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Rate Design For Gas Utilities

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and

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December 1, 2023

Delivered Remotely

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Incentives v. Cost Recovery

Economists: View world through lens of **incentives**

Decentralized decisions

Price is a **signaling device**

Result: People make good decisions, and the result is best for everyone

Engineers: View world through lens of **problem solving**

Concerned about making the best decision about deploying resources to meet the objectives of the investment

Price is a **cost recovery mechanism**

Result: Planners make good decisions, and the result is best for everyone

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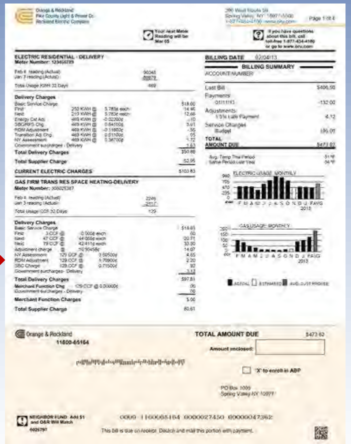
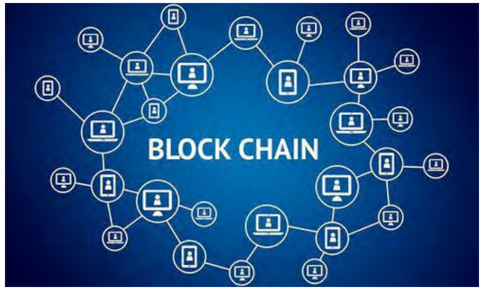
Why Does Pricing Matter?

OLD WORLD



Price



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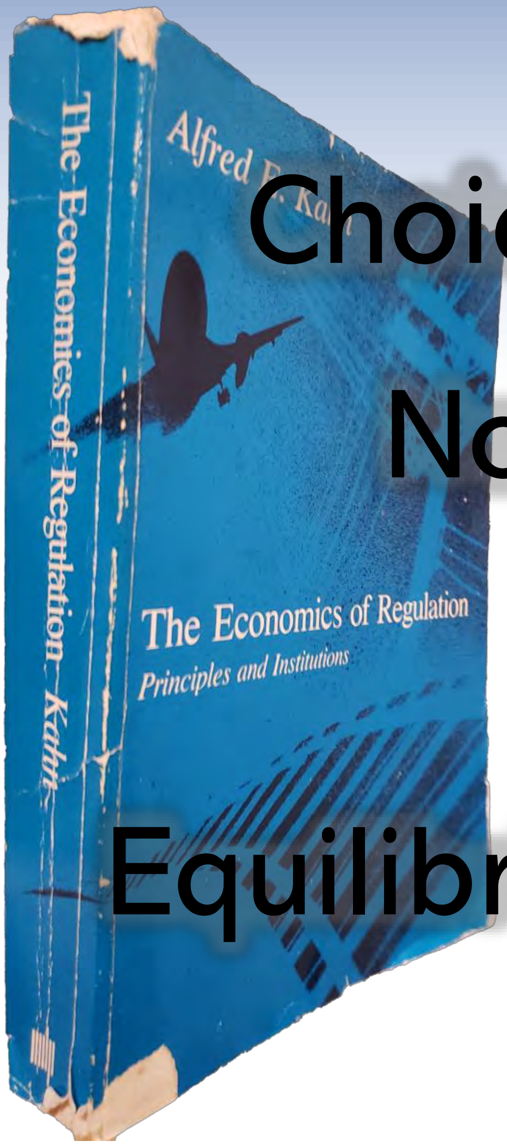
Principles



Scarcity

Choice has a Cost (Opportunity Cost)

Not all Costs Matter (Sunk Cost)

Comparing the Margins

Equilibrium: People Respond to Incentives

Demand Curve

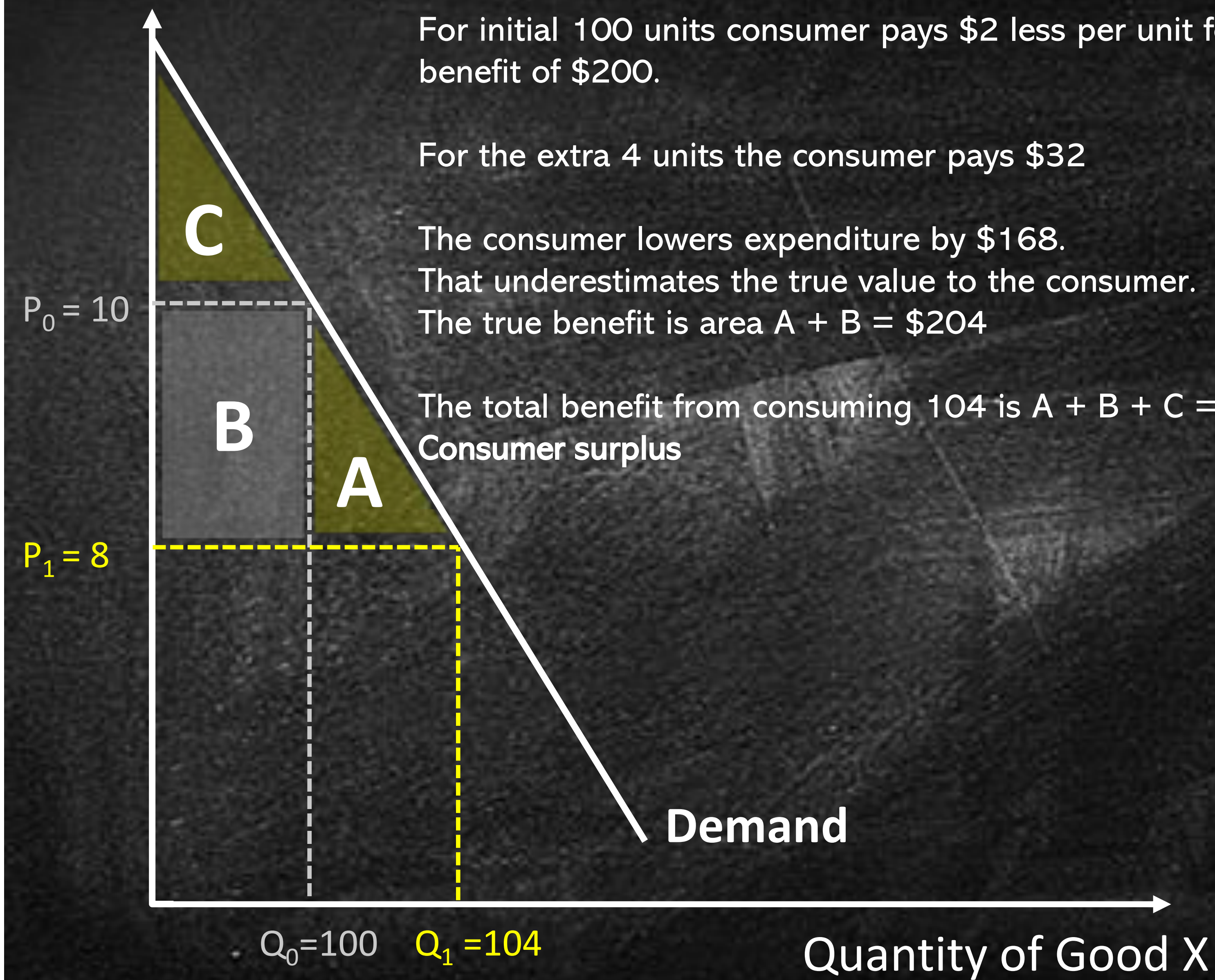
How does consumer benefit from fall in price?

For initial 100 units consumer pays $2 less per unit for a benefit of $200.

For the extra 4 units the consumer pays $32

The consumer lowers expenditure by $168.
That underestimates the true value to the consumer.
The true benefit is area A + B = $204

The total benefit from consuming 104 is A + B + C =
Consumer surplus



Law of Demand

- Substitution Effect
- Income Effect

Key Factors Shifting Demand For Utility Service

- Weather/Climate
- Preferences/Information
- Substitutes and Complements
- Income

Own-Price Elasticity of Demand for Electricity and Natural Gas

	Electricity		Natural Gas
	National Residential[1]	National Commercial[2]	National Residential[3]
Short-run	-0.24	-0.21	-0.12
Long-run	-0.32	-0.97	-0.36

Estimates use data from 1977-2004

(1) "Regional Differences in the Price Elasticity of Demand for Energy," RAND Corporation, 2005 Prepared for NREL p. 18

(2) Id. p. 21

(3) Id. P. 24

Long run Commercial and industrial number are as much as twice the residential numbers

Why is price elasticity important?

$$\varepsilon_d = \frac{\%\Delta Q_d}{\%\Delta P}$$

Revenue and demand elasticity are related

Total Revenue = P*Q

When price changes there a price effect and a quantity effect on total revenue

If demand is inelastic (i.e., $\%\Delta Q_d < \%\Delta P$) the price effect is **stronger** than the quantity effect and total revenue increases (decreases) when price increases (decreases). **Price and total revenue move in the same direction**.

If demand is elastic (i.e., $\%\Delta Q_d > \%\Delta P$) the quantity effect is **stronger** than the price effect and total revenue decreases (increases) when price increases (decreases). **Price and total revenue move in the opposite direction**.

Forecasting billing determinants

Creating decoupling plans

Understanding customer fuel-switching capabilities

Composite goods (energy efficiency implications)

NATURAL MONOPOLY PRICING PROBLEM

Option 1: Price at Marginal Cost

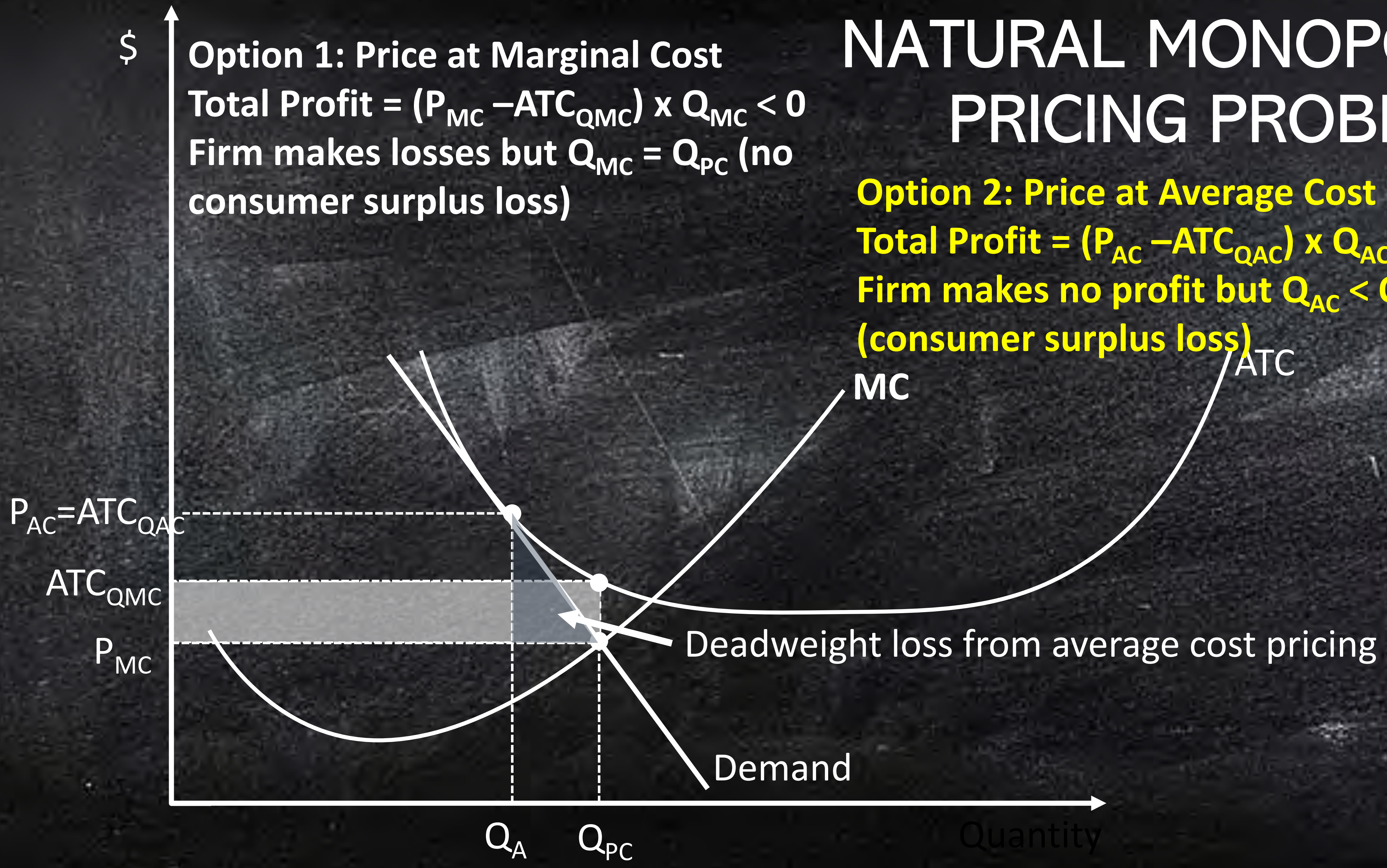
Total Profit = $(P_{MC} - ATC_{QMC}) \times Q_{MC} < 0$

Firm makes losses but $Q_{MC} = Q_{PC}$ (no consumer surplus loss)

Option 2: Price at Average Cost

Total Profit = $(P_{AC} - ATC_{QAC}) \times Q_{AC} = 0$

Firm makes no profit but $Q_{AC} < Q_{PC}$ (consumer surplus loss)



Early Principles of Ratemaking

Price discrimination should be the norm: Railroads

The public interest is best served when the rates are so apportioned as to encourage the largest practicable exchange of products between different sections of our country and with foreign countries; and this can only be done by making value an important consideration, and by placing upon the higher classes of freight some share of the burden that on a relatively equal apportionment, if service alone were considered, would fall upon those of less value. With this method of arranging tariff's little fault is found, and perhaps none at all by persons who consider the subject from the stand-point of public interest. (Interstate Commerce Commission, Annual Report, 1887, p. 36)

Price discrimination should be minimized: **Public Utilities**

Free from "Unjust" Discrimination

Rate Classes Based on Difference in Service

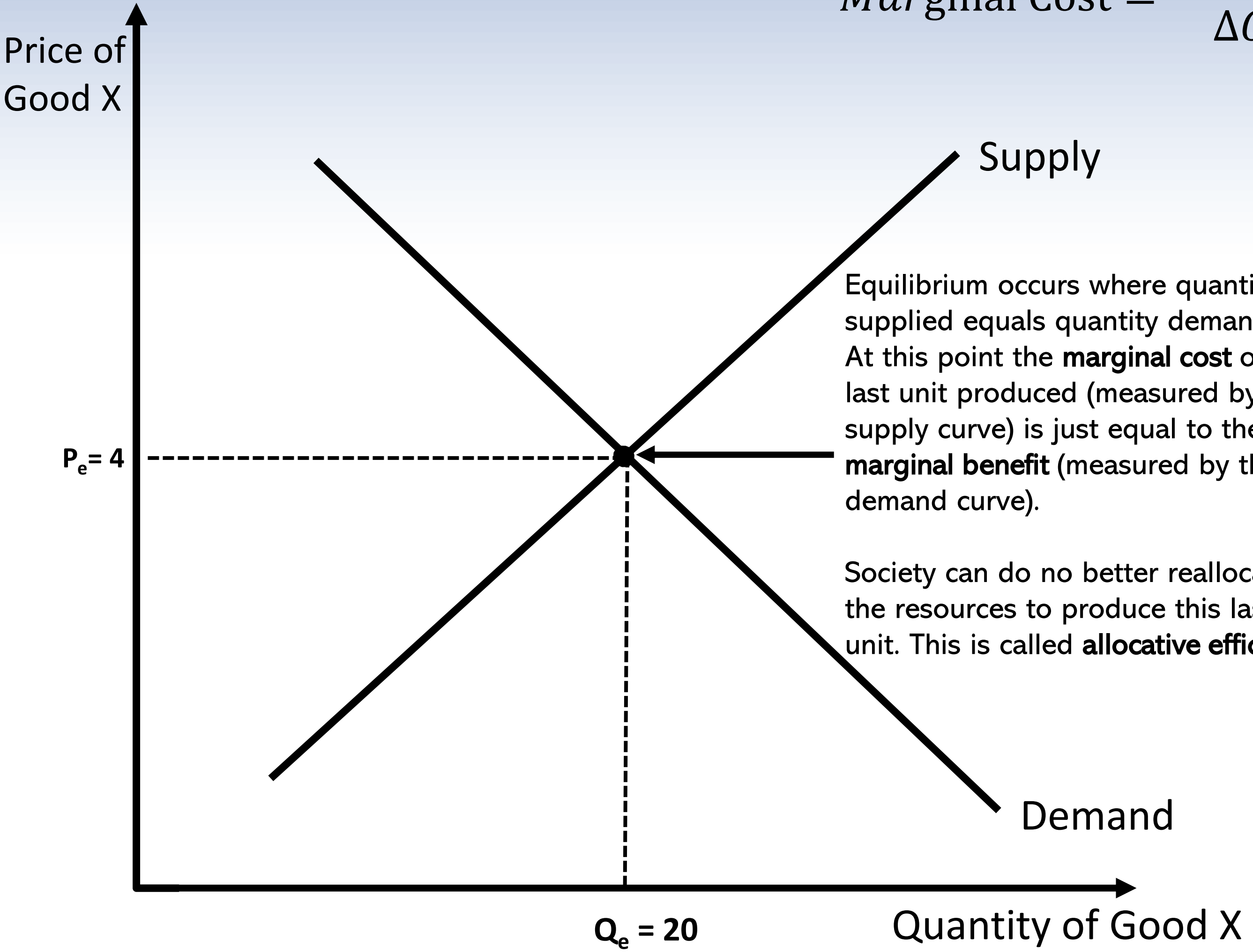
Rates Based on Class Cost of Service

Rates Should Recover Costs Including Return

Investigation of Commonwealth Edison Company, Report to Committee on Gas, Oil and Electric Light, Chicago City Council 1913

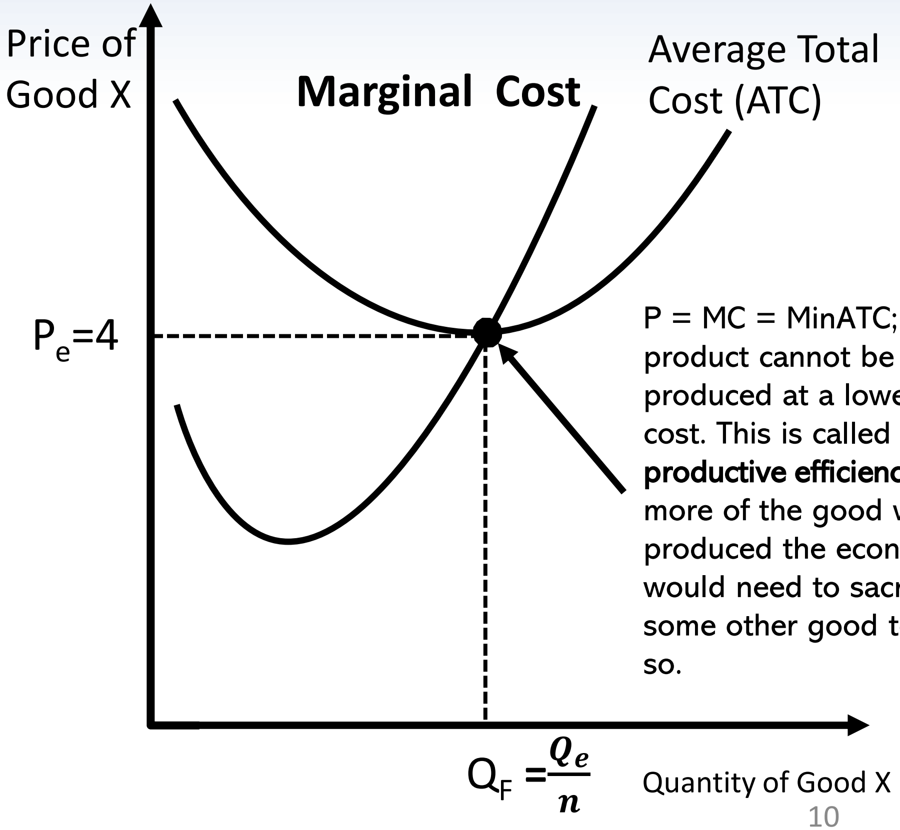
Why Marginal Cost?

$$Marginal\ \text{Cost} = \frac{\Delta Total\ Cost}{\Delta Output}$$



Equilibrium occurs where quantity supplied equals quantity demanded. At this point the **marginal cost** of the last unit produced (measured by the supply curve) is just equal to the **marginal benefit** (measured by the demand curve).

Society can do no better reallocating the resources to produce this last unit. This is called **allocative efficiency**



P = MC = MinATC; the product cannot be produced at a lower cost. This is called **productive efficiency**. If more of the good were produced the economy would need to sacrifice some other good to do so.

What Marginal Costs?

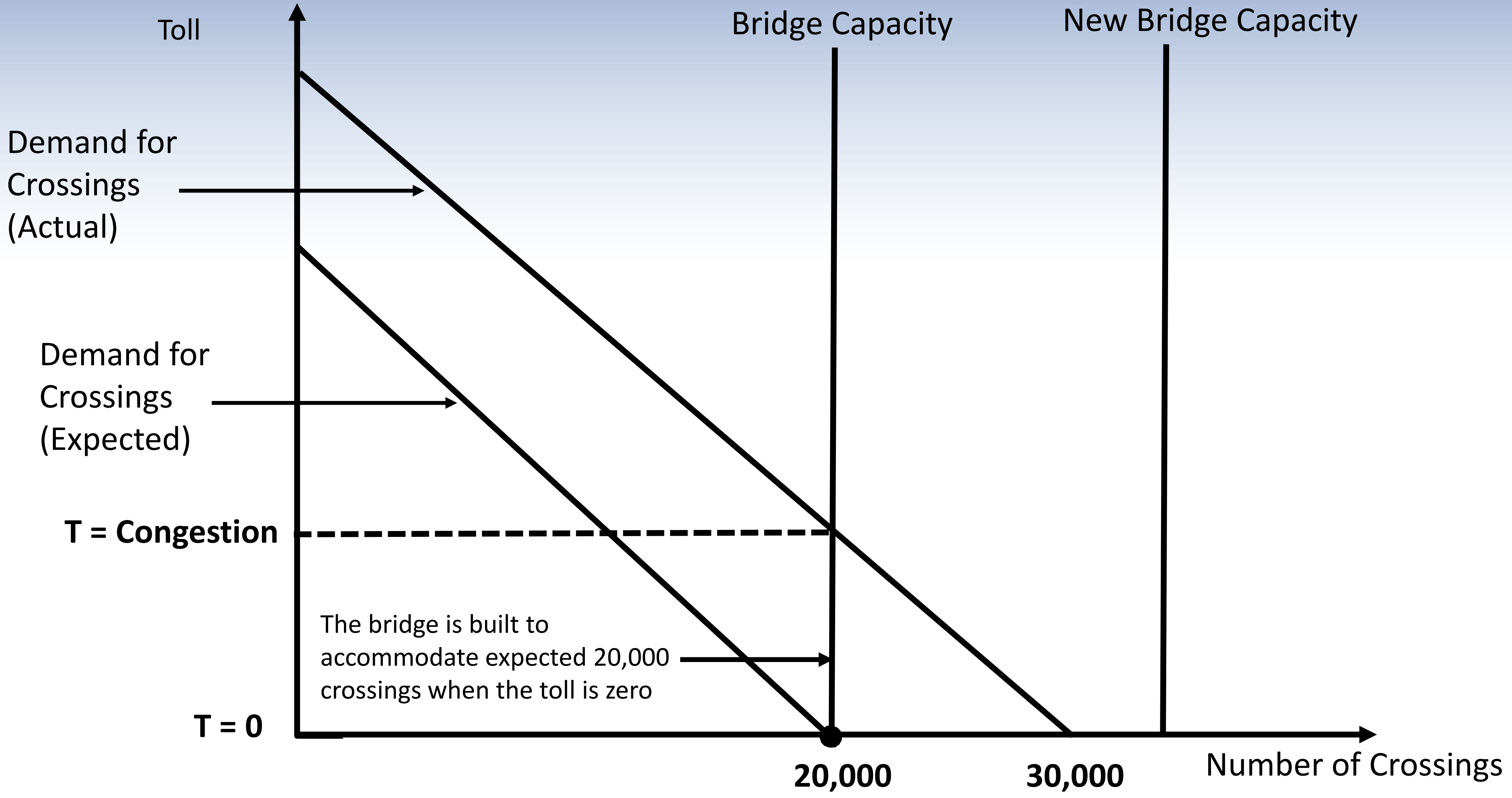
Bridge is built with a set of fixed assets

Charging a price greater than zero underuses the assets

What if charging price of zero causes congestion?

Set price equal to congestion costs (short-run marginal cost)

Toll Bridge Pricing



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What is wrong with SRMC?

SRMC changes with usage or congestion (i.e., demand)

- Volatile prices might cause customers to over or under invest
- The administrative cost of calculating and disseminating prices is too high
- What if SRMC does not cover cost of construction?

Set priced based on LRMC

- Isn't this the same as SRMC? Only under restrictive conditions
  - Capacity is continuous both increasing and decreasing
  - Investment is optimal or adjusts quickly to changing demands
  - Not likely for a gas utility
- LRMC Sends Constant Long-term Price Signals
- LRMC takes into Account Capital Costs
- LRMC is most Common Approach

Traditional Rate Design

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Revenue Requirement

Capital Expenses

OPEX +Interest + Taxes

Return of and on Capital

Cost of Service

Operational Data

Economic Analysis

Judgment

Rate Design Objectives

Revenue Recovery

Price Signals

Efficiency

Equity

Other Factors

Rate Shock

Social Concerns

Policy Concerns

Final Prices

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What is the Role of the Public Utility Price?

Capital Attraction

- Utilities should be willing to provide the level of service necessary to serve all comers
- Applies to rate structure and the rate levels

Efficiency-Incentive

- Prices in a competitive market provide incentives for firms to produce more efficiently to maximize profits
- If regulation is a substitute for competition, regulated prices should provide incentives for effective production

Demand Rationing

- Consumers also need price signals to make decisions about consumption.

Income Distribution

- Prices also serve as both a method of transferring cash from consumers to producers and as a method of transferring cash between consumers.

Regulatory Objectives for Rates*

Low-income and medical baseline customers should have access to enough electricity to ensure basic needs (such as health and comfort) are met at an affordable cost;

Rates should be based on marginal cost;

Rates should be based on cost-causation principles;

Rates should encourage conservation and energy efficiency;

Rates should encourage reduction of both coincident and non-coincident peak demand;

Rates should be stable and understandable and provide customer choice;

Rates should generally avoid cross-subsidies, unless the cross-subsidies appropriately support explicit state policy goals;

Incentives should be explicit and transparent;

Rates should encourage economically efficient decision-making;

Transitions to new rate structures should emphasize customer education and outreach that enhances customer understanding and acceptance of new rates, and minimizes and appropriately considers the bill impacts associated with such transitions.

*ALJ Ruling in CPUC R.12-06-013 “Order Instituting Rulemaking on the Commission’s Own Motion to Conduct a Comprehensive Examination of Investor Owned Electric Utilities’ Residential Rate Structures, the Transition to Time Varying and Dynamic Rates, and Other Statutory Obligations.”

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Factors Affecting Rate Design Choices

Economic

- Cost of service
- Value of service
- Competitor prices
- Price differences and discrimination
- Availability of gas supply and capacity
- Return and revenue stability

Regulatory Factors

- Precedent
- Intervenor interests

Historical Factors

- Rate perspective
- Rate continuity

Social and Political Factors

- Customer reaction and acceptance
- Public relations aspects
- Economic conditions of service territory
- Social obligations to particular customer groups
- Political attention and involvement

Pricing Strategies

Volumetric rates make up most rate structures at retail level (unlike at wholesale level)

Pricing strategies have largely focused on recovery of reasonable costs. This has led to:

- Trackers and riders
- Decoupling
- Formula ratemaking

Recognition of price as a signal is relatively new:

- MC-based pricing in 1970s
- Interruptible capacity pricing
- Economic Development and bypass rates
- Pricing for DER – Value of resources
- Demand charges and SFV
- Energy Efficiency
- Renewable standards
- Low-emissions credits
- Non-wires and non-pipe solutions

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Introduction to Rate Design

Rate design covers both the structure of rates

Traditionally rates were used (almost) solely to recover revenue, but today rates are also used to send signals, but what signals?

- What does it cost to serve the customer?
- How do we encourage “good” behavior?
- Should we consider externalities?

Terms Used in Rate Design

Billing determinants

Factors used to compute a customer's bill (e.g., number of customers, usages, demand, power factor, etc.)

Base Rates

rates that are set in the tariff until allowed to increase by a decision of the regulatory body

Riders

Mechanisms used to track certain costs (e.g., gas costs)

Economist Approach to Pricing

Define the value of a transaction

consumer surplus and producer surplus (i.e., profit).

Competitive markets maximize consumer surplus

Optimal pricing asks the question

Price such that, subject to the break-even constraint, surplus is maximized

Two things to remember

Total surplus = consumer surplus plus producer surplus. The economics does not differentiate between the two.

Surplus (always) increases if the quantity sold increases

Price Discrimination

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Is that how regulators look at it?

- Does not matter who gets the surplus if it is as large as possible
  - Most regulators charged with balancing the interests of consumers and utilities
- Surplus increases if quantity increases
  - Many regulators charged with promoting lower sales due to climate change concerns
- Pricing in practice does not seem to fit pricing in theory

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Methods of Charging Customers

Customer or base charge: $/customer

Demand (highest level of measured consumption): $/therm

Vol: $/usage

Energy-only Rates

- Flat Rates
- Blocked Rates

Demand and Energy Rates

- Customer, Demand, and Energy rates (Hopkinson)
- Hours-of-Use rates (Wright)

Time-Differentiated Rates

- Seasonal Rates
- Time-of-Use Rates (more on the electric side)

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Pricing Illustration

Residential Class - Full Cost Rate			
Customer Costs		$	33,212,000
Demand Costs		$	18,233,000
Energy Costs		$	-
Sales			206,858,022
Customers			179,951
Customer Charge		$	15.38
Volume Charge		$	0.0881
Total Cost		$	51,445,000
	Customer Charge	$	33,212,000
	Per Therm	$	18,233,000
Total Revenue		$	51,445,000

Residential Class - Customer Charge Capped at $10			
Customer Costs		$	33,212,000
Demand Costs		$	18,233,000
Energy Costs		$	-
Sales			206,858,022
Customers			179,951
Customer Charge		$	10.00
Volume Charge		$	0.1443
Total Cost		$	51,445,000
	Customer Charge	$	21,594,120
	Per Therm	$	29,850,880
Total Revenue		$	51,445,000

Residential Class - Multi Block (Customer Charge Capped at $10)			
Customer Costs		$	33,212,000
Demand Costs		$	18,233,000
Energy Costs		$	-
Sales			206,858,022
	0-50 Therms		41,371,604
	Over 50 Therms		165,486,418
Customers			179,951
Customer Charge		$	10.00
Volume Charge		$	0.1444
	0-50 Therms	$	0.3690
	Over 50 Therms	$	0.0881
Total Cost		$	51,445,000
	Customer Charge	$	21,594,120
	0-50 Therms	$	15,264,480
	Over 50 Therms	$	14,586,400
Total Revenue		$	51,445,000

Types of Utility Tariffs

Flat rates

Declining Tariffs

Inverted Black Tariffs

Hopkinson (Two-part) Tariffs

Time of Use (Seasonal)

Modern pricing (more unbundling, more granular costing)

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Advantages and Disadvantages of Flat Tariffs

Advantages

Easy to bill.

Easy for customers to understand.

Requires simple metering technology.

Disadvantages

Fails to capture differences in demand.

Fails to capture difference in time-of-use.

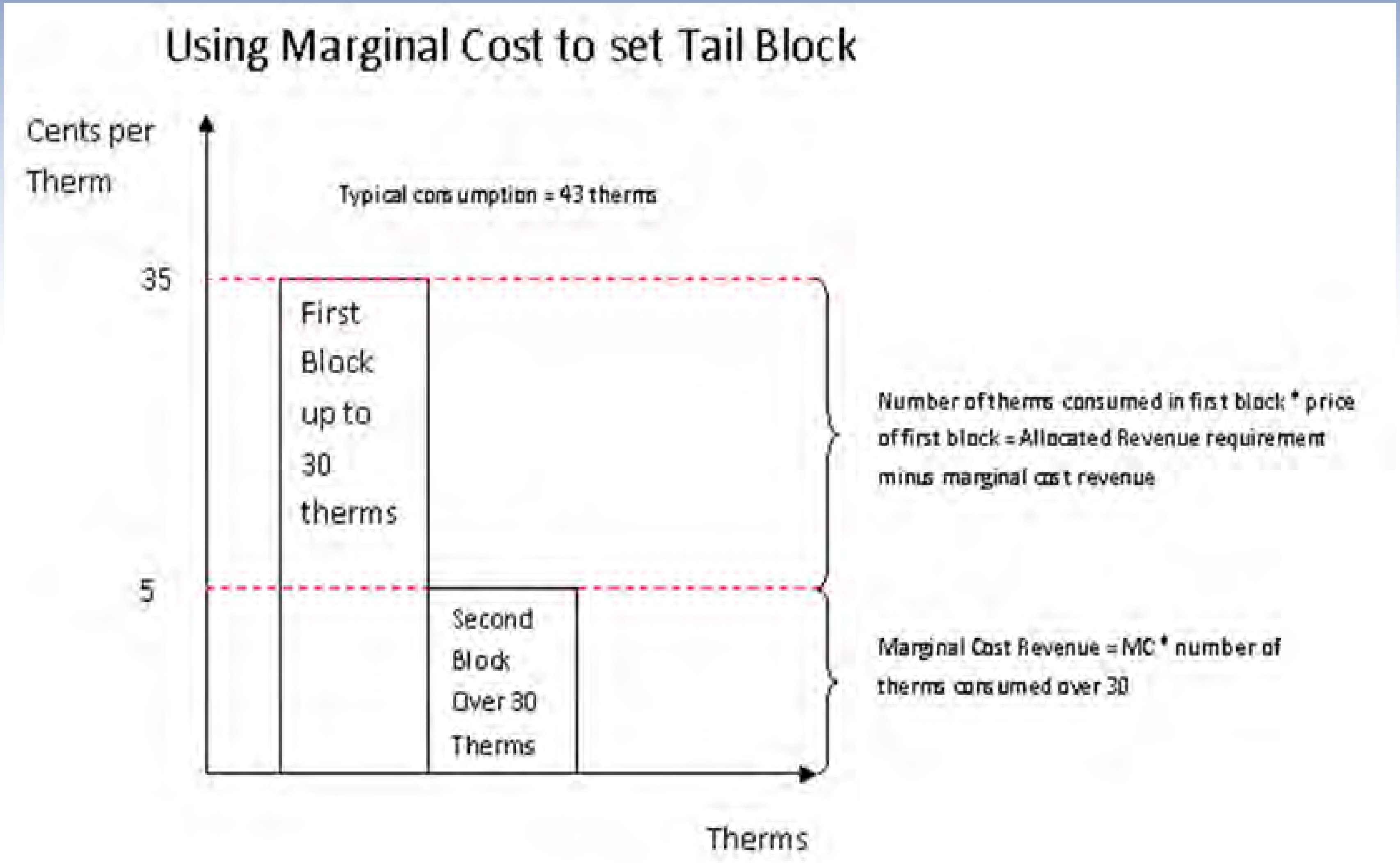
Requires that customers must be homogeneous.

Declining Tariffs

The declining tariff has two blocks with a reduced charge for the second block.

These tariffs are employed when the marginal cost to serve a customer is less than the average revenue requirement of the tariff.

Example



Using Marginal Cost to set Tail Block
Cents per Therm
Typical consumption = 43 therms
35
5
First Block up to 30 therms
Second Block Over 30 Therms
Therms
Number of therms consumed in first block * price of first block = Allocated Revenue requirement minus marginal cost revenue
Marginal Cost Revenue = MC * number of therms consumed over 30

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Advantages and Disadvantages of Declining Block Rates

Advantages

Simple for the utility to bill.

Simple for the utility to meter.

Fairly simple for customers to understand.

Appropriate when the average revenue requirement exceeds the marginal cost to supply customers.

Disadvantages

Fails to capture differences in demand.

Fails to capture difference in time-of-use.

Requires that customer classes be homogeneous.

Not appropriate unless average revenue requirement is less than marginal costs.

Can shift costs to smaller users

Increasing Block Tariffs

The Increasing Block Tariff is the opposite of the Declining Block Tariff – the last block of usage is billed at a higher charge.

This type of rate design is appropriate when the average revenue requirement is less than the marginal cost to serve customers.

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Increasing Block Tariffs – Advantages and Disadvantages

Advantages

Simple for the utility to bill.

Simple for the utility to meter.

Fairly simple for customers to understand.

Appropriate when the average revenue requirement is less than the marginal cost to supply customers

Disadvantages

Fails to capture differences in demand.

Fails to capture difference in time-of-use.

Requires that customers must be homogeneous.

Not appropriate unless average revenue requirement is greater than marginal costs.

Can shift costs to larger users.

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Advantages and Disadvantages of Hopkinson Tariffs

Advantages

Captures the differences in load factor form customer to customer.

Is generally understood by larger customers.

Provides explicit price signal to customers for both energy and capacity.

Disadvantages

Requires more costly meters. The metering investment must be balanced with the benefits of implementing the tariff.

Requires more effort to bill.

Modern Rate Design

Modern Pricing

Electric and gas markets have been evolving over the last 20-30 years

New pricing issues have led to new types of pricing:

- Competitive Rates
- Consolidation of rates
- Unbundling
- Peaking rates
- Line extension

Questions to Consider

- Suppose a gas company is selling delivery service at an average cost, but its competitor (e.g., an interstate pipeline) is selling at marginal cost.
  - How does this affect the decision to price delivery service? (Hint: suppose a customer can switch service between the two competitors.)
- How would you evaluate a proposal from a company with multiple subdivisions to consolidate its rates into one system-wide rate?
- Why would a utility unbundle rates?

Questions to Consider

What is a line extension rate?

- Regulator will typically include a set number of feet of line extension in rates (e.g., 100 feet)

What is the problem?

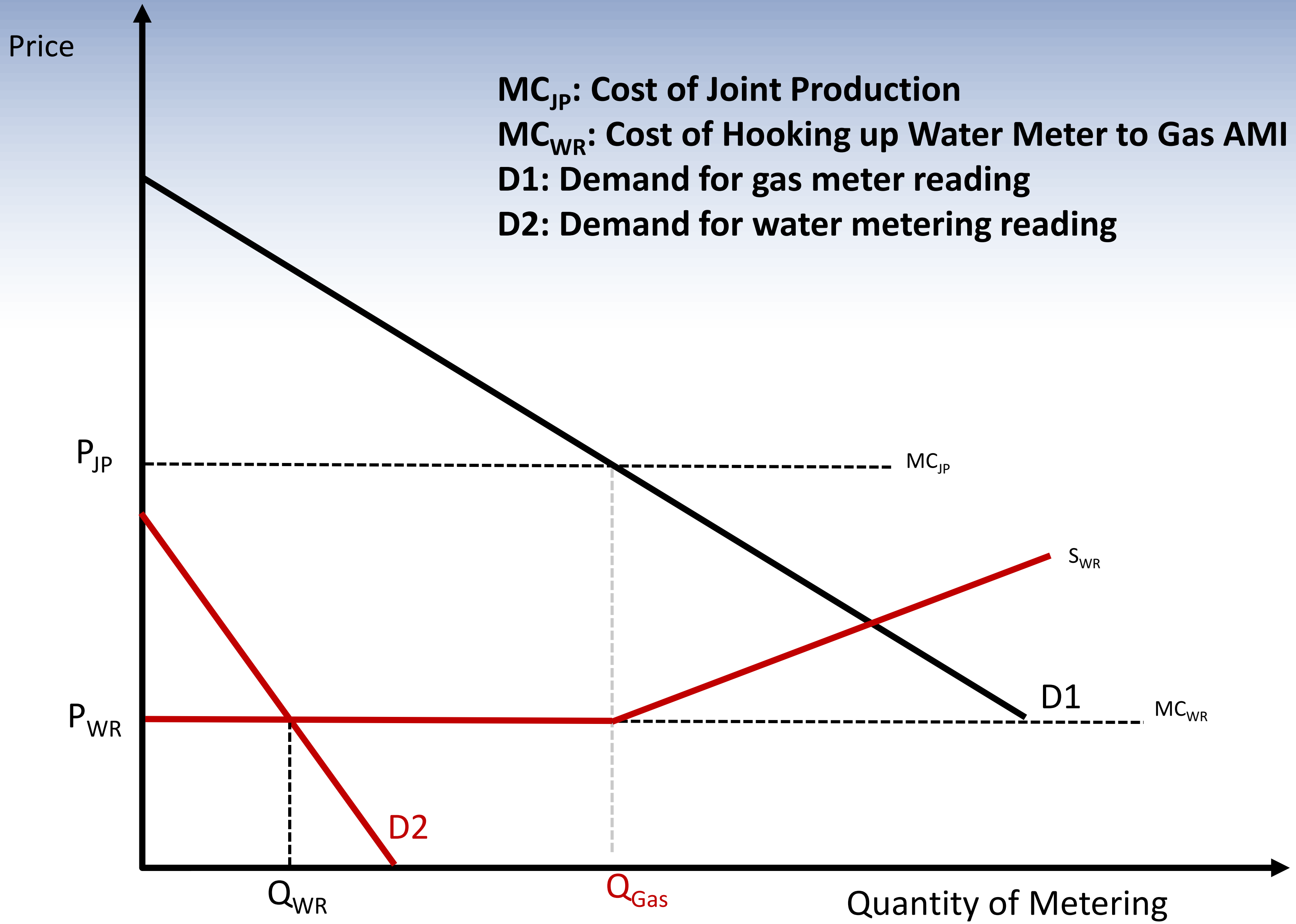
- Suppose a customer is 125 feet from the nearest main at $15 a foot that would entail a loss of margin to extend beyond the 100 feet
- Run a simple financial calculation (is it worth extending the line?)
- Include future gas sales growth
- What about competition (electric, oil, etc.)?
- What about climate change?

Pricing Issues with AMI

- End of 2022 about 72% of electric meters were smart meters (EIA, October 20, 2023)
- EIA does not publish gas AMI data, but number is significantly lower though many major utilities have or will soon have AMI
  - Can new services be provided?
  - Who should provide the communications network?
  - How can that network be priced?
  - Does this fit into smart grid, smart cities?

Pricing Issues with AMI: Joint Production

MC_{JP}: Cost of Joint Production
MC_{WR}: Cost of Hooking up Water Meter to Gas AMI mesh network
D1: Demand for gas meter reading
D2: Demand for water metering reading



Demand Response

Incentive-based

Price-based

Use in non-pipes solutions

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Current and Future Issues

We want to promote efficiency and good resource management but at the same time maintain and promote affordability

Fracking: Promotes lower cost gas but may run afoul of environmental goals

Electricity generation: competitive markets promote better pricing but gas is often marginal fuel ---how does it get to markets where it is needed? (gas v. electric transmission)

Exporting: creates opportunities for US citizens but may have cost and environmental issues (LNG facilities)

Current and Future Issues

Climate change: Gas can be part of solution v. coal but is it really a transition fuel?

Does lower usage makes gas utilities less attractive to investors and more costly to consumers (at least for delivery)

Need to maintain and expand current facilities

- Transport and storage constraints (NE, CA, etc.)
- While average prices are generally low very high prices can occur behind bottlenecks

Does this suggest another restructuring (Utility 3.0?)

- Biogas potential, competitive storage, more information to consumers
- Electrification (space heating, water heating)
  - …residential..[electric space heating applications]…are approaching cost parity with incumbent natural gas technologies in moderate to warm climates, but in cold climates, incumbent gas technologies…exhibit…[cost advantage]" NREL "Electrification Futures Study," 2017 (with caveats re: high regional gas prices)
- Gas demand management
  - Better pricing with AMI metering
  - Can DR save the day in transport tight regions?

Summary of pricing discussion

Pricing is not always about the economics: social, political, and other factors influence decisions

History matters: the best tax is an old tax (is this still true?)

Economic conditions in service territory – rate impact studies important

New technologies may make some/most of this discussion less relevant in the future (e.g., AMI)

Post-Test Year Ratemaking

Rates change after the rate case

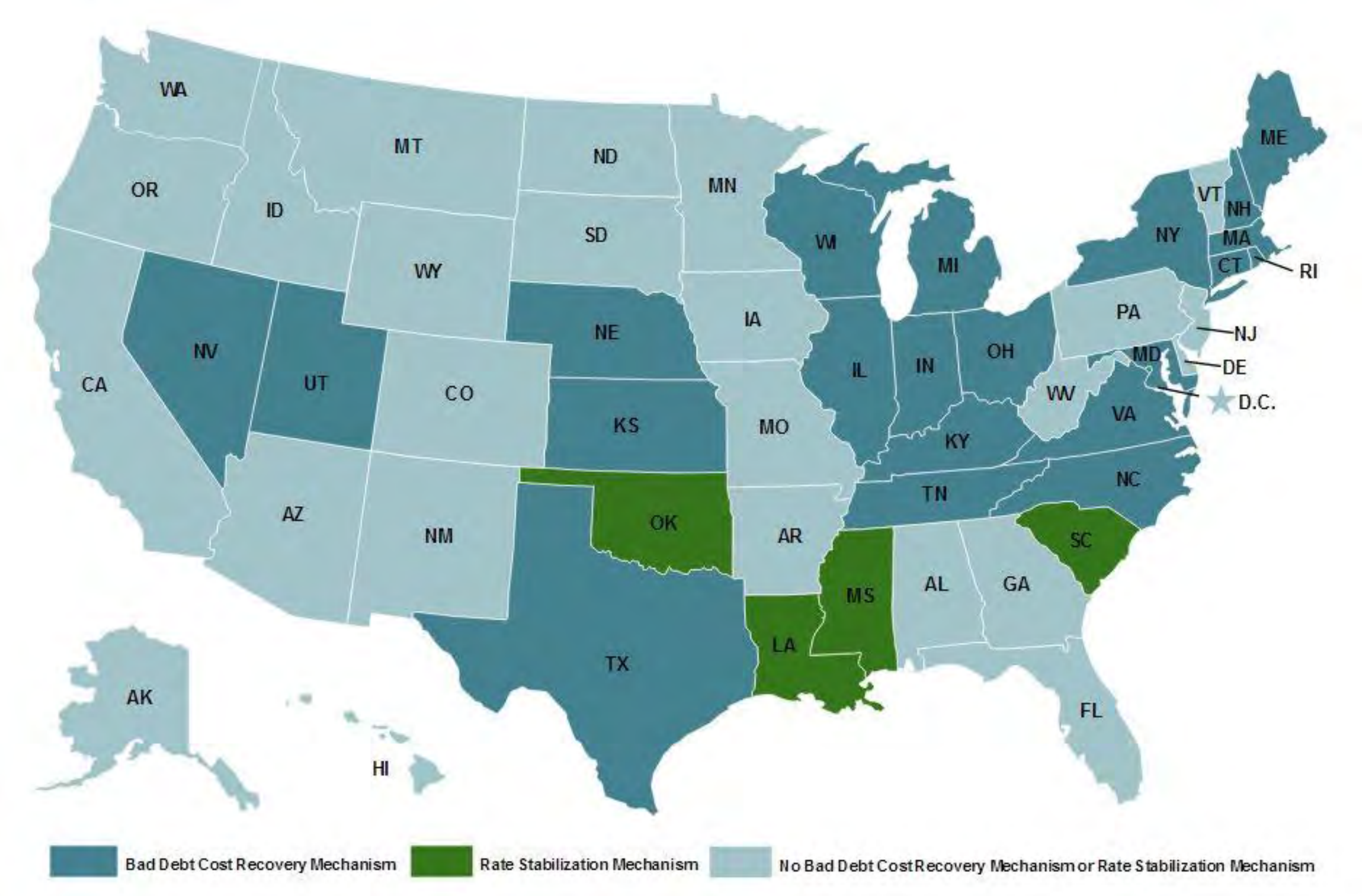
Addresses costs that are:

- Large
- Volatile
- Out of management control

Also may address:

- Inability to fairly predict usage
- Policy issues
- Lower regulatory costs

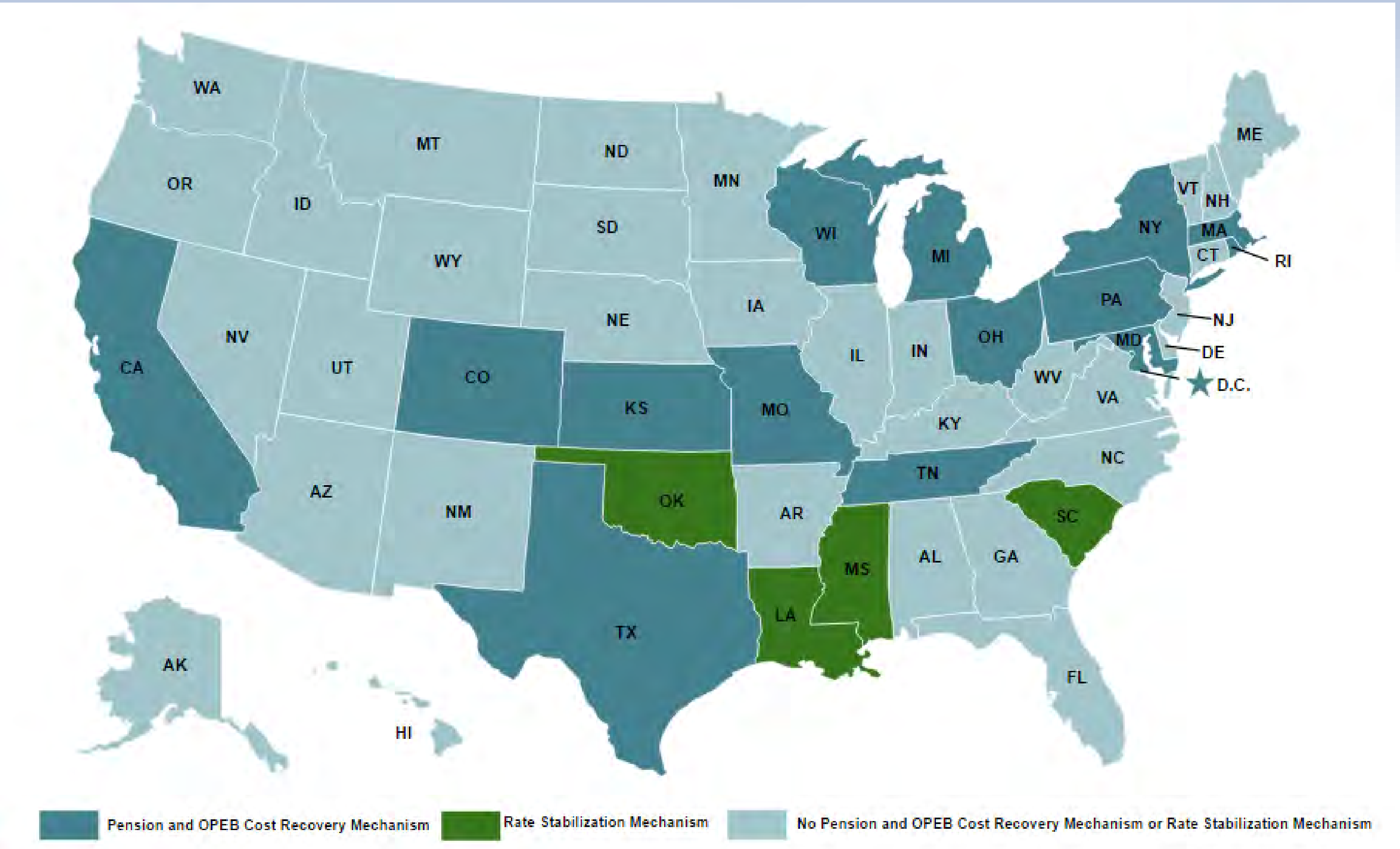
Natural Gas
Bad Debt Tracker



Source: American Gas Association December 2016

Natural Gas

Pension Trackers



Source: American Gas Association December 2016

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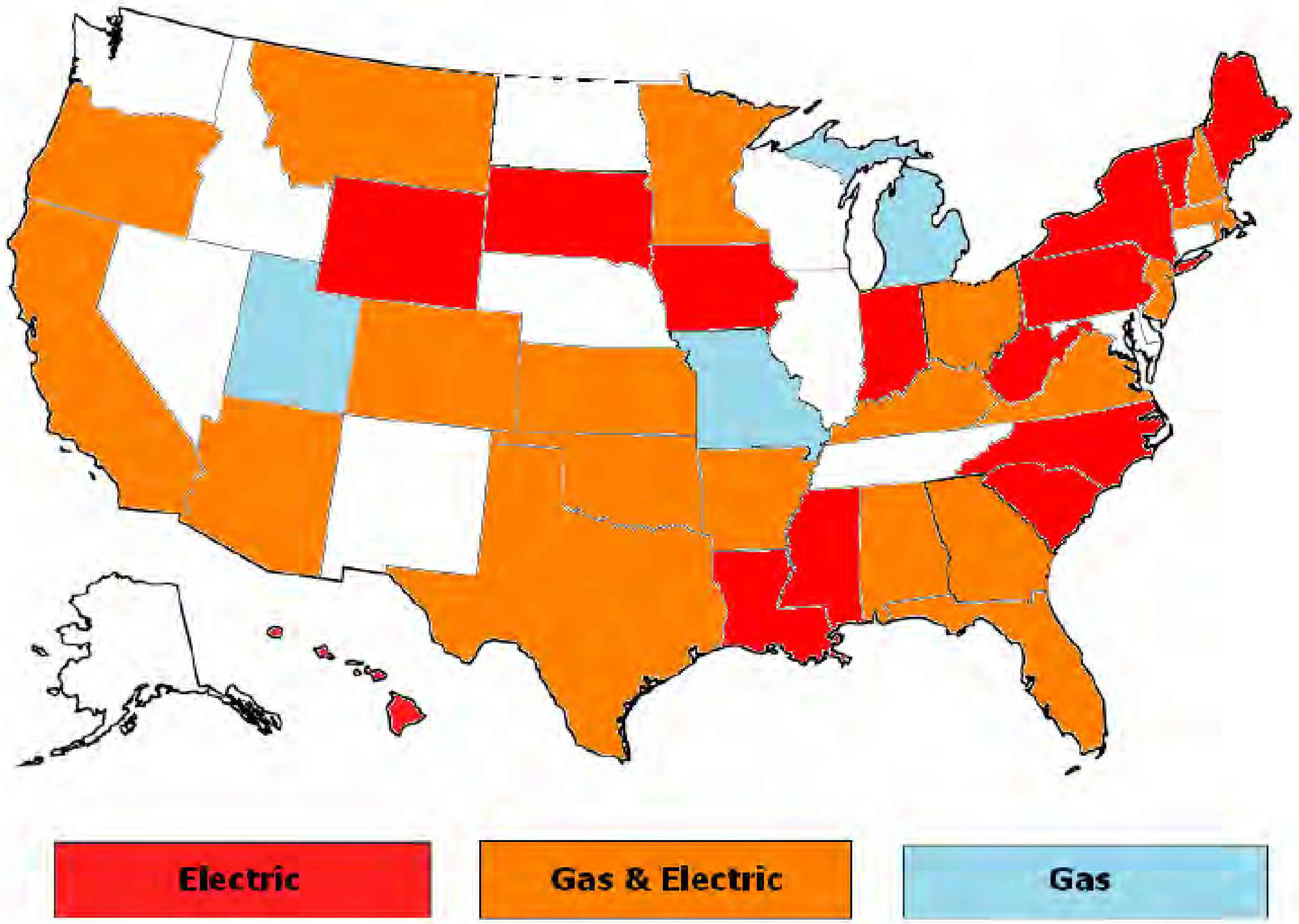
Natural Gas and Electric

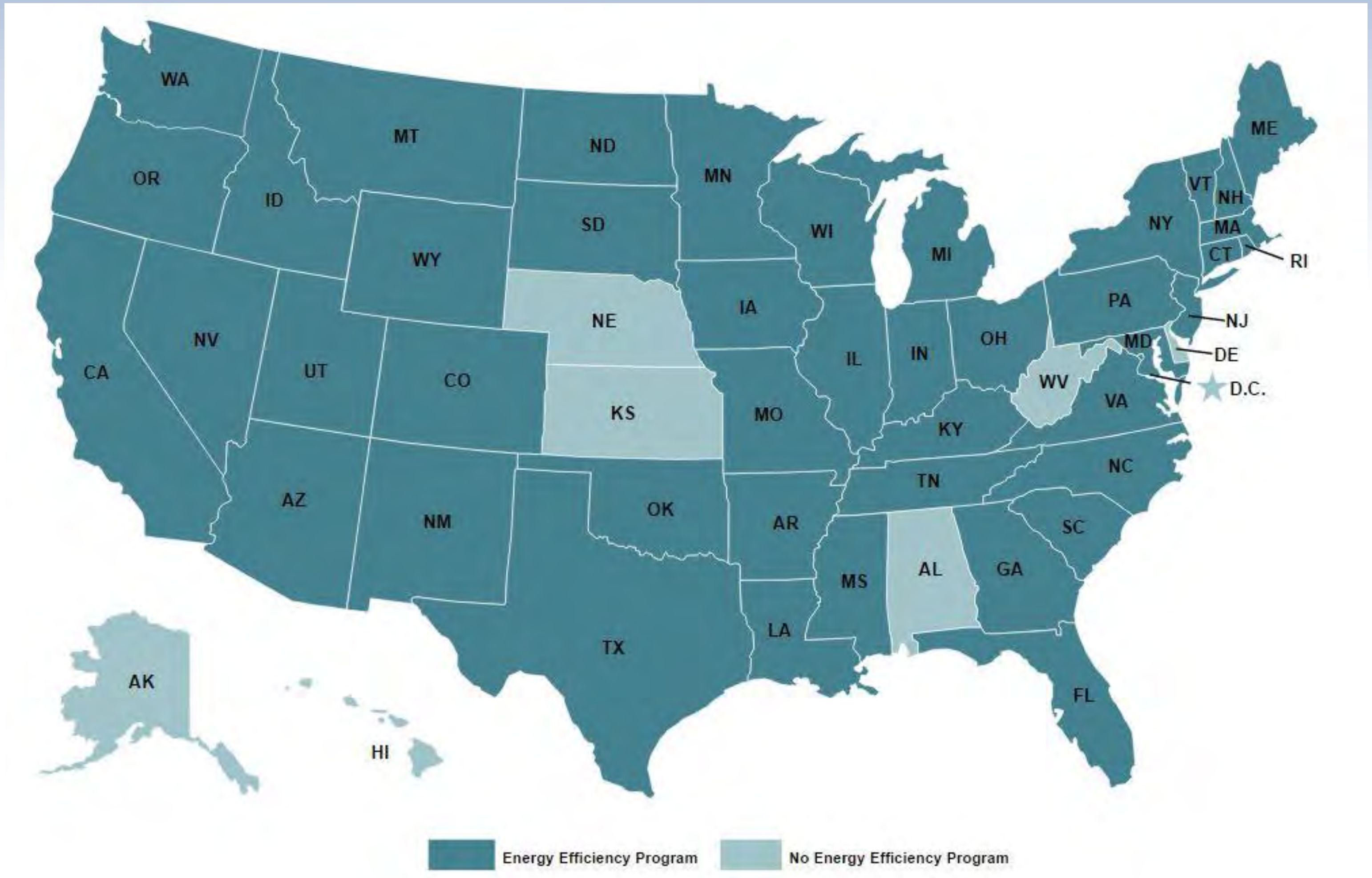
Accelerated Infrastructure Trackers



Source: EEI 2013

Natural Gas

Energy Efficiency Trackers



Source: American Gas Association December 2016

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Revenue Decoupling

Use Per Customer Basis

(RCUC – AUC) x Rate x RCC (or ACC) / Billing Units, where:

- RCUC = Rate Case Use Per Customer
- AUC = Actual Use Per Customer
- Rate = Distribution Rate
- RCC = Rate Case Customers
- ACC = Actual Customers

Margin Per Customer Basis

(RCMC – AMC) x RCC (or ACC) / Billing Units, where:

- RCMC = Rate Case Margin Per Customer
- AMC = Actual Margin Per Customer
- RCC = Rate Case Customers
- ACC = Actual Customers

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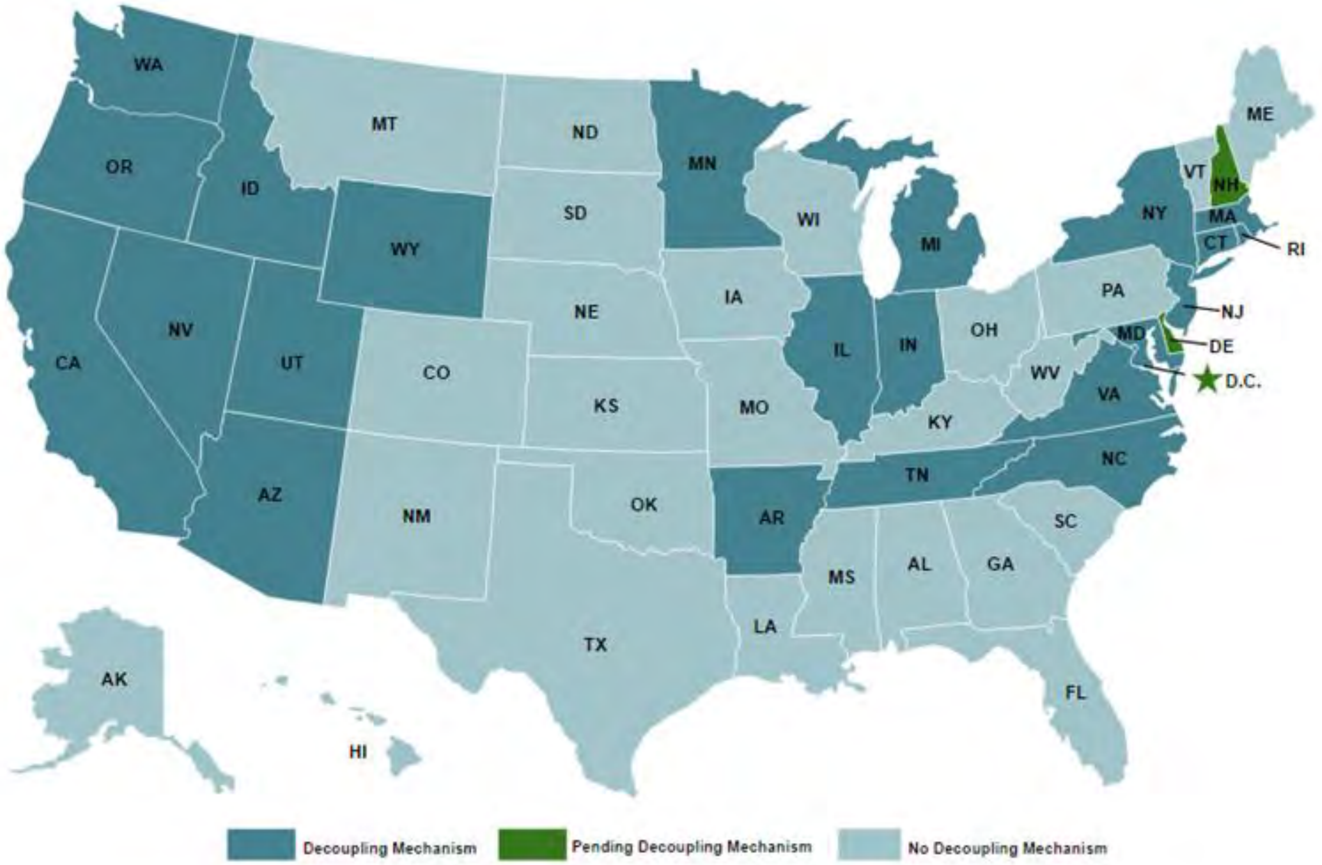
Decoupling

Natural Gas



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Thank You

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Appendix

Bonbright Principles

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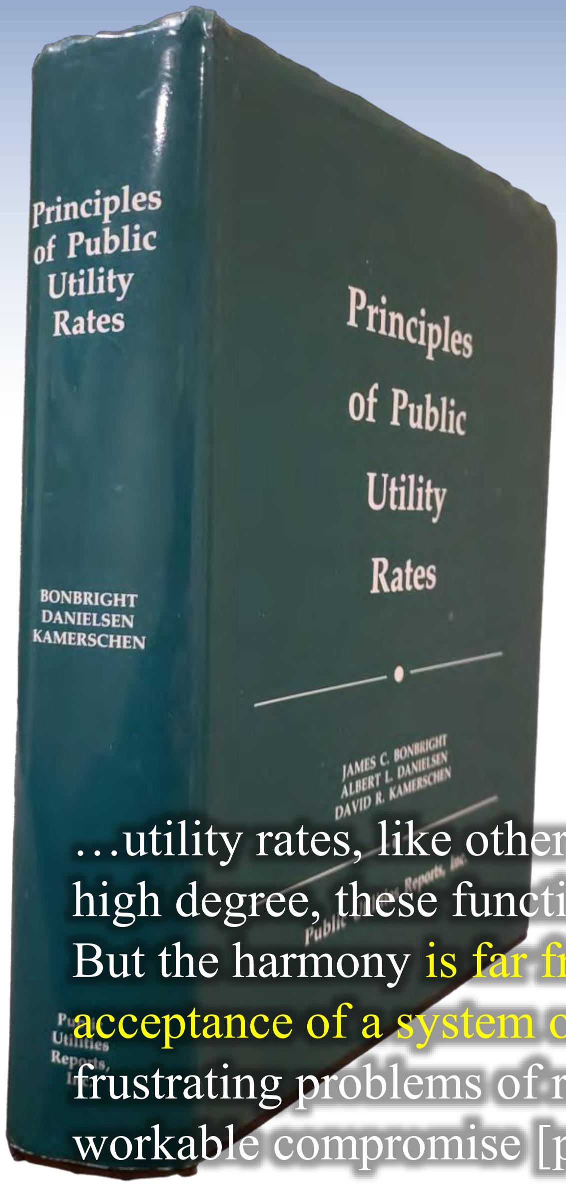
Role of Public Utility Rates



Capital Attraction

Efficiency Incentives

Demand Control

Income Distribution

…utility rates, like other prices, are designed to perform multiple functions as instruments of economic control. To a high degree, these functions can be performed in harmony; necessarily so, indeed, since they are partly complementary. But the harmony is far from complete, for the most efficient performance for any one function would require the acceptance of a system of rates not also best designed to perform any of the others. In consequence, one of the most frustrating problems of rate theory and of practical rate making is that of suggesting and applying principles of workable compromise [p. 386]

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Bonbright Principles

Bonbright (1961, p. 291)	Bonbright, Danielsen and Kamerschen (1988, pp.383-384)
The related, “practical” attributes of simplicity, understandability, public acceptability, and feasibility of application.	The related, “practical” attributes of simplicity, certainty, convenience of payment, economy in collection, understandability, public acceptability, and feasibility of application.
Freedom from controversies as to proper interpretation.	Freedom from controversies as to proper interpretation.
Effectiveness in yielding total revenue requirements under the fair-return standard.	Effectiveness in yielding total revenue requirements under the fair-return standard without any socially undesirable expansion of the rate base or socially undesirable level of product quality and safety.

Bonbright Principles

Bonbright (1961, p. 291)	Bonbright, Danielsen and Kamerschen (1988, pp.383-384)
Revenue stability from year to year.	Revenue stability from year to year with a minimum of unexpected changes seriously adverse to utility companies.
Stability of the rates themselves, with minimum of unexpected changes seriously adverse to existing customers. (Compare "The best tax is an old tax.)	Stability of the rates themselves, with a minimum of unexpected changes seriously adverse to ratepayers and with a sense of historical continuity. (Compare "The best tax is an old tax.)
Fairness of the specific rates in the apportionment of total costs of service among the different customers.	Fairness of the specific rates in the apportionment of total costs of service among the different ratepayers so as to avoid arbitrariness and capriciousness and to attain equity in three dimensions: (1) horizontal {i.e., equals treated equally); (2) vertical {i.e., unequals treated unequally); and (3) anonymous (i.e., no ratepayer's demands can be diverted away uneconomically from an incumbent by a potential entrant).

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Bonbright Principles

Bonbright (1961, p. 291)	Bonbright, Danielsen and Kamerschen (1988, pp.383-384)
Avoidance of "undue discrimination" in rate relationships.	Avoidance of "undue discrimination" in rate relationships so as to be, if possible, compensatory (i.e., subsidy free with no intercustomer burdens).
Efficiency of the rate classes and rate blocks in discouraging wasteful use of service while promoting all justified types and amounts of use:	Static efficiency of the rate classes and rate blocks in discouraging wasteful use of service while promoting all justified types and amounts of use:
(a) in the control of the total amounts of service supplied by the company;	(a) in the control of the total amounts of service supplied by the company;
(b) in the control of the relative uses of alternative types of service (on-peak versus off-peak electricity, Pullman travel versus coach travel, single-party telephone service versus service from a multi-party line, etc.)	(b) in the control of the relative uses of alternative types of service (on-peak versus off-peak service or higher quality versus lower quality service).