Three steps to market design

- Product design ➢ Last time
- Auction design ➢ Today
- Transition ➢ July-August
Responses to industry comments

Only the questions are shown here. Written answers are presented in the final version of the product design paper on CREG’s web site.
How will the aggregate demand curve be defined?
Are LSEs allowed to purchase energy in the auction that is not required for final customers?
Because 100% of the demand will be procured in the MOR auction, the LSE will not be required to purchase energy in the spot market for regulated customers. Is that correct?
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?
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.
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)?
The secondary market that may appear as a consequence of the auction will include participation of LSEs or only of generators?
Is it possible that the LSEs, on behalf of the demand, to give up in an auction? Is it convenient to have a reserve price for 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?
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.
In relation to the auction for nonregulated customers, the participating agents should be who define the products according to their own needs.
Efficient price formation requires active participation of the buyers, so the price should not be defined completely by the sellers. For that reason a double auction should be analyzed.
Buying in a single mechanism (MOR) reduces the liquidity of the products and the participation in other alternative markets.
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.
What would happen with deviations in projected demand?
What would happen when a new LSE enters the market? How can it purchase its requirements?
There is a five month planning period in the last quarterly auction. This is considered too short and risky.
Bearing in mind the energy variability of hydropower plants, a couple of agents 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.
The agents who act as suppliers should be limited to generators in order to avoid intermediation costs.
There has been a misunderstanding about the lot size. You have recommended a lot size in the following terms: “say 0.1% of regulated load (6 MW).” This expression has been interpreted as a fixed quantity (6 MW) instead of a percentage of the demand. It will be desirable to clarify this issue.
It will be necessary to establish a methodology to estimate the projected demand.
Product
**Two products, one auction**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Active/Passive Buyers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulated customers (68% of load)</td>
<td>Small customers <em>without</em> hourly meters</td>
<td>Passive</td>
</tr>
<tr>
<td>Nonregulated customers (32% of load)</td>
<td>Large customers <em>with</em> hourly meters</td>
<td>Active</td>
</tr>
</tbody>
</table>
Regulated product: Energy share of regulated load

- Supplier bids for % of regulated load
- Supplier that wins 10% share has an obligation to serve 10% of regulated load in each hour
- Deviations between hourly obligation and supply settled at the spot energy price (or scarcity price if spot is higher)
- Pay as demand contract
Price coverage of regulated customer

Old market

- Bilateral energy contracts and spot market
- Price risk
- Market power
- High transaction costs

New market

- Organized Regulated Market (MOR)
- Full price hedge
- Little market power
- Low transaction costs

Market power

High transaction costs

Bilateral energy contracts and spot market

$0

>$500

$260

>$500

$0

Firm energy market

Full price hedge

Low transaction costs

Organized Regulated Market (MOR)
Price coverage of nonregulated customer

Old market

- Bilateral energy contracts and spot market
- Price risk
- Market power
- High transaction costs

New market

- Full price hedge
- Little market power
- Low transaction costs
- As bid

<table>
<thead>
<tr>
<th></th>
<th>Old market</th>
<th>New market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price coverage</td>
<td>&gt;$500</td>
<td>&gt;$500</td>
</tr>
<tr>
<td>Firm energy market</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Forward energy market</td>
<td>$260</td>
<td>$0</td>
</tr>
</tbody>
</table>
Regulated demand participation

• Participation by LSE is mandatory and passive (no active bidding of demand)
• Regulated customer may decide to become a nonregulated customer
  – Purchase hourly meter
  – Actively participate in auction
• But switch to nonregulated status is permanent (or occurs after sufficient delay)
Nonregulated demand participation

• Nonregulated demand participates in the same auction
  – Single nonregulated product
• Product: *expected* energy, not *actual* energy
  – Hourly, but based on expected energy demand
  – Hedges expected energy demand, but exposes customer to spot price *on the margin*
  – Requires hourly meter (and demand management)
• Participation benefits both regulated and nonregulated customers, as well as suppliers
  – Improved liquidity and price formation
Planning, commitment, and frequency
Conclusion:
2-year contracts, starting in January are most common.
Recommendation:
Quarterly 2-year contracts, annual rolling

<table>
<thead>
<tr>
<th>Auction date</th>
<th>Energy commitment</th>
<th>Planning Months ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yr 2009 2010 2011</td>
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<tr>
<td>Year Qtr</td>
<td>1234 1234 1234</td>
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<tr>
<td>2008</td>
<td>11 11 11 11</td>
<td>14 11 8 5</td>
</tr>
<tr>
<td>2009</td>
<td>11 11 11 11</td>
<td>14 11 8 5</td>
</tr>
</tbody>
</table>

2 products, 8 prices at any one time.
Auction
Descending clock auction

- Same as in firm energy auction, but two substitutable products
- Bidders can be rationed at the clearing price
  - Typical case
    - A bidder drops from 2.0% to 1.5% at $70/kWh
    - Clearing occurs ($S = D$) at 1.7%.
    - Supplier wins 1.7%.
Descending clock auction

- Auctioneer announces high starting price
- Suppliers name quantities
- Excess supply is determined
- Auctioneer announces a lower price
- Process continues until supply equals demand
Starting price

- Starting price must be set sufficiently high to create significant excess supply
- Setting too high a starting price causes little harm
  - Competition among bidders determines clearing price; high start quickly bid down
- Setting too low a starting price destroys auction
  - Inadequate supply or insufficient competition
- Set starting price based on market fundamentals and indicative offers from suppliers at min and max starting prices
  - Min starting price roughly 20% above market
  - Max starting price roughly 50% above market
Mechanics

- Clock auction done in discrete rounds
- Two price “clocks,” one for each product
- In each round,
  - Auctioneer announces
    - Excess supply at end of prior round
    - Start of round prices (higher prices)
    - End of round prices (lower prices)
  - Each bidder submits a supply curve at all prices between start of round price and end of round price
  - Auctioneer determines excess supply at end of round price
    - For each product with excess supply, price increases
    - If no excess supply for either product, clearing prices are determined
• **Activity rule**
  – Bidders can only maintain or reduce quantity as price falls (upward sloping supply curve)
• **“Intraround bids”**
  – More accuracy without too many rounds
  – Better control of pace of auction
  – Ties are reduced
Descending clock auction

Price
starting price
$120.0 = P_0

$61.7 = P_6
$60.0 = P_6'

Aggregate supply curve

excess supply

Round 1
Round 2
Round 3
Round 4
Round 5

clearing price

Demand
Quantity
## Sample bid illustrating switch and reduction

### Activity rule
- A bidder can only maintain or reduce its *aggregate* quantity as price falls (its aggregate supply curve must be upward sloping)
- Allows full substitution between Reg and Nonreg products
- Bidders can switch or reduce or both at any price point

<table>
<thead>
<tr>
<th>Bidder activity</th>
<th>Price point</th>
<th>Price ($/kWh)</th>
<th>Quantity (%)</th>
<th>Aggregate supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of round prices and quantities</td>
<td>0.0%</td>
<td>$70.00</td>
<td>$68.00</td>
<td>3.0% 2.0%</td>
</tr>
<tr>
<td>Switches 1% Reg to Nonreg</td>
<td>37.0%</td>
<td>$66.30</td>
<td>$64.30</td>
<td>2.0% 4.0%</td>
</tr>
<tr>
<td>Reduces Reg by 1%</td>
<td>83.0%</td>
<td>$61.70</td>
<td>$59.70</td>
<td>1.0% 4.0%</td>
</tr>
<tr>
<td>End of round prices and quantities</td>
<td>100.0%</td>
<td>$60.00</td>
<td>$58.00</td>
<td>1.0% 4.0%</td>
</tr>
</tbody>
</table>
Information policy

• Demand curve and starting price announced before auction

• After every round, auctioneer reports
  – Aggregate supply
  – Excess supply at end of round price
  – End of round price for next round
    (determined from extent of excess supply)
Forward energy auction

• Simultaneous descending clock auction
  – Two clocks; two prices
  – Regulated; nonregulated
• Supplier qualification and credit identical for both regulated and nonregulated product
• Regulated demand is mostly vertical (typically a fixed quantity purchased in each auction)
• Nonregulated demand is as-bid at qualification
• Suppliers can arbitrage freely across the two products throughout clock auction
• Auction ends when no excess supply for either product
  – Clock ticks down if and only if excess supply on product
• Any price separation reflects difference in serving regulated load and nonregulated load
Administrative demand curve for regulated product addresses insufficient competition

Approx. market price $50

~ 20% above market price $60

~ 40% above market price $70

~ 50% above market price $75

Regulated demand target

Demand target

Price

Quantity

0.0%

10.0%

12.5%

∼ 50% above market price

∼ 40% above market price

∼ 20% above market price

Approx. market price
Demand curve for nonregulated product is submitted before auction by each nonregulated customer.

Determined by summing bids of all nonregulated customers.

<table>
<thead>
<tr>
<th>Price</th>
<th>Quantity</th>
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<tr>
<td>$75</td>
<td>0.0%</td>
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<tr>
<td>$70</td>
<td>10.0%</td>
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<tr>
<td>$60</td>
<td>12.5% Demand target</td>
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<tr>
<td>$50</td>
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</table>

Nonregulated demand curve.
Organized secondary auction

• Held monthly
• Simple uniform-price auction
  – Participants submit demand bids and supply asks for each product
  – Clearing-price determined from intersection of aggregate supply and demand curves
• Regulated and nonregulated products include
  – Monthly slice for next 12 months
  – Yearly slice for each year already auctioned in primary auction
Secondary market has 13 or 14 products each of Reg and Nonreg

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>P2</th>
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</tbody>
</table>

Primary market products

Organized secondary market products

primary 2008-2009

primary 2009-2010

2009

2010

2011

+ years 2010 and 2011

+ year 2010

+ year 2010

+ years 2010 and 2011
Handling differences among nonregulated customers

- Hourly demand is forecast for each nonregulated customer for every hour
- Single nonregulated product
- Rate is auction clearing price scaled by quality factor of each nonregulated customer
- Quality factor reflects expected cost difference (at spot price) for particular customer
- Each supplier receives its share of payments
- Supplier obligation is its share of aggregate nonregulated expected load
Forecasting hourly demand and cost
### Monthly demand and cost for regulated and nonregulated load

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</table>

#### Nonregulated Cost

- **Regulated Cost**
- **Nonregulated Demand**
- **Regulated Demand**

Cost is based on spot prices. Spot price ($/kWh) is shown in color.

#### Avg. Price

<table>
<thead>
<tr>
<th>Avg. Price</th>
<th>5.4</th>
<th>260.3</th>
</tr>
</thead>
</table>

*Note: The chart shows the trend of monthly demand and cost for regulated and nonregulated load from 1997 to 2007. The cost is based on spot prices, and the spot price ($/kWh) is indicated by color.*
Simple hourly demand model

- Sample: 1 Jan 2002 to 31 Mar 2007
- Linear growth trend
- Fixed effects for
  - Month of year
  - Day of week
  - Hour of day
Hourly mean and *standard deviation* of demand and cost

<table>
<thead>
<tr>
<th>Load</th>
<th>Price ($/kWh)</th>
<th>Demand (MWh)</th>
<th>Error (%)</th>
<th>Cost ($M)</th>
<th>Error ($/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Actual</td>
<td>Fitted</td>
<td></td>
<td>Actual</td>
</tr>
<tr>
<td>Regulated</td>
<td>42.6</td>
<td>3,841</td>
<td>3,841</td>
<td>0.01</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td>21.5</td>
<td>908</td>
<td>893</td>
<td><strong>4.45</strong></td>
<td>112</td>
</tr>
<tr>
<td>Nonregulated</td>
<td>42.6</td>
<td>1,689</td>
<td>1,689</td>
<td>0.02</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21.5</td>
<td>275</td>
<td>251</td>
<td><strong>6.89</strong></td>
<td>46</td>
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<tr>
<td>Total</td>
<td>42.6</td>
<td>5,530</td>
<td>5,530</td>
<td>0.01</td>
<td>246</td>
</tr>
<tr>
<td></td>
<td>21.5</td>
<td>1,062</td>
<td>1,033</td>
<td><strong>4.39</strong></td>
<td>155</td>
</tr>
</tbody>
</table>

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.
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.
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.
Graphs by year

Density

Error in demand estimate (%)

-50 -30 -10 10 30 50

2002 2003 2004

2005 2006 2007

Regulated  Nonregulated
Weekday peak hour (19) in 2006
Weekday shoulder hour (15) in 2006

Graph showing regulated demand (MWh) over the year with actual and fitted data.
Weekday off peak hour (3) in 2006

Regulated demand (MWh)

Actual
Fitted
Weekday peak hour (19) in 2006

Nonregulated demand (MWh)

Day

Actual

Fitted
Weekday shoulder hour (15) in 2006

Nonregulated demand (MWh)
Weekday off peak hour (3) in 2006

Nonregulated demand (MWh)

Day

Actual

Fitted
Weekday peak hour (19) in 2006 for Company 1
Weekday shoulder hour (15) in 2006 for Company 1

Company demand (MWh)

Day

Actual
Fitted

0 30 60 90 120 150 180 210 240 270 300 330 360
Weekday off peak hour (3) in 2006 for Company 1
Weekday peak hour (19) in 2006 for Company 2

Company demand (MWh)
Weekday shoulder hour (15) in 2006 for Company 2

Company demand (MWh)

Day

Actual

Fitted
Weekday off peak hour (3) in 2006 for Company 2

Company demand (MWh)

Day
Weekday peak hour (19) in 2006 for Company 3
Weekday shoulder hour (15) in 2006 for Company 3
Weekday off peak hour (3) in 2006 for Company 3

Company demand (MWh)
International experience and grades

- **Maryland:** F
  - Single RFP to procure many years of energy
    (all eggs in one basket)
  - Poor auction design

- **New Jersey:** A-
  - Annual auction for one-third of load
  - Very good auction design

- **Illinois:** A-
  - Nearly identical to New Jersey

- **France (Virtual Power Plant auction):** A
  - Quarterly auctions with flexibility on duration
  - Excellent auction design

- **Spain:** C?
  - Process appears too rushed at end
Conclusion
Background

Mostly presented in May meeting on product design.
Objective
Purpose of market

- Efficient price formation
- Transparency
- Neutrality
- Risk management
- Liquidity
- Simplicity
- Consistency
Efficient price formation

• Reliable price signals based on market fundamentals
• Competitive
• Mitigate market power
Transparency

• Offers are comparable
• Clear why winners won
• Prompt regulatory review and approval
• Regulatory certainty
Neutrality

• All suppliers treated equally
• All demanders treated equally
Risk management

- Reduces risk for both sides of market
- Rate stability, yet responsive to long-term market fundamentals
- Shields from transient events
- Addresses counterparty risk
Liquidity

• Promotes secondary market
• Liquid market for primary product
• Liquid market for derivative products
  – Long-term strips
  – Short-term slices
Simplicity

• For participants
• For system operator
• For regulator
Consistency

• Consistent with other key elements
  – Spot energy market
  – Firm energy market

• Consistent with best practice in world
Setting
Colombia setting

• Hydro-dominated electricity market
  – 80% of energy
  – 67% of capacity
  – 50% of firm energy (exceptional dry period)

• Hourly bid-based spot energy
  – Single zone

• Firm energy market
  – Assures sufficient firm energy
  – Hedges prices above scarcity price (about $260/kWh)

Note: All $ amounts in January 2007 Colombia Pesos
# Market structure of firm energy

(moderate concentration)

<table>
<thead>
<tr>
<th>Company</th>
<th>ENFICC Declared (GWh)</th>
<th>Market share</th>
<th>HHI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hydro</td>
<td>Thermal</td>
<td>Total</td>
</tr>
<tr>
<td>Emgesa</td>
<td>10,419</td>
<td>2,373</td>
<td>12,792</td>
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<tr>
<td>Epm</td>
<td>8,523</td>
<td>3,295</td>
<td>11,818</td>
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Pay-as-demand is common

Type of contracts

Market share

Take or Pay
Pay as Demand
Regulated product

• Regulated load is aggregate of all LSEs
• 100% of regulated load is purchased in auctions
• Mandatory for LSEs
• Voluntary for suppliers
• Accommodates multiple customer classes if required
  – For example, undesirable load shape of LSE
Conclusion: Only one customer class!
Further issues
Seasonal factor?

- Costs are about 19% higher in dry season
- Wet season .92; dry season 1.11
- Conclusion: seasonal factor *not* needed

![Graph showing average cost in wet and dry seasons, regulated market](image)

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.
Load-following not ideal for all

- Different resource types have different ideal dispatch
  - Baseload, peaker, limited-water hydro, etc.
- Difference in dispatch and obligation introduces risk and market power issues
- Problem mitigated by
  - Balanced portfolio of resources
  - Balanced portfolio of contracts (Reg. and NR)
- Conclusion: benefits of pay-as-demand greatly exceed costs
Index multi-year contracts with IPP

Market share (energy basis) of active contracts by price index
Small lot size

• 0.1% of load category (reg. and nonreg.)
  – About 6 MW average load for regulated
  – About 3 MW average load for nonregulated
  – Varies with each hour, since load following

• Great flexibility in expressing quantity

• Accommodates small bidders

• Improves secondary market
Planning period

- Time between auction and start of commitment
- Opportunity to make adjustments
- Impacts how much uncertainty has been resolved
- Longer implies price stability
- Longer implies more costly guarantees
Commitment period

- Time between start and end of commitment; contract duration
- Longer implies price stability
- Longer implies better financing
- Longer implies greater guarantees
Frequency

• Number of auctions per year
Alternative to improve liquidity of 1-year product:
Quarterly 1- and 2-year contracts, semi-rolling

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