



Transformation of the Peruvian Electricity Supply Industry: Small Markets Can Deliver

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Outline of Presentation

What does a country want from electricity industry re-structuring?

Can this be achieved in small markets?

Peru as a successful small market Peruvian market structure Peruvian market design Why has it been successful?

Adapting Peruvian success other small markets Focus on high benefit/cost ratio actions

Goal of Industry Re-structuring

Improve both short-term and long-term efficiency of electricity supply industry

Short-term efficiency

 Ensure that existing generation resources are used in least-cost manner to serve system demand

Long-term efficiency

 Ensure that least-cost mix of generation and load resources are built to serve demand

Consumers benefit from lower average retail prices that result from more efficient short-term and long-term industry operation

Small Market Challenges

Size of system demand makes competition in short-term market difficult

- Minimum efficient scale of generation units large relative to system demand
- Politically difficult to break up incumbent electricity supplier

Limited experience with regulation and antitrust policy

- Most small markets start from vertically-integrated state-owned monopoly industry structure
- Difficult to enforce regulatory invention in short-term and long-term market mechanisms

Limited amount of modern technology in transmission and distribution network and in customer's premises

Limited amount of real-time telemetry and deployment of interval meters

Industry Structure in Peru

Hydro and Natural Gas Generation



Concentration in Generation Ownership



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50 percent capacity owned by three firms Large firms own portfolio of thermal and hydro capacity

Generation Companies	Hydro	Thermal	Solar	Wind	Total Effective Capacity	Share %
Engie	254.47	2185.72	44.54		2484.73	20%
Kallpa	568.08	1047.74			1615.82	13%
ENEL	599.95	1226.96	144.48	132.30	2103.69	17%
ELECTROPERU	898.14	16.56			914.70	7%
SAMAY		723.57			723.57	6%
Fenix		567.19			567.19	4%
Huallaga	476.74				476.74	4%
Statkraft	447.95				447.95	4%
Orazul	375.74				375.74	3%
Termochilca		303.31			303.31	2%
Egasa	177.71	45.54			223.25	2%
CELEPSA	222.49				222.49	2%
Others	1057.77	814.50	96.00	279.91	2248.18	18%
Total Capacity	5079.04	6931.09	285.02	412.21	12707.36	100%

Growing Consumption and Peak Demand



4.5% Average Annual Peak Demand (MW) Growth Rate From 2010 to 2020

Growing Energy Demand



Average Annual Demand (GWh) Growth of 5.35 percent from 2010 to 2019

Key Features of Peruvian Market Design

Peruvian Short-Term Market

Cost-based real-time (single settlement) market

- Three-part costs—start-up, minimum load, variable cost of energy
 - Multi-step variable energy cost curve for each unit
 - Regulator-verified heat rate, price of natural gas, variable O&M costs, start-up, minimum load energy

Generation dispatch process runs every 15-minutes
 Locational marginal prices (LMPs) are set every 30 minutes at over 100 locations in Peru

- Opportunity cost of water used in short-term market solved for using stochastic discrete dynamic program (SDDP) based on
 - Historical distribution of water inflows
 - Thermal generation unit costs

Peruvian Market

Free consumers and distributors must purchase full-requirements contracts for their demand through

- Bilateral negotiation of price of contracts subject to the regulated ("tarifa de barra") busbar tariff cap
- Competitive tenders run by buyer
- Full requirements contracts imply all short-term price and quantity risk borne by suppliers
 - Cost of supply shortfalls borne by generators
- Short generator compensates long generator at short-term price
 Full requirements contracts can have an extremely long duration
 - Can be up to 20 years in duration
 - Free consumers were recently allowed to purchase up to 10 percent of their demand from short-term market

Keys to Peru's Success

Cost-Based LMP Short-Term Market

- Cost-based short-term LMP market
 - Allows for a highly concentrated generation market structure
 - Limits opportunities for suppliers to exercise unilateral market power through offer prices submitted to short-term market
 - Ensures efficient operation of existing generation resources
 - LMP mechanism minimizes sum of start-up, minimum load and energy costs to serve demand all 24 hours of the day
- Caveats
 - Regulated costs may not equal minimum costs for each generation unit

Full Requirements Retail Contracts

- All short-term energy price and quantity risk borne by suppliers
 - Seller of full requirements contract guarantees that buyer can purchase energy demanded throughout term of contract
 - Collectively suppliers have an incentive to ensure that demand meets supply all hours of the year
 - Limits need for interval metering and other technology for active demand side participation

Caveats

 Can limit incentive for loads to provide real-time demand flexibility Cost-Based Market and Full Requirements Retail Contracts

- Reduces barriers to entry by new suppliers
 - Cost-based market provides greater certainty about cost of supply shortfalls to new entrant
 - Supply shortfalls clear against cost-based short-term price rather than offer-based short-term price
 - In small market, offer-based short-term price may often reflect the exercise of significant unilateral market power
 - Cost-based short-term market provides commitment that government will not intervene in short-term market
 - Offer-based market can allow government-owned company to submit offer price that achieve low short-term prices

Focus on Major Sources of Benefits

- Peruvian design focuses on major sources of benefits of industry restructuring
 - Use existing generation resources in least cost manner
 - Create strong incentives for least cost mix of generation resources to be built
 - Assign risk of supply shortfalls to entities best able to manage it
 - Generation unit owners rather than retailers

Transferability of Peruvian Experience

Small Markets Can Successfully Restructure

- Cost-based LMP short-term market
 - Can allow incumbent utility to keep a significant amount generation assets
- Full requirements retail contracts
 - Contracts can be price-regulated or market-based depending on how far in advance they are negotiated
- Transparent international prices and technological parameters used to set generation unit costs for LMP market
 - Henry Hub plus transportation for natural gas
 - Heat rates based on publicly available international data

Small Markets Can Successfully Restructure

- Limited regulatory oversight of cost-based market relative to offer-based market
 - Adapt regulatory process to restructured market design
- Can preserve existing energy supply arrangements as purely financial
 - Seller of energy need not supply energy from own generation unit—Can also purchase it from the short-term market
 - Buyer of energy has right to purchase contract quantity at contract price

Concluding Comments

- Industrialized country offer-based short-term market where both suppliers and retailers participate symmetrically may not be appropriate for small markets
- Focus of major source of benefits of electricity restructuring
 - Efficient use of existing generation resources
 - Efficient investment in new generation capacity
- Many additional features that can add value
 - Day-ahead and real-time markets
 - Virtual bidding and financial transmission rights
 - Co-optimization of energy and ancillary services
 - Renewables portfolio standard
 - Interval meters for active demand side participation

Thank you Questions/Comments