Public utility cost allocation and rate design
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 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
- \( T \): taxes other than income and income tax expense

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

\[ \text{Revenue requirements (RR)} \]
\[ \text{Estimated sales (billing determinants)} \]
Utility ratemaking is an iterative process to establish tariffs.

- Revenue requirements specify the size of the pie and rate design 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” revenues (regressive “taxation”).

- Regulation can accommodate a wide range of pricing policies and methods.
  - Cost allocation and rate design is not “the regulatory paradigm”.
  - Cost allocation and rate design are the “black box” of ratemaking.

From revenue requirements to rates:

- Utility revenue requirements
- "Black box"
- Utility rates and charges
From revenue requirements to rates

- A tariff is more than a price – it is the schedule of rates, charges, and fees – may sound like a tax (!)
  - “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)
Dynamic role of utility prices in utility sustainability

System design: optimal?

Demand for service: informed?

Cost of service: prudent?

Price of service: reasonable?
Sustainable infrastructure systems

- Sustainability requires living within 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

- Utility model emphasizes enterprise sustainability
  - Total system revenue requirements are based on full accounting of all capital and operating costs
  - Subsidies (subvention) or transfers are justified, purposive, transparent, and generally limited
  - Expenditures ensure that systems are optimized to a service level compliant with all standards

- How revenues are achieved and how costs are allocated are value choices
  - Following A. Kahn (and others), regulated prices should “mimic” competitive prices (economic 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

<table>
<thead>
<tr>
<th>System revenues relative to expenditures*</th>
<th>&lt; 1: expenditures are below optimum (&quot;cost avoidance&quot;)</th>
<th>= 1: expenditures are optimal</th>
<th>&gt; 1: expenditures are above optimum (&quot;gold plating&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1: revenues are below expenditures (&quot;revenue avoidance&quot;)</td>
<td>Deficient system</td>
<td>Deficit system</td>
<td>Wasteful system</td>
</tr>
<tr>
<td>= 1: revenues are equal to expenditures</td>
<td>Underinvesting system</td>
<td><strong>SUSTAINABLE SYSTEM</strong></td>
<td>Overinvesting system</td>
</tr>
<tr>
<td>&gt; 1: revenues are above expenditures (&quot;profit-seeking&quot;)</td>
<td>Revenue-diverting system</td>
<td>Surplus system</td>
<td>Excessive system</td>
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</table>

*Revenues may flow from taxpayer or ratepayer funding. Revenue requirements from rates are net of any tax-based funding.
## Cost of service and its recovery

<table>
<thead>
<tr>
<th>Cost of service</th>
<th>Societal level</th>
<th>System level</th>
<th>Ratepayer level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full social cost and value</td>
<td>Full economic cost</td>
<td>Full-cost accounting</td>
</tr>
<tr>
<td>Environmental, economic, and social externalities (spillovers)</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic opportunity costs and avoided costs</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Capital and operating expenditures, depreciation, taxes, and reserves</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Source of revenues</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property and other taxes, fund transfers, government grants, and other income and contributions</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>User fees (rates and charges), including connection fees and system development charges</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Variations and trends in demand

- 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 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
  - To address 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 to peak)
Temporal demand (water and electricity)

Hourly electricity consumption varies throughout the day and across seasons

Impact of rising temperatures and air conditioning
Peaking and load duration

- Peak load
- Intermediate base load
- Base load

Graph showing the capacity requirement and capacity utilization over time.
5.5 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

1919 load curve

MISO contour map
New shape of (net) electricity loads

- Too much of a good thing?
  - The incremental value of distributed energy can diminish and the addition of renewable resources can be a challenge for operators, who at times might need to curtail excess
  - Cost-effective energy storage may help mitigate
From ducks to dragons

Solar Power Duck Curve

As more solar power is introduced into our grids, operators are dealing with a new problem that can be visualized as the “duck curve.”

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 energy resources has environmental and health benefits in terms of emissions reduction
  - 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. Big changes in usage
  - C. Small changes 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: \( \frac{\% \Delta \text{ in quantity demanded}}{\% \Delta \text{ in price}} \)
  - Represented as an absolute or negative value – and challenging to estimate
  - 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

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

Man Comes Up With Genius Hack To Avoid Baggage Fees

Silke Jasso, November 8, 2018 11:51 am
The cheaper the juice, the more use

The price of electricity varies dramatically from state to state, and so do the usage patterns. States with expensive electricity tend to use less of it—but after a point, it’s hard to conserve any more. That’s why this plot of price against electricity use looks like a boot.

Electricity is cheap in Louisiana, where an average household uses twice as much electricity as a household in Massachusetts.

The average price of electricity in the US is about 12 cents/kWh.

When the price gets really high, though, household use doesn’t drop much further.

At 37 cents/kWh, Hawaii has the most expensive electricity in the nation. It couldn’t fit on this chart.

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 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

<table>
<thead>
<tr>
<th>Less price-elastic</th>
<th>More price-elastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nondiscretionary goods or necessities</td>
<td>Discretionary goods of luxuries</td>
</tr>
<tr>
<td>Less expensive, low-volume, &amp; efficient usage</td>
<td>More expensive, high-volume, &amp; inefficient usage</td>
</tr>
<tr>
<td>Short-term or more immediate needs</td>
<td>Long-term or less immediate needs</td>
</tr>
<tr>
<td>Goods without substitutes and choices</td>
<td>Goods with substitutes and choices</td>
</tr>
<tr>
<td>Goods in noncompetitive markets</td>
<td>Goods in competitive markets</td>
</tr>
<tr>
<td>Indoor and dry weather water usage</td>
<td>Outdoor usage and wet weather usage</td>
</tr>
<tr>
<td>Discretionary usage at higher incomes</td>
<td>Discretionary usage at lower incomes</td>
</tr>
</tbody>
</table>
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 bill – household bill elasticity (aggregated average price)
  - Elasticities may vary for socioeconomic groups

- **Other elasticities also matter – weather, income**
  - Emerging research on demographic groups
  - Meta-analyses consolidate findings in this area
Price elasticity for water and electricity (meta-analyses)

Water

Electricity

Short-term elasticities

Long-term elasticities

Selected sample
Elasticity estimates for water and energy

**Price and income elasticity for water**

<table>
<thead>
<tr>
<th></th>
<th>Price (n=314)</th>
<th>Income (n=162)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>-0.41</td>
<td>0.43</td>
</tr>
<tr>
<td>Median</td>
<td>-0.35</td>
<td>0.24</td>
</tr>
<tr>
<td>Std. dev.</td>
<td>0.86</td>
<td>0.79</td>
</tr>
</tbody>
</table>

**Price elasticity of demand for energy**

- **Residential gas**
  - Short-run: -0.12
  - Long-run: -0.36

- **Residential electricity**
  - Short-run: -0.24
  - Long-run: -0.32

- **Commercial electricity**
  - Short-run: -0.21
  - Long-run: -0.97
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
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)

```
Community water system

  Discretionary: irrigation and other outdoor uses
                (price elastic)

  Home hygiene: laundry and cleaning
                (price inelastic)

  Personal hygiene: washing and sanitation
                (price inelastic)

  Consumption: drinking and cooking
                (highly price inelastic)

  Fire protection
                (capacity with intermittent usage)

Wastewater
                (price inelastic)
```
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
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)

![Graph showing heating and cooling demand vs. outdoor temperature](image1.png)

![Figure 1: Deaths Classified as "Heat-Related" in the United States, 1979–2013](image2.png)
Income and wealth and limits to pricing

- **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 and potential social gains
  - 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 allocate 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 may technically improve welfare
  - As defined by welfare economics but not other conceptions of social goods and the public interest

- Price response is limited by
  - Price levels, inelasticity, opportunity costs, and customer’s ability to control usage (incl. weather effects)
  - Some customers have limited agency to reduce or shift usage - fairness

- Demand reductions may affect market prices
  - Increased availability of resources from supply technology or demand efficiency may also promote more usage (e.g., gas) – Jevons paradox
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: allows 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 problem of sunk costs
- “Demand-suppression” adjustments may be used in rate setting
  - Account for anticipated changes in usage based on changes in price
  - Should be matched by changes in expenses and revenue requirements
- Implications of a 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 death spiral
  - Distributional consequences as healthy people leave the “pool” (like insurance)
  - Importance of flexible and adaptable infrastructure design under dynamic conditions
Rate shock

- “I’m shocked, shocked there are politics in ratemaking.”
- Big rate increases can induce economic reactions
  - A 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 rate increases
  - Gradualism in rate changes and frequent billing can help mitigate these effects
  - Rates may be going 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
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.
Variation in prices (water and electricity)

**Water prices continue to climb in 30 major US cities**

Source: Circle of Blue  
Credit: Sarah Frostenson

**2020 U.S. Average Electricity Retail Prices**  
(cents per kilowatt hour)
Methods for mitigating rising costs, rates, and bills

- Structural solutions to gain efficiency from scale (as realistic)
- Supply-side cost control and strategic planning and operations
- 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 goals
Poll 2: 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 economic sense, charging different rates for various services even when the costs were not correspondingly 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 respective elasticities of demand...
- Of course, price discrimination 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.”
CRITERIA OF A SOUND RATE STRUCTURE

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.).
Bonbright’s *economic* criteria for rates

- Bonbright viewed ratemaking and "welfare" through an economic lens
  - The “right way to price” and "rational use" are econocentric normative constructs
  - There is no right way to allocate & price – only alignment with principles and objectives
  - 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”

- Four functions of utility rates
  - Production motivation or capital attraction
  - Efficiency incentive
  - Demand control or consumer rationing
  - Income distribution

- Each is subject to interpretation – for example, what is a “fair” rate?
  - Significant tensions are found among the criteria (e.g., equity vs. efficiency)
  - Relevant criteria are excluded (e.g., affordability, sustainability intergenerational equity)

- 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 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, induce efficiency, 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 both the true cost and the true 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
  - 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

- 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)
  - “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 regarded as very unfair based on need or ability to pay (social equity)
  - Rates for different activities are expected to yield comparable returns (A. Kahn)
Procedures for adjusting rates

- Rate cases are triggered by
  - Rising costs, falling sales, or both

- Typically, a rate case is filed by the utility in support of revenue requirements and proposed tariffs
  - Preferred and default option
  - A largely reactive process
  - Burden of proof is on the utility
  - Rate reviews may be initiated by regulators

- Other methods as allowed
  - “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
  - Rationalized by saving rate-case expense but risk mechanization of ratemaking – and regulation
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

**Guiding principle**

**Informing discipline**

**Functional task**

**Step 1. Revenue requirements**
- Cost-based pricing
- Finance and accounting
- Determine the total cost of service (budget) for the rate year(s) based on test-year data

**Step 2. Cost allocation**
- Nondiscriminatory pricing
- Engineering and economics
- Link costs to customer usage based on varying contributions to system load

**Step 3. Rate design**
- Just and reasonable pricing
- Economics, law, and policy
- 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; Coast, 1946)
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 and targeted to alter economic behavior (incentives)
  - Subsidies are subjective and controversial

- Subsidies and transfers can occur
  - Between taxpayers and ratepayers
  - Between ratepayers within and across classes
  - 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
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

- 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
Subsidies may be explicit or embedded

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcast TV Fee</td>
<td>$15.10</td>
</tr>
<tr>
<td>Regional Sports Fee</td>
<td>$9.10</td>
</tr>
<tr>
<td>Taxes, fees and other charges</td>
<td>$6.06</td>
</tr>
<tr>
<td>Other charges</td>
<td>$6.06</td>
</tr>
<tr>
<td>Franchise Fee</td>
<td>$4.99</td>
</tr>
<tr>
<td>Public, Educ &amp; Govt Fee</td>
<td>$0.99</td>
</tr>
<tr>
<td>Regulatory Cost Recovery</td>
<td>$0.08</td>
</tr>
</tbody>
</table>
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 to provide 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 – and may include tax support (e.g., 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
  - Various services are expected produce comparable returns (A. Kahn)

- 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 – also 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**
  - Common cost (across organization – such as general plant) and joint cost of production (two services hard to allocate)
  - Allocated according to set of allocation rules – tied to accounting treatment of related plant, customers, usage, etc.
Commodity costs (natural gas and water)

Monthly average Henry Hub natural gas spot price (Jan 2000–Jun 2022)
dollars per million British thermal units

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
Coincident and non-coincident peaking (electricity)

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

Source: energynews.us
Cost functionalization, classification, & allocation

(1) Cost Functionalization
- Production & Gathering
- Storage
- Other Gas Supply
- Transmission
- Distribution

(2) Cost Classification
- Fixed
  - Customer
  - Demand (Capacity)
  - Commodity
- Variable
  - Commodity

(3) Cost Allocation
Cost functionalization, classification, & allocation (simplified)

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

* Capacity costs are fixed in the short term and variable in the long term.
** Methods and practices vary.
Cost allocation by class based on causation and demand

Cost Causation – Demands

Distribute Costs by Function

- Raw Water Pumping
- Source of Supply
- Raw Water Storage
- Treatment
- Pumping
- Transmission/Distribution
- Storage
- Billing
- Customer
- Meter Reading

Average Day Demands | Maximum Day Demands | Peak Hour Demands | Number/Size of Meters

Allocate Costs of Each Function to Customer Classes Based on “Use”
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)

* For water, customer classes and tariffs are differentiated by meter size.
Sales revenues and average prices by class

Percentage of sales and revenues/sales by customer class (2021)

- **Transportation** (10.1 ¢/kwh)
- **Industrial** (7.3 ¢/kwh)
- **Commercial** (11.3 ¢/kwh)
- **Residential** (13.7 ¢/kwh)
- **Public and other.** (.67 ¢/gal.)
- **Industrial** (.35 ¢/gal.)
- **Commercial** (.70 ¢/gal.)
- **Residential** (.91 ¢/gal.)
Average prices by class: economics, politics, and policy

Average retail price of electricity, United States, monthly

Source: U.S. Energy Information Administration

Effective water prices for American Water Works Company (AWK, 1,700 communities in 16 states)

Source: U.S. Energy Information Administration
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

- Infrastructure and utilities have proportionately high fixed 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 (generally shorter) time period
  - Variable costs vary with amount, location, and time of usage
  - A Coasian pricing solution is a two-part tariff with a 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 infrastructure capacity and commodity costs
  - Restructured gas markets with growing interest in electricity and water
  - Both capacity and commodity costs are variable (volumetric) over time
Poll 3: Fixed charges

- **What percentage of the utility bill should be fixed?**
  
  A. 0%
  
  B. 10%
  
  C. 30%
  
  D. 50%
  
  E. A percentage to cover short-term fixed costs
  
  F. A percentage to cover long-term fixed costs
  
  G. Not sure
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)
  - Many if not most utilities recover a substantial portion 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 for 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>
<thead>
<tr>
<th>Fixed (base) charge</th>
<th>Variable (volumetric) charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer costs</td>
<td>Capacity costs</td>
</tr>
</tbody>
</table>
**Fixed vs. variable charges: tradeoffs**

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

<table>
<thead>
<tr>
<th>Utility</th>
<th>Existing</th>
<th>Proposed</th>
<th>% Increase Sought</th>
<th>Approved</th>
<th>% Increase Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG&amp;E (CA)</td>
<td>$10.00</td>
<td>$10.00</td>
<td>0%</td>
<td>$10.00</td>
<td>0%</td>
</tr>
<tr>
<td>Delmarva Power (DE)</td>
<td>$11.70</td>
<td>$13.51</td>
<td>15%</td>
<td>$11.70</td>
<td>0%</td>
</tr>
<tr>
<td>National Grid (RI)</td>
<td>$6.59</td>
<td>$10.10</td>
<td>53%</td>
<td>$6.59</td>
<td>0%</td>
</tr>
<tr>
<td>Pepco (DC)</td>
<td>$15.09</td>
<td>$15.09</td>
<td>0%</td>
<td>$15.09</td>
<td>0%</td>
</tr>
<tr>
<td>Westar Energy (KS)</td>
<td>$14.50</td>
<td>$18.50</td>
<td>28%</td>
<td>$14.50</td>
<td>0%</td>
</tr>
<tr>
<td>Alliant Energy (WI)</td>
<td>$15.00</td>
<td>$15.00</td>
<td>0%</td>
<td>$15.00</td>
<td>0%</td>
</tr>
<tr>
<td>Xcel Energy (NM)</td>
<td>$8.50</td>
<td>$9.50</td>
<td>12%</td>
<td>$8.75</td>
<td>3%</td>
</tr>
<tr>
<td>Dayton Power &amp; Light (OH)</td>
<td>$4.25</td>
<td>$13.73</td>
<td>223%</td>
<td>$7.00</td>
<td>65%</td>
</tr>
<tr>
<td>Otter Tail Power (ND)</td>
<td>$8.00</td>
<td>$17.70</td>
<td>121%</td>
<td>$14.00</td>
<td>75%</td>
</tr>
</tbody>
</table>
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
- Dynamic pricing is less applicable to water due to storage (like natural gas)
  - Could be used for demand response and pressure management under emergency and other conditions (including interruptible rates for large-volume irrigators)
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 would facilitate 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
  - 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

The electricity use diagram below shows the difference between energy (kWh) and demand (kW):

Source: WE Energies.
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
Cost-adjustment mechanisms

- Known as cost trackers, riders, or surcharges for adjusting rates to costs
  - Provided for by approved tariff “clauses” – separate from base rates
  - Allow adjustments to customer rates when the actual costs incurred depart from a baseline amount determined in a rate case

- Meant to prevent financial hardship and earnings erosion between rate cases
  - Rationalized in terms of reducing regulatory lag, rate-case frequency, and expense
  - Considered “credit positive” by rating agencies for credit (debt, bonds)

- Not “automatic” - must be reviewed and reconciled
Poll 4: 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 only to variable operating costs meeting four criteria
  - Substantial
  - Recurring
  - Volatile
  - Largely outside of utility’s control

- Types of costs that may be tracked
  - Fuel or energy cost adjusters
  - New operating systems or plant
  - Regularized infrastructure replacement
  - Bad debt (uncollectible)

- Expanded to include capital-related costs that do not meet these criteria
  - Similarities to construction-work-in-progress (CWIP) in rate base

- Can be used to provide specific incentives to accelerate spending (FERC adders, DSIC)
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
  - Masks rate increases
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 adjustment
  - Weak incentives for cost control with strong investment incentive (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

- Regulators should not be “cost takers” (“cost-plus ratemaking”)
  - Mechanisms shift risks from investors (most able to manage) to ratepayers (least able)
  - Rate case should be the default practice and an earnings-sharing mechanism (based on ROR) may achieve the major objective (K. Costello)
  - Usage should require a comprehensive capital-improvement plan, rigorous certification, and risk analysis as well as reconciliation proceedings to ensure prudence
  - Fixed charges, decoupling, and adjustments are languid methods or ratemaking
Distribution system improvement charge (DSIC)

Constructive Regulatory Policies will continue to Accelerate Recovery of Capex Investment

Capital Expenditures covered by Regulatory Mechanisms

Aqua PA - Miles of Pipe Replaced and Rehabilitated

1,787 Miles (31% of our Pipe Network) Replaced and Rehabilitated over 21 Years

DSIC Increased to 7.5%

Aqua reported unaccounted-for water (%)

DSIC Implemented @ 5%
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 limited 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
  - Do apartment dwellers drive peak energy or water demand?
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 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)
Smart grids, meters, homes

Alexa – stop laughing and pay my water bill
Amazon may be currently getting some stick for its Alexa systems being disobedient and emitting evil laughs, yet water utilities are working with home artificial intelligence (AI) technology to help boost

RAW POWER
Smart meters undercut by human nature
The devices can help households save money by using less electricity — when people can be bothered to figure them out.

By ANCA GURZU | 5/29/18, 3:41 PM CET

CONSUMERS SAVED THE WORLD 20 TWH
with Oracle Utilities Opower Energy Efficiency programs

Which equals...
3 MILLION EVs traveling the equivalent
2 YEARS
Powering all of Japan for 1 MONTH
200,000
5 YEARS
600 BILLION cups of coffee brewing

Fox News
Government Wants to Control Your Thermostat
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 (and makes use of gravity)
  - Limited benefits of load shifting (some energy costs not total energy or water)
  - Water system pressure 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**
  - Relevant time differential is seasonal indoor/outdoor use (vs. hourly)
  - All water systems should be on time-variant electricity rates for off-peak pumping
Metering and solar prosumers

- Net metering, feed-in tariffs, and value-of-solar rates

- Using 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)
  - Using 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 (including capacity) as fully 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 should not be over-simplified as rate-design issues only
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 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
  - 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 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 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

- 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

Beecher-rates2022
Sample bill: natural gas

Bill Date: 03/01/2012  
Account Number: 99999 9999 9999  
Payment Due Date: 03/24/2012  
Amount Due: $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  
Balance: -$254.46  
$0.00

Delivery Charge:  
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  
Total Delivery Charge: $52.38

Gas Charge:  
Efficiency Program: $0.43150 x 144.43 Therms = $62.32  
Natural Gas Savings Pgm: $0.00790 x 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  
Total Gas Charge: $67.50

Taxes:  
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  
Total Taxes: $13.47

Total Current Charges: $140.97  
AMOUNT DUE: $133.41

Peoples Gas  
Customer Inquiries: 1-866-556-6001  
Emergencies: 1-866-556-8002  
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: 3.92  
Feb. 2012: 4.69

Temperature  
36°F  
33°F

Summary of Gas Usage in Therms

Summary of Total Current Charges
Sample bill: water

**WATER / SEWER BILL**

**Amount Due**

$55.00

Due Date: 06/20/2019

**Amount Due After 06/20/2019**

$57.75

---

**Account Summary**

Service Address: 555S STARFLOWER DR

Account Number: 5T0-40555-0000-01

Billing From: 05/04/2019

Billing To: 05/01/2019

---

**Previous Read Info**

<table>
<thead>
<tr>
<th>Code</th>
<th>Read Date</th>
<th>Type</th>
<th>New Read Date</th>
<th>Type</th>
<th>Usage</th>
<th>Amount</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$0.00</td>
</tr>
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<td>$5.90</td>
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<td>777200</td>
<td>A</td>
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<td>A</td>
<td>$300</td>
<td>$27.95</td>
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<tr>
<td>S</td>
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<td>A</td>
<td>777200</td>
<td>A</td>
<td>$300</td>
<td>$27.95</td>
</tr>
</tbody>
</table>

**TOTAL DUE:** $55.00

**DUE DATE:** 06/20/2019

---

**Water/Sewer Use in HCF (Hundred Cubic Feet)**

**Total Use:** 6.02 HCF

---

**IMPORTANT MESSAGES**

For night, weekend or holiday water/sewer public works emergency, call 517-349-0610

---

Please contact the Utility Billing Department at 517-853-6120 with any questions or concerns.

See our website at www.meridian.mi.us for online payment options.
Sample bill: telecom

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

AT&T Benefits
- Smarter TV. Better value. AT&T U-verse®.
There has never been a better time to get AT&T U-verse®. 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 1.666.291.2278 or go online at att.com/undersnow 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 .05
8. Emergency 911 - Johns Creek 1 1.50
Total Government Fees and Taxes 4.09

Total Plans and Services 29.05
Pricing with nudging, naming, shaming, and pleading

You used 43% less than efficient homes.

Great
Good
Using more than average

You
Efficient Homes: 473 units
Similar Homes: 1,287 units

Aug 19, 2016 - Sep 19, 2016
Units represent a combination of electricity (kWh) and natural gas (MCF). This comparison is based on approx. 100 nearby homes that are most similar to yours. Learn more.

How does my bill compare?
Click on a bill period in the chart below to see details on your energy costs.

- Electricity Cost
- Gas Cost
- Outside Temperature

Emergency Alert
Due to extreme temps Consumers asks everyone to lower their heat to 65 or less through Fri

Monday 10:55 AM
Consumers Energy Alert: 8/7 is an Energy Savings Day. Earn bill credits by using less energy from 2:00 PM to 6:00 PM. See email for details.

Today 2:43 PM
Consumers Energy Alert: On 8/7 Energy Savings Day, you earned $8.55 by using 9 kWh less than usual.

View email for full report.
Consumer engagement and switching

- Customer are not monolithic but stratified
  - A diverse “portfolio” of utility loads based on customer needs and preferences
  - Engagement and preferences are uneven

- 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)
  - An uprising of “nonsumers” (R. Ben-David, 2018)

- 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

Electricity residential retail choice participation has declined since 2014 peak

Source: U.S. Energy Information Administration, Annual Electric Power Industry Report

Trends in electric retail choice in key States
competitively-supplied portion of residential electricity sales (%)

Number of participating customers and percent of eligible customers participating in U.S. residential natural gas customer choice programs, 2001-2019

Note: Status at the end of the year. No data available for 2010 and 2011.
Source: U.S. Energy Information Administration, Natural Gas Residential Choice Programs - U.S. Summary, 2009 and Natural Gas Annual, September 2010
Retail choice (Deloitte, 2019)

Residential consumers are confused about retail choice, but cost is key to switching

<table>
<thead>
<tr>
<th>Year</th>
<th>Definitely do</th>
<th>Definitely do not</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>21%</td>
<td>22%</td>
<td>19%</td>
</tr>
<tr>
<td>2017</td>
<td>19%</td>
<td>19%</td>
<td>17%</td>
</tr>
<tr>
<td>2018</td>
<td>19%</td>
<td>59%</td>
<td>17%</td>
</tr>
<tr>
<td>2019</td>
<td>62%</td>
<td>64%</td>
<td>19%</td>
</tr>
</tbody>
</table>

Motivations for switching (extremely/very motivating)

<table>
<thead>
<tr>
<th>Reason</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower electricity costs for my household</td>
<td>85%</td>
<td>85%</td>
<td>86%</td>
<td>86%</td>
</tr>
<tr>
<td>Better service than I am receiving today</td>
<td>65%</td>
<td>63%</td>
<td>61%</td>
<td>58%</td>
</tr>
<tr>
<td>Electricity supply comes from renewable sources such as solar, wind, and hydroelectric</td>
<td>57%</td>
<td>57%</td>
<td>55%</td>
<td>50%</td>
</tr>
<tr>
<td>Someone I trust tells me another electric supplier is a better option</td>
<td>50%</td>
<td>49%</td>
<td>44%</td>
<td>45%</td>
</tr>
</tbody>
</table>
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
The more engaged customer: son #1

What's the best time to run dishwasher/laundry? Middle of the night, right?

We finally have appliances with timers, so I want to wash things at the most energy efficient time

is it good for the environment though?

complicated answer

oh dear

I think not actually they are not on board with that.
The less engaged customer son #2

just got thing in the mail that says "electric supplier choice - confirmation drop" from comed
from Constellation Energy to ComEd...
i'm confused

Omg freaking ComEd woke me up this morning to tell me they're installing smart meters today
For the last time, i don't care! Just do it already!
this better not be in one of your future presentations

i don't know if i have to do anything, just says if i want to switch to new electric supplier other than Comed i can visit this site

-------------- Forwarded message --------------
From: ComEd Energy Efficiency Program <emailme@marketing.comed.com>
Date: Wed, Sep 19, 2018 at 5:50 PM
Subject: Updated Energy Usage Guide available
To: <matzke88@gmail.com>
Go away
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
  - Some prefer simplicity and predictability in rates and rate design, including standard offers or rate stability plans (to lock in and hedge)
  - Not all customers want to engage or choose (“paradox of choice and “overload”)
Rate simplification

2015
4 TIERS

2016
3 TIERS

2017
2 TIERS + HIGH USAGE SURCHARGE

Percent of baseline

Percent of baseline

Percent of baseline

Now with Taxes & Fees Included

Why pay hundreds more every year for AT&T and Verizon’s limited plans? Sign up now for T-Mobile ONE and starting with your February charges, taxes and fees will be included. That’s one price—ALL IN!
Figure 10: Flexible Rate Options Transfer Price Volatility Signals from Supplier to Consumer And Provide an Incentive for Demand Response

- Flat Rate
- Seasonal Rate
- TOU
- CPP-Low
- CPP-High
- RTP Day Ahead
- RTP Real Time

Supplier Hedges 100% of Price Volatility

Supplier Hedges 0% of Price Volatility
Brattle 2020: FixedBill+ for earnings assurance

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

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

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

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

Texas utility panel decries ‘deceptive,’ confusing electricity marketplace

Posted by: Jermaine Black Date: June 05, 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.

Voicemail

-1 (517) 214-8331
Lansing, MI
August 26, 2020 at 5:02 PM

0:15

Transcription Beta

"Hello this is an apology call from your electric utility you got overcharged by your third-party supplier you will be receiving a rebate check along with the 30% discount on your electric and gas bill please press one to get your rebate check..."

Was this transcription useful or not useful?
Rate design
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.
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 (Met. St. Louis)

Residential Customers without Water Meters

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

<table>
<thead>
<tr>
<th></th>
<th>Estimated Water Usage in 100s of cubic feet per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each room</td>
<td>0.5900</td>
</tr>
<tr>
<td>Each water closet (toilet)</td>
<td>2.2053</td>
</tr>
<tr>
<td>Each bath or shower</td>
<td>1.8391</td>
</tr>
<tr>
<td>Frontage foot</td>
<td>n/a*</td>
</tr>
</tbody>
</table>

*A parcel's street frontage, measured in feet, is used by water utilities to estimate the amount of water used for lawn irrigation. However, MSD does not charge for water that is not returned to the sewer system.
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
  - Environmental and consumer advocates tend to favor increasing-block rates for efficiency and affordability (respectively) – empirical findings on impacts are mixed
  - Fixed charges and household size also affect affordability
Rate design details matter

Percentage of water systems surveyed using alternative rate structures
(AWWA/Raftelis Survey; sample varies)

- Water budget
- Flat charge
- IB-DB rates
- Increasing
- Uniform
- Decreasing

Tuscon and Phoenix water bills

Beecher-rates2022
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
Seasonal and standby rates

- Seasonal block rates recognize the cost impact of seasonal energy and water usage on system capacity requirements and may address equity concerns
  - Can be applied to all usage in the season or to the seasonal increment (based on cost)
  - 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 (water)

Note: tail blocks could also vary by time, location, or incremental supply costs (S)

Price/unit

Quantity consumed

S1
S2
S3

S = supply option

High cost
Mid cost
Low cost

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

Bill = usage * highest rate
Pricing to induce load shifting (electricity)

- Smart technologies and shifted load 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 (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 opportunities for arbitrage
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**
  - 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)
  - Can 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 blockchain technology
Effectiveness of TOU rates (Brattle Group, 2020)

There is compelling evidence from 70+ pilots and 350 treatments that residential customers respond to time varying rates.

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
Grid access charge with time-variant rate

- Small fixed customer charge
- Grid-access charge proportionate to monthly capacity usage
- Time of use
  - 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)

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

- An allocation-based rate providing a water budget and 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

Rate blocks and tiers for four water-budget billing scenarios ($/100 cf)

HH5, large lot, summer  HH3, small lot, summer  HH5, large lot, winter  HH3, small lot, winter
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
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 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

### Efficiency, revenues, rates, and bills

<table>
<thead>
<tr>
<th>Condition</th>
<th>Revenue requirements</th>
<th>Rate ($/unit)</th>
<th>Bill ($/customer)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Usage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usage decline (other things equal near term)</td>
<td>neutral</td>
<td>↑</td>
<td>neutral</td>
</tr>
<tr>
<td>Economic demand management</td>
<td></td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Uneconomic demand management</td>
<td></td>
<td>↑</td>
<td></td>
</tr>
<tr>
<td><strong>Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rising infrastructure or operating costs</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Supply-side efficiency</td>
<td></td>
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<td>↓</td>
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<tr>
<td><strong>Market</strong></td>
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</tr>
<tr>
<td>Customer additions (gain scale)</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Customer losses (lose scale)</td>
<td></td>
<td>↑</td>
<td></td>
</tr>
<tr>
<td><strong>Rate design</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price-elastic usage</td>
<td>neutral</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td>Price-inelastic usage</td>
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<td>↑</td>
<td></td>
</tr>
<tr>
<td>Cost reallocation</td>
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<td>↓</td>
<td>↑</td>
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<tr>
<td><strong>Full-cost pricing</strong></td>
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<tr>
<td>Subsidy</td>
<td></td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Transfers or loss of subsidy</td>
<td></td>
<td>↑</td>
<td></td>
</tr>
</tbody>
</table>
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 persists or rises, volatility will increase due to the larger disparity between peak and off-peak usage
  - If maximum (outdoor) use falls, volatility will decrease due to narrowing peak to off-peak
Poll 5: Decoupling

Which of the following is true?

A. Decoupling provides an incentive for utilities to invest in demand-side management
B. Decoupling does not necessarily remove the incentive of utilities to invest on the supply side
C. Decoupling is a reaction to declining sales and revenues associated with various trends
D. All of the above
E. None of the above
Decoupling is a revenue-assurance mechanism (the ultimate mechanism?)
- Compared to a cost-adjustment mechanism (e.g., DSIC)
- Detaches sales from revenues and profit potential – caps revenues (vs. prices)
- Similar to weather normalization or other revenue-related mechanisms
- 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 revenue neutrality per-customer
- Does not provide a positive incentive for efficiency (return incentives persist)

Traditional rate formula
- Revenues = fixed price * sales

Decoupling rate formula
- 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 largely without decoupling
  - 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 to achieve efficiency goals
  - Too little attention to equitable alternatives to allocation based on sales
  - Methods of (de)coupling also matters 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 targeting 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 about 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
Rates and affordability

- Low income may not mean low usage but peak usage may be wealth-driven
- Positive effects of access and social inclusion (public health, 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

![Price inflation and regressivity of household expenditures on utilities](image)

*Source: IPUMSU based on BLS data.*
Uncollectible accounts (electricity)

Bills, Bills, Bills
Uncollectible debt as a percentage of electric operating revenue

Mounting Bills
Allowance balance for uncollectible customer accounts

Source: The Federal Energy Regulatory Commission

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

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
  - 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-priced first block and may include a quantity allowance
  - 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
  - Do not comport with legal and practice frameworks (discrimination not based on cost)
  - Intuitive but administratively complicated and costly, and not necessarily equitable

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

**Connecticut looks to shrink energy burden disparities with discounted rates**

State regulators have asked utilities Eversource and United Illuminating to develop discounted rates for lower-income customers designed to ensure home energy costs don’t exceed 6% of income for any household.
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

- Various rate 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 may 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
  - Legal equity allows for discretion and pragmatism
  - Social equity considers fairness based on values – including rights

Q. Why should rate design be revenue neutral?
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)
Multi-criteria ratemaking: DER (LBL, 2019)

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

<table>
<thead>
<tr>
<th>Rate Design Trend</th>
<th>PV</th>
<th>Energy Efficiency</th>
<th>EV &amp; Electrification</th>
<th>Storage &amp; Demand Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-Based Rates</td>
<td>![Highly constrained]</td>
<td>![Slightly constrained]</td>
<td>![Highly constrained]</td>
<td>![Highly accelerated]</td>
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<tr>
<td>Load Building Rates</td>
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<td>![Highly constrained]</td>
<td>![Highly accelerated]</td>
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<tr>
<td>3-Part Rates</td>
<td>![Highly constrained]</td>
<td>![Slightly constrained]</td>
<td>![Highly constrained]</td>
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<tr>
<td>NEM Alternatives</td>
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<tr>
<td>EV-Specific Rates</td>
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<td>![Slightly constrained]</td>
<td>![Highly constrained]</td>
<td>![Highly accelerated]</td>
</tr>
</tbody>
</table>

Key: ● = Highly constrained, ○ = Slightly constrained, ◯ = No impact, ★ = Slightly accelerated, ☀ = Highly accelerated
Complex water pricing (Los Angeles)

<table>
<thead>
<tr>
<th>Tier</th>
<th>Use</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic indoor use</td>
<td>Least expensive water sources</td>
</tr>
<tr>
<td>2</td>
<td>Efficient drought resistant outdoor use</td>
<td>Some expensive water sources</td>
</tr>
<tr>
<td>3</td>
<td>Above average outdoor use</td>
<td>More expensive water sources</td>
</tr>
<tr>
<td>4</td>
<td>Excessive Use</td>
<td>Most costly water sources</td>
</tr>
</tbody>
</table>

During the winter, tiers are based on lot size only. All temperature zones receive the same amount of water. For the summer, hotter temperature zones are provided a slightly higher allotment to meet the needs of higher temperatures.

**WINTER – October through May**

<table>
<thead>
<tr>
<th>Lot Size Groups (sq. ft.)</th>
<th>Bimonthly Winter Usage Blocks (in HCF*) – All temperature zones</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tier 1</td>
</tr>
<tr>
<td>1 7,499</td>
<td>0 - 16</td>
</tr>
<tr>
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**SUMMER – June through September**

**LOW Temperature Zone**

<table>
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<tr>
<th>Lot Size Groups (sq. ft.)</th>
<th>Bimonthly Summer Usage Blocks (in HCF*) – LOW Temperature Zone</th>
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**MEDIUM Temperature Zone**

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**HIGH Temperature Zone**

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*One HCF equals 748 gallons*
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 not 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
  - 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 ①
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 (iEPA in US and EU) – perhaps to a fault
  - Move to 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, 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

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 should generally be minimized (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

![Diagram showing load shedding and peak shaving](image-url)
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](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

It’s an ill wind
Deaths caused by pollution, net exported/imported
Per million residents, 2007

Sources: Nature; World Bank

*"Rest of the world" includes Greenland
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 should 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?