Moving Ahead with Time-Varying Rates (TVR)

US AND GLOBAL PERSPECTIVES

PRESENTED TO

NARUC Staff Subcommittee on Rate Design

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THE Brattle GROUP

TVRs are deployed to residential customers around the world

	Type of Rate	Applicability	Participating Customers
Oklahoma *(OGE)*	Variable Peak Pricing (VPP)	Opt-in	20% (130,000)
Maryland *(BGE, Pepco, Delmarva)*	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)*	Peak Time Rebate (PTR)	Opt-in	27,000
Arizona *(APS, SRP)*	Time-of-Use (TOU)	Opt-in	APS: 57%, SRP: 36%
California *(PG&E, SCE, SDG&E)*	Time-of-Use (TOU)	Default (2020)	TBD – 75-90%*
California *(SMUD)*	Time-of-Use (TOU)	Default	75-90%*
Colorado *(Fort Collins)*	Time-of-Use (TOU)	Mandatory	100%
Illinois *(ComEd, Ameren IL)*	Real Time Pricing (RTP)	Opt-in	50,000
Michigan *(Consumers Energy)*	Time-of-Use (TOU)	Default (2020)	TBD – 75-90%*
France	Time-of-Use (TOU)	Opt-in	50%
Spain	Real Time Pricing (RTP)	Default	40%
Italy	Time-of-Use (TOU)	Default	75-90%*

*Estimated participation based on historical trends

But there is tremendous room for growth

The deployment of Advanced Metering Infrastructure (AMI) is creating an opportunity to enhance customer engagement by deploying TVRs and harness the load flexibility benefits created by these rates

- As of 2018, almost 87 million smart meters had been deployed to more than 60% of U.S. homes (*)
- Smart meter penetration is expected to increase to 81% of North American homes by 2024 (**)

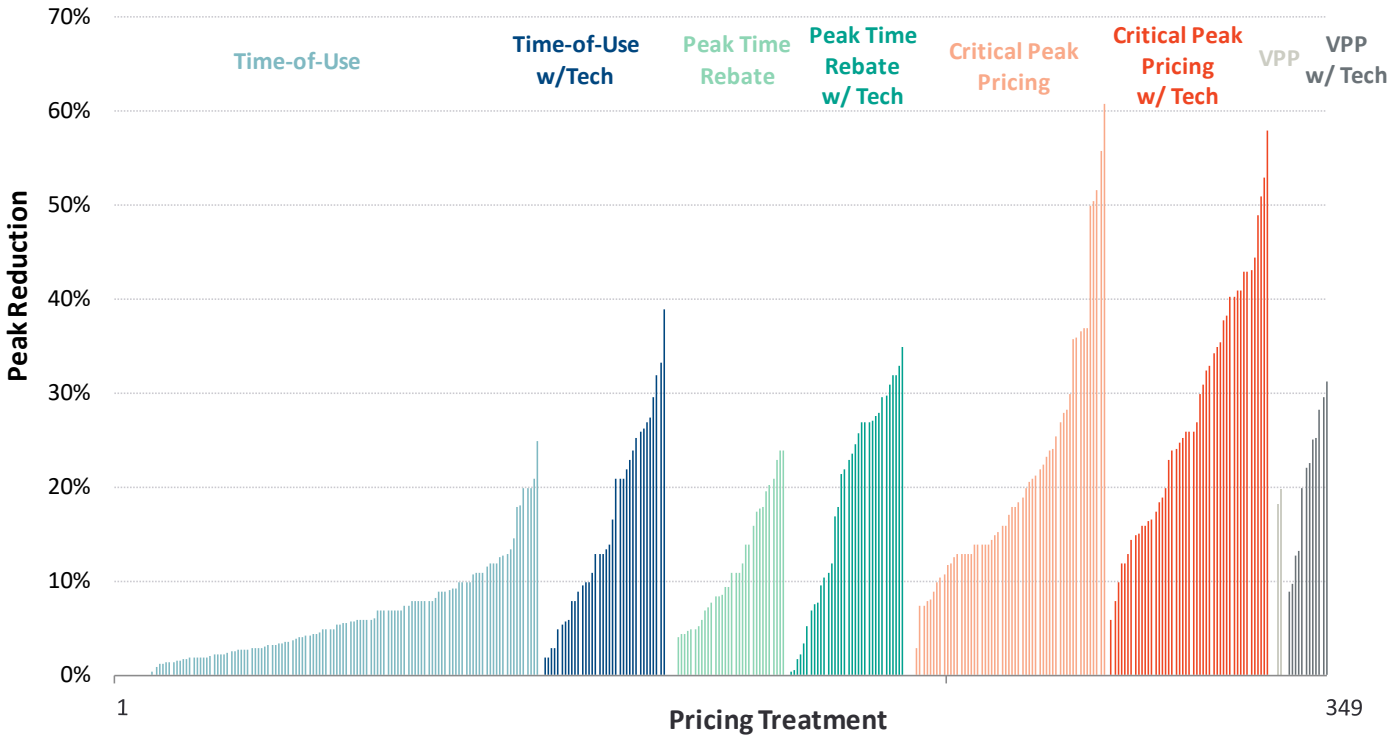
In the US, TVRs are only deployed to 6.5% of U.S. customers so there is a huge opportunity for expansion

By comparison, in Ontario, Canada, TVRs are deployed to all residential and small commercial and industrial customers and 90% are taking service on TVRs

Notes:
(*) EIA, "Nearly half of all U.S. electricity customers have smart meters," December 6, 2017, https://www.eia.gov/todayinenergy/detail.php?id=34012.
(**) Smart Energy, "Smart meter penetration in North America will reach 81% by 2024," July 5, 2019, https://www.smart-energy.com/industry-sectors/smart-meters/smart-meter-penetration-in-north-america-will-reach-81-by-2024/

There is compelling evidence from 300+ pilots throughout the globe that customers respond to TVRs

Pilots feature a combination of rate designs (TOU, CPP, PTR, and VPP), which influence the level of peak reduction



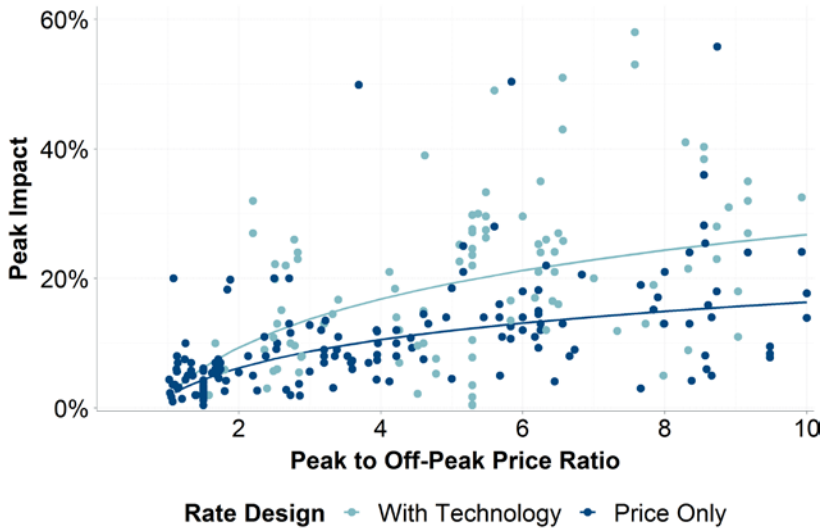
Source: The Brattle Group. Peak reductions represent results from 349 pricing treatments collected in the Arcturus 2.0 database.

The magnitude of demand response varies by the peak to off-peak price ratio

On average, residential customers reduce their on-peak usage by 6.5% for every 10% increase in the peak-to-off-peak price ratio

In the presence of enabling technology such as smart thermostats, the effect is stronger

- On average, customers enrolled on TVRs that offer enabling technologies reduce peak usage by 11% for every 10% increase in the price ratio



Source: Ahmad Faruqui , Sanem Sergici, and Cody Warner, "Arcturus 2.0: International Evidence on Time-Varying Rates," The Electricity Journal, 2017.

US Benchmark
Overview of TVR Offerings

According to 2018 EIA Form-861, **322 U.S. utilities offer at least one form of time-varying rate** to residential customers

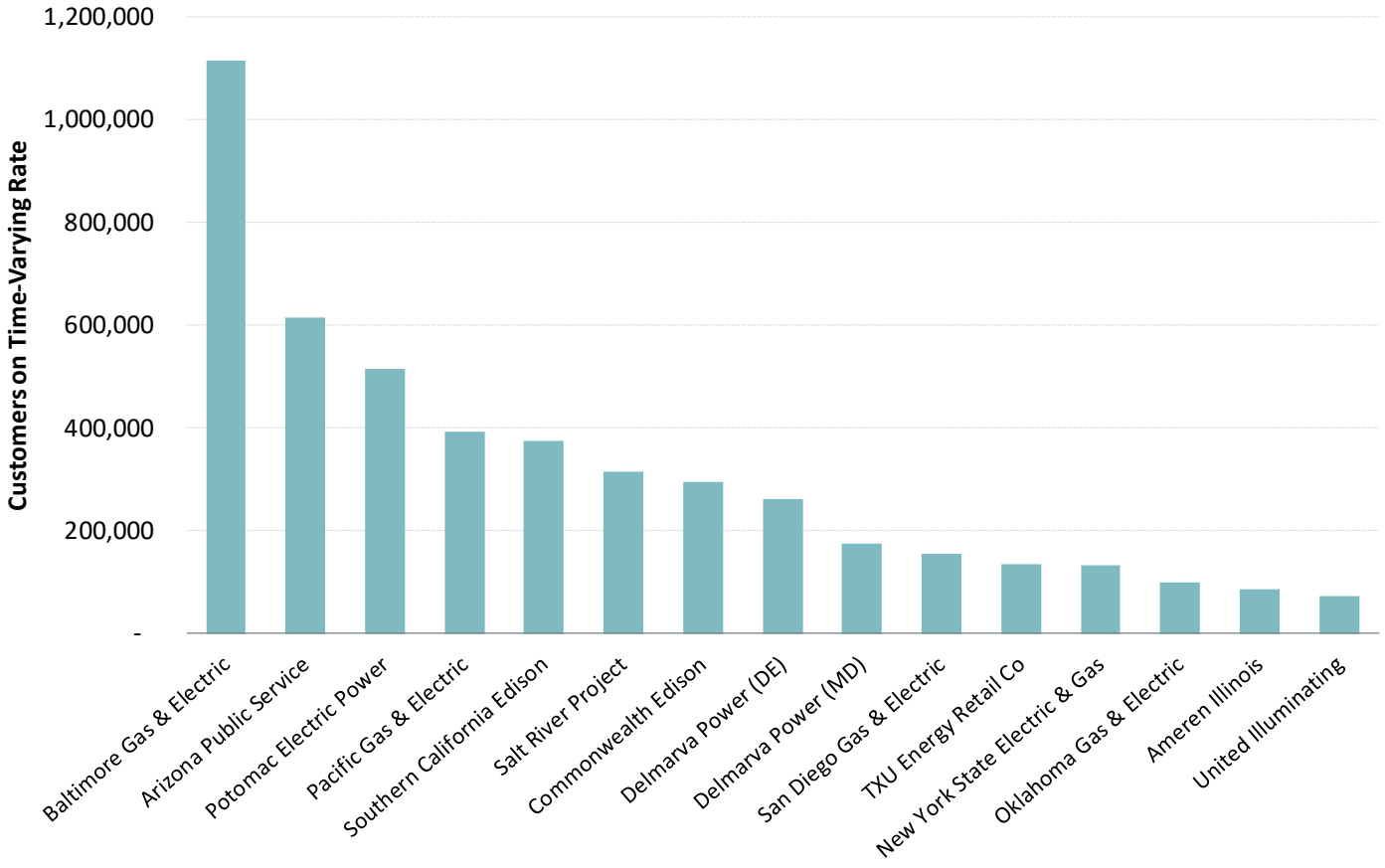
- 303 offer Time-of-Use (TOU)
- 29 offer Critical Peak Pricing (CPP)
- 14 offer Peak Time Rebate (PTR)
- 9 offer Variable Peak Pricing (VPP)
- 6 offer Real-Time Pricing (RTP)

Altogether, **5.5 million customers** (or 4% of all residential customers) are enrolled on one of these time-varying rates

US Benchmark

Largest Time-Varying Deployments

The following **15 utilities accounted for 86% of all customers** enrolled on a time-varying rate



Arizona
Time-of-Use Rates (1/2)

Arizona Public Service (APS) leads all U.S. utilities with the largest number of customers enrolled on an opt-in time-of-use rate

- Over 600,000 customers, or approximately 56% of its 1.1 million residential customers, are on a TOU rate

APS offers five residential rate schedules, of which three are time-of-use rates

- Saver Choice ("R-TOU-E") includes seasonal on-peak and off-peak energy charges, with a ratio of slightly over 2:1 and an on-peak period of 3-8 PM Monday-Friday. There is also a winter-only super off-peak energy charge
- The Saver Choice Plus ("R-2") and Saver Choice Max ("R-3") rates have a smaller peak/off-peak ratio and no super off-peak period, but include a demand charge
- The other two non-TOU rates are restricted to customers with an average usage of less than 1,000 kWh

References:

APS, Service Plans, https://www.aps.com/en/Utility/Regulatory-and-Legal/Rates-Schedules-and-Adjustors

Arizona
Time-of-Use Rates (2/2)

Salt River Project, Arizona's second largest utility, also offers three TOU options

- Roughly 315,000 customers, or 33% of its nearly 1 million residential customers, are enrolled on a TOU rate
- The SRP Time-of-Use Price Plan ("E-26") defines on-peak hours of weekdays 2-8 PM in summer and 5-9 AM and 5-9 PM in winter, with a peak/off-peak ratio of 1.4:1 in winter and 2.9:1 in summer
- SRP's Price Plan for Residential Super Peak Time-of-Use service offers two options, E-21 and E-22, both of which charge higher costs in a three hour week-day time frame
  - The E-21 plan defines an on-peak period of weekdays 3-6 PM, while the E-22 plan's peak period covers weekdays 4-6 PM
  - Both options have an peak/off-peak ratio of 3.5:1 in the summer, 4:1 in the summer peak, and 1.4:1 in the winter
  - Customers receive a 90-day bill protection. If their first three bills are higher than they would have been on the default Basic price plan, they are credited the difference and switched back to the Basic plan

References:

SRP, Time-of-Use Price Plan, https://www.srpnet.com/prices/home/tou.aspx
SRP, EZ-3 Price Plan, https://www.srpnet.com/prices/home/ez3.aspx

California
Time-of-Use Rates (1/3)

Pacific Gas & Electric (PG&E) currently has ~400,000 customers on an opt-in time-varying rate

- Currently, customers can opt into an E-TOU-B option with peak hours from weekdays 4-9 PM, capped at 225,000 customers
- Electric vehicle owners can sign up for rate schedule EV-B, a residential time-of-use service that requires the installation of a separate meter. EV-B charges lowest costs in the 11 PM – 7 AM off-peak period, and higher costs in the peak (2-9 PM) and partial-peak (7 AM-2 PM and 9-11 PM) periods
  - Some customers are on an EV-A option that combines the vehicle's electricity costs with those of the customer's residence, but this rate is now closed to new enrollments

The other two California investor-owned utilities, Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E), have approximately 370,000 and 155,000 customers on opt-in TOU rates respectively

- Almost 99% of customers that were moved to either SCE or SDG&E's TOU pilots chose to stay on a TOU plan

References: PG&E, Tariffs, https://www.pge.com/tariffs/index.page

California
Time-of-Use Rates (2/3)

All three California investor-owned-utilities are planning the deployment of default time-of-use rates

- SDG&E is beginning its rollout in March 2020, offering two TOU plans with a 4-9 PM peak period and a 2.1:1 peak/off-peak period, as well as an additional super off-peak period from 12-6 AM
- PG&E and SCE will transition customers in October 2020

The CPUC has ordered two customer guarantees as part of the rollout

- Customers will be provide an estimate of how their TOU bill compares with what their bill would have been on their old rate so they can see if they saved money or not
- A 12-month bill guarantee, such that customers whose first-year bill under the new TOU rate is higher than it would have been under their old rate will be credited the difference

References:

Utility Dive, California utilities prep nation's biggest time-of-use rate rollout, https://www.utilitydive.com/news/california-utilities-prep-nations-biggest-time-of-use-rate-roll-out/543402/

California
Time-of-Use Rates (3/3)

Sacramento Municipal Utility District (SMUD), one of the largest U.S. municipalities, already transitioned in 2019 to default TOU rates for its 600,000 residential customers

- The TOU rate has a peak period of 5-8 PM year-round
  - Summer rates, which are higher than in non-summer, feature a peak rate of $0.2941/kWh, an off-peak rate of $0.1209, and an additional mid-peak rate (for noon-5 PM and 8 PM-midnight) of $0.1671/kWh
- Customers without rooftop solar can opt out and elect the Fixed Rate, which charges three different flat volumetric prices based on three different periods of the year
  - SMUD estimates the Fixed Rate is approximately 4% higher than the TOU rate

Before filing for TOU, SMUD conducted a successful pilot program in 2012 and 2013 testing TOU, CPP, and TOU/CPP rates

- The pilot found significant load shifting, customer preference for TOU over CPP, and ~50% higher average reductions with opt-in versus opt-out (which had 90% retention)

References:

SMUD, Time-of-Day Rates, https://www.smud.org/en/Rate-Information/Time-of-Day-rates/Time-of-Day-5-8pm-Rate

SMUD, SmartPricing Options Final Evaluation, https://www.smud.org/-/media/Documents/Corporate/About-Us/Energy-Research-and-Development/research-SmartPricing-options-final-evaluation.ashx

Michigan
Time-of-Use Rates

In the summer of 2019, Consumers Energy rolled out a TOU "Summer Peak Rate" to approximately 3% of its 1.6 million customers, selecting communities that were representative of its service territory

- From June-September, the Summer Peak Rates charges a on-peak rate from weekdays 2-7 PM that is about 1.5 times higher than the off-peak rate
- The off-peak rate is the regular rate from October-May

On June 1, 2020, all residential customers will be defaulted to the TOU plan

- The rollout is part of Consumers' "Clean Energy Plan", which commits to 90% clean energy by 2040
- As part of the default TOU rollout, Consumers will deploy a bill impact tool in March 2020 so customers can see how their bill would differ under the new rate

References:

Consumers Energy, Summer Peak Rate, https://www.consumersenergy.com/residential/rates/electric-rates-and-programs/summer-time-of-use-rate

Maryland
Peak Time Rebate Programs

Baltimore Gas & Electric (BGE), Potomac Electric Power Co (Pepco), and Delmarva Power offer *opt-out* peak-time rebate programs that reward customers with $1.25/kWh bill credits for reducing energy usage during a handful of summer peak demand events

- Customers receive an alert, usually *the day before the savings event*, and can choose whether or not to participate in a particular event by reducing their use
- Energy and peak demand reductions are bid directly into the PJM wholesale market

All three utilities offer the program on an opt-out basis, resulting in the enrollment of nearly all customers with smart meters

- According to EIA Form-861, 1.1 million (96%) of BGE customers, 516,000 (98%) of Pepco customers, and 175,000 (98%) of Delmarva customers are enrolled
- In 2018, BGE reported a 76% participation rate among its 1.1 million eligible customers, with an average bill credit of $6.30. BGE's Energy Savings Days program is currently largest-scale deployment of dynamic pricing by any U.S. utility

References:

BGE, Energy Savings Days, https://www.bge.com/WaysToSave/ForYourHome/Pages/EnergySavingsDays.aspx
Pepco, Peak Energy Savings Credit, https://www.pepco.com/WaysToSave/ForYourHome/Pages/MD/AboutPeakEnergySavingsCredit.aspx
Delmarva, Peak Energy Savings Credit, https://www.delmarva.com/WaysToSave/ForYourHome/Pages/DE/PeakEnergySavingsCredit.aspx

Illinois
Peak Time Rebate Programs

Commonwealth Edison (ComEd) fully deployed smart meters to its 4 million customers between 2013-2019, finishing three years ahead of schedule

All customers with smart meters are eligible for the Peak Time Savings Program, with approximately 275,000 customers enrolled in summer 2018

- Customers earn a credit of $1 for every kWh saved relative to their expected usage, where a weather-normalized expected usage is calculated based on usage history. ComEd estimates that most customers will receive a $1-$12 bill credit for each event
- Customers are notified *on the day of the event*, as early as 9 AM up to 30 minutes before the event. Historically, ComEd has announced between 3 to 5 events during each summer season, with each event lasting a few hours between 11 AM – 7 PM
- Customers may not participate simultaneously in ComEd's Central AC Cycling program

References:

ComEd, Peak Time Savings, https://www.comed.com/WaysToSave/ForYourHome/Pages/PeakTimeSavings.aspx
ComEd, Peak Time Savings Program Annual Report, https://www.icc.illinois.gov/docket/files.aspx?no=P2012-0484&docId=290476

Illinois
Real-Time Pricing (1/2)

ComEd also offers its residential customers an Hourly Pricing Program

- Under ComEd's Hourly Pricing program, prices vary hourly according to wholesale market prices. Customers can access online energy-management tools and view their hourly usage from the prior day
- In 2018, the 30,251 Hourly Pricing participants saved an average of 10% (~$75) compared to ComEd's standard fixed-price rate
- An analysis by Citizens Utility Board and EDF found 97% of ComEd customers would have seen lower bills on RTP without changing behavior. The average customer would have saved $86.63 (13.2%) per year

	All Customers		Top 5% of Savers		Bottom 5% of Savers	
Rate	Amount	% of Bill	Amount	% of Bill	Amount	% of Bill
Average Annual Savings	$86.63	13.2%	$103.76	31.0%	$0.62	0.0%
Median Savings	$69.78	12.6%	$68.42	28.8%	$0.77	0.3%
Total Annual Savings	$29.8 m	-	$3.95 m	-	$10,121	-

References:
ComEd, Hourly Pricing Program 2018 Annual Report, https://www.icc.illinois.gov/docket/files.aspx?no=15-0602&docId=285594
"The Costs and Benefits of Real-Time Pricing," CUB; EDF, November 14, 2017, https://citizensutilityboard.org/wp-content/uploads/2017/11/20171114_FinalRealTimePricingWhitepaper.pdf

Illinois
Real-Time Pricing (2/2)

Ameren offers an equivalent Power Smart Pricing Program

- In 2018, 79% of the Power Smart Pricing's 13,339 active participants saw savings compared to what they would have paid under Ameren's standard fixed-price rate. Customers saved an average of 8% ($58)

Both programs are mandated by Illinois' Public Utilities Act, and overseen by the Illinois Commerce Commission

References:

Ameren, Power Smart Pricing 2018 Report, https://www.icc.illinois.gov/docket/files.aspx?no=11-0547&docId=285537

Oklahoma
Variable Peak Pricing

OGE rolled out a dynamic pricing rate coupled with a smart thermostat to its residential customers a few years ago

- "Smart Hours" features variable peak pricing, or four levels of peak pricing depending on what day type it happens to be (Low, Standard, High, Critical)
- There are fixed summer and winter peak hours
- Prices during peak hours vary depending on system conditions, and are communicated by 5:00 pm the previous day. Critical periods can be communicated with as little as two hours notice
- The expectation is that there would be 10 Low price days, 30 Standard price days, 36 High price days, and 10 Critical price days in a typical year.
- Is also offered to Small GS customers whose annual demand is less than 10 kW or less than 400 kW with a load factor of less than 25%

Some 130,000 customers out of 650,000 (20%) are on that rate today; they control their thermostat setting, not OGE

- Average peak load has dropped by ~40%
- Average bill savings amount to ~20% of the customer's bill

References:
Oklahoma Gas & Electric, SmartHours, https://www.oge.com/wps/portal/oge/save-energy/smarthours/faq/

New York
Time-of-Use Rates

Consolidated Edison (Con Edison), which serves 3.4 million customers in New York City's five boroughs and Westchester County, employs a standard Residential delivery rate consisting of a fixed charge and a variable charge

- For June through September, the variable charge is a two-tiered inclining block rate, while it is a flat volumetric charge in all other months

Con Edison also offers a voluntary TOU rate with a peak period of 8 AM to midnight

- The TOU rate's delivery rates reflect a 14.2:1 peak/off-peak ratio from June through September and a 5.2:1 ratio in all other months
  - The rate also has a year-round monthly customer charge of $20.46
- Summer super-peak pricing is in effect 2-6 PM on weekdays, but does not apply to customers who purchase their electricity from energy service companies

References:

Con Edison, Current Electricity Tariffs, https://www.coned.com/_external/cerates/documents/elecPSC10/electric-tariff.pdf
Con Edison, Time-of-Use Rates, https://www.coned.com/en/save-money/energy-saving-programs/time-of-use

New York
Time-Varying Demand Charges

Con Edison is also conducting a three-year Smart Energy Plan pilot program with time-varying demand charges for distribution service

- During the peak period (noon to 8 PM weekdays), the demand charge is $19.66/kW in the summer and $15.13/kW in the winter, compared to $7.64/kW in the year-round off-peak period
- Around 15,000 customers were initially recruited into the program, using both opt-in and opt-out enrollment, with the option to opt out of the program at any time
  - Con Edison's AMI rollout is ongoing and expected to be completed by the end of 2022. Pilot participants were selected from regions with high AMI penetration.
  - Customers that have smart meters but were not recruited for the pilot can currently still enroll on a "walk-in" basis
- Con Edison is also testing another demand rate with a peak period of 2-10 PM weekdays and a slight difference in prices

References:

Con Edison, Introducing the Smart Energy Plan, https://www.coned.com/en/accounts-billing/smart-energy-plan

Con Edison, Innovative Pricing Pilot Filing, https://www.coned.com/_external/cerates/documents/elec/pending/innovative-pricing-pilot-filing.pdf

Lessons earned from TVR deployments (1/2)

Utilities have long deployed time-varying rates, some more successfully than others. Following are key lessons learned during the past two decades of deployment

1	**Designing the rates**	• Rates should be cost-reflective to promote economic efficiency and equity. However, they should also be **customer focused** • Unless new rates have **savings opportunities**, customers will either not join or not alter their usage habits to respond. Savings opportunities can be maximized by discounting off-peak prices substantially compared to the existing rate
2	**Marketing the rates**	• Most utilities offer time-varying rates but only a handful of customers are on them. Often, customers don't even know the rates exist due to limited **customer outreach** and **advertising** on traditional and social media • Customers who know the rates exist have questions, but customer service staff are untrained to answer them while information on websites is poorly presented and couched in utility-speak that eludes customers • This can be remedied by studying customer service practices of utilities like APS and OGE, which have large numbers of customers on time-varying rates • Utilities can also conduct **focus groups** with customers to get insights on which design features appeal to customers and which ones turn them off. For further insights, **conjoint analysis** can be carried out with data gathered via online customer surveys

Lessons learned from TVR deployments (2/2)

3	**Inclusion of enabling technologies**	• Customer responses to time-varying rates can be facilitated and often magnified by including new **digital thermostats** rapidly being acquired by customers. For example, OGE has successfully used smart thermostats to boost response and take the pain out of demand management • Other enabling technologies include **digitally-enabled appliances** and **home-energy controllers**
4	**Inclusion of behavioral messaging**	• Research has shown that **behavioral messaging** or **social norming** can boost response • This can be done through mailers, emails and text messages, which inform customers of how their change in usage compares with the response of peers on the same rate
5	**Transitioning to new rates**	• Many rollouts are abruptly handled, such that customers are not prepared for the arrival of the new rates, and customer service staff are not trained to answer customer questions • This can be avoided through **proper planning**

References: See Faruqui, Ahmad and Dr. Stephen S. George, "Demise of PSE's TOU program imparts lessons," *EL&P* (Jan. 2003), https://www.power-grid.com/2003/01/01/demise-of-pses-tou-program-imparts-lessons/

Appendix A
Global Survey

Utilities across the globe are also experimenting with multiple pricing options

Since 2014, Spain has offered real-time pricing as the regulated default rate for residential customers, with approximately 40% of customers currently enrolled

In Italy, TOU rates have been mandatory since 2010 for all low-voltage residential customers

- A 1.5 year transitional phase included limited variation between the peak and off-peak prices, before expanding to a larger price difference for the final tariff

In the United Kingdom, Green Energy UK offers a time-varying TIDE tariff, while in 2018 Octopus Energy tested the first half-hourly TOU tariff and found that customers shifted usage out of peak periods by 28%

References:

REE, Voluntary price for the smaller consumer, https://www.ree.es/en/activities/operation-of-the-electricity-systemvoluntary-price-small-consumer-pvpc

Maggiore et. al., Evaluation of the effects of a tariff change on the Italian residential customers subject to a mandatory time-of-use tariff, https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2013/7-monitoring-and-evaluation/evaluation-of-the-effects-of-a-tariff-change-on-the-italian-residential-customers-subject-to-a-mandatory-time-of-use-tariff/

Octopus Energy, Agile Octopus: paving the way to a low carbon future, https://octopus.energy/static/consumer/documents/agile-report.pdf

Green Energy UK, A new and better way to control home energy bills, https://www.greenenergyuk.com/PressRelease.aspx?PRESS_RELEASE_ID=76

British Columbia, Canada
Time-of-Use Pilots

BC Hydro, which serves approximately 95% of British Columbia's 4.63 million residents, conducted a pilot from 2006-2008 testing TOU and TOU/CPP rates for approximately 2,000 opt-in customers

- BC Hydro's residential energy charge currently includes an inclining block structure, but at the time was simply a flat rate
- To avoid adverse selection, BC Hydro randomly assigned participants into either a control group, or a treatment group facing five different TOU rate schedules
  - The control group were billed on the regular residential rate, as was the treatment group during summer months. In winter, the TOU rates had peak/off-peak price ratios of 3-6, while the CPP/TOU rate had a peak/off-peak ratio of 7.9 for CPP and 3 for TOU
- At the time, BC Hydro staff found that over the pilot's first winter, the treatment group's peak kWh was 9.6% less than the control group's peak kWh, and that the availability of an in-home display (IHD) did not have a discernible effect
  - However, a more recent regression analysis based on the pilot's second winter of operation estimated that IHD would approximately double TOU reductions of 2.2%-4.4% without IHD, and critical peak reductions of 4.8%-5.3% without IHD

References:

Woo, C.K., J. Zarnikau, A. Shiu, R. Li, "Winter Residential Optional Dynamic Pricing: British Columbia, Canada", *The Energy Journal* 38:5 (2017)

Ontario, Canada
Time-of-Use Rates (1/2)

The Ontario Energy Board mandated the installation of smart meters for all customers to promote a culture of conservation. The C$ 2 billion rollout of 4.7 million smart meters was complete by 2014

Alongside smart meters, Ontario introduced default TOU rates in 2011-12 for residential and small commercial customers

- Some 90% of Ontario's 4 million residential customers have been buying their energy through a regulated supply option, which features a three-period TOU rate
- The TOU rates only apply to the energy portion of the customer's bill
- Off-peak, mid-peak, and on-peak prices are defined by season
- A small number of customers without smart meters are on Tiered Pricing rates with seasonally differentiated tiers and prices
- Large commercial and industrial customers pay wholesale prices

References:
Ontario Energy Board, Electricity Rates, https://www.oeb.ca/rates-and-your-bill/electricity-rates

Ontario, Canada
Time-of-Use Rates (2/2)

A Brattle analysis of the TOU rates from their inception in 2009 through 2014 found that for the province as a whole, TOU reduced usage during the summer peak by 3.3% in the pre-2012 period, 2.3% in 2012, 2.0% in 2013 and 1.2% in 2014

- Local distribution companies (LDCs) gradually adopted TOU rates beginning in 2009, and were all on TOU by 2012
- Load shifting impacts were lower in winter, which similar to the summer impacts decreased over successive years of the study
  - The peak/off-peak price ratio for all of LDCs throughout the analysis period was approximately 1.5
- No evidence of electricity conservation was observed

References:

Lessem, N., A. Faruqui, S. Sergici, and D. Mountain, "The Impact of Time-of-Use Rates in Ontario," *Public Utilities Fortnightly* (Feb. 2017)

Quebec, Canada
Dynamic Pricing (1/2)

From December 2008 to March 2010, Hydro-Québec (HQ) conducted a "Time it Right" pilot with 2,200 households in four cities

- The pilot tested two rate designs, Réso (TOU) and Réso+ (TOU/CPP), summarized below

	Réso				Réso+			
	Winter		Summer		Winter		Summer	
(CAD c/kWh)	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
First 15 kWh per day	6.57	4.34	6.15	4.65	6.15	3.60	6.15	4.65
Additional kWh	8.63	6.40	8.19	6.69	8.19	5.63	8.19	6.69
Critical peak usage	-	-	-	-	18.19	-	-	-

Notes: Winter is defined as December through March, and summer as April through November. Peak hours are from 6 AM – 10 PM under Réso, and 7-11 AM and 5-9 PM under Réso +. The default fixed charge of 40.46 c/day applied under both experimental rates.

  - Under Réso, usage reductions in the peak period were not statistically significant
  - Under Réso+, 28 critical days were called, with a statistically significant average reduction of approximately 6% (0.27 kW) in critical peak events over the two winters
- ~88% of participants stayed on the experimental rates through the end of the pilot

References:

Hydro-Quebec, Rapport final du Projet Tarifaire Heure Juste, http://www.regie-energie.qc.ca/audiences/3740-10/Demande3740-10/B-1_HQD-12Doc6_3740_02aout10.pdf

Quebec, Canada
Dynamic Pricing (2/2)

In April 2019, Hydro-Québec began gradually rolling out opt-in residential PTR and CPP rate offerings for a limited number of customers

- Randomly selected customers were invited to sign up for one of the two dynamic pricing rates, with sign ups reaching the maximum limit for winter 2019-2020
- The *Winter Credit Option* offers a 50 c/kWh peak time rebate for reducing electricity during winter peak demand events
  - The fixed charge and two-tiered variable charge for all other hours are the same as under the default residential rate, which charges 4.28 c/kWh for energy consumed up to 40 kWh a day, and 7.36 c/kWh for all other usage
- The *Rate Flex D* rate charges a higher rate of 50 c/kWh for energy consumed during winter peak demand events
  - In summer, the fixed charge and two-tiered variable charge for all other hours are the same as under the default residential rate, while in winter, the variable charge includes savings of 22%-30% depending on the tier
- There may be 25-33 events per winter, at most, for a maximum of 100 hours in all

References:
Hydro-Québec, Dynamic pricing, http://www.hydroquebec.com/residential/customer-space/rates/dynamic-pricing.html
Hydro-Québec, Electricity Rates effective April 1, 2019, http://www.hydroquebec.com/data/documents-donnees/pdf/electricity-rates.pdf

Australia
Time-of-Use Rates

SA Power Networks (SAPN), which serves around 1.7 million customers in South Australia, has recently proposed offering default TOU rates for residential customers with interval meters starting in July 2020

- Around 20% of residential and small business customers currently have interval meters, with that number expected to grow to 50% by 2025
- These rates will include a "solar sponge" component with a super off-peak period of 10 AM – 3 PM when solar exports are high, an off-peak period of 1-6 AM, and a peak period consisting of all other hours
  - In the super off-peak period of 10 AM – 3 PM, the "solar sponge" rate is 25% of the standard rate offered to customers without interval meters, versus prices that are 50% of the standard rate in the off-peak period and 125% in all other hours
- This is designed to respond to a change in the residential daily profile caused by an increase in solar PV adoption, which has caused a pattern of load peaks and troughs and shifted peak demand
  - Over 30% of customers have now installed solar on their rooftops

References:

SAPN, Attachment 17, Tariff Structure Statement Part B – Explanatory Statement, December 2019, https://www.aer.gov.au/system/files/SAPN%20-%20Revised%20Proposal%20-%20Attachment%2017%20-%20Tariff%20Structure%20Statement%20Part%20B%20-%20Explanatory%20Statement%20-%20December%202019_0.pdf

Note that the Australian Energy Regulatory approved these proposed rate structures in a draft decision to be effective in July 2020. However, the final decision is expected in April 2020.

Australia
Three-Part TOU Rates

SAPN is also proposing to offer an optional, three-part "Prosumer" tariff for customers with interval meters

- The monthly demand charge is estimated using average demand over a four-hour period from 5-9 PM for November through March
- The TOU usage rates under the Prosumer tariff will be halved relative to those under the default time-varying rate
- This rate structure accommodates customers who want to discharge energy storage systems during peak periods
- SAPN analysis finds that the standard deviation in customer outcomes (i.e., bill impact) is significantly larger under the Prosumer tariff than with TOU

References:

SAPN, Attachment 17, Tariff Structure Statement Part B – Explanatory Statement, December 2019, https://www.aer.gov.au/system/files/SAPN%20-%20Revised%20Proposal%20-%20Attachment%2017%20-%20Tariff%20Structure%20Statement%20Part%20B%20-%20Explanatory%20Statement%20-%20December%202019_0.pdf

New Zealand
Peak Time Rebate Programs

Vector, the distribution utility that serves Auckland, the most populous city in New Zealand, conducted a PTR pilot program from June – August 2019 with 630 customers

- At the time, Vector served most residential customers on a two-part rate with a flat volumetric charge
- The peak time rebate was applied only to the distribution rate, with a peak to off-peak ratio of 5.4:1
- There were 7 event days with both a morning peak period (7-11 AM) and evening peak period (5-9 PM)
  - Event days were triggered by Vector staff when minimum peak temperature was expected to drop below 9 degrees
- The pilot was carried out jointly with a retailer, Mercury

References:

Confidential The Brattle Group analysis of Vector's winter 2019 pilot

New Zealand
Time-of-Use Rates

In April 2020, Vector Limited expects to restructure its flat distribution charge as a TOU charge for Residential and General Consumer customers

- The TOU rates have a peak period of 7-11 AM and 5-9 PM weekdays, and a peak/off-peak ratio of approximately 2.5:1 for Low User customers and 5:1 for Standard customers
  - The Low User tariff represents a low fixed-charge option to assist low-use customers
- It will be up to the retailers whether to pass through these time-of-use delivery charges to retail customers or to bundle them into some other types of charges.

References and Notes:
Vector Limited, Electricity prices effective from 1 April 2020, https://www.vector.co.nz/personal/electricity/pricing/electricity-prices-2020

Appendix B
A Pocket History of Rate Design

Rate design developments **(1882 - 1961)**

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 kW 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	Published his canon, Principles of Public Utility Rates, that laid out the criteria for creating efficient and equitable rate designs

Rate design developments **(1971 - 2005)**

Year	Author	Contribution
1971	William Vickrey	Proffered 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, creating a two-tiered inclining rate
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 Began to study the role of price-responsive demand and advanced meters in linking retail and wholesale markets to prevent future crises
2005	U.S. Congress	Passed the Energy Policy Act of 2005, which requires all electric utilities to offer net metering upon request

Appendix C
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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.