

*ESD 126*

***ESD 126 Economic Markets for  
Power***

***Characteristics of Electric  
Demand***

# Electricity Demand in Hokkaido

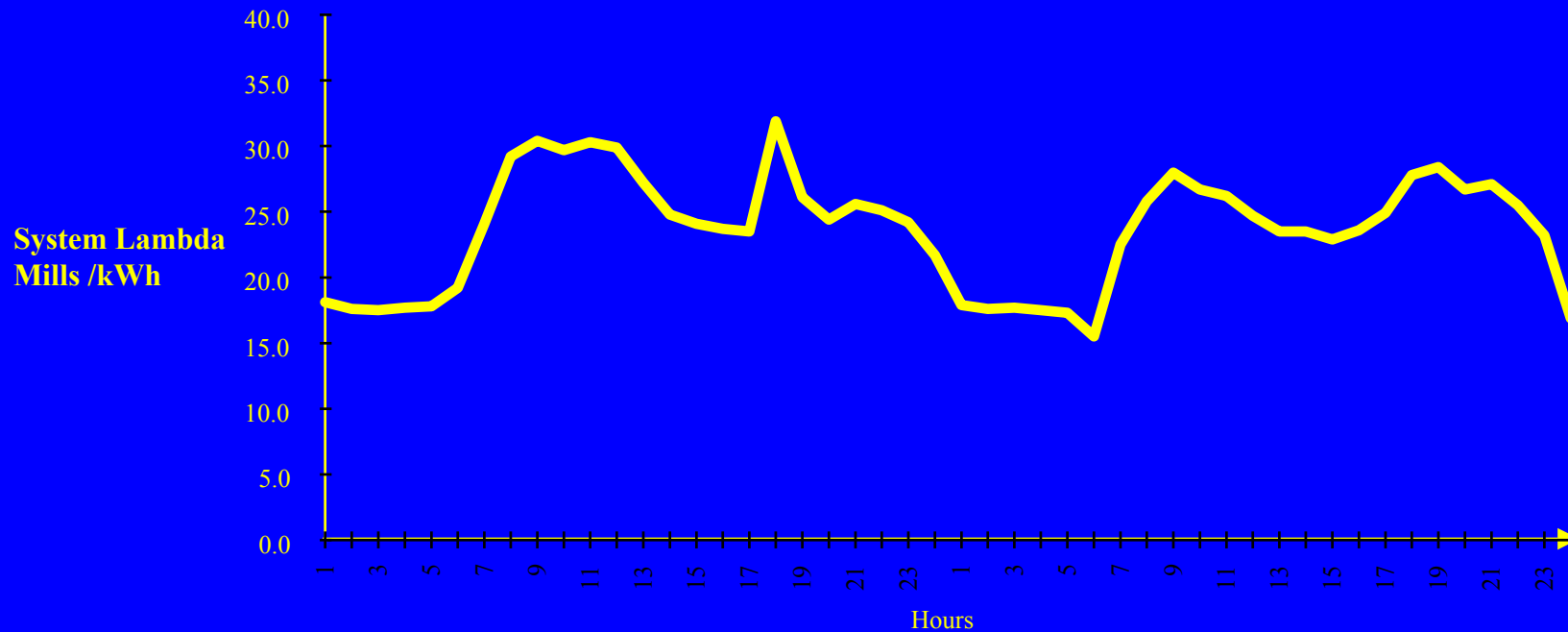
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- *FY '75 '80 '85 '90 '95 '02 '07 '12*
  - *11.7 16.3 17.6 20.5 24.4 29.2 31.5 33.9*
  - *%1 48 46 39 33 29 28 27 26*
  - *%2 52 54 61 67 71 72 73 74*
  - *! !*
  - *OUTLOOK -----!-----!*
  - *%1 = Industrial use %*
  - *%2 = Residential and commercial use %*
  - *Estimated demand from 1975-2009*

Courtesy of Hokkaido Electric Power Co.,Inc; Used with Permission.

# Two Days in January, 1993 Hourly Marginal Costs

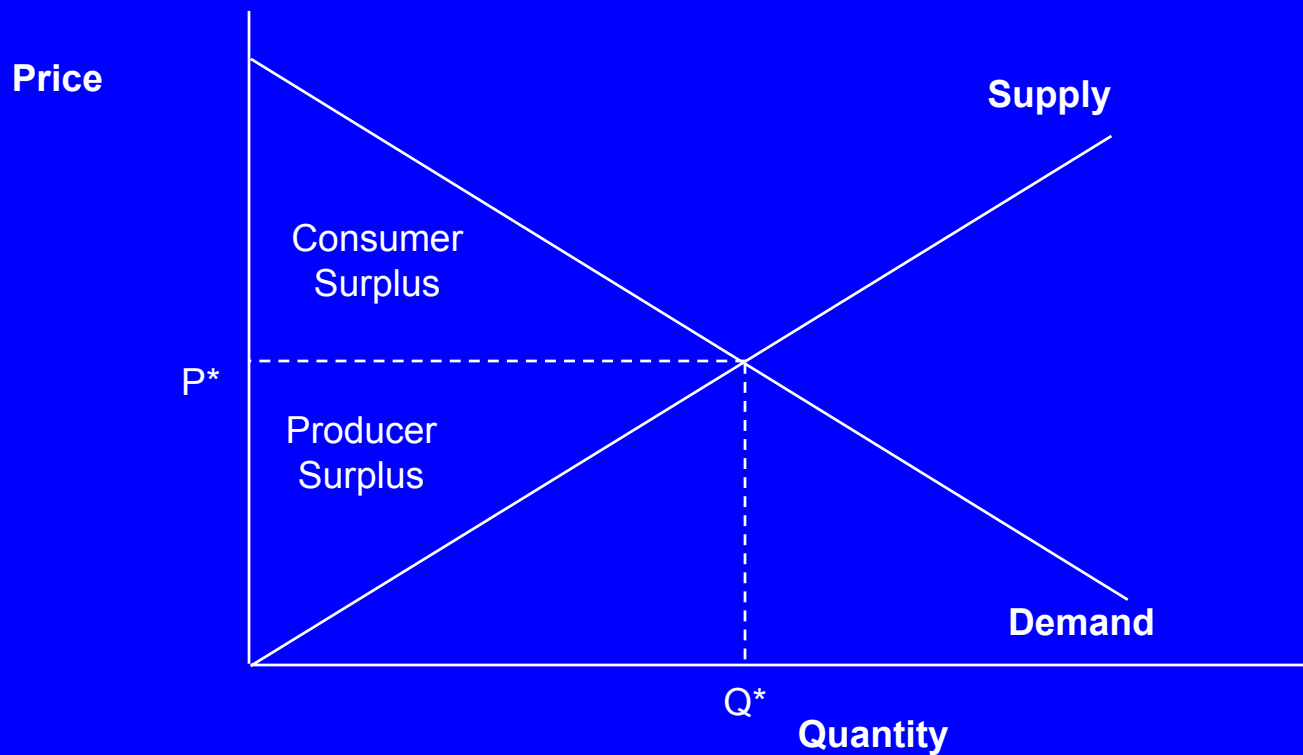
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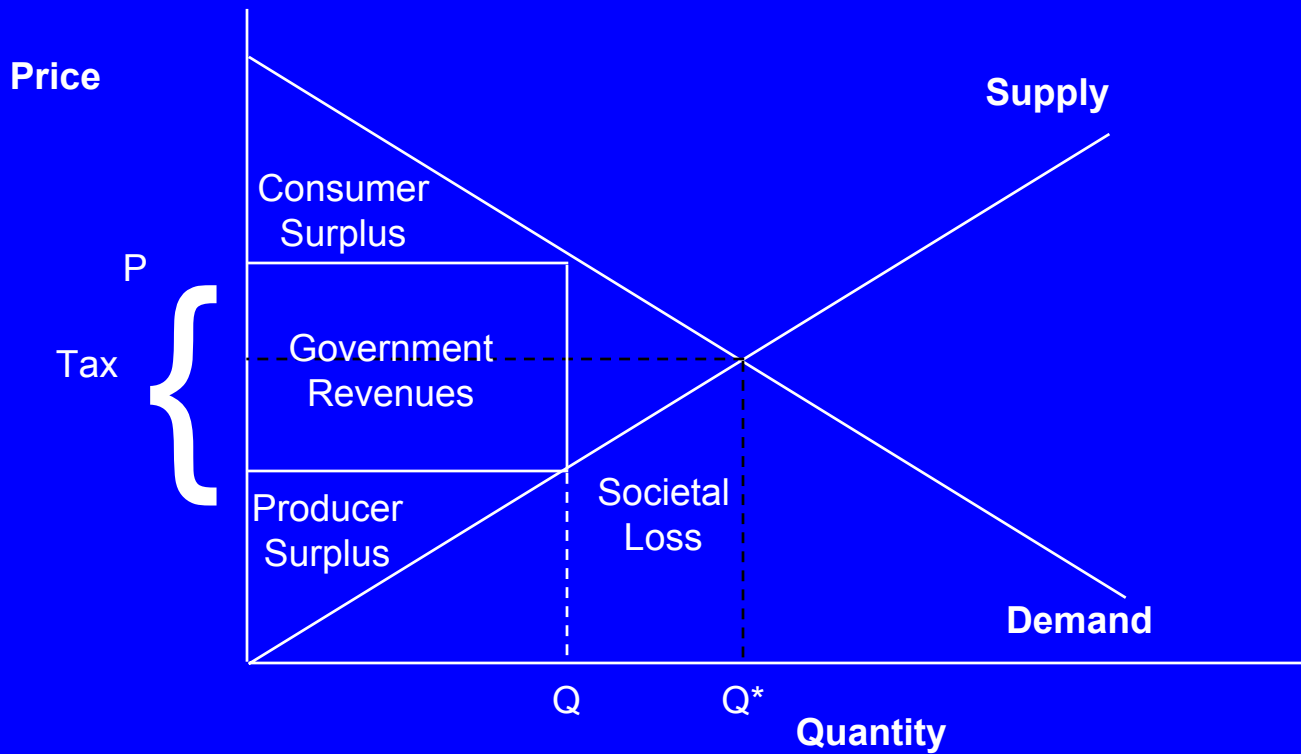
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***Power System Economics  
and Electric Markets***

# *Competitive Conditions*



# *Conditions under Taxation*



# *Profit Maximizing Firm*

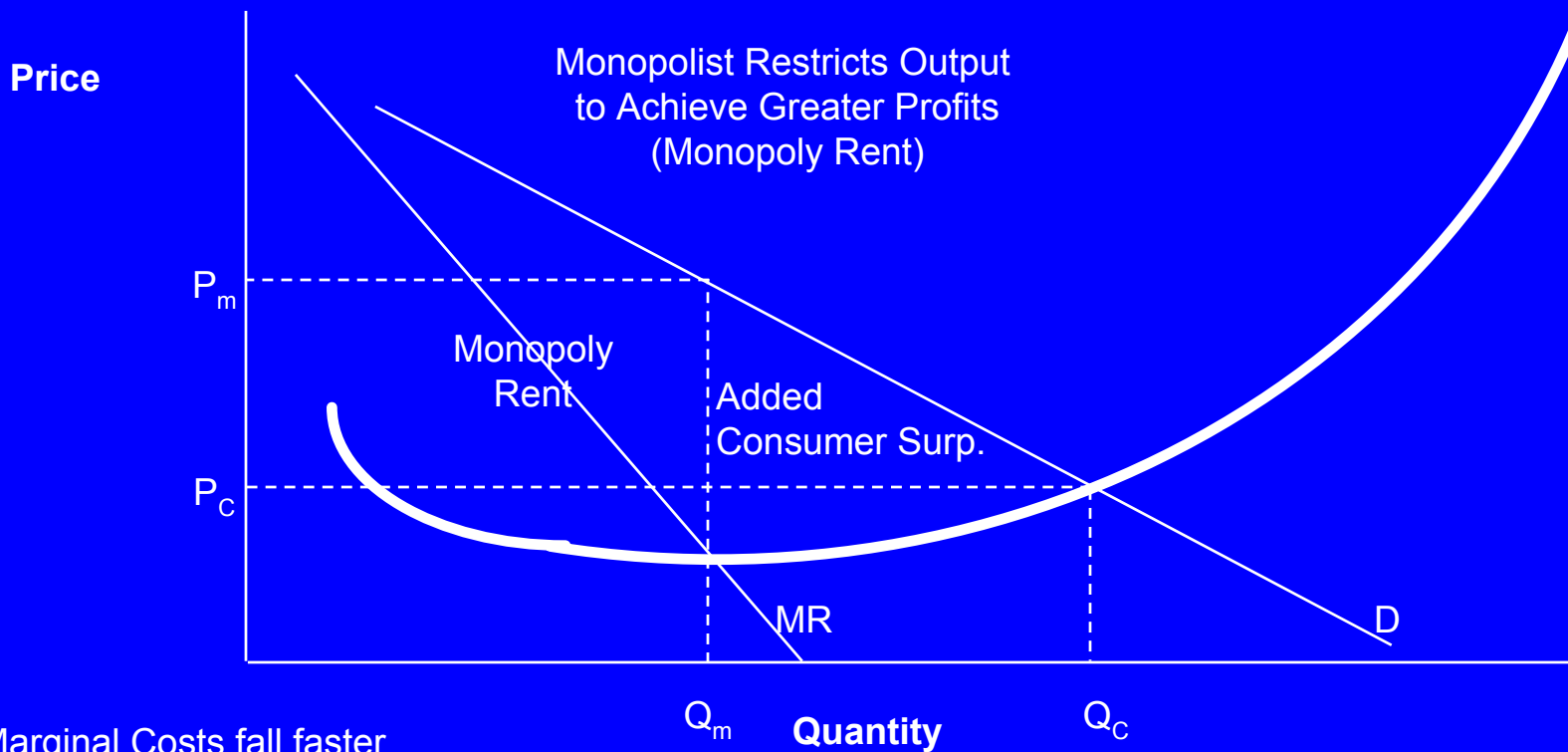
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# *Monopoly Pricing*

- *Objective is to capture benefits of economies of scale and at the same time providing those benefits to customers by charging as close to marginal cost as possible.*
- *Given that Marginal Cost < Average Cost alternative pricing structures are used*
  - Ramsey, or second best pricing
  - Provide form of marginal cost pricing while allowing firms to recover costs

# Monopoly Pricing



Marginal Costs fall faster than average costs thus if marginal costs are used as price, firm loses money

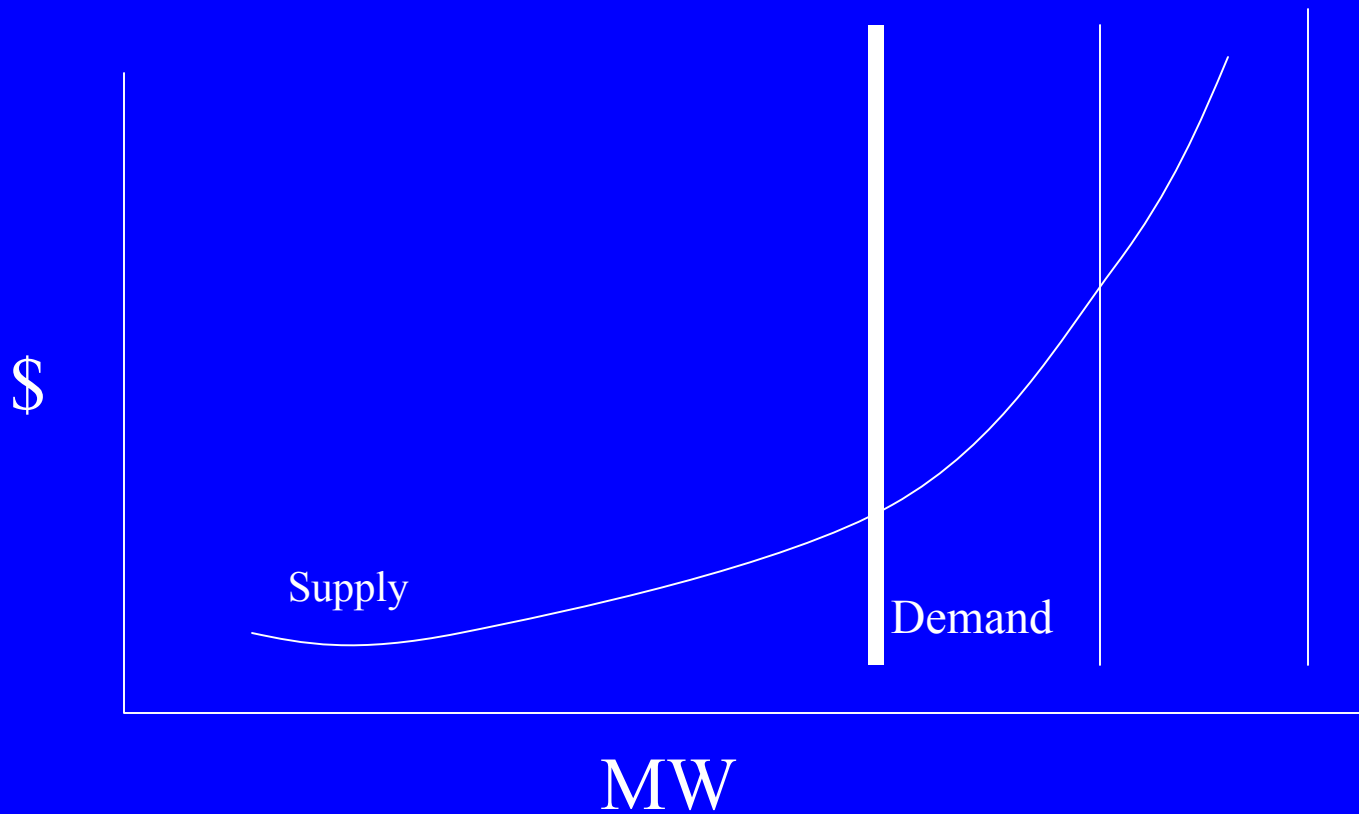
Marginal Revenue falls faster than price as output increases

## ***Pricing Structures***

- ***Short Run Marginal Cost (SRMC)***
  - In general under recovers because  $MC < AC$
- ***Long Run Marginal Cost (LRMC)***
- ***Average Cost Pricing***
- ***Ramsey Pricing***
  - Charge customers a price that is inversely proportional to their elasticity of demand
  - Time of use (TOU)
  - Real Time Pricing (RTP)

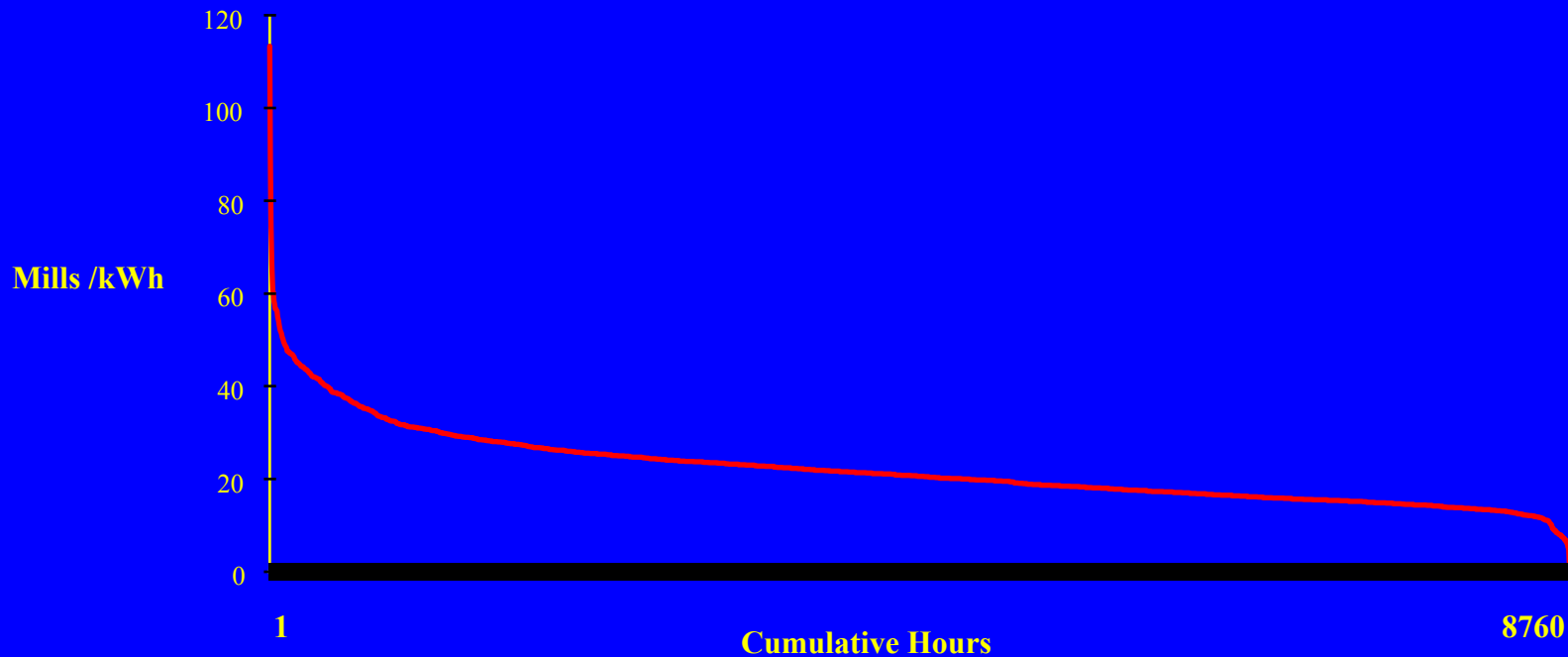
# Electric Markets

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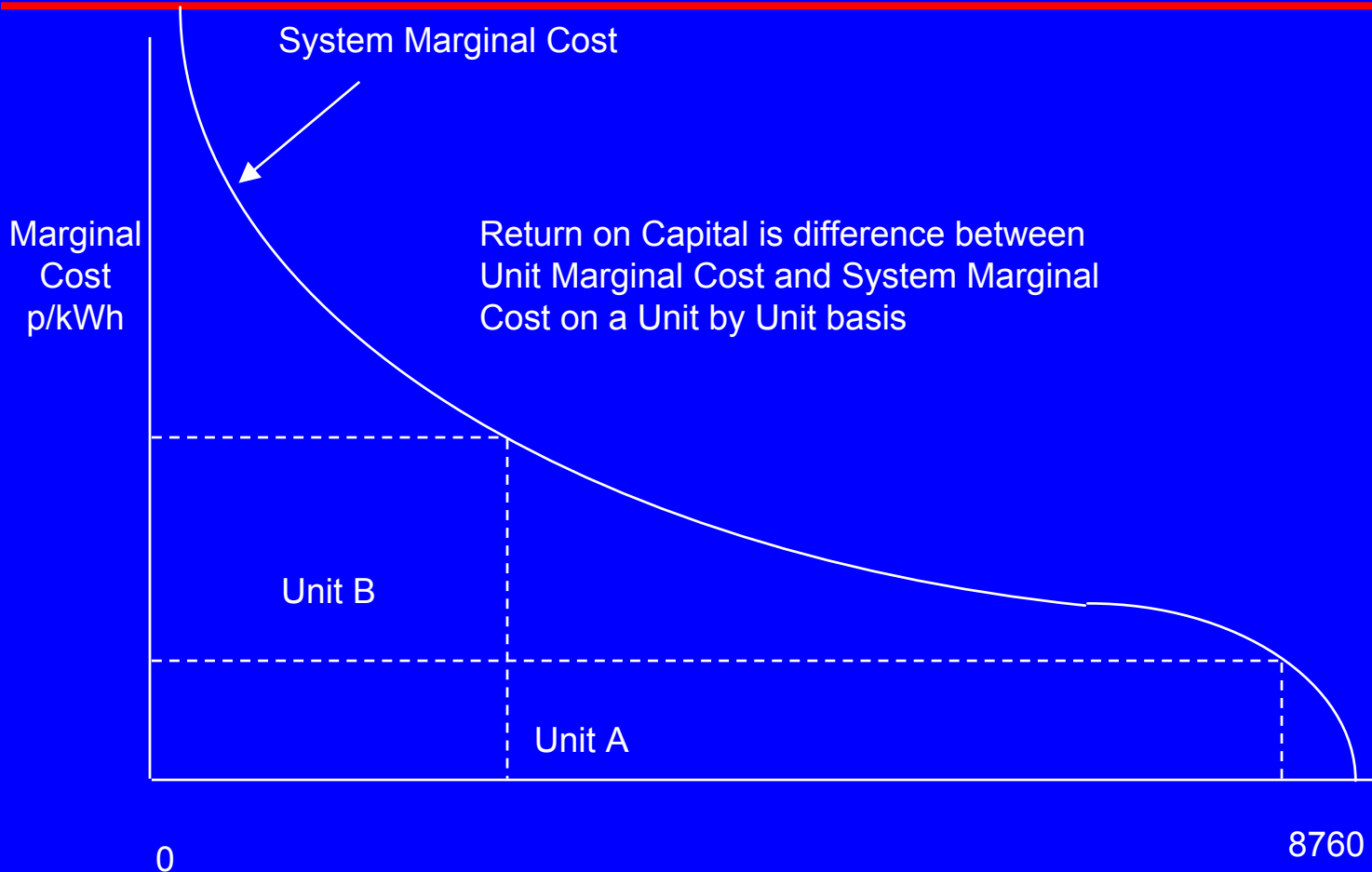


# Cost Duration Curve: Sorted by Marginal Cost

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# *Individual Unit Economics*



# *What is a Market?*

- *Rules for the ideal market:*
  - A Homogeneous product
  - Buyers and sellers can find one another
  - Perfect information is available
  - Entry and exit is free
- *Vocabulary of the imperfect market*
  - Market power
  - Imperfect measure of the imperfect market = HHI
- *In general:*
  - “A place where an independent buyer and an independent seller can exchange goods at an agreed upon *PRICE*”
- *The Key: PRICE not COST*

## *Players*

- *Generators*
- *Transmitters*
- *Distributors*
- *System Operator(s)*
- *Markets*
- *Brokers*
- *Consumers*

# *Players Roles: Generators*

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- *Strategies*
  - Multiple facilities
    - Geographic dispersion
      - Same fuel, same type units
    - Geographic contiguity
      - Diverse fuel, diverse units
  - Single facility
    - Niche supplier
      - Peaking ?

# ***Player's Roles: Marketers / Brokers***

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- ***Market Maker (Grease)***
  - Identify spreads
    - Buy Low
    - Sell High
  - Reduce risk to buyers and sellers
    - Buy forward to reduce producer risk and/or assure market for future capacity
    - Sell forward to reduce (eliminate) price risk to consumer
  - Fuel Swap
    - Gas for Electricity
    - Tolling
- ***Brokers: Match Maker only***

# ***Products in the Electric Market***

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- ***Capacity (short ==> long term)***
- ***Energy (time and location specific)***
- ***Transportation (Transmission)***
- ***Ancillary Services***
  - Loss Compensation
  - Constraint Mitigation
  - Spinning Reserves / Energy Imbalances
  - VAR Support
  - Black Start
  - System Protection
- ***Energy Services***
  - Cost packages
  - Value packages
  - The MCI and Sprint of Electricity

# *Products: Energy and Capacity*

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- *Energy*
- *Capacity*
  - Installed (Long Term)
  - Operable (Short Term)
  - Reserve
- *Separability and Timing are Critical Issues*
  - Multiple Products
  - Short time periods for trading and clearing
  - Minimize the role of the ISO in the market

## *Prices (Costs)*

- *For Energy and Capacity*
  - Bilateral Market Based
  - Swaps (contracts for differences)
  - Spot Market Based
- *Ancillary Services*
  - ? Regulation because of localized monopoly conditions
  - Independent System Operator
    - Call Contracts
      - Reservation
      - Strike

# ***Markets and Market Instruments***

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- ***Forward (Futures) Markets***
  - Price lock-in
  - Information for future investments
  - “Referent to”
    - Spot Market
    - Expectation of change
- ***Spot Markets***
  - High variability / uncertainty
- ***Ancillary Services Market***
  - Operating requirements
- ***Clearing Markets***
  - After the fact trading by buyers and suppliers

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# ***Prices in the Electric Market: Functions***

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- ***Provides signals to buyers***
  - Operations: how much to demand given value of end product
  - Investment: trade-off between
    - Fuels
    - Efficiency
- ***Provides signals to suppliers***
  - Operations: how much, when and where
  - Investment: when, what kind, and where

# ***Price Discovery Mechanisms in the Electric Market*** ***ESD 126***

- ***Regulated requirement***
  - (Avoided Costs) PURPA in the US
- ***Required bidding through regulated entity***
  - Mandatory Pool as in the UK
- ***Coordinated Bidding***
  - Voluntary PoolCo (Transactions may go “around” the pool)
  - NordPool ?
- ***Open market***
  - Bilateral Contracts

# ***How is price discovered in a Competitive Market?***

- *Supermarket and “Auto Mile”*
- *Industry knowledge / Word of Mouth*
  - The Natural Gas Model
  - Henry Hub plus basis points
- *Brokers and Marketers*
  - For complex markets / products
  - When information and contact failures occur
- *Electronic Bulletin Board (EBB)*

# *Information Required by the buyer*

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- *Define the product needed*
  - amount
  - delivery point
  - timing
  - reliability
- *Prices of delivered energy available in the market*
- *Who will sell (marketers and/or primary suppliers)*
- *Conditions of the offers to sell*
- *Credibility of the suppliers*

# ***Information Required by ESD 126 the Marketer***

- *Their sources and conditions of supply*
- *Their costs of energy*
- *Their costs of transmission (and distribution)*
- *Their ability to reliably deliver*
  - Hedged in energy and or \$

# ***Contract is written against ESD 126 specific terms:***

- *Cost of Energy*
- *Cost of Transmission*
- *Quantity*
- *Duration*
- *Reliability*
- *Delivery points*
- *Contingencies*

# ***What institutions and / or ESD 126 functions are necessary?***

- ***ISO***
  - Balancing
  - Responsible only for ISO's activities
- ***Billing***
  - handled on the basis of individual players.
    - Significant opportunity for additional specialization in the market -- firms established to provide metering and billing services as well as firms to do the actual billing

# *Summary*

- *Financial Markets Critical*
- *Restructuring will bring about:*
  - *Winners*
  - *Losers*
- *New entities will emerge*
- *New financial instruments will emerge*
- *New physical and service products will emerge*

# What are the markets that will develop and what will be sold? *ESD 126*

- *Spot Market*

- Energy
- Ancillary Services?

- *Futures Market*

- Energy
- Capacity?

- *Reliability Market*

- Capacity
  - Installed
  - Operable
  - Reserve
- Ancillary Services



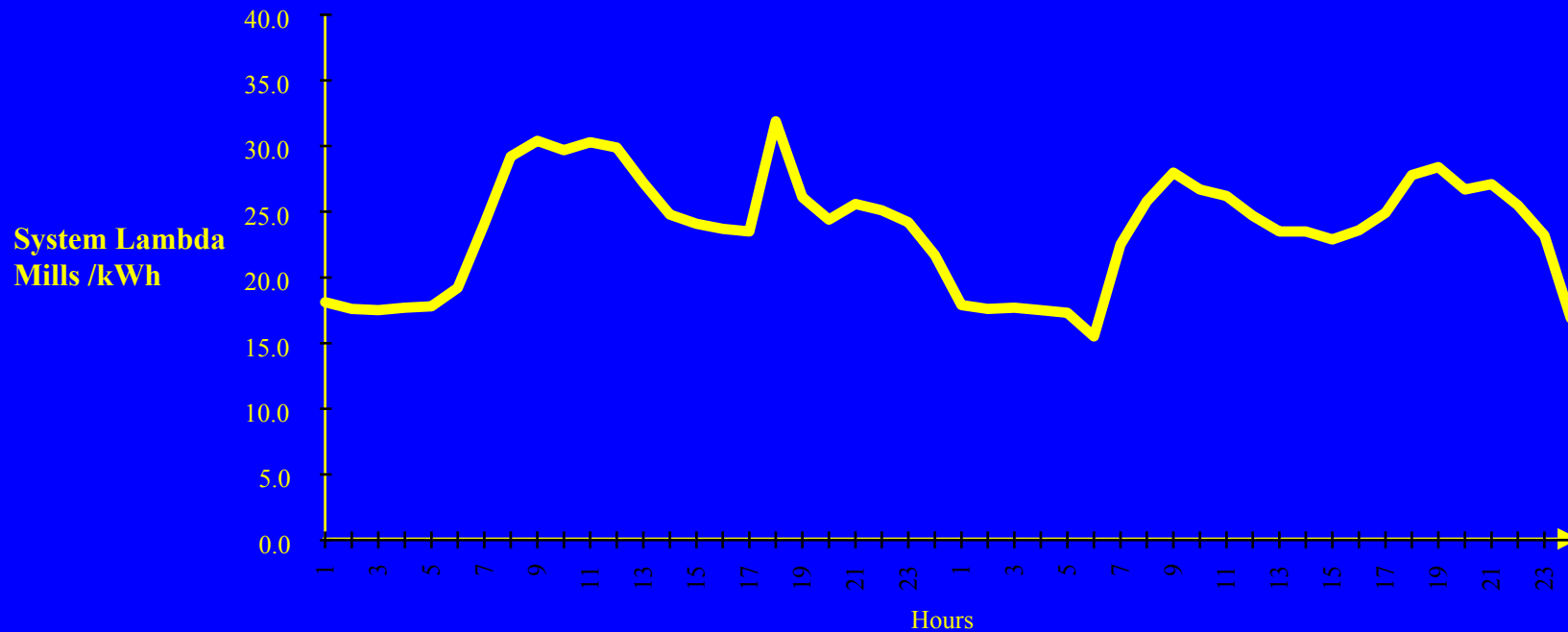
**Must be Closely  
Related in the  
Market**

## ***SRMC***

- *Operating Cost (Variable Cost) Based*
  - Fuel, O&M ...
- *Spot Price / PIP or POP*
- *Economically efficient operating rules*
- *Best when operating costs dominate*
  - Electricity

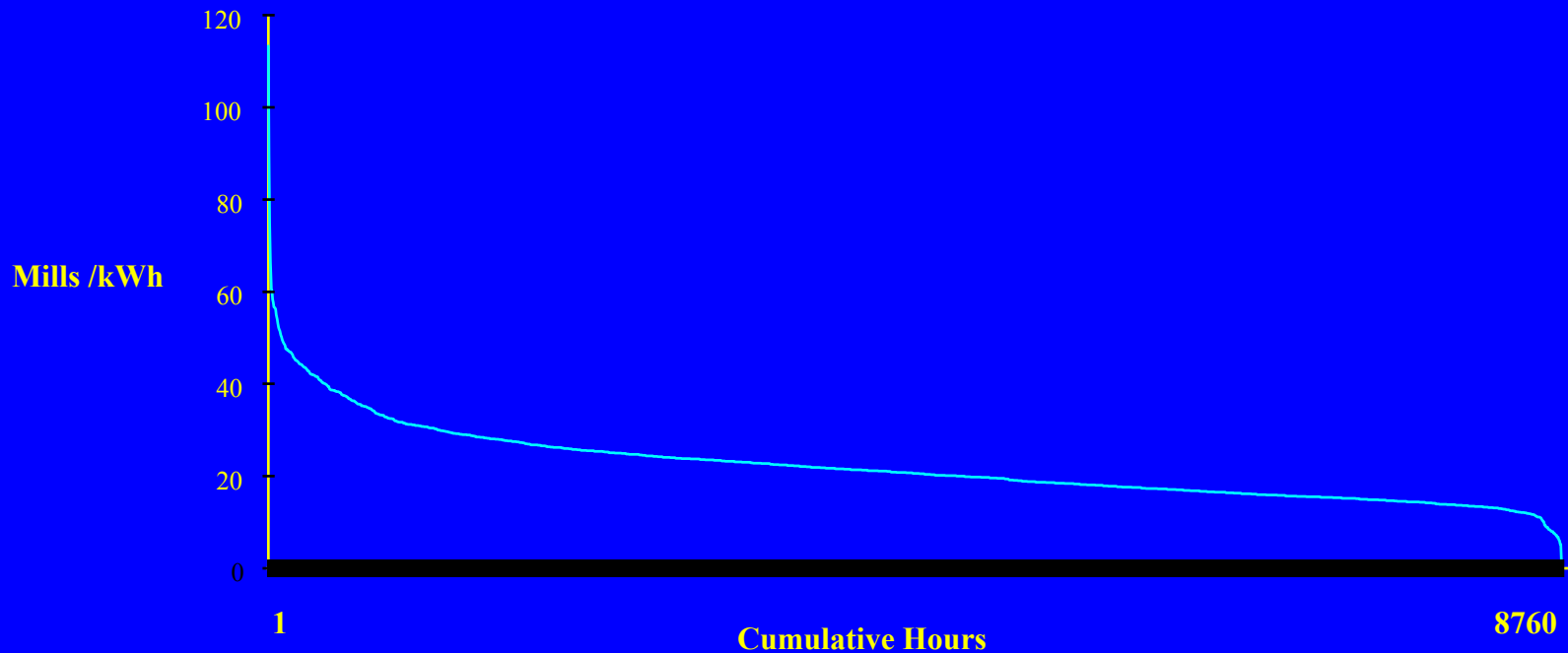
# Two Days in January, 1993 Hourly Marginal Costs

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# Cost Duration Curve: Sorted by *ESD 126* Marginal Cost

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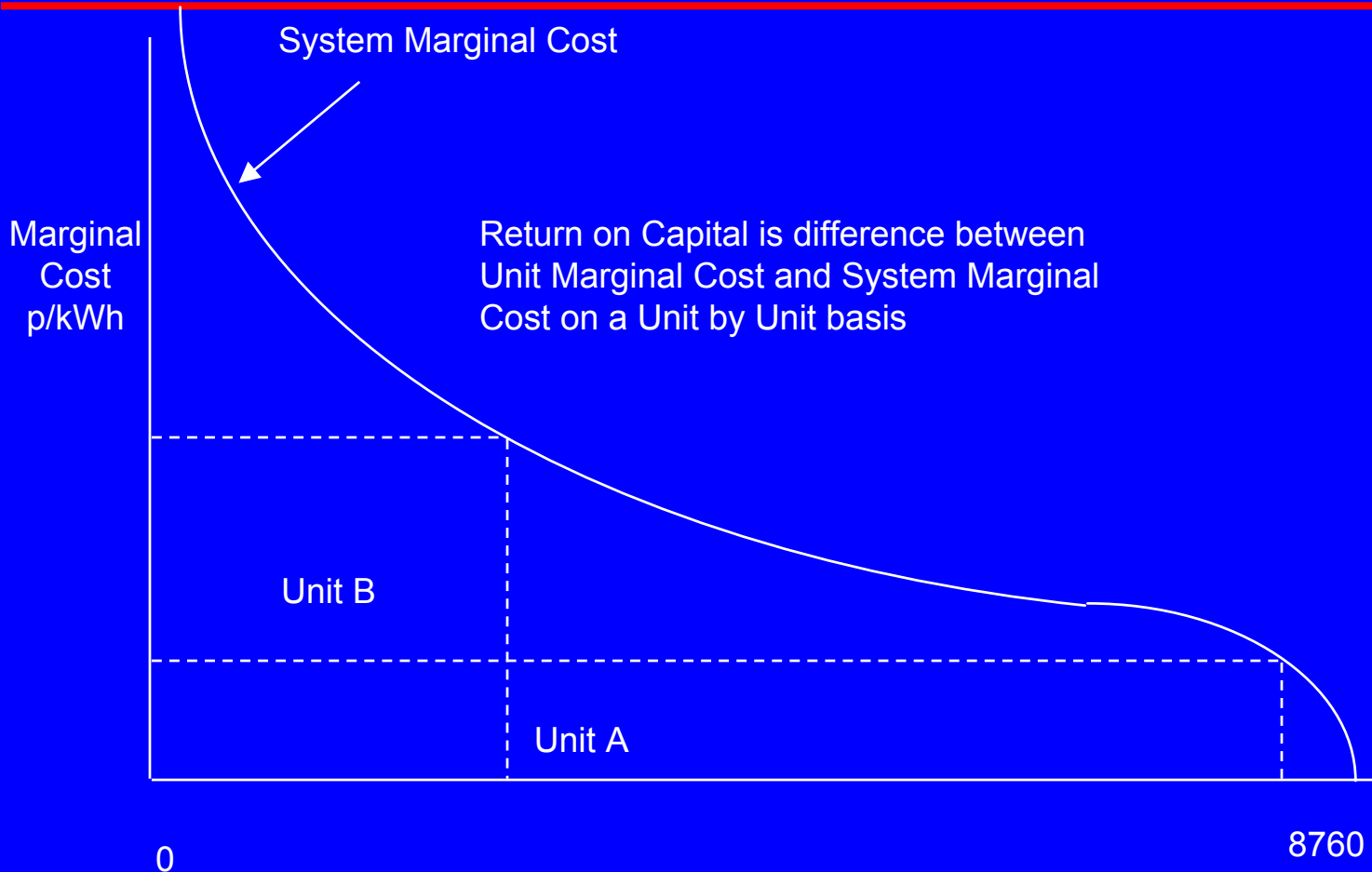


# **Ramsey version of SRMC** *ESD 126*

## **Rate: RTP (US) or ...**

$$\begin{aligned} MC_{GEN}(t) = & \text{System Lambda (t) or System} \\ & \text{Marginal Costs} \\ & + \\ & \text{Marginal Generation and Maintenance Cost (t)} \\ & + \\ & \text{Marginal Cost of Reserves and Contingencies (t)} \\ & + \\ & \text{Marginal Shortage Costs(t) (VOLL/LOLP or other} \\ & \text{approximation method)} \\ & + \\ & \text{Revenue Recovery Adjustment (US)} \end{aligned}$$

# Individual Unit Economics



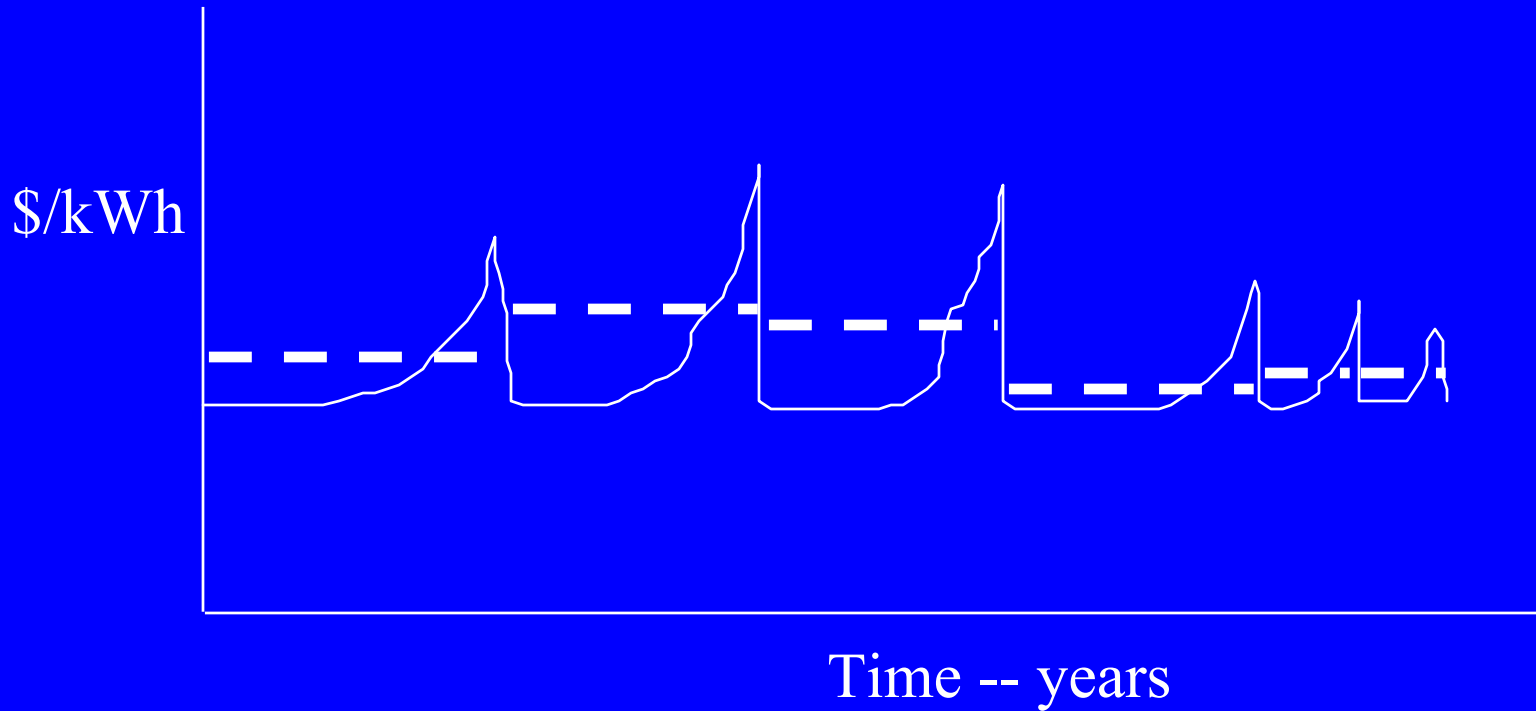
# *Revenue Recovery*

- *Objective: to match the financial calculation of required revenues to the economic earnings of marginal costs*
  - In general the earnings from  $MC < AC$
  - In theory, when you include Capacity Shortage Costs, and are in equilibrium, sufficient revenue will be generated with SRMC pricing.
  - Methods of recovery for difference between MC and AC
    - Adder (per kWh)
    - Lump Sum (connection charge)
    - Multiplier (per kWh)

## ***LRMC***

- *Forward looking to the next investment*
- *Includes expected operating costs*
- *“Saw toothed” behavior*
- *Best for infrastructure with little operating cost and high capital cost*
  - Water and Sewer

***LRMC***



# ***Summary of Pricing Rules and Realities: The Devil is in the Details*** *ESD 126*

- *What role will the regulator play?*
- *How quickly will “deep” markets emerge?*
- *Who will benefit and who will be hurt in the transition?*
- *How many products are there?*
  - *Who will decide?*
- *How will the futures market develop to provide for hedges on price?*
- *Can the regulator remain aloof -- in the UK the regulator has stepped in because of poor initial rules?*

# Swaps / Contracts for Differences

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