Public utility cost allocation and rate design

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MICHIGAN STATE UNIVERSITY

Introduction

- *“If all goods were free, like air and water, any man could get as much as he wanted without harming others” David Hume (1739)*
- Because utility services are not “free” we exact a price for their provision
  - User fees and charges (prices) are the primary means of funding infrastructure, although tax revenues and tax-funded subsidies can play a role
  - Reasonably accurate cost-based prices can communicate value, induce efficiency, and enable “self-rationing” (consumer sovereignty)
  - Well-regulated prices based on full-cost accounting understate both the true cost and the true value of utility services due to positive and negative externalities
  - Price is considered necessary but not always sufficient for inducing desirable production and consumption behavior and protecting the commons
- A pricing paradox
  - Should their essential nature make public utility services cheap or expensive?
  - Value of service should not be used to rationalize overpricing

*“Price is what you pay.
Value is what you get.”
Warren Buffet, 2008*

Utility, enterprise, or investment basis: private and some public

$$RR = r_a(RB) + O\&M + D + T$$

where:

RR	=	total test year (annualized) revenue requirements from rates
r_a	=	authorized (not guaranteed) rate of return to compensate debt holders and equity shareholders
RB	=	rate base (original cost of invested utility plant in service net of accumulated depreciation and adjustments)
O&M	=	operation & maintenance expenses, including administrative & general
D	=	depreciation and amortization expense
T	=	income tax expense and other taxes not included in O&M or billed

Cost-based rates and revenue sufficiency are a function of both the numerator and denominator:

$$\frac{\text{Revenue requirements (RR)}}{\text{Estimated sales (billing determinants)}}$$

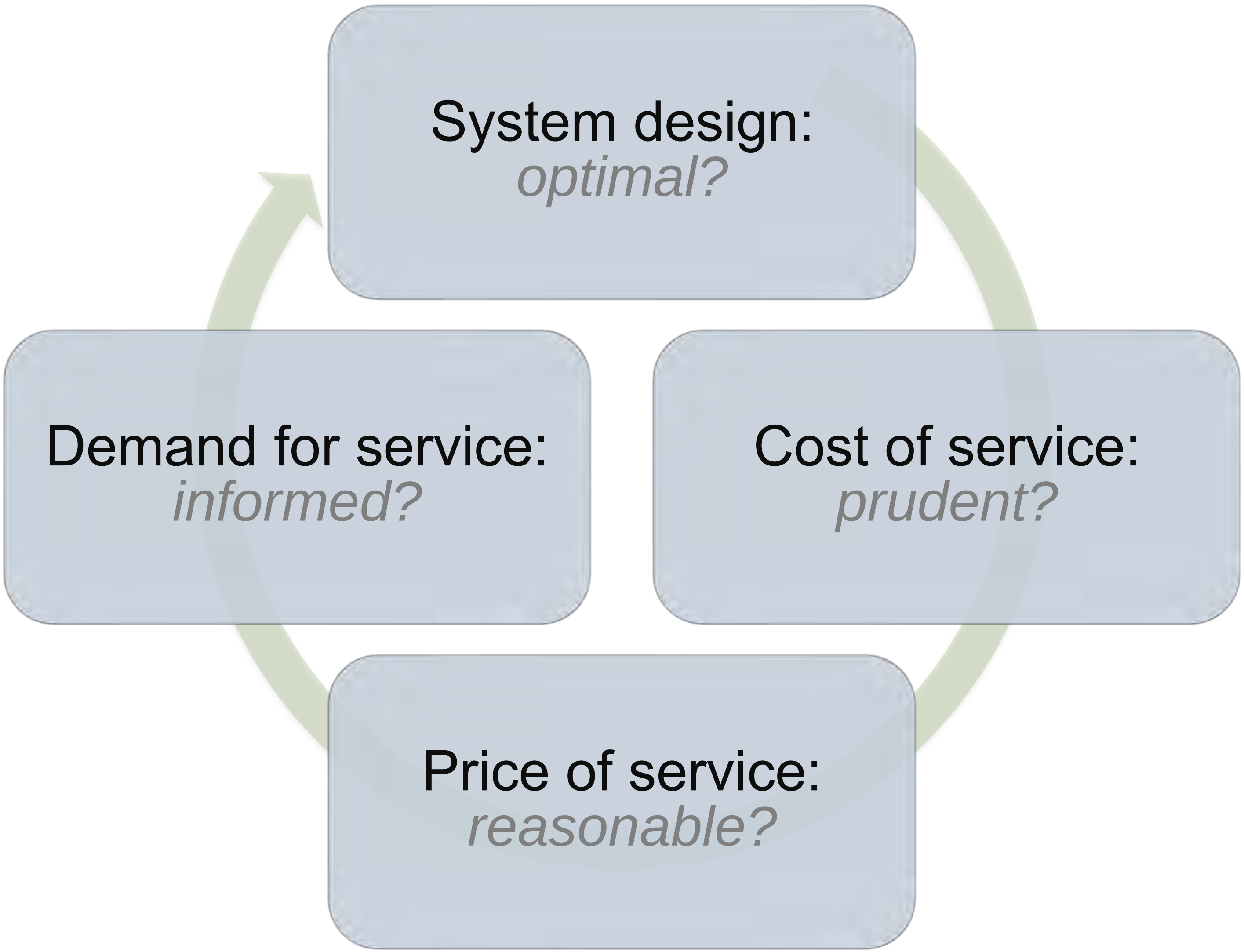
From revenue requirements to rates

- Utility ratemaking is an iterative process to establish tariffs
- Revenue requirements specify the size of the pie, and allocation slices it up
  - Rates recover revenue requirements net of other means of support
  - Alternative rate structures (designs) can recover revenue requirements
  - Fully allocating costs to ratepayers is considered both efficient and equitable
- Rate design should be *revenue neutral* – rate revenues only cover requirements
  - Cannot compensate for misestimated revenue requirements
  - Should not be used to “generate” additional revenues (regressive “taxation”)
- Regulation can accommodate a wide range of pricing policies and methods
  - Cost allocation and rate design are not “the regulatory paradigm”
  - Cost allocation and rate design are the “black box” of ratemaking

From revenue requirements to rates

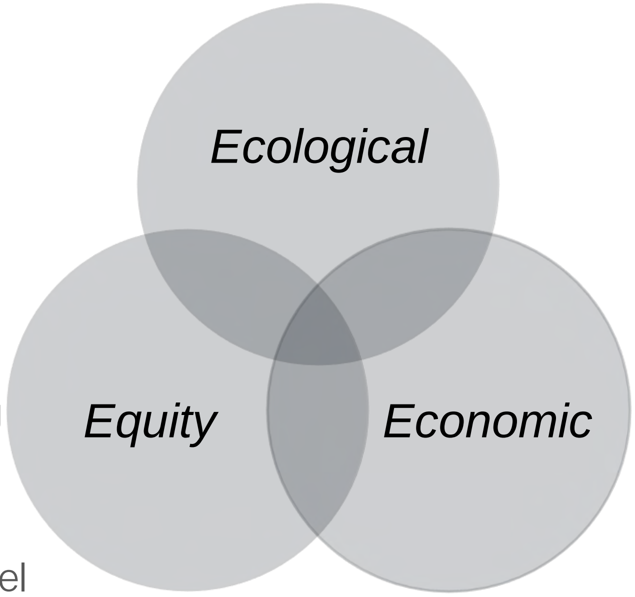
- Cost allocation and rate design
  - Shift attention from accounting costs to behavioral economics
- A tariff is more than a price – it is the utility’s schedule of rates, charges, and fees
  - “A compilation of all effective rate schedules of a particular company or utility. Tariffs include General Terms and Conditions along with a copy of each form of service agreement” (FERC)
  - “A tariff is a pricing schedule or rate plan that utilities offer to customers. Along with the pricing plan, there may be certain rules for each tariff a utility offers, such as the times or seasons when prices will vary, eligibility for a tariff, when/how a customer can join or leave the tariff, what type of meter must be installed and more. Other things that can be found in a utility's tariff book include sample forms that customers may be required to fill out, rules for applications for service, bill adjustment, low-income programs and service area maps” (CPUC)
- A tariff can sound like a tax – and be met with similar resistance

Dynamic role of utility prices in utility sustainability



Sustainable infrastructure systems

- Sustainability requires living within society's ecological, economic, and equity *tolerances*
  - Defined by natural, financial, and political boundaries
  - Relates to the idea of a "circular economy"
  - Not static or unresponsive to dynamic conditions
  - Infrastructure may be at an inflection
- Utility model for systems
  - Emphasizes economic or *enterprise* sustainability
  - Total system revenue requirements are based on full accounting of all capital and operating costs
  - Subsidies (subvention) or transfers are purposive, transparent, and generally limited
  - Expenditures ensure that systems are optimized to a service level compliant with all standards
- Pricing is a tool – *not an objective*
  - How revenues are achieved and how costs are allocated are *value choices*
  - Following A. Kahn, regulated prices should "mimic" competitive prices for efficiency
  - Systems can be autonomous and sustainable with or without user fees or cost-based rates
  - Public systems may not price to cost for policy reasons, as they do for other services



Financially sustainable utilities

	System capital and operating expenditures relative to an optimized compliant service level		
System revenues relative to expenditures*	< 1: expenditures are below optimum (“cost avoidance”)	= 1: expenditures are optimal	> 1: expenditures are above optimum (“gold plating”)
< 1: revenues are below expenditures (“revenue avoidance”)	Deficient system	Deficit system	Wasteful system
= 1: revenues are equal to expenditures	Underinvesting system	**SUSTAINABLE SYSTEM**	Overinvesting system
> 1: revenues are above expenditures (“profit-seeking”)	Revenue-diverting system	Surplus system	Excessive system

*Revenues may flow from taxpayer or ratepayer funding.
Revenue requirements from rates are net of any tax-based funding.
Economic regulation plays a role.

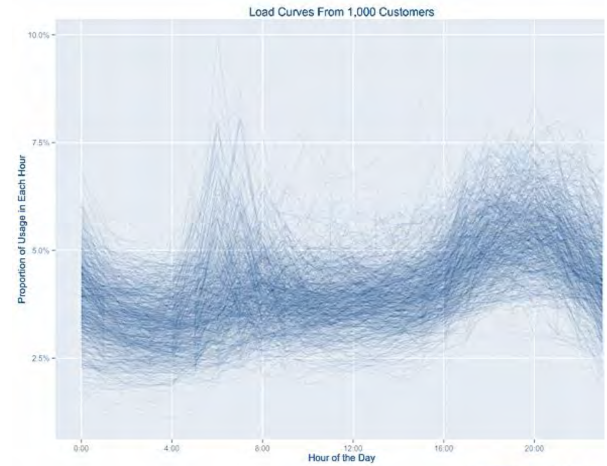
Infrastructure funding vs. financing: implications for equity and efficiency

			Financing	
			Public sector (not-for-profit)	Private sector (for-profit)
			Lower cost of capital and weaker provider incentives	*Higher cost of capital and stronger provider incentives*
Funding	Taxes	*Less regressive effects and weaker consumer incentives*	Public provider (e.g., municipal department)	Private partner (e.g., contract operator)
	User fees	*More regressive effects and stronger consumer incentives*	Public enterprise (e.g., publicly owned utility)	Private enterprise (e.g., investor-owned utility)

Cost of service and its recovery

	Societal level		System level		Ratepayer level
	Full social cost and value	Full economic cost	Full-cost accounting	Full-cost recovery	Full-cost allocation & pricing
Cost of service					
Environmental, economic, and social externalities (spillovers)	√				
Economic opportunity costs and avoided costs	√	√			
Capital and operating expenditures, depreciation, taxes, and reserves	√	√	√		
Source of revenues					
Property and other taxes, fund transfers, government grants, and other income and contributions				√	
User fees (rates and charges), including connection fees and system development charges				√	√

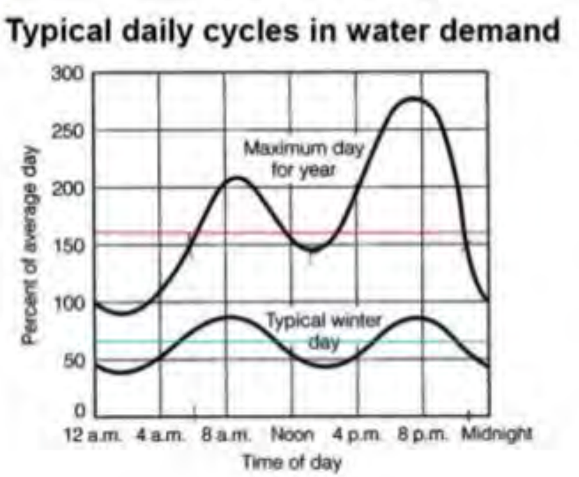
Variations and trends in demand

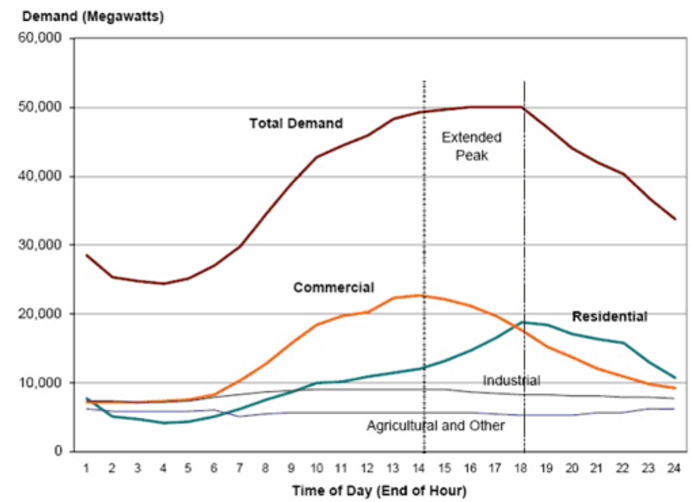


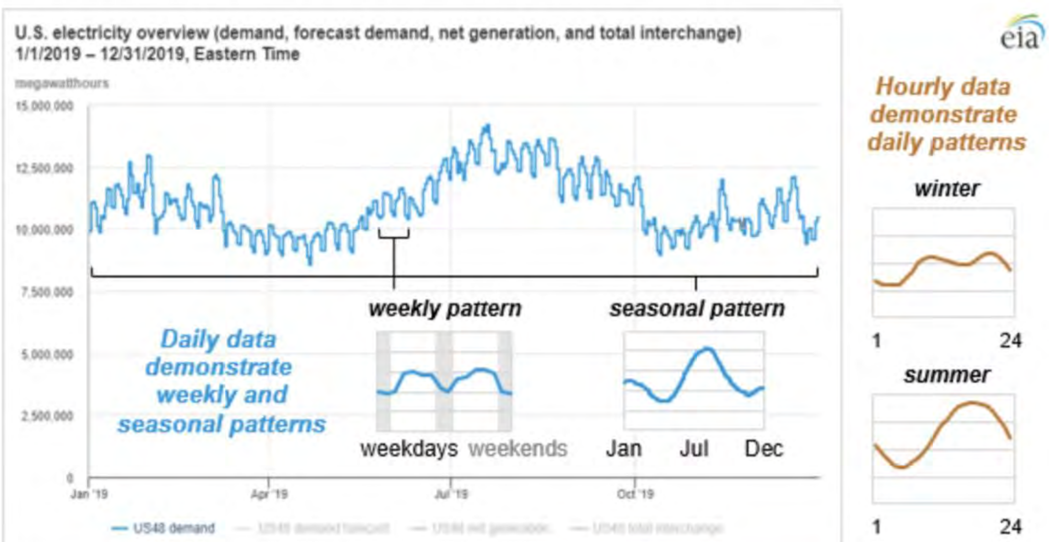
Source: Opower (2014)

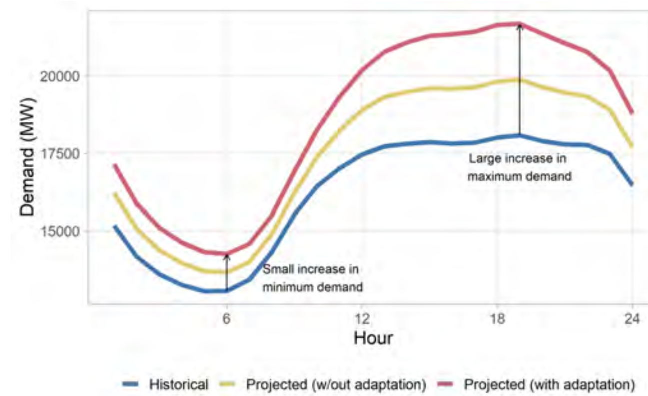
- How demand or “load” varies
  - From year to year (climatic)
  - From month to month (seasonal)
  - By day of week (work patterns)
  - By time of day (diurnal with hourly & “needle peaks”)
  - By class of customer
- Base load vs. peak demand
  - Base load is the minimum requirement over a period
  - Peaking load (capacity needs) are seen in load duration curves
- Demand (load curve) as an engineering challenge: “system design”
  - Solve from the bottom up – supply and storage
  - How to meet load with appropriate reserves?
- Demand (load curve) as an economic challenge: “load design”
  - Solve from the top down – prices and enabling technologies to "flatten the curve”
  - How to assign network capacity costs to peak users? (air conditioning, lawn watering)
- Special challenges in managing demand
  - Resource (commodity) scarcity and network congestion (capacity)
  - Reliability standards, persistent peaks, wealth effects, demand hardening, anomalies
  - Prudence calls for efficient load management and capacity utilization (average/peak demand)

Temporal demand (water and electricity)





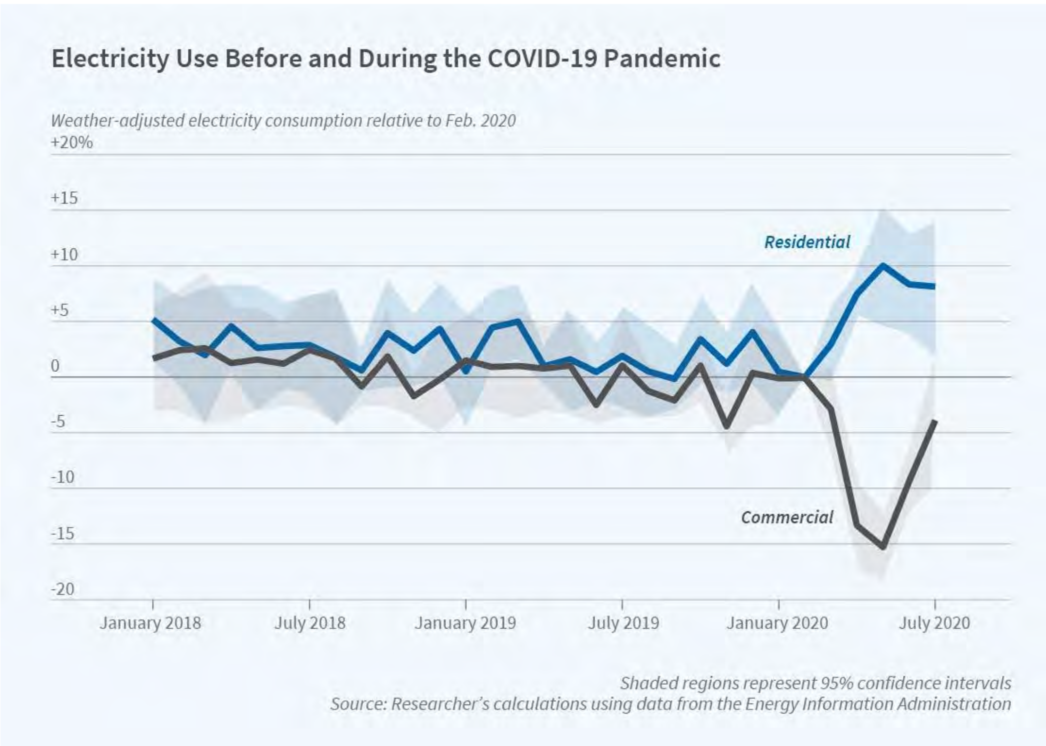


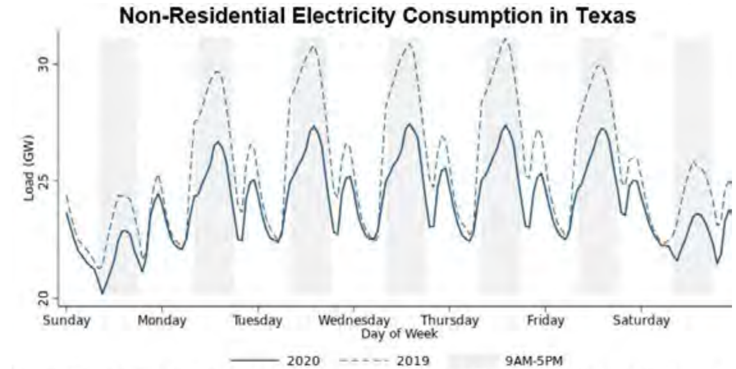


Source: U.S. Energy Information Administration, *Hourly Electric Grid Monitor*

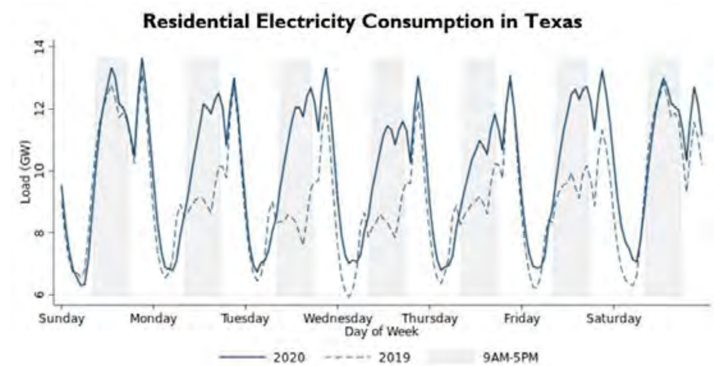
Impact of rising temperatures and air conditioning

Demand shock: impact of COVID-19 on electricity usage (EIA, Texas)

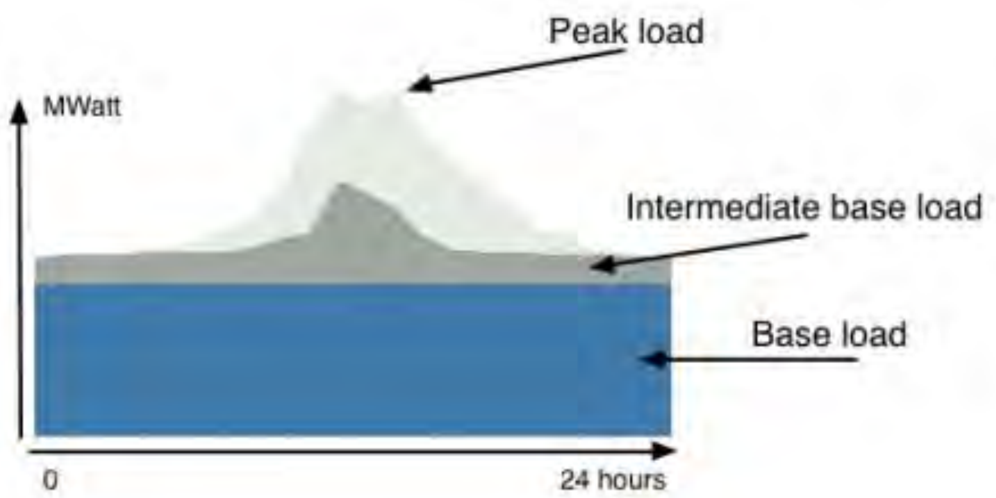


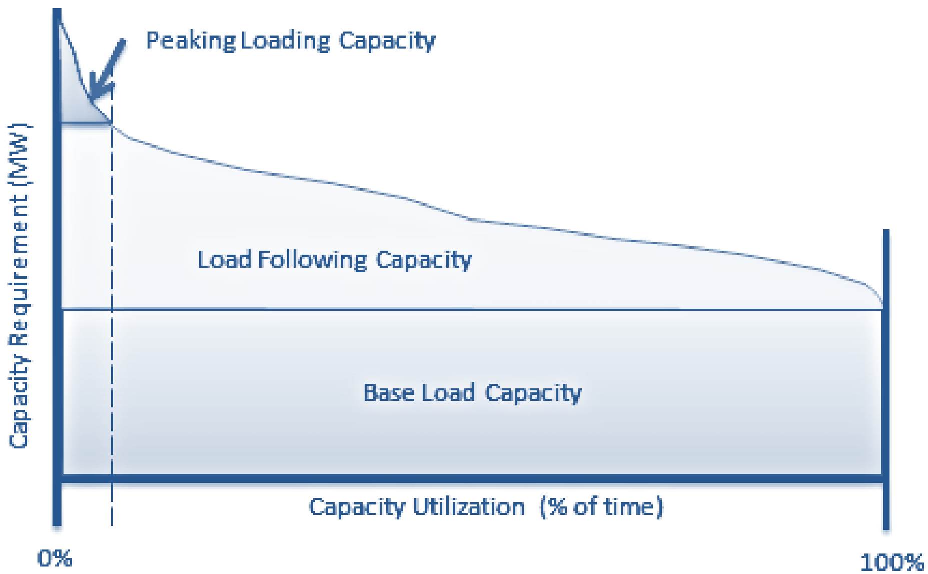


Source: This plot and the next one further below come from Steve Cicala "Powering Work from Home" and was constructed using data from Innowatts, a Houston-based energy data analytics company.



Peaking and load duration





Demand and system design (water)

Maximum-hour (hourly peak) demand*

- Distribution mains, pumping stations, treated water storage

Maximum-day (daily peak) demand*

- Transmission lines, water treatment plants

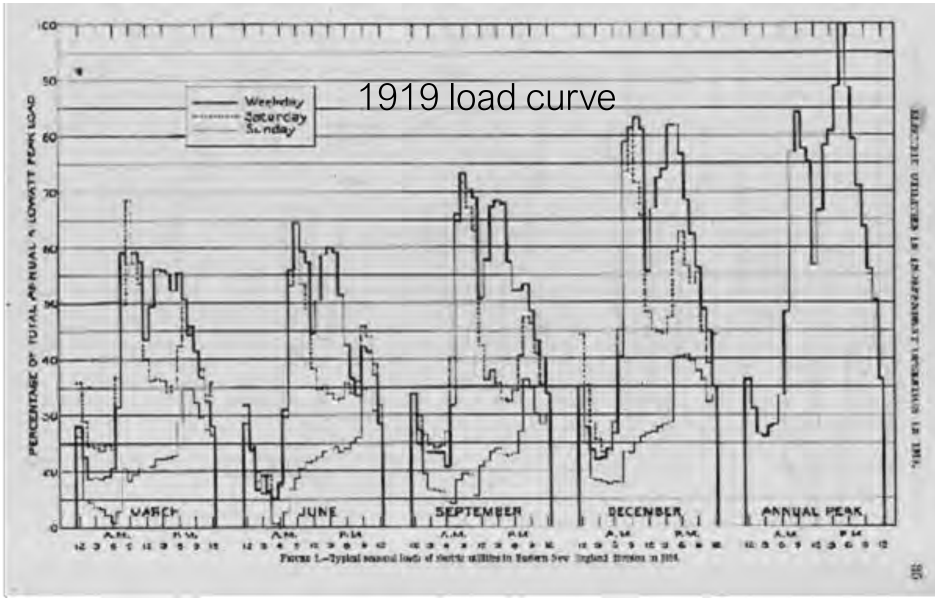
Average-day demand (annual/365)

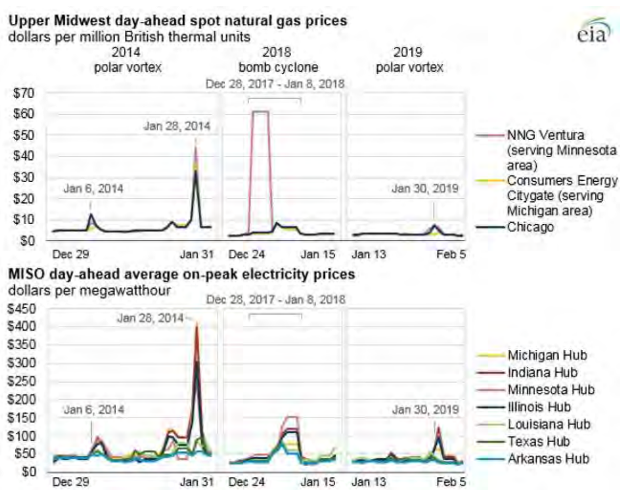
- Source-of-supply facilities, raw water storage (reservoirs)

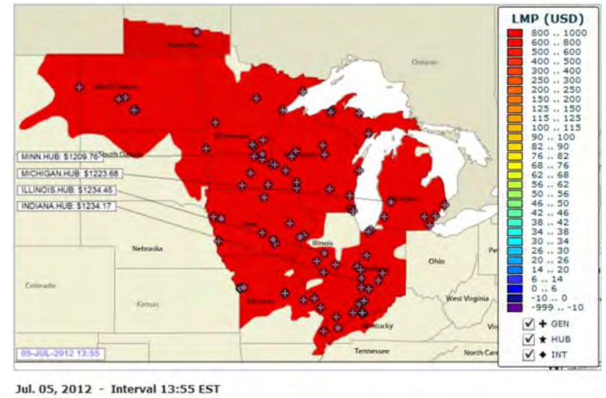
Based on Howe and Linaweaver (1967)

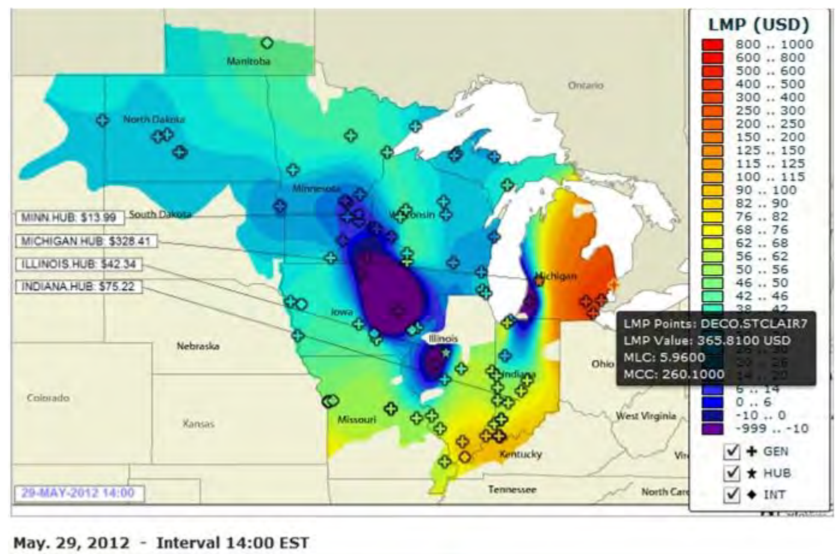
*Note: fire-flow requirements (codes, insurance) play a significant role in system design and cost – the greater of max-day or max-hour plus a fire.

Load monitoring: past and present





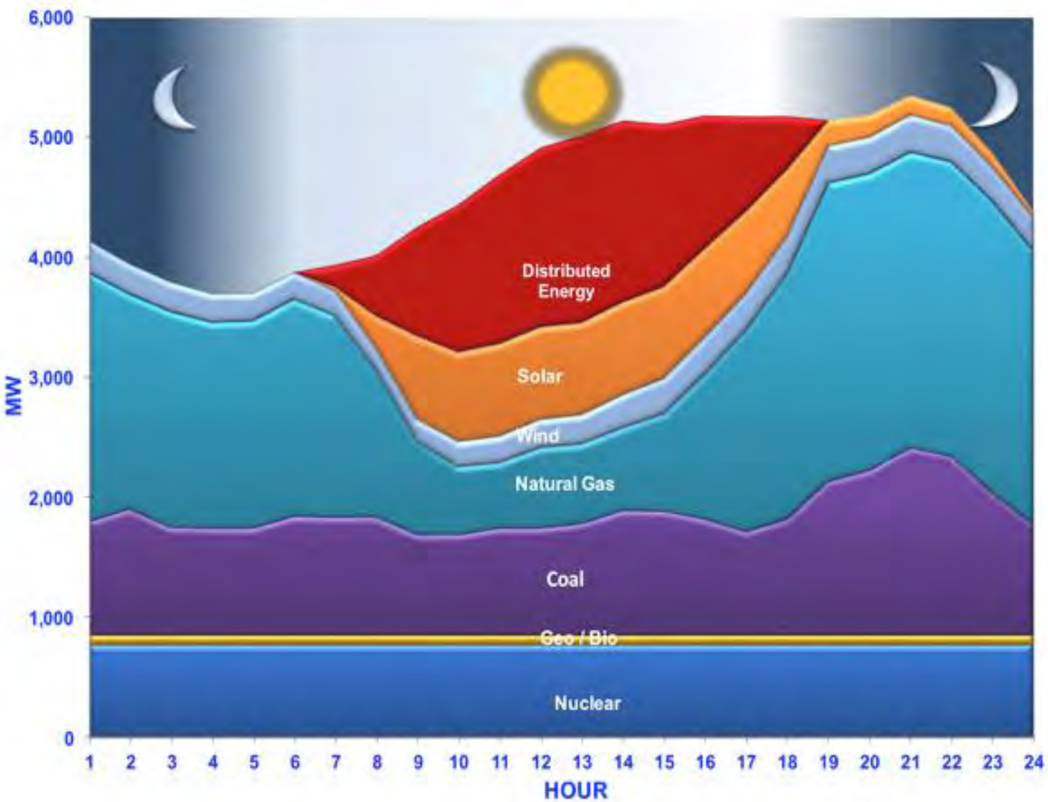


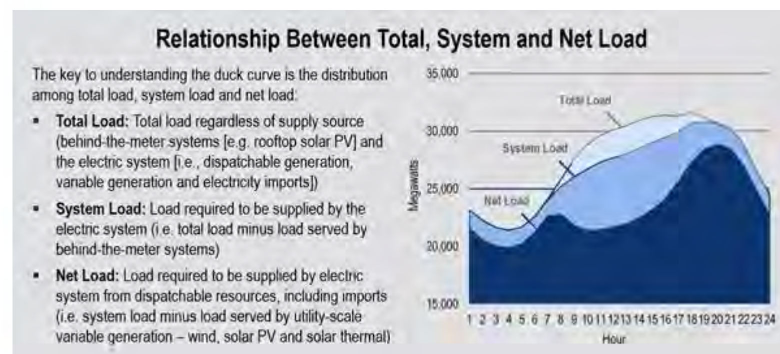


MISO contour map

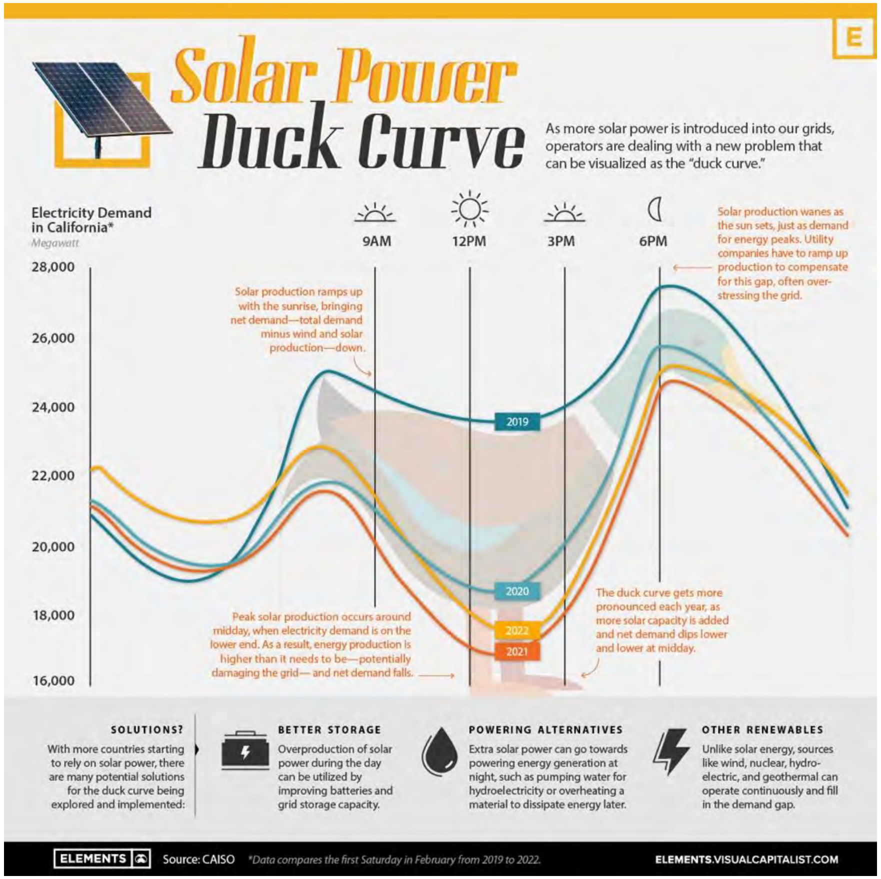
New shape of (net) electricity loads

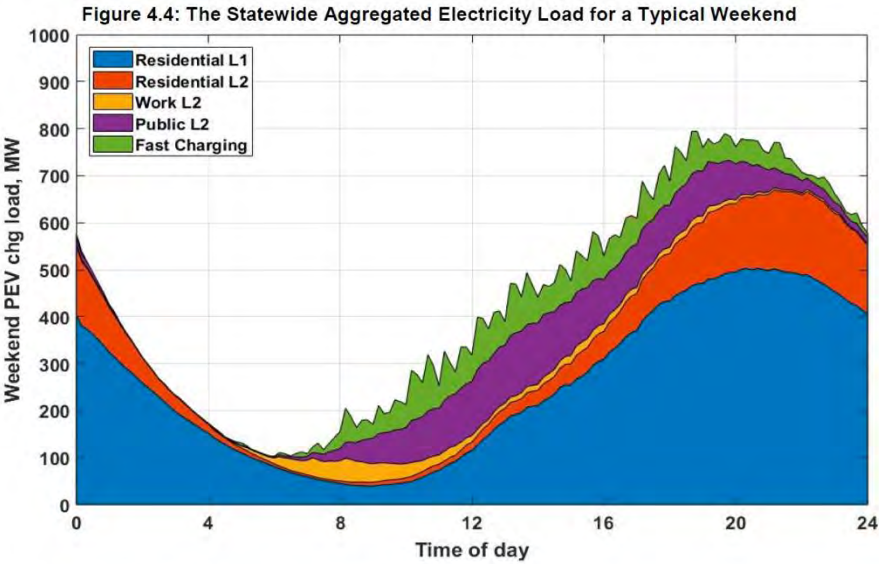
- Too much of a good thing?
  - Incremental value of renewable distributed generation can decline
  - Challenging for system operators, possibly requiring curtailment
  - Cost-effective energy storage can mitigate





From ducks to dragons

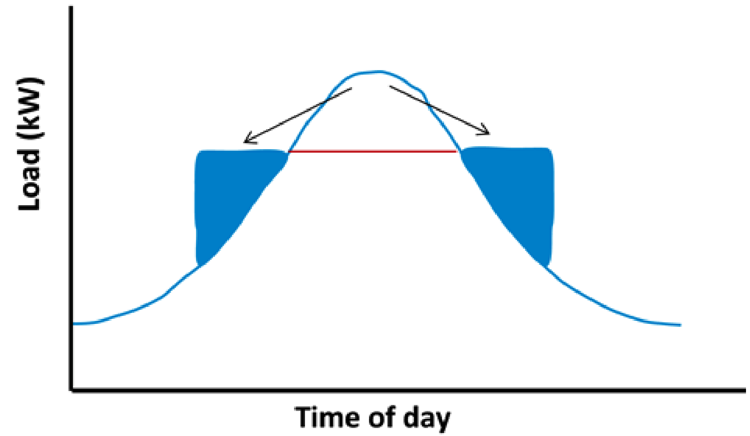




Source: California Energy Commission and NREL

Impact of vehicle charging

Shifting vs. changing load



- Load shifting methods
  - Time-variant and dynamic pricing
  - Automated off-peak cycling of equipment
  - Storage deployment (batteries, pumped storage)
- Some factors that increase load
  - Population and occupancy
  - Economic activity and growth
  - “Beneficial” electrification of transportation and heating
  - New types of demand (marijuana growing, crypto-mining)
- Some factors that reduce load
  - Price-elasticity effects and long-term behavioral change
  - Net durable gains from efficiency standards, process improvements, technologies
  - Permanent off-grid energy solutions (self-supply)
- Public policies influence the nature and pace of change
  - Matching load to clean resources yields emissions reduction benefits (health, environ.)
  - With more dynamic supply and demand, “base load” may become obsolete

Efficiency as a resource: static vs. dynamic view

Figure 6. Share of US electricity generation by resource in 2015

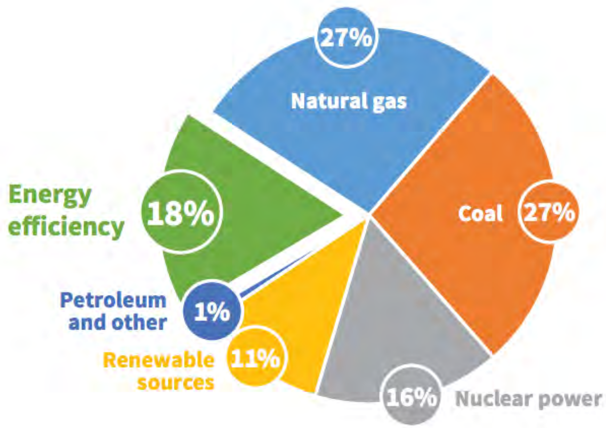
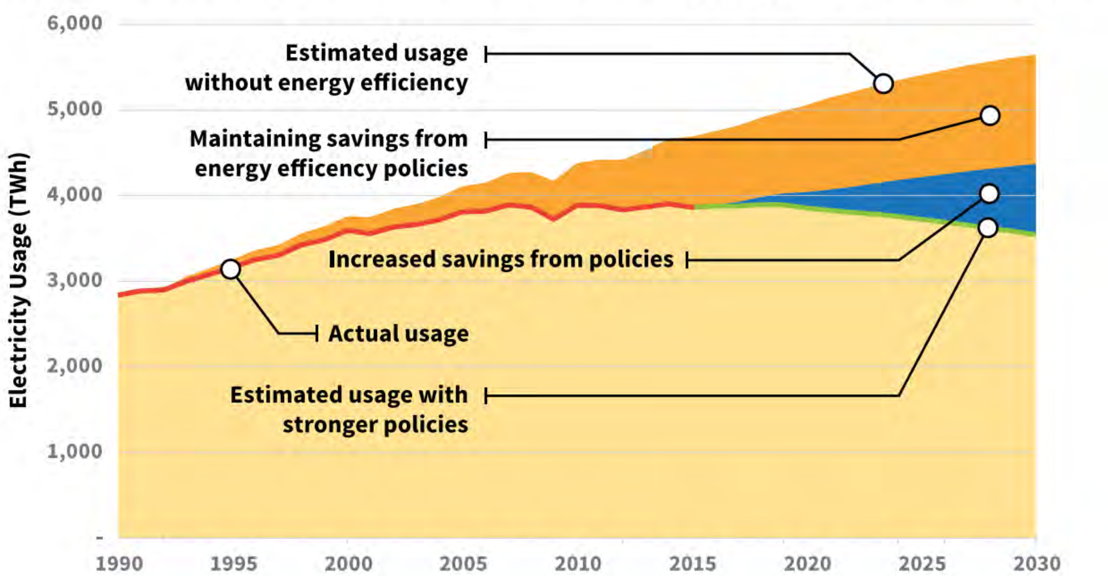


Figure 11. Estimated savings from both maintaining and increasing energy efficiency policies through 2030



Price elasticity

Pricing economics and potential welfare effects

Prices too high

Exaggerates price signals for discretionary usage
Extracts rents from essential usage (Ramsey pricing)
Regressive deprivation and endangerment
Drag on the local economy from income effect
Excess capacity and stranded investment
High reserves and transfers from system
Foregone revenues from lost sales, theft, bypass, defection

Prices too low

Weakens price signals for discretionary usage
Requires another means of cost recovery
Excessive and wasteful use of resources
Inadequate infrastructure investment
Poor capacity utilization and congestion
Low reserves and subsidies to system
Financial effects of revenue inadequacy

Poll 1: Price elasticity of demand

- A change in the price for utilities is associated with
  A. No change in usage
  B. A big change in usage
  C. A small change in usage
  D. Change that depends on the usage

Price elasticity of demand

- Price elasticity is the responsiveness or sensitivity of usage to price
  - For individual, system, or market – varies by various factors
  - Demand curve reflects the consumer's marginal willingness to pay
  - Price elasticity incorporates ability to pay (income effects)
- Measured as: (%△ in quantity demanded) / (%△ in price)
  - Represented as an absolute or negative value
  - A value of 1 (or -1) is unitary elasticity (e.g., price up 1%, usage down 1%)
  - Lower for necessities and higher for discretionary goods

Price elasticity in the real world

You can now pee for free at every major London station

Share Tweet

By **James Manning**
Posted: Monday April 1 2019, 12:37pm

Photograph: stevekeiretsu/Flickr

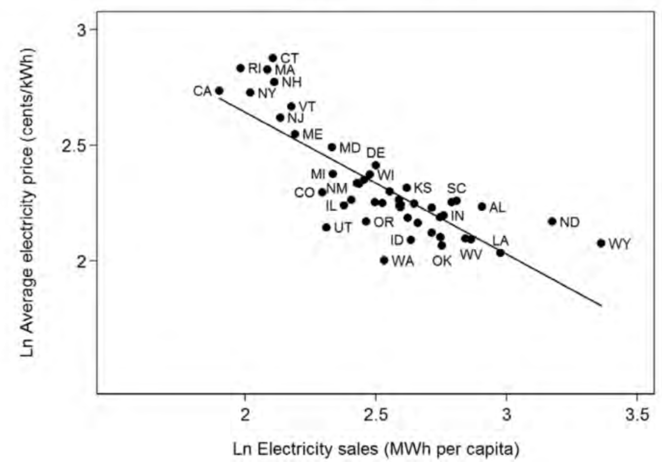
Man Comes Up With Genius Hack To Avoid Baggage Fees

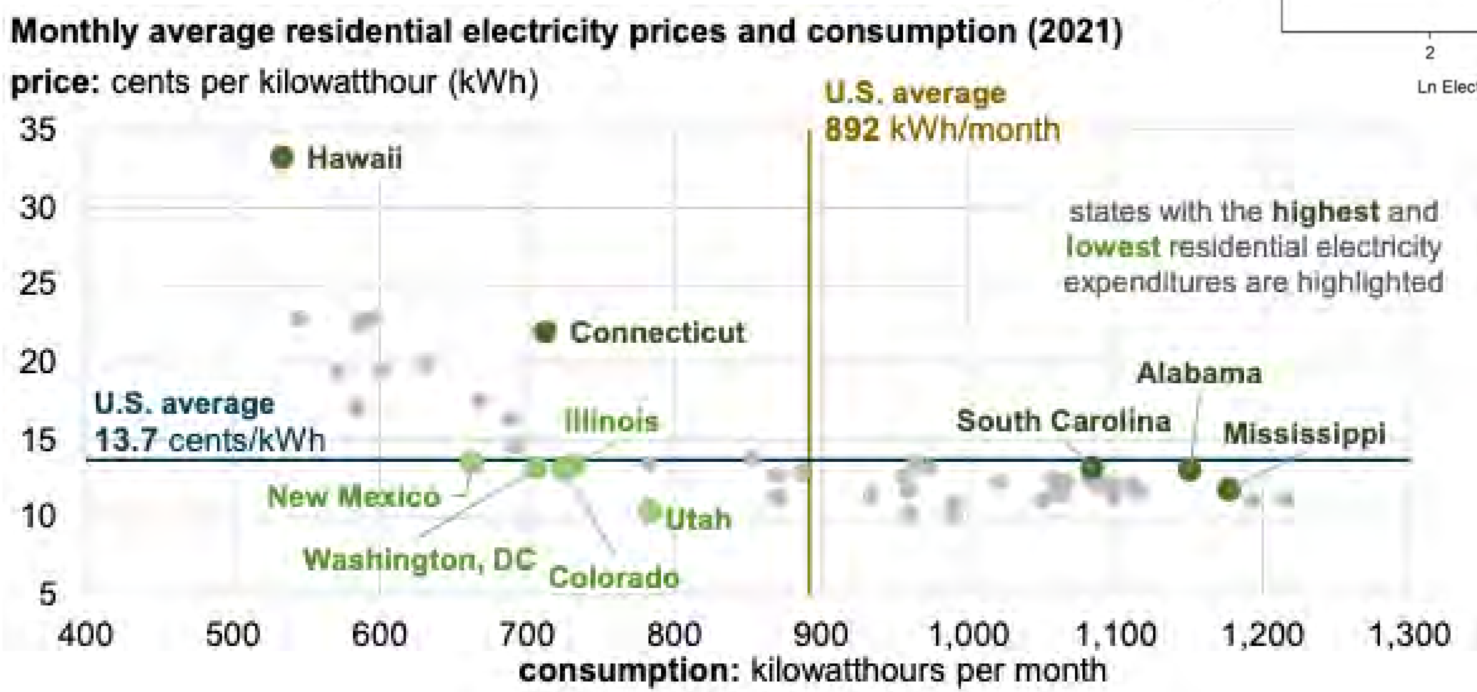
Silke Jasso, November 8, 2018 11:51 am

Facebook

Prices and usage for electricity (EIA data, 2021)

Figure 2: Average electricity price and per capita electricity sales across states in the US, 2015





Price elasticity for utility services

- Elasticities are relevant to ratemaking in terms of forecasting sales revenues
- Utility services are relatively price-inelastic – but variable by usge type
  - Price increases may not induce substantial usage reductions
  - First blocks tend to be more essential and less elastic – equity
  - Later blocks may be shaped by marginal prices – efficiency

Less price-elastic	More price-elastic
Nondiscretionary goods or necessities	Discretionary goods of luxuries
Less expensive, low-volume, & efficient usage	More expensive, high-volume, & inefficient usage
Short-term or more immediate needs	Long-term or less immediate needs
Goods without substitutes and choices	Goods with substitutes and choices
Goods in noncompetitive markets	Goods in competitive markets
Indoor and dry weather water usage	Outdoor usage and wet weather usage
Discretionary usage at higher incomes	Discretionary usage at lower incomes

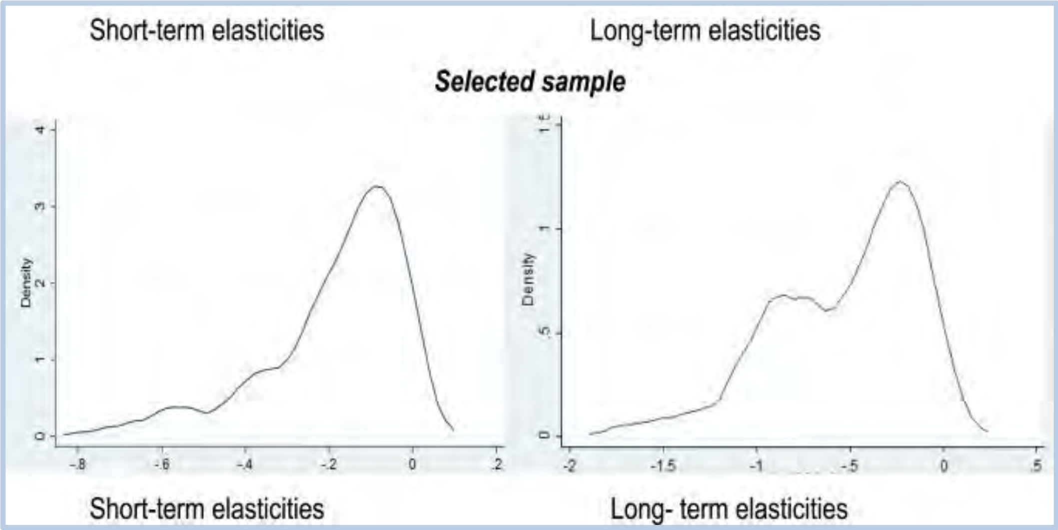
Price elasticity for utility services

- Price signals and response
  - Monthly bills make for timely signals but lessen the effect of the bill
  - Budget billing may mute signals, increase usage
  - Combined billing (gas/electric, water/wastewater) both mute and magnify signals
  - Consumers may respond mainly to total household bill (aggregated average price)
  - Elasticities may vary for socioeconomic groups
- Other elasticities of demand
  - Income – may be relatively inelastic and varies by level
  - Weather – may be relatively more elastic
  - Emerging research on demographic and cultural groups
  - Meta-analyses consolidate findings in this area

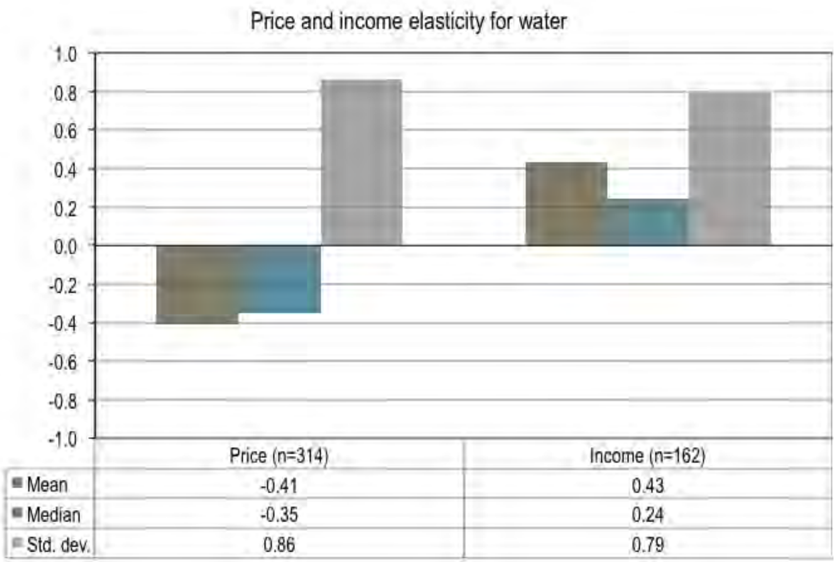
Price elasticity for water and electricity (meta-analyses)

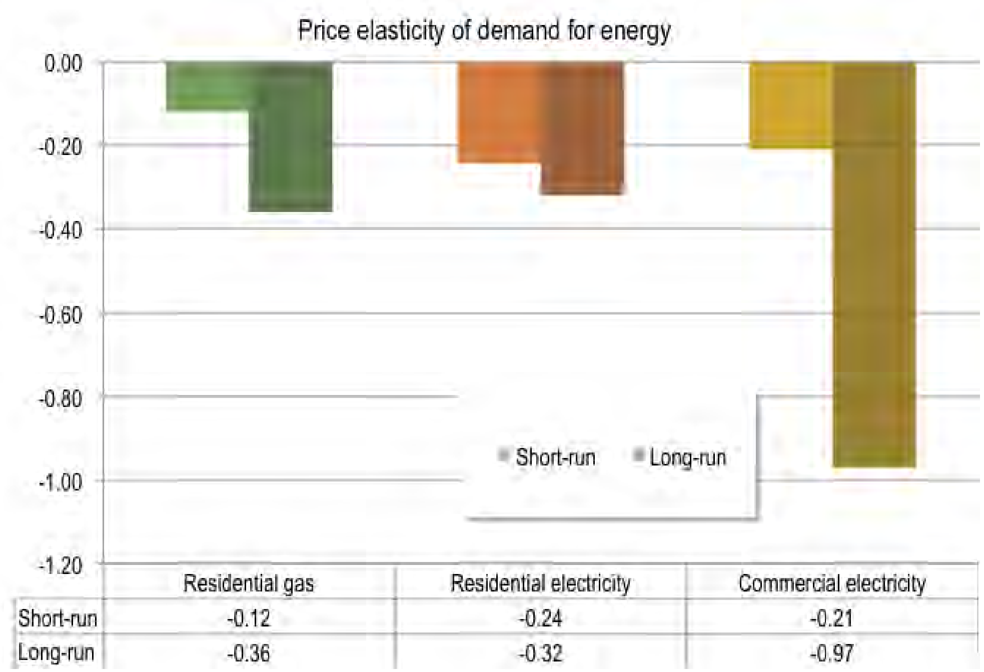
Water

Electricity



Elasticity estimates for water and energy





Price elasticity of water demand

- Role of water prices in theory and practice
  - Much water usage is relatively price inelastic but not perfectly so
  - Indoor water and wastewater usage is less discretionary and less price responsive
  - Price signals and rate structures should focus on discretionary (outdoor) water usage
  - Water prices are rising much faster than inflation generally or for other utilities
- Recent research (WRF, 2016) on reductions in household water usage
  - Due more to efficiency standards than changes in occupancy or behavior
  - Standards may work best for inelastic demand, prices for elastic demand
- In empirical studies, average prices appear to matter more than marginal prices

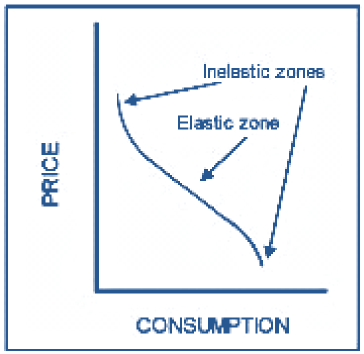
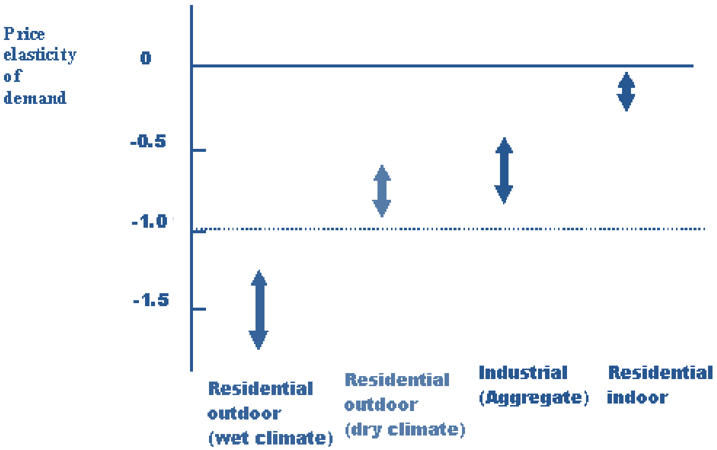
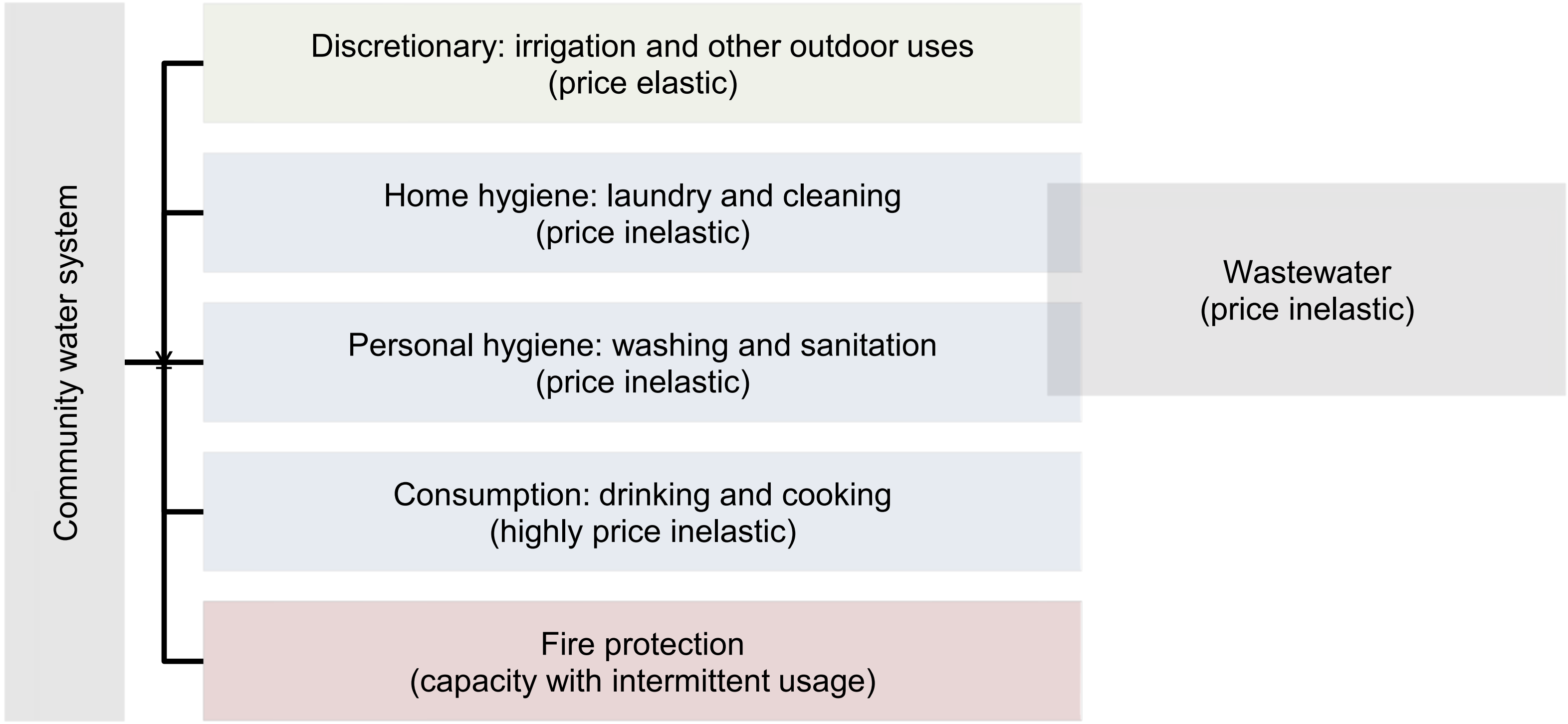


Figure 3
Water consumption (Q) versus price (P) (from Stephenson, 1999)



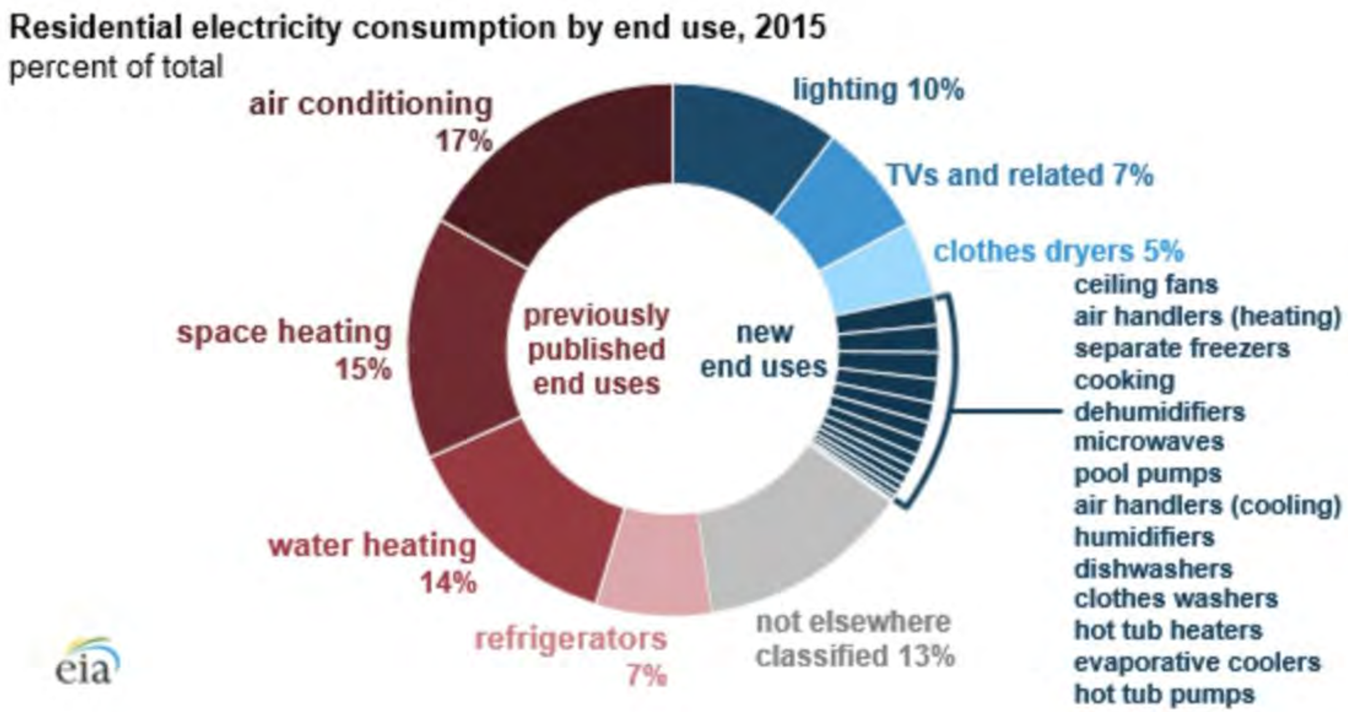
Water demand: five products, one set of pipes

- Water pricing does not differentiate based on cost or value of these services
  - Essential water usage is nondiscretionary – consumer agency is limited
  - Indoor water and wastewater is price inelastic (not conducive to demand response)
  - Water and wastewater services are symbiotic and often bundled – but uncritically
  - Water systems co-produce water, wastewater, and fire protection
  - Wastewater is a byproduct resource (water, energy, nutrients)



Energy demand: multiple end uses

EIA's residential energy survey now includes estimates for more than 20 new end uses



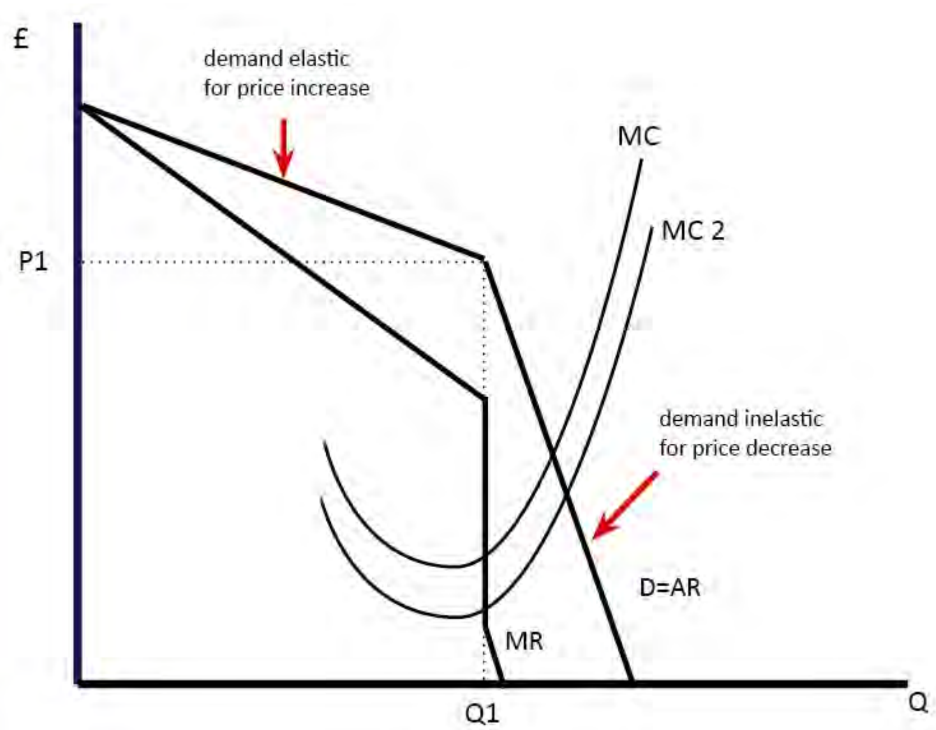
Source: U.S. Energy Information Administration, *2015 Residential Energy Consumption Survey*

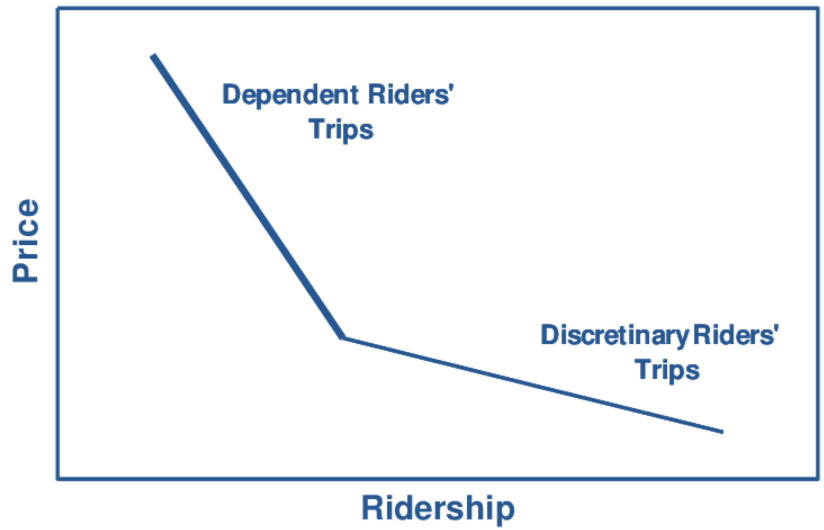
Poll 2: End uses of electricity

- What percentage of U.S. homes have a beer fridge?
  A. 24%
  B. 34%
  C. 44%
  D. 54%

Shape of the demand curve

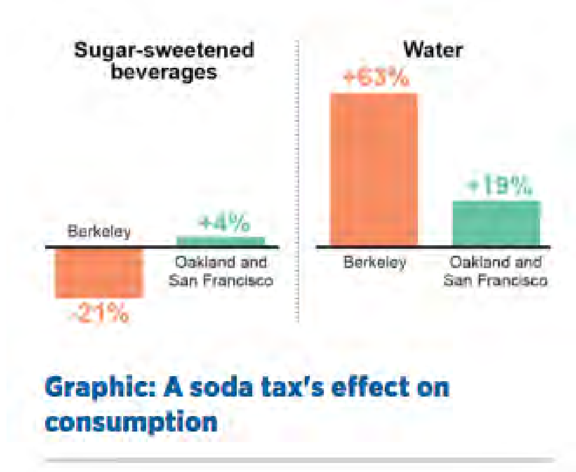
- A "kinked" demand curve exhibits a discernible change in elasticity
  - Associated with market power and price theory of oligopoly
  - Empirical evidence is mixed – but may depend on the theory behind the slopes

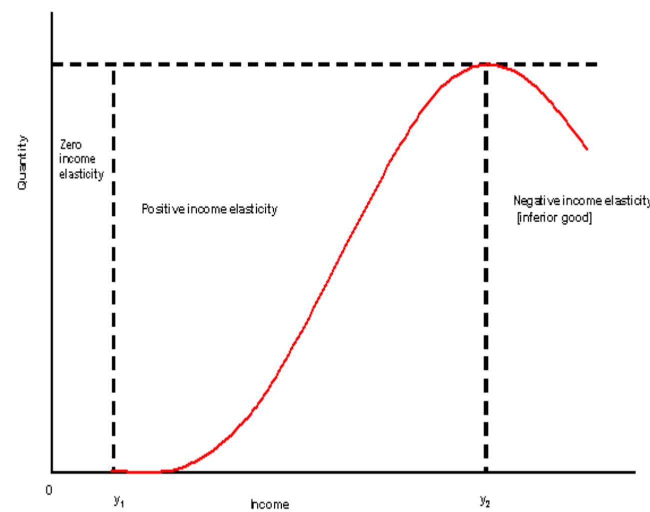




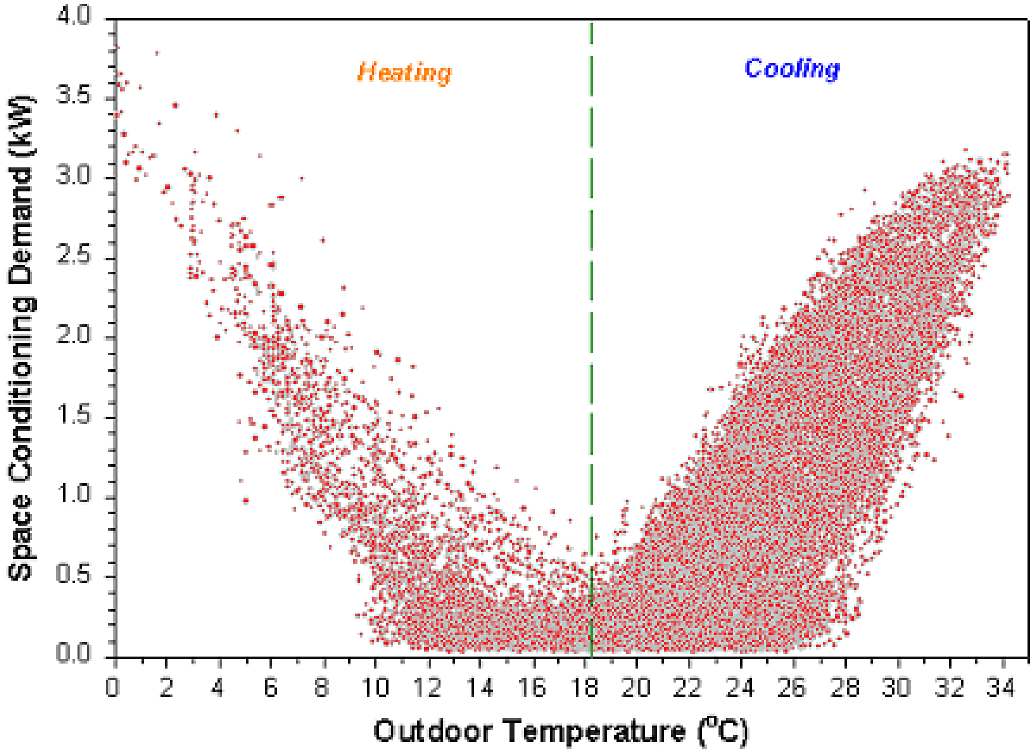
Other demand elasticities for goods and services

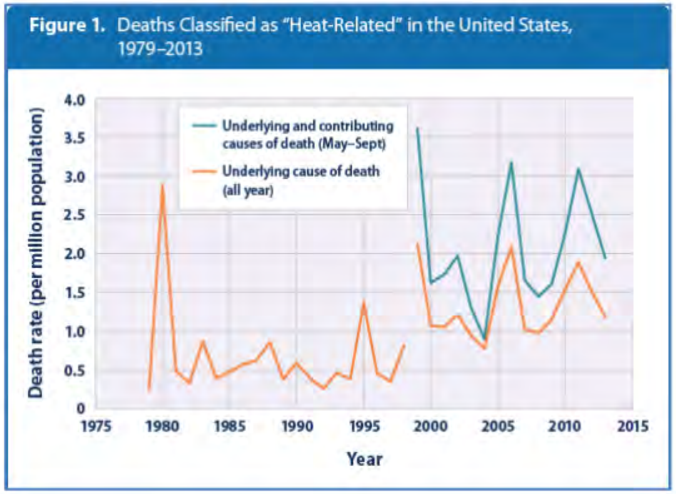
- Usage is affected by factors other than price – depending on time frame
  - Income, wealth, weather, economic conditions, and other influences on demand curves
  - Weather matters less with less outdoor water use
- Income elasticity defines different types of goods
  - Normal goods: positive income elasticity (most goods, including utilities)
  - Luxury goods: high positive elasticity (expensive cars and jewelry)
  - Inferior goods: negative elasticity (paycheck services, ramen noodles)
- Cross elasticity: change in price for one affects demand for another
  - Soda and bottled water (effect of sugar tax)





Weather elasticity of demand for space conditioning (Florida)





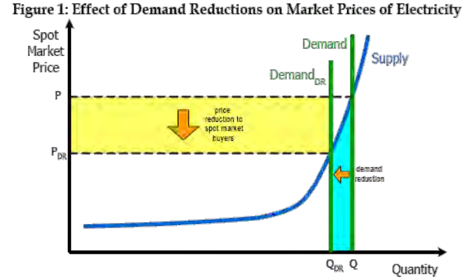
Income, wealth, and limits to price signals

- Low-income users
  - Tend to use less and contribute less to peaks but are more price-aware and sensitive
  - Inelasticity raises concerns about regressivity, disparity, affordability, security, and quality of life (e.g., living with heat or cold)
- High-income users
  - Tend to use more but are less price-aware and sensitive – especially in dry conditions
  - Price signals may "fall on deaf ears" – standards and nudging may help
- Equity and efficiency
  - Essential price-Inelastic usage can be subsidized without significant efficiency loss
  - Discretionary usage can be priced more aggressively

Price engineering ⓘ

- Using price strategically based on price sensitivities
  - Use of “price discrimination” for “demand response”
  - “Conservation” pricing allocates more costs to elastic usage (resource economics)
  - “Dynamic prices” shift elastic demand but extract more rents from inelastic usage
  - ”Cream skimming” targets “high-value” load
  - “Ramsey pricing” allocates more costs to inelastic usage
- Ramsey pricing might technically improve welfare
  - As defined by welfare economics
- Price response is limited by
  - Price levels, inelasticity, opportunity costs, weather effects. ability to control usage
  - Some customers have limited agency to reduce or shift usage – raising issues of fairness
- Demand reductions may affect market prices
  - Increased resource availability from supply technology or demand efficiency may promote usage (e.g., gas) – Jevons paradox

Figure 1: Effect of Demand Reductions on Market Prices of Electricity

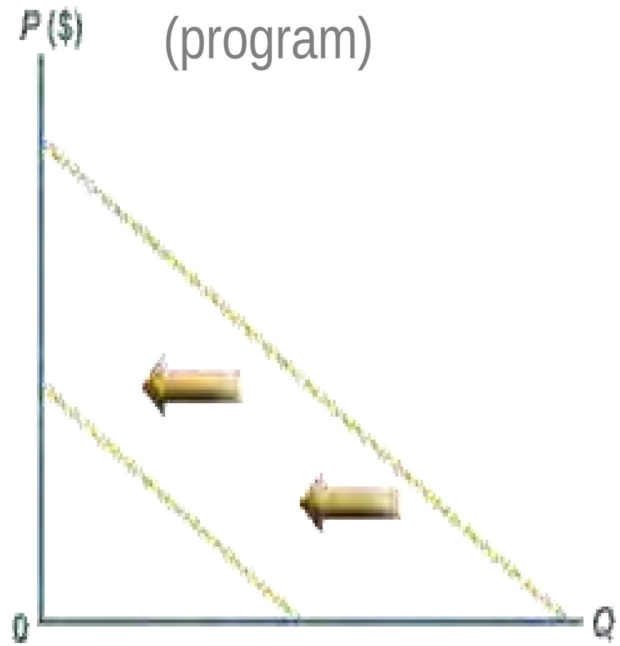


Source: Department of Energy Report to Congress, February 2006

Prices vs. programs

Change in usage (price)

Change in demand (program)



Pricing vs. programs (“command and control”)

- Alternative methods for shaping the demand curve
  - Pricing: metering and rates that move usage along the curve (demand-response)
  - Information and subsidies: used to accelerate adoption and alter/shift the entire curve
  - Technological standards: may alter demand with mixed efficiency effects
  - Direct load controls: allow utility to adjust service levels (air conditioning, irrigation)
  - Restrictions: use of local zoning and restrictions or prohibitions on usage (water)
- Evidence of efficiency and efficacy is stronger for pricing
  - Program evaluation: total resource/participant/utility cost tests and ratepayer impact
  - Not all efficiency programs are economically efficient (e.g., rebates)
  - Over time, non-price mechanisms (e.g., prepayment meters) can work with price to change consumer culture (like recycling)
- Policy tools should take elasticities and opportunity costs into account
  - Efficiency standards for inelastic demand (e.g., indoor water usage)
  - Efficiency pricing for elastic demand (e.g., outdoor water usage)
- What might work
  - Standards and automation (set and forget) to limit human attention and effort
  - Curtailment rewards and off-peak rates (“happy hours”)
  - Opting out vs. opting in consumer choice

Why elasticities matter in ratemaking

- Price elasticity for utilities is not zero but can be difficult to estimate
  - Inelastic demand: price increases may raise revenues and earnings
  - Elastic demand: price increases may lower revenues and earnings
- Aggressive pricing of inelastic usage may not yield efficiency gains
  - May undermine achievement of noneconomic social goals (affordability)
- Price-sensitive industrial customers may reduce or bypass utility services
  - Efficiency, shopping, fuel switching, self-supply, relocation
  - Industrial customers will consider service quality and reliability
  - Bypass may free up capacity for other economic purposes – or lead to “stranded capacity” that is no longer used and useful and thus sunk costs
- “Demand-suppression” adjustments may be used in setting rates
  - Account for anticipated changes in usage based on changes in price
  - Should be matched by changes in expenses and revenue requirements
- Implications of permanent (and “creative”) demand destruction
  - Operational economies and financial health related to scale and load diversity
  - Pricing to compensate for falling usage that contributes to a death spiral
  - Distributional consequences as healthy people leave the “pool” (like insurance)
  - Importance of flexible and adaptable infrastructure design under dynamic conditions

Rate shock

Dad Jokes
@Dadsaysjokes

Just opened my water bill and my electricity bill at the same time...

I was shocked.

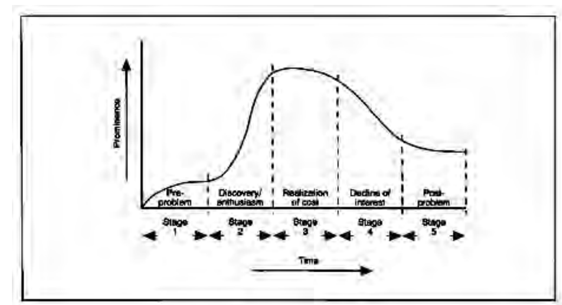
When I was young I was scared of the dark.

Now when I see my electric bill I am scared of the lights.

PAINTING:
"The arrival of the electric bill."
Oil on canvas.

Rate shock

- *"I'm shocked, shocked there are politics in ratemaking."*
- Big rate increases can induce economic reactions
  - Growing concern due to cumulative infrastructure costs
  - Instant effects on usage may or may not be "durable"
  - Effects can be transient with "rebounding" or "backfiring"
- Big increases also induce political reactions
  - Pricing requires a "willingness to charge"
  - Social media play a role in rate politics
- Utilities and regulators face pressure about rates
  - Gradualism in changes & frequent billing can help mitigate
  - Rates may go up faster than bills due to end-use efficiency
  - Communicating with customers is an ongoing challenge
- Public acceptance may take time
  - For both changes in rates or rate structures
  - Issue attention cycles and social memory



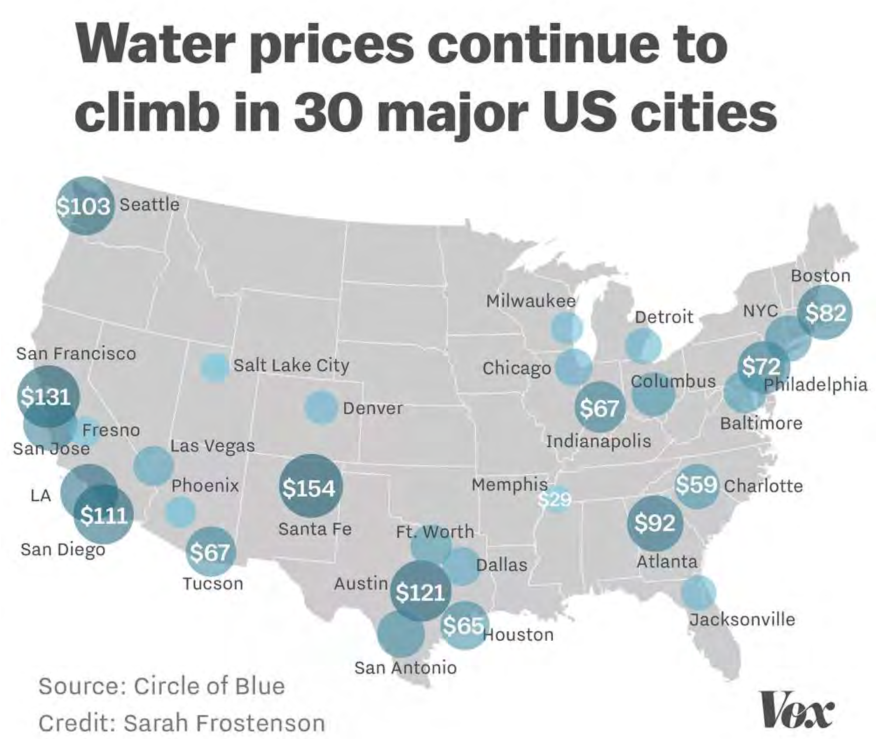
Eversource Standard Service Residential Rate (per kWh of residential usage)

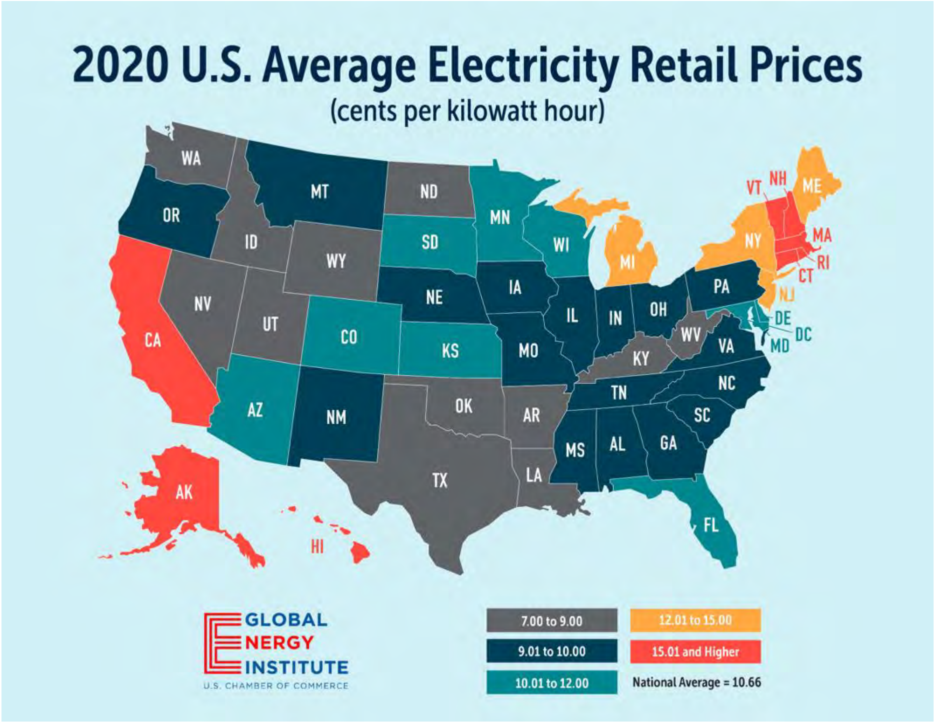
1/1/2022	7/1/2022	1/1/2023
$0.11484	$0.12050	$0.24172

United Illuminating Standard Service Residential Rate (per kWh of residential usage)

1/1/2022	7/1/2022	1/1/2023
$0.106731	$0.1062	$0.2194

Variation in prices (water and electricity)





Methods to mitigate rising costs, rates, and bills

- Structural solutions to gain efficiency from scale (as realistic)
- Supply-side cost control and efficiency (asset and input management)
- Strategic planning and optimized operations
- Competitive bidding for procurement of goods and services
- Demand-side efficiency programs
- Tax support for infrastructure (loans and grants)
- Refinancing and extended-term debt
- Limit inequitable subsidies through rates (overall and inter-customer)
- Alternative revenue streams (publicly owned)
- Ratepayer engagement, information, and assistance
- Alternative methods of cost allocation and rate design

Ratemaking objectives

Poll 3: Ratemaking objectives

- Ratemaking for public utilities should promote
  A. Efficient use of resources
  B. Affordable access to essential services
  C. Environmental protection and stewardship
  D. Economic development and jobs
  E. All of the above
  F. None of the above

Alfred Kahn on the economics of rates (1988) ⓘ

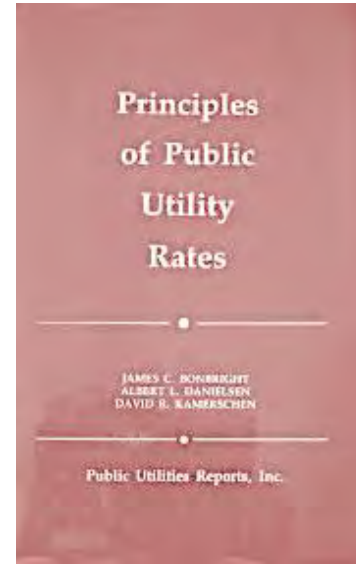
- Regulated prices should mimic competitive market prices to force cost control – but with appropriate checks on undue price discrimination
  - "The traditional legal criteria of proper public utility rates have always borne a strong resemblance to the criteria of the competitive market in long-run equilibrium.
  - The principal benchmark for 'just and reasonable' rate levels has been cost of production, including… the necessary return to capital... Rates that produce wisely divergent profits on different parts of the business are suspect...
  - [R]egulated companies have also been permitted to discriminate in the eocnomic sense, charging different rates for various services even when the costs were not corresponsindly different.
  - In particular, rates have been adjusted to the respective 'value of service' to difference classes of customers... They have in part been patterned on the basis of the respectrive elasticities of demand...
  - Of course, price discimination would be impossible under pure competition..."
  - Both [companies] and their regulators have found themselves groping for criteria by which to develop and to test competitive rates...
  - [C]ommissions have to decide under what circumstances these competitive rates are unduly or destructively discriminatory."

James Bonbright on rate structures (1961) ⓘ

CRITERIA OF A SOUND RATE STRUCTURE 291

one presentation. The sequence of the eight items is not meant to suggest any order of relative importance.

1. The related, "practical" attributes of simplicity, understandability, public acceptability, and feasibility of application.
2. Freedom from controversies as to proper interpretation.
3. Effectiveness in yielding total revenue requirements under the fair-return standard.
4. Revenue stability from year to year.
5. Stability of the rates themselves, with a minimum of unexpected changes seriously adverse to existing customers. (Compare "The best tax is an old tax.")
6. Fairness of the specific rates in the apportionment of total costs of service among the different consumers.
7. Avoidance of "undue discrimination" in rate relationships.
8. 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:
   (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.).



James Bonbright's economic criteria for rates

- Bonbright viewed ratemaking and "welfare" through an *economic lens*
  - "Right way to price" and "rational use" are econocentric normative constructs
  - Cost of service prevails over value of service – an "ancillary standard"
  - "Business principles" prevail over "so-called 'social' principles" – namely "ability-to-pay" and "diffusion-of-benefits"
- Criteria are subjective and subjective to interpretation (e.g., what's "fair"?)
  - Significant tensions are found among the criteria (e.g., equity vs. efficiency)
  - Parsimonious but relevant criteria are excluded – e.g., affordability, sustainability, intergenerational equity)
- Four functions of utility rates
  - Production motivation or capital attraction
  - Efficiency incentive
  - Demand control or consumer rationing
  - Income distribution
- Revisions to the text added
  - Avoidance of undue discrimination among customers
  - Promotion of innovation (dynamic efficiency)
  - Reflection of future private and social costs (externalities)

Economic principles and their limits

- Economic principles and rate practice favor prices based on the cost of service
  - Allocation of costs to cost causers for efficiency, equity, and sustainability
  - Accurate cost-based prices communicate value and induce efficiency
  - Prices enable “self-rationing” – consumer sovereignty) for discretionary usage
  - Focus on economic efficiency and “rationality” can obscure social equity concerns
- Cost, price, and value
  - Well-regulated prices based on full-cost accounting understate the true cost and value of utility services due to positive and negative externalities
  - Price is necessary but not always sufficient for inducing desirable production and consumption behavior and protecting the commons
  - Prices may be informative about variations in costs but not about efficiency
  - Non-price methods can amplify price signals – “nudging”
- Rate design may also consider
  - Need for and value of service
  - Economic and market conditions
  - Potential for customer bypass
- No “right way” to allocate costs and price
  - There is only the degree of alignment with principles and objectives
  - Just because we can price a certain way is not a justification
  - In many respects, all ratemaking is ”social” ratemaking

"Social principles" of ratemaking ⓘ

- Bonbright (1961) and the "so-called 'social' principles of ratemaking"
  - Ability-to-pay principle
  - Diffusion-of-benefits principle
- Bonbright's conclusions
  - "[T]hose services now called public utility services belong in that great class of economic products, including both commodities and services, that can be best offered for sale instead of being supplied without charge, and that can typically best be sold on the general principle of service at cost rather than at prices designed by a legislature or public service commission to accomplish some specific objective deemed by it to be in the public welfare... [which expresses] a rebuttable presumption in favor of so-called "business principles" of rate making."
- Departures from accepted principles and practices can be controversial
  - "Socialized costs" (spreading costs widely as a form of taxation)
  - "Social ratemaking" (economic development, affordability, justice)
  - "Social programs" supported by rates instead of taxes
  - "Socially defined" service or investment (clean energy, efficiency)
  - "Social tariffs" designed to ensure affordable access

Modern criteria for evaluating utility rates*

- Financial viability
  - To enable stable recovery of the utility's capital and operating costs
- Economic efficiency
  - To achieve an equilibrium that maximizes social welfare
- Equitable allocation
  - To allocate costs to usage based on cost causation
- Operational performance
  - To manage load for efficient capacity utilization
- Network optimization
  - To enhance system design, resource integration, and grid services
- Environmental stewardship *(social equity)*
  - To preserve resources and mitigate adverse outcomes (negative externalities)
- Distributive justice *(social equity)*
  - To promote universal service and advance beneficial outcomes (positive externalities)

*Bonbright (1961) modified by Beecher

Constraints and considerations

- Design choices are also bound by practical considerations (as Bonbright noted)
  - Including familiarity to the practice community, stakeholders, and analysts
- Rates and rate structures should be*
  - Understandable, unambiguous, and transparent
  - Technically feasible and cost effective
  - Politically acceptable and legally defensible
- Ratemaking can be considered a constrained optimization problem
  - Staying within value-defined tolerances over long term
  - Constraints are a function of mandates, rights, and obligations
  - Not limited to economic efficiency (e.g., public health)
- Regulated rates must also serve the public interest consistent with standards
  - Courts have allowed for a choice of rate mechanisms within a “zone of reasonableness” as well as “pragmatic” adjustments – discretion and judgment
  - Resulting rates and rate structures are subject to the statutory, regulatory, and judicial standard of “just and reasonable” (legal equity)
  - Rates can be “equitable” and still “unfair” based on need or ability to pay (social equity)
  - Rates for different classes, activities are expected to yield comparable returns (A. Kahn)

Procedures for adjusting rates

- Rate cases are triggered by earnings erosion
  - Caused by rising costs, falling sales, or both
- Comprehensive rate cases
  - Preferred and default option and a mostly reactive process
  - Burden of proof is on the utility to support proposed revenue requirements and tariffs
  - Regulators may also initiate rate reviews
- Other methods as allowed
  - Rationalized by saving rate-case expense – but risk mechanization of regulation and ratemaking
  - Include
    - “Automatic” adjustment mechanisms (e.g., fuel or energy)
    - Special-purpose surcharges (e.g., DSIC for capital costs)
    - Rate indexing for periodic adjustments based on inflation or other cost metrics
    - Formula rates for periodic adjustments based on returns outside of a predetermined band
- Disparities in practices lead to disparities in base rates


AQUA PENNSYLVANIA, INC.

RATES AND RULES

GOVERNING THE DISTRIBUTION

OF

WATER

IN PORTIONS OF

NOTICE

THIS TARIFF MAKES CHANGES, DECREASES AND INCREASES IN EXISTING RATES

Stakeholder expectations about ratemaking

Public utilities

- Revenue stability, reasonable certainty, and a fair return to ensure financial viability and attract investors

Utility ratepayers

- Safe, adequate, reliable, and convenient service, fair, reasonable, and stable rates, and a controllable and affordable bill

Utility regulators

- Utility services that serve society and promote the public interest in terms of infrastructure investment, operational efficiency, and other performance goals

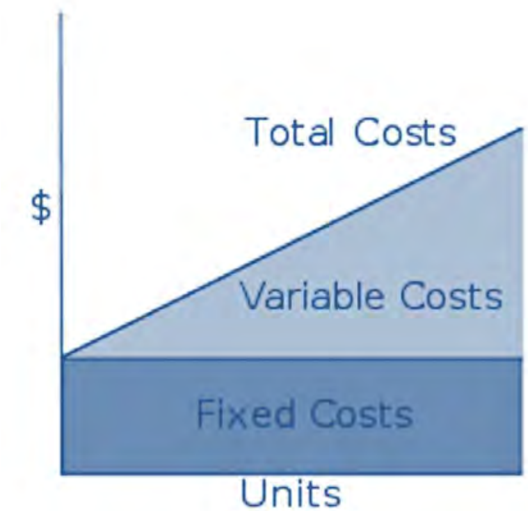
Ratemaking steps & guiding principles: all three matter

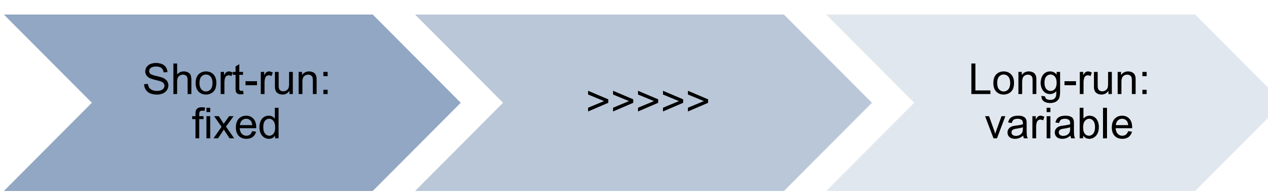
	Step 1. Revenue requirements	Step 2. Cost allocation	Step 3. Rate design
Guiding principle	Cost-based pricing	Nondiscrimi-natory pricing	Just and reasonable pricing
Informing discipline	Finance and accounting	Engineering and economics	Economics, law, and policy
Functional task	Determine the total cost of service (budget) for the rate year(s) based on test-year data	Link costs to customer usage based on varying contributions to system load	Construct revenue-neutral tariffs (rates and charges) to recover costs

Cost allocation

Economics of key cost concepts

- Total costs
  - Average total cost is the sum of average fixed & variable costs of production (more later)
  - Marginal cost (MC) relates to incremental changes in production
- Short-run and long-run costs
  - In the short run, many costs are fixed – marginal cost is low
  - In the long run, all costs are variable – potential avoidance
- Sunk and stranded costs
  - Sunk costs are fixed and unrecoverable *if no longer useful*
  - Economists say we should "ignore sunk costs"
  - Stranded costs are associated with major disruption
  - Risk relates to growth conditions and construction cycles
  - Must be allocated somehow – shareholders and ratepayers

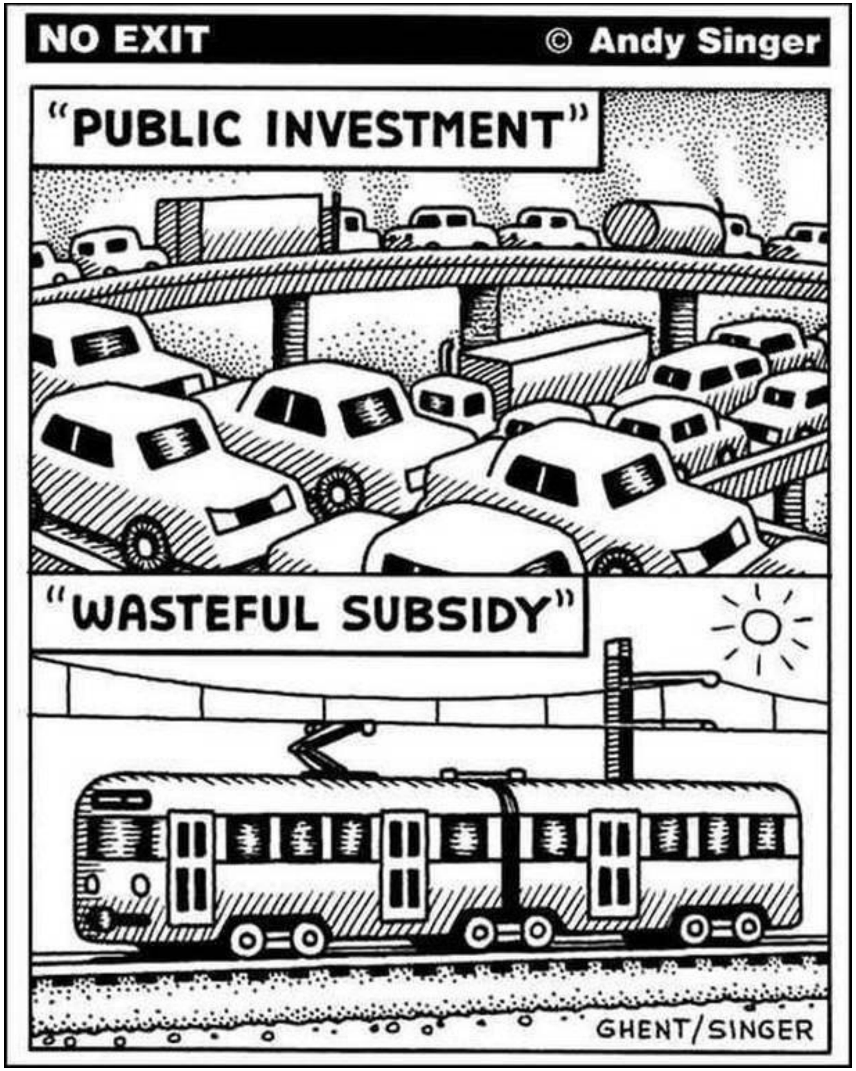




Marginal-cost pricing

- Market theory argues for setting prices at marginal (or incremental) costs
  - Reflects the cost (or value) of the next unit of supply (production capacity & commodity)
  - May be dynamic – and competition drives prices to marginal costs
  - When P=MC, market share is gained through innovation
- Marginal costs for utilities and infrastructure vary by time frame
  - Short-run marginal costs are realistic but generally low (high fixed costs)
  - Long-run marginal costs may send better price signals for discretionary usage
  - Economists disagree about average vs. marginal and SRMC vs. LRMC in design
- Marginal-cost pricing relates to resource efficiency
  - Supply constraints, network congestion, and dynamic pricing
  - Encourages efficient usage by sending forward-looking price signals
  - Equity can be achieved in first blocks, efficiency in tail blocks of any rate (elasticity)
- For utility monopolies, marginal cost is below average cost
  - For water, average-incremental costing and pricing is a practical approach
  - In theory, the fixed costs of networks could be (equitably) supported by tax dollars, with users then charged at marginal cost (Hotelling, 1938; Coase, 1946)

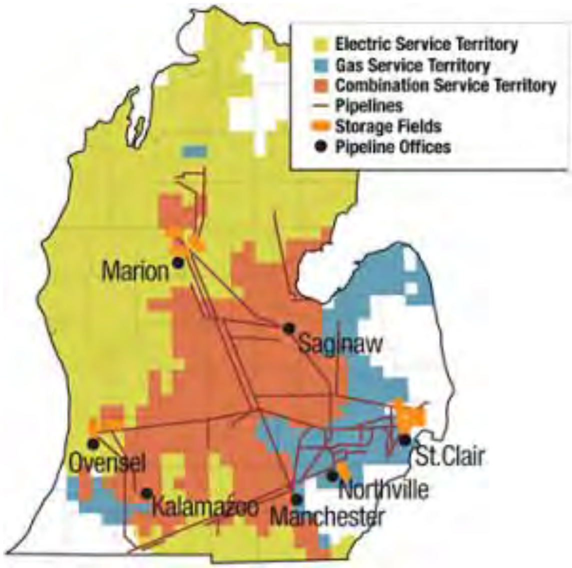
Subsidization is subjective



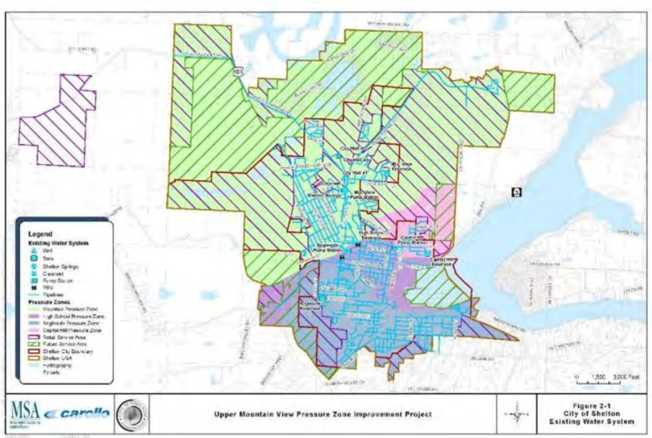
Price differentiation and subsidization

- Ratemaking always involves some pragmatic cost averaging (“smoothing”)
  - Price differentiation (“discrimination”) among users or usage can be “due or undue”
  - Due discrimination is based on cost-of-service criteria and informed judgment
  - Some differences are mostly ignored – e.g., locational (distance, gravity)
- Not all cost-sharing constitutes subsidization
  - A “subsidy” is also a form of financial support to address a social goal
  - May be intentional, acceptable, and targeted to alter economic behavior (incentives)
  - Subsidies are subjective and controversial – causation may be unclear
  - System subsidies are viewed positively, customer subsidies are viewed negatively
- Subsidies and transfers can occur
  - Between taxpayers and ratepayers (including grants, low-cost loans)
  - Between ratepayers within and across classes (including single-tariff pricing)
  - Between utility ratepayers and shareholders
- Subsidies and transfers have consequences
  - Subsidies may transfer wealth – intentionally or unintentionally
  - May distort price signals and place distributional burdens on ratepayers

Subsidies may be explicit or embedded

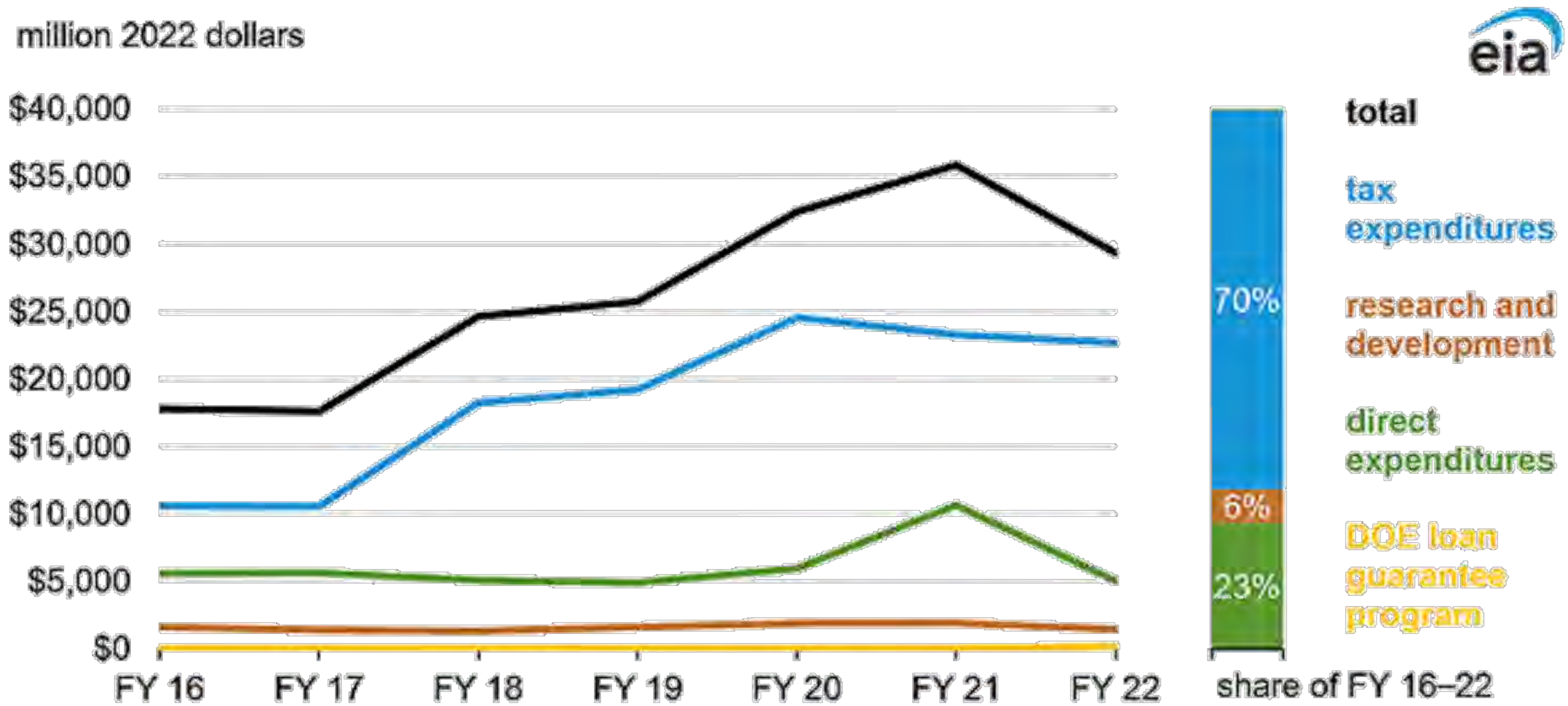


BROADCAST TV FEE	$15.10
REGIONAL SPORTS FEE	$9.10
Taxes, fees and other charges	**$6.06**
Other charges	$6.06
FRANCHISE FEE	$4.99
PUBLIC, EDUC & GOVT FEE	$0.99
REGULATORY COST RECOVERY	$0.08



Federal subsidies for energy

Figure 1. Energy-specific subsidies and support, FY 2016–22



Data source: U.S. Energy Information Administration, *Federal Financial Interventions and Subsidies in Energy in Fiscal Years 2016–2022*, Table 1 and Table A3

Note: DOE=U.S. Department of Energy.

Price differentiation and subsidization (continued) ⓘ

- *“The regulatory systems that were dismantled included all sorts of cross-subsidies, reflecting delicate balance among various interests” (R. Reich, 2007)*
- Restructuring was aimed in part at perceived subsidies
  - Re-balancing (telecommunications) and de-skewing or realignment (energy)
  - Pressure on residential rates could be due to higher costs, unwinding of subsidies or political and economic power of nonresidential customers
- Granting or eliminating subsidies across and within classes can be controversial
  - Differences in price elasticity will affect response
  - Redefining customer classification may be needed


Bloomberg Businessweek

Amazon Isn't Paying Its Electric Bills. You Might Be

The company's rate discounts have pushed up utility costs for everyone else.

By Mya Frazier

- Potential for real or perceived embedded subsidies in ratemaking
  - Inter-class (residential, commercial, industrial) and intra-class
  - Urban, suburban, and rural (regional)
  - Higher and lower income (lifelines)
  - Seasonal and non-seasonal residents
  - Program participants and nonparticipants (e.g., solar)
  - Transfers between ratepayers and taxpayers (general funds, grants, gov. projects)
  - Cost allocation between operations (e.g., water, sewer, and energy)
  - Economic development or retention rates that may provide systemwide benefits

Cost-allocation considerations

- Importance of “cost knowledge” to sustainability
  - Uniform systems of accounts (USoA)
  - Accounting informs both revenue requirements and cost allocation
  - Accounting rules are devised by national standards boards (FASB and GASB)
- Billing determinants are the inputs used to calculate the bill
  - Quantity (volume) consumed
  - Quality differentiation (including reliability)
  - Spatial or “zonal” considerations (distance)
  - Temporal considerations (hour, day, season)
  - Socioeconomic characteristics and environmental impacts
- Demand-allocation factors are used to assign costs
  - Based on weighted contributions of user classes to average and peak demand
  - Ordering of types of costs may matter – what is “base” vs. “extra”?
  - Sensitivity analysis may be useful to check for various influences
- Distribution of *revenues* is not a valid method for allocating *expenses*
  - Expenses are allocated based on the cost of providing a service

Precision in cost allocation

- *"All models are wrong, but some are useful" (George Box)*
- Cost allocation rules may falsely imply methodological precision
  - In terms of both accounting and economics as well as behavioral outcomes
  - Perfect knowledge and exact assignment of all costs is impractical – judgment needed
  - Theoretical basis may be overstated, and concept of subsidy may be overused
- Cost allocation and rate design involve policy and politics
  - Communities should have discretion to experiment and incorporate local goals and values (as feasible and permissible) – should allow for variation
  - Cost socialization can serve social goals such as network stability, universal service, affordability – may include tax support (e.g., fire protection, stormwater management)
  - Who should pay for car charging stations or lead service line replacement?
- All prices are inexact and "distorted" by "noise" (including TOU)
  - Federal and state grants and power and water projects
  - Tax revenues and payments
  - Contributed capital and customer advances
  - Externalities and intergenerational transfers

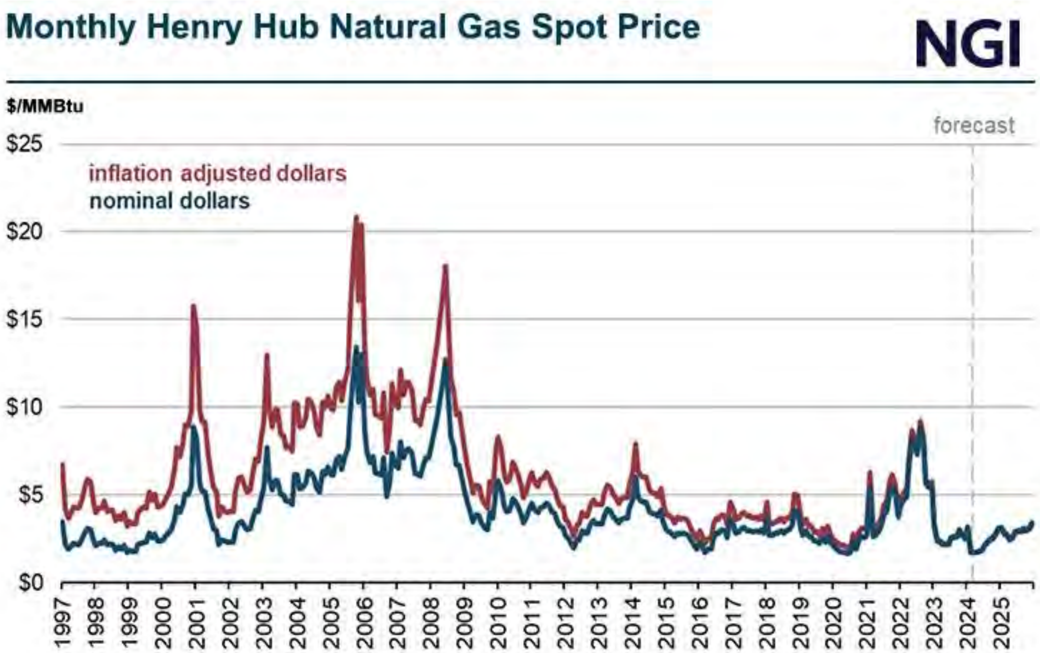
Cost-of-service studies

- Revenue requirements are established by the test-year analysis – a "cost study"
  - Total cost of service and revenue sufficiency
- Cost-of-service (or embedded or allocated c.o.s.) studies are used in ratemaking
  - To establish costs associated with each service according to customer classes (causality) and thus guide cost recovery – linking costs to who pays
- Used to establish and defend the reasonableness of cost allocation and rates
  - Reflect the principle that utility services should be provided at cost
  - Rely on accounting records as well as system operating data (“normalized”)
  - Each utility sector has manuals to support the process
- Results and impacts vary depending on inputs and methodology
  - Studies are informative but not determinative – involve judgment
  - Methods provide reference points for ratemaking – e.g., embedded vs. marginal costs
  - Policies and goals influence the choice of methods as well as rate design
- Key steps
  - Functionalization (activity-based accounting)
  - Classification by type of cost
  - Allocation to usage (customer class)

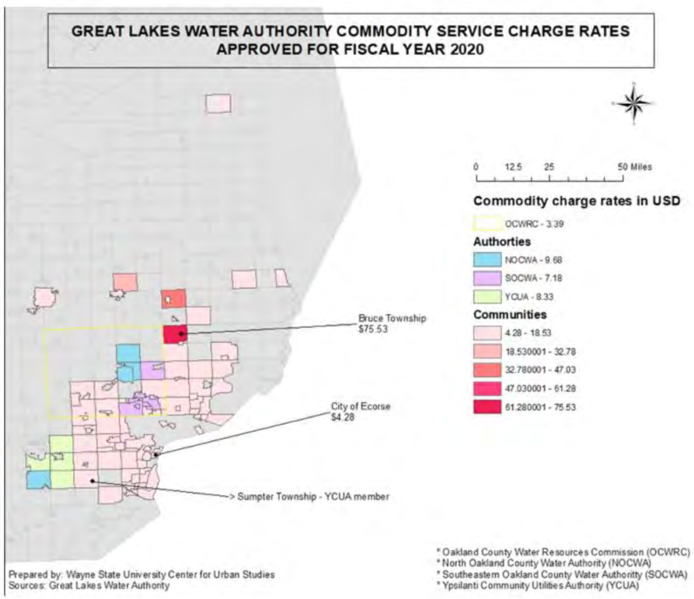
Cost classification

- Direct costs
  - Assigned to and recovered from individual customers receiving the service
- Customer (service) costs
  - Vary with customers but not with usage (e.g., meters, billing, other customer services)
  - Can be allocated by weighted average of costs for metering and billing
- Capacity (network infrastructure or demand) costs
  - Fixed in the short term and includes capital and O&M costs of network systems
  - Vary with aggregate demand over the long term (treatment, storage, distribution)
  - Can be recovered by availability, readiness-to-serve, facilities, and demand charges
  - Allocated by peaking factors and other determinants of usage (weighted)
- Commodity (resource) costs
  - Variable in short term and continuously with volumetric usage over time
  - Can be recovered by time-variant usage charges (including dynamic)
  - Allocated by actual consumption of resources (water, energy)
- Common and joint costs are challenging to allocate (see C. Peterson)
  - Common cost across the entity
  - Include general plant and joint cost of production (two services hard to allocate)
  - Allocated according to set of rules – tied to related accounting treatment

Commodity costs (natural gas and water)



Source: U.S. Energy Information Administration March 2024 Short-Term Energy Outlook



Siource: http://www.drawingdetroit.com/water-rates-vary-due-to-location-use/

Cost-allocation methods

- Role of functionalization, classification, and allocation
  - Attribute and assign to customers the respective functional costs of providing service as identified for test year revenue requirements
  - Design rates by customer class to allow cost recovery while recognizing practical constraints and policy goals
- Methods used to allocate costs (variations)
  - Functional or average use
  - Commodity-demand
  - Embedded-direct
  - Fully distributed
  - Marginal cost
  - Peak responsibility (class or system)
  - Base-extra capacity or average-excess
- Base-extra capacity method is commonly used in the water sector
  - Customer (service) costs
  - Base costs: average-day demand
  - Extra capacity: maximum-day demand
  - Fire protection: peak-hour demand

Schedule 2. Allocation of Expenses to Functions

Agency	Test Year COS	Allocation Metho	Customer % Allocation	Collection % Allocation	Treatment % Allocation	Total % Allocation	Customer $ Allocation	Collection $ Allocation	Treatment $ Allocation
							723,082	7,213,404	19,623,737
0043-046-8500-1000-1100 - Permanent Time Worked	$ 62,601	Indirect	4.64%	25.63%	69.73%	100.00%	2,907	16,045	43,649
0043-046-8500-1000-1200 - Temporary Pay	$ 29,190	Indirect	4.64%	25.63%	69.73%	100.00%	1,355	7,481	20,353
0043-046-8500-1000-1741 - Longevity Pay	$ 90	Indirect	4.64%	25.63%	69.73%	100.00%	4	23	63
0043-046-8500-1000-1800 - Equipment Allowance	$ 234	Indirect	4.64%	25.63%	69.73%	100.00%	11	60	163
0043-046-8500-1000-2100 - Professional Services	$ 31,000	Indirect	4.64%	25.63%	69.73%	100.00%	1,440	7,945	21,615
0043-046-8500-1000-2240 - Telecommunications	$ 800	Indirect	4.64%	25.63%	69.73%	100.00%	37	205	558
0043-046-8500-1000-2410 - Rent City Vehicles	$ 150	Indirect	4.64%	25.63%	69.73%	100.00%	7	38	105
0043-046-8500-1000-2420 - Rent Outside Vehicles/Mile	$ 50	Indirect	4.64%	25.63%	69.73%	100.00%	2	13	35
0043-046-8500-1000-2430 - Contracted Services	$ 9,000	Indirect	4.64%	25.63%	69.73%	100.00%	418	2,307	6,275
0043-046-8500-1000-2500 - Printing	$ 100	Indirect	4.64%	25.63%	69.73%	100.00%	5	26	70
0043-046-8500-1000-2660 - Software Maintenance	$ 400	Indirect	4.64%	25.63%	69.73%	100.00%	19	103	279
0043-046-8500-1000-2700 - Conference Training & Trav	$ 2,960	Indirect	4.64%	25.63%	69.73%	100.00%	137	759	2,064
0043-046-8500-1000-2951 - Employee Recognition	$ 200	Indirect	4.64%	25.63%	69.73%	100.00%	9	51	139
0043-046-8500-1000-3100 - Postage	$ 100	Indirect	4.64%	25.63%	69.73%	100.00%	5	26	70
0043-046-8500-1000-3400 - Materials & Supplies	$ 1,000	Indirect	4.64%	25.63%	69.73%	100.00%	46	256	697
0043-046-8500-1000-3440 - Property Plant & Equipmen	$ 200	Indirect	4.64%	25.63%	69.73%	100.00%	9	51	139
0043-046-8500-1000-4220 - Life Insurance	$ 150	Indirect	4.64%	25.63%	69.73%	100.00%	7	38	105
0043-046-8500-1000-4230 - Medical Insurance	$ 5,823	Indirect	4.64%	25.63%	69.73%	100.00%	270	1,492	4,060
0043-046-8500-1000-4234 - Disability Insurance	$ 298	Indirect	4.64%	25.63%	69.73%	100.00%	14	76	208
0043-046-8500-1000-4237 - Retiree Health Savings Accc	$ 249	Indirect	4.64%	25.63%	69.73%	100.00%	12	64	174
0043-046-8500-1000-4238 - Veba Funding	$ 6,353	Indirect	4.64%	25.63%	69.73%	100.00%	295	1,628	4,430
0043-046-8500-1000-4239 - Retiree Medical Insurance	$ 5,064	Indirect	4.64%	25.63%	69.73%	100.00%	235	1,298	3,531
0043-046-8500-1000-4240 - Workers Comp	$ 605	Indirect	4.64%	25.63%	69.73%	100.00%	28	155	422
0043-046-8500-1000-4250 - Social Security-Employer	$ 4,808	Indirect	4.64%	25.63%	69.73%	100.00%	223	1,232	3,352
0043-046-8500-1000-4259 - Retirement Contribution	$ 14,481	Indirect	4.64%	25.63%	69.73%	100.00%	672	3,712	10,097
0043-046-8500-1000-4270 - Dental Insurance	$ 789	Indirect	4.64%	25.63%	69.73%	100.00%	37	202	550
0043-046-8500-1000-4280 - Optical Insurance	$ 93	Indirect	4.64%	25.63%	69.73%	100.00%	4	24	65
0043-046-8500-1000-4300 - Dues & Licenses	$ 112	Indirect	4.64%	25.63%	69.73%	100.00%	5	29	78
0043-046-8500-1000-4423 - Transfer To IT Fund	$ 104,328	Indirect	4.64%	25.63%	69.73%	100.00%	4,845	26,740	72,744
0043-046-8500-1000-4440 - Unemployment Compensat	$ 159	Indirect	4.64%	25.63%	69.73%	100.00%	7	41	111
0043-046-8500-3360-1100 - Permanent Time Worked	$ 14,669	Indirect	4.64%	25.63%	69.73%	100.00%	681	3,760	10,228
0043-046-8500-3360-1800 - Equipment Allowance	$ 156	Indirect	4.64%	25.63%	69.73%	100.00%	7	40	109
0043-046-8500-3360-4220 - Life Insurance	$ 40	Indirect	4.64%	25.63%	69.73%	100.00%	2	10	28
0043-046-8500-3360-4230 - Medical Insurance	$ 2,228	Indirect	4.64%	25.63%	69.73%	100.00%	103	571	1,553
0043-046-8500-3360-4234 - Disability Insurance	$ 100	Indirect	4.64%	25.63%	69.73%	100.00%	5	26	70
0043-046-8500-3360-4238 - Veba Funding	$ 3,176	Indirect	4.64%	25.63%	69.73%	100.00%	147	814	2,214
0043-046-8500-3360-4240 - Workers Comp	$ 132	Indirect	4.64%	25.63%	69.73%	100.00%	6	34	92
0043-046-8500-3360-4250 - Social Security-Employer	$ 1,132	Indirect	4.64%	25.63%	69.73%	100.00%	53	290	789
0043-046-8500-3360-4259 - Retirement Contribution	$ 3,389	Indirect	4.64%	25.63%	69.73%	100.00%	157	869	2,363
0043-046-8500-3360-4270 - Dental Insurance	$ 169	Indirect	4.64%	25.63%	69.73%	100.00%	8	43	118
0043-046-8500-3360-4280 - Optical Insurance	$ 20	Indirect	4.64%	25.63%	69.73%	100.00%	1	5	14
0043-046-8500-3360-4440 - Unemployment Compensat	$ 45	Indirect	4.64%	25.63%	69.73%	100.00%	2	12	31
0043-046-8500-7019-1100 - Permanent Time Worked	$ 16,661	Customer	100.00%	0.00%	0.00%	100.00%	16,661	-	-
0043-046-8500-7019-1601 - Severance Pay	$ 17,000	Customer	100.00%	0.00%	0.00%	100.00%	17,000	-	-
0043-046-8500-7019-1800 - Equipment Allowance	$ 156	Customer	100.00%	0.00%	0.00%	100.00%	156	-	-
0043-046-8500-7019-4220 - Life Insurance	$ 40	Customer	100.00%	0.00%	0.00%	100.00%	40	-	-
0043-046-8500-7019-4230 - Medical Insurance	$ 2,227	Customer	100.00%	0.00%	0.00%	100.00%	2,227	-	-
0043-046-8500-7019-4234 - Disability Insurance	$ 100	Customer	100.00%	0.00%	0.00%	100.00%	100	-	-
0043-046-8500-7019-4238 - Veba Funding	$ 3,176	Customer	100.00%	0.00%	0.00%	100.00%	3,176	-	-

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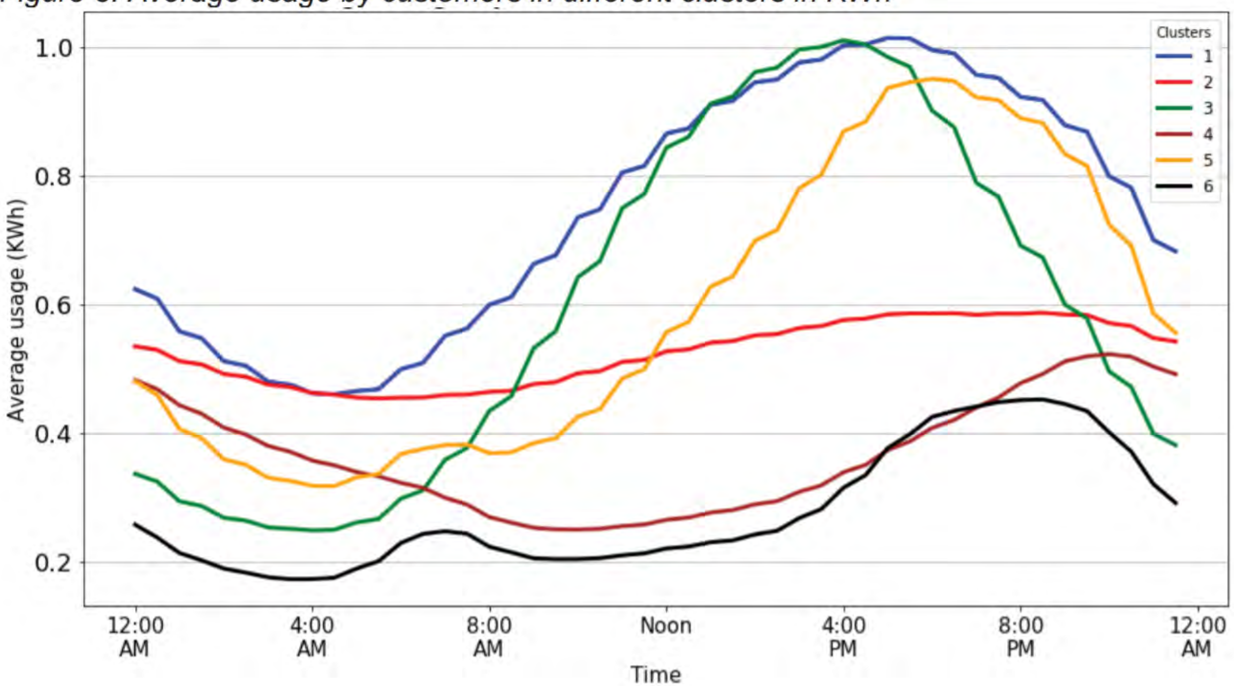
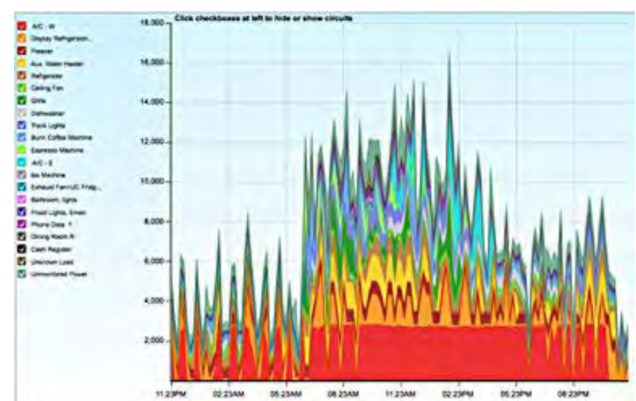
Coincident and non-coincident peaking (electricity)

Figure 5: Average usage by customers in different clusters in KWh



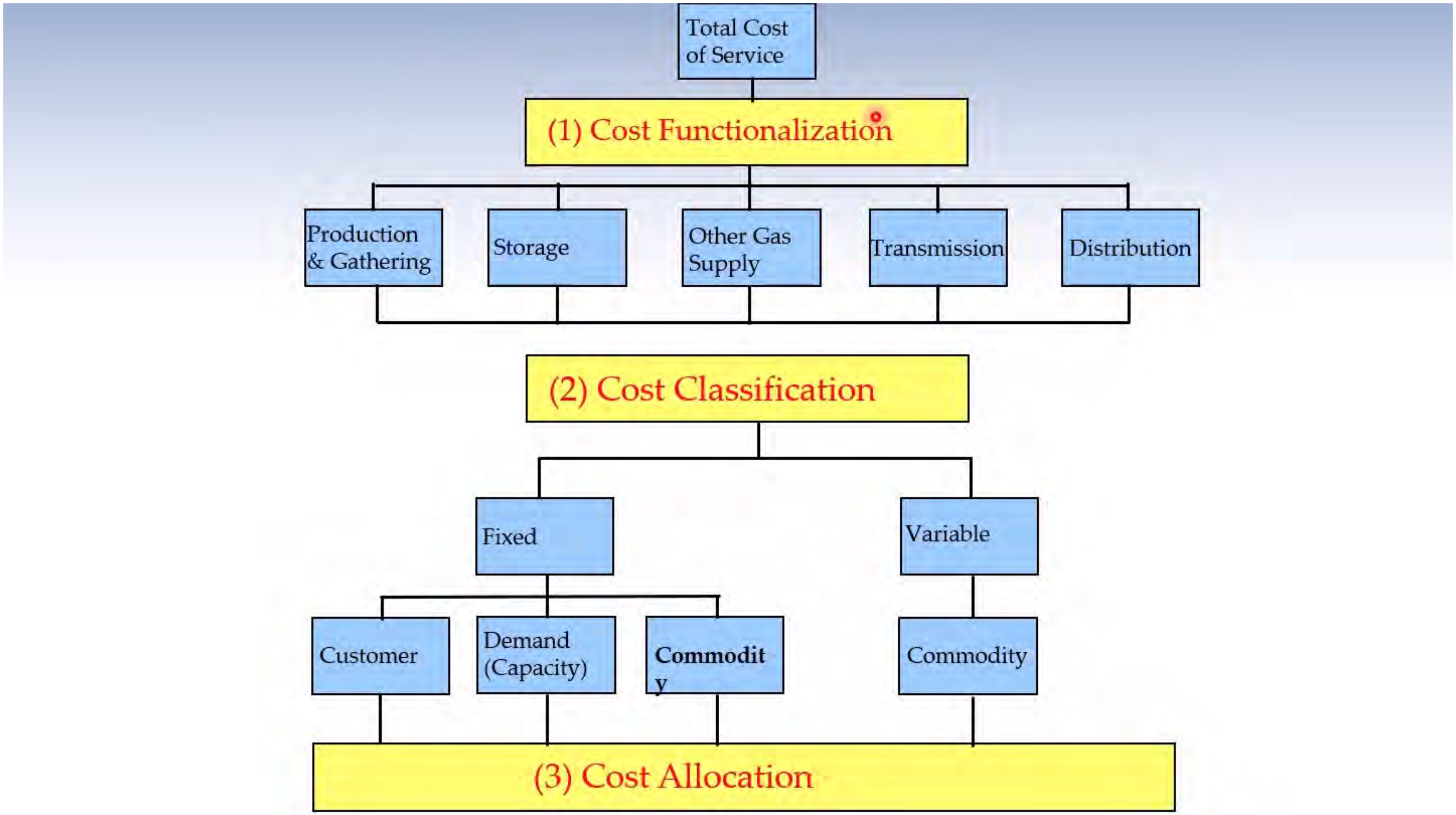
Source: energynews.us



Poll 4: Peak pricing

- Which peak should be used for cost allocation?
  A. Coincidental system peak
  B. Noncoincidental peak for the class
  C. Household-level peak usage
  D. Neither

Cost functionalization, classification, & allocation

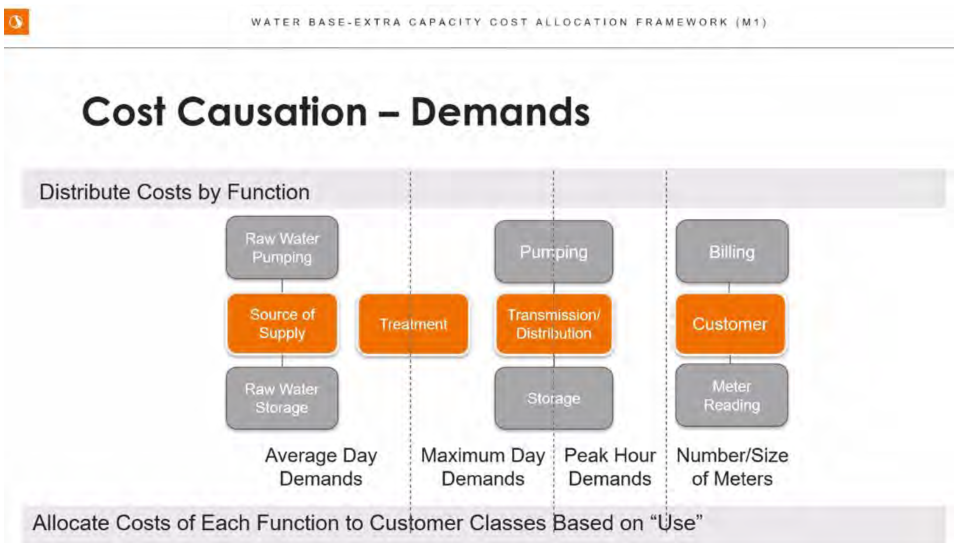


Cost functionalization, classification, & allocation (simplified)

Cost functionalization		Cost classification*	Cost allocation**
Contractual services ($)	Opex	Direct	Actual billed directly
Purchased water and fuel	Opex	Commodity	Metered usage
Customer accounts, metering, billing, revenue-related	Capex / Opex	Customer	By class in proportion to customers or bills
Source-of-supply facilities, raw water storage	Capex / Opex	Capacity	Average-day and maximum-day demand
Transmission lines, water treatment plants	Capex / Opex	Capacity	Maximum-day demand
Distribution mains, pumping stations, treated water storage	Capex / Opex	Capacity	Maximum-day and peak-hour demand
General and intangible plant, overhead, programs, taxes	Capex / Opex	Capacity	By class in proportion to customers, usage, other

* Capacity costs are fixed in the short term and variable in the long term.
** Methods and practices vary.

Cost allocation by class based on demand causation (Stantec)



	Single-Family Residential	Multi-Family Residential	Commercial/ Institutional	Industrial	Landscape/ Irrigation
Base Capacity	$467,672	$89,326	$55,276	$5,622	$30,755
Extra Capacity - Max Day	$174,270	$25,669	$20,605	$2,020	$28,059
Extra Capacity - Max Hour	$124,383	$19,677	$14,705	$-	$20,487
Public Fire Protection	$17,234	$4,706	$2,309	$370	$-
Customer	$469,924	$42,768	$20,990	$1,443	$9,315
Rate Revenue Requirement	**$1,253,490**	**$182,147**	**$113,887**	**$9,456**	**$88,616**

Cost allocation by customer class

- Costs are averaged within broad customer classes temporally and spatially
  - Individualized rates (vs. averaging) generally are not used (impractical)
  - Higher granular methods may be burdensome and raise issues of fairness
  - Zonal prices are sometimes used to take location into account (e.g., pressure zones)
  - Time-variant rates reduce cost averaging for peak and off-peak periods
- Cost allocation is based on the impact of usage on facilities
  - Costs must be allocated to "revenue-producing" activities (sales)
  - Rules are needed to allocate common or joint costs
  - System demand ratios are used as allocators
- Customer-specific costs and rates
  - System-development charges ("growth should pay for growth")
  - Special or negotiated contracts for high-volume unique-profile customers
- Customers classes (R/C/I) – may be too general and could become obsolete
  - Artifact of zoning and property tax methods
  - Masks substantial variation within classes – more so with aggregation
  - Re-classification should be logical, meaningful, and data-driven (AMI)

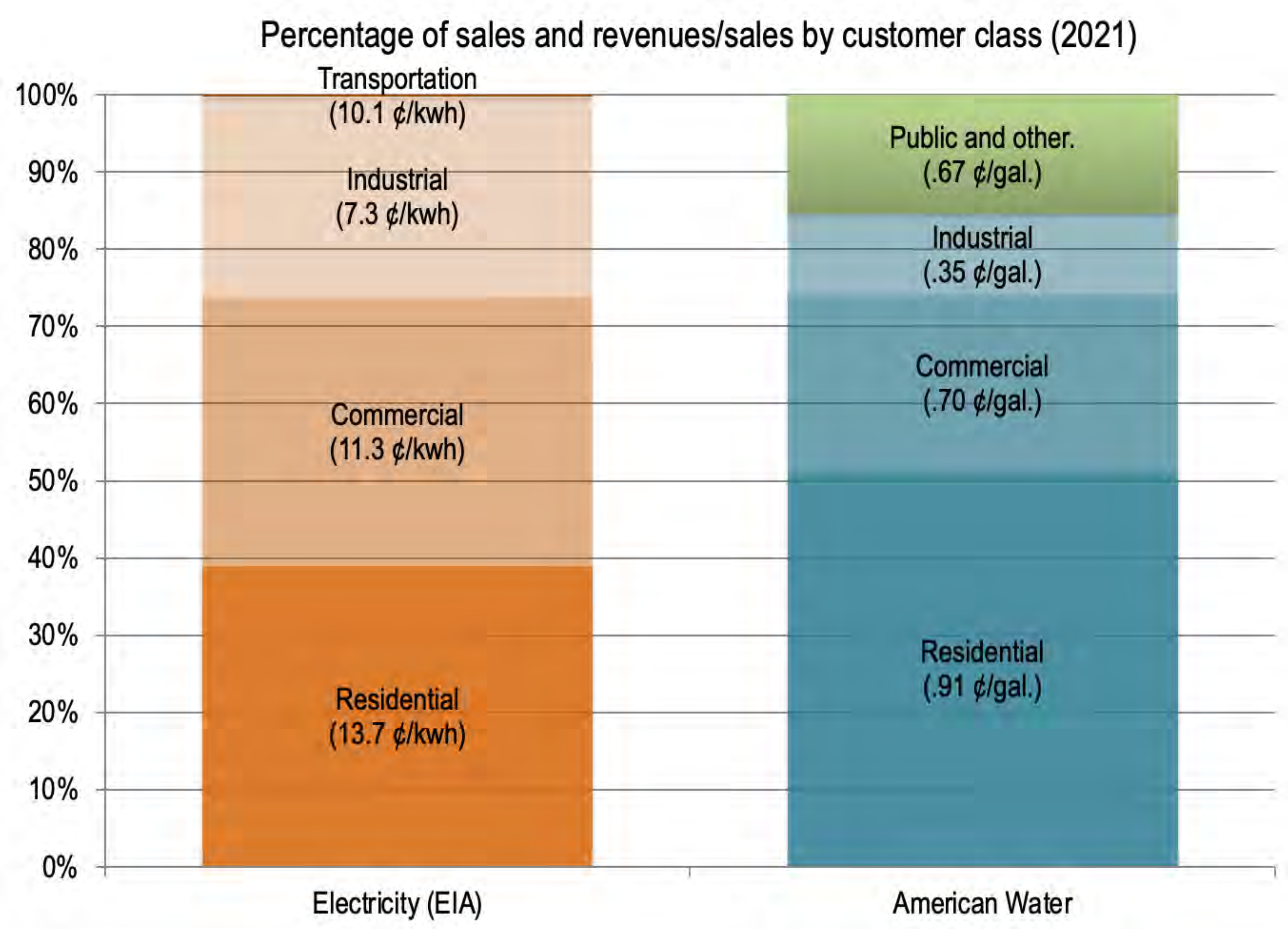
Customer classes and billing distribution (traditional)

Residential
Single family
Multi-family
Nonresidential*
Commercial
Industrial
Wholesale
Agricultural
Public authorities
Special use (street lighting, irrigation, public and private fire protection)

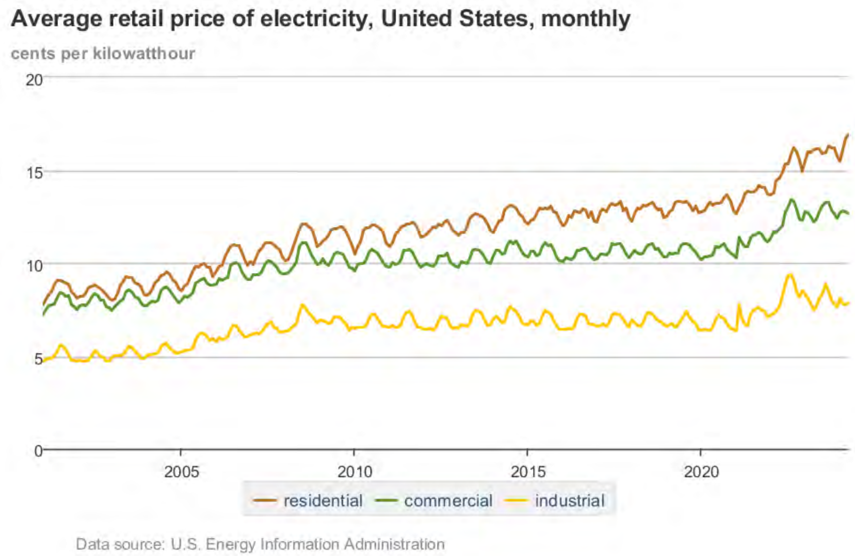
Fig. 8 Frequency distribution of DWU among 50 houses

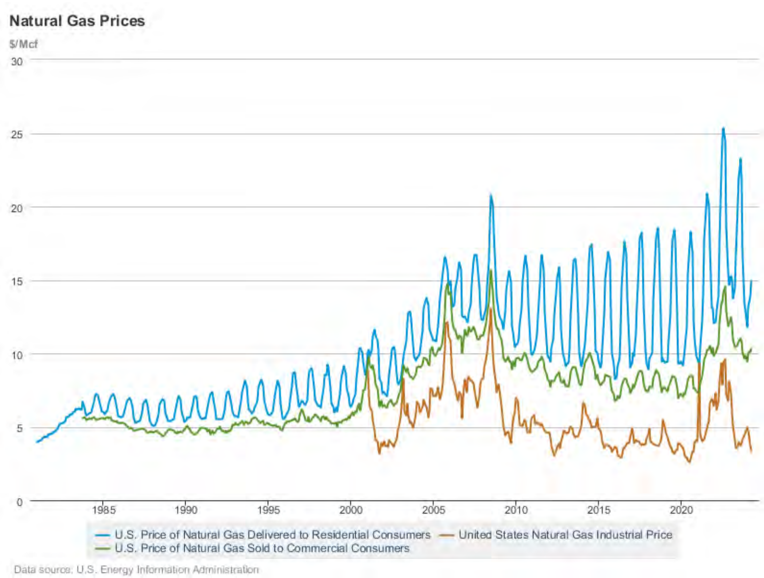
** For water, customer classes and tariffs are differentiated by meter size.*

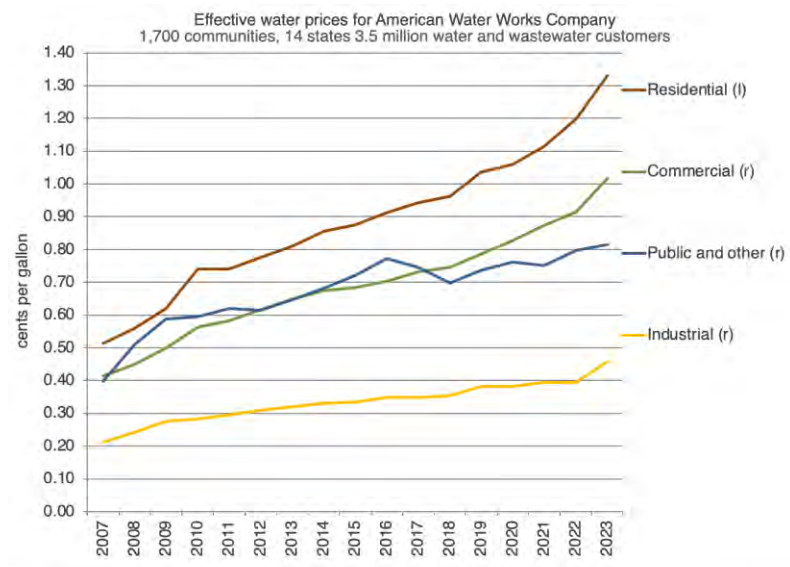
Sales revenues and average prices by class



Average prices by class: economics, politics, and policy



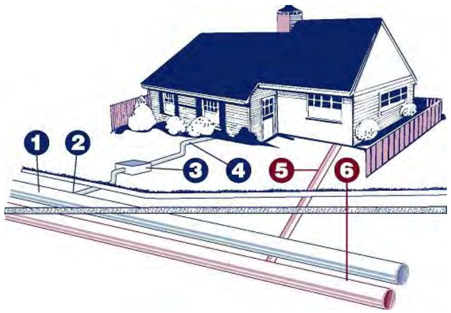




System development or impact fees ⓘ

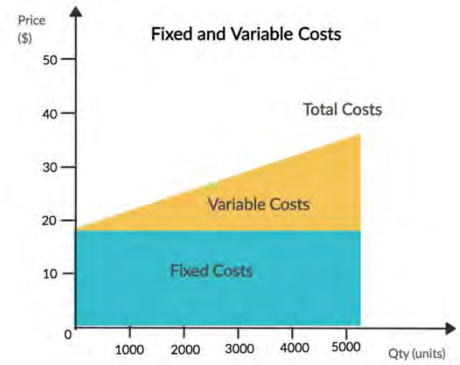
- Types of fees used in the water sector (UNC EFC)
  - Connection fees are based on the direct cost to hook up service a property
    - Connection fee, cut-on fee, installation fee, meter set fee, new meter connection fee, new service connection fee, service fee, tap fee, tap-on fee, turn-on fee
  - Development, capacity, or impact fees are used to support system-wide needs
    - Capacity fee, connection fee, cost recovery fee, impact fee, new customer fee, service fee, system development charge/fee
- Development fees are based on the concept that "growth should pay for growth"
  - More likely to be used by publicly owned than privately owned systems
  - Can be thousands of dollars and partly explains rate disparity between systems
- Ratemaking treatment
  - Not included in operating income (public)
  - Treated as a "contribution in aid of construction" and excluded from rate base (private)

Key: 1. Water Main; 2. Water Tap; 3. Water Meter; 4. Private Plumbing (water line); 5. Private Plumbing (wastewater line); 6. Wastewater Main. Source: City of Fort Worth, Texas



Fixed vs. variable costs

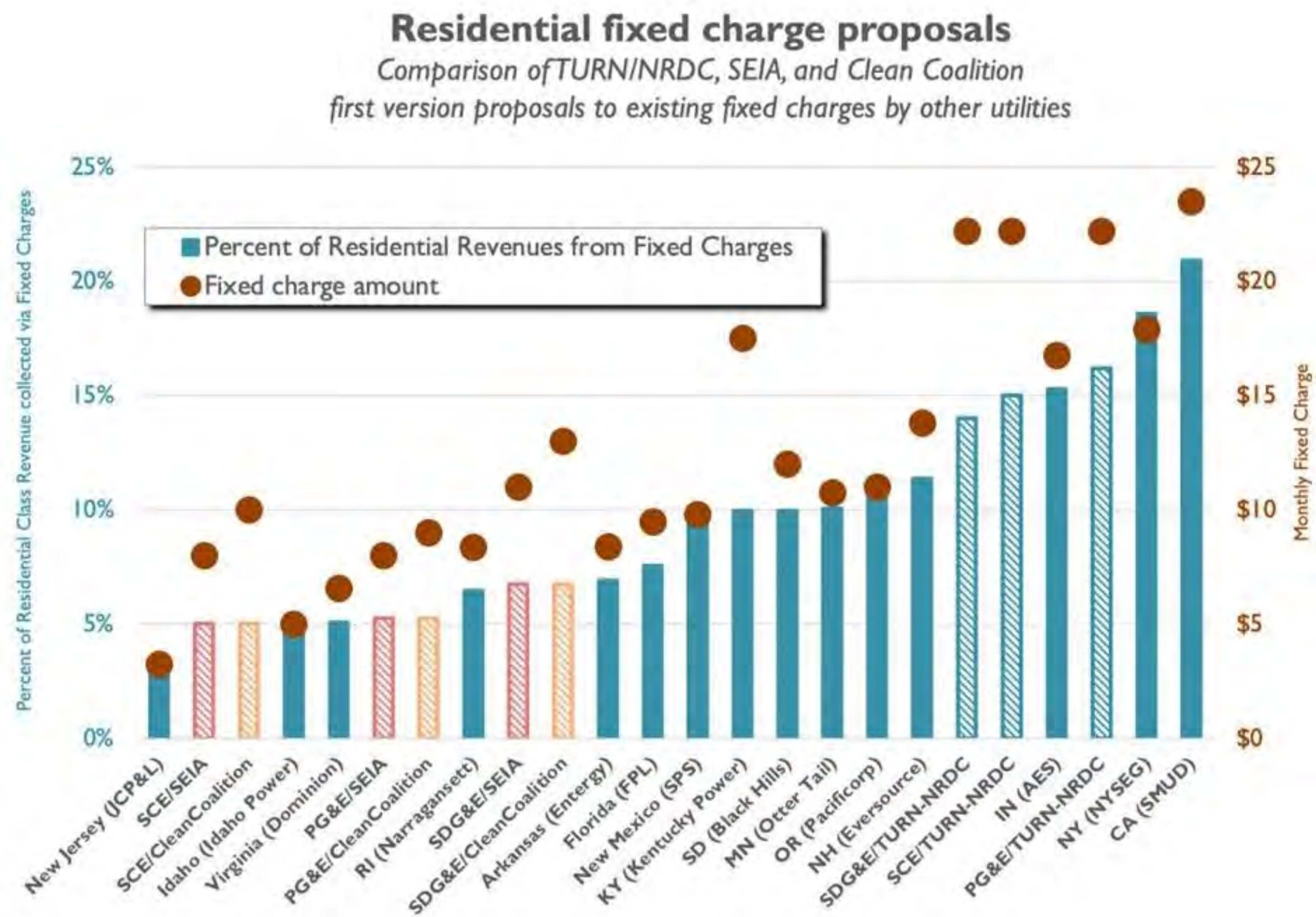
- Utilities have high fixed infrastructure network costs
  - Increasingly capital intensive as variable costs fall (efficiency, renewable resources)
- Total cost of service is the sum of fixed and variable
  - Fixed costs do not vary with usage within a relatively short period
  - Variable costs vary with amount, location, and time of usage
  - Coasian pricing – two-part tariff with fixed fee plus marginal cost
- Short-run and long-run costs
  - In the short run, many costs are fixed – and marginal cost is low
  - In the long run, all costs are variable – potential avoidance
- Functional unbundling of costs
  - Capacity and commodity costs are variable (volumetric) over time
  - Restructured gas market, some interest in electricity and water



Poll 5: Fixed charges

- What percentage of the utility bill should be fixed?
  A. 0%
  B. 10%
  C. 25%
  D. Enough to cover short-term fixed costs
  E. Enough to cover long-term fixed costs
  F. Not sure

Residential fixed charge proposals (TURN, 2024)



Fixed vs. variable charges

- Fixed and variable tariff charges may not match fixed and variable costs
  - "The mere existence of systemwide fixed costs doesn't justify fixed charges" (S. Borenstein, 2014)
  - Most utilities likely recover some fixed costs through variable charges ("absorption") – *as do competitive firms*
  - Cost classification guides design of fixed and variable charges but is not determinative
- Utilities favor fixed charges for recovery of network capacity costs
  - Environmental and consumer advocates tend to prefer variable to fixed charges
  - Improve price signals about costs and capacity requirements
  - Net metering for distributed energy poses new challenges in covering network costs
- Fixed charges are uncontrollable and unavoidable
  - A high proportion of the bill for low-volume customers
  - Consumer advocates also worry about higher bills overall and more disconnection

<table>
<tr><td colspan="2">Fixed (base) charge</td><td colspan="2">Variable (volumetric) charge</td></tr>
<tr><td>Customer costs</td><td colspan="2">Capacity costs</td><td>Commodity costs</td></tr>
</table>

Fixed vs. variable charges: tradeoffs ⓘ

Recovering more costs from fixed charges	Recovering more costs from variable charges
Static view of infrastructure (more sunk costs)	Dynamic view of infrastructure (less sunk costs)
Enhances revenue stability (less sales revenue risk to utility)	Reduces revenue stability (more sales revenue risk to utility)
Weakens price signals (less resource efficiency)	Strengthens price signals (more resource efficiency)
Familiar & understandable but less acceptable (more predictable and less controllable)	Familiar & understandable but more acceptable (less predictable and more controllable)
Less affordable for low-income households (more regressive)	More affordable for low-income households (less regressive)
Encourages self supply and grid defection (may raise some costs)	Preserves grid supply and participation (may lower some costs)
Possible advantage for combined households (one fixed customer charge)	Possible stability from first blocks (relatively inelastic usage)

Straight fixed-variable pricing

- Utilities have a strong impulse to raise fixed charges or minimum bills
  - More problematic for water than energy due to very high fixed costs
  - Inelasticity of base usage (especially for water) provides relative stability
  - Alters incentives for efficiency and innovation and undermines equity
  - Suggests adjustment to allowed returns due to lower revenue risk
- Recovery of capacity costs
  - Can be "calibrated to reflect cost differences in service levels" based on connection attributes – addressing efficiency and equity (Borenstein, 2017)

Proposed vs. Approved Residential Fixed Charge Increases
Rate Cases Decided in Q3 2018 (Electric)

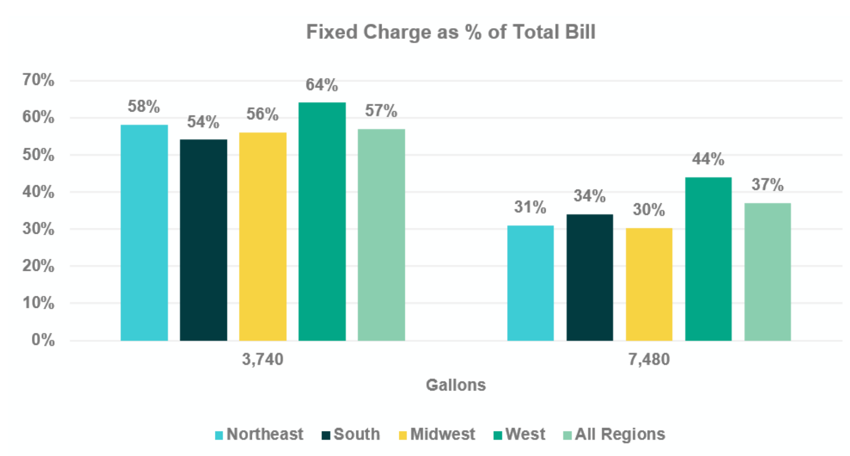
Utility	Existing	Proposed	% Increase Sought	Approved	% Increase Approved
PG&E (CA)	$10.00	$10.00	0%	$10.00	0%
Delmarva Power (DE)	$11.70	$13.51	15%	$11.70	0%
National Grid (RI)	$6.59	$10.10	53%	$6.59	0%
Pepco (DC)	$15.09	$15.09	0%	$15.09	0%
Westar Energy (KS)	$14.50	$18.50	28%	$14.50	0%
Alliant Energy (WI)	$15.00	$15.00	0%	$15.00	0%
Xcel Energy (NM)	$8.50	$9.50	12%	$8.75	3%
Dayton Power & Light (OH)	$4.25	$13.73	223%	$7.00	65%
Otter Tail Power (ND)	$8.00	$17.70	121%	$14.00	75%

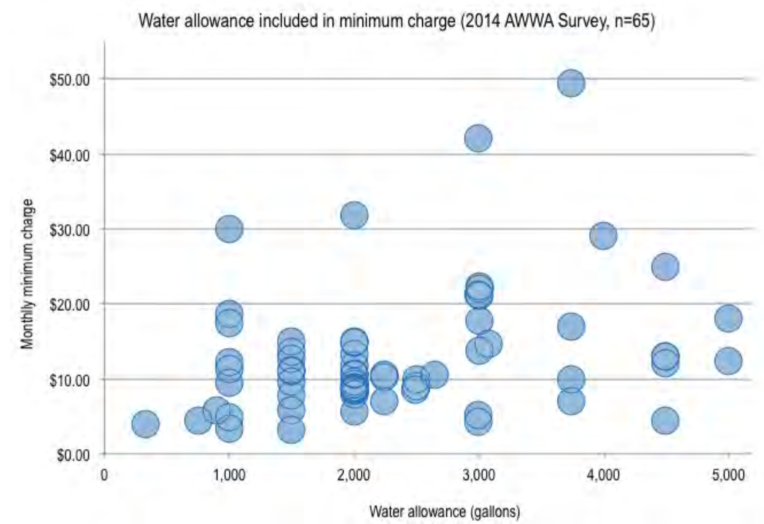
Fixing revenues with fixed prices ⓘ

- Utilities should resist the impulse to move toward fixed-variable pricing
  - In the long run, all costs are variable – and pricing should reflect this
- Simply raising fixed charges is a languid response
  - Undermine affordability and equity, where low-use subsidizes high-use
  - Undermine price signals to promote efficient outdoor usage (perpetuates peaking)
- Revenue stability can be provided by well-designed rates
  - Basic usage blocks can provide considerable stability
- New variable pricing models may be needed
  - Use of peaking factors to improve cost allocation and rate design
  - Use of three-part tariffs (customer, capacity, commodity)
  - Use of property value to assign some fixed capacity costs

Usage allowance (water)

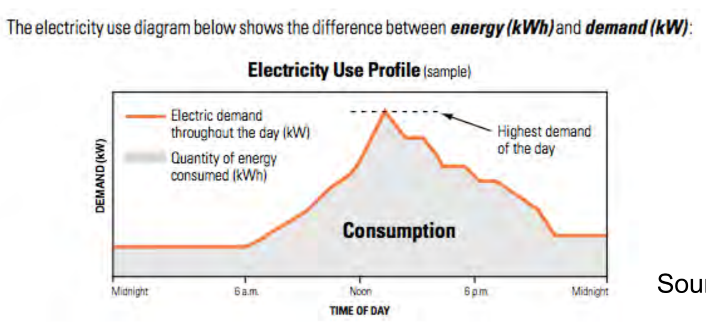
- Inclusion of a usage allowance in a fixed tax-exempt minimum bill
  - Useful in satisfying preference for universal equity (fairness)
  - Distorts end-use efficiency incentives only if usage is discretionary
  - May be more appropriate for water given storability, renewability, and externalities
- World Health Organization recommendations
  - Minimal provision of 50-100 liters per person per day for human health
  - Consider default at 25 gpcd (100 liters) or about 3,000 gal. per household per month
  - Indoor household usage in the U.S. varies but generally exceeds this amount
- Timely metered consumption data facilitates self-rationing





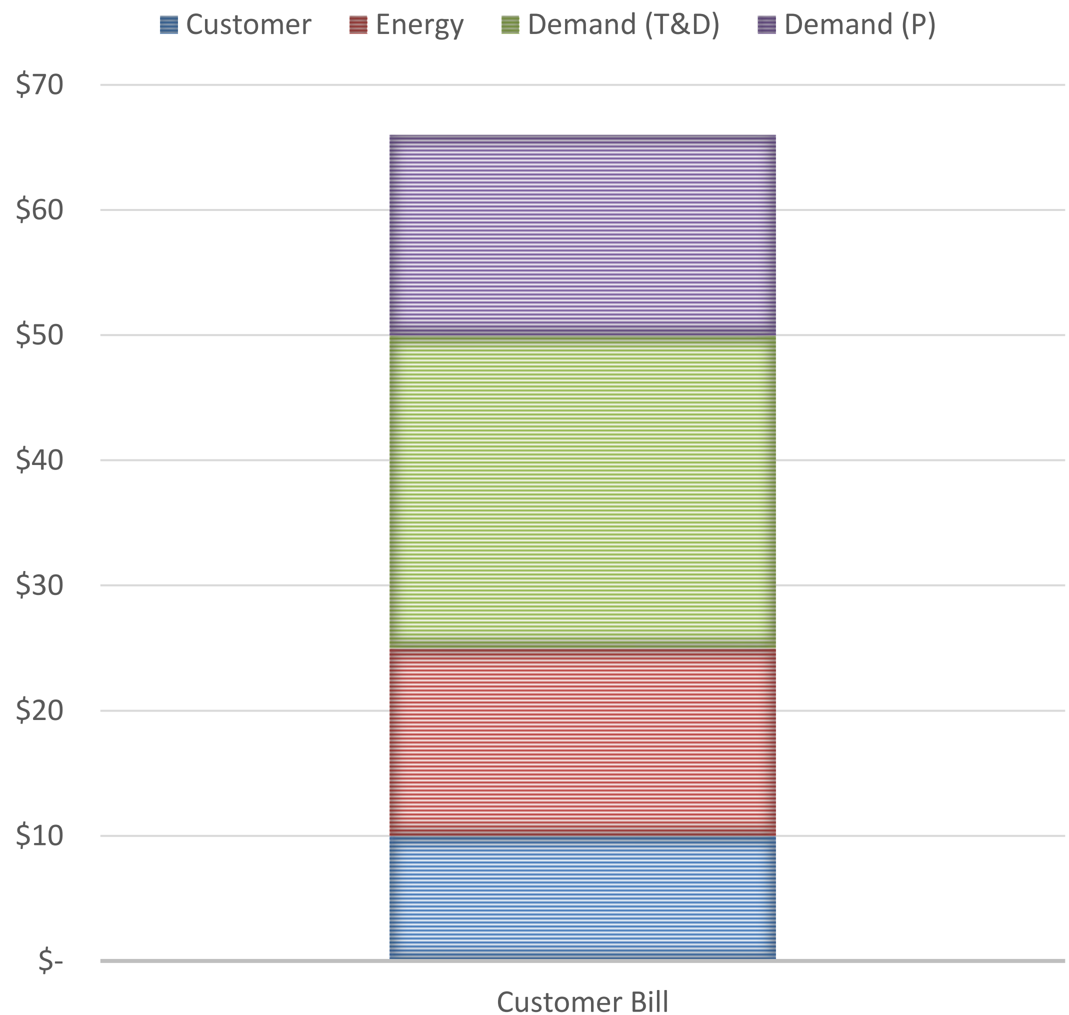
Demand charges (electricity) ⓘ

- Demand drives capacity ("on-demand"), volume drives commodity usage
- Demand charges are typically based on a customer's incidental peak usage
  - Not on the system's co-incidental peak (vs. dynamic pricing)
  - Used for high-volume users but proposed for residential – requires demand metering
  - Energy usage is measured and metered in watt-hours over a period of time
  - Demand is measured in total watts at a given point in time
  - With ratchet charges, the annual peak is used to ratchet the monthly demand peaks
  - Have also been used in water where meter size also approximates demand by class
- Rationalized as a means of recovering fixed network costs
  - Analysts question effectiveness given sunk costs, weak price signals (Borenstein, 2017)
  - Consumer advocates question adverse bill impacts (Springe, 2015) – "gotcha rates"
  - Most consider less than efficient; some consider less than equitable (Borenstein)
  - Time-variant may be better for promoting efficiency



Source: WE Energies.

Common commercial & industrial pricing (Hopkinson rates)



Source: C. Mickelson

Rates in competitive markets (C. Mikelson) ⓘ

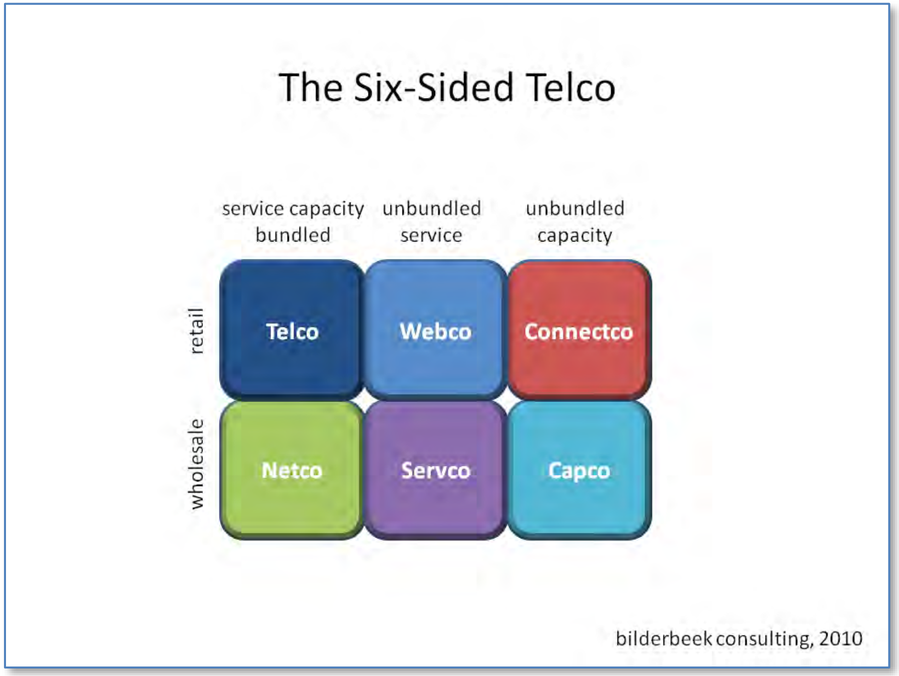
Plans	Description
Fixed	Fixed rate for the duration of the contract, which varies from months to years
Variable	Different price each month based on factors (e.g., weather, load profiles, supply, demand)
Renewable	Electricity from renewable sources to offset consumption
Index	Prices are pegged against an index (NYMEX NG futures) using a mathematical formula
Slab	Rate is stepped up or down based on usage range
Custom	Negotiated individual rate based on customer load profile

Utility bill components

- Charges that reflect "base rates" in the tariff
  - Combination of approved fixed and variable (unit rate) charges plus allowed adjustments in the form of variable cost trackers or formulaic riders or surcharges
- Operating-cost adjustments
  - Approved mechanisms for adjusting rates provided for by tariff "clauses"
  - Fuel (for energy production) or other major inputs that meet criteria
  - Purchased energy and water (wholesale) – inter-utility allocation
  - Uncollectible expenses
- Capital-cost adjustments (more recent)
  - Surcharges for costs (e.g., DSIC)
- Other charges (or credits)
  - Taxes, assessments, and regulatory fees
  - Environmental surcharges (e.g., carbon tax)
  - Renewable energy surcharges
  - Direct charges (e.g., connection, hook-up, turn on or off)
  - Penalties (e.g., late payment)
  - Mark-up for service outside of city boundaries
  - Social or public-benefit programs (involuntary and voluntary)
  - On-bill charges for unbundled services and utility-financed loans
  - Charges related to revenue assurance (decoupling) or stabilization
  - Credits for energy or water savings according to special tariffs
  - Unbundled service fees (e.g., maintenance, wiring, plumbing, water heating or softening)

Charges for unbundled services

- Unbundling involves separating services and charges (Spirit airlines)
  - Efficiency and economic equity arguments (cost causer pays)
  - Total element long-run incremental cost (TELRIC) in telecommunications
- Utilities can "unbundle" rates for services that present particular costs
  - Restructured markets separate charges for generation, transmission, and distribution
  - Allow for special optional offerings and product differentiation or enhanced services
- Some services may be deregulated
  - Ancillary and competitive services
  - Segregation and separation
  - Risk management

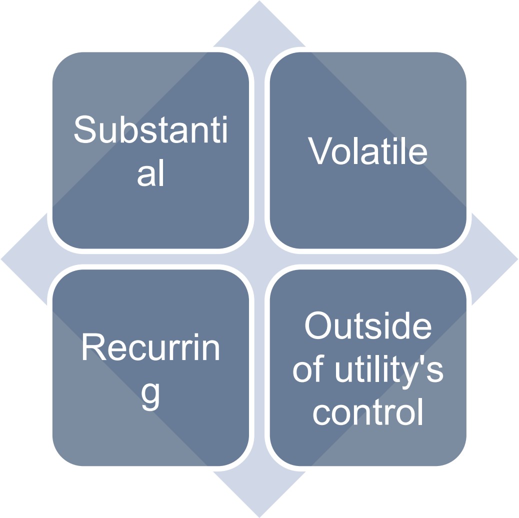


Poll 6: Cost-adjustment mechanisms

- **Which of the following is not among the traditional criteria for using cost trackers?**
  A. Large expenditures
  B. Volatile expenditures
  C. Nonrecurring expenditures
  D. Expenditures outside of the utility's control

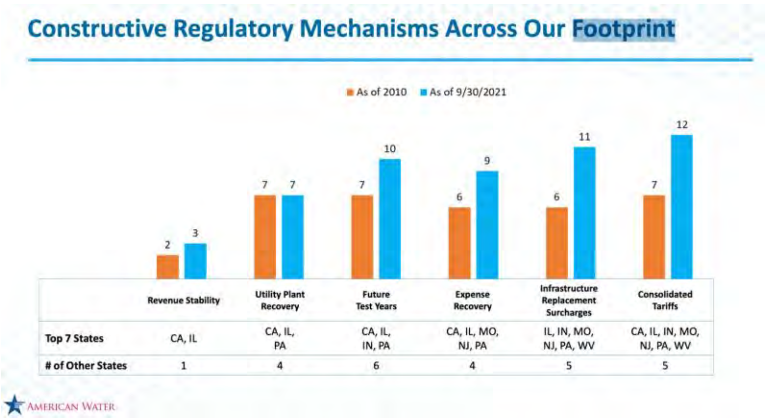
Cost-adjustment mechanisms

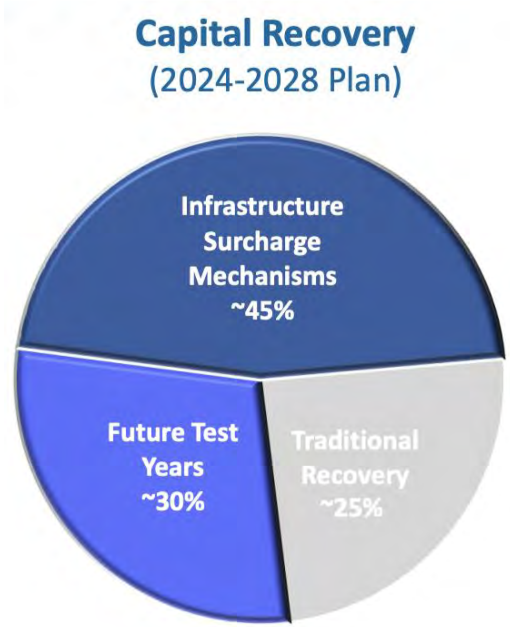
- Originally applied to variable operating expenses meeting four criteria
  - Substantial, recurring, volatile, and largely outside utility's control
- Known as cost trackers, riders, and surcharges for adjusting rates to costs
  - Allow adjustments to customer rates when the actual costs incurred depart from a baseline amount determined in a rate case
  - Provided for by approved tariff "clauses" – separate from base rates
  - Must be carefully reviewed and reconciled – not "automatic" and not "mechanized"
  - Not the same as revenue assurance mechanisms, such as decoupling
- Meant to prevent financial hardship and earnings erosion between rate cases
  - Considered "credit positive" by rating agencies (bonds)
- Distinct from revenue-adjustment mechanisms (decoupling)



Cost-adjustment mechanisms

- Types of costs that may be tracked
  - Fuel or energy cost adjusters
  - New operating systems or plant
  - Regularized infrastructure replacement
  - Bad debt (uncollectible)
  - Taxes and property valuation
  - Special programs (e.g., efficiency)
  - Regulatory compliance costs
- Expanded or proposed to include
  - Capital-related costs that do not meet the criteria
  - Rapidly rising costs (undermining incentives)
- May be used for special purposes
  - To incentivize accelerated spending (FERC adders, DSIC)
  - To fund public benefits (form of taxation)





Cost-adjustment mechanisms

Bill by City | Unit Cost | Company List | Chart by City | Map of Cities | Bill Trends | Bill Components

Ohio | Public Utilities Commission

Columbus Southern Power Residential
Electric Bill Total **$118.26** Components for **January 2023**
Based on County **Franklin** Sales Tax Rate **7.500%**

Total Charge	Charge Type	Name	% of Total Bill	Schedule	Short Name	Rate	Effective Date	Mu
$45.31	Generation	Generation Energy Rider	38.31%	RS	GE Rider	0.0604100	6/1/2022	
$23.34	Transmission	Basic Transmission Cost Rider-Residential	19.74%	RS	BTC Rider	0.0311199	4/1/2022	
$19.73	Distribution	Residential Service-Regular	16.69%	RS	RS	0.0263125	1/1/2022	
$10.00	Distribution	Residential Service-Regular	8.46%	RS	RS	10.0000000	1/1/2022	
$4.36	Generation	Generation Capacity Rider	3.68%	RS	GC Rider	0.0058100	6/1/2022	
$4.03	Distribution	Universal Service Fund Rider	3.40%	RS	USF Rider	0.0053667	1/1/2023	
$3.49	Distribution	KWH Tax Rider	2.95%	RS	KWH Tax Rid.	0.0046500	12/1/2021	
$2.92	Generation	Alternative Energy Rider-Secondary	2.47%	RS	AE Rider	0.0038973	12/1/2021	
$2.54	Distribution	Distribution Investment Rider	2.14%	RS	DIR Rider	0.1705366	12/1/2022	
$1.91	Distribution	gridSMART Phase 2 Rider	1.62%	RS	GSP2 Rider	1.9100000	12/1/2022	
$1.18	Distribution	Pilot Throughput Balancing Adjustment Rider	0.99%	RS	PTBAR	0.0015688	7/1/2022	
$1.12	Distribution	Economic Development Cost Recovery Rider	0.95%	RS	EDCR Rider	0.0755216	10/1/2022	
$0.91	Distribution	Enhanced Service Reliability Rider	0.77%	RS	ESR Rider	0.0614140	12/1/2021	
$0.10	Distribution	Solar Generation Fund-Residential	0.08%	RS	SGF	0.1000000	1/1/2023	
($0.02)	Generation	Legacy Generation Resource Rider - Part B	-0.02%	RS	LGR Rider B	-0.0200000	1/1/2023	
($0.17)	Distribution	Tax Savings Credit Rider	-0.15%	RS	TSCR	-0.0002300	12/1/2021	
($0.46)	Generation	Legacy Generation Resource Rider - Part A	-0.39%	RS	LGR Rider A	-0.4600000	1/1/2023	
($2.02)	Generation	Auction Cost Reconciliation Rider-Energy Cost	-1.71%	RS	ACR Rider	-0.0026951	1/1/2023	

City: Columbus
Customer Type: Residential
Utility Type: Electric
Report Date: January 2023
Charge Type: (All)
Monthly Usage (kWh): 750
Demand (kW): 0
Reactive Demand (kVAR): 0
Mcf or Ccf: Mcf
Monthly Usage (Mcf or Ccf): 10

New Charges & Credits
POD 40000000377209 (CNG - Cycle 01)

Current Supplier: Connecticut Natural Gas Corporation

Customer Charge		$	18.00
Delivery Charge	13.000 CCF @ $.818800	$	10.64
Distribution Integrity Management Program	13.000 CCF @ $.015000	$	0.20
Sales Service Charge	13.000 CCF @ $.081900	$	1.06
Purchased Gas Adjustment	13.000 CCF @ $.644300	$	8.38
Conservation Adjustment Mechanism	13.000 CCF @ $.046000	$	0.60
Decoupling Adjustment	12.000 CCF @ $.037087	$	0.45
Decoupling Adjustment	1.000 CCF @ $.061825	$	0.06
System Expansion Adjustment	12.000 CCF @ $.026800	$	0.32
System Expansion Adjustment	1.000 CCF @ $.028300	$	0.03
Total Gas Charges		$	**39.74**

Total New Charges	$	**39.74**

Amount Now Due: $ 39.74

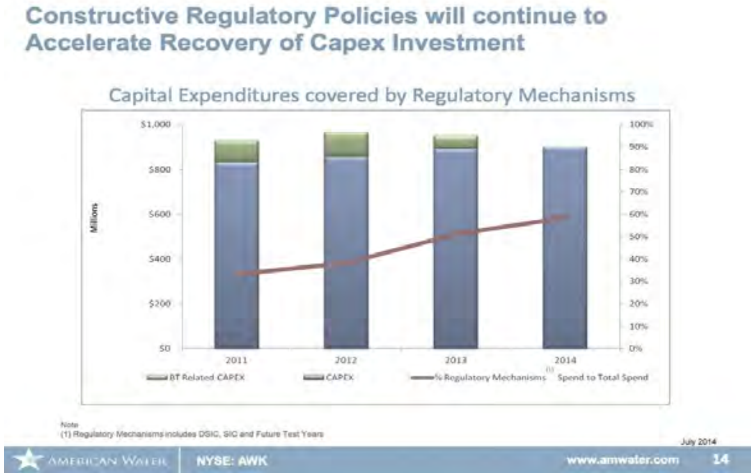
Rationales and concerns ⓘ

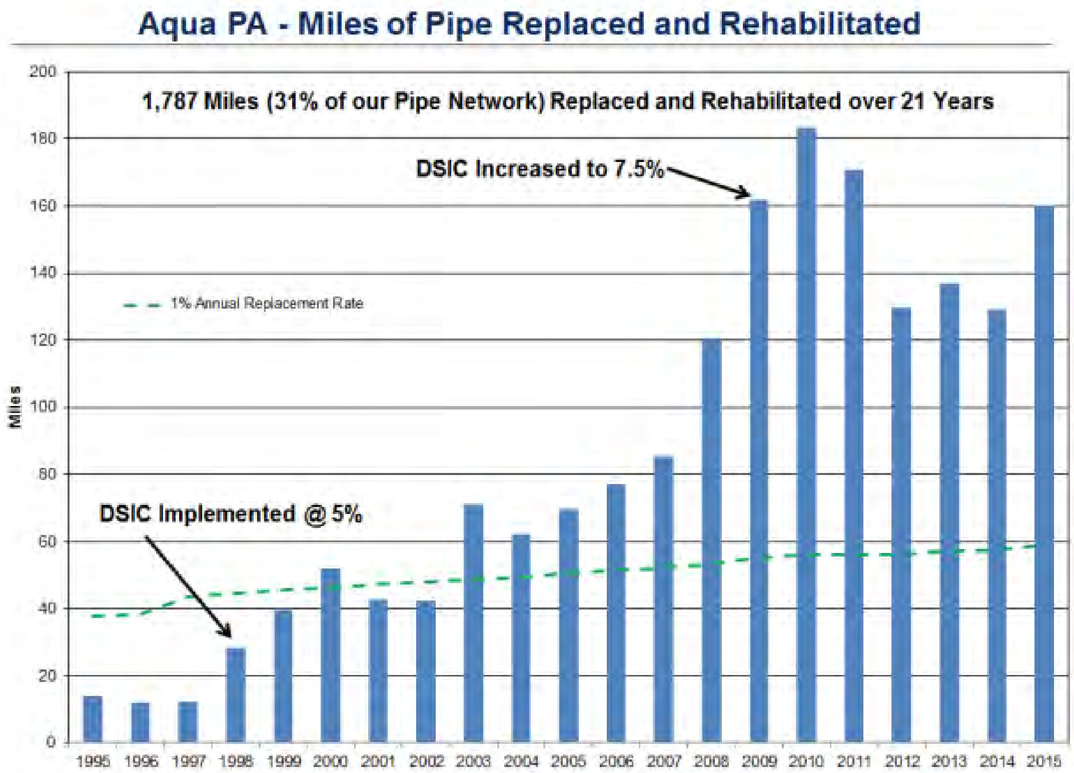
- Rationales
  - Reduces rate case frequency and expense, and regulatory deferrals ("lag")
  - Lowers risk and thus cost of debt to utilities (with possible efficiency offsets)
  - Prevents both shortfalls and windfall revenues to utilities
  - Mitigates rate shock through gradualism in rate adjustments
  - Consistent with economic price signals based on the cost of service
  - May be needed to address urgent issues (pipeline safety)
- Concerns
  - Undermines disciplinary effect of lag – upside and downside risk "cuts both ways"
  - Rate-case savings may be limited – and at cost of efficient performance
  - Overuse that shifts cost or revenue risks from shareholders to ratepayers
  - Asymmetrical and unidirectional (matching principle) focusing only on negative
  - Neglects dynamic and interrelated revenue and expenditure effects
  - Narrows scope of review (single-issue ratemaking)
  - Automates recovery and limits review of prudence and efficiency
  - Distorts CAPEX vs. OPEX incentives and deployment based on recovery
  - Weakens incentives for strategic planning and optimization for large and rising costs
  - Masks rate increases over time

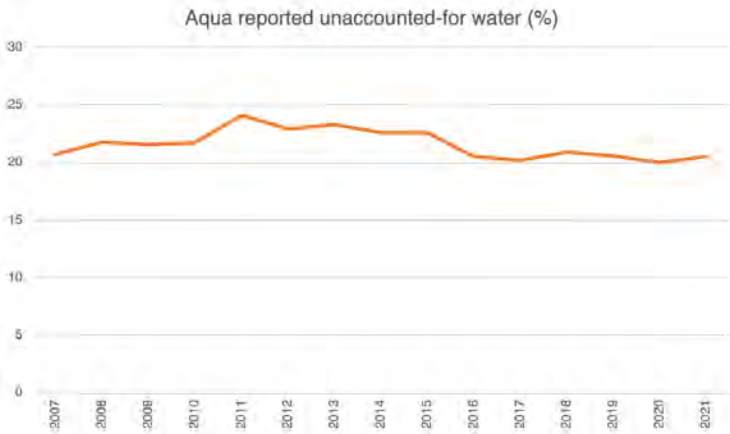
Capital-cost adjustment mechanisms

- Applying adjustment mechanisms to capital costs
  - Distribution system improvement charges (DSIC)
  - Converts long-term variable cost to a short-term fixed cost
  - Proposed for various uses (e.g., smart meters)
- Key issues for capital-cost adjustments
  - Weak incentives for cost control with strong investment incentives (Averch-Johnson)
  - Automated recovery with inadequate regulatory review (prudence, used and useful)
  - Net impacts - accounting, tax deferral, and risk/return issues
  - Capital additions may result in operating savings
  - Asynchronous (mismatched) revenues relative to actual costs
  - Emphasis on costs/inflation/additions vs. savings/deflation/retirements
  - Implies preapproval or rolling prudence, creating sunk costs and path dependency
  - Evidence from energy suggests they undermine productivity (M. Lowry)
- Regulators should not be “cost takers” (“cost-plus ratemaking”)
  - Rate case should be the default practice
  - Fixed charges, decoupling, and adjustments are languid methods of ratemaking
  - Mechanisms shift risks from investors (most able to manage) to ratepayers (least able)
  - An earnings-sharing mechanism (ROR) may achieve the major objective (K. Costello)
  - Use should require a capital-improvement plan, certification, risk analysis, and reconciliation to ensure prudence

Distribution system improvement charge (DSIC)







Ratemaking modifications that shift risk

- Purchased natural gas adjustments
- Electricity fuel-cost adjustments
- Purchased power adjustments
- Normalization and stabilization
- Single-issue ratemaking
- Interim rates
- Cost deferrals
- Allowance for construction (AFUDC)
- CWIP in rate base
- Attrition allowances
- Inflation adjustments
- Forward-looking test year
- Operating-cost trackers
- Accelerated depreciation
- Cost-of-service indexing
- Minimum bills
- Demand-suppression adjustments
- Lost-revenue adjustments
- Revenue decoupling
- System-improvement surcharges
- Capital-expenditure surcharges
- Securitization of stranded costs
- Project preapproval
- Rate-case time limits
- Self-implementing rates
- Cost-of-capital adjustments
- Earnings adjustments
- Higher fixed charges
- Demand charges
- Customer prepayment
- Multi-year rate plans
- Formula-rate plans

Metering and billing

Metering and billing

- Metering is needed for volumetric usage-based pricing (vs. “too cheap to meter”)
  - Meter accuracy and maintenance are important – aging can favor customers
  - Recalibration or replacement can boost sales revenues – needs regulatory review
  - Can induce short-term usage drop - “metering elasticity“ can be about 30%
  - Sub-metering and second meters may be justified under some circumstances
  - Net metering allows customers to sell what they produce back to utility
- Most utilities bill monthly (some quarterly)
  - Monthly provides timely price signals
  - Quarterly brings attention to total bills
  - Administrative costs are considered
  - Estimated bills have to be reconciled

- Automatic meter reading (AMR) vs. advanced metering infrastructure (AMI)
  - AMI adds two-way communication and control capabilities – making it “smart”
  - Can improve real-time monitoring, load management, and demand response
  - Benefits depend on meter and data-management capabilities
  - Sunk costs, operability standards, service life, obsolescence are concerns
  - Rates, appliances, and usage can be smarter without smart meters
  - Smart meters can be expensive and have a shorter life span (15-20 vs. 30+ years)

Submetering ⓘ

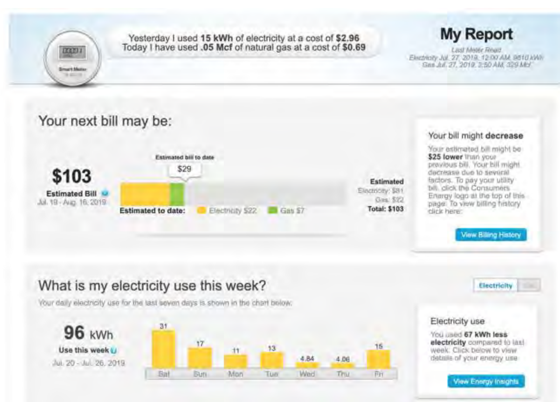
- For multi-family apartments and condominiums
  - Technical feasibility and cost of installation
  - Policy and affordability issues
- Water efficiency rationale
  - Meter/bill/price elasticity
  - Incentive to report and address waste
- Landlord profit rationale
  - Shifts burden from landlords to households
  - Condos vs. apartments
  - Incentives - she who owns the fixture or appliance should get the bill
- Policy issues
  - Add-on fees and impact on affordability
  - Possible creation of new small water utilities
  - Apartment dwellers may not drive peak demand
  - May facilitate rate design and customer assistance to address affordability

Technology enabled pricing

- Advanced ("smart") metering enables
  - Consumer information, self-rationing, and self-disconnection
  - Remote disconnection by utility
  - Prepayment plans
- Potential advantages
  - Budgeting, self-rationing for households with means and resources
  - Reduced disconnection (utility and self) for customers who can pay
  - May reduce or avoid need for for customer deposits
- Potential disadvantages
  - Shifts and masks the broader social problem of affordability
  - Converts utility disconnection to self-disconnection (privatizes)
  - Privatizes assistance as customers seek help from family and friends
  - May force customers to sacrifice basic comfort, safety, and health
  - Could add to physiological and psychological stress of poverty
  - Presumes discretion and opportunities where none may exist
- Policy issues
  - Positive externalities associated with access to essential services
  - Policies and methods for assisting low-income households
  - Should all customers prepay to promote efficiency and equity?

Smart technologies: cost, information, and privacy ⓘ

- Smart-grid benefits are clear for utilities but contingent for customers
  - Depend on access to technologies and realization of savings – evaluation is needed
- Progression of metering
  - Conventional metering: amount of utility usage during a period of time
  - Advanced metering: when utilities are used in the home
  - Smart technologies: how utilities are used in the home
- Customer response is an ongoing experiment in behavior economics
  - Customers probably value convenience and control over other factors
  - Opt-out provisions are controversial (e.g., health concerns)
  - Privacy and data security are legitimate issues (creepy or cool?)
  - Access to data – government, utilities, third parties
  - Emerging role of artificial intelligence (AI)

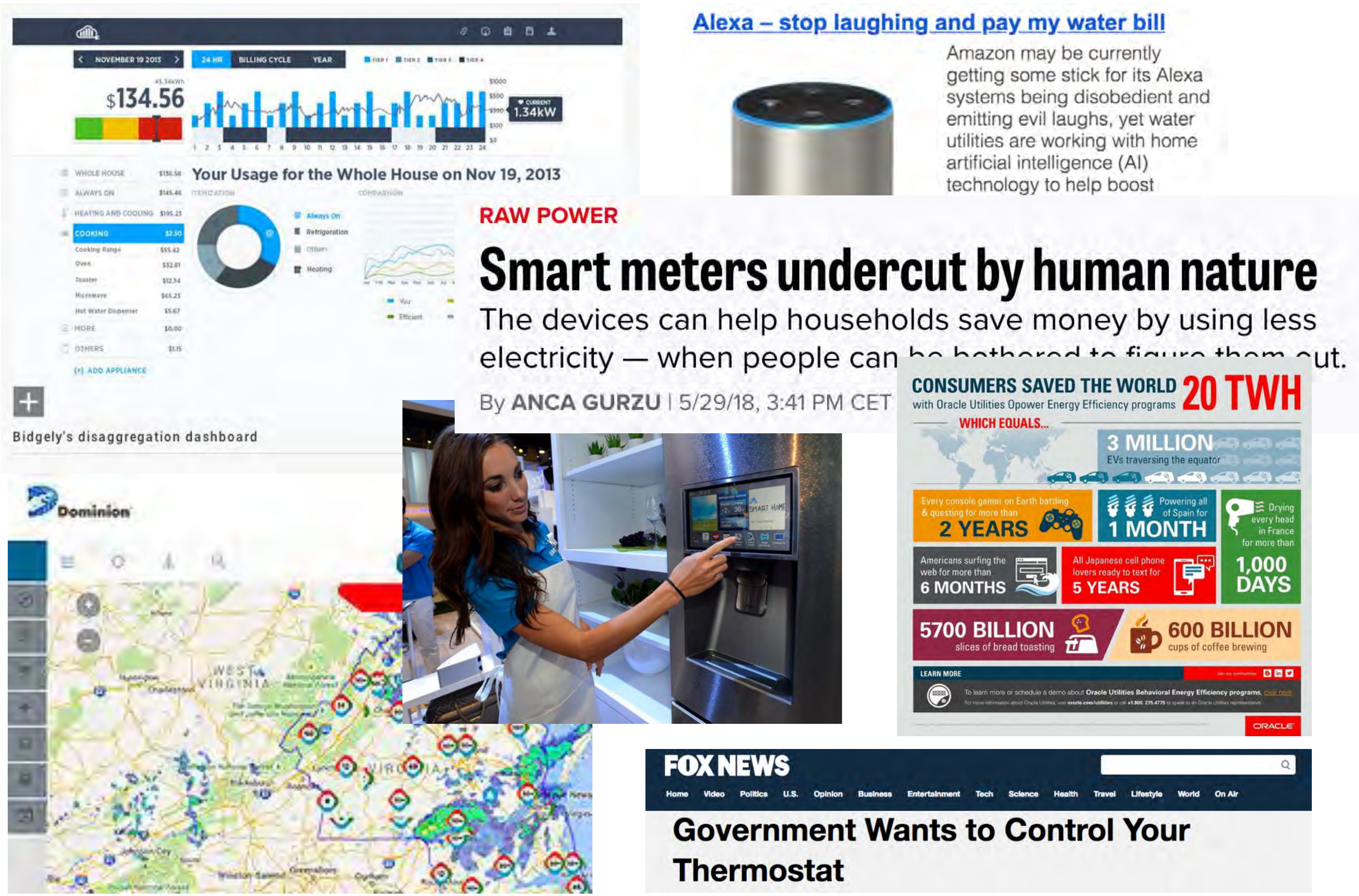


Hello,

Here's your energy use report for Friday July 19.

You earned a credit of $14.25 toward your Consumer Energy bill.
You used 1 kWh of electricity between 2:00 PM and 6:00 PM - this is 15 kWh less than your typical use of 16 kWh.

Smart grids, meters, homes, and cars



Smart grid and advanced metering for electricity

Potential benefits to utilities

- Opportunities for ratebase investment
- Opportunities for sales (EVs)
- Shift labor to capital (AJ effect - more RB and less O&M)
- Improved meter accuracy
- Improved billing systems and timing
- Revenue enhancement and stability
- Tampering and theft reduction
- Prepayment options (lower arrearage)
- Remote shut-off capability
- System monitoring and loss control
- Outage management and recovery
- Improved capacity utilization from dynamic pricing with high participation

Potential benefits to customers

- Timely usage and price information
- Technology deployment (devices, controls, cars)
- Lower cost of service (utility benefits)
- Infrastructure and information costs (grid, meters, data storage and use)
- End-use technology costs & payback
- Participation rates (affected by price differential & elasticity)
- Opportunity costs & personal sacrifice (privacy, convenience, control)
- Allocation of costs to participants and nonparticipants
- Avoided cost of inputs and capacity based on foregone or shifted usage

Smart grid and advanced metering for water ⓘ

- Advanced metering may not be cost-effective
  - Water is not electricity - storable by producers & consumers
  - Limited benefits of load shifting (some energy costs not total energy or water)
  - Water system pressure is affected by gravity (slope) and must be maintained
  - Peaks can be managed through rates and regulations
  - Water flows one way – no net metering

- Advanced water metering may facilitate
  - System monitoring and pressure regulation
  - Leakage detection and loss control
  - Labor-cost reduction (meter readers)
  - Cost analysis (data collection)
  - Drought and emergency management (rationing)
  - Customer information (feedback) and usage management
  - Prepayment, daily usage monitoring, self-rationing, and self-disconnection
  - Interruptible rates & irrigation controllers for pressure & peak management (large vol.)
- No clear cost basis for real-time or dynamic pricing due to storage (like natural gas)
  - All water systems should be on time-variant electricity rates for off-peak pumping
  - Relevant residential time differential is seasonal indoor/outdoor use (vs. hourly)
  - Could be used for demand response and pressure management under emergency and other conditions – including interruptible rates for large-volume irrigators

Metering and solar prosumers ⓘ

- Net metering, feed-in tariffs, and value-of-solar rates
  - One meter: "net metering tariffs enable customers to use the electricity they generate in excess of their consumption at certain times to offset their use of electricity from the grid at other times" (EIA)
  - Two meters: "feed-in tariffs guarantee customers "a set price from their utility for all of the electricity they generate and provide to the grid" (EIA)
  - Value-of-solar rates account for solar benefits to stakeholders net of costs (NREL)
- How should self-supply be compensated?
  - Short-run avoided marginal cost of energy to the utility
  - Long-run avoided cost (incl. capacity) embedded in tariff
  - Real-time net value based on time of use and possibly location – see inflow-outflow model (Michigan)
- Controversies
  - How to value access to and compensate the grid for buying, selling, and backup
  - Distributional impacts for participants and nonparticipants – incentives are also subsidies
  - Network issues are more complicated than simply rate design

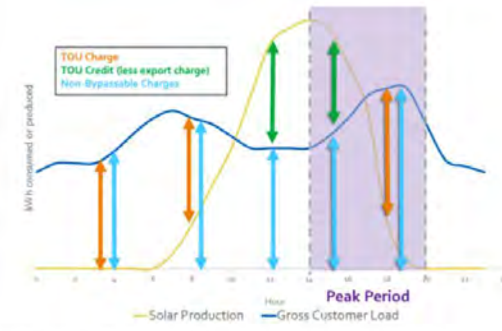
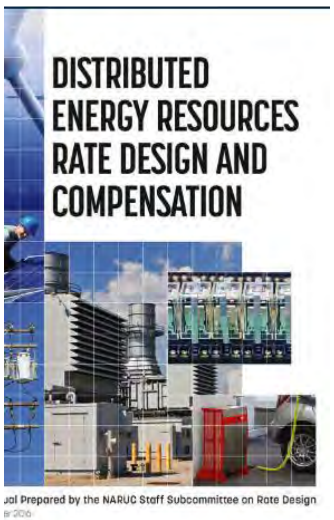


Chart 1: *Illustrative Example of Charges and Credits for a Typical DO Customer*



Metering and prepaid service

- Advanced metering enables prepaid service
  - India has mandated adoption of "smart" prepayment meters by 2022
- Potential advantages of prepaid service
  - Budgeting, self-rationing, and lower usage for households with means and ability
  - Reduced disconnection (utility and self) for customers who can pay
  - May reduce or avoid need for for customer deposits
- Potential disadvantages of prepaid service
  - Shifts and masks the broader social problem of affordability
  - Converts utility disconnection to self-disconnection (privatizes)
  - Privatizes assistance as customers seek help from family and friends
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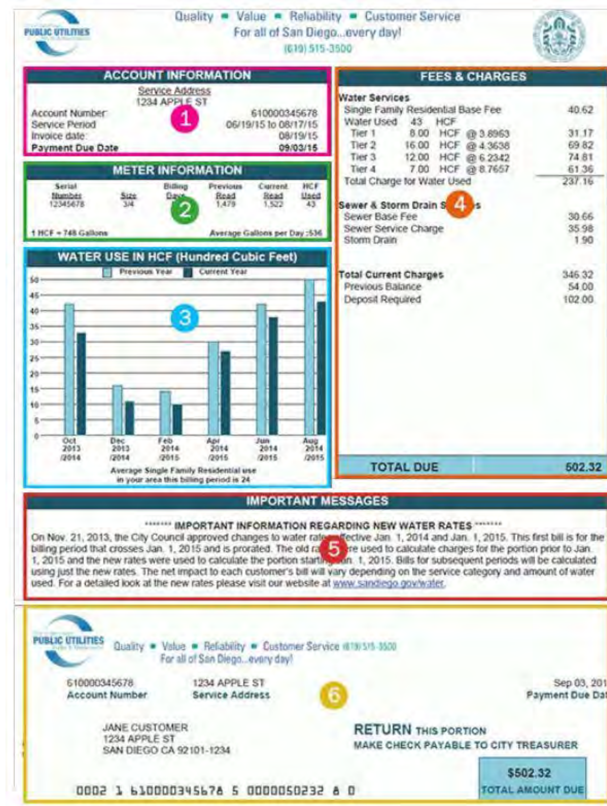
  - Presumes discretion and opportunities where none may exist
- Policy issues
  - Positive externalities associated with access to essential services
  - Policies and methods to assist low-income households
  - Should all customers prepay to promote efficiency and equity?

Advanced metering: regulatory and ratemaking issues

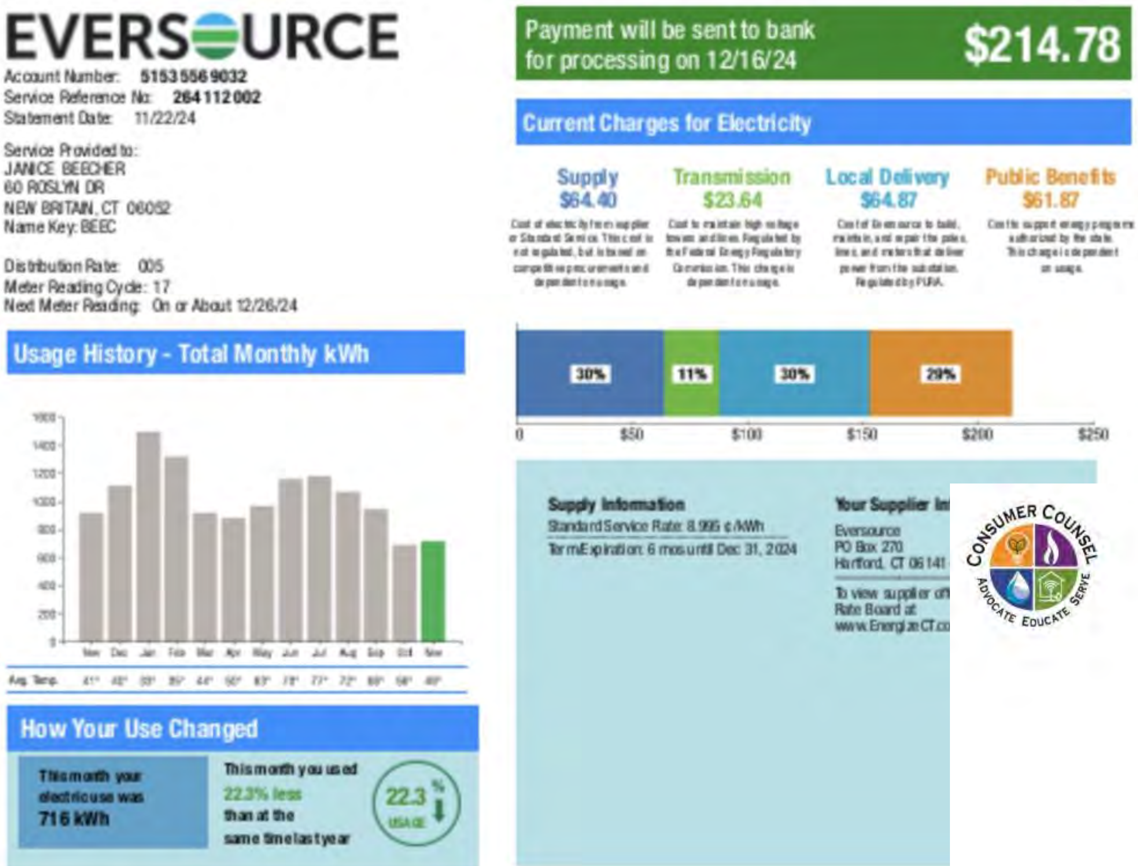
- Net benefits and flow through of cost savings to revenue requirements
  - Net reductions in costs (e.g., labor savings, operational efficiency, loss reduction)
  - Allocation of costs and distributional consequences (wealth transfer)
  - Effect on financial risks and earnings
- Infrastructure investment issues
  - AJ incentive effect and shift to from labor capital
  - Prudence and opportunity costs associated with the investment (best option?)
  - Asset life, obsolescence, premature retirement, and stranded cost
- Ratemaking issues
  - Treatment of contributed capital (including grants)
  - Use of trackers for cost recovery
  - Consumer acceptance, privacy, security, and opt-out provisions

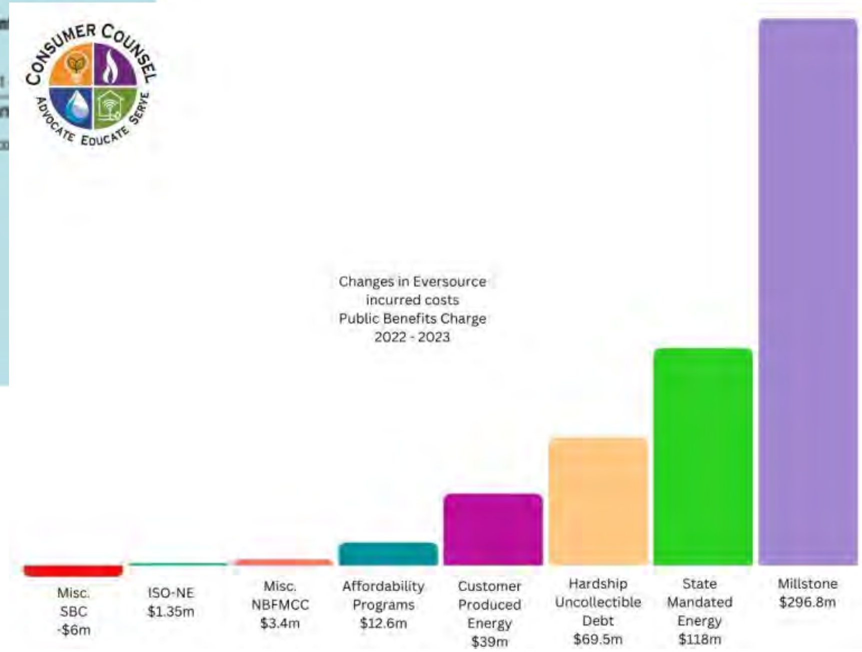
Cost assignment: the customer's bill

- Informed customers can make informed choices
- Types of charges on the bill
  - Fixed charges do not vary with usage
  - Variable charges vary with usage
  - Other charges and taxes, including "public benefits" (add to regressivity)
- Information provided on the bill
  - Usage trend, comparison usage, conservation ideas, assistance programs
  - Privacy issues include usage details, comparison with neighbors, marketing and consumer contact issues



Sample bill: electricity





Sample bill: natural gas

PEOPLES GAS
NATURAL GAS DELIVERY

www.peoplesgasdelivery.com

Bill Date	Account Number	Payment Due Date	Amount Due
03/01/2012	9 9999 9999 9999	03/24/2012 1	$133.41

Name	**John Q. Customer**
Service Address	123 Main St Chicago IL 60601-6207
Service Classification	**Rate 1 – Small Residential Service – Heating**

Activity Since Last Bill

Previous Balance			$254.46	
Thank You For Your Payment			-$254.46	
Balance				$0.00

Delivery Charge 2

Customer Charge					$22.13	
First 50 Therms	$0.25963 x	50.00	Therms	=	$12.98	
Over 50 Therms	$0.11806 x	94.43	Therms	=	$11.15	
Storage Service Charge	$0.04234 x	144.43	Therms	=	$6.12	
						$52.38

Gas Charge 3	$0.43150 x	144.43	Therms	=	$62.32
Efficiency Program					-$0.51
Natural Gas Savings Pgm	$0.00790	144.43	Therms	=	$1.14
Environmental Charge	$0.00320 x	144.43	Therms	=	$0.46
UEA - Gas Cost Adjustment	$62.32 x	0.0341		=	$2.13
Volume Balancing Adj	$0.01400 x	144.43	Therms	=	$2.02
Infrastructure Adj	$56.00 x	0.00	%	=	$0.00

Taxes 4

Chicago Municipal Tax	$119.94 x	8.24	%	=	$9.88	
State Tax	$119.94 x	0.10	%	=	$0.12	
State Gas Revenue Tax	$0.024 x	144.43	Therms	=	$3.47	
						$13.47
Total Current Charges						$133.41
AMOUNT DUE						$133.41

SAMPLE

Peoples Gas

Customer Inquiries	1-866-556-6001
Emergencies	1-866-556-6002
En Español	1-866-556-6003
TDD Line	1-866-556-6007

Current Usage
Billing Period From 01-31-12 To 02-29-12 29 days

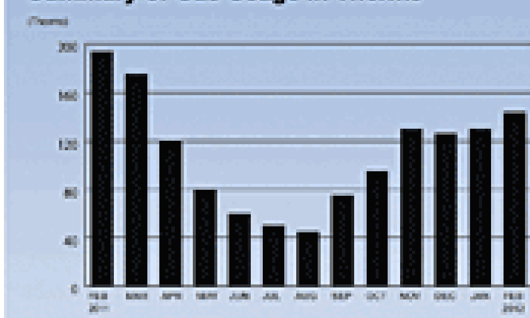
Meter Reading
Meter Number P9999999

Current Actual	5044	02-29-12
Previous Actual	4901	01-31-12
Difference	143 (100 cubic ft.)	

Therm Conversion
143 x 1.010 BTU Factor = 144.43 Therms

Average Daily	Feb. 2011	Feb. 2012
Therms Used	3.92	4.69
Temperature	36°F	33°F

Summary of Gas Usage in Therms



Summary of Total Current Charges

Sample bill: water

Charter Township of Meridian
Utility Billing Department
5151 Marsh Rd
Okemos, MI 48805-1400
(517) 853-4120
www.meridian.mi.us
Office Hours: 8:00-5:00 Monday-Friday

[redacted]

[redacted]

WATER / SEWER BILL

Amount Due
$55.00
Due Date
06/20/2019

Amount Due After 06/20/2019
$57.75

*^Please detach and return this portion with your payment.^*

Account Summary
Service Address: 5555 STARFLOWER DR
Account Number: STFL-005555-0000-01
Billing From: 02/01/2019 Billing To: 05/01/2019

Charter Township of Meridian
Utility Billing Department
(517) 853-4120

	----- Current Read Info -----			----- Previous Read Info -----				
Code	Read	Date	Type	Read	Date	Type	Usage	Amount
PB								$0.00
BC								$5.00
W	777000	5/1/2019	A	772000	2/1/2019	A	5000	$22.95
S							5000	$27.05

Unpaid water / sewer bills become a lien against the property.
A 5% late charge is added after due date
After-hours drop box located at the Municipal Building
Failure to receive a bill does not alter due date or waive the penalty.

TOTAL DUE: $55.00
DUE DATE: 06/20/2019

For night, weekend or holiday water/sewer public works emergency, call 517-349-0010

Billing Charges
BC-Billing Charge
W-Water Charge ($4.59/1000 gallons)
S-Sewer Charge ($5.41/1000 gallons)
IR-Irrigation Charge ($4.59 / 1000 gallons)
LS-Lift Station Fee
SC-Sewer Credit
MC-Meter Change
ON-Turn on/off fee

Read Information
A-Actual Reading
E-Estimated Reading
O-Other Reading

Please contact the Utility Billing Department at 517-853-4120 with any questions or concerns.

See our website @ www.meridian.mi.us for online payment options.

KEEP THIS PORTION FOR YOUR RECORDS

LAST READ / DATE / TYPE		NEW READ / DATE / TYPE		CONS	SERVICE	CHARGE		
986	11/20/2014 A	989	12/17/2014 A	3	Sewer Non-metered	15.51	Previous Balance	96.65
					Sewer Svc Chrg	34.48	Payments	-96.65
					Water	23.76	Adjustments	0.00
					Water Svc Chrg	22.90	Current Penalty	0.00
							New Charges	96.65
							Total Due	**96.65**
ACCOUNT:		SERVICE AT:					**Due Date**	**01/21/2015**

PENALTY ASSESSED 30 DAYS AFTER DUE DATE

PUBLIC UTILITIES
Quality ▪ Value ▪ Reliability ▪ Customer Service
For all of San Diego...every day!
(619) 515-3500

ACCOUNT INFORMATION

Service Address
1234 APPLE ST

1

Account Number:	610000345678
Service Period	06/19/15 to 08/17/15
Invoice date:	08/19/15
Payment Due Date	**09/03/15**

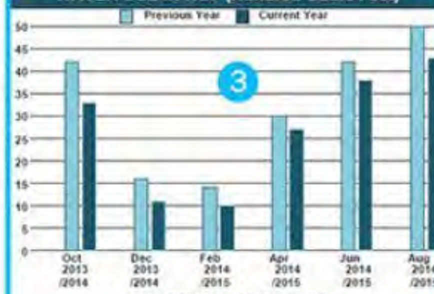
METER INFORMATION

2

Serial Number	Size	Billing Days	Previous Read	Current Read	HCF Used
12345678	3/4		1,479	1,522	43

1 HCF = 748 Gallons   Average Gallons per Day :536

WATER USE IN HCF (Hundred Cubic Feet)



Average Single Family Residential use in your area this billing period is 24

FEES & CHARGES

Water Services				
Single Family Residential Base Fee				40.62
Water Used	43	HCF		
Tier 1	8.00	HCF	@ 3.8963	31.17
Tier 2	16.00	HCF	@ 4.3638	69.82
Tier 3	12.00	HCF	@ 6.2342	74.81
Tier 4	7.00	HCF	@ 8.7657	61.36
Total Charge for Water Used				237.16
Sewer & Storm Drain S[illegible]s 4				
Sewer Base Fee				30.66
Sewer Service Charge				35.98
Storm Drain				1.90
Total Current Charges				346.32
Previous Balance				54.00
Deposit Required				102.00
TOTAL DUE				**502.32**

IMPORTANT MESSAGES

********* IMPORTANT INFORMATION REGARDING NEW WATER RATES *********

On Nov. 21, 2013, the City Council approved changes to water rat[illegible]ffective Jan. 1, 2014 and Jan. 1, 2015. This first bill is for the billing period that crosses Jan. 1, 2015 and is prorated. The old ra 5 [illegible]re used to calculate charges for the portion prior to Jan. 1, 2015 and the new rates were used to calculate the portion starti[illegible]an. 1, 2015. Bills for subsequent periods will be calculated using just the new rates. The net impact to each customer's bill will vary depending on the service category and amount of water used. For a detailed look at the new rates please visit our website at www.sandiego.gov/water.

PUBLIC UTILITIES
Quality ▪ Value ▪ Reliability ▪ Customer Service (619) 515-3500
For all of San Diego...every day!

610000345678 1234 APPLE ST 6 Sep 03, 201
Account Number **Service Address** **Payment Due Dat**

JANE CUSTOMER
1234 APPLE ST
SAN DIEGO CA 92101-1234

RETURN THIS PORTION
MAKE CHECK PAYABLE TO CITY TREASURER

$502.32
TOTAL AMOUNT DUE

0002 1 610000345678 5 0000050232 8 0

Sample bill: telecom (residential and business)

att.com

JOHN G DOE
123 ANY STREET
DULUTH GA 30097-1234

Page	1 of 2
Account Number	678 123-1234 545 1889
Billing Date	Mar 05, 2010
Web Site	att.com

at&t

Monthly Statement

Bill-At-A-Glance

Previous Bill	29.05
Payment Received 2-11 Thank You!	29.05CR
Adjustments	.00
Balance	.00
Current Charges	29.05
Total Amount Due	**$29.05**
Amount Due in Full by	**Mar 27, 2010**

Billing Summary

Questions? Visit att.com	**Page**	
Plans and Services 1 888-757-6500 **PIN: 9999** Repair Service: 611	1	29.05
Total Current Charges		**29.05**

AT&T Benefits

• Smarter TV. Better value. AT&T U-versež .
There has never been a better time to get AT&T U-versež . Now you can get incredible channels and features at a better value than cable. Plus, you can take advantage of some of our best offers ever. Geographic and service restrictions apply. Call 1.866.291.2278 or go online at att.com/uversenow today!

Plans and Services

Monthly Service - Mar 5 thru Apr 4

1. Residential Line	17.55

Surcharges and Other Fees

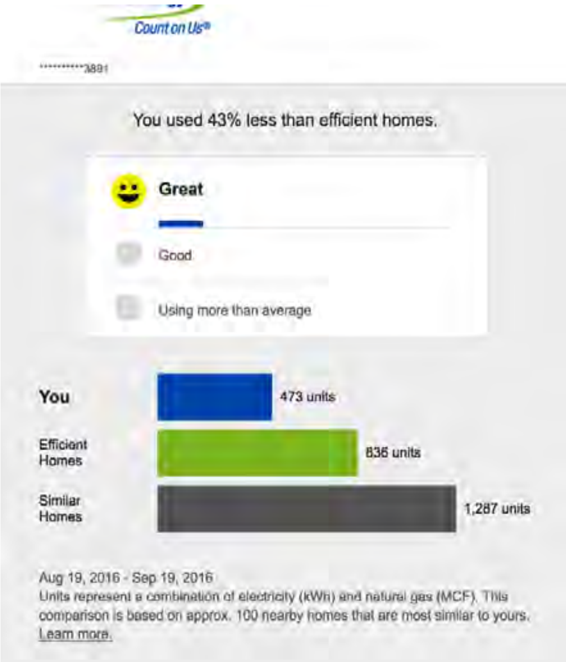
Item No. Description	Quantity	
2. Federal Universal Service Fee	1	.91
3. Federal Subscriber Line Charge	1	6.50
Total Surcharges and Other Fees		**7.41**

Government Fees and Taxes

Item No. Description	Quantity	
4. Federal Excise Tax		.74
5. GA - State/Local Tax		1.27
6. GA-Johns Creek Franchise Fee		.53
7. Telecommunication Relay Svc Fund	1	.05
8. Emergency 911 - Johnscreek	1	1.50
Total Government Fees and Taxes		**4.09**

Total Plans and Services	**29.05**

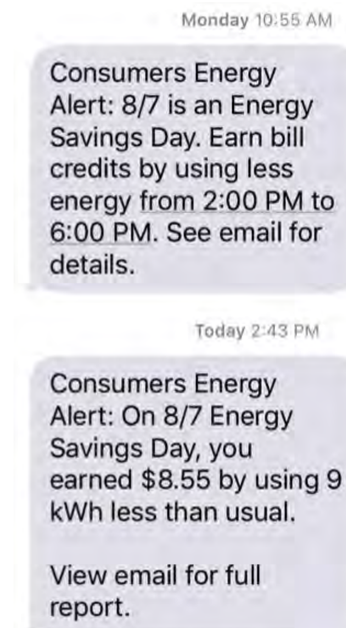
Pricing with nudging, naming, shaming, and pleading

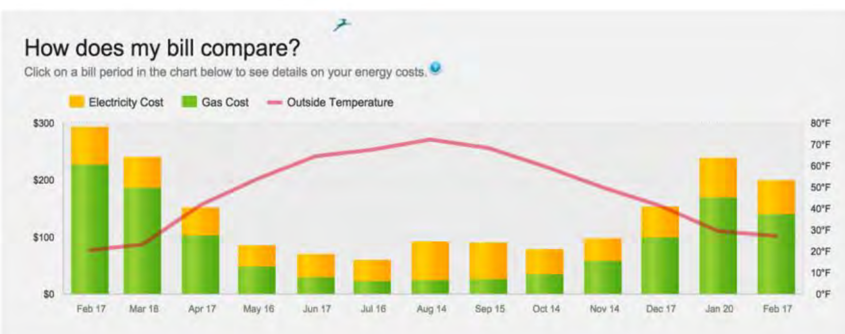


(a) MySmartE app

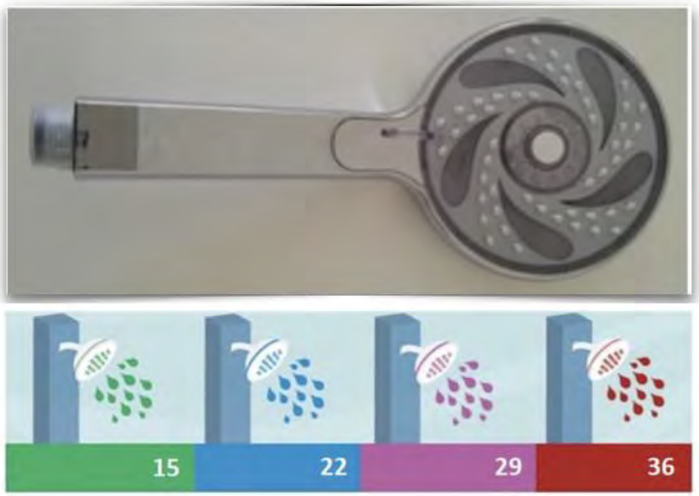
(b) 'My Energy Score' page

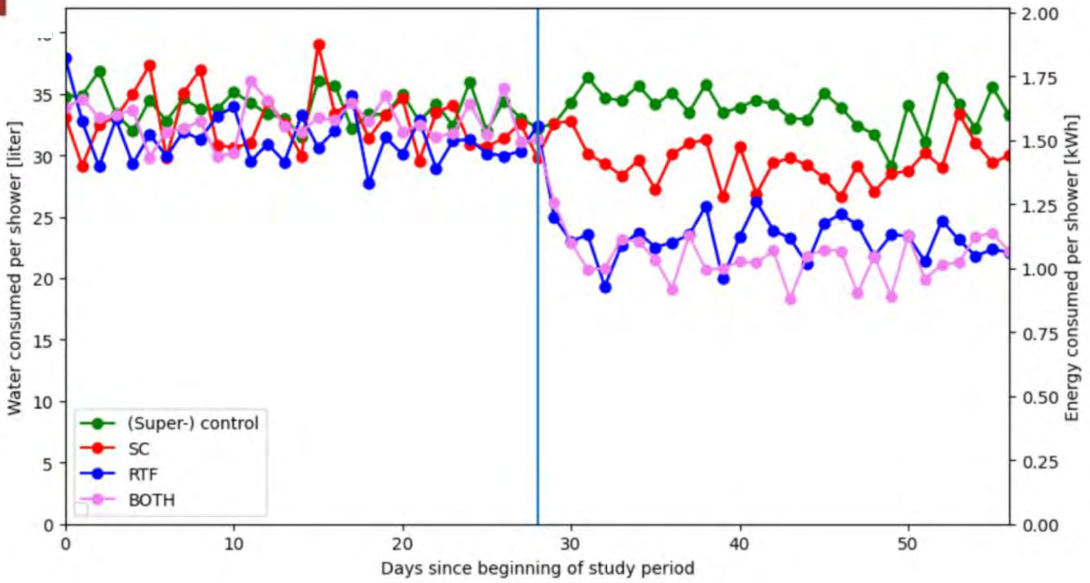
(c) 'Community game' page





Traffic light showerhead (Haas)

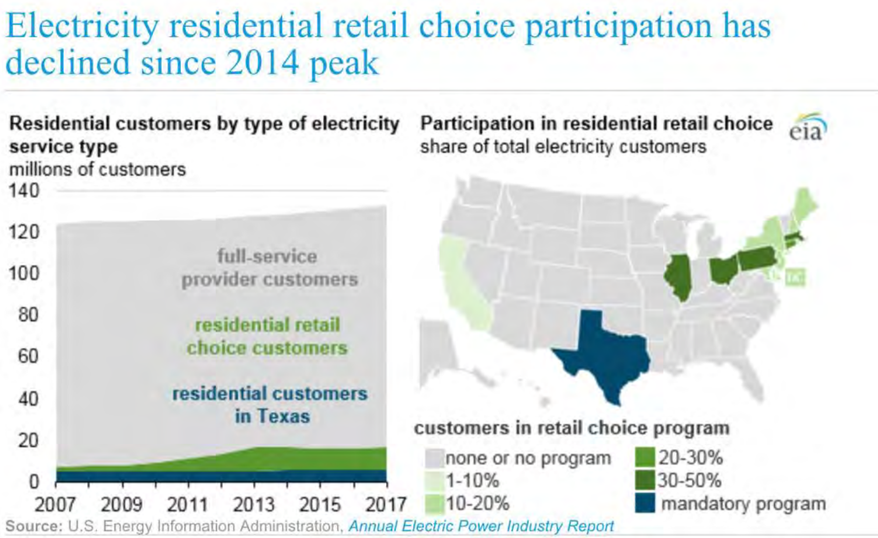


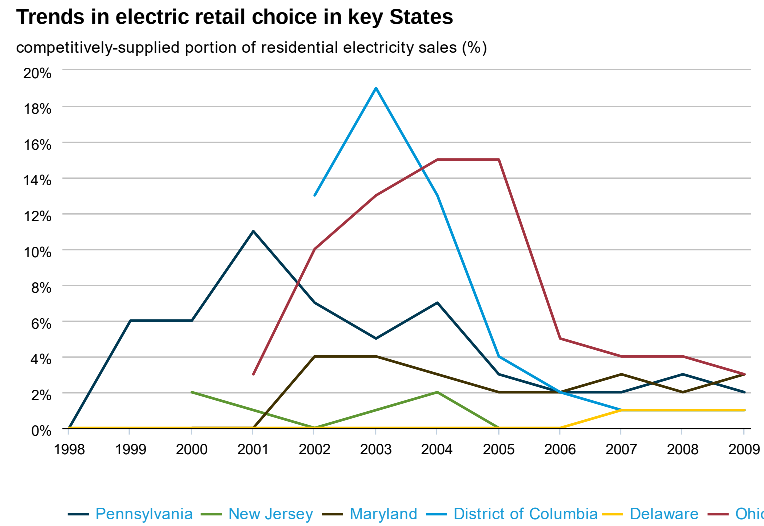


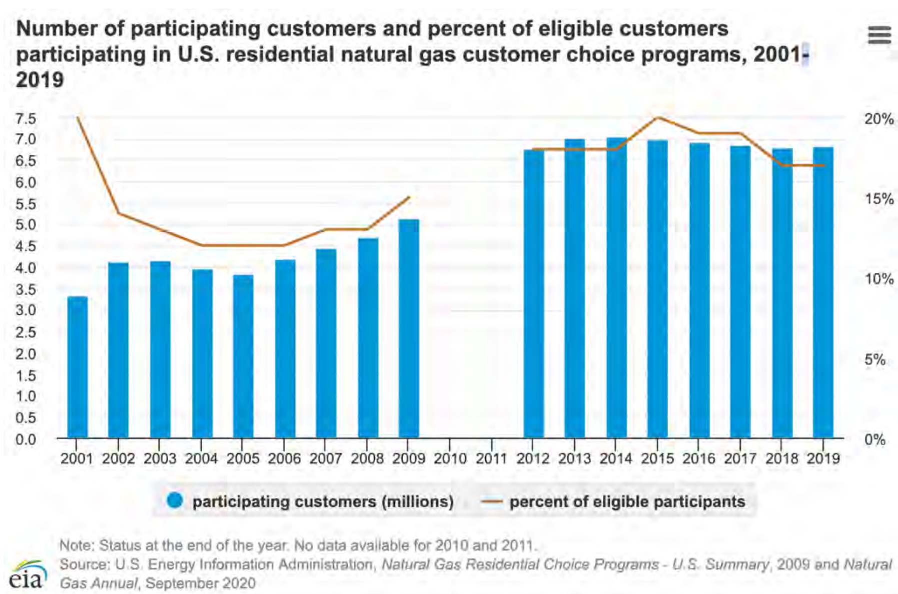
Consumer engagement and switching

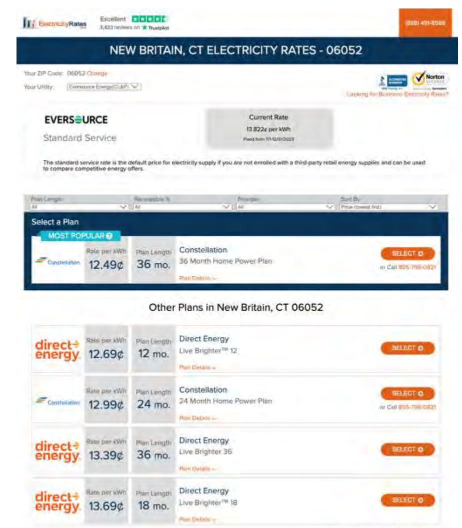
- Customers are not monolithic but stratified
  - A diverse “portfolio” of utility loads based on customer needs and preferences
  - Engagement and preferences are uneven
  - Should engagement be direct or through advocates or representatives?
- Customer behavior may not be (easily or intuitively) predictable
  - Relevance of behavioral phenomenon should not be underestimated (P. Lunn, 2015)
  - Customer perceptions of savings may not match reality (Sintov, 2018)
- “Nonsumers” are involuntary market participants (R. Ben-David, 2018
  - Price-inelastic users whose only option is shopping for suppliers and burdensome
- Potential burden of retail choice (“economic friction”)
  - Lack of product and quality differentiation
  - Disinterest in issue generally (boring)
  - Inertia and complexity of choices and shopping
  - Perceived value relative to opportunity costs
  - Privacy and reluctance to reveal preferences
- Disengagement and the role of regulation
  - To ensure that utilities are consumer-centric and responsive
  - Should consumers be able to take good service for granted?

Participation, switching, and default rates

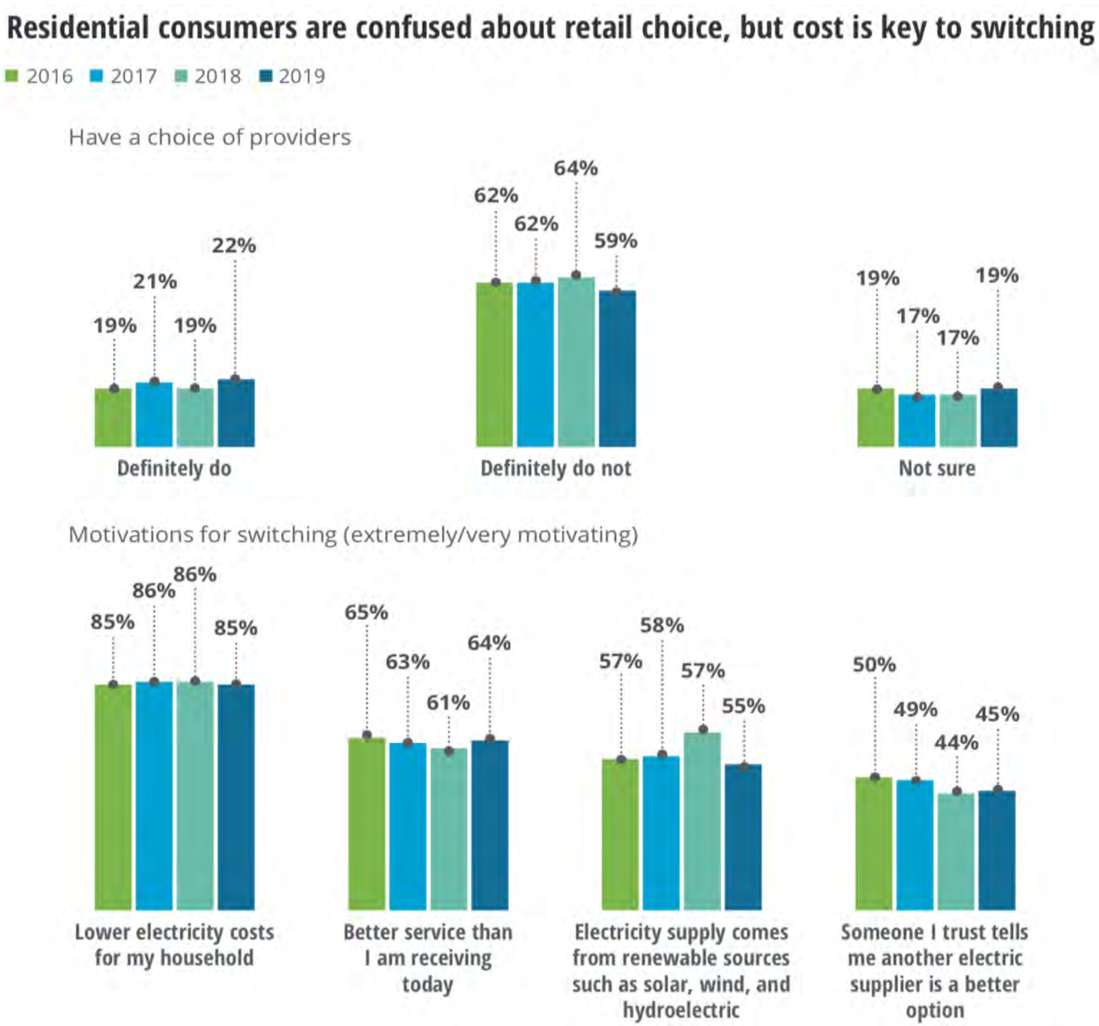


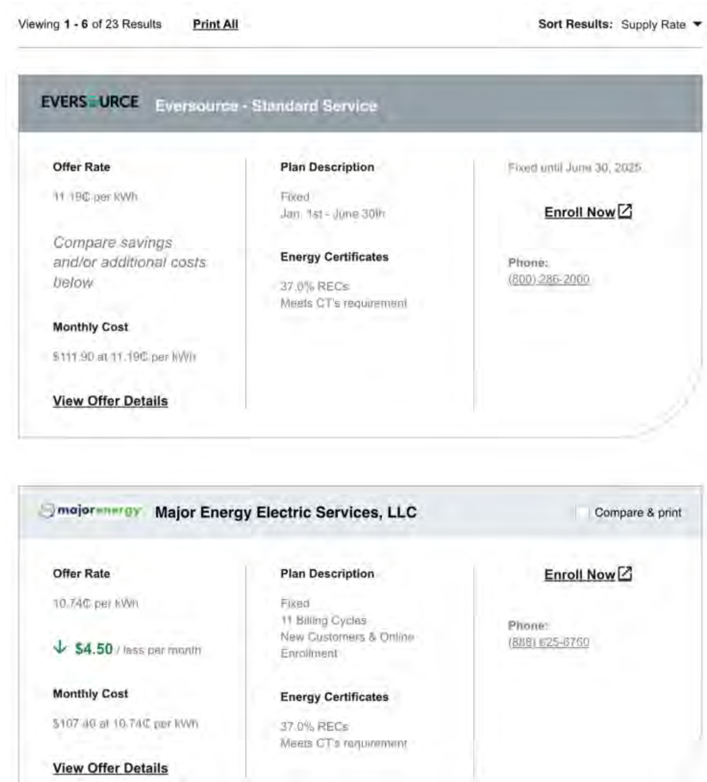






Retail choice (Deloitte, 2019)

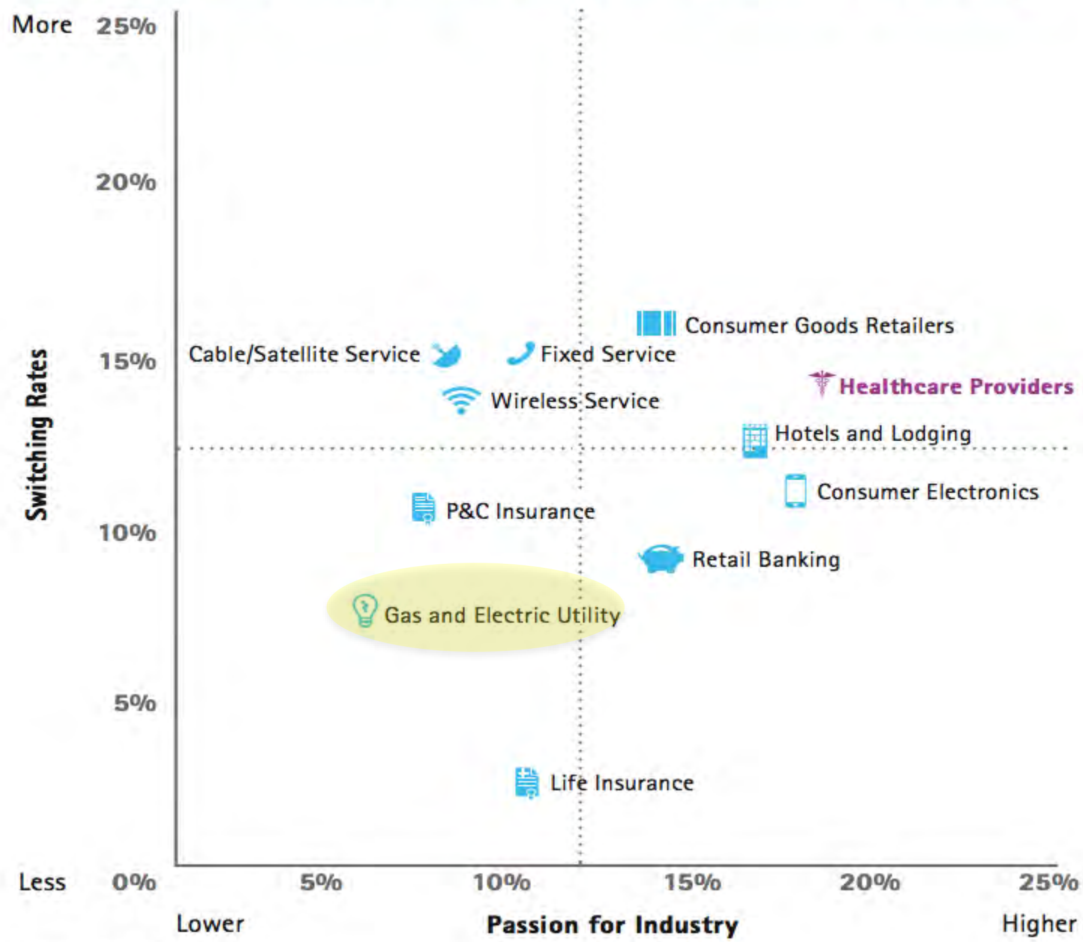




Utilities may not elicit “passion” (!) (Accenture, 2016)

- Shopping for stuff vs. shopping for insurance, cable and cell plans, schools, doctors, etc.
- Switching rates are low and cannot be forced
- Retail switching may drive prices up
- Default (regulated) options may be better
- Aggregation may help consumers if efficient

Figure 1: Passion and switching rates by industry: Consumers have high passion for healthcare providers and high rates of switching.



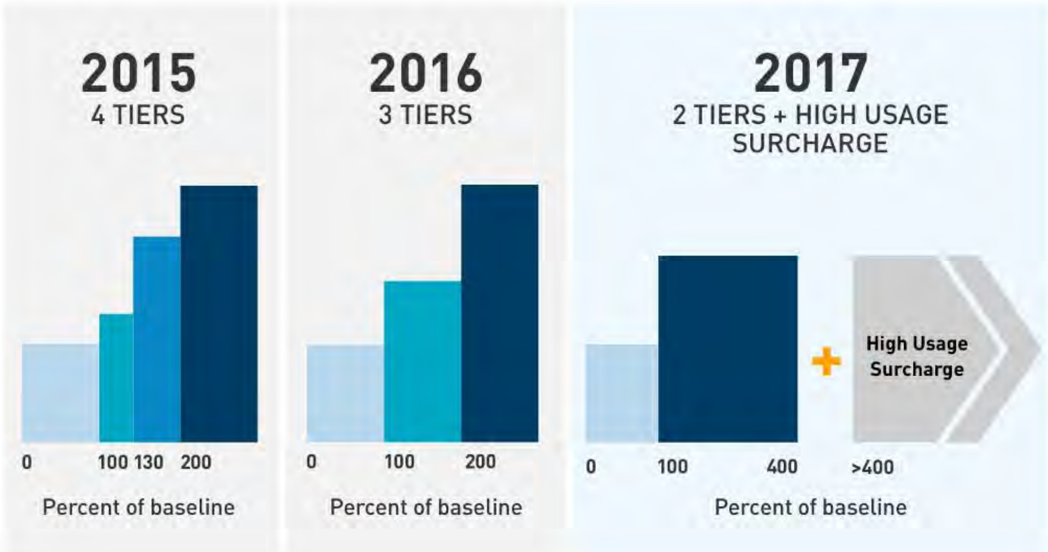
Source: Accenture analysis

A tale of two sons

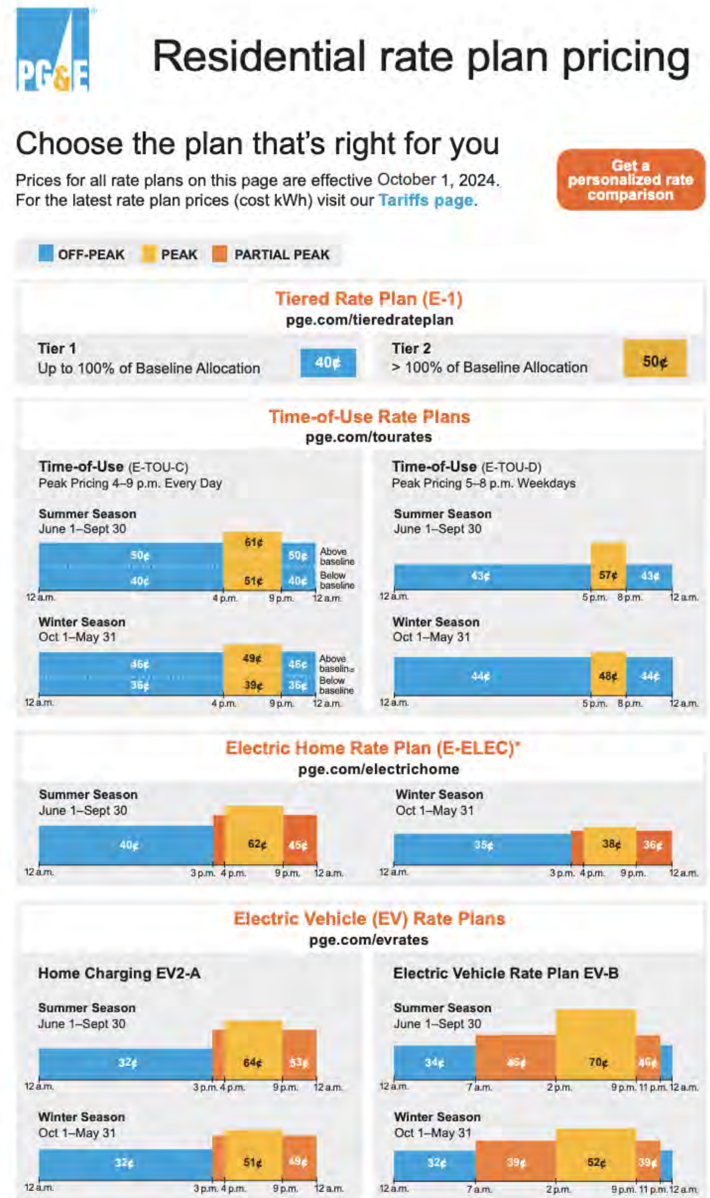
Customer behavior in the real world

- Customer behavior may be difficult to predict and change with time
  - Stated preferences (surveys) may not be matched by those revealed by action
  - Rate effectiveness depends on clarity, understanding, and acceptance
- Complex rate structures may impose opportunity costs
  - Many customers want to take regulated service reliability and quality for granted
  - Not all customers want to engage or choose (“paradox of choice and “overload”)
  - Some prefer simplicity and predictability in rates and rate design, including standard offers or rate stability plans (to lock in and hedge)

Rate plans

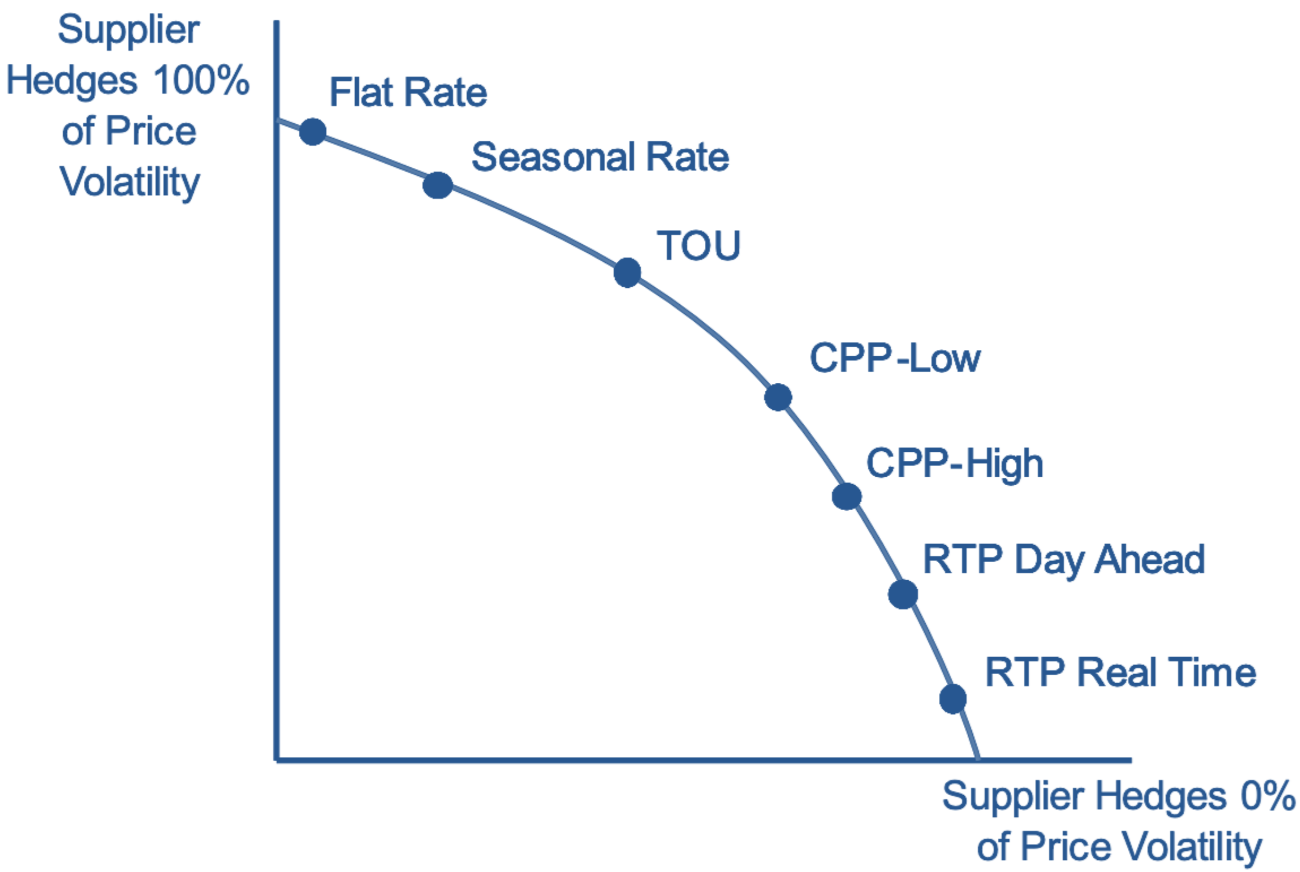


"Rate simplification"

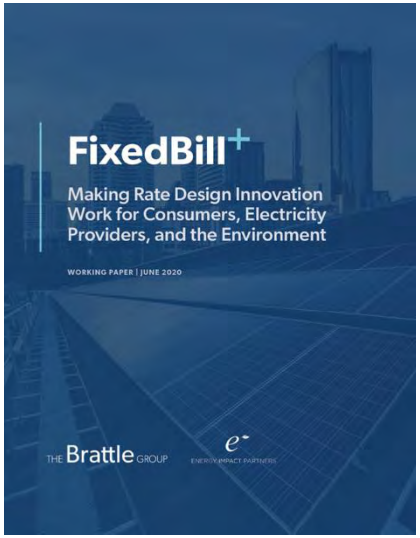


Brattle 2008: Variable price signals for demand response

Figure 10: Flexible Rate Options Transfer Price Volatility Signals from Supplier to Consumer And Provide an Incentive for Demand Response



Brattle 2020: FixedBill+ for "earnings assurance"



DEEP DIVE

Momentum grows for piloting Netflix-like fixed subscription rates, but not everyone's on board

A new flat bill concept can meet customer demand for simpler bills if smart technologies prevent abuse

AUTHOR
Herman K. Trabish

PUBLISHED
July 7, 2020

Momentum is growing for giving electricity customers the kind of predictable subscription bill options that smartphone and home entertainment customers get.

Fixed rates — once preferred to align costs and revenues — are losing regulatory support as variable supply and load make demand peaks the

"The alignment of incentives to reduce costs and carbon emissions, while maximizing electricity provider earnings, is a particularly important dimension of the FixedBill+ proposal."

The savings are modest per customer but add up when you have millions of customers

	Standard Volumetric Rate	Conventional Fixed Bill	FixedBill+
Volumetric charge ($kWh)	$0.11/kWh	0.00/kWh	0.00/kWh
Fixed charge ($/month)	$10/mo	$125/mo	$117/mo
Average annual customer bill ($/year)	$1,440/yr	$1,498/yr	$1,403/yr

Source: FixedBill+, The Brattle Group & Energy Impact Partners, June 2020

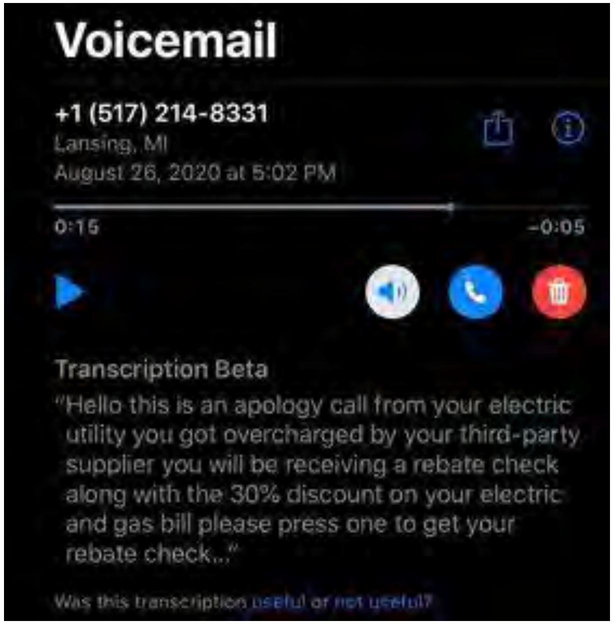
Consumer choice protection issues

Texas utility panel decries 'deceptive,' confusing electricity marketplace

Posted by Jordan Blum Date: June 09, 2016

Texas' utility commissioners complained Thursday about the "deceptive" rates many retail electricity companies offer to consumers.

The Public Utility Commission is investigating ways to make electricity shopping less onerous and confusing without greatly restricting the types of offers companies can make. The commission is looking to improve the state's Power to Choose website that offers comparative pricing from more than 50 retail companies.



Things that May Prevent Slamming:

- Read your bill carefully.
- Know the name of your electric provider.
- Never sign anything without reading it.
- Know when your contract expires. An early termination fee might be slamming.
- If you get asked to "verify" a change you did not authorize, notify your provider.
- If you don't receive your regular bill, notify your provider.
- A postcard from ERCOT will notify you of a change in providers.

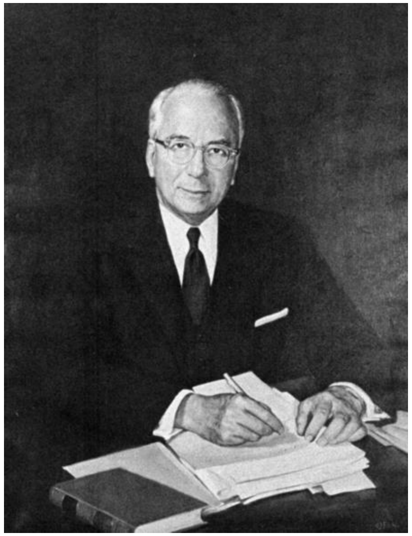
Source: Public Utility Commission

Rate design

“Too cheap too meter” (Lewis Strauss, 1954)

Transmutation of the elements, -- unlimited power, ability to investigate the working of living cells by tracer atoms, the secret of photosynthesis about to be uncovered, -- these and a host of other results all in 15 short years. It is not too much to expect that our children will enjoy in their homes electrical energy too cheap to meter, -- will know of great periodic regional famines in the world only as matters of history, -- will travel effortlessly over the seas and under them and through the air with a minimum of danger and at great speeds, -- and will experience a lifespan far longer than ours, as disease yields and man comes to understand what causes him to age. This is the forecast for an age of peace.

THE DETROIT EDISON COMPANY
BOX 2859, DETROIT, MICH. 48231
SERVICE INFORMATION
PLEASE USE ABOVE ADDRESS IF PAYMENT IS MAILED
DOMESTIC ELECTRIC DUE NOV20,68 3
MY WORK MY PAY
METER 1866736
UNITS USED OR TANK CAPACITY 63
AFTER DUE DATE 3.12
NET AMOUNT IF PAID BY DUE DATE 3.03
FROM SEP 5 METER READING 14377
TO NOV 4 METER READING 14440
DEMAND MULT. FUEL ADJUSTMENT
ACCOUNT NUMBER W06DSF 06042 AAES
"E" MEANS ESTIMATED METER NOT READ
"PB" MEANS PREVIOUS BALANCE
"PA" BALANCE PREVIOUS ACCOUNT
APPLICABLE TAXES INCLUDED
RATE INFORMATION AVAILABLE AT CUSTOMER OFFICES AND BY TELEPHONE



Evolution of rate design

- Postage stamp rates (full cost socialization)
- Unmetered charges
  - Flat fees or charges for total usage
  - Property taxes by publicly owned water systems
  - Water-using fixtures (water) or occupancy
  - Property values (UK)
  - Wastewater services – equivalent units, metered water, strength
  - Stormwater management – impervious/impermeable surface

- Metered rates
  - Uniform by volume
  - Block rates – decreasing and increasing
  - Time-variant and dynamic rates

- Monthly “plans”
  - Telecom – time and location no longer matter
  - Energy – budget billing, prepaid, fixed-rate contracts, even “free nights and weekends”

Sewer pricing without metering (St. Louis)

If your home does NOT have a water meter:

Bills are based on the number of rooms, baths and toilets in your residence.

Basis of Rates for Non-Metered Customers

	Estimated Water Usage in Gallons / Day	Estimated Water Usage in 100s of cubic feet per month
Each room	14.5	0.5900
Each water closet (toilet)	54.2	2.2053
Each bath or shower	45.2	1.8391
Frontage foot	n/a*	n/a*

Ratemaking standards: Public Utility Regulatory Policies Act (PURPA)

PURPA 1978

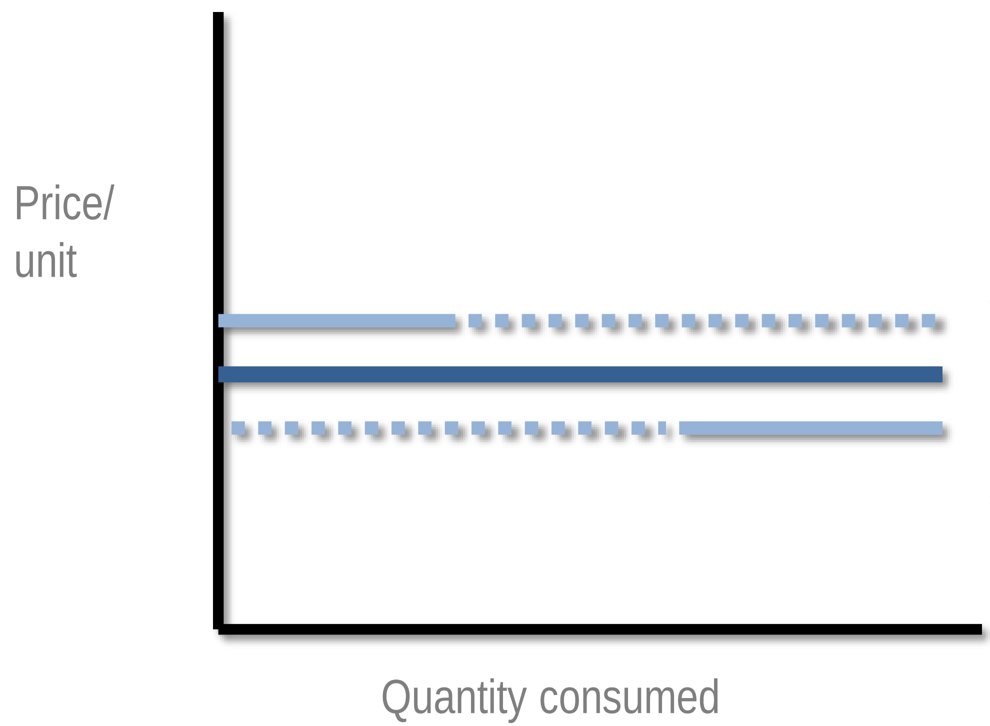
- Cost of service
- Block rates
- Time-of-day rates
- Seasonal rates
- Interruptible rates

PURPA 2005

- Net metering
- Fuel sources standard
- Fossil fuel generation efficiency standard
- Smart metering with time-based rate schedules
- Interconnection standard

Uniform rate (*not* "flat rate")

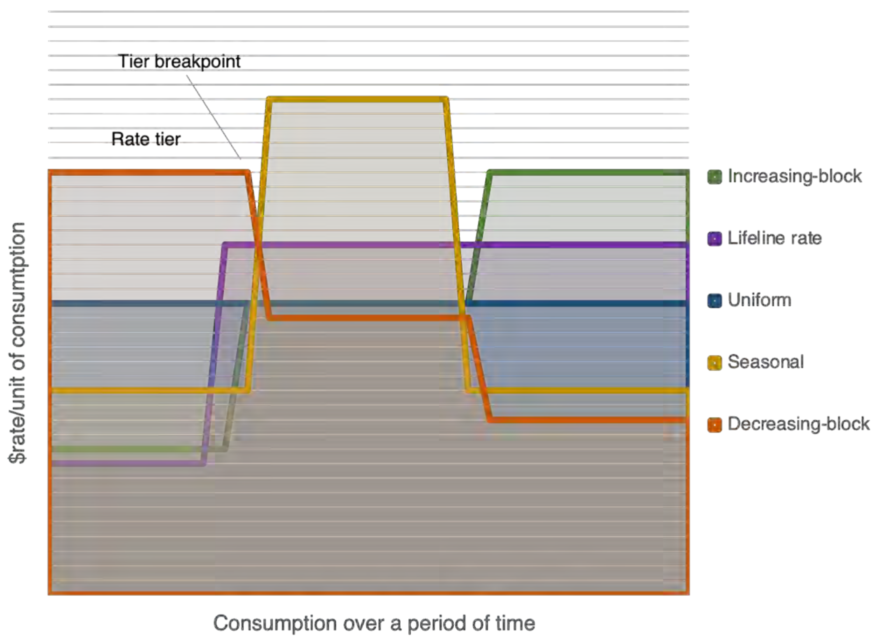
- Uniform by class may be embedded in declining block rate structures, which were once considered "the right way" to price services based on economies
- Easily communicated and understood and bills rise with usage (price signals)
- May mask temporal and spatial variations in system and customer costs of service (averaging)

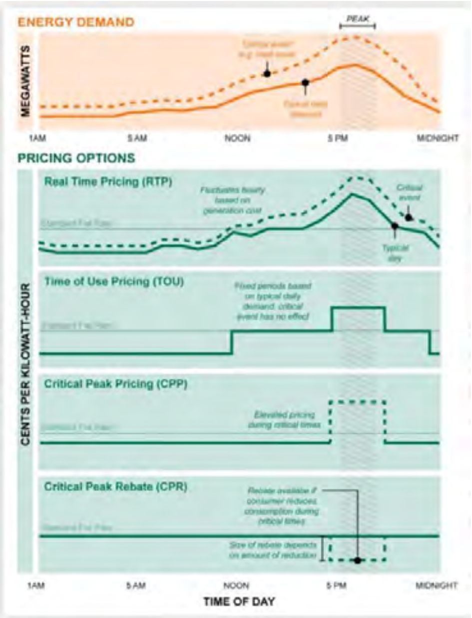


Note: peaking factors are an alternative means of customer classification.

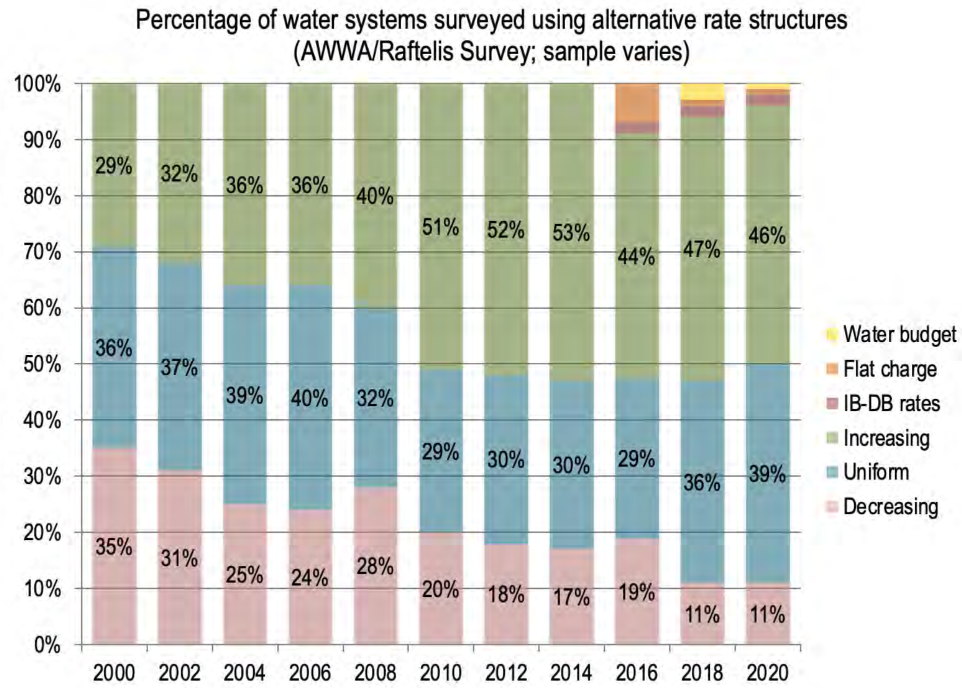
Block rates: decreasing and increasing

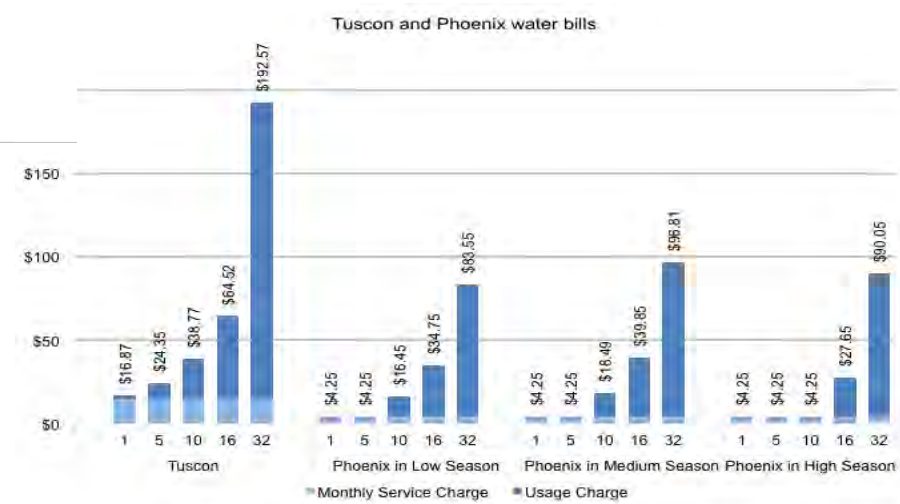
- Rate tiers (unit prices) for blocks of usage with breakpoints
  - Informed by engineering (cost) and economic (elasticity) analyses
- Block rates have different rationales
  - Like income taxes, total bills reflect cumulative calculations based on marginal rates
  - Decreasing-block are based on meter size & short-run marginal cost – less common
  - Fixed charges and household size also affect affordability
  - Environmental and consumer advocates tend to favor increasing-block rates for efficiency and affordability (respectively) – empirical findings on impacts are mixed





Rate design details matter



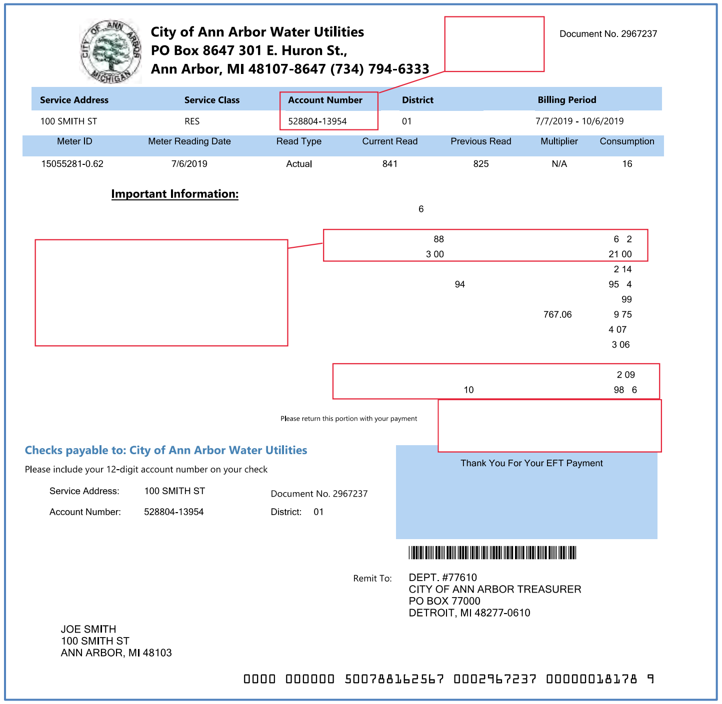


Wastewater and stormwater pricing

- Water, wastewater, and stormwater have strong social dimensions
  - Funding from taxpayers, ratepayers, or both
- Utility organizations may be combined with wastewater
  - Combined sewer overflow (CSO) is a major cost driver
- Wastewater rates and charges
  - Residential based on off-season use to separate outdoor use
  - Commercial and industrial adjusted for strength
  - Highly price inelastic
- Stormwater rates and charges
  - Flat fees or assessment
  - Uniform or rate based on impervious surface
  - Individualized

Detroit is billing residents for rain. It's going as well as you'd think.

Luljeta Duhani, owner of the Motown Cafe and Grill, tells Detroit neighborhood activist Russ Bellant that her restaurant's drainage fees have skyrocketed since the city changed how it imposes the rates in July. (Bridge photo by Joel Kurth)



City of Ann Arbor Water Utilities
PO Box 8647 301 E. Huron St.,
Ann Arbor, MI 48107-8647 (734) 794-6333

Document No. 2967237

Service Address	Service Class	Account Number	District	Billing Period
100 SMITH ST	RES	528804-13954	01	7/7/2019 - 10/6/2019

Meter ID	Meter Reading Date	Read Type	Current Read	Previous Read	Multiplier	Consumption
15055281-0.62	7/6/2019	Actual	841	825	N/A	16

Important Information:

Please return this portion with your payment

Checks payable to: City of Ann Arbor Water Utilities
Please include your 12-digit account number on your check

Service Address: 100 SMITH ST
Account Number: 528804-13954
Document No. 2967237
District: 01

Thank You For Your EFT Payment

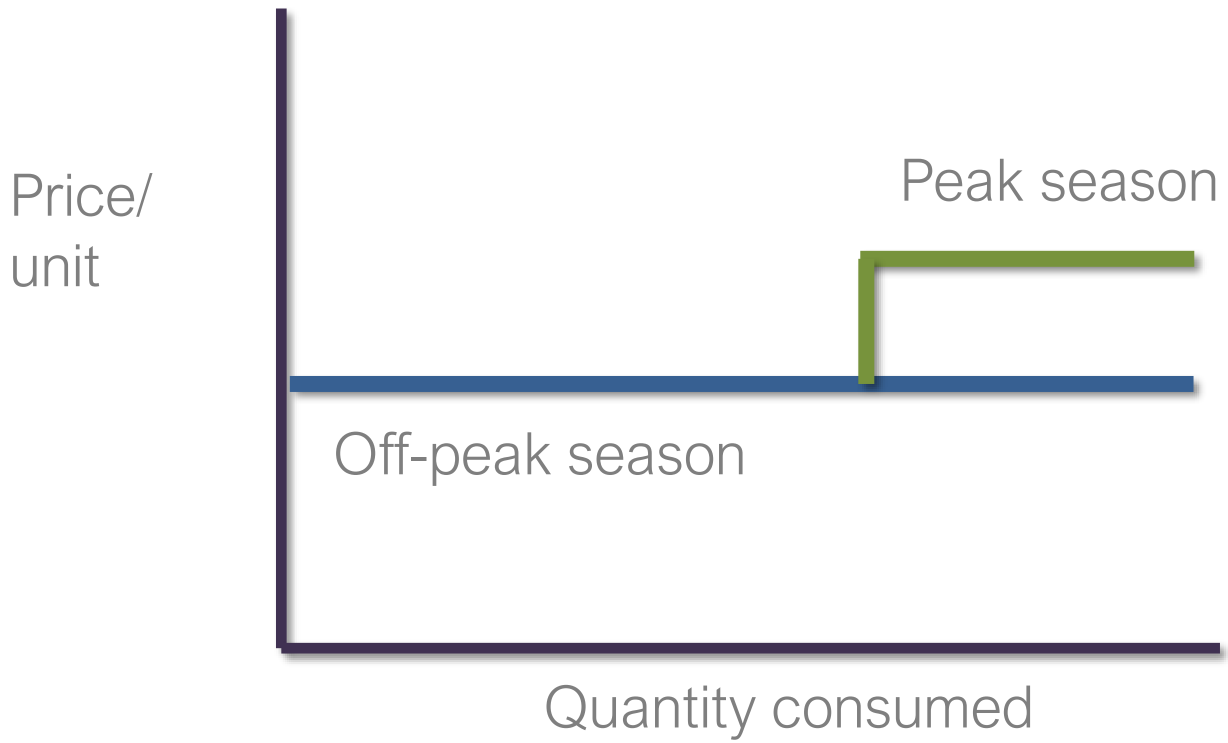
Remit To: DEPT. #77610
CITY OF ANN ARBOR TREASURER
PO BOX 77000
DETROIT, MI 48277-0610

JOE SMITH
100 SMITH ST
ANN ARBOR, MI 48103

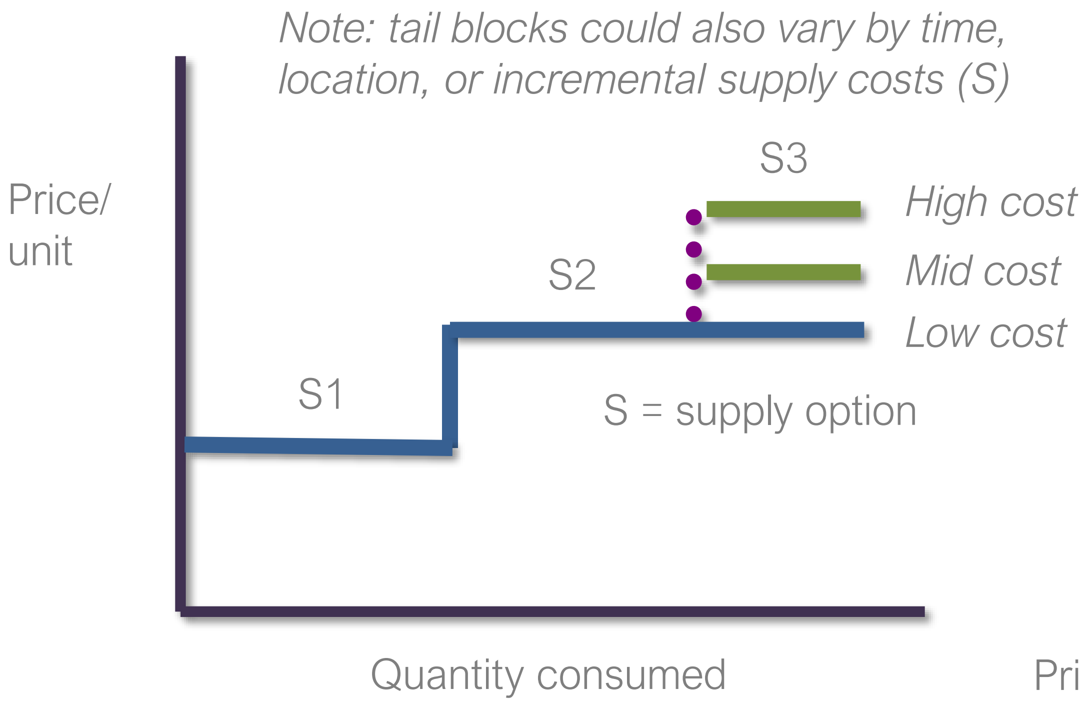
0000 000000 500788162567 0002967237 00000018178 9

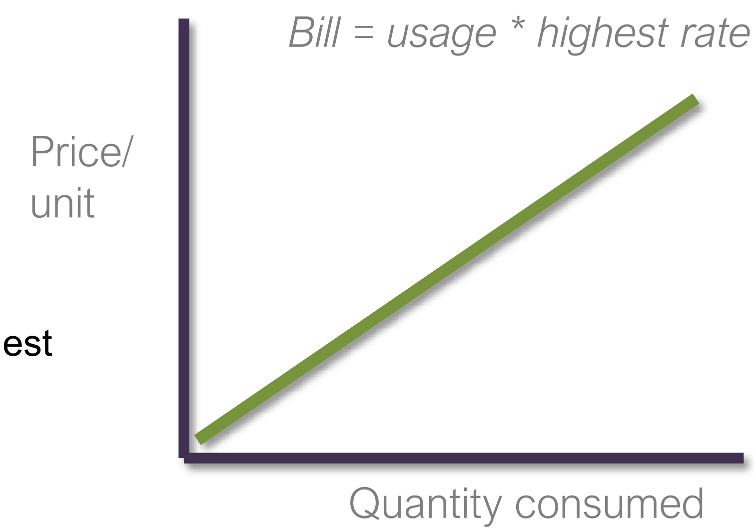
Seasonal and standby rates

- Seasonal block rates
  - Can be applied to all usage in the season or to the seasonal increment (based on cost)
  - Recognize the cost impact of seasonal energy and water usage on system capacity requirements and may address equity concerns
  - Seasonal-only homes and businesses may call for standby or ready-to-serve charges (using weighted peaking factors) to avoid subsidy by all-year customers



Incremental-cost and fully inclining rates

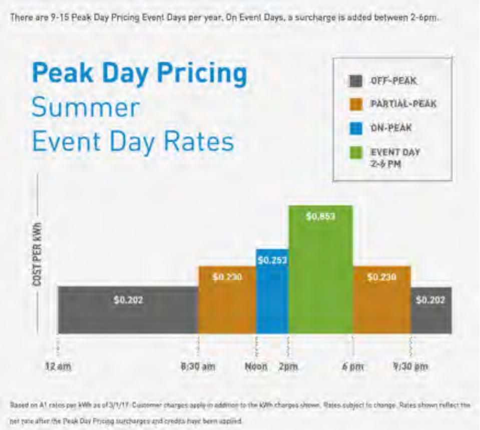


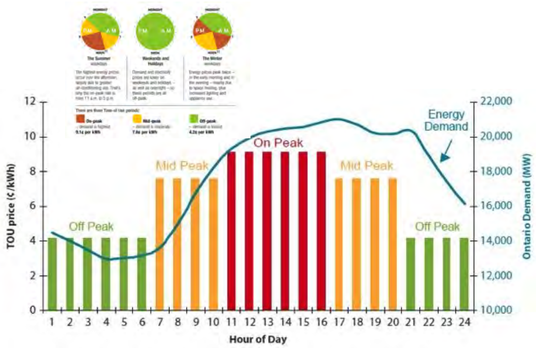


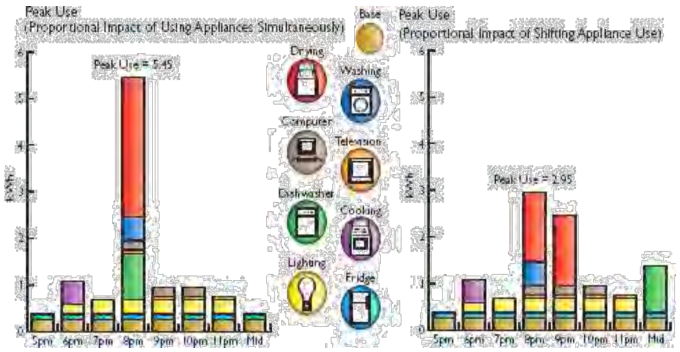
Fully inclining (linear) rates price all usage at the highest recorded usage level (as compared to block rates)

Pricing to induce load shifting (electricity)

- Smart technologies and load shifting may or may not affect total load (up or down)
- Customer capacity for load reduction or shifting varies (see LBL study of high-volume users)
- Results depend on customer preferences, technologies, aggregation, and opportunity and avoided costs
- Alternative technological means may be as effective as prices (passive vs. active)
- Controversy over who should have granular knowledge about usage (customers, utilities, third-party vendors)
- A smooth or constant baseload achieved through demand response or storage will mediate price differentiation and arbitrage opportunities







Time-variant and dynamic pricing

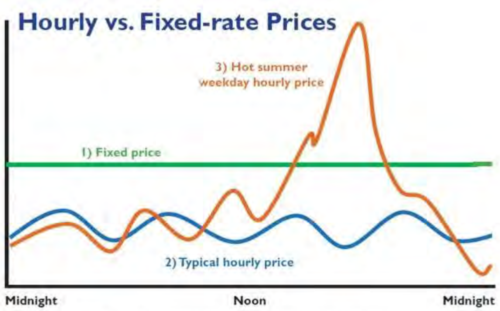
- Presume price elasticity of demand
  - May harm vulnerable households with inelastic demand and exacerbate energy injustice (White and Sintov, 2020)
- Time-variant pricing
  - Preferred and considered more effective than demand charges – especially for energy-related (commodity) costs
  - Relies on an economic model for load management
  - Technology-enabled (meters) and increasingly available
  - Can be effective in lowering peak demand (Ontario: 2.5%)
- Dynamic (real-time) pricing
  - Oxford Word of the Year nominee for 2024
  - Recognizes coincidental peaking (vs. demand charges)
  - Stronger incentives based on greater price variance (risk)
  - Demand response as a resource (aggregation, flexibility)
  - Used for managing critical peaks (events, congestion)
  - May be used to induce usage when resources are available
  - May reflect real-time generation (wholesale) costs
  - Can be implemented apart from retail competition
- Transactive energy
  - Presumes real-time trading of distributed energy among producers and consumers using block=chain technology

Electric Vehicle Home Charger Managed Charging

What is Managed Charging?

Receive a reward for using less energy when others are using more and help us maintain a healthy grid as EV adoption increases.

Participants in the Managed Charging program are encouraged to charge their EVs during off-peak hours and participate in peak demand events. This will help decrease the stress on the electric system while lowering your carbon emissions even further.

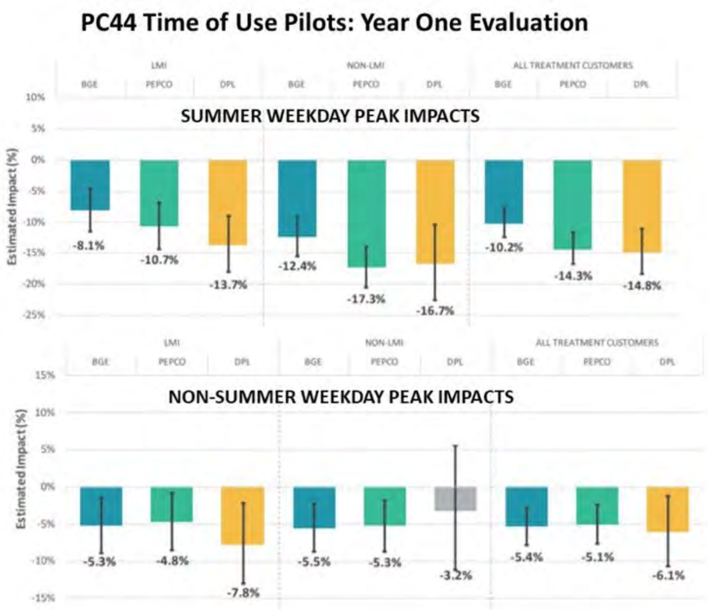


1) Fixed price: Most ComEd customers pay a fixed electricity supply rate that changes only twice a year. But ComEd's Hourly Pricing Program charges customers the actual market-based price, which can change hourly.

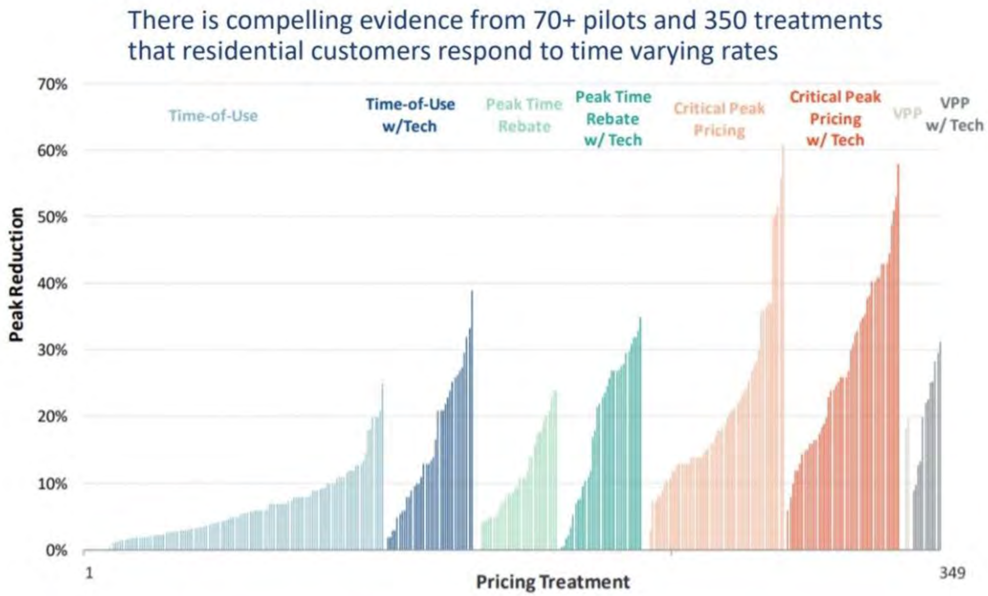
2) Typical hourly price: Typically, the average hourly market price over the year is lower than the standard utility fixed rate.

3) Hot summer weekday hourly price: While the market price can shoot high above the traditional fixed rate when demand is high, such as hot, summer, weekday afternoons, it often stays below the fixed price, such as in winter.

Effectiveness of TOU rates (Brattle Group, 2020)



Permission granted by The Brattle Group PC44 study

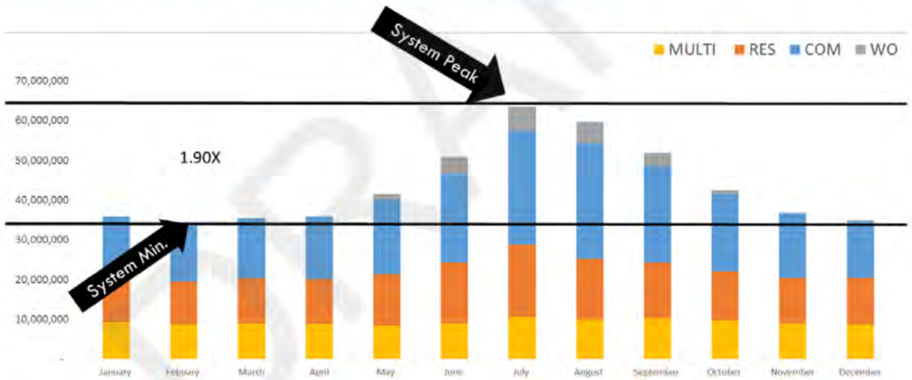


From: A Survey of Residential Time-Of-Use Rates

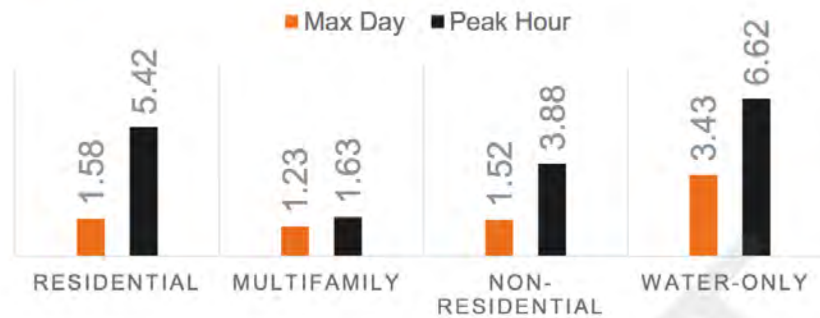
Permission granted by The Brattle Group

Informing rates with peaking data (Ann Arbor)

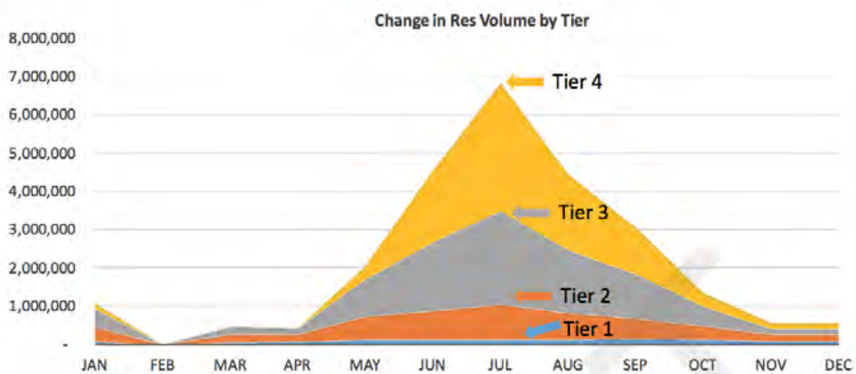
Graphic 4-8 Comparison of Multifamily to Other Rate Classifications



Graphic 4-10 AMI Derived Peaking Factors

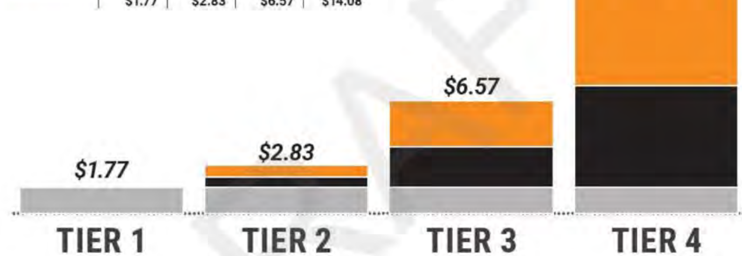


Graphic 5-3 Residential Water Usage by Tier in Cubic Feet (CF)



Graphic 5-5 Residential Water Pricing per CCF

	TIER 1	TIER 2	TIER 3	TIER 4
Average Day	$1.67	$1.67	$1.67	$1.67
Max Day	$0.05	$0.55	$2.32	$5.87
Max Hour	$0.06	$0.62	$2.59	$6.54
	$1.77	$2.83	$6.57	$14.08



Grid access charge with time-variant rate

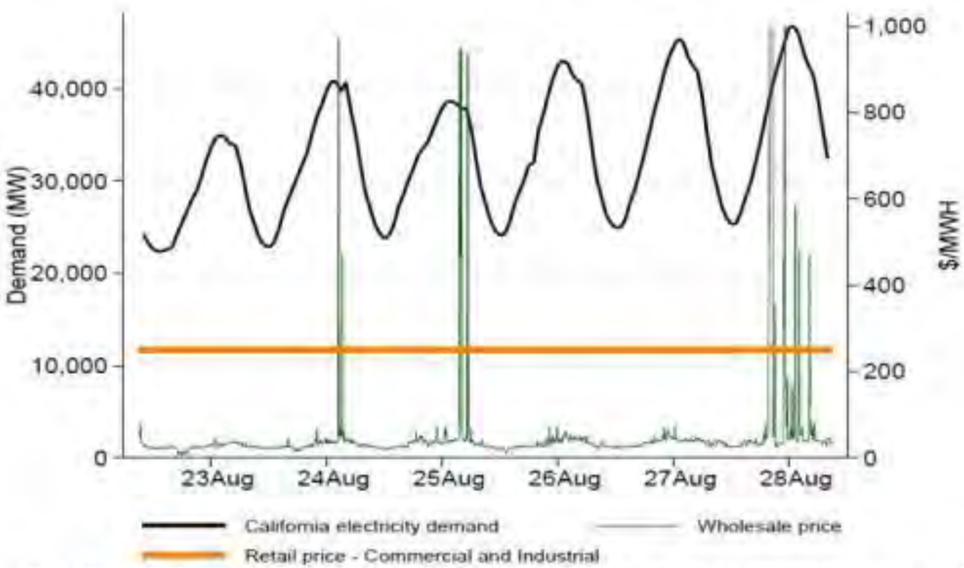
- Small fixed customer charge
- Grid-access charge proportionate to monthly capacity usage
- Time of use rates
  - Daytime ($), nighttime ($$), and evening ($$$)
  - Based on solar availability and demand

Hawaii moves to time-varying ‘smart’ rates for most utility customers

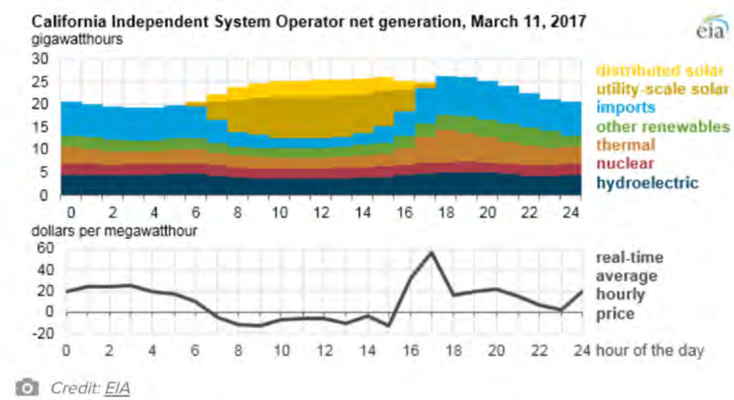
The first-in-the-nation statewide plan will nudge residents to shift their energy use to times that best align with Hawaii’s increasingly solar-powered grid.

8 November 2022

Optimizing wholesale and retail pricing (electricity)



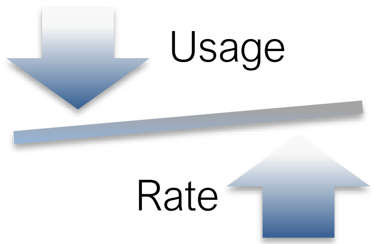
CA Electricity Demand and Prices (in one summer week)



Note: duck curve and negative prices in March 2017.

Pricing to induce conservation

- Many rate variations can reflect costs and achieve efficiency goals
  - Efficiency and waste reduction may be more palatable than "conservation"
  - Any metered rate where more usage leads to higher bills sends a signal re value
  - Different designs may be consistent with cost-of-service studies
  - Policies may specify (e.g., PURPA for energy, Minnesota for water)
- Conservation-oriented rates emphasize usage reduction
  - Usage-budget billing (inefficiency and inequity)
  - All-variable rates (revenue instability)
  - Social engineering (behavioral "nudging" may not be durable)

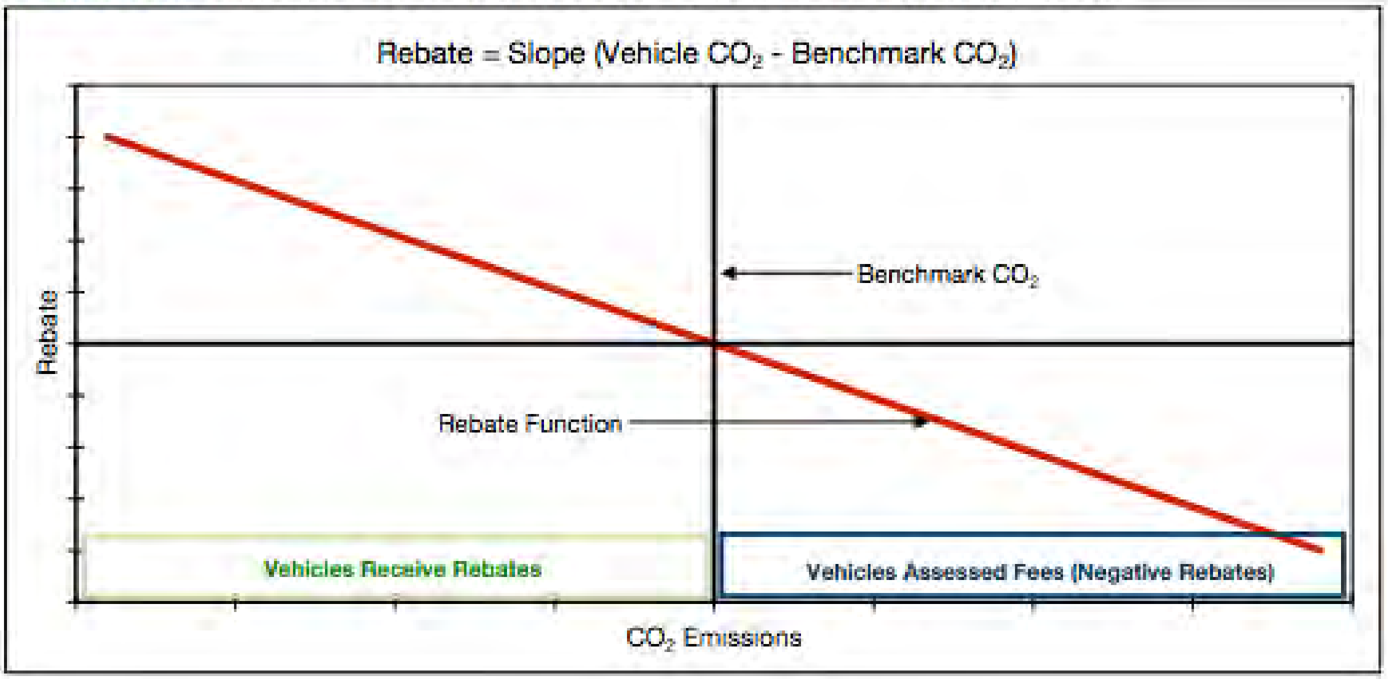


- Price efficiency can be improved
  - Differentiate prices according to usage discretion and contribution to load
  - Price based on long-run marginal capacity and commodity costs
  - Refine customer classes (e.g., clustering analysis, peaking factors)
  - Revisit fixed vs. variable costs and charges (including fire protection)
  - Use (network) congestion or (resource) scarcity pricing during emergencies (e.g., droughts)
- Falling sales and rising rates create a "conservation conundrum" for utilities
  - If higher rates mean lower usage, then lower usage means higher rates
  - Rates may rise due to usage reduction, but bills rise due to costs
  - Aggressive block rates (> mc) may undermine affordability and promote "death spiral"

Revenue-neutral feebates

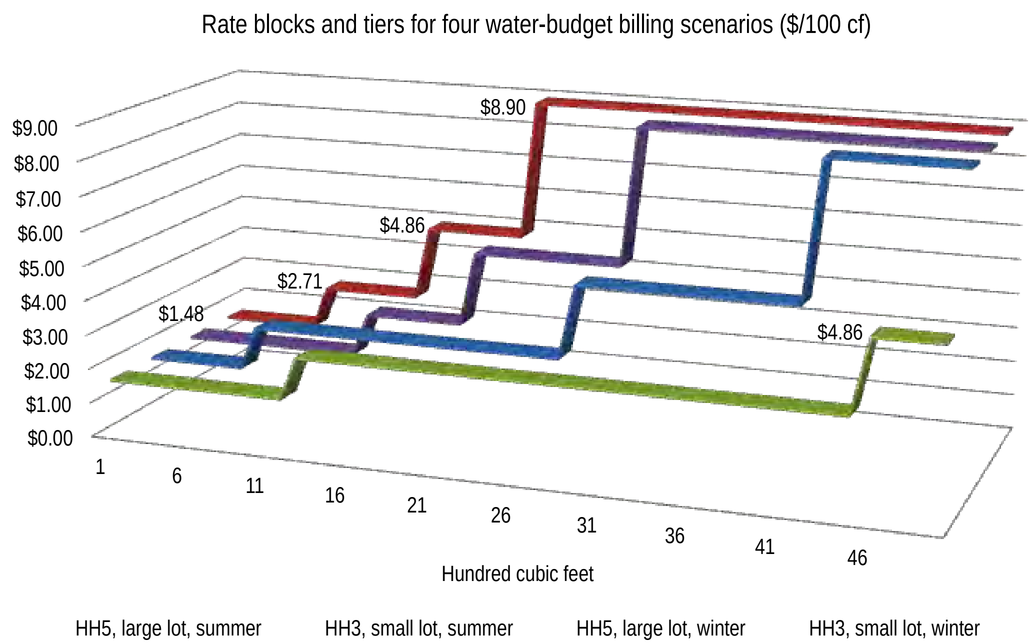
- Charge fees for less desirable (high-impact) forms of consumption
- Provide rebates for more desirable (low-impact) forms of consumption
- Can be administratively complex and customers must be engaged

FIGURE ES1. GENERALIZED DEPICTION OF AN IDEALIZED FEEBATE PROGRAM



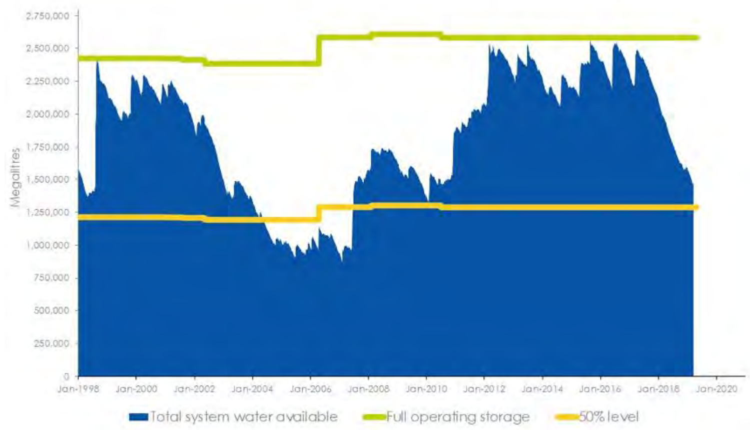
Allocation, excess-use, or usage-budget rates (water)

- An allocation-based rate that provides a water budget and specifies rate tiers
  - Based on household size, lot size, & weather conditions that define “need” and “waste”
  - Variances for swimming pools, large animals, etc.
- Raises issues of equity, fairness, and consistency with cost-of-service principles
- Advocates argue for effectiveness in realizing conservation and revenues



Conditional pricing based on supply or other constraints

- Sydney Australia's "Flexible Water Prices"
  - Rates are set by the Independent Pricing and Regulatory Tribunal New South Wales
  - Rates are designed "to enhance resilience to climatic extremes"
- Fixed-rate
  - Reduced in favor of variable rates tied to usage
- Variable rate based on dam levels
  - When dam levels are above 60%, customers pay $2.35 per kilolitre of water
  - When dam levels fall below 60%, price increases to $3.18 per kilolitre of water
- Prices reflect short-run marginal value and cost principles
  - Long-run value is not directly affected by dam storage levels



Conditional pricing based on supply or other constraints

Tariff Flags

Understand the amounts charged according to the country's energy generation conditions. Scroll the page down!

Since 2015, as regulated by Aneel (National Electric Energy Agency), the Tariff Flags system was implemented in Brazil. With it, the value of energy bills may vary according to the generation conditions of the country's energetic system, which depends on the reservoirs' capacity.

The Tariff Flags system aims to syncronise prices and costs, balancing the distributor's expenses with energy acquisition and the tariffs charged to consumers. Furthermore, it tries to educate society on responsible consumption, signalling where there is a shortage in the energy offering.

Green flag: no change in value.

Yellow flag: there will be an increase in the bill of R$ 1,50 for every 100kWh (kilowatt-hour) used.

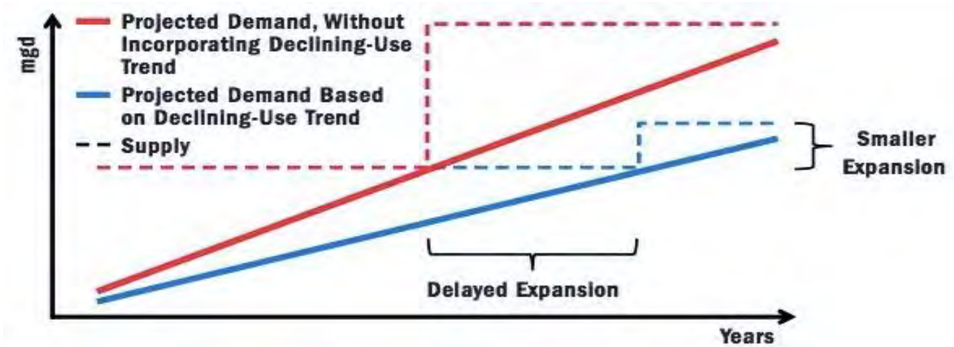
Red flag - Level 1: there will be an increase of R$ 4,00 for every 100kWh used.

Red flag - Level 2: the tariff goes up by R$ 6,00 for every 100kWh used.

ENEL Brazil

Efficiency and avoided cost

- Declining usage presents an opportunity to avoid operating costs (lower highs)
  - Short-run: avoid variable operating inputs – energy and chemicals
  - Long-run: extend asset life and resize, postpone, or avoid new capacity
- Benefits of prudent system and end-use efficiency
  - Value of efficiency varies spatially and temporally based on local conditions
  - Improved capacity utilization and reduced revenue risk and earnings volatility
  - "Conservation Can Benefit The Bottom Line" (S&P, 2012)
- Efficiency cannot avoid all system costs – particularly in the replacement cycle
  - Replacement costs and inflation of inputs may offset savings
  - Fire-protection and sanitation parameters set minimum system requirements
  - Hyper-efficiency may be unnecessarily deleterious for systems and customers
  - Regulators should adjust for effects on expenses as well as revenues



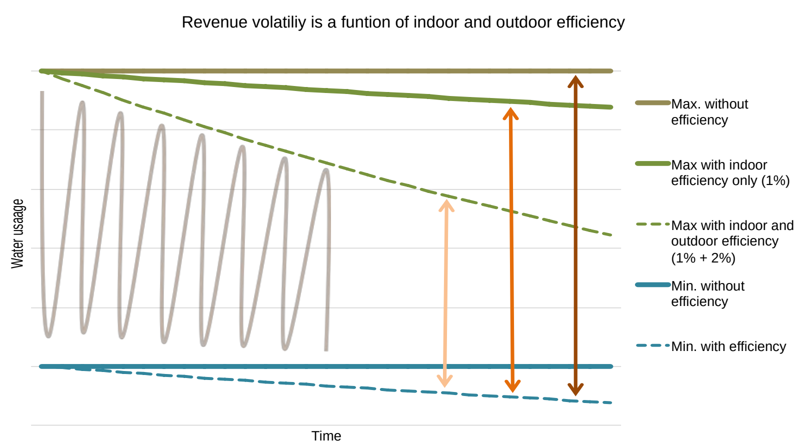
Source: Hunter, et al (Opflow, May 2011)

Efficiency, revenues, rates, and bills ⓘ

Condition	Revenue requirements	Rate ($/unit)	Bill ($/customer)
Usage			
Usage decline (other things equal near term)	neutral	↑	neutral
Economic demand management	↓	↑	↓
Uneconomic demand management	↑	↑	↑
Costs			
Rising infrastructure or operating costs	↑	↑	↑
Supply-side efficiency	↓	↓	↓
Market			
Customer additions (gain scale)	↑	↓	↓
Customer losses (lose scale)	↓	↑	↑
Rate design			
Price-elastic usage	neutral	↑	↓
Price-inelastic usage	neutral	↑	↑
Cost reallocation	neutral	↓ ↑	↓ ↑
Full-cost pricing			
Subsidy	↓	↓	↓
Transfers or loss of subsidy	↑	↑	↑

Efficiency and revenues (water)

- Gross sales volatility is primarily a function of weather-sensitive outdoor use
  - Indoor usage is less responsive (elastic) relative to price and other changes
  - Rising variable prices and bills could drive down outdoor usage significantly
  - Increased efficiency lowers revenue variance (see S&P note) – deficits and windfalls
- Trends in indoor and outdoor usage determine the weather effect on water sales
  - Supply-side (leak control) and indoor efficiency will lower base-load usage, although only the latter will affect sales revenues
- Sales and revenue volatility remain a function of outdoor water usage
  - If maximum (outdoor) use falls, volatility will decrease due to narrowing peak to off-peak
  - If maximum (outdoor) use persists or rises, volatility will increase due to the larger disparity between peak and off-peak usage

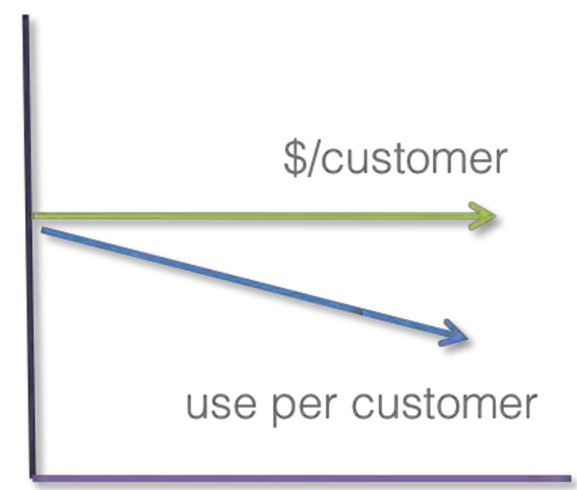


Poll 7: Decoupling

- Which of the following statements about decoupling is *false*?
  A. It incentivizes utilities to invest in demand-side management
  B. It neutralizes the incentive to sell more power or water
  C. It does not necessarily remove the incentive of utilities to invest on the supply side
  D. It is a reaction to declining sales and revenues associated with various trends

Rates under revenue decoupling

- Decoupling is a revenue-assurance mechanism (the ultimate mechanism?)
  - Distinct from cost-adjustment mechanisms (e.g., DSIC)
  - Detaches sales from revenues and profit potential – caps revenues (vs. prices)
  - Similar to weather normalization or other revenue-related mechanisms
  - Straight fixed-var pricing is decoupling – but decoupling is more than "just rate design"
- Meant to address the presumed "split" or "throughput" incentives (to sell more)
  - Reactive policy to address nonstationary declining usage and sales due to efficiency in the context of persistent capital intensity – lowering revenue risk
  - Addresses revenue erosion or attrition by maintaining per-customer revenue neutrality
  - Does not provide a positive incentive for efficiency (return incentives persist)
- Rate formulas
  - Traditional: revenues = fixed price * sales
  - Decoupling: price = fixed revenue / sales
- Alternatives
  - Better demand forecasting
  - Frequent rate adjustments
  - Rate or revenue stabilization funds



Concerns about decoupling ⓘ

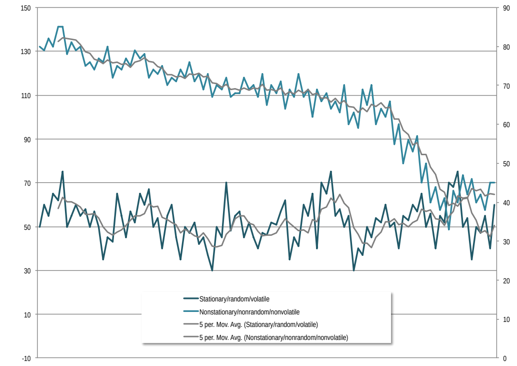
- Decoupling conflicts with
  - Consumer sovereignty and dynamic price signals about value
  - Concept of variable capacity costs and long-term optimization
  - Competition, market forces, and dynamic pricing (reinforces status quo)
  - Risk allocation under regulatory compact (guarantees of profit and recovery of uneconomic “stranded” costs)
- Decoupling issues
  - Public utilities are not meant to be “revenue maximizers”
  - Decoupling is largely reactive and compensatory
  - Water usage has fallen dramatically without decoupling (driven by other factors)
  - Utilities enjoy higher sales but can do little to actualize them except under-price
  - Presumes utility role in conservation and need for special incentives (see water)
  - Publicly owned utilities can make more frequent adjustments
  - Mandates and standards are likely more effective in achieving efficiency goals
  - Too little attention to equitable alternatives to allocation based on sales
  - Methods of (de)coupling also matter to efficiency and equity
  - Rationale varies over time and by utility sector – and not all utilities favor

Concerns (continued) ⓘ

- Reasons for changes in demand cannot be easily isolated
  - May be due to recession, price elasticity, or other forces
  - Partial decoupling attempts to target only purposive or mandated reductions
- Intractable problem for utilities is the investment (not sales) incentive
  - Private utilities are motivated by investment opportunity
  - Decoupling makes utilities indifferent to sales only if the allowed return is close to the cost of capital to minimize preference for capital spending (S. Kihm)
  - Revenue caps have been strongly criticized (M. Crew and P. Kleindorfer; K. Costello)
- A somewhat languid tool and not a panacea for the incentives problems

Alternatives to decoupling ⓘ

- To address revenue shortfall and compensate utilities (reactive)
  - “Organic” decoupling with more efficiency and stability over time (i.e., do nothing)
  - More frequent rate cases to address utility lag in strategic response (gradualism)
  - Prospective (forward-looking) test year for both costs and sales
  - Evidence-based rate design to provide stability from inelastic usage blocks
  - Demand-suppression adjustments to account for price elasticity effects
  - Cost or revenue adjustment mechanisms (with performance, earnings checks)
  - Alternatives for recovery of fixed costs (e.g., service level, property value)
  - Improved demand forecasting and modeling (beyond moving averages)
  - Rate or revenue stabilization funds with appropriate ring--fencing
- To encourage efficiency investment by utilities (proactive)
  - Resource and asset planning that recognizes demand dynamics
  - Conditional franchises to include resource efficiency goals
  - Specification of reasonable capacity utilization profiles
  - Application of prudence and used and useful standards
  - Incentive-based returns based on performance and outcomes
  - Use of incentives must consider risk and equity effects



From passive to active forecasting and modeling (water)

- Simple trends or moving averages are insufficient for non-stationary trends
- Forecasts used in capital planning and ratemaking should be consistent
- Climate change and weather volatility are growing concerns

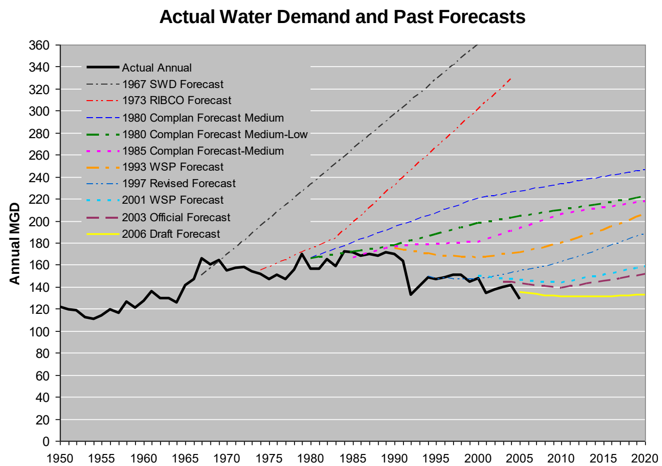
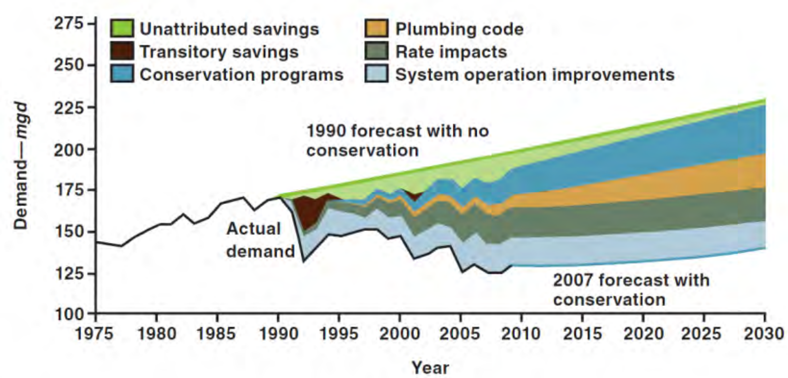
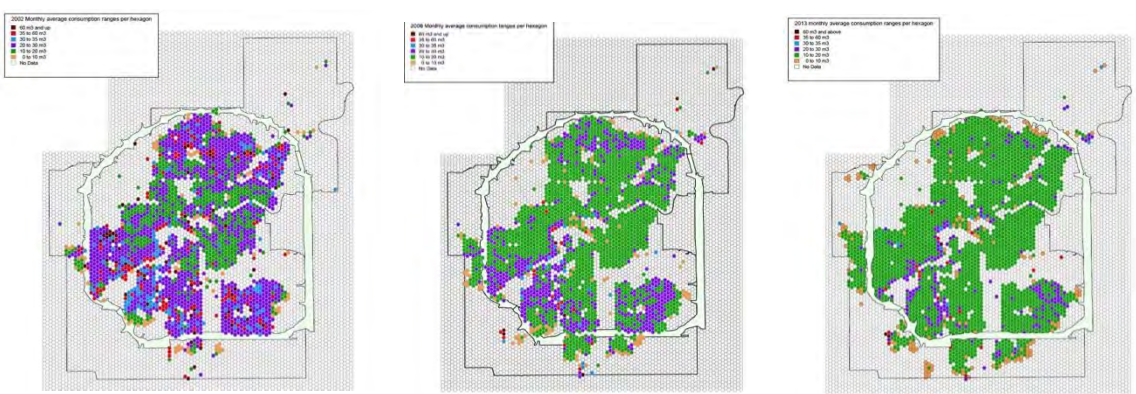


FIGURE 2 Demand forecasts with and without conservation



Source: Graphic courtesy of Bruce Flory, Seattle Public Utilities (2009)



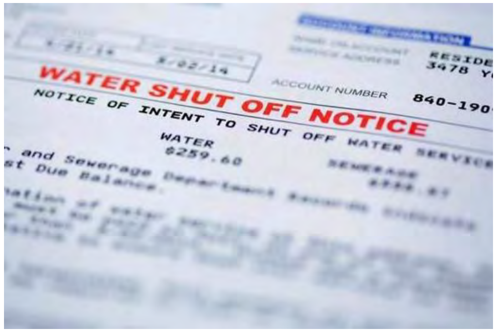
Utility rates and affordability

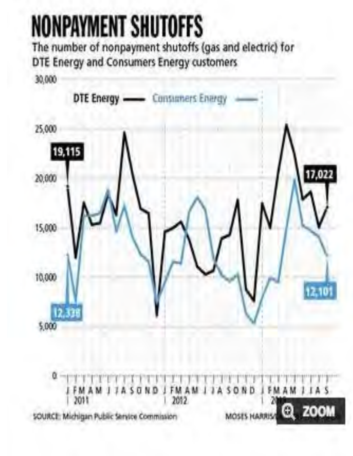
"So what do you want for Christmas?"

Well, lately I've been really into groceries and gas. Utilities are cool. Stuff like that.

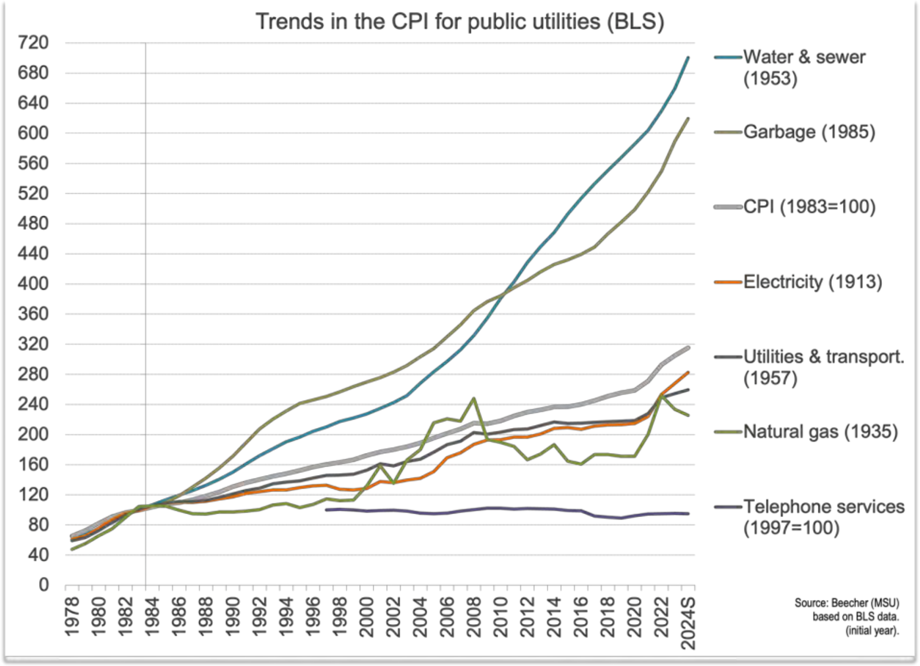
Utility rates and affordability

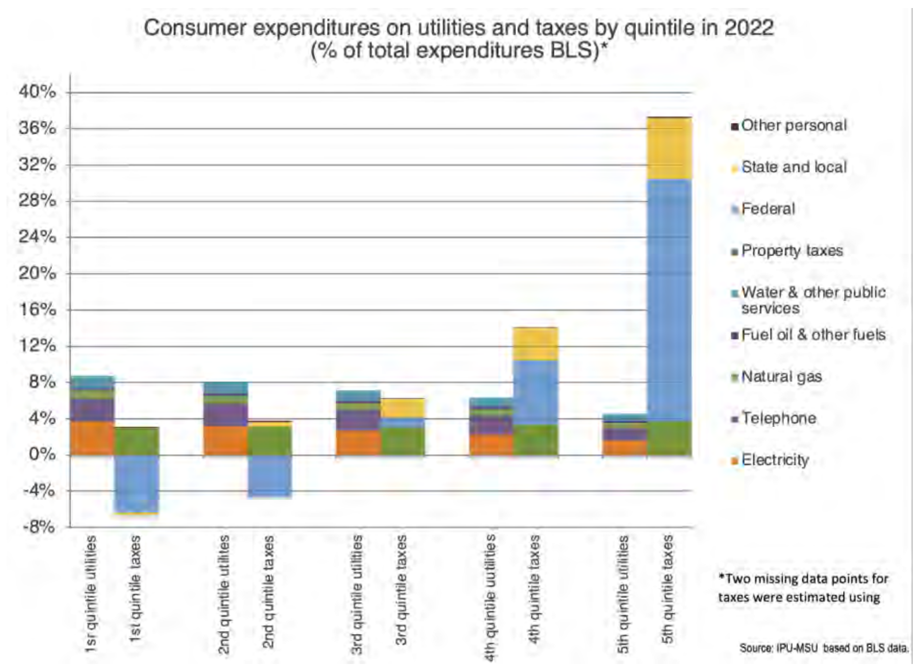
- Low income may not mean low usage and peak usage may be wealth-driven
- Positive effects of access and social inclusion (public heath, safety, and welfare)
- Negative effects of service denial and disconnection (discomfort and stress)
- Additive and regressive nature of household costs for utilities
- Justice, rights, and dignity (including children)
- Price inelasticity of demand for basic services
- Housing and fixture conditions
- Multifamily units and billing
- Collection and reconnection costs
- Customer deposits and fixed charges
- Access to technologies and programs
- Information issues (e.g., language, internet)
- Financial impact on utilities (short term and long term)
- Political, legal and financial barriers to solutions





Price inflation and regressivity of household expenditures on utilities





Uncollectible accounts (electricity)

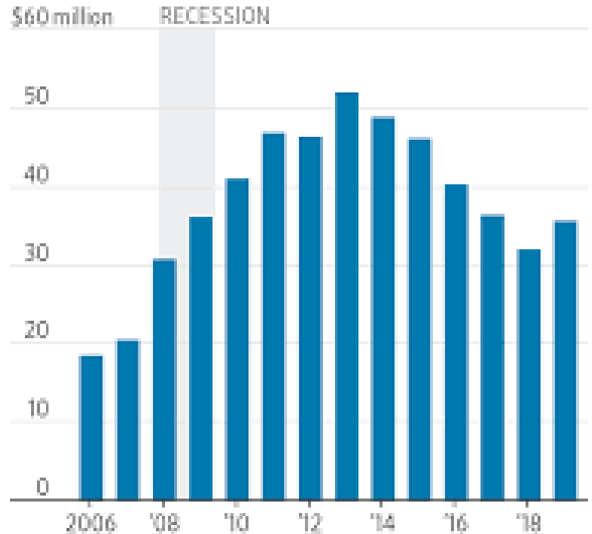
Bills, Bills, Bills

Uncollectible debt as a percentage of electric operating revenue

Source: The Federal Energy Regulatory Commission

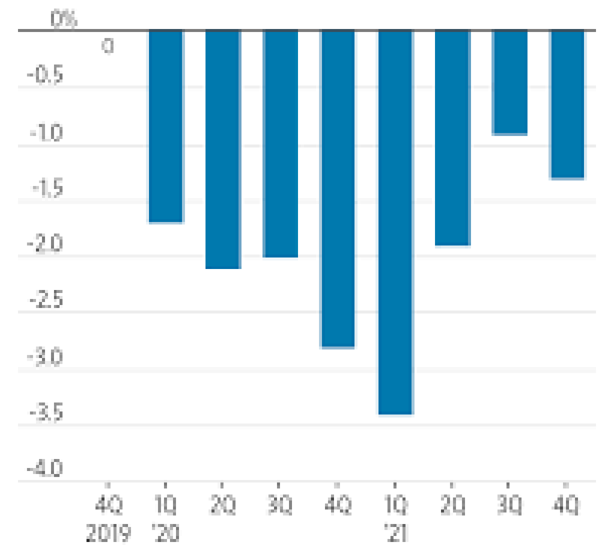
Mounting Bills

Allowance balance for uncollectible customer accounts



Source: Edison International's 10-K filings with the Securities and Exchange Commission

Change in expected total U.S. electricity sales from previous forecast



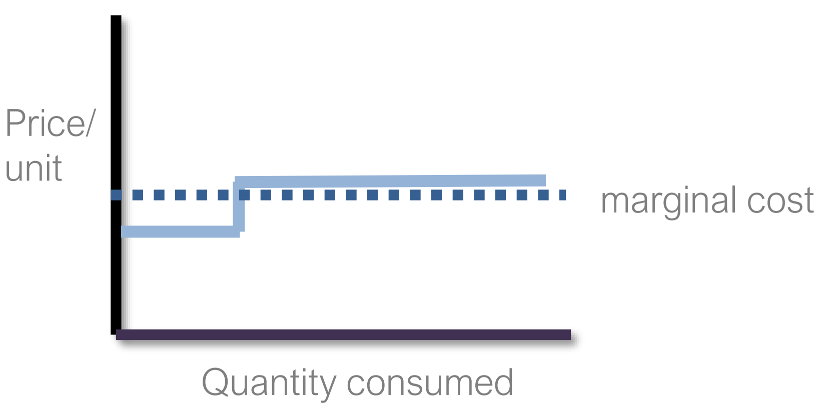
Note: Current forecast is as of April 7. The previous forecast was from March 11.
Source: U.S. Energy Information Administration

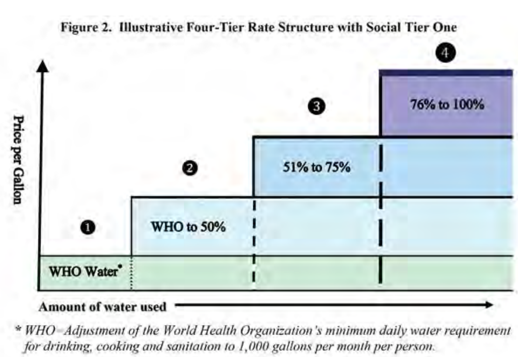
Affordability policy options

- Payment discounts, credits, or assistance (including voluntary funding)
- Tax exemption for water bills
- Arrearage forgiveness
- Budget billing
- Bill timing (monthly)
- Payment convenience (kiosks)
- Lifeline and other rate structures
- Smart meters (tamper resistant)
- Coordinated outreach and counseling
- Disconnection policies (including prohibition)
- Service limiters (flow, volume, or time limiting)
- Prepaid meters (self-rationing, self-disconnection)
- Tailored efficiency programs and dynamic pricing
- Fixed charges calibrated to property values with usage allowance (water)

Pricing to promote affordable access

- Pricing and affordability – considering the ability to pay
  - Utility rates are regressive – they take a bigger share of the low-income budget
  - First usage block is highly price-inelastic: use standards, programs, assistance, lifelines
  - Additional blocks of usage are price-elastic – set prices to encourage efficiency
  - Require affordability metrics and may also consider household size
- Lifelines provide a low-price first block to eligible customers
  - Limited by policies, practices, politics related to price discrimination and subsidies
  - Programmatic discounts to qualified customers (low-income, disabled, seniors)
- Income-based rates - pioneered by Philadelphia, Baltimore, Detroit
  - May not comport with legal and practice frameworks (discrimination not based on cost)
  - Intentional & intuitive but administratively complicated, costly, not necessarily equitable

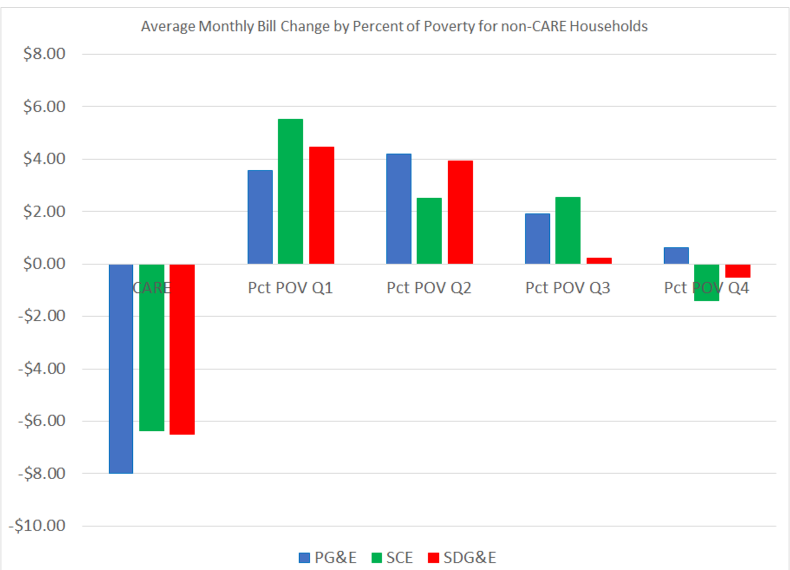




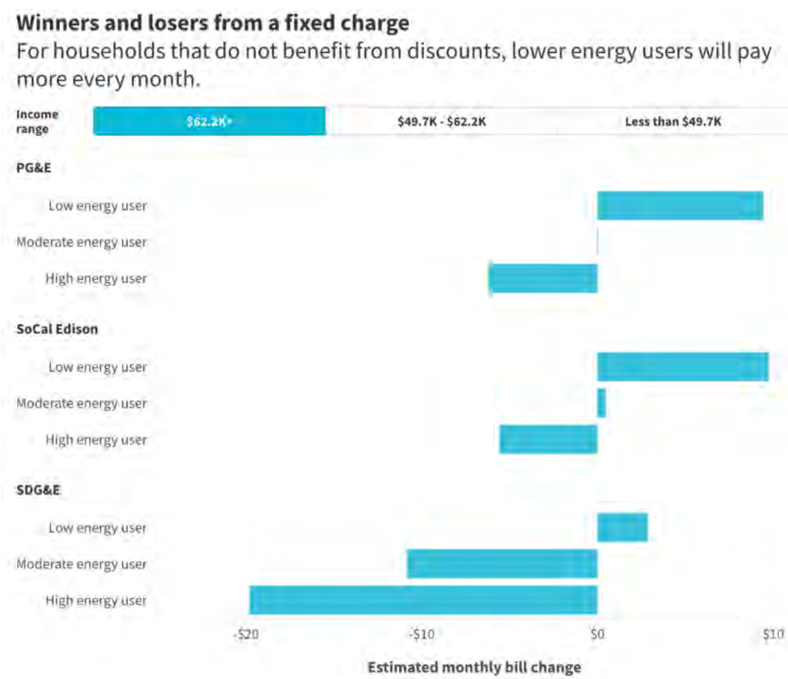

For low-income residents, Philadelphia unveiling income-based water bills

Income-based electricity rates

- Context
  - Rising network costs, declining marginal energy costs, proposals to raise fixed charges
  - States moving in this direction – California, Connecticut, Rhode Island
- Issues
  - Implementation, privacy, incentives, voter opposition, justice, income redistribution



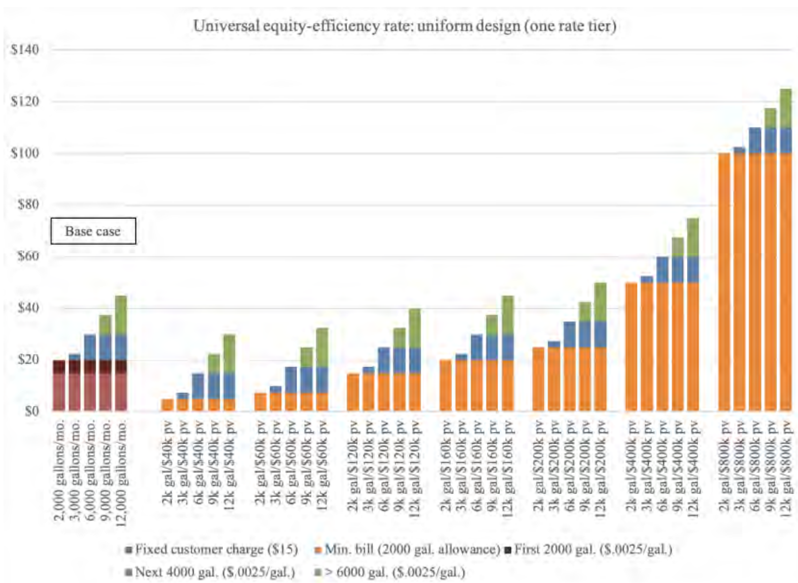
Source: https://energyathaas.wordpress.com/2024/05/13/reality-checking-californias-income-graduated-fixed-charge/

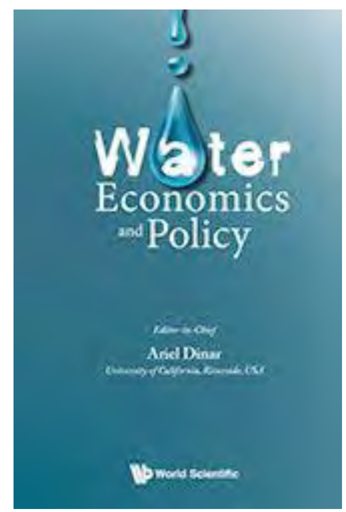


Source: https://calmatters.org/housing/2024/05/californians-electricity-rates/

Universal equity-efficiency pricing model (Beecher, 2020)

- Universal, principled, and defensible – applicable to all water customers
  - Theoretical, practical, and normative rationales – possible stakeholder appeal
  - May become more relevant for network-intensive industries
- Five elements
  - Recognize public functionality in cost allocation (scope economies)
  - Calibrate a minimum bill to property assessment (capacity value)
  - Provide an essential-use allowance for all households (public health)
  - Design cost-based rates for variable water usage (resource management)
  - Prohibit disconnection and deploy service limiters instead (water security)





Values, judgment, and tradeoffs

- Pricing is a tool, not an objective
  - Various options can fulfill revenue requirements and meet other objectives
  - Rate design should be revenue neutral – no more or less
  - No structure is inherently "right" or "wrong"
  - Choices reflect complex tradeoffs among values
  - More attention is paid to efficiency than equity
  - Impacts depend on all fixed and variable components

- Rate design can be controversial and "political" – might not be a bad thing
  - Who pays, how much, and how they pay (interclass and intraclass)
  - "Social ratemaking" departs from accepted cost-of-service principles and practices
  - Sacrifices (some) efficiency in resource allocation to achieve (legitimate) social goals
  - Reflects community values, as well as regulatory authority and discretion
  - Examples: lifeline rates, economic-development rates, and usage-budget rates
- "Just and reasonable" is informed by economics but is a legal standard
  - Economic conception of equity in ratemaking focuses on cost causation
  - Legal equity allows for discretion and pragmatism
  - Social equity considers fairness and outcomes based on values and rights

Differentiated water pricing (Los Angeles)

LADWP Water Rates

Schedule A Residential Bi-monthly Usage Blocks

Alternate Bi-monthly Tier Allotment View:

Winter Season: October – May Summer Season: June - September

Lot Size Groups (sq. ft.)		Winter Usage Blocks (in HCF*) - All Temperature Zones			
		Tier 1	Tier 2	Tier 3	Tier 4
1	7,499	16	6	12	> 34
7,500	10,999	16	8	16	> 40
11,000	17,499	16	16	32	> 64
17,500	43,559	16	20	40	> 76
43,560	& above	16	20	40	> 76

*one HCF equals 748 gallons

Lot Size Groups (sq. ft.)		Summer Usage Blocks (in HCF*) - Low Temperature Zone			
		Tier 1	Tier 2	Tier 3	Tier 4
1	7,499	16	12	24	> 52
7,500	10,999	16	18	36	> 70
11,000	17,499	16	34	68	> 118
17,500	43,559	16	42	84	> 142
43,560	& above	16	42	84	> 142

Lot Size Groups (sq. ft.)		Summer Usage Blocks (in HCF*) - Medium Temperature Zone			
		Tier 1	Tier 2	Tier 3	Tier 4
1	7,499	16	14	28	> 58
7,500	10,999	16	20	40	> 76
11,000	17,499	16	38	76	> 130
17,500	43,559	16	48	96	> 160
43,560	& above	16	48	96	> 160

Lot Size Groups (sq. ft.)		Summer Usage Blocks (in HCF*) - High Temperature Zone			
		Tier 1	Tier 2	Tier 3	Tier 4
1	7,499	16	18	36	> 70
7,500	10,999	16	24	48	> 88
11,000	17,499	16	50	100	> 166
17,500	43,559	16	62	124	> 202
43,560	& above	16	62	124	> 202

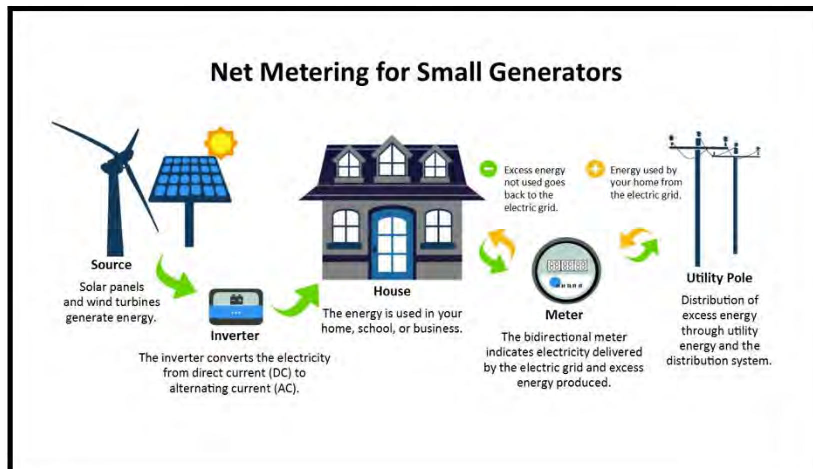
Zip Code	Temp Zone
90001-90044	Medium
90045	Low
90046-90048	Medium
90049	Low
90056-90065	Medium
90066	Low
90067-90071	Medium
90073-90077	Low
90089	Medium
90094	Low
90210-90232	Medium
90245	Low
90247-90250	Medium
90254	Low
90260-90261	Medium
90266-90277	Low
90278	Medium
90291-90293	Low
90301-90305	Medium
90401-90405	Low
90501-90506	Medium
90510	Low
90710-90717	Medium
90731-90732	Low
90744	Medium
90810-90844	Medium
91040-91367	High
91393	High
91401	Medium
91402	High
91403	Medium
91405-91411	High
91423	Medium
91436	High
91502	Medium
91504-91505	Medium
91600-91607	Medium

Multi-criteria pricing for DER (LBL, 2019)

Table ES - 1. Potential Impacts on Near-Term DER Deployment Levels

Rate Design Trend	PV	Energy Efficiency	EV & Electrification	Storage & Demand Response
Time-Based Rates	Highly constrained, Slightly constrained, No impact, Slightly accelerated	Slightly constrained, No impact, Slightly accelerated	Slightly accelerated	Slightly accelerated
Load Building Rates	Highly constrained, Slightly constrained, No impact	Slightly constrained, No impact	No impact, Slightly accelerated, Highly accelerated	Slightly accelerated, Highly accelerated
3-Part Rates	Highly constrained, Slightly constrained	Slightly constrained	Highly constrained, Slightly constrained, No impact, Slightly accelerated	Slightly accelerated, Highly accelerated
NEM Alternatives	Highly constrained, Slightly constrained, No impact	Slightly constrained, No impact	No impact, Slightly accelerated, Highly accelerated	No impact, Slightly accelerated, Highly accelerated
EV-Specific Rates	No impact	No impact	Slightly accelerated, Highly accelerated	No impact

Key: =Highly constrained, =Slightly constrained, =No impact, =Slightly accelerated, =Highly accelerated

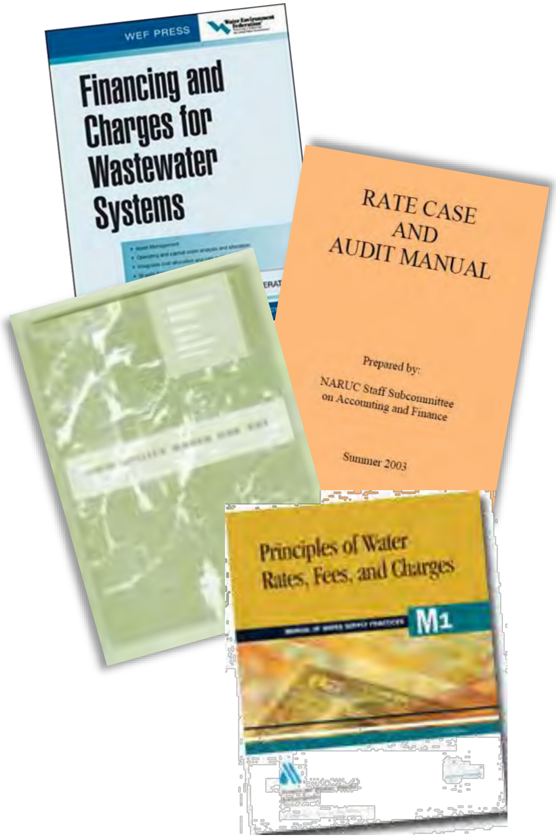


Rate design variations and policy orientation

- Uniform (simplicity)
- Seasonal (load management)
- Marginal cost (efficiency)
- Lifeline (affordability)
- Prepaid (payment certainty)
- Spatially differentiated or zonal (efficiency)
- Spatially equalized or STP (regionalization)
- Locational (network congestion)
- Emergency or drought (resource scarcity)
- Negotiated (attraction and retention)
- Economic development (growth and jobs)
- System development charges (growth)
- Interruptible (load management)
- Curtailment (supply management)
- Standby or ready-to-serve (assurance)
- Peaking-factor (efficiency)
- Time-variant (load management)
- Real-time and dynamic (demand response)
- Critical-peak or event-day (load management)
- Quality differentiated (optimization)
- Value-of-service pricing (optimization)
- Excess-use or budget based (use control)
- Property-value based (affordability)
- Restricted or limited service (access)
- Net metering, feed-in tariffs, and value-of-solar (distributed solar generation)
- Virtual net metering (shared renewables)
- System development or impact fees
- Exit and abandonment fees (defection and stranded cost)
- Vehicle charging (electrification)

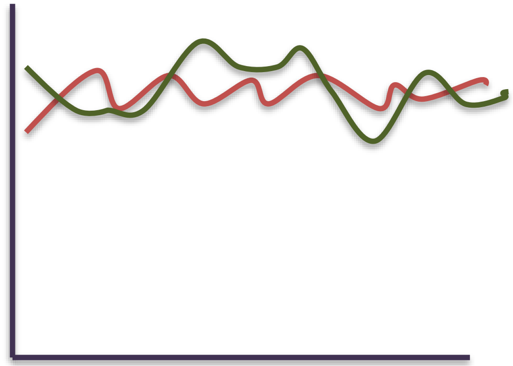
Complexity in rate design

- Rate design need not be overly complex to be consistent with sound principles and practices for achieving goals (cost) effectively
- Complex rates raise complex efficiency and equity issues and sometimes "less may be more"
- A highly complex rate structure can be difficult to communicate (e.g., dynamic pricing)
- Customer understanding and acceptance are important for price-responsive behavior
- Incremental benefits of rate design refinement should outweigh implementation costs
- Resources are available for basic ratemaking (e.g., professional training and manuals)
- Rate structures can and should evolve with changing utility and social values, needs, and goals – but within accepted constraints



Rates, revenues, risks, and returns

- All utilities today are concerned about revenue risk – sufficiency and stability
  - Careful analysis and design of rate blocks can enhance revenue stability while maintaining price signals that support efficiency and affordability goals
  - Shareholders should not be shielded from revenue risk by design (excess capacity) – any insurance to this effect should nbot be born by ratepayers
- Rate design can shift risks between ratepayers and investors
  - Well-designed rates provide symmetrical risk relative to returns (upside/downside)
  - Many rate options call for revisiting the cost of capital and authorized returns within the context of a rate review and other policy decisions (totality of the rate case)
- Demand management and end-use efficiency can smooth load over time
  - Reducing volatility and making sales revenues more stable and predictable



Sales revenues and costs in reality

Totality of a rate case

- Regulatory policies and rate case decisions
  - Impose, mitigate, and allocate risks and rewards – each relates to incentives
  - No issue can be considered in isolation (single-issue ratemaking)
  - Be aware of interest-based "best practices"
- Regulators should consider the totality of regulatory treatment
  - Test year (historical or future)
  - Treatment of construction costs (pre-approval, CWIP)
  - Cost-adjustment mechanisms (opex and capex)
  - Revenue-assurance mechanisms (decoupling)
  - Recovery of operating expenses
  - Depreciation practices and rates
  - Demand (load) projections
  - Demand-trend adjustments
  - Cost allocation and rate design
  - Authorized rates of return
  - Timing of cases and decisions

Implementing rate changes

- Focus more attention on total bill burden as compared to rates
- Avoid excessive complexity and unnecessary confusion (gal. vs. ccf)
- Recognize trade-offs and impacts explicitly (sensitivity analysis)
- Evaluate demand elasticity and distributional effects
- Provide opportunities for stakeholder input
- Explore a full range of rate-design options
- Communicate policy goals to ratepayers clearly
- Prepare a qualified customer-service workforce
- Phase-in substantial changes to avoid rate shock (gradualism)
- Clarify price signals with information through social and other media
- Approach empirically and experimentally by collecting and analyzing data
- Monitor and evaluate for intended and unintended consequences
- Modify based on response, outcomes, and evolving goals and conditions

A cautionary note about “best practices”

- Concept is inconsistent with sound policy analysis
  - Often appropriated by regulated and special interests that define and promote
  - Who decides and from which perspective (utilities, ratepayers) – “best” to whom?
  - Even good practices can become obsolete
  - Practices evolve in dynamic environments
  - Innovation emerges through experimental method
  - Continuous improvement should be the goal
- A “best practice” would have to be
  - Theoretically sound with proven efficacy
  - Scrutinized, field tested, and widely adopted
  - Recognized widely by unbiased experts and practitioners
- Regulators should consider the totality of their practices
  - Regulation cannot be “automated” – there is no substitute for reasoned judgment
  - Asymmetric treatment of sales, costs, and revenues alters risk
  - Cumulative or excessive adaptation may erode the regulatory compact
- A better term is “generally accepted regulatory practices” (GARP)
  - “Standard” or “established” for proven
  - “Promising” for experimental

Questions?
Thanks!

Appendix on utility pricing criteria ⓘ

Financial viability

- *To enable stable recovery of the utility's capital and operating costs*
- In accounting terms, the utility is expected to be viable as a "going concern"
  - Utility "enterprises" are expected to be a "going concern"
  - Ideally, utilities are financially stable, self-sufficient and resilient in the face of stress
  - Stable revenues favor utilities and their investors – high if not singular priority
- "Gradualism" in ratemaking can provide stability in both revenues and rates
  - However, rates are becoming more dynamic (less static)
- Full-cost recovery supports financial sufficiency and enterprise viability
  - Presumes spending that is necessary to ensure compliance with standards
  - Promoted by economists, consultants, regulators (EPA in US and EU) – perhaps to a fault
  - Financialization and full-cost pricing as a fiscal necessity for local government (vs. taxes)
  - Investor-owned utilities invariably charge full cost, including overhead, taxes, & returns
- Full-cost recovery is related to but not the same as full-cost pricing
  - Rates and charges may be the primary but not necessarily the only revenue source
  - Bills under full-cost pricing may be difficult for some households to bear
  - Subsidies to or from the enterprise are generally are discouraged in favor of pricing
  - Full-cost pricing may not be sufficient for beneficial infrastructure investment
  - Public subsidies (subvention) may be strategic and justified based on community values or policy priorities and necessary to protect public health & welfare (historic precedent)

Economic efficiency

- *To achieve an equilibrium that maximizes social welfare*
- Welfare economics argues for price levels that promote allocative efficiency and impose discipline at the macro (system) level
  - Sufficient revenues, reasonable profits, and proper allocation of societal resources
  - Price levels and consequences are defined and evaluated in economic terms
  - Marginal-cost pricing is favored by theory, but may be below average cost
- Economic regulation provides a proxy for competition
  - Firms should minimize costs and establish rates that promote economic efficiency
  - Focus is on pricing over other means (e.g., managerial and performance reviews)
- Efficiency suggests that prices should reflect the full cost of service
  - Suggests recovery of all prudent accounting costs from rates and charges
  - Revenue requirement (numerator) is a function of test year and cost forecasting
  - Forecast sales (denominator) is a function of demand analysis and modeling
  - Tax-based and grant subsidies to systems are contradictory
- Efficiency suggests a long-run equilibrium (A. Kahn, 1988)
  - Perfectly efficient rates are elusive – the goal is efficiency improvement

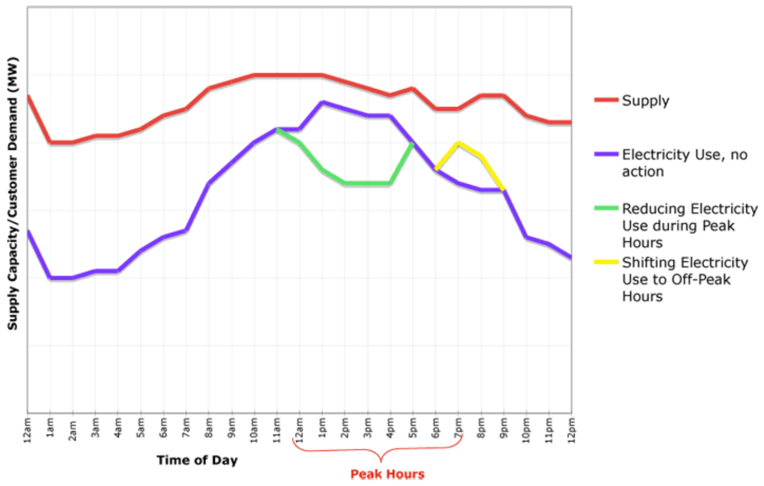
Equitable allocation

- *To allocate costs to usage based on cost causation*
- Resource economics argues for price levels that promote allocative efficiency and impose discipline at the (micro) user level
  - Assumes all consumers have "agency" and must be responsible for their choices and costs, and that the "true cost" of serving a user can be known – cost causers must pay
- Cost-based rates are considered "rational" and consistent with "economic equity"
  - Burdens should follow benefits and vice versa (no free ridership)
  - Cross subsidies generally should be limited (inter-class and intra-class)
  - Undue price discrimination is not allowed (just and reasonable standard)
- Cost differences may or may not be reflected in rates for policy reasons
  - Growth is expected to pay for growth (system-development charges)
  - Old vs. new customers and distance from central plant (cost averaging vs. marginal)
- Regulators consider three types of "economic equity"
  - Vertical (inter-class) equity: different costs, different rates
  - Horizontal (intra-class) equity: same costs, same rates
  - Intergenerational equity: one generation should not be forced to subsidize another
- Intergenerational equity is challenging for capital intensive, long-life assets
  - Financing and depreciation methods are related to this issue (life cycles)

Socializing costs <<<<<<<<<< >>>>>>>>>> ***Individualizing costs***

Operational performance

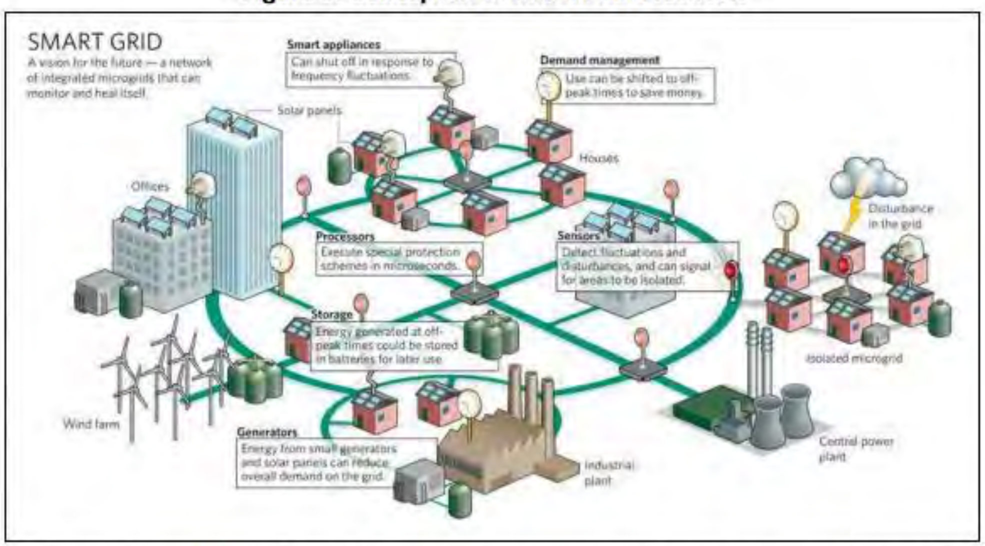
- *To manage load for efficient capacity utilization*
- Modern prudence calls for attention to resource and load management
  - Capacity utilization – ratio of peak to average load
  - System optimization – temporal, spatial, and proportional (scale)
- Operational & end-use efficiency lower revenue requirements by avoiding costs
  - Short-run operating costs – reduce use of resources and other inputs
  - Long-run capital costs – extend asset life and resize, postpone, or avoid new capacity
- Prices can be used to shape load (peak shaving and valley filling)
  - Time-of-use (hourly, daily, seasonal) and dynamic rates



Network optimization

- *To enhance system design, resource integration, and grid services*
- Both supply and demand (and equilibriums) are increasingly dynamic
  - Need for comprehensive and integrative solutions – spatial and temporal
  - Continuing challenges to assumptions about technologies and scale
- Grids allow for pooling of resources and matching them to needs
  - Prices can be used to help maintain healthy and optimal grids
  - Relates closely to other goals and policies related to choices and cost allocation

Figure 3. Concept of a Smart Grid Network

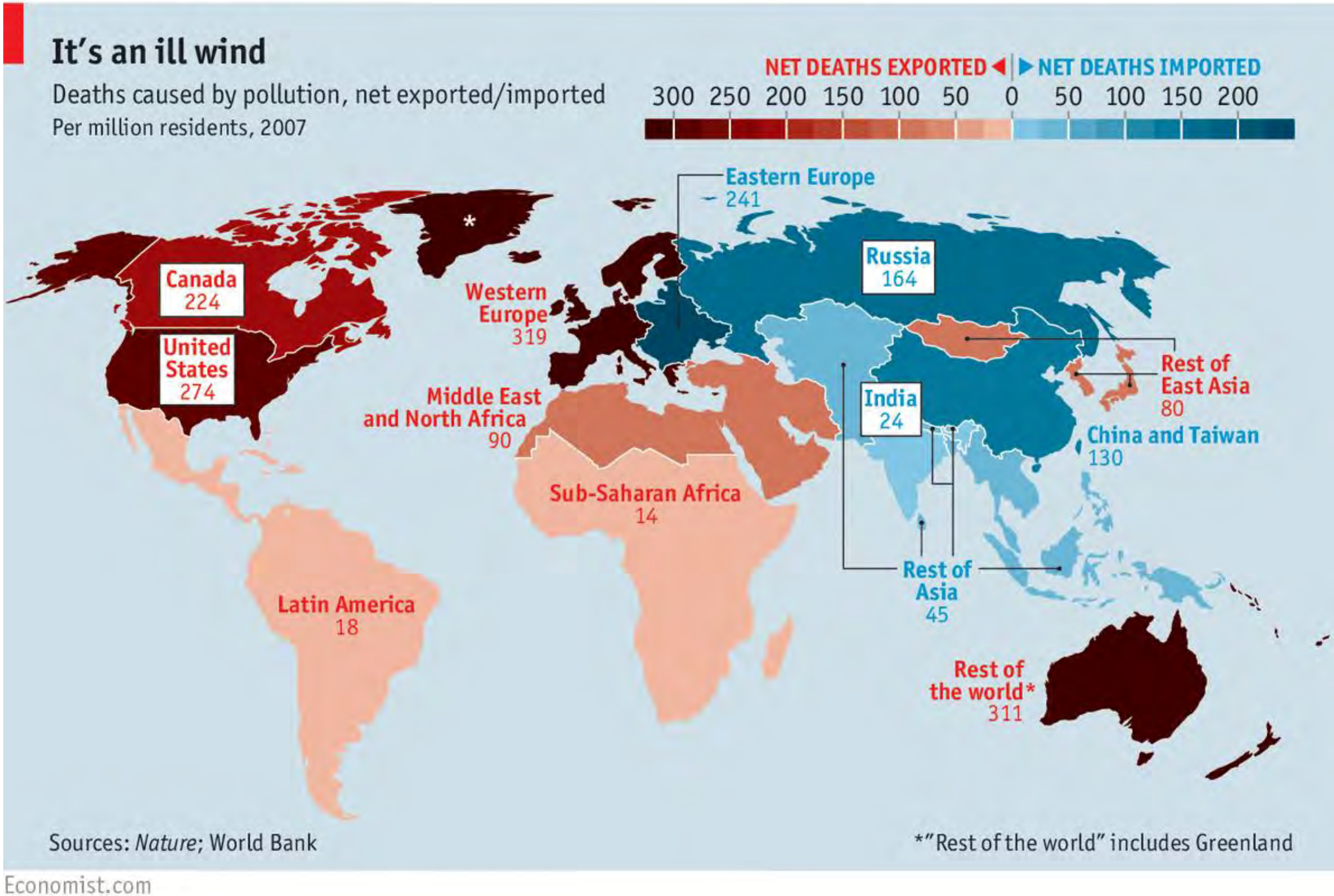


Source: Consumer Energy Report. See http://www.consumerenergyreport.com/wp-content/uploads/2010/04/smartgrid.jpg.

Environmental stewardship *(social equity)*

- *To preserve resources and mitigate adverse outcomes (negative externalities)*
- True economic value reflects resource depletion, cost escalation, and environmental externalities (e.g., pollution, climate change)
  - Externalities are difficult to quantify and weight, not well reflected in market or regulated prices (internalized), and have inequitable impacts – including intergenerational transfers
  - Society can subsidize activities with positive externalities (e.g., clean energy)
  - Society can tax activities with negative externalities (e.g., Pivogian tax on carbon)
- In the absence of an authoritative policy mandate and cost, utilities should not simply charge excessive prices to captive customers (see FERC)
  - Prices at economic or environmental value can exceed accounting costs and lead to excess revenues and earnings that simply enrich the monopoly
  - Individual action can be arbitrary, inequitable, and disadvantaging
  - Arguably, positive externalities should also be considered in the calculus
- Utilities can address externalities through
  - Prudent asset and risk management (resulting in reduced revenue requirements)
  - Efficiency-oriented rate design (marginal costs, scarcity pricing)
  - Voluntary payments through rates (e.g., green pricing, community solar)

Global externalities



Distributive justice *(social equity)*

- *To promote universal service and beneficial outcomes (+ externalities)*
- Universal service requires both access and affordability
  - To the extent possible, pricing should ensure that essential services are affordable
  - Services render positive externalities in terms of public health and welfare
  - Inequity is manifested in energy and water poverty and insecurity, and the digital divide
  - Rawlsian justice argues that society should devote resources to lifting up the least advantaged
- Rates under the utility model can be burdensome – intentionally or unintentionally
  - Made worse by strict, rigid, and blind adherence to cost-causation/cost-allocation rules
  - Price reform can focus on households vs. systems and strategic subsidies
  - Voluntary and customer-funded programs will be insufficient in many cases
  - Emerging technologies include dynamic pricing, prepayment, service limiters
  - Rate design can mitigate distributional impacts
- Issues of poverty, affordability, and rights are complex
  - Utility rates are regressive and rate changes have distributional consequences
  - Unaffordability leads to unhealthy and unsafe choices and behaviors
  - Water disconnection can lead to property liens & seizure, loss of child custody, forced moving
  - Affordability and good payment behavior are good for business and sustainability
  - Economic development is another consideration too (businesses, jobs)
- For isolated, shrinking, and “legacy” systems, technical and policy options are limited
  - Sacrifice service quality, subsidize cost via taxes, abandon service, relocate population

Notes on distributive justice and fairness

- Utility ratemaking intersects with issues of distributive justice and communitarianism
  - Utility services are essential to health and welfare and service differentiation is inequitable
  - Profiting from essential and monopolistic services is met with suspicion (must be accountable)
  - Issues of utility justice, poverty, and disparity are increasingly relevant
  - These intractable problems are beyond the scope of regulation (absent a mandate)
  - Other institutions must contend with the broader challenge of social equity
  - Some countries and communities address these issues more deliberately
- A compensatory rate is easier to determine than a "just" or "fair" rate
  - Legal standard of "just and reasonable" allows for discretion
  - Values and perceptions about equity can vary by culture, place, conditions, and over time
- Different approaches to rate design reflect different conceptions of fairness
  - In practice, rate design mixes art, science, and politics –"who gets what, when, how"
  - Fairness concerns escalate with rising prices and complex allocation choices
  - Allocating the cost of service should not be about punishing ratepayers for usage
  - Established laws, precedents, and practices thwart solutions (undue discrimination)
- New issues challenge conventional notions of equity and justice
  - How will costs to meet broad policy goals be recovered and allocated?
  - Should regulators delegate the determination of "just and reasonable" to markets?
  - What are the implications of departing from cost-based ratemaking (economic equity)?
  - Should rates be used for wealth transfer, whether regressive or progressive (social equity)"
  - If the law is a barrier, should the law be changed?