2040: A Pricing Odyssey

PRESENTED TO

EEI SPRING RATES AND REGULATORY AFFAIRS COMMITTEE MEETING

SAN DIEGO, CA

PRESENTED BY

Ahmad Faruqui, Ph.D.
Principal
925-408-0149

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THE Brattle GROUP

Rip Van Winkle, Jr. had spent his entire career seeking to modernize rate designs

He had talked to customers, utilities and regulators, participated in focus groups and designed and evaluated experiments to test customer engagement

He had concluded that modern rate designs would recover energy costs through time-varying rates, recover capacity costs with demand charges, and recover metering, billing and customer care costs with fixed charges.

But he kept running into the same objections in rate case after rate case. Customers won't understand them, customers won't respond to them, they will harm low income customers, they will destroy the solar industry, and they will remove the incentive for energy efficiency.

After a beautiful April day hiking in the high Sierras, Rip slipped into his sleeping bag under the night sky.

He was mesmerized by the Milky Way, began to count the stars, and fell into a deep slumber.

He woke up two decades later. It was the year 2040.

On first glance, the grid looked very much the same. Transmission lines, substations, circuits, feeders, line transformers and meters. So wireless electricity had not been invented.

But on further examination, the grid looked different

It was digitalized, with smart sensors and Wi-Fi capabilities

What was even more different was what was happening in people's homes

All of them had smart meters, every other home had solar panels on the roof and every fifth home had an electric car in the driveway

Many had battery storage in the garage and heat pumps were the norm

Before he dozed off in 2020, modern rate designs had begun to be offered

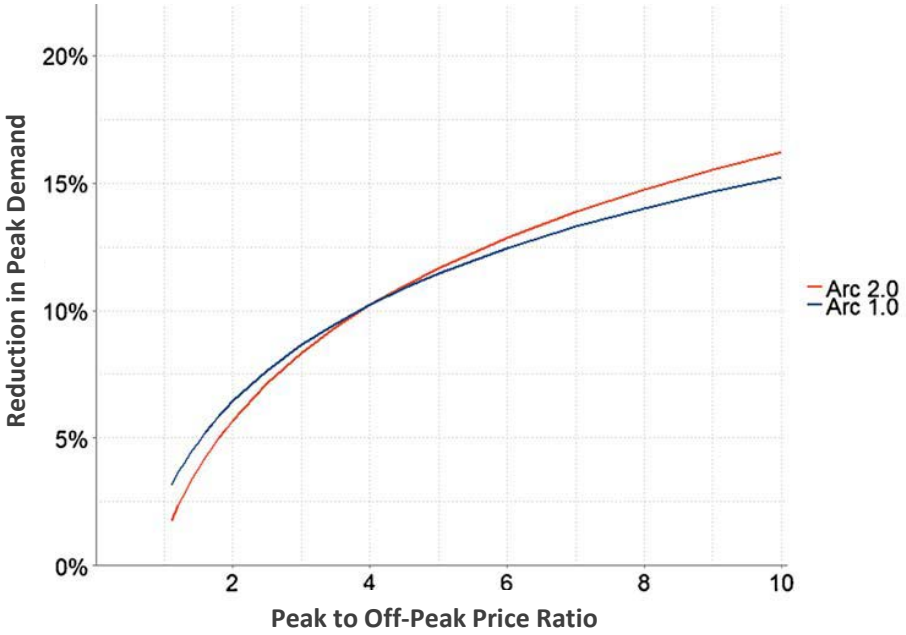
Utility or Location	Type of Rate	Applicability	Participating Customers
Oklahoma Gas & Electric	Variable Peak Pricing (VPP)	Opt-in	20% (130,000)
Maryland (BGE, Pepco, Delmarva)	Dynamic Peak Time Rebate (PTR)	Default	80%
Ontario, Canada	Time-of-Use (TOU)	Default	90% (3.6 million)
Great Britain	Time-of-Use (TOU)	Opt-in	13% (3.5 million)
Hong Kong (CLP Power Limited)	Dynamic Peak Time Rebate (PTR)	Opt-in	27,000
Arizona (APS, SRP)	Time-of-Use (TOU)	Opt-in	57% of APS' residential customers (20% of which are also on a demand charge), 36% of SRP's
California (PG&E, SCE, SDG&E)	Time-of-Use (TOU)	Default (2019)	TBD – 75-90%*
California (SMUD)	Time-of-Use (TOU)	Default	75-90%*
Colorado (Fort Collins)	Time-of-Use (TOU)	Mandatory (for residential)	100%
Illinois (ComEd, Ameren Illinois)	Real Time Pricing (RTP)	Opt-in	50,000
France	Time-of-Use (TOU)	Opt-in	50%
Spain	Real Time Pricing (RTP)	Default	50%
Italy	Time-of-Use (TOU)	Default	75-90%*

*Estimated participation based on historical trends

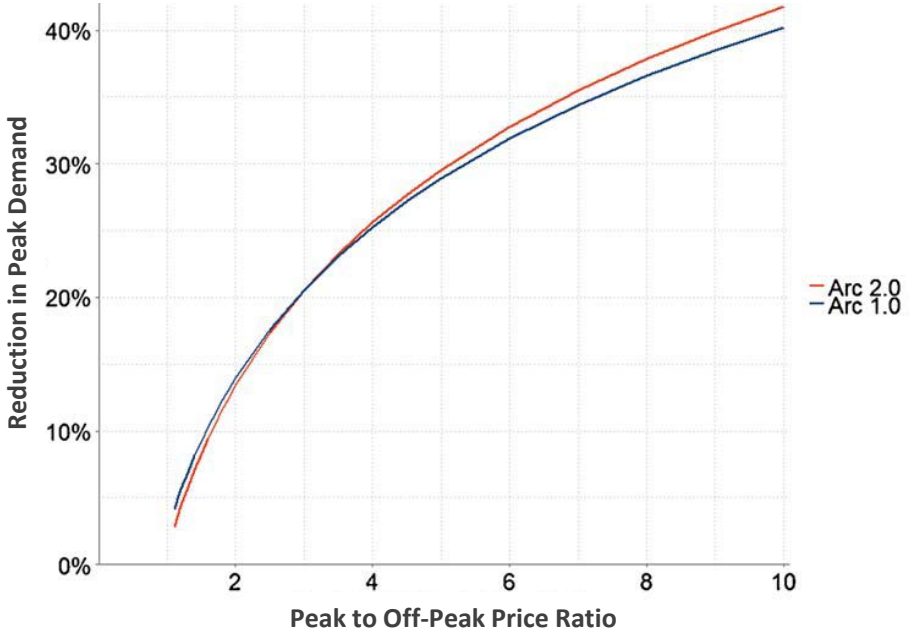
Modern tariffs had begun changing load shapes in a favorable direction

Evidence from more than 300 deployments worldwide showed that when customers face a strong price signal (a higher on-peak price), they reduced peak electricity usage. And if the price signal was accompanied by enabling technology, they reduced their peak electricity usage even more.

Price Responsiveness without Enabling Technology



Price Responsiveness with Enabling Technology



Note: Arcturus 1.0 is a database of 163 experimental pricing treatments from 34 pilots, originally published in 2013. Arcturus 2.0 is a database of 337 treatments from 63 pilots, published in 2017.

In 2040, the grid had gone 100% green in many states

California, Hawaii and New York had led the way, with Colorado, Illinois, Minnesota, and New Mexico right behind them.

The air felt good. He thought that the threat of catastrophic climate change had passed or at least been deferred to the long term future.

Al Gore and Jerry Brown, icons of his era, would have been so happy to see this happy end state.

Then he started to talk to the ISOs

He discovered that the power system now had had to deal with new challenges. Power supply had become very intermittent, as it switched rapidly and unpredictably between wind, solar, hydro, natural gas and nuclear resources.

Electricity prices fluctuated in wholesale markets from second to second, minute to minute.

But the system was fully able to cope with that. The lights stayed on and power bills had become affordable.

Dynamic load flexibility had emerged as the complement to renewable resource intermittency

Wholesale prices were seamlessly flowing directly to the appliances.

Many homeowners, who were interested in lowering their power bills, had programmed their preferences into their smart phones and their Alexa 5.0 devices.

As prices rose, the least important appliance was either turned off or toned down. As prices continued to rise, the next least important appliance was either turned off or toned down. And so on, in a pre-determined loading order of end use loads.

The opposite happened when prices fell

Homeowners did not have to spend time in front of their phone checking hourly prices, as the skeptics had argued.

They simply took advantage of getting a lower bill in return for sacrificing some comfort.

Each home owner was able to make the tradeoff between comfort and bill savings at their own pace.

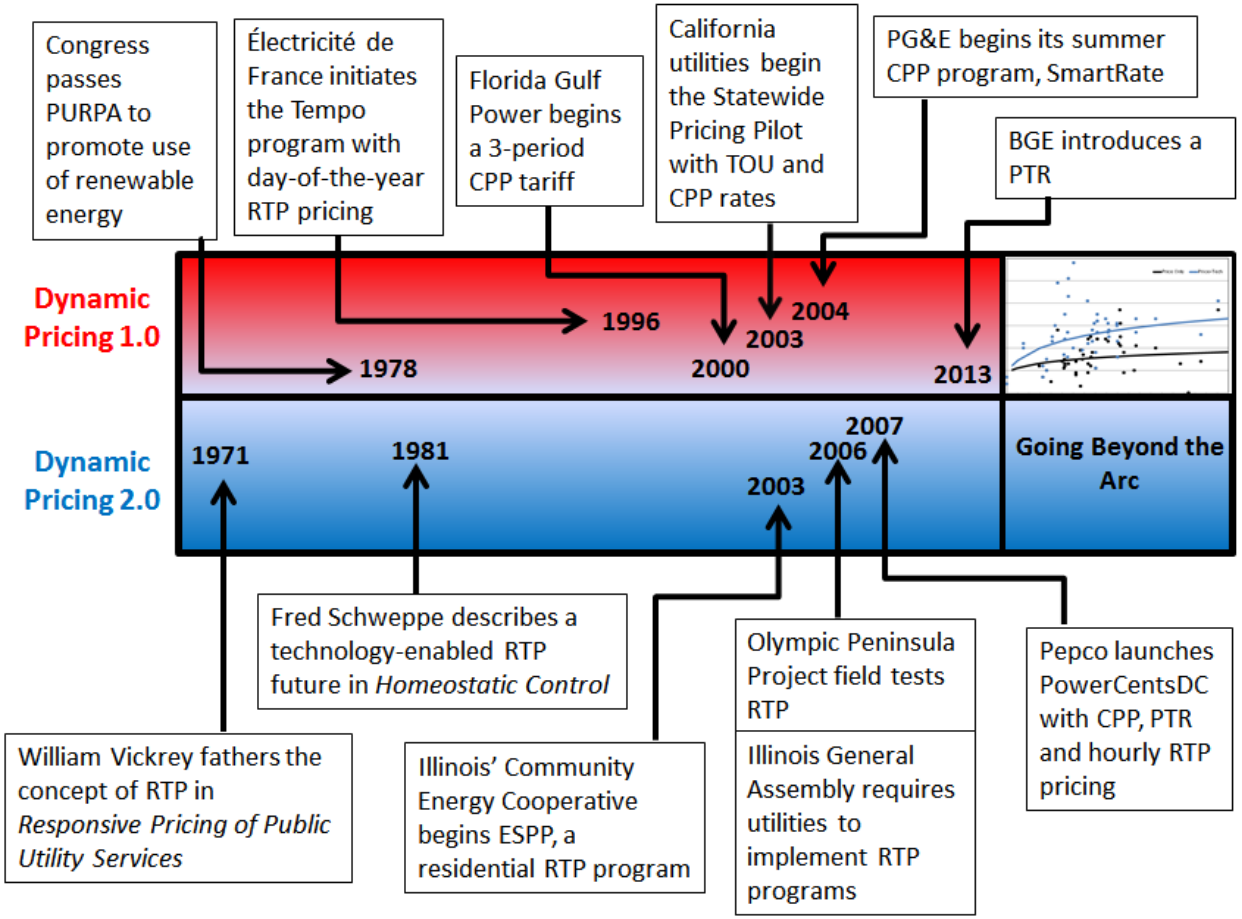
Most home owners bought “baseline” usage on the forward market and “incremental” usage on the spot market

Some hedged it entirely by buying their entire usage on the forward market, essentially having a flat bill.

Rip Van Winkle Jr. concluded that market pricing concepts which were ubiquitous in wholesale markets in 2020 before the onset of his Big Sleep had become ubiquitous in retail markets in 2040.

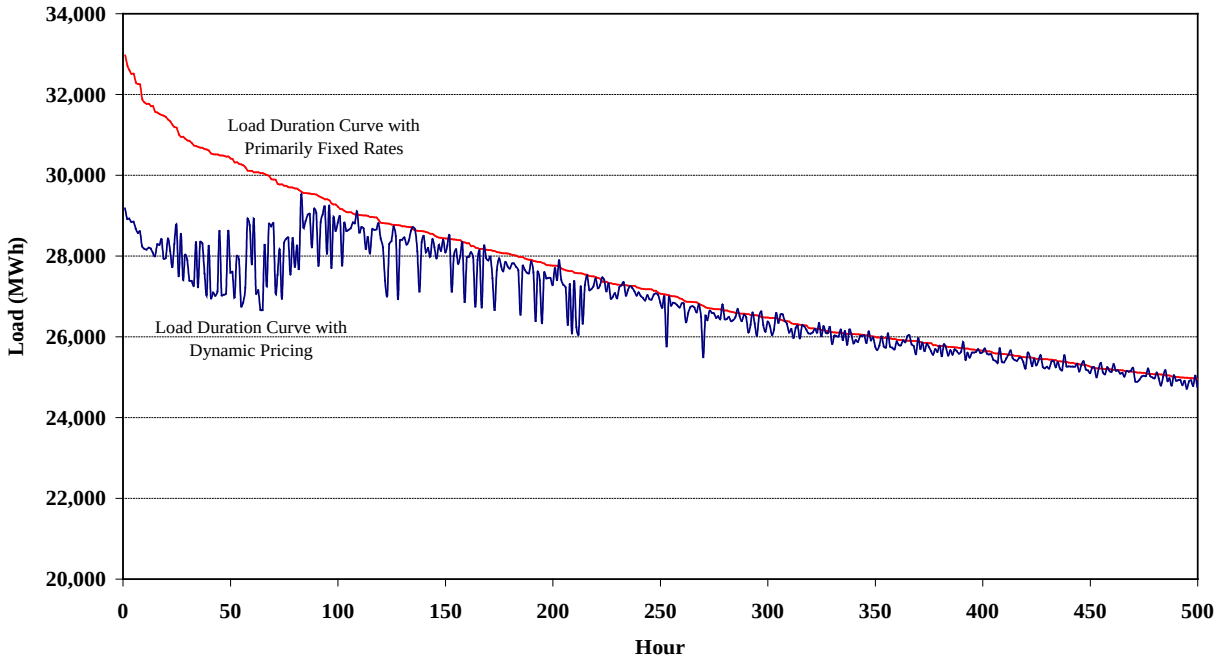
MIT’s Schweppe and EPRI’s Gellings were simply ahead of their time. Their vision had finally come to pass.

Dynamic pricing, begun in the late 1970s, was ubiquitous in 2040



Source: The Brattle Group

Then he recalled a study of real-time pricing that had been carried out in the late 2000's for the Empire State



Source: The Brattle Group

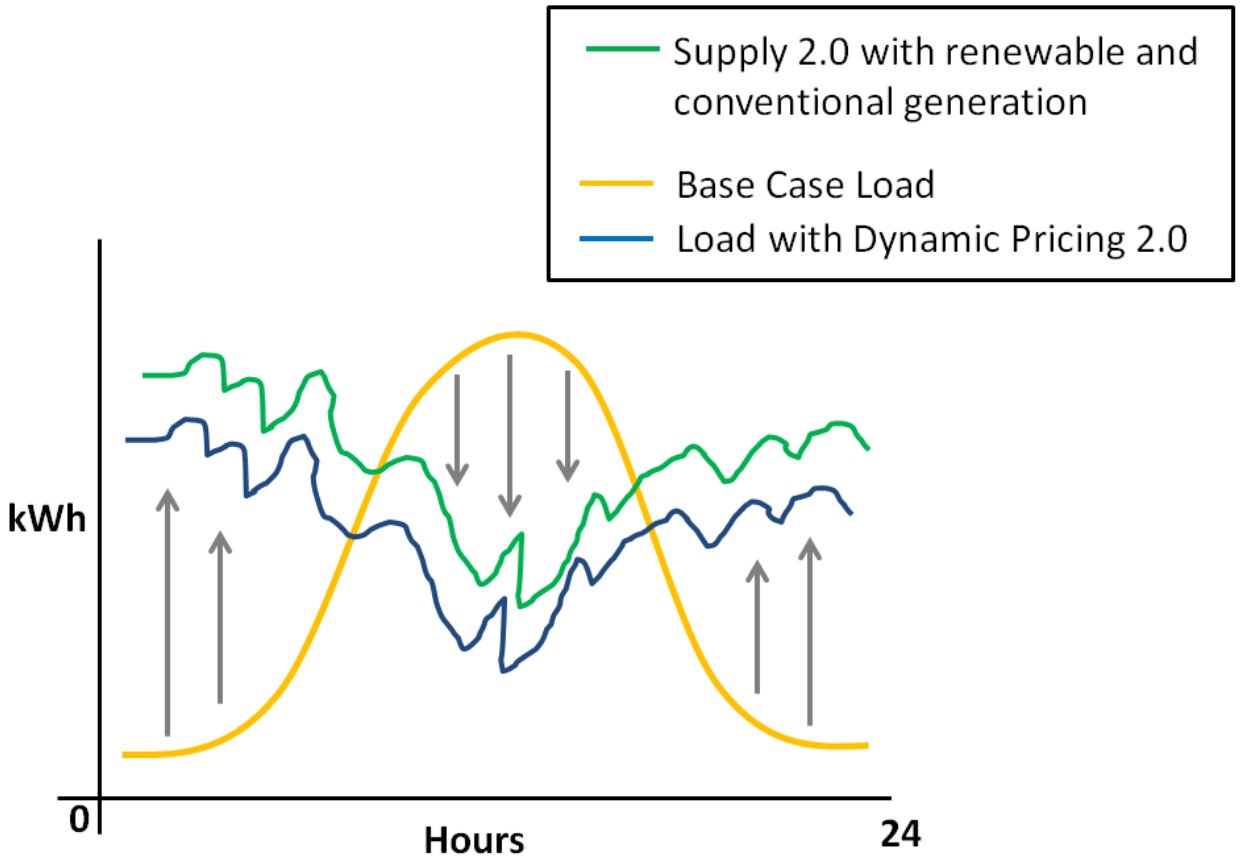
The study found that …

…dynamic pricing created value by avoiding the economic inefficiencies associated with flat rates, thus increasing the sum of consumer surplus and producer surplus.

But at the time New York did not have smart meters or smart technologies in people's homes; neither did it have strong environmental goals

The study had been forgotten

In 2040, dynamic load flexibility was helping balance demand and supply



Source: The Brattle Group

And then he woke up from the Big Sleep – it was still 2020

Regulators and ISO were still having a hard time accepting the case for modernizing retail rate designs.

The Economic Report of the President in 2019 talked about the need to reform wholesale markets but said nothing about retail markets or about rate design reform: NOTHING.

A lot of work needed to be done. He packed up, got into his SUV and drove back to his office in San Francisco.

He turned on the computer, and got to work.

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Presenter Information

AHMAD FARUQUI, PH.D.

Principal | San Francisco, CA

Ahmad.Faruqui@brattle.com

+1.925.408.0149

Ahmad Faruqui is an internationally recognized authority on the design, evaluation and benchmarking of tariffs. He has analyzed the efficacy of tariffs featuring fixed charges, demand charges, time-varying rates, inclining block structures, and guaranteed bills. He has also designed experiments to model the impact of these tariffs and organized focus groups to study customer acceptance. Besides tariffs, his areas of expertise include 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 nearly 150 clients on 5 continents, including electric and gas utilities, state and federal commissions, governments, independent system operators, trade associations, research institutes, and manufacturers.

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, Saudi Arabia, and Texas. He has presented to governments in Australia, Egypt, Ireland, the Philippines, Thailand, New Zealand and the United Kingdom and given seminars on all 6 continents. He has also given lectures at Carnegie Mellon University, Harvard, Northwestern, Stanford, University of California at Berkeley, and University of California at Davis and taught economics at San Jose State, the University of California at Davis, and the University of Karachi.

His research been cited in Business Week, The Economist, Forbes, National Geographic, The New York Times, San Francisco Chronicle, San Jose Mercury News, 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 4 books and more than 150 articles, papers and reports on energy matters. He has published in peer-reviewed journals such as Energy Economics, Energy Journal, Energy Efficiency, Energy Policy, Journal of Regulatory Economics and Utilities Policy and trade journals such as The Electricity Journal and the Public Utilities Fortnightly. He is a member of the editorial board of The Electricity Journal. He holds BA and MA degrees from the University of Karachi, both with the highest honors, and an MA in agricultural economics and a PhD in economics from The University of California at Davis, where he was a research fellow.