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Customer Lowered Electricity Price: Advancing the Modern Grid Capabilities Through Rate Design

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Abstract

In this paper, we discuss innovative electricity pricing rate design as a solution to a problem brought about by an "Old Utility Model," namely the problem of ratepayers shifting, or dumping, cost onto other electricity ratepayers. The solution involves time-of-use pricing, smartly implemented new technologies, and an updated "Utility of the Future "model that turns ratepayers from consumers to prosumers alongside a rate design that incentivized deep investments into DER (Distributed Energy Resources), energy efficiency and storage, such as whole-home batteries, while taking advantage of the practice of net metering.

Keywords: Renewable Energy • Energy Efficiency • Energy Storage • Electricity Pricing Rate Design • Cost of Electricity • Cost of Service • Distributed Energy Resources • Net Metering • Solar • Wind • Whole Home Batteries

Introduction

One common concern in electricity pricing is whether or not customers are shifting, or dumping, cost-of-electricity or cost-of-service costs onto other ratepayers. There is a solution, which is articulated in the rate design we will discuss further. The fundamental problem with Old Utility Model is the lack of price signals.

CLEP

Customer Lowered Electricity Price is a mechanism that provides customers direct access to the wholesale electricity market, thereby incentivizing choices that benefit that consumer, other rate-payers, the utility itself, and the environment with a free-market solution without any government subsidies [1].

CLEP is a subsidy-free, free-market solution, while is also a solution that address environmental issues such as climate change it's a political winner.

CLEP's implementation has a few requirements, such as "smart meters", and of course a regulatory structure permitting it. Beyond this, it's then up to the energy consumer to make good choices.

Based on the 5-minute wholesale market, which for New Orleans is provided by MISO, a regulated utility that provides wholesale energy to New Orleans, CLEP has two fundamentally different electricity pricing formula components. The first, known as CLEP5, applies continuously at 5 minute intervals, while the second, CLEPm, applies only during specific, identified high energy demand periods and rewards customers for lowering their energy use during critical time periods. Both provide profit to the utility for the pass-through services they provide and an additional fee that lowers the electricity price for others.

The CLEP mechanism incentivizes energy consumers to apply sensible, money-saving strategies that benefit all by a market-based pricing that, as compared with non-CLEP pricing, "pays" consumers to use energy at less-expensive times and/or to install equipment to lower their bill. Among these choices that CLEP encourages are changing time of use, energy efficient devices, solar PV (especially Community Solar), and a critical option for New Orleans batteries. Electrical batteries especially when combined with solar can benefit everyone involved by increasing grid stability. Similarly, ice based air conditioning can serve as a form of battery, shifting demand to better times of the day. Together these provide resilience during power outages, reduce and/or provide energy at vital times to reduce the need for stand-by power ("spinning reserve"), and can even provide customers a profit, converting them into "prosumers" [2].

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Starting Assumptions

To measure the energy-cost shift, keep in mind:

1. An electricity bill is calculated by multiplying "kWh purchased" by the sum of (cost-of-service + cost-of-energy).

2. Because electricity storage is still rare, customer purchases always affect cost-of-service and cost of energy.

3. In fact, upon Customer demand, utilities must either increase production or increase wholesale purchases.

4. The monthly, average wholesale price is what is called the cost-of energy.

A ratepayer's electricity bill = kWh*(cost-of-service + cost of energy)

New Orleans' current utility model is such that utilities must purchase kWh on demand, meaning when there is

Energy Cost Burden

So how does CLEP measure Energy-Cost burden?

The way a customer shifts costs onto others, all depends on the time when the electricity is purchased. If that wholesale kWh purchase is overpriced, the average wholesale price of electricity increases. The key concept is that buying too high or selling too low will always increase the cost-of-energy and cause all bills to go up. Measuring demand-cost burden, or how High kW-demand at peak hours raises cost-of-service for all customers, is also a part of CLEP and will be explained in more detail during later presentations [3].

Cost-of service = Average wholesale price

If a wholesale purchase is overpriced, then cost-of-energy increases

CLEP's Formula

CLEPs simple formula is CLEPm + ∑CLEP5.

CLEPs is the Energy cost-shift, which was explained in the introduction section above, and pays every 5-minutes.Much like the Net Energy Metering (NEM) tariff used by rooftop solar owners, CLEP is an optional electricity rate that will either pay a CLEP customer or charge them if used incorrectly. It doesn't change which rate governs your utility bill it's an additional cash flow.

CLEPm is the monthly cash flow that provides a utility bill credit for delivering power, or a charge for demanding power, but it is only charged or paid during the utility's peak demand hours.

The target magnitude of CLEPm is to generate a cash flow equal to the same average demand-charge as that levied on commercial customers, using $s/KW-year as the unit.

$s/KW-year means twelve times the monthly charge per KW. For example, if the average demand charge is $10/KW-month, this is equivalent to $120/KW-year.

By predicating demand rewards on actions only done during the utility's peak demand hours, these cashflows pay customers to avoid the utility's most expensive equipment upgrades, which are those for providing power during peak demand times.

CLEP5 = p * n * (e-w) [/5min]

- p = Utility regulator; "percent," $0<p<2$
- n = number of kWh purchased; if outbound, n is negative.
- w = instantaneous wholesale cost of power
- e = monthly average cost of energy

CLEPm = q * 50 * d

- d = average demand during peak hour avoided (i.e. d = observed reference building demand minus observed demand)
- q = utility regulator determined "percent"; $0 < q < 2$

Reference Demand = d_R = the demand a customer should have, so ignoring the utility regulator's "percent" for the moment, CLEPm = 50 * (d_R – d).

Thus, CLEPm is more accurately described as

CLEPm = q * 50 * (d_R – d)

Peak Utility Demand Times (PUDT)

PUDT means "Peak Utility Peak Demand Times" or the hours where the utility's annual peak demand times will occur. This is reset annually by the utility regulator so that they are "reasonably" "continuous" within a year, and the Regulator is 99% certain that they will contain the peak hours next year. The time slice is

- Chosen to include all hours that are within 80% of last year's annual peak.
- Chosen to include at least 500 hours a year.

Initially, in 2019, New Orleans was chosen at: 2PM - 7PM, weekdays, May through September; however, PUDT will be different for different utilities and will even change for New Orleans from year to year because of changing climate and decreases in the peak demand over time.

CLEPm Example Calculation

Let's walk through an example of calculating CLEPm. CLEPm's charges and rewards lower bills if d is low enough; and raise energy bills, if d is too high.

If we assume that the reference demand for a particular residence is 5 KW, and that home experiences 4 KW of demand when d is measured, that meter reading will lower that customer's bill by 5 x $50 * (5 – 4) = $250/y.If the same customer were a business, we can image the demand charge would rise by $1000/y.

The "q" is the utility's "percent" of the operation, which we will assume is around 5%, so to pay administrative costs and share savings with non-participants by setting q = 95% and reset CLEPm = q * CLEPm.

Calculations might look different depending on industry. Concerning community solar practices,

CLEP = CLEPm + ∑CLEP5 where

CLEPm = q * 50 * (0 – d)

However, because Community Solar always produces a negative demand, d is always negative, therefore,

CLEPm = q * 50 * (0 – d) > 0

CLEP5 Example Calculation

Remember that CLEP5 measures energy-cost shifts. Also recall that the standard electricity Bill = kWh*(cost-of-service + cost of energy). Furthermore,

- Utilities must purchase kWh on demand
- cost-of service = average wholesale price
- If a wholesale purchase is overpriced, then cost-of-energy increases

This is how CLEP measures the energy-cost burden a customer shifts onto others depending as it does, on the time of electricity purchases. If that purchase (in kWh) is overpriced, AVG wholesale electricity price increases. The key concept here is that buying energy too high or selling it too low will always increase the cost-of-energy and cause ratepayer bills to go up.

Measuring the demand-cost burden, i.e., how high demand (in kW) at peak hour can raise cost-of-service for all customers is also a part of CLEP.

Without incentives or time-dependent metering, customers will "dump energy consumption onto the electricity grid" at any time.

More energy efficient homes will dump onto others less, but improved energy efficiency alone will not guarantee against either pushing energy or demand costs onto others.

The fastest and cheapest way to lower cost-of-energy for your utility is by fully exploiting the wholesale market: by day trading: by pushing all/most purchases to times of lowest wholesale prices.

CLEP5 = p * n * (e-w) [/5min]

There are roughly 12* 24 * 30 = ~8600 five-minute periods/month. If you're a CLEP customer, increasing ∑ CLEP5 pays you real money.

The Old Utility Model

Creating electricity under 20th century technology required very high capital costs with a central power plant, which led to monopoly utility: Either government utility or private utility regulated by the govt. to provide low priced, reliable electricity. Significantly, the Central Power Plant model assumes that individual buildings cannot provide or store electricity.

Rates under the old utility model do not reflect the actual cost of electricity produced at the time that the electricity is used by the consumer.

The current utility model uses a "one size fits all" standard electric bill.

Standard Electric Bill:

= # kWh * [Cost-of-Energy + Cost-of-Service]

Consumers get a Cost of Energy surcharge on their bill for energy purchased by the utility during the month, but this is an after-the-fact charge; the consumer does not know or feel the monetary effect of purchases made at the specific time during the previous month. An issue this raises is that there is no price signal on whether or not their electricity consumption choices are economical or efficient. Furthermore, because the consumer does not know, or feel the monetary effect of purchases made at the time the electricity is used, during the previous month, there is no incentive to reduce consumption during peak periods or change consumption to low periods, particularly nighttime.

This lack of price signals causes ratepayers to inadvertently dump energy cost onto one another. Even at peak periods, Mr. Customer is still charged at the average 10ℂ/kwh rate. This ignores that the actual costs borne by the utility is many multiples of that price. In effect, his consumption is being subsidized by other customers.

At the same peak time, his neighbor, Ms. Customer, is also being charged at the average rate, 10ℂ/kwh, when the actual cost is many multiples of those prices. Her consumption is also being subsidized by other customers.

Because residential customers have no demand charges, they dump large virtual demand charges onto each other. But demand charges are poor price signals.

Commercial rates include demand charges, but too little avail. The business' peak demand may not coincide with the utility peak demand. (Example: churches peak demand is generally on Sunday mornings). No price signal given at the time energy is purchased. Little incentive to reduce rates at peak periods.

Changes in the energy industry are leading to a new paradigm, which we call the Utility of the Future.

The Utility of the Future

Recent developments that will allow customers to lower the price of utility.

- Distributed Energy Resources (DER)
- Batteries and Thermal Storage
- Smart Meters
- Wholesale Marketplaces
- Aggregation Services
- Prosumers

All Distributed Energy Resources (DER) encounter problems or are under compensated under the Old Utility Model -"one size fits all."

A heat pump water heater is 3 times as efficient as a standard electric. Energy Efficiency is a major resource, but implementation is always within a zero-sum, self-limiting situation because the payback is limited by previous investments and cannot exceed the initial energy bill.

Photo Voltaic solar comes in both Rooftop Solar and Community solar. Both have precarious cash flows, because they tend to use Net Energy Metering which never pays back in $. Under attack in many jurisdictions -- NEM's perceived subsidy, i.e., cost-shifting.

Wind power is often sold at minus one cent / kWh in Iowa, because it often produces when there is little demand. An example of the MISO Real-time Demand Contour Map is shown below (Figure 1).

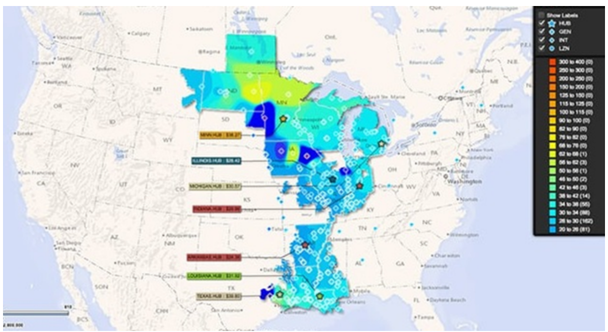


Figure 1. Demand Contour Map.

The Solution

Roughly half of US customers have smart meters. Smart meters are coming to NOLA in 2020 or 2021. This development allows for NOLA ratepayers to use bidirectional electricity flow Allow for selling to the grid as well as purchasing from the utility and (unlike mechanical meters which turn backward) they record the time of purchase and/or selling.

Prosumers are people who produce as well as consume a product here, the product is energy. Individual household or business. Under CLEP, which provides price signals at the time that electricity is either consumed, or produced, customers will be incentivized to produce, as well as consume, electricity.

Customers will find new ways (think software, hardware and aggregation service providers for now) to provide that value at increasingly lower costs to themselves and thereby make a profit for themselves and the companies who innovate or provide these technologies, while at the same time, lower the wholesale electricity price for everyone else.

Were it possible to pay customers for providing this service almost precisely at the same value of the cost shift avoided and do this in a steady enough fashion to provide reliable and predictable annual cash flows, this should create a mass market sufficient to support businesses to jump in and finance the deepest investments in DER all of which can be expected to happen at the normal speed of innovation, namely: quite rapidly and at no cost to ratepayers.

Implementing a Data-Driven Model

From its inception, CLEP was articulated as a set of mathematical formulas. Data-driven modeling is the approach used in the CLEP Dashboard.

Features of this Dashboard have included

1. An entire year's dataset of MISO pricing,

2. Data that would allow more accurate estimates of New Orleans cooling loads, and much more, including,

3. Data that would interest regulators.

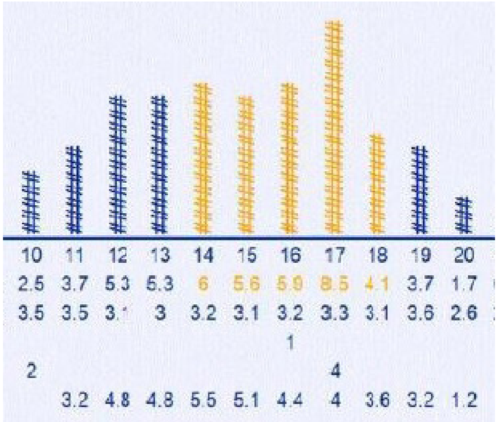
Other unavoidable deviations from a real-world implementation include the fact that CLEP calls for weighted-averages to ascertain the "cost-of-energy" which requires information that is unavailable to us. To be truly accurate, the CLEP Dashboard would require a substantial amount of information that only ENO has today. The good news is that this weighting error is most likely underestimating real CLEP5 values: because the correctly weighted average wholesale price will cause peak demand times, which have both more consumption and higher prices, to disproportionally raise the cost-of-energy. Higher cost-of-energy will more encourage CLEP consumers to make more purchases outside of peak times get more CLEP5 income therefore everyone wins: consumers and the utility.

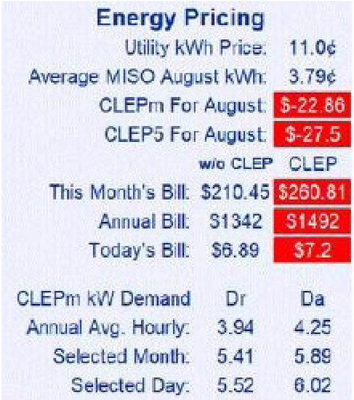
We would like to point out for anyone following along our screenshots with a calculator: The values displayed are always rounded, so while the CLEP Dashboard is calculating correctly and is only rounding the displayed value, using the displayed values as input to a calculator will have small apparent errors.

Below, we show several "screenshots" that show CLEP's calculated estimated ratepayer savings, given decisions a ratepayer would make about energy efficiency upgrades. (See Appendix A).

The Home, as Configured displays

- CLEP Annual Loss, e.g., $150, can change to
- CLEP Annual Savings, e.g., $95, and can change to
- CLEP Annual Profit, e.g., $543, as the model progresses from its starting condition

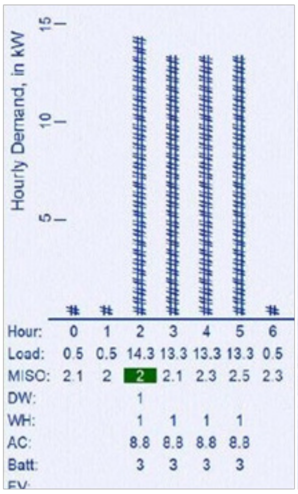


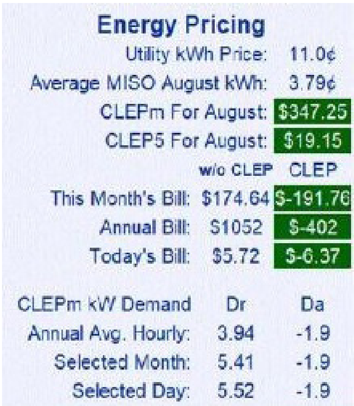


Energy Pricing		
Utility kWh Price:	11.0¢	
Average MISO August kWh:	3.79¢	
CLEPm For August:	$-22.86	
CLEP5 For August:	$-27.5	
	w/o CLEP	CLEP
This Month's Bill:	$210.45	$260.81
Annual Bill:	$1342	$1492
Today's Bill:	$6.89	$7.2
CLEPm kW Demand	Dr	Da
Annual Avg. Hourly:	3.94	4.25
Selected Month:	5.41	5.89
Selected Day:	5.52	6.02

However, after installing a whole-home battery and participating in CLEP… (See Appendix B).

A





Energy Pricing		
Utility kWh Price:	11.0¢	
Average MISO August kWh:	3.79¢	
CLEPm For August:	$347.25	
CLEP5 For August:	$19.15	
	w/o CLEP	CLEP
This Month's Bill:	$174.64	$-191.76
Annual Bill:	$1052	$-402
Today's Bill:	$5.72	$-6.37
CLEPm kW Demand	Dr	Da
Annual Avg. Hourly:	3.94	-1.9
Selected Month:	5.41	-1.9
Selected Day:	5.52	-1.9

Whole Home Battery (WHB) can provide all the electricity necessary to run the home for 20 hours after 4 hours of charging.

Without CLEP, payback is far from possible because a Whole Home Battery does not even reduce kWh consumption (and, in fact, loses 3% to 10% of the energy that passes through the inverter/converter cycle). However, CLEP can provide over $600/year income by i) preventing load during peak periods CLEPm saving, ii) buying energy from the grid when the current energy price is low with CLEP5, or iii) by selling energy to the grid when the current energy price is high: this activity pays back in a reward from CLEPm as well as from CLEP5.

The Contractor's Perspective

A typical interaction between the contractor and the developer or designer results in the following question: "You want What?" This question is often the contractor resisting the desire or interest expressed by the client.

Desire

The contractor wants to build what he or she understands and to make a profit. Also, if he or she is a negotiating contractor, he wants a repeat client. What he or she does not desire is to mess up installing something they do not understand or know how to service.

Education

Most contractors employ estimators and project managers who come out of schools or up thru the tradesman ranks. Due to shortages in labor, many are hiring workers with non-technical backgrounds to fill positions. This reality does not help you when you explain what you are trying to construct.

Green Community

Most contractors see idealists who promise unrealistic performance and underestimate the cost impact to the project to implement the technology.

Challenges

Convincing the contractor and the client of the enhanced value these technologies will bring to the project thru consumer (buyer) perceived differentiation and that the benefits can be objectively measured thru a cost benefit financial analysis.

Engagement

If the contractor is not bought in, he or she may advise the client at every opportunity to chop out the costly "Green" components that do not add SF or rental/sales revenue.

Once bought in thru being educated and understanding the value of CLEP, they may better understand the concepts of energy efficiency, load shifting, and resiliency and how they relate to our utility model

Conclusion

The fundamental problem with Old Utility Model is the lack of price signals. Lack of price signals means that there is no incentive to purchase wind power at night and store it for sale to the grid at peak times.

The Old Utility Model has no adequate means of financing Rooftop Solar or Community Solar.

The Old Utility Model has no means of adequately financing batteries provide important public service during grid outages

We think that CLEP solves the core problem with the Old Utility Model by providing price signals to customers who will enable them to monetize and thereby minimize shifting energy and demand costs onto others. And this arbitrage of the variation in energy costs will provide predictable annual cash flows sufficient to support the deepest investments in DER.

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