three 3-year products. The customer rate is still the average of sixteen numbers from twelve different auctions, so the same time diversification is achieved.

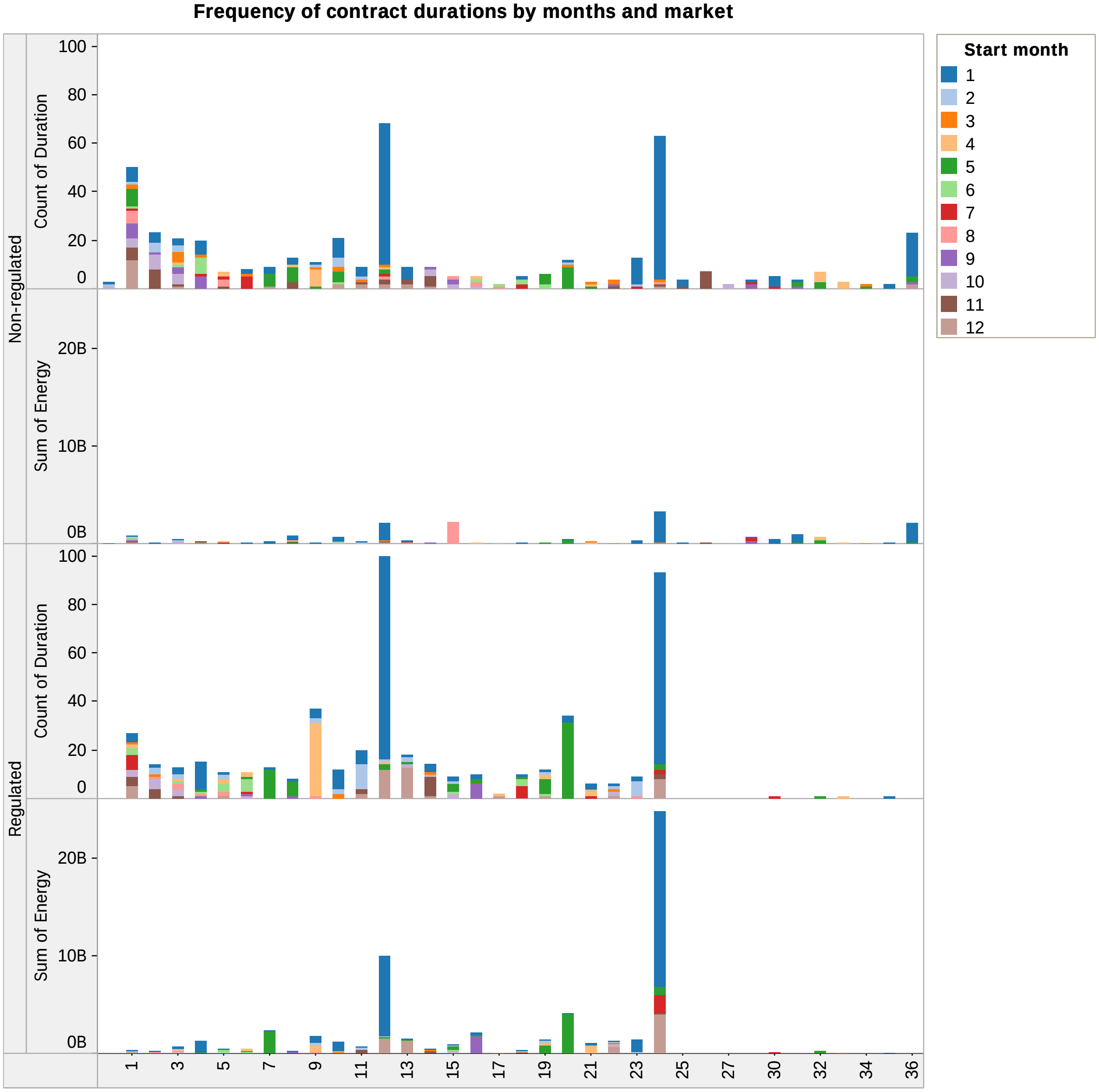
Option 6. Quarterly auction for 1-year and rolling 3-year commitments (variable planning length)



5.3.5 Recommendation

It is instructive to look at the existing contract data to get a sense of historical contract durations and also the timing of contracts. Figure 9 below shows the number of contracts for each contract duration, as well as the quantity of energy contracted with each duration. Durations greater than 3 years are rare and have been omitted. The top-two panels show the results for the nonregulated market and the bottom-two show the regulated market. The color indicates the start month of the contract.

Figure 9. Two-year contracts starting in January are most common

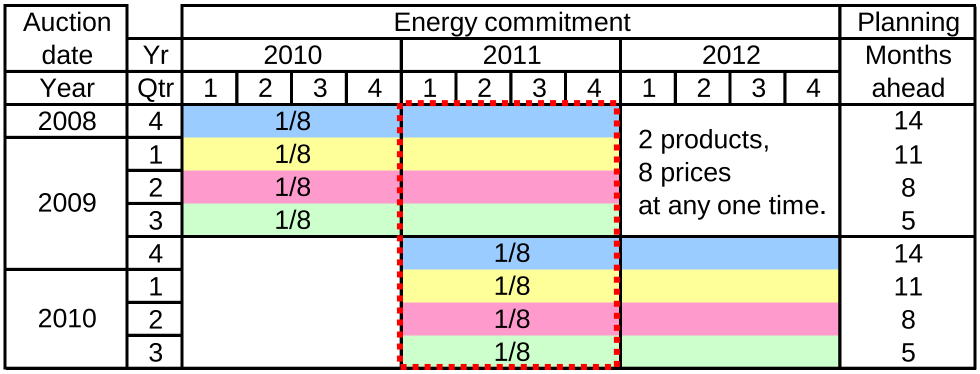

Frequency of contract durations by months and market

Count of Duration and sum of Energy for each Duration broken down by Market. Color shows details about Start month. The view is filtered on Duration of 3 years or less.

There are several things to note. First, the most common contract durations are one-year and two-year contracts. In energy terms for the regulated market, two-year contracts dominate. The vast majority of one and two year contracts start in January, following the calendar year.

After studying the various options, the tradeoffs involved, and the historical contracts, I recommend quarterly auctions of 2-year contracts, rolling on an annual basis, as shown in Figure 10. With this approach there are two products active at any one time. The customer rate is based on eight auctions equally spaced over a two-year period. One-eighth of regulated load is purchased in each auction. Even the final auction of each year has a planning period of five months. This means the auction takes place in August, before much information has been resolved about the severity of the following dry season. Importantly, information about the firm energy auction, both price and quantities, for the commitment years has been resolved at the time of the forward energy auction.

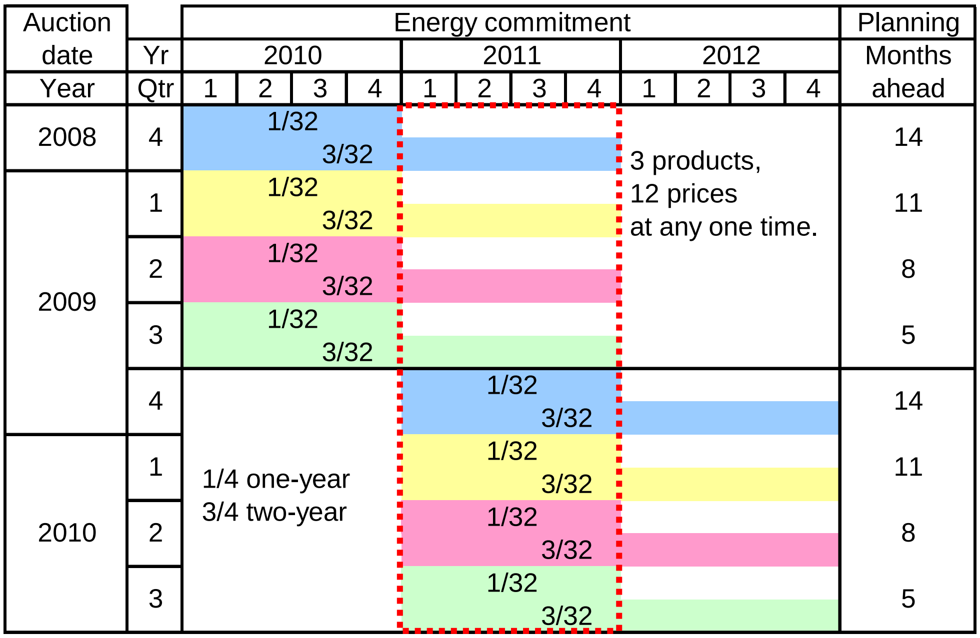
Figure 10. Quarterly auction for 2-year commitments with variable planning period



Auction		Energy commitment												Planning
date	Yr	2010				2011				2012				Months
Year	Qtr	1	2	3	4	1	2	3	4	1	2	3	4	ahead
2008	4	🟦 1/8				🟦				2 products, 8 prices at any one time.				14
2009	1	🟨 1/8				🟨								11
	2	🟥 1/8				🟥								8
	3	🟩 1/8				🟩								5
	4					🟦 1/8				🟦				14
2010	1					🟨 1/8				🟨				11
	2					🟥 1/8				🟥				8
	3					🟩 1/8				🟩				5

An alternative is shown in Figure 11, in which both 1-year and 2-year contracts are procured in each auction. This complicates the auction somewhat, but increases the liquidity of 1-year product and enables bidders to do more balancing within the primary auctions. It is shown below with a 1 to 3 ratio of 1-year to 2-year product. On balance, my view is that it is better to keep the primary auction simpler. I believe that there will be ample liquidity for the 1-year product in the organized secondary market, described below. Hence, I recommend the approach in Figure 10 with only 2-year product procured in the primary auction.

Figure 11. Quarterly auction for 1-year and rolling 2-year commitments



Auction		Energy commitment												Planning
date	Yr	2010				2011				2012				Months
Year	Qtr	1	2	3	4	1	2	3	4	1	2	3	4	ahead
2008	4	🟦 1/32 3/32				 🟦				3 products, 12 prices at any one time.				14
2009	1	🟨 1/32 3/32				 🟨								11
	2	🟥 1/32 3/32				 🟥								8
	3	🟩 1/32 3/32				 🟩								5
	4	1/4 one-year 3/4 two-year				🟦 1/32 3/32				 🟦				14
2010	1					🟨 1/32 3/32				 🟨				11
	2					🟥 1/32 3/32				 🟥				8
	3					🟩 1/32 3/32				 🟩				5

5.4 Industry questions on product design

How will the aggregate demand curve be defined? Will it be obtained as the sum of all the demand purchased by the LSEs in the auction?

The forward energy market aggregate demand is equal to 100% of regulated load. Any particular forward energy auction will procure some fraction, typically 12.5%, of the regulated load. The amount of energy that is purchased as a result of the forward energy auction will vary from hour-to-hour, since it is a load-following product. Regulated load is readily estimated. Hourly estimates of regulated and nonregulated load will be made available to bidders before each auction.

Are LSEs allowed to purchase energy in the auction that is not required for final customers? If the answer is yes, will the aggregate demand curve be obtained exclusively from the sum of the demand of the regulated costumers?

LSEs are passive participants in the forward energy auction; that is, the quantity that each LSE purchases in the forward energy auction is determined from the demand curve as established by CREG before the auction. LSEs can participate on either the buy or sell side in the auction for nonregulated energy contracts.

Because 100% of the demand will be procured in the forward energy auction, the LSE will not be required to purchase energy in the spot market for regulated customers. Is that correct?

Yes, typically the LSE will purchase 100% of its need for regulated customers in the forward energy market. However, it is possible that due to a lack of competitive supply offers in the final quarterly auction less than 100% of the load would be procured in the forward energy market. In this case, the remainder will be purchased in the spot market.

We understand that the agents in the secondary market will be limited to suppliers, as long as the LSEs will not have to trade any energy in this market. Is that true?

Yes, that is true, except for the unusual circumstance described above. However, an LSE serving nonregulated customers may participate in the secondary market for nonregulated load on behalf of these nonregulated customers.

The proposal is not favorable for the supply side, because all the risk is assigned to it. As a consequence, the implementation of a secondary market is suggested.

For a supplier with the ability to generate electricity (a working generator with a fuel contract), the forward energy market reduces a supplier’s risk, since the supplier is able to lock in a long-term price and have less exposure to the volatile spot market. Nonetheless, I agree that the auction design should include an organized secondary market.

Is it correct that the regulated demand will be passive in the auction? Will there be competitive bidding only on the part of the generators (sellers)?

Yes. For the regulated demand, the buy side is passive. Only the suppliers bid. However, for the nonregulated market, both the demand and supply sides are active.

The secondary market that may appear as a consequence of the auction will include participation of LSEs or only of generators?

As described above, typically only the generators will participate in the secondary market for regulated demand. An exception may occur in the unusual case of insufficient competitive supply offers in the final quarterly auction. In this case, the residual regulated demand is purchased in the organized secondary market.

Is it possible for the LSEs, on behalf of the demand, to give up in an auction? Is it convenient to have a reserve price for the auction?

Yes, although the target demand in each auction is 12.5% of regulated load, a smaller amount may be purchased if there are insufficient competitive supply offers. The quantity that is purchased in every auction is determined from the intersection of the demand curve, determined by CREG in advance of the auction, and the generators aggregate supply curve as bid in the descending clock auction. The demand curve serves as the reserve price in the auction.

What will happen if there is not enough quantity offered in the auction? Is it possible to assign obligations, even if the auction does not have enough competition? In that case, will the residual demand be exposed to the spot prices? If the answer to the previous question is yes, can those prices be passed through to the customers. Is it possible to include the residual demand in the following auction?

If there is insufficient quantity offered in the auction, then less will be procured in the particular auction, and more in subsequent auctions. It is not possible to assign obligations in the event of insufficient supply. Rather we simply postpone the assignment to a later auction or possibly even the spot market. Wherever the assignment is made—a primary auction or the spot market—the price is passed through to the customer.

Regarding the 2-year commitment period, it is suggested to include also a product with a 1-year commitment in order to improve risk management.

This is something I have considered. Based on my experience with other markets, I believe it will suffice to include the one-year product in the secondary market. In particular in each monthly secondary auction, generators can buy and sell the one-year product.

In relation to the auction for nonregulated customers, the participating agents should be who define the products according to their own needs.

I agree that for nonregulated customers, market participants should be able to trade whatever products they wish; that is, the bilateral market has no restrictions on contracts for nonregulated customers. However, to minimize transactions costs, reduce risk, and improve liquidity, it makes sense to define a standard product for nonregulated customers. Generators and nonregulated customers that do not want to take advantage of the standard product are free to transact on whatever terms they find mutually desirable.

Buying in a single mechanism (the forward energy auction) reduces the liquidity of the products and the participation in other alternative markets.

It is true that to the extent that the forward energy auction is highly efficient, then the quantity traded in secondary markets will be less. However, this is not a reason to construct an inefficient auction. Moreover, experience over many decades and in many countries has consistently confirmed that the development of standardized products allocated in efficient auctions promotes secondary markets and market liquidity.

What would happen with deviations in projected demand?

This is not an issue in the forward energy market. Since what is auctioned is a percentage of the realized load on an hour-by-hour basis throughout the commitment period. Any deviation from projections is the responsibility of the supplier. This puts a little bit of risk on the supplier, which it must account for in its bid. Fortunately, the additional risk is not large. Aggregate regulated load is well understood and readily estimated. Estimating aggregate load to within say 2% is not difficult.

What would happen when a new LSE enters the market? How can it purchase its requirements?

Restructuring of LSEs is beyond the scope of this paper. Nonetheless, in the event of a restructuring, the obligations and payments would simply move with the customers. If the customers of LSE A are shifted to LSE B, then the obligations to LSE A customers would simply shift to LSE B.

There is a five month planning period in the last quarterly auction. This is considered too short and risky.

Keep in mind that only 12.5% of load is being procured in this final auction; 87.5% of load is being procured well in advance of the final auction. In the New Jersey BGS auction, 33.3% of load is procured less than four months before the start of the commitment. In the context of Colombia’s hydro-dominated system, I recommend a longer planning period.

Bearing in mind the energy variability of hydropower plants, some have proposed to analyze the possibility to allow offers with different percentages of the aggregate demand each month without changing the price and commitment period.

My view is that a supplier with a hydro plant having lower expected supply in the dry season has several methods of managing the risk: 1) the supplier can have a diversified portfolio of resources that enables the supplier to better follow load in both dry and wet seasons, 2) the supplier can sell less forward energy contracts and sell more to nonregulated customers during the wet season, 3) the supplier can have a bilateral contract with another supplier to supply any obligation in the dry season that the supplier may not be able to handle with its own resources, and 4) the supplier can simply purchase in a secondary auction or the spot market the extra energy it needs in the dry season.

Given that the forward energy market will facilitate the secondary market with monthly secondary auctions, I think that the methods above will be sufficient to let the resource owner effectively manage the risk of a load-following obligation. The alternative would be to introduce more complex products, but I do not think that that is advisable. It is not possible for suppliers to simply pick the months in which they would like to supply more. All suppliers would then pick the months in which the expected spot price is lowest. This would only work if multiple products were defined, which reduces liquidity and adds complexity.

The agents who act as suppliers should be limited to generators in order to avoid intermediation costs.

Generators are free to participate directly in the forward energy auction and I suspect that nearly all will. One incentive for the generator participating directly is to avoid intermediation costs. However, there may be cases where the intermediary adds value that exceeds its intermediation cost. In this case, generators should be free to use an intermediary. Intermediaries often play an important role in markets by improving market liquidity and risk management.

You have recommended a lot size in the following terms: "say 0.1% of regulated load (6 MW)." Does this mean that the lot size is a fixed quantity (6 MW) instead of a percentage of the demand?

The lot size is not fixed, but rather is a percentage of regulated load, such as 0.1%. Today, 0.1% is approximately 6 MW on average. The hour-by-hour obligation is based on the percentage of load, so that in one hour 0.1% may be 10 MW and in another it may be 4 MW, and indeed on average the obligation may differ from 6 MW depending on whether load growth is more or less than expected. My mention of 6 MW was simply as a means to provide a rough estimate of the average hourly obligation associated with 0.1% of regulated load. Before the auction, detailed estimates of hourly load will be provided to bidders. However, even these detailed estimates are still only estimates. The bidders must recognize that actual load may be more or less than the estimate in any hour, and that their obligation is based on the actual load realization on an hour-by-hour basis for regulated product and expected load on an hour-by-hour basis for nonregulated product.

It will be necessary to establish a methodology to estimate the projected demand.

Yes. It will be helpful to estimate the projected demand. For the forward energy market this is useful to the bidders in understanding their likely obligations. This information is provided to bidders in advance of the auction. However, for regulated load, the supplier's obligation is based on a percentage of actual hour-by-hour load. Thus, for settlement, all that matters is the actual load and what the supplier provided. Any deviation between the obligation and the supply in any hour is settled at the spot price. Hourly demand estimates are helpful in planning, but do not impact obligations or settlement for regulated load.

In contrast, for nonregulated customers, estimating hourly load is essential for both planning and settlement, since for nonregulated load the obligation is based on the estimated hourly load, rather than the actual. Hence, for nonregulated load, the estimates of nonregulated load are of primary importance. These estimates are fully disclosed before each auction.

If the obligation of the product will be verified on a daily basis, there may not be enough remuneration for the peak plants. It is important to remember that in the Reliability Charge discussions it was said that the peak plants would have a high price during peak hours in the contract market.

I am sympathetic with this comment. This is my primary concern with daily verification, rather than hour-by-hour variation. Daily verification may distort the generation mix toward baseload units. I anticipate that the impact would not be too great, since there should not be large within day price swings in a hydro-dominated system. However, on balance I still favor hour-by-hour verification to avoid any potential distortion of the generation mix.

How can market participants be certain of projected demand in light of the fact that large consumers can opt to participate in either the regulated or nonregulated sectors of the market?

Of course, market demand is never certain. It is, however, well understood. To provide greater certainty about nonregulated load, I recommend that all large consumers with hourly meters be in the nonregulated sector. Large consumers without hourly meters should migrate to the nonregulated sector as soon as hourly meters can be installed. I view the migration from regulated to nonregulated as a one way street: regulated consumers can switch to the nonregulated sector with the installation of hourly meters, but not vice versa.

Please provide a more detailed explanation about the size and other characteristics of the nonregulated product.

The nonregulated sector currently is 32% of the Colombian load. This number will increase over time as regulated consumers switch to the nonregulated sector with the installation of hourly meters.

The nonregulated product is similar to the regulated product in that it is a load-following energy product. Each supplier has an obligation to supply a particular share of the aggregate nonregulated load in every hour. Hourly deviations are settled at the spot price or the scarcity price, whichever is less. The hourly obligation is based on the expected demand (forecast), not the actual. To promote liquidity and enhance substitution, other features, such as the two-year term, are the same as with the regulated product.

Is it possible for a LSE to aggregate the demand of many nonregulated customers?

Yes. An LSE can aggregate the demands of any number of nonregulated customers. Before the start of the clock auction, the LSE would submit a demand curve for each of the nonregulated customers it has bidding authority.

6 Auction design: simultaneous descending clock auction

The proposed auction design is a simultaneous descending clock auction, similar to the firm energy market (see Cramton and Stoft 2007). There are two important differences. First, bids at the clearing price may be rationed in this auction, whereas in the firm energy market, bids by new entrants are not rationed. This simplifies auction clearing in the forward energy market. Second, there are two substitutable products, regulated and nonregulated energy, rather than a single product. Multiple substitutable products are readily handled within the descending clock auction.

The motivation for using a dynamic auction, rather than a sealed bid auction, is explained in detail in Cramton (1998) and Ausubel and Cramton (2004, 2006). In brief, the approach allows price discovery: bidders can learn from the bidding process and condition their bids on this information. This is especially useful when there are multiple products, as is the case here. Then the bidders can freely arbitrage across the two products. This arbitrage improves liquidity and auction efficiency. Competitive market prices are determined for each product. In particular, the price separation between the regulated and nonregulated product reflects the difference in the cost of supply.

The descending clock auction is an especially simple and powerful dynamic auction. In each round, the auctioneer announces the regulated price, and the approximate price spread between the two regulated and nonregulated products. Each bidder then indicates the total quantity, both regulated and nonregulated, it desires to sell at the current price. In subsequent rounds, the price decreases, and the bidders again express the total quantity at the new price. This process is repeated until there is no excess supply.

6.1 Starting price

For the descending clock auction to work as intended, it is important for the starting price to be set sufficiently high that it creates significant excess supply. Setting too high a starting price causes little harm. It is competition among the bidders that determines the clearing price. The high starting price will quickly be bid down, unless there is insufficient competition, which is unlikely in this context. In contrast, setting too low a starting price can damage the auction.

There are several methods available to determine the starting price. The most common is basing the starting price on market fundamentals, price indices, and recent experience. This approach is often augmented by getting indicative offers from suppliers at minimum and maximum starting prices shortly before the auction as part of qualification. A reasonable approach would be to estimate the market price from market intelligence and to specify the minimum starting price at roughly 20% above market and the maximum starting price at roughly 50% above market. These percentages are not meant to be fixed rule; they depend upon how much uncertainty there is about the market price. Typically there will be more uncertainty in the first of the quarterly auctions, although this uncertainty depends on other factors such as weather.

6.2 Auction mechanics

The clock auction is done in discrete rounds. There is one price "clock" for the regulated product. The price for the nonregulated product depends on the regulated price and the price spread between the two products, which depends on the bidders' substitution preferences. In each round, the auctioneer announces: 1) the total excess supply at the end of the prior round, 2) the price spread between regulated and nonregulated products at the end of the prior round, 3) the start of round price, and 4) the end of round price. Since this is a procurement auction, the clock descends, so the start of round price is above the end of round price.

Each bidder submits an aggregate supply curve at all prices between the start of round price and end of round price. The auctioneer determines the total excess supply at end of round price. So long as there is excess supply, the price decreases. The price decrement is determined by best-practice methods, essentially in relation to the extent of excess supply. If there is no excess supply, the clearing prices are determined.

6.2.1 Activity rule

An activity rule in a dynamic auction is intended to enhance price discovery by motivating each bidder to bid throughout the auction in a manner that is consistent with the bidder's true interests. To the extent that bids better reflect each bidder's true preferences, prices are more apt to progress in a manner consistent with final competitive prices. This allows bidders to focus their decision-making attention on more realistic packages of items. This focus improves bidder decision making, especially with respect to costly information acquisition. For example, it typically is costly for a bidder to determine the cost of supplying a particular portfolio of contracts. Bidder participation costs are reduced and efficiency is improved if the bidder's evaluation is guided by prices that better reflect true market preferences.

The need for an activity rule in a dynamic auction is seen in the tendency of sophisticated bidders in eBay auctions to bid snipe. Bid sniping is waiting until the last minute before submitting a bid. There are numerous reasons for this common behavior, but one of the most frequent is a desire to prevent other bidders from responding to your bid. If all bidders bid snipe, then the dynamic auction becomes a sealed-bid auction and all the benefits of price discovery are lost.

Fortunately, there is a simple and general activity rule, based on one of the basic principles of economics: revealed preference. Whenever a consumer selects one package over another, the consumer is effectively saying, “At these prices, I prefer this item.” The economist then infers this preference from the consumer’s choice. This is revealed preference: the consumer reveals something about her preferences through her choices.

We can apply the same revealed preference approach in a clock auction. In each round of the auction, the bidder is given a set of prices and is asked to select its most preferred package of products. The bidder is effectively saying, “At these prices, I prefer this package.” The activity rule requires the bidder to bid consistently with this revealed preference throughout the auction. In the context of the forward energy auction, the activity rule is especially simple. Since there are two products that are close substitutes, the rule simplifies to

Activity rule: *A bidder can only maintain or reduce aggregate quantity as prices fall. That is, the bidder must bid a (weakly) upward sloping aggregate supply curve throughout the auction.*

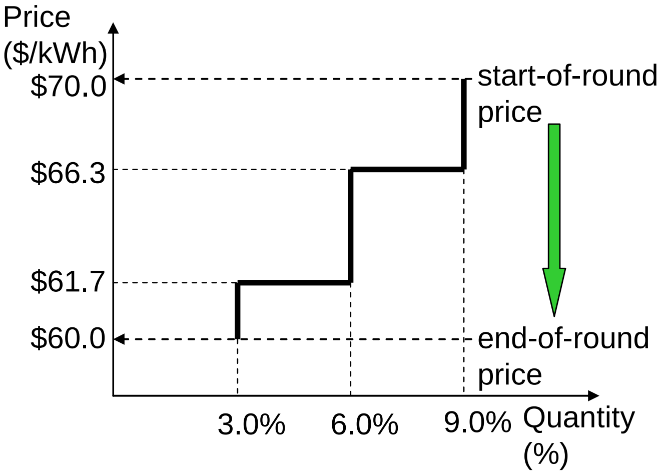
Note that this activity rule imposes no restriction on the ability of the bidder to arbitrage across the two products—the restriction is with respect to the aggregate quantity offered, not the individual quantity.

6.2.2 Intraround bids

An important feature in the clock auction is what is known as intraround bidding: the ability to express a supply curve for all prices between the start of round prices and the end of round prices. This feature allows better expression of bidder preferences without requiring too many rounds. This improves auction efficiency and lets the auctioneer better manage the pace of the auction. A further advantage is that ties are reduced, making it likely that only a single bidder will be rationed at the clearing price.

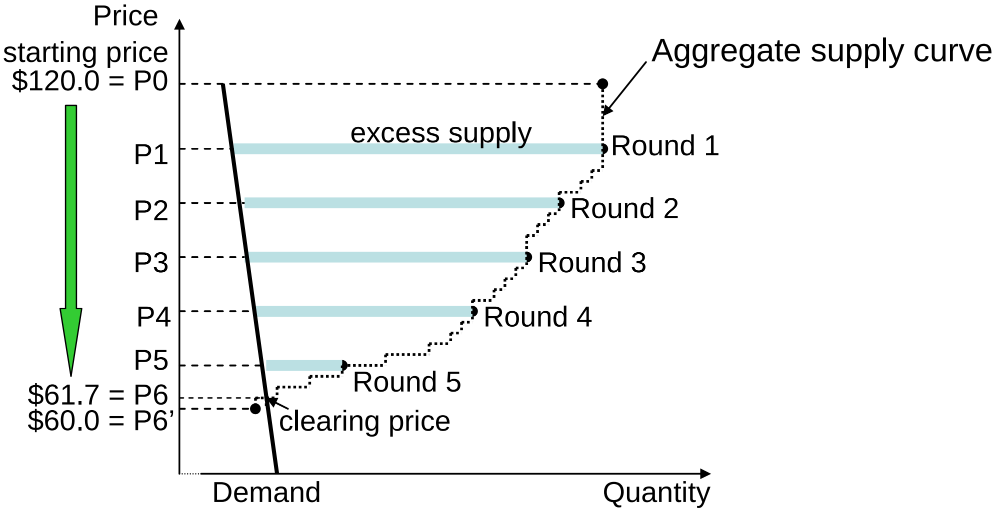
Figure 12 shows a graphical version of a bid in a round. The steps in the supply curve are the points at which the bidder wishes to reduce its quantity as prices fall. The curve is easily expressed by bidding the points at which the bid desires to reduce aggregate quantity. For example, the bid below is submitted by the bidder specifying two price-quantity pairs: ($66.30, 6.0%) and ($61.70, 3.0%).

Figure 12. Individual supply bid for a round



At the end of every round, the auction system collects all the individual bids and aggregates them together to form the aggregate supply curve. Figure 13 shows a sample aggregate supply curve and process of the auction for a hypothetical auction with a single price clock.

Figure 13. Descending clock auction



6.2.3 Auction clearing rule

The auction ends when there is no excess supply. The clock ticks down while there remains excess supply. Thus, the auction will conclude when excess supply is zero or negative at the end of round prices. The auctioneer then backs up the supply curve to determine the clearing price and price spread, where supply and demand balance.

In a forward energy auction, it is desirable to facilitate clearing by rationing bids at the clearing price if necessary. In the typical case, clearing is reached (supply and demand balance) when a single bidder reduces quantity at a particular price. For example, a supplier might drop from 2.0% to 1.5% at $70/kWh, and clearing occurs (S = D) at 1.7%. The supplier wins 1.7%, not either 2.0% or 1.5%. Indeed, the supplier's bid is interpreted as "at $70/kWh, I am happy with any quantity between 1.5% and 2.0%." The supplier sells 2.0% if the price is above $70/kWh and sells 1.5% if the price is below $70/kWh. Only when the bidder's reduction is at the clearing price can the quantity fall between the two quantities.

In the unlikely event that there are multiple bidders on the margin (multiple bidders reduce quantity at the clearing price), then proportionate rationing is used. Each receives its proportionate share. Thus, if one bidder dropped from 2.0% to 1.5% at $70/kWh and a second bidder dropped from 4.0% to 3.0% at the same price, and if a total quantity of 5.1% is needed for the market to clear, then the two bidders are offering between 6.0% and 4.5% at $70/kWh, and the first bidder wins 1.5% + 0.2% = 1.7% and the second wins 3.0% + 0.4% = 3.4%. The second gets twice as much of the rationed quantity, since its reduction is twice as large at the clearing price.

In auctions with lumpy investments and without good secondary opportunities for purchase or sale, then rationing is not used. An example is the bid of a new entrant in the firm energy market. Here, however, the going-forward investments are not so lumpy, and there are ample secondary opportunities for trading. Thus, rationing bids at the clearing price is perfectly appropriate.

6.2.4 Information policy

The information policy determines who knows what in the auction. I recommend that the demand curve for both products and the starting price be announced before the auction. At the end of every round, the auctioneer reports: 1) the total excess supply at the end of the prior round, 2) the price spread between regulated and nonregulated products at the end of the prior round, 3) the start of round price, and 4) the end of round price. Since this is a procurement auction, the clock descends, so the start of round price is above the end of round price. This is an anonymous auction in the sense that no individual supply offers are reported.

6.2.5 Handling two products

The examples and figures above are all based on a single product, or in this case a single total supply including both regulated and nonregulated product. It remains to explain how the two products are handled and in particular the substitution between the two products.

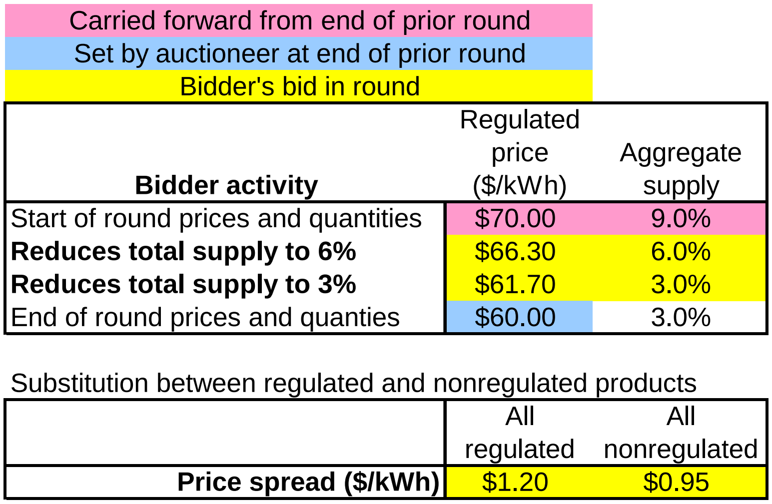
The first point to make is that the two products are excellent substitutes. They differ in only two respects. First, the regulated product has slightly more risk, since the supplier is offering to serve a fraction of the actual realized load, rather than forecasted load. And second, the regulated product has a different load shape, which implies a different cost of service. Table 1 calculates the average cost of servicing regulated and nonregulated load at the spot price for the last ten years and the first five months of 2007. Typically, regulated load is slightly more expensive to serve than nonregulated load.

Table 1. Average cost ($/kWh) at spot price for regulated and nonregulated load by year

Average Cost	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Regulated	105.81	65.39	12.22	33.12	38.60	26.94	40.92	40.51	53.97	51.79	70.77
Nonregulated	107.81	61.33	11.50	31.45	36.78	26.15	40.37	39.33	52.78	50.07	70.11
Difference	-2.00	4.06	0.72	1.67	1.82	0.78	0.55	1.18	1.19	1.72	0.66

Figure 14 gives a sample bid with two products. The first part of the bid expresses the bidder's aggregate supply (both regulated and nonregulated) as a function of the regulated price, for all prices from the start of round price to the end of round price. The bidder's offer at the start of round price is carried forward from the prior round. The end of round price is specified by the auctioneer. The supplier simply has to express the prices at which it desires to reduce its quantity. In the example below, the supplier indicates that at a regulated price of $66.30, it desires to reduce its quantity from 9.0% to 6.0%, and then at a price of $61.70, it desires to further reduce its quantity from 6.0% to 3.0%. A bidder can specify up to five prices at which it desires to reduce quantity in any particular round.

Figure 14. Sample bid



Carried forward from end of prior round
Set by auctioneer at end of prior round
Bidder's bid in round

Bidder activity	Regulated price ($/kWh)	Aggregate supply
Start of round prices and quantities	$70.00	9.0%
Reduces total supply to 6%	$66.30	6.0%
Reduces total supply to 3%	$61.70	3.0%
End of round prices and quanties	$60.00	3.0%

Substitution between regulated and nonregulated products

	All regulated	All nonregulated
Price spread ($/kWh)	$1.20	$0.95

The second part of the bid, shown in the lower box of Figure 14, is where the bidder expresses its substitution preferences between regulated and nonregulated products. In this example, the bidder is stating:

1. whenever the price spread—the difference between the regulated price and the nonregulated price— is greater than $1.20, the supplier wants all its quantity to be regulated product;
2. whenever the price spread is less than $0.95, the supplier wants all its quantity to be nonregulated product; and
3. whenever the price spread falls between $0.95 and $1.20, the bidder gets a linear mix of regulated and nonregulated product, according to the formula:

$$\text{regulated quantity} = \text{total quantity} \times (\text{spread} - 0.95) / (1.20 - 0.95),$$

where spread = regulated price – nonregulated price.

This approach gives the bidder great flexibility in expressing its substitution preferences. For example, if the two products are perfect substitutes, then the bidder would give a single number for "all regulated" and "all nonregulated," reflecting the bidder's cost of service difference between the regulated product and the nonregulated product. Then the bidder's supply would be either all regulated or all nonregulated depending on whether the price spread is above or below the number bid. Alternatively, the bidder can slow the substitution across products by submitting a lower number for “all nonregulated.” Then the supplier’s mix of regulated and nonregulated product shifts gradually to nonregulated as the price spread increases.

Figure 15. The price spread is calculated to balance excess supply across products

	$/kWh	S/D ratio		Reg	Nonreg
Spread	1.51	120.0%	Price	$60.00	$58.49
			Share of total market	68%	32%
			Demand in own market	12.5%	10.0%
Demand	11.7%			8.5%	3.2%
	Supplier offer			120.0%	120.0%
		All	All	Supply	
Supplier	Supply	Reg	Nonreg	Reg	Nonreg
A	1.1%	2.20	1.71	0.0%	1.1%
B	1.1%	2.00	1.50	0.0%	1.1%
C	0.8%	1.80	1.42	0.2%	0.6%
D	2.8%	1.60	1.36	1.8%	1.0%
E	1.7%	1.50	1.23	1.7%	0.0%
F	2.2%	1.40	1.20	2.2%	0.0%
G	0.6%	1.11	1.11	0.6%	0.0%
H	1.4%	1.20	0.95	1.4%	0.0%
I	1.7%	1.10	0.94	1.7%	0.0%
J	0.6%	1.00	0.90	0.6%	0.0%
Supply	14.0%			10.2%	3.8%

Figure 15 shows how the price spread at the end of round price is calculated to balance excess supply across the two products. In the example, the end of round regulated price is $60.00. The question is what is the price spread that results in the same ratio of supply over demand for both products. In this case, given the aggregate supply of all the bidders, it turns out that a price spread of $1.51 results in a supply over demand ratio of 120% for both the regulated and nonregulated products. Given the strictly downward sloping demand curves for both products, the weakly upward sloping total supply curves for each bidder, and the linear substitution across products for each bidder, there will always be a unique price spread that balances the supply over demand ratio for each product. As the price falls and bidders make reductions in quantities, we eventually will reach the point where supply equals demand for each product. The motivation for calculating the price spread in this way is that it provides the best predictor for the price spread at the ultimate clearing price.

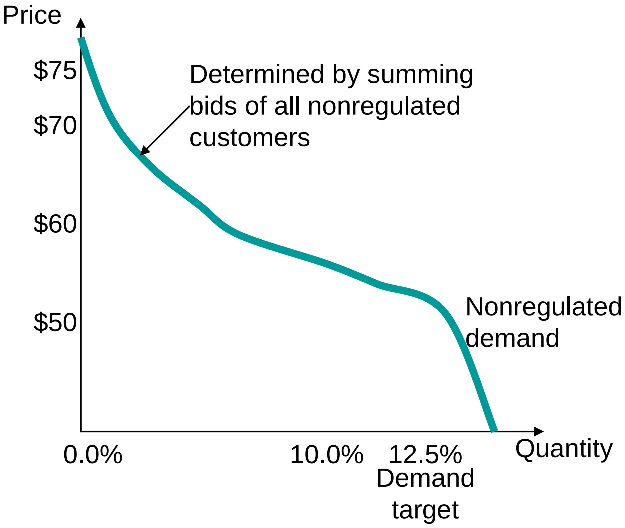
6.3 Demand

The demand curves are essential to the auction. Both curves are determined and disclosed before the auction starts. The important difference is that the regulated demand curve is determined administratively by the regulator; whereas, the nonregulated demand curve is as bid by the nonregulated customers.

Importantly, the nonregulated demand bids are all submitted before the start of the auction. I recommend that the nonregulated demand bids be submitted one week before the auction starts. I also recommend that the individual demand curves be piecewise linear and strictly downward sloping. Such a curve is specified with a sequence of price-quantity pairs, where as the prices decline, the quantities strictly increase. Quantities are stated as a percentage of the customer’s target demand, which is its expected demand over the commitment period.

Figure 16 shows a hypothetical nonregulated demand curve, which is formed as a weighted average of the individual demand curves where the weights reflect the size of each customer relative to the total. The aggregate nonregulated demand curve is piecewise linear and strictly downward sloping, since each of these properties is inherited from the individual curves.

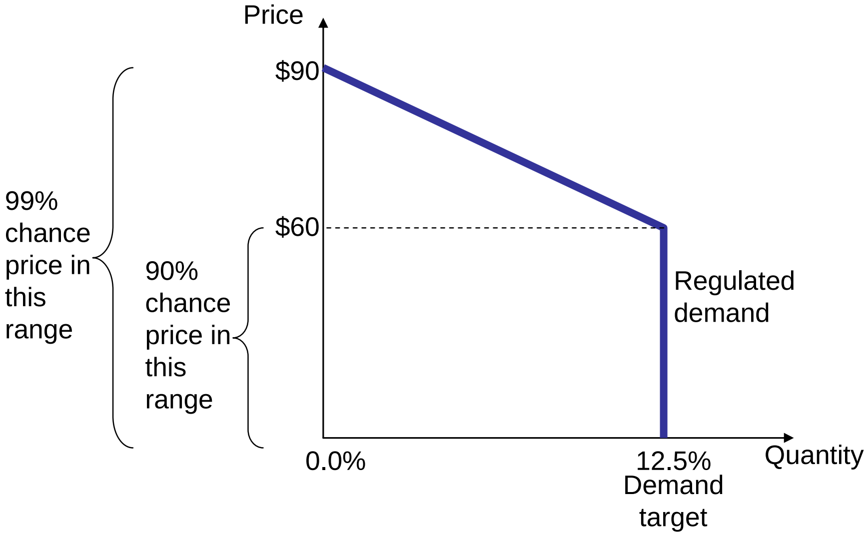
Figure 16. Demand curves of nonregulated customers are submitted before auction



Since the nonregulated demand curve is submitted before the auction starts and before the regulated demand curve is determined, the nonregulated demand curve is a further piece of information that the regulator uses in determining the regulated demand curve.

A hypothetical regulated demand curve is shown in Figure 17. The administrative demand curve is determined by specifying two prices: (1) a high price at which there is only a 1 in 10 chance the clearing price is higher, and (2) a very high price at which there is only a 1 in 100 chance the clearing price is higher. The demand curve is vertical from 0 up to the high price ($60/kWh in the figure); the demand falls to zero at the very high price ($90/kWh in the figure). Thus, by construction, *it is extremely likely that the targeted regulated quantity is purchased in each quarterly auction*. In the event, that the target is not purchased, the shortfall is carried over to the next quarterly auction. If there is a shortfall in the last quarterly auction, then the shortfall quantity is purchased in the spot market. I believe that this approach is both simple and effective.

Figure 17. Administrative demand curve addresses insufficient competition



For both the regulated and nonregulated customers the purpose of reducing the quantity in response to high prices is to protect against insufficient competition or inadequate supply. The demand curve is simply a generalization of the reserve price that is used in nearly all auctions. The demand response for each of the products helps address market power on the supply side. Demand-side market power is addressed by requiring that both demand curves are submitted and published before the auction starts.

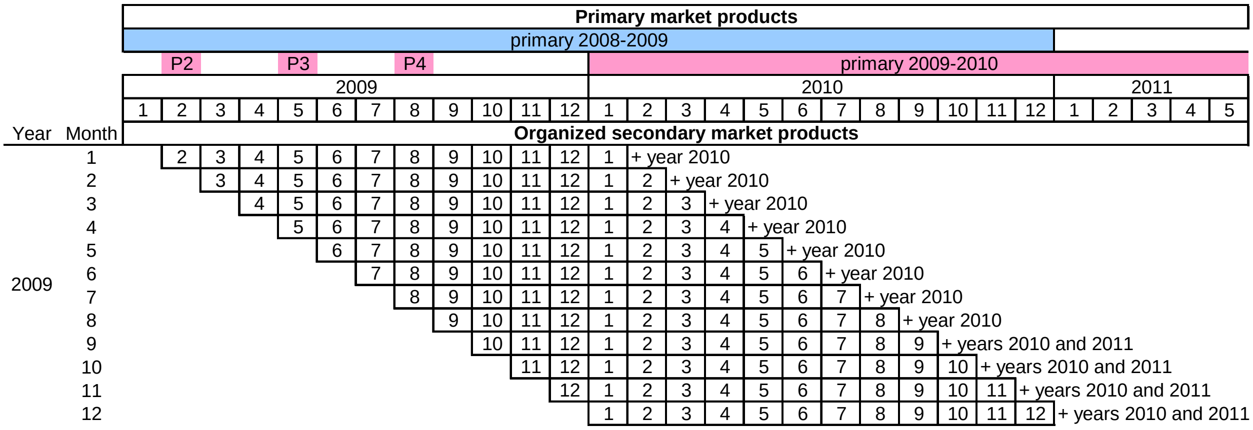
6.4 Organized secondary market

To allow suppliers and demanders to rebalance positions, I propose an organized secondary market. Parties, other than regulated demand, are free to trade bilaterally in any secondary market. Regulated demand makes all purchases through the quarterly forward energy auction (the primary auction) and in exceptional circumstances in the spot market. Hence, the secondary market is almost entirely for suppliers. For this reason the specific structure of the secondary market should be based largely on the needs of the suppliers. I sketch one approach below.

The organized secondary market is held monthly. Since the volume is likely small, it makes sense for this to be a sealed-bid auction, rather than a dynamic auction. This accomplishes two things: 1) it reduces transactions costs, and 2) it reduces market power concerns that often arise in thin markets. I recommend a simple uniform-price auction, using the same clearing rule as in the clock auction. To facilitate clearing, I recommend that the demand bids be piecewise linear and strictly decreasing, and the supply offers be a weakly increasing step function. This is the same structure as in the primary auction. Alternatively, the demand bids could also be specified as a step function to preserve symmetry with the supply offers. Either method is fine.

Both the regulated and nonregulated products include: 1) monthly slice for next 12 months, and 2) a yearly slice (January to December) for each year already auctioned in the primary auction. Figure 18 shows the products that are auctioned in each monthly secondary auction. In each month there are either 13 or 14 products (12 monthly and 1 or 2 yearly) for both regulated and nonregulated energy. Thus, there are a total of 26 or 28 products in each auction.

Figure 18. Secondary market includes annual products and monthly slices



		Primary market products																												
		primary 2008-2009																												
			P2			P3			P4					primary 2009-2010																
		2009												2010												2011				
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Year	Month	Organized secondary market products																												
2009	1		2	3	4	5	6	7	8	9	10	11	12	1	+ year 2010															
	2			3	4	5	6	7	8	9	10	11	12	1	2	+ year 2010														
	3				4	5	6	7	8	9	10	11	12	1	2	3	+ year 2010													
	4					5	6	7	8	9	10	11	12	1	2	3	4	+ year 2010												
	5						6	7	8	9	10	11	12	1	2	3	4	5	+ year 2010											
	6							7	8	9	10	11	12	1	2	3	4	5	6	+ year 2010										
	7								8	9	10	11	12	1	2	3	4	5	6	7	+ year 2010									
	8									9	10	11	12	1	2	3	4	5	6	7	8	+ year 2010								
	9										10	11	12	1	2	3	4	5	6	7	8	9	+ years 2010 and 2011							
	10											11	12	1	2	3	4	5	6	7	8	9	10	+ years 2010 and 2011						
	11												12	1	2	3	4	5	6	7	8	9	10	11	+ years 2010 and 2011					
	12													1	2	3	4	5	6	7	8	9	10	11	12	+ years 2010 and 2011				

More products could be included in the organized secondary market. For example it would be possible to include monthly slices for more than 12 months ahead, such as including all of the months for which the primary auctions have already been completed. The inclusion of products should be based largely on supplier interest.

6.5 Handling differences among nonregulated customers

I propose that there be just a single nonregulated product. This greatly simplifies the market and improves liquidity. From a supplier viewpoint, this approach is best, since each supplier then is supplying a share of the total nonregulated load. This aggregate demand is better understood and easier to model than the demand of any individual customer. Hence, supplier risk is reduced.

The potential problem with this approach is that different customers have different load shapes. Some load shapes are more desirable than others. Hence, absent some adjustment in customer payments there would be a cross subsidy from those with the most attractive load shapes to those with the least attractive load shapes. Fortunately it is straightforward to remove this cross subsidy with an appropriate adjustment to the customer’s payment. This is done as follows.

First, we forecast hourly demand for each nonregulated customer for every hour of the commitment period. The electricity rate paid by the nonregulated customer is the auction clearing price scaled by a quality factor that reflects the customer’s cost to serve relative to the average service cost. For example, a customer with an unattractive load shape may have a quality factor of 1.05, which means that its payment is 5% higher than the average payment. The quality factor reflects the expected cost difference, evaluated at the spot price, for the particular customer.

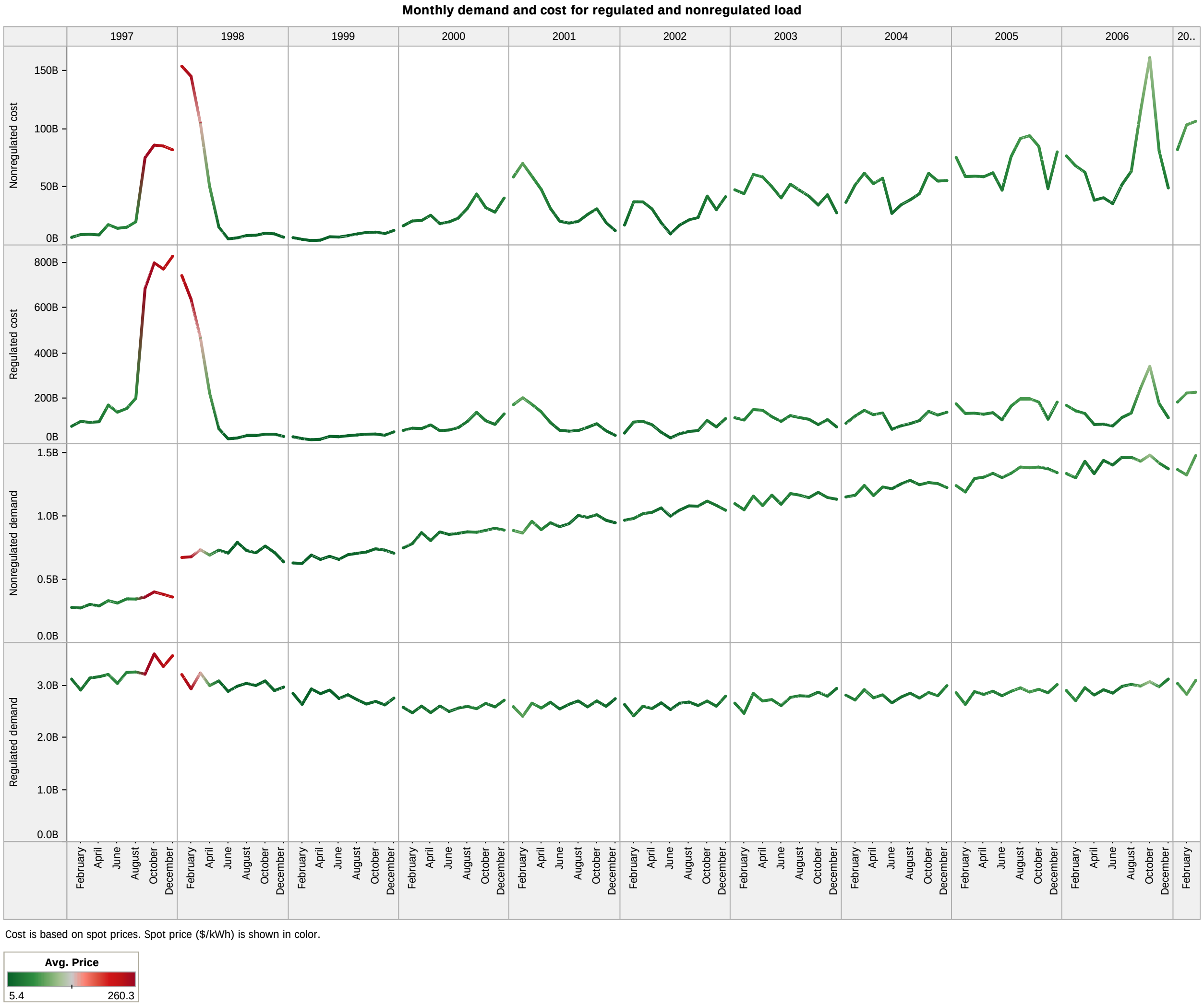
Each supplier is unaffected by the quality adjustment. The supplier’s obligation is its share of the aggregate nonregulated expected load. The supplier receives its share of payments, regardless of the quality factors. The quality factors simply remove, what would otherwise be a cross subsidy to those with unattractive load shapes.

6.6 Forecasting hourly demand and cost

Forecasting hourly demand for each nonregulated customer and for the regulated load is important to the forward energy market. In addition, to determine the quality factors it is necessary to forecast the relative cost of supply for each nonregulated customer. This section presents a preliminary forecasting method to demonstrate that such forecasting is readily done. Even the simple approach presented here results in good forecasts of both hourly demand and relative cost.

Figure 19 shows the monthly demand and cost for regulated and nonregulated load since 1997. The spot energy price is shown by the line color.

Figure 19. Monthly demand and cost for regulated and nonregulated load



I now present a simple hourly demand model. It is based on the hourly demand and spot price data from 1 January 2002 to 31 March 2007 (the last five and a quarter years) for both regulated and nonregulated customers. I limit the analysis to the last five years, since this data is more relevant in a forecast, especially for individual nonregulated customers. The model includes a linear growth trend and fixed effects for the month of year, the day of week, and the hour of the day. It also includes an indicator variable for major holidays that occur on weekdays.

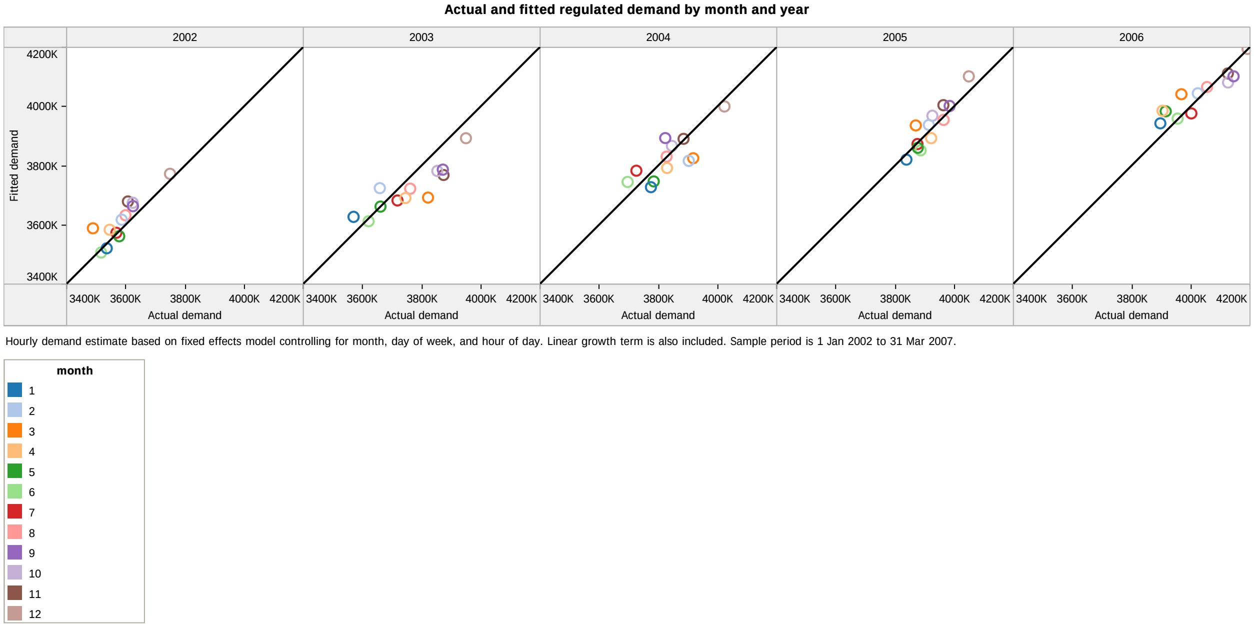
Table 2 shows the hourly mean and standard deviation of demand and cost for both regulated and nonregulated customers for both the actual data and the fitted values. What is most relevant here is the error in the estimates. For regulated customers the model's 1-standard deviation demand error is 4.5%. This means that for roughly two-thirds of the hours, the demand error was less than 4.5%, and for roughly 95% of the hours the demand error is less than 9%. For nonregulated customers, the demand error is 6.9%, which means that for two-thirds of the hours the model demand error is less than 6.9% and for 95% of the hours the error is less than 13.8% (two standard deviations). The model also does a good job of predicting hourly cost. For regulated customers, the error in the model value is approximately normally distributed with a standard deviation of $1.96/kWh, compared with a mean price of $42.6/kWh. For nonregulated customers, the error in the hourly cost estimate is normally distributed with a standard deviation of $3.42/kWh.

Table 2. Hourly mean and standard deviation of demand and cost

	Price	Demand (MWh)		Error	Cost ($M)		Error
Load	($/kWh)	Actual	Fitted	(%)	Actual	Fitted	($/kWh)
Regulated	42.6	3,841	3,841	0.01	171	171	0.03
	21.5	*908*	*893*	*4.45*	*112*	*110*	*1.96*
Nonregulated	42.6	1,689	1,689	0.02	75	74	-0.09
	21.5	*275*	*251*	*6.89*	*46*	*45*	*3.42*
Total	42.6	5,530	5,530	0.01	246	245	0.03
	21.5	*1,062*	*1,033*	*4.39*	*155*	*153*	*2.00*

Note: Hourly mean and *standard deviation* for the period 1 Jan 2002 to 31 May 2007. Price and cost are in January 2007 Colombian pesos. Cost is based on spot price. Hourly demand estimate based on fixed effects model controlling for month, day of week, and hour of day. Linear growth term is also included.

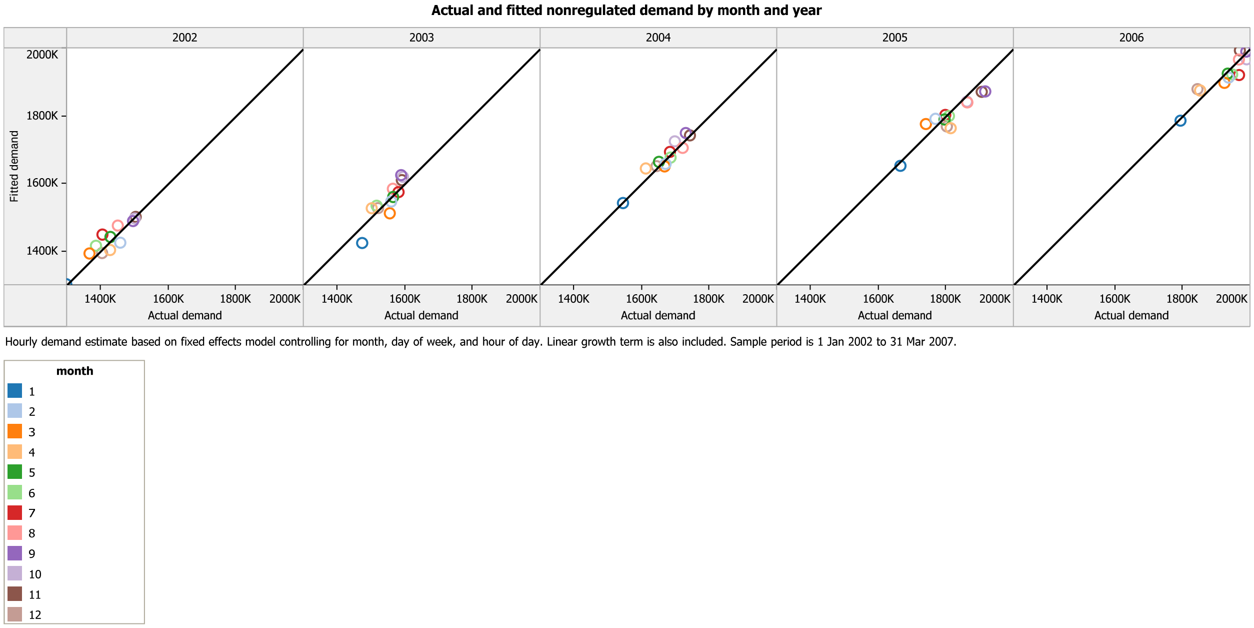
Figure 20. Actual and fitted regulated demand by month and year



Hourly demand estimate based on fixed effects model controlling for month, day of week, and hour of day. Linear growth term is also included. Sample period is 1 Jan 2002 to 31 Mar 2007.

Of course both consumers and suppliers are more interested in monthly or even yearly cash flows, so it makes sense to aggregate the hourly data over longer time periods. Figure 20 shows the actual and fitted regulated demand by year and month. Each circle represents the data for a particular month and year. If the actual and fitted values are equal for the month (zero error), the circle will lie on the 45 degree line.

Figure 21. Actual and fitted nonregulated demand by month and year



Hourly demand estimate based on fixed effects model controlling for month, day of week, and hour of day. Linear growth term is also included. Sample period is 1 Jan 2002 to 31 Mar 2007.

Figure 21 shows the actual and fitted nonregulated demand by year and month. Again each circle represents the data for a particular month and year. If the actual and fitted values are equal for the month (zero error), the circle will lie on the 45 degree line.

Figure 22. Error in demand estimates for regulated and nonregulated load by year

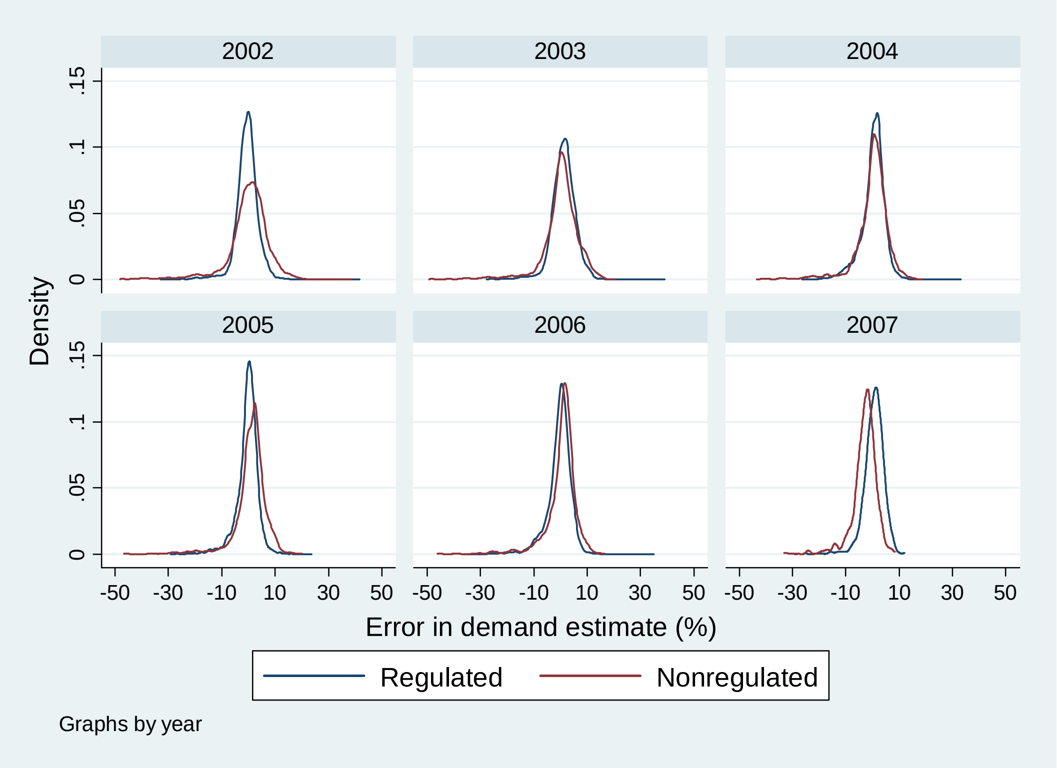


Figure 22 shows the kernel density of the error in the hourly demand estimate for both regulated and nonregulated customers. It is clear that the error is approximately normally distributed.

Figure 23. Cost of demand error for regulated and nonregulated load by year

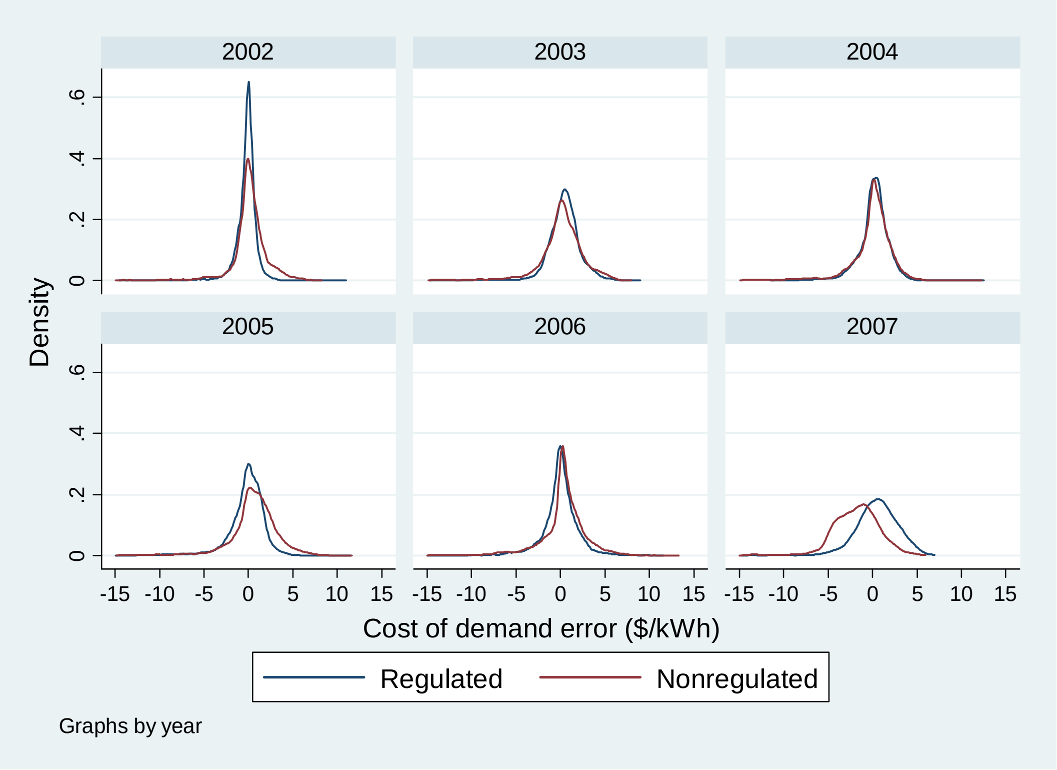
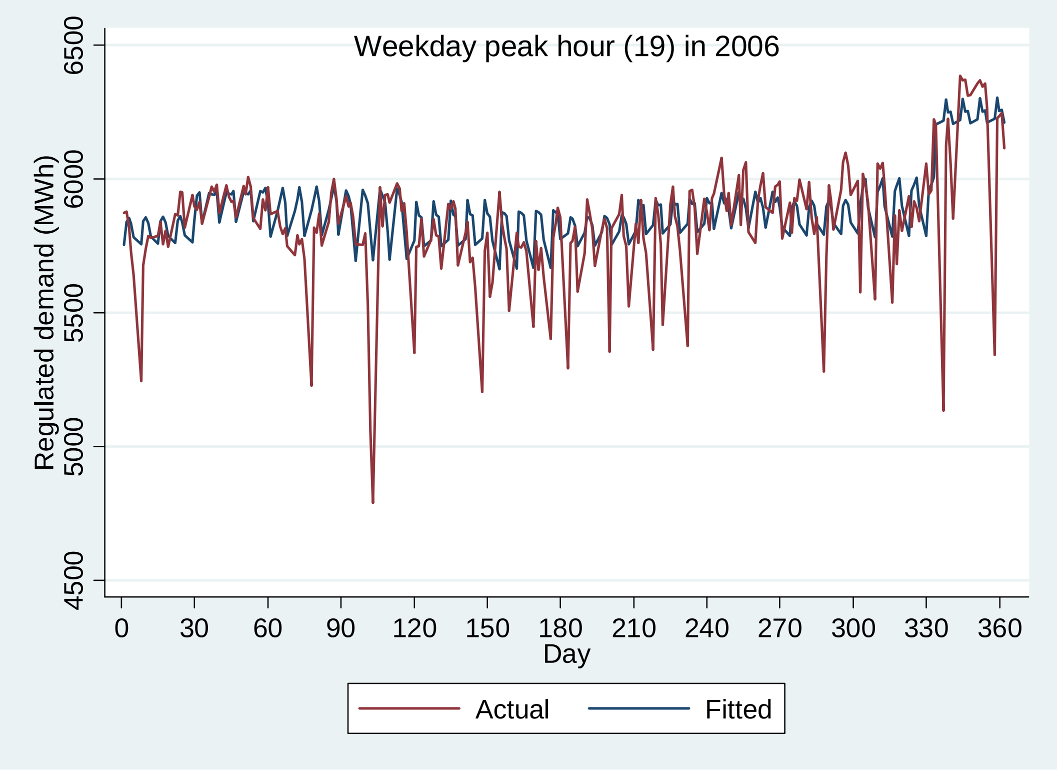


Figure 23 shows the kernel density of the error in the hourly cost estimate for both regulated and nonregulated customers. Again the errors are approximately normally distributed.

Figure 24. Actual and fitted regulated demand in weekday peak hour for 2006



Finally, I look in detail at the hourly data for a particular year and customer group. This is useful in identifying where the model error is coming from. Figure 24 shows the actual and fitted regulated demand for a peak hour (hour 19) for each weekday of the year. There are 9 days in which the error exceeds 10%, and in all cases the actual is more than 10% less than the fitted value, suggesting that these are holidays that I did not control for.

Figure 25. Actual and fitted nonregulated demand in weekday peak hour for 2006

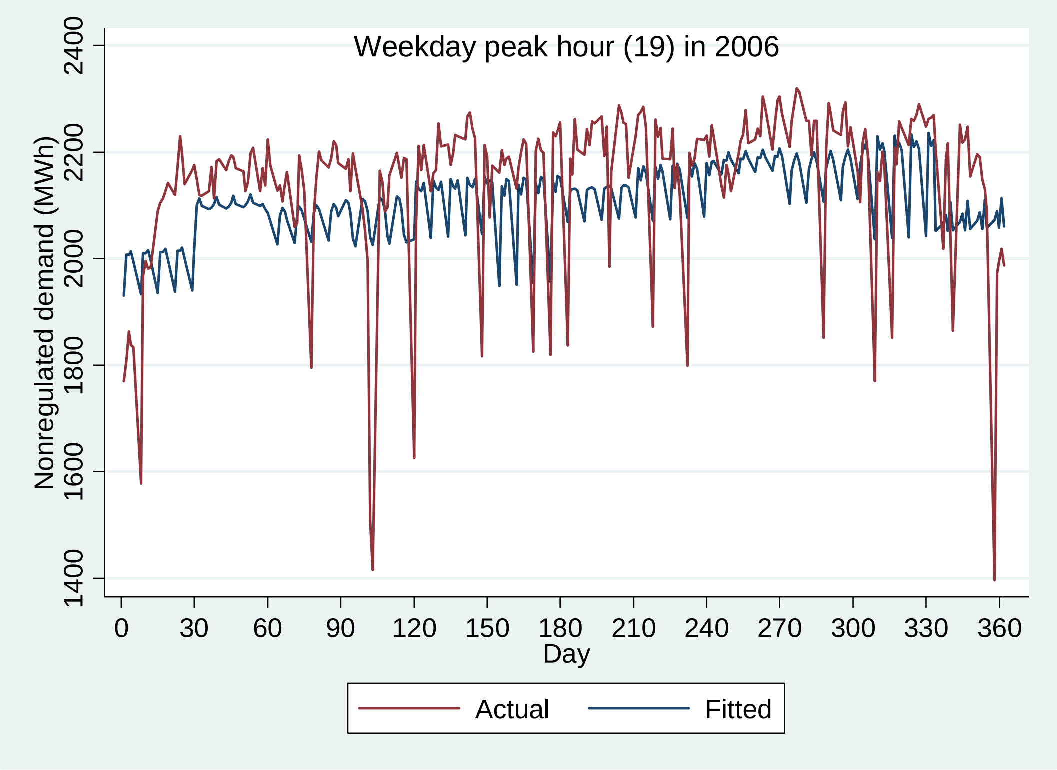
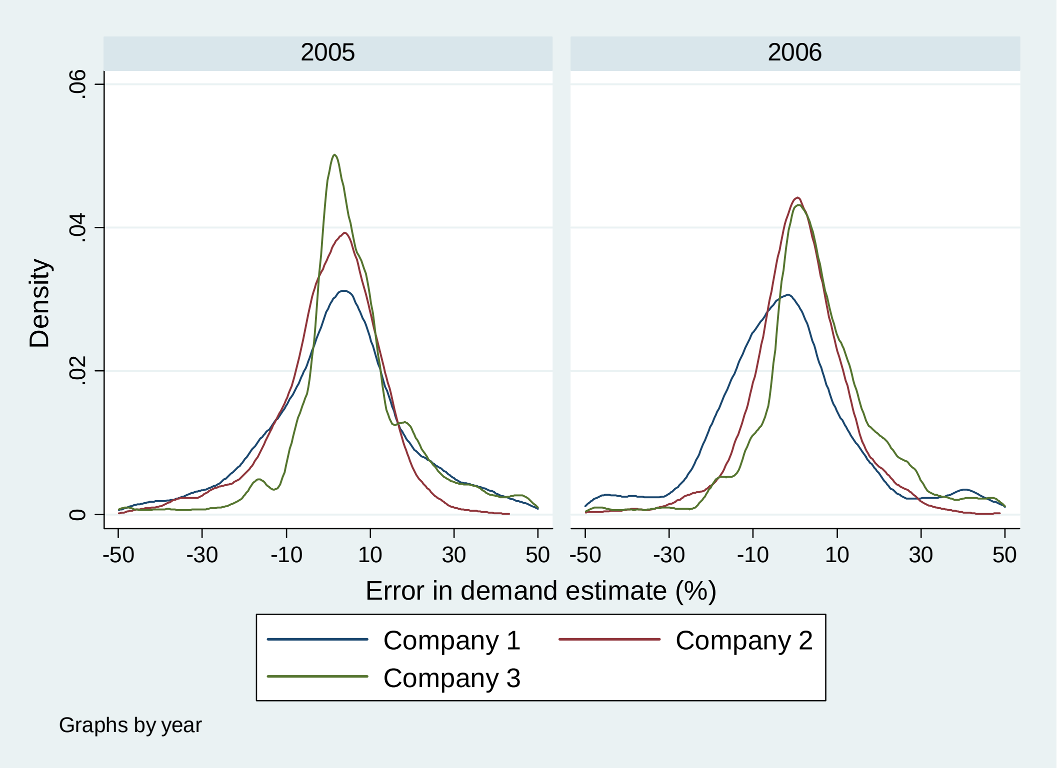


Figure 25 shows the actual and fitted nonregulated demand for a peak hour (hour 19) for each weekday of the year. For nonregulated load, there are about 15 days with large errors (about 20%). Again in each of these days, the actual is much less than the fitted, suggesting that the model is simply missing a number of holidays.

Figure 26. Error in demand estimates for three nonregulated customers by year



For the regulated customers, it makes sense to aggregate across all regulated customers, as I have done above. However, for nonregulated customers, such an aggregation makes senses for suppliers, since each supplier is serving the aggregate nonregulated demand. However, the individual nonregulated customer cares about its individual demand forecast and error. To explore, the individual customer forecast, I have applied the same model to individual nonregulated customers, using the most recent two years of data (2005 and 2006). Figure 26 shows the kernel density of the hourly error in the demand estimate for three companies selected at random. Again normal error is a reasonable approximation.

Figure 27. Cost of demand error for three nonregulated customers by year

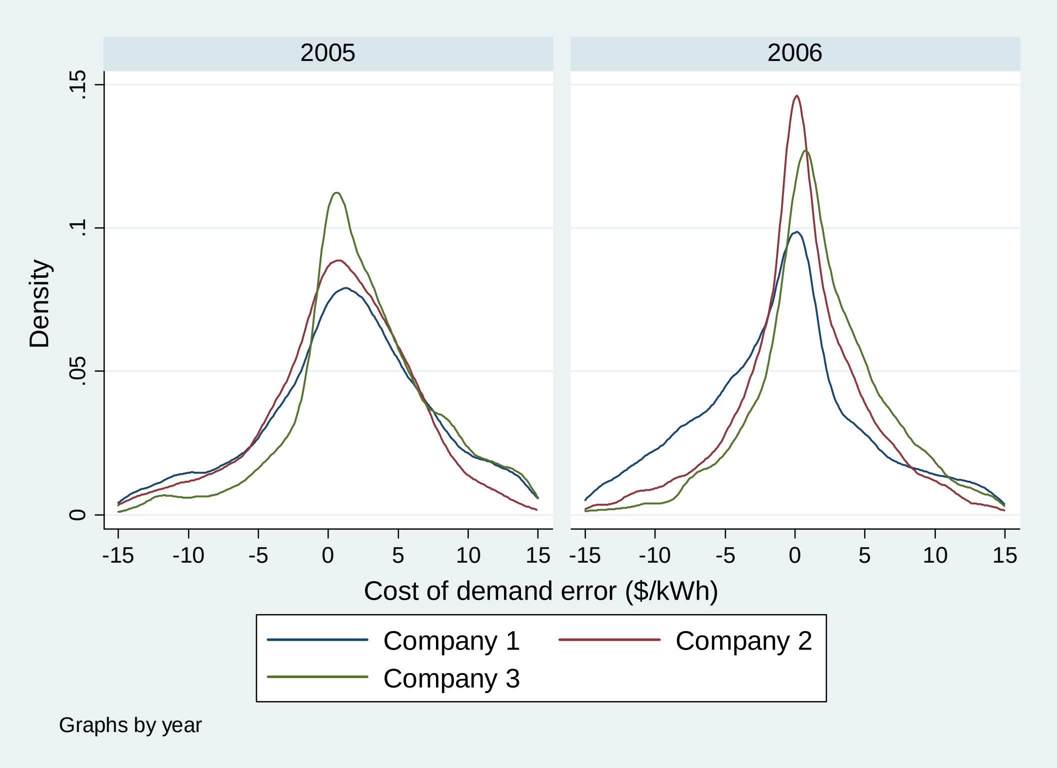
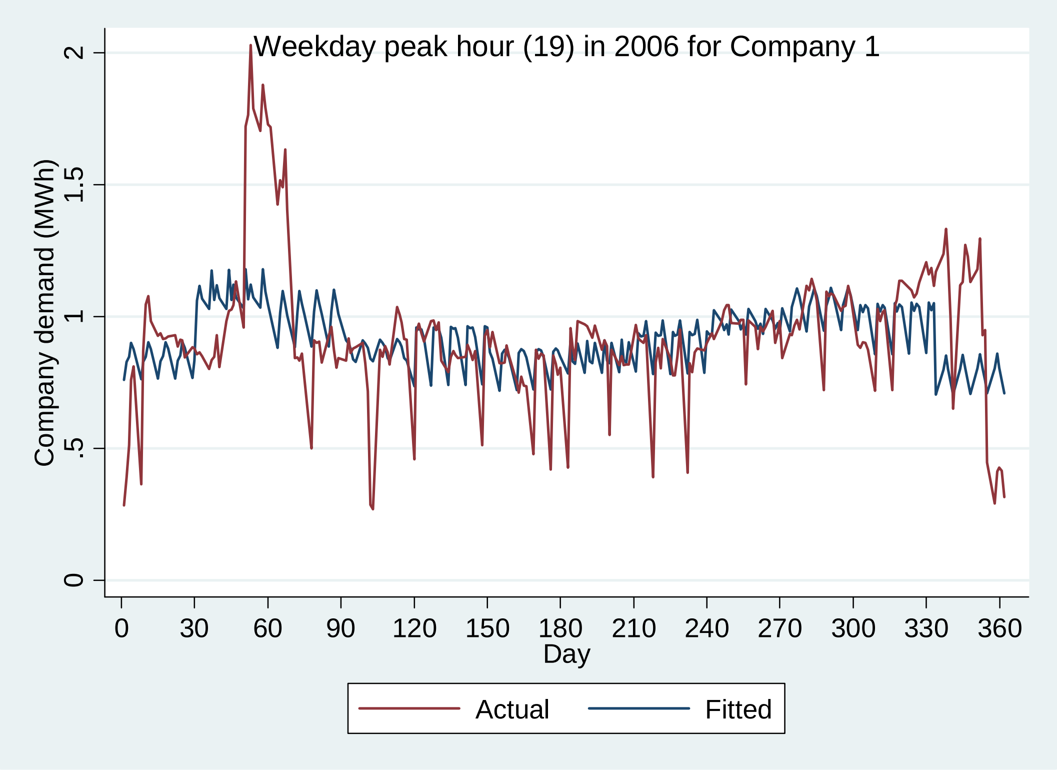


Figure 27 shows the kernel density of the error in the cost estimate for the same three companies.

Figure 28. Actual and fitted Company 1 demand in weekday peak hour for 2006



Finally, Figure 28 shows the actual and fitted demand for Company 1 during a weekday peak hour (hour 19) throughout 2006. There are about a dozen days in which the actual is well below the fitted suggestion holidays. In addition, there is an extended period in the end of February and early March in which Company 1's demand is well above the fitted demand.

The Appendix includes numerous other figures that show other companies and other hours.

6.7 Industry questions on auction design

Efficient price formation requires active participation of the buyers, so the price should not be defined completely by the sellers. For that reason shouldn't a double auction be used?

Indeed, the nonregulated consumers do actively participate on the buy side of the market through their submission of demand curves before the clock auction starts. Regulated consumers do not participate actively, but through an administrative demand curve set by the regulator. Nonetheless, the simultaneous descending clock auction is such that both clearing prices are effectively determined from the market decisions of the suppliers and the nonregulated demand.

Given that supplier participation is voluntary, is it possible that in one of the eight auctions some sellers will not participate, generating inefficiencies in the price formation.

It is possible, but unlikely, provided supply in Colombia is competitive. The absence of one or more large suppliers from an auction will increase the clearing price in that particular auction. This price reaction is precisely what motivates the supplier to show up. It is the missed auctions that are likely to have the highest prices and provide the supplier its best opportunity to sell its energy.

How are the bid decrements determined in the clock auction? Is this done at the discretion of the auctioneer, or should the regulation define some criteria?

Bid decrements are established by the auctioneer following best practice for high-stake clock auctions. There is now a great deal of experience with setting bid decrements in clock auctions. Before the auction, bidders will be given some broad guidance on bid decrement policy, but it is not necessary and is generally undesirable to set a specific formula for bid decrements. As a general matter, bid decrements are larger when there is greater excess demand.

Do the bid decrements impact the offers from the suppliers?

The primary impact of the bid decrements is determining how quickly the suppliers express their supply preferences (their supply curve) and how much time the suppliers are given to adjust their supply curves in response to market information revealed during the clock auction. Smaller decrements give the supplier additional time to react to market information. In general, the pace of the auction should balance the value of price discovery with the higher transaction costs of a longer auction.

Does the administrative demand curve for the regulated product vary from auction to auction?

The vertical portion of the demand curve is fixed in every auction, with the exception that the target in subsequent auctions shifts to the right if the target is not purchased in the prior primary auction. The sloped portions of the demand curve are adjusted on an auction-by-auction basis according to market conditions and best practice.

Can a seller that has not offered since the first round enter to sell in subsequent rounds?

No. The seller must submit an offer in every round. Further, the supplier's aggregate supply must be weakly upward sloping. That is, the supplier can only maintain or decrease its aggregate quantity as prices decline.

Regarding the secondary market, is it centralized or bilateral? How does the secondary market work in general terms?

The secondary market is both centralized and bilateral. First, suppliers, nonregulated customers, and their agents are free to negotiate any bilateral contracts they find advantageous. Second, there is an organized secondary market, so that market participants can trade the primary products and certain derivatives of the primary products, such as monthly slices. The secondary market is organized as a clearing-price auction (uniform-price double auction).

Is the offer curve in each round reported to the auctioneer?

The offer curve is communicated over the secure auction system. At the end of each round, the offer curves are reported to the auctioneer. However, only the aggregate supply, summing over all bidders, is reported to the bidders.

What happens to a buyer in the auction (an LSE) when the supply resource is out on maintenance (planned or not) or the plant does not comply with its commitment, for any *reason? Should the LSE buy in the spot market? Or should the LSE buy in a new primary auction? Or should the LSE buy in the secondary market?*

The supplier has an obligation to perform. Short-run deviations are settled in the spot energy market; that is, the supplier buys energy in the spot market to make up its shortfall. For a longer supply problem, the supplier could procure energy in the organized secondary market or through bilateral contract. Long-term shortages, can be addressed in the primary auctions.

Please provide a more detailed explanation of exactly how the auction will work.

Further details of the auction including detailed auction rules will be provided as part of the auction implementation. Participants will have ample time to study and ask questions about the detailed rules. In addition, bidder training and a mock auction will be conducted to further acquaint the bidders with the mechanics of the auction system.

Please describe the various roles in the auction—CREG, the Auctioneer, the Auction Advisor, the Auction Monitor, and the Bidders.

As regulator, CREG establishes the general market rules and regulations including the administrative demand curve for regulated consumers.

As the Auctioneer, XM establishes the detailed auction rules and implements those rules through a suitable auction system.

It makes sense for XM to contract for an Auction Advisor, who can helps XM conduct the auction by providing expert auction advice, and any auction software and hardware as required.

The Auction Monitor observes the auction and confirms that it is conducted consistent with the auction rules.

There are several types of bidders:

1. Regulated customers are passive participants. Their preferences are represented by CREG's administrative demand curve.
2. Nonregulated customers are active participants. Through an authorized agent, each nonregulated customer submits its demand curve before the clock auction starts. In the organized secondary market, nonregulated customers can submit additional demand bids or supply offers to balance positions.
3. Suppliers are active participants. Either directly or through an authorized agent, each supplier submits its supply curve during the descending clock auction. In the organized secondary market, suppliers can submit additional supply offers or demand bids to balance positions.
4. LSEs act on behalf of either suppliers or nonregulated customers. As authorized, an LSE can submit demand bids or supply offers in either the primary auctions or the organized secondary market.

Why will having two simultaneous auctions, instead of two auctions at different times, be the most efficient method of establishing final prices?

A single simultaneous auction enables suppliers to substitute between the two products throughout the clock auction. This facilitates price discovery and leads to efficient market pricing. In particular, any price difference between the regulated and nonregulated products is the proper reflection of the different costs of supplying the two products.

In contrast, if the products were sold in sequence, then arbitrage between the two products would be more limited, and the bidders would have to speculate about the likely price of the product sold in the later auction.

Will bilateral contracts among agents be allowed?

Yes. Bilateral contracts are allowed between any suppliers and nonregulated customers. However, bilateral contracts are not allowed between regulated customers and suppliers. This restriction prevents self-dealing between a supplier and its affiliate LSE.

If the energy purchased in an auction for the regulated market is lower than the target demand will the remaining demand be purchased in the next auction?

Yes, the next primary auction. If the target is not procured in the last primary auction, then any residual is purchased in the spot energy market.

What is the time between rounds? Is it defined by the auctioneer during the auction?

Rounds last between 2 hours and 20 minutes. Typically, the early rounds tend to be conducted more slowly. As the bidders gain experience the rounds can occur more quickly.

More generally, the pace of the auction is managed by the auctioneer to facilitate as much response to market information as possible, but at the same time to limit transaction cost by concluding the auction in a limited time. I anticipate that the first auction will conclude in two days. As bidders gain experience it will be possible to conclude auctions in a single day and about eight rounds. The advantage of concluding in one day is that then the bidders are not forced to hold an open position over night.

In the simultaneous auction, is it possible for one of the products, say the regulated product, to close before the nonregulated product?

No. Both products close at the same time. Until both products clear and the auction ends, the bidders can switch quantity from one product to the other.

For a bidder, must both the regulated and nonregulated supply curves be weakly upward sloping, or is it sufficient for the bidder's aggregate supply curve to be weakly upward sloping?

Only the bidder's aggregate supply curve needs to be upward sloping. This allows the supplier to switch from one product to the other.

Is there a more objective method to determining the administrative demand curve?

Unfortunately, the upper part of the administrative demand curve is somewhat arbitrary. This is unavoidable. The diminishing demand at higher prices reflects the reality that an optimizing buyer would want to shift demand to a later auction if the current auction price is too high. I recommend that the point of initial slope be set sufficiently high that there is only about a 1 in 10 chance of the clearing price being above this point; that is, there is a 9 in 10 chance that the clearing price will be in the vertical portion of the demand curve.

What happens if the regulated demand curve does not intersect the supply curve?

The auction fails. This is an extremely unlikely event that only occurs if no supplier is willing to supply any quantity below the highest demand point, where the demand curve intersects the quantity axis. This could only occur if CREG grossly misestimates the market price. In the event of auction failure, the auction is rerun with a revised demand curve.

Is it possible to include a cap on the obligation for the regulated product in order to limit supplier quantity risk?

Yes. A cap of about 4% above the forecast regulated load would be reasonable. This would mean that regulated load is fully hedged so long as the load growth is not more than 4% higher than expected. If the load growth is more than 4% of the forecast, then the regulated load purchases the residual on the spot market. In this way, regulated load is substantially hedged, and supplier's quantity risk is bounded by the 4% cap.

If the primary auctions do not cover the total regulated demand, where will the residual be purchased?

The residual quantity will be purchased in the spot market. An advantage of this approach is that the secondary market is entirely about the suppliers balancing their positions. Thus, the secondary market can be designed entirely with the suppliers needs in mind.

We are unsure whether an organized secondary market can meet the specific needs of all the players in the market. Could we start with a bilateral secondary market and, depending on the results, later establish an organized secondary market?

Yes. This would be a reasonable approach. Nonetheless, I still favor a simple secondary market organized by XM as a standard clearing-price auction in which suppliers submit bids and asks to balance forward energy positions as they desire. The market may be thin, but the sealed-bid uniform price auction handles thin markets well. Suppliers can readily protect themselves from a thin market by submitting bids and asks that do not differ too much from the perceived market price.

Will the product in the secondary market be the same as the product in the primary market, differing only in the duration of the contract, or will the secondary market product differ in other ways from the primary market product? Please define the characteristics of the product to be traded in the secondary market.

I recommend that the primary product as well as monthly slices of the primary product be traded in a monthly organized secondary market. However, the particular structure of products in the secondary market should be based largely on input from suppliers.

What is the information policy for the secondary market?

I recommend a sealed-bid clearing-price auction.

7 Transition

Here I describe a simple transition approach.

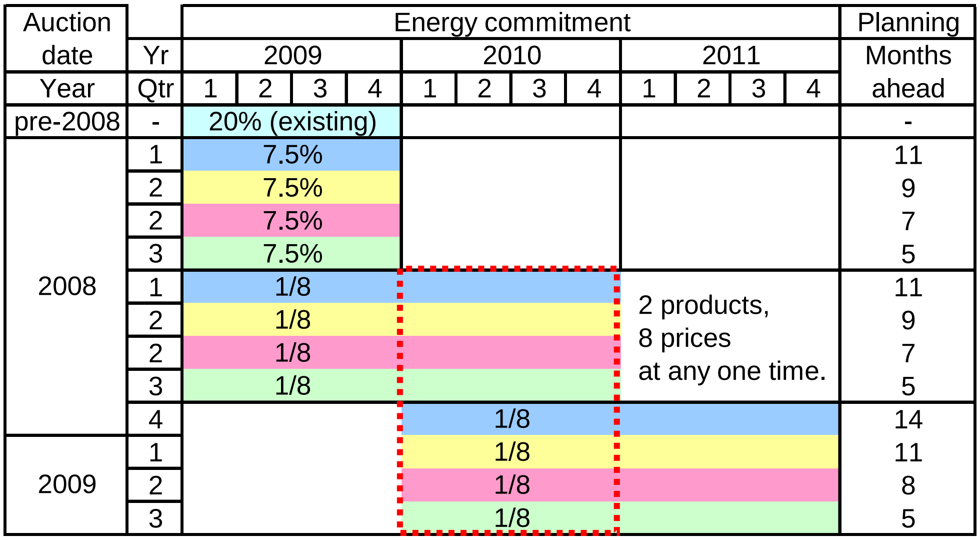
An important first step is a ban on new contracts for 2009 and beyond. For regulated customers, contract cover will come from the forward energy market, beginning 1 January 2009. Coverage for 2009 will be procured in four primary auctions in 2008. New long-term contracts would raise concerns of self-dealing between the LSE and its affiliated supplier. It is best that all new price coverage come from the forward energy market.

I recommend that the first year of auctions, which take place in 2008 for the 2009-2010 commitment period, be the same as the later years, except:

- There is some compression in the auction schedule to accommodate a late start of the quarterly auctions;
- Roughly 30% of load in 2009 is procured as 1-year contracts;
- Roughly 20% of load in 2009 represents existing contracts that will end after 2009.

Figure 29 displays how the transition year (the auction in 2008) is handled. I am assuming that 20% of the load in 2009 remains covered under existing contracts, which will expire at the end of 2009. 50% of the load is procured as 2-year contracts, just as in the steady state. The remaining 30% of the load is procured as 1-year contracts. Notice that the planning periods for the first three "quarterly" auctions are shorter than in the steady state. This assumes that the first auction is conducted three months late.

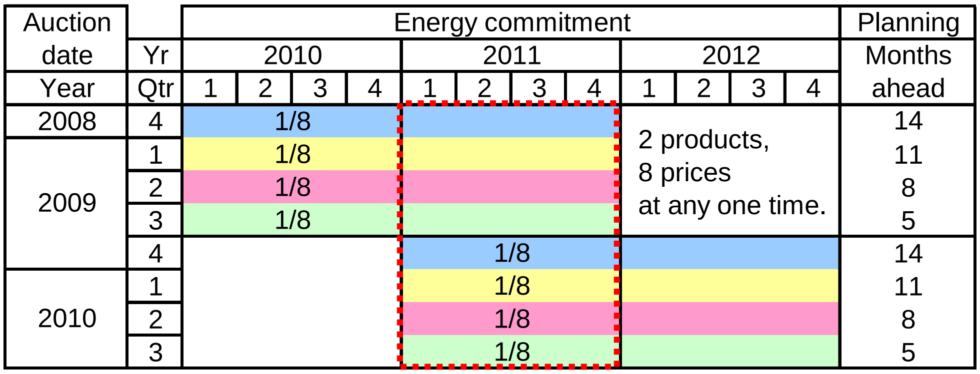
Figure 29. Both 2-year and 1-year procurements in transition year



Auction date		Energy commitment												Planning
	Yr	2009				2010				2011				Months
Year	Qtr	1	2	3	4	1	2	3	4	1	2	3	4	ahead
pre-2008	-	20% (existing)												-
2008	1	7.5%												11
	2	7.5%												9
	2	7.5%												7
	3	7.5%												5
	1	1/8								2 products, 8 prices at any one time.				11
	2	1/8												9
	2	1/8												7
	3	1/8												5
	4					1/8								14
2009	1					1/8								11
	2					1/8								8
	3					1/8								5

An advantage of this approach is that the steady state is reached after only a single transition. Figure 30 shows the steady state for auctions occurring in 2009 and beyond.

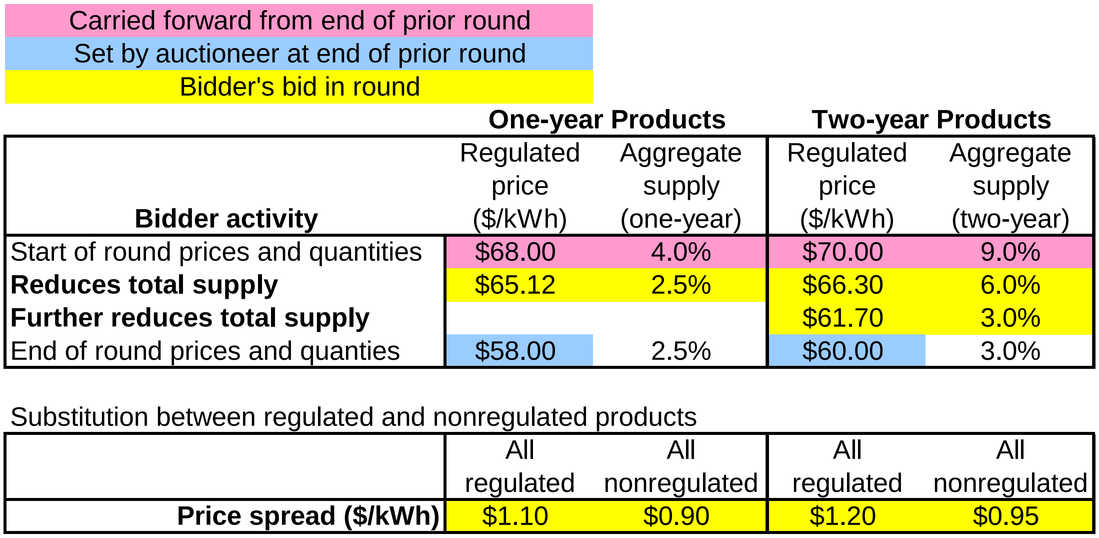
Figure 30. Steady state reached after a one-year transition



Auction		Energy commitment												Planning
date	Yr	2010				2011				2012				Months
Year	Qtr	1	2	3	4	1	2	3	4	1	2	3	4	ahead
2008	4	1/8								2 products, 8 prices at any one time.				14
2009	1	1/8												11
	2	1/8												8
	3	1/8												5
	4					1/8								14
2010	1					1/8								11
	2					1/8								8
	3					1/8								5

For simplicity, the transition year auctions are conducted using the same mechanics as in the non-transition years. The only difference is that there are two product groups (1-year and 2-year), with each product including both the regulated and nonregulated product. Bidding is the same, except now there are two price clocks, one for each product group (1-year and 2-year). Each bidder in each round, separately specifies a weakly upward-sloping supply curve for each product group for all prices between the start of round price and the end of round price. In addition, each bidder specifies its substitution preferences for regulated and nonregulated product within each product group.

Figure 31. Sample offer in transition year



Carried forward from end of prior round
Set by auctioneer at end of prior round
Bidder's bid in round

	One-year Products		Two-year Products	
Bidder activity	Regulated price ($/kWh)	Aggregate supply (one-year)	Regulated price ($/kWh)	Aggregate supply (two-year)
Start of round prices and quantities	$68.00	4.0%	$70.00	9.0%
Reduces total supply	$65.12	2.5%	$66.30	6.0%
Further reduces total supply			$61.70	3.0%
End of round prices and quanties	$58.00	2.5%	$60.00	3.0%

Substitution between regulated and nonregulated products

	All regulated	All nonregulated	All regulated	All nonregulated
Price spread ($/kWh)	$1.10	$0.90	$1.20	$0.95

Figure 31 shows a sample offer in the transition year. It is identical to the offer in the non-transition year, except the supply curve and substitution preferences are stated for each product group. The activity rule—the supply curve must be weakly upward sloping—applies separately for both the one-year product group and the two-year product group. The two product groups close independently, although the auctioneer will adjust the bid decrements in such a way to increase the likelihood that both product groups will clear in the same round. This enhances the substitution possibilities across the product groups.

7.1 Industry questions on the transition

How are the auction prices passed through to the final customers in this period?

The settlement during the transition is analogous to the settlement after the transition. Existing bilateral contracts are settled first, then the forward energy market contracts are settled, just as is done after the transition.

Given the fact that existing contracts cover differing portions of the demand from month to month, how can fixed one- or two-year contracts cover the remaining demand for each and every month of the transition period?

The two-year contracts cover 50% of load. The one-year contracts cover the remaining 50% less all the existing contracts on a month-by-month basis. This simple approach would be problematic if there were large month-by-month swings in the quantity of existing contracts, but in fact given the dominance of calendar year contracts, the month-by-month quantity changes are not too large.

What determines the order of settlement of existing and MOR contracts?

Existing contracts are settled first and then the MOR contracts.

In order to reduce demand risk, is it necessary to restrict the movement of customers between regulated and nonregulated markets?

Yes. Movement is one way: from regulated to nonregulated. A regulated customer can switch after acquiring an hourly meter, which is necessary for the hour-by-hour settlement.

Is it necessary to ban new bilateral contracts for regulated customers before the auction or can the ban wait until after the first auction?

Yes. It is important to ban bilateral contracts for the regulated customers to avoid the self-dealing problem inherent between an LSE and its generation affiliate.

8 International experience

The approach proposed here for the forward energy market is consistent with best-practice in the U.S. and elsewhere. Indeed, it improves upon it in important respects. Most importantly, the integration of the regulated and nonregulated markets will lead to greater liquidity, improved price formation, and lower transaction costs. All of the markets of which I am aware use a load-following product similar to what I have proposed. The product has worked well. Informal secondary markets appeared both before and after the auctions, enabling suppliers to balance positions in response to changed circumstance. I propose a formal secondary market to further support trading to balance positions.

The worst approach I am familiar with is in my own state of Maryland.[5] Maryland procured multiple years of load all at a single time through an RFP process organized by each EDC. As fate would have it, the time of purchase coincided with the peak of a large gas price rise. As a result, the Maryland process resulted in large rate increases for residential customers. This problem is avoided in the five acceptable options described above.

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[5] See http://www.psc.state.md.us/psc/electric/SOSRFP.htm.

New Jersey has had the longest and most successful procurement program.[6] The program has procured energy for regulated customers for five years, since 2002, through an annual auction. Initially, contracts were for one year, but after the first auction, 3-year contracts were introduced. In the second year (2003), 67% were 1-year contracts and 33% were 3-year contracts; in 2004, the split between 1-year and 3-year was 50-50. Now 100% of load is purchased in rolling 3-year contracts. The one complaint I hear from participants is that it would be better to have more frequent auctions. It is partly for this reason that I am recommending quarterly auctions.

Despite the fact that the New Jersey market is highly concentrated—the largest supplier has about 50% of the capacity—prices have been remarkably competitive. Part of the answer is that substantial imports are possible from outside New Jersey. As of now, market power appears to remain an unrealized concern.

Illinois adopted a program nearly identical to New Jersey for its two largest LSEs.[7] So far, they have had only a single auction. The auction outcome appeared to be competitive, despite a market structure that is worse than in Colombia. Unfortunately, like Maryland, the first auction was held at a time of high gas prices, so rates increased, causing some political problems. However, the problems were modest compared with the fire-storm created in Maryland.

In France, my colleagues and I have been conducting large “virtual power plant” auctions for EDF as part of EDF’s virtual divestiture program to address market power issues.[8] These are auctions to *sell* energy, rather than *buy*, but the experience is still relevant. These auctions are quarterly and involve multiple durations. The quarterly auctions have performed well compared with industry benchmarks.

Spain has recently conducted its first quarterly energy auction for regulated customers.[9] A descending clock auction was used. Although the process was rushed in the end, the first auction was completed successfully on 19 June 2007. In total, 21 companies won supply contracts covering 6.5 GW at a clearing price of €46.27/MWh.

It is my view that the market design presented here is consistent with, and indeed improves upon, the best practices elsewhere.

9 Conclusion

The forward energy market promises to reduce transaction costs and enhance competition for regulated and nonregulated customers. I have proposed a product design and an auction design that will achieve all of the main objectives of the market.

Most importantly, the market is based upon a two load-following products, one for regulated customers and one for nonregulated customers. Suppliers bid to supply a share of the regulated load and a share of the nonregulated load—aggregated across all LSEs. This simple approach

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[6] See http://www.bgs-auction.com/.

[7] See http://www.illinois-auction.com/index.cfm?fa=hm.home.

[8] See http://www.edf.com/345i/Home-fr/Capacity-auctions.html.

[9] See http://www.subasta-cesur.eu/Auction.asp?selectedTab=announcements&language=english.

enhances liquidity and competition, since all suppliers are competing for and trading in the same two products.

Since regulated customers are procuring 100% of the regulated load, these customers are fully-hedged from the spot price. Similarly, suppliers are able to lock in a long-term price to stabilize their revenues.

Several options were discussed for the timing and frequency of auctions, and the duration of contracts. After studying the options and various tradeoffs, I recommend quarterly auctions of 2-year contracts, rolling on an annual basis. This approach is simple and yet provides substantial time diversification. It enables suppliers and customers—both regulated and nonregulated—to best manage price and credit risks and minimize transaction costs.

Including nonregulated customers in the centralized market has two important advantages. First, substitution between the regulated and nonregulated products assures that both customer classes pay market-based rates for electricity. And second, the demand response of nonregulated customers in the forward energy market helps protect both nonregulated and regulated customers from supplier market power, and reduces the importance of the administrative demand curve in determining prices. In the vast majority of auctions, it is competition among suppliers and the competitive choices of the nonregulated customers that determine the auction clearing prices.

The product is fully consistent with, and indeed complementary to, the other key elements in the Colombian market: the spot energy market and the firm energy market. The firm energy market together with the forward energy market put suppliers in a nearly balanced position in the spot market. Not only does this reduce risk for both sides of the market, it greatly mitigates incentives to exercise market power in the spot market. Thus, I anticipate that the forward energy market will not only solve problems in the contracting market, but will improve the performance of the spot energy market. Both the electricity industry and its customers will benefit from the forward energy market.

Efficient price formation is one of the most important objectives of the forward energy market. The simultaneous descending clock auction is ideally suited to promote efficient price formation. The descending clock auction provides excellent price discovery and enables suppliers to freely arbitrage across the regulated and nonregulated products. This assures that any price difference between the two products is a reflection of cost differences.

My view is that the forward energy market as proposed here will dramatically improve the energy contract market for both regulated and nonregulated customers, and improve the spot market as well.

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Appendix

Figure A1. Actual and fitted regulated demand in weekday shoulder hour for 2006

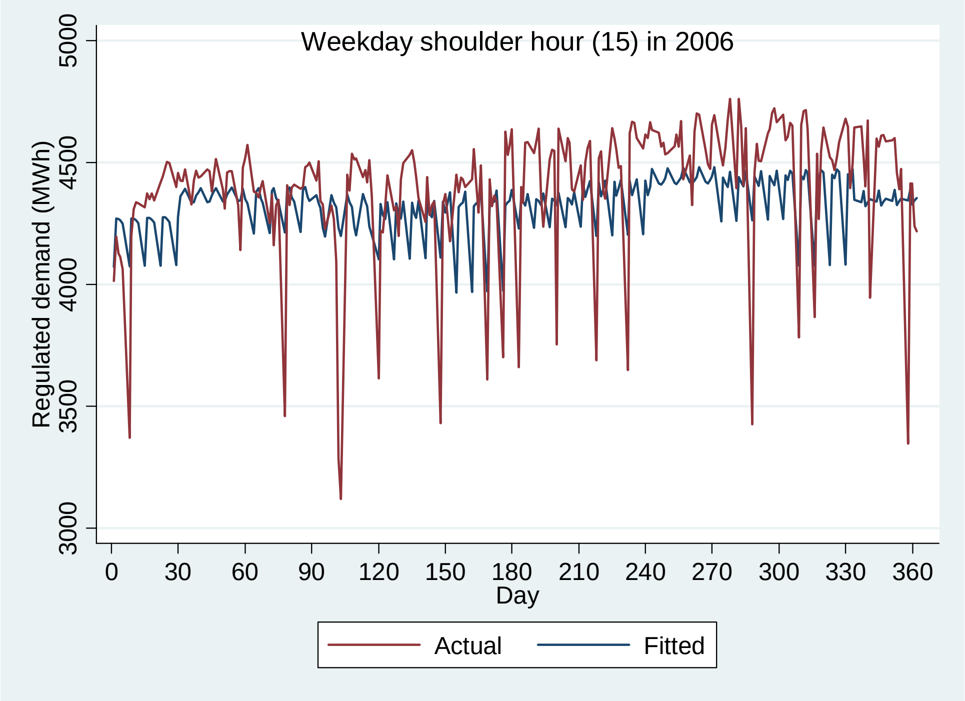

Figure A2. Actual and fitted regulated demand in weekday off peak hour for 2006

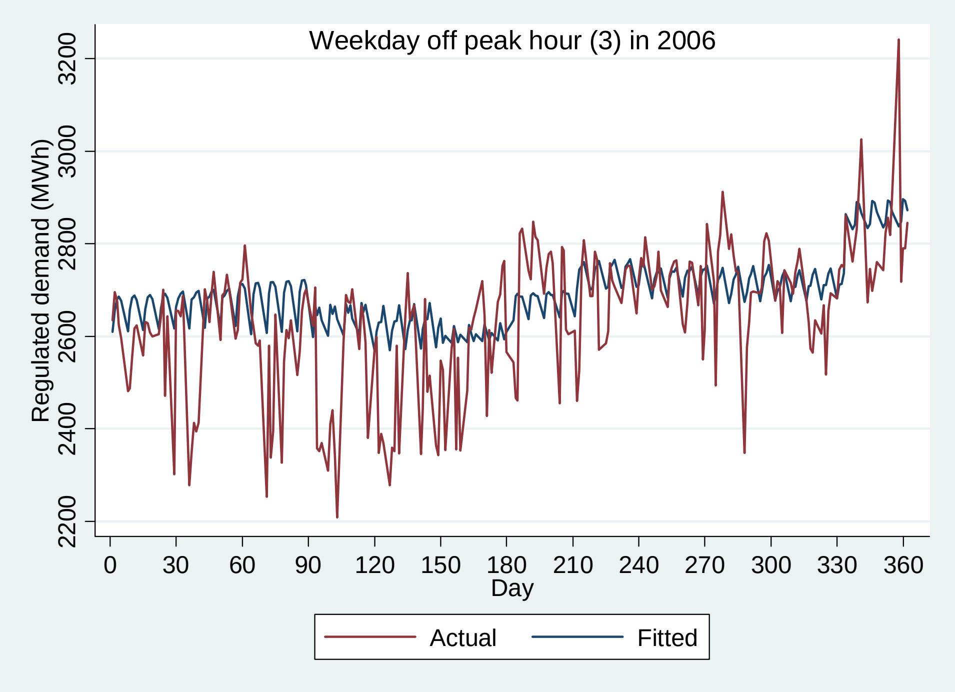

Figure A3. Actual and fitted nonregulated demand in weekday shoulder hour for 2006

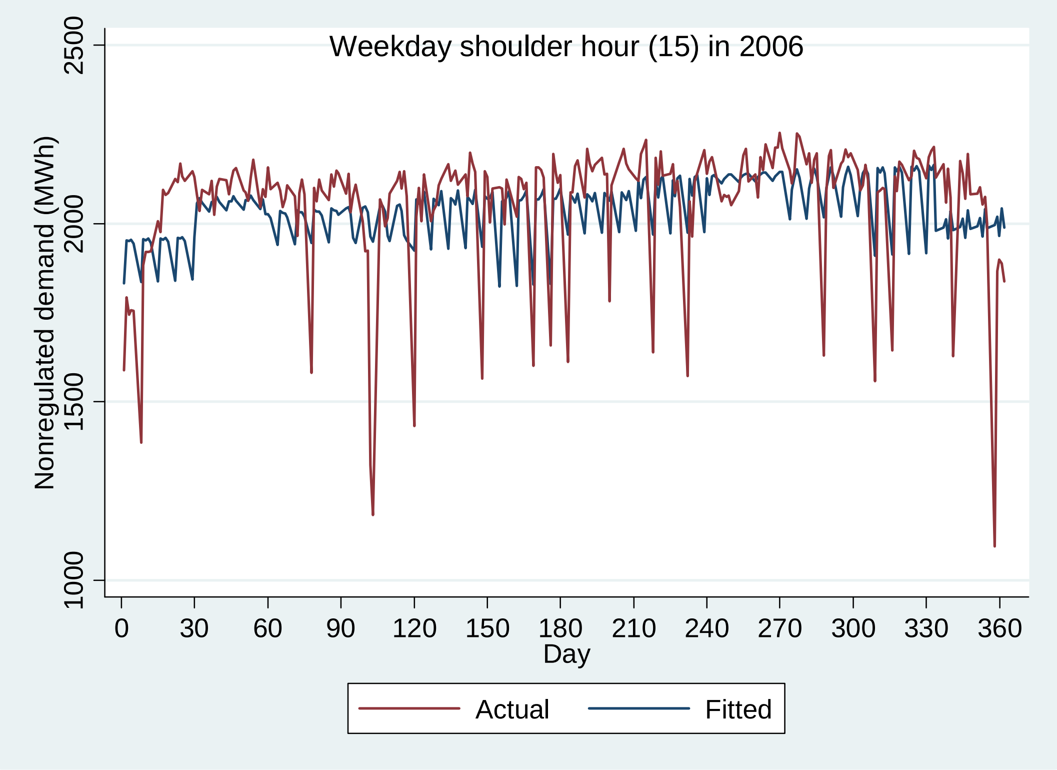

Figure A4. Actual and fitted nonregulated demand in weekday off peak hour for 2006

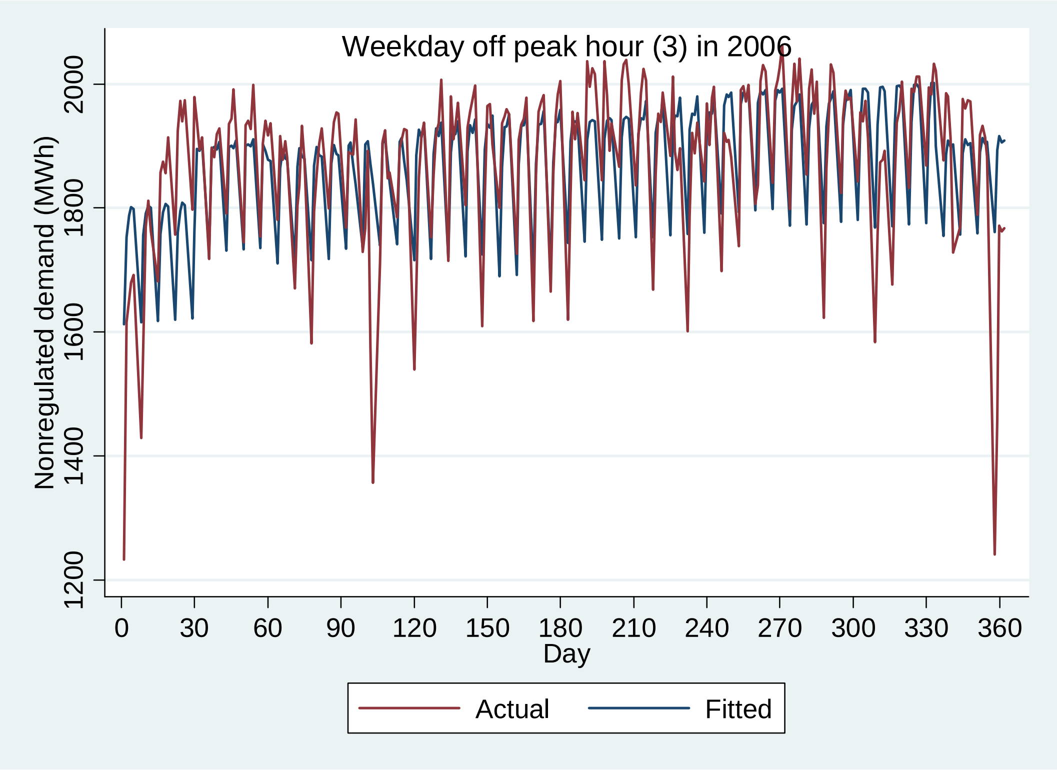

Figure A5. Actual and fitted Company 1 demand in weekday shoulder hour for 2006

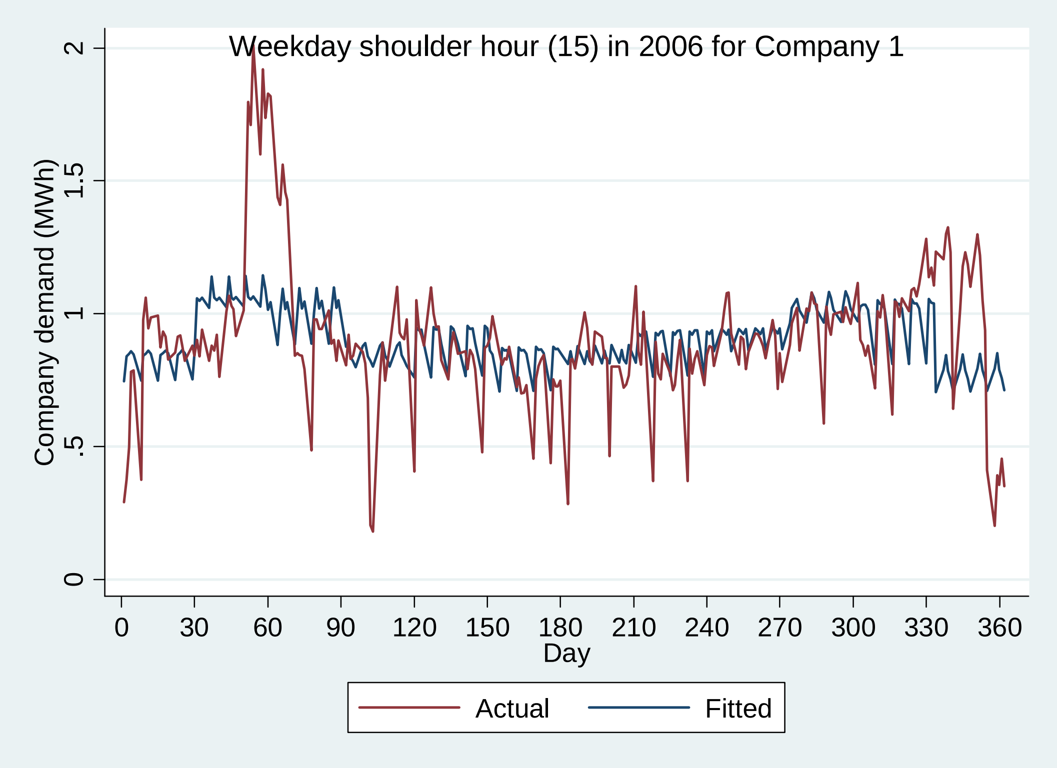

Figure A6. Actual and fitted Company 1 demand in weekday off peak hour for 2006

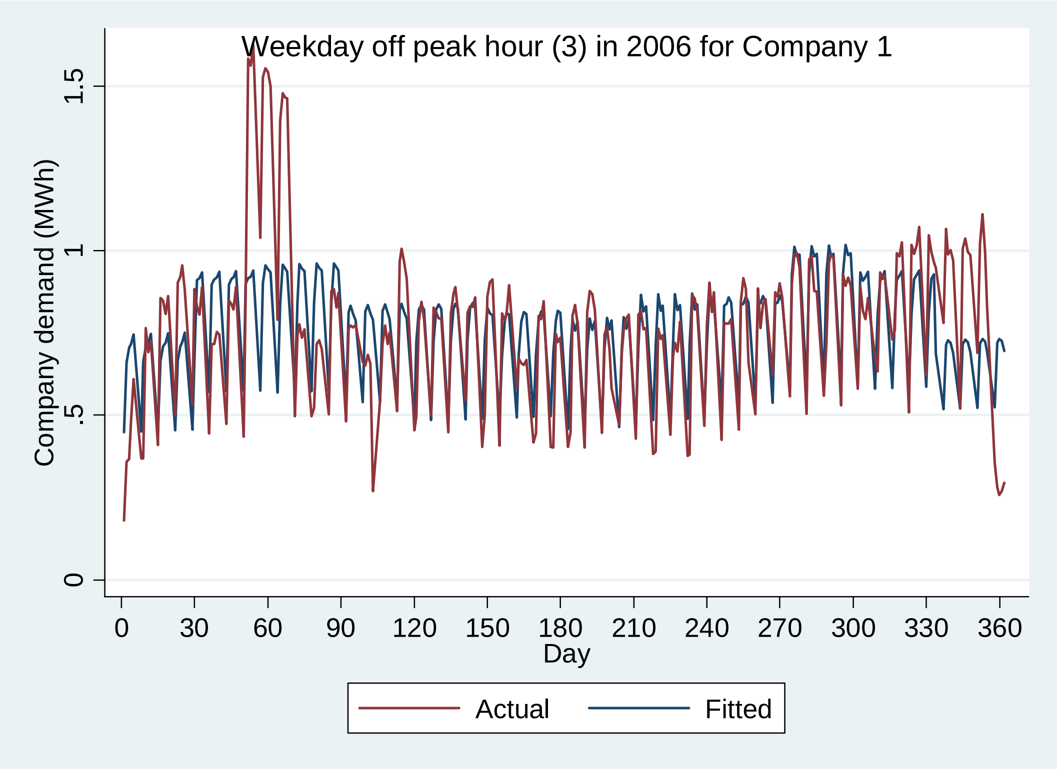

Figure A7. Actual and fitted Company 2 demand in weekday peak hour for 2006

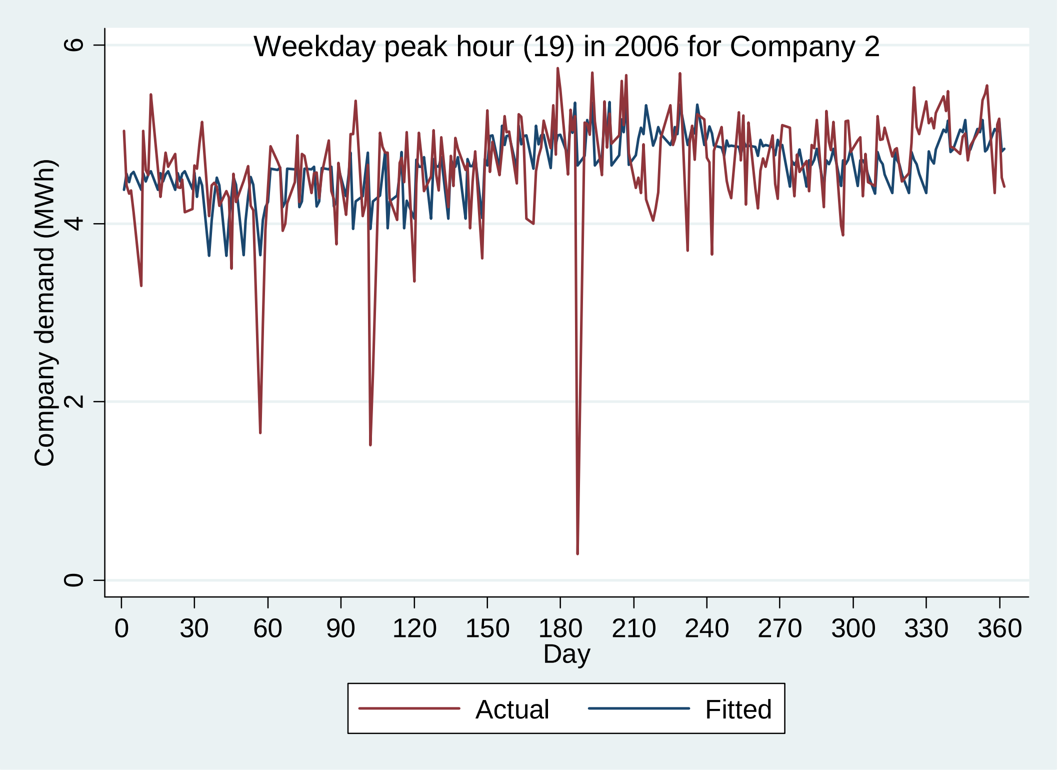

Figure A8. Actual and fitted Company 2 demand in weekday shoulder hour for 2006

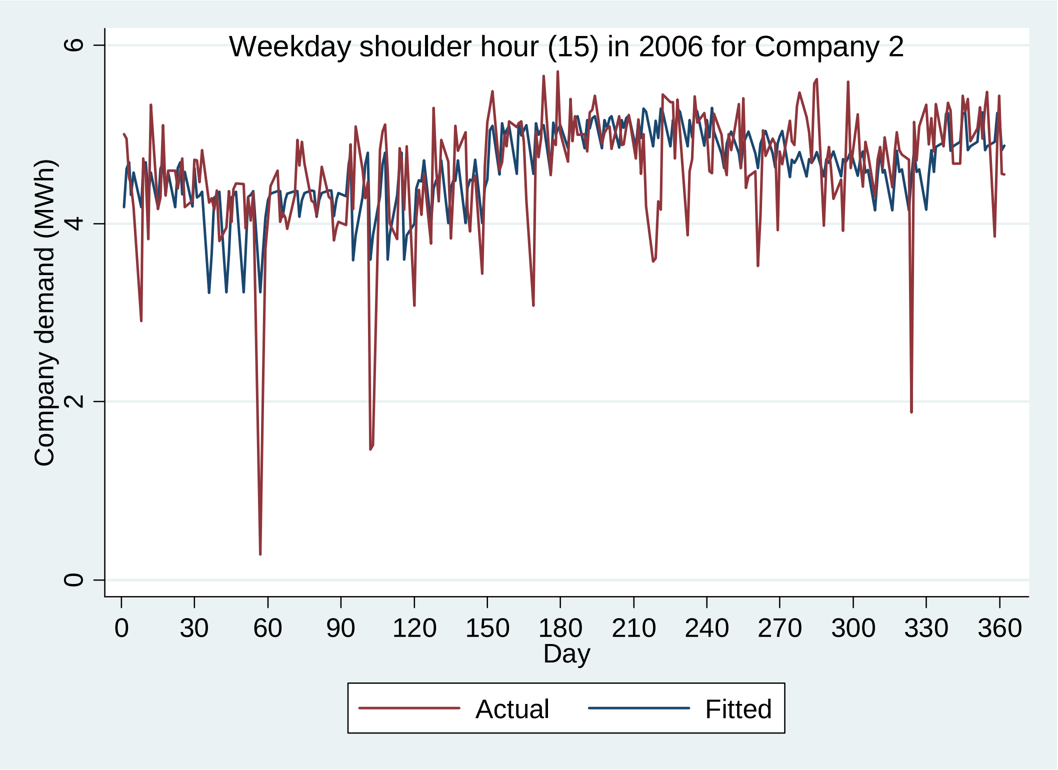

Figure A9. Actual and fitted Company 2 demand in weekday off peak hour for 2006

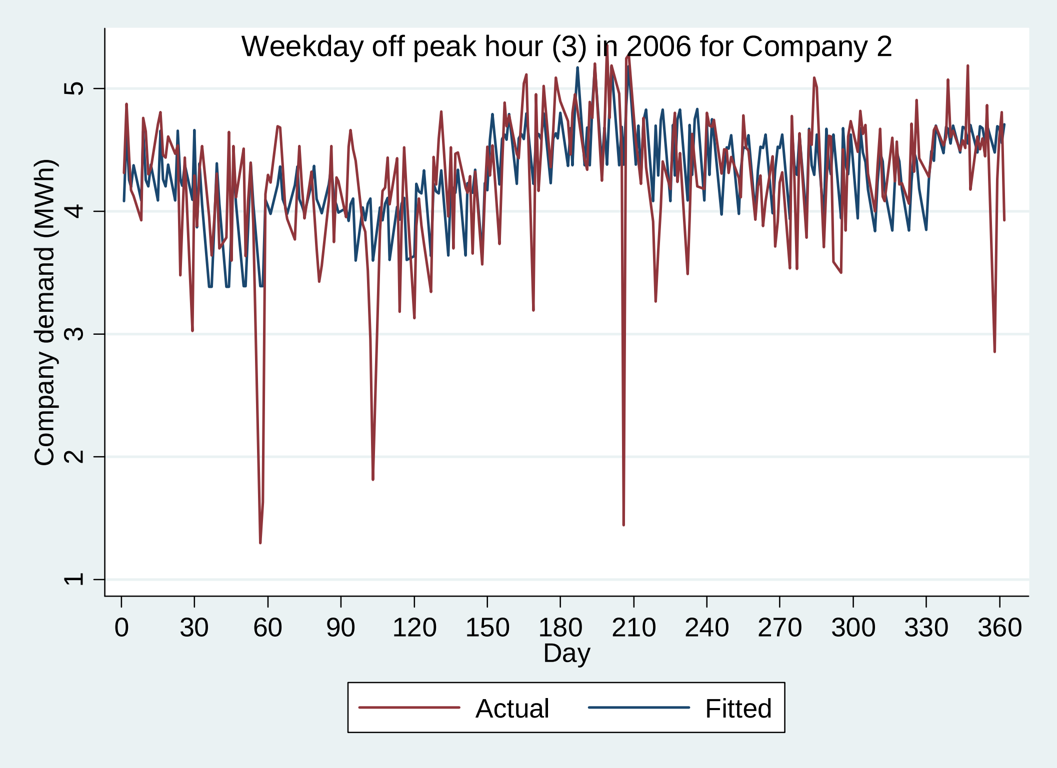

Figure A10. Actual and fitted Company 3 demand in weekday peak hour for 2006

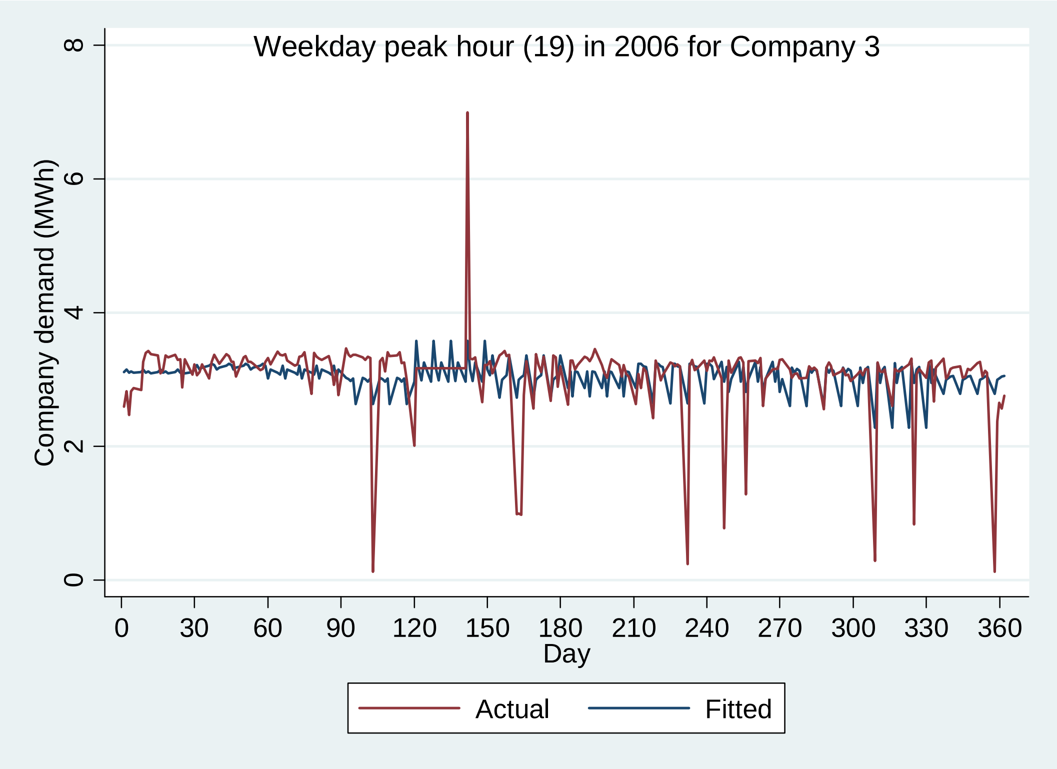

Figure A11. Actual and fitted Company 3 demand in weekday shoulder hour for 2006

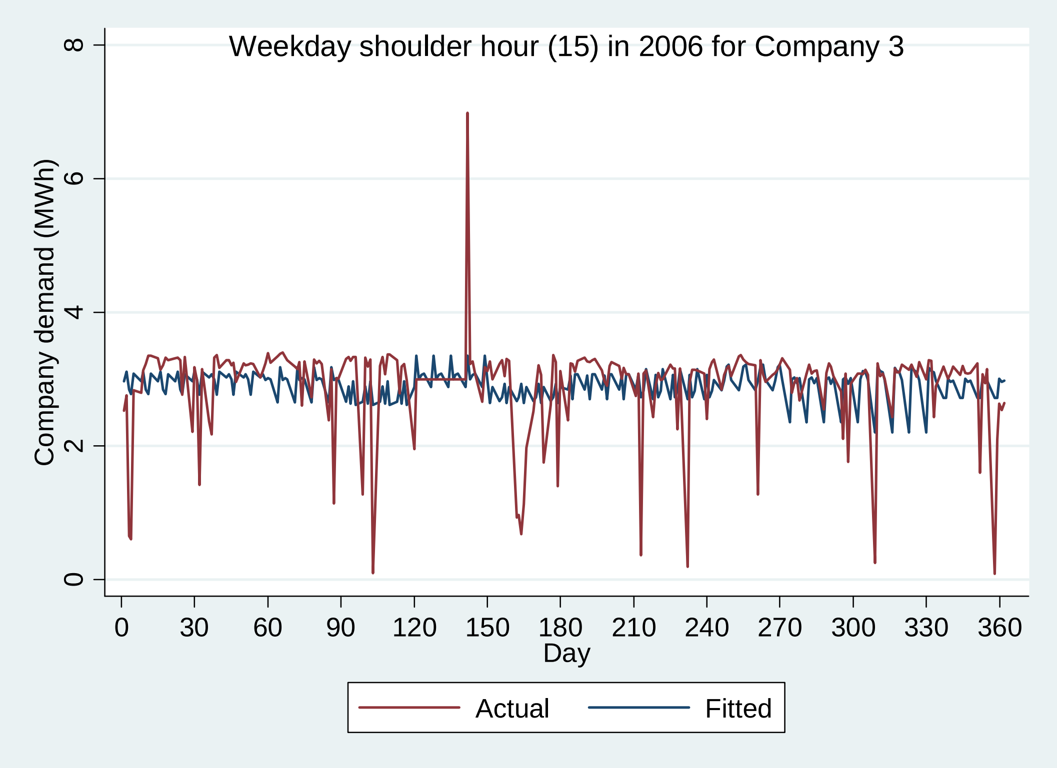

Figure A12. Actual and fitted Company 3 demand in weekday off peak hour for 2006