The Economics of Utility Regulation

How are renewable energy and distributed resources changing things?

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Unregulated monopoly pricing ($P^M$)

- **Price** ($/kWh)
- **Quantity** (kWh)

<table>
<thead>
<tr>
<th>Efficiency Loss</th>
<th>Demand</th>
<th>How much people buy at each price.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marginal Cost</td>
<td>Average Cost</td>
<td>Total cost of production divided by Q.</td>
</tr>
<tr>
<td>Marginal Revenue</td>
<td>Profit</td>
<td>Incremental revenue to monopoly of dropping price enough to sell one more unit of Q.</td>
</tr>
</tbody>
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- **$P^M$**
- **$Q^M$**
- **MC**
- **AC**
- **MR**
- **D**

**Marginal Revenue**
Incremental revenue to monopoly of dropping price enough to sell one more unit of Q.
What is a *natural* monopoly?

**Answer:**
The most efficient way to produce the good is with **one** firm.
A Natural Monopoly

Price ($/kWh) vs. Quantity (kWh)

AC
MC
D

Revenue = Price x Quantity

Marginal Revenue (MR) = AC

Marginal Revenue (MR) = MC

MR = MC at equilibrium
Not a natural monopoly

Price ($/kWh)

Quantity (kWh)

Competitive price

P*

MC

AC

Q*

D

P*
Usual Policy Conclusions

When there is a natural monopoly:
allow monopoly but regulate it to prevent it from monopolistic pricing.

When there is not a natural monopoly:
prevent the growth of monopolies and the exercise of monopoly power.
Utilities: the classic natural monopoly

Three pieces

1. Production of the good.

2. Delivery to local area (Transmission).

3. Delivery to customer (Distribution).
Today, **distribution** is the main natural monopoly

1. Multiple power plants for a service area

2. Usually redundancy in transmission (not Hawaii)

3. Only **one** wire to each customer
Efficient marginal-cost pricing (P*)

Price ($/kWh)

P^M

Consumer gain relative to monopoly

P*

Q^M

Q*

Quantity (kWh)

AC

MC

Demand
Efficient, marginal-cost pricing ($P^*$)

**Price ($/kWh)**

$P^*$ represents the marginal cost ($MC$) at the market equilibrium. The vertical distance between the demand curve and the marginal cost curve at $Q^*$ represents the loss to the utility company.

**Quantity (kWh)**

$Q^*$ is the quantity demanded at the equilibrium price $P^*$. The area under the demand curve up to $Q^*$ illustrates the total revenue, while the area under the marginal cost curve up to $Q^*$ illustrates the total cost. The difference between these areas represents the profit to the utility company.
Solution: Two-part tariff

1. Charge $P^*$ per kWh
2. Fixed charge $F$ per customer
A fixed *rebate* instead?

1. Charge $P^*$ per kWh
2. Charge each customer $F$ per month

Excess profit to utility
MC Pricing is nice in theory. What about practice?

**Key Challenge**

Hard to get a regulated firm to minimize costs

- **Regulator forces**

  \[ P^* \times Q^* + \text{fixed charges} = AC \times Q^* \]

- Firm has no incentive to **minimize** cost like a competitive firm would.

- Quality of service at issue, not just price.
Main Regulatory Frameworks

1. Cost of Service
   a. Operation cost allowance
   b. Capital costs approved by PUC get allowed rate-of-return

2. Price Cap Regulation
   a. PUC sets price cap at or above AC
   b. Firm gets to keep some or all of cost reductions
   c. Optional ratchet: adjust allowed price down with cost reductions

3. Targeted “performance based” metrics
   a. Heat rates
   b. Outages
   c. Environmental performance
“You can’t do these cost-plus sole-source contracts, because then the incentive structure is all messed up... you’re incenting the contractor to maximize the cost of the program because they get a percentage....

[it’s] Economics 101: Whatever you incent, that will happen...”
Imperfect Cost of Service Regulation (with no fixed charge)

Price ($/kWh)

Quantity (kWh)

P_{AC'}

Q^{AC'}

D

AC'

AC_{minimum}
Regulator does not know true cost of capital

Suppose regulator sets “fair” return

At true cost of capital:

\[ P = \text{true AC} \]

Monopoly has no incentive to minimize cost.

Above true cost of capital:

\[ P > \text{true AC} \]

Monopoly has incentive to use too much capital.

Below true cost of capital:

\[ P < \text{true AC} \]

Monopoly becomes insolvent.
Price Cap regulation
(with no fixed charge)

Price ($/kWh)

Profit potential gives utility incentive to minimize cost

Utility profit

Quantity (kWh)

Profit potential gives utility incentive to minimize cost
Problems with Price Cap Regulation

1. Quality of service may go down
   a. Utility won’t lose customers for bad service
   b. Utility may fear that cost reductions will lead to lower future cap – better to just exaggerate costs?

2. Incentive to grow demand
   a. Increasing returns to scale -> lower cost -> higher profit
   b. Discourage energy efficiency
   c. Discourage distributed solar
   d. Price discrimination
Problem with price cap regulation?

Incentive to grow demand

Key issues:
1.) energy efficiency
2.) price discrimination
3.) distributed solar

Profit grows with Q

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<th>Quantity (kWh)</th>
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<tr>
<td>D</td>
<td>Q^cap</td>
</tr>
<tr>
<td>P^cap</td>
<td>AC^minimum</td>
</tr>
<tr>
<td>D'</td>
<td>Q^cap</td>
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Problem with price cap regulation?

If demand falls, profit falls

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<td>( P_{\text{cap}} )</td>
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Key issues:
1.) energy efficiency
2.) price discrimination
3.) distributed generation

Profit shrinks with \( Q \)
### Price ($/kWh)

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<th>Price</th>
<th>Q^AC'</th>
<th>AC'</th>
<th>AC_{minimum}</th>
<th>D</th>
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Alternatives

1. Markets or competitive bidding where viable
   a. Mainly generation
   b. Transmission?
   c. What is the minimum viable scale? Has it changed?

2. Customer-oriented performance metrics
   a. Share of cost reduction
   b. Pollution reduction
   c. Service quality metrics

3. Alternative ownership models
   a. Government municipality
   b. Cooperatives
Things are about to change....
.....faster than you may think

Experience curves compiled by Bloomberg New Energy Finance

LITHIUM-ION EV BATTERY EXPERIENCE CURVE COMPARED WITH SOLAR PV EXPERIENCE CURVE

Note: Prices are in real (2014) USD.
Source: Bloomberg New Energy Finance, Maycock, Battery University, MIT

Michael Liebreich, New York, 14 April 2015
@MLiebreich  #BNEFSummit
Utility-scale PV with Battery

Tesla installation on Kaua`i: 13.9 cents/kWh

New AES installation on Kaua`i: 11 cents/kWh

NextERA installation in Arizona: 4.5 cents/kWh

These are subsidized rates. Still, unsubsidized, the Arizona project ~ 8 – 9 cent/kWh
Should we worry more about grid defection?
Two Futures

1. Smart Grid
   Mix of distributed and centralized generation, smart appliances, building control systems and storage. Exchange of power managed by utility in vast variable pricing scheme.

2. Self Supply and Self Storage
   Economies of scale in generation and storage overwhelmed by costs and possible vulnerabilities of managing a smart grid.

Hybrid?
Self-supply and self-storage backed up by old, dumb grid?
Does the old regulatory model fit?

1. Only natural monopoly is grid management and real-time balancing.

2. Multilateral flows of energy
   - All customers buy and sell

3. Vanishing fuel costs
   - All fixed costs, zero marginal costs.
   - New “marginal cost” will be reflect scarcity value of energy on hand and speculation about future supply and demand.
When all costs are fixed

Price ($/kWh)

Quantity (kWh)

AC

MC

D
All costs are fixed, & supply and demand vary
Choices, and regulation, much more complex

• Centralized vs. distributed generation.
• Centralized vs. distributed storage.
• Major grid upgrades or minor ones.
• Smart meters for all, or only those with large, flexible loads?
• Information asymmetry between PUC and utility more acute.
• Planning and management software built for the past, not the present or future.