

**ELECTRICITY PREPAYMENT,  
CONSERVATION AND  
BEHAVIORAL CHANGE**

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INNOVATIONS IN INFORMATION AND COMMUNICATIONS TECHNOLOGY TO CHANGE BEHAVIOR

## About DEFG

We are a management consulting firm, specializing in energy, and focused on retail energy consumers

Our clients participate in our collaborative research groups. We help utilities improve customer service, refine customer strategy and create customer-facing smart-grid programs

- Demand & Energy Technology Research Consortium
- Utility Customer Research Consortium
- Low Income Energy Issues Forum
- Prepay Energy Working Group
- ABACCUS



# Prepayment is not new; prepayment is not odd

We prepay for gasoline



We prepay for groceries





## “This I Believe”

- Opportunity and choice are bedrocks of American society and can be wielded effectively to increase welfare
- One tariff for all residential customers has been the definition of “fairness” in utility regulation, but it is not fair to require everyone to purchase the same level of service
- Product and service differentiation (choice) is good for consumers, can increase fairness, and is good for economic efficiency; regulators must facilitate consumer choice
- State regulation of electric utility monopolies is a program—this program can be executed very well or very poorly; it can constantly improve or it can stagnate
- Prepayment is a option (choice) that some utilities have offered for decades: prepaid electric service + advanced metering infrastructure = interesting behavioral changes!
- Using pricing and transactions to engage consumers, and change their behavior, may be more effective than additional programs
- A choice mindset is useful to examine the rich potential for energy efficiency and economic efficiency; programs have just scratched the surface

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## Prepayment Basics

*How does it work? What are the impacts?*

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## Quick Introduction to Prepayment: Two Public Utilities

### SRP: Arizona public power utility

- 984,000 electric customers; 150,000 on prepay (>15%)
- M-Power Program is provided as a voluntary alternative to standard residential price plans
- 20 years of experience; uses an in-home device; currently making a transition to advanced metering infrastructure (AMI)
- Lower startup cost: \$87.50 deposit, paid over time (compared to normal \$275 deposit)
- Average customer purchase is \$24 every 5 days (6 times per month)
- Verified impact: 12% average annual savings
- Customers have better control over budget and cash flow; they pay for electricity as they use it and avoid surprises

Source: Renée Castillo, Sr. Director, Customer Experience Services, SRP

### JEA: Jacksonville, FL municipal utility

- 420,000 electric customers; 7,300 on prepay (1.7%)
- Rates are the same as traditional service
- No seasonal disconnection moratorium—limitations based on high/low temperatures
- No disconnection on weekends; reconnections occur 24x7; no electric reconnection fee
- Customers have the ability to defer a portion of their outstanding balance
- Crisis LIHEAP funding eligibility
- Average payment \$33; payment frequency 2.5 times per month (every 12 days)
- SMS alert is the preferred messaging tool for the account balance

Source: Sheila Pressley, Director, Customer Revenue Services, JEA

***PREPAY ENERGY IS A VOLUNTARY BILL PAY OPTION FOR CONSUMERS  
TO PAY AHEAD FOR ENERGY CONSUMPTION IN THE FUTURE***



## Typical Communications for Prepay Service

Alert Type	Description
Daily Balance	Notifies the prepay customer of his/her current account balance as of the latest meter reading (the latest daily transaction)
Daily Usage	Informs the prepay customer of his/her daily consumption in kWh as of the latest daily meter reading
Low Balance	Notifies the prepay customer when his/her account balance reaches a predetermined amount established by the customer
High Usage	Notifies the prepay customers when consumption is unusually high, based on a defined threshold
Recharge Confirms	Notifies the prepay customer to confirm a successful posting of a payment to his/her account
Pending Disconnect	Notifies the prepay customer when his/her account is subject to disconnection
Disconnect	Notifies the prepay customer when service has been disconnected
Reconnect	Notifies the prepay customer when service has been reconnected



## Typical Features of Prepay Service

Feature	Description
Eligibility	No one on medical devices can participate
Account Initiation	No security deposit; customer opens a prepay account with a specified minimum using cash, check, money order, electronic fund transfer, debit card, credit card, rechargeable prepaid card
Account Balance	Account balance is decreased daily as kWh are consumed Customer determines when, where and how much to add
Communications	Customer determines the communication channel (text, email, phone) Customer selects the frequency of communications (daily, weekly) Low balance alerts indicate when the account balance is low
Prior Debt	Customers with prior debt can pay it down over time (applying a percentage of each payment)
Devices	Some utilities use in-home devices to display the account balance and usage Prepay meters are being replaced by advanced metering infrastructure Some utilities use payment kiosks; others recognize many payment locations
Prices and Fees	Generally the same price as other customers, applied daily Some utilities charge a monthly fee Certain methods of payment require a third-party fee
Disconnection	Automatic zero balance disconnection; no disconnecting during severe weather; no disconnection when payment options are not available
Reconnection	A positive account balance restores service

# Prepayment in a Competitive Environment: Texas

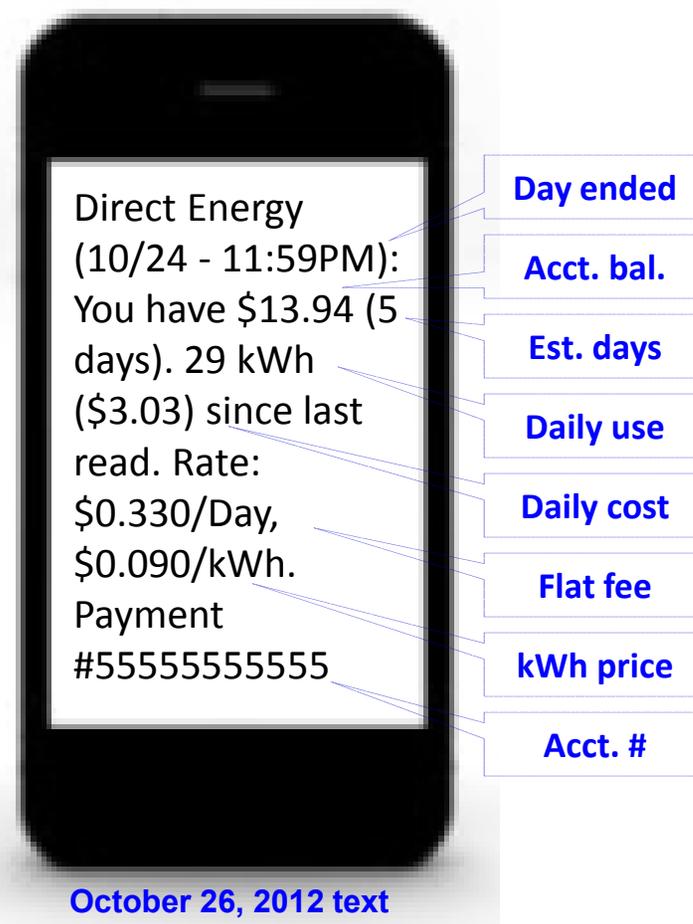
**Competitive “retail electric providers” (REP) offer service to 62% of Texans; 50+ REPs; 300+ distinct products**

- Everyone must select a REP and a price plan
- There is no price regulation. Choices: month-to-month pricing; fixed-pricing contracts for 3 to 36 months; free Saturdays, nights, mornings/evenings; 100% green power; 5% back for DR; twice-a-year HVAC checkup; free Nest with two-year contract; flat monthly bills with no true-up; cash rewards; promotional pricing with discounts at various usage levels; EV pricing; solar buyback; etc.

**Prepaid electric service: 15 different residential products**

- Prepay appeals to students, recent immigrants, unbanked customers, low- to moderate-income customers
- Month-to-month pricing is typical; REPs focus on customer retention; raising the price may result in switching (loss of account)
- Customer monitors account balance in dollars; many customers think in terms of buying “days of service” (not kWh)
- ERCOT has AMI: signup, service initiation, disconnection and reconnection all occur within minutes or hours
- Disconnections are more frequent and shorter in duration (compared to post-pay)
- Customer receives frequent, timely, data-rich communications

## Daily Text for Prepaid Service Content Rich & Timely

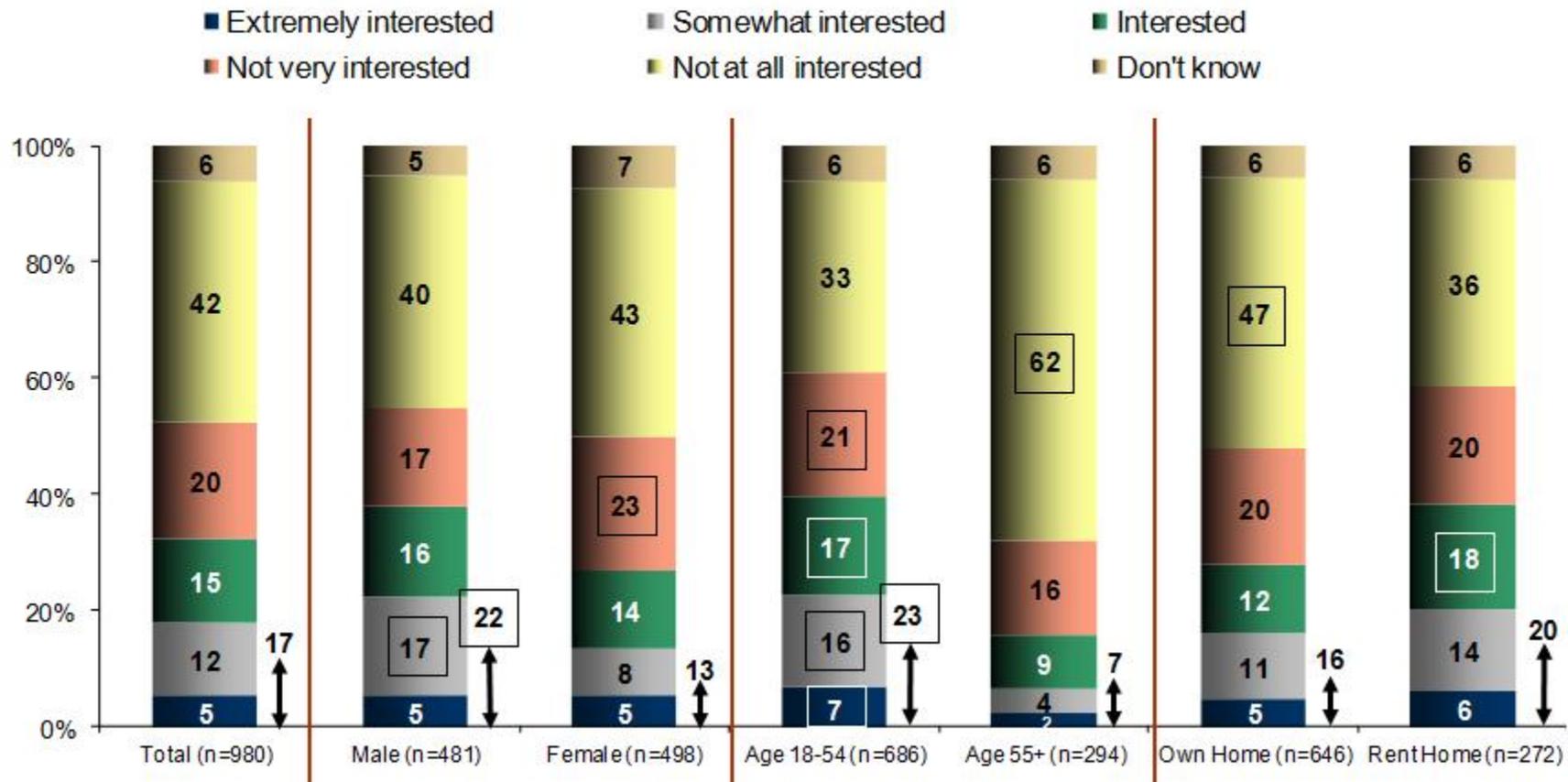


Source: Direct Energy text for residential prepaid electric service in Houston.

# Interest in Voluntary Prepay Energy Service Concept

Interest in prepay energy was highest among men (22% v. 13% of women) and younger adults (23% among those 18 to 54 v. 7% of those 55+)

## Consumer Interest in Voluntary Prepaid Program for Electricity



Base: Total Respondents (n=980)

Q.3: Your local electric utility or service provider may offer voluntary prepaid electric service to consumers in the future. Under this option, you would choose to pay upfront anytime you wanted before you used the energy rather than paying your bill at the end of the month after you used the service. Reasons for possibly using prepaid electricity would include no security deposit required or better managing your budget and energy use. You would always be able to check the balance remaining in your prepaid account. If your local utility or provider were to offer a voluntary prepaid option for consumers, how interested would you be?



## Conservation Impact Estimation: Econometric Analysis

- DEFG engaged Michael Ozog, PhD, of Integral Analytics, Inc. in 2011 to prepare a methodology to account for the conservation behavior or efficiency measures that might arise through prepayment. A fixed-effects panel was chosen. Monthly billing data from electric cooperatives were analyzed.

*The fixed effects model can be viewed as a type of differencing model in which all characteristics of the home, which (1) are independent of time and (2) determine the level of energy consumption, are captured within the customer-specific constant terms. In other words, differences in customer characteristics that cause variation in the level of energy consumption, such as building size and structure, are captured by constant terms representing each unique household.*

Algebraically, the fixed-effect panel data model is described as follows:

$$\ln(kWh_{it}) = \lambda_t + \alpha_i + \beta(\lambda_t \cdot Temp_t) + \delta PP_{it} + \gamma PP_{it} Disc_{it} + \psi Disc_{it} + \varepsilon_{it}$$

where:

$kWh_{it}$	= energy consumption for home $i$ during month $t$
$\lambda_t$	= binary (1/0) variable denoting each month in the analysis
$\alpha_i$	= constant term for home $i$
$Temp_t$	= temperature during month $t$
$PP_{it}$	= a binary variable denoting if home $i$ was under prepay during month $t$
$Disc_{it}$	= the number of disconnects for home $i$ during month $t$
$\beta$	= vector of estimated coefficients denoting the effect of temperature on energy consumption during each month
$\delta$	= the estimated change in energy usage associated with prepay
$\Psi$	= the estimated change in energy usage associated with disconnection
$\gamma$	= the estimated change in energy usage associated with disconnection under prepay
$\varepsilon_{it}$	= error term for home $i$ during month $t$ .

Ozog, M. (2011, November). *A Method for Estimating the Conservation Effects of Energy Prepayment*. Series of Regulatory Choices 7. Washington, DC: Distributed Energy Financial Group LLC. <http://defgllc.com/publication/method-for-estimating-the-conservation-effects-of-energy-prepayment/>

Ozog, M. (2013, March). *The Effect of Prepayment on Energy Use*. Prepay Energy Working Group. Washington, DC: Distributed Energy Financial Group LLC. <http://defgllc.com/publication/the-effect-of-prepayment-on-energy-use/>

## Conservation Impact Studies

- 12% reduction in usage based on an evaluation of the Oklahoma Electric Cooperative program in 2008 (Buck, Utility Automation, May 2008)
- 11% reduction in usage when customers receive training on the system, and a 4% reduction when for customers without training (EEI, January 2008)
- 12.8% reduction in energy usage due to prepay at the Salt River Project (SRP) M-program (EPRI Technical Update 1020260, October 2010)
- 11% reduction in usage based on an evaluation of the Oklahoma Electric Cooperative prepay program (DEFG and Ozog, 2011)
- 10.6% average reduction in energy use across two electric cooperative in the Pacific Northwest (NEEA and DEFG, January 2014)
- Savings of 10-15% confirmed; most of the savings appear to be weather related (Zarnikau, 2013)
- Further research\*
  - Changes to the econometric model will be required, depending on whether the analyst is using monthly whole-house data, advanced meter data with smaller time intervals (e.g., 15 minute), or data that is disaggregated by end-uses (space heating and cooling, cooking, etc.)
  - More prepay impact studies are needed to better understand impacts in different regions
  - A comparative analysis of multiple prepay programs could provide a better understanding of consumer motivations in joining the program and the behavior changes after joining
  - More analysis of the persistence of conservation is needed
  - More analysis of disconnection behavior is needed

\* Zarnikau, J. et al. (2014, January). *How Do Prepay Electricity Programs Impact Consumer Behavior?* Prepay Energy Working Group. Washington, DC: Distributed Energy Financial Group LLC. Summary: <http://defgllc.com/publication/how-do-prepay-electricity-programs-impact-consumer-behavior/>

## Consumer Survey in the Northwest: Actions Taken to Use Less Electricity

We asked about specific actions that consumers may have taken since switching to prepay.\* These included behavioral actions, efficiency investments and voluntary disconnection to reduce usage

- Q-5. Now I am going to read a list of actions that some people take after they switch to prepay service. Please indicate whether you have taken this action since switching to prepay service with a simple “yes” or “no.”

Rank	Action Type	Action	“Yes”
1	Behavior	Made sure the lights are off in unused rooms	97%
2	Behavior	Intentionally made an effort to use less electricity	92%
3	Behavior	Adjusted the thermostat a few degrees to use less electricity <i>when the residence was empty</i>	84%
4	Behavior	Adjusted the thermostat a few degrees to use less electricity when you or others <i>are in the residence</i>	80%
5	Investment	Replaced light bulbs with energy-efficient light bulbs	74%
6	Investment	Applied weather stripping to windows and doors or added insulation to the attic or around the water heater	52%
7	Behavior	Changed the time of day or how often you use your appliances	48%
8	Investment	Made a major investment in the home heating system, in new insulated windows or in new energy-efficient appliances	43%
9	Behavior	Lowered the temperature setting on the water heater to use less electricity	40%
10	Investment	Upgraded or replaced the thermostat	37%
11	Other	Allowed my electricity to be shut off as a way to use less electricity	36%

\* Source: DEFG. (2014). *Prepay Customer Survey*. Report prepared for the Northwest Energy Efficiency Alliance. Final release: forthcoming.

## Prepay Conservation and Climate Change: AZ & TX

- If an estimated 150,000 Arizona prepay customers and 250,000 Texas prepay customers each saving 10% annually, the conservation savings—based on the average residential usage in those states—would equal 541 million kilowatt-hours per year (541 GWH)
  - Average monthly residential usage in 2013 (DOE EIA): Arizona—1,049 kWh; Texas—1,174 kWh
  - This is more than one quarter Vermont's residential electricity use in 2013 (2,125 GWH)
- 541 million kilowatt-hours per year at \$0.10 per kWh is an annual savings in avoided residential electric bill payments of \$54 million
- 541 million kilowatt-hours per year is an annual conservation impact of approximately 130,000 metrics tons of CO<sub>2</sub> avoided annually



## Prepay Conservation and Climate Change: U.S. Scenarios

Utility offerings that combine customer preferences, robust communications and transactions (e.g., bill pay and energy management) could be the fastest, cheapest and most satisfactory means to achieve positive environmental outcomes

Engaging consumers through transactions is powerful; modifying transactions may be a more effective way to change human behavior than creating energy efficiency programs

### Potential of Prepay Energy to Reduce Electric Power GHG

Adoption scenarios	High	Medium	Low
Adoption rates	18%	10%	3%
Average electricity savings	12%	10%	8%
Million metric tons CO <sub>2</sub> avoided annually	16.35	7.57	1.51
Percent of CO <sub>2</sub> from residential electricity usage	2.2%	1.0%	0.2%

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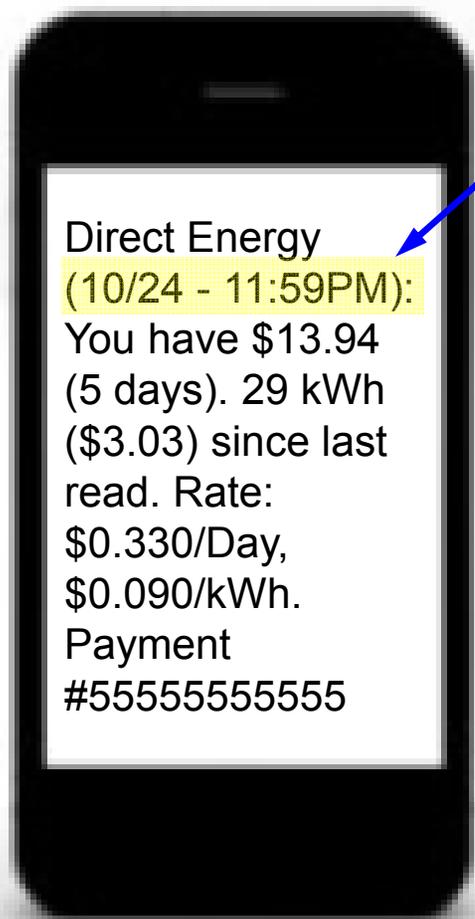
## Prepayment Behaviors

*What are the drivers of behavior change?*

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# Drivers of Behavior: Communication

## Daily Text for Prepaid Service



October 26, 2012 text

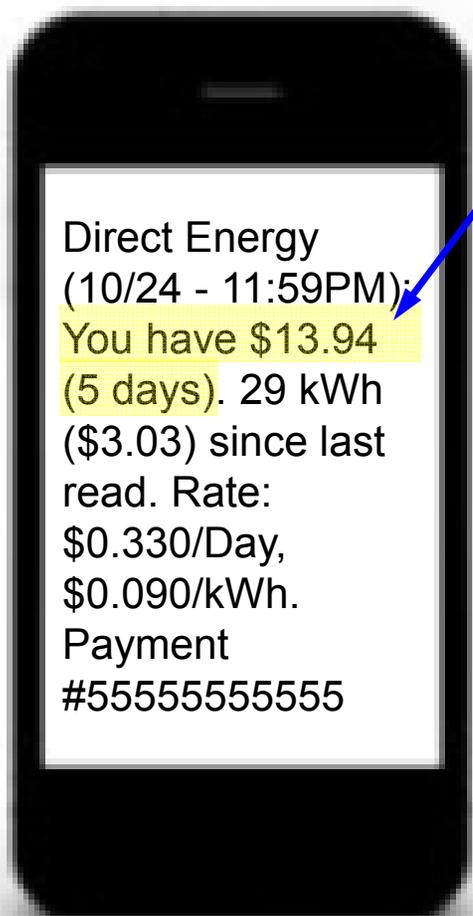
What is this?	What does it provide?	How is that different?
Period covered	Identifies the day	Standard bills cover and entire month
The brief text message clearly identifies the day that is reported		

*INFORMATION ABOUT YESTERDAY'S USAGE IS TIMELY AND RELEVANT*

Source: Direct Energy text for residential prepaid electric service in Houston.

# Drivers of Behavior: Communication

## Daily Text for Prepaid Service



October 26, 2012 text

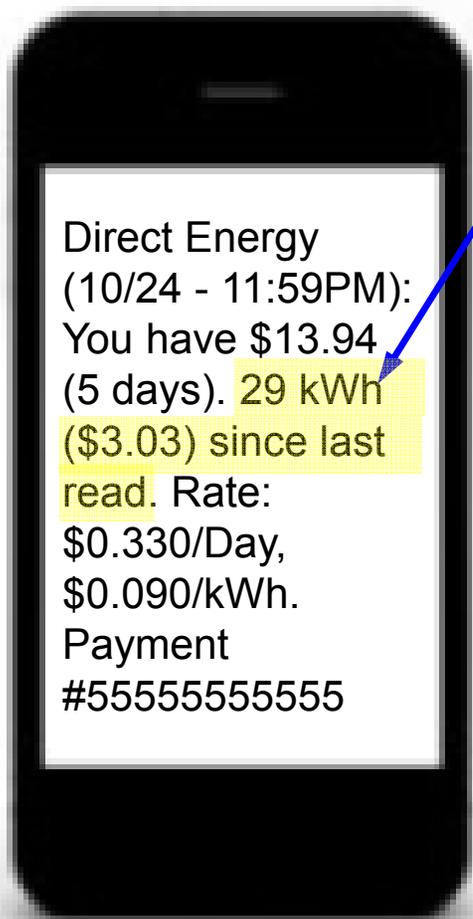
What is this?	What does it provide?	How is that different?
Account balance and estimated days remaining	Identifies the amount of money left in the account; estimates how long service will last with this balance	Standard bills do not give any projections about future costs
The prepay customer can immediately assess where they stand regarding their account balance and estimated days of service remaining		

*INFORMATION ABOUT YESTERDAY'S COST IS MORE PRACTICAL THAN LAST MONTH'S COST*

Source: Direct Energy text for residential prepaid electric service in Houston.

# Drivers of Behavior: Communication

## Daily Text for Prepaid Service



October 26, 2012 text

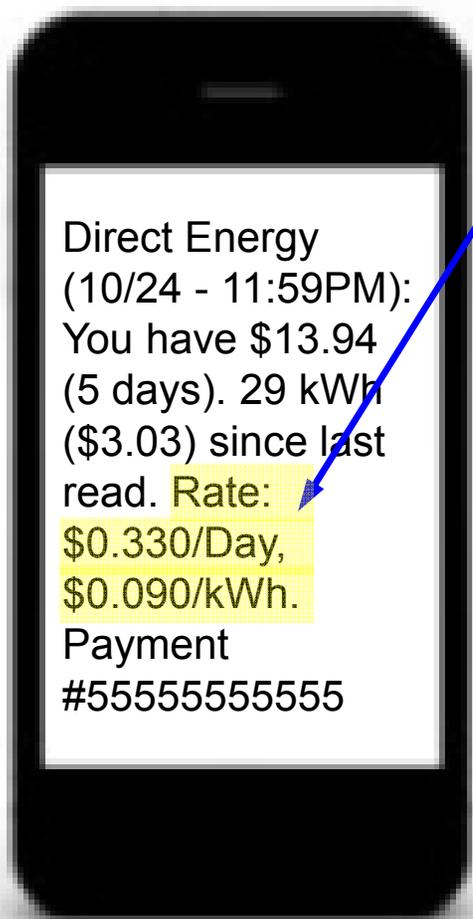
What is this?	What does it provide?	How is that different?
Actual usage for the day; actual amount (daily bill) deducted for that day	Identifies the actual usage for yesterday (or the day before) and the actual cost of service for one day	Standard bills give usage and cost for a month, and the information is greatly delayed
The customer can learn the cost of one day of service; the customer receives cost information close to the time of use; the customer can review prior day messages to check account balance for arithmetic errors		

*EXPOSING THE CUSTOMER TO HIS DAILY COST CREATES AN OPPORTUNITY FOR CONSCIOUS CHANGES IN BEHAVIOR*

Source: Direct Energy text for residential prepaid electric service in Houston.

# Drivers of Behavior: Communication

## Daily Text for Prepaid Service



October 26, 2012 text

What is this?	What does it provide?	How is that different?
Actual rate paid allows daily bill calculation	Simple pricing approach (flat charge plus usage rate) give confidence	Standard bills are highly disaggregated in an effort to be truthful about the cost centers
The prepay customer can calculate the daily bill and request additional information as necessary (about franchise fees, for example)		

*SIMPLE PRICING INFORMATION BUILDS TRUST; COMPLEX LINE-ITEMS ON A BILL (“ADJUSTMENT FACTORS”) REDUCE BILL TRANSPARENCY AND TRUST*

Source: Direct Energy text for residential prepaid electric service in Houston.

## Drivers of Behavior: Choice, Commitment & Empowerment

The ability to choose—even between two items—is empowering

The ability to choose increases customer commitment to the chosen option

The creation of an account balance—your money held by another party for a particular purpose—increases commitment and encourages individual responsibility

Consumers can discover on their own the particular household behaviors that drive usage



## Drivers of Behavior: Transactions & Understandability

Transactions in dollars and cents (deductions from the account balance) are more readily understood than kWh used in a month

Dollars are literally our currency and they convey value; kilowatt-hours are a fiction to normal humans

People are comfortable paying for days of electric service (even if they are not doing that)

An account balance is something that I own and can manage

Traditional monthly utility bills have become unwieldy and complex—the good intentions of “transparency” simply reveal the ugly complexities of regulation



## Drivers of Behavior: Mobility, Lifestyle, Customization

Mobile communications are becoming more prevalent; mobile transactions may be preferred by many utility customers

Each household is unique: prepayment will fit certain lifestyles and not others

Advanced metering now allows utilities to better target conservation tips to individual customers (this is top down customization of messages based on sound engineering)

More significantly, households can discover on their own how best to manage usage in a way that suits their unique situation (this is individual authority, autonomy and control)



## Responsibility for “Keeping the Lights On”

“You turned my electricity off”

“My electricity ran out”

Traditional Tariff and Billing	Prepay Electric Service
<p><b>Utility-designed and government-approved residential rate design; the utility reads the meter, calculates the bill and determines the due date</b></p>	<p><b>Customer-selected alternative with choices about communications and payment frequency; customer is empowered, informed and in control</b></p>
<p><i>The utility disconnects the customer for failure to pay past-due amounts</i></p>	<p><i>The customer disconnects himself when account balance reaches zero</i></p>

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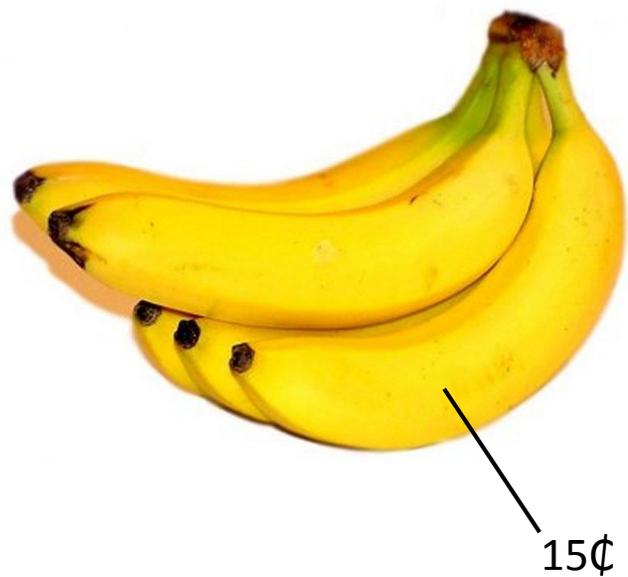
## Prepayment is not odd

*The century-old system of electric utility regulation, rate design and billing is odd!*

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# The Common Thread?

Shopping Basket Item



Electric Service Item



## “Innovation” in the Purchase and Payment for Groceries\*



- Assume the family food basket has 100 items.
- Imagine a low-income household with a monthly food budget of \$300. They shop weekly at a local store.
- They select items and place them in the basket. No prices are marked on any items.
- They check out, and the clerk tells them: “an accurate bill will be mailed to you at the end of the month.”
- After four weeks—and a great deal of concern—the family receives a \$400 grocery bill. Nothing is itemized. The bill states the “number of items purchased” and the total amount due.
- They are given several weeks to pay; they cut money from somewhere else in the household budget.
- They repeat this for another four weeks, reducing the number of items in the basket.
- The next bill is \$350. If they cannot pay after a few months, they are not allowed to shop for groceries.

\* This is sarcasm.

## Summary

- **Prepayment is popular:** 15% of residential utility consumers may prefer it to current billing practices
- **Prepayment is a game changer:** it shifts some control from utilities to consumers; rather than utility disconnections, prepay customers accept responsibility for disconnecting themselves by allowing their account balance to fall to zero; it transforms consumers from receptors of utility conservation tips to investigators of energy uses in the household
- **Consumers can become energy literate:** prepayment customers receive detailed and timely information; they increase their control over their usage and the household budget; they become conscious of household behaviors
- **Prepayment appears to change consumer behavior:** there is 10% conservation savings; utilities like prepayment because it improves utility cash flow and revenue recovery even if revenues are lower
- **Human perception:** prepayment customers may think in terms of purchasing days of electric service which is consistent with their comprehensive view of the value of electric service
- **Technical transformation:** improved pricing is a small step toward fully integrating devices (the Internet of things) with the electric system (real-time costs and demand for ancillary services)
- **Prepayment is one choice** in a potentially rich set of retail electric service choices; jurisdictions that do not allow any residential customers choices (e.g., one residential tariff without variation) reduce welfare and economic efficiency; “one size fits all” is not fair
- **Modifying utility transactions with consumers** may be a more effective way to change human behavior than creating utility energy efficiency programs

# Contact

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Prepay Energy Working Group



Low Income Energy Issues Forum



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