Curating the future of rate design

KEYNOTE ADDRESS

EUCI Residential Demand Charges Conference
Chicago, Illinois

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Principal

October 20, 2016

THE Brattle GROUP

The Grid is being reinvented as we speak

In a widely reviewed book, "The Grid," a cultural anthropologist at McGill University, Dr. Gretchen Bakke, says that the current move toward more sustainable energy solutions will require "a serious reimagination of the grid. The more we invest in 'green' energy, the more fragile our grid becomes."

The grid is aging and in significant need of an upgrade in the face of new technologies which customers and producers now want to attach to it.

- Bakke says that "the grid is worn down, it's patched up, and every hoped-for improvement is expensive and bureaucratically bemired."

The utilities are trapped in an existential dilemma

The business model built by Samuel Insull was premised on continuing electrification of the economy

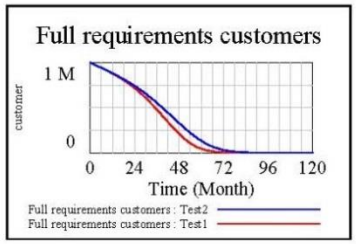
- There were economies of scale in power plants. Bigger power plants produced electricity at lower costs than smaller plants. Falling costs meant falling prices which meant rising electricity sales and higher earnings for the utilities.

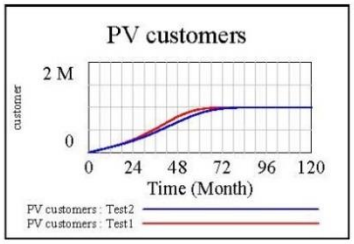
Now that cycle has run out of steam

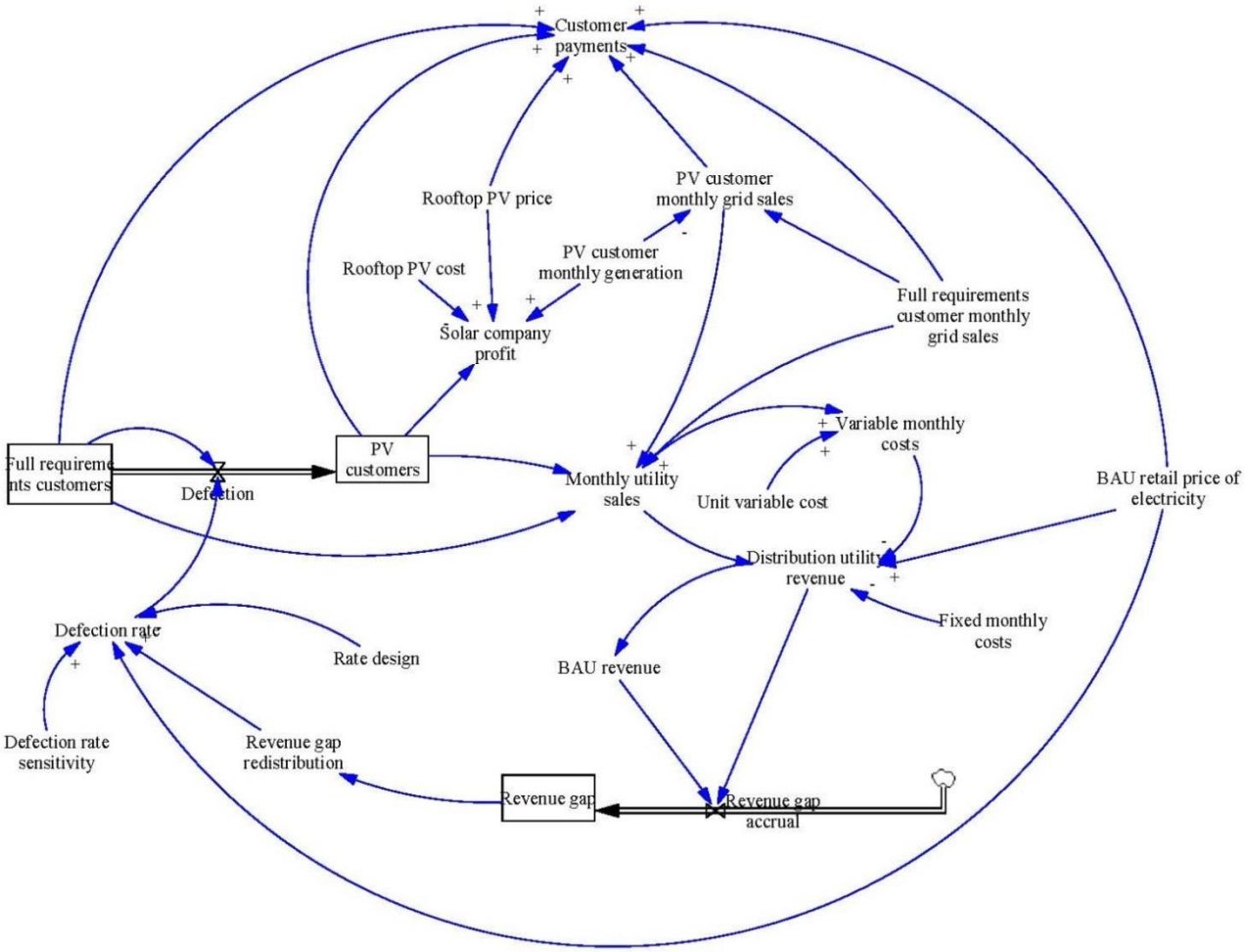
- Smaller decentralized power plants are emerging on residential and commercial rooftops and larger consumers are engaging in co-generation.

Notes Bakke, "The utilities don't know how to upgrade existing technology without putting themselves out of business. Nor do they know how to continue with the existing infrastructure without going out of business."

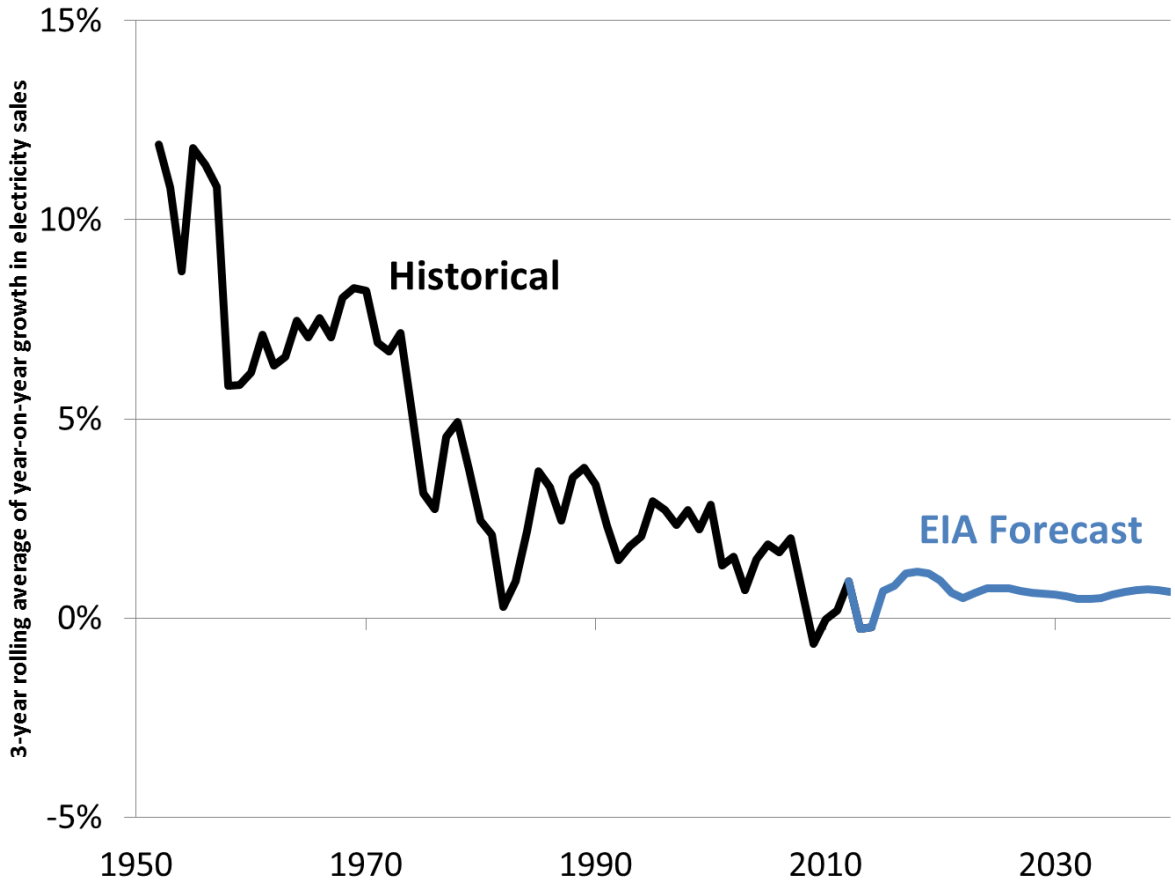
Technology, regulation, and information are interacting dynamically in complex ways, requiring a reinvention of the utility







In the United States, growth in electricity sales has slowed down since the mid-1950s



Source: 2015 Annual Energy Outlook, U.S. Energy Information Administration

EEI's John Caldwell has been tracking the relationship of electricity to GDP

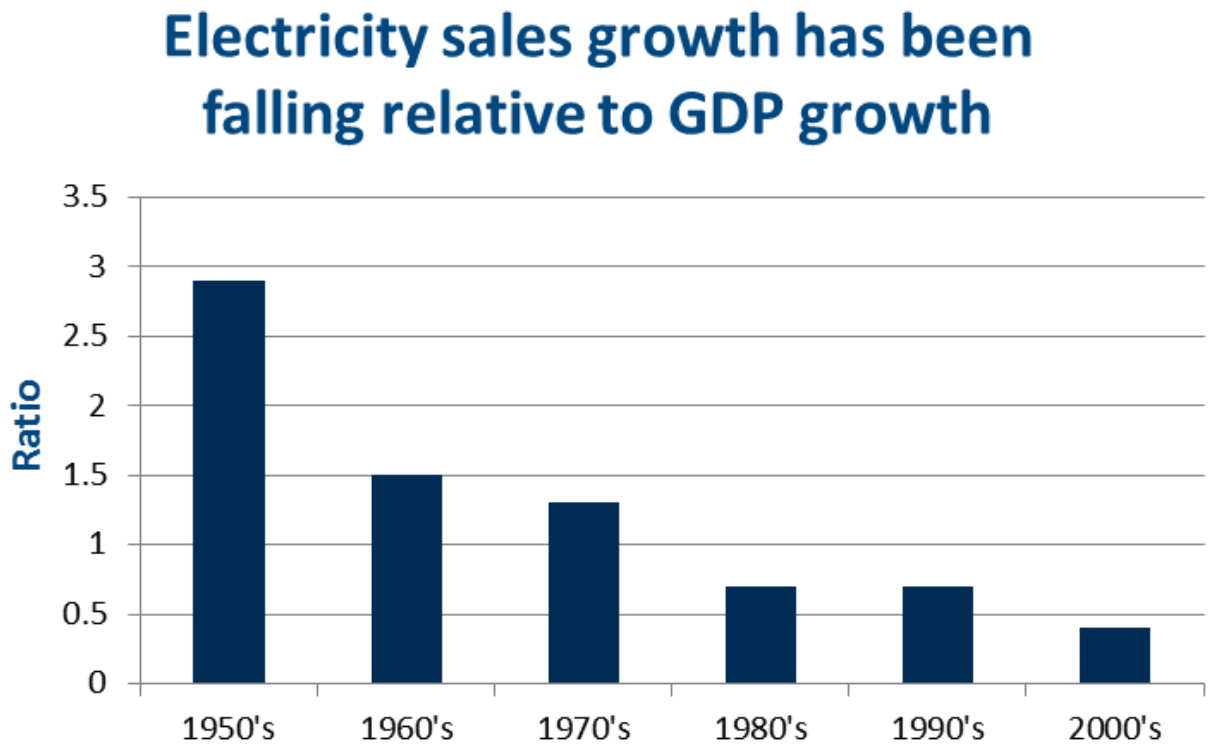
He has found that in all prior recessions, electricity sales growth has usually recovered to pre-recessions levels within a year after the recession ended

However, after the Great Recession of 2008-09 ended, sales did not recover to pre-recession levels until five years later in 2014

But the return was short lived

Electricity sales fell again in 2015

The US economy has been de-electrifying since the 1950's



Five factors are contributing to the slowdown in growth

The Economy

- "The Great Recession" of 2008-09 and its aftereffects

Consumer Behavior

- The arrival of the millennials and the emergence of organic conservation

Utility Energy Efficiency Programs

- $7 billion a year of programmatic spending

State and Federal Codes & Standards

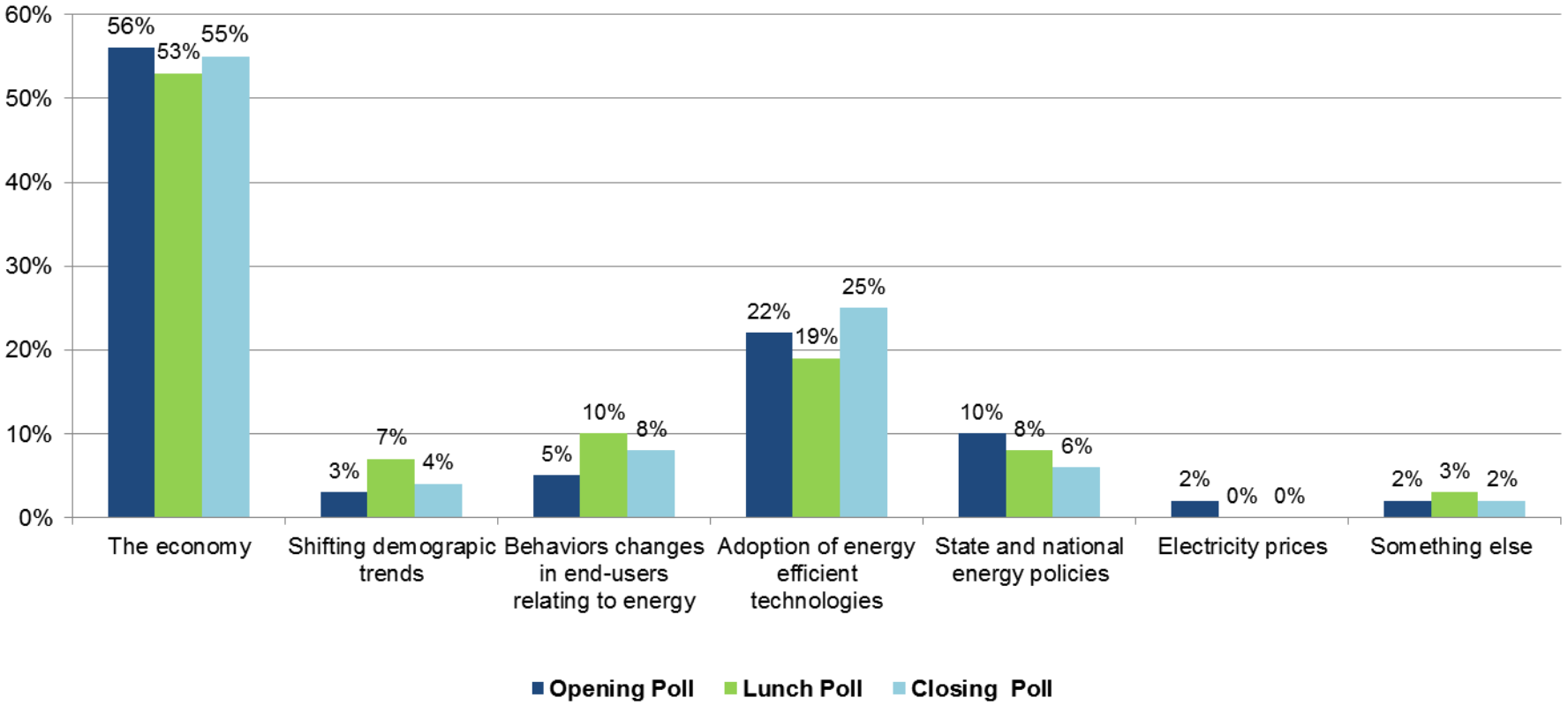
- Becoming more stringent by the day

Distributed Generation

- While its contribution is relatively small, it is growing fast

Perceptions on the sources of the slowdown in electricity sales

The audience at PJM Grid 20/20 Conference in 2014 was surveyed through a live poll to opine on the drivers behind the slowdown in electricity sales.



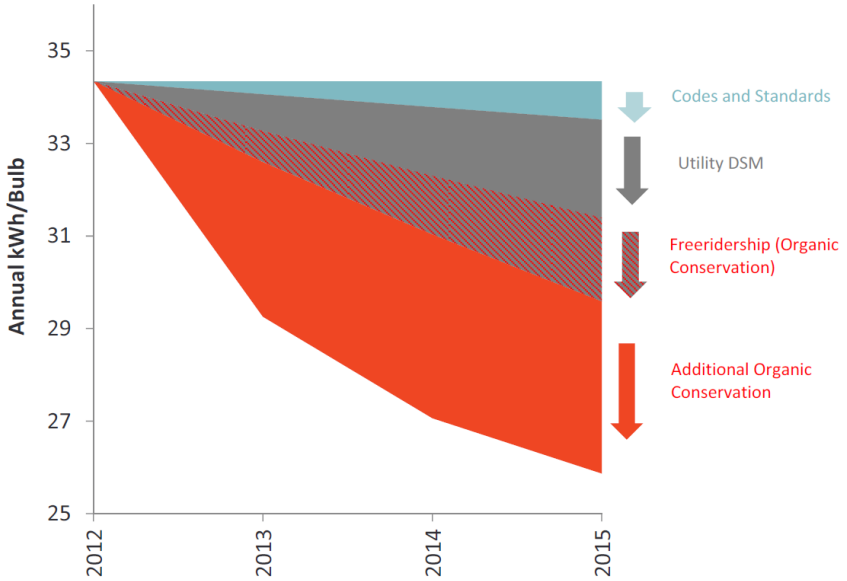
Source: http://www.pjm.com/committees-and-groups/stakeholder-meetings/symposiums-forums/grid-2020-focus-on-energy-demand.aspx

There has been a shift in consumer behavior

Organic conservation:

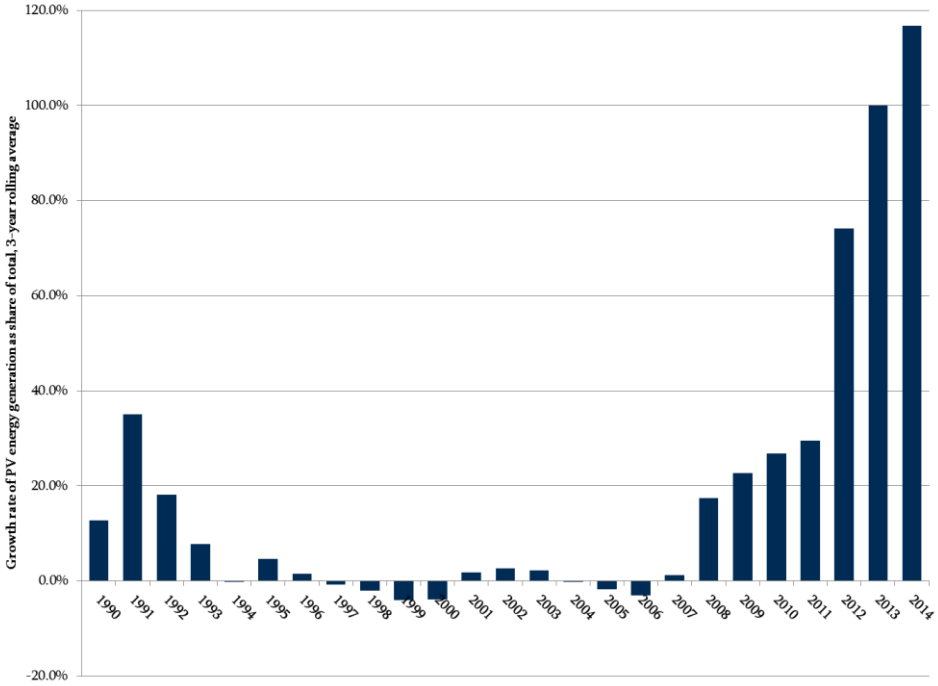
Naturally-occurring improvements in energy efficiency on top of utility programs and governmental codes & standards

A study for a Midwestern utility found that organic conservation accounted for 40-60% of total energy savings.

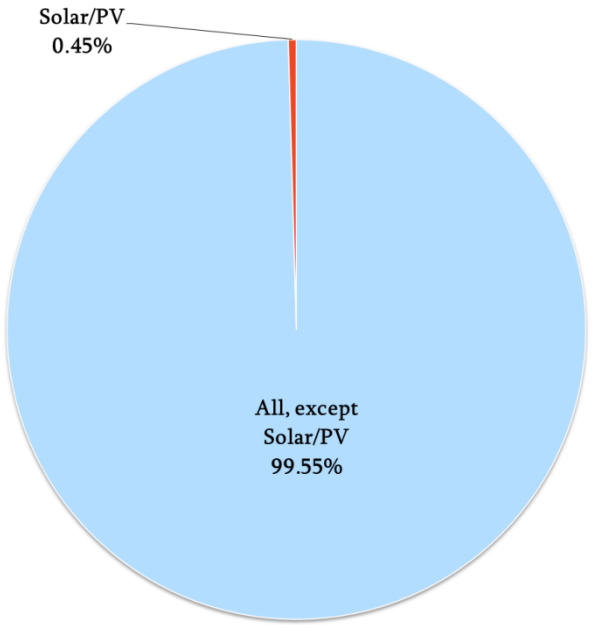


The contribution of DG has been growing rapidly

Growth Rate of Net Energy Generation from Solar/PV as a Share of Total, 1990-2014

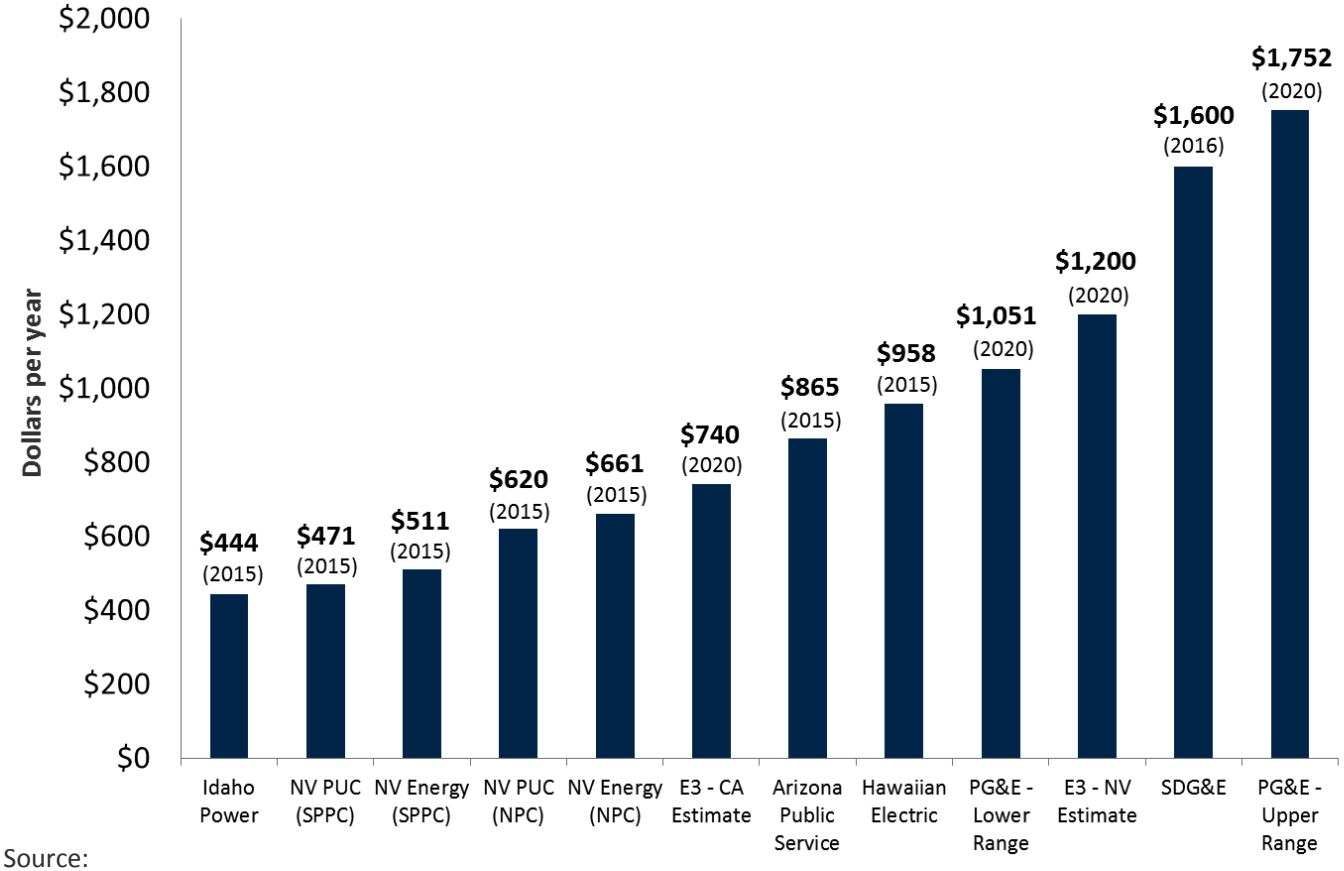


Share of Total Net Energy Generation, 2014



Source: September 2015 Monthly Energy Review, U.S. Energy Information Administration

Solar customers are being subsidized by non-solar customers in existing rate designs



Source:
Barbara Alexander, Ashley Brown, and Ahmad Faruqui, "Rethinking Rationale for Net Metering," *Public Utilities Fortnightly*, October 2016.
Notes:
Year indicates date of cost-shift estimate, which is sometimes a forecast.
In some cases, reported estimates were converted to annual dollars per NEM customer for comparison purposes.
The PG&E ranges are calculated using assumptions from the California Public Utilities Commission's Public Modeling Tool.
SPPC and NPC refer to Sierra Pacific Power Company and Nevada Power Company service territories respectively.

Will decarbonization, pursuant to the Paris Agreement, lead to electrification and a reversal of the declining trend in sales growth?

Much of it is likely to occur in the transportation sector, where change happens slowly

MIT has put out a "realistically aggressive" scenario in which a fifth of the cars by 2030 will be EV's; but, even then, four-fifths will still be gasoline powered cars

And so while the impact may be substantial, it is decades away from making a material impact on the declining trend in sales growth

As uncertainties about sales growth loom large, it is time to move ahead with rate reform

The bedrock principles of rate design find their best expression in the writings of Professor James Bonbright

These assert that cost-causation should be the overriding principle in order to promote equity between customers and efficiency in the utilization of scarce capital and fuel resources

Rates should reflect costs

Bonbright argued that a purely volumetric rate assumes that the total costs of the utility vary directly with the changes in the kWh output of energy.

- He calls this "a grossly false assumption" and says such a rate "violates the most widely accepted canon of fair pricing, the principle of service at cost."

And, while discussing the Hopkinson rate, he said that such a "rate distinguishes between the two most important cost functions of an electric-utility system: between those costs that vary with changes in the system's output of energy, and those costs that vary with plant capacity and hence with the maximum demands on the system (and subsystems) that the company must be prepared to meet in planning its construction program."

Bonbright cited the earlier work of the British engineer, D. J. Bolton

"More accurate costing has shown that, on the average, only one-quarter of the total costs of electricity supply are represented by coal or items proportional to energy, while three-quarters are represented by fixed costs or items proportional to power, etc. If therefore only one rate is to be levied it would appear more logical to charge for power and neglect the energy."

Rates for commercial and industrial customers have long conformed with these principles

These rates are comprised essentially of three elements

- a fixed service charge to cover the costs of billing, metering and customer care;
- a demand charge to cover the costs of the distribution grid and of transmission and generation capacity costs;
- and an energy charge to cover fuel costs; this often varies by time-of-day and is sometimes dynamic

They mirror the cost structure of electricity and promote equity and efficiency

Residential rates are stuck in a time warp

They consist of two-parts, a volumetric energy charge and a small fixed charge

- Capacity costs are buried in the volumetric charge, using the load factor of the class
- The fixed charge does not fully recover the fixed costs of serving the customer

In 98% of the cases, the energy charge is flat and does not vary with time-of-use

The two-part rate creates subsidies between customers with different load factors; neither does it promote efficient use of energy

Two-part rates do not reflect the utility's cost structure

Cost categories	Utility's Costs	Customer's Bill
Variable ($/kWh) - Fuel - Operations & maintenance	Variable = $60	Variable = $115
Fixed ($/customer) - Metering & billing - Overhead	Fixed = $10	Fixed = $5
Size-related (demand) ($/kW) - Transmission capacity - Distribution capacity - Generation capacity	Demand = $50	

The time has arrived to rethink residential rates

Back in 1961, Professor Bonbright asked us to guard against the "tyranny of the status quo"

However, two-part rates are ubiquitous today

They have persisted over the past century because of two reasons

- Lack of advanced metering
- A perception that residential customers are not ready for a change, which has become a self-fulfilling prophecy

Flat energy rates should be replaced with time-varying rates that capture energy costs and some generation capacity costs

Economic efficiency

- The costs of supplying and delivering electricity vary by day, and by hours within a day
- Unless consumers see this time variation in prices, they will have no incentive to consume less when energy is more expensive and to use more when energy is less expensive
- Excess generation capacity will have to be built and kept on reserve to meet peak loads during a few hundred hours of the year

Equity

- Under flat energy rates, customers who consume relatively less power during peak periods subsidize those who consume relatively more power during peak periods

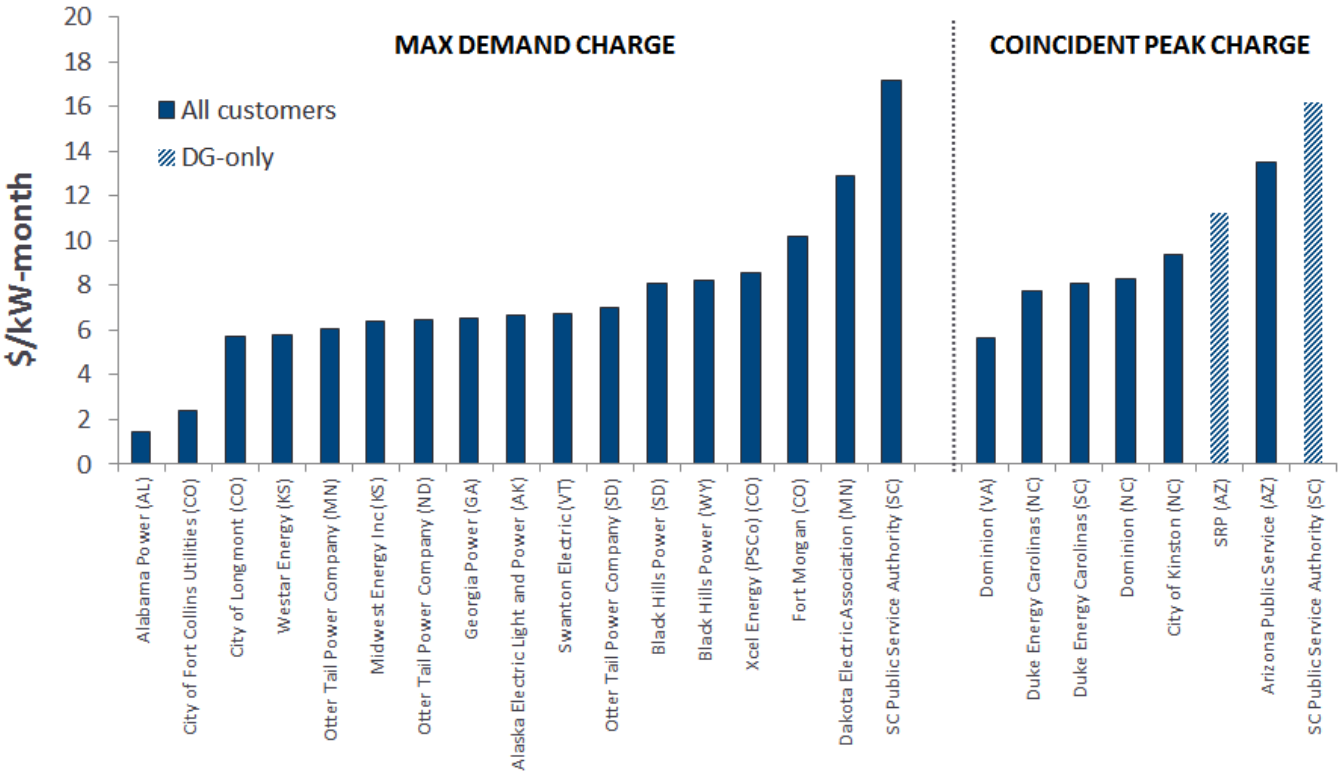
All grid capacity costs and some generation capacity costs should be recovered through demand charges

Utilities have begun moving to a three-part rate, i.e., a monthly service charge, a demand charge and a time-varying energy charge

- Time-variation in energy rates does not eliminate the need for demand charges
- Georgia Power has 2,200 C&I customers on real time pricing but these customers still face a demand charge for their use of the grid https://www.georgiapower.com/docs/rates-schedules/marginally-priced/6.20_RTP-DA.pdf
- Facility-based demand charges persist in California even when dynamic pricing rates have been rolled out to commercial and industrial customers

Some utilities offer demand charges today while others are planning to offer them

Summer Demand Charges in Existing Rates



Notes:
1) All rates are drawn from their respective utility tariff sheets, valid as of July 2015.
2) The SRP rate is tiered and varies by season and amount of demand; we show the average summer demand charge for a 10 kW customer for illustrative purposes.
3) The SC Public Service Authority DG rate includes a peak rate of $11.34/kW-mo and an off-peak rate of $4.85/kW-mo. We present the sum for simplicity.

Comments

- 19 utilities offer residential demand charges, 10 of which are IOUs
- 25 unique rate offerings across 14 states
- 2 are only available to DG customers

Fixed costs should be raised to recover the monthly cost of serving customers

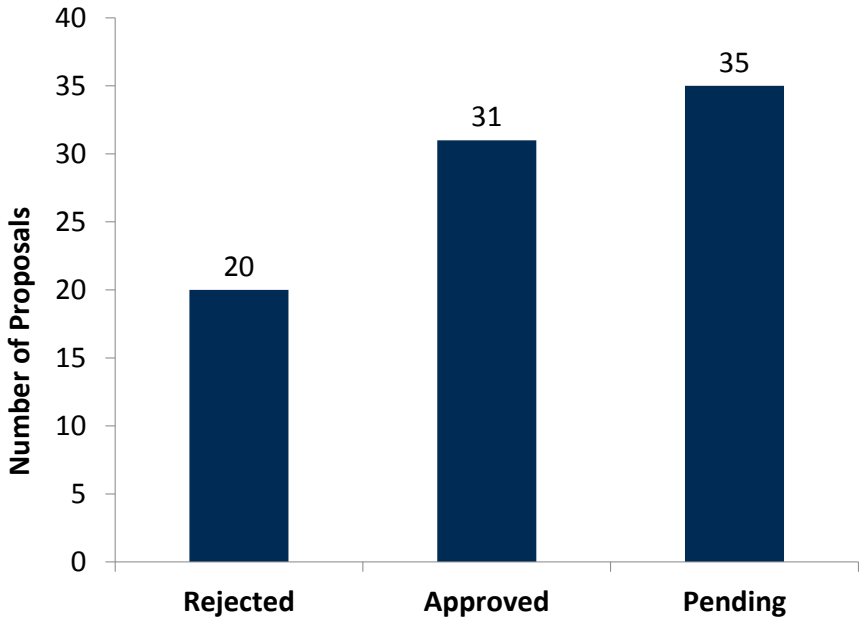
Currently they are set arbitrarily to a number that is often less than $10 a month and is actually zero in some cases

These should be raised to cover the costs of metering, billing, customer service

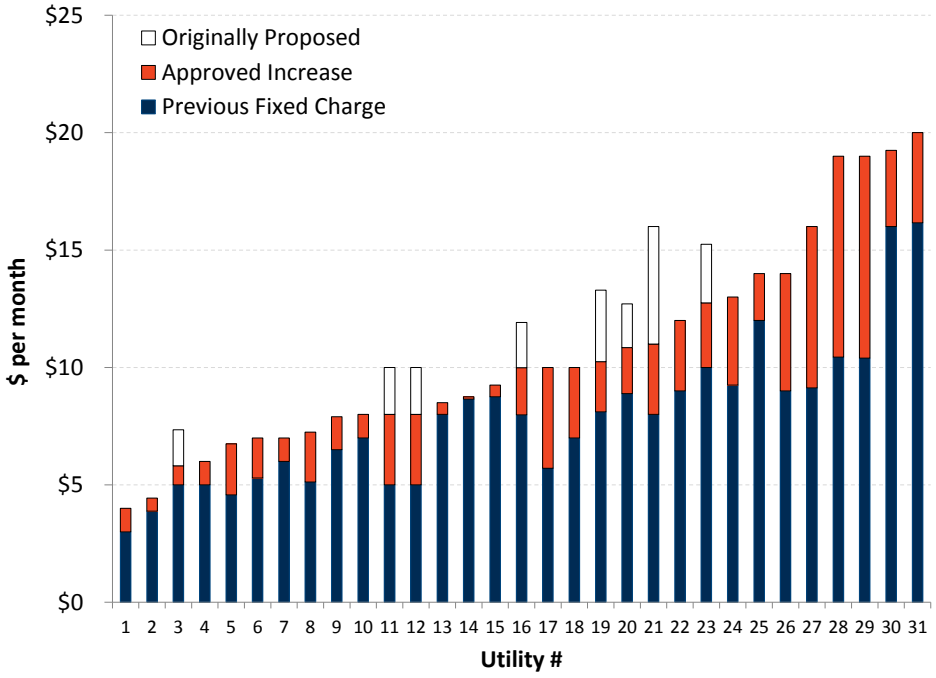
In some cases, it may be appropriate to recover in them the costs of connecting the transformer to the customer's meter

Many utilities have proposed to increase the fixed charge, with varying degrees of success

Recent Proposals to Increase Fixed Charge



Amount of Approved Increase



Data sources: NC Clean Energy, "The 50 States of Solar," Q2 2015. Supplemented with review of additional utility rate filings.

Three-part rates convey a cost-based price signal

Utilities that supply energy would use a five-part rate

- Monthly service charge
- Charge for connected load (or maximum customer demand)
- Maximum demand charge (coincident with the distribution peak)
- Charge for generation capacity
- Time-varying energy charge

Distribution-only utilities would use a three-part rate

- Monthly service charge
- Charge for connected load (or maximum customer demand)
- Maximum demand charge (coincident with the distribution peak)

To summarize, a three-part tariff can address both efficiency and equity concerns

GENERATION

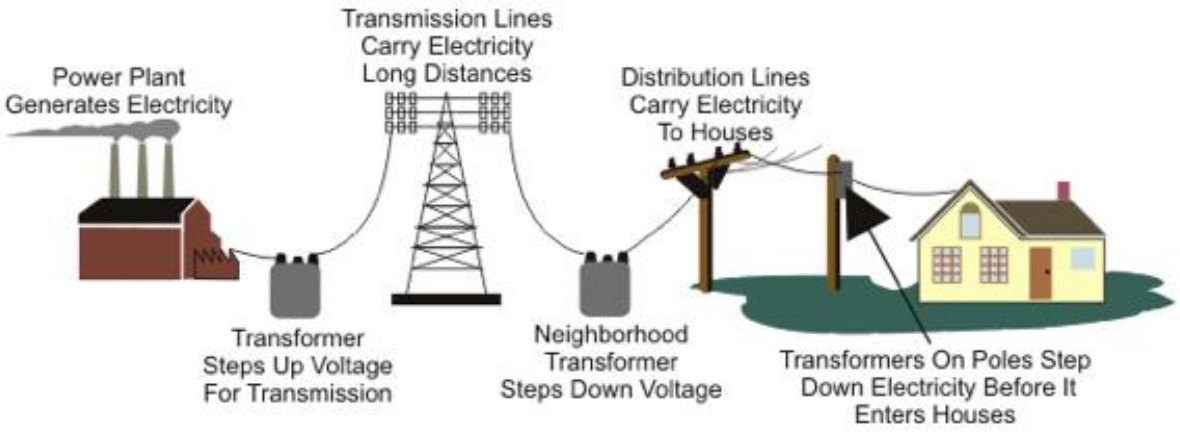
- **Service charge** ($)
- **Charge for generation capacity** ($/kW)
- **Time-varying energy charge** ($/kWh)

TRANSMISSION

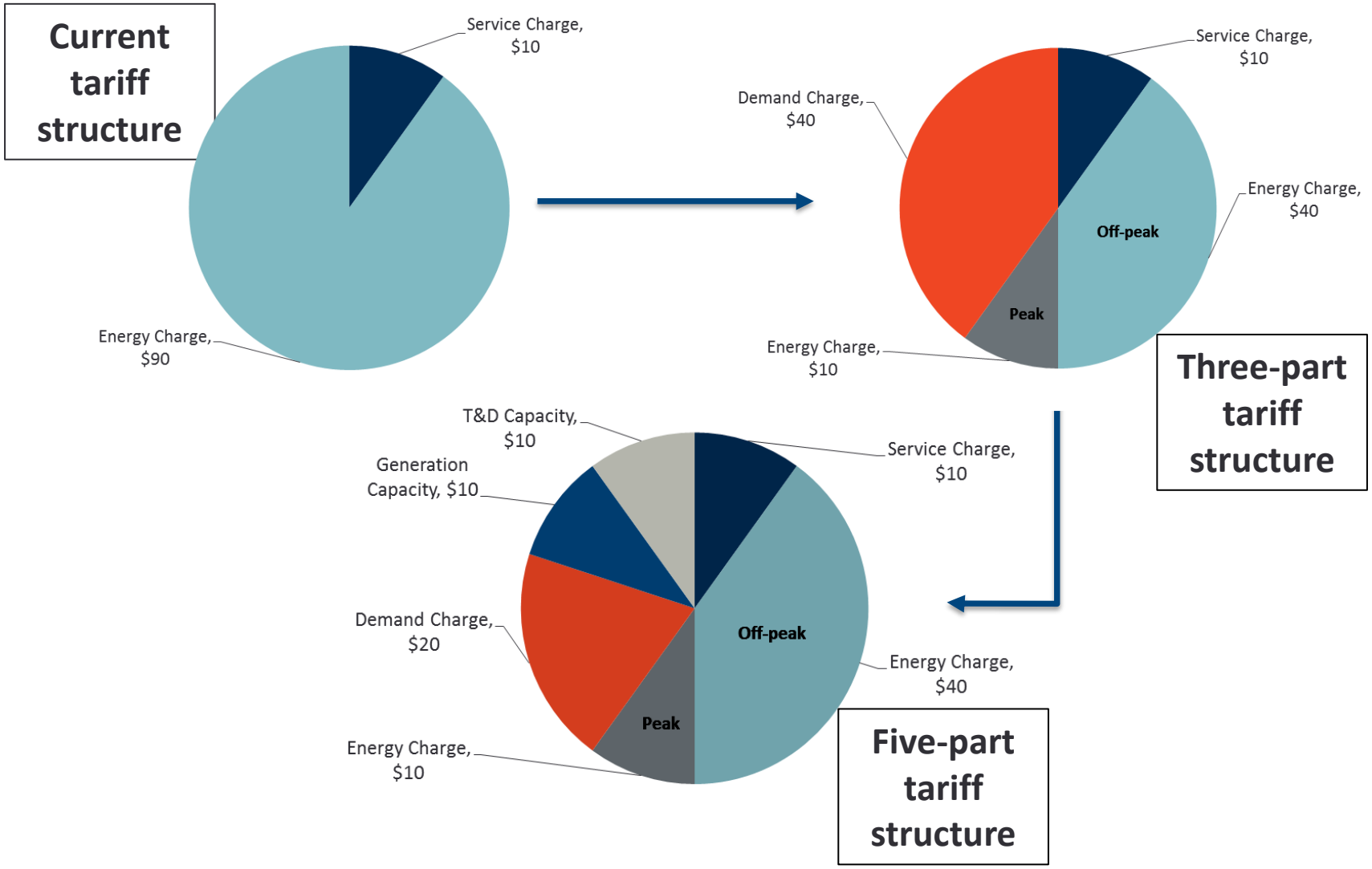
- **Service charge** ($)
- **Charge for connected load** ($/kW)
- **Maximum demand charge** ($/kW)

DISTRIBUTION

- **Service charge** ($)
- **Charge for connected load** ($/kW)
- **Maximum demand charge** ($/kW)



Proposed structure of a $100 customer bill



Conclusions

- We are standing at the cusp of a revolution in rate design, driven by the arrival of the internet of things, the deployment of smart meters and the greening of consumers

- Over the next three to five years, residential rates will begin evolving into three-part rates, featuring fixed charges, demand charges and time-varying energy charges

- When energy-smart customers face cost-based prices, a win-win outcome that emphasizes economic efficiency and restores equity among customers will become increasingly likely

Presenter Information

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Ahmad Faruqui is an economist whose consulting practice is focused on the efficient use of energy. His areas of expertise include rate design, demand response, energy efficiency, distributed energy resources, advanced metering infrastructure, plug-in electric vehicles, energy storage, inter-fuel substitution, combined heat and power, microgrids, and demand forecasting. He has worked for more than a hundred clients on five continents. These include electric and gas utilities, state and federal commissions, independent system operators, government agencies, trade associations, research institutes, and manufacturing companies. Ahmad has testified or appeared before commissions in Alberta (Canada), Arizona, Arkansas, California, Colorado, Connecticut, Delaware, the District of Columbia, FERC, Illinois, Indiana, Kansas, Maryland, Minnesota, Nevada, Ohio, Oklahoma, Ontario (Canada), Pennsylvania, ECRA (Saudi Arabia), and Texas. He has presented to the governments of Australia, Egypt, Ireland, Philippines, Thailand and the United Kingdom and given energy seminars on all six continents. His research on the energy behavior of consumers has been cited in Business Week, The Economist, Forbes, National Geographic, The New York Times, the San Francisco Chronicle, the San Jose Mercury News, the Wall Street Journal and USA Today. He has appeared on Fox Business News, National Public Radio and Voice of America. He is the author, co-author or editor of four books and more than 150 articles, papers and reports on energy matters. His work has appeared in peer-reviewed journals such as Energy Economics, Energy Journal, Energy Efficiency, and the Journal of Regulatory Economics and trade journals such as The Electricity Journal and the Public Utilities Fortnightly. He holds bachelors and masters degrees from the University of Karachi and a doctorate in economics from The University of California at Davis.

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Appendix B: Videos on rate design

- Georgetown University's CSIS. A 90-minute panel session on time-variant pricing. Washington, DC.
  https://www.youtube.com/watch?v=0p6ZHaXszRQ

- NYU School of Law. A day-long a conference on time-variation pricing as part of the REV Proceedings. New York, NY.
  http://www.sallan.org/Sallan_In-the-Media/2015/04/rev_agenda_time_variant_p.php

- Northwestern University's Kellogg Alumni Club. A two hour debate on the merits of dynamic pricing. San Francisco, CA.
  https://vimeo.com/20206833

Appendix C: A history of rate design

Year	Author	Contribution
1882	Thomas Edison	• Electric light was priced to match the competitive price from gas light and not based on the cost of generating electricity
1892	John Hopkinson	• Suggested a two–part tariff with the first part based on usage and the second part based on connected demand
1894	Arthur Wright	• Modified Hopkinson's proposal so that the second part would be based on actual maximum demand
1897	Williams S. Barstow	• Proposed time-of-day pricing at the 1898 meeting of the AEIC, where his ideas were rejected in favor of the Wright system
1946	Ronald Coase	• Proposed a two-part tariff, where the first part was designed to recover fixed costs and the second part was designed to recover fuel and other costs that vary with the amount of kWh sold
1951	Hendrik S. Houthakker	• Argued that implementing a two-period TOU rate is better than a maximum demand tariff because the latter ignores the demand that is coincident with system peak
1961	James C. Bonbright	• Laid out his famous Principles of Public Utility Rates

Back to the future (concluded)

Year	Author	Contribution
1971	William Vickrey	• Fathered the concept of real-time-pricing (RTP) in *Responsive Pricing of Public Utility Services*
1976	California Legislature	• Added a baseline law to the Public Utilities Code in the *Warren-Miller Energy Lifeline Act*
1978	U.S. Congress	• Passed the *Public Utility Regulatory Act (PURPA),* which called on all states to assess the cost-effectiveness of TOU rates
1981	Fred Schweppe	• Described a technology-enabled RTP future in *Homeostatic Control*
2001	California Legislature	• Introduced *AB 1X,* which created the five-tier inclining block rate where the heights of the tiers bore no relationship to costs. By freezing the first two tiers, it ensured that the upper tiers would spiral out of control
2001	California PUC	• Began rapid deployment of California Alternative Rates for Energy (CARE) to assist low-income customers during the energy crisis
2005	U.S. Congress	• Passed the *Energy Policy Act of 2005*, which requires all electric utilities to offer net metering upon request

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